INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

University of Alberta

The Sedimentology and Geochemistry of the Second White Specks Formation, North/Central Alberta, Canada

by

Kelli H.A. Fraser

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Science

Department of Earth and Atmospheric Sciences

Edmonton, Alberta

Fall, 2005

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Library and Archives Canada
Published Heritage Branch
395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque et Archives Canada
Direction du Patrimoine de l'édition
395, rue Wellington
Ottawa ON K1A 0N4
Canada

0-494-09166-5

Your file *Votre référence*
ISBN:
Our file *Notre reference*
ISBN:

NOTICE:
The author has granted a non-exclusive license allowing Library and Archives Canada to reproduce, publish, archive, preserve, conserve, communicate to the public by telecommunication or on the Internet, loan, distribute and sell theses worldwide, for commercial or non-commercial purposes, in microform, paper, electronic and/or any other formats.

The author retains copyright ownership and moral rights in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

AVIS:
L'auteur a accordé une licence non exclusive permettant à la Bibliothèque et Archives Canada de reproduire, publier, archiver, sauvegarder, conserver, transmettre au public par télécommunication ou par l'Internet, prêter, distribuer et vendre des thèses partout dans le monde, à des fins commerciales ou autres, sur support microforme, papier, électronique et/ou autres formats.

L'auteur conserve la propriété du droit d'auteur et des droits moraux qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

In compliance with the Canadian Privacy Act some supporting forms may have been removed from this thesis.

While these forms may be included in the document page count, their removal does not represent any loss of content from the thesis.

Conformément à la loi canadienne sur la protection de la vie privée, quelques formulaires secondaires ont été enlevés de cette thèse.

Bien que ces formulaires aient inclus dans la pagination, il n'y aura aucun contenu manquant.

Canada

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Dedication

This thesis is dedicated to all those that I love most dearly. Especially to my family who has always been there to support me in every aspect. To my mother, Shannon Fraser, my father, Douglas Fraser, and my brother, Andrew Fraser. There will never be such excellent and admirable people. And to Wayne Peters, my beloved friend who passed away before his time, I will always miss you.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Abstract

Deposition of the calcareous and organic carbon-rich Cenomanian-Turonian Second White Specks Formation occurred during maximum transgression of the Western Interior Seaway with corresponding high organic productivity in the upper water column and anoxic bottom waters. The Formation has been well studied in southern Alberta, however, less is known about the unit's properties in central and northern Alberta. To characterize the Formation in central and northern Alberta, paleontology, palynology, sedimentology and geochemistry have been used with geophysical logs to produce a basin-wide framework.

The shale is unique due to its potential as both a source and reservoir rock for hydrocarbons. Geochemically, some maximum values for the unit include: 1331 ppb Ag, 140 ppm Cu, 169 ppm Mo, 290 ppm Ni, 469 ppm Zn, 22.1 % S and 10.8 % organic carbon. Some locations are enriched enough in organic carbon and metals to be geochemically classified as a metalliferous black shale.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Acknowledgements

I would like to thank my supervisor, Dr. Octavian Catuneanu, for supporting me through this process, and for all of his help. I am indebted to Dr. Reg Olson, Dr. Randy Rice and Dr. Glen Prior, whose help and support throughout the whole of my masters program was essential. Thank-you to Dr. Sarah Gleeson. Your advice and recommendations have always been appreciated. Thank-you to the Alberta Geological Survey for providing financial support for this thesis in addition to NSERC support from a research grant to Dr. Catuneanu. I would also like to thank the staff at the Alberta Geological Survey for their valued help and support. A special thank you to Natasha Blundon for all of her help with Arcview.

I appreciate and would like to thank the University of Alberta for supporting me, both as a teaching assistant and throughout my masters. I am grateful to the support staff at the University of Alberta and the Earth and Atmospheric Sciences Department, especially the Digital Imaging Facility and the Thin Section Lab. I am indebted to all of my colleagues for their time and help throughout my two years at the University of Alberta. I would also like to extend thanks to the staff at the Gallagher Library at the University of Alberta.

I am grateful to the staff at the Calgary Core Research Center for their patience and innumerable sample bags. Thank-you as well to those at the Edmonton Minerals and Core Research Facility. I appreciate the great work of Claudia Schroder-Adams on the micropaleontology and Graham Dolby for his work on the palynology.

Finally, I would like to thank my friends and family for sticking with me through the good times and the bad. Without your support, I could never have achieved my goals. Thank-you to my father, Douglas Fraser, for taking time out of his busy schedule to assist me with thesis editing and proofreading.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table of Contents

Description:	Page:
List of Tables	
List of Figures	
List of Plates	
1.1 INTRODUCTION	1
1.1 Introduction	1
1.2 Study Area	2
1.3 The Colorado Group	6
1.4 The Second White Specks Formation	11
1.5 Regional Tectonics and Depositional History	14
1.6 Previous Work	15
1.7 Objectives	19
1.8 References	20
2.0 METHODOLOGY	27
2.1 Methods	27
2.1.1 Accumap and Cross Sections	28
2.1.2 Logging Core	29
2.1.3 Palynology	29
2.1.4 Micropaleontology	30
2.1.5 Geochemistry	30
2.1.51 Sample Collection Procedures	30
2.1.52 Sample Preparations	31
2.1.53 Analytical Procedures	31
2.2 References	36
3.0 THE STRATIGRAPHY AND SEDIMENTOLOGY OF THE SECOND WHITE SPECKS FORMATION, NORTH/CENTRAL ALBERTA	37

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.1 Introduction 37
3.2 Micropaleontology 39
3.2.1 Background 39
3.2.2 Micropaleontology Results 40
3.3 Palynology 42
3.3.1 Background 42
3.3.2 Palynology Results 42
3.4 Logged Core 44
3.4.1 General Description of the Sedimentology of the Second White Specks Formation 44
3.4.2 Limitations of the Core 45
3.4.3 Contacts with the Overlying and Underlying Formations 46
3.4.4 Descriptions and Interpretations of the Logged Core 48
3.5 Contourites and General Discussion of the Core 70
3.6 Cross Sections 78
3.6.1 Log Characteristics 78
3.6.2 Cross Section A-A' 79
3.6.3 Cross Section B-B' 83
3.6.4 Cross Section C-C' 86
3.6.5 Cross Section D-D' 89
3.6.6 Cross Section E-E' 93
3.6.7 Cross Section F-F' 97
3.6.8 Cross Section and Thickness Discussion 100
3.7 Sequence Stratigraphy 102
3.8 Discussion 104
3.9 References 106

4.0 THE GEOCHEMISTRY OF THE ORGANIC RICH SECOND WHITE SPECKS FORMATION, NORTH/CENTRAL ALBERTA 110
4.1 Introduction 110

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

4.1.1 Ore Body Background: Sedex vs. MVT vs. Ni-Mo 111
4.1.11 Sedex 111
4.1.12 Mississippi Valley-type deposits 114
4.1.13 Shale-hosted Ni-Zn-Mo-PGE 115
4.1.2 Metals from Sea Water 116
4.1.3 Other Shales 116
4.2 Analytical Procedures and Data 117
4.2.1 Lower Detection Limits 117
4.2.2 Precision 120
4.2.3 Duplicate Pairs 122
4.3 Elemental Values with Depth 124
4.3.1 Discussion 139
4.4 Aerial Distribution Metals 141
4.4.1 Discussion 153
4.5 Total Organic Carbon Content 154
4.6 Black Shale Metal Enrichment 156
4.7 Discussion 164
4.7.1 Ore Bodies vs. Sea Water 165
4.8 References 170

5.0 GENERAL DISCUSSION AND CONCLUSIONS 176

6.0 APPENDICES 179

6.1 Logging Forms and Extra Logged Core Descriptions 180
6.2 Micropaleontology Results 291
6.3 Palynology Results 305
6.4 Geochemistry Results 309
6.5 Precision and Accuracy Calculations 463
6.6 Elements vs. Depth for All Core 536

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

List of Tables

Description:		Page:
Table 1.1:	Unique well identifiers for each geophysical log used within this study. The numbers refer to locations in figure 1.2. The table also indicates if the well contains a cored section.	**4**
Table 3.1:	Table with the unique well identifiers for cross section A-A'.	**79**
Table 3.2:	Table with the unique well identifiers for cross section B-B'.	**83**
Table 3.3:	Table with the unique well identifiers for cross section C-C'.	**86**
Table 3.4:	Table with the unique well identifiers for cross section D-D'.	**89**
Table 3.5:	Table with the unique well identifiers for cross section E-E'.	**93**
Table 3.6:	Table with the unique well identifiers for cross section F-F'.	**97**
Table 4.1:	Group 1F1 Elements, and summary of number of sample results below LDL.	**117**
Table 4.2:	Group 1EX Elements, and summary of number of sample results below LDL.	**118**
Table 4.3:	Group 4B - REE Elements, and summary of number of sample results below LDL.	**119**
Table 4.4:	Group 4A Elements, and summary of number of sample results below LDL.	**120**
Table 4.5:	Relative standard deviation results for GROUP 1F1 elements.	**121**
Table 4.6:	Relative standard deviation results for GROUP 1F1 elements part 2.	**121**
Table 4.7:	Relative standard deviation results for GROUP 1EX elements.	**121**
Table 4.8:	Relative standard deviation results for GROUP 4B – REE.	**122**
Table 4.9:	Relative standard deviation results for GROUP 4A.	**122**
Table 4.10:	Relative standard deviation results for CO2.	**122**
Table 4.11:	Relative percentage difference for GROUP 1F1 elements.	**123**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table 4.12: Relative percentage difference for GROUP 1F1 elements. **123**

Table 4.13: Relative percentage difference for GROUP 1EX elements. **123**

Table 4.14: Relative percentage difference for GROUP 4B – REE. **124**

Table 4.15: Relative percentage difference for GROUP 4A. **124**

Table 4.16: The table lists some of the maximum values received for the Second White Specks Formation. **157**

Table 4.17: Shale concentrations for multiple elements. **158**

Table 4.18: Summary table showing the differences and similarities between three sediment hosted deposit types and sea water. **165**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

List of Figures

Description:		Page:
Figure 1.1:	Locations of core and geophysical logs for this study. The study area is outlined.	**3**
Figure 1.2:	A close-up of the study area from figure 1.1, with numbers assigned to each well (please refer to table 1.1 for the unique well identifiers associated with each number).	**4**
Figure 1.3:	Stratigraphic chart for the Colorado Group for Western Canada (modified from Bloch et al., 1999).	**8**
Figure 1.4:	Map of western Canada with outlined study areas for some of the published works on the Second White Specks Formation (modified from Bloch et al., 1999).	**12**
Figure 1.5:	Schematic representation of the Western Canada Sedimentary basin during maximum transgression (from Leckie and Smith, 1992).	**14**
Figure 1.6:	Graphical representation of the median for various elements in the study by Dufresne et al., (2001).	**16**
Figure 1.7:	The Western Interior Seaway during the deposition of the Second White Specks Formation. The sea is shown for Canada, the United States and northern Mexico. Note that during this time, the warm southern Tethyan waters have intermixed with the northern cool Boreal waters (from Travis, 2002).	**18**
Figure 2.1:	Chart illustrating the picks that are reported to the Alberta Energy and Utilities Board (AEUB) for the Colorado Group. This demonstrates the difficulty in identifying the Second White Specks Formation from other shales within the Colorado Group using only the picks from Accumap (adapted from Stancliffe et al., 2003).	**28**
Figure 3.1:	Study area showing the location of the two cores that contain both the upper and lower contacts of the Second White Specks Formation.	**47**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Figure 3.2:	Cretaceous (91 Ma) deep water circulation patterns within the Western Interior Seaway (from Glancy, 1993).	**75**
Figure 3.3:	Map of Alberta illustrating the 6 cross sections constructed in this study.	**78**
Figure 3.4:	Cross section A-A' with the base of Fish Scales as the datum.	**81**
Figure 3.5:	Cross section A-A' with the base of the Second White Specks Formation as the datum.	**82**
Figure 3.6:	Cross section B-B' with the base of Fish Scales as the datum.	**84**
Figure 3.7:	Cross section B-B' with the base of the Second White Specks Formation as the datum.	**85**
Figure 3.8:	Cross section C-C' with the base of Fish Scales as the datum.	**87**
Figure 3.9:	Cross section C-C' with the base of the Second White Specks Formation as the datum.	**88**
Figure 3.10:	Cross section D-D' with the base of Fish Scales as the datum.	**91**
Figure 3.11:	Cross section D-D' with the base of the Second White Specks Formation as the datum.	**92**
Figure 3.12:	Cross section E-E' with the base of Fish Scales as the datum.	**95**
Figure 3.13:	Cross section E-E' with the base of the Second White Specks Formation as the datum.	**96**
Figure 3.14:	Cross section F-F' with the base of Fish Scales as the datum.	**98**
Figure 3.15:	Cross section F-F' with the base of the Second White Specks Formation as the datum.	**99**
Figure 3.16:	Isopach map of the thickness of the Second White Specks Formation across the study area.	**102**
Figure 3.17:	Paleoenvironmental maps for the Belle Fourche and the Second White Specks Formation (from Bloch et al., 1999).	**106**
Figure 4.1:	Values for various metals and elements with depth for the core 7BK03.	**126**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Figure 4.2: Values for various metals and elements with depth for the core 7BK03. **128**

Figure 4.3: Values for various metals and elements with depth for the core 10-22-047-03W4. **130**

Figure 4.4: Values for various metals and elements with depth for the core 06-31-046-08W5. **132**

Figure 4.5: Molybdenum (ppm) aerial distribution for the Second White Specks Formation. **142**

Figure 4.6: Nickel (ppm) aerial distribution for the Second White Specks Formation. **143**

Figure 4.7: Silver (ppb) aerial distribution for the Second White Specks Formation. **144**

Figure 4.8: Zinc (ppm) aerial distribution for the Second White Specks Formation. **145**

Figure 4.9: Barium (ppm) aerial distribution for the Second White Specks Formation. **146**

Figure 4.10: Cobalt (ppm) aerial distribution for the Second White Specks Formation. **147**

Figure 4.11: Copper (ppm) aerial distribution for the Second White Specks Formation. **148**

Figure 4.12: Iron (%) aerial distribution for the Second White Specks Formation. **149**

Figure 4.13: Lead (ppm) aerial distribution for the Second White Specks Formation. **150**

Figure 4.14: Sulphur (%) aerial distribution for the Second White Specks Formation. **151**

Figure 4.15: Uranium (ppm) aerial distribution for the Second White Specks Formation. **152**

Figure 4.16: Vanadium (ppm) aerial distribution for the Second White Specks Formation. **152**

Figure 4.17: The Second White Specks petroleum system, showing immature, **155**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

mature and overmature areas of the shale (from Creaney et al., 1994).

Figure 4.18: Second White Specks Formation contour maps for A) hydrogen index (mgHC/gOC); B) total organic carbon (wt%); and C) Tmax (from Bloch et al., 1999) **156**

Figure 4.19: A plot of average Second White Specks Formation values/USGS black shale values from table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the Second White Specks Formation. **160**

Figure 4.20: A plot of average shale in core from hole 7BK03 Second White Specks Formation values/USGS black shale values from table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the 7BK03 Second White Specks Formation core. **161**

Figure 4.21: A plot of average Second White Specks Formation values/Mason average shale values from table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the Second White Specks Formation compared to Mason's values. **163**

Figure 4.22: A plot of average 7BK03 Second White Specks Formation values/Mason average shale values from table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the 7BK03 Second White Specks Formation core compared to Mason's values. **164**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

List of Plates

Description:		Page:
Plate 3.1:	Images of sedimentary structures from the Second White Specks Formation.	**67**
Plate 3.2:	Images of shells and shell imprints from the Second White Specks Formation.	**68**
Plate 3.3:	Images of fish debris, white specks, ripples and soft sediment deformation from the Second White Specks Formation.	**69**
Plate 3.4:	Images of pyrite nodules and pyrite laminations from the Second White Specks Formation.	**70**
Plate 3.5:	Images of sedimentary structures and contourites from the Second White Specks Formation.	**76**
Plate 3.6:	Continued images of sedimentary structures and contourites from the Second White Specks Formation.	**77**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

1.0 INTRODUCTION:

1.1 Introduction

Shales are extremely important within the sedimentary record because they represent fairly continuous sediment packages (Potter et al., 1980) and they embody a large portion of the sedimentary record during the Cretaceous within Alberta. With the supply of hydrocarbons from conventional reservoirs in Alberta being reduced, more and more exploration and production companies are seeking out unconventional reservoirs. Today, by employing new technologies, it is becoming more economic to explore for shale gas. The Cretaceous Second White Specks Formation is a shale that is found within the Alberta Colorado Group and extends across the Western Canadian Sedimentary Basin (Bloch et al., 1999). The shale is of interest because it has potential as both a source and reservoir rock (Leckie et al., 1994). Previous studies have also shown that the black organic rich shale contains anomalous metal concentrations (Dufresne et al., 2001). Thus, the Second White Specks Formation has the potential to be economic for both the oil and gas and minerals industry. Much research, however, still needs to be conducted in order to assess the economic value of the shale.

It has been suggested that the Second White Speckled Shale, which was studied in a geochemical context in the Birch Mountains of northeastern Alberta, could be a distal member of a sedimentary-exhalative or nickel-molybdenum deposit due to the higher concentrations of metals in comparison with surrounding formations (Dufresne et al., 2001, Reg Olson personal communication, 2002). Elemental concentrations such as 3.1 % Ba, 510 ppm Ni, 1010 ppm Zn, 352 ppm Mo, 470 ppm As, 51 ppm Sb, 3.6 ppm Ag, 17.3 % S, 1322 ppm V, 180 ppm Co, 138 ppb Au, 22 ppb Pt and 14 ppb Pd were obtained from surface and subsurface samples in the combined study by Dufresne et al. (2001) and Tintina Mines Limited (Sabag, 1996). It is therefore necessary from a geochemical point of view to evaluate whether or not the Second White Specks Formation is a metalliferous shale, and whether or not there are any changes seen in the geochemical signature across the basin within Alberta.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The knowledge base of the Second White Specks Formation is much more extensive in southern Alberta and Saskatchewan; therefore, an investigation of the lithological variations of this shale across the basin is required in conjunction with the geochemical investigation. The study of the Second White Speckled Shale in central and northern Alberta will allow for the combination of previous studies in southern Alberta to be extended into central and northern Alberta.

1.1 Study Area

Although the Second White Specks Formation is basin-wide in extent with equivalent units in Saskatchewan and Manitoba (Leckie et al., 1994), this study focuses on the formation within Alberta. The study area is bound by townships 44 to 101 and ranges 01 W4 to R13 W6 (see Figure 1.1) and a close-up of the locations and the associated unique well identifiers for each well are attached in Figure 1.2 and Table 1.1. The original core for this study came from the Birch Mountains (northeastern Alberta indicated by the blue circles in Figure 1.1). The well information was then extended into central Alberta for a basin wide study, thus allowing the comparison of geochemical signatures herein with those from the report of Dufresne et al., (2001). In addition, a total of six cross sections were constructed and are discussed in the following chapter.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

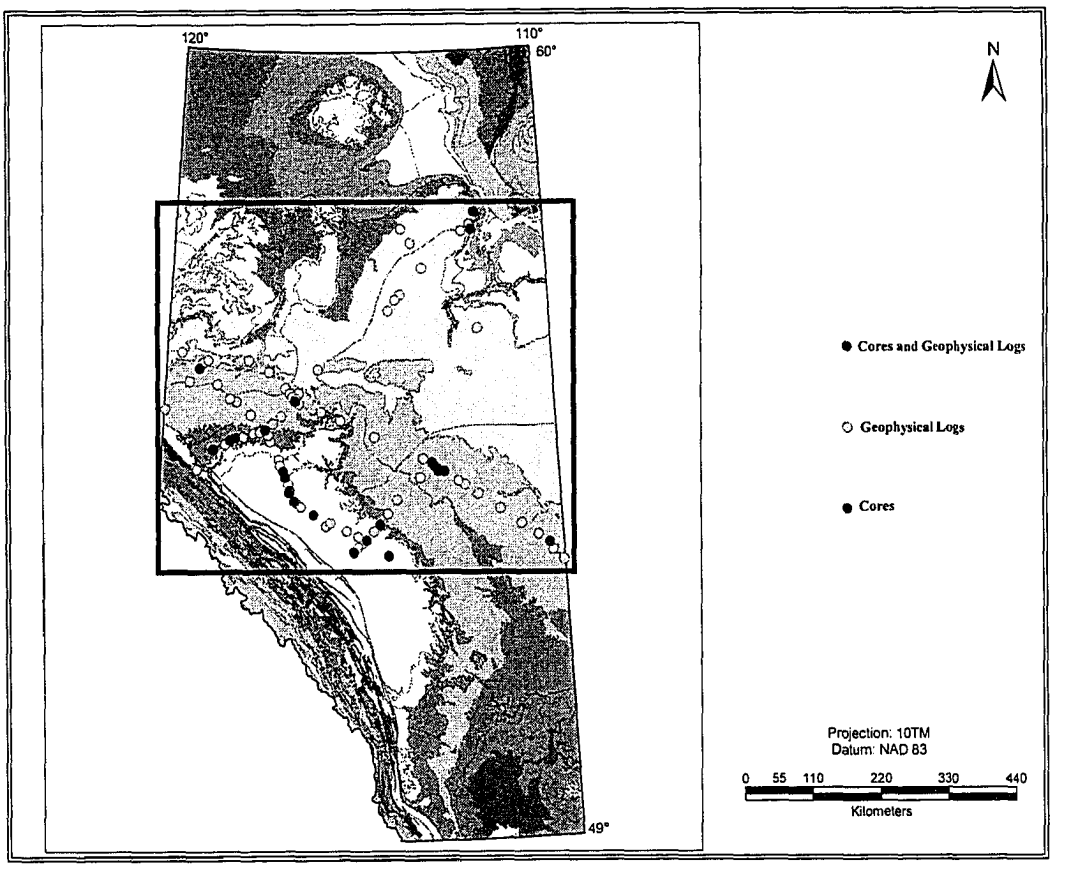


Figure 1.1: Locations of core and geophysical logs for this study. Note: Yellow circles represent geophysical logs, red circles represent geophysical logs with logged core, blue circles represent logged core with no geophysical logs. The study area is outlined.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

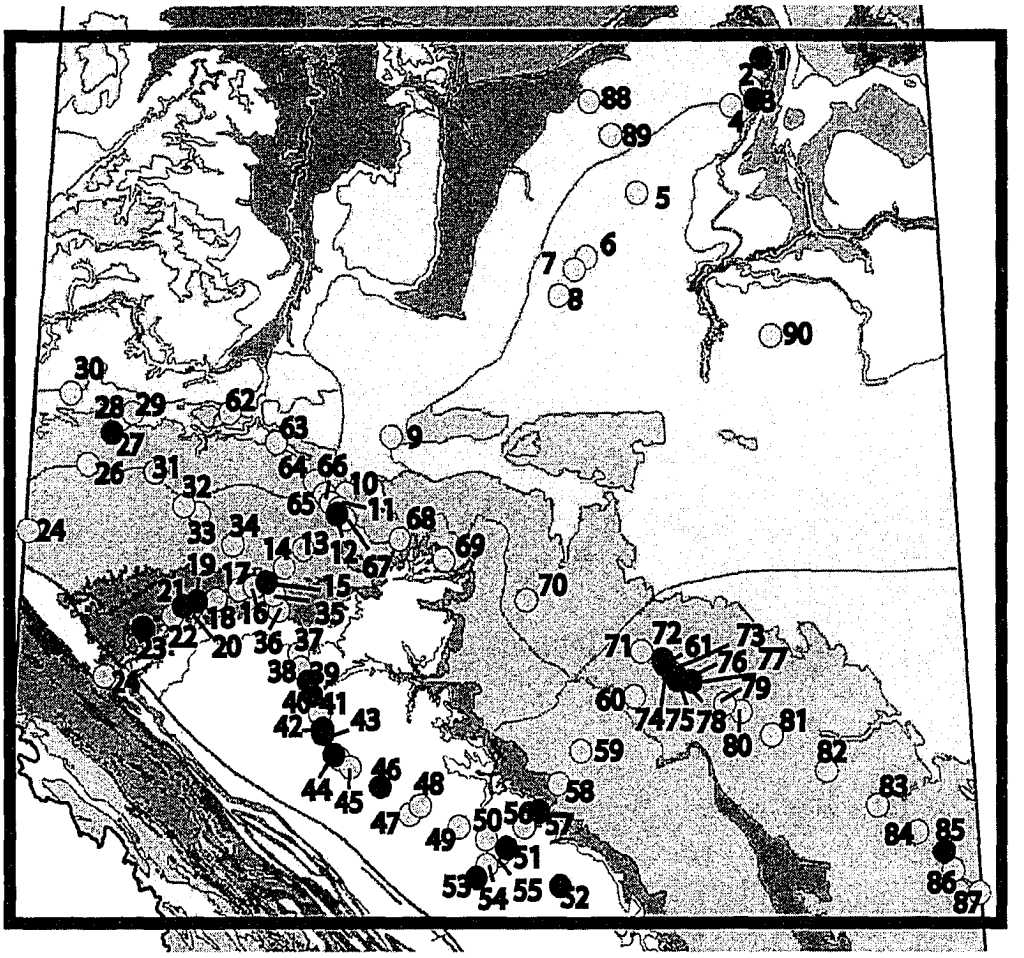


Figure 1.2 and Table 1.1: A close-up of the study area from Figure 1.1, with numbers assigned to each well (please refer to Table 1.1 for the unique well identifiers associated with each number).

Table 1.1: Unique well identifiers for each geophysical log used within this study. The numbers refer to locations in Figure 1.2. The table also indicates if the well contains a cored section.

Location (unique well identifier):	Associated # from Figure 1.2:	Logged Core (Y/N):
00/02-03-101-12W4/0	1	Yes
00/10-02-099-13W4/0	2	No
00/06-12-098-13W4/0	3	Yes
W0/12-32-097-14W4/0	4	No
00/11-08-092-21W4/0	5	No
00/02-04-088-25W4/0	6	No
00/06-10-087-01W5/0	7	No
00/07-21-085-02W5/0	8	No
00/12-03-076-14W5/0	9	No

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

00/10-08-072-17W5/0	10	No
00/12-12-071-18W5/0	11	No
00/04-02-071-18W5/0	12	Yes
00/10-20-068-20W5/0	13	No
00/14-12-067-22W5/0	14	No
00/10-09-066-23W5/0	15	Yes
00/16-34-065-24W5/0	16	No
00/04-27-065-25W5/0	17	No
00/02-01-065-27W5/0	18	No
02/06-30-064-01W6/0	19	Yes
00/07-23-064-02W6/0	20	No
02/16-18-064-02W6/0	21	Yes
00/11-28-063-03W6/0	22	No
00/14-28-062-05W6/0	23	Yes
00/16-14-059-08W6/0	24	No
00/11-30-068-13W6/0	25	No
00/06-19-073-09W6/0	26	No
00/16-22-075-08W6/0	27	Yes
00/06-20-076-07W6/0	28	No
00/11-06-077-06W6/0	29	No
00/08-03-078-11W6/2	30	No
00/07-11-073-05W6/0	31	No
00/14-01-071-03W6/0	32	No
00/12-19-070-01W6/0	33	No
00/14-20-068-25W5/0	34	No
00/11-18-065-22W5/0	35	No
00/10-16-064-22W5/0	36	No
00/04-23-061-21W5/0	37	No
00/08-25-060-21W5/0	38	No
00/10-28-059-20W5/0	39	Yes
02/16-27-058-20W5/0	40	Yes
02/16-19-057-19W5/0	41	No
00/09-09-056-19W5/0	42	Yes
00/02-28-054-18W5/0	43	No
00/10-31-054-18W5/0	44	Yes
00/10-05-054-17W5/0	45	No
02/07-33-052-15W5/0	46	Yes
00/06-03-051-13W5/0	47	No
00/15-20-051-12W5/0	48	No
00/10-12-050-10W5/0	49	No
02/16-14-049-08W5/0	50	No
00/14-29-048-06W5/0	51	Yes
00/16-12-046-03W5/0	52	Yes
00/06-31-046-08W5/0	53	Yes
02/06-25-047-08W5/0	54	No

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

02/06-14-048-07W5/0	55	No
00/08-09-050-05W5/0	56	No
00/05-10-051-04W5/0	57	Yes
00/09-01-053-03W5/0	58	No
00/07-10-055-01W5/0	59	No
00/14-27-058-24W4/0	60	No
00/10-36-060-22W4/0	61	Yes
00/04-18-077-25W5/2	62	No
00/06-21-075-22W5/0	63	No
00/06-06-073-19W5/0	64	No
00/06-12-072-19W5/0	65	No
00/10-20-071-18W5/0	66	No
00/16-19-070-17W5/0	67	No
00/03-18-069-13W5/0	68	No
00/16-31-067-10W5/0	69	No
00/05-13-065-05W5/0	70	No
00/01-32-061-23W4/0	71	No
00/06-11-061-22W4/0	72	Yes
00/10-36-060-22W4/0	73	Yes
00/06-10-060-21W4/0	74	No
00/03-16-060-21W4/0	75	No
00/06-35-059-21W4/0	76	Yes
00/07-36-059-21W4/2	77	No
00/06-26-059-20W4/0	78	Yes
00/11-01-058-18W4/0	79	No
00/09-24-057-17W4/2	80	No
00/16-31-055-14W4/0	81	No
00/11-14-053-11W4/0	82	No
00/10-31-050-07W4/0	83	No
00/16-35-048-05W4/0	84	No
00/10-22-047-03W4/0	85	Yes
00/01-18-046-02W4/0	86	No
B0/07-25-044-01W4/0	87	No
00/11-17-098-24W4/0	88	No
00/06-11-096-23W4/0	89	No
00/15-13-082-13W4/0	90	No

1.3 The Colorado Group

The Colorado Group consists of a mudstone dominated package of rocks of Albian to Santonian (25 to 30 million years) age. The Group also contains sandstones, conglomerates, shaley chalk, chalky limestones, and horizons of bentonite (Leckie et al.,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

1994). The Colorado Group is important, in part, because it accounts for 14% of Western Canada's hydrocarbon reserves (Podruski et al., 1988; Porter, 1992). During the time of deposition of the Colorado Group, sea level maximas occurred during the Late Albian, the Early Turonian and the Middle Santonian (Caldwell, 1984, Haq et al., 1987, Leckie et al., 1994). In between these sea level rises, four regressive periods occurred, marked by the deposition of the Peace River-Viking, the Dunvegan, the Cardium-Bad Heart and the Milk River Formations. A comparative stratigraphic chart for the Colorado Group is illustrated in Figure 1.3 (Leckie et al., 1994). A basin-wide unconformity can be found at the base of the Colorado Group. The Group overlies the non-marine Mannville Group in most of the subsurface of Alberta (Leckie et al., 1994). The Milk River, Lea Park and Puskwaskau Formations conformably to disconformably overlie the Colorado Group throughout southern to northwestern Alberta (Bloch et al., 1993).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

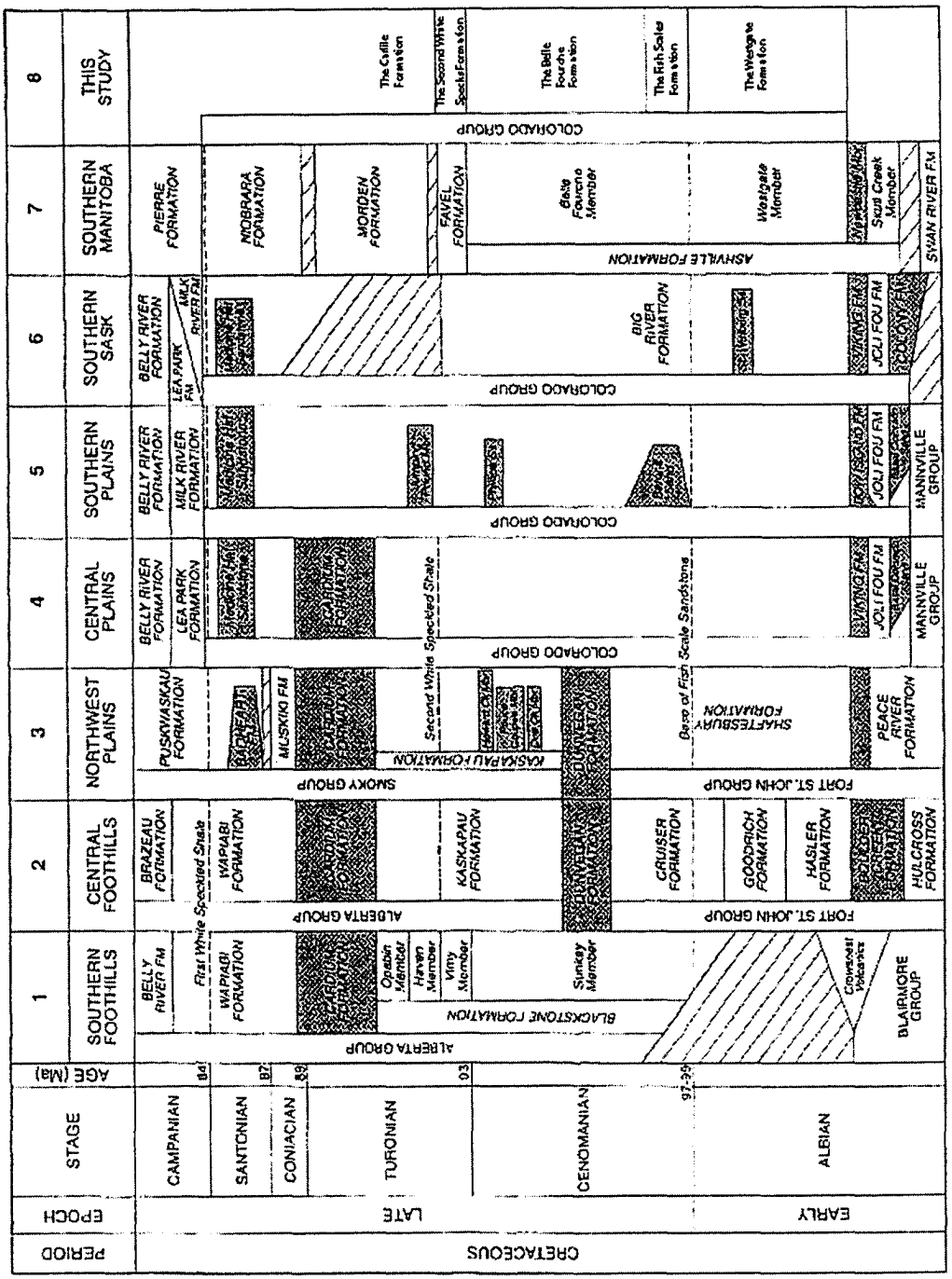


Figure 1.3: Stratigraphic chart for the Colorado Group for Western Canada. Stippling shows oil and/or gas production (modified from Bloch et al., 1999).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The oldest contact within the Colorado Group is represented by the basal basin-wide unconformity. The lowermost units are Albian in age. They consist of the Spinney Hill Sandstone in eastern and central Saskatchewan, the Basal Colorado Sandstone in southeastern Alberta and the marine shales of the Joli Fou Formation in other areas (Leckie et al., 1994). The younger Albian units (and equivalents) consist of the sandy Viking Formation, which is found in central and southern Alberta and Saskatchewan, the Bow Island Formation in southwestern Alberta, the Pelican Formation in northeastern Alberta and the Paddy Member of the Peace River Formation in northwestern Alberta (Leckie et al., 1994).

Many authors have not divided the Late Albian to Turonian shales. Instead, they have either left the section as a mass of Colorado Group shales, or with the name of La Biche (Leckie et al., 1994, Bloch et al., 1999). Bloch et al. (1999) have published reports which divided the Colorado Group from the Late Albian to the Middle Turonian by distinguishing four unique regionally mapable shale units that include (from oldest to youngest): the Westgate Formation, the Fish Scales Formation, the Belle Fourche Formation, and the Second White Specks Formation (see Figure 1.3). The Westgate and the Belle Fourche names came from the Ashville Formation in Manitoba. The Westgate is a shale unit that was deposited during the Late Albian. It was distinguished by a siltstone to mudstone character that was deposited close to the base of the Colorado Group (Leckie et al., 1994, Bloch et al., 1999). Disconformably overlying the Westgate is the muddy to clayey Fish Scales Zone. This condensed section was deposited during the Early Cenomanian. A basal conglomeratic layer was identified which likely represented a dramatic environmental change. The contact with the overlying Belle Fourche Formation is gradational. This Middle to Late Cenomanian unit was affected in the northwest by the progradation of the Dunvegan Formation. The final, and stratigraphically highest unit, which was described in Bloche et al., (1999), is the Second White Specks Formation that lies conformably to disconformably above the Belle Fourche Formation. The Second White Specks Formation ranges from a marlstone, to a limestone, to a shale. It was deposited in fully marine conditions (Bloch et al.,1999).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The Barons Sandstone should also be mentioned because it is Cenomanian in age and was reported by Leckie et al., (1994) to overlie the Fish Scales Zone in southern Alberta. The Big River Formation (Albian to Cenomanian) is designated in Saskatchewan as the section sandwiched between the Viking Formation and the base of the Second White Speckled Shale (Leckie et al., 1994). In northwestern Alberta, the Dunvegan Formation is a fluvio-deltaic wedge that is Middle/Upper Cenomanian in age. Above the Dunvegan is the Kaskapau Formation, which includes the Doe Creek, the Pouce Coupe and the Howard Creek members. The Kaskapau Formation also is found in northwestern Alberta. The Phillips Sandstone/Second White Speckled Sandstone seems to correspond in time, at least in southwestern Saskatchewan and southeastern Alberta, with the sandstones of the Kaskapau Formation. The Cardium Formation is a marine sand/silt/conglomerate unit, is Turonian/Coniacian in age, and is found in northwestern Alberta, the Rocky Mountain Foothills and the Interior Plains. It is disconformably overlain by Coniacian/Early Campanian marine shales and sandstones. Overlying the Cardium, in some areas, is the Muskiki Formation. It in turn is overlain by the Marshybank Formation. A regional unconformity caps the Marshybank and separates it from the overlying Bad Heart Formation which is found in the plains. The stratigraphically younger Wapiabi and Puskwasku Formations overlie the Bad Heart Formation. Finally, the First White Speckled Shale is Santonian/Campanian in age and exists the whole Western Canada Sedimentary Basin. In parts of Saskatchewan, the First White Specks unconformably overlies the Second White Specks (Leckie et al., 1994). These and more details on the Colorado Group can be found in the stratigraphic chart in Figure 1.3 and the *Geological Atlas of the Western Canada Sedimentary Basin* (Leckie, 1994).

In northeastern Alberta, the Colorado Group has an unconformity at its base, and occurs above the non-marine Manville Group. Within the Colorado Group, the stratigraphically lowest unit is the non-calcareous Joli Fou Formation marine shale, which is Albian in age (Leckie et al., 1994). The Joli Fou pinches out towards the Rockies and foothills (Glass, 1990). In addition there are the Pelican/Viking Formation sandstones of Albian age, which have a disconformable contact with the underlying Joli

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Fou. These sandstones are equivalent to the Viking and Paddy Formations in other areas (Glass, 1990). Above this, the remaining shales are grouped into the La Biche Formation that comprises dark grey and brown shales that contain white speckled layers and skeletal fish material near its base (Glass, 1990). The La Biche Formation spans from Albian to the Campanian and includes the Fish Scales Zone (divides the Albian from the Cenomanian), a Colorado Shale, the Second White Speckled Shale (Cenomanian to Turonian), a Colorado Shale, the First White Speckled Shale (Santonian to Campanian) and, finally, the Lea Park, which is the youngest unit.

1.4 The Second White Specks Formation

The Second White Specks Formation has been described as laminated, non-bioturbated marlstones to limestones in Saskatchewan, calcareous claystone to siltstones in eastern and southern Alberta, and calcareous siltstone in northwestern Alberta. The formation is approximately 25 m thick at the Saskatchewan-Manitoba border, is less than 20 m in southern Alberta, thickens to 55 m in southwestern Alberta and thickens to over 90 m in the Peace River Arch area of northwestern Alberta (Bloch et al., 1999, Glass, 1990). Figure 1.4 illustrates some previous study areas of the Second White Specks Formation within southern Alberta by selected other workers (Stasiuk and Goodarzi 1988; Gilboy, 1988; Ridgley, 1998; and Bloch et al., 1999).

The white specks within this formation result from fecal pellets that contain coccoliths and coccospheres (Leckie et al., 1994). Pelecypod fragments, fish scales and bones, ammonites, shell fragments, Inoceramid prisms and algal cysts are some of the organic material that can be found in this speckled unit (Leckie et al. 1994, Bloch et al., 1999). Sandstone beds and bone beds may also be found along with bentonites. Bloch et al., (1999) report abundances of carbonate ranging from 0 to 88 weight percent, dolomite from 1.5 to 6.3 weight percent, framboidal pyrite from 0.0 to 7.0 weight percent, rare siderite, quartz from 2 to 52 weight percent, illite/smectite from 5 to 48 weight percent, kaolinite from 2 to 25 weight percent, K feldspar from 0 to 5 weight percent, plagioclase

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

is less than 3 weight percent and minor to trace amounts of biotite, muscovite, chlorite, glauconite and jarosite/gypsum/anhydrite as cements filling microfractures.

The basal contact of the Second White Specks Formation is conformable in some areas of the basin and disconformable in others. Overlying the formation is a low-angle unconformity. Above this unconformity there is an unnamed non-calcareous shale and with shales also underlying the Second White Specks Formation (Glass, 1990). The Second White Specks Formation is named the Greenhorn Formation in the U.S. and the Favel Formation (Keld Member) in Manitoba. It partly correlates to the Vimy member of the Blackstone and the middle Kaskapau Formation found in northern Alberta and British Columbia (Leckie et al., 1994).

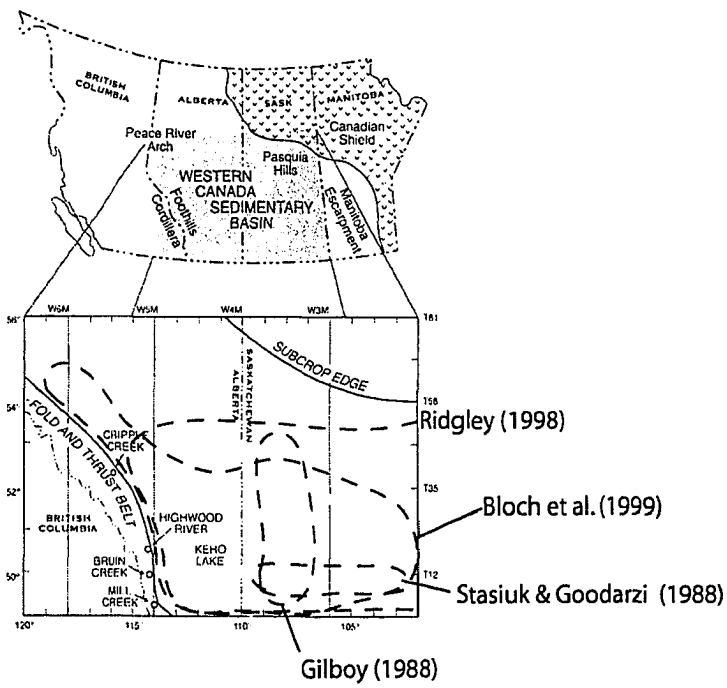


Figure 1.4: Map of western Canada with outlined study areas for some of the published works on the Second White Specks Formation (modified from Bloch et al., 1999).

The Second White Specks Formation is approximately 93 million years old (Haq et al., 1987, Leckie et al., 1994). This marker bed represents the division between the Turonian and Cenomanian. The age of the formation is defined by the presence of the *Hedbergella loetterlei* Zone within Alberta and represents latest Cenomanian to Middle

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Turonian time (Caldwell et al., 1978). The Western interior zone fossils for the Second White Specks Formation include *Watinoceras devonense, Pseudaspidocerase flexuosum, Vascoceras birchbyi, Mammites nodosoide* and *Collingnoniceras woollgari,* and these comprise both agglutinated and planktic specimens (Bloch et al., 1999). The basal boundary of the Second White Specks Formation has been defined as the first occurrence of planktic foraminifers and coccoliths (Bloch et al., 1999).

It is generally believed that Type II marine organic matter is the dominant organic within the Second White Specks Formation (Leckie et al., 1994, Bloch et al., 1999). The total organic carbon (TOC) content reaches a maximum of 12 wt %, and this is a very high TOC content when compared to the surrounding shales (Bloch et al., 1999). Investigations by Bloch et al. (1999) have shown that the Second White Speckled Shale is a mature source rock west of 114° longitude, where the migration of hydrocarbons most likely occurred through fractures. Ibid also described the wireline log signature as exhibiting an increase in resistivity and radioactivity with a variable response in the lower part of this unit. In contrast, the upper contact has decreasing resistivity and sonic velocity. Leckie et al. (1994) also noted that due to abundant kerogen in the unit, a high uranium content exists; this is because the kerogen acts as a precipitant or 'scrubber' of uranium from circulating syngenetic, diagenetic and epigenetic waters. This enhanced uranium content, and the radiogenic daughter products, cause the spike on gamma-ray logs. The higher readings also occur due to radioactive bentonites found within the unit.

The Second White Speckled Shale was deposited in anoxic waters during the maximum transgression peak of the Late Cenomanian to Early Turonian and subsequent sea level fall during the Middle Turonian in the Cretaceous (Bloch et al., 1999). Leckie et al., (1994) stated that when the sea level was rising during the Turonian transgression, cool boreal waters were intermixing with much warmer waters from the Gulf of Mexico. Abundant fine-grained material was deposited, and coalesced into large layers of shales. This formed the basis of the Colorado Group within which the Second White Speckled Shale can be found. It has been noted that during the maximum transgression, waters warmed from 5°C to as much as 20°C north of 54°N latitude (McNeil and Caldwell,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

1981) because warm Tethyan waters penetrated northward into the cool Boreal waters (Bloch et al., 1999). This may explain why both benthic and planktonic foraminiferas can be found in the Second White Specks Formation.

1.5 Regional Tectonics and Depositional History

During the Late Cretaceous in Western Canada, the Western Canada Sedimentary Basin was forming a foreland basin, with tectonic loading occurring to the west (Leckie and Smith, 1992). The sediments that were deposited during the time the Colorado Group was being created in a wedge shaped geometry, measured approximately 700 m in thickness in southwestern Alberta, 200 m in the Manitoba Escarpment, and more than 1500 m in the Peace River Arch area, which was subsiding during this time (Leckie et al., 1994). The Colorado Group sedimentation, therefore, took place while the foreland basin was tectonically active and is illustrated in Figure 1.5 below. Even though abundant sediment was deposited, during maximum transgression, the sea level only reached 200 to 300 m in depth (Leckie and Smith, 1992).

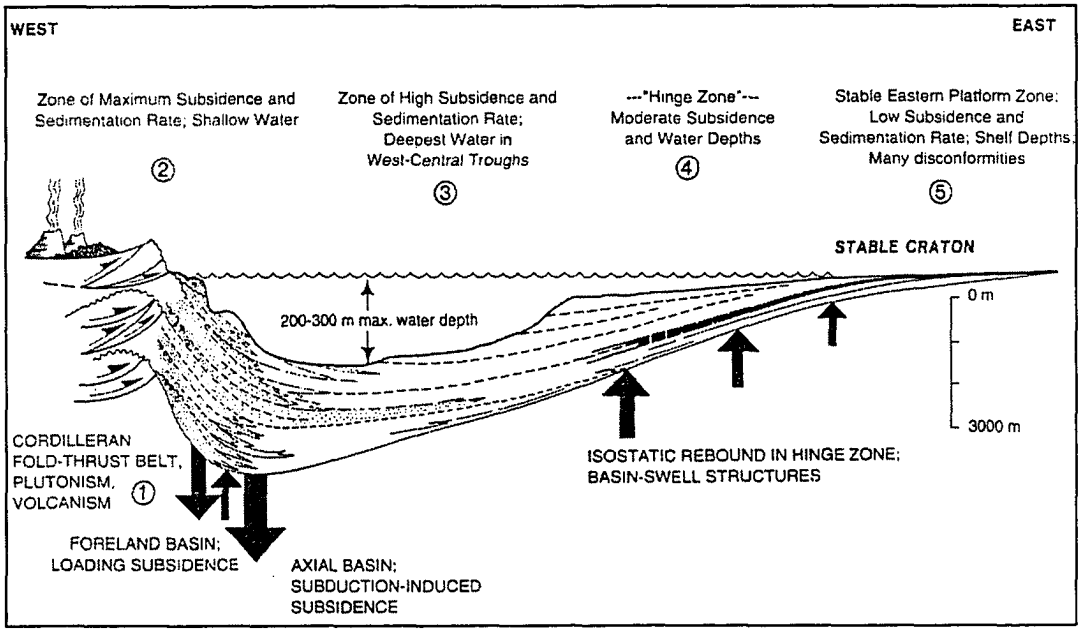


Figure 1.5: Schematic representation of the Western Canada Sedimentary basin during maximum transgression. The arrows represent thrusting, subsidence and uplift (from Leckie and Smith, 1992).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

1.6 Previous Work

Work by Fraser et al., (1935) initially identified the Second White Speckled Shale in a survey of southern Saskatchewan in the 1930s. This survey covered southern Alberta and all of the Cretaceous strata were discussed. Fraser (Ibid) noted that a dark shale with white specks existed in the subsurface and could be traced across the basin into Alberta. There was no type locality designated at that time, but more recently, a stratotype section for the Second White Specks Formation was listed as the Amoco B-1 Youngstown 6-34-30-08W4 well (Bloch et al., 1999).

Bloch et al.'s (1999) work is one of the more recent publications that summarize the Colorado Group and its stratigraphic subdivisions. This Geological Survey of Canada (GSC) Bulletin (Ibid) addressed several cores and outcrops that exist in southern Alberta and Saskatchewan, and proposed a subdivision for the Colorado Group shales that includes the Westgate, the Fish Scales, the Belle Fourche and the Second White Specks formations. This (Ibid) very detailed work also covered paleoenvironments, mineralogy, stratigraphy, geochemistry, paleontology and the geological history of all the newly named formations. The *Geological Atlas of the Western Canada Sedimentary Basin* (Mossop and Shetsen, 1994) devotes a whole chapter to the Colorado Group/Alberta Group and its inclusive formations and members. It (Ibid) provides a comprehensive geological history and stratigraphy of the Group. The sedimentology and depositional history of the Second White Speckled Shale is addressed by Leckie et al. (1994) who describe the Formation as being both a source and reservoir rock. Basin wide cross sections for the Group are included in Leckie et al. (Ibid) and reveal the wedge-shaped geometry of the Colorado Group, which thins towards the northeast of Alberta. The chapter by Leckie et al. (Ibid) also illustrates geophysical log signatures expected for the various formations within the Colorado Group across Alberta.

An Alberta Energy and Utilities Board/Alberta Geological Survey (EUB/AGS) publication, by Dufresne et al. (2001) was the impetus for this thesis. This publication (Ibid) investigated the detailed geochemistry of the Second White Speckled Shale,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

amongst other units, such as the Fish Scales Formation and the Shaftesbury Formation. It detailed work performed in northern Alberta, and indicated the Second White Speckled Shale has anomalous base metal concentrations, high total organic carbon content, and some anomalous diamond indicator minerals (Dufresne et al., 2001). In particular, the Second White Specks Formation in the Birch Mountains area (northeastern Alberta) returned anomalous to, in places, very high concentrations of one or more of: Au, Pt, Pd, Ag, Sb, As, Cu, Zn, Cd, Co, Ni, V, Mo, Fe, Mn, Ba, Ca, Br, Se, U, Eu, Ce, La, Lu, Nd, Sm, Tb, Y, Yb, S and total organic carbon (Dufresne et al., 2001). Figure 1.6 illustrates the median of various elements from the Second White Specks Formation, the Fish Scales Formation, the Westgate Formation and the Loon River Formation, and demonstrates that in that study, the Second White Specks Formation often shows the highest median.

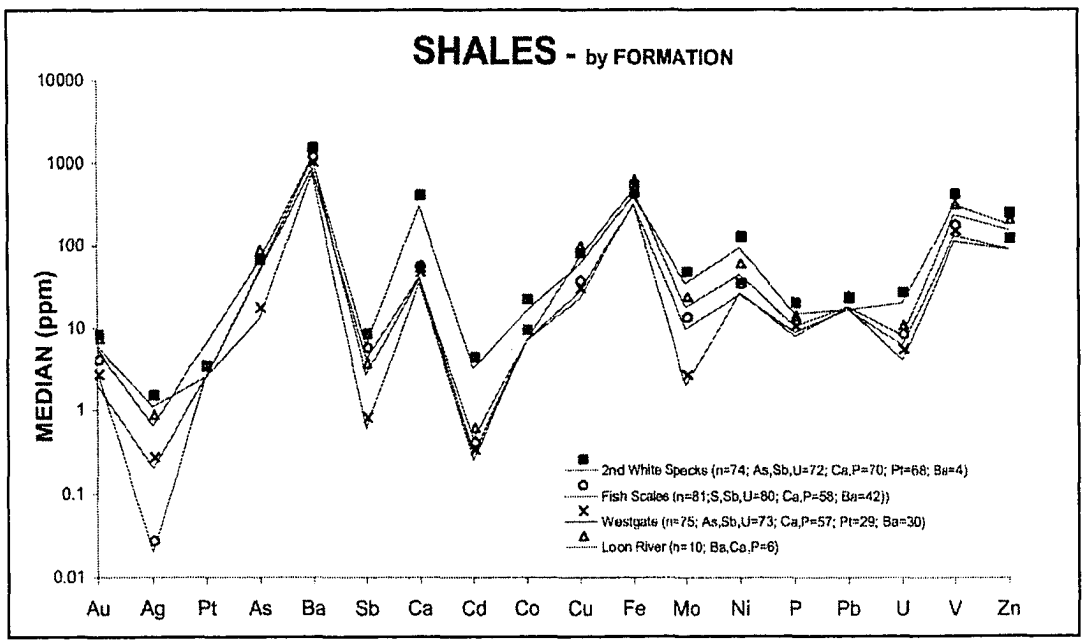


Figure 1.6 Graphical representation of the median for the various elements in the study by Dufresne et al., 2001. Notice that the Second White Specks Formation (represented by the square symbol) tends to consistently show higher median values for most elements compared to the Fish Scales, Westgate and Loon River formations (from Dufresne et al., 2001).

Other works that describe the geochemistry of the Second White Specks Formation include recent work by Travis (2002). This (Ibid) report covers the organic

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

geochemistry of the Formation, as well as the geochemistry of the Belle Fourche Formation. In her (Ibid) analyses Travis demonstrates that the Second White Specks Formation has a high total organic carbon content, Type II kerogen, early maturity and fair to very good hydrocarbon potential in central/western Alberta (west of Edmonton). Six Second White Specks Formation cores and two Belle Fourche Formation cores were studied and sampled by Travis (Ibid), who concluded that both Formations have potential for shale gas production. An article on the organic petrology of the Second White Speckled Shale within Saskatchewan indicated that the shale is thermally immature in that area (Stasiuk, 1988). It (Ibid) also suggested that there may be a link within the shale between bituminite and biogenic gas. As well in southwestern Saskatchewan, an investigation of the geology and natural gas production from the Second White Speckled Shale showed that it can also be a reservoir for sweet, dry, biogenic gas (Gilboy, 1987, Gilboy, 1988). Gilboy's article (s) (Ibid) also described the Second White Specks lithologically, dividing the unit into subunits, and describing the depositional environment of each unit. Snowdon (1995) described in a detailed way, the rock-eval thermal maturation parameter T_{max} suppression of the Second White Specks Formation, and stated that below 453°C the suppression is around 1°C for each increase in the hydrogen index of 50 mg hydrocarbon/g total organic carbon content. Issler et al. (2002) developed a method to determine organic carbon content from well logs. The study (Ibid) dealt with the Colorado Shales and used core petrophysical and geochemical data. Porosity characteristics of shales, from the southern section of the Western Canada Sedimentary Basin, have also been investigated (Katsube, 1998). Some of the characteristics of the Colorado Group included extremely tight and well compacted lithologies in places (Katsube, 1998).

Seismic profiling in central Alberta suggested the influence of the basement rocks on the overlying sedimentary cover, of which the Second White Specks Formation is included (Milkereit et al., 1995). A compilation by Pana et al. (2001) using Geographical Information Systems shows the known and inferred structural elements (i.e., faults) in northern Alberta, and also discusses the fault zone and tectonic elements that were active during the Cretaceous. Other works on the structures within the Western Canada Foreland

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Basin during the Cretaceous are those by Leckie and Smith (1992) and Kauffman and Caldwell (1993). These studies (Ibid) discuss the processes inherent during basin formation, including paleoenvironments, depositional and sea level cycles throughout the Cretaceous. As well, Kauffman (1984) outlined some changes in the environment throughout the Cretaceous in the Western Interior Seaway; these included a warming period, normalization of salinity and changes in oxygenated/anoxic waters during the time of peak transgression (i.e., during the time the Second White Speckled Shale was reportedly deposited – see Figure 1.7). Glancy et al. (1993) produced a paleoclimate model of warm weather and periods of humidity for the North American sea during the Cretaceous (specifically from the Cenomanian-Turonian). Kauffman (1977) provided an overview of the Western Interior Cretaceous Basin in a field trip guide across the Basin in which he described the tectonics, geochronology, sedimentation patterns, organisms and paleoclimate during this time frame (as for example shown in Figure 1.5). One of the broadest discussion of the entire Mesozoic was by Haq et al. (1987) who outlined the sequence stratigraphy, the magnetostratigraphy, the chronostratigraphy, the biostratigraphy and, finally, the eustatic sea level curves since the Triassic.

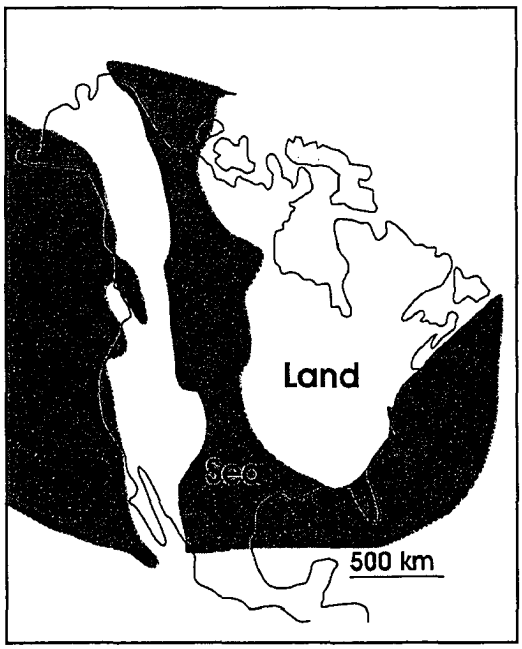


Figure 1.7: The Western Interior Seaway during the deposition of the Second White Specks Formation. The sea is shown for Canada, the United States and northern Mexico. Note that during this time, the warm southern Tethyan waters have intermixed with the northern cool Boreal waters (from Travis, 2002).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

There are many published articles that describe the biostratigraphy (usually using foraminifera) and paleogeography of the Colorado Group or its time equivalent units. For example, Lang and McGugan (1988) described the Albian to Turonian in northern Montana and southern Alberta, close to the Sweetgrass Arch area; they combined biostratigraphy and lithology in order to propose a paleogeographic model. Schröder-Adams et al. (1996) described paleoenvironmental changes for the Colorado Group Shales based on microfossil, sedimentological and geochemical evidence. Some other scientists, such as Kauffman (1967), Eicher (1967,1969), Kent (1967, 1969), Jeletzky (1968) and Caldwell et al. (1978), also have defined biostratigraphic zones within the Cretaceous. Wall (1963) described micro- and mega-faunal assemblages for the Alberta Group (the time equivalent of the Colorado Group) and related these to possible environments of deposition. Caldwell (1982) combined the various lines of evidence with radiometric dating in order to record the Cretaceous Seaway's history, which also was described by Lang and McGugan, (1988).

Furthermore, articles such as those on the Lower Kaskapau Formation (Wallace-Dudley and Leckie, 1993), the Dunvegan, the Shaftesbury and the Kaskapau Formations (Bhattacharya and Walker, 1991), and the Lower Kaskapau and the Dunvegan Formations (Plint, 2000), described units that either are time-equivalent or close in age to the Second White Specks Formation/Colorado Group Shales.

Therefore, the present study is intended to build on the work of these previous authors, but more specifically aims to investigate the Second White Specks Formation across Alberta from a sedimentological, stratigraphical and, especially, a geochemical point of view.

1.7 Objectives

The key objectives of this thesis are:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

- To investigate the sedimentology, stratigraphy and basin wide distribution of the Second White Specks Formation.
- To investigate the geochemistry of the unit on a regional scale.
- Lastly, to assess its potential as a host rock for sedimentary exhalative (Sedex) base-precious metal deposits.

1.8 References

Bhattacharya, Janok and Walker, Roger G. (1991): Allostratigraphic subdivision of the Upper Cretaceous Dunvegan, Shaftesbury, and Kaskapau formations in the northwestern Alberta subsurface, *Bulletin of Canadian Petroleum Geology*, v. 39, pages 145-164.

Bloch, J., Schröder-Adams, C., Leckie, D.A., McIntyre, D.J., Craig, J. and Staniland, M. (1993): Revised stratigraphy of the lower Colorado Group (Albian to Turonian), Western Canada, *Bulletin of Canadian Petroleum Geology*, v. 41, pages 325-348.

Bloch, J.D., Schröder-Adams, C.J., Leckie, D.A., Craig, J. and McIntyre, D.J. (1999): Sedimentology, micropaleontology, geochemistry and hydrocarbon potential of shale from the Cretaceous lower Colorado Group in western Canada, *Geological Survey of Canada*, Bulletin 531, 183 pages.

Caldwell, W.G.E., North, B.R., Stelck, C.R. and Wall, J.H. (1978): A foraminiferal zonal scheme for the Cretaceous System in the Interior Plains of Canada;. *in* Western and Arctic Canadian biostratigraphy; Stelck, C.R. and Chatterton, B.D.E., Editors, *Geological Association of Canada*, Special Paper 18, pages 495-575.

Caldwell, W.G.E. (1982): The Cretaceous System in the Williston basin – a modern appraisal; *in* Fourth International Williston Basin Symposium; Christopher, J.E. and Kaldi, J., Editors, *Saskatchewan Geological Society*, Special Publication 6, pages 295-312.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Caldwell, W.G.E. (1984): Early Cretaceous transgressions and regressions in the southern Interior Plains; *in* The Mesozoic of Middle North America; Stott, D.F. and Glass D.J., Editors, *Canadian Society of Petroleum Geologists*, Memoir 9, p.173-203.

Dufresne, Michael B. and Eccles, Roy D. and Leckie, Dale A. (2001): The geological and geochemical setting of the Mid-Cretaceous Shaftesbury Formation and other Colorado Group sedimentary units in northern Alberta, *Alberta Geological Survey*, Special Report 09, 654 pages.

Eicher, D.L. (1967): Foraminifera from Belle Fourche Shale and equivalents, Wyoming and Montana. *Journal of Paleontology*, v. 41, pages 167-188.

Eicher, D.L. (1969): Cenomanian and Turonian planktonic foraminifera from the Western Interior of the United States; *in* Proceedings of the International Conference of Planktonic Microfossils; Bronniman, P. and Renz H.H., Editors, First Proceedings of the International Conference of Planktonic Microfossils, Geneva, Switzerland, 1967, v. 2, pages 163-174.

Fraser, F.J., McLearn, Frank Harris, Russell, Loris Shano, Warren, Percival Sidney and Wickenden, Robert Thomas Daubigny. (1935): Geology of southern Saskatchewan, *Geological Survey of Canada*, Memoir 176, 137 pages.

Glass, D. (1990): Lexicon of Canadian Stratigraphy volume 4: Western Canada, *Canadian Society of Petroleum Geologists*; Glass, D., Editor.

Gilboy, C.F. (1987): Aspects of the regional geological framework of low-permeability shallow gas reservoirs in Upper Cretaceous strata, Southwestern Saskatchewan; *in* Summary of Investigations 1987, *Saskatchewan Geological Survey;* Saskatchewan Energy and Mines, Miscellaneous Report 87-4, pages 199-213.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Gilboy, C.F. (1988): Geology and natural gas production of the Upper Cretaceous Second White-Speckled Shale, Southwestern Saskatchewan; *in* Summary of Investigations 1988, *Saskatchewan Geological Survey; Saskatchewan Energy and Mines*, Miscellaneous Report 88-4, pages 183-195.

Glancy, T.J. Jr., Arthur, M.A., Barron, E.J. and Kauffman, E.G. (1993): A paleoclimate model for the North American Cretaceous (Cenomanian-Turonian) epicontinental sea; *in* Evolution of the Western Interior Basin; Caldwell, W.G.E. and Kauffman, E.G., Editors, *GAC Special Paper 39*, pages 219-241.

Haq, Bilal U., Hardenboi, Jan and Vail, Peter R. (1987): Chronology of fluctuating sea levels since the Triassic, *Science*, v. 235, pages 1156-1167.

Issler, Dale R., Hu, Kezhen, Bloch, John D. and Katsube, John T. (2002): Organic Carbon Content Determined from Well Logs: Examples from Cretaceous Sediments of Western Canada, *Geological Survey of Canada*, Open File 4362, 18 pages.

Jeletzky, J.A. (1968): Macrofossil zones of the marine Cretaceous of the Western Interior of Canada and their correlation with the zones and stages of Europe and the western Interior of the United Sates, *Geological Survey of Canada*, Paper 67-72.

Katsube, T.J., Cox, W.C. and Issler, D.R. (1988): Porosity characteristics of shale formations from the Western Canada Sedimentary Basin; *in* Current Research 1998-E, *Geological Survey of Canada*, pages 63-74.

Kauffman, E.G. (1967): Coloradan macroinvertebrate assemblages, central Western Interior; *in* Paleoenvironments of the Cretaceous seaway in the Western Interior; Colorado School of Mines, Golden, CO, pages 67-143.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Kauffman, Erle G. (1977): Geological and Biological Overview: Western Interior Cretaceous Basin, *The Mountain Geologist*, v. 14, pages 75-99.

Kauffman, Erle G. (1984): Paleobiogeography and evolutionary response dynamic in the Cretaceous Western Interior Seaway of North America, *Geological Association of Canada Special Paper* 27, Westermann, G.E.G. Editor, pages 273-306.

Kauffman, E.G. and Caldwell, W.G.E. (1993): The Western Interior Basin in Space and Time; *in* Evolution of the Western Interior Basin; Caldwell, W.G.E. and Kauffman, E.G., Editors, *Geological Association of Canada*, Special Paper 39, pages 1-30.

Kent, H.C. (1967): Microfossils from the Niobrara Formation (Cretaceous) and equivalent strata in northern and western Colorado, *Journal of Paleontology*, v. 41, pages 1433-1456.

Kent, H.C. (1969): Distribution of keeled Globotruncanidae in Coniacian and Santonian strata of the Western Interior region of North America; *in* Proceedings of the International Conference of Planktonic Microfossils; Bronniman, P. and Renz, H.H., Editors; First Proceedings of the International Conference of Planktonic Microfossils, Geneva, Switzerland, 1967, vol. 2, pages 323-327.

Lang, Harold R. and McGugan, Alan. (1988): Cretaceous (Albian-Turonian) foraminiferal biostratigraphy and paleogeography of northern Montana and southern Alberta, *Canadian Journal of Earth Sciences*, v. 25, pages 316-339.

Leckie, D.A, Bhattacharya, J.P., Bloch, J., Gilboy, C.F., Norris, B. Campbell, R., Plint, G., Gilders, M., Holmstrom, G., Krause, F.F., Reinson, G.E., Safton, D., Sawicki, J. and Sawicki, O. (1994): Cretaceous Colorado/Alberta Group of the Western Canada Sedimentary Basin; *in* Geological Atlas of the Western Canada

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sedimentary Basin, *Alberta Research Council and the Alberta Geological Survey*, pages 335-352.

Leckie, Dale A. and Smith, David G. (1992): Regional setting, evolution, and depositional cycles of the Western Canada foreland basin; *in* Foreland Basins and Fold Belts; Macqueen, Roger W. and Leckie, Dale A., Editors, *American Association of Petroleum Geologists,* AAPG Memoir 55, pages 9-46.

McNeil, D.H., and W.G.E. Caldwell. (1981): Cretaceous rocks and their foraminifera in the Manitoba escarpment: *Geological Association of Canada Special Paper No. 21*, 439 pages.

Milkereit, D.W. Eaton, Ross, G.M, Kanasewich, E.R., Geis, W., Edwards, D.J, Kelsch, L. and Varsek, J. (1995): Lithoprobe basin-scale seismic profiling in central Alberta: influence of basement on the sedimentary cover, *Bulletin of Canadian Petroleum Geology*, v. 43, pages 65-77.

Pana, D., Waters, J. and Grobe M. (2001): GIS Compilation of structural elements in Northern Alberta, Release 1.0, *Alberta Geological Survey*, *Alberta Energy and Utilities Board*, 53 pages.

Plint, Guy A. (2000): Sequence stratigraphy and paleogeography of a Cenomanian deltaic complex: the Dunvegan and lower Kaskapau formations in subsurface and outcrop, Alberta and British Columbia, Canada, *Bulletin of Canadian Petroleum Geology*, v. 48, pages 43-79.

Podruski, J.A., Barclay, J.E., Hamblin, A.P., Lee, P.J., Osadetz, K.G., Proctor, R.M., and Taylor, G.C. (1988): Conventional oil reserves of Western Canada (light and medium). *Geological Survey of Canada*, Paper 87-26, 149 pages.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Porter, J.W. (1992): Oil and gas reserves of the Western Canada Foreland Basin; *in* Foreland Basins and Fold Belts; Macqueen, R.W. and Leckie, D.A., Editors, *American Association of Petroleum Geologists*, Memoir 55, pages 125-158.

Potter, P.E., Maynard, J.B., Pryor, W.A. (1980): Sedimentology of shale: study guide and reference source, Springer-Verlag, New York, 306 pages.

Ridgley, Jennie L. (1998): Gas geochemistry of Upper Cretaceous Second White Speckled Shale, southern Alberta and western Saskatchewan, Canada – A regional perspective; *in* Eighth International Williston Basin Symposium; Christopher, J.E., Gilboy, C.F., Patterson, D.F. and Bend, S.L., Editors; *Saskatchewan Geological Society Special Publication No. 13*, pages 278-289.

Sabag, S.F. (1996): Buckton Property: Summary Report Exploration Programs 1993-1995 and Work In Progress 1996, Tintina Mines Limited and NSR Resources Inc., Ontario, 1801 pages PDF.

Schröder-Adams, C.J., Leckie, D.A., Bloch, J., Craig, J., McIntyre, D.J. and Adams, P.J. (1996): Paleoenvironmental changes in the Cretaceous (Albian to Turonian) Colorado Group of Western Canada: microfossil, sedimentological and geochemical evidence, *Cretaceous Research*, v. 17, pages 311-365.

Snowdon, Lloyd R. (1995): Rock-Eval Tmax suppression: Documentation and amelioration, *AAPG Bulletin*, v. 79, pages 1337-1348.

Stancliffe, R.P.W. and McIntyre, David J. (2003): Stratigraphy and palynology of the Cretaceous Colorado Group and Lea Park Formation at Cold Lake, Alberta, Canada, *Bulletin of Canadian Petroleum Geology*, v. 51, pages 91-98.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Stasiuk, L.D. and Goodarzi, F. (1988): Organic petrology of Second White Speckled Shale, Saskatchewan, Canada – A possible link between bituminite and biogenic gas?, *Bulletin of Canadian Petroleum Geology*, v. 36, pages 397-406

Travis, Sarah. (2002): Organic Geochemical Analysis of the Second White Speckled Shale Formation, Upper Cretaceous Colorado Group, west central Alberta. Implications for Shale Gas Production; B.Sc. thesis, *University of Calgary*, 76 pages.

Wall, J.H. and Germundson, R.K. (1963): Microfauna, magafaunas, and rock-stratigraphic units in the Alberta Group (Cretaceous) of the Rocky Mountain Foothills, *Bulletin of Canadian Petroleum Geology*, v. 11, page 327-349.

Wallace-Dudley, Karen and Leckie, Dale. (1993): The Lower Kaskapau Formation (Cenomanian): A multiple-frequency, retrogradational shelf systems, Alberta, Canada, *The American Association of Petroleum Geologists Bulletin*, v. 77, pages 414-435.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

2.0 Methodology:

This study was intended to answer the following questions:

- What are the regional to local geochemical variations within the Second White Speckled Shale, and are there potentially localized metal concentrations?
- Is the Second White Specks a potential host unit for a sedimentary exhalative deposit?
- Is there a physical or geochemical change, or both, in the unit in central and northern Alberta as compared to previous studies in southern Alberta?
- How does the Second White Specks fit into a stratigraphic and depositional model on a regional scale?

The methods used to achieve the answers to these questions include the use of geophysical logs to produce cross sections, supplemented by logged core, whole rock geochemistry; as well, relative dates have been obtained using palynology and micropaleontology.

2.1 Methods

Geophysical logs of both gamma ray and resistivity were used in this study. The gamma ray log was chosen to build regional cross sections because it best represents the changes in grain size and the presence of bentonites within and proximal to the Second White Speckled Shale. The resistivity log varies much more within the Second White Specks Formation than the underlying and overlying units (Bloch et al., 1999), and thus was useful in this study in conjunction with the gamma ray log to evaluate lithostratigraphic variations within the unit.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

2.1.1 Accumap and Cross Sections

The search for the Second White Specks Formation was performed using Accumap by searching for "Second White Specks" and "core", then by identifying whether or not the pick was correct and contained a shale or sand package. Approximately 34 cores in the Study Area contained the "Second White Specks" and a reasonable amount of cored sections. Difficulties were encountered with this search because the Belle Fourche Formation was not picked in any of the cored sections within the study area. This, in turn, made the base of the Second White Specks Formation difficult to pick, and hence the distinction between the Second White Specks shale, the Belle Fourche shale and the Fish Scales was often extremely difficult with just the initial geophysical logs from Accumap (see Figure 2.1).

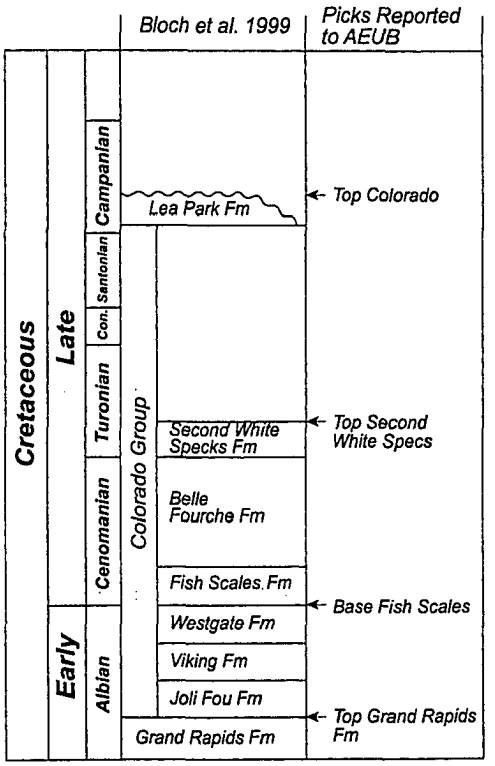


Figure 2.1: Chart illustrating the picks that are reported to the Alberta Energy and Utilities Board (AEUB) for the Colorado Group. This demonstrates the difficulty in identifying the Second White Specks Formation from other shales within the Colorado Group using only the picks from Accumap for the Colorado Group (adapted from Stancliffe et al., 2003).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The lines of cross section were chosen to be of maximum extent across the study area, and appropriate geophysical logs were chosen along these lines of section (see Figure 1.2). A sequence stratigraphic approach was then applied to the cross sections in order to correlate the wells. Three are dip sections and three are strike sections. These are composed of some logged cores, supplemented by geophysical logs, which fills in the gaps between the logged cores.

2.1.2 Logging Core

Selected core at both the Calgary and Edmonton EUB core facilities were logged during the summer of 2003. These were logged box by box, from the top of the interval to the base. Some aspects that were logged include: grain size and grain size changes, bentonite horizons, changes in reaction to hydrochloric acid, the presence of fossils, colour changes, presence/absence of 'white specks', sedimentary structures and any sulphides present. A detailed logging form was filled out and inserted into Powercore software so that all information could be catalogued. Samples were collected from the cores at a 1m interval, marked and placed in a cloth bag. The logging forms are included in their entirety in Appendix 6.1.

2.1.3 Palynology

Shale was ubiquitously encountered in the cores and as a result, formation contacts could be difficult to place when there was no readily apparent change in physical characteristics in the core. Thus positive identification using only the physical characteristics of the formations became impossible for some of the cores. Therefore, dating (using micropaleontology and palynology) of each core became necessary to try and ensure that the interval of core contained the Second White Specks Formation. If dates could not be identified using micropaleontology, as was the case for the cores from the Birch Mountains in northeastern Alberta, samples were subsequently sent in for palynology dating.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

According to Mr. Dolby, Calgary (personal communication, 2004), "About 20g of the rock sample is crushed to 3 mm fragments (lentil-split pea size) and heated with concentrated HCl to remove any carbonates. It is then washed in distilled H_2O and 70% HF is added to dissolve the silicates. The residual HF is removed by repeated dilution with distilled H_2O and centrifugation. The residue is then treated with hot HCl to remove any fluorides and then washed again. The undigested mineral matter is removed by heavy liquid separation using ZnCl. The float (kerogen) is removed and a small amount is made into a kerogen slide by dispersing it in PVA on a cover-slip which, after drying is mounted onto a microscope slide using a two-part resin. The remaining kerogen is sieved using a 10 micron sieve and another slide is made. The kerogen is then oxidized using either concentrated HNO_3 or Schultz's Solution (HNO_3 + $KClO_3$) washed by sieving at 10 microns, stained using Safranin and another slide is made. The stained slide is systematically scanned and the palynomorphs counted to obtain abundance data for the different species. The slides of unoxidized material are used for kerogen analysis if required." The palynology results are tabulated in Appendix 6.3.

2.1.4 Micropaleontology

To extract the foraminifera from the sediment, the samples were crushed using Then and Dougherty's (1983) method (Dr. Claudia Schröder-Adams at Carleton University, personal communication, 2004). The samples were then sieved and the residual material was picked for foraminifera. The micropaleontology results are tabulated in Appendix 6.2.

2.1.5 Geochemistry

2.1.51 Sample Collection Procedures

In total, 730 samples were collected from 24 cores from the Energy and Utilities Board (EUB) Calgary Core Research Center and the Edmonton Minerals Core Research Facility during the summer of 2003. The core was sampled at 1 m intervals and additional samples were taken primarily for micropaleontology, bentonites and any thin section

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

work. Samples typically were collected over a length of 1 to 7 cm, and a width of 2.5 cm from the outer edge of the core. Thus, the geochemical samples represent 'short' intervals (i.e., essentially 'spot sampling') rather than being across the entire 1 m interval; this was done due to sampling limitations, imposed by the EUB core facilities. In some cases, the core could not be removed by hand. Where appropriate, it was subsequently labeled and sawed by the Calgary Core Research Facility. The samples were labeled immediately and inserted into separate cloth bags. These were stored until shipment to the laboratory for analysis in December 2003 and March 2004.

2.1.52 Sample Preparations

The geochemical rock samples were sorted and detailed in a Microsoft Excel spreadsheet as tabulated in Appendix 6.4. Due to budget constraints, not all of the samples could be analyzed. Some of the samples, therefore, had to be eliminated based on the probability of the core representing, or not, the Second White Specks Formation. The end result was that 556 selected samples were sent for analysis, along with 36 duplicates and 18 standards. Of the 556 samples, 540 were sent for the 1F package (the other 16 only sent for the more rigorous package along with 68 samples from the 540 samples which were also sent for the 1F package to make up the 84 samples described) and 84 of the samples from 5 cores: 00/10-22-047-03W4/0, 00/14-29-048-06W5/0, 00/06-31-046-08W5/0, 00/05-10-051-04W5/0, 00/02-03-101-12W4/0 (7BK03), were sent for near total major oxides, trace elements, total C, organic C, CO2, S and SO4. These 5 cores were chosen due to the fact that they represented the most complete sections of the Second White Specks Formation in north-eastern Alberta, eastern Alberta and the deep basin in west-central Alberta. The samples which were analyzed were sent to the laboratory in their original bags. The bags were collected into bundles and packaged in large plastic containers, then sent to the laboratory in Vancouver.

2.1.53 Analytical Procedures

The following procedures are from ACME Labs (J. Gravel, personal communication, 2004).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Group 1F: Ultratrace by Induction Coupled Plasma - Mass Spectrometer (ICP-MS) Analysis:

Steps include:

Sample Preparation:

1) The samples are dried at 60°C.
2) The sediment is sieved to -80 mesh (-177 μm)
3) Rock fragment and core are jaw crushed to 70 % passing 10 mesh (2 mm), then a 250 g riffle split is pulverized to 95 % passing 150 mesh (100 μm) in a mild-steel ring-and-puck mill.
4) Pulp splits of 1 g are weighed into test tubes.

Sample Digestion:

1) An aqua regia solution of equal parts concentrated ACS grade HCl and HNO_3 and de-mineralized H_2O is added to each sample (6mL/g).
2) The samples are leached in a hot water bath (~95°C) for one hour.
3) Once cooled, the solution is made up to a volume with 5% HCl. Sample weight to solution volume ration is 1 g per 20 mL.

Sample Analysis:

The solutions are aspirated into a Perkin Elmer Elan 6000 ICP mass spectrometer. Concentrations were determined for 53 elements (Ag, Al, As, Au, B, Be, Ba, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pd, Pt, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr).

Group 1EX: 4 Acid Digestion:

Steps include:

Sample Preparation:

1) The samples are dried at 60°C.
2) The sediment is sieved to -80 mesh (-177 μm).
3) Rock fragment and core is jaw crushed to 70 % passing 10 mesh (2 mm), then a 250 g riffle split is pulverized to 95 % passing 150 mesh (100 μm) in a mild-steel ring-and-puck mill.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

4) The pulp splits of 0.25 g are weighted into Teflon test tubes.

Sample Digestion:

1) A 10 mL aliquot of acid solution (2:2:1:1 H_2O-HF-$HClO_4$-HNO_3) is added, heated until fuming on a hot plate and then taken to dryness.
2) A 7.5 mL aliquot of 50 % HCl is added to the residue and heated in a hot water bath (~95°C) for 30 minutes.
3) The solutions cool and are moved to polypropylene test-tubes and made to a 10 mL volume with 5 % HCl.

Sample Analysis:

The solutions are aspirated into a Perkin Elmer Elan 6000 ICP mass spectrometer. Concentrations were determined for 41 elements (Ag, Al, As, Au, Ba, Be, Bi, Ca, Ce, Cd, Co, Cr, Cu, Fe, Hf, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, S, Sb, Sc, Sn, Sr, Ta, Th, Ti, U, V, W, Y, Zn, Zr).

Group 4A: Whole Rock Analysis by Induction Coupled Plasma – Emission Spectrometer:

Steps include:

Sample Preparation:

1) The samples are dried at 60°C.
2) The sediment is sieved to -80 mesh (-177 μm).
3) Rock and drill core is jaw crushed to 70 % passing 10 mesh (2 mm), then a 250 g riffle is pulverized to 95 % passing 150 mesh (100 μm) in a mild-steel ring-and-puck mill.

Sample Digestion:

1) A 0.2 g sample aliquot is weighed in a graphite crucible and mixed with 1.5 g of $LiBO_2$ flux.
2) The sample is heated in a muffle furnace for 15 minutes at 1050°C.
3) The mixture is removed and immediately poured into 100 mL of 5 % HNO_3 (ACS grade nitric acid in de-mineralized water).
4) The solution is shaken for 2 hours, then an aliquot is poured into a polypropylene test tube.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

5) Calibrated standards, verification standards and reagent blanks are added to the sample sequence.

Sample Analysis:

1) Sample solutions are aspirated into an ICP emission spectrometer (Jarrel Ash Atomcomp Model 975). Concentrations were determined for 11 oxides (SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O, MnO, TiO_2, P_2O_5, Cr_2O_3), LOI and 5 elements (Ba, C, Ni, S, Sc).
2) A 1 g sample split is ignited for 90 minutes at 950°C, cooled in a dessicator, then weighed with the difference expressed as percent Loss on Ignition (%LOI).
3) A 0.1 g sample split is analyzed for total Carbon and Sulphur by the LECO method.

Group 4B: Whole Rock Trace Elements by ICP-MS:

Steps include:

Sample Preparation:

1) The samples are dried at 60°C.
2) The sediment is sieved to -80 mesh (-177 μm).
3) Rock and drill core is jaw crushed to 70 % passing 10 mesh (2 mm), then a 250 g riffle split is pulverized to 95 % passing 150 mesh (100 μm) in a mild-steel ring-and-puck mill.

Sample Digestion:

1) A 0.2 g sample aliquot is weighed into a graphite crucible and mixed with 1.5 g of $LiBO_2$ flux.
2) The sample is heated in a muffle furnace for 15 minutes at 1050°C.
3) The mixture is removed and immediately poured into 100 mL of 5 % HNO_3 (ACS grade nitric acid in de-mineralized water).
4) The solution is shaken for 2 hours then an aliquot is poured into a polypropylene test tube.
5) Calibration standards, verification standards and reagent blanks are added to the sample sequence.

Sample Analysis:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

1) Sample solutions are aspirated into an ICP mass spectrometer (Perkin-Elmer Elan 6000). Concentrations were determined for 29 elements (Ce, Co, Cs, Dy, Er, Eu, Ga, Gd, Hf, Ho, La, Lu, Nb, Nd, Pr, Rb, Sm, Sn, Sr, Ta, Tb, Th, Tm, U, V, W, Y, Yb, Zr).

Group 2A: Total Carbon and Sulphur:

Steps include:

Sample Preparation:

1) The samples are dried at 60°C.
2) The sediment is sieved to -80 mesh ASTM (-177 μm).
3) Rocks and drill core is crushed and pulverized to -150 mesh ASTM (-100 μm).
4) Sample splits (0.1 g) are placed in Leco crucibles.

Sample Analysis:

1) After precise weighing, induction flux is added and the sample is ignited at >1650°C in an induction furnace.
2) A carrier gas sweeps up released carbon and sulphur to be measured by adsorption in an infrared spectrometric cell.
3) Results are total and attributed to the presence of carbon and sulphur in all forms. Analysis is by infrared adsorption using Leco C244 Carbon-Sulphur analyzer.
4) Organic carbon is calculated using the total carbon minus the graphite carbon and carbonate.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

2.2 References

Bloch, J.D., Schröder-Adams, C.J., Leckie, D.A., Craig, J. and McIntyre, D.J. (1999): Sedimentology, micropaleontology, geochemistry and hydrocarbon potential of shale from the Cretaceous lower Colorado Group in western Canada, *Geological Survey of Canada*, Bulletin 531, 183 pages.

Stancliffe, R.P.W. and McIntyre, David J. (2003): Stratigraphy and palynology of the Cretaceous Colorado Group and Lea Park Formation at Cold Lake, Alberta, Canada, *Bulletin of Canadian Petroleum Geology*, v. 51, pages 91-98.

Then, D.R. and Dougherty, B.J. (1983): A new procedure for extracting foraminifera from indurated organic shale, *Geological Survey of Canada*, 83-1B, pages 413-414.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.0 THE STRATIGRAPHY AND SEDIMENTOLOGY OF THE SECOND WHITE SPECKS FORMATION, NORTH/CENTRAL ALBERTA

3.1 Introduction

The Second White Specks Formation has been described as both a source and reservoir rock by Leckie et al., (1994) and has therefore been studied extensively in Saskatchewan and southern Alberta. However, little work has been done to further delineate the sedimentology and stratigraphy of the unit in central and northern Alberta. As a result, this is one of the primary focuses of this chapter.

The Second White Specks unit ranges from a calcareous claystone/siltstone with a thickness of 20 m in southern Alberta, to a calcareous siltstone with a thickness greater than 90 m in northwestern Alberta (Bloch et al., 1999, Glass, 1990). The name of the unit came from an old driller's term for a unit they encountered with white specks within a dark grey shale; these were subsequently identified as fecal pellets that contain coccoliths and coccospheres (Leckie et al., 1994). As well, other organic matter has been observed in the Second White Specks formation; this includes *Inoceramus*, fish debris, ammonites, bone beds and algal cysts (Leckie et al. 1994, Bloch et al, 1999). In places, bentonites have been reported along with sandstone beds (Bloch et al., 1999). Finally, Bloch et al. (1999) has also described carbonate, dolomite, pyrite, quartz, illite/smectite, kaolinite, K feldspar, plagioclase, biotite, muscovite, chlorite, glauconite and minor amounts of siderite within the formation in southern Alberta cores.

The Second White Specks Formation is approximately 93 million years old and spans the end of the Cenomanian into early Turonian (Haq et al., 1987, Leckie et al., 1994). The dating of the Colorado Group in the Western Canada Sedimentary Basin has often been by microfossils and the Second White Specks is defined within Alberta by the presence of the *Hedbergella loetterlei* Zone which represents latest Cenomanian to Middle Turonian times (Caldwell et al., 1978). The lower boundary of the Second White

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Specks Formation is described by the first occurrence of planktic foraminifers and coccoliths (Bloch et al., 1999).

The deposition of the Second White Specks Formation occurred during the maximum transgression of the Late Cenomanian/Early Turonian shallow sea (Bloch et al., 1999). Leckie et al. (1994) noted that when the sea level was rising during the late Cenomanian to Turonian transgression, cool boreal waters were intermixing with much warmer waters from the Gulf of Mexico, warming the sea water from 5°C to as much as 20°C north of 54°N latitude (McNeil and Caldwell, 1981). This is the reason why both benthic and planktonic foraminiferas can be found in the Second White Specks Formation (Bloch et al., 1999).

The Second White Specks Formation contains varying grain sizes from clay to sand size, with most sediments very fine grained, with small laminations of silty-sandy grains which may have been deposited via contour currents. Documented studies have shown that contour currents may carry and deposit sediments even in very shallow seas, like in the case of the Second White Specks Formation. Very weak currents have been recorded in the Yellow Sea/East China sea, which average less than 200m in depth with a low slope (less than 1°C) and transport fine grained sediments (Johnson and Baldwin, 1996). Variations in temperatures and winds cause muds to be deposited during cold southward-flowing currents and sandy zones from warm northward flows (Ibid).

The following sections of this chapter cover the depositional environment of the Second White Specks Formation during the Cenomanian and Turonian, as well as the basin scale processes by which it was deposited within Alberta. To assist with interpreting the depositional environment in central and northern Alberta, selected core across the study area were collected and logged for details such as grain size changes, sedimentary structures, presence of fossils, reaction with hydrochloric acid and mineral content. The presence of contourites is also discussed, using observations from the logged core. Finally, selected core was also analyzed for micropaleontology and palynology dates and the results are presented below.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

On a much larger scale, the basin scale processes are then discussed. Basin wide cross sections (3 along dip, 3 along strike) are included; these incorporate the logged core and their geophysical logs, with additional geophysical logs along the lines of section. The variations in thickness are discussed and all of the data are put into a sequence stratigraphic context.

3.2 Micropaleontology

3.2.1 Background

The overlying Carlile Formation, the Second White Specks Formation and the underlying Belle Fourche Formation are all shales that can be difficult to distinguish one from the other using only the physical characteristics logged from the core. This was especially true when no definite upper or lower contacts for the Second White Specks Formation were obviously present in the core. It was therefore necessary to apply dating techniques to try to distinguish the relative ages of the sediment in each core.

The samples sent for micropaleontology analysis spanned the study area. Problems in micropaleontology dating can arise, however because the differences in depth of burial can affect the preservation of calcium carbonate, and as well, the depositional rates and diagenetic dissolution can affect the amounts of calcareous organic debris (Schröder-Adams, unpublished data, 2004).

The following points list some of the micropaleontological characteristics expected of each formation according to Schröder-Adams (unpublished data, 2004).

- Fish Scales Formation: barren of foraminifera; abundant algal cysts and phosphatic debris

- Belle Fourche Formation: areas barren of benthic organisms; species present include *Verneuilinoides perplexus*

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

- Second White Specks Formation: characterized by planktic foraminifera, nannofossils, *Inoceramus*, lack of benthic foraminifera; *Heterohelix globulosa* and *Hedbergella spp* found in low numbers

- Carlile Formation: usually barren of foraminifera; agglutinated species in the upper part of the Formation

All micropaleontology samples were analyzed and described by Claudia Schröder-Adams of Schröder Paleo Consulting; the details are included in Appendix 6.2 and results are summarized in the following section.

3.2.2 Micropaleontology Results

Cores that were confirmed to contain an interval of Second White Specks Formation include: 00/06-26-059-20W4/0, 00/16-12-046-03W5/0, 02/07-33-052-15W5/0, 00/09-09-056-19W5/0, 00/10-28-059-20W5/0 and 00/10-36-060-22W4.

The first core was confirmed 00/06-26-059-20W4/0 based on the presence of *Inoceramus* and planktonic foraminifera; the core samples are described in detail in Appendix 6.2. Because of a lack of benthic foraminifera within the samples from this core, there is strong paleontological evidence that the bottom waters were fairly anoxic and inhospitable to the benthic foraminifera. This is compatible with a highstand during the time of deposition (Claudia Schröder-Adams, results reported in Appendix 6.2).

Core 00/16-12-046-03W5/0 was also confirmed to be the Second White Specks Formation due to the presence of planktic and agglutinated foraminifera.

Two samples were sent for analysis from core 02/07-33-052-15W5/0. The basal sample, from 1964 m depth, showed a lack of planktic foraminifera and was therefore placed in the Upper Belle Fourche (Bloch et al., 1999). However, a sample from 1955 m

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

depth, which is 9 m stratigraphically above the first sample, indicated it is the Second White Specks Formation due to the presence of planktic foraminifera species. The second sample was therefore placed near the maximum flooding surface (Appendix 6.2; this is discussed further in the following sections).

Samples of core from 00/09-056-19W5/0 and 00/10-28-059-20W5/0 were confirmed as the Second White Specks Formation due to the presence of planktic foraminifera.

The final core, 00/10-36-060-22W4/0, was confirmed as the top of the Second White Specks Formation and the base of the Carlile Formation because of the presence of *Inoceramus* shells and the species of benthic foraminifera indicate the environment was returning to improved benthic condition.

Core from 00/10-22-047-03W4/0 was not sent for micropaleontological analysis because it has been confirmed from prior work to be the Second White Specks Formation (Bloch et al., 1999; Claudia Schröder-Adams, personal communication, 2004).

Core samples from wells 00/05-10-051-04W5/0, 00/06-11-061-22W4/0, 00/06-12-098-13W4/0 (7AS01) and 02/16-27-058-20W5/0 returned inconclusive results using micropaleontology. The first core contained rare *Inoceramus* and white specks were present. However, no planktic foraminifera species were distinguished and the samples could possibly be from the Second White Specks Formation or instead could be from the First White Specks Formation. At any rate, this could not be confirmed using micropaleontology alone. Core from well 00/06-11-061-22W4/0 was completely barren of foraminifera. Thus the sampled intercept may represent the base of the Carlile Formation (which overlies the Second White Specks Formation) because this unit is typically barren of foraminifera in southern and eastern Alberta (Claudia Schröder-Adams in Appendix 6.2). Core samples from well 00/06-12-098-13W4/0 returned planktic species of foraminifera. This would be expected during a sea level highstand and thus the core here may represent either the First of Second White Specks Formation. One

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

of the samples included a bioclastic layer which is typical of the base of the Second White Specks Formation; however, this could not be confirmed using only micropaleontology and the species of foraminifera present (see appendix 6.2). The final core contains calcareous content and *Inoceramus,* but the interval could not be confirmed as the Second White Specks Formation due to the lack of microfossils.

Some of the cores yielded no information about the Second White Specks Formation. For example, samples from 00/02-03-101-12W4/0 (7BK03), 00/06-31-046-08W5/0, 00/06-35-059-21W4/0, 00/14-28-062-05W6/0, 00/15-21-056-19W5/0, 00/16-22-075-08W6/0 and 02/16-18-064-02W6/0 contain some fossils, but no foraminifera. Samples from the two cores, 00/04-02-071-18W5/0 and 00/10-09-066-23W5/0, were completely barren of fossils. As well, core from well 02/06-30-064-01W6/0 was given no stratigraphic placement, because although it did contain rare agglutinated foraminifera, they were poorly preserved. Therefore, none of these cores were placed stratigraphically by micropaleontology.

3.3 Palynology

3.3.1 Background

It was necessary to date the core that did not have a stratigraphic placement and that were in key locations for the study. Samples were chosen from five cores to assign relative dates and to verify the extent of the depth to which the unit penetrates.

All samples were analyzed and described by Graham Dolby of Dolby and Associates (Graham Dolby, unpublished data, 2004).

3.3.2 Palynology Results

Three samples from wells 00/06-31-046-08W5/0, 00/10-22-047-03W4/0 and 00/14-29-048-06W5/0 were confirmed as the Second White Specks Formation; the

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

details for these samples are in Appendix 6.3. The first core was tested because it was not given a relative age using micropaleontology. Core from well 00/10-22-047-03W4/0 was sent for analysis to confirm the results stated in the study by Bloch et al., (1999); the results herein using palynology confirm that the sample is Turonian in age. The final core had not been chosen as one of the core to be sent for micropaleontological analysis; but it was decided at a later time that this core needed to be dated, and thus it was sent to the lab for palynological dating.

The sample from well 00/05-10-051-04W5/0 gave a palynological age that was no older than latest Albian. Therefore, this sample is most likely from the Second White Specks Formation, and this is confirmed by the information provided from the micropaleontology analysis (see above in section 3.2).

The core from well 00/02-03-101-12W4/0 (7BK03) was deemed very important to date because this well was the focus of the anomalous geochemistry results from Dufresne et al's (2001) work and the core represents the overall highest concentration of base and precious metals in this study. Two samples were sent for palynology analysis: one from the base of the core, and the second from the top of the core. The basal sample from 97.8 m returned a Turonian age of the Second White Specks Formation and Dolby (personal communication, 2004, Appendix 6.3) noted that the presence of certain palynomorphs indicates a restricted environment. However, the sample from 84.52 m depth indicates an inconclusive age, although the age of Santonian or younger was suggested, but not confirmed. Due to time and budget restrictions, more samples could not be sent in to confirm this date. However, Dufresne et al. (2001) also noted that there is a 4 to 8 Ma time gap between the top of the Second White Specks Formation and the overlying Lea Park Formation in the Birch Mountains region of Alberta. The problem is compounded because no geophysical logs are available for this core. Therefore, for simplicity, it is assumed for this study that the Second White Specks Formation includes the calcareous shales within the core, and the time gap exists at the top of the formation. The results from the micropaleontology and palynology analyses agreed with the core

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

and log interpretations for the Second White Specks Formation intervals (which follow), with the exception of sample 6131.

3.4 Logged Core

3.4.1 General Description of the Sedimentology of the Second White Specks Formation

Overall, the Second White Specks Formation is primarily composed of shales that are dominated by clays, with minor silt and micas. Generally, towards the northeast, the shale becomes siltier. The shale ranges from medium to dark grey in colour and is fissile to blocky in nature. However, very fine-to medium-sized sand laminations and beds are present in some of the cores. Planar parallel laminations dominate the sedimentary structures, but in places some micro-ripples and soft-sediment deformation features (flame structures, convoluted bedding, slumping, microfaults) exist if sand laminations or beds are present in the core.

Generally, the Second White Specks Formation reacts with hydrochloric acid because it is calcareous. Having said this, the strength of this reaction can vary throughout the length of the formation. This is because the white specks (fecal pellets comprised of calcareous coccoliths) are often present within the Formation, but they are not consistently so. The specks are usually white to yellow in colour, are sand sized and may be concentrated along laminations. Calcite nodules, ranging from 0.5 cm up to a few cms in width, often occur randomly or in clusters. Pyrite also exists as nodules, disseminations and/or grains preferentially concentrated along laminations in many of the cores. While pyrite is abundant in some cores, it is a minor component of others. In general, the concentration of pyrite appears to be higher near the base of the Second White Specks unit, and within the underlying Belle Fourche Formation.

Bentonites are often present as thin units in the Second White Speckled Shale. They range in colour from green, with disseminated pyrite, to white, to a steel blue colour. Bentonitic zones range from competent to very recessive and soft. The abundance

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

of bentonite horizons increases towards the northeast, where core from the Birch Mountains contains the most numerous bentonites and the thickest horizons.

Abundant organic matter is common throughout the Second White Specks unit. For example, macrofossil shells are present, vary in size and type, and they often line up with the fissility. *Inoceramus*, for example is a pelecypod that is often observed. Fish debris, which may be represented by teeth, scales and bones, are often concentrated on surfaces as brown resinous matter. Bone beds occur at the base of a few cores. The bone beds comprise a large amount of organic materials, and also exist in fractures and infilling with carbonates.

3.4.2 Limitations of the Core

The poor condition of some of the core material proved to be a limitation of the study. For example, of the 23 cores logged and included in this study, 3 are very fractured. Further, some of the cores had never been slabbed, therefore, making it very hard to identify sedimentary structures and grain size changes. Three of the core were only a few cms in diameter, making details very difficult to observe. In total, approximately 25 % of the cores were not in ideal condition.

Secondly, the new nomenclature of Bloch et al. (1999) for the Second White Specks Formation, which is used in this work, is not used within the Accumap program. This made it difficult to search for core and logs in this study. It is, therefore, virtually impossible to create a search for the Second White Specks Formation because the underlying shales between the Fish Scales Formation and the Second White Specks Formation have not been divided into the Belle Fourche Formation (see Section 2.2.1 and Figure 2.1). As a result, when a search for core from the Second White Specks Formation was entered, the results returned all shales between the top pick for the Second White Specks Formation and the base of the Fish Scales Formation. This meant that, in some cases, core from the Belle Fourche Formation was improperly identified in the search as lying within the Second White Specks Formation. As a result, some of the cores which

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

were logged, were later identified as the Belle Fourche Formation by sedimentology and micropaleontology dates (see Appendix 6.2). As well, above and below the Second White Specks Formation there also are shales. Finally, the log signature of the Second White Specks Formation varies widely across the basin, thus it was essential in some cases to see the core in order to try and identify which formation the shale actually belongs to.

3.4.3 Contacts with the Overlying and Underlying Formations

Only two cores logged in this study have contacts with both the overlying and underlying units. One core was from the Birch Mountains while the other was from well 10-22-047-03W4 (see Figure 3.1). In some cases it is difficult to identify contacts with the overlying and underlying units. It is also difficult to identify with certainty which unit is present when one or both contacts are missing. Micropaleontology and Palynology samples were therefore sent to help give dates to the formations (see "micropaleontology" and "palynology" sections above for summaries, and the Appendix for details).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

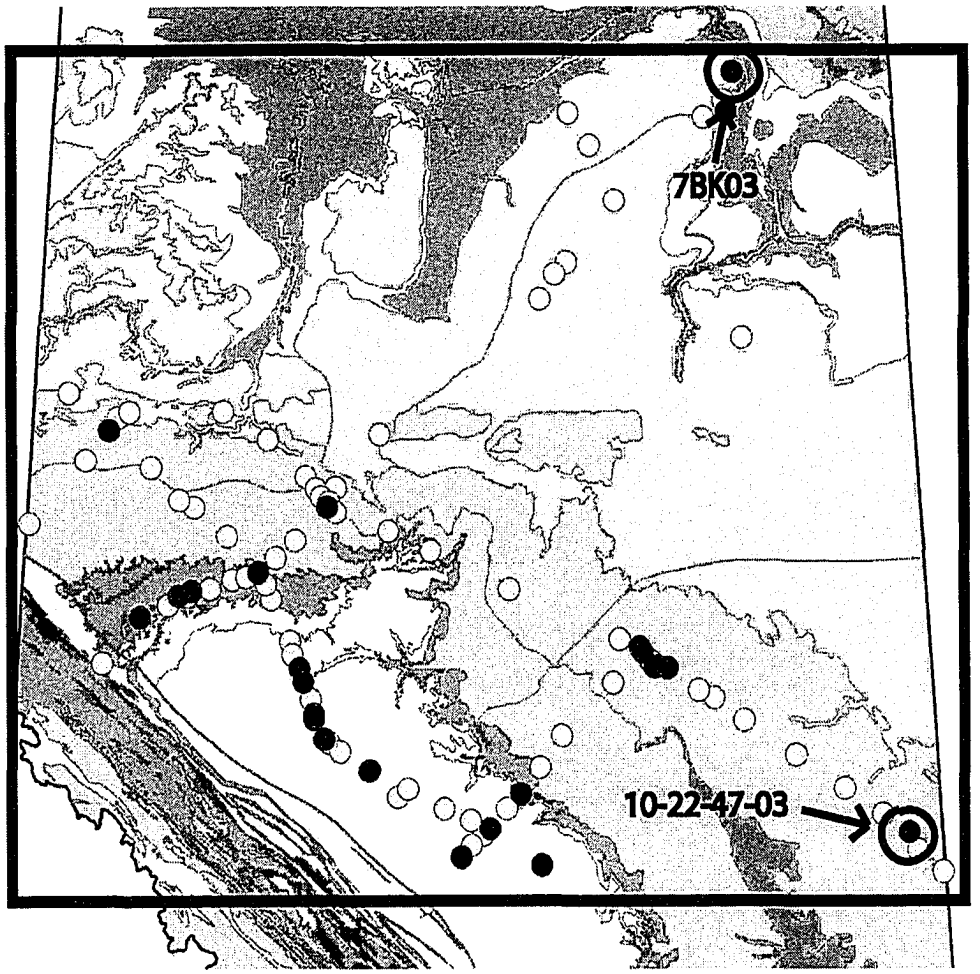


Figure 3.1: Study area showing the location of the two cores that contain both the upper and lower contacts of the Second White Specks Formation.

Following is a brief summary of the Carlile, Second White Specks and Belle Fourche Formations for the most complete and dated core from well 10-22-047-03W4.

Carlile Formation

* Little to no reaction with HCl, minor bentonites, dark grey in colour, little organic debris

---

* Base Carlile/top Second White Specks contact is fairly sharp (organic debris decreasing up section)

Second White Specks Formation

* White specks present; moderate to strong reaction with HCl; minor sandy laminations; medium grey

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

	colour; *Inoceramus,* fish debris, disseminated pyrite near the base
———————	* Base Second White Specks/top Belle Fourche contact is gradual, with the abundance of pyrite increasing down hole
Belle Fourche Formation	* Decrease in reaction with HCl down hole, occasional pyritic mineralized zone (1-5%); fish and shelly debris increasing up hole; may have siderite nodules)

3.4.4 Descriptions and Interpretations for the Logged Core

The following section includes summaries of the observations and short interpretations for each core logged in this study except for the core that were identified as not containing the Second White Specks Formation. These extra descriptions of core are included with the logged core forms in Appendix 6.1.

00/02-03-101-12W4/0 (7BK03): Birch Mountains
Core: 72.17m – 102.05m
Second White Specks interval: 74.875m – 100.94m
Observations:

The interval is dominated by a dark grey calcareous shale which contains clay with minor silt, disseminated pyrite, shell and fish fragments. White specks are not visible in the Birch Mountains core (i.e.: 7BK03 and 7AS01). Bentonites are abundant throughout the interval and are the most abundant of any core logged in this study. The bentonites are steel blue/grey in colour and range in thickness from a couple mms to 26cm. A total of 28 bentonites are identified within the 26m Second White Specks

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Formation interval. At the base of the interval there is fracturing and carbonate fills the veins and fractures. There are abundant shells and fish debris in what appears to be two sandy bone beds in-filled with carbonate. No bioturbation is observed. The core is fairly homogeneous. The shale is siltier than the shales of the Second White Specks Formation south of the Birch Mountains.

Interpretation:

The core comes from the Fort MacKay area of northeastern Alberta. The core represents the whole interval of the Second White Specks Formation and also contains the upper and lower contacts. The absence of coarser grains, and the dominance of finer grains, suggests a low energy environment. This agrees with the observation that abundant bentonites are preserved. The bentonites found in the Birch Mountains core do not all correlate with bentonites found in central and southern Alberta. Due to the presence of abundant bentonites compared with the southern wells, local volcanism is suggested (Dufresne et al., 2001) and is discussed in the following sections. There are very few sand sized particles and the coarsest grains are dominated by silt sized particles and organic debris which are concentrated by contourites. The two bone beds at the base of the interval may have been kill zones where abundant fish and shelly debris accumulated. The core is fairly homogeneous indicating that the environment of deposition remained stable and low energy. As the shale is fairly silty compared to the core in the southern Alberta locations, it is inferred that the site of deposition was closer to the sedimentary entry point (the paleoshoreline).

00/05-10-051-04W5/0: Wabamun No 1

Core: 1252.36m – 1305. 675m

Second White Specks interval from cross section: 1202m – 1289m

Observations:

The core has a very small diameter, making it difficult to log. At the base of the core is a dark grey shale with minor silt and organic debris. A 9 cm thick bentonite is

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

observed as well as minor very fine silty laminations. At a depth of 1303m, sand is no longer observable. The shale has minor shells and a weak reaction with hydrochloric acid. With decreasing depth in the core the only change observed is a few minor very fine sand laminations between the depths of 1292m to 1285.5m, along with a few 0.5-1cm ripples near the top. A few siderite grains and cement are observed at 1287.8m. Stratigraphically above the sand laminations, within the shale, is a dark grey shale with minor silt, shelly and fish debris and planar parallel laminations. The reaction with hydrochloric acid increases up the logged section. The core is a homogenous dark grey shale at the top. It contains minor disseminated pyrite, and a few thin mm thick bentonites are observable.

Interpretation:

The core is found near the base of the Second White Specks interval and has a lower contact with the underlying Belle Fourche Formation. The core is dominated by a dark grey shale with minor silt and represents sedimentation in a low energy environment. The silt and organics were concentrated into laminations and small ripples by contourites. This is supported by the observation of a few small asymmetrical ripples which indicate a unidirectional current and the overall fine grained nature of the sediment, which is discussed further in the following section. There was an increase in current activity, due to the presence of minor sand laminations up section. Through time, as the sea level continued to rise, the paleoshoreline moved further away from the site of deposition. The energy was low enough to preserve bentonites.

00/06-11-061-22W4/0: Northstar Abee 6-11-61-22

Core: 499.85m – 513.52m

Second White Specks interval from cross section: 506m – 553m

Observations:

The base of the core comprises a dark grey shale with shelly material, minor bioturbation, minor sandy laminations and soft sediment deformation. A sandy package is present up the logged section of the shale with minor bioturbation, shale laminations,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

ripples and soft sediment deformation. There is a transition into overlying dark grey shales with white specks, ripples, fine sandy laminations and minor soft sediment deformation. Minor burrows are observed along with a bentonite horizon. The dark grey shale and sand laminations continue up the core, and are fairly consistent, although the bioturbation is no longer observed at the top of the core.

Interpretation:

The core represents the top of the Belle Fourche Formation and the base of the Second White Specks Formation. At the base of the core there is abundant sand and bioturbation which is expected for the Belle Fourche Formation. The sediments fine upward toward the bentonite layer, indicating that the sea level was rising and the presence of a bentonite is observed at the base of the Second White Specks Formation. The environment was hospitable to organisms (there is a small amount of bioturbation), but was also able to preserve some organic material. The core above the bentonite (which is represented by the Second White Specks Formation) is dominated by shales which indicate a quieter low energy environment but where contourites were still able to transport sands. Currents were able to concentrate the coarser grains into laminations and lenses. The environment became less hospitable to organisms.

00/06-12-098-13W4/0 (7AS01): Birch Mountains

Core: 11.27m – 19.48m

Second White Specks interval: 11.27m - 18.48m

Observations:

This core is from the Birch Mountains, slightly south of 7BK03. At the base of the available core is a light to medium grey shale, with an overlying bed of siltstone. Above the siltstone is a dark grey silty shale that coarsens upwards into a siltstone. Up the logged core are two crystalline sandstone beds that appear out of place within the shale and are discussed in the interpretation below. Above this is lost core (see Appendix 6.1) then a light to medium grey silty shale with abundant bentonite horizons (10 bentonites

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

within 2.5m thickness), some shelly and fish debris, and a strong reaction with hydrochloric acid. Between 14.5m to 14m depth, a few small scale ripples were observed.

Interpretation:

The core begins at the surface and covers the contact between the Second White Specks Formation and the underlying unit, the Belle Fourche Formation. The actual contact between the two formations appears to have been lost in section of lost core which is recorded on the logging form (see appendix 6.1) The lithologies present in the core are fairly uniform, suggesting a consistent environment of deposition. The environment was lower energy and had the capacity to preserve organic debris and bentonitic horizons. The currents most likely concentrated the sand, silt and organic debris, as well as producing the observed ripples. The shale in this core is coarser grained than the Second White Specks Formation cores south of the Birch Mountains and appears similar in lithology to the core from 7BK03. This is probably due to the fact it was closer to the paleoshoreline, allowing the coarser grains to be brought to the deeper basin where the shales were deposited.

The two units that are crystalline in nature and embedded within the interval appear to be glacial deposits. The rock does not look like anything seen or described within the Second White Specks Formation, is white, coarse crystalline in nature, has abrupt sharp contacts and does not resemble sands previously observed in the Second White Specks Formation, which are not crystalline. It is also noted that the core lies within 20m of the surface in the Birch Mountains, and it is probable that glacial sediments could be deposited within the unit. These would be eroded sediments from the glaciers that were deposited within the shales.

00/06-26-059-20W4/0: Northstar Radway 6-26-59-20

Core: 458.09m – 471.05m

Second White Specks interval from cross section: 447m – 486m

Observations:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The core is fairly uniform. It consists of a dark grey shale with a moderate reaction with hydrochloric acid and fish debris, minor silt, sand and abundant shelly debris (see Plate 3.2A) at the base of the core. There is no visible grain size change. There are a few bentonites which occur throughout the interval. White specks are observed, and pyrite in disseminated and nodular form occurs towards the top of the succession. One third of the way up the core, calcite nodules are observed.

Interpretation:

The core is from the center of the interval of the Second White Specks Formation. There are no contacts with the overlying or underlying units. This was a quiet, deeper marine environment where currents concentrated silt, sand, shells and fish debris in between the planar parallel laminations of shales. The waters had low enough energy to preserve bentonite horizons. The environment of deposition remained fairly constant, as the section of core does not show many physical changes.

00/06-31-046-08W5/0: Amoco Pembina

Core: 1803m – 1822.49m

Second White Specks interval from cross section: 1782m – 1904m

Observations:

The core is homogeneous. It is composed of a dark grey shale with minor silt and sand grains, with a strong reaction to hydrochloric acid, shell debris and parallel laminations. At 1820.5m depth, calcareous nodules are observed. White specks and fish debris occur above this depth. At 1816.2m depth, a light grey upper very fine sand lamination with disseminated pyrite is observed. The shale remains uniform to the top of the core.

Interpretation:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

This section of core lies within the Second White Specks Formation interval, and does not represent any contacts with overlying or underlying formations. The environment remained fairly constant because there was not much change seen within the core. This was a low energy, deeper environment with currents moving and concentrating the sands, silts and organic debris. The sea floor was hospitable to the preservation of organic debris and pyrite. This core did not experience much sand deposition from contourites.

00/06-35-059-21W4/0: Grt Plns Thorhild 6-35-59-21

Core: 457.18m – 469.37m

Second White Specks interval from cross section: 463m – 504m

Observations:

The base of the core comprises a dark grey shale that reacts vigorously with hydrochloric acid. Steel grey bentonites are visible, and very fine sandy laminations occur along with ripples. White specks are abundant. Stratigraphically higher, the sandy laminations coarsen into fine grained sediments. Ripples and soft sediment deformation become more abundant. The overlying shale is composed of dark grey shales that have weak, to no reaction, with hydrochloric acid. The abundance of sandy laminations decreases upwards, however, siderite is visible near the top of the core.

Interpretation:

The core straddles the boundary between the Second White Specks Formation and the overlying unit, most likely the Carlile Formation. The base of the core (represented by the Second White Specks Formation) consists of a low energy depositional environment because of the fine grained sediments and the preservation of bentonites. The unit is typical of the Second White Specks Formation, and sands with ripples indicate that there was a unidirectional current, most likely contourites, concentrating coarser grained sediment. Stratigraphically above the Second White Specks Formation is the Carlile Formation which has no reaction with hydrochloric acid and contains siderite

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

concretions. The energy of deposition is still low, with contourites continuing to concentrate coarser grained sediment.

00/09-09-056-19W5/0: HCS Et Al Beavercreek 9-9-56-19

Core: 2237.12m – 2273.09m

Second White Specks interval from cross section: 2198m – 2282m

Observations:

The core is fairly uniform, consisting of a clay-rich dark grey shale containing minor silt. Shelly debris persists throughout the interval (see Plate 3.2B, 3.2C), as well as disseminated pyrite (see Plate 3.4A), and pyritized shells. The unit contains abundant organic debris. Near the base of the core, calcite nodules are present. There is generally a weak reaction with hydrochloric acid. Bentonite horizons are preserved. Above the section of lost core indicated in the logging form (in the Appendix 6.1) the Second White Specks Formation reacts strongly with hydrochloric acid. Minor thin sandy calcareous laminations are visible, often with disseminated pyrite. At approximately 2245m depth, abundant pyrite nodules are present. Above this, minor very fine sandy laminations are visible. Near the top of the core, the reaction with hydrochloric acid decreases. The core is dominated by dark grey shale with abundant shelly debris, minor silt and disseminated pyrite.

Interpretation:

This core lies within the Second White Specks Formation, towards the top of the interval, with no contacts with the overlying or underlying units. The core is fairly uniform, indicating that there was not a lot of change in the environment of deposition. The environment appears to be anoxic due to the preservation of abundant pyrite and organic debris. Bentonites are preserved near the base of the interval indicating that there was volcanism. Abundant fine grained sediments are also preserved indicating a quiet environment. There are interdispersed sandy laminations and pockets of silt which were most likely concentrated by currents.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

00/10-22-047-03W4/0: Anderson Et Al Paradise 10-22-47-3

Core: 409.02m – 463.27m

Second White Specks interval from cross section: 426m – 440m

Using micropaleontology analyses (see above section), this unit was confirmed to be the Second White Specks Formation between 426.7m and 440.415m depth (Schröder-Adams, personal communication, 2004). This is the only core south of the Birch Mountains in this study that has both top and basal contacts.

Observations:

Carlile Formation:

This is a medium to dark grey shale with little to no reaction with hydrochloric acid. There is also some fish debris in places. Bentonites are present throughout the interval and the thickest (up to 15 cm) bentonites are at the top of the unit. There are abundant, thin, calcareous, very fine sandy laminations. Minor sandy ripples are present. Some shells and shelly debris are present. The organic debris increases in abundance towards the underlying contact with the Second White Specks Formation.

Second White Specks Formation:

The upper contact with the overlying Carlile Formation is fairly sharp, changing from the overlying dark grey shales of the Carlile Formation to the underlying medium grey shales of the Second White Specks Formation. There is also a greater abundance of organic debris in the Second White Speckled Shale. White specks are visible and they have a strong reaction with hydrochloric acid. At the base of the Carlile Formation there is a slight increase in the abundance of fine sandy laminations just before the contact with the Second White Specks Formation.

In general, the Second White Specks interval is fairly uniform in that it is a fissile, medium grey shale dominated by clays with abundant white specks (see Plate 3.3B). It

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

reacts vigorously with hydrochloric acid. The Formation contains white/grey coloured fine sand laminations up to 3 mm in thickness. There is abundant fish debris and shells, including *Inoceramus*. There are a few very thin steel grey coloured bentonites. Minor disseminated pyrite is visible near the base of the unit.

The basal contact between the underlying Belle Fourche and the overlying Second White Specks is gradual. The shale becomes blocky. The reaction with hydrochloric acid decreases. Multiple millimeter thick bentonites are present at the base. At the top of the Belle Fourche Formation, there is an increase in the abundance of sandy laminations, as well as ripples and soft sediment deformation.

Belle Fourche Formation:

This is a dark grey shale. At the base of the unit, there are very few sandy laminations. In places, there is a strong reaction with hydrochloric acid. In other locations, there is weak to no reaction with acid. Some thin bentonites occur throughout the Formation, but they are concentrated at 459.5 m and 447.25 m depth. At approximately 458 m depth, there is an increase up section in the abundance of pyrite, both in disseminated and nodular form. The shale is finely laminated, with minor sandy laminations. At 454.13 m to 455.67 m depth, a heavy mineralized zone of pyrite is observed. Upward in the Belle Fourche Formation, fish and shelly debris increases. The abundance of sand laminations also increases. Minor bioturbation is present. The upper contact of the Belle Fourche Formation with the overlying Second White Specks Formation shows an increased occurrence of sandy laminations, an increase in the abundance of fish and shelly debris, and as well ripples and soft sediment deformation.

Interpretation:

The base of the Belle Fourche Formation in core is dominated by shales with few sandy laminations and the occurrence of bentonites. This indicates a deep, quiet environment for the bentonites to be preserved. The concentration of silt, sand, fish and shell debris appears to have been transported by currents. There is no evidence of any

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

bioturbation. Primary bedding structures are still apparent. At 458 m depth, there is an increase in pyrite, which is indicative of an anoxic environment. The preservation of pyrite continues up section and includes a 20 cm thick unit that is pervasively pyritized.

An increase in the abundance of sandy laminations occurs upward, as well as an increase in the amount of organic debris within the Belle Fourche. Soft sediment deformation and ripples are locally present. The asymmetrical ripples point to a unidirectional current and also indicates an enhanced current activity that allowed an increased amount of sand to be transported to the sight of deposition. The contourites also concentrated an increased amount of organic debris. Finally, because bentonites are preserved, this indicates the energy was low at the deposition site.

The preservation of more organic remains marks the deposition of the Second White Specks. The concentration of the white specks into laminations by currents is apparent. Bentonites are preserved, and much fewer sandy laminations are present. A bentonite horizon, along with an increase in the abundance of organic debris, is present at the base of the formation in the core. The unit is fairly uniform with abundant organic debris being preserved. Minor amounts of pyrite are present, and indicate a reducing environment.

Near the contact with the overlying Carlile Formation, the abundance of sand laminations increases within the Second White Specks Formation, indicating an increase in the current activity and this transported the coarser grains to deeper waters. Ripples and soft sediment deformation occur near the contact; this may be due to storm activity and current reworking. The contact between the two units is sharp (moving into a darker shale) and this may indicate a decrease in the abundance of organic matter, but the environment of deposition in both the Second White Specks and Carlile Formation shales remained low energy. Primary sedimentary structures are still present and the low energy environment allowed the preservation of bentonites within the Carlile Formation, as well as laminations and ripples. It appears that there was intermittent activity depositing the coarser sands, while still allowing the deposition of much finer grains.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

00/10-28-059-20W5/0: Hol Taurvs Fir 10-28-59-20

Core: 1876.56m – 1888.5m

Second White Specks interval from cross section: 1787m – 1906m

Observations:

The core is not slabbed. It is rubbly in some areas, therefore, it was difficult to carry out detailed descriptions of the core. The base of the core consists of a dark grey shale with little to no reaction with hydrochloric acid. The shale is dominated by clays. Minor silt and shelly debris (see Plate 3.2D) increases in abundance up section. A few siderite grains are visible, as well as a thin bentonitic horizon.

Moving up section, the reaction with hydrochloric acid increases. At approximately 1883.5m depth, disseminated pyrite and pyritized shells become apparent. Very fine calcareous sandy laminations become more abundant with decreasing depth. Near the top of the core, small ripples and loading is observed, as well as pyrite within calcareous laminations, and abundant shelly debris.

Interpretation:

This core is found near the base of the Second White Specks Formation interval. The base of the core represents a low energy deeper environment. The environment preserved a fine grained bentonite. The silt and shelly debris was most likely concentrated by currents. The environment was anoxic and preserved pyrite and pyritized shells. Moving up section, calcareous sandy laminations increased in abundance, due to an increase in the current activity, allowing coarser grains to be carried out to the deeper water environment. This is also supported by the fact that ripples are observed, indicating a unidirectional current. The environment continues to be fairly inhospitable to organisms as no bioturbation is observed.

00/10-36-060-22W4/0: Amoco Thorhild 10-36-60-22

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Core: 489.79m – 498.59m

Second White Specks interval from cross section: 491m – 535m

Observations:

At the base of the core is a dark grey shale that reacts vigorously with hydrochloric acid. It contains laminations of fine to medium grained sand that increase in abundance up section. The shale contains minor fish and shelly debris and some soft sediment deformation (see Plate 3.3C). At approximately 496.50m depth, there is a dramatic increase up the logged core in the sand to shale ratio. The unit becomes much sandier, with laminations of shale and minor bioturbation present. Continuing up the core at approximately 493.75m, the sand to shale ratio decreases. This section is composed of a dark grey shale with thin sandy laminations which fine upwards. There is abundant fish and shelly debris, as well as some soft sediment deformation.

Interpretation:

This core partially lies at the top of the Second White Specks Formation and the contact between the overlying Carlile Formation. There is a gradual contact between the Second White Specks and the Carlile Formation. White specks are observed at the base of the core and there is a reaction with hydrochloric acid, therefore, it appears that this is the top of the Second White Specks Formation. The mixture of shale with sand laminations was deposited in a deeper marine setting. During the time of deposition, contour currents transported and deposited the coarser grains while there were periods where the contourites carried much more sand in this location. This agrees with the unidirectional ripples and soft sediment deformation observed. Because of the presence of bioturbation where the sand to shale ratio increases, there is indication that the time and location of sediment deposition was slightly more hospitable to organisms. It must also be noted that the location of core is W4, and was deposited in a location that was closer to the paleoshoreline. Near the top of the cored section, the environment became less hospitable to organisms as the sea level continued to rise during the highstand (see section on sequence stratigraphy). The environment of deposition remained fairly low energy, as the

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

dominant sediment continues to be shale, but where currents were still able to concentrate and transport sands, silts and organic matter.

00/14-29-048-06W5/0: Imp Cdn-Sup Pembina 14-29 Br-48-6

Core: 1539.16m – 1577.32m

Second White Specks interval from cross section: 1532m – 1595m

Observations:

The core has a very small diameter, therefore, details can be difficult to observe. There appears to be some lost/extra core in areas, therefore, the depths may not be trusted to be true in all cases. At the base of the core is a dark grey shale with minor silt, fish debris and weak to no reaction with hydrochloric acid. There is an interval of lost core. Above this is a dark grey shale with minor silt with an increasing reaction with hydrochloric acid up the core. White specks are observed as well as shell and fish debris. A bentonite is observed in addition to a very fine sand lamination.

Up section, the very fine sand laminations become slightly more abundant. The silt percentage of the shale also increases slightly. Pyrite is observed (see Plate 3.4B). In between 1559.5m and 1557m depth, the sand laminations increase in abundance. Ripples and soft sediment deformation are apparent. A bentonite is observed in this interval. Moving up the logged core, the sand laminations decrease in abundance. Sand occurs dominantly in lenses. There is a strong reaction with hydrochloric acid. A bentonite is observed as well as disseminated pyrite, shell and fish debris. White specks are perceived and the remaining top of the core is fairly homogeneous.

Interpretation:

The core is representative of the top and the center of the Second White Specks interval for this hole. There are no contacts with the overlying or underlying units. This is a lower energy environment, dominated by fine grained sediments with minor silt and

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

sand, which were most likely concentrated by currents. Shells, fish debris and other organic matter, as well as pyrite, were preserved due to anoxic sediment.

The environment of deposition remained fairly constant, aside from a slight increase in the percentage of silt and sand due to an increase in activity of the contourites. This agrees with the unidirectional ripples observed and the minor soft sediment deformation. The sand and silt percentages then decreased near the top of the core, due to a decrease in current activity.

00/16-12-046-03W5/0: Imperial-Battle Lake No 1

Core: 1533.07m – 1574.99m

Second White Specks interval from cross section: 1474m – 1552m

Observations:

This core has a very small diameter, and logging in detail was difficult. The base of the core comprises a dark grey shale with weak to no reaction with hydrochloric acid. It includes lenses of very fine sand and silt. Shell debris is present. Above the section of lost core, fish debris is also observed. There is a "burnt looking" unit at 1571m depth. It is red/black in colour and heavily mineralized and contains pyrite. At 1566m depth, multiple bentonite horizons are observable. Pyrite and a pyrite nodules are discernable, as well as grains of siderite. A few small scale ripples are observed at 1558m, as well as large shells, some of which are pyritized.

The core above the lost core includes a dark grey shale with less silt and sand present than the underlying shale. There are minor white specks, fish debris and shell debris present. The reaction with hydrochloric acid increases up the core. A bentonite is observed at 1543.3m depth. At 1542m depth, a calcareous fine sandy lamination is observed with disseminated pyrite. The percentage of sand continues to decline up section. White specks and disseminated pyrite can easily be observed at the top of the core.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Interpretation:

This core is found at the base of the Second White Specks Formation, and the top of the underlying Belle Fourche Formation. The location of core where there should be a contact between the Belle Fourche and the Second White Specks is part of the lost core. The underlying Belle Fourche Formation was deposited in a deeper water, low energy environment. There was a gradual change from the Belle Fourche to the Second White Specks unit which had a strong reaction with hydrochloric acid and contains white specks, although the actual contact is missing due to lost core. The Second White Specks shale contains silty and very fine sandy lenses, most likely deposited and concentrated by currents. The environment was fairly anoxic because pyrite and organic matter was preserved. The core, however, remains fairly constant as did the depositional environment. The only noticeable difference in this core between the Second White Specks and the Belle Fourche was that the Second White Specks had a much more vigorous reaction with hydrochloric acid.

02/06-30-064-01W6/0: Rax Et Al 102 KA Karr 6-30-64-1

Core: 1555m – 1563.6m

Second White Specks interval from cross section: 1515m - ?

Observations:

The core begins with a dark grey shale and very fine sand laminations (see figure 3.1A) with interfingering ripples and cross laminations. These are starved ripples where the tops of the laminations are truncated. Calcite nodules are observed. There is a weak reaction with hydrochloric acid. White specks are abundant, as well as loading and convoluted bedding. In the center of the core, there is disseminated pyrite. Upwards, the occurrence of sand laminations decreases. The core is fairly uniform. White specks can be seen throughout the whole unit (aside from the very top of the core). The specks are slightly yellow and react mildly to vigorously with hydrochloric acid. The top of the unit is more calcareous than the base of the unit.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Interpretation:

It is not known how near to the base of the Second White Specks interval this core lies. There was not much changing throughout the core. The grain sizes remained fairly constant indicating that the environment of deposition remained fairly constant during the deposition of the logged section. This was a low energy environment. The organic debris, white specks, sand and silt appeared to have been concentrated by currents. This agrees with the unidirectional ripples observed and the soft sediment deformation. The bottom waters were most likely anoxic due to the lack of bioturbation and the preservation of organics and pyrite.

02/07-33-052-15W5/0: Husky Et Al Skinner 7-33-52-15

Core: 1950m – 1969.18m

Second White Specks interval from cross section: 1880m – 1955m

Observations:

The interval is fairly uniform. The basal section of the core is a dark grey shale dominated by clays, with minor silt and little to-no-reaction with hydrochloric acid. There is some fish (see Plate 3.3A) and shelly debris. Some shells have been pyritized. Some very fine sandy lenses can be discerned. Up the core, *Inoceramus* shells can be identified, as well a few very fine sand laminations. The upper shale is composed of the same dark grey shale, with a moderate reaction with hydrochloric acid. Shells, fish debris and organics are abundant as well as disseminated pyrite, and pyrite replacing shells.

Interpretation:

The core occurs near the base of the Second White Specks Formation interval. It crosses into the underlying Belle Fourche Formation. There was not much change seen in this core. It was fairly homogeneous with the contact between the Second White Specks and the Belle Fourche being very gradual. The shales were deposited within a low energy, deep marine setting. The location was reducing, allowing the preservation of

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

pyrite, and pyritization of shells. Abundant organic matter was also preserved. Currents were most likely the mechanism by which silt, sand and organic matter was concentrated. The physical differences observed in the core, include the presence of *Inoceramus* within the Second White Specks Formation and in increase in reaction with hydrochloric acid.

02/16-18-064-02W6/0: Rax Et Al 102 KA Karr 16-18-64-2

Core: 1696m – 1706.1m

Second White Specks interval from cross section: 1659m – 1717m

Observations:

There is not much change in lithology throughout the core. It is dominated by a dark grey shale, with minor shells, very fine sandy laminations, abundant ripples and soft sediment deformation. At 1699.8m depth there is a calcite concretion. Up section, minor pyrite is observable. There is generally a weak reaction with hydrochloric acid. The reaction with the shale results in a sulphurous smell. The occurrence of sand laminations increases slightly up the core, along with an increase in the appearance of cross laminations, ripples and soft sediment loading. The core is zebra-like in colour, where the shale is black and with white laminations comprised of white specks (coccolith debris).

Interpretation:

The interval of core lies within the center/base of the Second White Specks Formation. The core seems typical of the Second White Specks Formation. It is a very fine grained shale indicating a low energy of deposition. Contourites concentrated the sand sized grains, silt and organic matter into unidirectional ripples, and deformed them through soft sediment deformation. The interbedded sandy laminations are almost white in comparison with the surrounding dark shale and are most likely concentrated with white specks making them almost white in colour. There was not much change throughout this core. This was an indication that the environment remained unchanging, as the thickness and abundance of sandy laminations did not change much throughout the unit.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

02/16-27-058-20W5/0: Amoco Pinenm 16-27 Ek-58-20

Core: 1825.05m – 1836.8m

Second White Specks interval from cross section: 1772m – 1856m

Observations:

Many locations of the core are rubbly. The core has not been slabbed. As a result, features are hard to distinguish. The core is fairly homogeneous. It is dominated by a mica rich dark grey shale with lenses of silt, some shells (*Inoceramus*) and very fine sandy calcareous laminations. It appears that the core is siltier towards the base, along with a minor increase in abundance of shells in the center of the unit. There is a minor increase in the occurrence of calcareous laminations towards the top. The reaction with hydrochloric acid ranges from weak to strong, with minor disseminated pyrite and pyritized shells. One bentonite is identified at 1832.72m depth. No white specks are observed.

Interpretation:

The core is found in the base/center of the interval of the Second White Specks Formation and there are no contacts with underlying or overlying units. The environment of deposition was fairly constant, due to the lack of heterogeneity observed in the core. The sediments were deposited in a low energy, deeper environment. The environment allowed fine grained sediments to be preserved without any visible bioturbation. Silts and sandy laminations could have been concentrated by currents. The occurrence of pyrite and pyritized shells and the lack of bioturbation indicated that the environment was anoxic and inhospitable to organisms. This also preserved the organics within the dark grey shale. An increase in current influence would explain the small increase in occurrence of sandy laminations towards the top of the core.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

A) B)

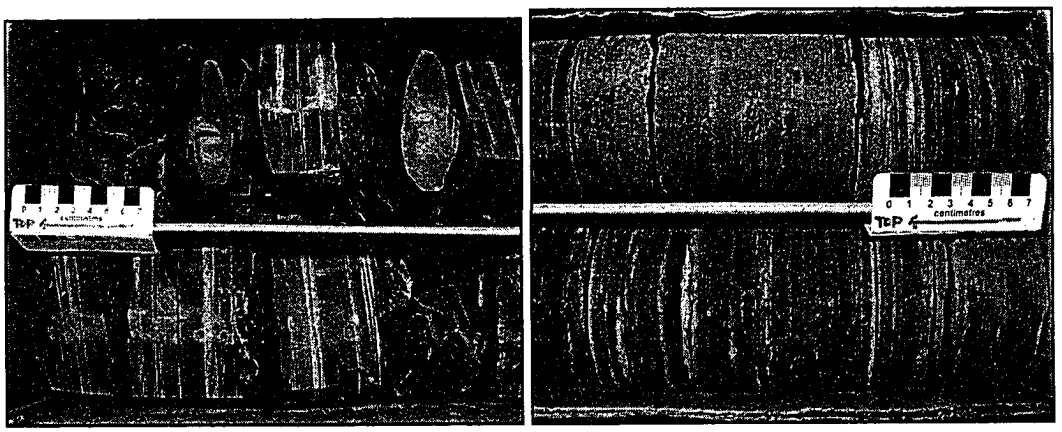


Plate 3.1: Pictures of various core: A) Core from well 02/06-30-064-01W6/0 with shale core with abundant lenses and laminations, 1550 m depth; B) Core from well 00/06-03-061-22W4/0 with shale core showing lensing, laminations and soft sediment deformation, 504.15 m depth.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

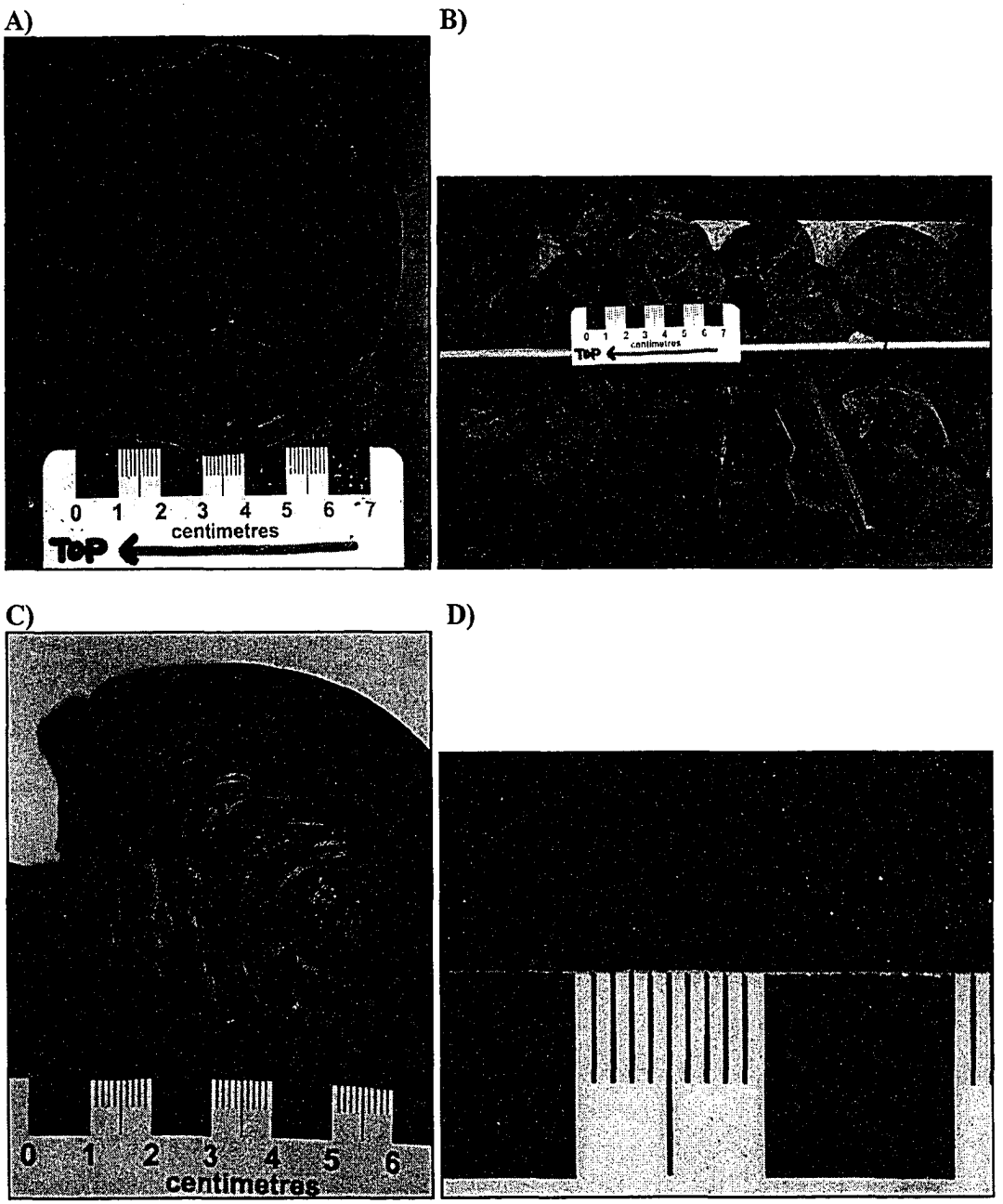


Plate 3.2: Pictures of various core: A) Core from well 00/06-26-059-20W4/0 with a cross section through a large shell at 458.9 m depth; B) Core from well 00/09-09-056-19W5/0 shows broken dark grey shale core, with abundant shelly imprints, at 2246.42 m depth; C) Core from well 00/09-09-056-19W5/0 shows a large shell within dark grey shale at 2247.58 m depth and D) Core from well 00/10-28-059-20W5 shows a dark grey shale with a very small organic debris... (the scale is in cms; see picture C) at 1879.14 m depth.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

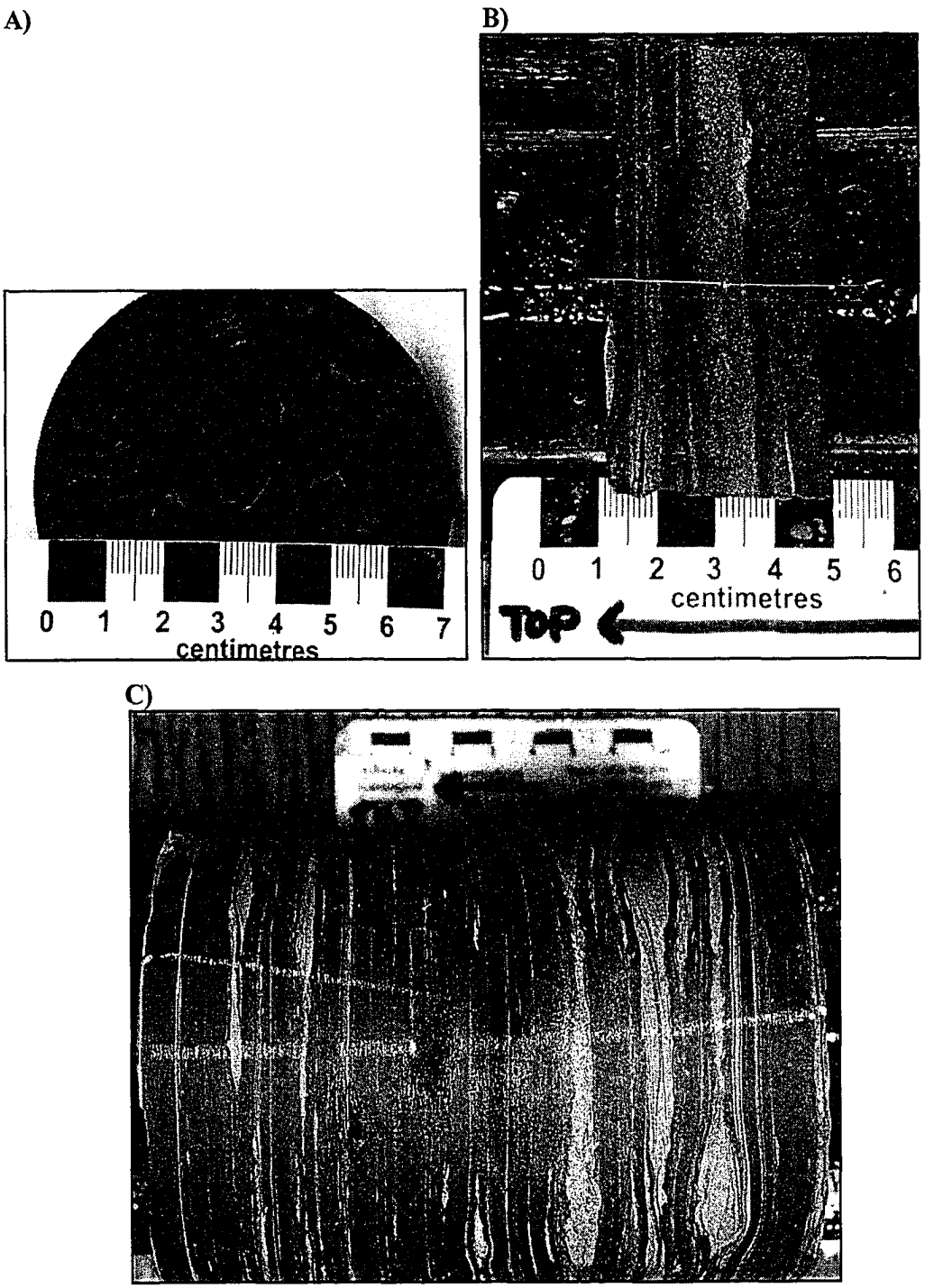


Plate 3.3: Pictures of various core: A) Core from well 02/07-33-052-15W5/0 shows a broken surface of dark grey shale with fish debris at 1967.54 m depth; B) Core from well 00/10-22-047-03W4/0 shows abundant white specks, some are disseminated, some are concentrated into laminations and react vigorously with HCl, at 427.995 m depth and C) Core from well 00/10-36-060-22W4/0 shows small scale ripples and soft sediment deformation, at 498.17 to 498.3 m depth.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

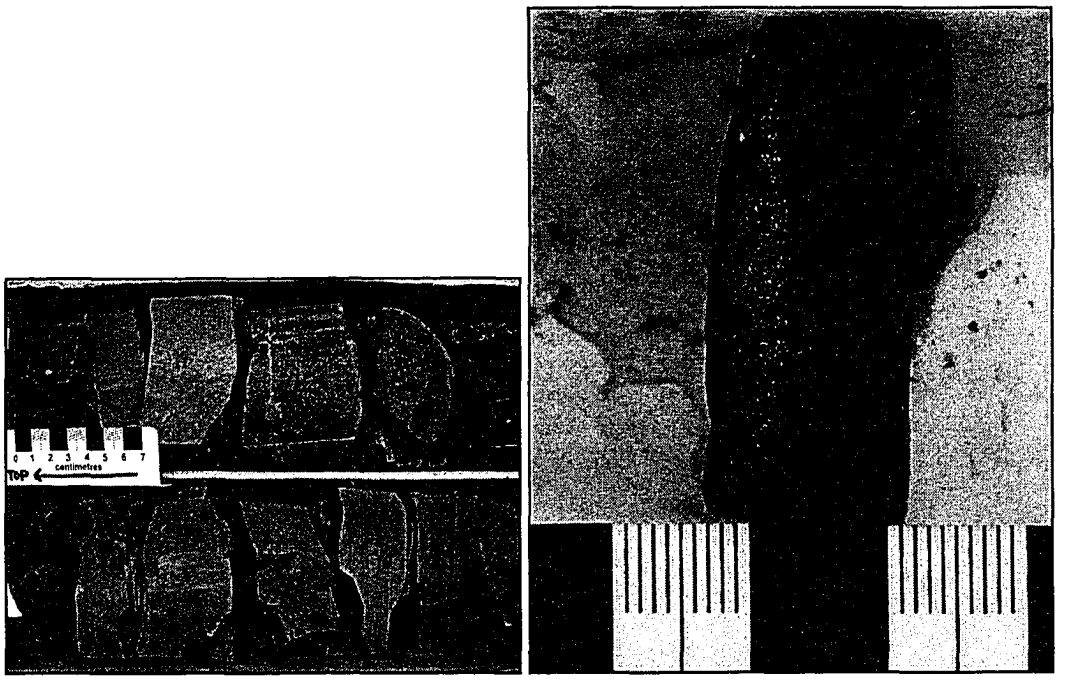


Plate 3.4: Pictures of various core: A) Core from well 00/09-09-056-19W5/0 shows two pyrite nodules at 2244.87 m depth and B) Core from well 00/14-29-048-06W5/0 shows a lense of pyrite at 1567.03 to 1567.035 m depth.

3.5 Contourites and a General Discussion of the Core

West of the 6th meridian (118 degrees west longitude), the core from this part of the study represents sedimentation within the deepest location of the basin during the Mid-Late Cretaceous. Only four cores from this area were logged in this study, and only two of them appear to contain an interval of the Second White Specks Formation, whereas and the other two appear to cover the underlying Belle Fourche Formation. None of the core contains contacts with the overlying and underlying units; therefore, the descriptions are of the center of the formations. Within the underlying Belle Fourche Formation, sand laminations within a dark grey shale and minor bioturbation was observed. From the observations, the Belle Fourche within the deep basin was deposited in a fairly low energy environment, but it could still support minor biota on the sea floor. The waters were, therefore, oxygenated enough and contour currents could transport and concentrate sands and shell debris. Siderite is also a common occurrence within the Belle Fourche Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Generally, the Second White Specks in the area is represented by a uniform dark grey shale and minor sand laminations. Located in the deepest part of the foreland basin, it is expected that the environment of deposition was of the lowest energy and remained fairly stable. This agrees with what was observed in the core. As opposed to the underlying Belle Fourche Formation, there is no bioturbation present and this indicates that the environment became more anoxic and inhospitable for organisms. Bentonites are also not recorded in these cores of the Second White Specks Formation. This is due to either the source of volcanism being too far away to reach the location of deposition or else the depths where the bentonites occur were not cored. It should be noted that often a bentonite occurs near the base of the Second White Specks Formation (Bloch et al., 1999), therefore, the second scenario is the most probable.

West of the 5th meridian (114 degrees west longitude), 12 cores were logged within this study, but 4 of the cores were found to not represent any interval of the Second White Specks Formation. The remaining 8 cores represent the middle of the basin within Alberta, and are still within the deeper part of the basin, but closer to the paleoshoreline to the east than the core west of the 6th meridian. The core logged within this study represents the basal and middle portions of the Second White Specks Formation within the area, but no core were available that represented the top of the Second White Specks Formation.

The underlying Belle Fourche Formation shales within this location demonstrate a gradual shift into the Second White Specks Formation, and no sharp transitions are observed. This would indicate a slow change into the Second White Specks Formation environment. There is little difference between the two units, aside from a slight increase in reaction to hydrochloric acid and the presence of white specks (coccoliths). Bioturbation is observed within the Belle Fourche of one of the cores, but not in the other cores. This may indicate that this location was less hospitable to organisms, and that sediment became increasingly inhospitable up through into the overlying Second White Specks Formation. The environment of deposition was very low energy and continuous,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

due to the small grain size observed, and the lack of any sharp contacts. Whole sections of core are represented by unchanging calcareous dark grey shales. The environment remained stable. Minor bentonites are observed indicating volcanic activity within the area. Up section, the environment of deposition of the Second White Specks remains the same. A slight increase in concentration of pyrite and organic matter is observed. Pyrite as nodules and within laminations are observed more frequently than the lower formation. Minor bentonites are observed throughout the middle and upper formation, indicating that rare volcanic activity still occurred within the vicinity.

West of the 4th meridian (110 degrees west longitude) and south of the Birch Mountains, 5 cores were logged. These cores represent sediment that was deposited closest to the paleoshoreline within central Alberta. The underlying Belle Fourche Formation in this region is composed of sediments deposited within a low energy environment with minor burrowing. The environment was slightly more oxygenated, and could support a limited biota. The waters were still fairly anoxic, as indicated by the abundant presence of pyrite. Bentonites are often observed throughout the formation, therefore, volcanic activity occurred throughout the deposition of the formation. Bentonites and an organic debris layer are observed at the base of the Second White Specks Formation, but the contact is gradual. Minor pyrite is observed, with abundant organic debris along with no bioturbation, indicating that the waters were anoxic, and inhospitable to organisms. Bentonites continue up section, indicating that volcanism remained active in the area. There is a gradual change into the overlying Carlile Formation, with fine grained shales becoming the dominant lithology, with thin sand laminations and bentonite horizons. The environment appears to return slightly to more oxygenated sediment, as there are minor occurrences of bioturbation in some of the cores near the top of the Second White Specks Formation and into the Carlile formation. The energy of the environment still remained fairly low, as indicated by the fine grained nature of the sediment and the preservation of bentonites.

The core from the Birch Mountains is from a location that would have been the closest to the paleoshoreline during the Cenomanian-Turonian. These cores appear much

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

siltier than the core to the south and east, and most likely represents a slightly higher energy environment that could transport silty shales. Bone beds are observed near the base of the Second White Specks Formation and most likely represent a kill zone. Above this, the energy was low enough to preserve multiple bentonites which do not correlate with the number of bentonites in the southern core. The source of the bentonites is not entirely known, although kimberlite pipes have been found in northeastern Alberta and have been suggested as possible sources for bentonites in the region (Dufresne et al., 2001). The environment was not hospitable to organisms, as no bioturbation was recorded. This is consistent throughout the whole interval of this core.

Sands, from core west of the 6th meridian, are often concentrated into laminations along with fish and shell debris, as well as calcareous white specks. Within the Second White Specks Formation, unidirectional ripples are common and thus indicate a unidirectional current direction. Starved ripples, and often just the cross laminations, are present and indicate that there was very little sand, such that the ripple was slightly eroded on the top. Soft sediment deformation was often observed in the form of loading, flame structures and convoluted bedding (see Plate 3.5 C). Sand, from core west of the 5th meridian, contains minor sand laminations near the base of the Second White Specks Formation, but the percentage is much less than what is observed within the cores to the west. Small scale ripples and the concentration of organic material are also present. The percentage of sand laminations generally increases slightly up the core. Some distorted beds are observed including the presence of loading and small scale ripples. West of the 4th meridian, sand laminations occur frequently throughout the Second White Specks Formation. Coarser grained sediment and organic matter are often concentrated into thin laminations. The sandy laminations are often very fine grained, and ripples and soft sediment deformation are often observed at the top and the base of the formation (see Plates 3.5 A,B and Plate 3.6 A,B,C,D). Minor sandy laminations are observed within core from the Birch Mountains, but do not compare to the concentration observed within the southern core.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Most of the core within the Second White Specks Formation across the study area, contains minor sand within an overall shale package. The shale has been discussed as being deposited within a low energy, anoxic environment. Therefore, the sands were also deposited within this overall environment. Processes which act on the marine floor to move coarser grains include current action, specifically, contour currents. Eriksson and Reczko (1998) define contourites as "lenticular silts and fine sand deposited in deep water on the continental rise, by geostrophic thermohaline currents flowing parallel to bathymetric contours (that) form a significant component of deep marine sedimentation systems." Stow et al. (1996) define two types of contourites: muddy contourites and sandy contourites. The former are much finer grained with less than 15% sand, usually structureless, but may have irregular layering, lamination and lensing. The latter may occur as more irregular beds (<1 to 5 cm) or thicker (5 to 25 cm) that may also be structureless or may demonstrate primary horizontal bedding and cross lamination plus or minus bioturbation. They may also have sharp or gradational bedding contacts (Ibid). These definitions fit what is observed in the Second White Specks Formation, and currents have been historically described as concentrating sediment within the Second White Specks Formation (Bloch et al., 1999). These currents would have enough energy to transport the fine grained sands, white specks, silts and organic debris that are found concentrated into laminations and ripples within the core. The best evidence is provided by the small scale ripples observed, which indicate a unidirectional current produced by the contour currents.

The contourites are a plausible argument for the presence of sands because during the Cenomanian-Turonian there was mixing of much cooler Boreal waters from the north with much warmer waters from the southern Tethyan sea, forming geostrophic thermohaline currents (Figure 3.2). What provides the currents is a difference in density of waters due to temperature and/or salinity variations; this is referred to as thermohaline circulation (Boggs, 1995). With much warmer Tethyan waters intermixing with much cooler Boreal waters, differences in temperature and salinity could produce these bottom currents. These currents were most likely what allowed the movement of coarse grains found within the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

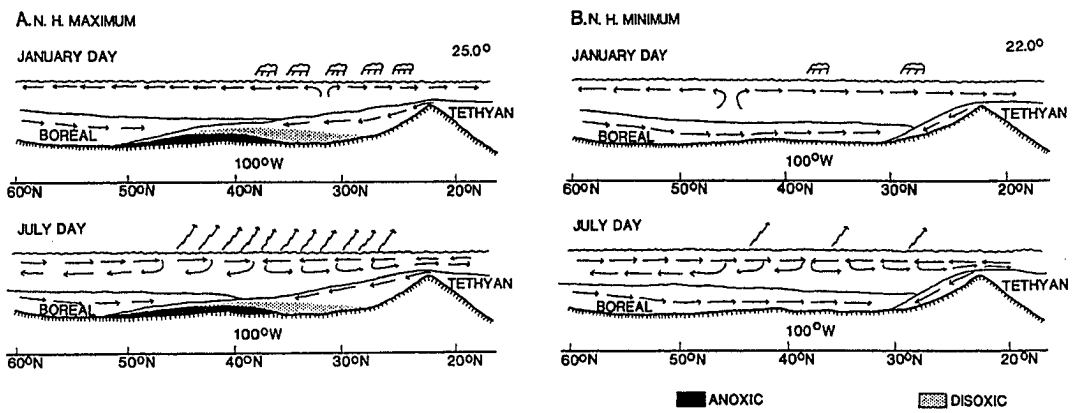


Figure 3.2: Cretaceous (91 Ma) deep water circulation patterns within the Western Interior Seaway for the northern hemisphere during the winter and summer. A) Maximum isolation forcing; B) Minimum isolation forcing (from Glancy at al., 1993).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

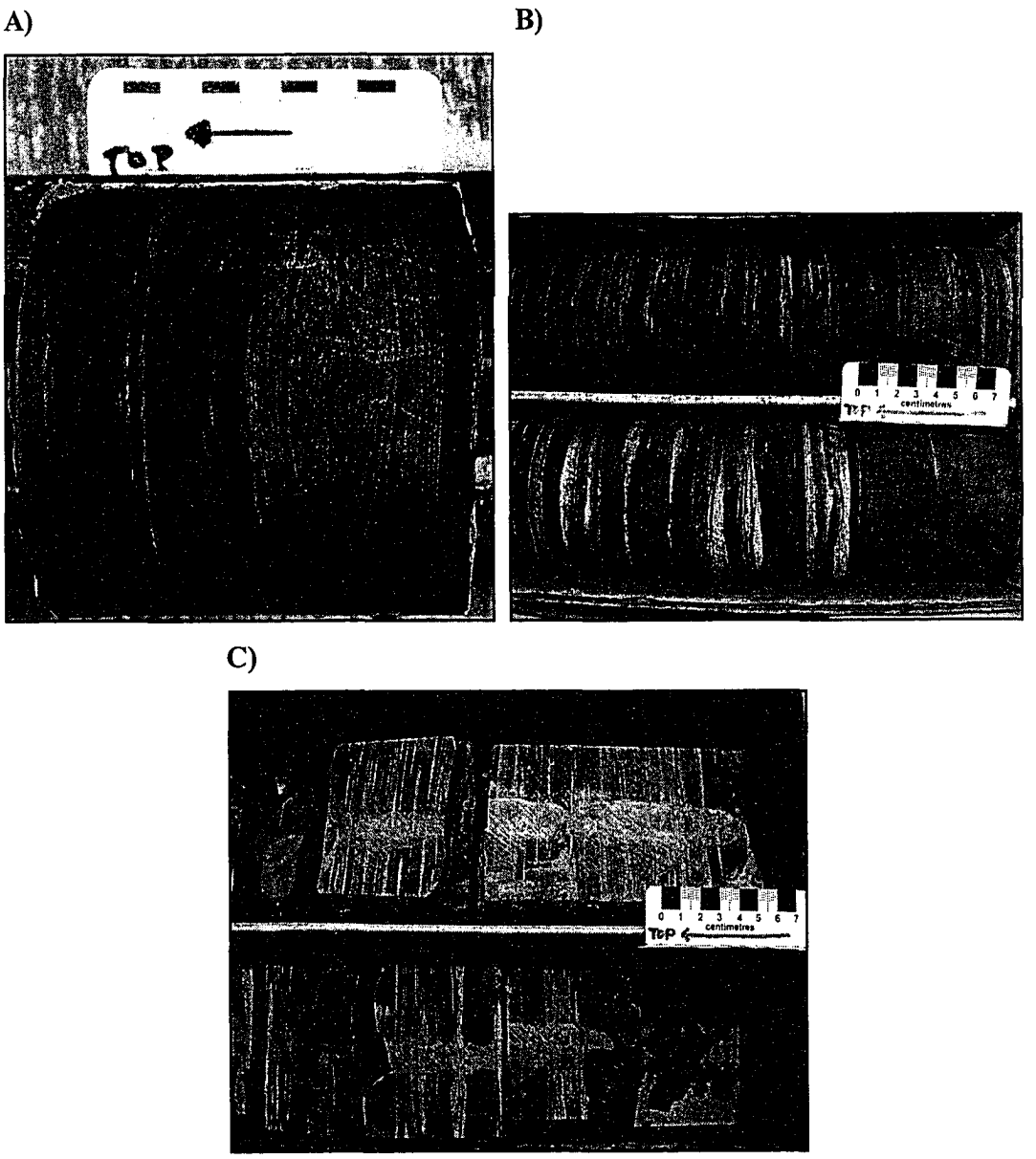


Plate 3.5: Photographs of various cores that show evidence of contourites: A) Core from well 00/06-03-061-22W4/0 shows a dark grey shale with silty deformed laminations of sand and ripples, 502.63 m depth; B) Core from well 00/06-35-059-21W4/0 shows abundant dark grey shale with minor concentrations of sand into deformed laminations, 467.34 m depth and C) Core from well 02/06-30-064-01W6/0 shows abundant dark grey shale with minor concentrations of sand into deformed laminations and small ripples, 1557.3 m depth.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

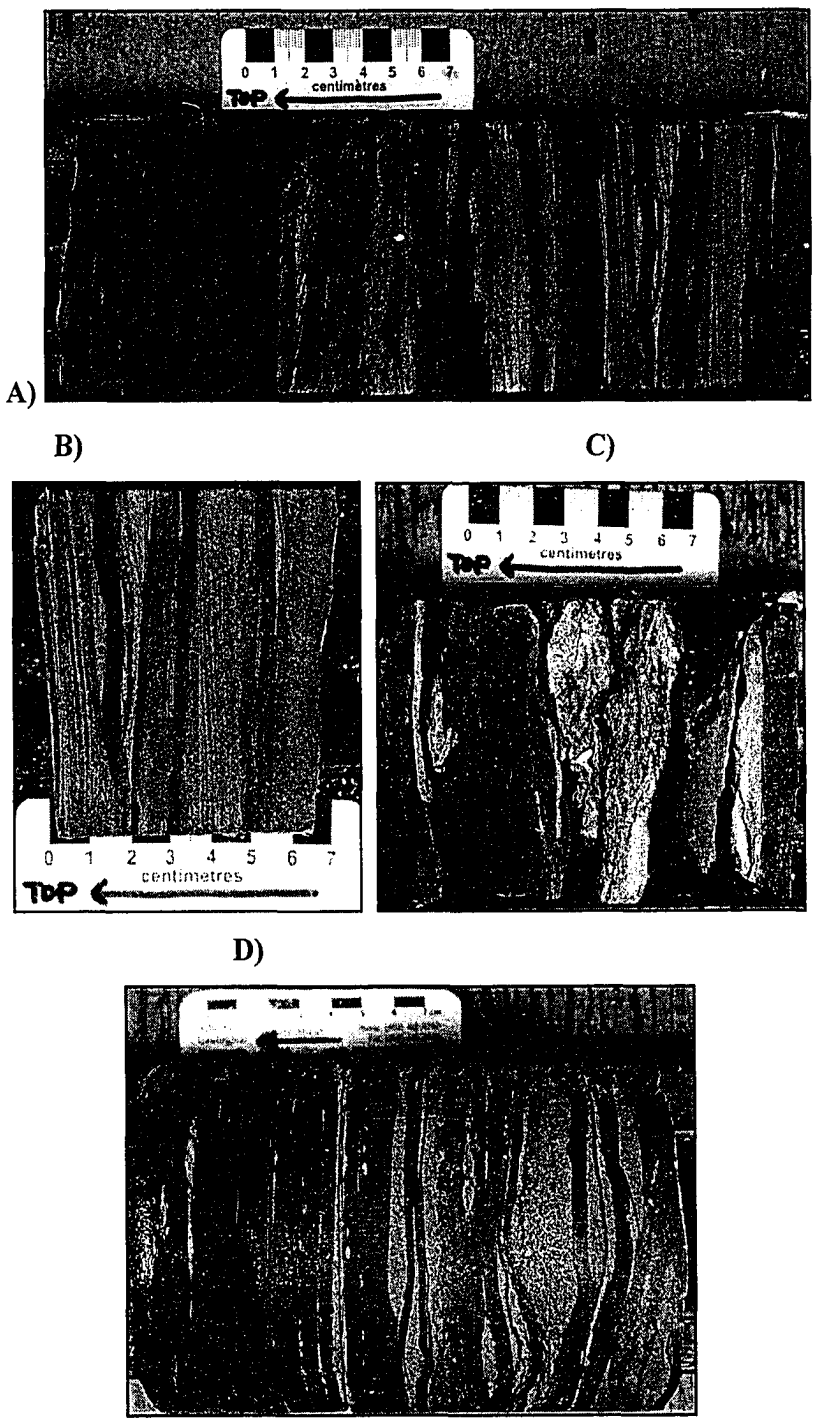


Plate 3.6: Photographs of various cores that show evidence of contourites: A) Core from well 00/10-22-047-03W4/0 shows a dark grey shale with small scale sandy ripples, low angle laminations and deformed laminations, 440.89 m depth; B) Close-up of A; C) Core from well 00/10-22-047-03W4 shows concentrated shelly debris lining up with fissility and a bentonite to the right hand side, silty undulatory contacts, 421.63 m depth and D) Core from well 00/10-36-060-22W4/0 shows a section of dark grey shale with deformed laminations and lenses of sand, a few starved ripples, 491.25m depth.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.6 Cross Sections

Six regional cross sections were constructed in total, three dip and three strike sections (Figure 3.3), using the base of the Fish Scales Formation as the datum. A second set of the same cross sections were constructed using the base of the Second White Specks Formation as the datum to better visualize the changes in thickness.

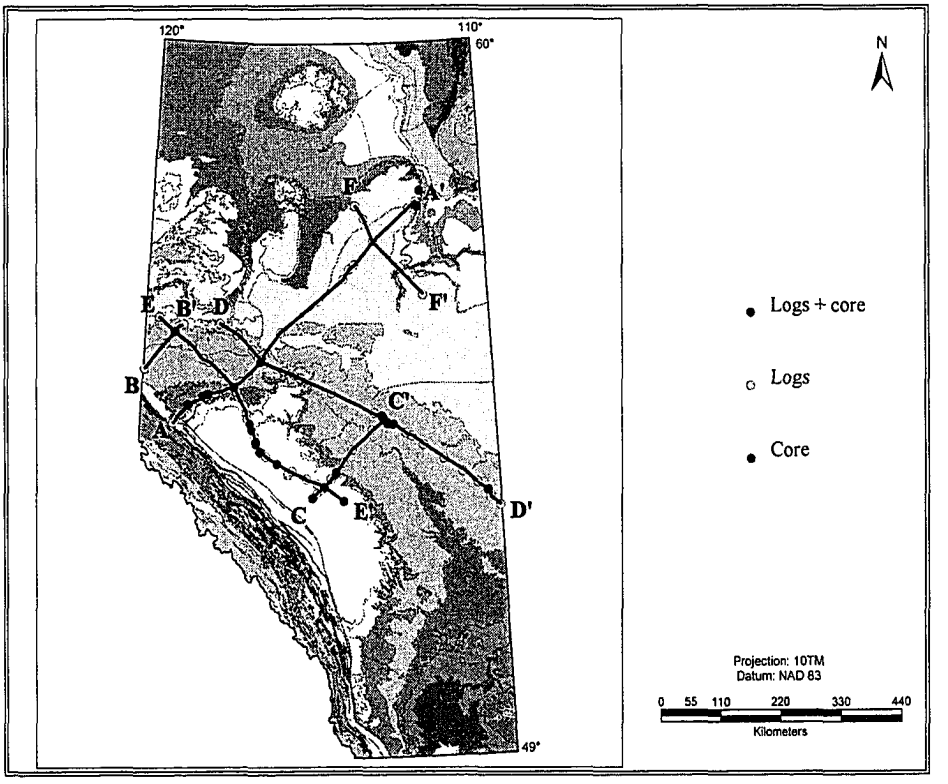


Figure 3.3: Map of Alberta showing the 6 cross sections constructed in this study. Yellow points show geophysical logs with no core, red points indicate geophysical logs with logged core and blue points indicate logged core with no geophysical logs. Map from the Alberta Geological Survey.

3.6.1 Log Characteristics

One of the difficulties encountered in this study was defining clear characteristics for the identification of the Second White Specks Formation on geophysical logs. This

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

was not always possible, as the physical and hence the geophysical characteristic of the Formation varies widely across the Western Canada Sedimentary Basin.

The basal contact between the Second White Specks Formation and the underlying Belle Fourche Formation generally shows an increase in resistivity and radioactivity into the Second White Specks Formation, whereas the gamma-ray signal is much more variable (Block et al., 1999). This is because of the presence of bentonites. Also, the gamma-ray does not always reflect a change in grain size. While observing the detailed geophysical signature next to the core, the reasons for the variations in the responses are not clear. An explanation for the lack of correlation between the two may be that the sediment within the Second White Specks Formation is higher in organic carbon content and this may have an associated higher concentrations of radioactive material (Leckie et al., 1994, Bloch et al., 1999).

The contact between the top of the Second White Specks Formation and the overlying shales (named the Carlile Formation) shows a decrease in resistivity and sonic velocity as well as a more uniform gamma-ray response within the overlying shale (Bloch et al., 1999).

3.6.2 Cross Section A-A'

Table 3.1: Table showing the unique well identifiers for each geophysical log in cross section A-A', whether there is associated core with the geophysical log, and the interval of the Second White Specks Formation.

Location:	**Second White Specks Formation Interval:**	**Thickness:**	**Logged Core (Y/N):**
00/16-14-059-08W6/0	2142m – 2260m	118m	No
00/14-28-062-05W6/0	1873m - ?	120m?	Yes
00/11-28-063-03W6/0	1801m – 1951m	150m	No
02/16-18-064-02W6/0	1659m – 1717m	58m	Yes
00/07-23-064-02W6/0	1585m – 1658m	73m	No
02/06-30-064-01W6/0	1515m - ?	85m?	Yes
00/02-01-065-27W5/0	1552m – 1658m	106m	No
00/04-27-065-25W5/0	1287m – 1407m	120m	No
00/16-34-065-24W5/0	1283m – 1388m	105m	No

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

00/10-09-066-23W5/0	1106m – 1235m	129m	Yes
00/14-12-067-22W5/0	914m – 1001m	87m	No
00/10-20-068-20W5/0	885m – 946m	61m	No
00/04-02-071-18W5/0	722m – 740m	18m	Yes
00/12-12-071-18W5/0	703m – 750m	47m	No
00/10-08-072-17W5/0	540m – 610m	70m	No
00/12-03-076-14W5/0	265m – 319m	54m	No
00/07-21-085-02W5/0	220m – 254m	34m	No
00/06-10-087-01W5/0	201m – 275m	74m	No
00/02-04-088-25W4/0	108m – 182m	74m	No
00/11-08-092-21W4/0	99m – 119m	20m	No
W0/12-32-097-14W4/0	225m – 257m	32m	No
00/10-02-099-13W4/0	185m – 279m	94m	No

This is the longest dip section in this study. It stretches from the deep basin (southwest Alberta) to the Birch Mountains (northeast Alberta) and is 615 km in length. In the deep basin there are many units between the Second White Specks Formation and the base of the Fish Scales Formation. In contrast in northeastern Alberta there is only a thin shale package between the Second White Specks Formation and the base of the Fish Scales Formation; this thin shale is the Belle Fourche Formation.

The Second White Specks unit generally is a wedge shape, thickening to the deep basin and thinning towards the paleoshoreline in north eastern Alberta. The base of the Second White Specks Formation varies from a depth of 2260 m in the southwest to only 279 m at the most northeastern geophysical log. The thickness of the formation varies from over 100 m to less than 20 m. As well, the core from the Birch Mountains (from diamond drill holes 7BK03 and 7AS01) are slightly more northeast than the last geophysical log from oil/gas wells, and are closer to where the Second White Specks crops out. There are local areas that show thickening; these are discussed below (Figure 3.4).

When the base of the Second White Specks Formation is plotted as the datum, it is apparent that there are locations which are thicker than others, with a general thinning towards the northeast (Figure 3.5).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

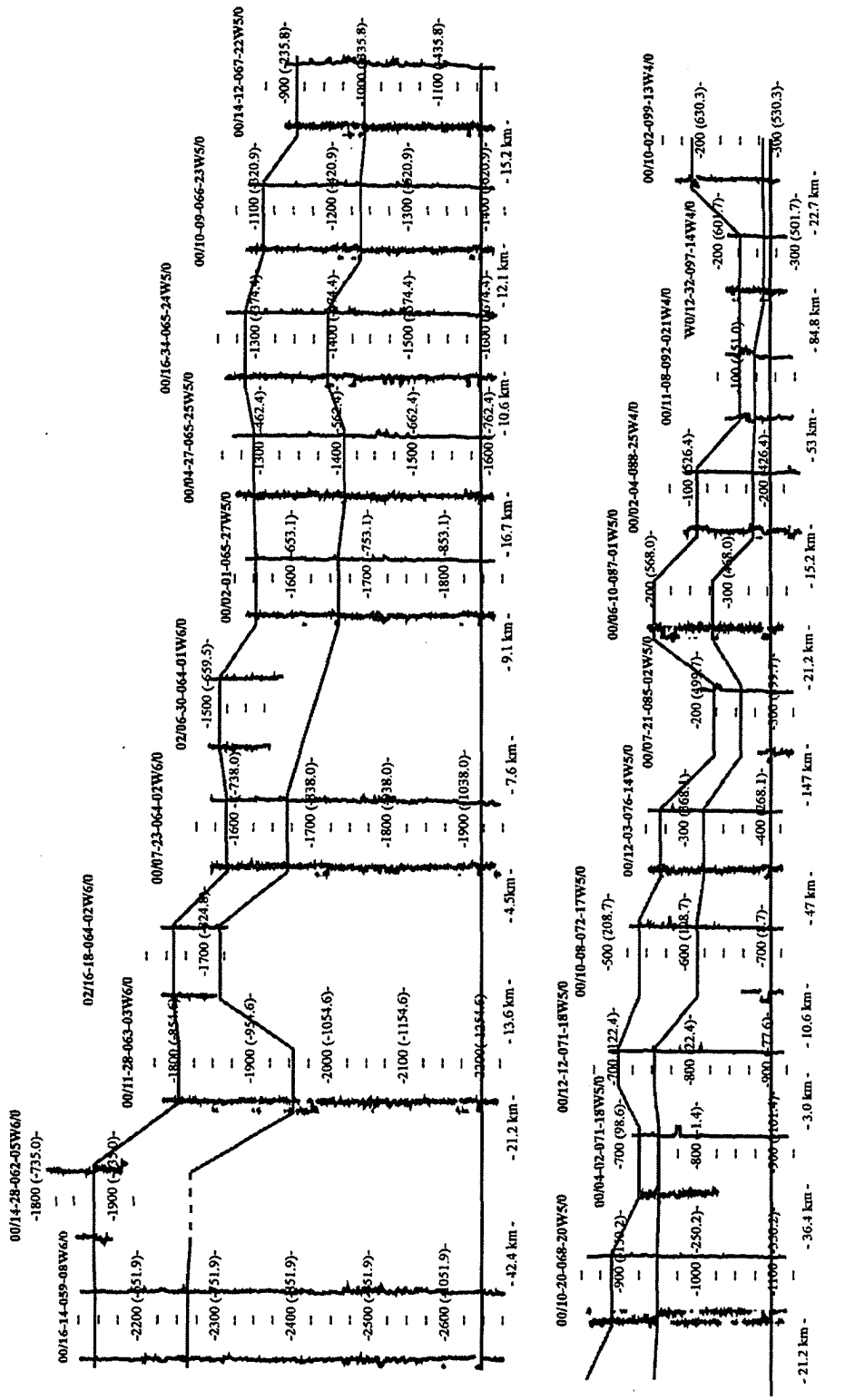


Figure 3.4: Cross section A-A' with the base of Fish Scales as the datum (bottom line). Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. The top two correlations represent the base and top picks for the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

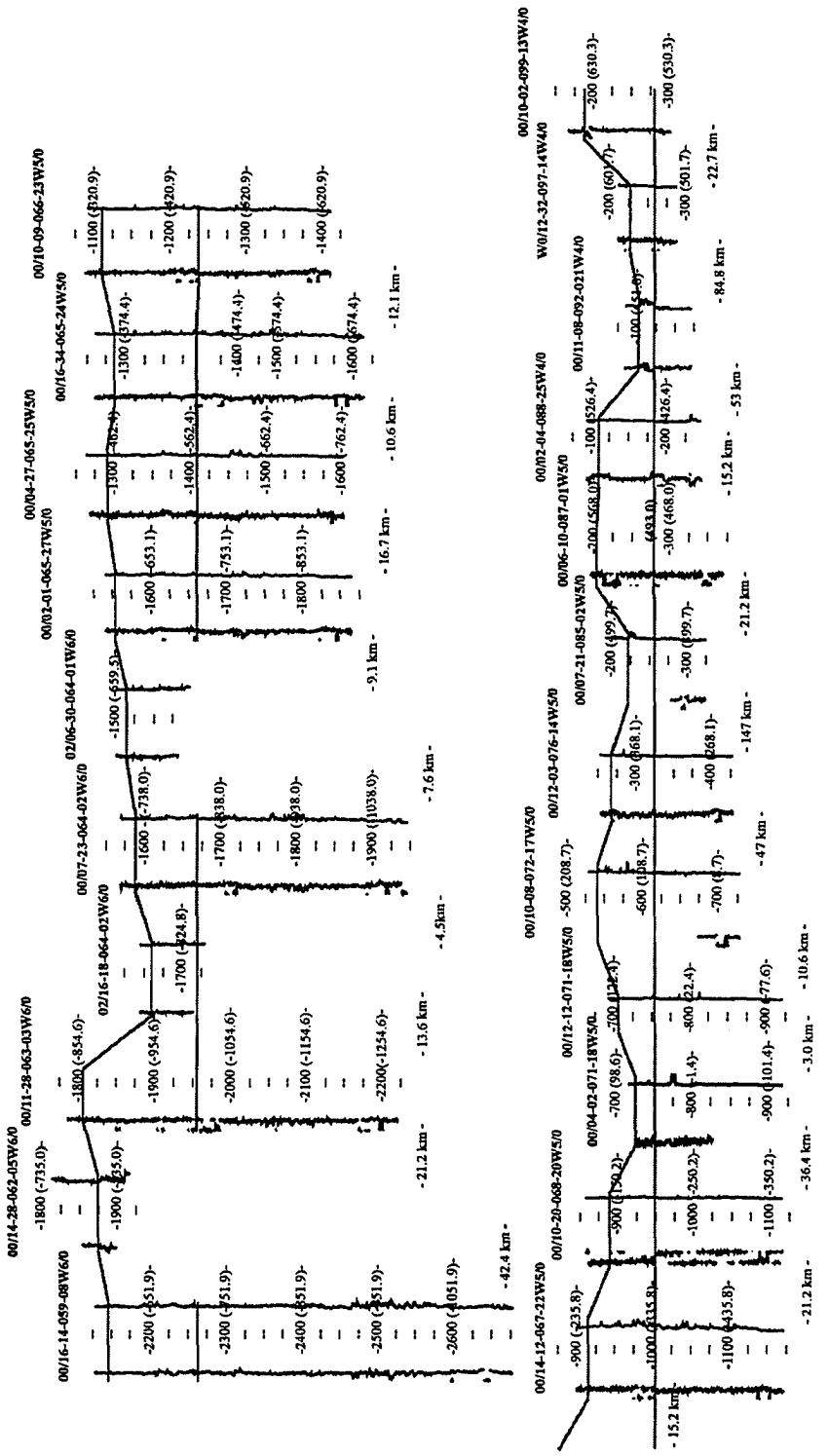


Figure 3.5: Cross section A-A' with the base of the Second White Specks Formation as the datum. Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. Correlations are the top and base of the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.6.3 Cross Section B-B'

Table 3.2: Table showing the unique well identifiers for each geophysical log in cross section B-B', whether there is associated core with the geophysical log, and the interval of the Second White Specks Formation.

Location:	**Second White Specks Formation Interval:**	**Thickness:**	**Logged Core (Y/N):**
00/11-30-068-13W6/0	*1596m – 1710m*	*114m*	No
00/06-19-073-09W6/0	718m – 826m	108m	No
00/16-22-075-08W6/0	658m - ?	80m?	Yes
00/06-20-076-07W6/0	423m – 497m	74m	No
00/11-06-077-06W6/0	404m – 449m	45m	No

This cross section is a short dip section in north west-central Alberta, and extends from the southwest to the northeast and spans 112 kms in length (Figure 3.6). From the short distance (relative to other cross sections) there is a dramatic shallowing of the unit from southwest to northeast. This is expected for a wedge shaped morphology of the sediments deposited during this time. The thickness ranges from 114 m to 98 m in the most northern core of the section. The dramatic change in depth at the base of the Second White Specks Formation ranges from 1710 m to a much shallower 521 m depth. This is a change of almost 1200 m over a distance of only 112 kms. There are abundant units present in between the base of the Fish Scales Formation marker horizon and the Second White Specks Formation. When the base of the Second White Specks is used as a datum, the wedge shaped morphology of the unit thins towards the northeast (Figure 3.7).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

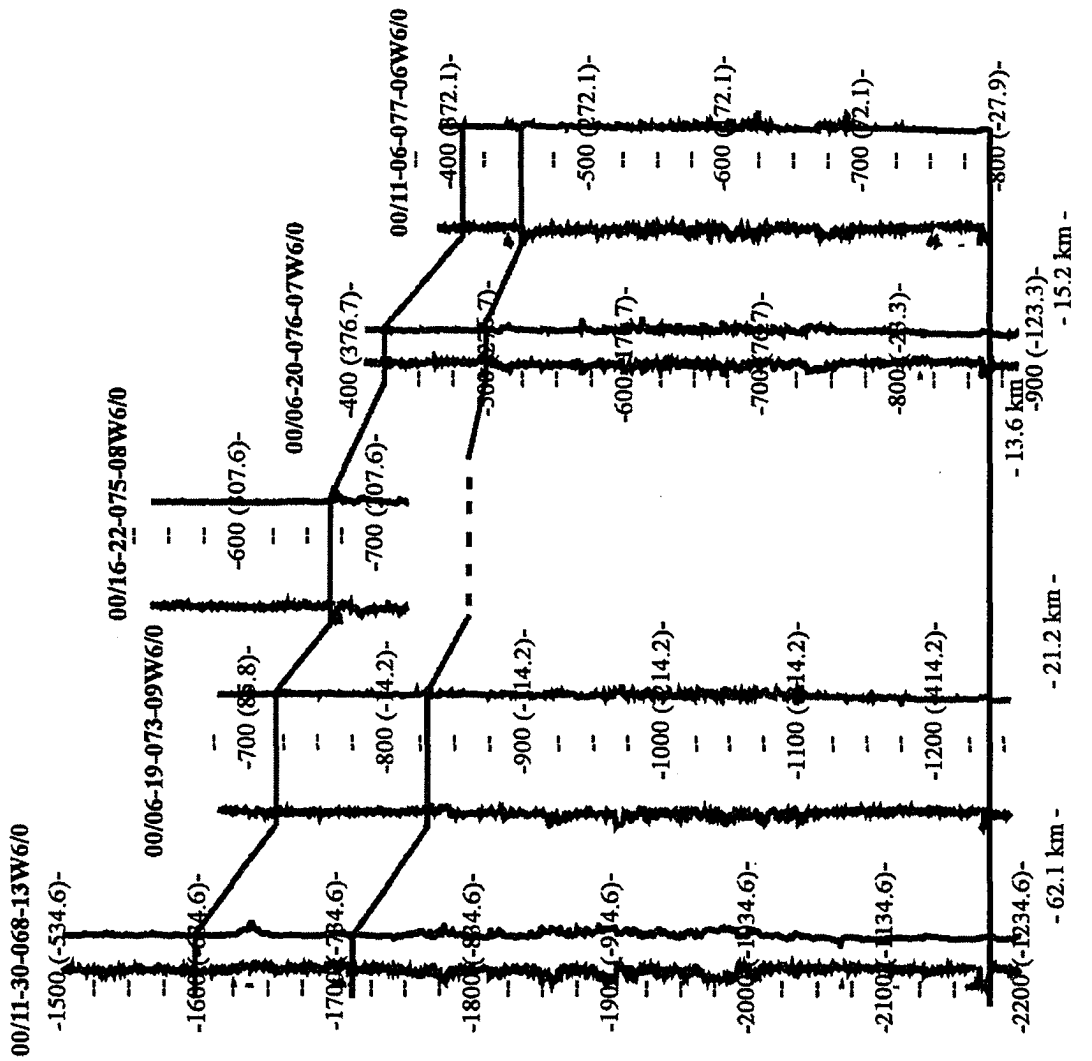


Figure 3.6: Cross section B-B' with the base of Fish Scales as the datum (bottom line). Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. The top two correlations represent the base and top picks for the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

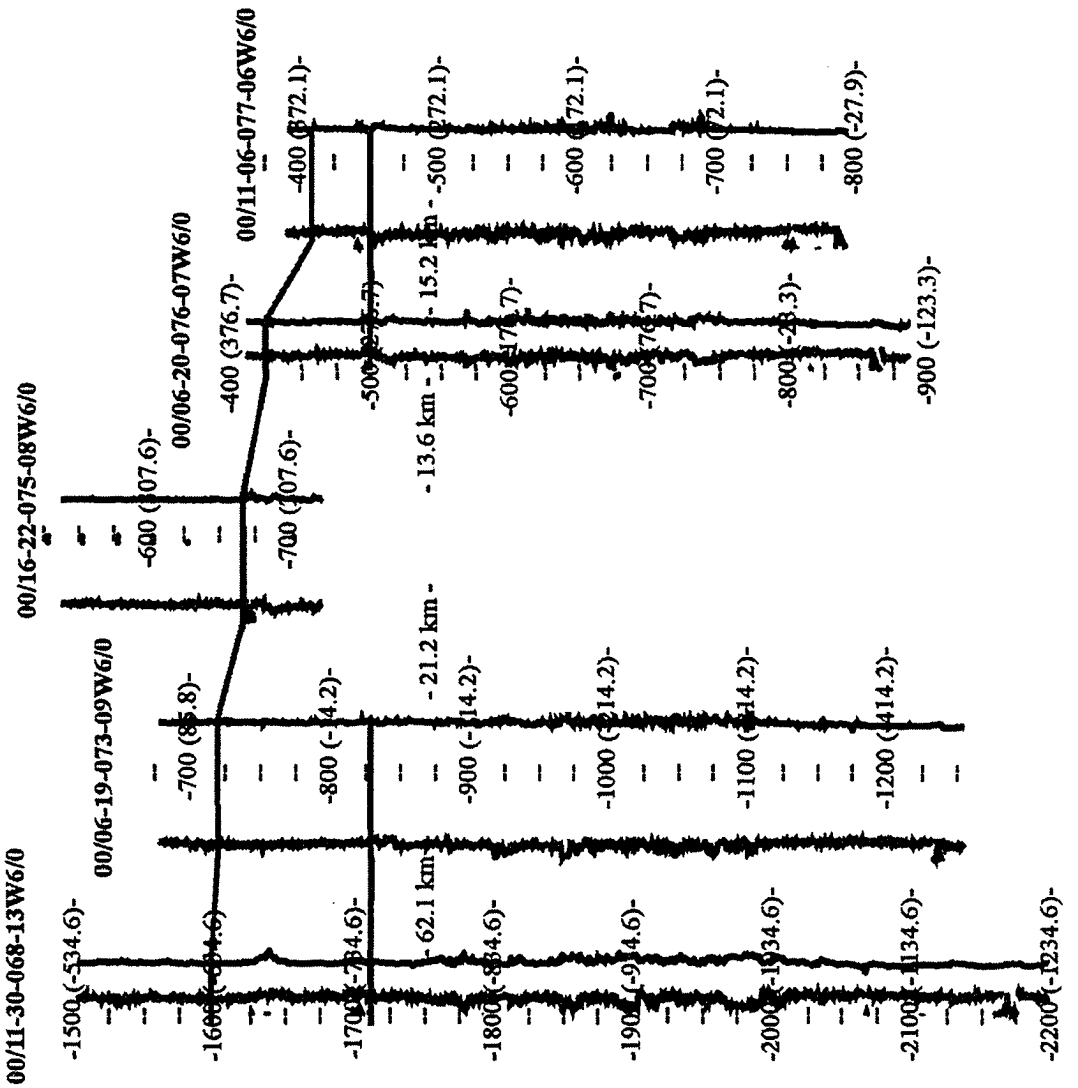


Figure 3.7: Cross section B-B' with the base of the Second White Specks Formation as the datum. Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. Correlations are the top and base of the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.6.4 Cross Section C-C'

Table 3.3: Table showing the unique well identifiers for each geophysical log in cross section C-C', whether there is associated core with the geophysical log, and the interval of the Second White Specks Formation.

Location:	Second White Specks Formation Interval:	Thickness:	Logged Core (Y/N):
00/06-31-046-08W5/0	1782m – 1904m	122m	Yes
02/06-25-047-08W5/0	1573m – 1685m	112m	No
02/06-14-048-07W5/0	1533m – 1622m	89m	No
00/14-29-048-06W5/0	1532m – 1595m	63m	Yes
00/08-09-050-05W5/0	1272m – 1347m	75m	No
00/05-10-051-04W5/0	1202m – 1289m	87m	Yes
00/09-01-053-03W5/0	1021m – 1086m	65m	No
00/07-10-055-01W5/0	873m – 944m	71m	No
00/14-27-058-24W4/0	571m – 612m	41m	No
00/10-36-060-22W4/0	491m – 535m	44m	Yes

This is the third and final dip cross section; it extends from central to east-central Alberta and is 187 kms in length (Figure 3.8). Generally, there is a thinning from the deeper basin to the shallower basin, i.e. the unit has a wedge like morphology. This is not shown as clearly as cross section B-B' because there is some local thickening and thinning. With the base of the Fish Scales Formation as the datum, the unit that lies between it and the Second White Specks Formation is the Belle Fourche Formation. This latter formation ranges in thickness from approximately 125m to approximately 45 meters in east-central Alberta. The base of the Second White Specks Formation ranges from approximately 1900m to 535m depth at its shallowest point.

When the base of the Second White Specks Formation is plotted, the thickness generally decreases towards east-central Alberta (Figure 3.9), with locations of thinning, perhaps due to bad picks, basin topography during deposition, contourites concentrating sands and/or tectonics (see following section for the discussion).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

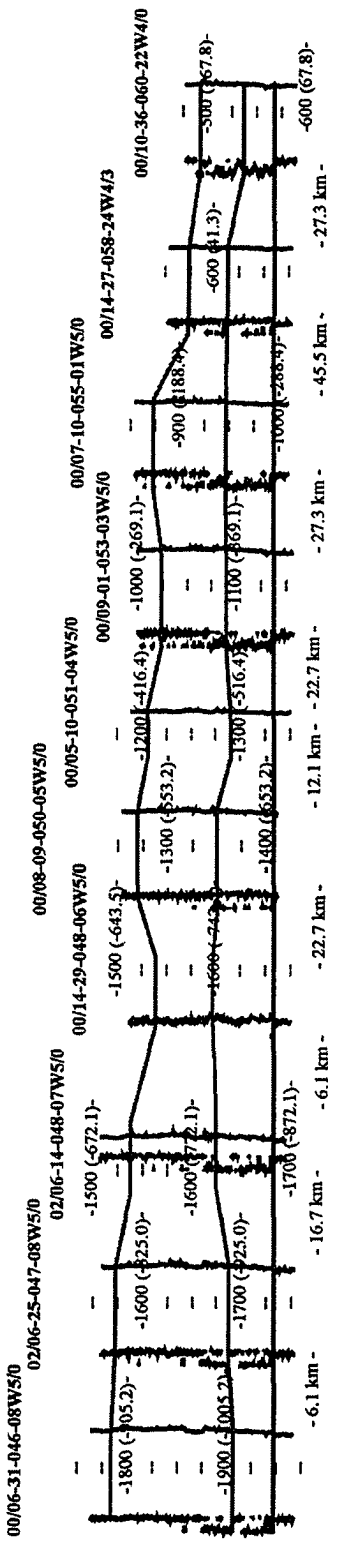


Figure 3.8: Cross section C-C' with the base of Fish Scales as the datum (bottom line). Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. The top two correlations represent the base and top picks for the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

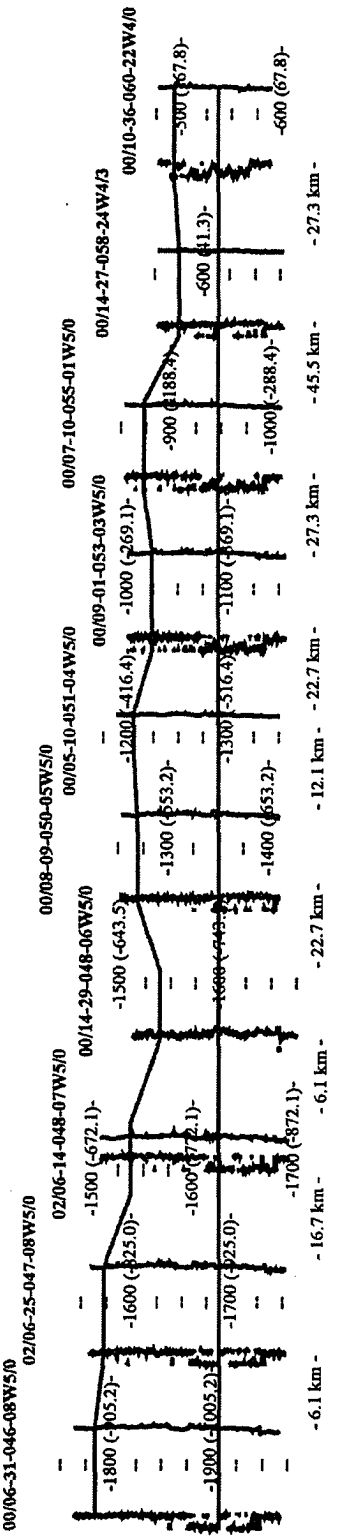


Figure 3.9: Cross section C-C' with the base of the Second White Specks Formation as the datum.. Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. Correlations are the top and base of the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.6.5 Cross Section D-D'

Table 3.4: Table showing the unique well identifiers for each geophysical log in cross section D-D', whether there is associated core with the geophysical log, and the interval of the Second White Specks Formation.

Location:	Second White Specks Formation Interval:	Thickness:	Logged Core (Y/N):
00/04-18-077-25W5/2	359m – 392m	33m	No
00/06-21-075-22W5/0	274m – 300m	26m	No
00/06-06-073-19W5/0	425m – 470m	45m	No
00/06-12-072-19W5/0	632m – 650m	18m	No
00/10-20-071-18W5/0	624m – 667m	43m	No
00/04-02-071-18W5/0	722m – 740m	18m	Yes
00/16-19-070-17W5/0	725m – 743m	18m	No
00/03-18-069-13W5/0	765m – 783m	18m	No
00/16-31-067-10W5/0	983m – 1014m	31m	No
00/05-13-065-05W5/0	610m – 657m	47m	No
00/01-32-061-23W4/0	521m – 561m	40m	No
00/06-11-061-22W4/0	506m – 553m	47m	Yes
00/10-36-060-22W4/0	491m – 535m	44m	Yes
00/06-10-060-21W4/0	469m – 510m	41m	No
00/03-16-060-21W4/0	467m – 508m	41m	No
00/06-35-059-21W4/0	463m – 504m	41m	Yes
00/07-36-059-21W4/2	447m – 497m	50m	No
00/06-26-059-20W4/0	447m – 486m	39m	Yes
00/11-01-058-18W4/0	421m – 460m	39m	No
00/09-24-057-17W4/2	399m – 441m	42m	No
00/16-31-055-14W4/0	400m – 438m	38m	No
00/11-14-053-11W4/0	476m – 499m	20m	No
00/10-31-050-07W4/0	394m – 415m	21m	No
00/16-35-048-05W4/0	425m – 445m	20m	No
00/10-22-047-03W4/0	426m – 440m	14m	Yes
00/01-18-046-02W4/0	431m – 445m	14m	No
B0/07-25-044-01W4/0	373m – 385m	12m	No

This is a strike cross section, following the strike of the Foothills. The section is from the northwest to the southeast portion of the study area. Generally, the unit thins towards the southeast, with the depths remaining fairly constant. There is a slight deepening in the center of the cross section to depths of approximately 1000 m. The greatest depth for the base of the Second White Specks Formation in this cross section is

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

1014 m. The shallowest is 385 m depth in east-central Alberta. In northwestern Alberta, there are multiple units between the base of the Fish Scales Formation and the base of the Second White Specks Formation. Further east, the Belle Fourche Formation is the only formation between the two. The thickness ranges from approximately 125 m to less than 20 m. The first log 00/04-18-077-25W5/2 may have been picked incorrectly because it does not seem to correlate well with the other logs, or something structural may not be observed. More geophysical logs would be needed to increase the resolution of this part of the cross section. The cross section spans 639 km in length (Figure 3.10).

When the base of the Second White Specks Formation is used as a datum, the thickness of the formation seems to be thinning towards the edges of the cross section. It is the thickest in the central part of the section. Generally, this is a gradual change that may represent the central part of the Western Canada Sedimentary basin at the time of deposition and structural elements (discussed below). This would be the area with the most accommodation and potential to accumulate thicker packages of sediment (Figure 3.11).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

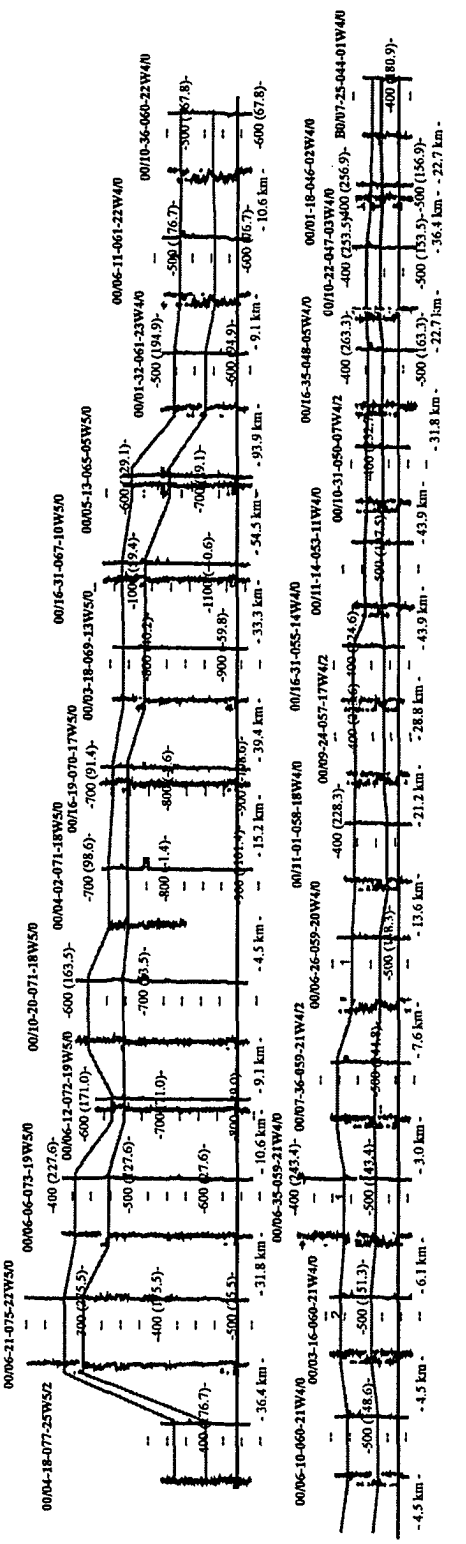


Figure 3.10: Cross section D-D' with the base of Fish Scales as the datum (bottom line). Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. The top two correlations represent the base and top picks for the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

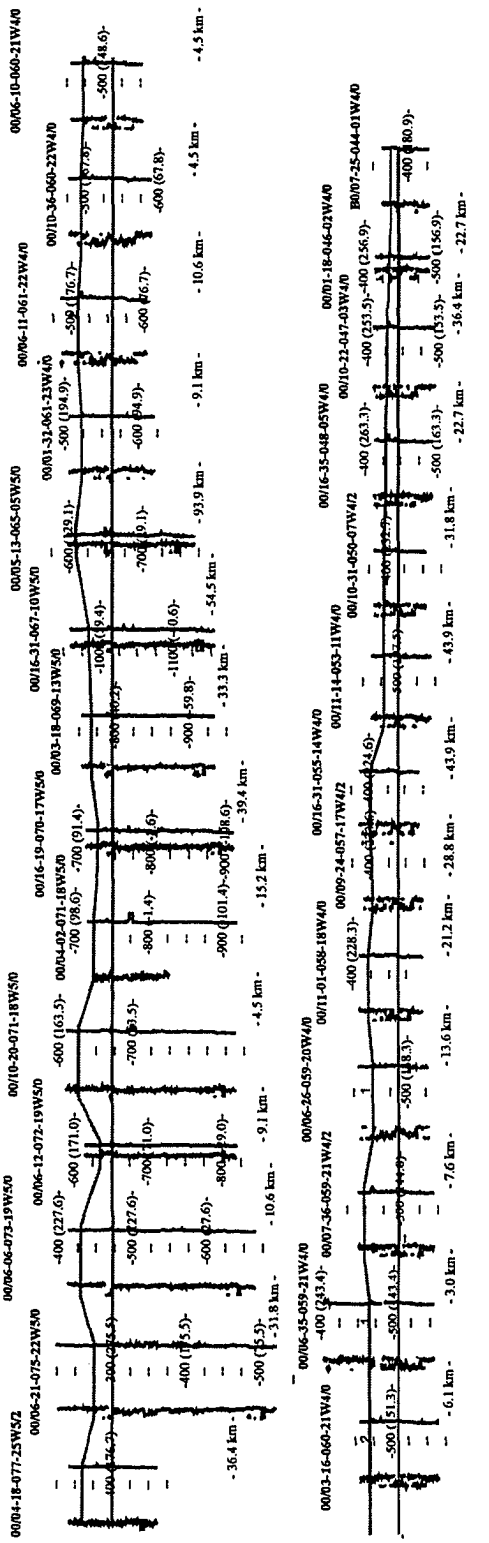


Figure 3.11: Cross section D-D' with the base of the Second White Specks Formation as the datum.. Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. Correlations are the top and base of the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.6.6 Cross Section E-E'

Table 3.5: Table showing the unique well identifiers for each geophysical log in cross section E-E', whether there is associated core with the geophysical log, and the interval of the Second White Specks Formation.

Location:	Second White Specks Formation Interval:	Thickness:	Logged Core (Y/N):
00/08-03-078-11W6/2	341m – 427m	86m	No
00/16-22-075-08W6/0	658m – ?	80m?	Yes
00/07-11-073-05W6/0	651m – 696m	45m	No
00/14-01-071-03W6/0	740m – 808m	68m	No
00/12-19-070-01W6/0	773m – 838m	65m	No
00/14-20-068-25W5/0	910m – 986m	76m	No
00/10-09-066-23W5/0	1106m – 1235m	129m	Yes
00/11-18-065-22W5/0	1216m – 1319m	103m	No
00/10-16-064-22W5/0	1302m – 1393m	91m	No
00/04-23-061-21W5/0	1633m – 1739m	106m	No
00/08-25-060-21W5/0	1685m – 1792m	107m	No
00/10-28-059-20W5/0	1787m – 1906m	119m	Yes
02/16-27-058-20W5/0	1772m – 1856m	84m	Yes
02/16-19-057-19W5/0	2024m – 2111m	87m	No
00/09-09-056-19W5/0	2198m – 2282m	84m	Yes
00/02-28-054-18W5/0	1964m – 2094m	130m	No
00/10-31-054-18W5/0	2037m – 2075m	138m	Yes
00/10-05-054-17W5/0	1957m – 2086m	129m	No
02/07-33-052-15W5/0	1880m – 1955m	75m	Yes
00/06-03-051-13W5/0	1948m – 2050m	102m	No
00/15-20-051-12W5/0	1912m – 1973m	61m	No
00/10-12-050-10W5/0	1704m – 1796m	92m	No
02/16-14-049-08W5/0	1565m – 1655m	90m	No
00/14-29-048-06W5/0	1532m – 1595m	63m	Yes
00/16-12-046-03W5/0	1474m – 1552m	78m	Yes

This cross section is the most westerly cross section in the study. It therefore represents the deepest location of sedimentation. It also strikes southeasterly parallel to the direction of the Alberta Foothills. The thickest package of Second White Specks Formation sediments lies in the center of the cross section, which is also apparent in cross section D-D'. The thickness is less variable than the previous cross section, varying from approximately 50 m to 100 m. In northwestern Alberta, there is a great vertical distance between the base of the Fish Scales Formation and the Second White Specks Formation;

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

this is due mainly to many subdivisions between the two, whereas moving more southeasterly, only the Belle Fourche Formation lies between the two formations. There are a few areas of local thinning, but, overall the change in thickness across the cross section is fairly gradual. The base of the Second White Specks Formation ranges from a depth of 2282 m in the center of the cross section and the basin, to much shallower depths on the flanks (Figure 3.12). The shallowest depth in this cross section is in northwestern Alberta where the base is only at 427 m depth. The cross section is 484 kms in length.

When the base of the Second White Specks Formation is used as the datum for the cross section, the thickest parts of Second White Specks Formation are within the central portions of the cross section, which also corresponds with the deeper basin. The thinnest location is in northwestern Alberta. In general, there are a few local areas of thinning, but the thickness remains fairly constant southeastwards (Figure 3.13).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

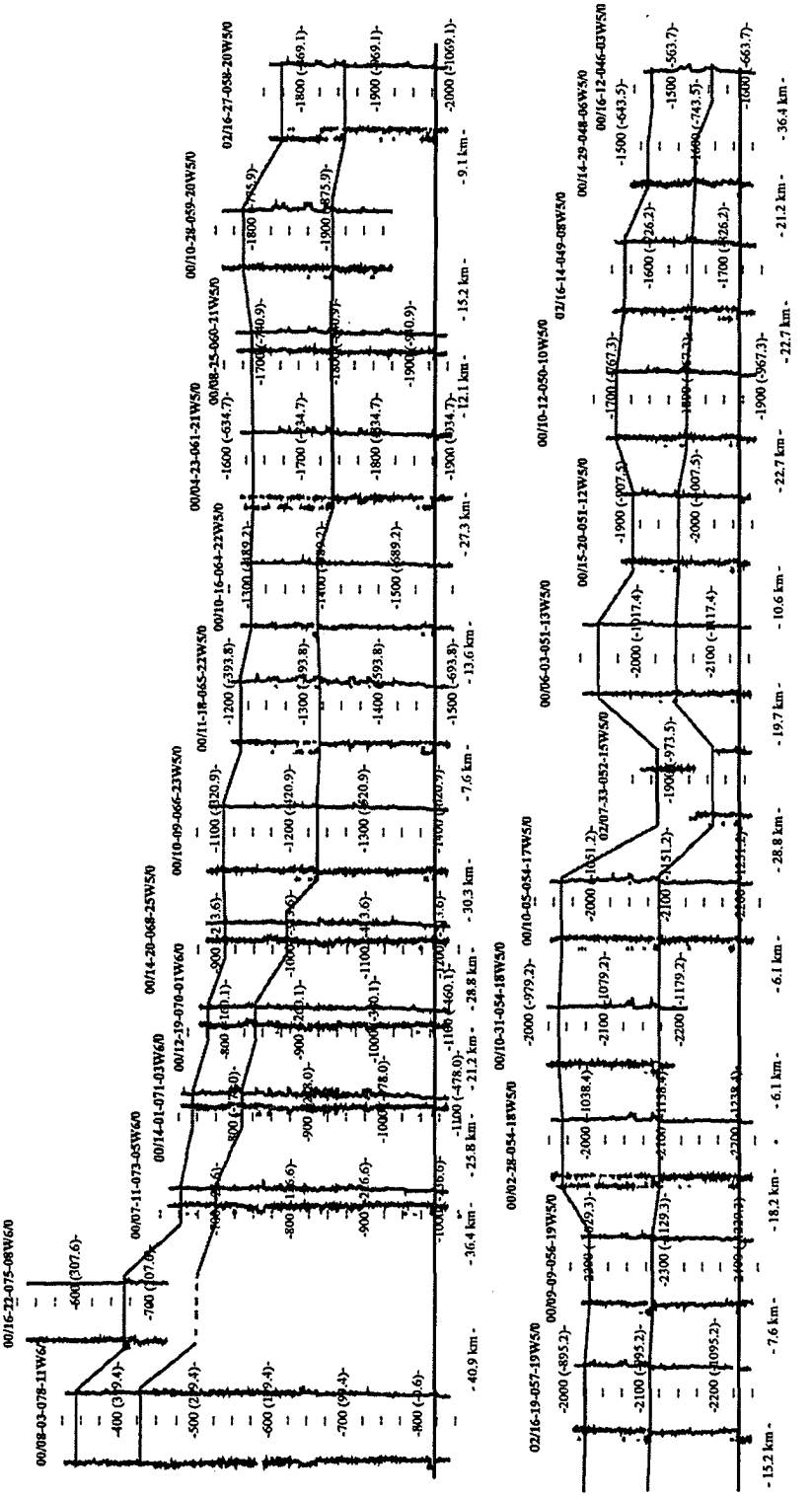


Figure 3.12: Cross section E-E' with the base of Fish Scales as the datum (bottom line). Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. The top two correlations represent the base and top picks for the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

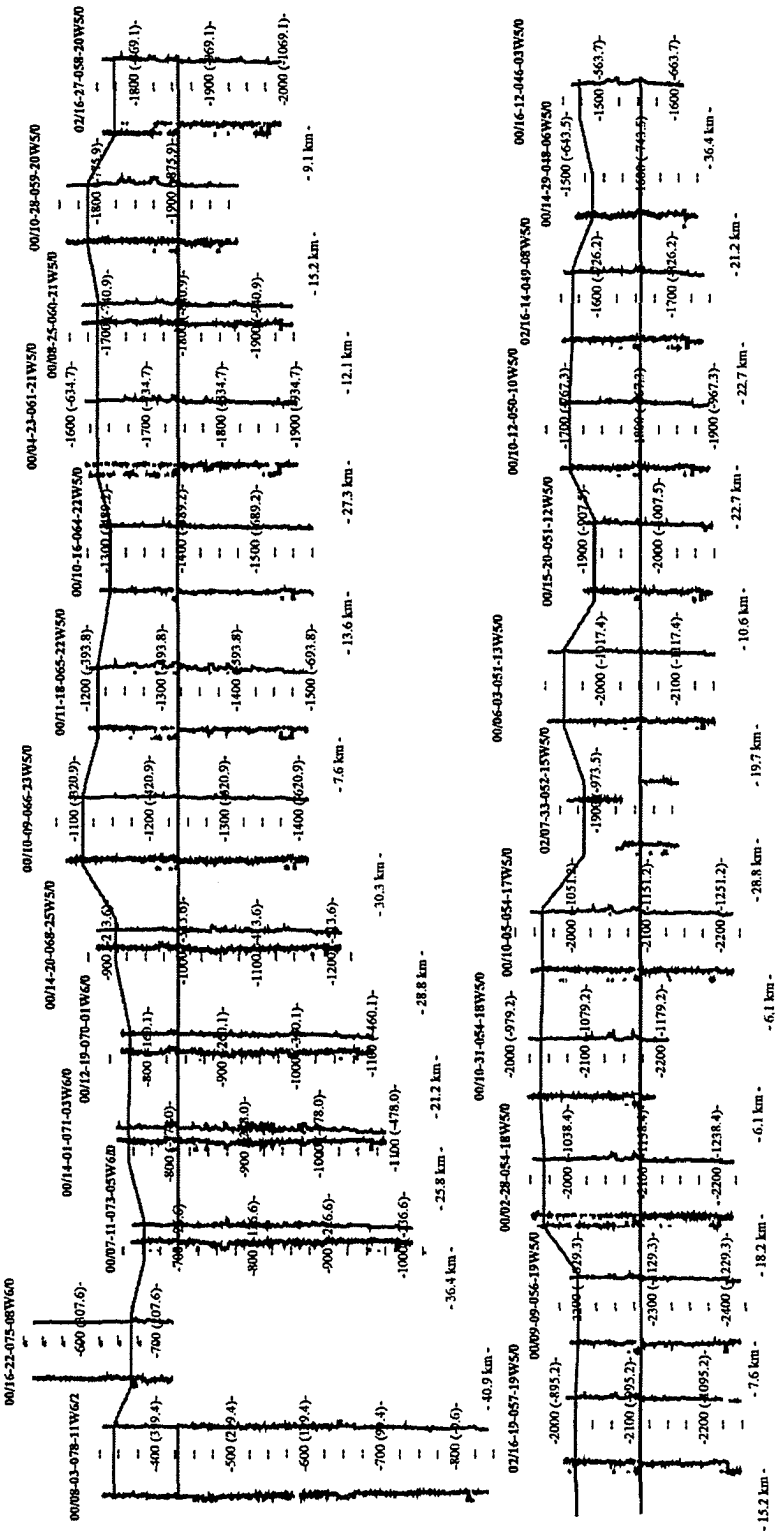


Figure 3.13: Cross section E-E' with the base of the Second White Specks Formation as the datum. Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. Correlations are the top and base of the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.6.7 Cross Section F-F'

Table 3.6: Table showing the unique well identifiers for each geophysical log in cross section F-F', whether there is associated core with the geophysical log, and the interval of the Second White Specks Formation.

Location:	**Second White Specks Formation *Interval:***	**Thickness:**	**Logged Core (Y/N):**
00/11-17-098-24W4/0	215m – 231m	16m	No
00/06-11-096-23W4/0	177m – 194m	17m	No
00/11-08-092-21W4/0	99m – 119m	20m	No
00/15-13-082-13W4/0	116m – 136m	20m	No

This cross section is the most northeasterly strike section. There was no logged core in this cross section, therefore, it must be noted that none of the geophysical logs have been confirmed using dating techniques or core. The thickness remains fairly constant and is very thin compared to the previous cross sections which are approximately 20 m in thickness. The deepest location of the base of Second White Specks is in the most northwestern core, at 231 m depth. The shallowest section is in the southeast at 119 m depth. The cross section is 96 kms in length (Figure 3.14).

When the base of the Second White Specks Formation is used as a datum, the thickness of the formation increases slightly towards the southeast. The change is negligible compared to the previous cross sections (Figure 3.15).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

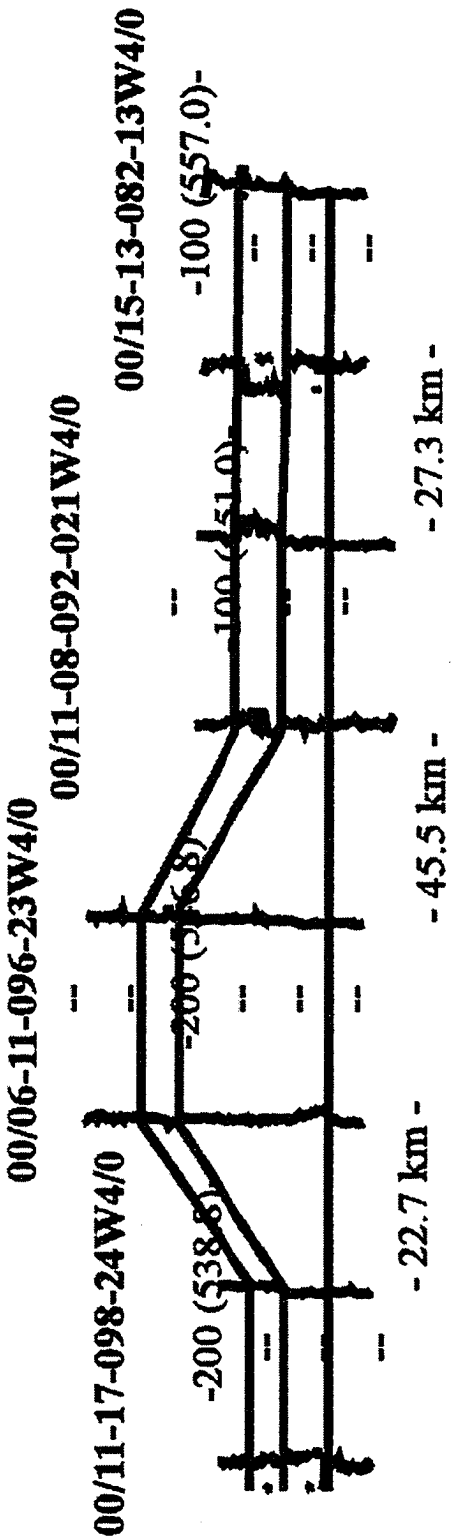


Figure 3.14: Cross section F-F' with the base of Fish Scales as the datum (bottom line). Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. The top two correlations represent the base and top picks for the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

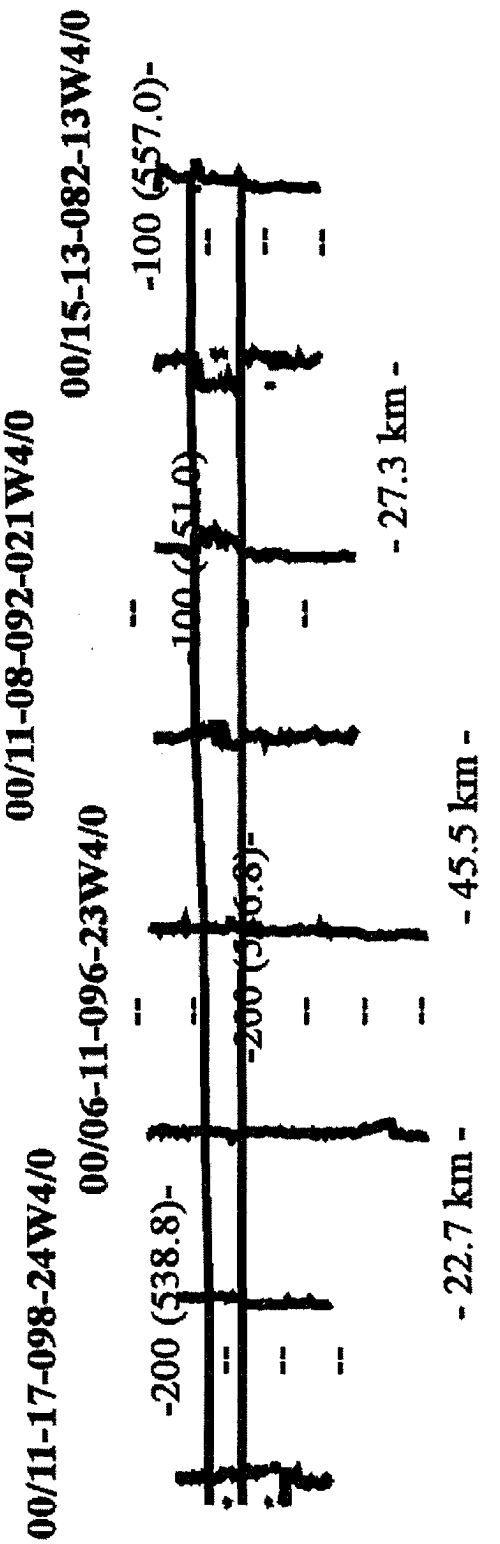


Figure 3.15: Cross section F-F' with the base of the Second White Specks Formation as the datum. Notes: The log to the left is always a gamma-ray log, and the log to the right is always a resistivity log for each well. Both logs are not always present for every well. Correlations are the top and base of the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

3.6.8 Cross Section and Thickness Variations Discussion

There are a few explanations for the variation in thickness. Firstly, some of the picks were difficult to choose and may not be correct. Secondly, the basin topography may have been variable resulting in local areas of thickening and thinning. Local lows allow a thicker sediment package to accumulate and local highs allow thinner sediment packages to be preserved, which is often observed with Cretaceous sediments due to underlying carbonate formations (highs where there are Devonian reefs, lows in inter-reef zones) and salt dissolution (Wright, 1994) . Thirdly, there may have been structural elements involved which are discussed below. Fourthly, the location and frequency of the geophysical logs may not be showing the resolution needed. Fifthly, there was the action of contourites, moving sands and accumulating sands preferentially, causing slightly thicker packages of sediment to be preserved in some places and eroding other locations. The effects of contourites are discussed in Section 3.5.

Structural control includes basement faults, propagated into the overlying Phanerozoic as well as the third option, structural features, have been noted elsewhere affecting sedimentation thickness within the Cretaceous (Wright, 1994). Salt and carbonate dissolution, specifically the dissolution of Devonian salt which has been postulated to cause variations in the thickness of Cretaceous sediment Ibid, 1994. Variations in thickness in northeastern Alberta have been noted and may be due to present day erosion of positive structures (Wright, 1994) such as the Birch Mountains. During the formation of the foreland basin, a forebulge was present, and was migrating during the time, possibly causing thickness variations. Movement along pre-existing fault planes in the basement also was occurring and most likely caused thickening and thinning. Pana (2001) noted that subsidence of the Peace River arch was occurring from the earliest Cretaceous, controlling structure in the area and thus may have caused thickening of the Second White Specks. He (Ibid) noted that during the Albian to Cenomanian there were affects on the depositional trends due to intermittent uplift and subsidence of the Cordilleran orogeny and the Peace River Arch. Thickness variations have also been noted in previous studies, such as Bloch et al. (1993), where a cross

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

section of the Second White Specks Formation varies in thickness up to 25m but does not address why this variation was observed.

An isopach map of the Second White Specks Formation (Figure 3.16) demonstrates that, generally, the Second White Specks has a wedge shape geometry and thickens towards the mountains. Within the Birch Mountains, there is a large thickness variation, which is most likely due to erosion and exposure of the shale. There also is abrupt local thickening and thinning within the middle of the study area; this may or may not be real and needs to be resolved with more well control. Having said this, based on the information available, this irregular thickening and thinning may be due to salt dissolution of older strata, causing the sea floor to be irregular and preferentially having caused local areas of accommodation for the sediment to accumulate and possibly also the activation of faults.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

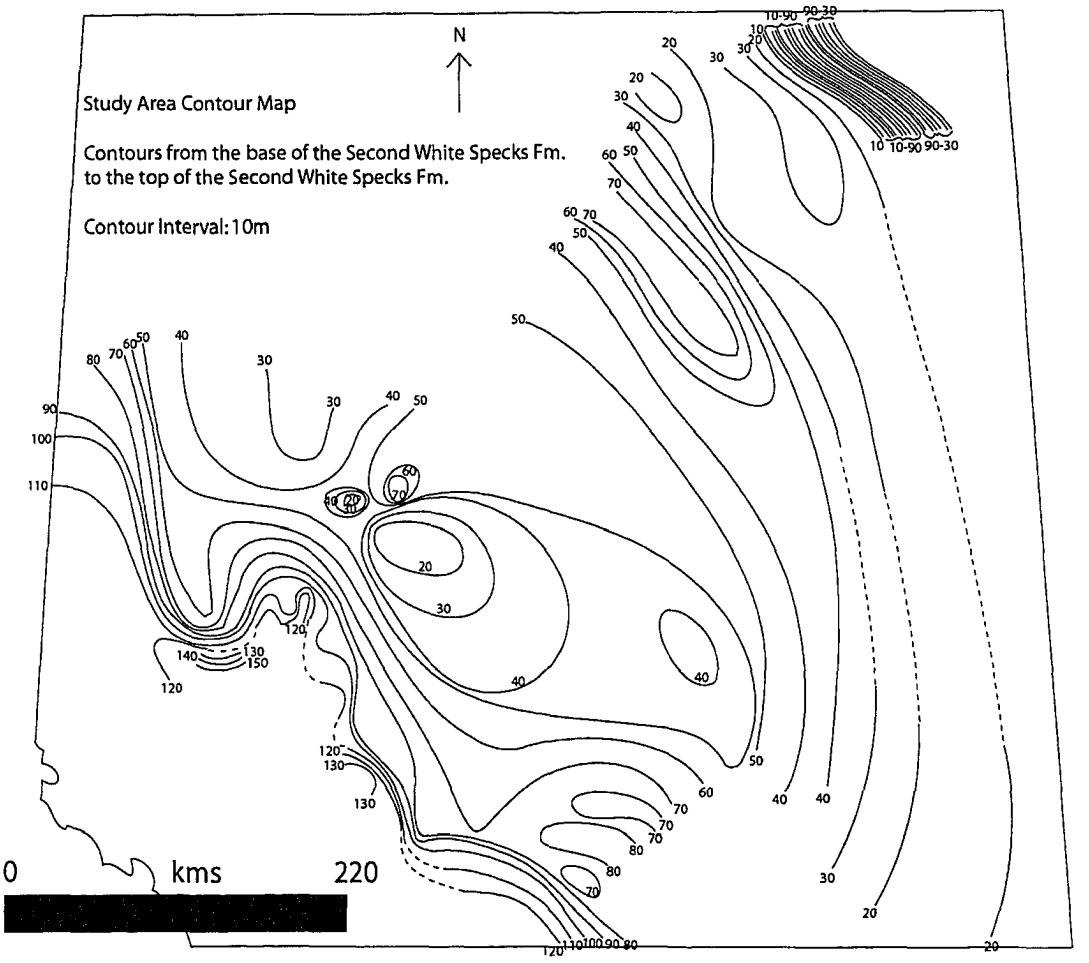


Figure 3.16: Isopach map of the thickness of the Second White Specks Formation across the study area. Contour interval of 10 m.

3.7 Sequence Stratigraphy

The depositional system for the Second White Specks Formation may be classified as shallow marine (shelf-type setting). Many authors agree (Possamentier and Allen, 1999, Catuneanu, 2003) that, because of the distal location of the deeper marine from the sediment entry points, the deeper marine deposits are the most difficult to study using sequence stratigraphy. Catuneanu (2003) also noted the fact that there is often a lack of connection between the sediment entry points and the sedimentation site, and condensed sections may develop. This is made even more difficult with the Second White Specks Formation due to the fact that the gamma-ray response often does not always

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

reflect grain size changes. Instead, higher values on the gamma-ray logs are often produced by bentonites or organic matter.

The Second White Specks Formation was deposited during an overall sea level highstand, therefore, little sediment was being transported to the distal deeper marine environment. As the gamma ray response is not a reliable source for grain size changes in this study, the maximum flooding surface is tentatively placed at the base of the Second White Specks Formation, where a bentonite bed and a bone bed are often observed. The bone bed most likely represents a kill zone that was deposited during the connection of the southern and northern oceans. It is noted that bioturbation is observed within the underlying Belle Fourche Formation, indicating that sediments were more oxygenated; in contrast, no bioturbation is observed at the base or the middle of the Second White Specks Formation, indicating that the environment became anoxic and inhospitable for the organisms. This point is reinforced by the micropaleontology in that planktic foraminifera occur only within the Second White Specks Formation, presumably when the Boreal and Tethyan waters were intermixing and during the maximum flooding surface. The maximum flooding surface signals the end of the transgressive systems tract.

After the maximum flooding surface at the base of the Second White Specks Formation, the highstand systems tract begins while sea level continues to rise and deposits the remaining Second White Specks Formation. The bottom waters remain anoxic, but gradually return to more normal marine conditions during the deposition of the overlying Carlile Formation.

Within this shallow marine environment, three processes can cause the aggradation of clastic sediments; these comprise; (1) gravity flows; (2) contour currents; and, (3) pelagic sedimentation (Catuneanu, 2003). The pelagic sedimentation occurs throughout base level rise and fall, and primarily deposits the shales themselves throughout the Second White Specks Formation. As mentioned above, however, sands are present in some cores from the study area. These sands were most likely brought to the deeper locations of the Western Interior Seaway by contour currents. The fine grained

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

nature of the sediments, and the low proportion of sand, along with sedimentary current flow structures such as small scale ripples, indicate that there was mainly unidirectional flow. The most probable cause of the concentration of these sands, silts, organic debris and white specks is contour currents acting on the base of the sea floor. Finally, the activity of gravity flows is negligible in the cores studied because no turbidite sequences were observed.

3.8 Discussion

The Second White Specks was deposited within an overall sea level high within the western Interior seaway. The top of the underlying Belle Fourche was deposited during transgression, while sea level was rising, but sediments were largely anoxic but locally slightly oxygenated, allowing for organisms to inhabit the sediment in locations. As sea level continued to rise, warm waters from the Tethyan ocean began to connect to the cooler waters of the Boreal ocean (see Figure 3.17). During this peak in transgression, the maximum flooding surface was attained, and this was the start of deposition of the Second White Specks Formation. This maximum flooding surface is marked by a bioclastic layer, where shells and fish debris are deposited. During this time, coccoliths appear within the formation. This also marks the first instance of planktic foraminifera and a decrease in the abundance of benthic foraminifera, due to the bottom waters becoming more anoxic and inhospitable to organisms. No bioturbation is observed close to the maximum flooding surface.

The basin topography during this time was most likely undulatory due to fault movements and dissolution of underlying evaporites, but has a general wedge shaped geometry, thickening towards the west, where loading of the foreland basin was occurring. The Second White Specks Formation, therefore, has a general wedge shaped geometry, with local areas of thickening and thinning. Because of the mixing of oceans, currents moved long the sea floor, carrying and concentrating very fine sands, silts, coccoliths and organic debris into fine laminations and ripples.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The sea level continued to rise during the following highstand. The environment of deposition varied slightly across the study area. Within the deep basin, and possibly to the east due to the abundance of preserved organic matter (Figure 3.17), a low energy, anoxic environment accumulated fine grained sediment as shales. Within northeastern Alberta, the energy was still fairly low, but energetic enough to deposit slightly coarser sediment in the form of silty shales. This location may even have been slightly restricted from the rest of the basin because of the palynology observed and the coarser grained sediment. Throughout the basin, contour currents transported fine grained sediment throughout the Second White Specks Formation. This is indicated by the presence of thin laminations within the shales. These currents also concentrated organic matter and shell debris from the sea floor into thin laminations and lenses. The influence of currents varied, depositing more sands in some locations and less in others throughout the deposition of the Second White Specks Formation. It appears as though the influence of currents was stronger during the start of highstand, and then decreases slightly closer the top of the Second White Specks Formation.

Across the study area, general anoxia during the highstand continued for a long period, but then the sediment became slightly more oxygenated as evidenced by bioturbation at the top of the Second White Specks Formation in some core. The low energy depositional environment continued during the start of deposition of the overlying Carlile Formation, but as time progressed normal marine conditions started to return.

Volcanism was present during the deposition of the Second White Specks Formation, depositing bentonites across the basin. In general, it is probable that most of the volcanism of the west in what is now the British Columbia accreted terranes, and volcanic ash was transported easterly via winds to accumulate in the Second White Specks Formation. However, it appears as though local volcanism may have occurred within the Birch Mountains area, due to the unusual local abundance of bentonites in the area.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

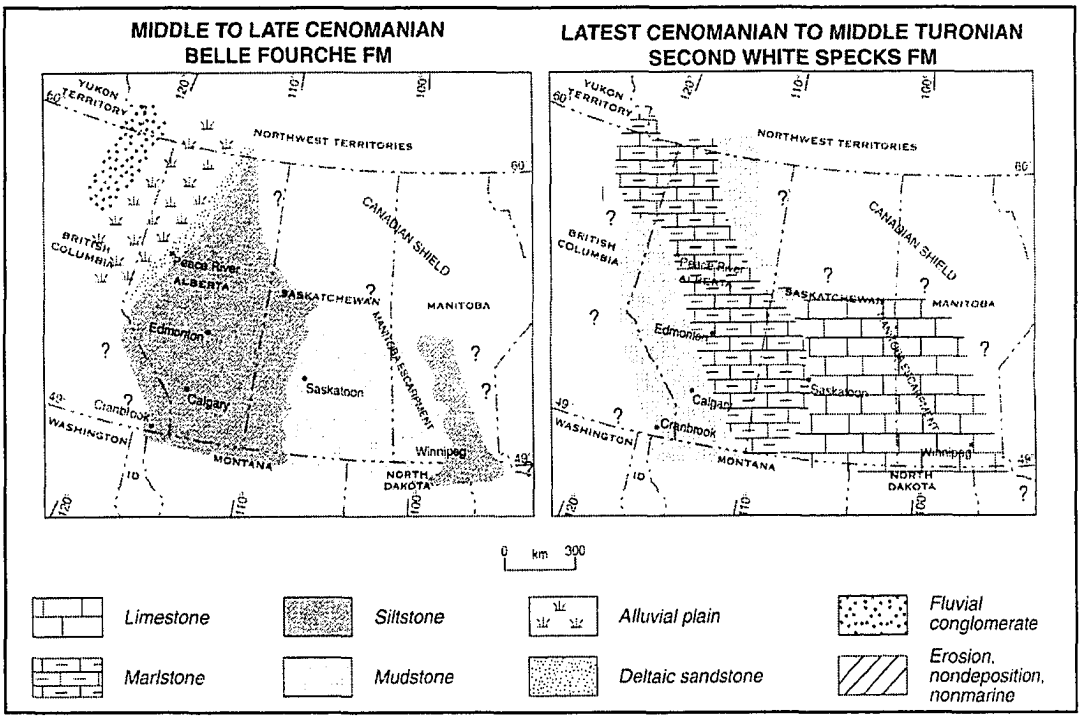


Figure 3.17: Paleoenvironmental maps for the Belle Fourche and the Second White Specks Formation (from Bloch et al., 1999).

3.9 References

Bloch, J., Schröder-Adams, C., Leckie, D.A., McIntyre, D.J., Craig, J. and Staniland, M. (1993): Revised stratigraphy of the lower Colorado Group (Albian to Turonian), Western Canada, *Bulletin of Canadian Petroleum Geology*, v. 41, pages 325-348.

Bloch, J.D., Schröder-Adams, C.J., Leckie, D.A., Craig, J. and McIntyre, D.J. (1999): Sedimentology, micropaleontology, geochemistry and hydrocarbon potential of shale from the Cretaceous lower Colorado Group in western Canada, *Geological Survey of Canada*, Bulletin 531, 183 pages.

Boggs, Sam Jr. (1995): Siliciclastic marine environments; *in* Principles of Sedimentology and Stratigraphy – 2nd Edition, pages 418-460.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Caldwell, W.G.E., North, B.R., Stelck, C.R. and Wall, J.H. (1978): A foraminiferal zonal scheme for the Cretaceous System in the Interior Plains of Canada;. *in* Western and Arctic Canadian biostratigraphy; Stelck, C.R. and Chatterton, B.D.E., Editors, *Geological Association of Canada*, Special Paper 18, pages 495-575.

Catuneanu, Octavian (2003): Sequence stratigraphy of clastic systems, *Geological Association of Canada*, Short Course Notes, v. 16, 248 pages.

Creaney, S, Allan, J., Cole, K.S., Fowler, M.G., Brooks, P.W., Osadetz, K.G., Macqueen, R.W., Snowdon, L.R. and Riediger, C.L. (1994): Cretaceous Colorado/Alberta Group of the Western Canada Sedimentary Basin; *in* Geological Atlas of the Western Canada Sedimentary Basin, *Alberta Research Council and the Alberta Geological Survey*, pages 455-468.

Dufresne, Michael B. and Eccles, Roy D. and Leckie, Dale A. (2001): The geological and geochemical setting of the Mid-Cretaceous Shaftesbury Formation and other Colorado Group sedimentary units in northern Alberta, *Alberta Geological Survey*, Special Report 09, 654 pages.

Eriksson, Patrick G. and Reczko, Boris F.F. (1997): Contourites associated with pelagic mudrocks and distal delta-fed turbidites in the Lower Proterozoic Timeball Hill Formation epeiric basin (Transvaal Supergroup), South Africa, *Sedimentary Geology*, v. 120, pages 319-335.

Glancy, T.J. Jr., Arthur, M.A., Barron, E.J. and Kauffman, E.G. (1993): A paleoclimate model for the North American Cretaceous (Cenomanian-Turonian) epicontinental sea; *in* Evolution of the Western Interior Basin; Caldwell, W.G.E. and Kauffman, E.G., Editors, *GAC Special Paper 39*, pages 219-241.

Glass, D. (1990): Lexicon of Canadian Stratigraphy volume 4: Western Canada, *Canadian Society of Petroleum Geologists*; Glass, D., Editor.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Haq, Bilal U., Hardenboi, Jan and Vail, Peter R. (1987): Chronology of fluctuating sea levels since the Triassic, *Science*, v. 235, pages 1156-1167.

Johnson, H.D. and Baldwin, C.T. (1996) Shallow clastic seas, *in* Sedimentary Environments: Processes, Facies and Stratigraphy, Reading, H.G., Editor, pages 232-280.

Leckie, D.A, Bhattacharya, J.P., Bloch, J., Gilboy, C.F., Norris, B. Campbell, R., Plint, G., Gilders, M., Holmstrom, G., Krause, F.F., Reinson, G.E., Safton, D., Sawicki, J. and Sawicki, O. (1994): Cretaceous Colorado/Alberta Group of the Western Canada Sedimentary Basin; *in* Geological Atlas of the Western Canada Sedimentary Basin, *Alberta Research Council and the Alberta Geological Survey*, pages 335-352.

McNeil, D.H., and W.G.E. Caldwell. (1981): Cretaceous rocks and their foraminifera in the Manitoba escarpment: *Geological Association of Canada Special Paper No. 21*, 439 pages.

Pana, D., Waters, J. and Grobe M. (2001): GIS Compilation of structural elements in Northern Alberta, Release 1.0, *Alberta Geological Survey*, *Alberta Energy and Utilities Board*, 53 pages.

Possamentier, H.W. and Allen, G.P. (1999): Siliciclastic sequence stratigraphy: concepts and applications, SEPM Concepts in Sedimentology and Paleontology, no. 7, 210 pages.

Schröder-Adams, Claudia J., Adams, Peter J, Haggart, Jim, Leckie, Dale A., Bloch, John, Craig, Jim and McIntyre, David J. (1998): An integrated paleontological approach to reservoir problems; Upper Cretaceous Medicine Hat Formation and First White Speckled Shale in southern Alberta, Canada, *Palaios 13*, pages 361-375.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Stow, D.A.V., Reading, H.G. and Collinson, J.D. (1996): Deep seas; *in* Sedimentary Environments: Processes, Facies and Stratigraphy; Reading, H.G., Editor, pages 395-453.

Wright, G.N., McMechan, M.E., Potter, D.E.G., Holter, M.E. (1994): Structure and architecture of the Western Canada Sedimentary Basin; *in* Geological Atlas of the Western Canada Sedimentary Basin, *Alberta Research Council and the Alberta Geological Survey*, pages 25-50.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

4.0 THE GEOCHEMISTRY OF THE ORGANIC RICH SECOND WHITE SPECKS FORMATION, NORTH/CENTRAL ALBERTA

4.1 Introduction

The organic geochemistry of the Second White Specks Formation has been well documented because it has been of interest to exploration companies, as a result of it being both a source and reservoir rock, (Leckie et al., 1994). However, little work has been published on the inorganic geochemistry and metalliferous economic potential of the formation.

Information about the organic geochemistry of the Second White Specks Formation is common. For example, Travis (2002) demonstrated that the Second White Specks Formation has a high total organic carbon content, Type II kerogen, early maturity and fair to very good hydrocarbon potential in central/western Alberta (west of Edmonton). Travis (Ibid) concluded that the formation has the potential for shale gas production within Alberta. Other workers have generally agreed that the dominant organics are Type II marine organic matter within the Second White Specks Formation (Leckie et al., 1994, Bloch et al., 1999). The total organic carbon content has been recorded as reaching a maximum of 12 wt%, and has a much higher total organic carbon content than either the underlying Belle Fourche or the overlying Carlile formations (Bloch et al., 1999). Investigations by Bloch et al. (1999) have demonstrated that the Second White Speckled Shale is a mature source rock west of 114° longitude, where the migration of hydrocarbons most likely occurred through fractures. Snowdon (1995) described rock-eval T_{max} suppression for the Second White Specks Formation, and stated that below 453°C, the suppression is around 1°C for each increase in the hydrogen index of 50 mg hydrocarbon/g total organic carbon content.

On the inorganic side, a report was completed by the Alberta Geological Survey/Alberta Energy and Utilities Board and Tintina Mines Limited (Dufresne et al., 2001, Sabag, 1996) which investigated various Colorado Group shales in northern

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Alberta. The results from this investigation indicated that the Second White Specks Formation has elevated values for most elements in comparison with the overlying and underlying shales in northeastern Alberta. For example, the results showed anomalous concentrations of: Au, Pt, Pd, Ag, Sb, As, Cu, Zn, Cd, Co, Ni, V, Mo, Fe, Mn, Ba, Ca, Br, Se, U, Eu, Ce, La, Lu, Nd, Sm, Tb, Y, Yb, S, especially in the northeastern part of the Birch Mountains. The current study is intended to confirm and refine the results obtained for the Birch Mountains core and, if feasible, assess whether the anomalous geochemistry extends into central Alberta. Therefore, the focus of this chapter is on the inorganic geochemistry of the Second White Specks Formation and its potential to contain a Sedex or Ni-Mo type deposit. The following section summarizes various sedimentary metalliferous deposits and compares the results in this study to the various metalliferous deposit types.

4.1.1 Summary of: Sedex vs. MVT vs. Ni-Mo Metalliferous Sedimentary Deposits

4.1.11 Sedex (Sedimentary Exhalative) Deposits

Sedex deposits are a source of much of the world's zinc and lead production (Lydon, 1996). The definition of a sedimentary exhalative sulphide (Sedex) deposit is given by Lydon (1996) as "*a sulphide deposit formed in a sedimentary basin by the submarine venting of hydrothermal fluids and whose principle ore minerals are sphalerite (ZnS) and galena (PbS)*". There is some difficulty in trying to classify Sedex deposits, because it seems that every deposit is slightly different. For example, various Sedex deposits have different host rocks, which can include one or more of the following; carbonaceous black shales, siltstones, cherty argillites, cherts, sandstones, conglomerates, limestones to dolostones, and even in some areas associated with evaporites, calcareous siltstones or mudstones, or even volcanic rocks (MacIntyre, 1995).

The main economic minerals found in a Sedex deposit are base metal and iron sulphide minerals including sphalerite (ZnS), galena (PbS), pyrite (FeS_2), pyrrhotite (FeS), and less commonly, chalcopyrite ($CuFeS_2$), arsenopyrite (FeAsS), marcasite

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

(FeS_2), and some other sulphide minerals (Large, 1983, Olson et al, 1994). In general, chalcopyrite is usually in small abundances compared to the much larger amounts seen in a volcanogenic massive sulphide (VMS) deposit. Barite ($BaSO_4$) is common in some Sedex deposits, but absent in others. It is reportedly found more often in Proterozoic Sedex deposits according to Lydon (1996). Carbonates, such as siderite ($FeCO_3$), ankerite ($Ca(Mg,Fe)(CO_3)_2$), quartz and tourmaline, exist as gangue minerals (Olson et al, 1994). Antimony, arsenic and bismuth can be present in sulphosalts, such as tetrahedrite, freibergite and boulangerite and they are often found proximal to the vent area (Lydon, 1996). The sulphosalts may also carry silver. Molybdenite, enargite, millerite, freibergite, cobaltite, cassiterite, vallerite and melnikovite have been reported in trace amounts in some deposits (MacIntyre, 1995), but are not very common.

With the above definition and characteristics in mind, a Sedex deposit can be distinguished from some other sedimentary hosted metalliferous deposits as follows. Lydon, (1983) distinguished volcanogenic massive sulphides (VMS) deposits in a few ways. Fore example, he (Ibid) noted that Sedex deposits contain less copper (often as chalcopyrite) in comparison to the lead-zinc in a VMS deposit. VMS deposits have much less lead-zinc relative to Sedex deposits. In general, chalcopyrite is usually economically insignificant in a Sedex deposit (Lydon, 1996). VMS deposits are generally formed at higher temperatures (>300°C) as a result of 'black smokers' in a submarine setting. The average tonnage and total metal content of Sedex deposits tend to be greater than what is observed in most VMS deposits. Sediment hosted deposits often occur singularly, whereas volcanogenic massive sulphide deposits tend to occur in 'bunches' in an ore district. VMS deposits have a volcanic character, whereas Sedex deposits have a sedimentary character (Sangster, 2000). This does not mean that volcanic processes are not be associated with the sedimentary exhalative deposits, but instead the two deposit types primarily have different hosts for the ores.

Sedex deposits vary from Mississippi Valley type (MVT) deposits in that they have more iron and silver, and generally seem to have been emplaced earlier in the sedimentary-diagenetic history (Gustafson et al, 1981). Mississippi Valley type deposits

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

tend to be dominantly or entirely epigenetic. However, there is much debate as to whether Sedex deposits are epigenetic, diagenetic, syngenetic, or all three. Having said this, a syngenetic origin is currently favoured for most Sedex deposits. Lydon (1996) noted that MVT deposits may have a much larger time gap in between the deposition of the host rock and the subsequent timing of mineralization. Sedex deposits, on the other hand appear to have a much earlier timing of mineralization.

Even though not all Sedex deposits are economic, they do provide for interesting study. The variety of Sedex deposits lies in the fact that the geology and the environments of the Earth have been constantly changing throughout its history (Lydon, 1996). The geochemical signature for Sedex deposits is an increase in sulphides, especially Zn, Pb and Fe with or without barite. There is often zoning, with Pb found closest to the vent with increasing Zn outward and upward away from the vent. If barite is present, it is usually found distally from the vent and Cu is often observed within the feeder zone or close to the vent (MacIntyre, 1995).

It is of interest to look at a present day locations that may become a future Sedex deposits. The Black Sea is one such area, where there are deep, sediment starved, anoxic waters where scientists believe that a present day Sedex deposit may develop. This situation appears to be similar to the depositional environment of the Second White Speckled Shale. As discussed in the previous chapter, the Second White Specks Formation was deposited in an overall anoxic environment that was inhospitable to organisms and fairly starved of sediment. This will be further investigated within this chapter, as well as the possibility of the Second White Specks Formation potentially being a host for other metalliferous deposit types.

The Red Dog deposit is an example of a large Mississippian-Pennsylvanian Sedex deposit in Alaska with reported reserves of 150 Mt with average grades of 16.2% Zn, 4.4% Pb and 110 g/t Ag with a vent field of 2400m by 400m deposited within shales (Edgerton, 1997). The ore lies within breccia, transitional and stratiform facies, with the stratiform facies being the periphery of the body and barite rock deposited during the late

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

stage mineralization (Ibid). This deposit will be compared with the Second White Specks Formation later in this chapter.

4.1.12 Mississippi Valley-type deposits

There is some discussion as to the relatedness of the Mississippi Valley-type (MTV) deposits to the Sedex deposits and whether or not they represent a continuum with each being an end member. If MVT and Sedex deposits are the end members of a continuum, then the Irish-type deposits would lie somewhere in between the two. MVT deposits are epigenetic and are hosted in carbonate rocks, as opposed to being hosted in clastic rocks, which is the case for Sedex deposits (Sangster, 1996). Galena (PbS) and sphalerite (ZnS) fill spaces between the carbonate (usually limestone or dolomite) breccia host (Sangster, 1996). Other minerals commonly include pyrite and dolomite, with smaller quantities of marcasite, calcite, quartz, barite, fluorite and chalcopyrite (Olson et al., 1994). Frequently, the ore minerals tend to be coarse grained (Sangster, 1996). The marine platformal carbonates are usually peripheral to undisturbed cratonic sedimentary basins, often below an unconformity or nonconformity (Olson et al., 1994; Sangster, 1996). They occur in tectonically stable areas, unlike those of Sedex deposits.

The age of MVT deposits indicates that they occurred during the Proterozoic to the Cretaceous. In most or all cases, MVT mineralization clearly took place much later in the sediment depositional history whereas Sedex deposits typically are believed to form early in the sediment history; that is, syngenetically or during diagenesis. Finally, in MVT deposits there commonly is associated, and development of high porosity due to a host rock dissolution and brecciation event or dolomitization (Olson et al., 1994). In some cases the breccia may have been formed due to the dissolution of underlying or surrounding beds (Sangster, 1996).

MVT deposits tend to be smaller with sizes on the average of 1 to 10 Mt. MVT grades commonly average between 5 to 10% combined Pb/Zn. Finally, although they are epigenetic MVT deposits tend to be stratabound, and they may occur in groupings of

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

several small to large mineralized bodies (Sangster, 1996). The geochemical signature for these types of deposits includes elevated values for Pb, Zn and Ag.

Deposits of the MVT type in Canada include the Newfoundland Zinc deposit, Polaris deposit, Nanisivik deposit, Gays River deposit, Pine Point deposit and Robb Lake deposit, with Pine Point perhaps being the best known and studied. Further afield, MVT deposits occur in the Tri-State district (USA), East Tennessee district (USA), Old Lead Belt district (USA), Viburnum district (USA) and Bou Beker-El Abed district (Morocco-Algeria) (Sangster, 1996).

4.1.13 Shale-hosted Ni-Zn-Mo-PGE

This type of deposit tends to be sheet-like nickel enriched sulphide layers in marine shales. The commodities include mainly Ni, Mo, with lesser amounts of Zn, Pt, Pd, Au. The sulphide minerals commonly are in thin layers (less than 1 cm to 15 cm thick), comprise pyrite, vaesite (NiS_2), jordisite (amorphous MoS_2) and sphalerite clusters and zones for tens of kms (Lefebure et al., 1995). Lefebure et al., (1995) also noted that these deposits have usually been found in conjunction with shales deposited within an orogenic belt, but in some places this may occur in shales within stable cratonic settings. They may also be associated with carbonaceous shales and/or phosphorite (Goodfellow et al., 2001).

The two most famous shale-hosted Ni-Mo-Zn-PGE deposits are the middle Devonian Nick deposit in the Yukon and the early Cambrian southern Chinese deposits. However, the Chinese deposits of this type currently are the only ones in the world that have been found to be of economic grade (Hulbert, 1996). Although these metalliferous black shales may not always be of ore grade (aside from the Chinese shales), it has been demonstrated that they are deposited within anoxic waters which are often stagnant bottom waters (Schultz, 1991). This environment of deposition is similar to that of the Second White Specks Formation because the Second White Specks Formation is a dark, organic rich marine shale that was deposited in fairly anoxic conditions. Lefebure and

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Coveney (1995) state that the geochemical signature for nickel deposits includes elevated values for Ni, Mo, Au, PGE, C, P, Ba, Zn, Re, Se, As, U, V and S.

4.1.2 Metals from Sea Water

A study of 88 samples from the Atlantic Ocean were analyzed (Brumsack, 1980). They showed that the order of heavy metal enrichment in the shale, relative to average shale in the study, was Pb<Co<Cr<Ni<Cu<V<Zn<Mo<Ag. Therefore, they noticed heavy metal enrichment in the shales where there were no hydrothermal processes, resembled the metal enrichment recorded in normal sea water. Aside from Ag, this conforms to the increasing concentration in normal seawater (Brumsack, 1980). V and Mo are also preferentially concentrated in black shales (Brumsack, 1980). The paper demonstrates that very high concentrations of metals can be produced simply by seawater under the right depositional setting. Thus, the model does not require a source for hydrothermal fluids, restricted basins or fractures, as is normally the case advocated for Sedex, MVT and Irish-type deposits.

4.1.3 Other Shales

A study by Schultz and Coveney (1992) describes Pennsylvanian black shales in the United States which were deposited during almost fully anoxic conditions of sedimentation where the degree of pyritization (DOP) correlates positively with total organic carbon (TOC), with decreasing DOP and TOC suggesting improvement of bottom-water oxygenation and decreased organic matter. The author (Ibid) also discusses papers by Klein (1991) and Hallam (1967) which state that black shales may form at any depth, from deep waters to sea level, and that organic carbon and depth below sea level do not always have a simple relationship for black shales. Recorded values from Schultz and Coveney's 1992 study show variations of elements from over 100 ppm U to much less than 50 ppm U, less than 200 ppm Zn to 3500 ppm Zn and less than 10 ppm Mo to over 500 ppm Mo for the Pennsylvanian black shales.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

A study by Lyons and Berner (1992) published an article on deep water coccolith-rich, microlaminated sediments and muds from the black sea where pyrite is forming in the anoxic sulphidic water column and/or near the sediment-water interface with the pyrite formation appearing to vary with regards to the location on the basin slope. The deeper sediments were characterized by 5.3 weight % mean organic carbon with low rates of sulphate reduction (below surficial layers) which demonstrates a low organic matter reactivity even with the basinal anoxia and may be related to accumulation rates. Therefore, black shales can vary widely across geological space and time and must each be treated separately.

4.2 Analytical Procedures and Data

4.2.1 Lower Detection Limits

The following tables summarize each analysis and the results for each element that returned a significant number of sample values below the lower detection limit (LDL). The elements that returned more than 25% of values below the lower detection limit include; Ge, Pd, Pt, Ta, Ti and W for Group 1F, Au for Group 1EX and Sn for Group 4B. Please refer to Appendix 6.5 for the complete tables and calculations for accuracy and precision.

Table 4.1: Group 1F1 Elements, and summary of number of sample results below LDL

	Ag (ppb)	Al (%)	As (ppm)	Au (ppb)	B (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Ca (%)
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02	0.01
Number of Samples	540	540	540	540	540	540	68	540	540
Values < LDL	0	0	0	95	1	0	0	1	0
Percentage < LDL	0	0	0	17.6	0.2	0	0	0.2	0

	Cd (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Fe (%)	Ga (ppm)	Ge (ppm)
LDL	0.01	0.1	0.1	0.5	0.02	0.01	0.01	0.1	0.1
Number of Samples	540	68	540	540	68	540	540	540	68
Values < LDL	0	0	0	0	0	0	0	0	56
Percentage < LDL	0	0	0	0	0	0	0	0	82.4

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

	Hf (ppm)	Hg (ppb)	In (ppm)	K (%)	La (ppm)	Li (ppm)	Mg (%)	Mn (ppm)	Mo (ppm)
LDL	0.02	5	0.02	0.01	0.5	0.1	0.01	1	0.01
Number of Samples	68	540	68	540	540	68	540	540	540
Values < LDL	2	0	0	0	1	0	0	0	0
Percentage < LDL	2.9	0	0	0	0.2	0	0	0	0

	Na (%)	Nb (ppm)	Ni (ppm)	P (%)	Pb (ppm)	Pd (ppb)	Pt (ppb)	Rb (ppm)	Re (ppb)
LDL	0.001	0.02	0.1	0.001	0.01	10	2	0.1	1
Number of Samples	540	68	540	540	540	68	68	68	68
Values < LDL	0	0	0	0	0	62	48	0	4
Percentage < LDL	0	0	0	0	0	92.2	70.6	0	5.9

	S (%)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Te (ppm)	Th (ppm)
LDL	0.02	0.03	0.1	0.1	0.1	0.5	0.05	0.02	0.1
Number of Samples	540	540	540	540	68	540	68	540	540
Values < LDL	1	0	0	0	0	0	68	14	0
Percentage < LDL	0.2	0	0	0	0	0	100	2.6	0

	Ti (%)	Tl (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
LDL	0.001	0.02	0.1	2	0.1	0.01	0.1	0.1
Number of Samples	540	540	540	540	540	68	540	68
Values < LDL	208	0	0	0	533	0	0	0
Percentage < LDL	38.5	0	0	0	98.7	0	0	0

Table 4.2: Group 1EX Elements, and summary of number of sample results below LDL

	Ag (ppm)	Al (%)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Ca (%)	Cd (ppm)
LDL	0.1	0.01	1	0.1	1	1	0.1	0.01	0.1
Number of Samples	0	0	0	84	0	1	0	0	0
Values < LDL	0	0	0	84	0	1	0	0	0
Percentage < LDL	0	0	0	100	0	1.2	0	0	0

	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Fe (%)	Hf (ppm)	K (%)	La (ppm)	Li (ppm)
LDL	1	1	0.1	0.1	0.01	0.1	0.01	0.1	0.1
Number of Samples	84	84	84	84	84	84	84	84	84
Values < LDL	0	0	0	0	0	0	0	0	0
Percentage < LDL	0	0	0	0	0	0	0	0	0

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

	Mg (%)	Mn (ppm)	Mo (ppm)	Na (ppm)	Nb (ppm)	Ni (ppm)	P (%)	Pb (ppm)	Rb (ppm)
LDL	0.01	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Number of Samples	84	84	84	84	84	84	84	84	84
Values < LDL	0	0	0	0	0	0	0	0	0
Percentage < LDL	0	0	0	0	0	0	0	0	0

	S (%)	Sb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	Ti (%)	U (ppm)
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.001	0.1
Number of Samples	84	84	84	84	84	84	84	84	84
Values < LDL	0	0	0	0	0	0	0	0	0
Percentage < LDL	0	0	0	0	0	0	0	0	0

	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
LDL	1	0.1	0.1	1	0.1
Number of Samples	84	84	84	84	84
Values < LDL	0	0	0	0	0
Percentage < LDL	0	0	0	0	0

Table 4.3: Group 4B - REE Elements, and summary of number of sample results below LDL

	Ce (ppm)	Co (ppm)	Cs (ppm)	Dy (ppm)	Er (ppm)	Eu (ppm)	Ga (ppm)	Gd (ppm)	Hf (ppm)
LDL	0.5	0.5	0.1	0.05	0.05	0.05	0.5	0.05	0.5
Number of Samples	84	84	84	84	84	84	84	84	84
Values < LDL	0	0	0	0	0	0	0	0	0
Percentage < LDL	0	0	0	0	0	0	0	0	0

	Ho (ppm)	La (ppm)	Lu (ppm)	Nb (ppm)	Nd (ppm)	Pr (ppm)	Sn (ppm)	Rb (ppm)	Sm (ppm)
LDL	0.05	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Number of Samples	84	84	84	84	84	84	84	84	84
Values < LDL	0	0	0	0	0	0	42	0	0
Percentage < LDL	0	0	0	0	0	0	50	0	0

	Sr (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Tm (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1	0.1
Number of Samples	84	84	84	84	84	84	84	84	84
Values < LDL	0	0	0	0	0	0	0	0	0
Percentage < LDL	0	0	0	0	0	0	0	0	0

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

	Yb (ppm)	Zr (ppm)
LDL	0.05	0.5
Number of Samples	84	84
Values < LDL	0	0
Percentage < LDL	0	0

Table 4.4: Group 4A Elements, and summary of number of sample results below LDL

	Al2O3 (%)	Ba (ppm)	CaO (%)	Cr2O3 (%)	Fe2O3 (%)	K2O (%)	LOI (%)	MgO (%)	MnO (%)
LDL	0.03	5	0.01	0.001	0.04	0.04	0.1	0.01	0.01
Number of Samples	84	84	84	84	84	84	84	84	84
Values < LDL	0	0	0	0	0	0	0	0	0
Percentage < LDL	0	0	0	0	0	0	0	0	0

	Na2O (%)	Ni (ppm)	P2O5 (%)	Sc (ppm)	SiO2 (%)	TiO2 (%)	TOT/C (%)	TOT/S (%)
LDL	0.01	30	0.01	1	0.02	0.01	0.01	0.01
Number of Samples	84	84	84	84	84	84	84	84
Values < LDL	0	8	0	0	0	0	0	0
Percentage < LDL	0	9.5	0	0	0	0	0	0

4.2.2 Precision

Ziegler and Combs (1997) give the percentage recovery for each standard measurement, which is a measure of accuracy, by the following equation (G. Prior, personal communication, 2004):

Percentage recovery = 100 x C_M/C_A where

C_M = the measured concentration of the standard sample

C_A = the actual concentration of the standard sample (recommended or provisional value)

For the data sets which have a sufficient quantity of replicate determinations for a given standard sample, the relative standard deviation (RSD) can be calculated which provides a measure of precision. The following equation is applied:

RSD = s/x

where

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

RSD = relative standard deviation

s = standard deviation

x = mean of replicate determinations

The following tables contain the results for the precision calculations for each element. Please refer to Appendix 6.5 for the full calculations.

Table 4.5: Relative standard deviation results for GROUP 1F1 elements

Laboratory standards RSD values	Elements
</= 5%	Al, Ba, Fe, Ga, K, La, Mg, Mn, Na, Sr, Ti, Tl, Zn
>5% and </=10%	Ca, Co, Cr, Cu, Ni, P, Pb, V
>10% and </=20%	Cd, Mo, Sc, Th, U
>20% and </=50%	Ag, B
>50% and </=100%	Se
>100% and </=150%	
N/A (over 25% samples <LDL)	As, Au, Bi, Hg, S, Sb, Te, W

Table 4.6: Relative standard deviation results for GROUP 1F1 elements part 2

Laboratory standards RSD values	Elements
</= 5%	Al, Ba, Ca, Co, Cs, Cu, Fe, Ga, K, La, Li, Mg, Mn, Na, P, Rb, Sr, Ti, Tl, Y, Zn
>5% and </=10%	Ce, Cr, Nb, Ni, Pb, Sc, Sn, U, V, Zr
>10% and </=20%	B, Cd, Mo, Th
>20% and </=50%	Ag, Be, Hf, In, Se
>50% and </=100%	
>100% and </=150%	
N/A (over 25% samples <LDL)	As, Au, Bi, Ge, Hg, Pd, Pt, Re, S, Sb, Ta, Te, W

Table 4.7: Relative standard deviation results for GROUP 1EX elements

Laboratory standards RSD values	Elements
</= 5%	Al, Fe, K, Mn, Zn
>5% and </=10%	Ca, Li, Mg, Na, Nb, P, Pb, Sr, Ti
>10% and </=20%	Ba, Cr, Cu, Hf, Ni, Sn, Ta, Y, Zr
>20% and </=50%	As, Be, Cd, Ce, La, Mo, Rb, Th, U, V
>50% and </=100%	Co
>100% and </=150%	
N/A (over 25% samples <LDL)	Ag, Au, Bi, S, Sb, Sc, W

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table 4.8: Relative standard deviation results for GROUP 4B - REE

Laboratory standards RSD values	Elements
</= 5%	Ce, Dy, Er, Ga, Gd, La, Lu, Nb, Nd, Pr, Rb, Sm, Sr, Ta, Y, Yb, Zr
>5% and </=10%	Co, Cs, Eu, Hf, Ho, Tb, Tm
>10% and </=20%	
>20% and </=50%	Sn, Th, U
>50% and </=100%	
>100% and </=150%	W
N/A (over 25% samples <LDL)	V

Table 4.9: Relative standard deviation results for GROUP 4A

Laboratory standards RSD values	Elements
</= 5%	Al2O3, Ba, CaO, Fe2O3, K2O, MgO, MnO, Na2O, SiO2, TiO2, TOT/C
>5% and </=10%	LOI, P2O5
>10% and </=20%	
>20% and </=50%	Sc
>50% and </=100%	
>100% and </=150%	
N/A (over 25% samples <LDL)	Cr2O3, Ni, TOT/S

Table 4.10: Relative standard deviation results for CO2

Laboratory standards RSD values	Elements
</= 5%	CO2
>5% and </=10%	
>10% and </=20%	
>20% and </=50%	
>50% and </=100%	
>100% and </=150%	
N/A (over 25% samples <LDL)	C/ORG, C/GRA, SO4

4.2.3 Duplicate Pairs

The relative percentage difference (RPD) represents a measure of precision and is calculated with the following equation (Ziegler and Combs, 1997, Zimmerman et al., 2001, G. Prior, personal communication, 2004):

$$RPD = 100 \times |C_1 - C_2| / C_x$$

where

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

RPD = relative percentage difference

$|C_1 - C_2|$ = absolute value of the difference between the two duplicate pair concentrations

C_x = mean of the two results

The following tables summarize the calculations for the duplicate pairs (precision calculations).

Table 4.11: Relative percentage difference for GROUP 1F1 elements

Laboratory duplicate pair Average RPD values	Elements
</= 5%	Cu, Fe, Mg, Ni, Sr
>5% and </=10%	Ag, Al, As, Bi, Ca, Cd, Co, Cr, Ga, K, La, Mn, Mo, Na, P, Pb, Sb, Se,Th, U, V, Zn
>10% and </=20%	B, Ba, Hg, S, Tl
>20% and </=50%	Te
>50% and </=100%	Au
>100% and </=150%	
N/A (over 25% samples <LDL)	Ti, W

Table 4.12: Relative percentage difference for GROUP 1F1 elements

Laboratory duplicate pair Average RPD values	Elements
</= 5%	
>5% and </=10%	Ag, As, B, Bi, Cu, Fe, Hg, La, Mo, Na, Sn, Sr, Th
>10% and </=20%	Al, Ba, Ca, Cd, Ce, Co, Cs, Ga, In, Li, Mg, Mn, Ni, P, Pb, Rb, S, Sb, Sc, Se, Te, Tl, U, Y, Zn, Zr
>20% and </=50%	Be, Cr, Hf, K, Nb, Re, V
>50% and </=100%	Au
>100% and </=150%	
N/A (over 25% samples <LDL)	Ge, Pd, Pt, Ta, Ti, W

Table 4.13: Relative percentage difference for GROUP 1EX elements

Laboratory duplicate pair Average RPD values	Elements
</= 5%	S, Ta
>5% and </=10%	Al, Ce, Fe, Hf, Li, Mg, Na, Nb, Pb, Sc, Sr, Th, Ti, V, Zr
>10% and </=20%	Ag, As, Ca, Co, Cr, Cu, K, La, Mn, Mo, Ni, P, Sb, Sn, U, W, Y, Zn
>20% and </=50%	Ba, Be, Bi, Cd, Rb
>50% and </=100%	
>100% and </=150%	
N/A (over 25% samples <LDL)	Au

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table 4.14: Relative percentage difference for GROUP 4B - REE

Laboratory duplicate pair Average RPD values	Elements
</= 5%	Ce, Ga, La, Pr, Zr
>5% and </=10%	Gd, Hf, Lu, Nb, Nd, Rb, Sm, Sr, Ta, Tm, V, Y, Yb
>10% and </=20%	Co, Cs, Dy, Er, Eu, Ho, Tb, Th, U
>20% and </=50%	W
>50% and </=100%	
>100% and </=150%	
N/A (over 25% samples <LDL)	Sn

Table 4.15: Relative percentage difference for GROUP 4A

Laboratory duplicate pair Average RPD values	Elements
</= 5%	Al2O3, LOI, SiO2, TiO2
>5% and </=10%	Ba, Cr2O3, Fe2O3, K2O, MgO, Na2O, Sc, TOT/S
>10% and </=20%	CaO, Cr2O3, MnO, P2O5, TOT/C, C/ORG, SO4
>20% and </=50%	Ni, CO2
>50% and </=100%	
>100% and </=150%	
N/A (over 25% samples <LDL)	C/Gra

Overall, the accuracy and precision calculations seem reasonable for the elements that have enough information above their lower detection limits.

4.3 Elemental Values with Depth

Values for Zn, S, Ni, Mo, Fe, Cu, Ag and C-org (if available) are plotted against depth for every core in Appendix 6.6. It must be noted, however, that not every core has been confirmed to include the Second White Specks Formation, so general conclusions can not be made on the geochemistry of all the cores and these generalizations for core not of Second White Specks origin are also included in Appendix 6.6. Therefore, the cores that have the most information will be concentrated on in this section and brief comments about the other core are included, with their graphs of elemental values versus depth included in Appendix 6.6. 7BK03 represents the core from northeastern Alberta, 10-22-047-03W4 represents core from east central Alberta and 06-31-046-08W5 is plotted to represent a partial core from the deep basin.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

7BK03 (Birch Mountains Core):

The core placement was determined based on the combination of palynology and lithology. The core interval ranges from 72.17 m to 102.05 m depth and the Second White Specks interval represents 74.875 m to 100.94 m depth. Therefore, the core represents the Second White Specks Formation and the overlying and underlying shales.

Values observed for the core in the Birch Mountains show a bimodal distribution, with a smaller peak near the base of the Second White Specks Formation, and a much larger peak near the top of the Formation. Values for the elements are much lower in the underlying Belle Fourche Formation and the overlying Labiche Shales. The peak values for most elements occur at the same depth of around 80 m. This would indicate that for this core, the upper Second White Specks Formation is more metalliferous than the base. Organic carbon shows this general trend strongly with Ag, Ni, Zn, Mo and Cu. Fe and S show a general trend of higher values near the base and top of the formation, but are not as prominent as the other elements mentioned (Figure 4.1).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

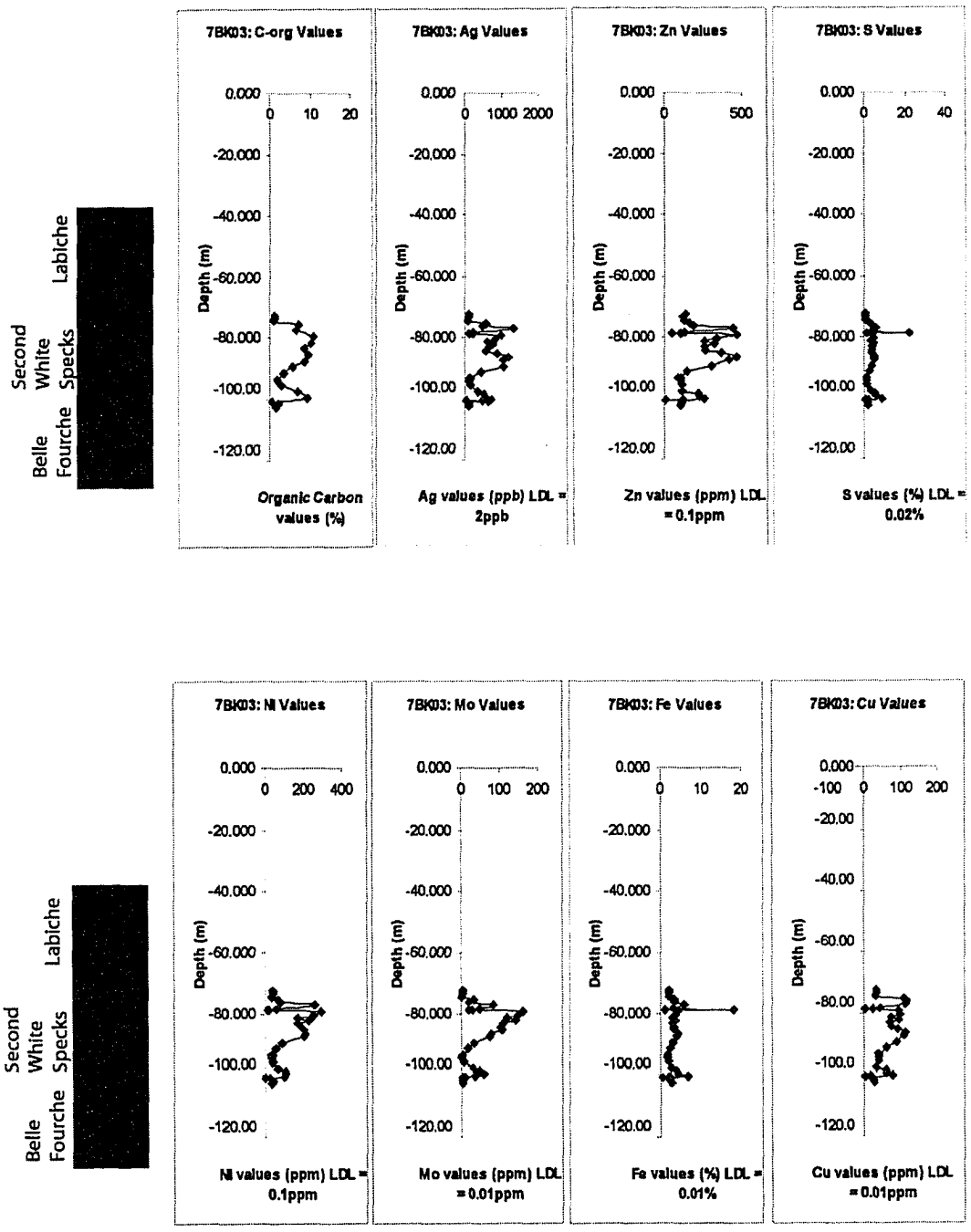


Figure 4.1: Values for various metals and elements with depth for the core 7BK03.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

7BK03 (Birch Mountains Core – Tintina Report (Sabag, 1998)): Second White Specks Formation depth from 75.03 m to 101.23 m

The following plots were constructed from information from the Tintina assessment reports (Sabag, 1996; Sabag 1998). The geochemistry in the report was much more extensive than this study; nonetheless the results for the Second White Specks Formation were very close to those in the Tintina report.

These plots reinforce the bimodal concentration of elements within the Second White Specks Formation in northeastern Alberta. The top of the Second White Specks is much more metalliferous than the base. The plots also show a nice comparison between the much more metal rich Second White Specks Formation and the overlying and underlying shales which have much lower concentrations of metals. Another observation is the fact that the organic carbon content is greatly reduced in the overlying and underlying shales. The rest of the plotted elements tend to follow this general pattern (Figure 4.2).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

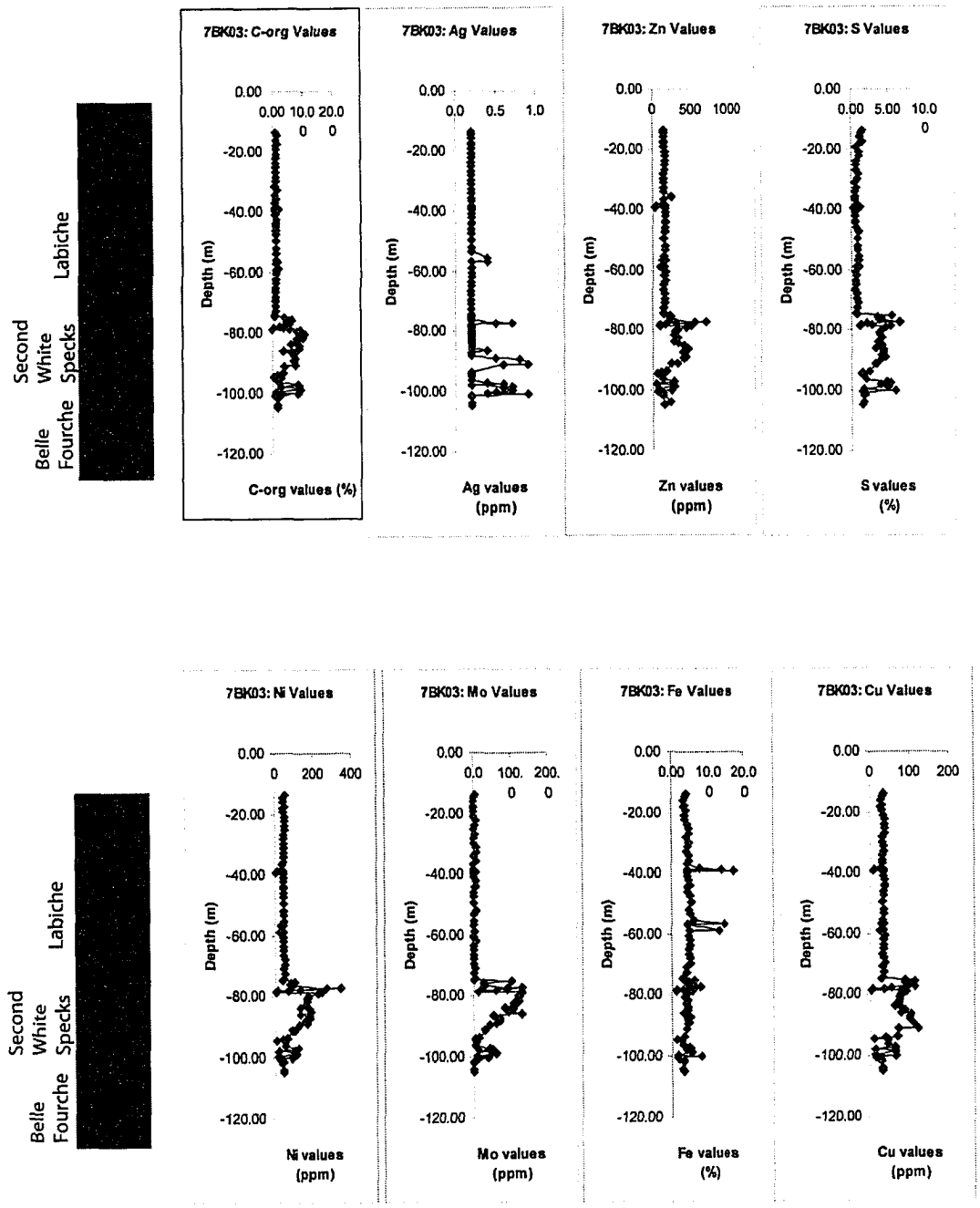


Figure 4.2: Values for various metals and elements with depth for the core 7BK03.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

10-22-047-03W4:

The core placement was determined based on precise dating using micropaleontology. The exact depth of the Second White Specks Formation is known. The cored interval ranges from 409.02 m to 463.27 m depth and the Second White Specks Formation interval ranges from 426 m to 440 m. Therefore, the core represents the whole Second White Specks Formation interval and the overlying Carlile Formation shales and the underlying Belle Fourche Formation shales.

A general increase in organic carbon is seen within the Second White Specks Formation, but unlike the core from 7BK03, the metals do not all follow the same trend. There appears to be a bimodal distribution in the elements, but the highest values are observed near the base of the core, with the lowest values near the center of the core, and slightly more elevated values near the top of the formation. Molybdenum shows the greatest correlation with the organic carbon content. Most of the other metals, aside from Fe, are slightly concentrated within the Formation. The most likely explanation of the increased concentration of both S and Fe in the underlying Belle Fourche Formation is the increased amount of pyrite observed within the core (Figure 4.3).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

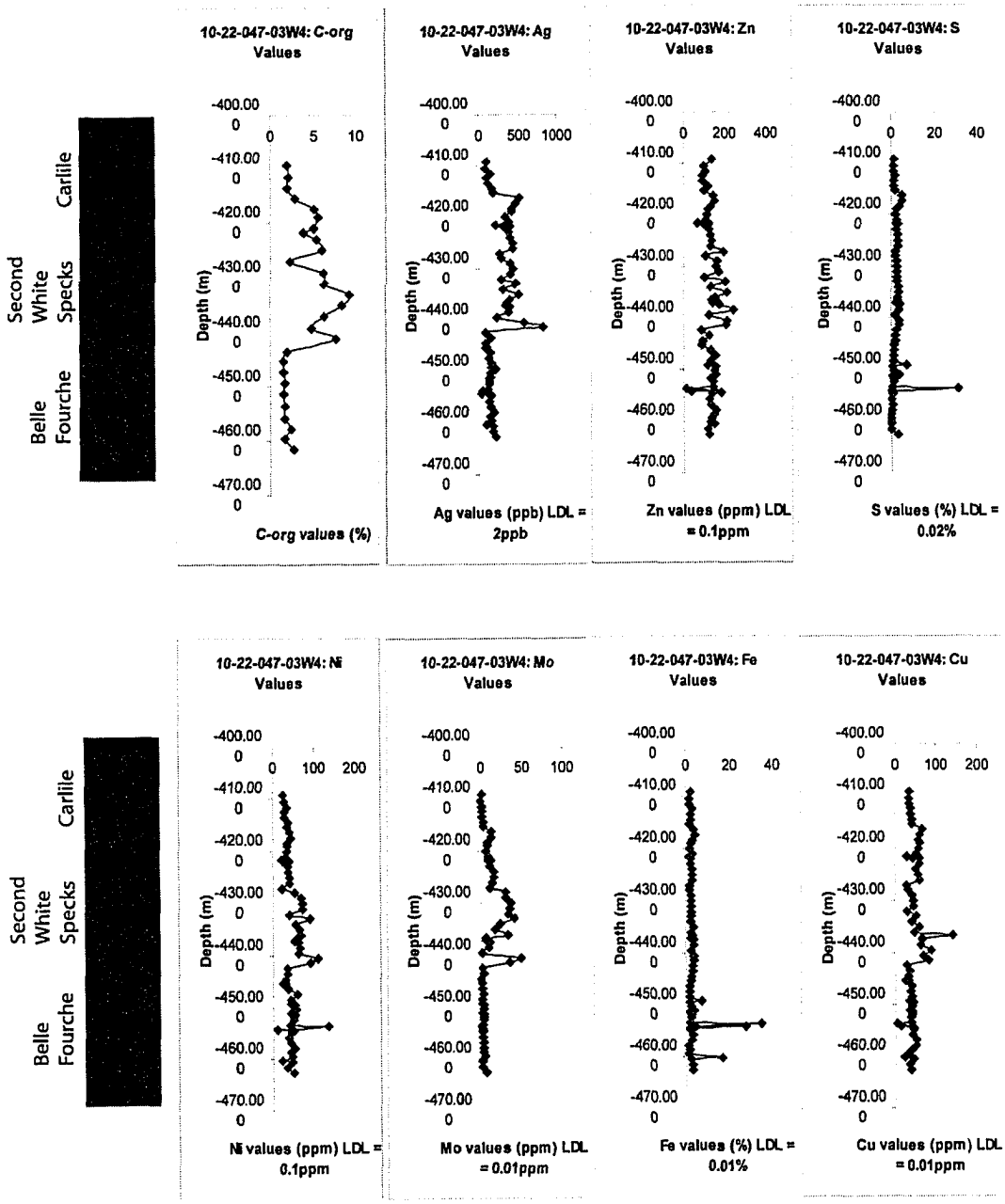


Figure 4.3: Values for various metals and elements with depth for the core 10-22-047-03W4.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

06-31-046-08W5:

The core placement was determined based on geophysical log signatures, palynology and lithology. The core ranges from 1803 m to 1822.49 m and the Second White Specks Formation ranges from 1782 m to 1904 m depth. Therefore, the core represents the top portion of the Second White Specks Formation. Mo decreases slightly up section. Ag, Cu, Fe, Ni, S and Zn show similar geochemical signatures, only varying within a small window of values. The geochemical signature does not correspond to anything specifically observed within the core. The core is a homogeneous dark grey shale with minor amounts of pyrite and calcite nodules at the base.

Of the plots, this one represents core that is from the deeper basin within Alberta. It has the lowest concentration of organic carbon content. This may be due to the core being closer to the area of maturation for the Second White Specks Formation, and consequently, hydrocarbons were lost from the shale, showing a much lower organic carbon content than what was originally in place (a discussion of this is in the following sections). This might also explain why the other plots of metals and elements do not follow the general trend of the present organic carbon content. The organic carbon response is fairly flat, decreasing slightly up hole towards the Carlile Formation (Figure 4.4).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

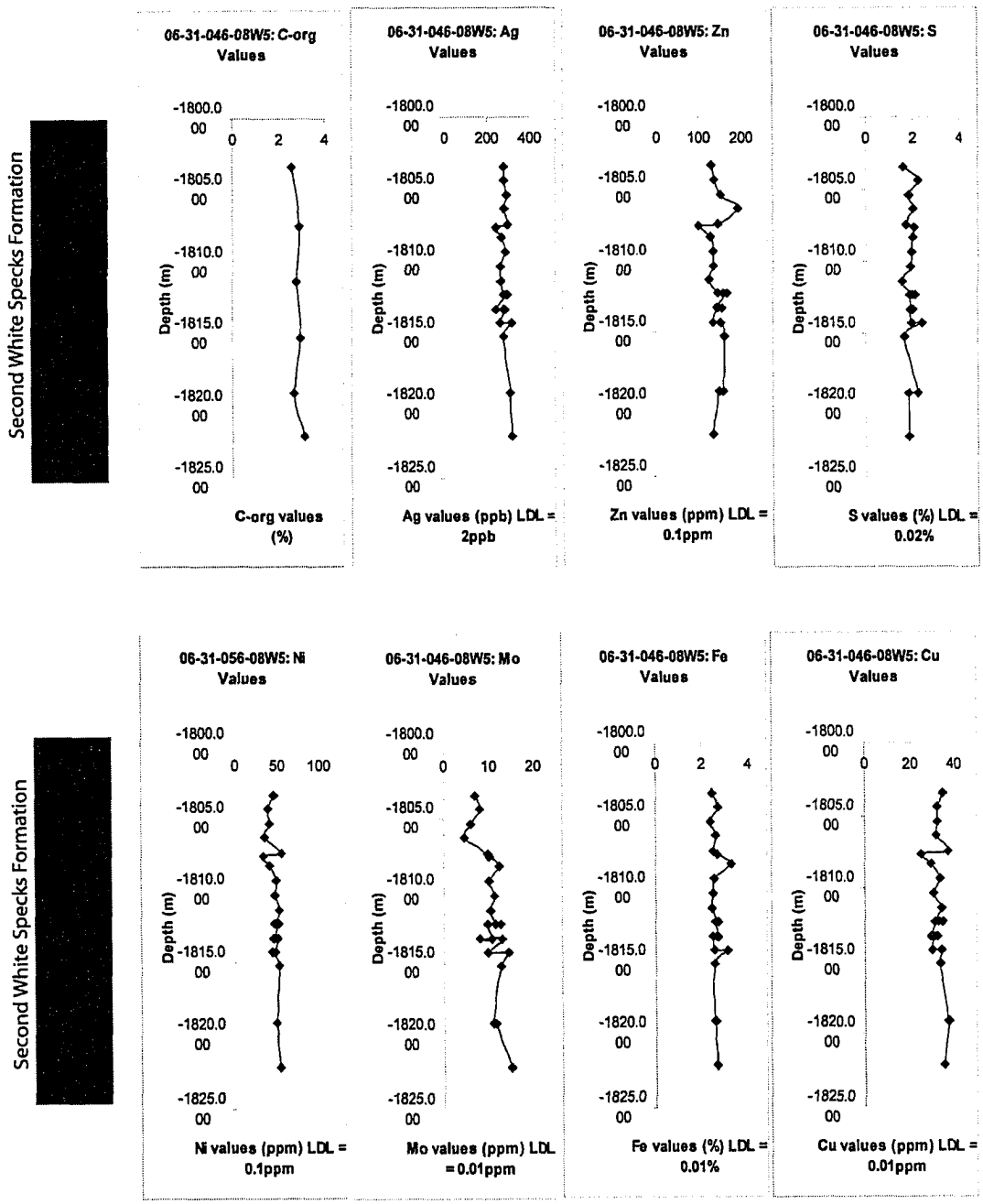


Figure 4.4: Values for various metals and elements with depth for the core 06-31-046-08W5.

Refer to Appendix 6.6 for the plots of elements versus depth for each core.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

00/05-10-051-04W5/0

The core placement was determined based on the combination of geophysical log signatures and confirmation by palynology. The core ranges from 1252.36 m to1305.675 m and the Second White Specks Formation interval was determined to be from 1202 m to 1289 m depth. Therefore, the top of the underlying Belle Fourche is represented by 1289 m to 1305 m depth and the base of the Second White Specks Formation is represented by 1252 m to 1289 m depth. The organic carbon response is much higher (ranging from 3 to 5 %) within the Second White Specks Formation than the 2 to 3 % for the underlying Belle Fourche Formation. Ag, Cu, Ni, S, Zn follow the same general signature as organic carbon where the values are variable in the underlying Belle Fourche, but are generally slightly higher within the Second White Specks Formation. The low values at the base of the core represent fractured locations within the formation where carbonate has infilled the voids. The rest of the core remains a homogeneous dark grey shale with minor sandy laminations and pyrite. The higher values observed at approximately 1259 m do not correlate with anything directly observed in the core. The Fe signature remains fairly constant throughout the core with small lows and highs. The Mo signature is slightly different, with the maximum values being in the middle of the core at the base of the Second White Specks Formation. The Mo values increase up to the base of the Second White Specks Formation, and then decreases upwards.

00/06-11-061-22W4/0

The core placement was determined based on the combination of geophysical log signatures, micropaleontology and lithology. The core ranges from 499.85 m to 513.52 m and the Second White Specks interval ranges from 506 m to 553 m. Therefore, the core represents the top of the Second White Specks Formation from 506 m to 513.52 m depth and the basal Carlile from 499.85 m to 506 m depth. All of the plotted elements tend to follow the same geochemical pattern, aside from the last top two samples from the Carlile Formation. The top two samples increase upwards for Ag, Fe, Mo, S and Zn and decrease upwards for Cu and Ni. The signature has two low points within the top of the Second

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

White Specks Formation and generally increases slightly within the Carlile Formation. The low results within the Second White Specks correspond to sands observed within the core. The higher values correspond to the dark grey shales. The higher values within the Carlile Formation correspond to a higher concentration of pyrite observed within the core.

00/06-26-059-20W4/0

The core placement was determined based on a combination of geophysical log signatures, micropaleontology and lithology. The core ranges from 458.09 m to 471.05 m and the Second White Specks Formation ranges from 447 m to 486 m. Therefore the core represents the centre of the Second White Specks Formation. The Mo values within this hole are quite distinct in that the values increase to the top of the core. There are multiple bentonites within this core, and concentrations of pyrite in lenses and nodules which most likely correlates with the variation in response of Fe and S which have similar geochemical signatures. Ag, Cu, Ni and Zn increase in value up the core to approximately 464 m depth, drastically decreasing at 464 m and then increase up to the top of the core. There are no clear correlations with the physical core and the variations in geochemical signature, aside from a slight visible increase in concentration of pyrite and organic matter up hole above 464 m depth.

00/06-35-059-21W4/0

The core placement was determined based on geophysical log signature and lithology. The core ranges from 457.18 m to 469.37 m depth and the Second White Specks Formation ranges from 463 m to 504 m depth. Therefore, the core represents the top 6 m (463 m to 469 m) of the Second White Specks Formation and the bottom 6m of the overlying Carlile Formation. The geochemical signature is fairly distinct with a general increase in metal values to 465 m depth where there is a low point, and a general decrease in all the metals up the core within the Carlile Formation. Ag, Cu, Fe, Mo, Ni, S and Zn all have the lowest values at approximately 465 m in depth, which corresponds to

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

a sandier package within the shale. The values of the metals tend to increase within the Second White Specks Formation toward the sandier interval, then decreasing values are observed within the Carlile Formation.

00/09-09-056-19W5/0

The core placement was determined based on geophysical log signature, micropaleontology and lithology. The core ranges from 2237.12 m to 2273.09 m and the Second White Specks Formation interval ranges from 2198 m to 2282 m. Therefore the core represents the center and base of the Second White Specks Formation. Generally, the plotted elements Ag, Cu, Mo and Ni demonstrate a bi-modal distribution with higher values near the base and top of the core, with the lowest values between 2255.5 m and 2265 m depth. There is no correlation between these lower values or anything observed within the core, aside from the fact pyrite and organic matter are more concentrated below 2254 m and above 2265 m. Zn, S and Fe demonstrate fairly consistent values with small variations.

00/10-28-059-20W5/0

The core placement was based on geophysical log signatures, micropaleontology and lithology. The core ranges from 1876.56 m to 1888.5 m depth and the Second White Specks Formation interval ranges from 1787 m to 1906 m. Therefore, the core represents the base of the Second White Specks Formation. Ag, Cu, Fe, Ni, S and Zn have variable responses that peak at approximately 1880 m depth and tend to decrease to the top of the core. Within the logged core, this corresponds to a general increase in the abundance of sand and reaction with hydrochloric acid. Pyrite is also present more often up the section of core. Molybdenum's response increases up the core to 1882 m, then decreases to 1880 m, then increases to its maximum at 1878 m and then decreasing in value up the core. This pattern is not reflected by any physical characteristic observed within the core.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

00/10-36-060-22W4/0

The core placement was based on geophysical logs and micropaleontology. The core ranges from 489.79 m to 498.59 m depth and the Second White Specks Formation interval ranges from 491 m to 535 m depth. Therefore, the core represents the top of the Second White Specks Formation from 491 m to 498.59 m and the base of the overlying Carlile Formation from 489.79 to 491 m depth. All of the elemental values plotted follow the same trend, remaining constant at the base of the core, decreasing to minimum values between 494 m to 496 m and then increasing back to the initial values observed at the base of the core. The low values correspond to a sand package observed 493 and 496.5 m depth with an increase in abundance of sand above this interval. The remaining shales at the base of the core (Second White Specks) and the shales from the overlying Carlile Formation have similar values for Ag, Cu, Fe, Mo, Ni, S and Zn.

00/14-29-048-06W5/0

The core placement was based on geophysical logs, palynology and lithology. The core interval ranges from 1539.16 m to 1577.32 m and the Second White Specks Formation ranges from 1532 m to 1595 m depth. Therefore, the interval represents the top and center of the Second White Specks Formation. The Zn, Mo and Fe values correspond well, with consistent lower values throughout the core with a high value at approximately 1567 m depth. The physical feature at this point is a lense of pyrite. Values for Ag, Cu, Ni and Zn remain fairly constant, with a slight high at 1567 m. Organic carbon increases to 1567 m and gradually decreases up the core.

00/16-12-046-03W5/0

The core placement was based on geophysical log signatures and micropaleontology. The core ranges from 1533.07 m to 1574.99 m depth and the Second White Specks Formation interval ranges from 1474 m to 1552 m depth. Therefore, the core covers the base of the Second White Specks Formation (from 1533.07 m to 1552.07

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

m depth) and the top of the underlying Belle Fourche Formation from 1552.07 m to 1574.99 m depth. There are not enough samples for the organic carbon to make any concise observations, but the trend appears to decrease up the core. The values of Ag, Zn and Cu are higher within the underlying Belle Fourche Formation and decrease upwards into the Second White Specks Formation. The values for Mo, S and Ni are higher within the Second White Specks as opposed to the underlying Belle Fourche Formation, and Fe remains fairly constant throughout the two formations. It is hard to make generalizations for this core because there was abundant lost core throughout the cored interval.

02/06-30-064-01W6/0

The core placement was determined based on geophysical log signatures and lithology. The core interval ranges from 1555 m to 1563.6 m depth , and the range of the Second White Specks Formation ranges from 1515 m to an unknown depth. The core does, however, appear to contain the basal section of the Second White Specks Formation. Cu, Ni, S, Zn, Ag and Fe have similar patterns where the values remain fairly constant, aside from a low value at approximately 1559 m depth. This corresponds to a sample that was slightly sandier than other samples sent, and the rest of the core is a homogeneous dark grey shale with minor silt and sand. The Mo value decreases up the section of core and does not follow the pattern of the other elements.

02/07-33-052-15W5/0

The core placement was determined using geophysical log signatures, micropaleontology and lithology. The interval range for the core is from 1950 m to 1969.18 m and the Second White Specks Formation interval ranges from 1880 m to 1955 m depth. Therefore, the core represents the base (1950 m to 1955 m) of the Second White Specks Formation and the top (1955 m to 1969.18 m) of the Belle Fourche Formation. Generally, the values of Ag, organic carbon, Cu, Mo and Ni increase upward into the Second White Specks Formation with a minimum value at the contact between the two formations that can not be explained by a physical feature observed in the core. Fe, Zn

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

and S remain fairly constant throughout the formations, with the peaks in the Fe values corresponding to Fe staining observed within the core, and the low value corresponding to the contact between the Second White Specks Formation and the Belle Fourche Formation.

02/16-18-064-02W6/0

The core placement was determined using geophysical log signatures. The interval for the core ranges from 1696 m to 1706.1 m and the interval for the Second White Specks Formation ranges from 1659 m to 1717 m. Therefore, the interval of the core represents the base of the Second White Specks Formation. Ag, Mo and S tend to decrease slightly up the cored section. Cu and Ni have similar signatures and tend to increase slightly up section. Iron and Zn have values that remain fairly constant throughout the core. These value shifts do not appear to correspond to any physical changes observed within the core.

02/16-27-058-20W5/0

The core placement was determined based on geophysical log signatures, micropaleontology and lithology. The cored interval ranges from 1825.05 m to 1836.8 m depth and the Second White Specks Formation ranges from 1772 m to 1856 m depth. Therefore, the core represents the middle to base of the Second White Specks Formation interval. All elements that were plotted tend to follow a similar geochemical pattern aside from Mo. Molybdenum values increase up the cored section. The values for Ag, Cu, Fe, Ni and S remain constant up the core aside from a peak at approximately 1828 m depth and gradually return up section to the values observed at the base of the core. The values may have increased in the interval due to the presence of pyritized shells. The value of Zn fluctuates slightly throughout the interval of core.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

7AS01 (00/06-12-098-13W4)

The core placement was determined based on micropaleontology and lithology. The cored interval ranges from 11.27 m to 19.48 m depth and the Second White Specks interval ranges from 11.27 m to 18.48 m. Therefore, the core represents the Second White Specks Formation and the top of the underlying shale. The values of Ag and Cu decrease up the core and increases just at the top of the core. Ni, Mo and Zn all increase in value up the core. S and Fe decrease in value up the core and just at the top of the core, the values increase slightly. The only change in the core is the increase in organic matter up section.

4.3.1 Discussion

The two cores that contain the top and basal contacts for the Second White Specks Formation show an increase for most of the plotted elements (organic carbon, Ag, Zn, Ni, Mo, Cu) within the Second White Specks and a lower response within the underlying and overlying shales. Both these cores are in eastern Alberta, which was closest to the paleoshoreline to the east during the deposition of the Second White Specks Formation. Both have a geochemical response that is higher near the base of the formation, decreases and then increases again near the top of the formation giving a bimodal distribution in high elemental values. Fe and S do not vary as much within the Second White Specks Formation, but vary much more in the underlying Belle Fourche Formation. This is most likely due to the abundance of pyrite observed within the underlying shales.

No other core within the study represents a full section of core, so they are grouped together into three categories; core that represents the top of the Second White Specks Formation, core that represents the middle of the Second White Specks Formation, and core that represents the base of the Second White Specks Formation.

Core from the first category that represent the top of the Second White Specks Formation include; 00/06-11-061-22W4/0, 00/06-35-059-21W4/0, 00/10-36-060-22W4/0 and 02/06-30-064-01W6/0. There is no consistent geochemical signature observed

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

between these cores, although most of the signatures appear to vary slightly at the top of the Second White Specks Formation, decrease at the contact between formations and then increase into the overlying shales. The variations in 06-35-059-21W4 values may be associated with variations in organic matter within the Second White Specks Formation and the variations within the Belle Fourche may be associated with the presence or absence of siderite and pyrite.

Core from the second category that represent the middle of the Second White Specks Formation include: 00/06-31-046-08W5/0, 00/06-26-059-20W4/0, 00/09-09-056-19W5/0, 00/10-28-059-20W5/0, 00/14-29-048-06W5/0, 02/16-18-064-02W6/0 and 02/16-27-058-20W5/0. Some of the core show a bimodal response, with elements slightly higher near the bottom of the Second White Specks, a lower response in the middle of the formation, and a higher response near the top of the formation. Because the Second White Specks varies so widely across the basin with regards to thickness, it is difficult to compare cores to one another across the basin when a full core with upper and lower contacts is not available.

Core from the third category that represent the base of the Second White Specks Formation include: 00/05-10-051-04W5/0, 00/15-21-056-19W5/0, 02/07-33-052-15W5/0, and 7AS01 (00/06-12-098-12W4/0). There is no single consistent geochemical signature observed within these core, although there maybe a general trend with an increase in values near the base of the Second White Specks Formation.

There does not appear to be a single unique geochemical signature across the basin for the Second White Specks Formation. However, this may partly be due to the lack of a complete core for this unit within the deeper basin. Having said this, organic carbon is much more elevated in the Second White Specks Formation compared to the overlying and underlying shales. As well, the overall metal content appears to increase to the northeast, with core from hole 7BK03 having the highest total organic carbon content and most of the elevated metal concentrations. In places identified in this study, there is a slight bimodal pattern in the unit. This typically is characterized by a slight increase in

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

values of a suite of elements near the base of the formation, a low in values near the central part of the unit, then returning again to higher values closer to the top of the formation.

4.4 Aerial Distribution Plots for Selected Metals

Aerial distribution plots for twelve selected elements follow; the elements include; Mo, Ni, Ag, Zn, S, Pb, Co, Ba, Fe, Cu, V and U (Figures 4.5 to 4.16). These plots illustrate the average values of an element across all locations of core that contain the Second White Specks Formation; (that is the elemental values throughout the whole of the Second White Specks interval within a specific core were averaged). Core from the northeastern area of the maps represents the Second White Specks Formation that also exists nearby in outcrop. The plotted results are all from core, although in northeastern Alberta the Second White Specks Formation does crop out in a few places. Furthermore, the results in the northeast and eastern parts of Alberta represent the 'near-shore' part of the formation, whereas those to the west represent a more distal and deeper water facies.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

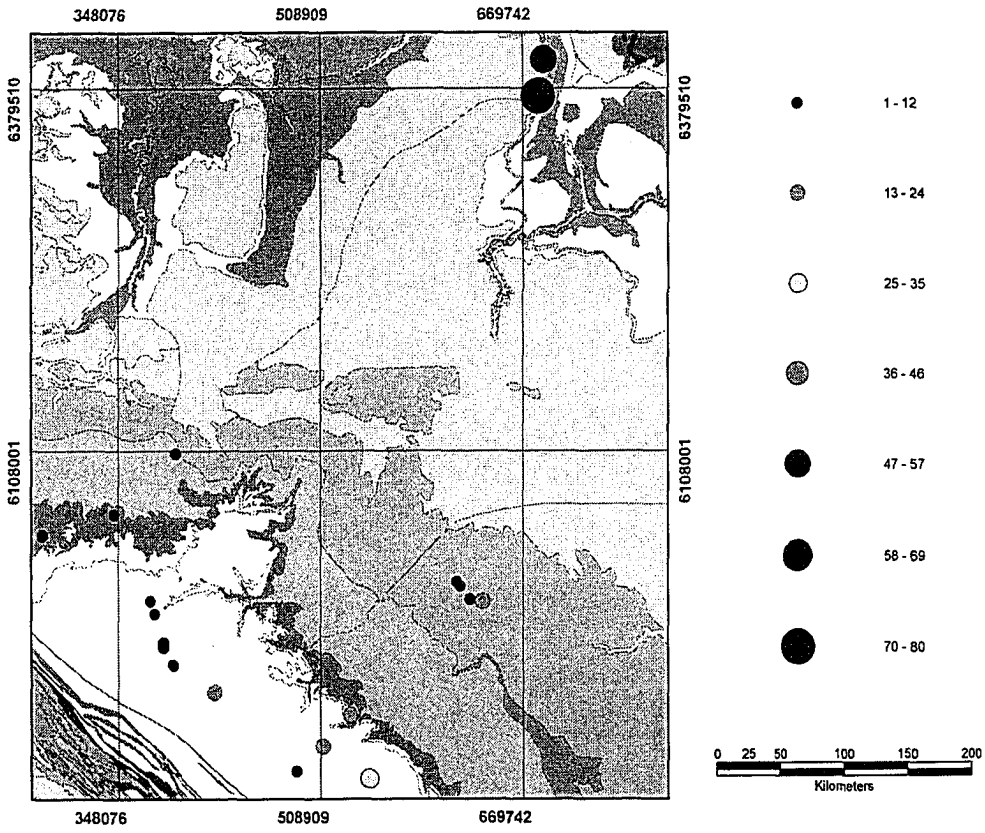


Figure 4.5: Molybdenum (ppm) aerial distribution for the Second White Specks Formation.

Molybdenum values are highest in the Birch Mountains in northeast Alberta (Figure 4.5). For example, the average Mo value for core from drill hole 7AS01 is 75 ppm and the average value for core from hole 7BK03 is slightly lower at 52 ppm. In contrast, to the southwest the average Mo concentrations are greatly reduced, averaging between 1 to 35 ppm. In summary, there are very high Mo values in northeastern Alberta, with a few moderate Mo values in eastern and southern Alberta and very low values to the west in the deep basin.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

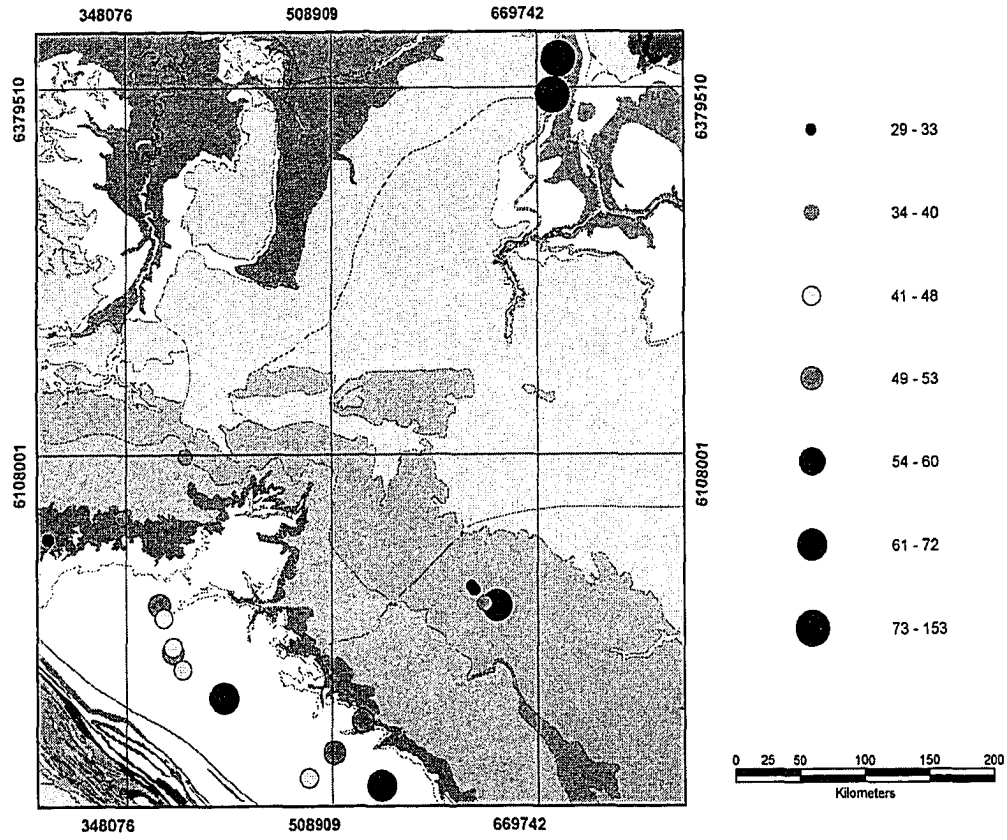


Figure 4.6: Nickel (ppm) aerial distribution for the Second White Specks Formation.

Nickel also exhibits high average values in the Birch Mountains cores in northeastern Alberta, averaging from 73 to 153 ppm (Figure 4.6). However, unlike the Mo values, there are also high concentrations of Ni in several places in central and eastern Alberta. Similar to Mo, the lowest average values of Ni are located to the west in the deep basin.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

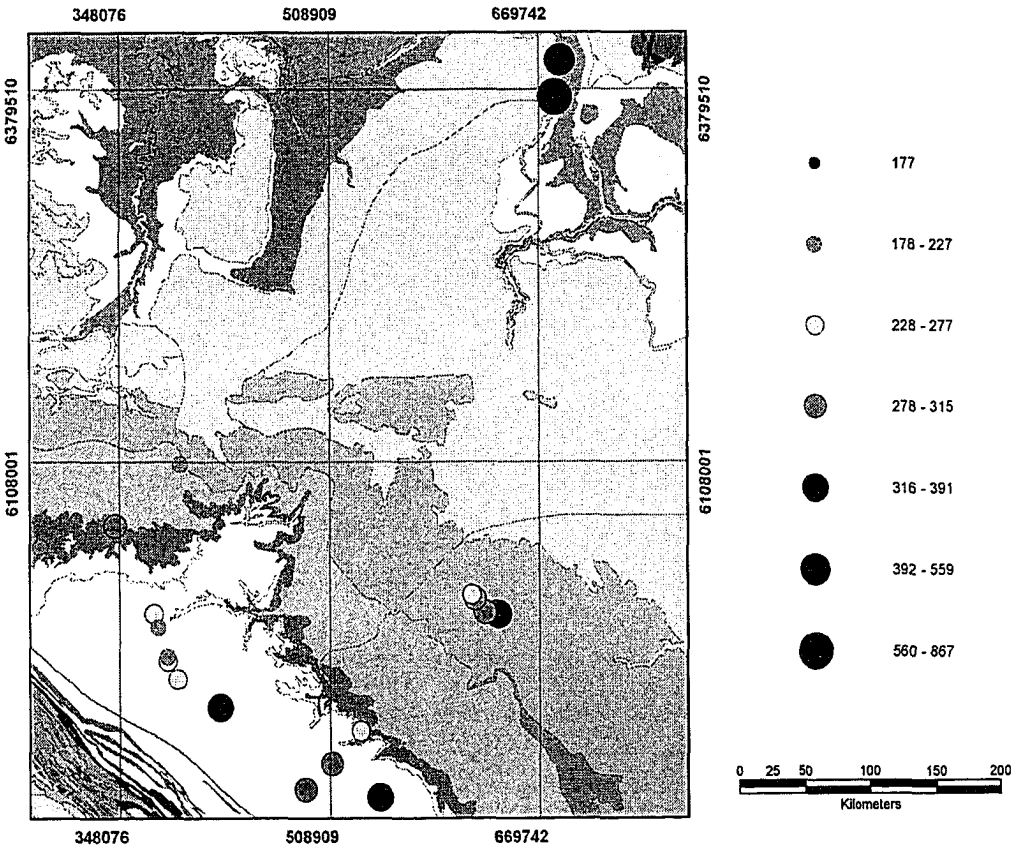


Figure 4.7: Silver (ppb) aerial distribution for the Second White Specks Formation.

As for Ni and Mo, Ag values are highest in the Birch Mountains (Figure 4.7). As well, and similar to the pattern for Ni, Ag has a few moderate values in eastern and central Alberta, with the lowest concentrations for Ag found in the west in the deep basin.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

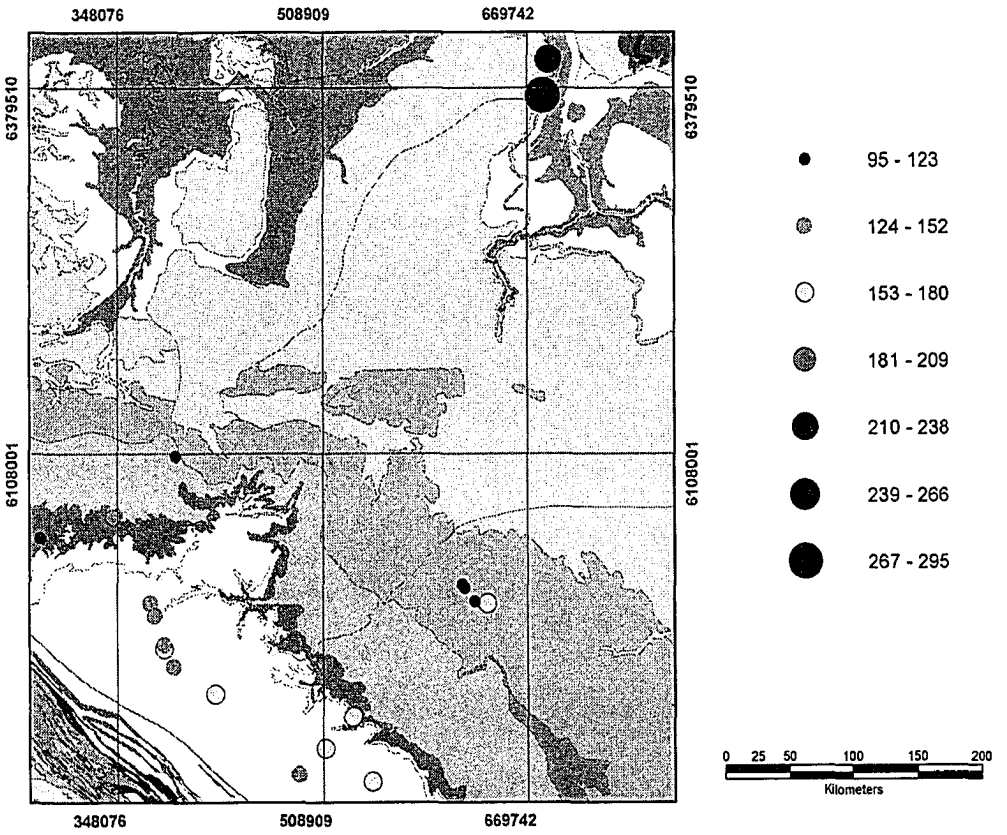


Figure 4.8: Zinc (ppm) aerial distribution for the Second White Specks Formation.

Zinc mimics the pattern for Mo, Ni and Ag in that it also has the highest values in the Birch Mountains (Figure 4.8). As well, zinc is moderately concentrated in southern Alberta and perhaps least concentrated in the deep basin in the extreme west. In general, the zinc plot most resembles the Mo plot with regards to the aerial distribution of the concentration of the metal.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

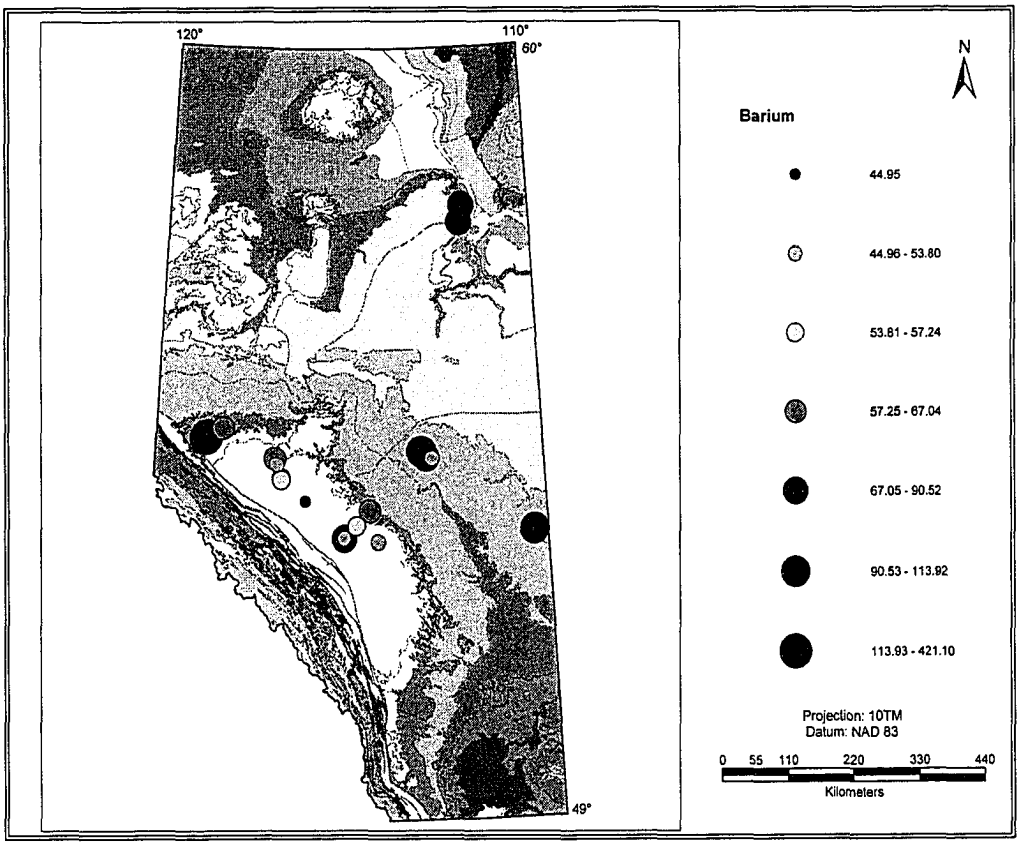


Figure 4.9: Barium (ppm) aerial distribution for the Second White Specks Formation.

The values for barium have a different aerial distribution than that for Mo, Ni, Ag and Zn (Figure 4.9). For example, the highest values for barium are in the extreme west in the deep basin in core from the hole closest to the deformed belt. As well, other high Ba values exist in east-central Alberta and northeastern Alberta. The lowest Ba values within the Second White Specks Formation are in core from a hole in the central deep basin of Alberta.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

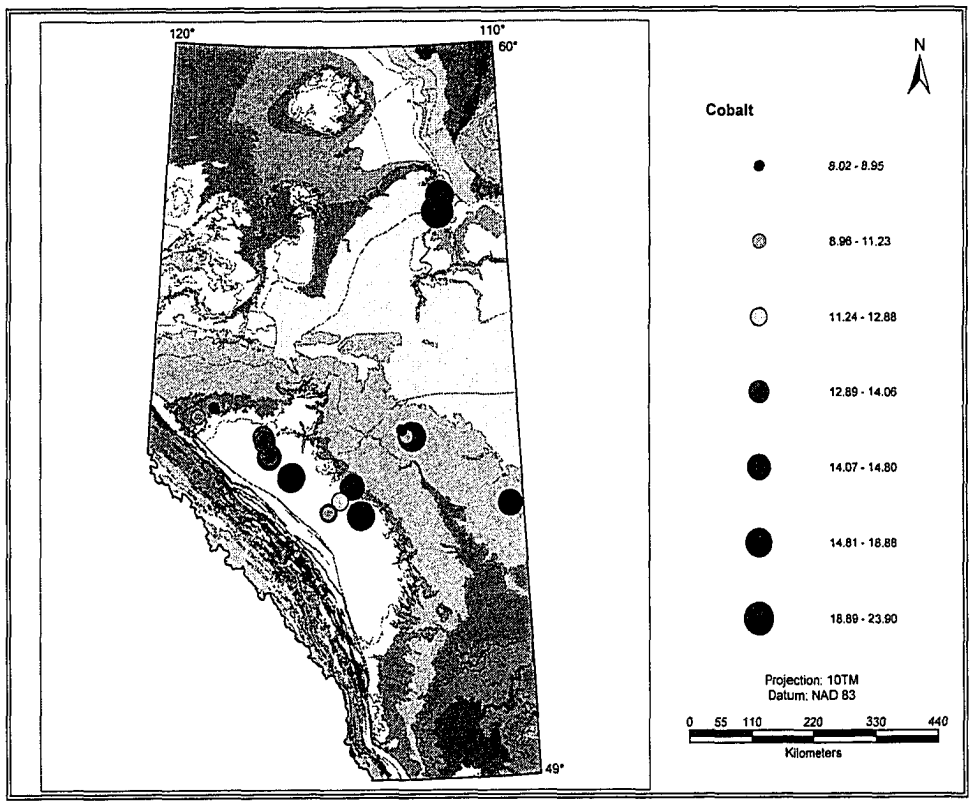


Figure 4.10: Cobalt (ppm) aerial distribution for the Second White Specks Formation.

The values for cobalt are highest in the Birch Mountains and the southern part of the central deeper basin (Figure 4.10). The lowest values are spread throughout western and northwestern part of the deep basin, seemingly scattered among the higher Co values. This pattern for Co thus differs from that exhibited by Mo, Ni, Ag, and Zn, but is perhaps similar to that for Ba.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

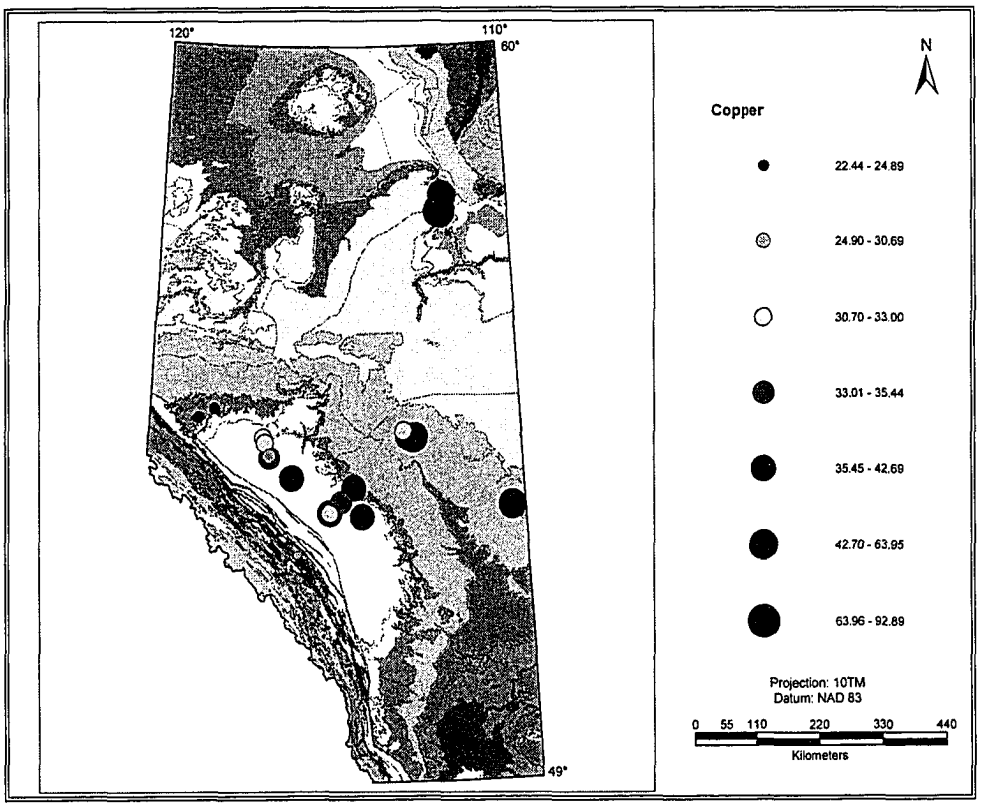


Figure 4.11: Copper (ppm) aerial distribution for the Second White Specks Formation.

The aerial distribution plot for Cu shows the maximum values occur in northeastern Alberta and east central Alberta (Figure 4.11), whereas more moderate Cu values occur in the central deep basin. The minimum Cu values occur in the center of the study area and in the deep basin in western Alberta.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

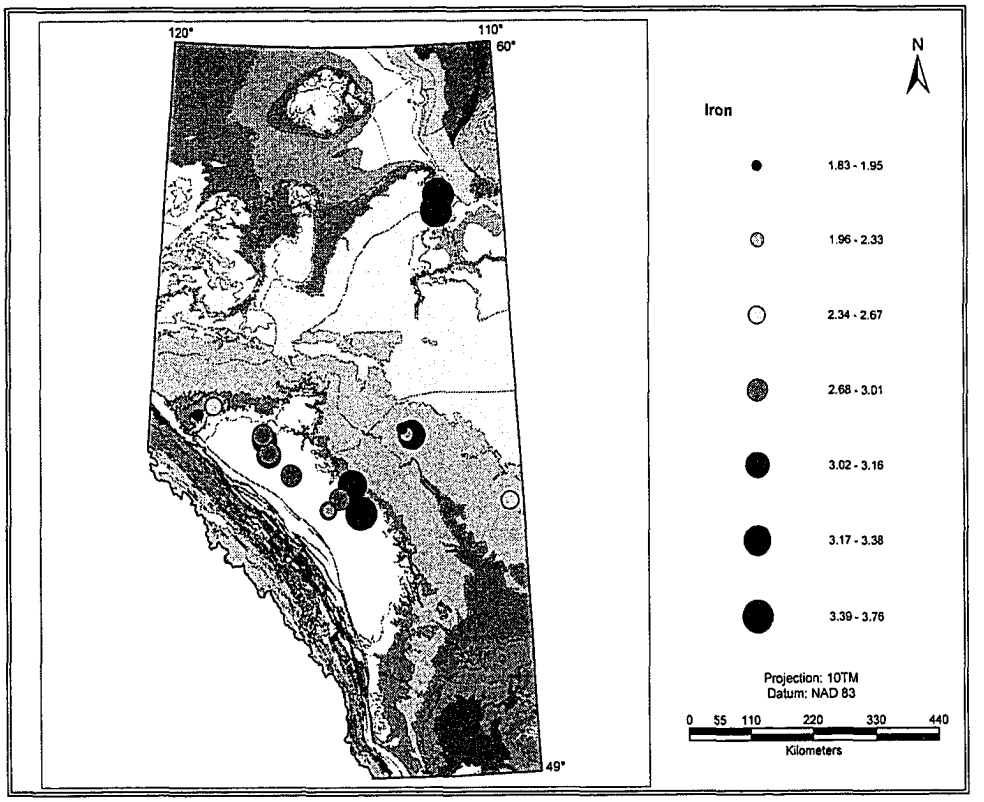


Figure 4.12: Iron (%) aerial distribution for the Second White Specks Formation.

The aerial distribution plot for Fe also shows the maximum average values occur within the Birch Mountains (Figure 4.12). Moderate Fe values occur within the center of the study area, with the minimum Fe values occurring to the southeast and southwest.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

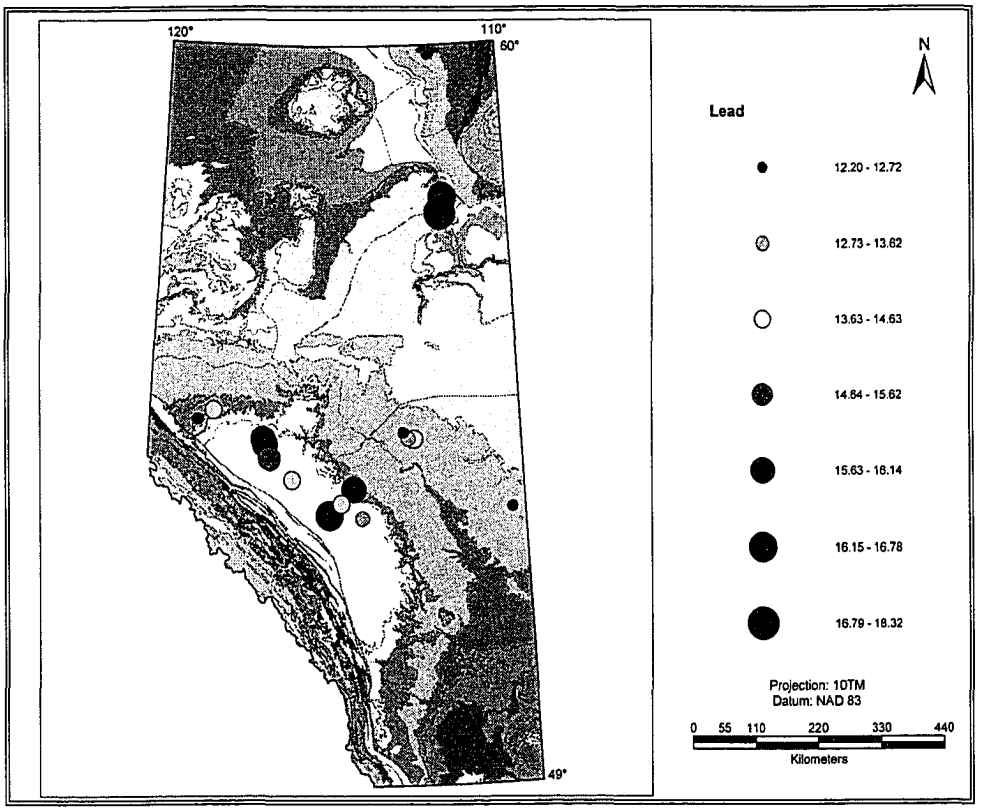


Figure 4.13: Lead (ppm) aerial distribution for the Second White Specks Formation.

The aerial distribution plot for Pb shows that the highest values are in the Birch Mountains core (Figure 4.13). As for Fe, the moderate Pb values occur in the center of the deep basin, with the lowest values to the southeast and northwest.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

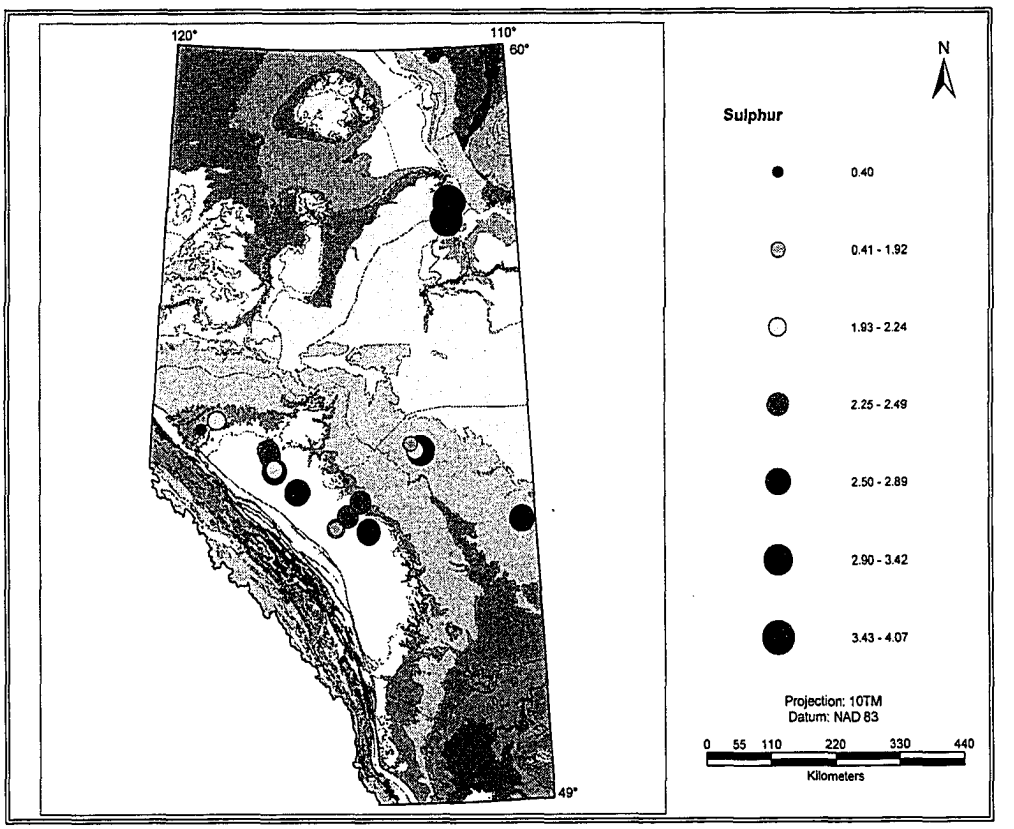


Figure 4.14: Sulphur (%) aerial distribution for the Second White Specks Formation.

The aerial distribution plot for sulphur, as for most of the other elements, shows maximum S values are located the Birch Mountains (Figure 4.14). Moderate S values exist in the core from the south, with the lowest S values being in the western study area.

Plots for both uranium and vanadium (Figures 4.15 and 4.16) show both the highest U and V values are once again within the Birch Mountains core. Moderate U and V values exist to the south and east, with the minimum U and V values being located within the deep basin to the west.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

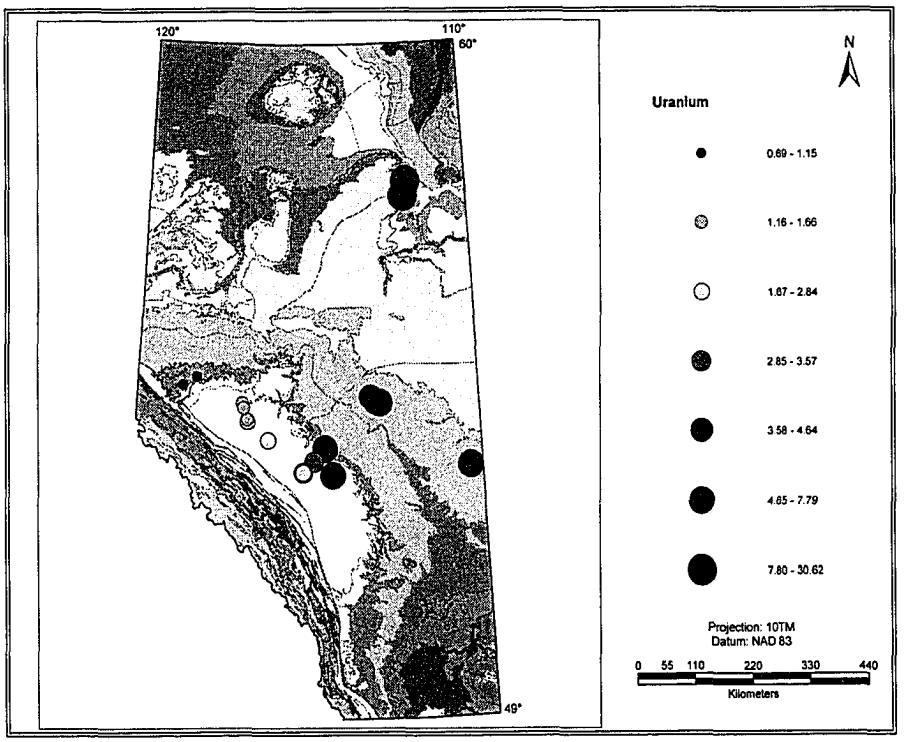


Figure 4.15: Uranium (ppm) aerial distribution for the Second White Specks Formation.

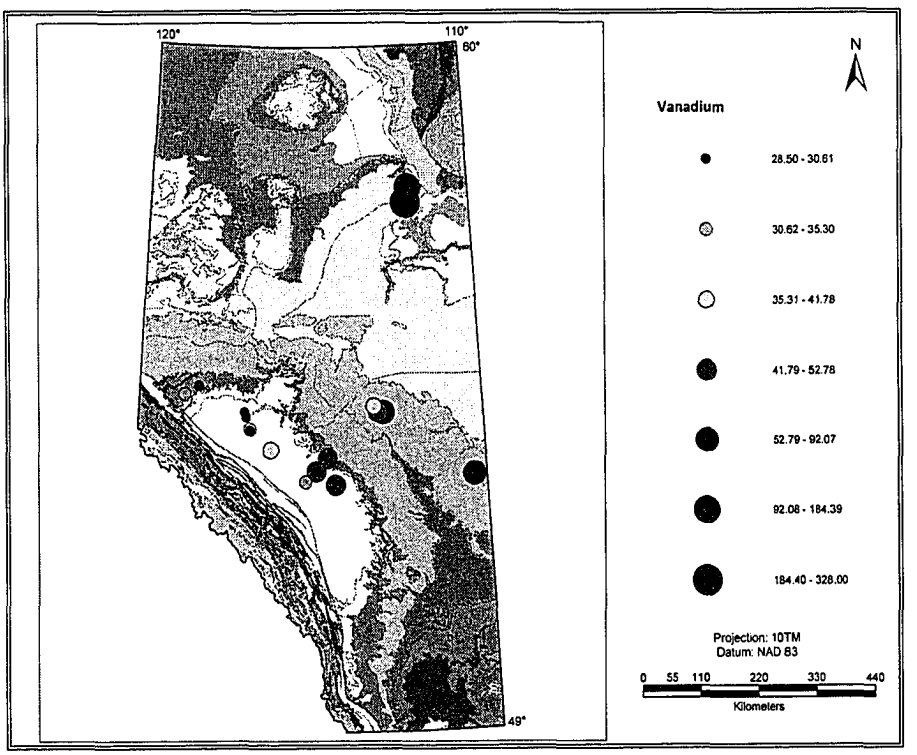


Figure 4.16: Vanadium (ppm) aerial distribution for the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

4.4.1 Discussion

When all of the aerial distribution plots are compared, 11 of the 12 elements have the highest average values within the Birch Mountains core from holes 7BK03 and 7AS01. These elements include Mo (47 to 80 ppm), Ni (73 to 153 ppm), Ag (392 to 867 ppb), Zn (210 to 295 ppm), Co (14.81 to 23.90 ppm), Cu (42.70 to 92.89 ppm), Fe (3.39 to 3.76 %), Pb (16.15 to 18.32 ppm), S (3.43 to 4.07 %), U (7.80 to 30.62 ppm), and V (92.08 to 328.00 ppm). This shows that the Birch Mountains has anomalous elemental concentrations compared to the Second White Specks Formation to the south and west. Barium is the only element that does not follow this trend. That is, barium within the Birch Mountains has an average value, much lower than some of the Second White Specks core observed to the south and the highest average value for barium occurs in the deep basin, closest to the deformed cordilleran belt.

Generally the aerial distributions for Mo, Ni, Ag, Zn, Co, Cu, Fe, Pb, S, U and V have moderate elemental values within eastern and central Alberta, with the lowest average elemental values clustering between the moderate average values, and in some cases extending to the west. Barium again does not show this pattern. That is, for barium the moderate average values occur in northeastern and eastern Alberta, with the lowest average values being in the south and west-central.

The elements which demonstrate the highest values closest to the paleoshoreline to the east include Mo, Cu, V and to a lesser extent S and U. These elements have their lowest average values in the deep basin. Elements that have the highest values within the Birch Mountains and the central deep basin include Pb, Ni, Fe, Co, Zn and Ag, whereas the lowest average values for these elements are in the deepest part of the basin and eastern Alberta.

In summary, the most consistent pattern is that 11 of the 12 elements have their highest values within the Birch Mountains of Alberta. Interestingly, Dufresne et al. (2001) also noted the anomalous metal concentrations in the Second White Specks

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Formation in the Birch Mountains. Elsewhere within the study area, average values split into two categories, with some elements more concentrated in the center of the basin, and others more concentrated to the east closer to the paleoshoreline. Barium is the exception in that it shows high values on the peripheries of the study area, with the lowest values being in the center of the study area. Because of this these variations in element distribution, no other conclusions about anomalous elemental concentrations can be made for the Second White Specks Formation outside of the Birch Mountains.

4.5 Total Organic Carbon Content

Within this study, most of the geochemistry carried out was inorganic aside from the testing of certain cores for their organic carbon content. The details of the analytical technique for carbon are included in the Methodology in Section 2.1.5. The organic carbon content of the Second White Specks Formation ranges from 0.7 % to 10.82 % with an average of 4.9 %. This is a much higher average total organic carbon content than in the underlying and overlying shales and explains why the Second White Specks Formation has been suggested by Travis (2002) to be a good source rock. The highest organic carbon values came from the Birch Mountains core which have an average organic carbon content of 6.5 % in this study area. However, Bloch et al. (1999) and Leckie (1944) have reported up to 12 weight percent for the total organic carbon content of the Second White Specks Formation. Other cores from this study with elevated organic carbon include: 00/05-10-051-04W5/0, which has an average 4.2 %; 00/06-31-046-08W5/0, which has an average of 2.8 %; 00/10-22-047-03W4/0, which has an average of 6.2 %; 00/14-29-048-06W5/0, which has an average of 3.9 %; 00/16-12-046-03W5/0, which has an average of 3.8 %; and 02/07-33-052-15W5/0, which has value of 3.5 %.

In general, the organic carbon content is highest in the Birch Mountains, followed by moderate to high organic carbon content in core from the eastern parts of the study area. Finally, the core from the deeper basin contains the lowest total organic carbon contents. This trend may be attributed to increased biological activity in eastern Alberta during the time of deposition of the Second White Specks Formation, causing abundant

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

organic matter to be deposited and buried more quickly because of the higher sedimentation rates (Claudia Schröder-Adams, personal communication 2004). However, another possible explanation are the maturity levels of the Second White Specks Formation as illustrated in Figures 4.17 and 4.18. That is, these two figures show the Second White Specks Formation is mature in the deeper basin and immature towards the northeast. Therefore, when the formation started to mature in the west, hydrocarbons may have been expelled from the unit, decreasing the organic carbon content that is now observed.

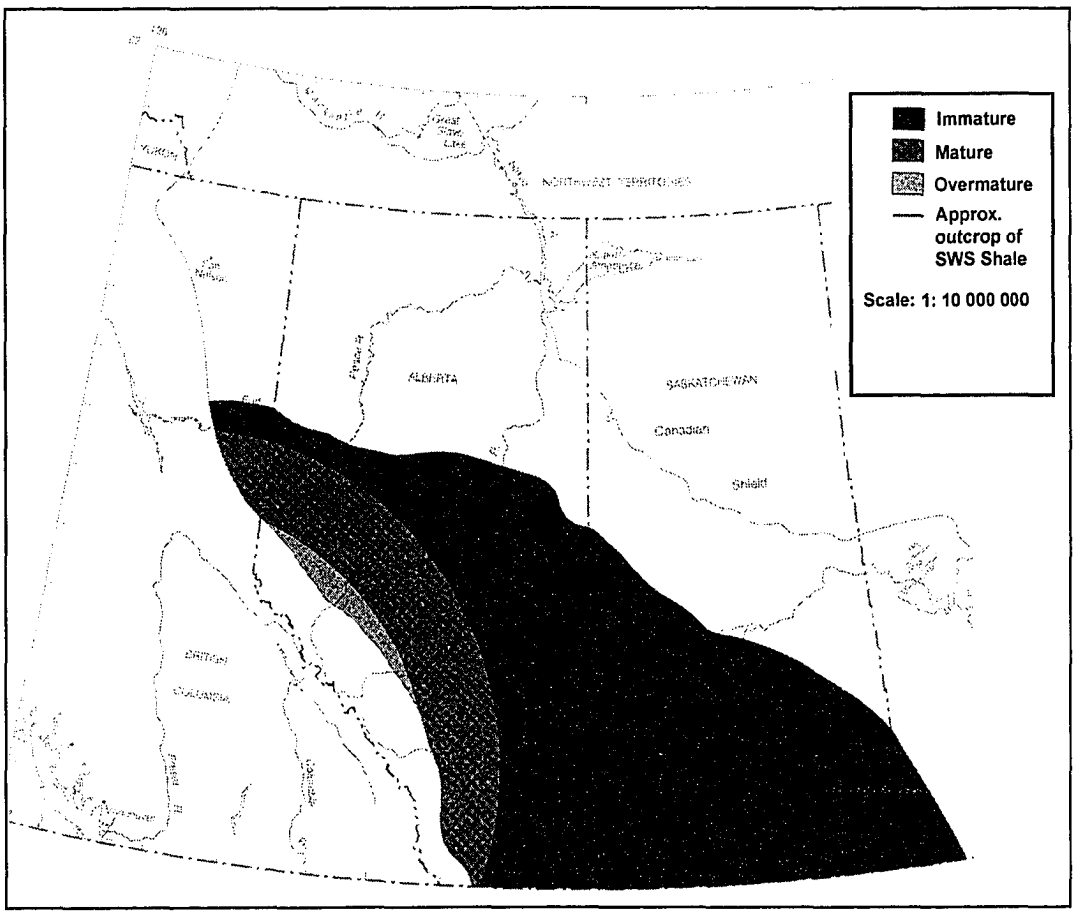
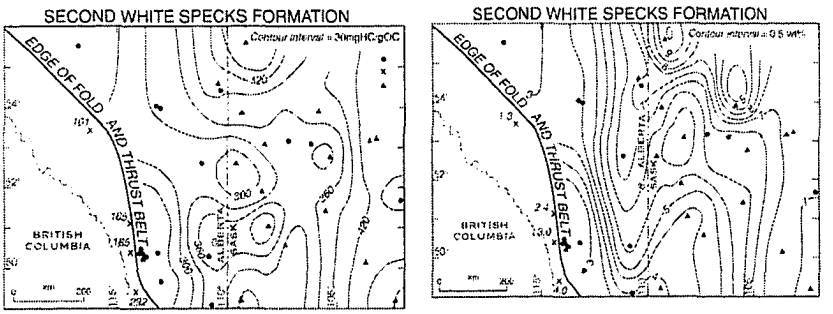


Figure 4.17: The Second White Specks petroleum system, showing immature, mature and overmature areas of the shale (from Creaney et al., 1994).

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

A) B)



C)

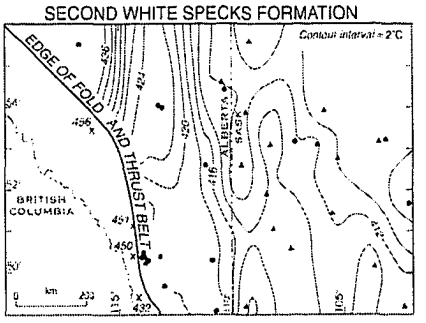


Figure 4.18: Second White Specks Formation contour maps for A) hydrogen index (mgHC/gOC); B) total organic carbon (wt %); and C) Tmax (from Bloch et al., 1999)

4.6 Black Shale Metal Enrichment

There are a few definitions that are important in this study. One is the definition of a black shale as "a dark-colored, laminated, fine-grained, clastic sediment that contains 50 % or more particles sized less than 0.062mm equivalent spherical diameter (i.e. silt or clay) and greater than 0.5 % organic carbon" (Huyck, in press and Schultz, 1991). It is clear that the Second White Specks Formation fits into this definition. The other definition is that a metalliferous black shale is "a black shale that is enriched in any given metal by 2X (except for beryllium, cobalt, and uranium where 1X is sufficient) relative to the United States Geological Survey Geochemical Standard SDO-1 of Ohio Devonian Shale" (Schultz, 1991). Table 4.16 lists some of the maximum elemental values received

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

in this study, and Table 4.17 provides a comparison between metalliferous black shales and the USGS Geochemical Standard SDO-1.

Table 4.16: The table lists some of the maximum values received for the Second White Specks Formation.

Element:	Maximum Value:	Core:	Analysis:
Ag	1331 ppb	7BK03	Group 1F
As	460 ppm	00/14-29-048-06W5/0	Group 1F
Au	6.2 ppb	7AS01	Group 1F
Ba	590.8 ppm	00/14-28-062-05W6/0	Group 1F
Bi	0.87 ppm	7BK03	Group 1F
Cd	313.3 ppm	00/10-22-047-03W4/0	Group 1F
Co	44 ppm	7BK03	Group 1F
Cr	55.9 ppm	7AS01	Group 1F
Cu	139.97 ppm	00/10-22-047-03W4/0	Group 1F
Fe	18.26 %	7BK03	Group 1F
Hg	727 ppb	00/05-10-051-04W5/0	Group 1F
Mg	4.74 %	00/05-10-051-04W5/0	Group 1F
Mn	2012 ppm	7BK03	Group 1F
Mo	169.15 ppm	7AS01	Group 1F
Ni	289.5 ppm	7BK03	Group 1F
Pb	36.34 ppm	7BK03	Group 1F
Pd	17 ppb	7BK03	Group 1F
Pt	9 ppb	7BK03	Group 1F
S	22.09 %	7BK03	Group 1F
U	69.58 ppm	7BK03	Group 1F
V	556 ppm	7BK03	Group 1F
Zn	468.9 ppm	7BK03	Group 1F
Cr	141.6 ppm	00/10-22-047-03W4/0	Group 1EX
V	1275 ppm	7BK03	Group 1EX
Zn	481 ppm	7BK03	Group 1EX
Dy	33.17 ppm	00/10-22-047-03W4/0	Group 4B
Ba	12054 ppm	7BK03	Group 4A
C-org	10.82 %	7BK03	CO2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

A plot has been made to compare how 'metal rich' the Second White Specks Formation is compared to average shales listed by Mason (1982) and the USGS (see Table 4.17 for values and Figures 4.19 and 4.20 for the plots).

Table 4.17: Shale concentrations for multiple elements.

Elements	Mason Shale Values (%)	USGS Values (%)	Average SWS Values (%)	Average 7BK03 Values (%)
SiO2	58.4	49.3	51.3	49.5
TiO2	0.8	0.7	0.6	0.5
Al2O3	15.1	12.3	13.4	11.8
Fe2O3	6.7	9.3	5.1	5.2
MnO	0.1	0.04	0.02	0.04
MgO	2.5	1.5	1.6	1.5
CaO	3.1	1.1	7.2	7.1
Na2O	1.3	0.4	0.6	0.7
K2O	3.2	3.4	2.4	2.0
P2O5	0.2	0.1	0.3	0.5

	Mason Shale Values (ppm)	USGS Values (ppm)	Average SWS Values (ppm)	Average 7BK03 Values (ppm)
Li	66	28.6	15.1	18.8
Be	3	3.3	0.8	10
B	100	128	11.8	19.0
C	1000	99500	60959.6	76528.6
N	60	N/A	N/A	N/A
F	740	0.01	N/A	N/A
S	2400	53500	25176.9	40153.6
Cl	180	116	N/A	N/A
Sc	13	13.2	4.5	3.9
V	130	160	356.8	617.3
Cr	90	66.4	15.8	20.0
Co	19	46.8	14.1	18.9
Ni	68	36.6	56.0	109.9
Cu	45	60.2	39.9	64.0
Zn	95	64.1	154.4	219.6
Ga	19	16.8	3.1	4.6
Ge	1.6	1.3	0.17	0.18
As	13	68.5	30.2	47.4
Se	0.6	3	5.6	24.3
Br	4	5	N/A	N/A
Rb	140	126	95.1	13.5
Sr	300	75.1	119.0	177.1
Y	26	40.6	24.2	39.7
Zr	160	165	8.4	20.0
Nb	11	N/A	0.2	0.5
Mo	2.6	134	17.5	54.4

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Ru	<0.01	N/A	N/A	N/A
Rh	<0.01	N/A	N/A	N/A
Pd	<0.01	N/A	< 10	< 10
Ag	0.07	0.09	0.3	0.6
Cd	0.3	2	1.8	7.3
In	0.1	0.2	0.04	0.05
Sn	6	2.9	0.7	1.1
Sb	1.5	4.1	1.5	5.7
Te	<0.01	N/A	0.1	0.2
I	2.2	N/A	N/A	N/A
Cs	5	6.9	7.4	0.6
Ba	580	397	86.1	75.1
La	24	38.5	9.7	32.0
Hf	2.8	4.7	3.8	4.4
Ta	0.8	1.1	< .05	< .05
W	1.8	3.3	< .1	< .1
Re	<0.01	N/A	0.1	0.3
Os	<0.01	N/A	N/A	N/A
Ir	<0.01	N/A	N/A	N/A
Pt*	<0.01	N/A	<0.01	0.004
Au	0.003	0*	0.0009	0.002
Hg	0.4	0.19	0.1	0.1
Tl	1	8.3	0.6	3.2
Ce	50	79.3	31.8	53.0
Pr	6.1	6	9.7	11.4
Nd	24	11.4	38.5	48.0
Sm	5.8	7.7	7.4	9.5
Eu	1.1	1.6	1.5	1.8
Gd	5.2	6.5	6.5	9.2
Tb	0.9	1.2	1.0	1.4
Dy	4.3	5.7	5.8	8.2
Ho	1.2	1.1	1.1	1.5
Er	2.7	2.5	3.2	4.3
Tm	0.5	0.34	0.5	0.6
Yb	2.2	3.4	3.0	3.8
Lu	0.6	0.52	0.4	0.6
Th	12	10.5	4.9	6.3
U	3.7	48.8	5.5	21.2
Pb	20	27.9	15.1	16.8
Bi	0.4	2	0.3	0.4
C-org	N/A	96800	48492	65428

Estimated average composition of shale (Mason, 1982), Lentz (2003)
USGS Values from Schultz (1991)

*Pt values below LDL set to 1/2 LDL
Au set to 0.00001 for graphical purposes

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

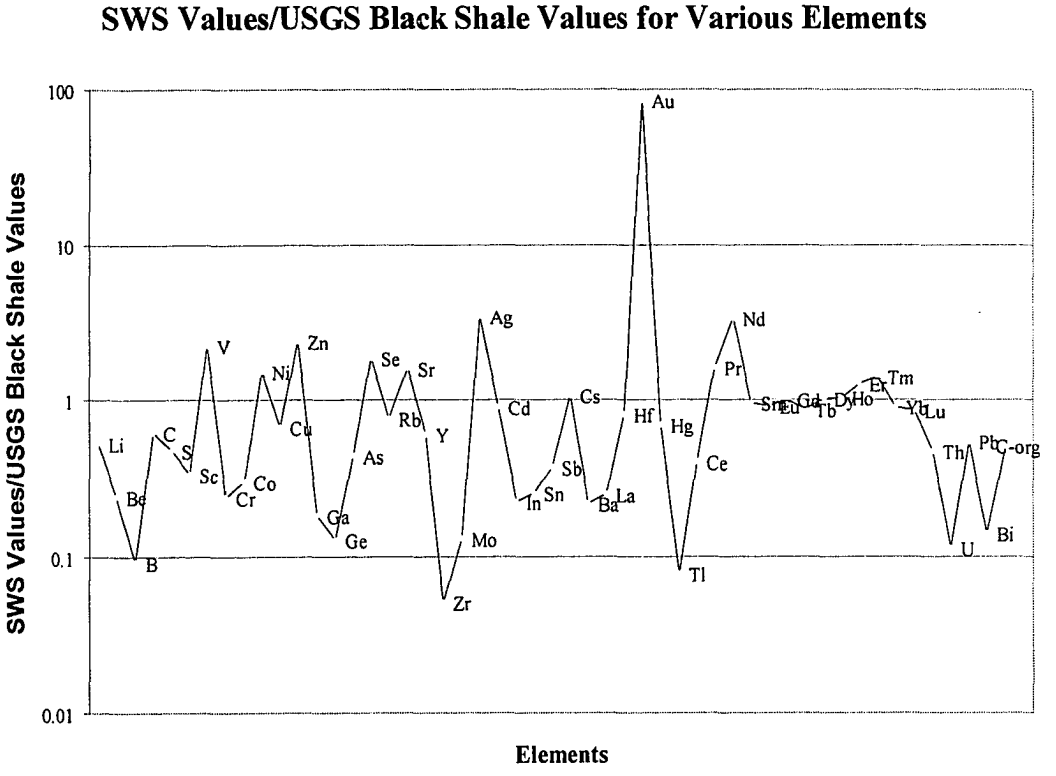


Figure 4.19: A plot of average Second White Specks Formation values/USGS black shale values from Table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

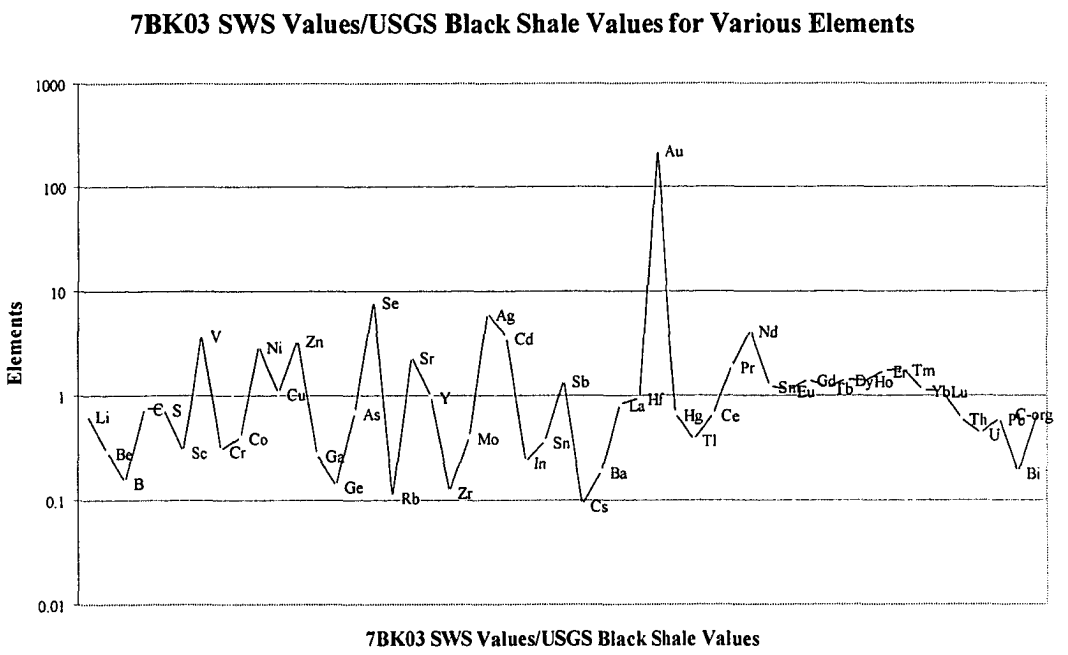


Figure 4.20: A plot of average shale in core from hole 7BK03 Second White Specks Formation values/USGS black shale values from Table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the 7BK03 Second White Specks Formation core.

Once these results are plotted, it is evident that the Second White Specks Shale fits the definition of Schultz as a metalliferous black shale. The values for V, Zn, Nd, Au and Ag are clearly 2x the values stated by the USGS. The same elevated trend can be observed by the Second White Specks Formation in northeastern Alberta, represented by 7BK03 with even more elements that are enriched: V, Ni, Zn, Se, Ag, Cd, Au and Nd.

Another definition of a metalliferous black shale is given in Huyck (in press) as:

$$[(V + Cr + Co + Ni + Cu + Zn + Mo + Ag + Cd + Pb + U) + (As + Se + Sb + Ti) + (Ba + Mn + REE + Zr)/5] > 1000$$

Once the average Second White Specks Formation values are inserted into the equation, the result is as follows:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

$$[(356.84615 + 15.818692 + 14.138629 + 55.995327 + 39.902025 + 154.38255 + 17.5381 + 0.3116105 + 1.804891 + 15.050935 + 5.5409969) + (30.224299 + 5.6077882 + 1.5206854 + 0.0039277) + (86.054517 + 121.79439 + 9.6959375 + 31.823404 + 9.7428846 + 38.5 + 7.3923077 + 1.4667308 + 6.5453846 + 1.0436538 + 5.7976923 + 1.1401923 + 3.1671154 + 0.4778846 + 3.0338462 + 0.4482692 + 69.809615)/5] = 794.3$$

Therefore, using Huyck's mathematical definition of a metalliferous black shale, the Second White Specks Formation does not fit, although it is fairly high. However, if the maximum values for the Second White Specks Formation were substituted into the equations, the shale would become a metalliferous shale.

By comparing the two definitions it would appear that the Second White Specks Formation does have some anomalous metal concentrations compared to other shales, but not throughout the whole suite of elements. To investigate how the Second White Specks Formation compares to average shale values published by Mason (1982), Second White Speckled Shale values divided by Mason's (Ibid) average shale were plotted and a comparison was made (Figures 4.21 and 4.22). The Second White Speckled Shale, when compared to average shale values, is elevated in most elements. The Formation in northeastern Alberta is elevated to an even higher extent. Therefore, compared to Mason's (1982) average shale values, the Second White Specks Formation is elevated in many of plotted elements.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

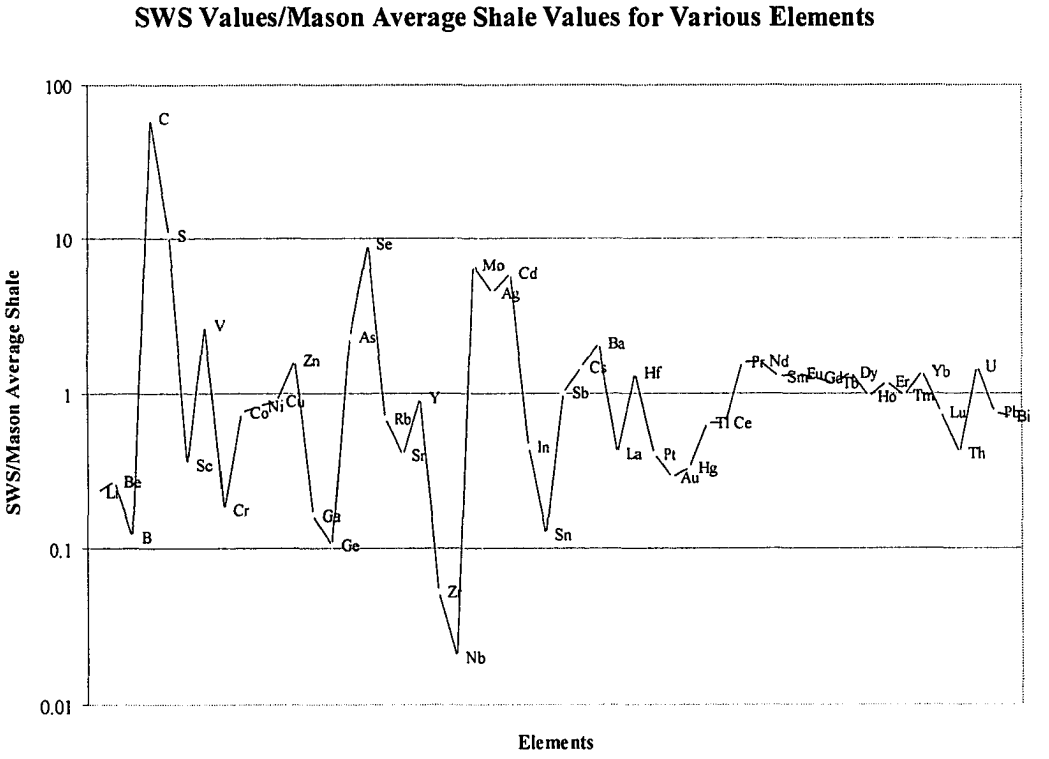


Figure 4.21: A plot of average Second White Specks Formation values/Mason average shale values from Table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the Second White Specks Formation compared to Mason's values.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

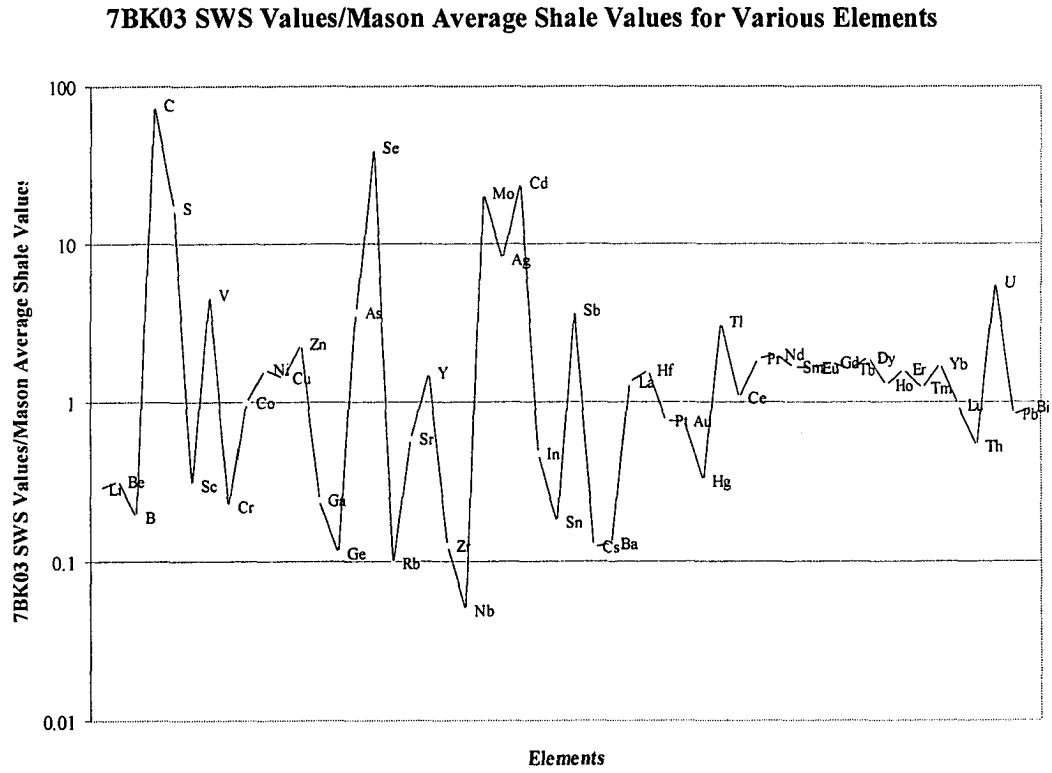


Figure 4.22: A plot of average 7BK03 Second White Specks Formation values/Mason average shale values from Table 4.17 for each element. Any element that has a ratio >1 has an enrichment of that metal in the 7BK03 Second White Specks Formation core compared to Mason's values.

4.7 Discussion

Brumsack (1980) noted that there are four possible ways for metals to accumulate in Cretaceous sediments: (1) precipitation in marginal basins; (2) from hydrothermal solutions; (3) during marine organism's metabolism; and (4) deposition from normal seawater. He gives examples of each, where type (1) is represented by the Kupferschiefer deposit in Europe where proportions of Pb, Ag, Cu and Zn are comparatively much higher than in the average Atlantic black shales or in the shales of this study. Having said this, the possibility cannot yet be ruled out for metals also to have been concentrated in the Second White Specks Formation within Alberta by one or more of mechanisms of hydrothermal solutions, marine organism metabolism and from normal sea water.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

4.7.1 Ore Bodies vs. Sea Water

Table 4.18 provides a comparative summary table of Sedex, Mississippi Valley, Ni-Mo type deposits and sea water. All four genetic models are processes that can produce the anomalous concentrations of metals observed in some shales. The reason why the Mississippi Valley type deposits are included within this study is due to the fact that the Second White Specks Formation equivalent to the east (towards Manitoba) is the Favel Formation which is a carbonate (refer to Figure 4.17). To the south of the border, the Second White Specks Formation also becomes more carbonaceous, and may be a possible Mississippi Valley type deposit rather than a Sedex type deposit.

Table 4.18: Summary table showing the differences and similarities between three sediment hosted deposit types and sea water.

	Sedex	**MVT**	***Ni-Mo***	**Sea Water**
Examples:	*Australia: Mt Isa, McArthur Basin and Broken Hill *Canada: Cirque, Sullivan, Howard's Pass and Driftpile *USA: Red Dog	*Canada: Pine Point, Polaris, Monarch-Kicking Horse deposits *Upper Mississippi Valley	*Nick, Yukon, Canada *Southern China	*Cretaceous black shales from the Atlantic ocean
Primary Elements:	*Pb, Zn, Ag, Ba, Cu	*Pb, Zn, F, Ba	*Ni, Mo, Zn, PGEs, Cu, Au, Pt, Pd	*Most metals and elements
Host:	*Clastic or other sedimentary rock (typically shale or siltstone)	*Carbonate Breccias *Usually dolostone or dolomitized limestone	*Black shales	*Any sediments
Description:	*Ores are usually lense shaped *Galena, sphalertie, barite, chalcopyrite, sulphosalts +/- pyrite, marcasite, pyrrhotite	*Sulphides usually fill cavities in the brecciated host rock *Pyrite, sphalerite, galena, dolomite	*Layers of pyrite, vaesite, jordisite, wurtzite, sphalerite... *May be a hydrothermal source * Bitumen and barite may be present	*May have associated metals due to marine organism metabolism
Tectonic Settings:	*Deep marine and epicontinental to shallow marine *Usually associated with wither growth faults, syndepositional block faults, rifts	*Orogenetically inactive platforms *Relatively undisturbed basins, or foreland fold and thrust belts	*Continental platform *Often have a spatial association with growth/reactivated faults	*Any setting
Environment:	*Second or third order basins *Often oxygen-starved marine basins	*Marine platformal carbonates	*Sedimentary sequences *Anoxic, black shales *Between platform shelf carbonates and deeper clastic marine sediments	*Marine settings
Age:	*Proterozoic - Cretaceous	*Proterozoic - Cretaceous	*Post Archean – Late Precambrian to Phanerozoic	*Any age
Geochemical Signature:	*Usually zoned; Pb closest to vent, grading to more Zn	*Abundant dolomite, elevated Zn and Pb but typically within	*Elevated: Ni, Mo, Au, PGE, C, P, Ba, Zn, Re, Se, As, U, V,	*May show a heavy metal enrichment relative to average shale of

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

	rich facies away *Cu is usually close to the feeder zone *Barite, chert and hematite are the distal facies	or very close to the mineralized zone	S	Pb<Co<Cr<Ni<Cu<V<Zn<Mo<Ag
Grade and Tonnages:	*Average: 41.3Mt *Average grades: 6.8 % Zn, 3.5 % Pb, 50 g/t Ag[1] *High tonnage, moderate grade	*Usually 1-10Mt *Usually between 5-10 % Pb + Zn[2] *Most are Zn rich-relative to Pb *Low tonnage, moderate grade	*Grades often are in % for at least two of: Ni,Mo or Zn *China (Zunyi): ~4 % Mo, up to 4 % Ni, 2 % Zn, 0.7 g/t Ag, 0.3 g/t Pt, 0.4 g/t Pd[3] *Large tonnages *Not always economic	*Various grades, but can be very widespread *Some mean values given for black shales with >1% organic carbon are: 6.8 % C-org, 2.19 % S, 910 ppm Mn, 828 ppm Zn, 156 ppm Cu, 202 ppm Cr, 186 ppm Ni, 16 ppm Pb, 822 ppm V, 59 ppm Mo, 4.5 ppm Ag, 530 ppm Ba[4]
Other Comments:	*Stratiform *Usually has a vent complex, bedded ores and distal hydrothermal products	*Epigenetic, but can be strata-bound on a district scale (often in clusters) *Sulphide zone may be irregular in shape *Often organic material is present	*Soft sediment deformation often observed *Layered *Often thin ore zones	

[1]From: Lydon, 1996; [2]From: Sangster, 1996; [3]From: Lefebure, 1995; [4]From: Brumsack, 1980
Sedex from : Olson, 1994, MacIntyre, 1995, Lydon 1996; MVT from: Olson, 1994, Sangster, 1996 and Ni-Mo from: Lefebure, 1995, Olson, 1994, Hulbert, 1996

Mississippi Valley type deposits were included within this study, because the Second White Specks Formation grades into limestones toward Manitoba and may be an economic deposit in the carbonates, outside of the study area of this project. The first three deposit types in Table 4.18 are all formed by or associated with deposition of metals and related gangue minerals by hydrothermal solutions. In contrast, the fourth has metal enrichment occur by deposition due to normal sea water processes. The average values for metals in the Second White Specks Formation from this study may correspond best with deposition by seawater metal enrichment and organism metabolism. This interpretation also is supported by the Second White Specks Formation having a high total organic carbon content with the two being related. Another factor supporting this genetic interpretation is that the metal enrichment seems to be widespread across the basin. In contrast, the Sedex, MVT and Ni-Mo deposit type models require a restricted area in which mineralization occurred. In addition, the ore grades tend to be in the percentages for the economic parts of the Sedex, MVT and Ni-Mo deposit types, whereas most elemental values for the Second White Specks Formation are in the ppm or ppb range. Maximum values from this study include 469 ppm Zn, 36 ppm Pb, 290 ppm Ni and 169 ppm Mo, are much lower than the percentages levels found at economic Sedex

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

and Ni-Mo type deposits. No mineralized horizons were observed within the core, aside from very thin pyrite laminations.

Nonetheless, there does exist the anomalous metal concentrations in the core from the Birch Mountains in north eastern Alberta, as was demonstrated for the Second White Specks Formation in the aerial distribution plots. These plots show that almost all metal and elemental values are higher in the core from the Birch Mountains, although most are not in the percentage range. There are a few possible explanations for this. One is that the elevated organic carbon content observed further north is related to the elevated metal concentrations. This could simply be a normal seawater trend, or a result of carbon scavenging metals from later diagenetic fluids. A second possibility is that the Birch Mountains location was a restricted 2nd or 3rd order basin and the elevated metals result from syngenetic or diagenetic hydrothermal fluids. This hypothesis is supported by palynology data that indicate species from the Birch Mountains area represent a restricted basin setting. There may also have been a hydrothermal imput, allowing for the concentration of metals and the formation of metalliferous shales that are precursors to or weakly mineralized examples of the types Sedex or Ni-Mo deposit types. However, no feeder or brecciated zones were identified during this study. This may indicate that although there may be a Sedex Ni-Mo deposit, it likely will not be economic. In fact, most Ni-Mo deposits that have been described are not of an economic grade (aside from those in China). Having said this, if a strong hydrothermal source existed some place in northeastern Alberta, the Second White Specks Formation would have been deposited in the ideal environment for a Sedex/Ni-Mo type deposit.

Some similarities and differences exist between the Second White Specks Formation and known Sedex deposits. A comparison between the Red Dog deposit and the Second White Specks Formation is examined. Firstly, the Red Dog deposit is Mississippian-Pennsylvanian in age and hosted within a black shale in Alaska (Moore, 1986). The Second White Specks is slightly younger and is Cretaceous in age, deposited across the whole Western Canada Sedimentary Basin (therefore is much more expansive), but is also a black carbonaceous shale. The Red Dog deposit has been shown

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

to have a brecciated zone, transitional zone and stratiform zone in four vents which were later deformed by the Brooks Range orogeny (Edgerton, 1997). The Second White Specks Formation does have lenses and laminations of pyrite and carbonaceous material. Red Dog was later deformed by thrust plates (Lange et al., 1985) with the latest stage of mineralization being represented by minor sulphides and barite, with the overlying Upper Pennsylvanian zones barren of Zn-Pb mineralization (Edgerton, 1997). Although the Second White Specks Formation was deposited within the main basin, it is deformed to the west (foothills), and could have been deposited within restricted basin in what is now the Birch Mountains area. Lang et al., (1985) note that sulphides can be observed in zones several 1000 ms long, with thicknesses up to 10s of ms in the Red Dog deposit. The Second White Specks Formation also shows widespread accumulation of pyrite. Moore et al., (1986) note that the sulphides observed at Red Dog include sphalerite, pyrite, marcasite and galena with the dominant gangue minerals as quartz, barite and shale. The Red Dog deposit is a known Sedex deposit with reserves of 150 Mt with average grades of 16.2% Zn, 4.4% Pb and 110 g/t Ag (Edgerton, 1997). Although Red Dog has very high ore grades and mineralization concentrations, there are similarities with the thin laminations of pyrite observed in the Second White Specks Formation and the "peripheral" stratiform deposits of the Red Dog deposit, which have very low concentrations of metals. The Second White Specks also contains barite, and may therefore be similar to the last stage of mineralization of the Red Dog deposit which contains barite and low concentrations of sulphides.

The Sedex footprint, exploration guide and geochemical signature includes zoning with Pb closer to vent, and decreasing laterally and vertically to Zn rich rock (MacIntyre, 1995). He (Ibid) also notes that Cu is found close to the hydrothermal venting zone, with barite, chert and/or hematite in the distal rock, much further away from venting. It is therefore possible that the Second White Specks Formation in the Birch Mountains zone is a distal signature for a Sedex deposit. Stratiform facies (like what is observed in the Second White Specks Formation) is often indicative of the periphery of a deposit as is noted in the Red Dog orebody (Edgerton, 1997). Further work must be done in the vicinity of the Birch Mountains to determine if there are any vents/feeder zones with

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

higher metal concentrations which would indicate a Sedex deposit. An airborn and ground geophysical survey may help to locate elevated sulphide concentrations.

Irregardless of whether or not the Second White Specks hosts an economic metalliferous mineral deposit, it still is a metalliferous black shale. The data herein show that the Second White Specks Formation has elevated organic carbon and metal contents compared to the overlying and underlying shales. The data also indicate that the Second White Specks has an increase in metal concentration near the base and the top of the formation, with lower values near the center of the formation. Having said this, the core study did not discern any visible physical explanation for these metal variations (i.e.: brecciation, feeder zones, vents). Therefore, within the Second White Specks unit, the connection is most likely with the organic carbon content. That is, organic carbon is concentrated within the Second White Specks Formation as compared to the overlying and underlying units, and there is an increased total organic carbon content within the formation near its base and top. Thus, the organic carbon content appears to be directly related to the abundance of metals observed in the formation in this study.

Figures 4.21 and 4.22 show that with respect to the maturity levels of the Second White Specks Formation, where the formation is immature to the east and northeast also are the locales with a higher organic carbon content in core. This could be due to multiple factors, such as varying biogenic activity and sedimentation rates. There also is a possibility that to the west and southwest, the mature and overmature Second White Speckled Shale may have lost some of the organic carbon content through expulsion of hydrocarbons.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

4.8 References

Bloch, J.D., Schröder-Adams, C.J., Leckie, D.A., Craig, J. and McIntyre, D.J. (1999): Sedimentology, micropaleontology, geochemistry and hydrocarbon potential of shale from the Cretaceous lower Colorado Group in western Canada, *Geological Survey of Canada*, Bulletin 531, 183 pages.

Brumsack, H.J. (1980): Geochemistry of Cretaceous black shales from the Atlantic Ocean (DSDP legs 11, 14, 36 and 41), *Chemical Geology*, v. 31, pages 1-25.

Dufresne, Michael B. and Eccles, Roy D. and Leckie, Dale A. (2001): The geological and geochemical setting of the Mid-Cretaceous Shaftesbury Formation and other Colorado Group sedimentary units in northern Alberta, *Alberta Geological Survey*, Special Report 09, 654 pages.

Edgerton, David. (1997): Reconstruction of the Red Dog Zn-Pb-Ba orebody, Alaska: implications for the vent environment during the mineralizing event, *Canadian Journal of Earth Science*, v. 34, pages 1581-1602.

Evans, Anthony M. (1993): Ore Geology and Industrial Minerals: An Introduction, 3rd Edition, Blackwell Science, 389 pages.

Goodfellow, Wayne D., Geldsetzer, Helmut, Pride, Ken, Uyeno, Tom T and Gregoire, Conrad C. (2001): Genesis of carbonaceous shale-hosted Ni-Mo-PGE Deposits; *Government of British Columbia*, Ministry of Energy and Mines, URL <http://www.em.gov.bc.ca/Mining/Geolsurv/MetallicMinerals/depmodel/3-sedhst.HTM>, August 2002.

Gustafson, Lewis B. and Williams, Neil. (1981): Sediment-hosted stratiform deposits of copper, lead and zinc, *Economic Geology*, 75th Anniversary Volume, pages 139-178.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Hallam, A. (1967): The depth significance of shales with bituminous laminae, *Marine Geology*, v. 5, pages 481-493.

Hitzman, Murray W. and Beaty, David. (1996): The Irish Zn-Pb-(Ba) orefield, *Society of Economic Geologists Special Publication 4*, pages 112-143.

Hoy, Trygve. (1996): Irish-type carbonate hosted Zn-Pb; *in* Selected British Columbia Mineral Deposit Profiles, Volume 2- Metallic Deposits; Lefebure, D.V. and Hoy, T., Editors, *British Columbia Ministry of Employment and Investment*; Open File 1996-13, pages 21-24.

Hulbert, Larry J. (1996): Sedimentary nickel sulphides; *in* Geology of Canadian Mineral Deposit Types; Eckstrand, O.R, Sinclair, W.D. and Thorpe, R.I., Editors, *Geological Survey of Canada*, Geology of Canada, no. 8, pages 152-158.

Huyck, H.L.O. (1990): Proposed definitions of "black shale" and "metalliferous black shale" for IGCP Project 4; *in* 8th IAGOD symposium in conjunction with international conference on Mineral deposit modeling; program with abstracts, *Proceedings of the Quadrennial IAGOD Symposium*, 8, pages A183-A184.

Klein, G. deV. (1991): Basin sedimentology and stratigraphy – the basin-fill, *in* Sedimentology and Diagenetic Mineral Deposits: A Basin Analysis Approach to Exploration: Reviews in Economic Geology, Force, E.R., Eidel, J.J. and Maynard, J.B., Editors, *Society of Economic Geology*, v. 5, pages 51-90.

Lange, Ian M., Nokleberg, Warren J., Plahuta, Joseph T., Krousem H. Roy and Doe, Bruce R. (1985): Geologic Setting, Petrology and Geochemistry of Stratiform Sphalerite-Galena-Barite Deposits, Red Dog Creek and Drenchwater Creek Areas, Northwestern Brooks Range, Alaska, *Economic Geology*, v. 80, pages 1896-1926.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Large, Duncan E. (1983): Sediment-hosted massive sulphide lead-zinc deposits: an empirical model; *in* Short Course in Sediment-hosted stratiform lead-zinc deposits; Sangster, D.F., Editor, *Mineralogical Association of Canada*, pages 1-29.

Leckie, D.A, Bhattacharya, J.P., Bloch, J., Gilboy, C.F., Norris, B. Campbell, R., Plint, G., Gilders, M., Holmstrom, G., Krause, F.F., Reinson, G.E., Safton, D., Sawicki, J. and Sawicki, O. (1994): Cretaceous Colorado/Alberta Group of the Western Canada Sedimentary Basin; *in* Geological Atlas of the Western Canada Sedimentary Basin, *Alberta Research Council and the Alberta Geological Survey*, pages 335-352.

Lefebure, D.V. and Coveney, R.M. Jr. (1995): Shale-hosted Ni-Zn-Mo-PGE; *in* Selected British Columbia Mineral Deposit Profiles, Volume 1 - Metallics and Coal; Lefebure, D.V. and Ray, G.E., Editors, *Brisith Columbia Ministry of Energy of Employment and Investment*, Open File 1995-20, pages 45-48.

Lentz, D. R. (2003): Geochemistry of sediments and sedimentary rocks: historical to research perspectives; *in* Inorganic Geochemistry of Sediments and Sedimentary Rocks: Evolutionary Considerations to Mineral Deposit-Forming Environments; Lentz, D.R. Editor, *Geological Association of Canada*, GeoText 4, pages 1-6.

Lydon, John W. (1983): Chemical parameters controlling the origin and deposition of sediment-hosted stratiform lead-zinc deposits; *in* Short Course in Sediment-hosted stratiform lead-zinc deposits; Sangster, D.F., Editor, *Mineralogical Association of Canada*, pages 175-250.

Lydon, John W. (1996): Sedimentary exhalative sulphides (Sedex); *in* Geology of Canadian Mineral Deposit Types; Eckstrand, O.R., Sinclair, W.D. and Thorpe, R.I., Editors, *Geological Survey of Canada*, Geology of Canada, no.8, pages 130-152.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Lyons, Timothy W. and Berner, Robert A. (1992): Carbon-sulfur iron systematics of the uppermost deep-water sediments of the Black Sea, *Chemical Geology*, v. 99, pages 1-27.

MacIntyre, Don. (1995): Sedimentary Exhalative Zn-Pb-Ag; *in* Selected British Columbia Mineral Deposit Profiles, Volume 1- Metallics and Coal; Lefebure, D.V. and Ray, G.E. Editors, *British Columbia Ministry of Energy of Employment and Investment*, Open file 1995-20, pages 37-39.

Mason, B (1982): Principles of Geochemistry: John Wilet and Sons Limited, New York, 329 pages.

Moore, D.W., Young, L.E., Modene, J.S. and Plahuta, J.T. (1986): Geologic setting and genesis of the Red Dog Zinc-Lead-Silver Deposit, Western Brooks Range, Alaska, *Economic Geology*, v. 81, pages 1696-1727.

Olson, R.A., Dufresne, M.B., Freeman, M.E., Richardson, R.J.H. and Eccles, D.R. (1994): Regional Metallogenic Evaluation of Alberta, APEX Geoscience Ltd., R.A. Olson Consulting Ltd., 150 pages.

Sabag, S.F. (1996): Buckton Property: Summary Report Exploration Programs 1993-1995 and Work In Progress 1996, Tintina Mines Limited and NSR Resources Inc., Ontrario, 1801 pages PDF.

Sabag, S.F. (1998): Report on exploration programs 1996-1997, Tintina Mines Limited and NSR Resources Inc, 774 pages.

Sangster, D.F. (1996): Mississippi Valley-type lead-zine; *in* Geology of Canadian Mineral deposit Tpyes; Eckstrand, O.R., Sinclair, W.D. and Thorpe, R.I., Editors, *Geological Survey of Canada*, Geology of Canada, no. 8, pages 253-261.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sangster, D.F. and Hillary, E.M. (2000): Sedex lead-zinc deposits – proposed sub-types and their characteristics, *Exploration Mining Geology,* v. 7, pages 341-357.

Schultz, R.B. (1991): Metalliferous black shales: accumulation of carbon and metals in cratonic basins; *in* Sedimentary and Diagenetic Mineral Deposits: A Basin Analysis Approach to Exploration; Force, E.R., Eidel, J.J. and Maynard, J.B., Editors, *Reviews in Economic Geology*, v. 5, pages 171-176.

Schultz, Richard B. and Coveney, Raymond M. Jr. (1992): Time-dependent changes for Midcontinent Pennsylvanian black shales, U.S.A., *Chemical Geology*, v. 99, pages 83-100.

Snowdon, Lloyd R. (1995): Rock-Eval Tmax suppression: Documentation and amelioration, *AAPG Bulletin*, v. 79, pages 1337-1348.

Travis, Sarah. (2002): Organic Geochemical Analysis of the Second White Speckled Shale Formation, Upper Cretaceous Colorado Group, west central Alberta. Implications for Shale Gas Production; B.Sc. thesis, *University of Calgary*, 76 pages.

Wedepohl, K.H. (1964): Untersuchungen am Kupferschiefer in Nordwestdeutschland: Ein Beitrag zur Deutung der Genese bituminoser, *Sedimente. Geochim. Cosmochim. Acta.*, v. 28, pages 305-364.

Wilde, Pat, Lyons, Timothy W. and Quinby-Hunt, Mary S. (2003): Organic carbon proxies in black shales: molybdenum, URL <http://users.rcn.com/patwilde/cgeo03.html>, March 2004.

Ziegler, A.C. and Combs, L.J. (1997): Baseline data-collection and quality-control protocols and procedures for the *Equus* beds groundwater recharge demonstration

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

project near Wichita, Kansas, 1995-96; *United States Geological Survey*, Open File Report 97-235, 24 pages.

Zimmerman, L.R., Strahan, A.P. and Thurman, E.M. (2001): Methods of analysis and quality-assurance practices by the United States Geological Survey organic geochemistry research group – determination of four selected mosquito insecticides and a synergist in water using liquid-liquid extraction and gas chromatography/mass spectrometry; *United States Geological Survey*, Open File Report 01-273, 18 pages.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

5.0 GENERAL DISCUSSION AND CONCLUSIONS

The regional study of the Second White Specks Formation was challenging, not only because it varies lithologically, markedly across the basin within Alberta, but also because it is difficult to obtain cored sections across the entire unit at some satisfactory spacing. Nonetheless, this study was able to extend the previous knowledge of the formation in southern and central Alberta into central and northern Alberta, and to look at the geochemical signature, both organic and inorganic, of the unit.

The results from this study provide a large amount of new information with regards to the sedimentology, geochemistry and stratigraphy of the Second White Specks Formation in northern and central Alberta. This information includes data from logged and sampled core, palynology, micropaleontology, stratigraphy, and organic and inorganic geochemistry.

Sea level was rising during the Belle Fourche Formation transgression, and reached the maximum flooding surface during the start of the deposition of the Second White Specks Formation. A low energy environment deposited shale, and abundant organic matter was preserved due to the anoxic environment created by the intermixing of warm ocean waters from the south and cool ocean waters from the north. This intermixing limited the biota, being hospitable mainly to planktic foraminifera, but less hospitable to benthic foraminifera. Due to the lack of bioturbation at the base of the Second White Specks and bottom water anoxia, the organic matter was preserved, which is reflected by a high total organic carbon content in the geochemical data. The highest total organic carbon was preserved in the northeast part of the basin due to the proximity of the core to the paleoshoreline and possibly also to increased bioactivity in the seawater at the time of deposition. As well, and probably largely due to the environment of deposition being favorable to the preservation of organic carbon, metals were also concentrated from sea water. Finally, the pyrite nodules and laminations that are present could be due to marine organism metabolism.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

As the sea level continued to rise during the ensuing highstand, the low energy environment of deposition remained fairly stable during the Second White Specks formation time. Slightly less organic matter was preserved during this later time, and a lower concentration of metals was also concentrated by normal sea water. The bottom waters remained fairly anoxic, and bioturbation is rare to non existent. Fish debris, *Inoceramus* shells and fecal pellets containing coccoliths were concentrated into laminations. Contour currents acted on the basin floor to move the grains of fine-grained sand and silt into laminations and ripples.

Near the top of Second White Specks Formation, there is evidence that slightly more organic matter is preserved. This is reflected by the higher organic carbon concentrations and correspondingly higher metal concentrations. The seafloor at this time late in the deposition of the Second White Specks remained fairly inhospitable to organisms, although minor bioturbation is present and extends up into the overlying shales within the southern core. Finally, as deposition of the overlying Carlile Formation occurred, the waters became slightly more oxygenated and starting returning to normal marine conditions.

The Second White Specks Formation in the Birch Mountains is different from that elsewhere within the study area. Unfortunately, there is no available core between township 97 and 71, to assess whether or not there is a gradual or sudden change in metal values and lithology within the Second White Specks Formation. The most notable characteristics of the Second White Specks Formation in the Birch Mountains includes: coarser lithology, abundance of bentonites, high total organic carbon content and elevated metal concentrations. This variation may be due to the Birch Mountain core being closer to the paleoshoreline, the great distance from other core within this study and possibly restricted conditions in the Birch Mountains that favoured metal enrichment. This locale may represent a metalliferous mineral deposit that is not economic, but with the metal concentrations occurring from hydrothermal fluids. An alternative possibility is that the environment of deposition preserved abundant organic matter and metals in the dark grey shales by direct precipitation from sea water. No bioturbation was observed within the

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

core, indicating that the bottom waters were fairly anoxic and inhospitable to organisms in the Second White Specks Formation deposited in the Birch Mountains.

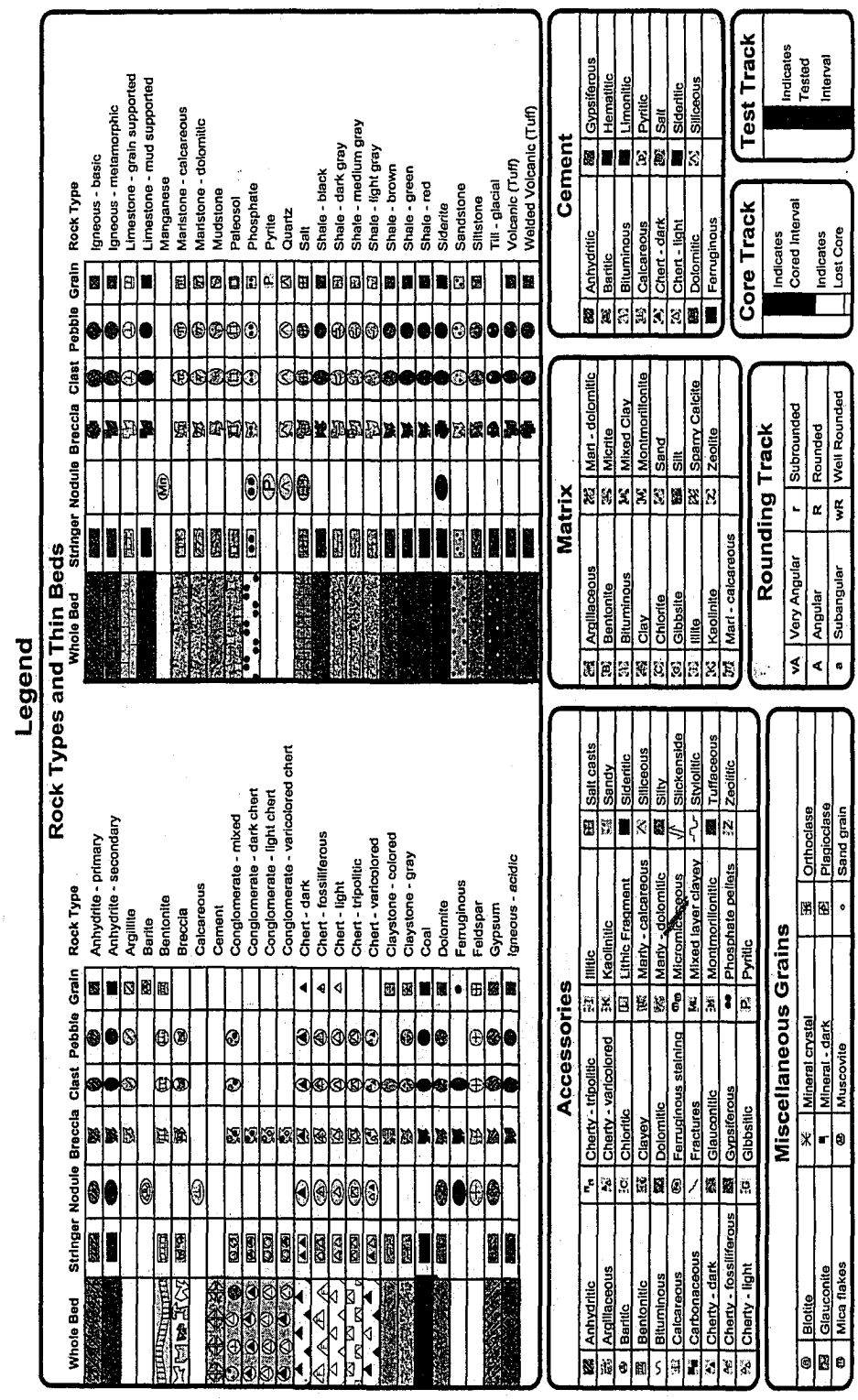
To conclude, the Second White Specks Formation is a great source rock for organic carbon as demonstrated from previous studies, and by the high organic carbon contents found within this study. The highest organic carbon content is in the Birch Mountains and eastern Alberta where the formation is immature. The Second White Specks Formation is often used only as a marker horizon on geophysical logs, but its importance throughout Alberta as a source rock for hydrocarbons, and as a potential reservoir rock for oil or gas and host rock metalliferous shale, makes it a unique unit within the Cretaceous strata of the Western Interior Seaway.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

6.0 APPENDICES

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

6.1 Logging Forms and Extra Logged Core Descriptions



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Fossils (Rock Builders)

	Aggregate grains		Algae - laminations		Algae-non descript		Algae - ootoid
	Algae - skeletal		Amphipora		Belemnite		Bioclastic
	Brachiopod		Bryozoa		Calciphaera		Cephalopod
	Chaetetes		Coated grain		Conodont		Coral
	Coral - branching		Coral - head		Coral - colonial		Coral - solitary
	Crinoid		Diatom		Echnoid		Echnoid - spine
	Fish Remains		Euryamphipora		Foraminifera		Fossil
	Fragmental		Gastropod		Graptolite		Hydrozoa
	Intraclast		Mollusc		Oncolite		Oolite
	Ostracod		Pelecypod		Pellet		Pisolite
	Plant Remains		Scaphopod		Spicule		Sponge
	Stromatoporoid		Stromatoporoid-bulbous		Stromatoporoid - massive		
	Stromatoporoid - tabular				Tentaculites		Trilobite

Trace Fossil Track

An	Anconichnus	Ar	Arenicolites	At	Arthrophycus	As	Asterosoma
Au	Aulichnites	Be	Bergaueria	Cg	Camborygma	Cf	Celliforma
Cb	Chabutolithes	Ch	Chondrites	Cl	Climactichnites	Co	Conichnus
Cp	Cosmoraphe	C	Cruziana	Cy	Cylindrichnus	Da	Dactyloidites
Dm	Dimorphichnus	D	Diplocraterion	Ea	Eatonichnus	En	Entobia
Et	Entomichnus	Esc	Escape Traces	Ga	Gastrochaenolites	Gl	Glossifungites
G	Gyrolithes	Gy	Gyrophyllites	H	Helminthopsis	K	Kouphichnium
L	Lockeia	Lo	Lorenzinia	Mp	Macanopsis	Ma	Macaronichnus
Mo	Monocraterion	Ne	Neonereites	N	Nereites	O	Ophiomorpha
Pa	Palaeophycus	Pd	Paleodictyon	Pc	Paleohelcura	Pl	Paleoscolytus
Pt	Petalichnus	Py	Phycodes	Ph	Phycosiphon	P	Planolites
Pm	Psammichnites	Ps	Psilonichnus	Rh	Rhizocorallium	Rg	Rogerella
Ro	Rosselia	Ru	Rusophycus	Sb	Scalarituba	Sc	Schaubcylindrichnus
Sy	Scoyenia	Si	Siphonichnus	S	Skolithos	Sp	Spirophycus
Su	Subphyllochorda	Syn	Synaeresis Cracks	Te	Teichichnus	Tr	Terebellina
Td	Teredolites	Th	Thalassinoides	Tc	Trichichnus	Tp	Trichophycus
Ty	Trypanites	Z	Zoophycos				

Sedimentary Structures

	Ball and pillow		Bioturb-churned	-0-	Bioturbated-slightly	m0-	Bioturb-moderate
m0w	Bioturb-mod well	-0w	Bioturbated-well		Boudinage		Burrows
	Clastic Dike		Clastic sill		Desiccation crack		Dish structure
	Fault-Large scale		Fault-Small scale		Flame structure		Flute mark
	Geopetal		Groove casts		Gutter casts		Load casts
	Inclined heterolithic strata				Mud chips		Mud drapes
	Neptunian dike		Pit marks		Pull-a-part		Rill marks
	Rip up clasts		Roots / root trace		Scour and Fill		Slump structure
	Swash marks		Synersis crack		Teepee structure		Tool marks
	Water Escape						

Porosity Type Track

e	Earthy - low permeability - crystals / grains less than 1 / 16 mm		
⊡	Fenestral - voids from gas bubbles - shrinkage cracks - birdseye texture		
X	Intercrystalline - Interfragmental - Intergranular		
F	Fracture	O	Organic - Bridged - Intrafossil
◇	Interoolitic - Interpelletoidal	P	Pinpoint - voids less than 1/ 16 mm
∽	Moldic	V	Vuggy - voids greater than 1 / 16 mm

Oil Show Track

●	Even staining (75 - 100% of the rock is stained) - fluoresces in solvent
◕	Spotted staining (50 - 75% of the rock is stained) - fluoresces in solvent
◉	Spotted staining (25 - 50% of the rock is stained) - fluoresces in solvent
⊙	Spotted staining (1 - 25% of the rock is stained) - fluoresces in solvent
○	Questionable oil staining - No fluorescents in solvent
D	Dead oil staining - asphaltic - bitumen - pyrobitumen etc.
F	Fluoresces - no visible oil staining

Textures

C	Chalky	e	Earthy	mx	Microcrystalline
cx	Cryptocrystalline	L	Lithographic		Slickenside
MS	Mudstone	GS	Grainstone	BFS	Bafflestone
WS	Wackestone	FLS	Floatstone	BS	Bindstone
PS	Packstone	RS	Rudstone	FS	Framestone

Sedimentary Structures Bedding / Cross Bedding

CM	Centimeter bedding		Inverted graded bedding		Massive bedding
DM	Decimeter bedding		Normal graded bedding		Chevron cross-bedding
MM	Millimeter bedding		Herringbone cross-bedding		Sigmoidal cross-bedding
	Hummocky cross-bedding		Swaley cross-bedding		Planar/Tabular x-bedding
	Trough cross-bedding				

Sedimentary Structures Laminations / Cross Laminations

	Climbing ripple cross-lams		Contorted / Slumped lams		Current ripple cross-lams
	Flaser laminations		High angle cross-lamination	///	High angle parallel lams
	Lenticular laminations		Low angle cross-lamination		Low angle parallel lams
	Parallel laminations		Trough cross-laminations		Varved laminations
	Wave ripple cross-lams		Wavy laminations		

Sorting Track

vP	Very poorly sorted - > 10 phi size grade classes
P	Poorly sorted - 6-10 phi size grade classes
M	Moderately sorted - 3-6 phi size grade classes
mW	Moderately well sorted - 2-3 phi size grade classes
W	Well sorted - < 2 phi size grade classes

Framework Track

Framework is a ratio between clastic material greater than 1/16 mm and primary void filler less than 1/16 mm.

? indicates questionable interpretation

Well Information

Operator:	
Well Name:	7BK03
Location:	
UWI:	100020310112W400
Pool:	
Field:	
Province / State:	
Country:	

Elevations

Reference:		Ground:	m
Cut(-) / Fill(+):		Kelly Bushing:	m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

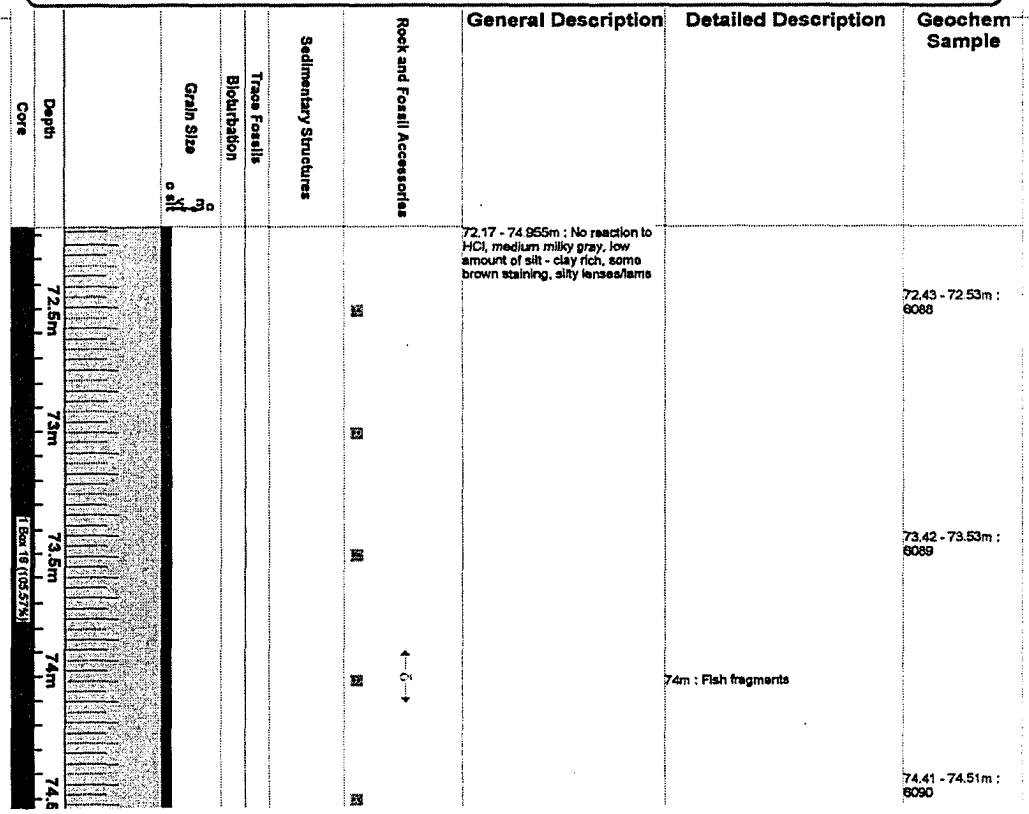
Well Type:	Straight
Longitude:	
Latitude:	
N / S Co - Ordinates:	6398930
E / W Co - Ordinates:	447770

Bottom Hole Co - Ordinates

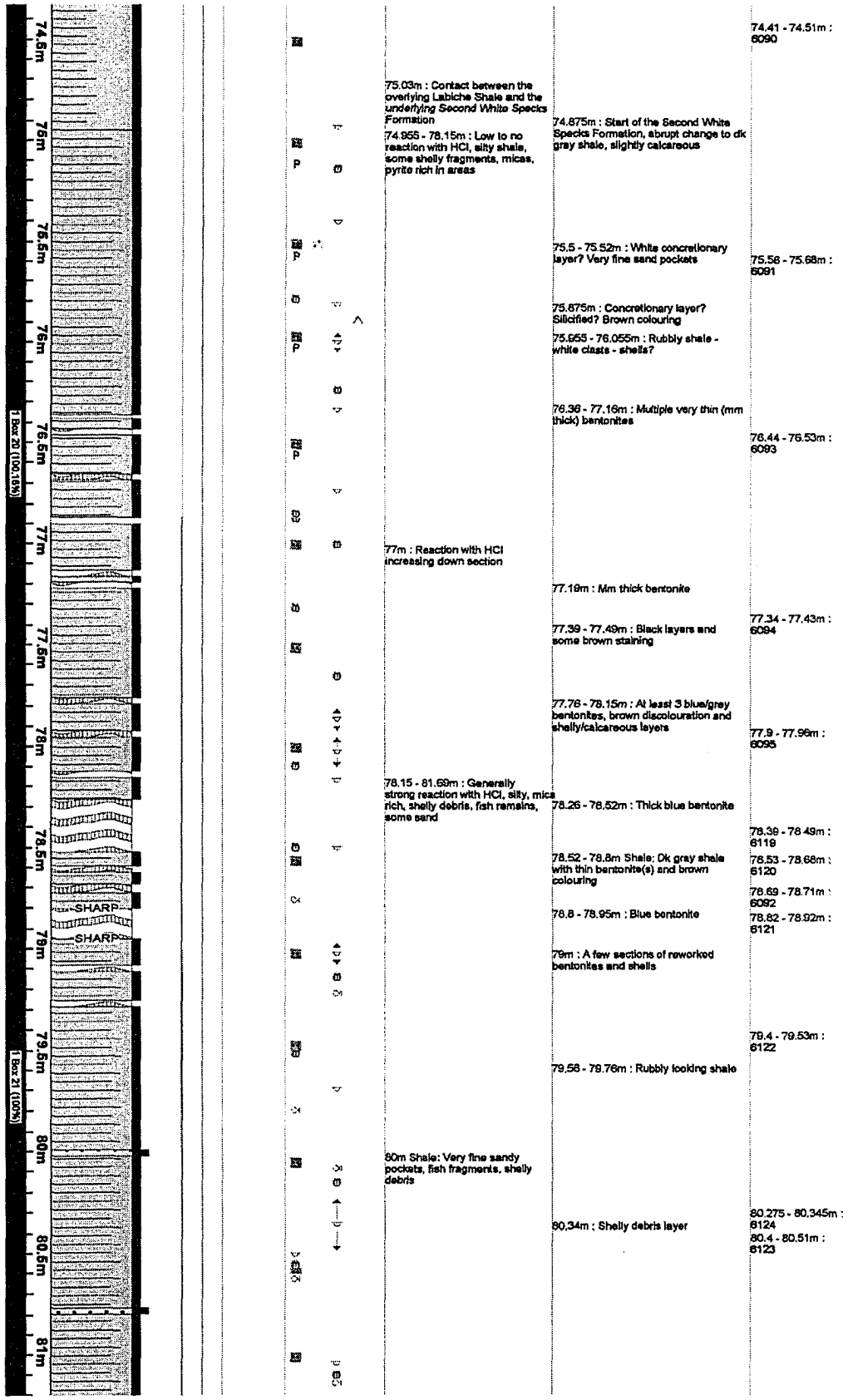
Longitude:	
Latitude:	
N / S Co - Ordinates:	
E / W Co - Ordinates:	

Well Summary

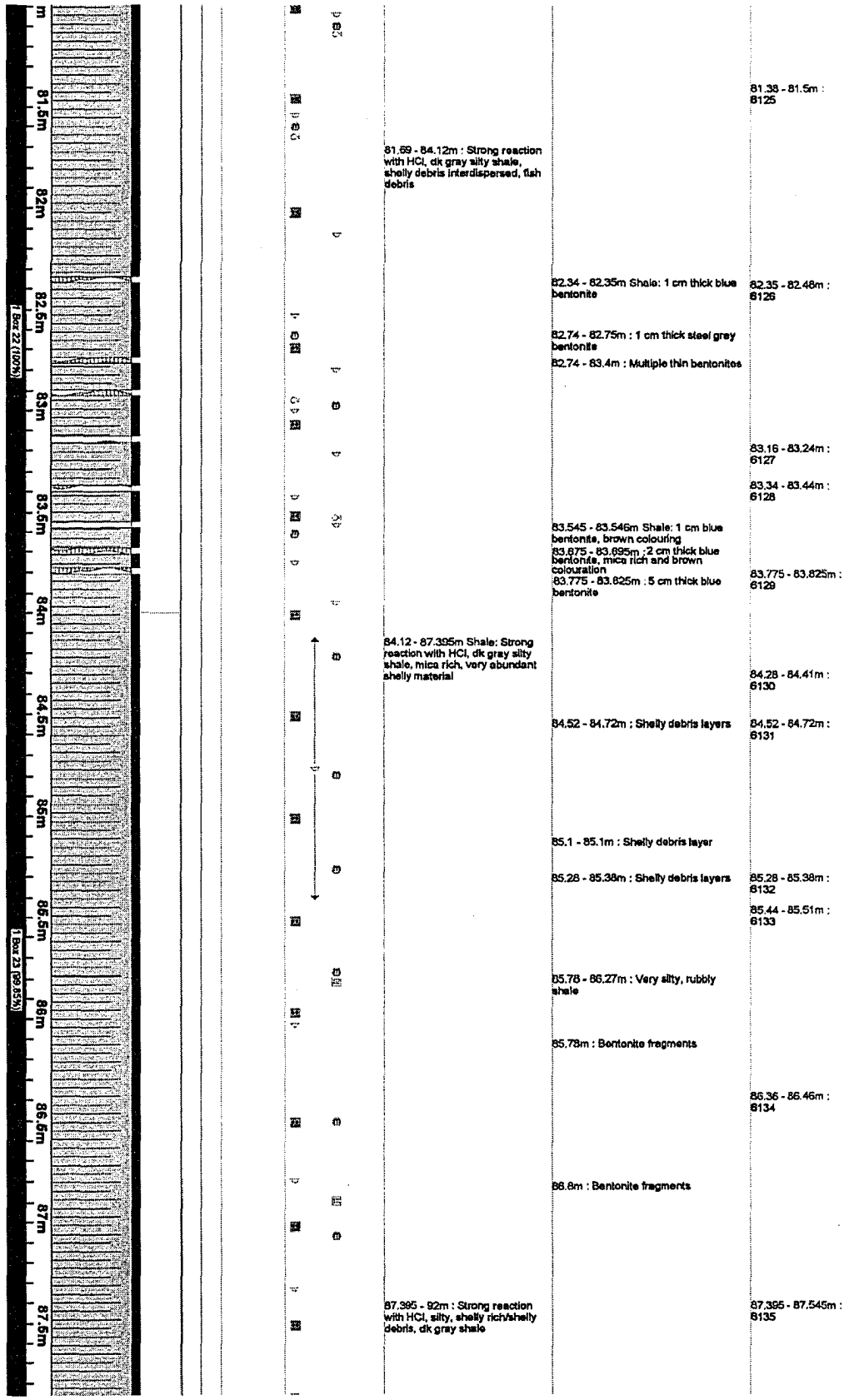
Spud Date:		Contractor:	Elgin Exploration Company
TD Date:		Rig Release Date:	



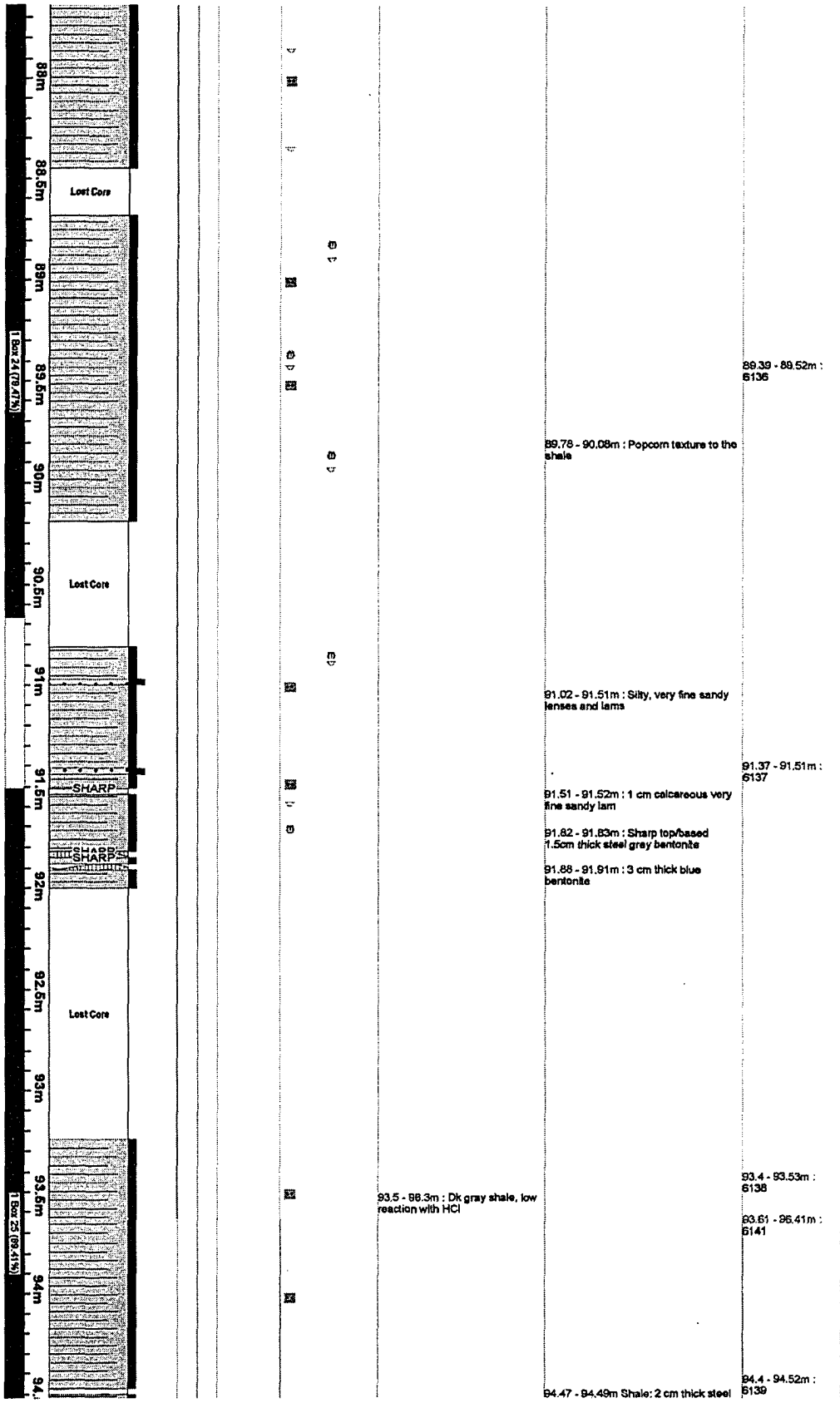
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



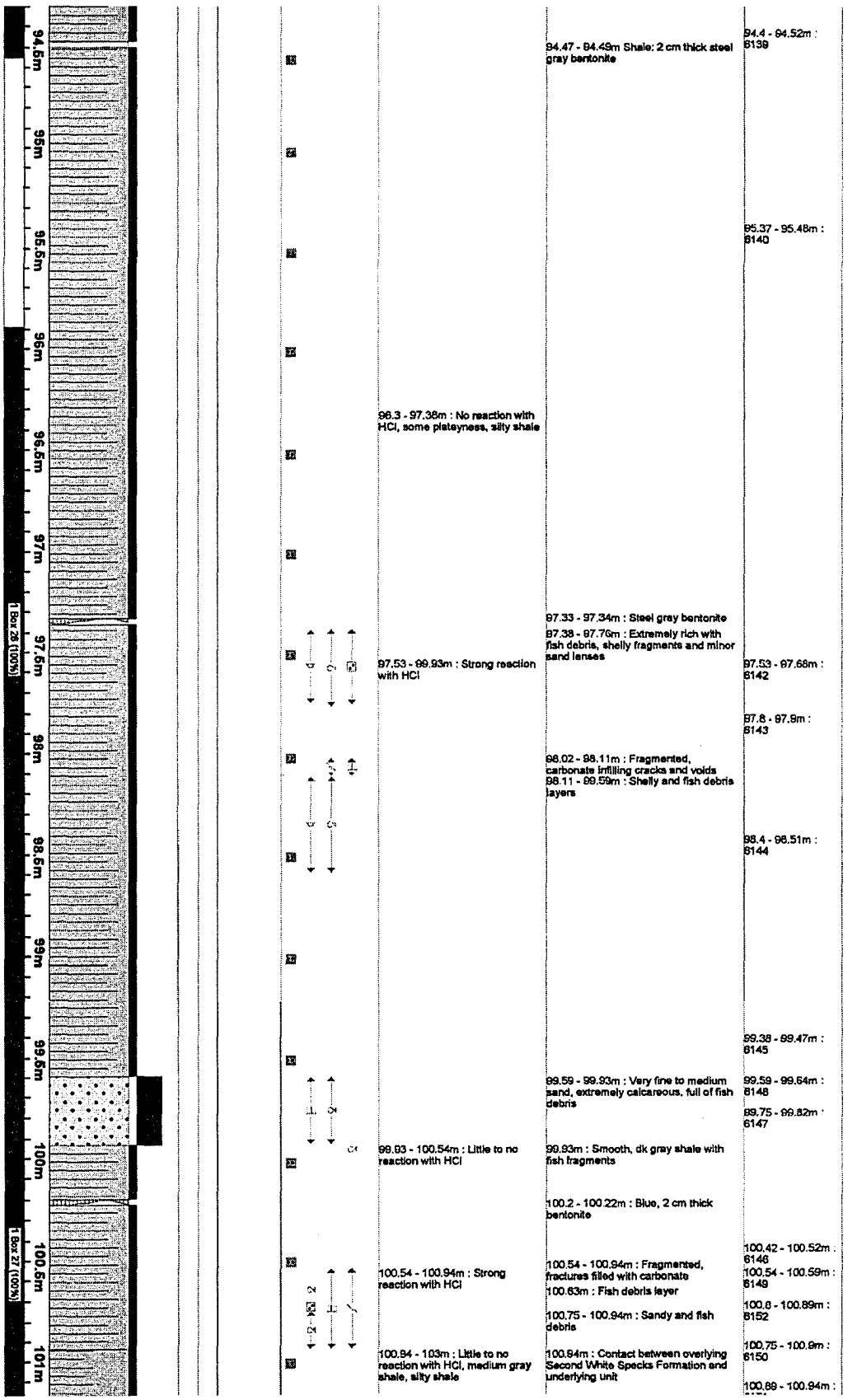
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



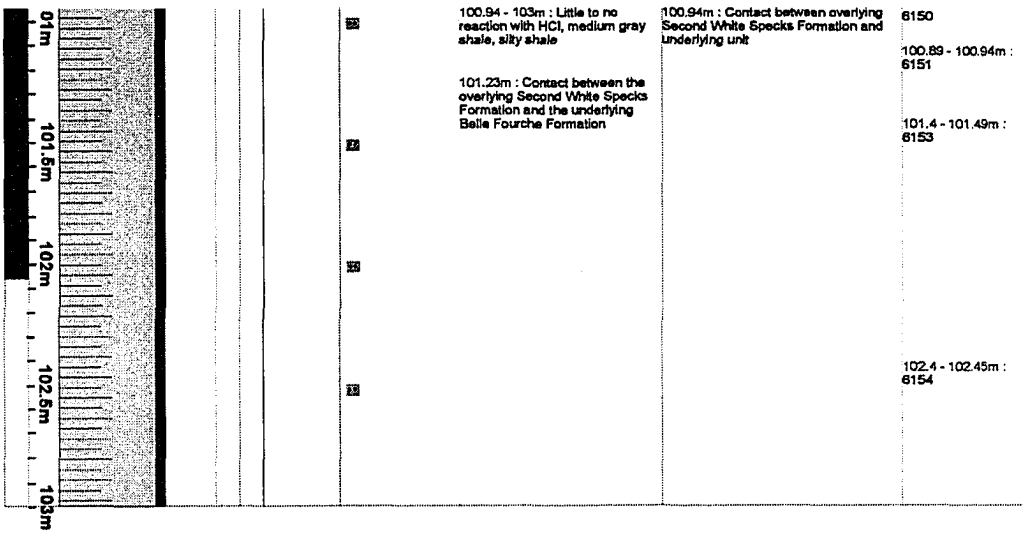
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Apache Canada Ltd.
Well Name:	ACL Snipelk 4-2-71-18
Location:	
UWI:	100040207118W500
Pool:	Beaverhill Lake (744000)
Field:	Snipe Lake (856)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	794.3 m
Cut(-) / Fill(+):		Kelly Bushing:	798.6 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

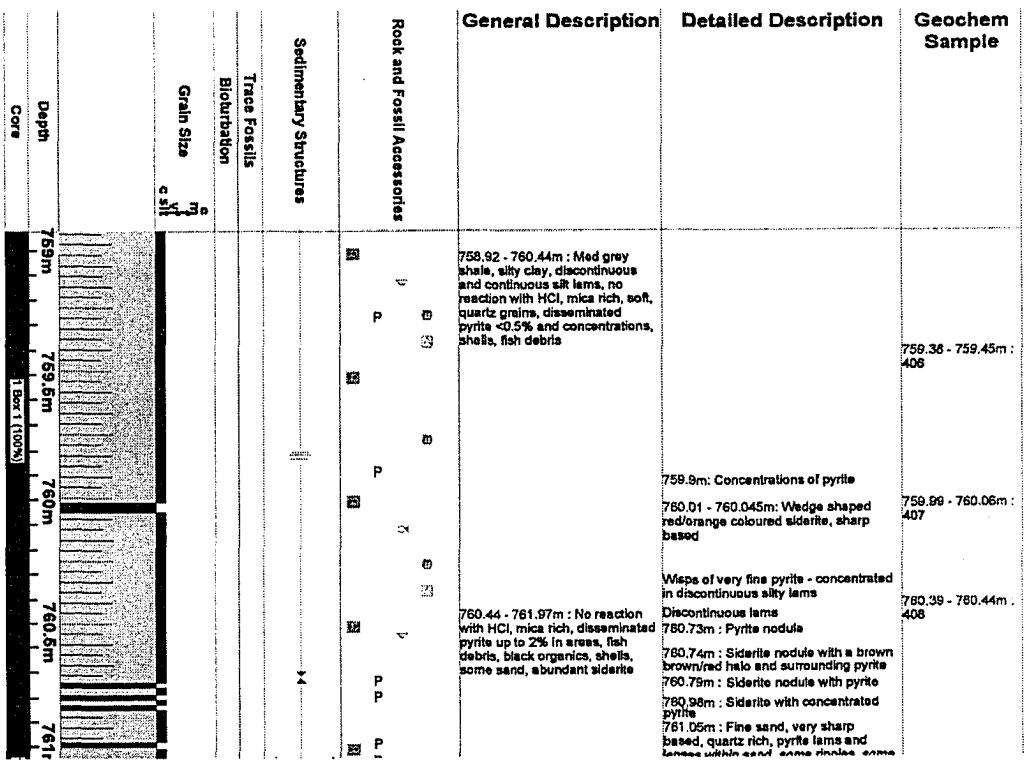
Well Type:	Straight
Longitude:	-116.663060
Latitude:	55.114423
N / S Co - Ordinates:	200.9
E / W Co - Ordinates:	201.7

Bottom Hole Co - Ordinates

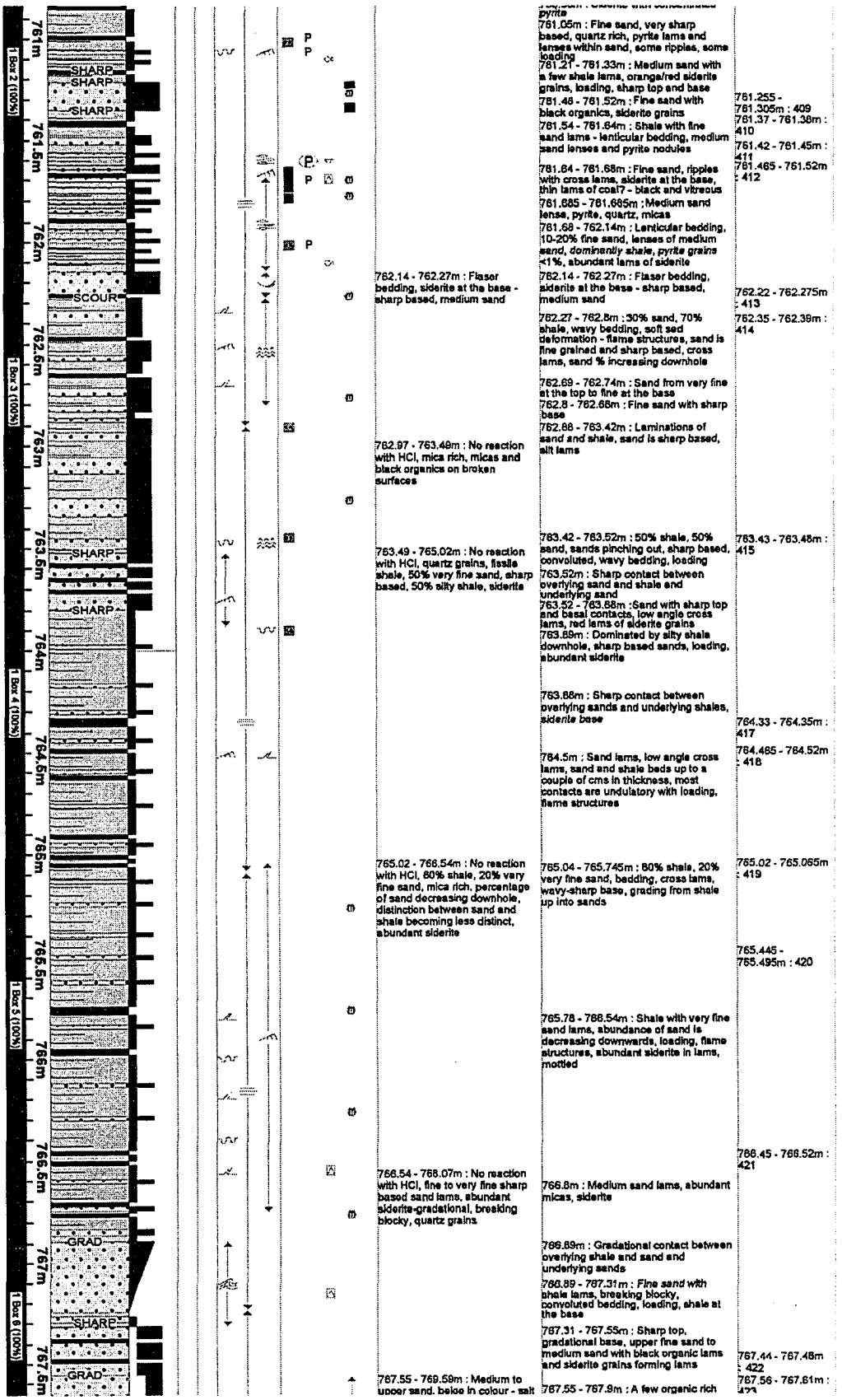
Longitude:	-116.663060
Latitude:	55.114423
N / S Co - Ordinates:	200.9
E / W Co - Ordinates:	201.7

Well Summary

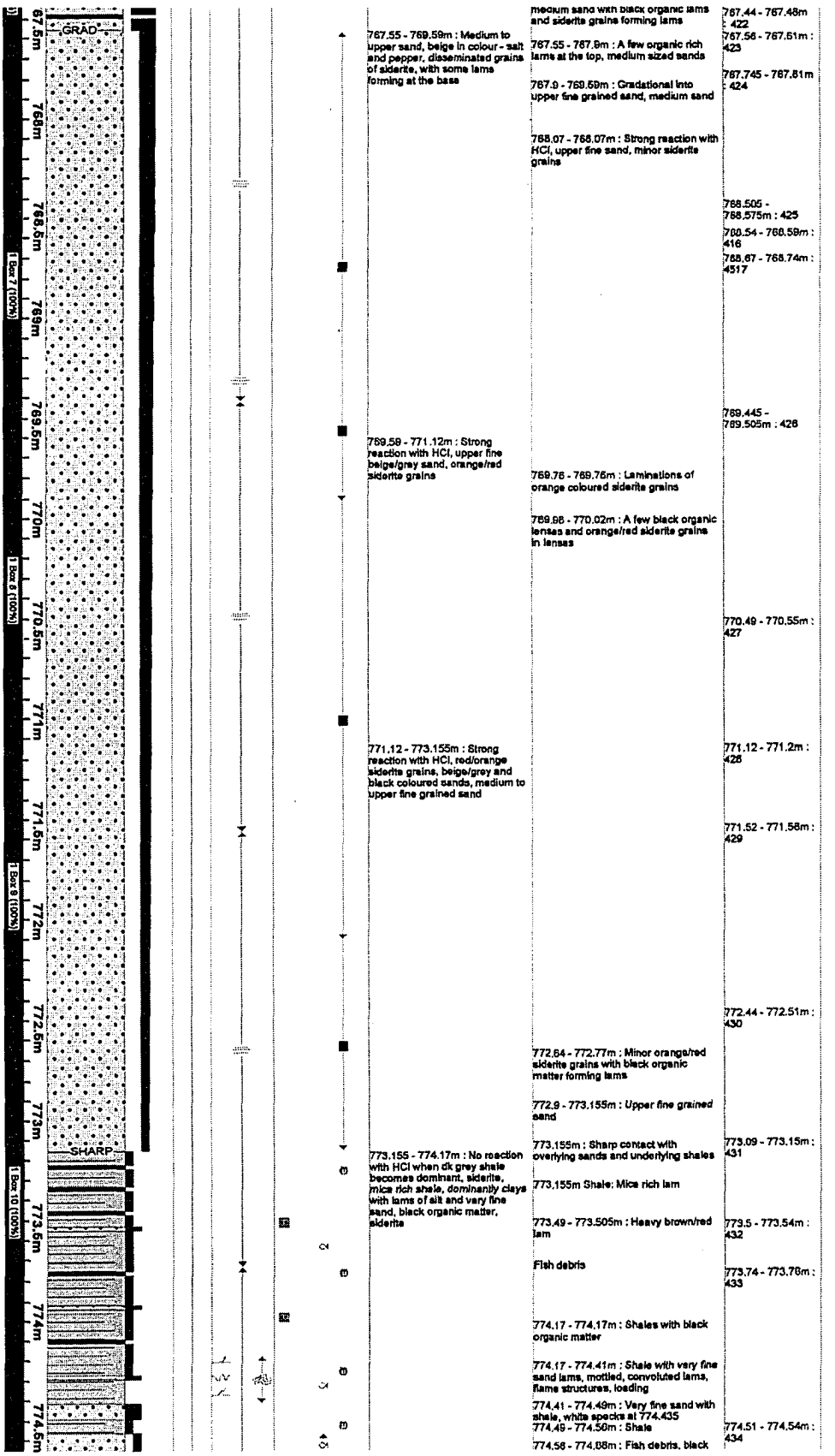
Spud Date:	Jan 17, 1964	Contractor:	
TD Date:		Rig Release Date:	Feb 17, 1964



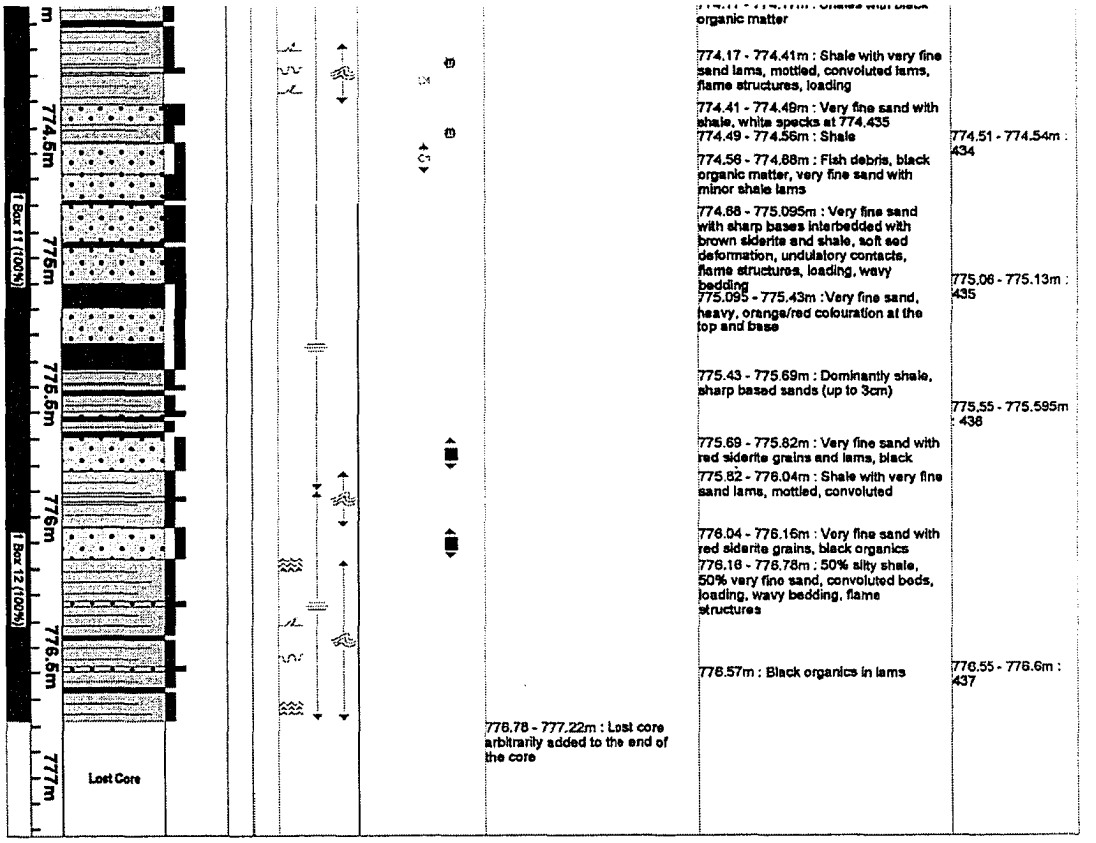
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



00/04-02-071-18W5/0: ACL Snipelk 4-2-71-18

Core: 758.92m – 776.78m

Second White Specks interval from cross section: 722m – 740m

Observations:

The core is dominated by beds of non-calcareous medium grey shale. Abundant siderite, fine-to-medium sand, disseminated pyrite, shell and fish debris are observed. There is abundant soft sediment deformation as well as ripples with cross laminations. There is a 6m interval which is dominated by sand, and no white specks are identified.

Interpretations:

The core is stratigraphically below the Second White Specks Formation and may represent the Belle Fourche Formation or another underlying unit. Sedimentologically,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

this core has much more sand than expected for the Second White Specks Formation, as well as abundant siderite.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Conocophillips Canada Resources Corp.
Well Name:	Wabamun No 1
Location:	
UWI:	100051005104W500
Pool:	Unknown
Field:	Highvale (477)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	780.9 m
Cut(-) / Fill(+):		Kelly Bushing:	783.6 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

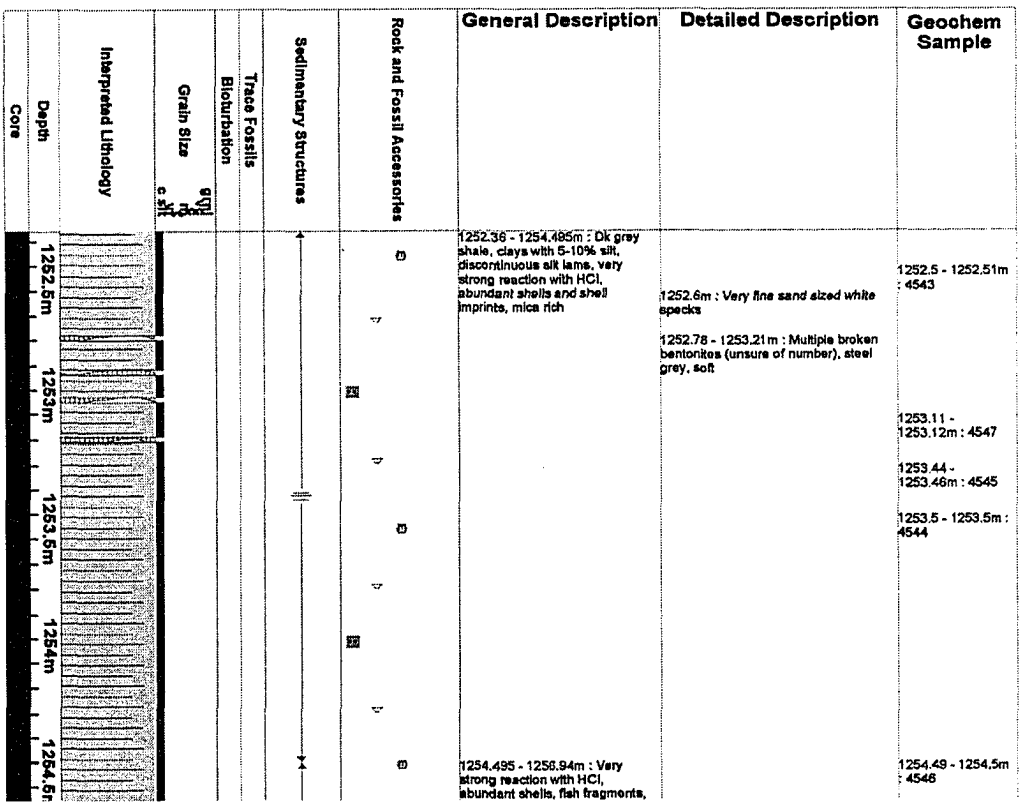
Well Type:	Straight
Longitude:	114.514664
Latitude:	53.386385
N / S Co - Ordinates:	566.5
E / W Co - Ordinates:	101.4

Bottom Hole Co - Ordinates

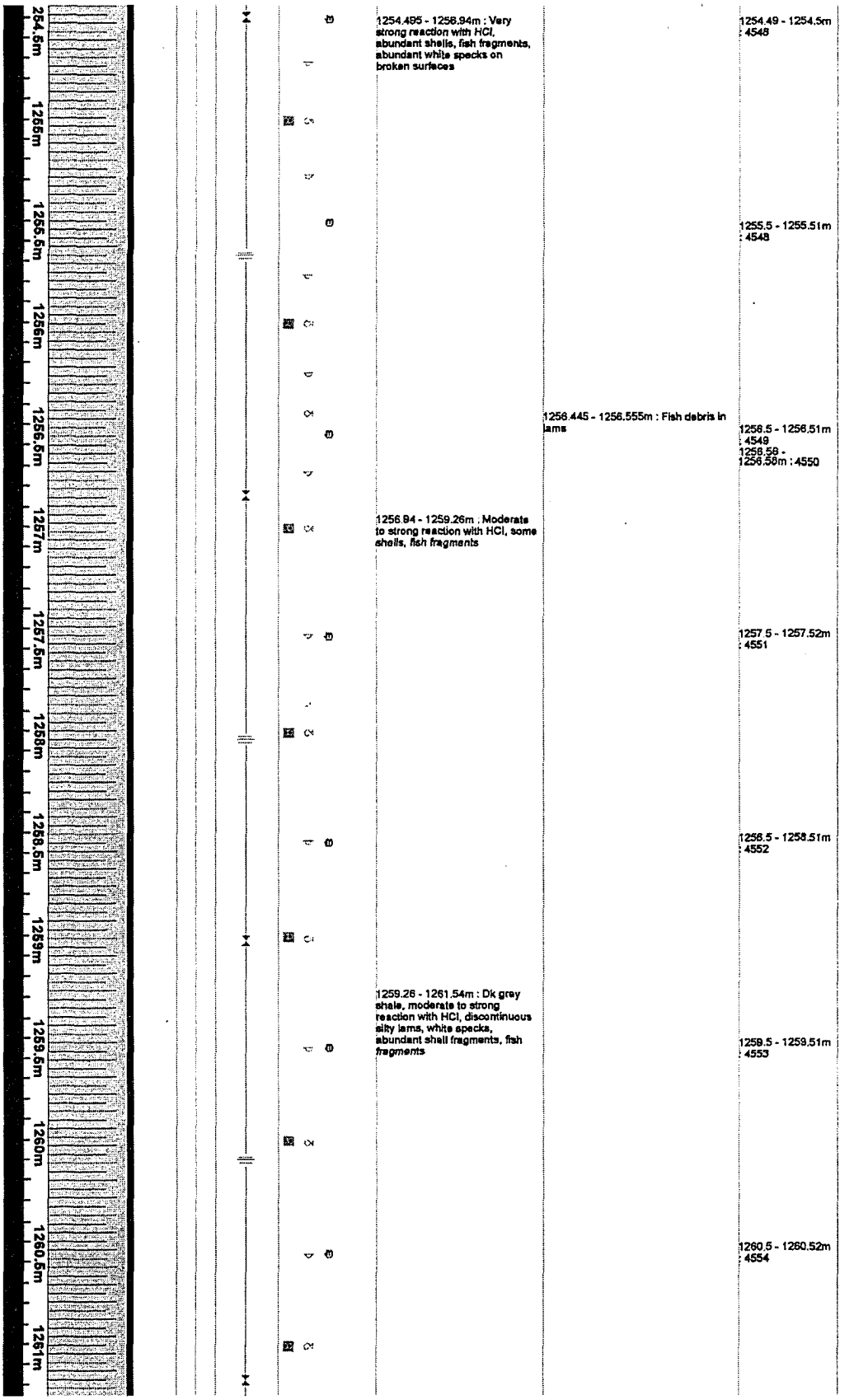
Longitude:	114.514664
Latitude:	53.386385
N / S Co - Ordinates:	566.5
E / W Co - Ordinates:	101.4

Well Summary

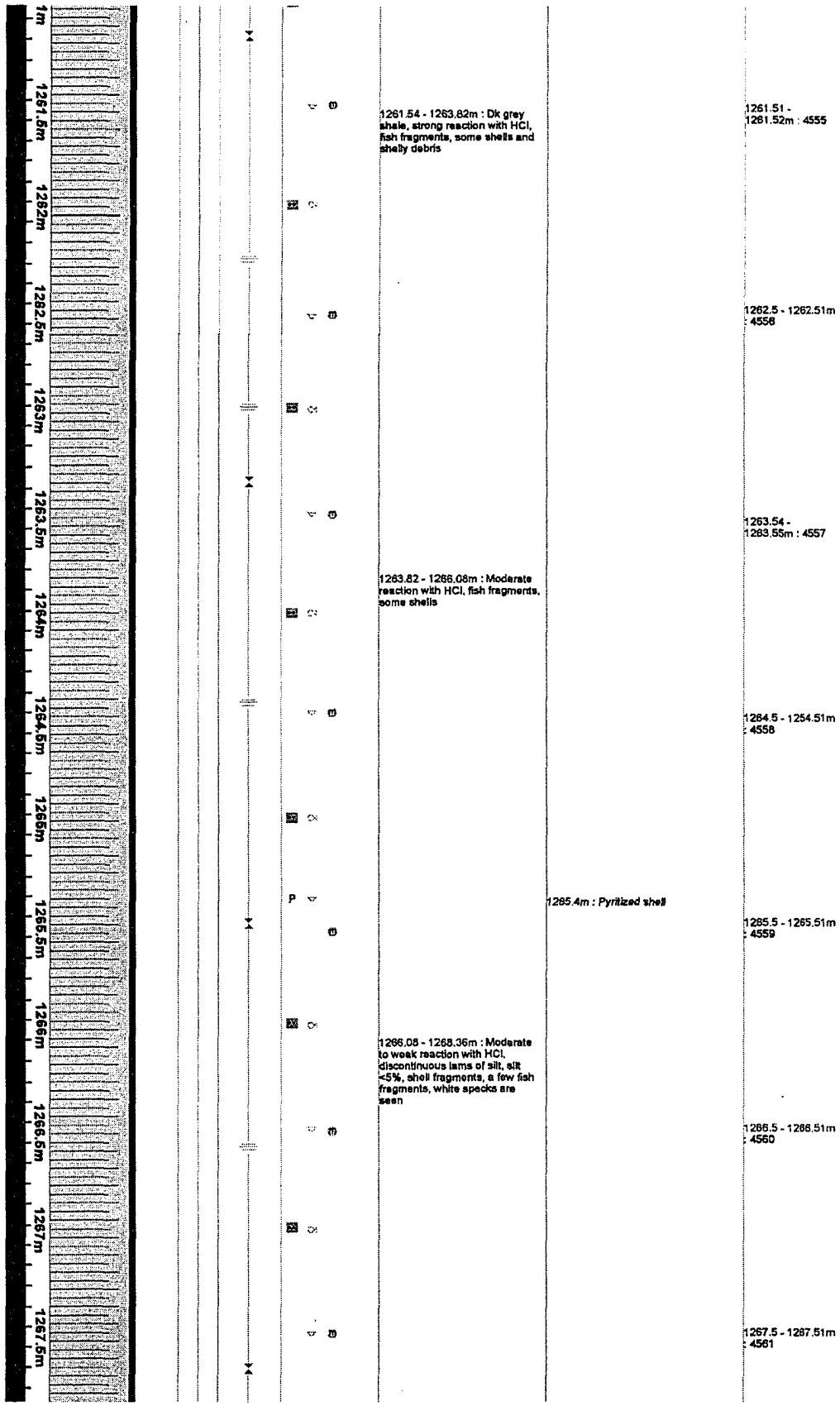
Spud Date:	Aug 7, 1947	Contractor:	
TD Date:		Rig Release Date:	Feb 25, 1948



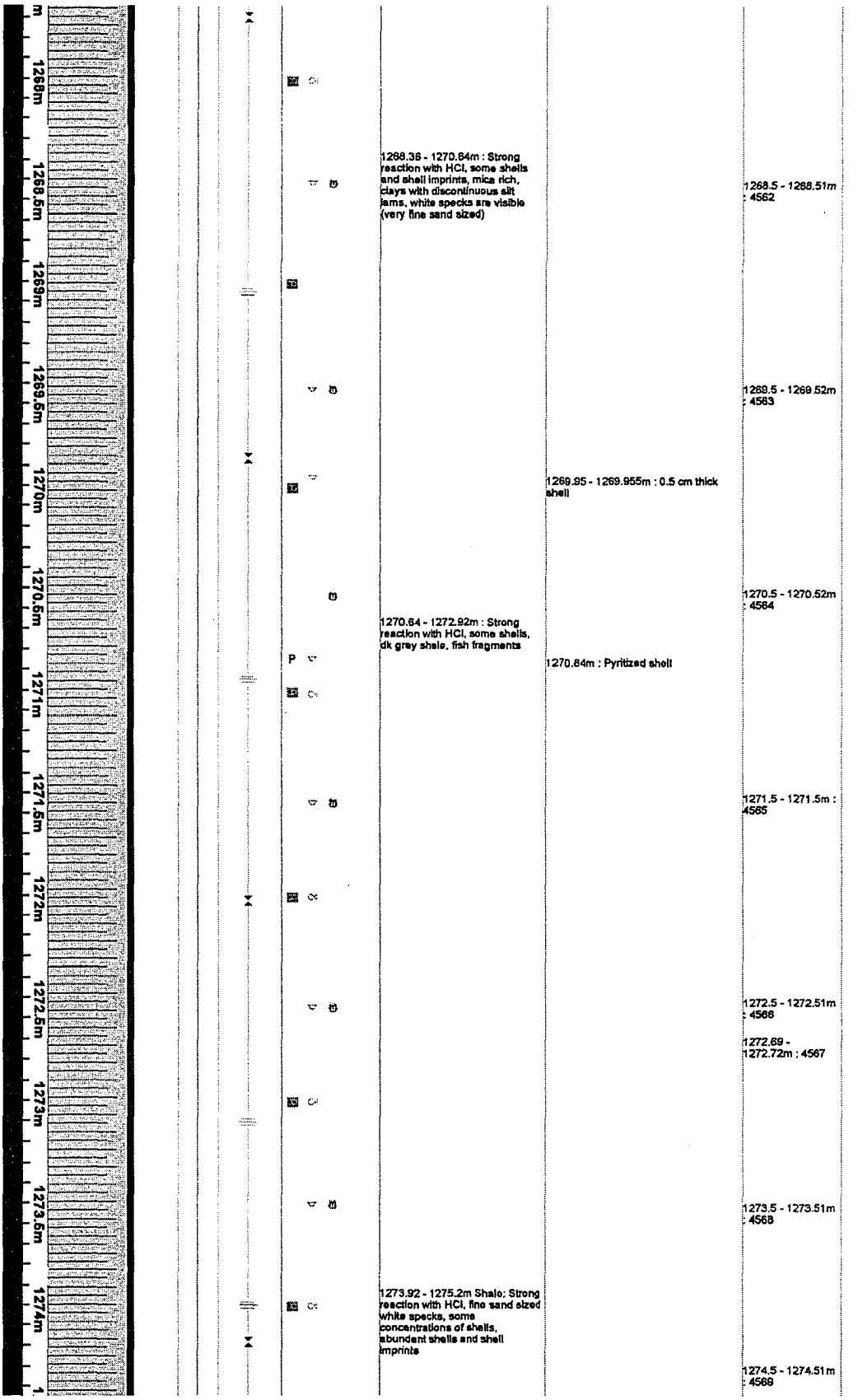
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



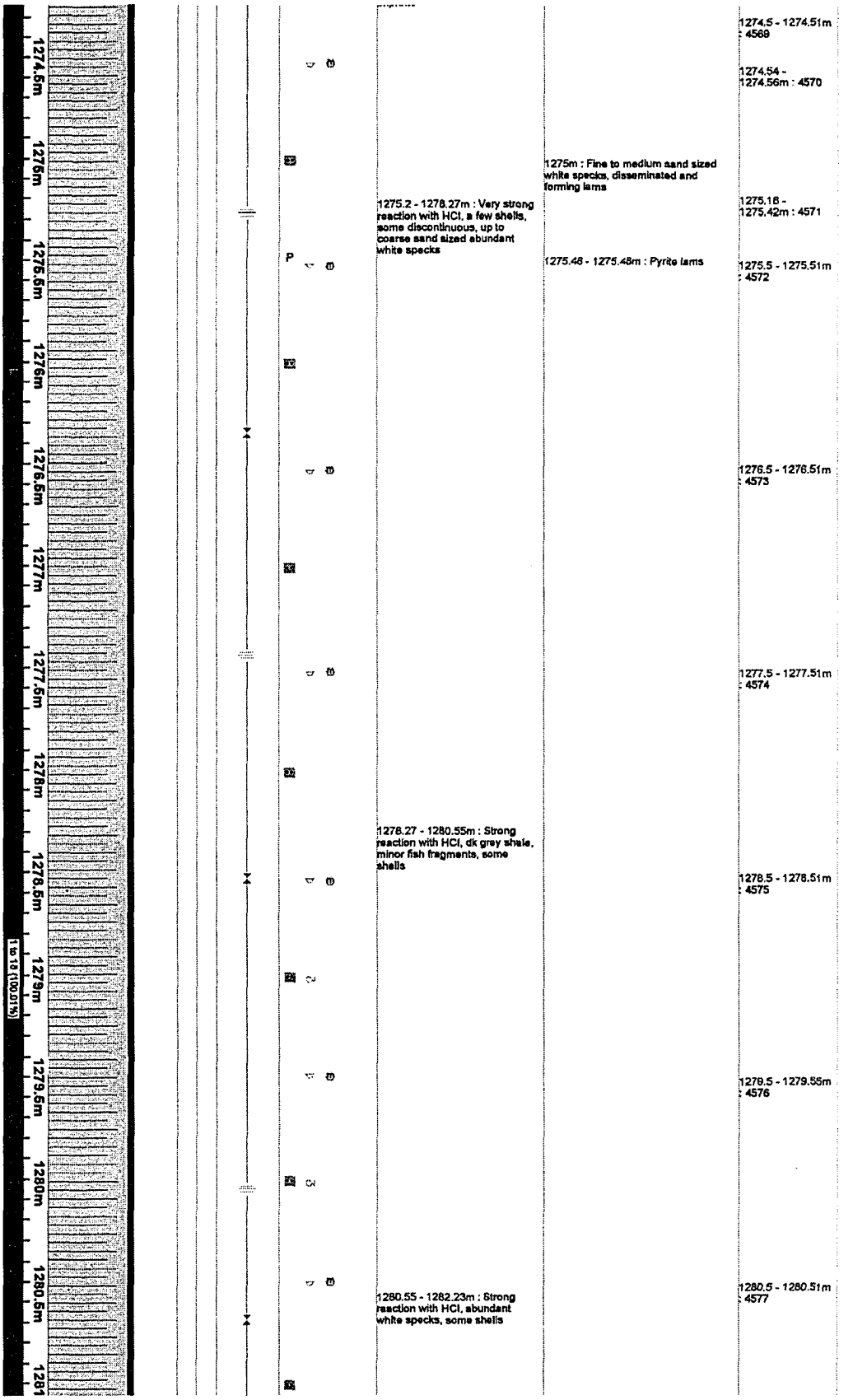
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



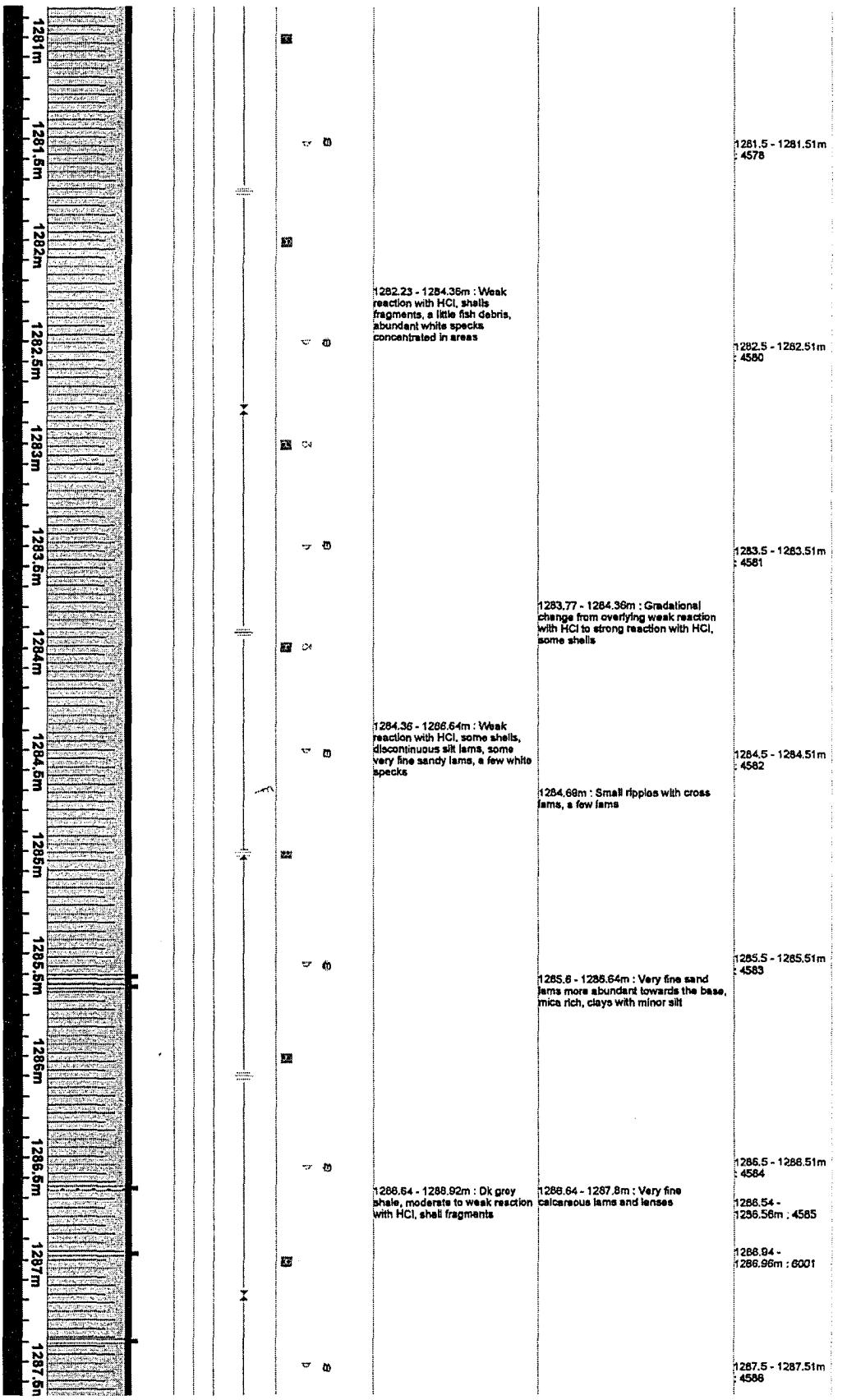
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



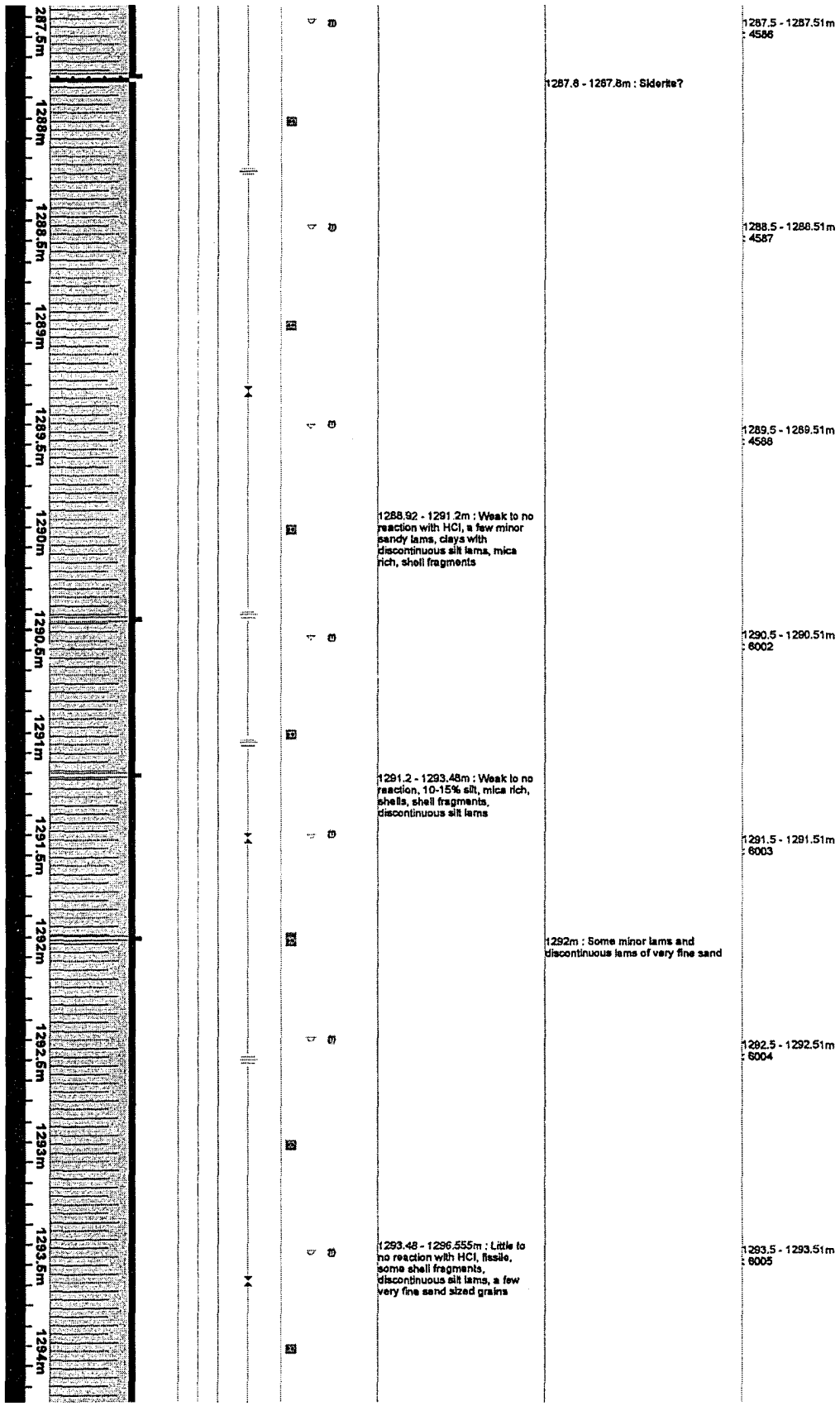
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



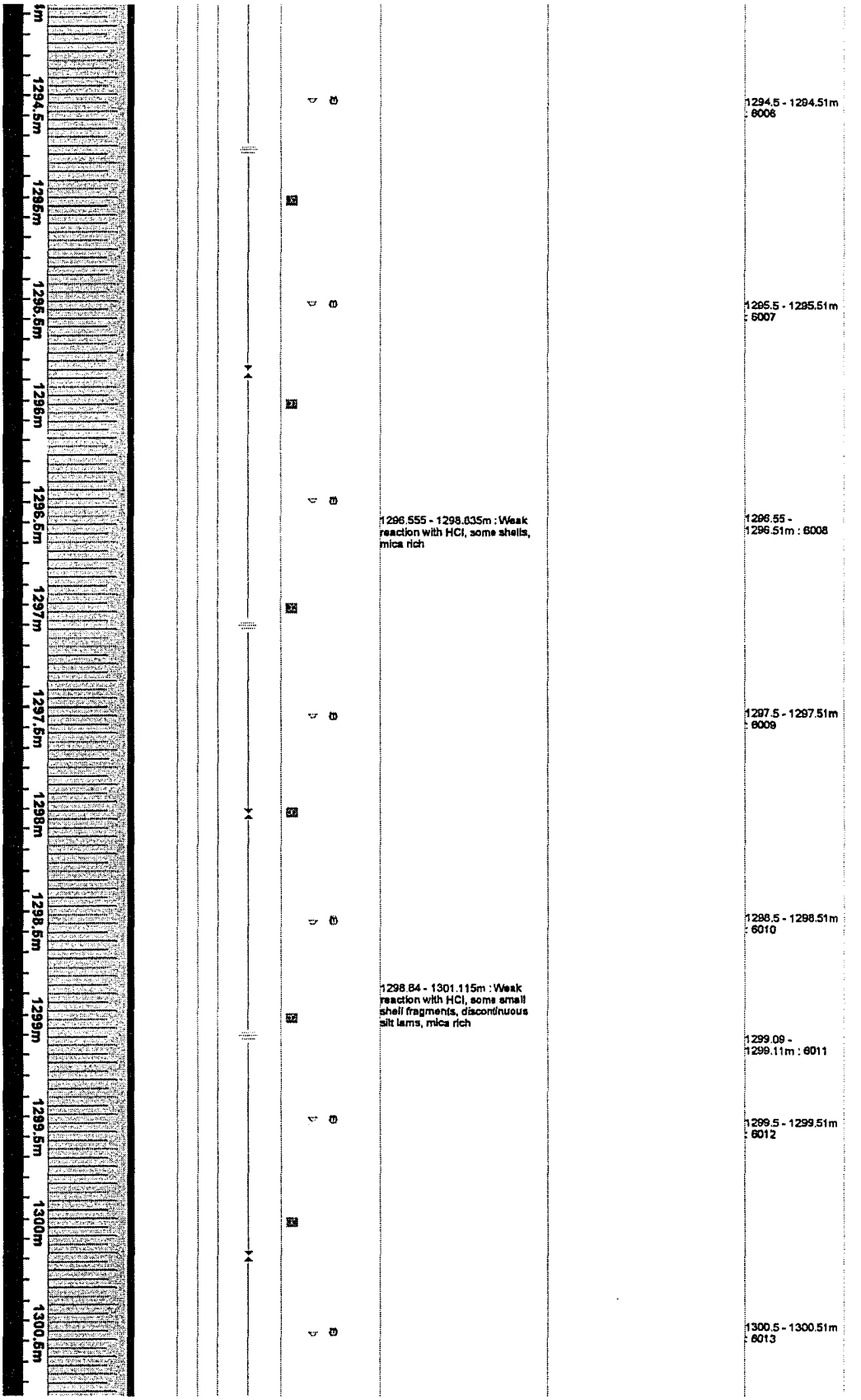
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



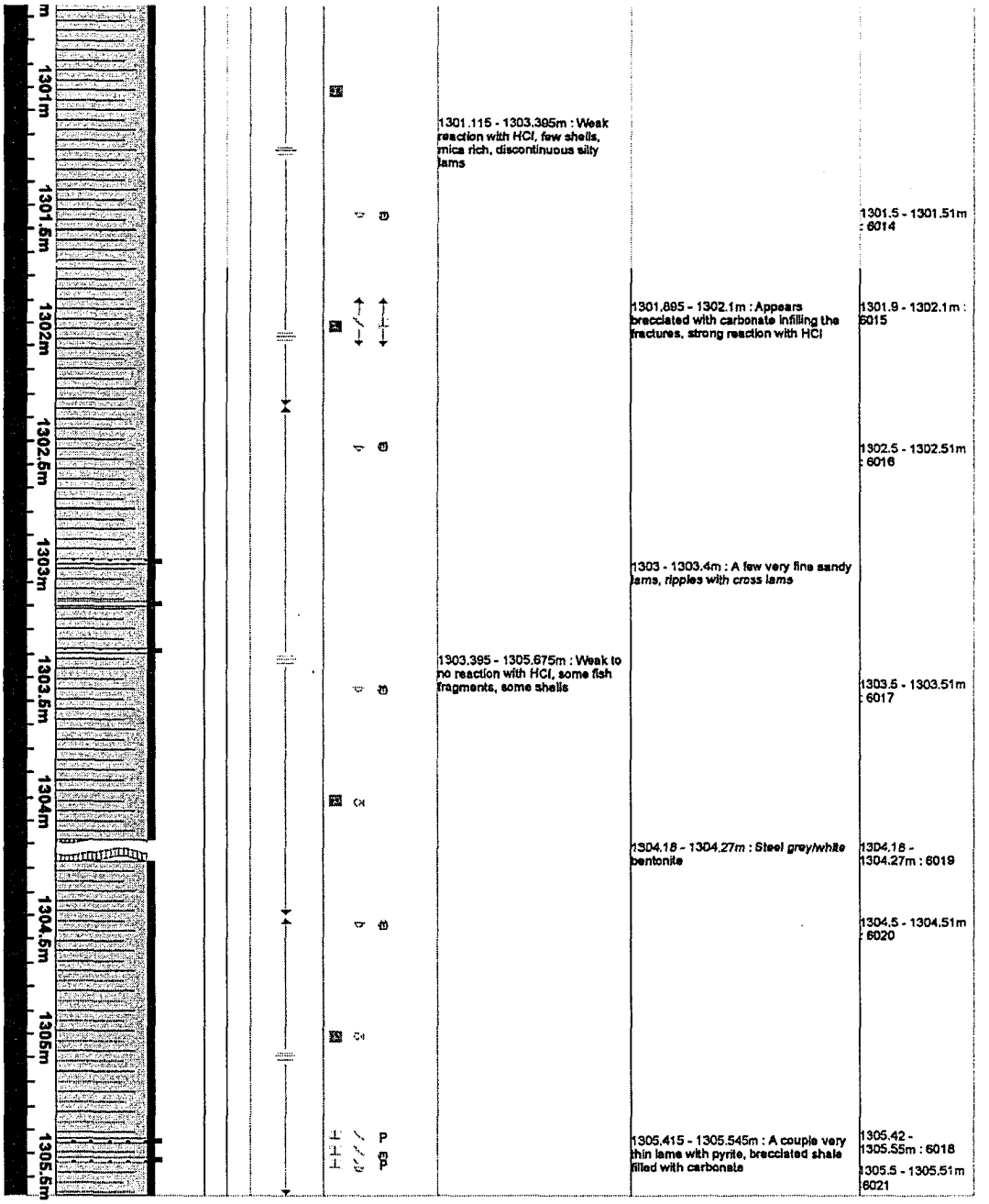
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Northstar Energy Corporation
Well Name:	Northstar Abee 6-11-61-22
Location:	
UWI:	100061106122W400
Pool:	Ellerslie Undefined (336098)
Field:	Abee 3
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	672.7 m
Cut(-) / Fill(+):		Kelly Bushing:	676.7 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

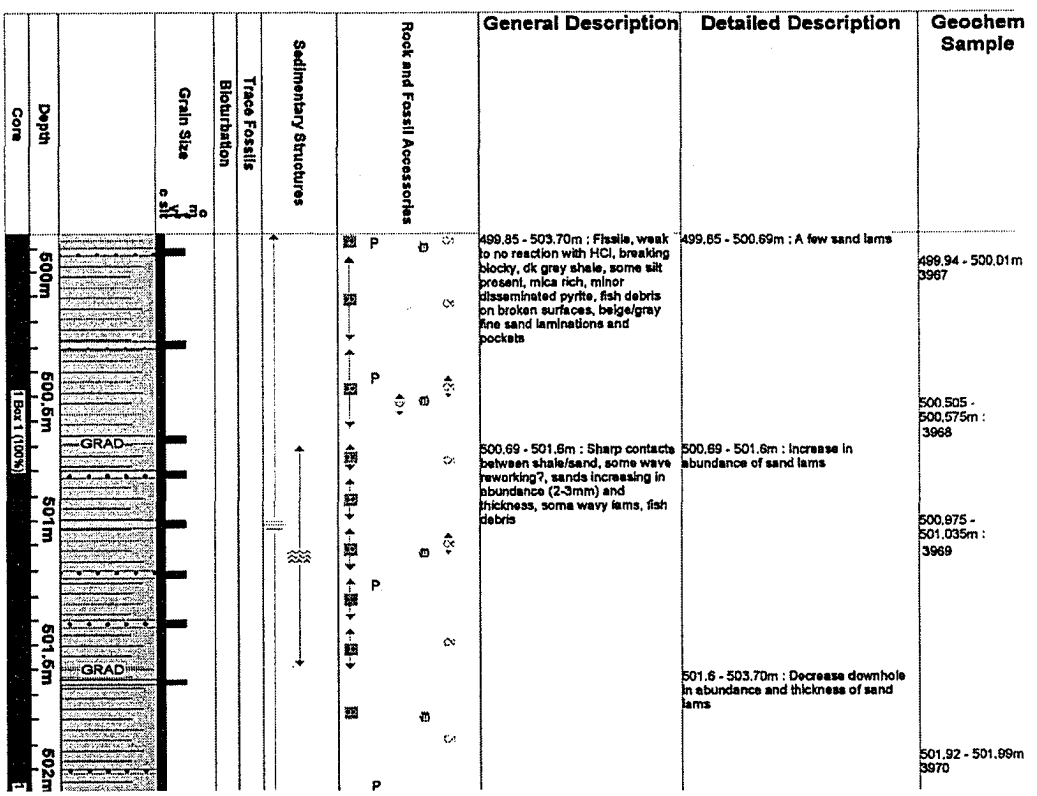
Well Type:	Straight
Longitude:	-113.192286
Latitude:	54.259019
N / S Co - Ordinates:	560.6
E / W Co - Ordinates:	457.0

Bottom Hole Co - Ordinates

Longitude:	-113.192286
Latitude:	54.259019
N / S Co - Ordinates:	560.6
E / W Co - Ordinates:	457.0

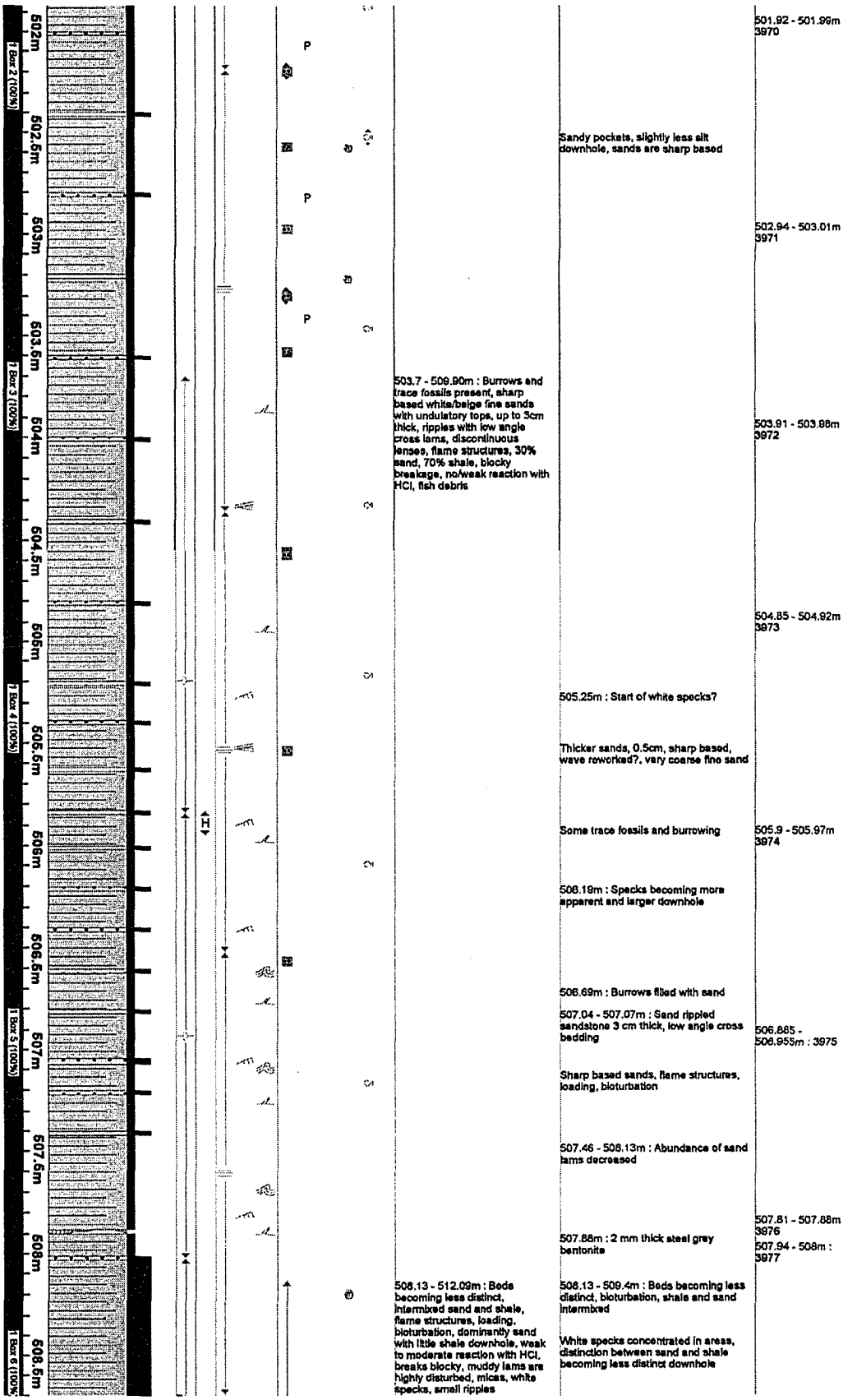
Well Summary

Spud Date:	Feb 1, 1977	Contractor:	
TD Date:		Rig Release Date:	Feb 7, 1977

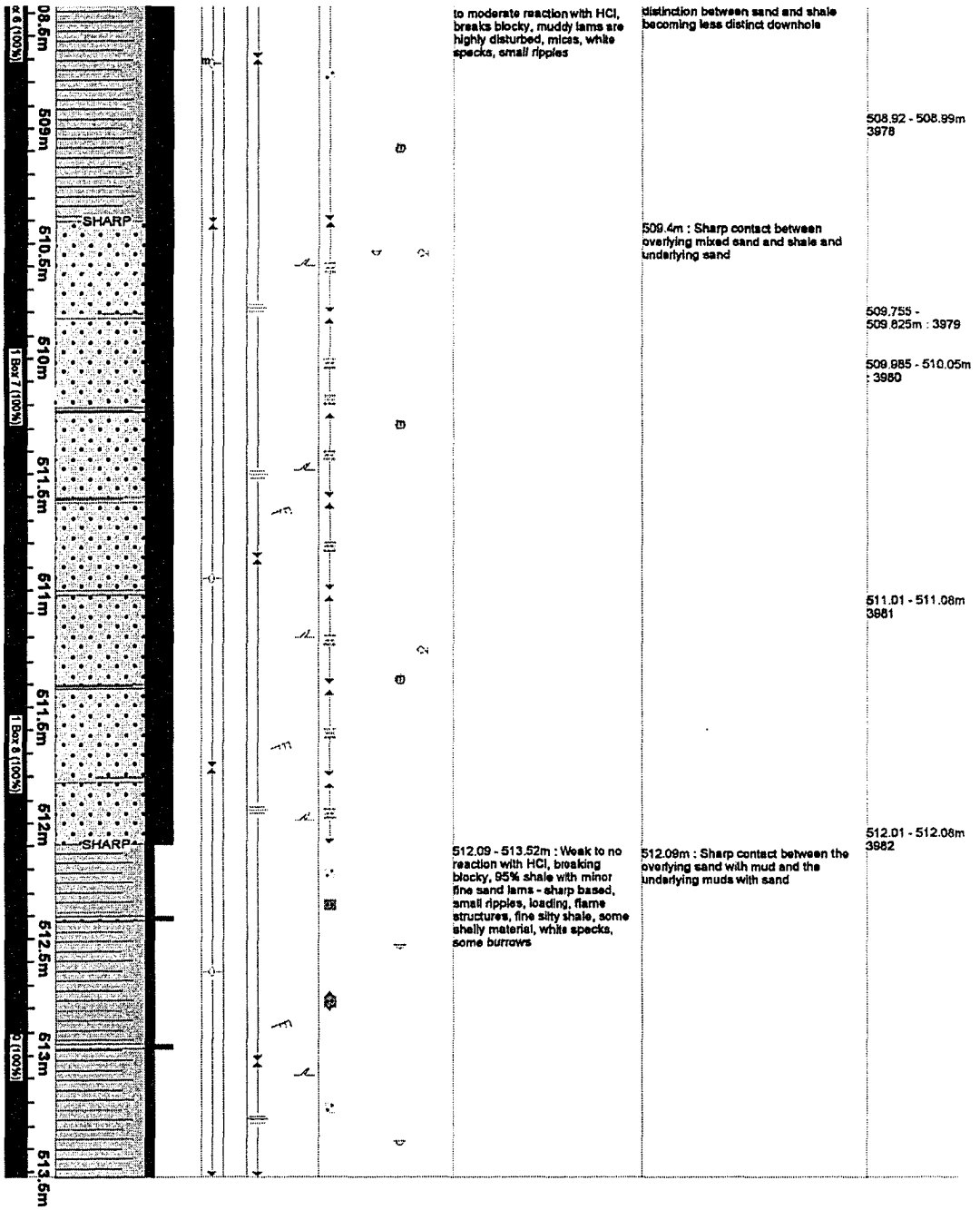


General Description	Detailed Description	Geochem Sample
499.85 - 503.70m : Fissile, weak to no reaction with HCl, breaking blocky, dk grey shale, some silt present, mica rich, minor disseminated pyrite, fish debris on broken surfaces, beige/gray fine sand laminations and pockets	499.85 - 500.69m : A few sand lams	499.94 - 500.01m 3967
		500.505 - 500.575m : 3968
500.69 - 501.6m : Sharp contacts between shale/sand, some wave reworking?, sands increasing in abundance (2-3mm) and thickness, some wavy lams, fish debris	500.69 - 501.6m : Increase in abundance of sand lams	
		500.975 - 501.035m : 3969
	501.6 - 503.70m : Decrease downhole in abundance and thickness of sand lams	
		501.92 - 501.99m 3970

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	
Well Name:	Tintina 7AS01
Location:	
UWI:	100061209813W400
Pool:	
Field:	
Province / State:	
Country:	

Elevations

Reference:		Ground:	m
Cut(-) / Fill(+):		Kelly Bushing:	m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

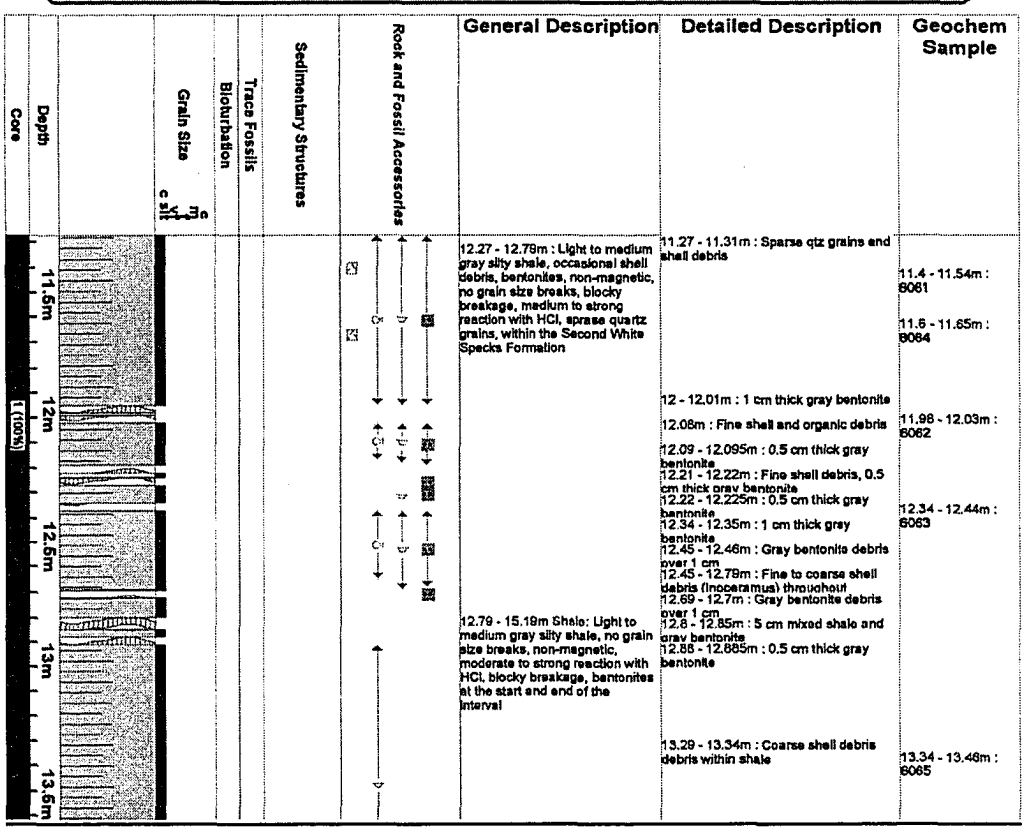
Well Type:	Straight
Longitude:	
Latitude:	
N / S Co - Ordinates:	6372500
E / W Co - Ordinates:	441800

Bottom Hole Co - Ordinates

Longitude:	
Latitude:	
N / S Co - Ordinates:	6372500
E / W Co - Ordinates:	441800

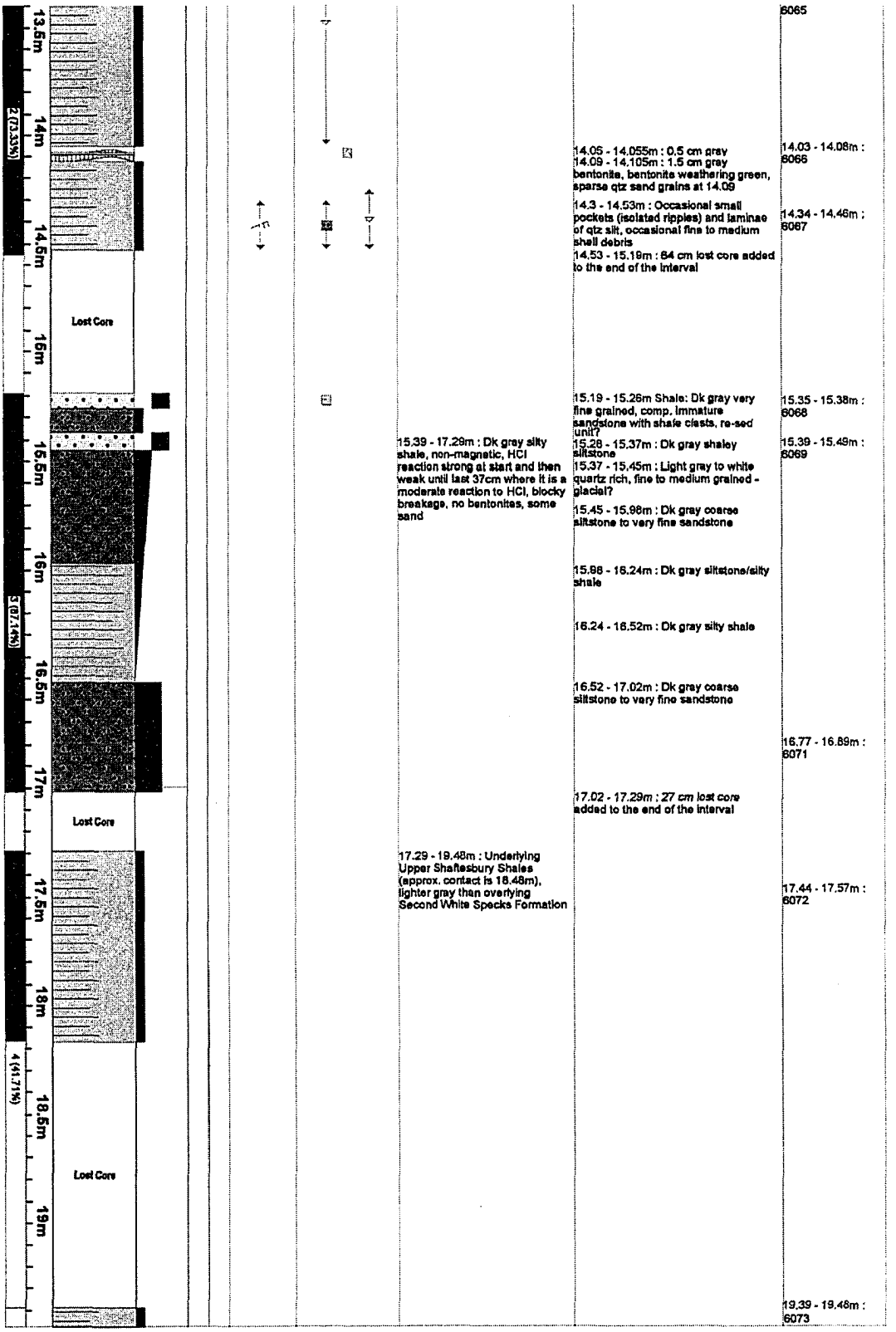
Well Summary

Spud Date:		Contractor:	
TD Date:		Rig Release Date:	



General Description	Detailed Description	Geochem Sample
12.27 - 12.79m : Light to medium gray silty shale, occasional shell debris, bentonites, non-magnetic, no grain size breaks, blocky breakage, medium to strong reaction with HCl, sprase quartz grains, within the Second White Specks Formation	11.27 - 11.31m : Sparse qtz grains and shell debris	
		11.4 - 11.54m : 6061
		11.6 - 11.65m : 6064
	12 - 12.01m : 1 cm thick gray bentonite	
	12.08m : Fine shell and organic debris	11.98 - 12.03m : 6062
	12.09 - 12.095m : 0.5 cm thick gray bentonite	
	12.21 - 12.22m : Fine shell debris, 0.5 cm thick gray bentonite	
	12.22 - 12.225m : 0.5 cm thick gray bentonite	
	12.34 - 12.35m : 1 cm thick gray bentonite	12.34 - 12.44m : 6063
	12.45 - 12.46m : Gray bentonite debris over 1 cm	
	12.45 - 12.79m : Fine to coarse shell debris (Inoceramus) throughout	
	12.69 - 12.7m : Gray bentonite debris over 1 cm	
12.79 - 15.19m Shale: Light to medium gray silty shale, no grain size breaks, non-magnetic, moderate to strong reaction with HCl, blocky breakage, bentonites at the start and end of the interval	12.8 - 12.85m : 5 cm mixed shale and gray bentonite	
	12.88 - 12.885m : 0.5 cm thick gray bentonite	
	13.29 - 13.34m : Coarse shell debris debris within shale	13.34 - 13.46m : 6065

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Northstar Energy Corporation
Well Name:	Northstar Radway 6-26-59-20
Location:	
UWI:	100062605920W400
Pool:	Wabamun Undefined (658098)
Field:	Radway (752)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	644.3 m
Cut(-) / Fill(+):		Kelly Bushing:	648.3 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

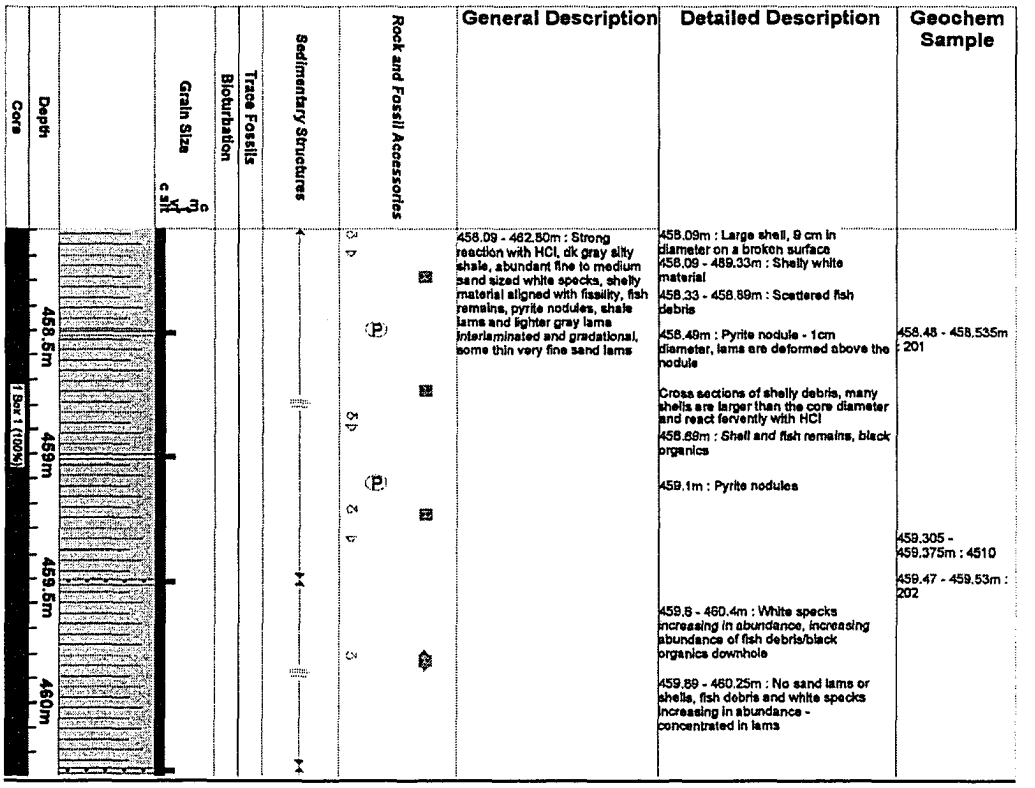
Well Type:	Straight
Longitude:	-112.890603
Latitude:	54.126511
N / S Co - Ordinates:	479.6
E / W Co - Ordinates:	589.8

Bottom Hole Co - Ordinates

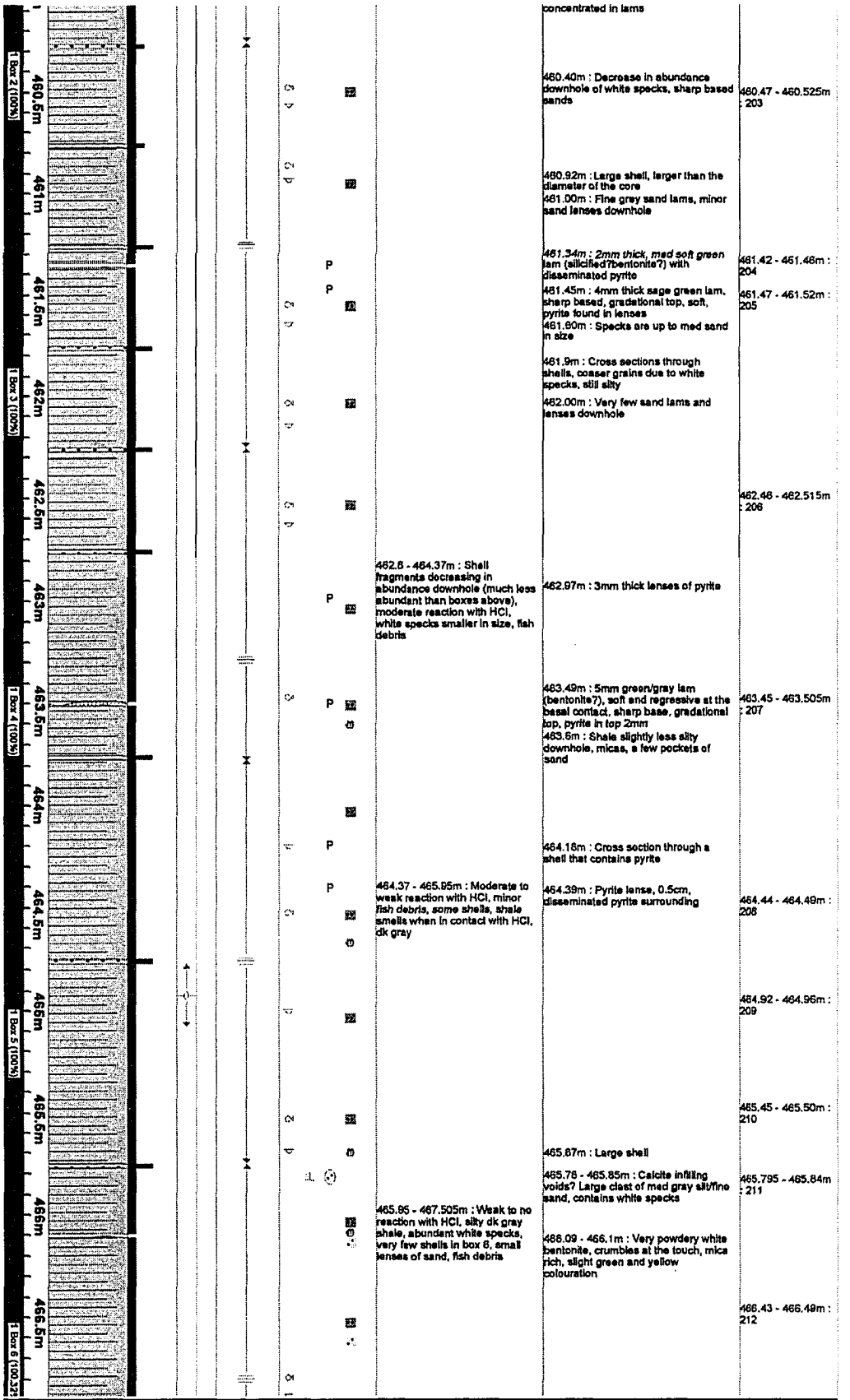
Longitude:	-112.890603
Latitude:	54.126511
N / S Co - Ordinates:	479.6
E / W Co - Ordinates:	589.8

Well Summary

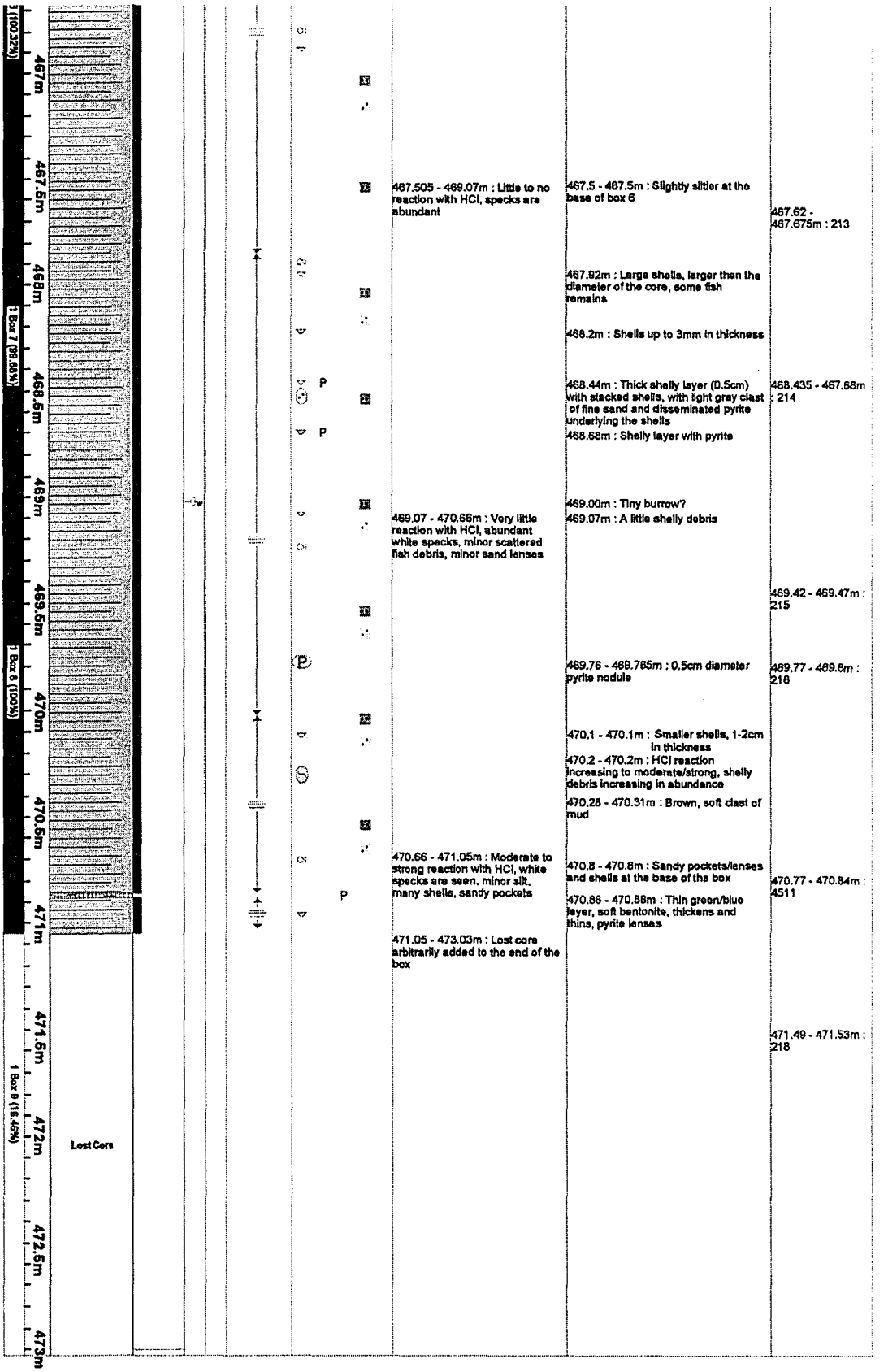
Spud Date:	Feb 15, 1977	Contractor:	
TD Date:		Rig Release Date:	Feb 19, 1977



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Omers Resources Limited
Well Name:	Amoco Pembina
Location:	
UWI:	100063104608W500
Pool:	Viking, Mannville, Jurassic... (220360)
Field:	Pembina (685)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	889.7 m
Cut(-) / Fill(+):		Kelly Bushing:	894.8 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

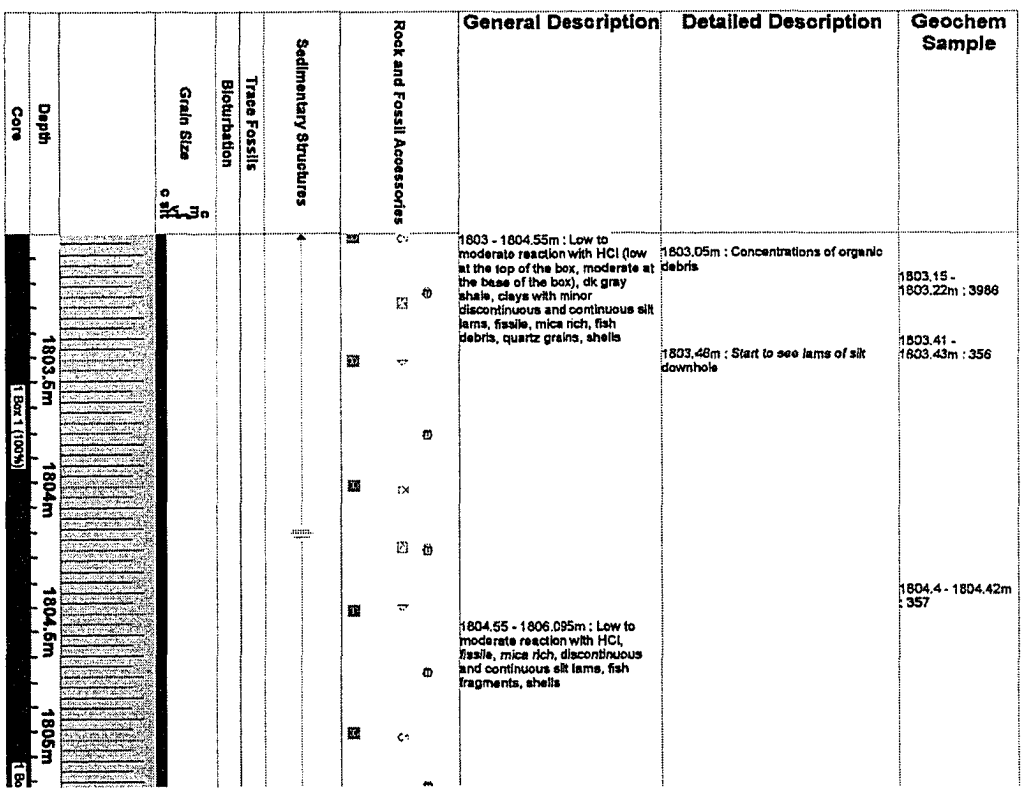
Well Type:	Straight
Longitude:	-115.152694
Latitude:	53.008381
N / S Co - Ordinates:	548.6
E / W Co - Ordinates:	547.5

Bottom Hole Co - Ordinates

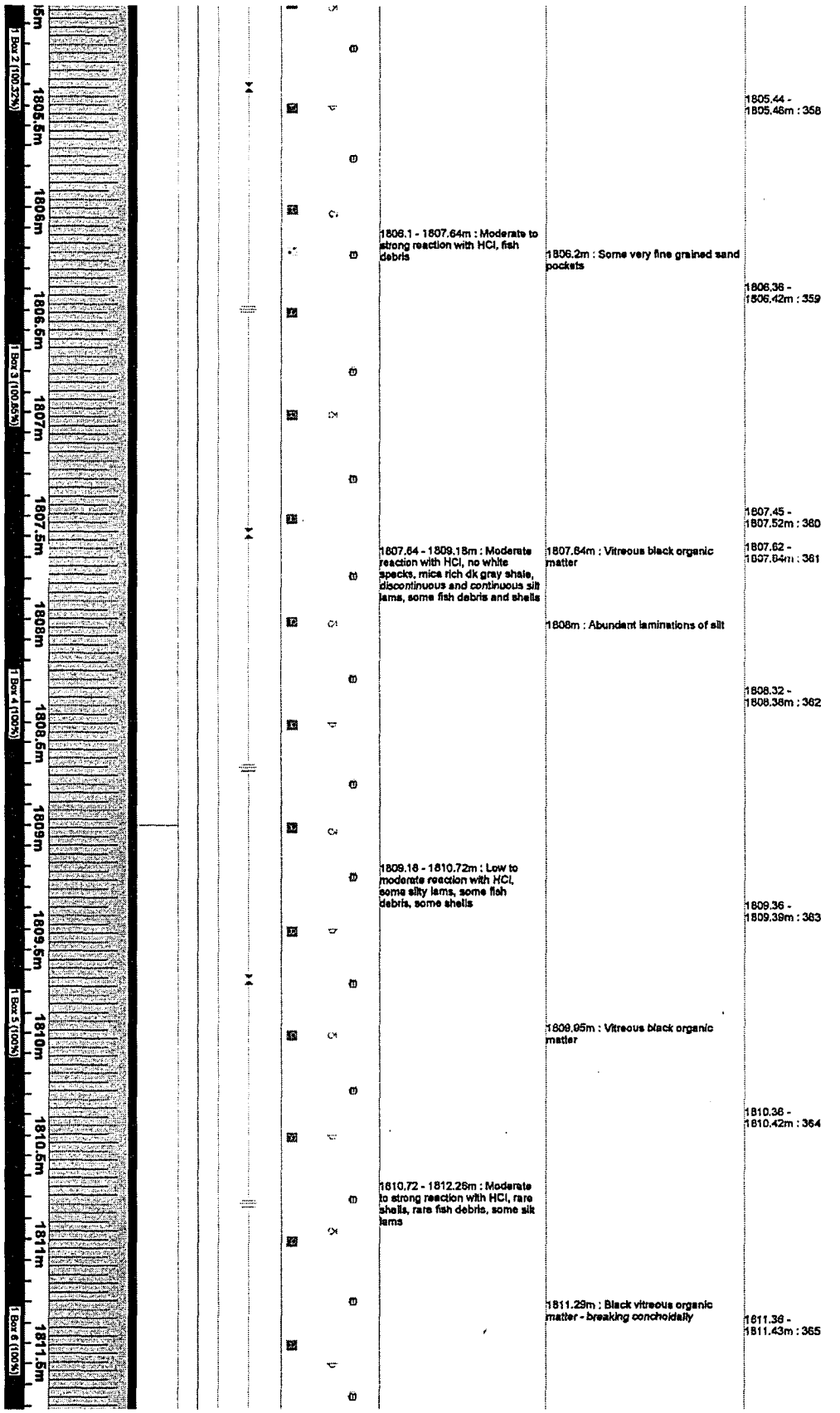
Longitude:	-115.152694
Latitude:	53.008381
N / S Co - Ordinates:	548.6
E / W Co - Ordinates:	547.5

Well Summary

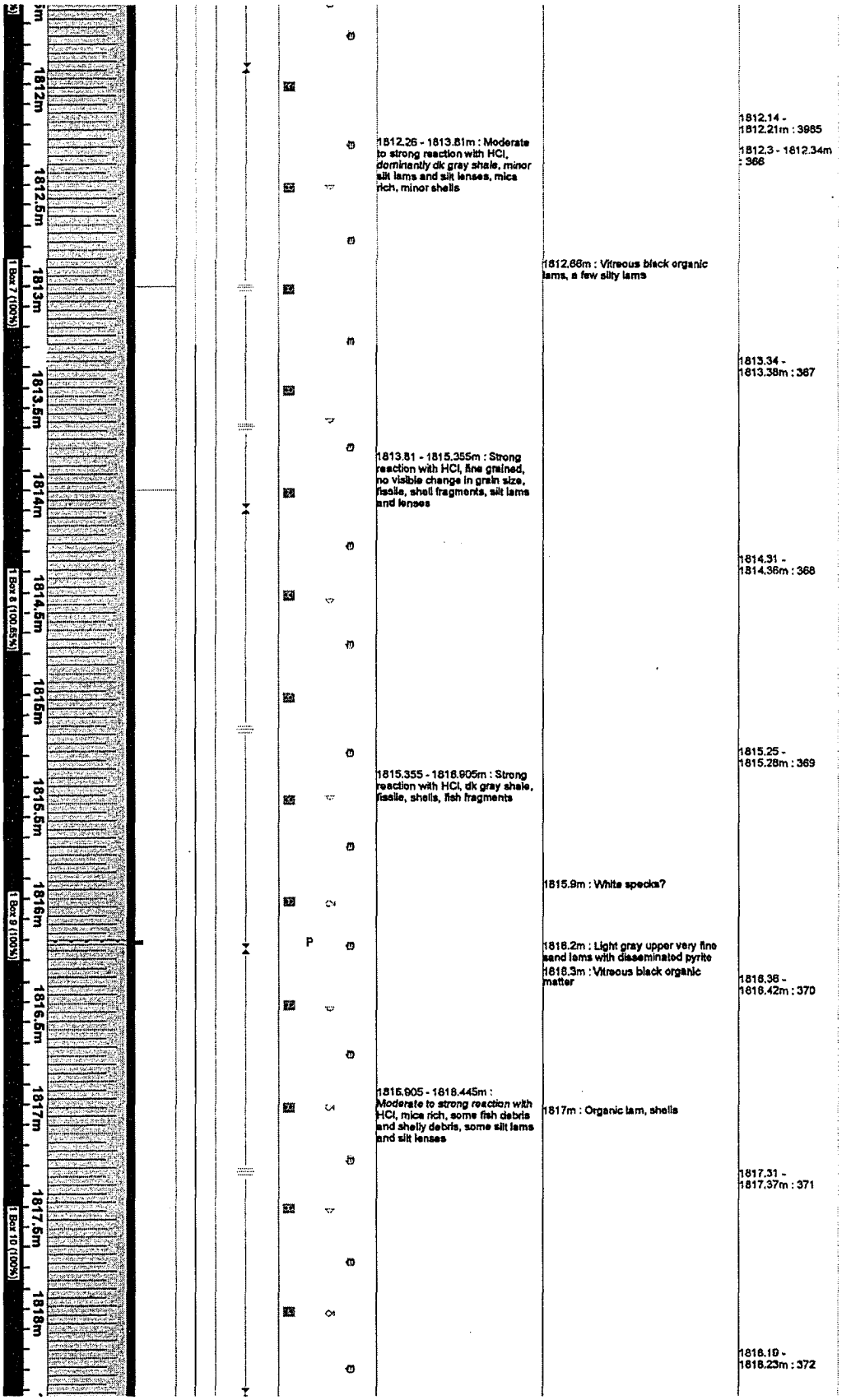
Spud Date:	Feb 28, 1986	Contractor:	
TD Date:		Rig Release Date:	Mar 27, 1986



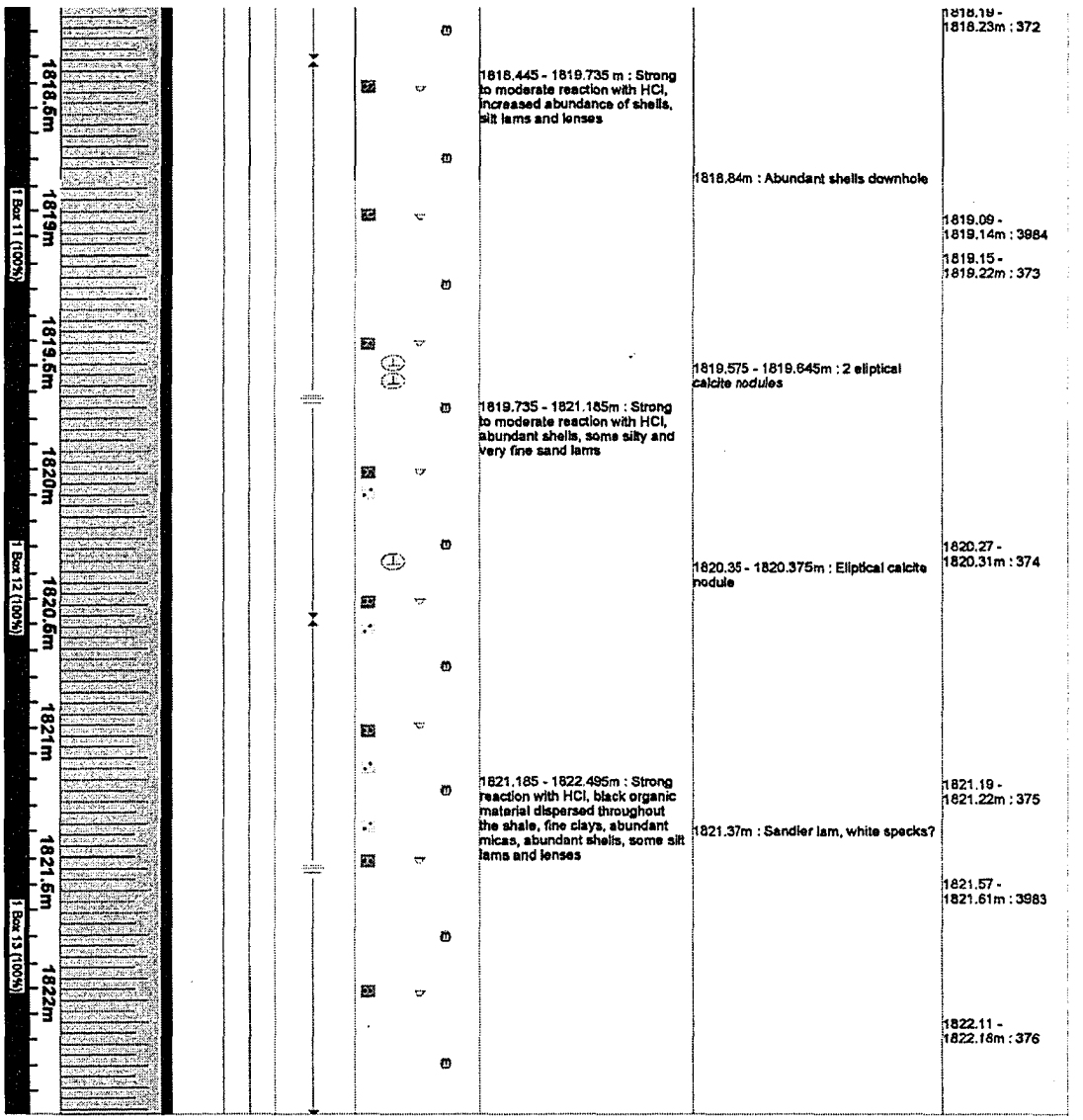
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Anadarko Canada Corporation
Well Name:	Grt Plns Thorhild 6-35-59-21
Location:	
UWI:	100063505921W400
Pool:	Unknown
Field:	Thorhild (903)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	641.6 m
Cut(-) / Fill(+):		Kelly Bushing:	643.4 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

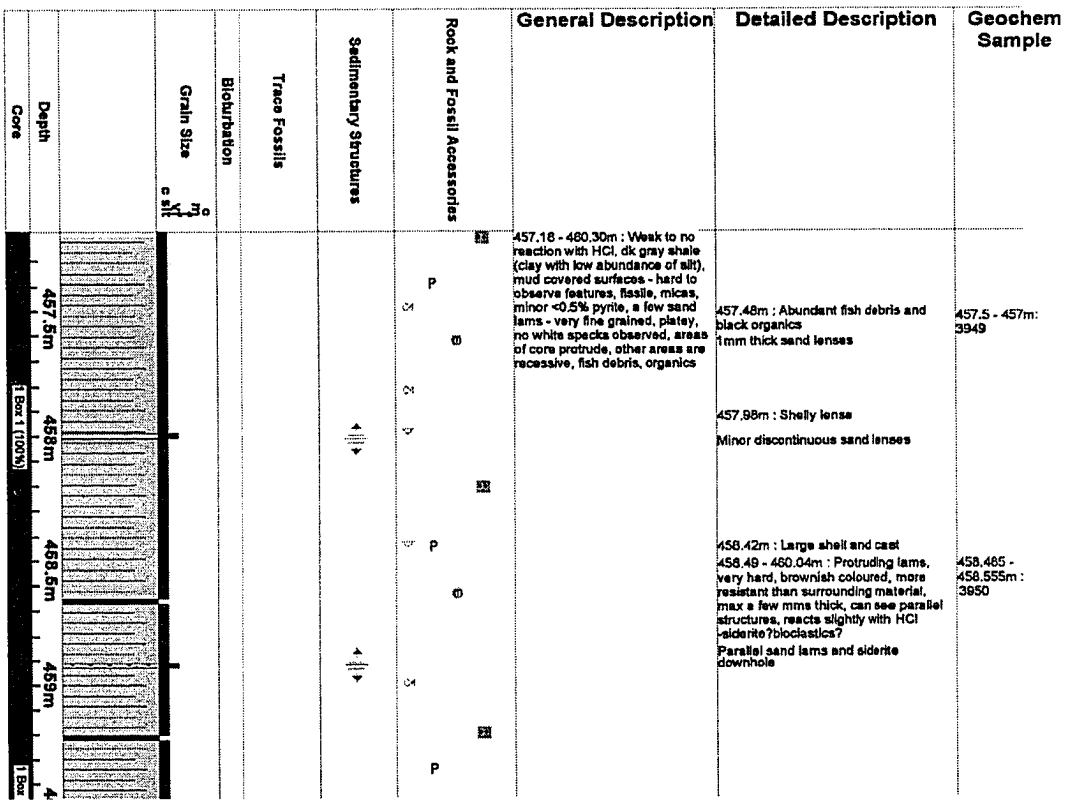
Well Type:	Straight
Longitude:	-113.040407
Latitude:	54.142405
N / S Co - Ordinates:	603.8
E / W Co - Ordinates:	602.8

Bottom Hole Co - Ordinates

Longitude:	-113.040407
Latitude:	54.142405
N / S Co - Ordinates:	603.8
E / W Co - Ordinates:	602.8

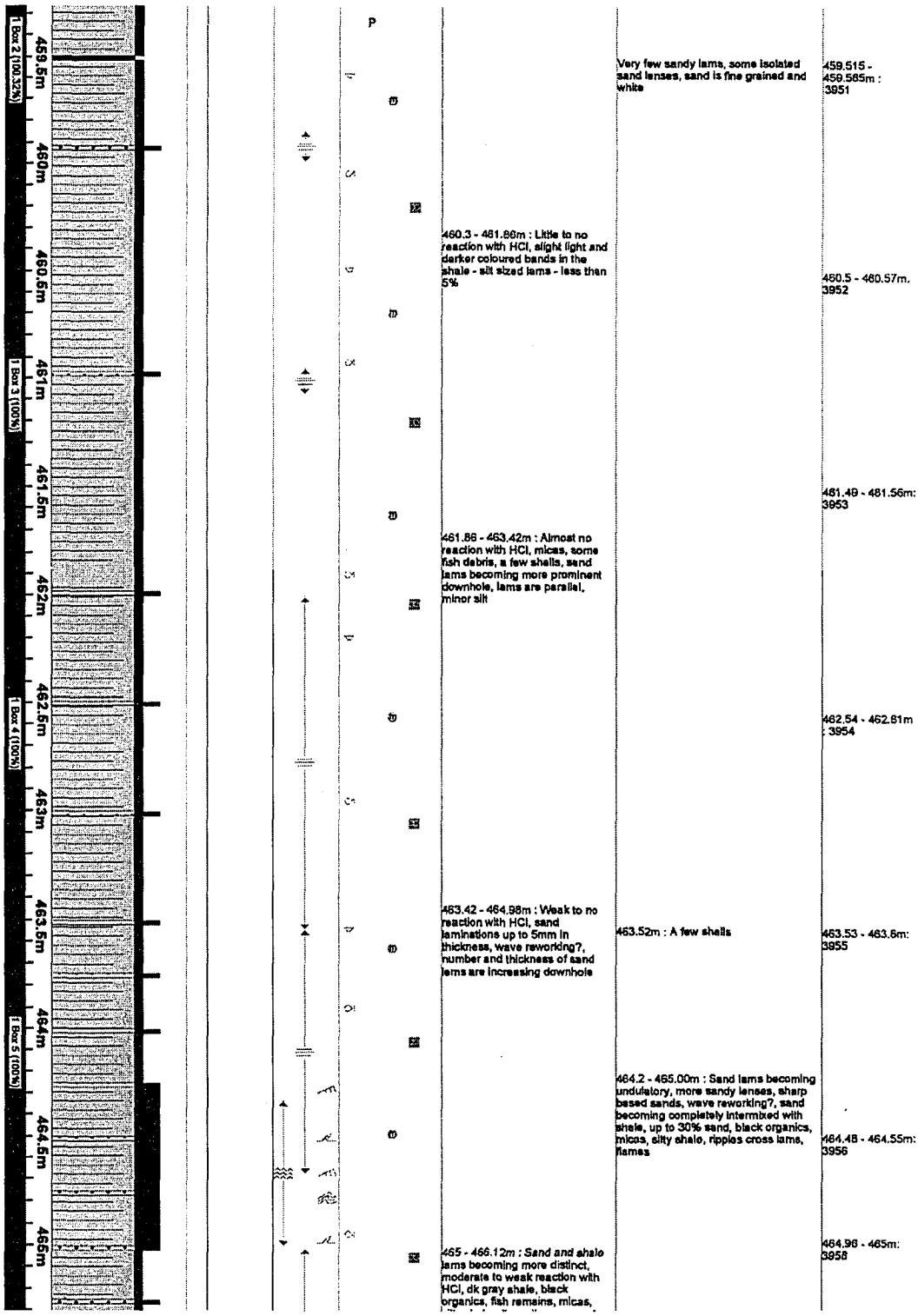
Well Summary

Spud Date:	Jun 4, 1964	Contractor:	
TD Date:		Rig Release Date:	Jun 14, 1964

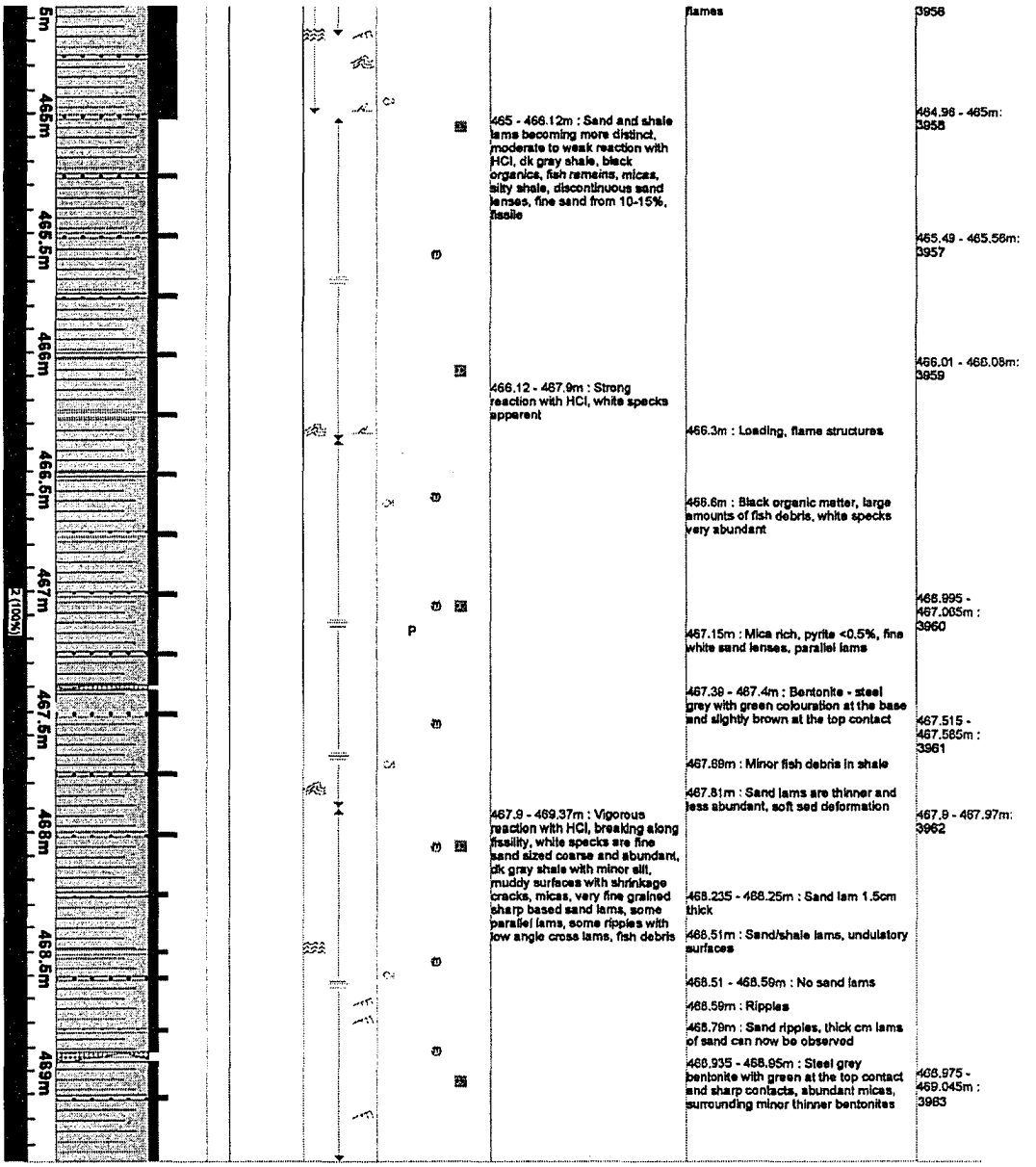


General Description	Detailed Description	Geochem Sample
457.18 - 460.30m : Weak to no reaction with HCl, dk gray shale (clay with low abundance of silt), mud covered surfaces - hard to observe features, fissile, micas, minor <0.5% pyrite, a few sand lams - very fine grained, platey, no white specks observed, areas of core protrude, other areas are recessive, fish debris, organics	457.48m : Abundant fish debris and black organics 1mm thick sand lenses	457.5 - 457m: 3949
	457.98m : Shelly lense Minor discontinuous sand lenses	
	458.42m : Large shell and cast 458.49 - 460.04m : Protruding lams, very hard, brownish coloured, more resistant than surrounding material, max a few mms thick, can see parallel structures, reacts slightly with HCl -siderite?bioclastics? Parallel sand lams and siderite downhole	458.465 - 458.555m : 3950

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Hunt, Lamar and Caroline
Well Name:	HCS Et Al Beavercreek 9-9-56-19
Location:	
UWI:	100090905619W500
Pool:	Uknown
Field:	Pine Creek (706)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	1165.9 m
Cut(-) / Fill(+):		Kelly Bushing:	1170.7 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

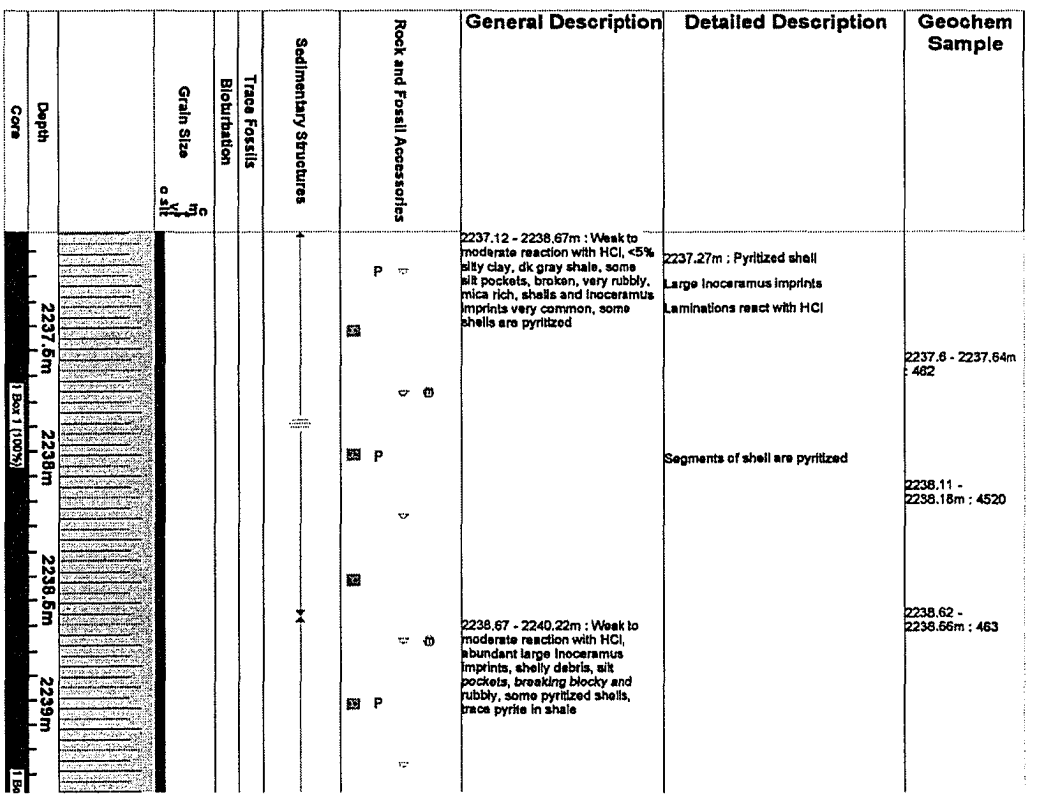
Well Type:	Straight
Longitude:	-116.755651
Latitude:	53.827446
N / S Co - Ordinates:	492.2
E / W Co - Ordinates:	355.6

Bottom Hole Co - Ordinates

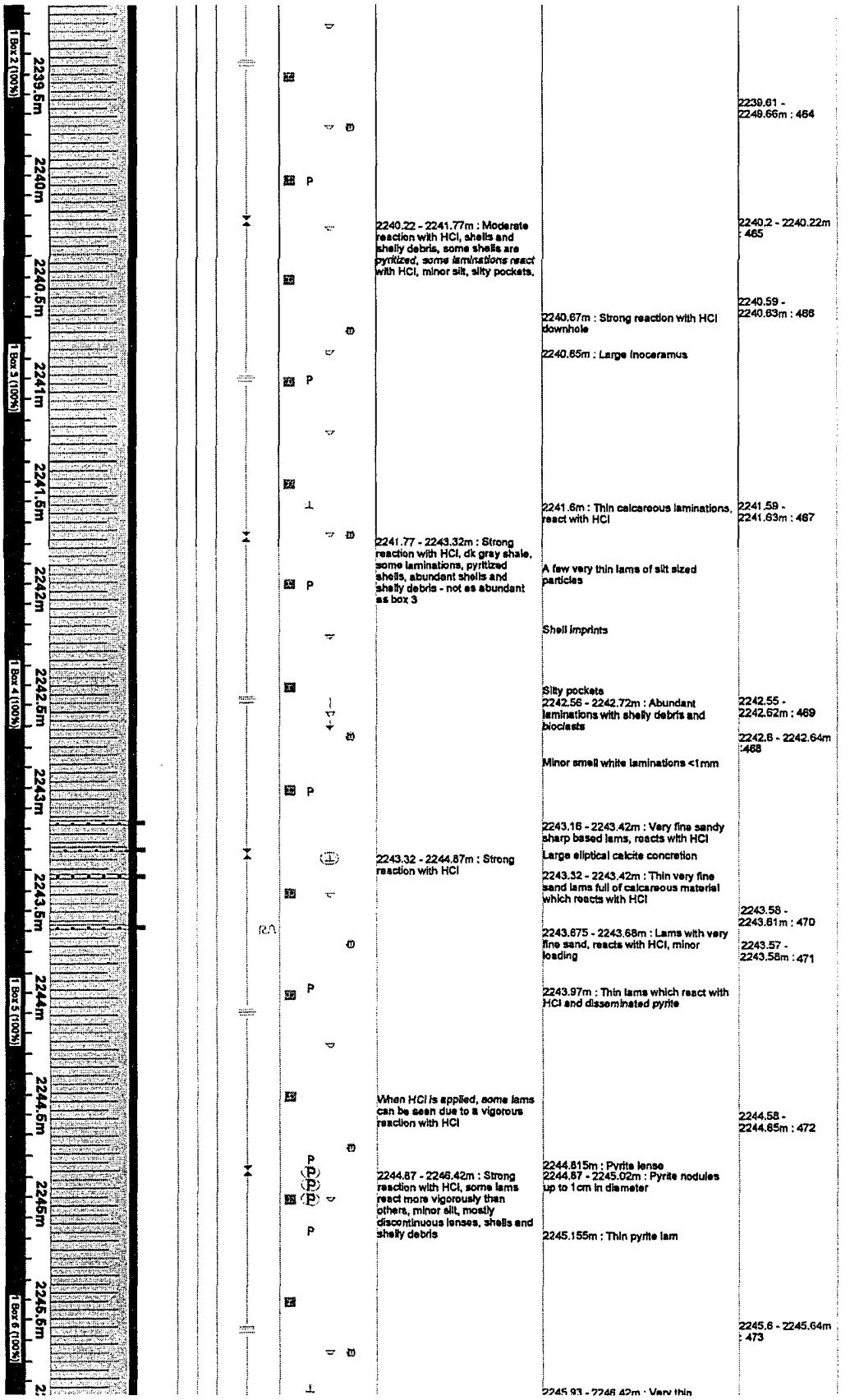
Longitude:	-116.755651
Latitude:	53.827446
N / S Co - Ordinates:	492.2
E / W Co - Ordinates:	355.6

Well Summary

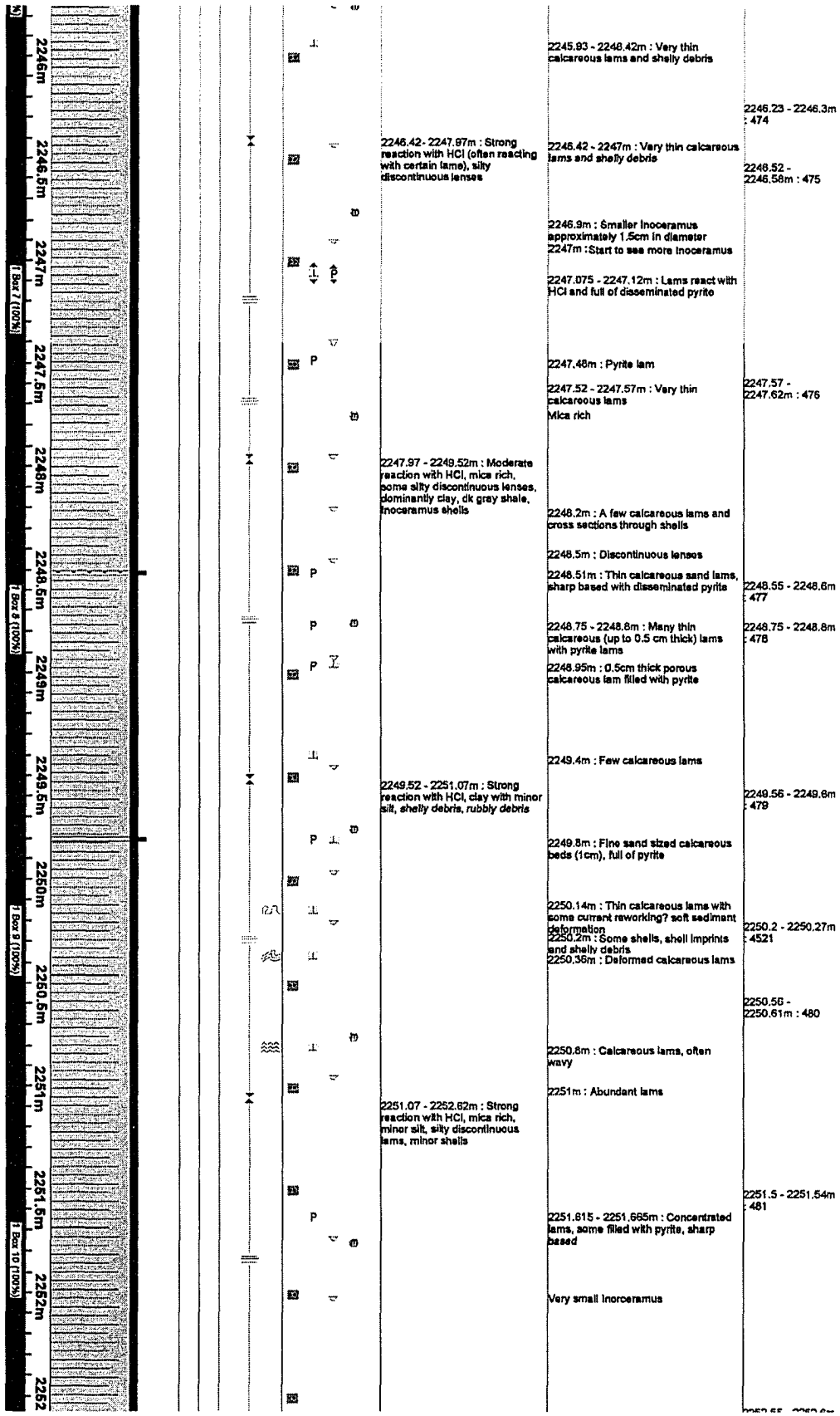
Spud Date:	Dec 2, 1973	Contractor:	
TD Date:		Rig Release Date:	Jan 24, 1974



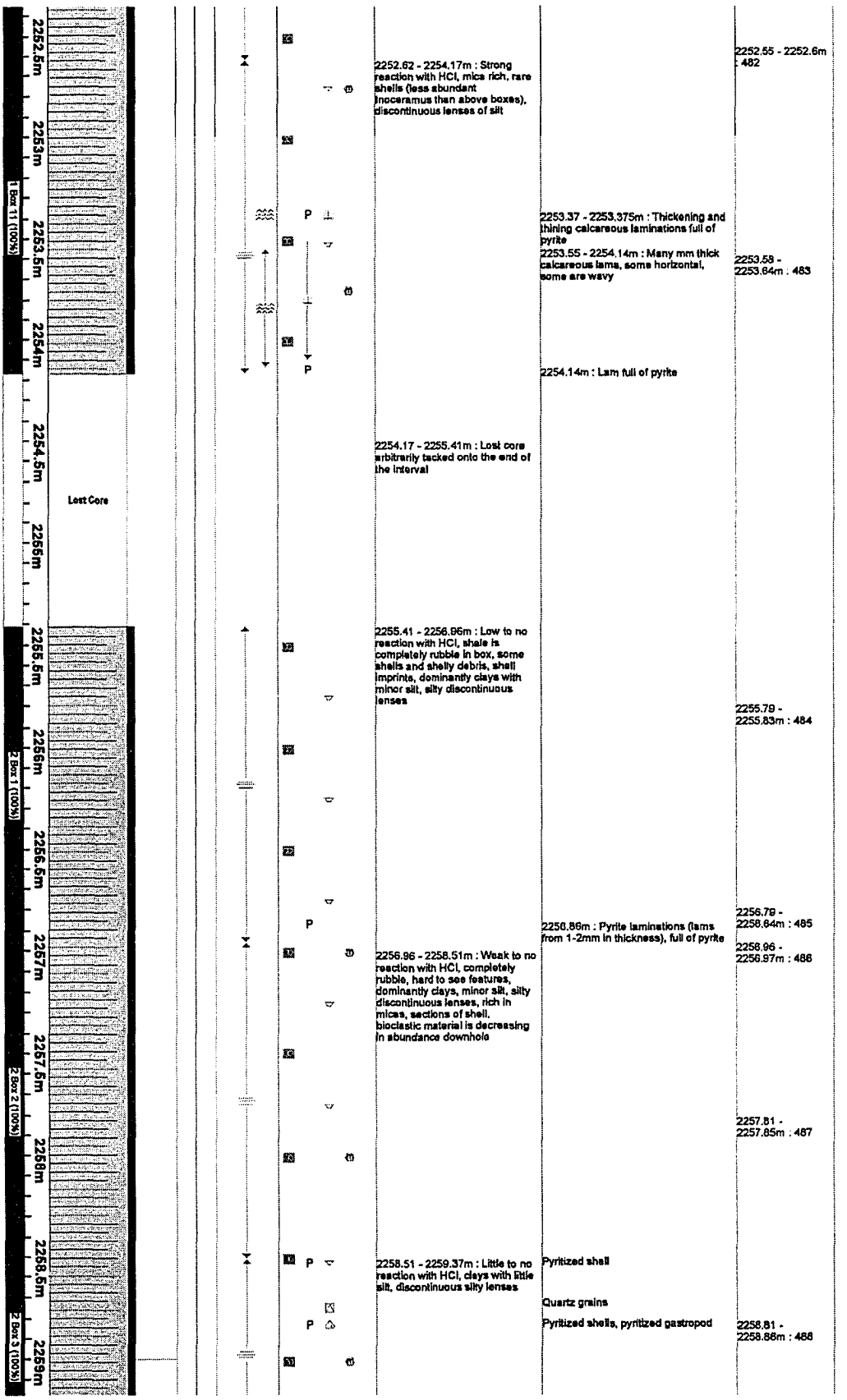
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



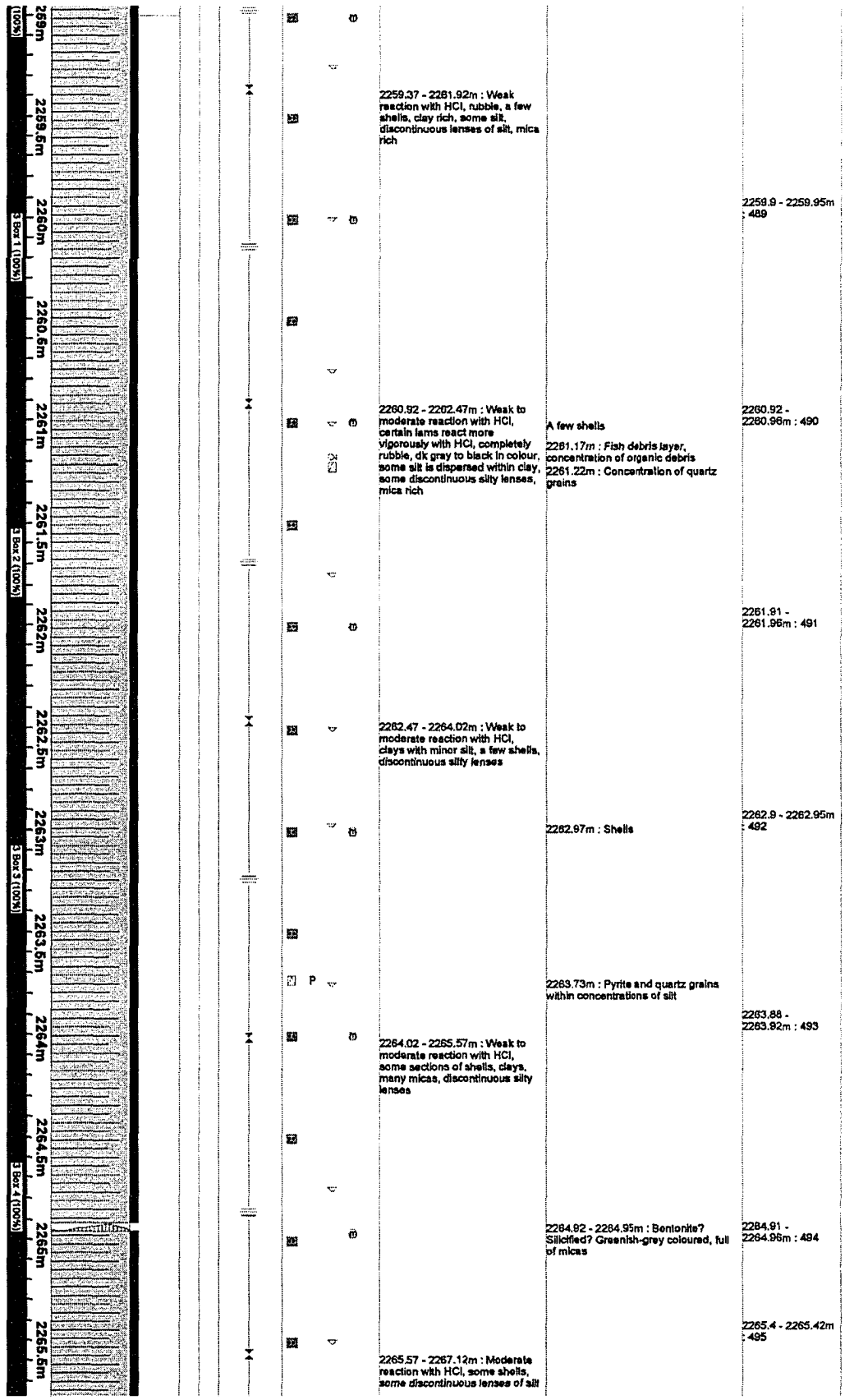
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



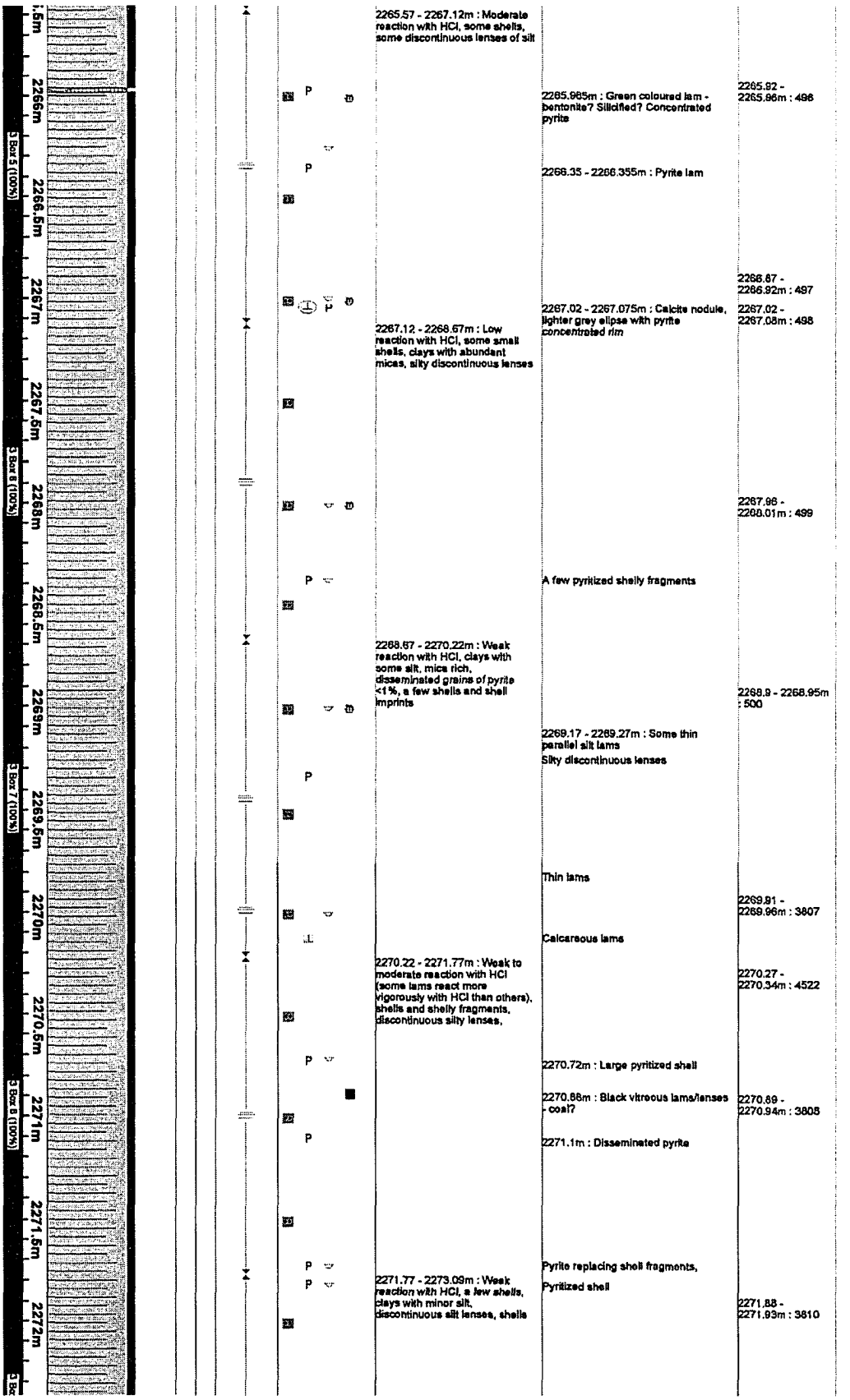
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



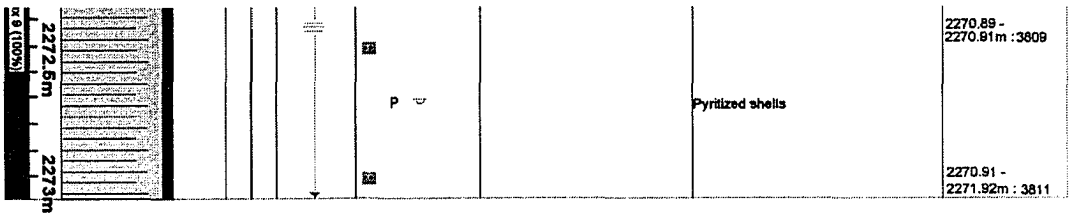
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Canadian Natural Resources Limited
Well Name:	Rax Et Al Ante 10-9-66-23
Location:	
UWI:	100100906623W500
Pool:	Unknown
Field:	Amte Creek (55)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	773 m
Cut(-) / Fill(+):		Kelly Bushing:	779.1 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

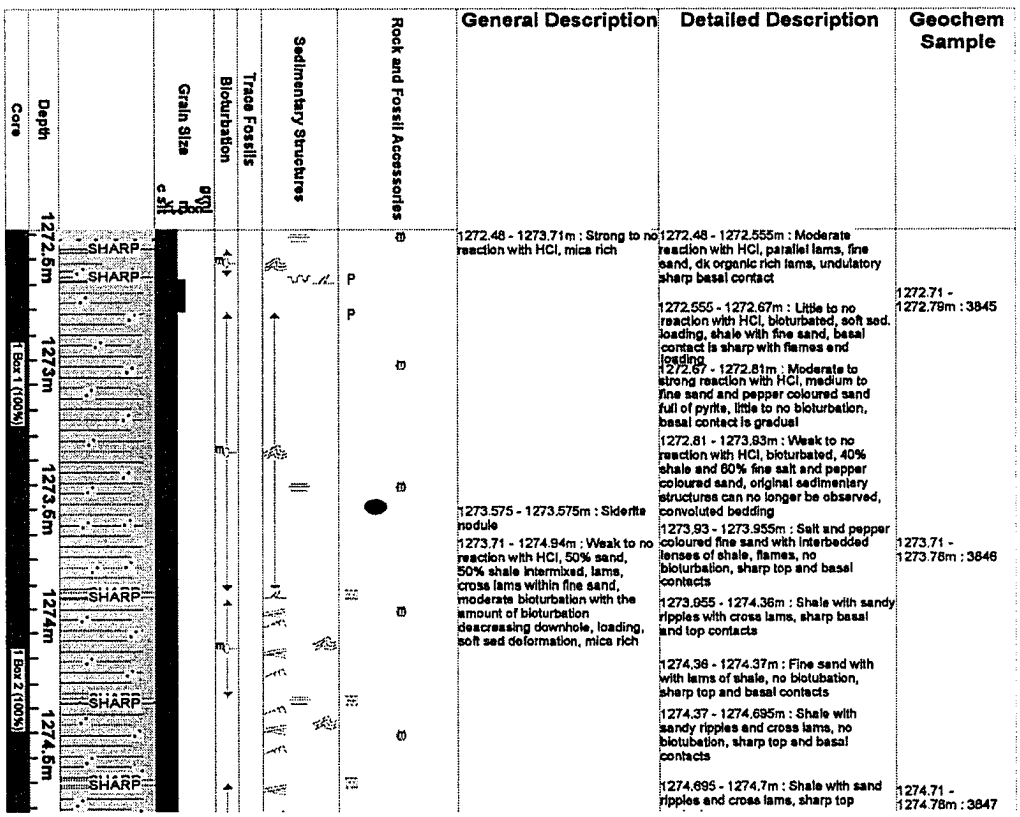
Well Type:	Straight
Longitude:	117.410259
Latitude:	54.700355
N / S Co - Ordinates:	514.4
E / W Co - Ordinates:	453.1

Bottom Hole Co - Ordinates

Longitude:	117.410259
Latitude:	54.700355
N / S Co - Ordinates:	514.4
E / W Co - Ordinates:	453.1

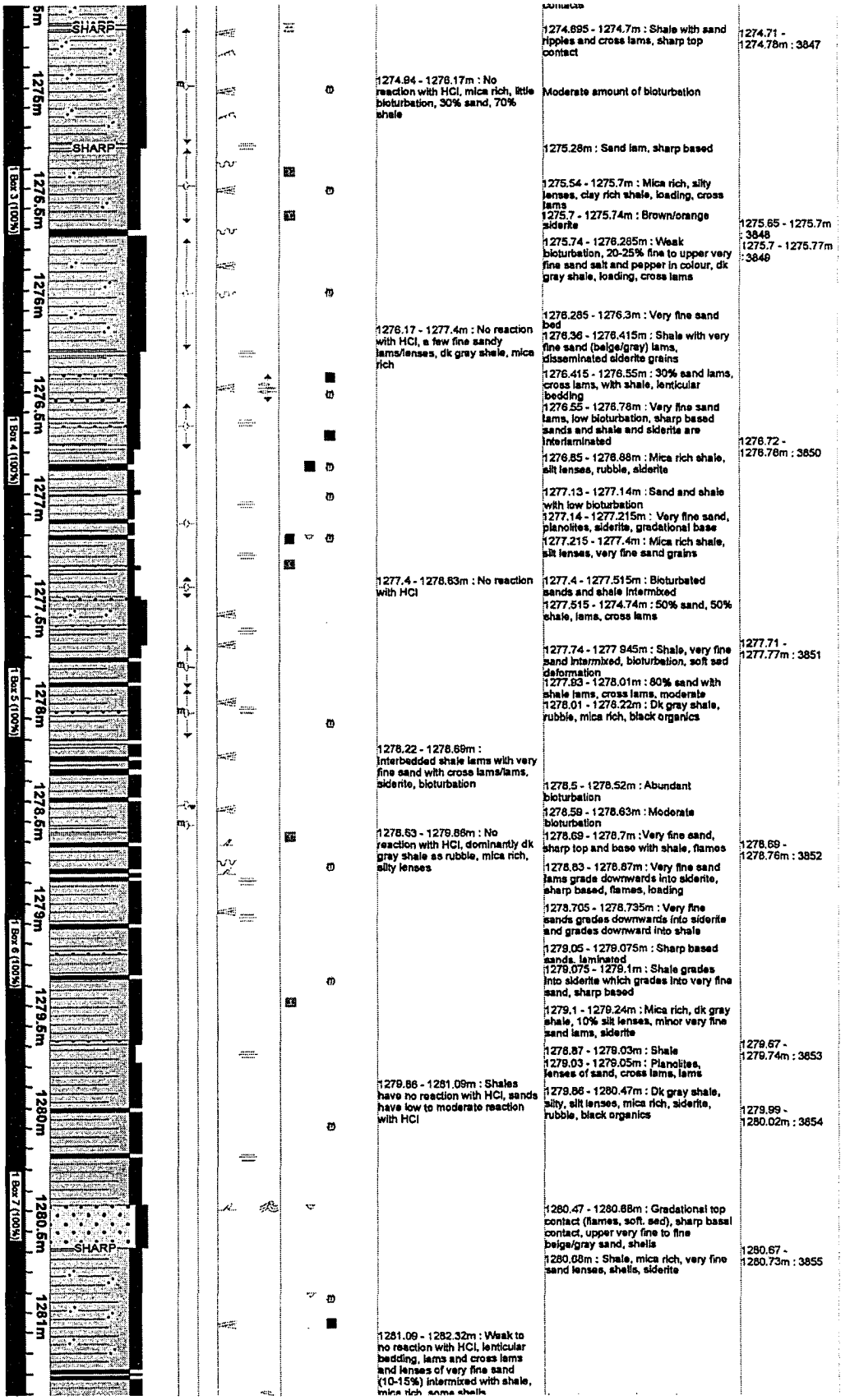
Well Summary

Spud Date:	Sep 6, 1976	Contractor:	
TD Date:		Rig Release Date:	Oct 10, 1976

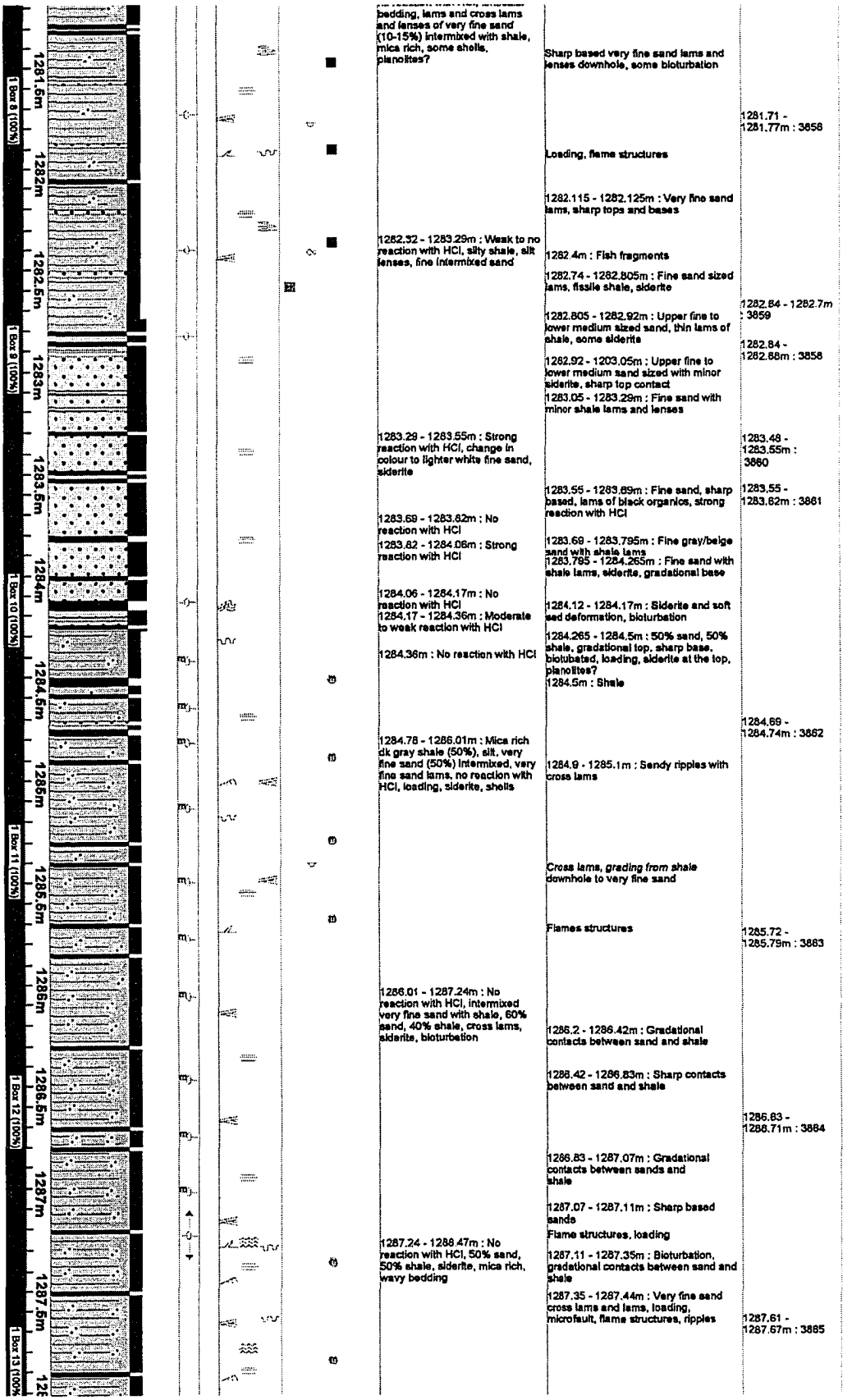


General Description	Detailed Description	Geochem Sample
1272.48 - 1273.71m : Strong to no reaction with HCl, mica rich	1272.48 - 1272.555m : Moderate reaction with HCl, parallel lams, fine sand, dk organic rich lams, undulatory sharp basal contact	
	1272.555 - 1272.67m : Little to no reaction with HCl, bioturbated, soft sed. loading, shale with fine sand, basal contact is sharp with flames end loading	1272.71 - 1272.78m : 3845
	1272.67 - 1272.81m : Moderate to strong reaction with HCl, medium to fine sand and pepper coloured sand full of pyrite, little to no bioturbation, basal contact is gradual	
	1272.81 - 1273.93m : Weak to no reaction with HCl, bioturbated, 40% shale and 60% fine salt and pepper coloured sand, original sedimentary structures can no longer be observed, convoluted bedding	
1273.575 - 1273.575m : Siderite nodule		
1273.71 - 1274.94m : Weak to no reaction with HCl, 50% sand, 50% shale intermixed, lams, cross lams within fine sand, moderate bioturbation with the amount of bioturbation descreasing downhole, loading, soft sed deformation, mica rich	1273.93 - 1273.955m : Salt and pepper coloured fine sand with interbedded lenses of shale, flames, no bioturbation, sharp top and basal contacts	1273.71 - 1273.78m : 3846
	1273.955 - 1274.36m : Shale with sandy ripples with cross lams, sharp basal and top contacts	
	1274.36 - 1274.37m : Fine sand with with lams of shale, no biotubation, sharp top and basal contacts	
	1274.37 - 1274.695m : Shale with sandy ripples and cross lams, no biotubation, sharp top and basal contacts	
	1274.695 - 1274.7m : Shale with sand ripples and cross lams, sharp top	1274.71 - 1274.78m : 3847

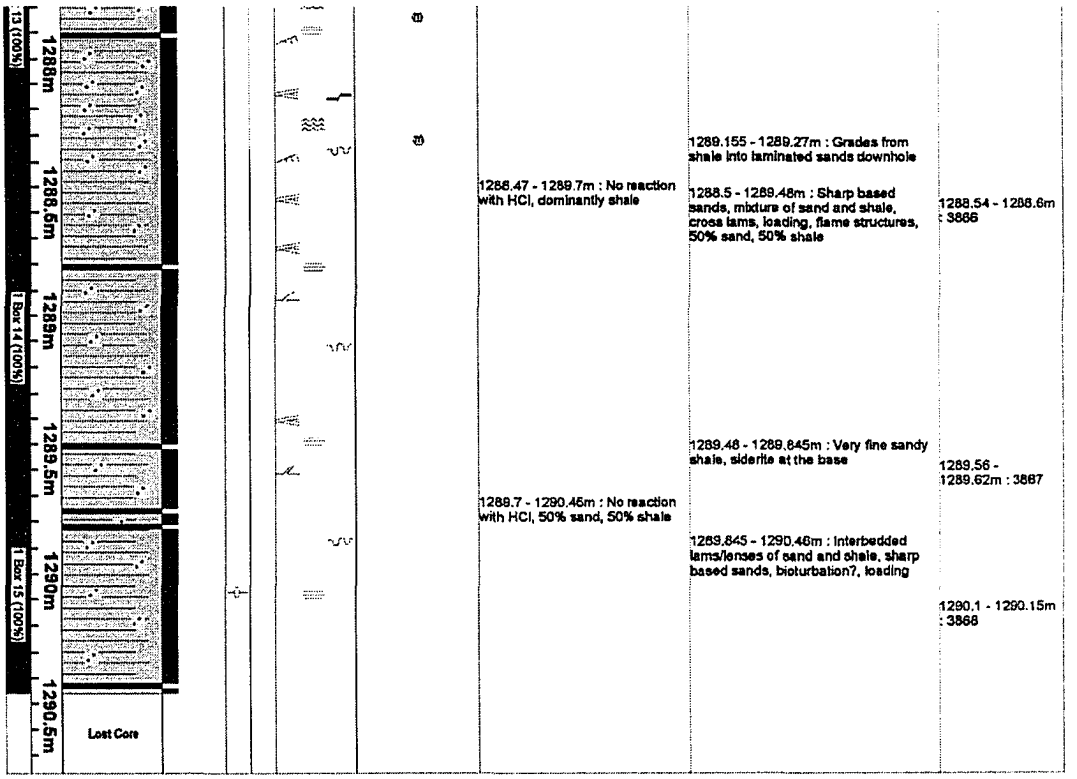
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



00/10-09-066-23W5/0: Rax Et Al Ante 10-9-66-23

Core: 1272.48m – 1290.46m

Second White Specks interval from cross section: 1106m – 1235m

Observations:

The core comprises a dark grey shale, very fine to medium sized sand in laminations, beds and lenses, as well as siderite. Throughout the interval, there is abundant bioturbation, soft sediment deformation and ripples.

Comments (from the base to the top of the interval):

The core is found stratigraphically below the Second White Specks interval. This may represent the Belle Fourche Formation or a lower unit. Absolutely no white specks were discovered throughout the whole unit. This core did not look like any other observed cores. It was extremely sandy, and was bioturbated. It also did not react with

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

hydrochloric acid. There was abundant siderite. This appeared to be more typical of the Belle Fourche Formation. The source of the sediment is closer to the area of deposition.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Devon Canada Corporation
Well Name:	Anderson Et Al Paradise 10-22-47-3
Location:	
UWI:	100102204703W400
Pool:	Unknown
Field:	Undefined - Alta (998)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	650.4 m
Cut(-) / Fill(+):		Kelly Bushing:	653.5 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

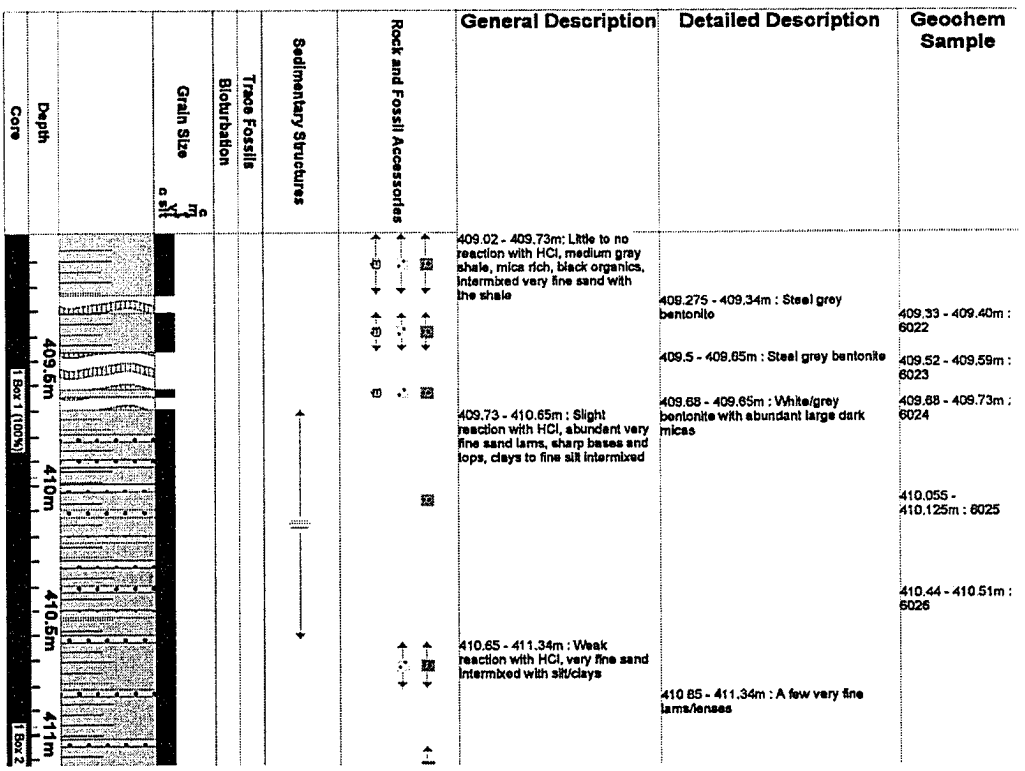
Well Type:	Straight
Longitude:	-110.352306
Latitude:	53.070258
N / S Co - Ordinates:	424.4
E / W Co - Ordinates:	426.6

Bottom Hole Co - Ordinates

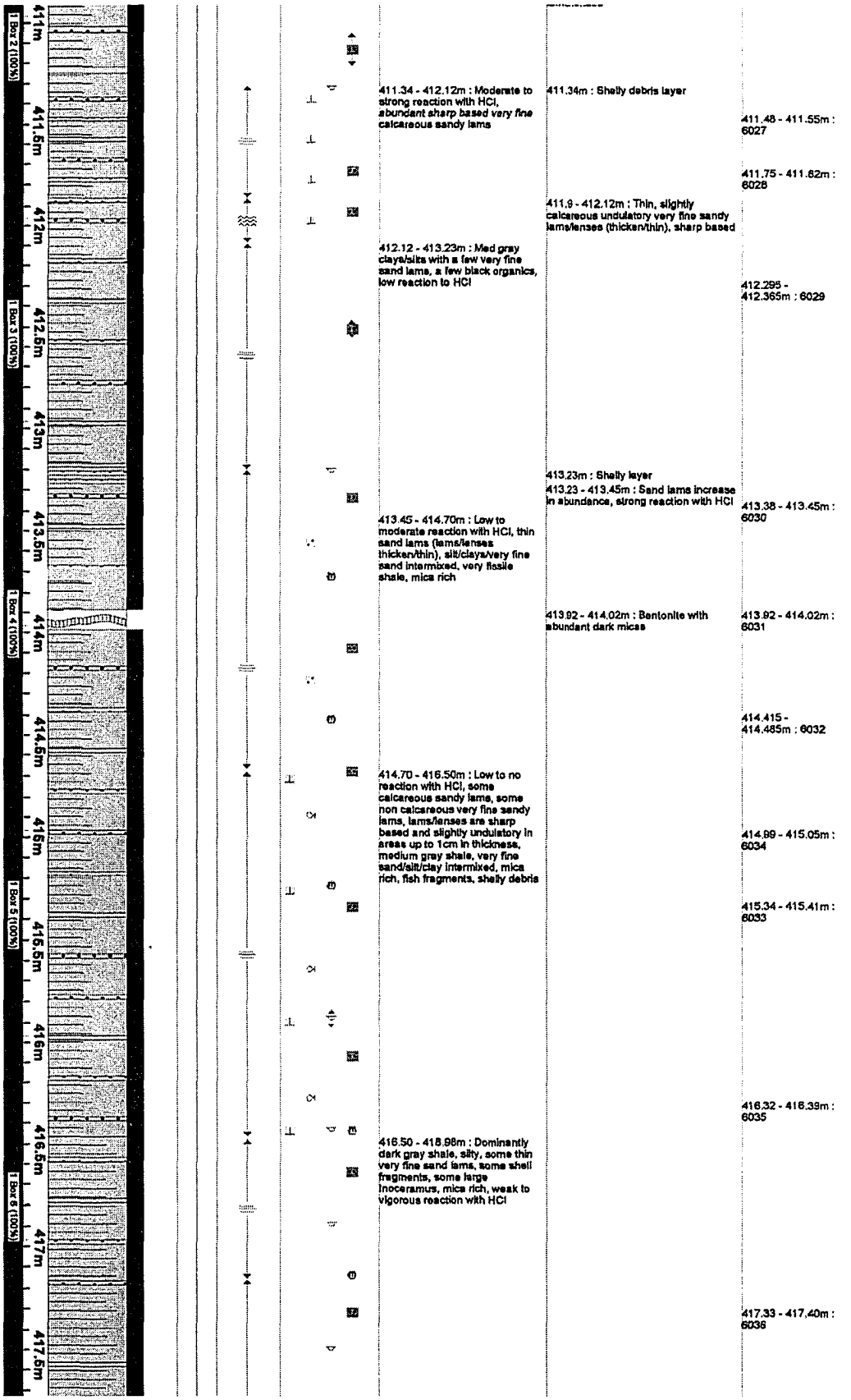
Longitude:	-110.352306
Latitude:	53.070258
N / S Co - Ordinates:	424.4
E / W Co - Ordinates:	426.6

Well Summary

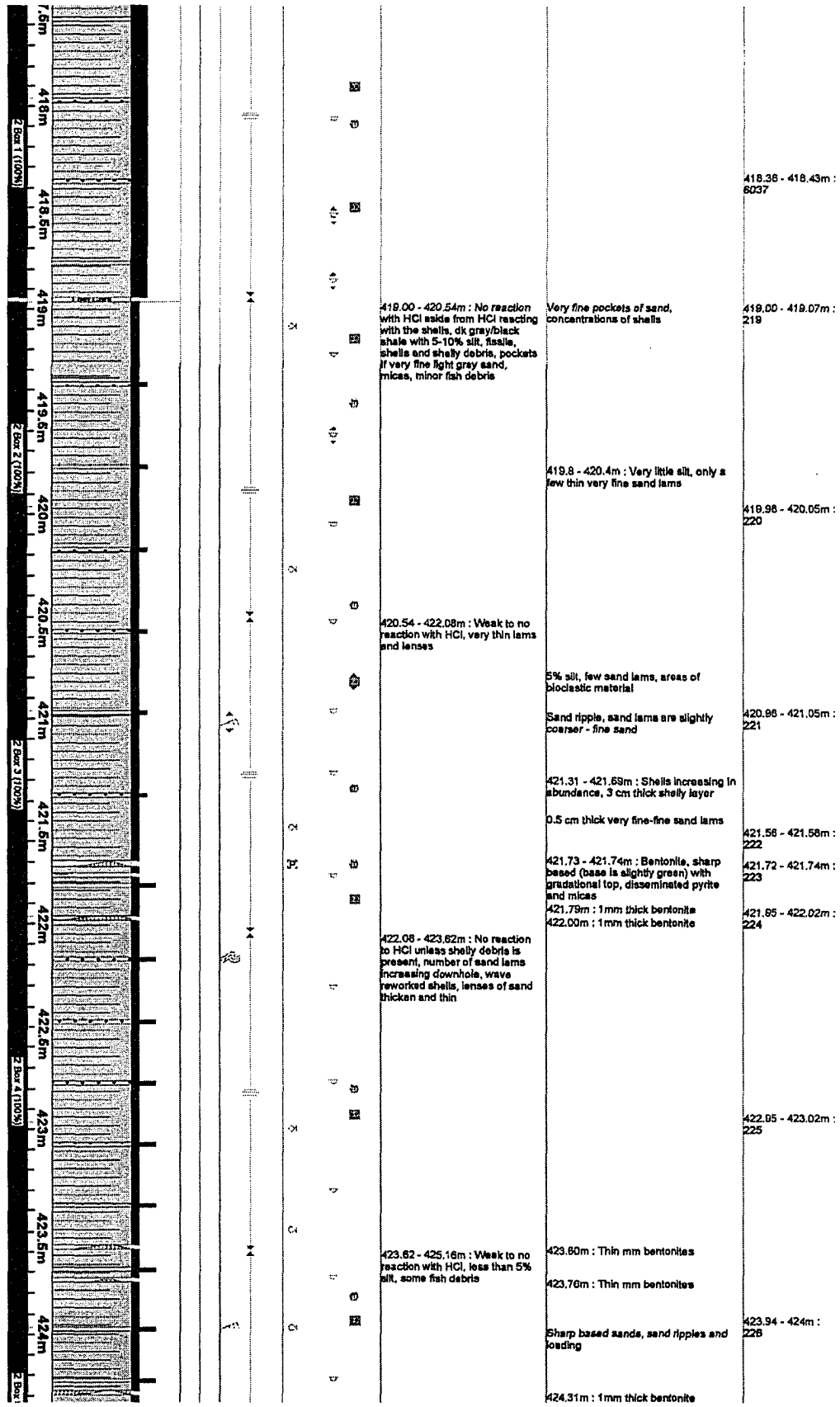
Spud Date:	Nov 18, 1976	Contractor:	
TD Date:		Rig Release Date:	Nov 25, 1976



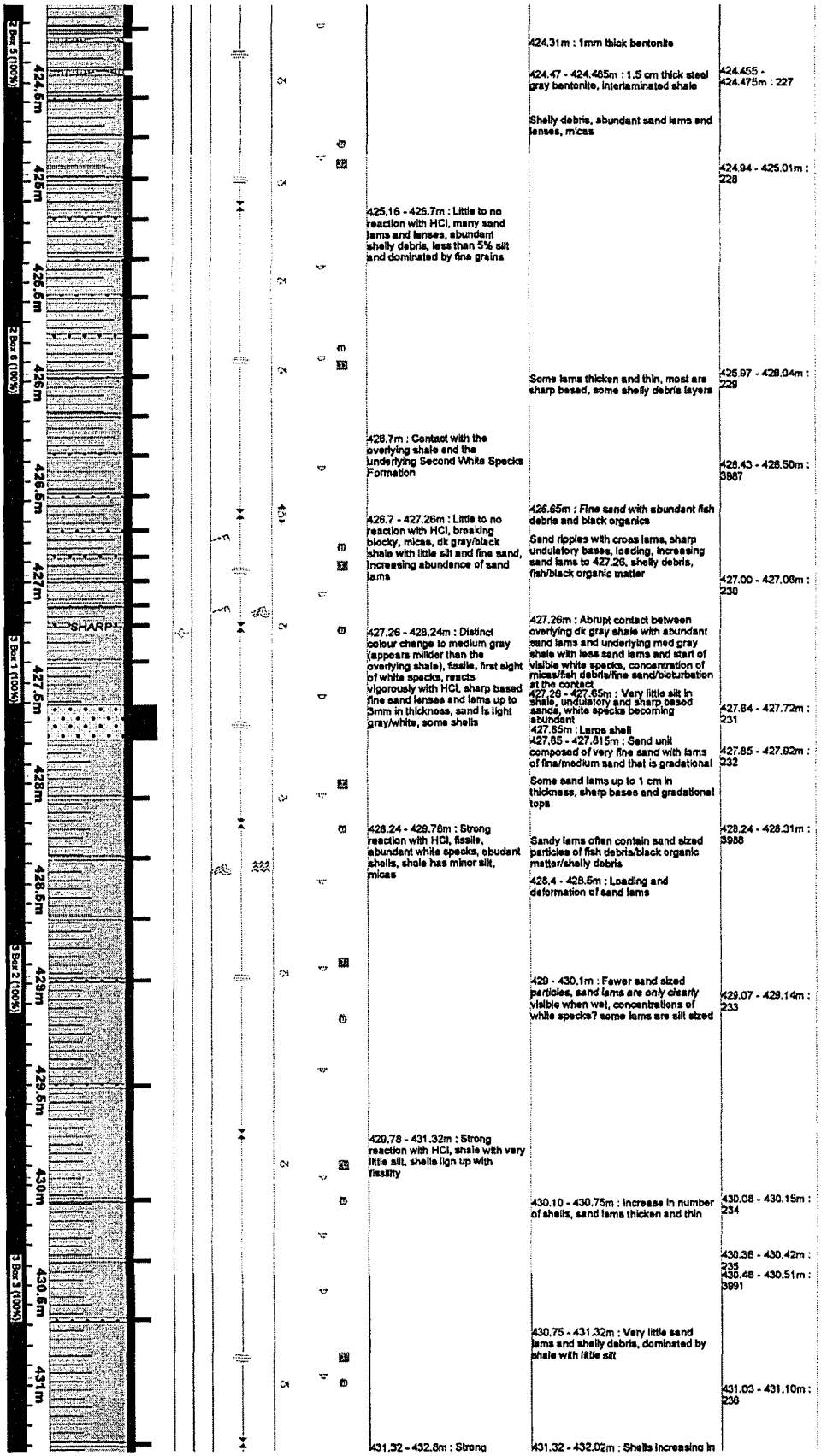
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



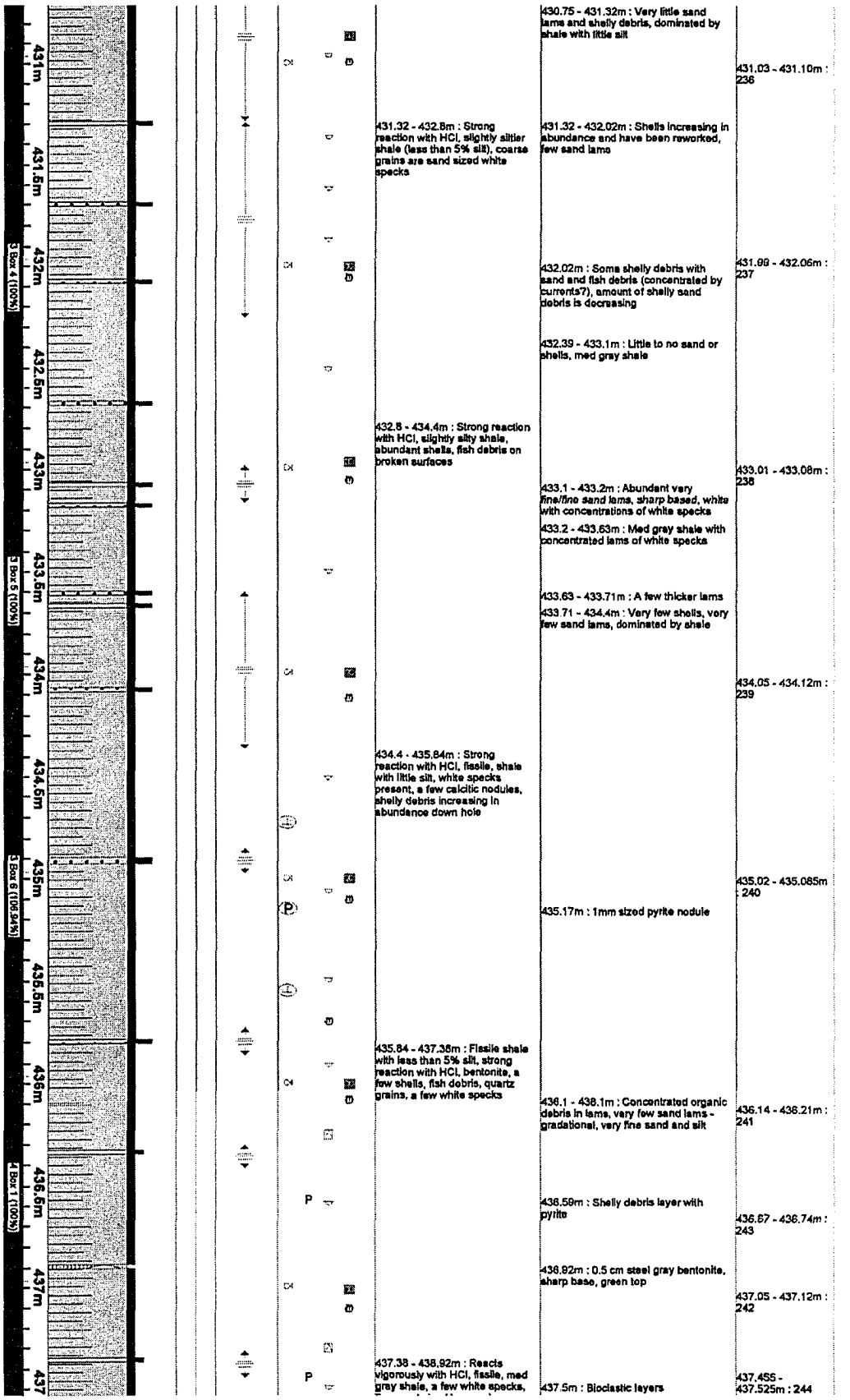
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



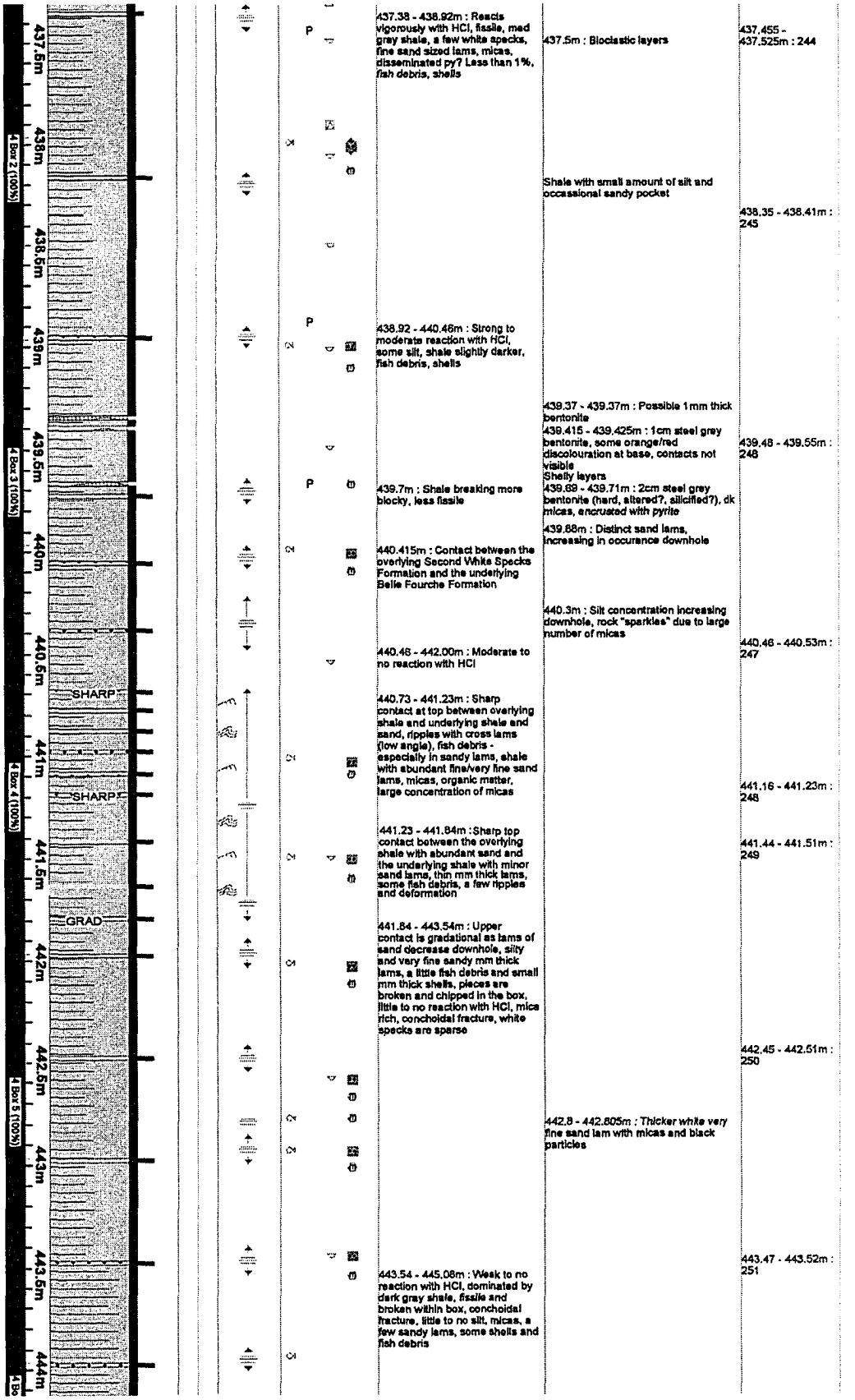
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



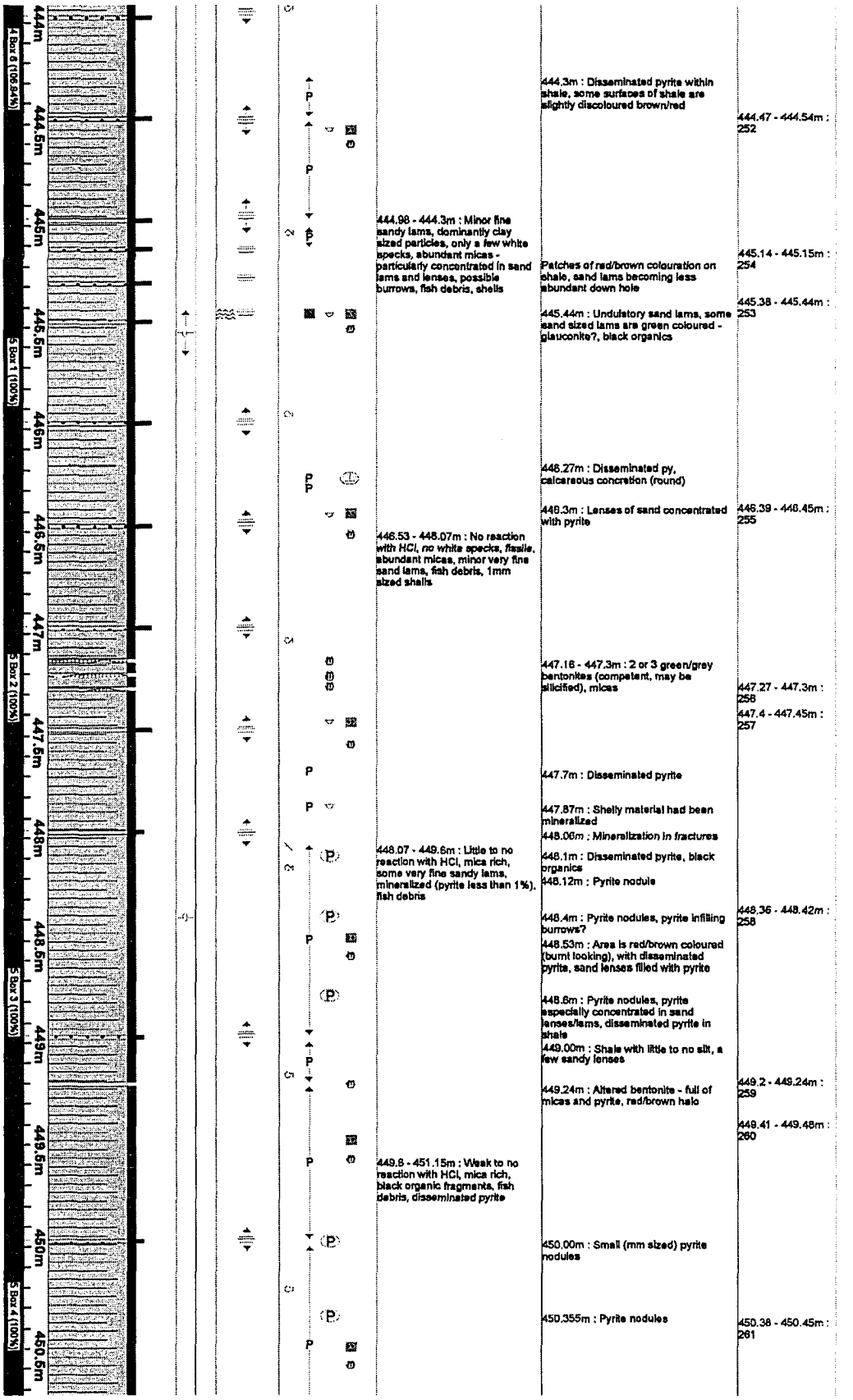
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



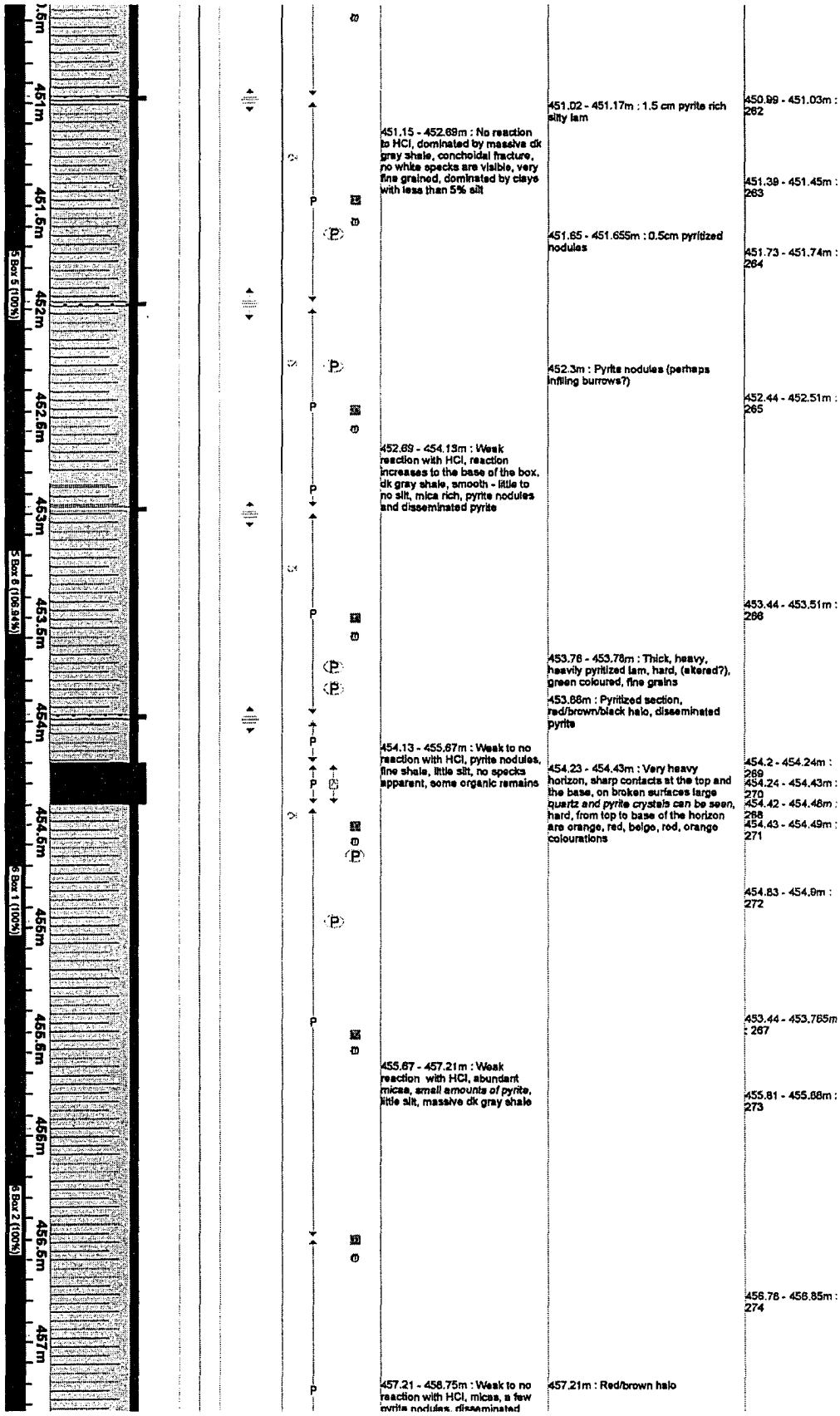
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



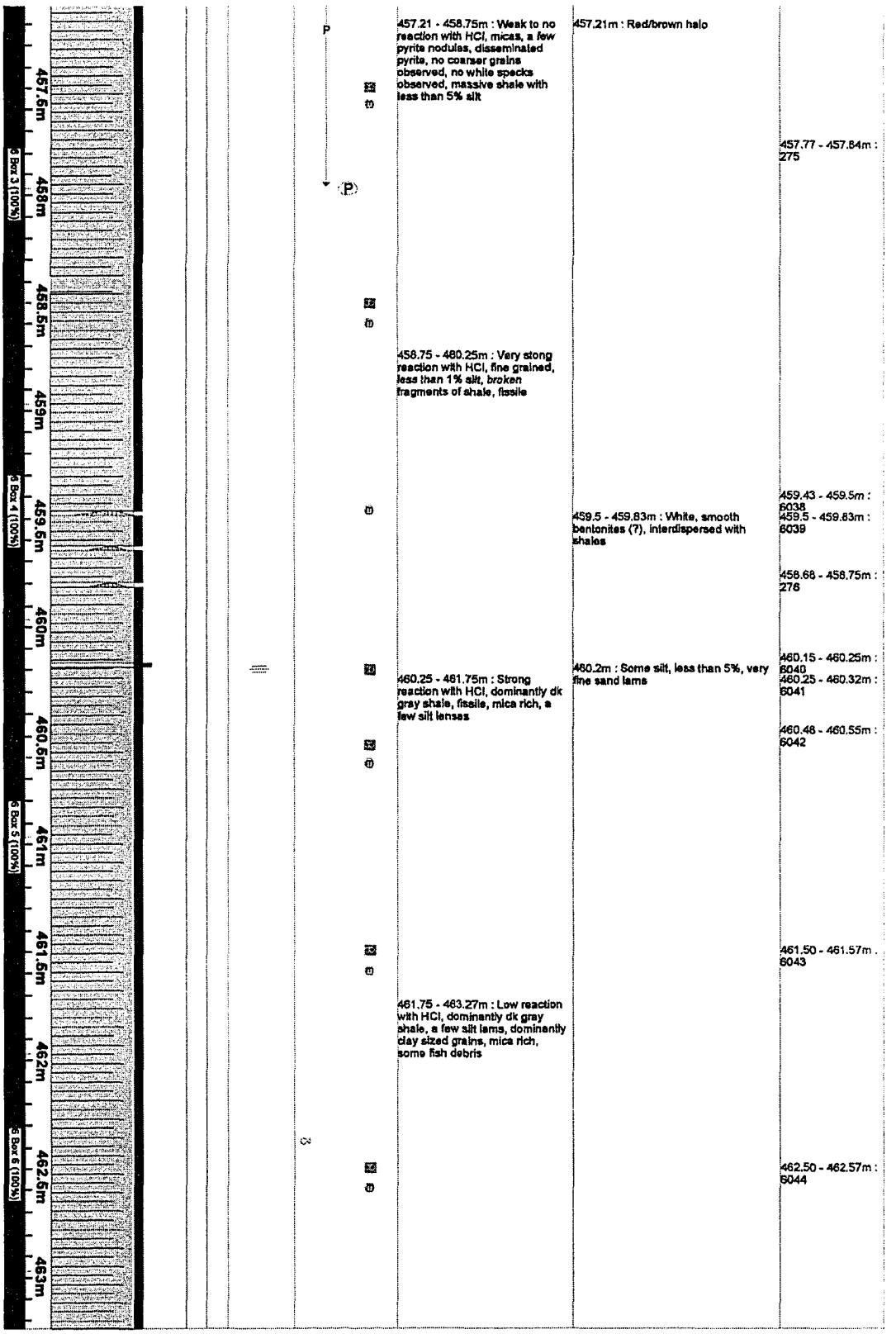
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Home Oil Company Limited
Well Name:	Hol Taurvs Fir 10-28-59-20
Location:	
UWI:	100102805920W500
Pool:	Unknown
Field:	Fir (379)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	1019.6 m
Cut(-) / Fill(+):		Kelly Bushing:	1024.1 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

Well Type:	Straight
Longitude:	-116.932429
Latitude:	54.133561
N / S Co - Ordinates:	460.8
E / W Co - Ordinates:	478.9

Bottom Hole Co - Ordinates

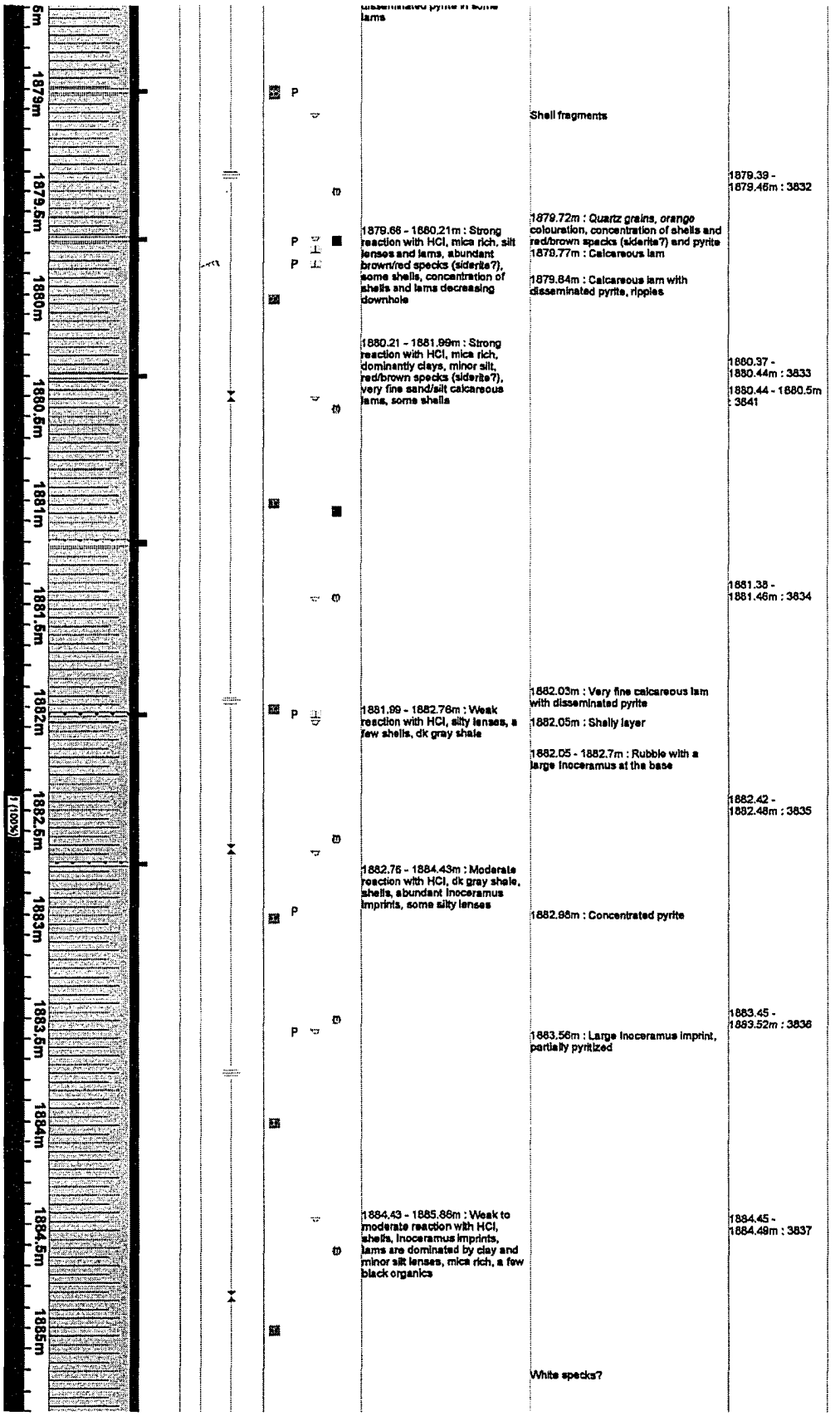
Longitude:	-116.932429
Latitude:	54.133561
N / S Co - Ordinates:	460.8
E / W Co - Ordinates:	478.9

Well Summary

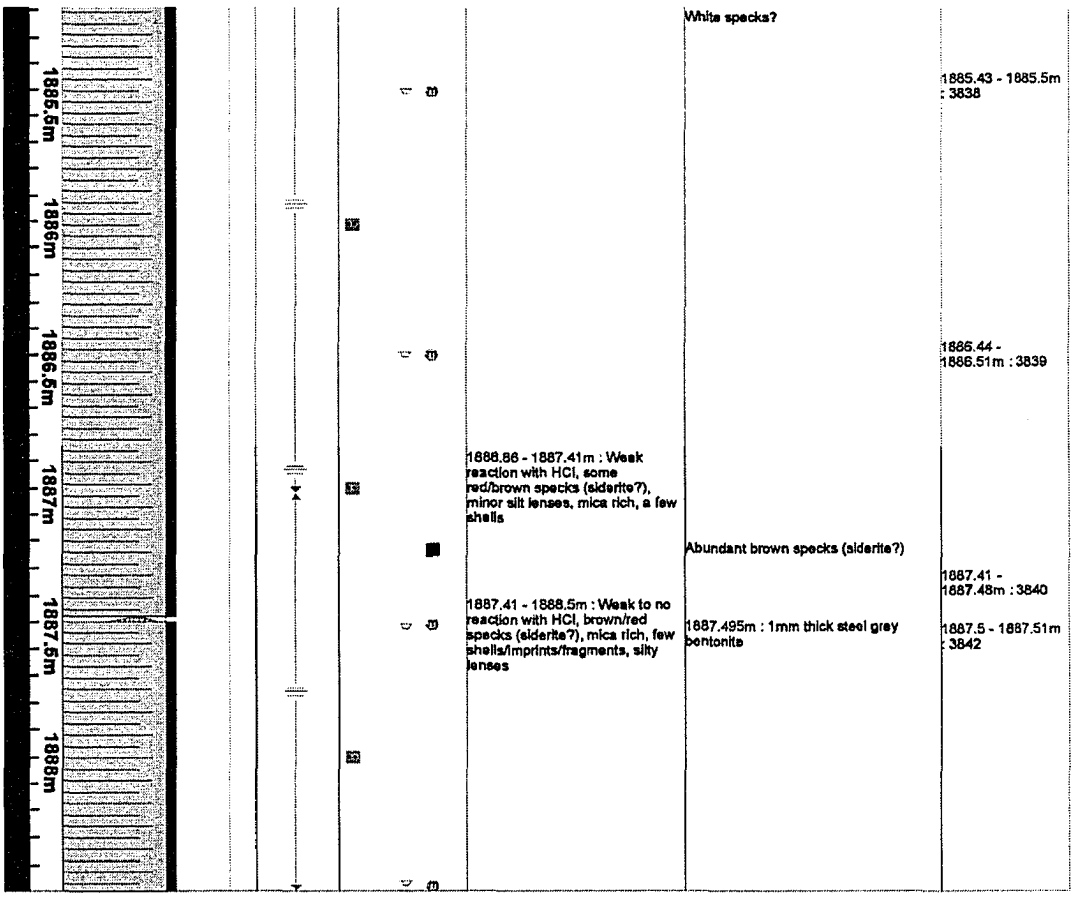
Spud Date:	Jan 14, 1974	Contractor:	
TD Date:		Rig Release Date:	Jan 24, 1974

Core	Depth		Grain Size	Trace Fossils	Sedimentary Structures	Rock and Fossil Accessories	General Description	Detailed Description	Geochem Sample
	1877m 1877.5m 1878m 1878.5m						1876.58 - 1878.11m : Strong reaction with HCl (particular lams are more reactive with HCl), dk gray shale, fissile, clays with 5-10% silt, sharp based very fine sand sized calcareous lams, mica rich, large and small shells, disseminated pyrite in many lams, discontinuous lams of silt 1878.11 - 1879.66m : Strong reaction with HCl (some lams react more vigorously than others), dk gray shale, fissile, lams less abundant than overlying core, some shell fragments, Inoceramus, discontinuous silt lams, disseminated pyrite in some lams	1876.58m : 2mm thick very fine calcareous lam with disseminated pyrite Brown/red specks (siderite?) 1876.88m : Brown specks (siderite?), fish fragments 1877.13m : Brown/red specks (siderite?), shelly lam 1877.3m : Calcareous lams with sharp bases, gradational tops 1877.48m : Thin shelly debris layer 1877.55m : Small ripple with cross lams 1877.8m : Loading, ripples 1878.185m : Fine sand lenses Abundant thin calcareous lams with lams of red/brown specks (siderite?)	1876.82 - 1876.87m : 3827 1877.13 - 1877.18m : 3828 1877.28 - 1877.33m : 3829 1877.41 - 1877.48m : 3830 1878.35 - 1878.42m : 3831

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Murphy Canada Exploration Company
Well Name:	APL Et Al Pine 10-31-54-18
Location:	
UWI:	100103105418W500
Pool:	Cardium, 2WPSK, U Mann M... (177660)
Field:	Pine Creek (706)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	1016.7 m
Cut(-) / Fill(+):		Kelly Bushing:	1020.8 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

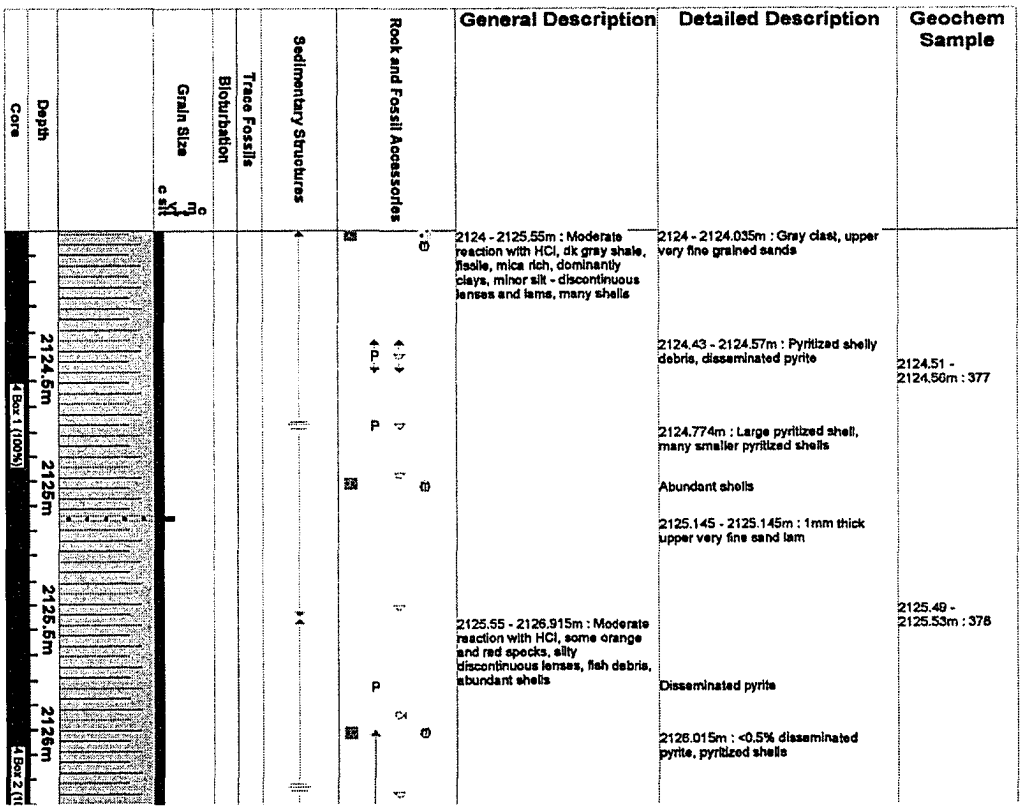
Well Type:	Straight
Longitude:	-116.636386
Latitude:	53.711393
N / S Co - Ordinates:	458.7
E / W Co - Ordinates:	490.3

Bottom Hole Co - Ordinates

Longitude:	-116.636386
Latitude:	53.711393
N / S Co - Ordinates:	458.7
E / W Co - Ordinates:	490.3

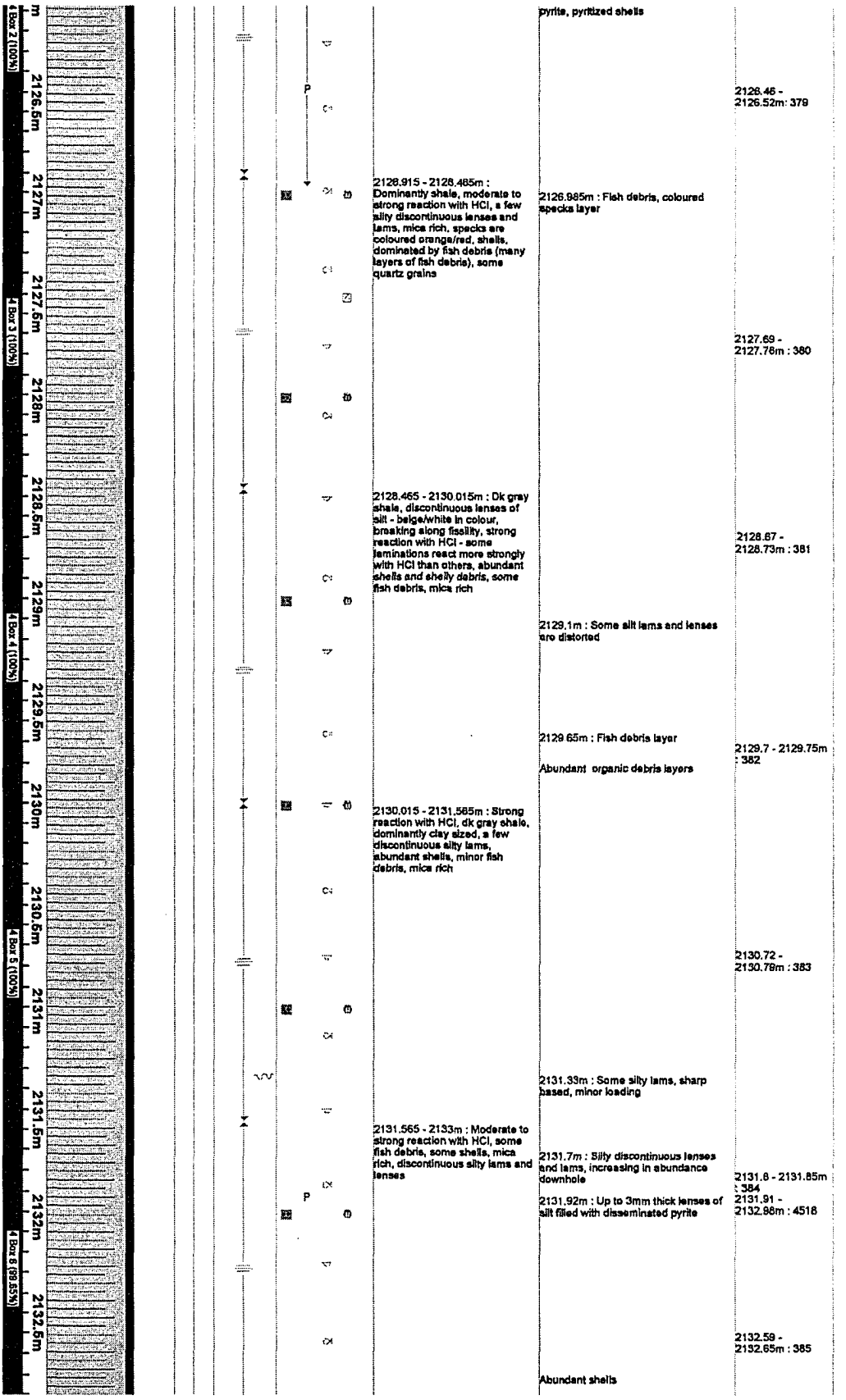
Well Summary

Spud Date:	Jan 3, 1981	Contractor:	
TD Date:		Rig Release Date:	Feb 3, 1981

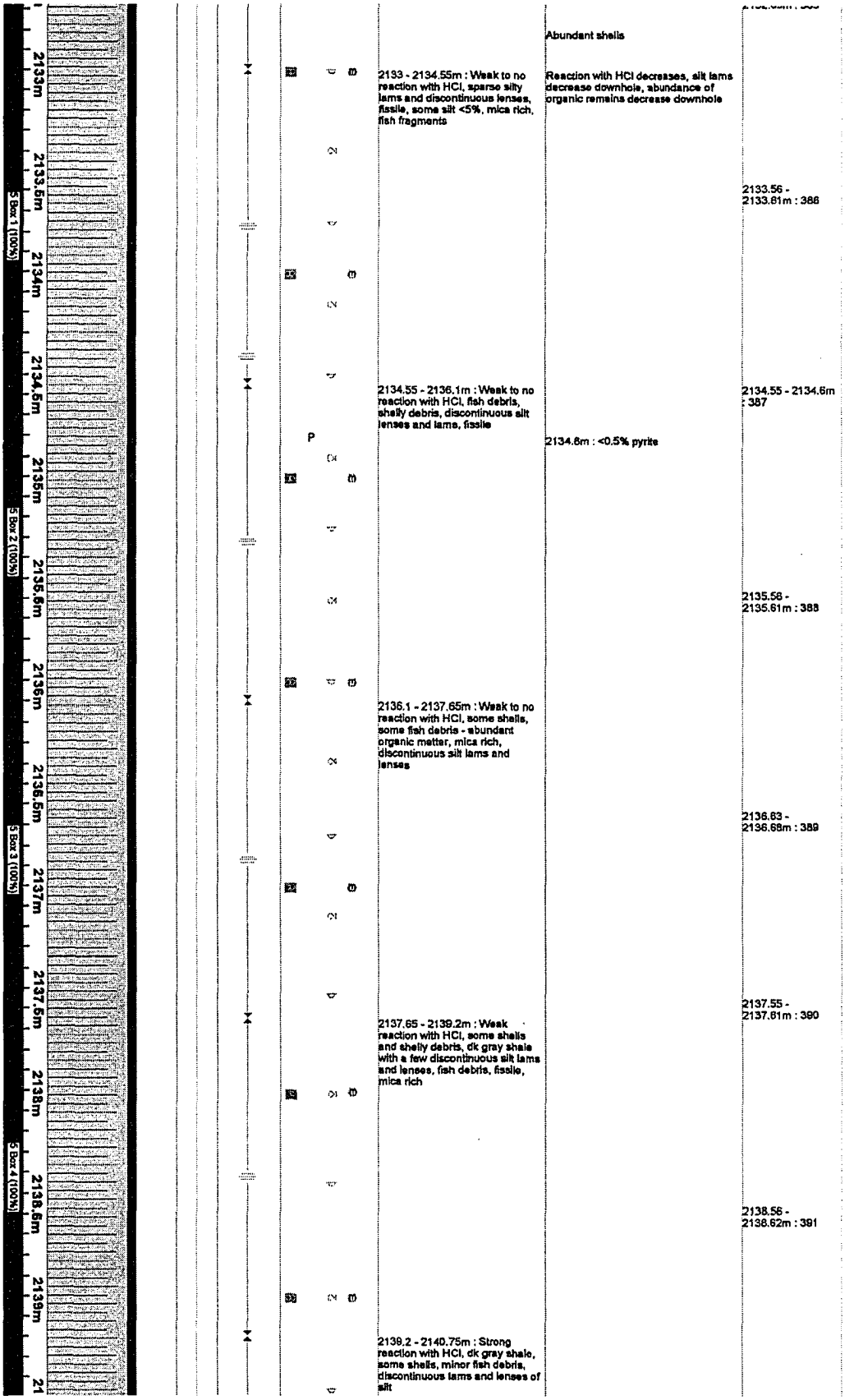


General Description	Detailed Description	Geochem Sample
2124 - 2125.55m : Moderate reaction with HCl, dk gray shale, fissile, mica rich, dominantly clays, minor silt - discontinuous lenses and lams, many shells	2124 - 2124.035m : Gray clast, upper very fine grained sands	
	2124.43 - 2124.57m : Pyritized shelly debris, disseminated pyrite	2124.51 - 2124.56m : 377
	2124.774m : Large pyritized shell, many smaller pyritized shells	
	Abundant shells	
	2125.145 - 2125.145m : 1mm thick upper very fine sand lam	
2125.55 - 2126.915m : Moderate reaction with HCl, some orange and red specks, silty discontinuous lenses, fish debris, abundant shells		2125.49 - 2125.53m : 378
	Disseminated pyrite	
	2126.015m : <0.5% disseminated pyrite, pyritized shells	

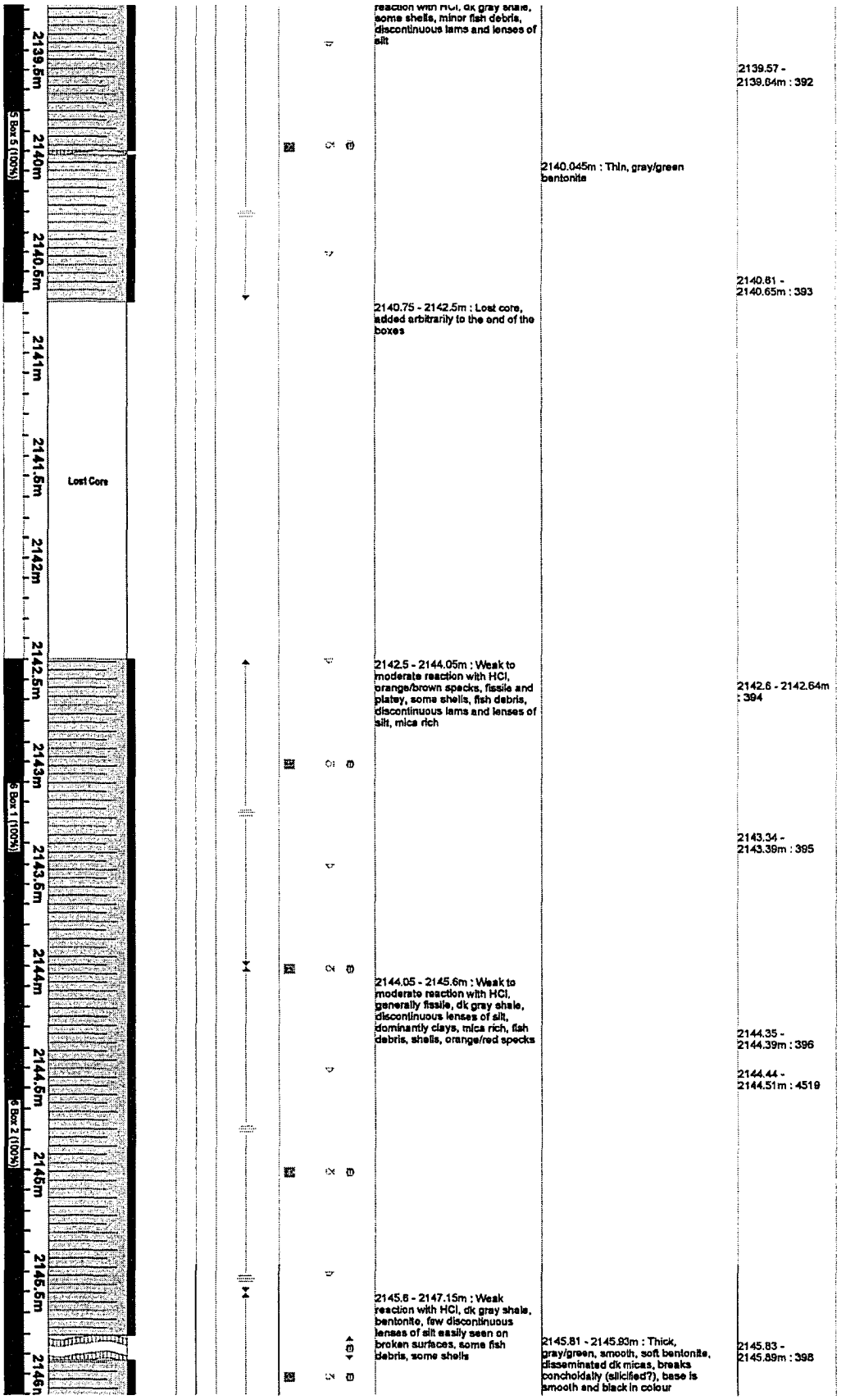
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



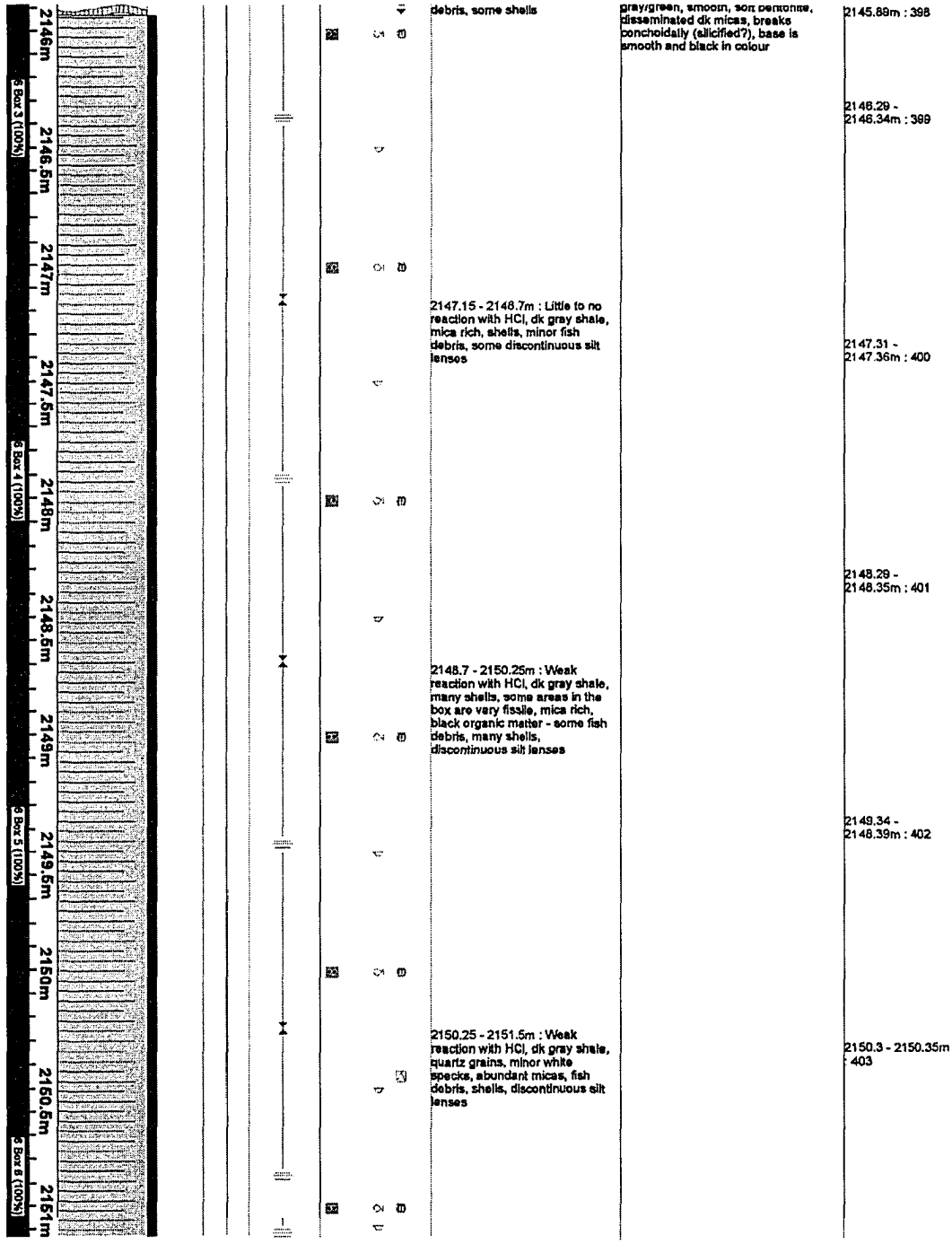
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



00/10-31-054-18W5/0: APL Et Al Pine 10-31-54-18

Core: 2124m – 2151.5m

Second White Specks interval from cross section: 2037m – 2075m

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Observations:

The core is fairly homogeneous, dark grey in colour, dominated by clays with minor silt. There is abundant fish and shelly debris, along with a thick bentonite at 2145.6m depth.

Interpretation:

The core does not lie within the Second White Specks Formation interval. The core is stratigraphically lower than the interval. It may represent the Belle Fourche Formation, or an older formation. No micropaleontology or palynology samples were sent for this core, therefore, the picks are based on stratigraphical correlations. The bentonite may be part of the Fish Scales Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Sunfire Energy Corporation
Well Name:	Amoco Thorhild 10-36-60-22
Location:	
UWI:	100103606022W400
Pool:	Unknown
Field:	Thorhild (903)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	663.9 m
Cut(-) / Fill(+):		Kelly Bushing:	667.8 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

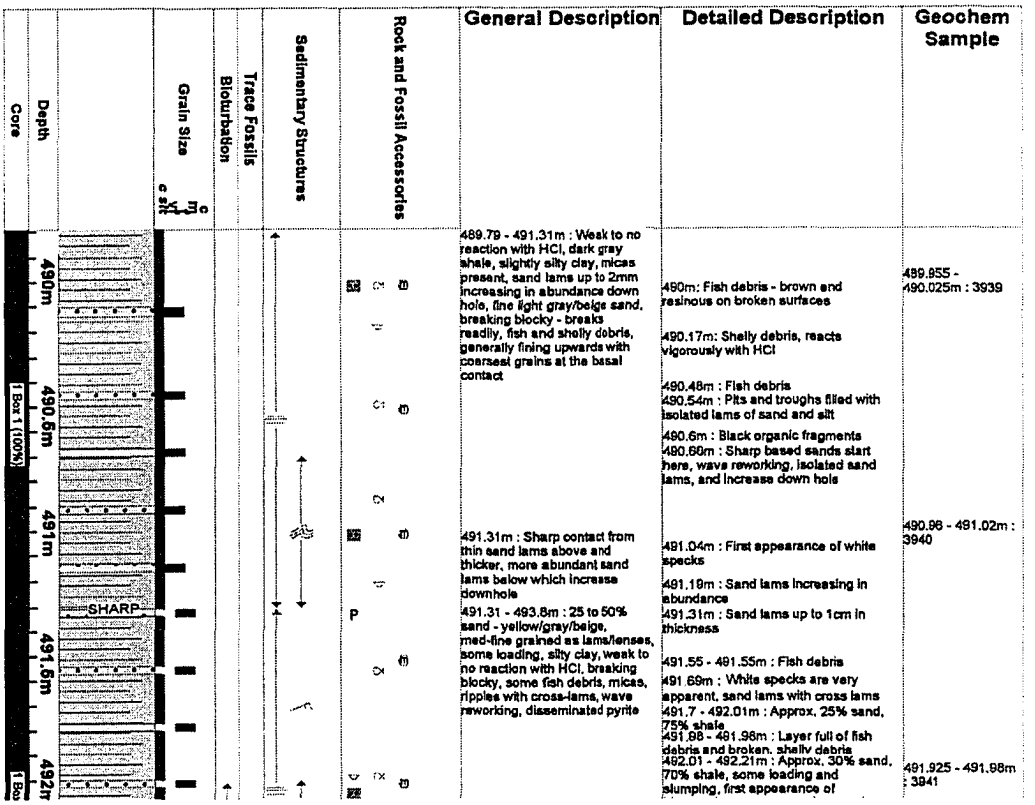
Well Type:	Straight
Longitude:	-113.156881
Latitude:	54.234284
N / S Co - Ordinates:	560.8
E / W Co - Ordinates:	488.8

Bottom Hole Co - Ordinates

Longitude:	-113.156881
Latitude:	54.234284
N / S Co - Ordinates:	560.8
E / W Co - Ordinates:	488.8

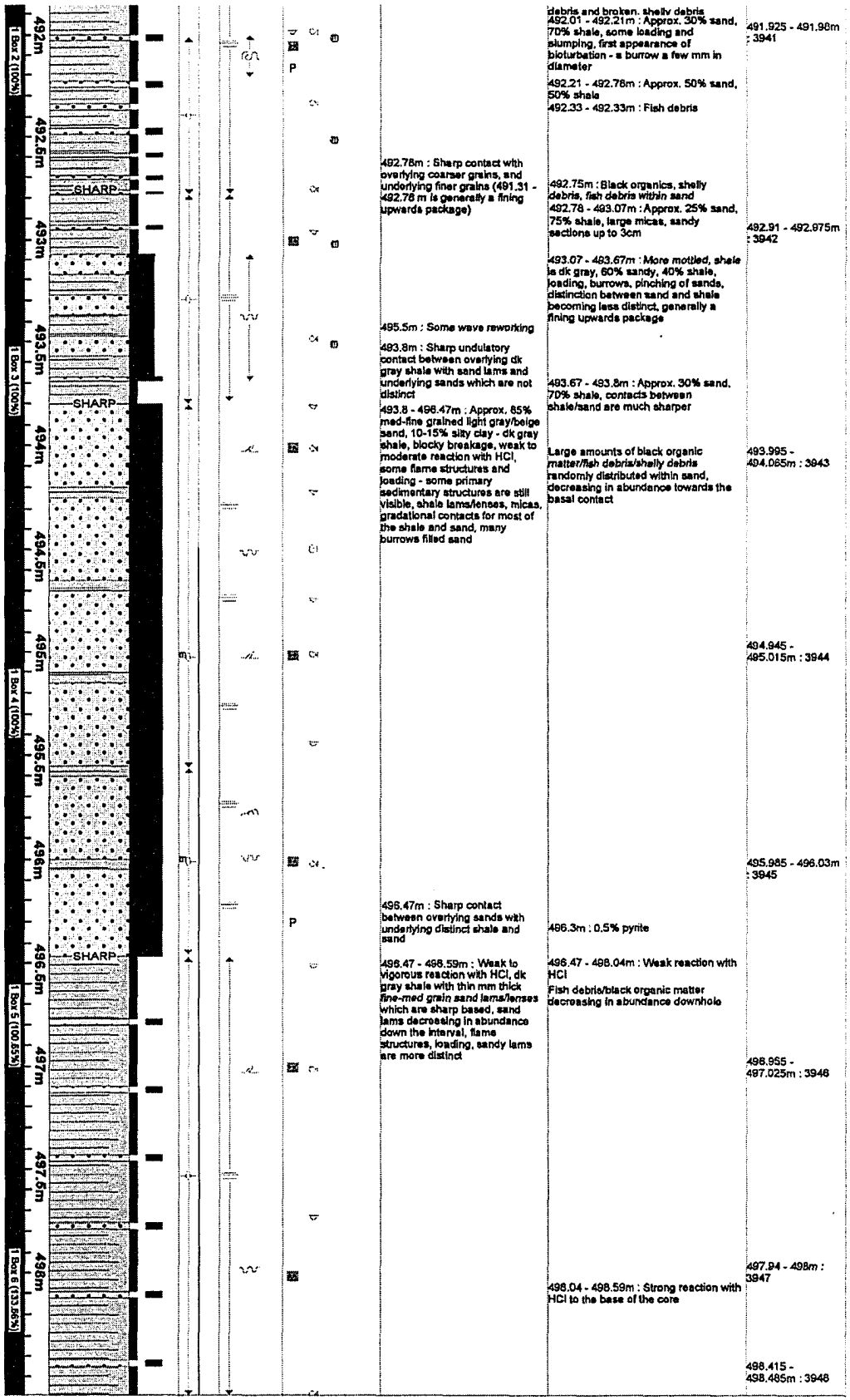
Well Summary

Spud Date:	Jan 15, 2977	Contractor:	
TD Date:		Rig Release Date:	Jan 22, 1977



General Description	Detailed Description	Geochem Sample
489.79 - 491.31m : Weak to no reaction with HCl, dark gray shale, slightly silty clay, micas present, sand lams up to 2mm increasing in abundance down hole, fine light gray/beige sand, breaking blocky - breaks readily, fish and shelly debris, generally fining upwards with coarsest grains at the basal contact	490m: Fish debris - brown and resinous on broken surfaces 490.17m: Shelly debris, reacts vigorously with HCl 490.48m : Fish debris 490.54m : Pits and troughs filled with isolated lams of sand and silt 490.6m : Black organic fragments 490.66m : Sharp based sands start here, wave reworking, isolated sand lams, and increase down hole	489.955 - 490.025m : 3939
491.31m : Sharp contact from thin sand lams above and thicker, more abundant sand lams below which increase downhole 491.31 - 493.8m : 25 to 50% sand - yellow/gray/beige, med-fine grained as lams/lenses, some loading, silty clay, weak to no reaction with HCl, breaking blocky, some fish debris, micas, ripples with cross-lams, wave reworking, disseminated pyrite	491.04m : First appearance of white specks 491.19m : Sand lams increasing in abundance 491.31m : Sand lams up to 1cm in thickness 491.55 - 491.55m : Fish debris 491.69m : White specks are very apparent, sand lams with cross lams 491.7 - 492.01m : Approx. 25% sand, 75% shale 491.98 - 491.98m : Layer full of fish debris and broken, shelly debris 492.01 - 492.21m : Approx. 30% sand, 70% shale, some loading and slumping, first appearance of	490.96 - 491.02m : 3940 491.925 - 491.98m : 3941

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Marathon Canada Limited
Well Name:	Marathon Et Al Kakwa 14-28-62-5
Location:	
UWI:	100142806205W600
Pool:	Undefined Pool (999998)
Field:	Kawka (519)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	1059.8 m
Cut(-) / Fill(+):		Kelly Bushing:	1065 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

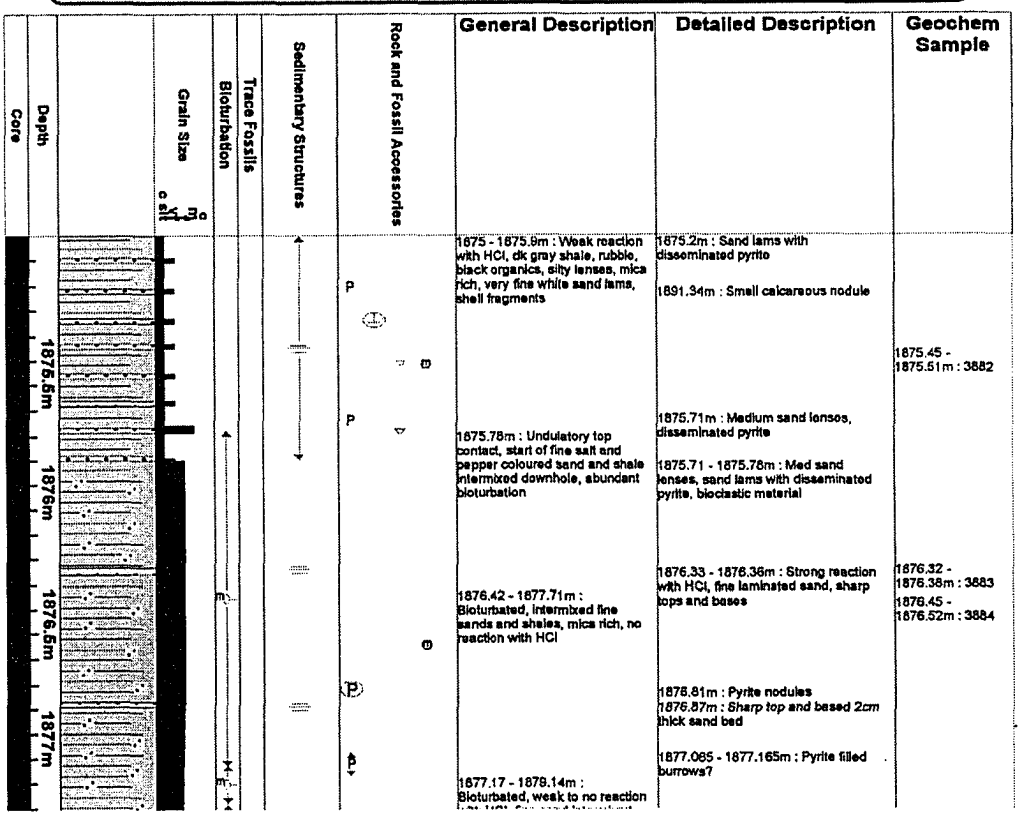
Well Type:	Straight
Longitude:	-118.689728
Latitude:	54.39630
N / S Co - Ordinates:	362.8
E / W Co - Ordinates:	561.4

Bottom Hole Co - Ordinates

Longitude:	-118.689728
Latitude:	54.39630
N / S Co - Ordinates:	362.8
E / W Co - Ordinates:	561.4

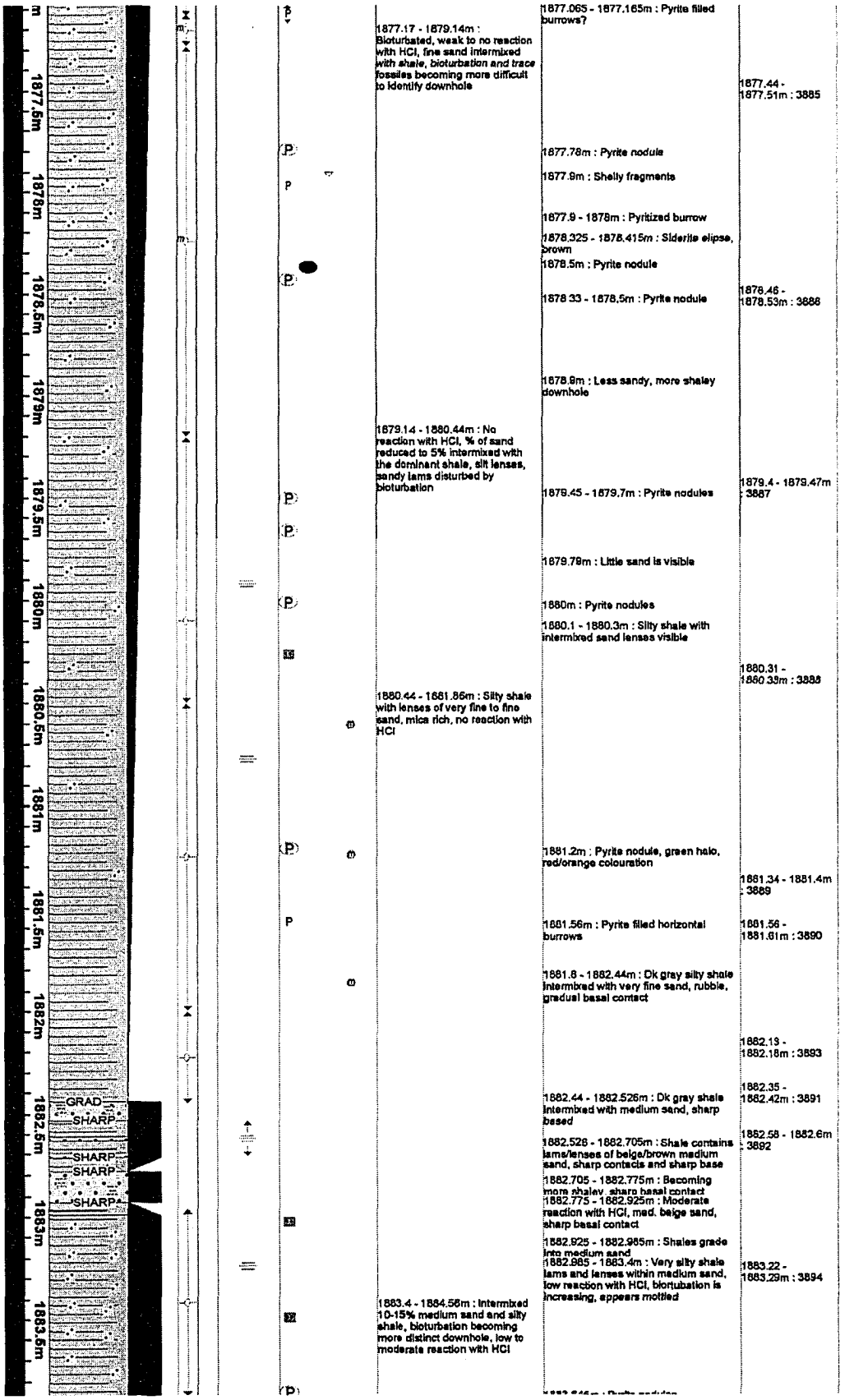
Well Summary

Spud Date:		Contractor:	
TD Date:		Rig Release Date:	

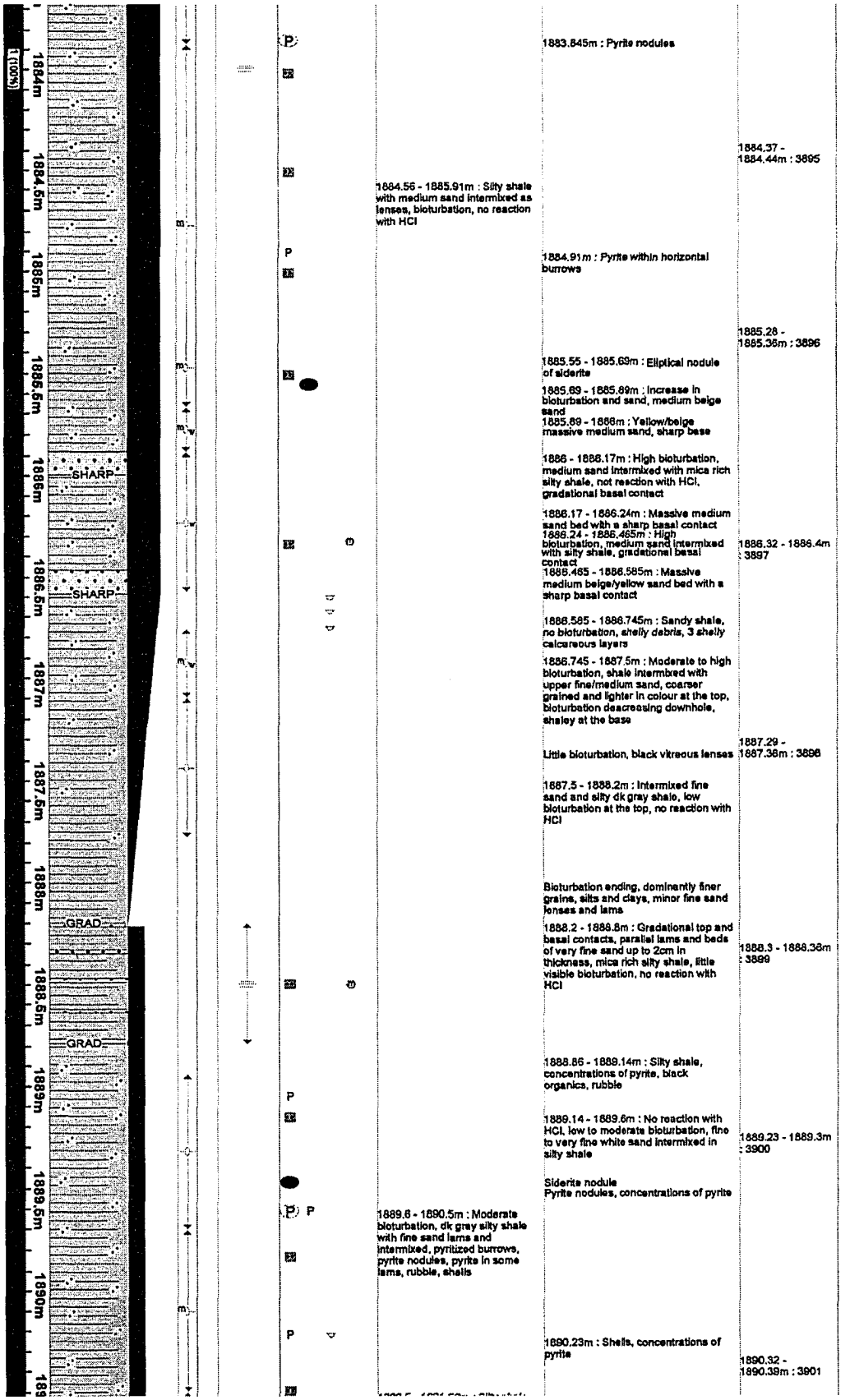


General Description	Detailed Description	Geochem Sample
1875 - 1875.8m : Weak reaction with HCl, dk gray shale, rubble, black organics, silty lenses, mica rich, very fine white sand lams, shell fragments	1875.2m : Sand lams with disseminated pyrite 1891.34m : Small calcareous nodule	1875.45 - 1875.51m : 3882
1875.78m : Undulatory top contact, start of fine salt and pepper coloured sand and shale intermixed downhole, abundant bioturbation	1875.71m : Medium sand lenses, disseminated pyrite 1875.71 - 1875.76m : Med sand lenses, sand lams with disseminated pyrite, bioclastic material	
1876.42 - 1877.71m : Bioturbated, intermixed fine sands and shales, mica rich, no reaction with HCl	1876.33 - 1876.36m : Strong reaction with HCl, fine laminated sand, sharp tops and bases 1876.61m : Pyrite nodules *1876.87m : Sharp top and based 2cm thick sand bed* 1877.065 - 1877.165m : Pyrite filled burrows?	1876.32 - 1876.38m : 3883 1876.45 - 1876.52m : 3884
1877.17 - 1879.14m : Bioturbated, weak to no reaction		

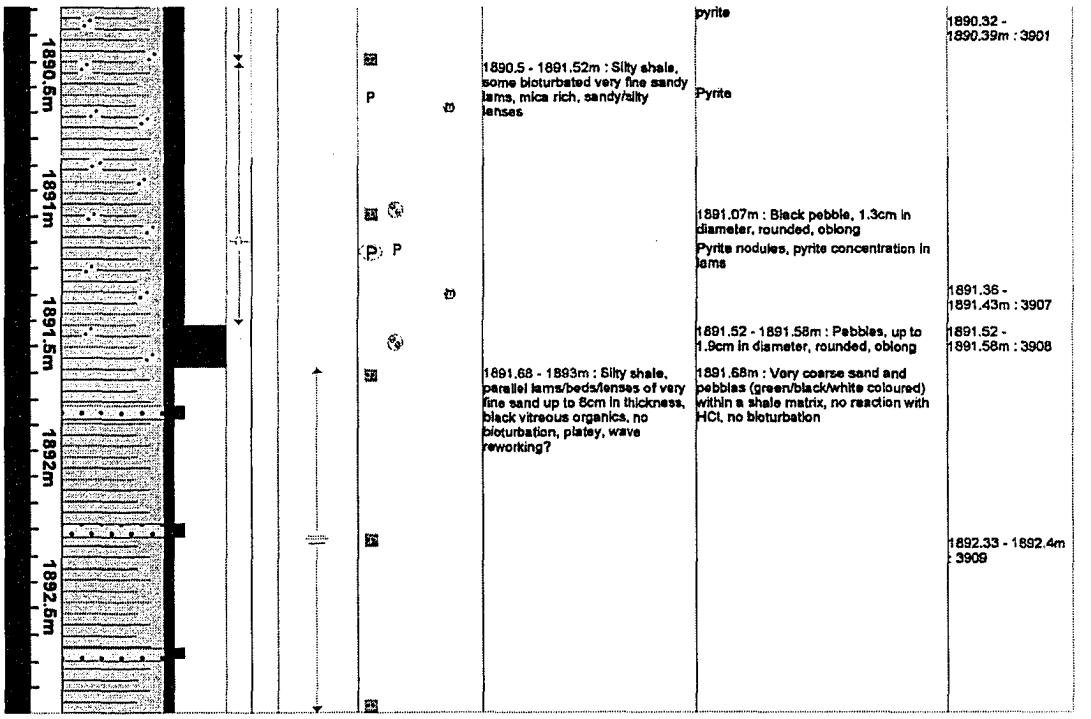
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



00/14-28-062-05W6/0: Marathon Et Al Kakwa 14-28-62-5

Core: 1875m – 1893m

Second White Specks interval from cross section: 1873m - ?

Observations:

A lot of this core is fractured. The details were often difficult to log. At the base of the core, a combination of very fine sand and shale is observed with occasional sharp based sands. Above this is a pebble layer in a matrix of mud. Up section is the first time that bioturbation is observed within sandy shale. There seems to be an occasional influx of sands as well as the bioturbation increases up this section along with the abundance of siderite. Above this, there is a lack of bioturbation. It is dominated by a shale with occasional sandy laminations.

The next package is a coarsening upwards sequence (with an increase in the amount of sand and sand size up the logged core). Bioturbation also increases upwards. There is an abundance of shells, then a sharp based package of sand with no bioturbation observable. This is followed by a gradual transition back into bioturbation and muds, a

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

sharp transition into sands, then gradually back into bioturbated sands. There is a slow upwards return to bioturbated sediments with some sands. At the top of the core is a shale with sandy laminations.

Interpretation:

There were no white specks observed at all in the core. Very little of the core reacted with hydrochloric acid. There was nothing to indicate whether or not this core was from the Second White Specks interval. This core did not look 'typical' of the Second White Specks Formation. Grain sizes all the way up to pebble size were observed. Very few shells or siderite were seen. The core resembles what would be expected for the Belle Fourche Formation, but this is unclear.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Imperial Oil Resources Limited
Well Name:	Imp Cdn-Sup Pembina 14-29 Br-48-6
Location:	
UWI:	100142904806W500
Pool:	Belly River 1 (126009)
Field:	Pembina (685)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	851.9 m
Cut(-) / Fill(+):		Kelly Bushing:	856.5 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

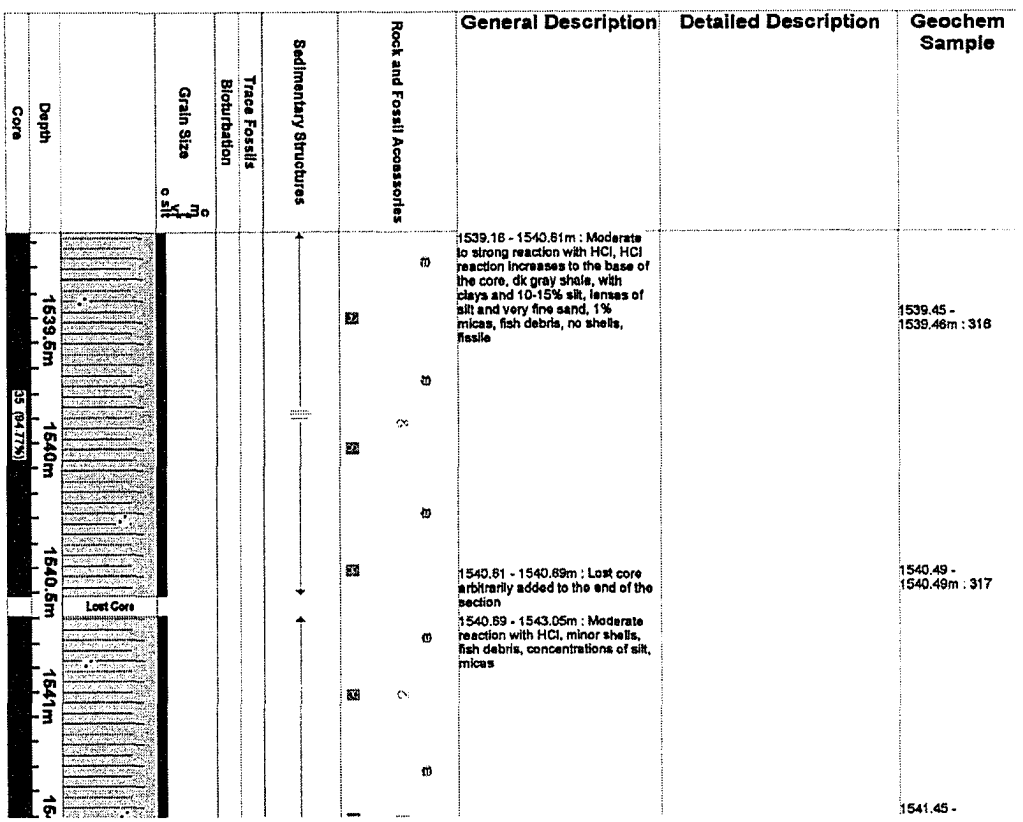
Well Type:	Straight
Longitude:	-114.844461
Latitude:	53.176285
N / S Co - Ordinates:	163.0
E / W Co - Ordinates:	603.5

Bottom Hole Co - Ordinates

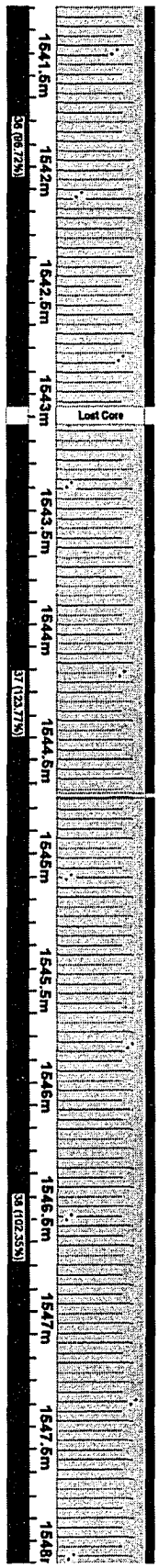
Longitude:	1-14.844461
Latitude:	53.176285
N / S Co - Ordinates:	163.0
E / W Co - Ordinates:	603.5

Well Summary

Spud Date:	Oct 25, 1953	Contractor:	
TD Date:		Rig Release Date:	May 28, 1954



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



1543.05 - 1543.13m : Lost core arbitrarily added to the end of the core

1543.13 - 1545.57m : Moderate to strong reaction with HCl, HCl reaction increasing downwards, mica rich, 5-10% silt and silt lenses, fish debris, shelly debris

1545.57 - 1546.15m : Extra core in core 37

1545.57 - 1547.75m : Strong reaction with HCl, abundant micas, shells, fish debris, 5-10% silt as lenses and lams, quartz grains

1547.7 - 1547.75m : Extra core in core 38

1547.7 - 1549.88m : Strong reaction with HCl, dk gray shale, a few shells, concentrations and lams of silt, fish debris

1541.65m : Concentrated layer of fish debris

1541.72m : White specks, concentrated shelly/fish debris

1542.09m : Shelly layer

1544.08m : Thin lams composed of concentrations of white specks

Large shell

1544.73m : 1cm (reworked?) clast of bentonite, quartz, large black mica flakes

1545.08m : Thin lams of concentrated white specks

Medium sand sized quartz grains

1547.32m : Black vitreous organics, breaking randomly

Very large shells

1541.45 - 1541.45m : 318

1542.45 - 1542.46m : 319

1543.49 - 1543.5m : 320

1544.37 - 1544.38m : 321

1545.45 - 1545.46m : 322

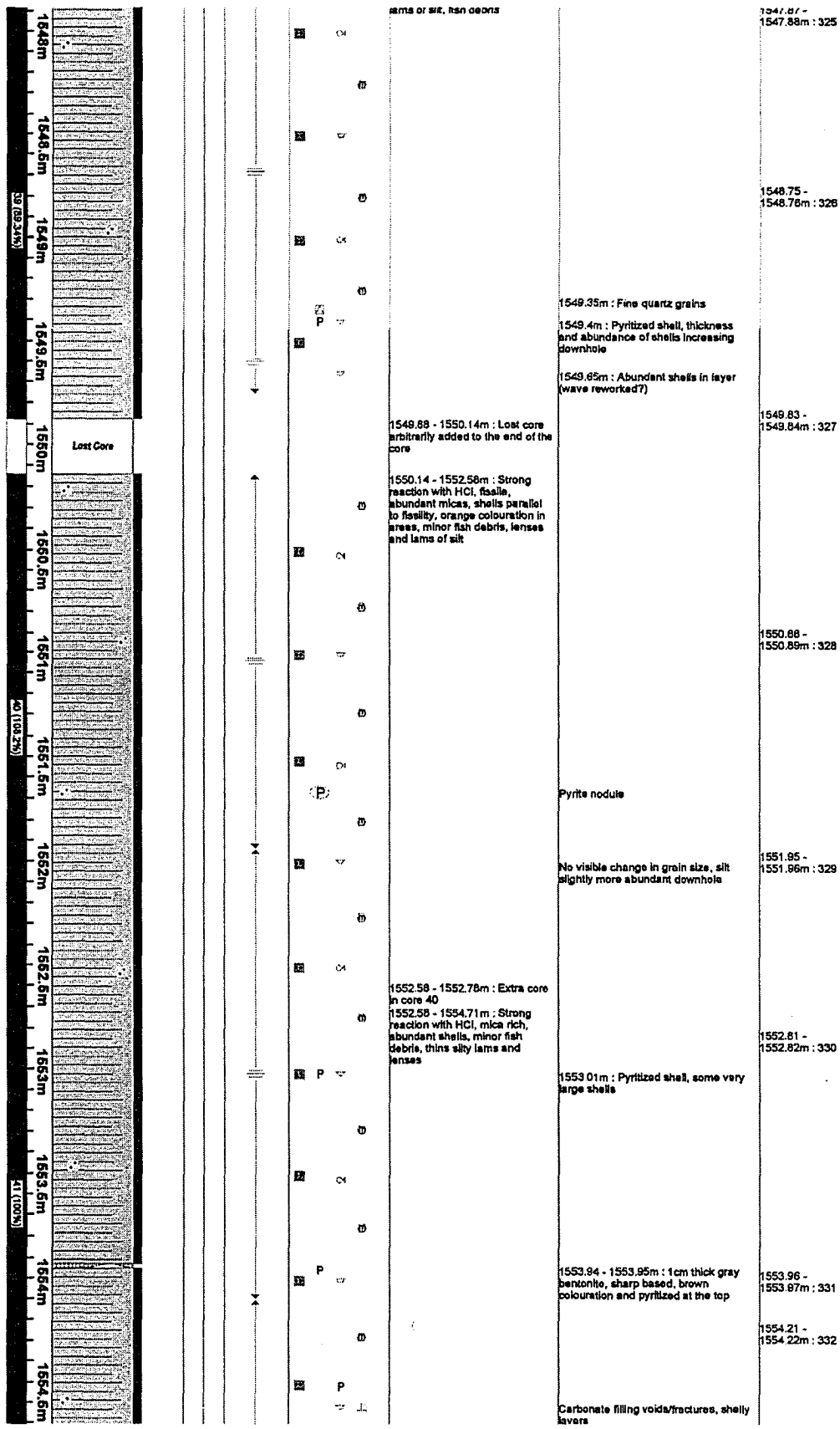
1546.09 - 1546.1m : 323

1546.98 - 1546.99m : 324

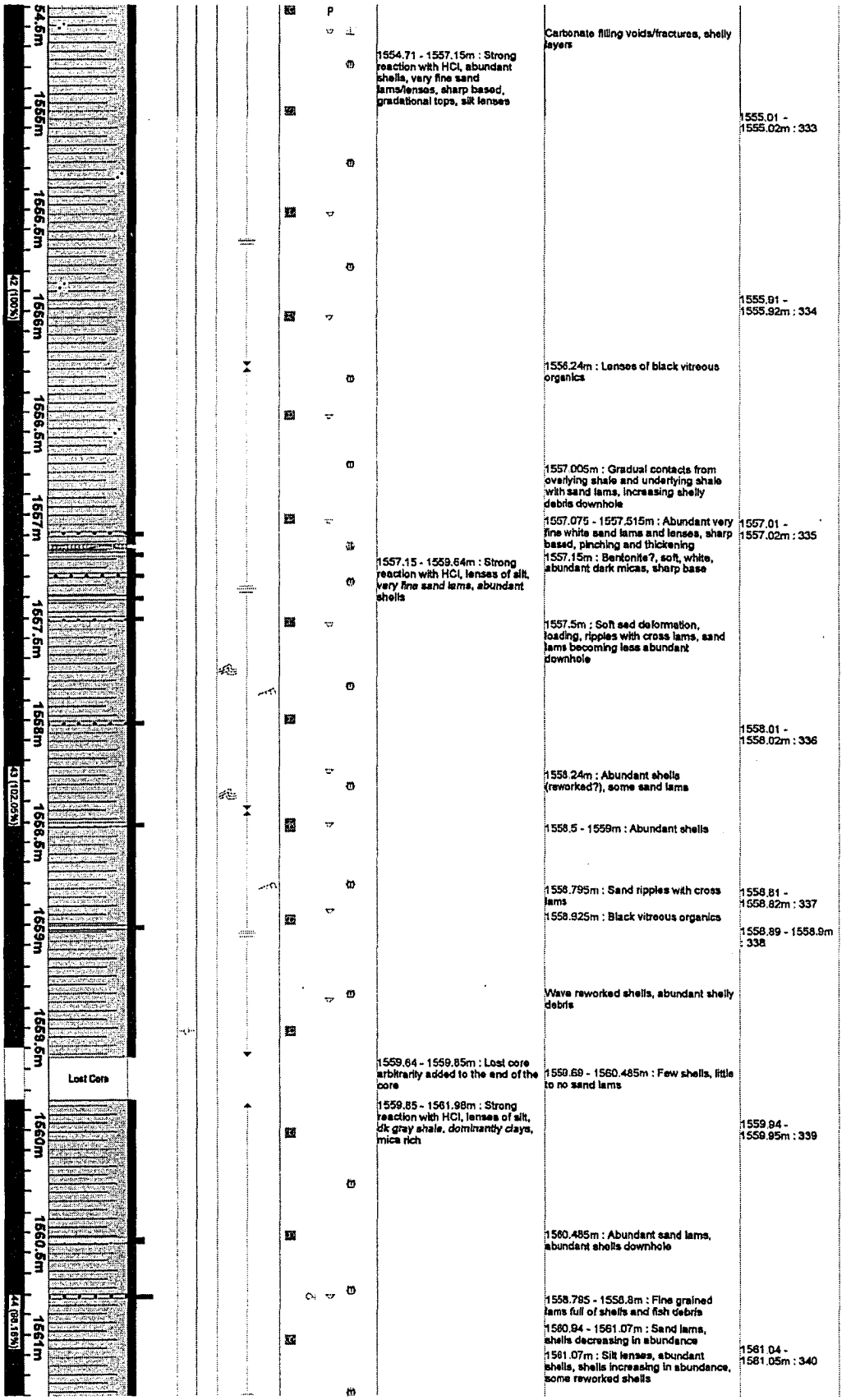
1547.45 - 1547.47m : 4514

1547.87 - 1547.88m : 325

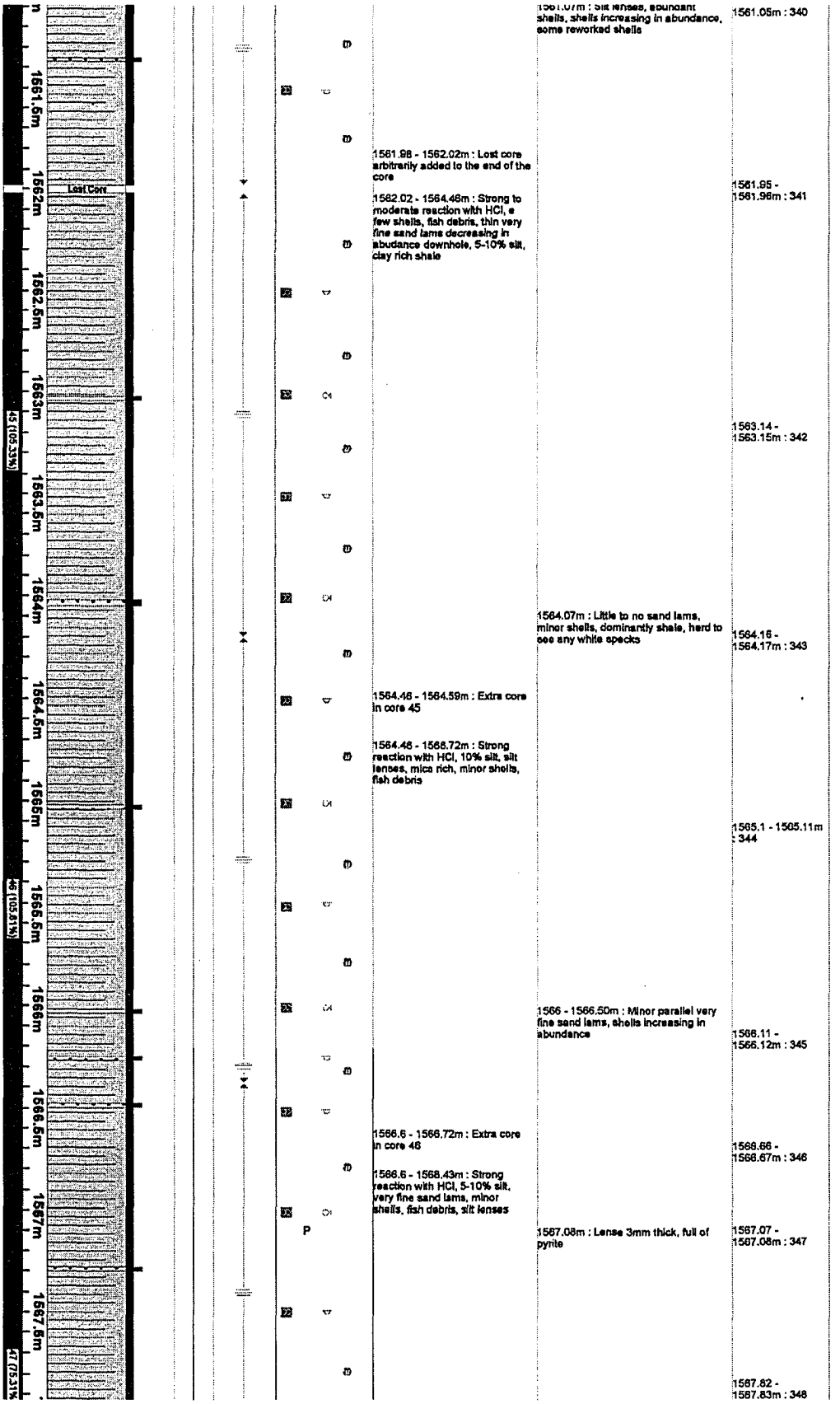
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



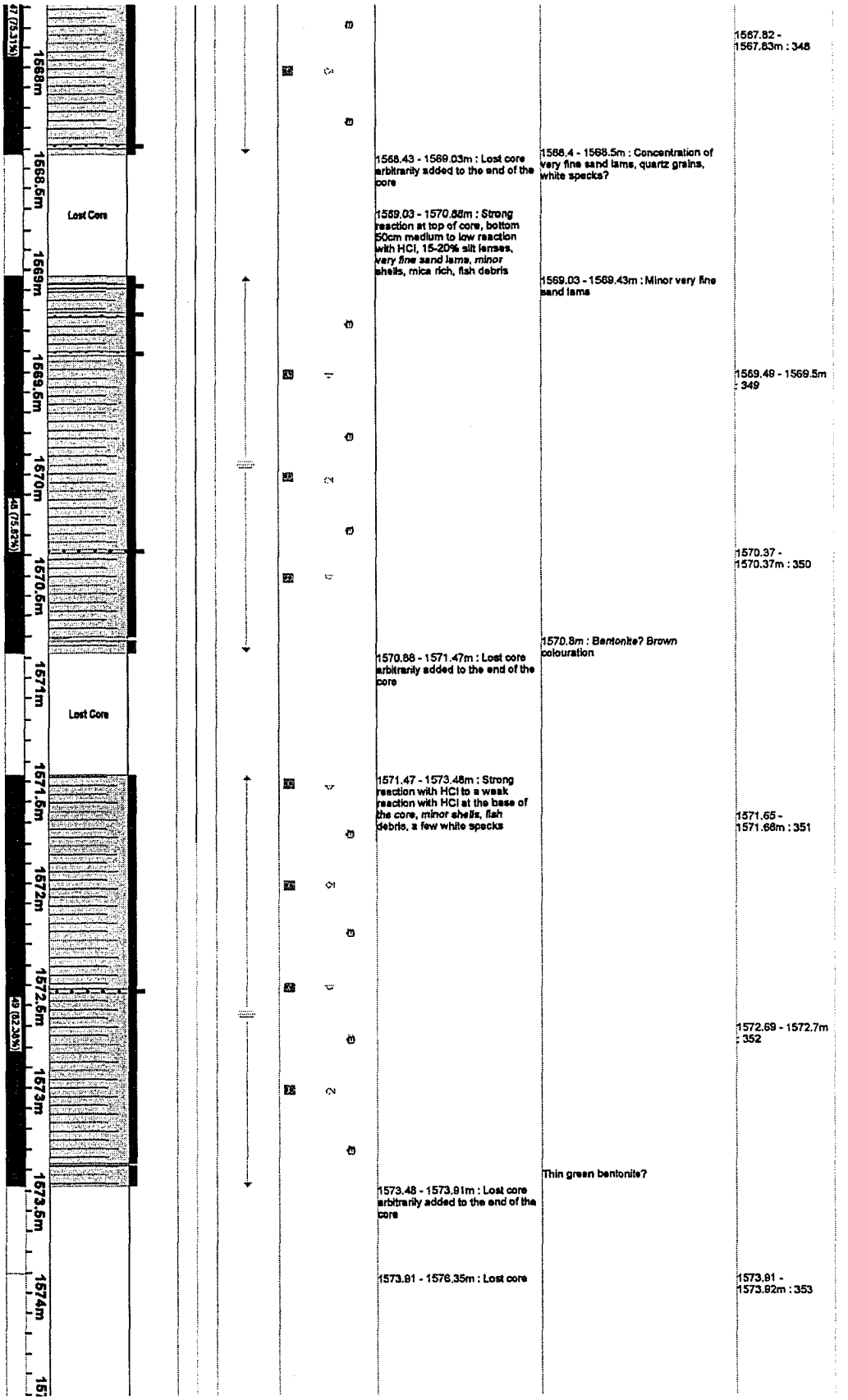
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



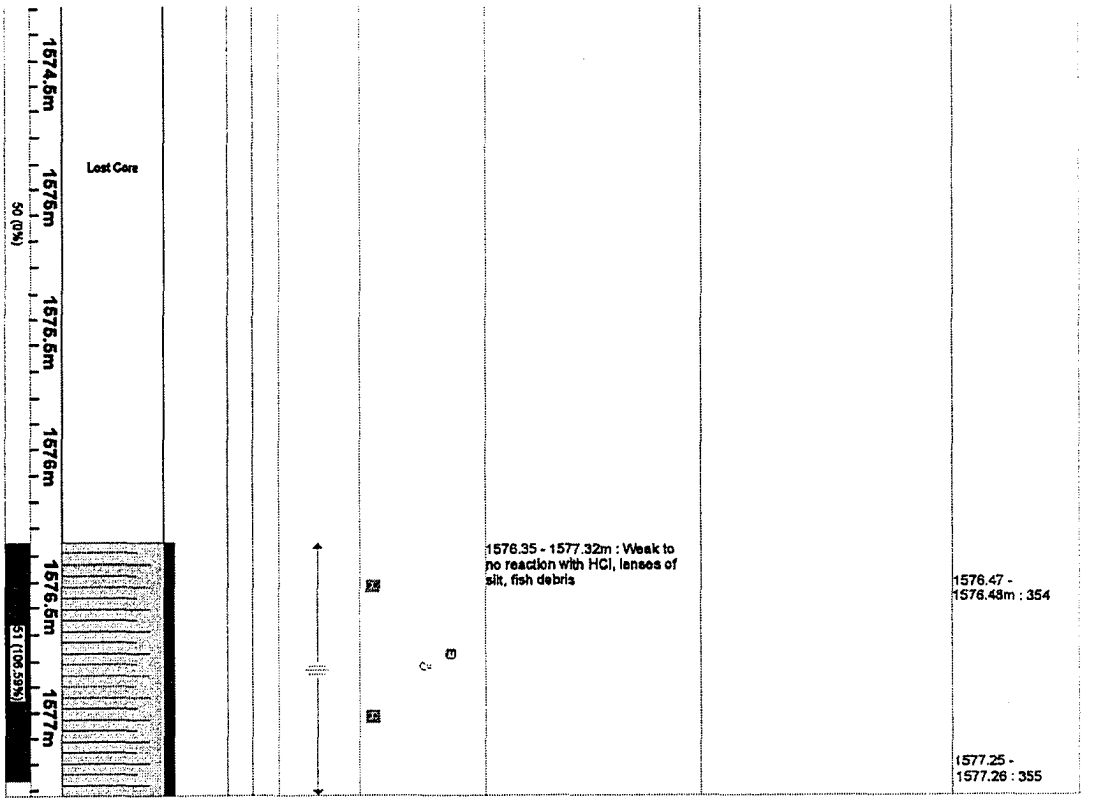
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Canadian Natural Resources Limited
Well Name:	CNRL Pine 15-21-56-19
Location:	
UWI:	100152105619W500
Pool:	Cardium, 2WPSK, U Mann M... (177660)
Field:	Pine Creek (706)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	1353.9 m
Cut(-) / Fill(+):		Kelly Bushing:	1357.6 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

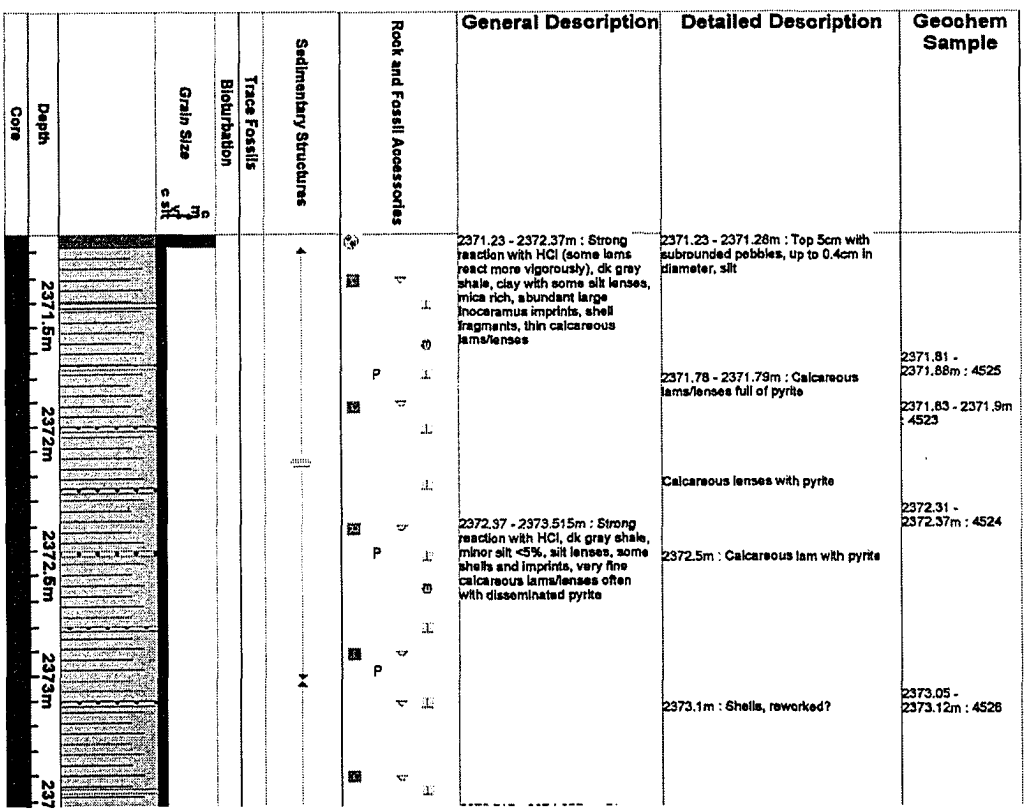
Well Type:	Straight
Longitude:	-116.756922
Latitude:	53.857979
N / S Co - Ordinates:	332.7
E / W Co - Ordinates:	439.5

Bottom Hole Co - Ordinates

Longitude:	-116.756922
Latitude:	53.857979
N / S Co - Ordinates:	332.7
E / W Co - Ordinates:	439.5

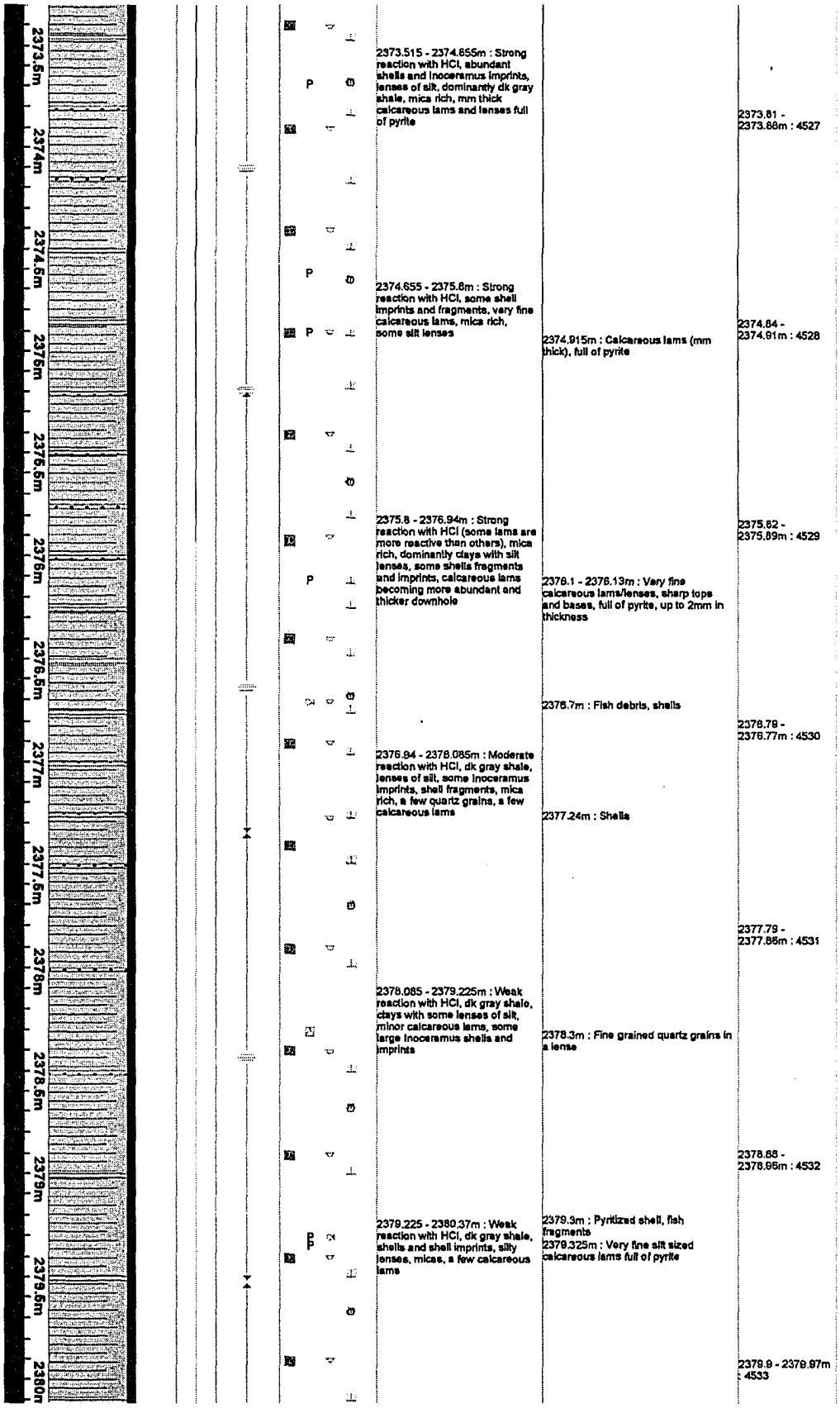
Well Summary

Spud Date:	Oct 2, 1977	Contractor:	
TD Date:		Rig Release Date:	Oct 30, 1977

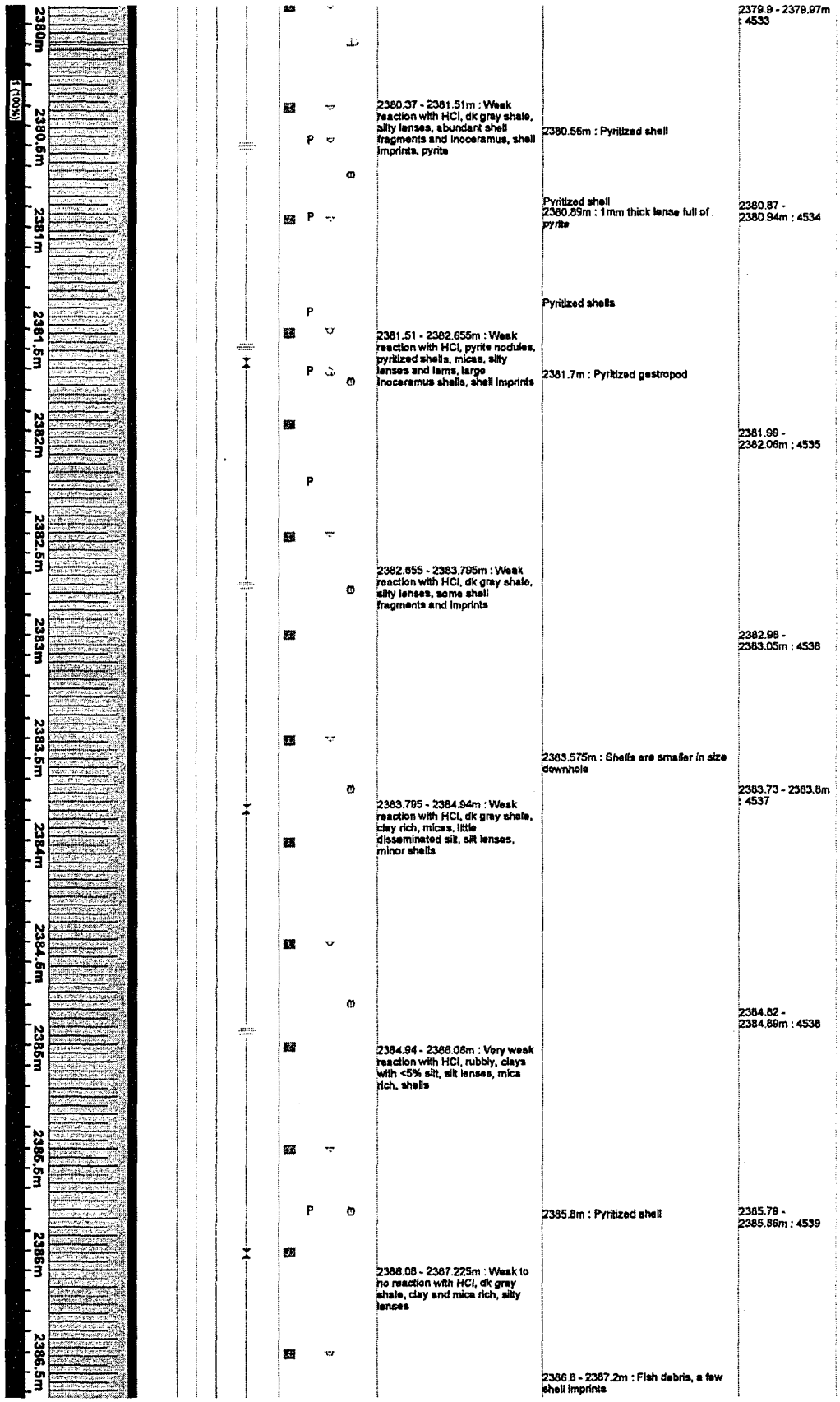


General Description	Detailed Description	Geochem Sample
2371.23 - 2372.37m : Strong reaction with HCl (some lams react more vigorously), dk grey shale, clay with some silt lenses, mica rich, abundant large Inoceramus imprints, shell fragments, thin calcareous lams/lenses	2371.23 - 2371.28m : Top 5cm with subrounded pebbles, up to 0.4cm in diameter, silt	
	2371.78 - 2371.79m : Calcareous lams/lenses full of pyrite	2371.81 - 2371.88m : 4525
		2371.83 - 2371.9m : 4523
	Calcareous lenses with pyrite	
2372.37 - 2373.515m : Strong reaction with HCl, dk gray shale, minor silt <5%, silt lenses, some shells and imprints, very fine calcareous lams/lenses often with disseminated pyrite	2372.5m : Calcareous lam with pyrite	2372.31 - 2372.37m : 4524
	2373.1m : Shells, reworked?	2373.05 - 2373.12m : 4526

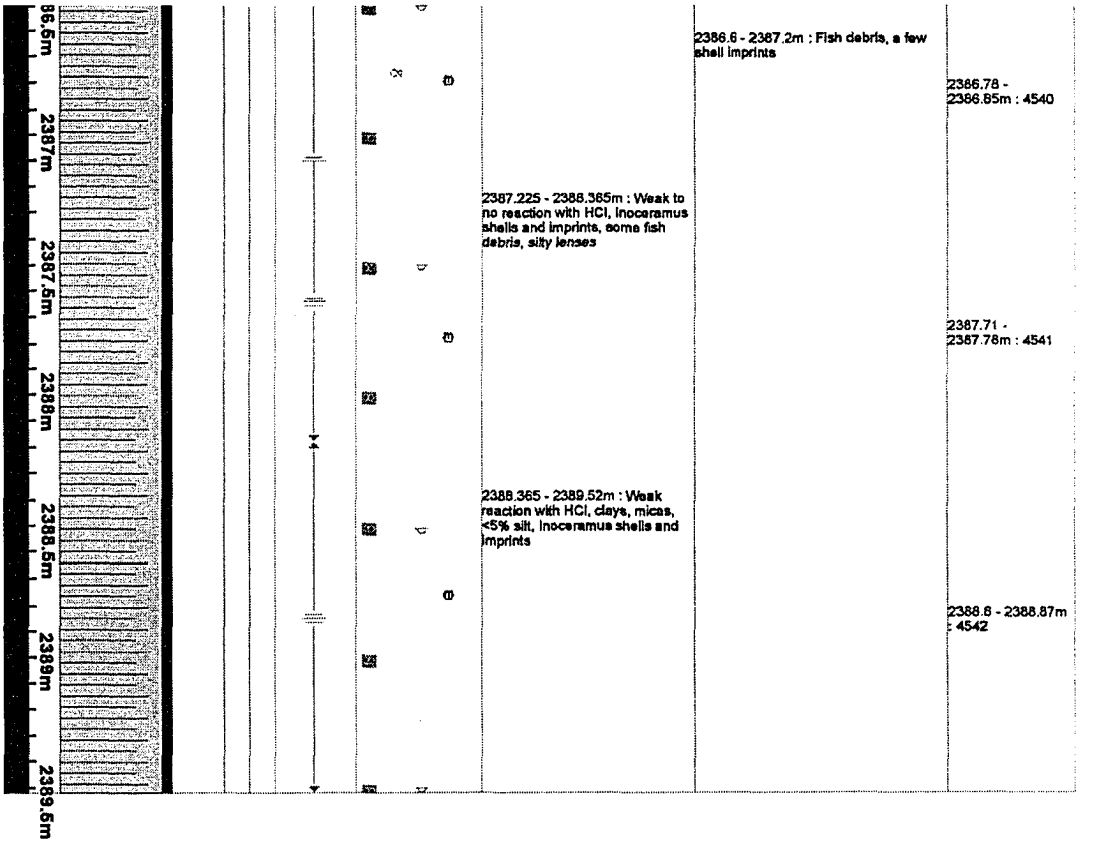
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



00/15-21-056-19W5/0: CNRL Pine 15-21-56-19

Core: 2371.23m – 2389.52m

Second White Specks interval from cross section: Not in cross section

Observations:

The base of the core is composed of a dark grey shale, dominated by clays with minor silt. There is weak to no reaction with hydrochloric acid. Some *Inoceramus* shells and imprints are visible. Moving up the logged core, there is minor disseminated pyrite, along with a few pyritized shells. At 2380m depth, shells become more abundant. Sandy calcareous laminations become visible, along with an increase in reaction with hydrochloric acid. Planar parallel laminations are present. The top 5cm of core consists of sub rounded pebbles, up to 0.4cm in diameter with concentrations of silt.

Interpretation:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Based on the log signatures, it appears that this core lies near the base of the Second White Specks Formation interval. Using micropaleontology, the core could not be confirmed to be the Second White Specks Formation. The base of the core was most likely deposited during a sea level rise because of the fine grained sediments coupled with the lack of sand. Silt appears to have been concentrated along bedding planes due to the action of bottom currents. The core was fairly homogeneous, indicating stable conditions, until 2380m depth, where sandy calcareous laminations are visible along with an increase in the abundance of fish and shelly debris. Current activity increased and most likely concentrated the sandy laminations and allowed for the deposition of coarser grains in the deeper environment. Disseminated pyrite and abundant organic debris are preserved, therefore, the environment was most likely more reduced. The deposition of fine grained sediments within a low energy environment continued up hole until the top of the core where pebbles are observed. Pebble sized sediments are not expected within the Second White Specks Formation. This, in conjunction with the fact that no white specks are observed indicates that the core is most likely of another formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Imperial Oil Resources Limited
Well Name:	Imperial-Battle Lake No 1
Location:	
UWI:	100161204603W500
Pool:	Undefined Pool (999998)
Field:	Pembina (685)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	933.9 m
Cut(-) / Fill(+):		Kelly Bushing:	936.3 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

Well Type:	Straight
Longitude:	-114.293665
Latitude:	52.957954
N / S Co - Ordinates:	201.0
E / W Co - Ordinates:	200.8

Bottom Hole Co - Ordinates

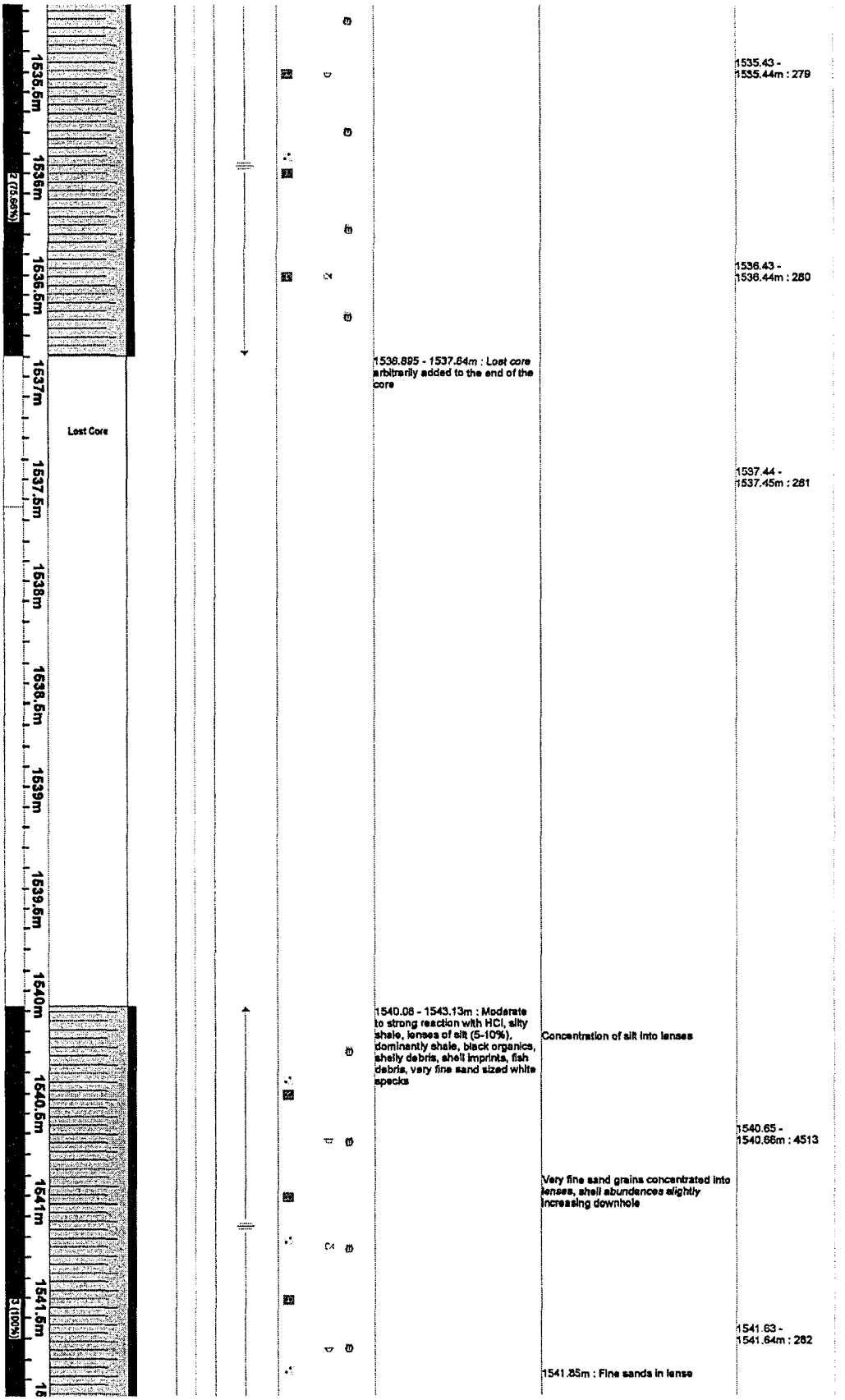
Longitude:	-114.293665
Latitude:	52.957954
N / S Co - Ordinates:	201.0
E / W Co - Ordinates:	200.8

Well Summary

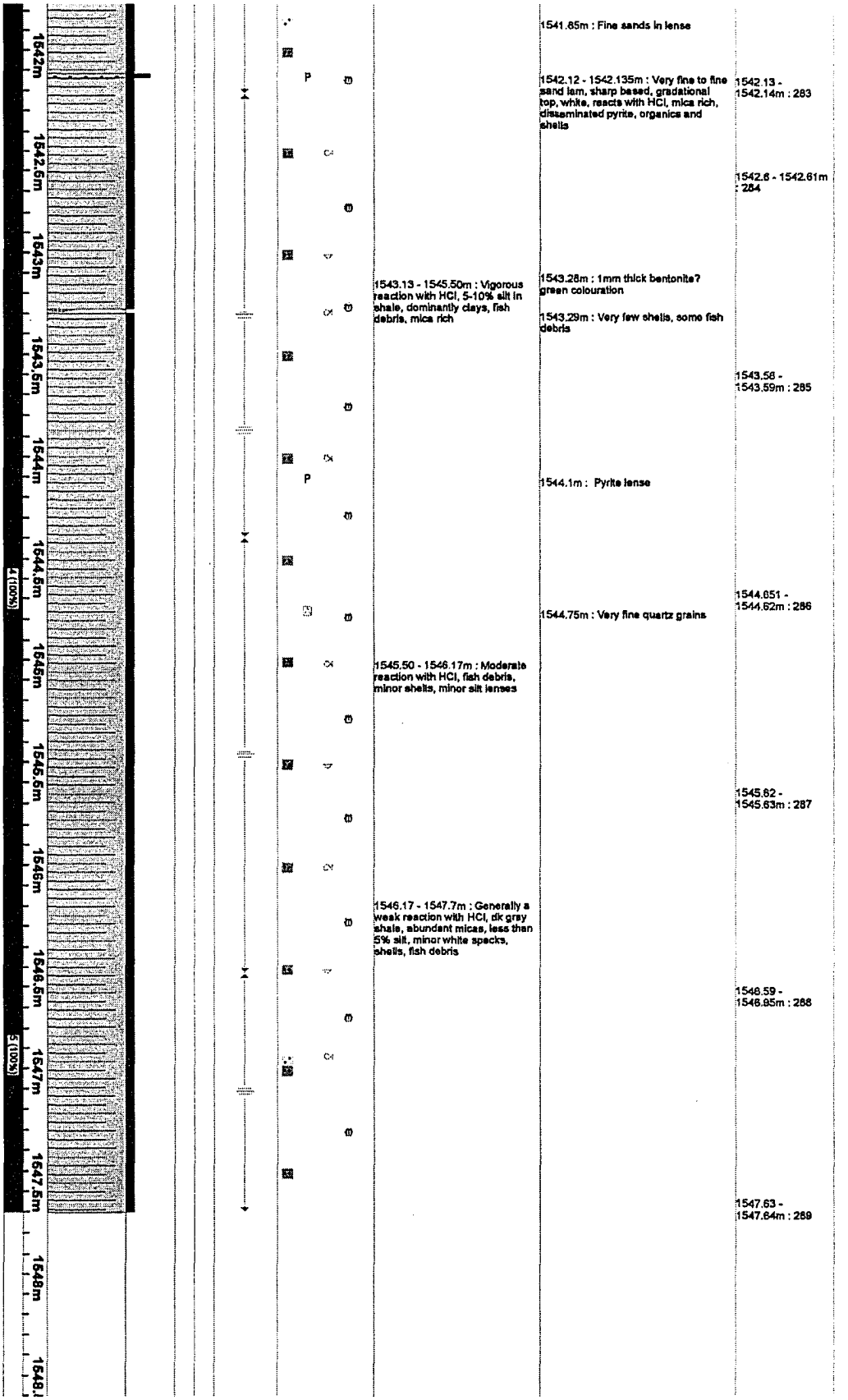
Spud Date:	Jun 23, 1947	Contractor:	
TD Date:		Rig Release Date:	Jan 3, 1948

Core	Depth	Grain Size	Bioturbation	Trace Fossils	Sedimentary Structures	Rock and Fossil Accessories	General Description	Detailed Description	Geochem Sample
1 (100%)	1533.5m 1534m 1534.5m 1535m	clay silt vf f m c					1533.07 - 1534.6m : Weak to moderate reaction with HCl, dk gray shale, very fine white specks concentrated in lenses, mica rich, minor silt lenses <10%, clays, disseminated pyrite, shells, shelly debris and imprints 1534.6 - 1536.895m : Moderate reaction with HCl, shale with less than 5% silt, shelly debris and imprints, black organic material, fish debris	Concentrations of silt and sand into lenses 1533.65m : Silt content increased downhole to 15-20% silt, disseminated pyrite 1534.355m : Pyritized shell 1534.6m : Some fish debris 1534.65m : Sand increasing in abundance downhole	1533.07 - 1533.08m : 4512 1533.43 - 1533.12m : 277 1534.44 - 1534.44m : 278

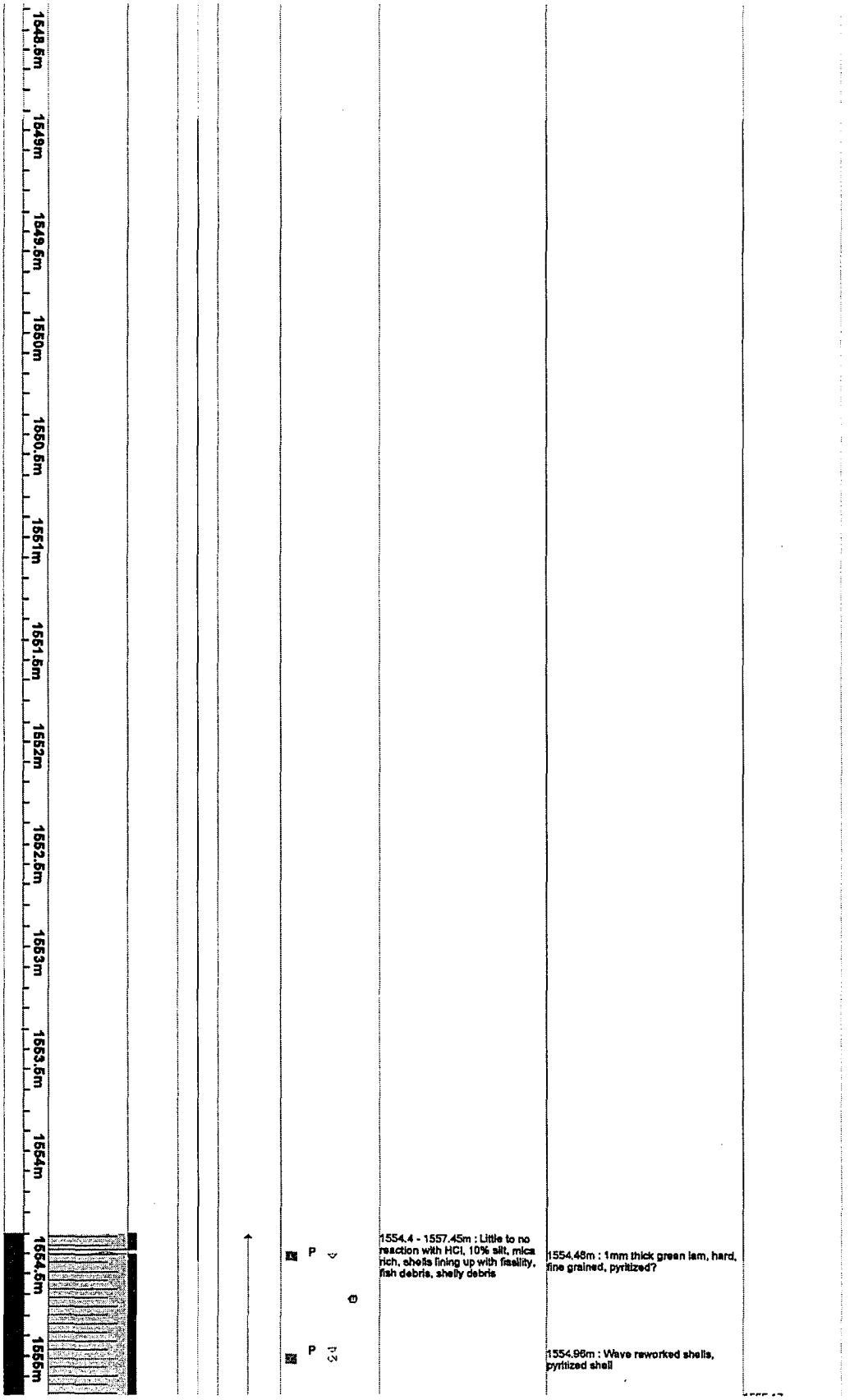
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



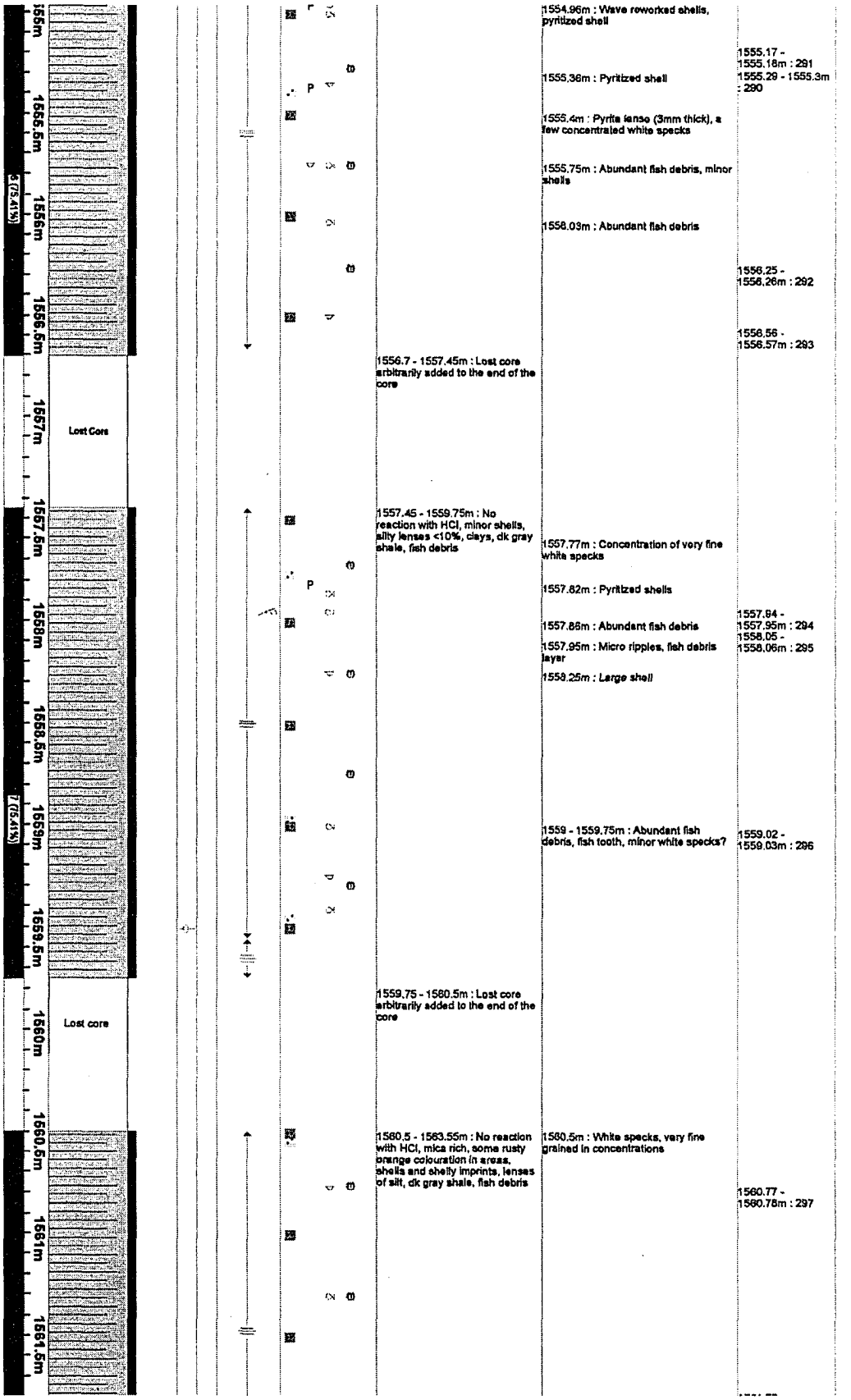
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



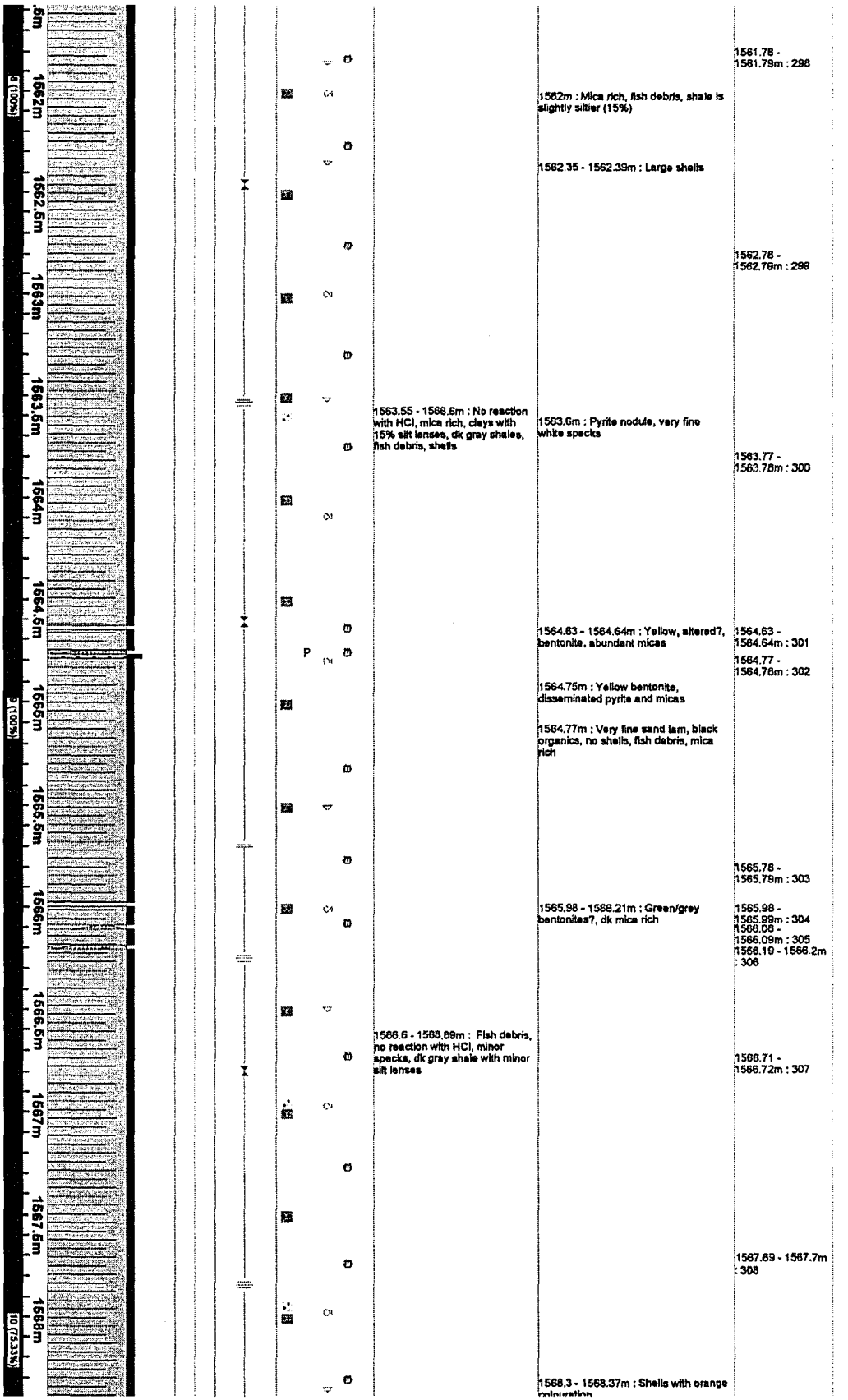
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



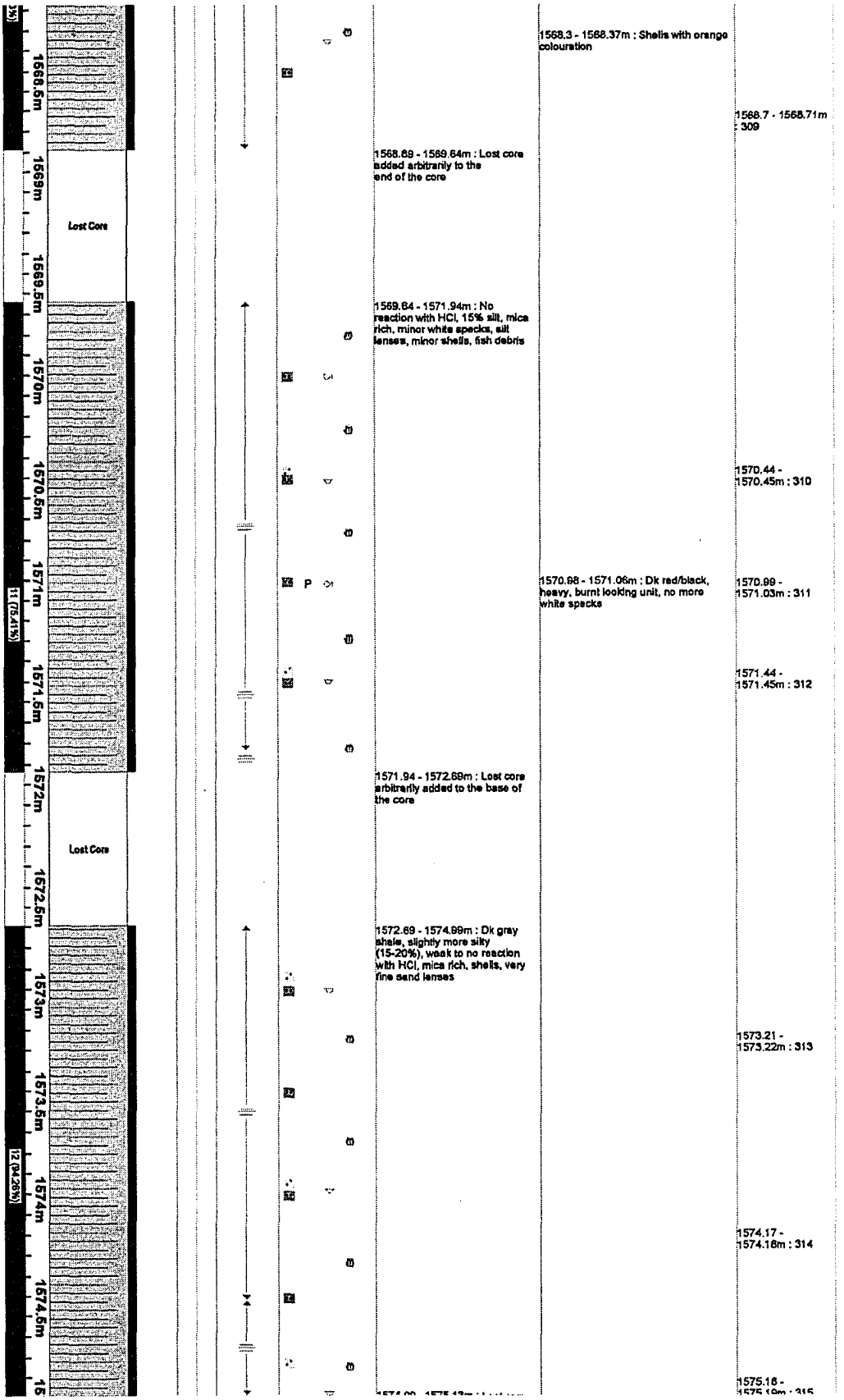
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



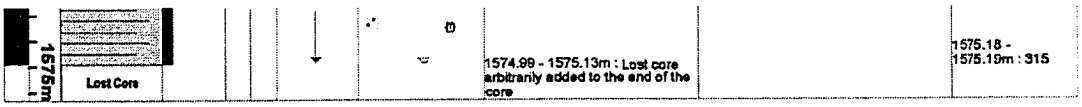
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Husky Oil Operations Limited
Well Name:	Husky Valhalla 16-22-75-8
Location:	
UWI:	100162207508W600
Pool:	Doe Creek 1 (190009)
Field:	Valhalla (920)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	904.6 m
Cut(-) / Fill(+):		Kelly Bushing:	907.6 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

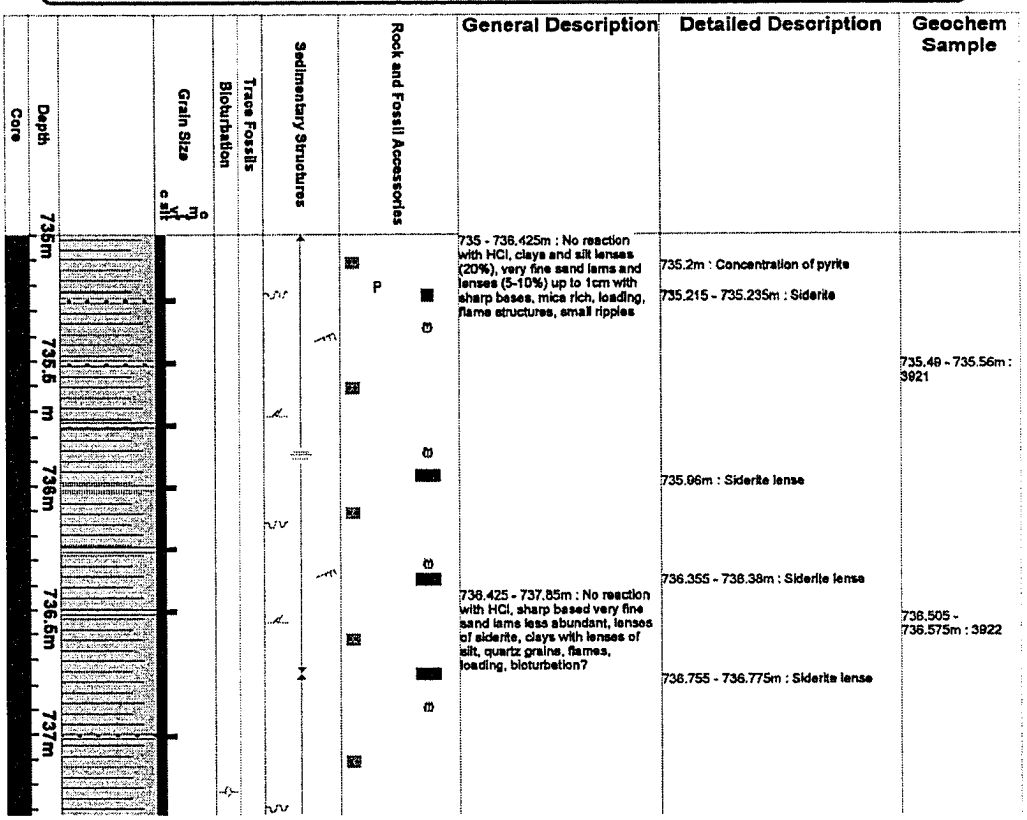
Well Type:	Straight
Longitude:	-119.137550
Latitude:	55.518915
N / S Co - Ordinates:	69.8
E / W Co - Ordinates:	49.7

Bottom Hole Co - Ordinates

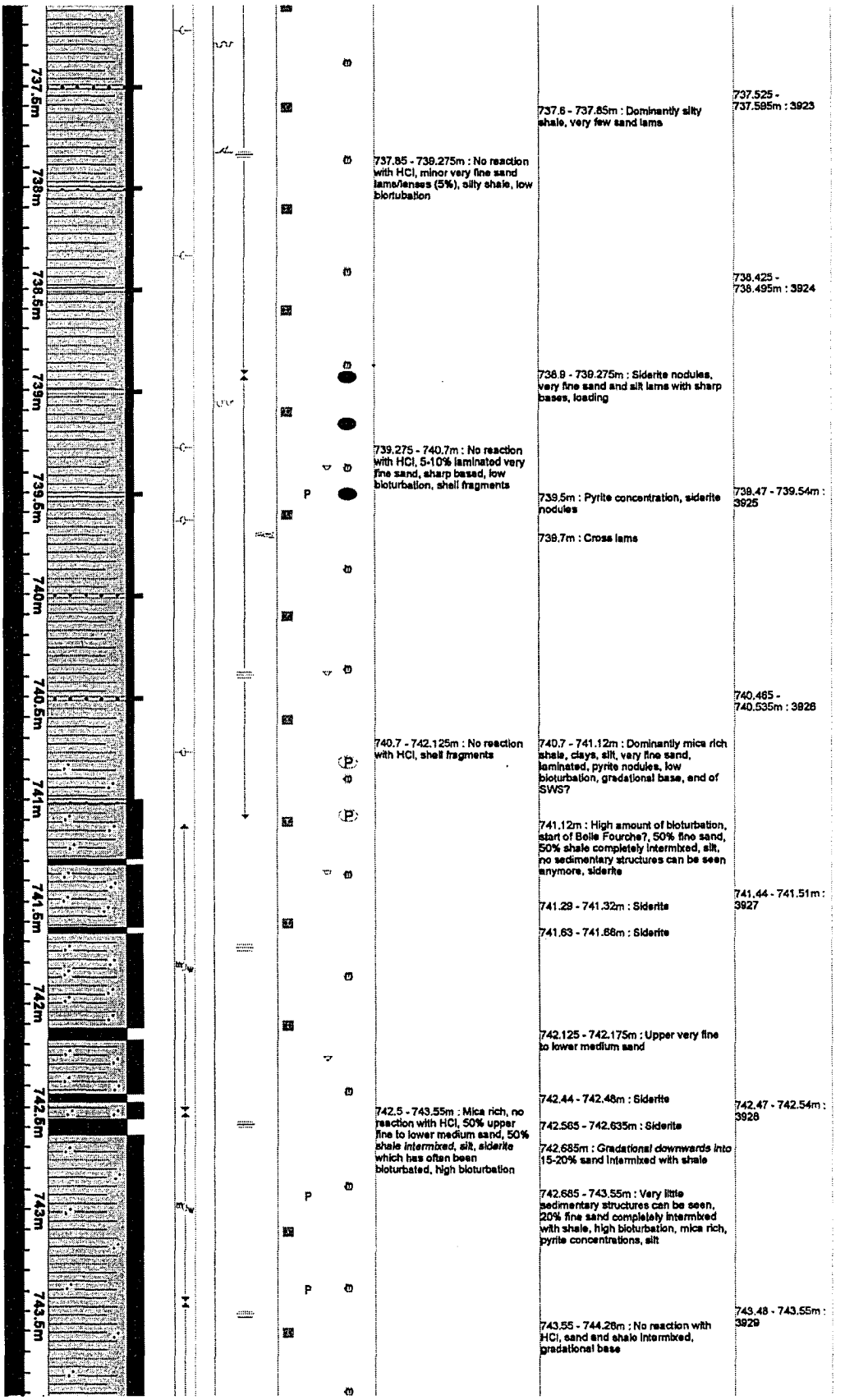
Longitude:	-119.137550
Latitude:	55.518915
N / S Co - Ordinates:	69.8
E / W Co - Ordinates:	49.7

Well Summary

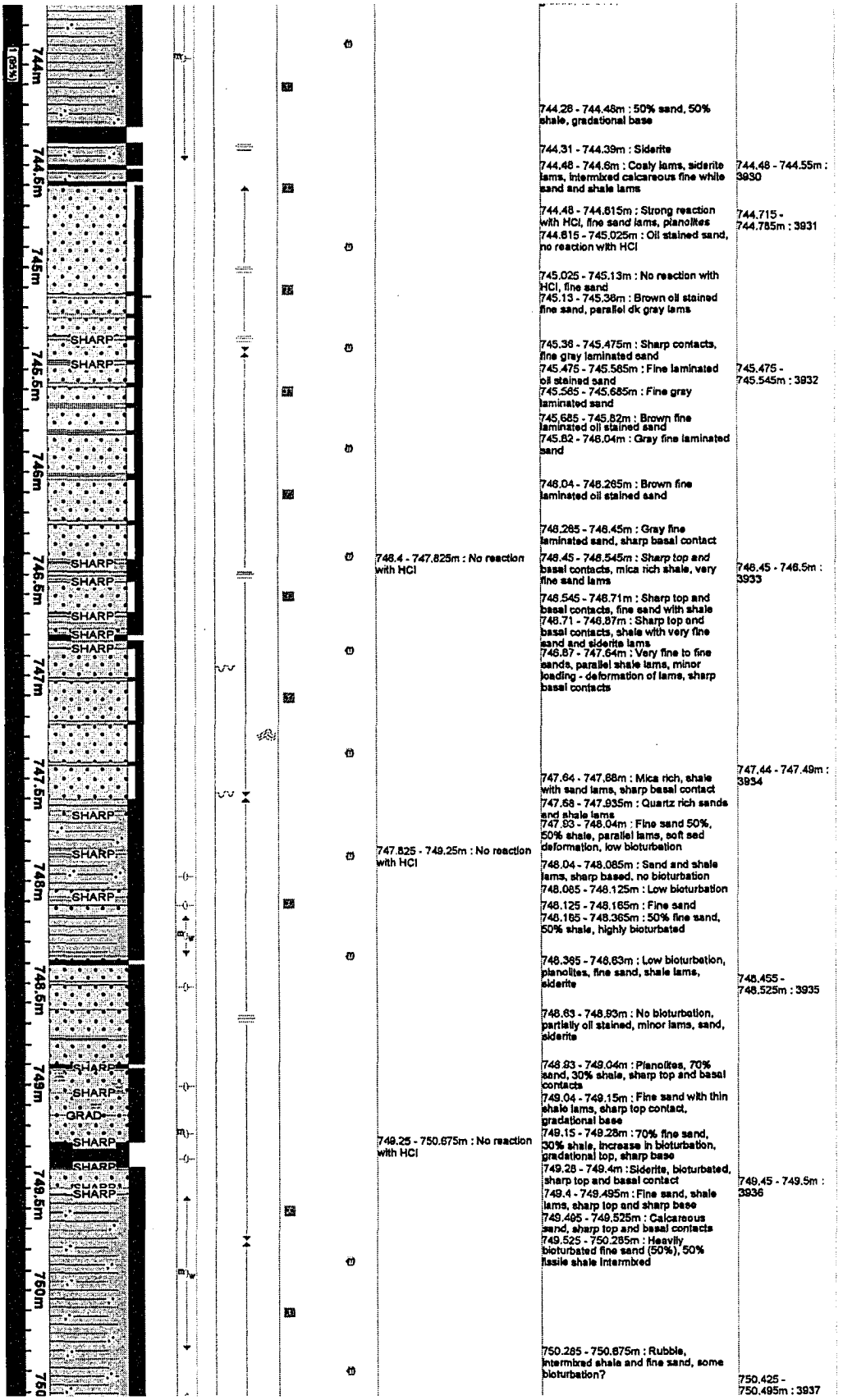
Spud Date:	Oct 19, 1984	Contractor:	
TD Date:		Rig Release Date:	Oct 25, 1984



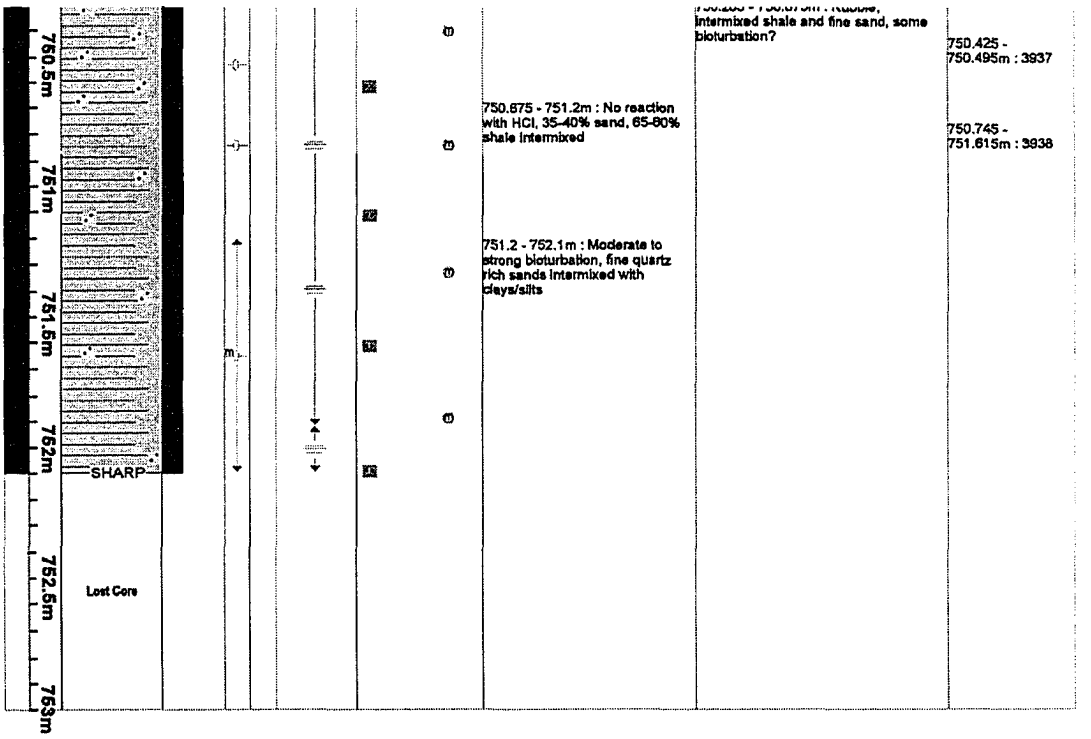
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



00/16-22-075-08W6/0: Husky Valhalla 16-22-75-8

Core: 735m – 752.1m

Second White Specks interval from cross section: 658m - ?

Observations:

The base of the core consists of a dark grey shale with fine sand lenses. There is moderate to strong bioturbation. There is no reaction with hydrochloric acid. Up the core, the percentage of sand increases, and siderite concretions are observed. Bioturbation is observed in many locations, as well as some loading and soft sediment deformation. In between 744m and 746m depth, oil staining is observed. Above this, there is approximately 50% sand, 50% shale with abundant bioturbation. Siderite and pyrite is observed. The percentage of sand decreases up section, along with the amount of bioturbation. There is no reaction with hydrochloric acid, however, ripples and soft sediment deformation becomes visible.

Interpretation:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

It is not known from the geophysical logs whether or not this core lies within the Second White Specks Formation because the logs do not extend to the depth of the core. However, based on the core, this interval does not appear to be the Second White Specks interval. It appears more likely to be the Belle Fourche Formation, or a lower interval. The abundant bioturbation, the high percentage of sand and the presence of siderite resembles the Belle Fourche Formation. No white specks were observed, nor was there much reaction with hydrochloric acid, which would be expected of the Second White Specks.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Canadian Natural Resources Limited
Well Name:	Rax Et Al 102 Ka Karr 6-30-64-1
Location:	
UWI:	102063006401W600
Pool:	Unknown
Field:	Underfined - Alta (998)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	836.1 m
Cut(-) / Fill(+):		Kelly Bushing:	840.5 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

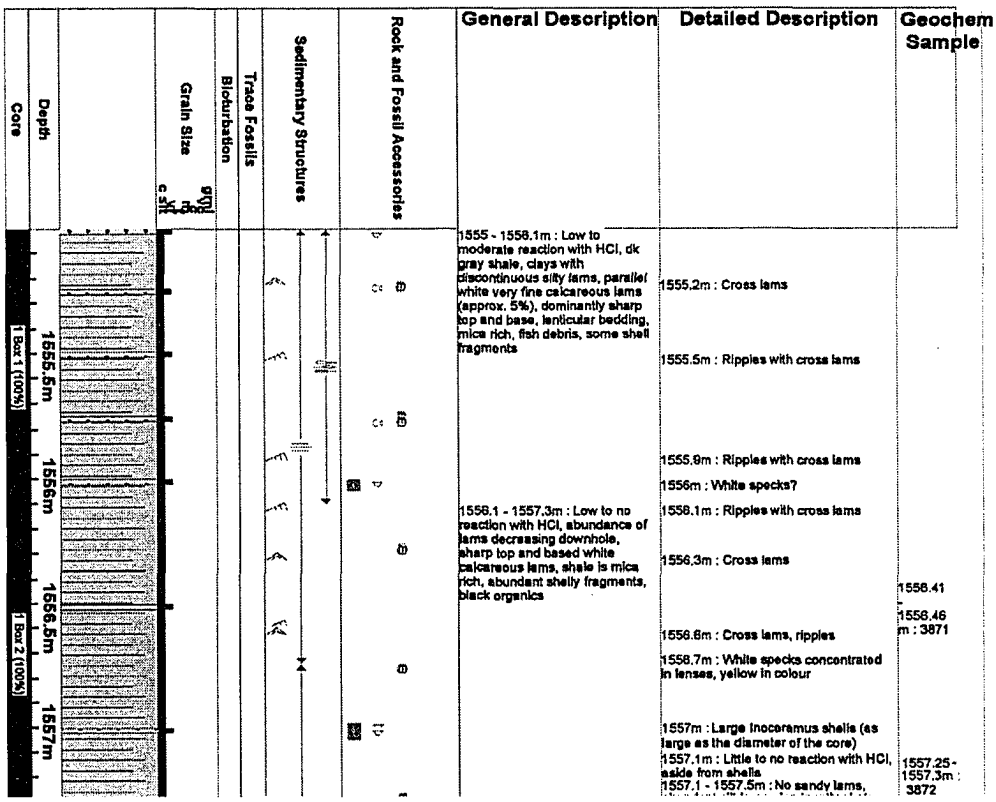
Well Type:	Straight
Longitude:	118.138962
Latitude:	54.565516
N / S Co - Ordinates:	636.3
E / W Co - Ordinates:	706.0

Bottom Hole Co - Ordinates

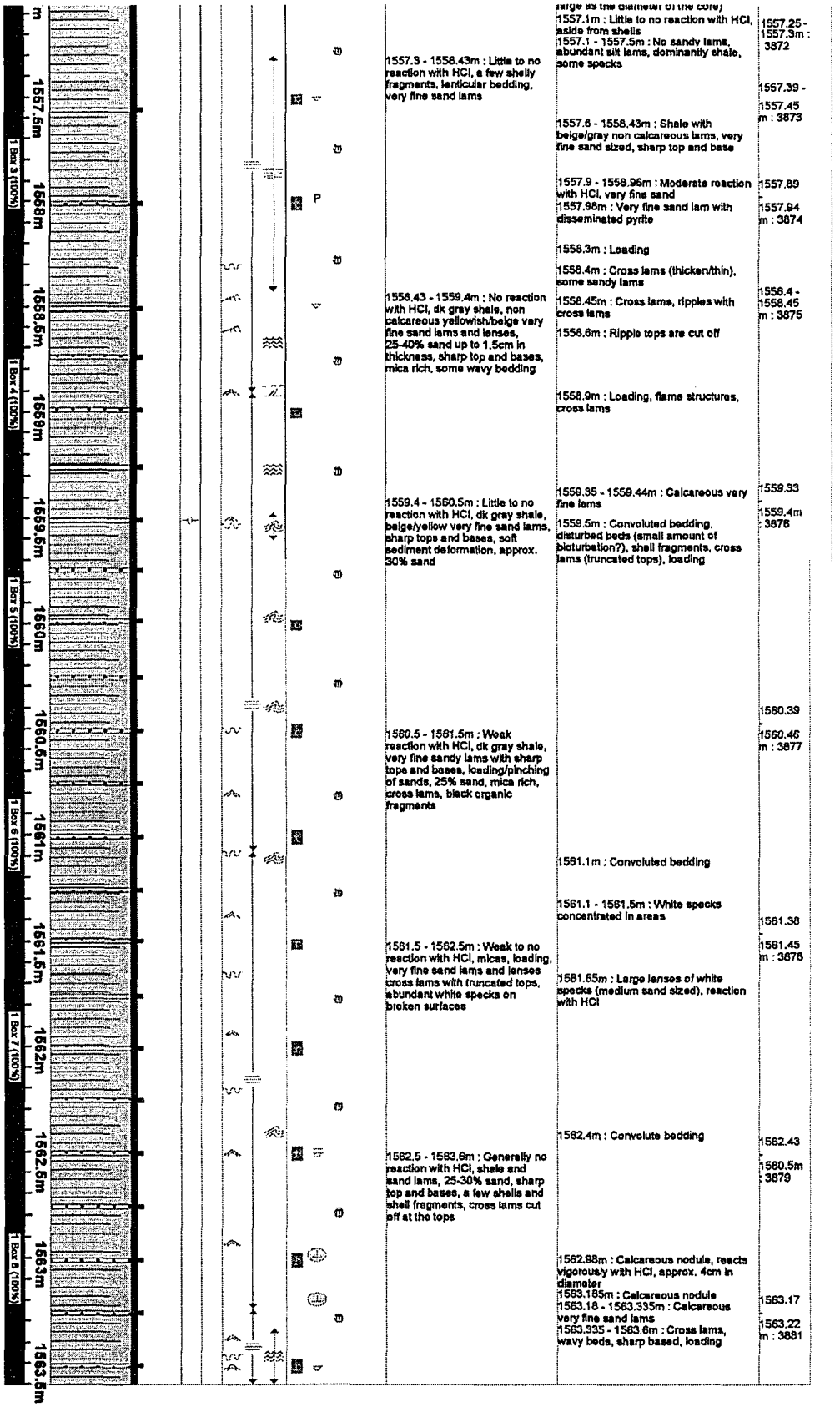
Longitude:	118.138962
Latitude:	54.565516
N / S Co - Ordinates:	636.3
E / W Co - Ordinates:	706.0

Well Summary

Spud Date:	Dec 30, 1993	Contractor:	
TD Date:		Rig Release Date:	Jan 10, 1994



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Husky Oil Operations Limited
Well Name:	Husky Et Al Skinner 7-33-52-15
Location:	
UWI:	102073305215W500
Pool:	Second White Speck Undef (186098)
Field:	Edson (320)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	922.5 m
Cut(-) / Fill(+):		Kelly Bushing:	926.5 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

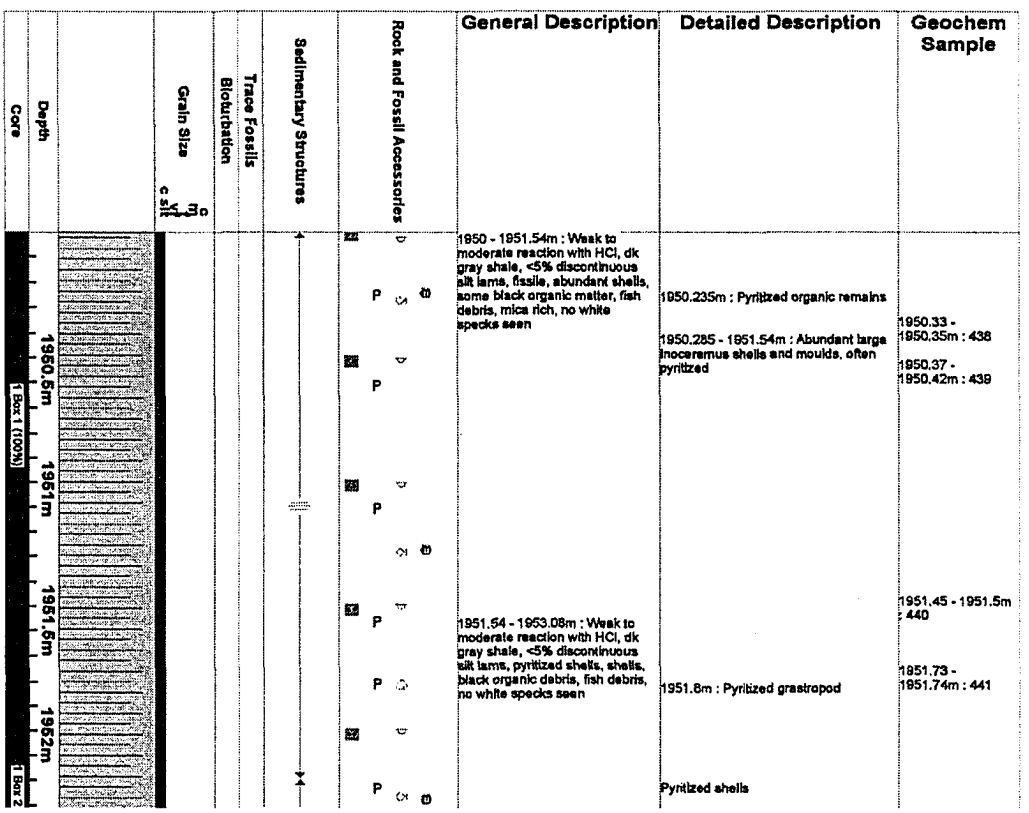
Well Type:	Straight
Longitude:	-116.145474
Latitude:	53.533243
N / S Co - Ordinates:	748.4
E / W Co - Ordinates:	490.1

Bottom Hole Co - Ordinates

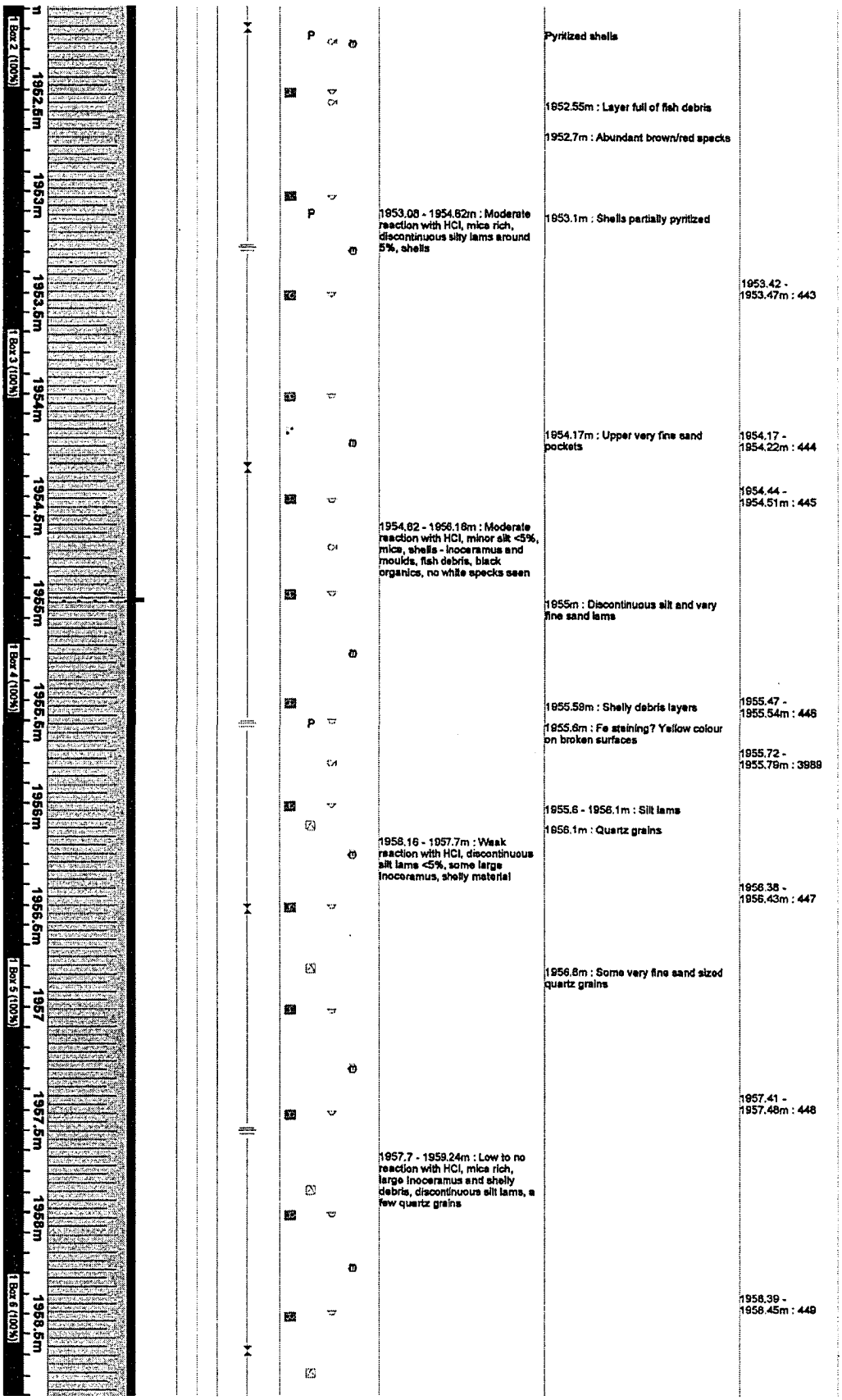
Longitude:	-116.145474
Latitude:	53.533243
N / S Co - Ordinates:	748.4
E / W Co - Ordinates:	490.1

Well Summary

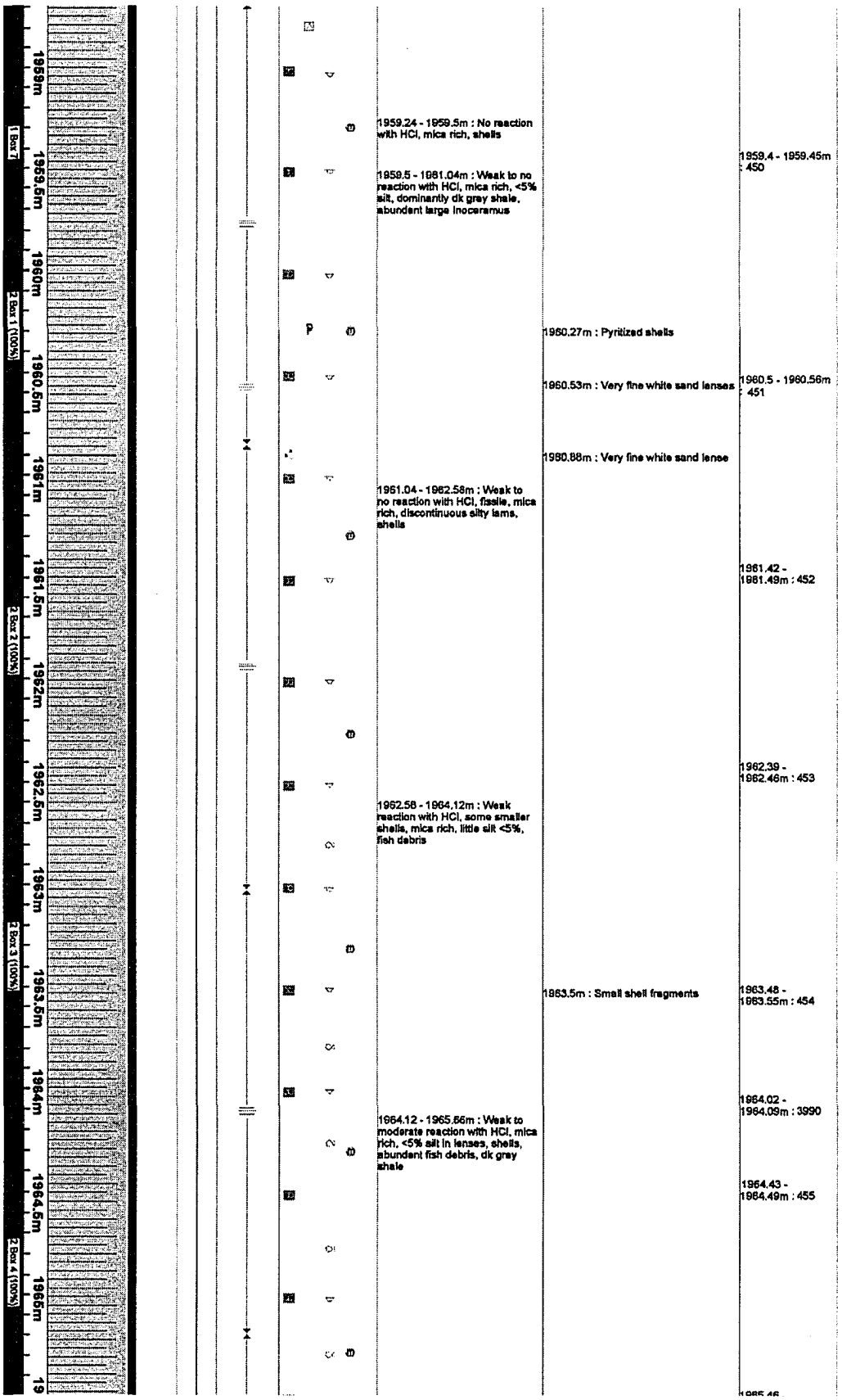
Spud Date:	Oct 30, 1988	Contractor:	
TD Date:		Rig Release Date:	Nov 26, 1988



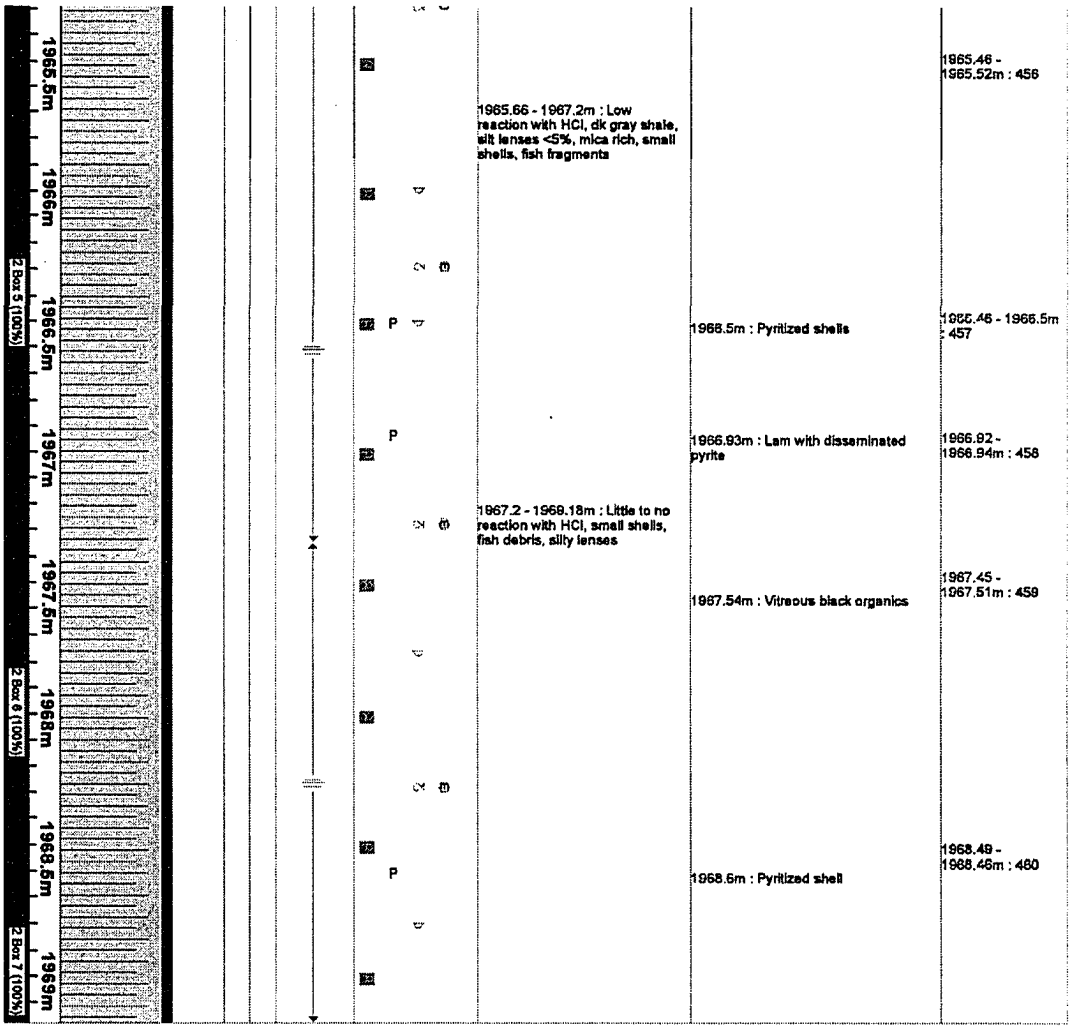
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	Canadian Natural Resources Limited
Well Name:	Rax Et Al 102 KA Karr 16-18-64-2
Location:	
UWI:	102161806402W600
Pool:	Unknown
Field:	Karr (515)A
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	870.7 m
Cut(-) / Fill(+):		Kelly Bushing:	875.2 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

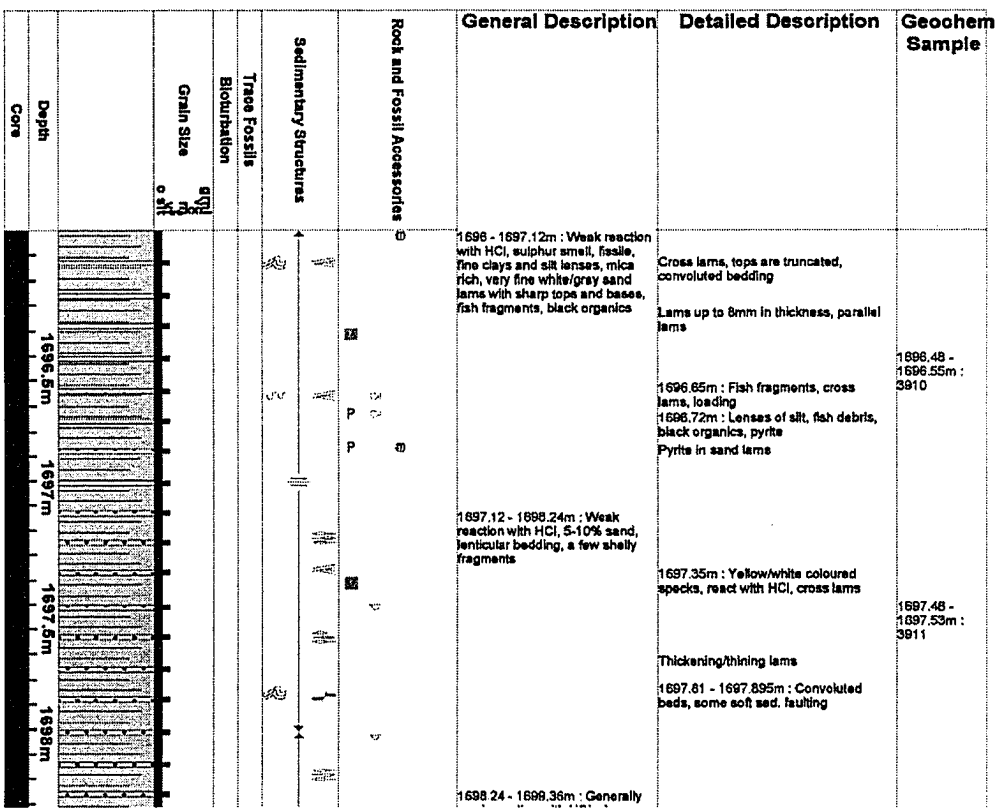
Well Type:	Straight
Longitude:	118.281382
Latitude:	54.541641
N / S Co - Ordinates:	395.1
E / W Co - Ordinates:	347.6

Bottom Hole Co - Ordinates

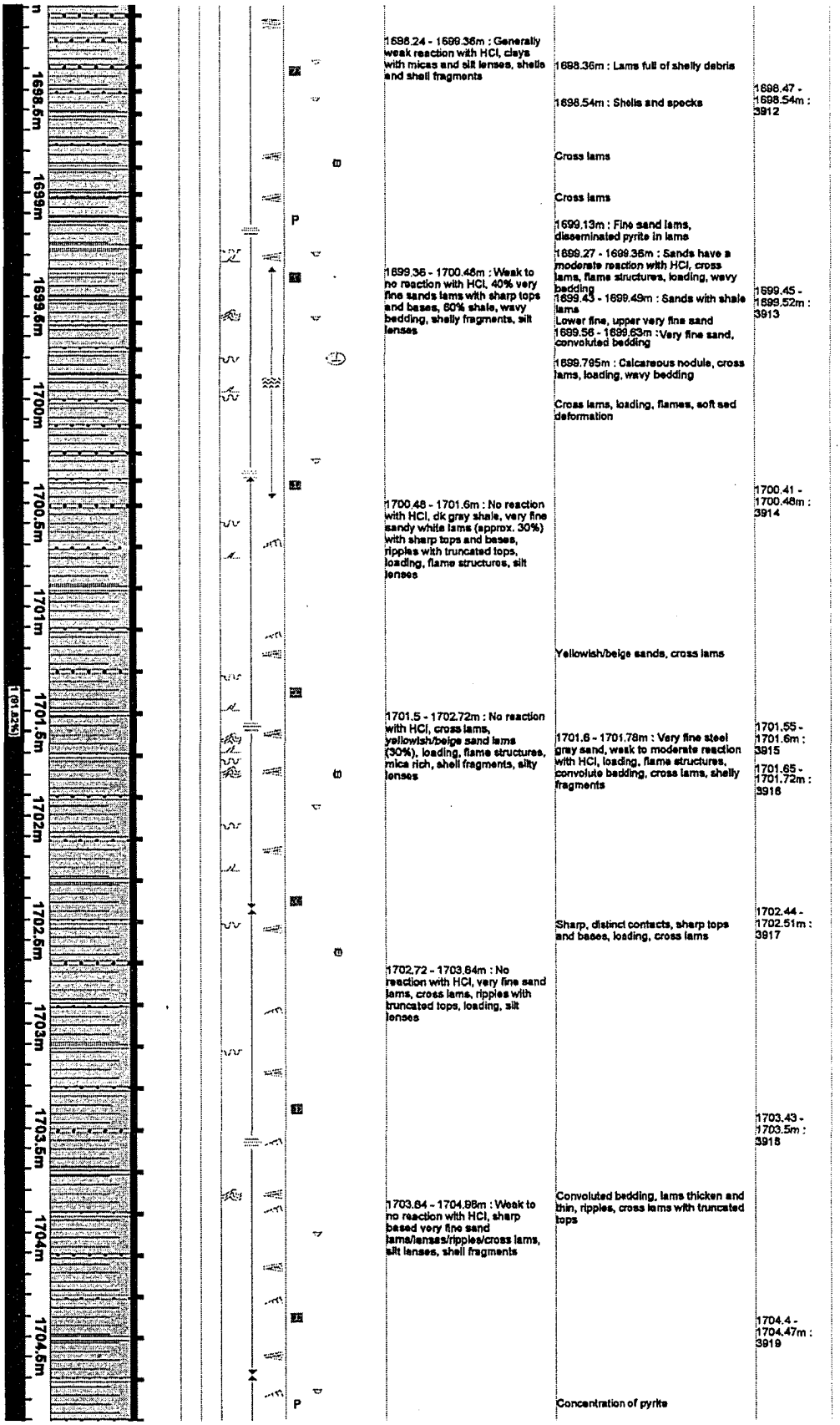
Longitude:	118.281382
Latitude:	54.541641
N / S Co - Ordinates:	395.1
E / W Co - Ordinates:	347.6

Well Summary

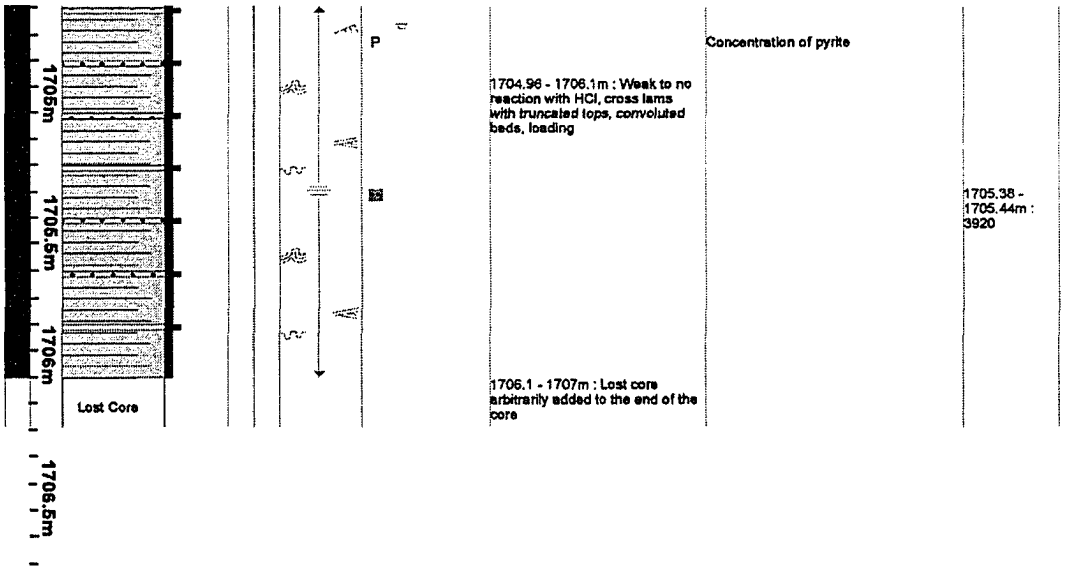
Spud Date:	Dec 13, 1993	Contractor:	
TD Date:		Rig Release Date:	Dec 23, 1993



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Well Information

Operator:	BP Canada Energy Company
Well Name:	Amoco Pinenw 16-27 Ek-58-20
Location:	
UWI:	102162705820W500
Pool:	Elkton B (638002)
Field:	Pine Creek (706)
Province / State:	Alberta
Country:	Canada

Elevations

Reference:		Ground:	927.2 m
Cut(-) / Fill(+):		Kelly Bushing:	930.9 m
K.B. to Ground:	m	Casing Flange:	m

Surface Co - Ordinates

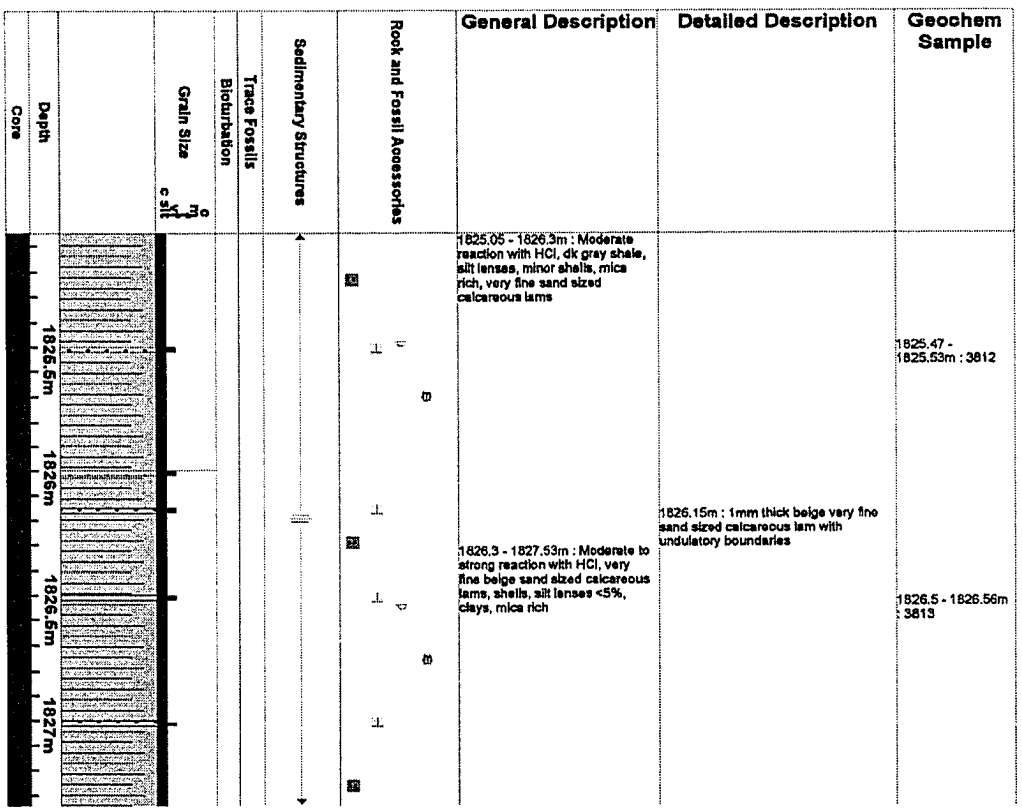
Well Type:	Straight
Longitude:	-116.877692
Latitude:	54.049053
N / S Co - Ordinates:	122.7
E / W Co - Ordinates:	233.6

Bottom Hole Co - Ordinates

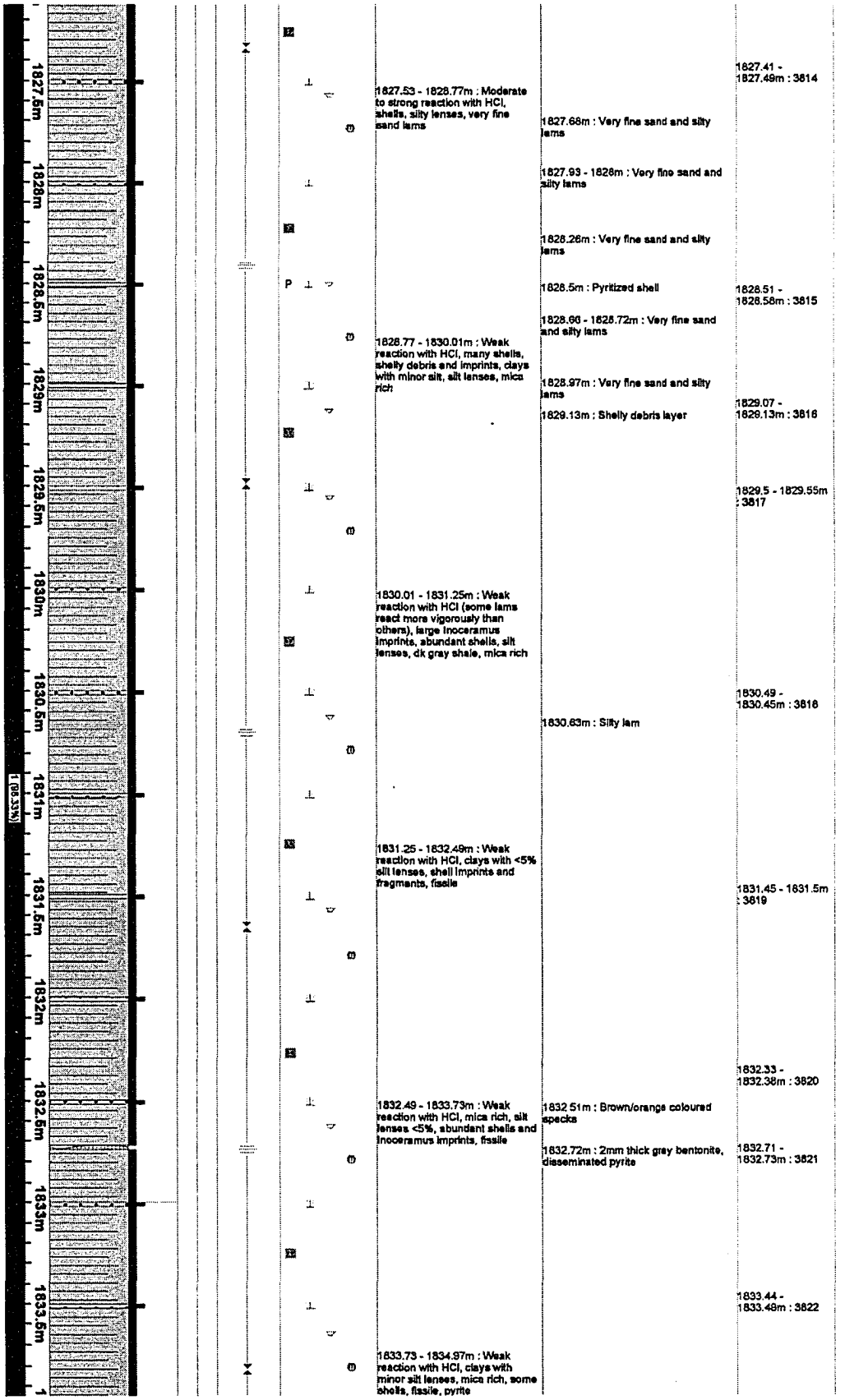
Longitude:	-116.877692
Latitude:	54.049053
N / S Co - Ordinates:	122.7
E / W Co - Ordinates:	233.6

Well Summary

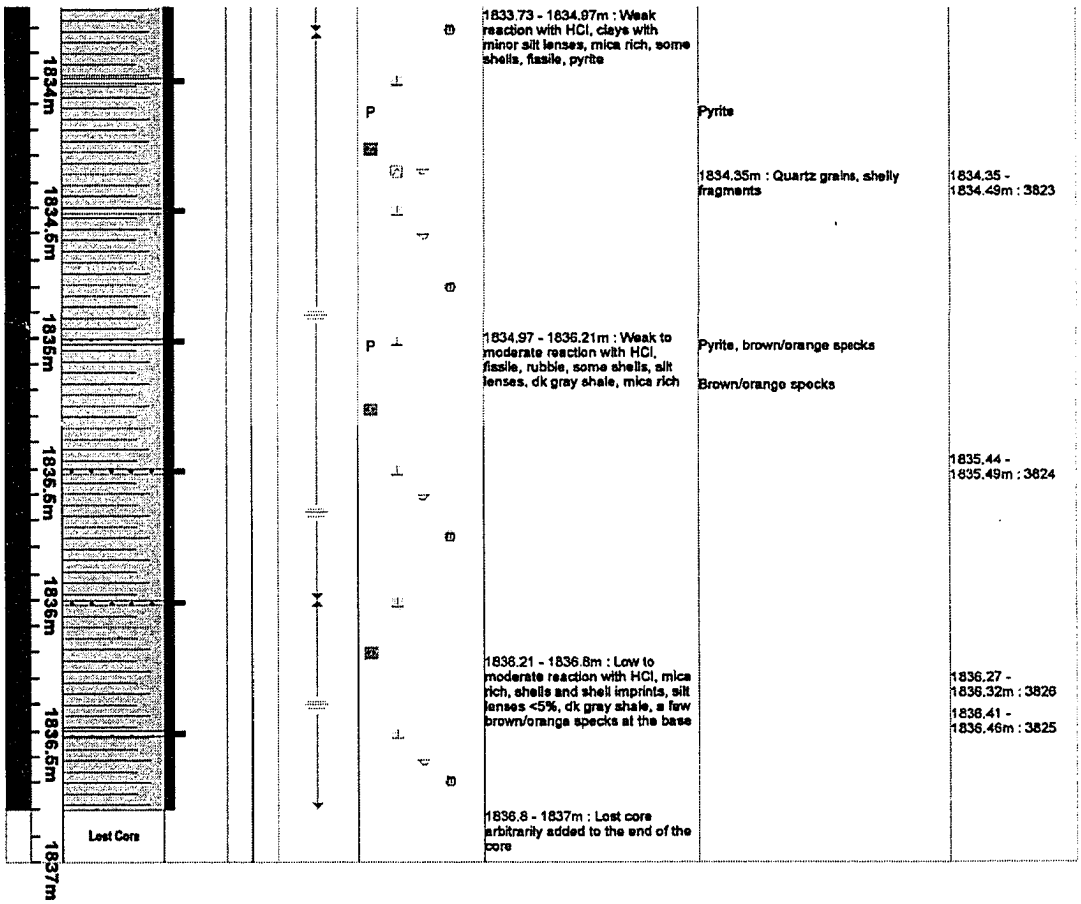
Spud Date:	Nov 11, 1977	Contractor:	
TD Date:		Rig Release Date:	Dec 20, 1977



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

6.2 Micropaleontology Results

Location:* 00/02-03-101-12W4/0 *(7BK03)

Sample Number: 6148

Interval: 99.59m - 99.64m

Sample Description:

Coarse-grained sandstone consisting mainly of angular quartz and some rounded chert, some pebbles, poorly sorted, calcareous cement. Very abundant phosphatic debris. Few *Inoceramus* prisms.

Results:

No foraminifera.

Sample Number: 6124

Interval: 80.275m - 80.345m

Sample Description:

Dark, organic-rich shale, strongly calcareous. Abundant shell fragments and a few *Inoceramus* prisms. Abundant phosphatic debris.

Results:

No foraminifera.

Comments:

No stratigraphic placement is suggested for either of these samples due to the lack of evidence.

Location: 00/04-02-071-18W5/0

Sample Number: 413

Interval: 762.22m - 762.275m

Sample Description:

Sandstone dominated by angular quartz grains, abundant mica, non-calcareous.

Results:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Barren of all fossils.

Comments:

The micropaleontology can not place this sample within a given formation due to a lack of evidence.

Sample Number: 4517

Interval: 768.67m - 768.74m

Sample Description:

Coarse-grained sandstone, calcareous cement, angular quartz grains, some micas. No phosphatic debris. No *Inoceramus* prisms.

Results:

Barren of all fossils.

Comments:

No stratigraphic placement is suggested.

Location: 00/05-10-051-04W5/0

Sample Number: 6011

Interval: 1299.09m - 1299.11m

Sample Description:

Silty shale with fine pyrite. Rare phosphatic debris. Rare *Inoceramus* prisms.

Results:

No planktic foraminifera. Questionable, poorly preserved agglutinated benthic foraminifera.

Sample Number: 4585

Interval: 1286.54m - 1286.56m

Sample Description:

Silty to sandy shale, rusty, calcareous white specks. Rare phosphatic debris.

Results:

No planktic foraminifera. Questionable, agglutinated benthic foraminifera.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sample Number: 4550

Interval: 1256.56m - 1256.58m

Sample Description:

Silty shale, calcareous white specks. Common phosphatic debris.

Results:

No planktic foraminifera. Questionable agglutinated benthic foraminifera.

Comments:

For these three samples, it is difficult to attach a formation name to any of them. White specks were present in some of the samples, as well as some *Inoceramus*, which may be of Second White Specks origin. This could not, however, be confirmed.

Location: 00/06-11-061-22W4/0

Sample Number: 3979

Interval: 509.755m - 509.825m

Sample Description:

Coarse-grained sandstone with calcareous cement. No organic matter. No *Inoceramus* prisms, but rare calcareous shell pieces.

Results:

No foraminifera.

Comments:

May represent the base of the Carlile Formation, which is typically barren of foraminifera in southern and eastern Alberta.

***Location:* 00/06-12-098-13W4/0 (*7AS01*)**

Sample Number: 6071

Interval: 16.77m - 16.89m

Sample Description:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Medium Sandstone resembling a bioclastic layer, rounded quartz grains. Abundant coarse-grained phosphatic debris. Strongly calcareous. No organic matter is visible.

Results:

No foraminifera.

Comments:

No stratigraphic placement is suggested due to the lack of evidence for this sample. There may have been winnowing of the seafloor, however, and this may represent a bioclastic layer often associated with the base of the Second White Specks Formation.

Sample Number: 6064

Interval: 11.6m - 11.65m

Sample Description:

Black, organic-rich shale, visible organic matter. Abundant phosphatic debris. Abundant *Inoceramus* prisms.

Results:

Rare planktic foraminifera.

Heterohelix globulosa

Hedbergella spp.

Comments:

There are small planktic species found in this sample, indicating a sea level highstand. It may represent the First or the Second White Specks Formation.

Location: 00/06-26-059-20W4/0

Sample Number: 4510

Interval: 459.375m - 459.375m

Sample Description:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Black, organic-rich shale. Sand-fraction is mainly organic matter including abundant algal cysts. Abundant phosphatic debris. Very abundant *Inoceramus* prisms and fragments.

Results:

Abundant planktic foraminifera, no benthic foraminifera.

Hedbergella loetterlei

Whiteinella aprica

Heterohelix globulosa

Hedbergella spp. (unidentifiable species due to poor preservation)

Comments:

The species does confirm the Second White Specks Formation in this sample. The bottom waters were most likely anoxic because of the lack of benthic foraminifera, during a highstand and fully marine conditions.

Sample Number: 4511

Interval: 470.77m - 470.84m

Sample Description:

Silty calcareous shale, rusty within a coarsening upwards cycle. Abundant phosphatic debris. Abundant algal cysts. Abundant *Inoceramus* prisms.

Results:

Common planktic foraminifera, dominated by small test sizes. Rare agglutinated benthic foraminifera.

Hedbergella loetterlei

Heterohelix globulosa

Trochammina rainwateri

Comments:

The species does confirm the Second White Specks Formation in this sample. The low occurrence of *T. rainwateri* suggests movement towards a fully marine environment along with anoxic bottom waters.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Location: 00/06-31-046-08W5/0

Sample Number: 3983

Interval: 1821.565m - 1821.61m

Sample Description:

Silty rusty shale, slightly calcareous. Rare phosphatic debris. Few Inoceramus prisms.

Results:

No foraminifera.

Sample Number: 3986

Interval: 1803.15m - 1803.22m

Sample Description:

Silty shale, slightly calcareous. No *Inoceramus* prisms.

Results:

No foraminifera.

Comment:

The micropaleontology results can not confirm which formation the samples represent.

Location: 00/06-35-059-21W4/0

Sample Number: 3964

Interval: 469.45m - 469.52m

Sample Description:

Mainly sandstone dominated by quartz with calcareous cement. Common phosphatic debris. Coaly pieces. No *Inoceramus* prisms.

Results:

No foraminifera.

Comments:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

No stratigraphic placement is suggested for this sample due to the lack of evidence.

Location: 00/09-09-056-19W5/0

Sample Number: 469

Interval: 2242.55m - 2242.62m

Sample Description:

Organic-rich shale, strongly calcareous. Abundant *Inoceramus* prisms.

Results:

Few planktic foraminifera showing various degrees of dissolution.

Hedbergella spp.

Comments:

The suggested placement for this sample is within the Second White Specks Formation due to the presence of the planktonic foraminifera.

Sample Number: 4522

Interval: 2270.87m - 2270.34m

Sample Description:

Silty shale, slightly calcareous. Rare *Inoceramus* prisms. Rare, poorly preserved agglutinated foraminifera.

Results:

Ataxophragmiidae, no genus or species level was identifiable.

Comments:

The suggested formation for this sample is the Second White Specks Formation based on the calcareous content, as well as the presence of *Inoceramus*.

Location: 00/10-09-066-23W5/0

Sample Number: 3860

Interval: 1283.48m - 1283.55m

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sample Description:

Sandstone, mainly angular quartz grains, reddish colour, coalified pieces, calcareous cement.

Results:

Barren of all fossils.

Comments:

There is no suggested stratigraphic placement for this sample.

Location: 00/10-28-059-20W5/0

Sample Number: 3829

Interval: 1877.28m - 1877.33m

Sample Description:

Rusty shale, slightly calcareous. No *Inoceramus* prisms. No phosphatic debris.

Results:

Rare, poorly preserved planktic foraminifera.

Hedbergella spp.

Comments:

This sample is confirmed Second White Specks Formation because of the planktic foraminifera.

Location: 00/10-36-060-22W4/0

Sample Number: 3948

Interval: 498.415m - 498.485m

Sample Description:

Mainly fine-grained sandstone dominated by quartz, slightly calcareous. Coaly fibers. Few *Inoceramus* prisms, shell fragments.

Results:

Few agglutinated benthic foraminifera.

Verneuilinoides perplexus

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Spiroplectammina ammovitrea

Trochammina rainwateri

Ammobaculites sp.

Comments :

This sample is found at the top of the Second White Specks Formation and the base of the overlying Carlile Formation, where the environment returned the improvement of benthic oxygenated conditions.

Location: 00/14-28-062-05W6/0

Sample Number: 3883

Interval: 1876.32m - 1876.375m

Sample Description:

Sandstone, mainly quartz, calcareous cement. No visible organic matter. No phosphatic debris. No *Inoceramus* prisms.

Results:

No foraminifera.

Sample Number: 3893

Interval: 1882.125m - 1882.175m

Sample Description:

Sandstone, mainly quartz, slightly calcareous cement. No visible organic matter. No phosphatic debris. No *Inoceramus* prisms.

Results:

No foraminifera.

Comments:

There is no stratigraphic placement suggested for these samples due to the lack of evidence. It does not appear like the Second White Specks Formation.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Location: 00/15-21-056-19W5/0

Sample Number: 4524

Interval: 2372.31m - 2372.37m

Sample Description:

Silty Shale, slightly calcareous. Few *Inoceramus* prisms. Rare phosphatic debris.

Results: No foraminifera.

Comments:

Based on micropaleontology, no formation is suggested for this sample.

Location: 00/16-12-046-03W5/0

Sample Number: 4512

Interval: 1533.07m - 1533.08m

Sample Description:

Silty shale, slightly calcareous. Black coaly pieces. Calcite crystals. Few *Inoceramus* prisms.

Results:

Rare planktic foraminifera. Rare poorly preserved agglutinated foraminifera.

Heterohelix globulosa

Trochammina sp.

Verneuilinoides sp.

Comments :

The environment was not favourable for planktic forminifera. It is only represented by one species that can inhabit salinity fluctuations and the presence of the planktic taxon Heterohelix. This indicates the Second White Specks Formation.

Sample Number: 4513

Interval: 1540.65m - 1540.66m

Sample Description: Silty shale, strongly calcareous. Few *Inoceramus* prisms.

Results: Few planktic foraminifera.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Heterohelix globulosa

Hedbergella spp.

Comments :

The planktic species confirms the Second White Specks Formation.

Location: 00/16-22-075-08W6/0

Sample Number: 3931

Interval: 744.715m - 744.785m

Sample Description:

Sandstone, angular to rounded quartz grains, calcareous cement. No *Inoceramus* prisms. No phosphatic debris.

Results:

No foraminifera.

Comments:

No stratigraphic placement is suggested for this sample due to the lack of evidence.

Location: 02/06-30-064-01W6/0

Sample Number: 3870

Interval: 1555.61m - 1555.68m

Sample Description:

Silty to sandy shale, slightly calcareous, some coarse-grained quartz grains. Rare *Inoceramus* prisms. Some phosphatic debris.

Results:

Few poorly preserved agglutinated foraminifera.

Psamminopelta sp.

Trochammina sp.

Ataxophragmiidae

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sample Number: 3881

Interval: 1563.165m – 1563.215m

Sample Description:

Rusty, silty to sandy shale, slightly calcareous, abundant quartz. Common phosphatic debris. Rare, poorly preserved *Inoceramus* prisms.

Results:

Rare poorly preserved agglutinated foraminifera. Rare poorly preserved planktic foraminifera indicating dissolution of calcium carbonate.

Hedbergella sp. (1 specimen)

Verneuilinoides sp.

Comments:

No stratigraphic placement is suggested for these two samples due to the lack of evidence.

Location: 02/07-33-052-15W5/0

Sample Number: 3989

Interval: 1955.715m - 1955.785m

Sample Description:

Silty to sandy shale, slightly calcareous, no visible organic matter. Few *Inoceramus* prisms.

Results:

Few planktic foraminifera, some poorly preserved. Few agglutinated foraminifera.

Heterohelix globulosa

Hedbergella sp.

Verneuilinoides perplexus

Saccammina alexanderi

Textularia sp.

Comments:

The sample is from the base of the Second White Specks Formation, near the maximum flooding surface, based on the planktic species found in this sample.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sample Number: 3990

Interval: 1964.02m - 1964.09m

Sample Description:

Silty shale, slightly calcareous. No Inoceramus prisms. No phosphatic debris.

Results:

Rare poorly preserved agglutinated foraminifera.

Verneuilinoides perplexus

Comments:

In this sample, there is a lack of planktic foraminifera in combination with the presence of *Verneuilinoides perplexus*. The sample most likely originated from the upper Belle Fourche Formation.

Location: 02/16-18-064-02W6/0

Sample Number: 3916

Interval: 1701.65m - 1701.72m

Sample Description:

Coarse-grained sandstone, angular quartz grains, black coaly pieces, calcareous cement, small metallic balls (siderite?), chert. Little phosphatic debris.

Results:

No foraminifera. 1 Diatom

Comments:

No stratigraphic placement is suggested for this sample due to the lack of evidence.

Location: 02/16-27-058-20W5/0

Sample Number: 3816

Interval: 1829.07m - 1829.13m

Sample Description:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Grey silty shale, slightly calcareous. Rare *Inoceramus* prisms. Recrystallized calcite crystals.

Results:

No Foraminifera.

Comments:

The Second White Specks Formation is suggested for this sample. Calcareous fossils were likely dissolved and there is a presence of *Inoceramus*.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

6.3 Palynology Results

***Location:* 00/02-03-101-12W4/0 (*7BK03*)**

Sample Number: 6131

Interval: 84.52m – 84.72m

Results and Comments:

Dinogymnium spp.

D. sp. 1 McIntyre

D. cf. westralium

Heterosphaeridium difficile (A)

Chatangiella ditissima (C)

Isabelidinium acuminatum (C)

Diconodinium/ Laciniadinium spp. (A)

Spinidinium echinoideum

Alterbidinium minor

Trithyrodinium suspectum

Spongodinium cf. delitiense

Lebederocysta chlamydata

Dorocysta litotes

Palaeoperidinium pyrrophorum

This core was difficult to date. Abundant dinocysts, especially *Dinogymnium* spp., suggests a Turonian (89.5m) age. The combination of *Dinogymnium* sp. 1 McIntyre, *Spongodinium* sp., and probably *S. delitiense*, however, may suggest an age of Santonian or younger. This date is uncertain and could be debated. The upper age limit is not easy to determine. In a limited study, McIntyre 1998 (in Schröder-Adams et al., 1998) found *Dinogymnium* sp. 1 in the First White Specks, but not in the underlying Medicine Hat Formation. It must be emphasized, however, that the sections studied did not extend very far into the lower unit. Therefore a Santonian – Early Campanian age is suggested, but can not be confirmed.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sample Number: 6143

Interval: 97.8m – 97.9m

Results and Comments:

Fromea glabella (A)

Leiosphaeridia spp. (A)

Isabelidinium globosum

Eurydinium glomeratum

Cribroperidinium exilicristatum

Palaeohystrichophora infusiorides

A mid-Turonian age (lower Middle Second White Specks Formation) is assigned to this sample due to the presence of *Eurydinium glomeratum*, *Isabelidinium globosum* and *Florentinia cooksoniae*. The presence of the other palynomorphs suggests a restricted environment - possibly even sub-normal salinities.

Location: 00/05-10-051-04W5/0

Sample Number: 4567

Interval: 1272.69m – 1272.72

Results and Comments: Solid amorphous kerogen. Dinocysts are very rare and there are no good markers. The suggested age is no older than latest Albian.

Palaeohystrichophora infusiorides

Surculosphaeridium longifurcatum

Location: 00/06-31-046-08W5/0

Sample Number: 3985

Interval: 1812.14m – 1812.21m

Results and Comments:

Eurydinium glomeratum

Isabelidinium globosum

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Heterosphaeridium difficile

I. magnum

Dinocysts are numerous in this sample, but most are poorly preserved. Sapropelic debris is also abundant. *Eurydinium glomeratum*, *Isabelidinium globosum* and *I. magnum* all indicate a similar age of Turonian and appear to be lower Middle Second White Specks Formation.

Location: 00/10-22-047-03W4/0

Sample Number: 235

Interval: 430.36m – 430.42m

Results and Comments: Amorphous, sapropelic debris dominates this sample and obscures some of the palynomorphs but dinocysts are abundant.

Chatangiella ditissima (ER)

Florentinia cf. cooksoniae (ER)

Eurydinium glomeratum (A)

Isabelidinium globosum (C)

Fromea glabella (C)

Circulodinium distinctum

Odontochitina operculata

Spinidinium echinoideum

Trichodinium castaneum

Dinopteryagium cladoides

The age was determined based on the presence of *Florentinia* cf. *cooksoniae*, a *Chatangiella ditissima*, multiple samples of *Isabelidinium globosum* which show an overlapping occurrence during the time of the middle Turonian. There are very few species of *Chatangiella* in this sample, which is characteristic of the upper Second White Specks, therefore, it is more likely to be a sample from the lower section of the Second White Specks. The data suggest that the sample is most likely lower middle Second White Specks.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Location: 00/14-29-048-06W5/0

Sample Number: 4514

Interval: 1547.45m – 1547.47m

Results and Comments:

Eurydinium glomeratum

Isabelidinium globosum

There is a poor assemblage in this sample. Due to the presence of *Eurydinium glomeratum* and *Isabelidinium globosum,* the sample is assigned a Turonian age, which appears to be the lower Middle Second White - similar to samples 235 and 3985.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

6.4 Geochemistry Results

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
201	00/06-26-059-20W4/0	54.126511	-112.890603	458.480	458.535	Dec. 2003
202	00/06-26-059-20W4/0	54.126511	-112.890603	459.470	459.530	Dec. 2003
203	00/06-26-059-20W4/0	54.126511	-112.890603	460.470	460.525	Dec. 2003
204	00/06-26-059-20W4/0	54.126511	-112.890603	461.420	461.460	Dec. 2003
206	00/06-26-059-20W4/0	54.126511	-112.890603	462.460	462.515	Dec. 2003
207	00/06-26-059-20W4/0	54.126511	-112.890603	463.450	463.505	Dec. 2003
208	00/06-26-059-20W4/0	54.126511	-112.890603	464.440	464.490	Dec. 2003
210	00/06-26-059-20W4/0	54.126511	-112.890603	465.450	465.500	Dec. 2003
212	00/06-26-059-20W4/0	54.126511	-112.890603	466.430	466.490	Dec. 2003
213	00/06-26-059-20W4/0	54.126511	-112.890603	467.620	467.675	Dec. 2003
214	00/06-26-059-20W4/0	54.126511	-112.890603	468.435	468.490	Dec. 2003
215	00/06-26-059-20W4/0	54.126511	-112.890603	469.420	469.470	Dec. 2003
216	00/06-26-059-20W4/0	54.126511	-112.890603	469.770	469.800	Dec. 2003
217	00/06-26-059-20W4/0	54.126511	-112.890603	470.455	470.505	Dec. 2003
218	00/06-26-059-20W4/0	54.126511	-112.890603	471.490	471.530	Dec. 2003
219	00/10-22-047-03W4/0	53.070258	-110.352306	419.000	419.070	Dec. 2003
219	00/10-22-047-03W4/0	53.070258	-110.352306	419.000	419.070	April 2004
220	00/10-22-047-03W4/0	53.070258	-110.352306	419.980	420.050	Dec. 2003
221	00/10-22-047-03W4/0	53.070258	-110.352306	420.980	421.050	Dec. 2003
222	00/10-22-047-03W4/0	53.070258	-110.352306	421.560	421.580	Dec. 2003
223	00/10-22-047-03W4/0	53.070258	-110.352306	421.720	421.740	Dec. 2003
224	00/10-22-047-03W4/0	53.070258	-110.352306	421.950	422.020	Dec. 2003
225	00/10-22-047-03W4/0	53.070258	-110.352306	422.950	423.020	Dec. 2003
226	00/10-22-047-03W4/0	53.070258	-110.352306	423.940	424.000	Dec. 2003
228	00/10-22-047-03W4/0	53.070258	-110.352306	424.940	425.010	Dec. 2003
229	00/10-22-047-03W4/0	53.070258	-110.352306	425.970	426.040	Dec. 2003
230	00/10-22-047-03W4/0	53.070258	-110.352306	427.000	427.060	Dec. 2003
232	00/10-22-047-03W4/0	53.070258	-110.352306	427.850	427.920	Dec. 2003
233	00/10-22-047-03W4/0	53.070258	-110.352306	429.070	429.140	Dec. 2003
234	00/10-22-047-03W4/0	53.070258	-110.352306	430.080	430.150	Dec. 2003
236	00/10-22-047-03W4/0	53.070258	-110.352306	431.030	431.100	Dec. 2003
237	00/10-22-047-03W4/0	53.070258	-110.352306	431.990	432.060	Dec. 2003
238	00/10-22-047-03W4/0	53.070258	-110.352306	433.010	433.080	Dec. 2003
239	00/10-22-047-03W4/0	53.070258	-110.352306	434.050	434.120	Dec. 2003
240	00/10-22-047-03W4/0	53.070258	-110.352306	435.020	435.085	Dec. 2003
241	00/10-22-047-03W4/0	53.070258	-110.352306	436.140	436.210	Dec. 2003
242	00/10-22-047-03W4/0	53.070258	-110.352306	437.050	437.120	Dec. 2003
243	00/10-22-047-03W4/0	53.070258	-110.352306	436.670	436.740	Dec. 2003
244	00/10-22-047-03W4/0	53.070258	-110.352306	437.455	437.525	Dec. 2003
245	00/10-22-047-03W4/0	53.070258	-110.352306	438.350	438.410	Dec. 2003
246	00/10-22-047-03W4/0	53.070258	-110.352306	439.480	439.550	Dec. 2003
247	00/10-22-047-03W4/0	53.070258	-110.352306	440.460	440.530	Dec. 2003
249	00/10-22-047-03W4/0	53.070258	-110.352306	441.440	441.510	Dec. 2003
250	00/10-22-047-03W4/0	53.070258	-110.352306	442.450	442.510	Dec. 2003
251	00/10-22-047-03W4/0	53.070258	-110.352306	443.470	443.520	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
201	Probable	Second White Specks	Dk grey shale, silt, a few white specks, organic fragments
202	Known	Second White Specks	Dk grey shale, some silt
203	Known	Second White Specks	Dk grey shale with abundant shells
204	Known	Second White Specks	Dk grey shale (white specks, silty lams) with bentonite + pyrite - thin section, test bentonites
206	Known	Second White Specks	Dk grey shale, shell fragments, silt
207	Known	Second White Specks	Shale and bentonite with pyrite, some silt and micas – thin section as well
208	Known	Second White Specks	Dk grey shale, a few white specks, fissile, some silt
210	Known	Second White Specks	Shell layer - thin section
212	Known	Second White Specks	Dk grey shale, silt
213	Known	Second White Specks	Dk grey shale, shell fragments, some silt, fish debris
214	Known	Second White Specks	Dk grey shale, silty
215	Known	Second White Specks	Dk grey shale, white specks, some silt
216	Known	Second White Specks	Pyrite nodule
217	Known	Second White Specks	Dk grey shale, white specks, shells
218	Known	Second White Specks	Dk grey shale, micas, fish debris, some silt
219	Known	Belle Fourche (or underlying unit)	Dk grey shale, silty pockets
219	Known	Belle Fourche (or underlying unit)	Dk grey shale, silty pockets
220	Known	Belle Fourche (or underlying unit)	Dk grey shale, some shelly fragments, silty pockets/lams
221	Known	Belle Fourche (or underlying unit)	Dk grey shale + white sand lams
222	Known	Belle Fourche (or underlying unit)	Shell/fish debris
223	Known	Belle Fourche (or underlying unit)	Bentonite
224	Known	Belle Fourche (or underlying unit)	Dk grey shale, shell fragments, some silt
225	Known	Belle Fourche (or underlying unit)	Dk grey shale, silty/sandy lams
226	Known	Belle Fourche (or underlying unit)	Dk grey shale, silty/sandy lams
228	Known	Belle Fourche (or underlying unit)	Dk grey shale, silty/sandy pockets
229	Known	Belle Fourche (or underlying unit)	Dk grey shale, silty/sandy lams
230	Known	Second White Specks	Start of SWS (?) Dk Grey shale, sandy ripples/lams, organic fragments
232	Known	Second White Specks	Shale with coarser grains (sand sized lams), white specks, shelly fragments,
233	Known	Second White Specks	Dk grey shale, sandy/silty lams, white specks
234	Known	Second White Specks	Dk grey shale, silt lams, shelly fragments, white specks
236	Known	Second White Specks	Dk grey shale, silty lams, shells, white specks
237	Known	Second White Specks	Dk grey shale, organic fragments, white coloured sand lams
238	Known	Second White Specks	Dk grey shale, white specks, bone fragments, silt lams
239	Known	Second White Specks	Dk grey shale, silty, abundant white specks
240	Known	Second White Specks	Dk grey shale, abundant white specks
241	Known	Second White Specks	Dk grey shale, minor white specks, silty lams
242	Known	Second White Specks	Dk grey shale (overlap with next box, see log - core 3, box 7/7), shell, bone fragments, silt
243	Known	Second White Specks	Dk grey shale (overlap with previous box, see log – core 4, box 1/6), silty, some white specks visible
244	Known	Second White Specks	Dk grey shale, very fissile, white specks present, silty
245	Known	Second White Specks	Dk grey shale, very fissile
246	Known	Second White Specks	Dk grey shale, fissile, some white specks
247	Known	Carlile (or overlying shale)	Dk grey shale, very platey, micas, shelly fragments, minor silt
249	Known	Carlile (or overlying shale)	Dk grey shale, silty/sandy lams, micas
250	Known	Carlile (or overlying shale)	Broken fragments of shale, some shelly fragments, some silt
251	Known	Carlile (or overlying shale)	Broken fragments of shale, silty pockets, some white specks

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
201	543	0.73	41	1.4	16	64.7		0.25
202	581	0.61	44.6	1.9	17	72.1		0.35
203	376	0.71	28.8	0.9	17	78.1		0.25
204	351	0.86	48.7	1.4	17	39.5		0.28
206	341	0.72	38.8	0.9	17	41.9		0.28
207	289	0.82	56.8	0.9	14	27.5		0.28
208	489	0.61	34.4	1.3	14	58.3		0.25
210	433	0.77	32.5	1.2	19	37.6		0.32
212	358	0.92	20.7	0.9	24	46.1		0.31
213	326	0.92	27.2	0.6	21	42.6		0.33
214	332	0.9	21.8	< .2	20	53.9		0.33
215	348	0.89	22.4	1	19	55.3		0.36
216	391	0.91	22.6	1.2	19	54.6		0.34
217	380	0.72	28.6	1.1	18	53.5		0.27
218	330	0.81	39.4	0.8	17	37.4		0.29
219	407	1.32	20.7	1.9	17	63.4		0.66
220	329	1.15	14.2	1	18	88.4		0.55
221	372	0.8	25.4	1.4	14	72.7	0.6	0.41
222	217	1.18	18.6	1.7	14	170.4		0.22
223	309	1.15	21.2	2	13	64.8	0.8	0.42
224	394	1.18	24	1.4	13	54.7		0.47
225	380	0.84	23.2	1.7	12	76.1	0.5	0.49
226	398	1.24	30.2	1	10	37		0.44
228	426	0.82	32.3	1.9	13	56.8	0.8	0.52
229	421	1.11	33.3	0.9	15	43.3		0.47
230	255	2.13	24.7	0.6	24	71.3	1.1	0.25
232	285	0.52	16.9	0.8	7	125.4		0.15
233	394	0.58	26	1.5	13	139.7	0.6	0.23
234	426	0.58	26.7	1	10	145.1		0.22
236	400	0.52	27	1.3	14	126.4	0.5	0.23
237	284	0.47	22	0.2	9	115.4		0.16
238	458	0.72	30.6	0.7	15	129.8	0.8	0.31
239	306	0.62	28.6	0.3	12	122.7		0.21
240	512	0.57	37.5	1.3	13	123	0.8	0.31
241	401	0.58	28.8	1.3	15	115.4		0.21
242	351	0.73	26.5	1.4	17	91.5	0.6	0.32
243	367	0.9	21.4	1.8	14	69.7		0.68
244	390	0.65	27.1	0.3	11	76.3		0.3
245	380	0.8	23.7	0.9	13	54.8		0.31
246	235	0.83	12	1.5	17	96.5	0.7	0.34
247	577	0.8	38.4	1.9	15	65.3		0.43
249	822	1.09	38.1	3.1	18	45.1	1	0.58
250	86	1.44	7.2	< .2	18	63.4		0.54
251	147	1.01	10.8	0.2	15	86.4	0.5	0.55

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
201	7.5	4.26		24.1	19.5		53.65	3.27
202	8.51	3.91		24.3	18.8		56.56	3.33
203	6.02	2.4		17.2	18.2		43.64	2.78
204	3.27	2.48		16.5	13.5		50.92	3.78
206	3.06	2.34		18.4	16.6		43.19	3.32
207	2.96	1.77		13.8	13.8		43.35	4.14
208	6.37	3.68		23.4	18.2		64.85	3.76
210	2.31	2.87		21	20.5		59.65	3.51
212	1.6	1.91		16	28.1		51.73	3.21
213	1.69	1.96		14.2	23.6		48.13	3.3
214	2.43	1.36		15.2	23.4		50.86	3.07
215	2	1.25		14.3	22.6		51.89	2.99
216	2.2	1.39		13.3	23.7		55.69	3.1
217	4.48	2.41		17.2	18.8		49.96	3.44
218	3.06	1.93		17.1	18.8		45.08	3.66
219	0.43	0.65		8.5	17.2		59.94	2.62
220	0.4	0.53		8.1	15.2		55.18	2.07
221	3.72	0.8	26.5	9.6	10.4	0.77	48.59	2.76
222	14.65	0.66		6.7	10.9		29.54	2.01
223	0.77	0.67	17.6	9.3	10.3	0.6	42.35	2.36
224	0.99	0.96		10	15.3		60.1	2.68
225	0.69	0.92	20.6	10.1	11.2	0.84	58.7	2.39
226	1.28	1.15		10.5	12.7		49.56	2.92
228	1.5	1.15	22.2	11.3	11.1	0.73	57.03	2.81
229	1.23	1.32		11	14.6		58.09	2.91
230	5.01	2.67	313.3	7.1	14.6	0.46	29.15	2.03
232	15.04	1.82		9.4	9.4		30.1	1.62
233	9.29	2.54	22.3	12	12.4	0.61	39.73	2.2
234	9.8	2.53		14.4	12		43.37	2.24
236	8.62	2.72	15.3	14.2	13.3	0.62	42.96	2.38
237	15.1	1.5		10.1	7.8		29.39	2.13
238	7.04	3.43	21.6	14.6	15.6	0.56	48.68	2.32
239	9.14	1.83		14.9	12.6		40.73	2.56
240	8.2	2.92	16.2	20.5	14.1	0.64	58.25	3.35
241	7.93	2.51		16.9	15		47.87	2.56
242	3.47	1.38	15.3	16.9	18.1	0.9	66.05	2.68
243	3.55	1.72		17.6	25.6		139.97	2.98
244	5.78	2.26		20.7	17.6		64.25	3.78
245	4	2.53		18.5	21.8		62.16	3.43
246	1.51	0.64	23.3	13.9	34.4	1.05	87.42	2.26
247	5.76	3.09		20.9	20		69.11	3.46
249	1	3.13	61.1	20.3	21	0.87	82.45	3.66
250	0.27	0.18		14.7	24.8		28.39	2.8
251	0.34	0.62	49.2	15.7	14.7	1.16	35.06	2.7

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
201	3.6			249		0.22	7.6	
202	3.6			175		0.19	9.2	
203	3.7			158		0.23	9.5	
204	5			102		0.22	9.1	
206	4.3			96		0.23	8.3	
207	4.7			89		0.2	9.9	
208	3.9			107		0.18	9.8	
210	4.3			95		0.22	9.7	
212	4.3			103		0.26	9.3	
213	4.4			191		0.26	9.5	
214	4.8			188		0.27	9.4	
215	4.6			103		0.25	10.3	
216	4.5			139		0.26	9.9	
217	4.2			96		0.19	8.9	
218	4.4			132		0.26	9.9	
219	4.2			205		0.29	16.4	
220	3.6			127		0.26	16	
221	3	<.1	0.3	101	0.04	0.16	15.6	10.6
222	3.2			63		0.18	49.6	
223	3.7	<.1	0.31	92	0.04	0.21	10.1	9.3
224	3.8			121		0.25	15	
225	3.4	<.1	0.24	99	0.04	0.19	12	10.2
226	4.6			100		0.2	14.5	
228	3.5	<.1	0.22	134	0.05	0.2	13.4	8.4
229	4			119		0.24	14.8	
230	5.4	0.1	0.02	214	0.04	0.21	177.8	17.1
232	2.6			129		0.12	7.9	
233	2.8	0.1	0.16	196	0.03	0.18	12.6	5.1
234	3			111		0.17	7.8	
236	2.6	<.1	0.11	111	0.03	0.18	8.8	5
237	2.5			109		0.13	7.5	
238	4.4	<.1	0.28	111	0.04	0.2	11.5	7.1
239	2.9			163		0.2	7.8	
240	3.4	<.1	0.15	110	0.04	0.2	9.3	5.9
241	3			91		0.19	8.5	
242	3.4	<.1	0.19	134	0.03	0.26	8.9	9.6
243	4.1			107		0.26	10.1	
244	3.5			359		0.2	9.4	
245	3.6			401		0.26	10.3	
246	4.1	<.1	0.2	149	0.05	0.26	13.4	14.4
247	4.4			187		0.21	21.4	
249	5.3	<.1	0.43	187	0.05	0.25	38.3	18.3
250	5.7			76		0.32	21.4	
251	4.2	<.1	0.22	71	0.05	0.24	23	20.7

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
201	0.36	97	53.59	0.28		132.6	0.06	11.66
202	0.39	142	56.63	0.26		115.9	0.07	12.26
203	0.51	95	32.31	0.287		69.9	0.066	12.79
204	0.34	178	21.77	0.309		47.1	0.058	15.32
206	0.33	67	17.16	0.302		74.1	0.05	13.56
207	0.3	138	10.36	0.328		41	0.077	14.5
208	0.52	151	24.04	0.254		81.3	0.056	13.32
210	0.3	90	11.68	0.282		64.4	0.063	15.04
212	0.35	83	12.53	0.286		115.8	0.061	15.66
213	0.33	94	11.69	0.284		83.6	0.063	16.6
214	0.31	77	5.01	0.271		54.6	0.061	16.66
215	0.3	74	4.41	0.285		49.6	0.058	17.16
216	0.31	75	4.88	0.267		49.7	0.056	16.46
217	0.31	130	12.46	0.25		58.4	0.06	12.61
218	0.31	85	9.62	0.284		47.5	0.06	13.94
219	0.36	98	7.22	0.572		35	0.068	25.19
220	0.34	86	6.04	0.6		35	0.072	19.63
221	0.29	137	8.87	0.549	0.13	30.2	0.09	15.95
222	0.44	287	9.62	0.509		20.4	0.325	9.73
223	0.34	145	9.54	0.791	0.14	26.3	0.064	18.38
224	0.37	104	12.38	0.623		40.4	0.073	18.19
225	0.3	92	10.54	0.584	0.14	38.3	0.066	17.96
226	0.37	139	15.44	0.751		38.4	0.063	17.83
228	0.3	93	15.89	0.526	0.21	40.5	0.078	17.73
229	0.4	100	14.73	0.568		40.4	0.077	17.7
230	0.92	206	11.24	0.703	0.38	21.3	1.335	11.18
232	0.39	917	28.96	0.311		52.8	0.071	7.83
233	0.41	148	30.06	0.375	0.18	67.3	0.12	10.75
234	0.38	209	35.77	0.355		71.4	0.057	10.38
236	0.33	157	34	0.326	0.14	73.2	0.078	11.09
237	0.37	352	32.82	0.323		39.3	0.067	7.5
238	0.36	172	40.98	0.465	0.26	90.3	0.071	14.77
239	0.42	314	23.49	0.346		55	0.057	11.47
240	0.42	225	17.18	0.395	0.18	64.8	0.071	16.07
241	0.45	242	33.14	0.303		68.3	0.061	12.44
242	0.34	122	5.74	0.391	0.4	53.3	0.069	13.88
243	0.36	174	6.02	0.431		59.5	0.068	13.91
244	0.31	220	11.42	0.329		61.4	0.063	12.74
245	0.35	160	8.92	0.309		65.1	0.08	13.42
246	0.33	162	2.25	0.405	0.12	61.4	0.068	15.63
247	0.21	469	48.76	0.409		110.7	0.082	17.51
249	0.26	178	34.77	0.494	0.46	89.8	0.178	25.29
250	0.36	594	0.88	0.698		33	0.043	20.47
251	0.27	583	2.78	0.672	0.04	33.5	0.055	20.04

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
201					3.47	3.21	3.6	9.1
202					3.69	3.37	3.7	8.5
203					2.8	2.13	3.9	5.9
204					3.9	2.64	3.9	6
206					3.33	2.03	3.3	4.7
207					4.38	1.88	4	4.4
208					3.86	2.26	3.7	7.8
210					3.74	1.57	3.2	6.6
212					3.1	0.78	5.1	7.4
213					3.18	1.26	4.9	7.7
214					2.94	0.82	4.7	4.2
215					2.87	0.8	4.6	4.3
216					2.94	0.84	4.4	4.5
217					3.41	1.91	3.8	6.4
218					3.76	1.81	3.3	4.2
219					2.44	0.28	3.5	2.8
220					1.99	0.24	3.4	2.4
221	< 10	< 2	12.5	41	2.53	0.28	2.7	2.9
222					2.34	0.24	6.2	2.5
223	< 10	2	11.6	34	2.22	0.37	2.5	2.8
224					2.89	0.29	3.4	3.8
225	< 10	< 2	13.7	52	2.25	0.37	2.4	3.4
226					3.28	0.27	3.4	3.8
228	< 10	< 2	13.2	53	2.8	0.45	2.8	4.3
229					3.24	0.4	3.2	4.1
230	< 10	< 2	10.5	37	1.64	0.71	10.8	3.1
232					1.64	1.2	2.4	3.9
233	< 10	< 2	11.4	54	2.24	1.85	3.9	6
234					2.58	1.73	3.1	5.8
236	11	< 2	12.1	56	2.45	1.96	3.2	7
237					2.49	1.33	2.5	4.5
238	< 10	< 2	12	72	2.39	1.97	3.4	7.6
239					2.95	1.92	2.9	4.7
240	< 10	2	13.4	50	3.43	2.05	3.5	6.6
241					2.95	2.13	3.1	6.1
242	< 10	2	17.2	39	2.59	1.19	2.5	4.4
243					3.24	0.76	5	6.5
244					4.14	0.97	3.5	6.5
245					3.59	0.85	4.1	6.2
246	< 10	2	18.1	36	1.97	0.64	4.6	4.3
247					3.73	1.25	4.1	8
249	< 10	< 2	17.9	105	3.38	1.58	4.5	8.2
250					2.35	0.15	4.2	0.6
251	< 10	< 2	20.6	7	2.03	0.26	3.8	1.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
201		199.9		0.15	3.3	< .001	2.68	10.26
202		221.8		0.15	3.8	< .001	2.22	14.75
203		174.3		0.14	4.5	< .001	1.16	7.73
204		117.1		0.2	5.2	< .001	0.72	5.91
206		107		0.23	4.7	< .001	1.05	4.67
207		106.2		0.14	4.7	< .001	0.41	5.45
208		139.9		0.28	3.8	0.007	1.26	7.79
210		108.1		0.21	4.4	< .001	0.88	5.73
212		104.4		0.11	4.9	< .001	1.14	3.45
213		97.3		0.21	5.2	< .001	0.94	3.98
214		108.9		0.16	5.2	0.002	0.53	2.37
215		102.2		0.22	5.9	< .001	0.51	2.23
216		101.6		0.2	5.4	< .001	0.51	2.02
217		147.3		0.3	4.2	< .001	0.62	6.44
218		109.3		0.18	4.9	< .001	0.48	4.99
219		117.2		0.18	8.3	< .001	0.32	4.27
220		118.8		0.14	7.3	0.005	0.28	3.65
221	0.7	211.4	< .05	0.17	5.4	0.003	0.37	4.11
222		585.3		0.1	3.6	< .001	0.27	7.97
223	0.8	129.4	< .05	0.11	8.7	0.001	0.4	2.66
224		127.8		0.13	6.3	0.006	0.44	4.78
225	0.7	119.9	< .05	0.16	5.8	0.006	0.44	3.74
226		134.1		0.11	6.6	0.004	0.51	5.24
228	0.7	122.1	< .05	0.17	6.1	0.006	0.46	5.19
229		117.1		0.14	6.8	< .001	0.53	5.81
230	0.9	332.9	< .05	0.1	19.1	0.004	0.47	31.15
232		327.3		0.08	2.7	0.002	1.32	8.42
233	0.4	227.9	< .05	0.11	3.9	0.001	1.75	9.36
234		279.2		0.1	3.5	< .001	1.39	9.11
236	0.4	234.8	< .05	0.11	3.5	< .001	1.78	7.18
237		430.4		0.09	2.4	< .001	0.65	7.94
238	0.9	179.8	< .05	0.09	5.4	0.007	2.02	7.99
239		181.6		0.14	3.4	< .001	1.18	5.72
240	0.6	181.3	< .05	0.21	4.5	0.004	1.45	6.86
241		166.2		0.18	3.7	0.004	1.52	6.97
242	0.7	144	< .05	0.24	4.6	< .001	0.88	2.63
243		138.4		0.4	5.3	0.004	0.79	3.13
244		163.5		0.36	3.9	0.003	1.03	4.28
245		146.8		0.33	4.3	< .001	1.02	3.57
246	0.9	105.2	< .05	0.22	5.1	< .001	0.36	2.61
247		142.7		0.2	6.5	0.003	2.71	16.94
249	1.4	122.8	< .05	0.21	10.4	0.006	3.34	17.19
250		106.4		0.09	10.9	0.002	0.13	1.78
251	1.2	117.2	< .05	0.11	10.5	< .001	0.31	2.99

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
201	266	<.1		249.4				
202	179	<.1		225.7				
203	121	<.1		156.8				
204	79	<.1		180				
206	83	<.1		162.5				
207	55	<.1		136.9				
208	116	<.1		221.7				
210	84	<.1		195.4				
212	67	<.1		160.8				
213	63	<.1		163.3				
214	52	<.1		144.9				
215	46	<.1		138.5				
216	48	<.1		183.1				
217	68	<.1		171.5				
218	54	<.1		171.6				
219	36	<.1		115.7		0.4	7.05	18
220	28	<.1		115.2				
221	22	<.1	19.36	105.3	13	0.4	6.34	21
222	31	<.1		69.2				
223	21	<.1	8.5	101.3	14	0.4	7.55	20
224	40	<.1		124.4				
225	24	<.1	12.89	125.6	12.8	0.4	6.75	19
226	33	<.1		132.4				
228	29	<.1	14.88	136	15.3	0.4	6.21	29
229	42	<.1		132.4				
230	90	<.1	193.37	191.5	1.5	0.3	6.25	20
232	90	<.1		103.6				
233	102	<.1	18.5	160.3	7.5	0.4	4.48	20
234	82	<.1		155.8				
236	95	<.1	11.8	171.4	6.3	0.4	4.58	19
237	52	<.1		101.4				
238	110	<.1	10.96	199.4	13.1	0.5	5.6	19
239	87	<.1		131				
240	75	<.1	12.13	209.8	8.2	0.5	5.06	27
241	101	<.1		158.9				
242	48	<.1	8.5	144.9	8.7	0.4	6.65	20
243	74	<.1		140.4				
244	54	<.1		175.2				
245	61	<.1		242.6				
246	46	<.1	12.82	124.3	9	0.3	7.09	12
247	119	<.1		213.9				
249	98	<.1	38.66	204.9	19	0.8	6.99	23
250	24	<.1		88.3				
251	18	<.1	15.92	123.4	10	0.2	8.4	12

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
219	<.1	69	2	0.6	0.5	0.7	68	10
221	<.1	67	3	0.5	4.1	0.8	62	10
223	<.1	64	1	0.5	1.1	0.6	42	9
225	<.1	79	2	0.5	0.73	0.9	53	10
228	<.1	53	3	0.6	1.63	1.1	50	12
230	<.1	53	1	0.3	5.5	2.4	292	6
233	<.1	110	1	0.3	9.88	2.3	50	13
236	<.1	122	2	0.2	8.97	2.5	45	15
238	<.1	178	2	0.3	7.01	2.9	50	13
240	<.1	103	1	0.2	7.71	2.4	46	18
242	<.1	65	5	0.3	3.46	1.4	51	15
246	<.1	105	2	0.2	1.45	0.8	53	14
249	<.1	62	3	0.5	1.03	2.8	91	21
251	<.1	173	3	0.5	0.37	0.5	64	18

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
219	97.4	61.6	3.58	3.3	2.01	37.7	40.1	0.91
221	70.2	50.4	3.62	2.4	1.5	30.1	35.8	0.94
223	59.8	45.8	3.23	2.8	1.34	20.4	38.2	1.2
225	81.3	56	3.18	2.6	1.77	27.3	38.3	0.98
228	76.1	58.5	3.85	2.4	1.67	24.1	32.2	0.92
230	41.4	30	2.35	2.2	1.02	156.8	32.2	1.3
233	74.5	41.8	2.88	1.7	1.48	26.6	25	0.76
236	72.9	44.2	3.04	1.6	1.49	22.8	23.6	0.67
238	75.4	48.9	2.87	2.3	1.47	24.2	30.2	0.81
240	76.4	52.7	3.79	1.7	1.61	24	26	0.75
242	93	63	3.55	2.2	2.02	26.6	43.4	0.78
246	141.6	82.5	3.24	2.5	2.11	25.5	59.7	0.77
249	81.8	80.9	4.5	3	1.79	43.7	58.1	0.69
251	82.5	36.2	4.32	3.4	1.74	27.4	69.2	0.85

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
219	109	8.5	0.761	11.2	39.8	0.091	25	111.5
221	164	9.9	0.775	8.4	30.7	0.096	18.9	92.1
223	177	10.9	1.267	7.3	29.3	0.07	23.8	71.7
225	124	11	0.804	10.1	37.6	0.069	20.5	97
228	123	17.5	0.742	9.8	44.6	0.084	21.5	84.9
230	236	12.1	1.192	6.2	21.8	1.323	13.2	44.6
233	183	31.6	0.572	7.9	68.5	0.125	12.6	78.4
236	179	35.2	0.471	8	78.2	0.081	13.1	84.5
238	187	41.4	0.576	8.7	82.6	0.068	15.4	84.4
240	225	16.2	0.521	8.4	58.4	0.07	16.7	92.5
242	147	5.9	0.54	10.3	53.8	0.071	15.2	115.6
246	195	2.8	0.592	11.4	63.1	0.075	16.7	98.5
249	224	38.5	0.698	11.4	93.4	0.17	28.5	94.8
251	755	3.8	0.8	12.6	41.7	0.063	23.5	87.6

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
219	2.9	0.8	12	2.4	188	0.8	11.9	0.387
221	3.1	0.6	9	1.6	283	0.5	8.6	0.292
223	2.7	0.9	8	1.8	299	0.7	11	0.307
225	2.5	0.6	10	1.8	185	0.7	8.7	0.323
228	3.4	1	9	1.6	190	0.7	9.1	0.313
230	2	1.1	13	1	471	0.6	21.1	0.225
233	3	3.5	8	1.3	307	0.4	6.6	0.228
236	3.2	3.4	8	1.2	287	0.5	6.3	0.243
238	2.8	4.1	8	1.7	218	0.7	7.8	0.249
240	3.8	3.8	9	1.4	224	0.5	7.1	0.26
242	2.9	2.5	10	1.9	207	0.6	7.9	0.321
246	2.3	1.2	12	2	162	0.7	7.1	0.394
249	3.9	3	11	2.7	178	0.7	12.9	0.319
251	2.2	0.6	11	2.6	157	0.8	11.5	0.44

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
219	5.9	213	1.5	25.5	137	89.9	78.7	9.6
221	5.8	172	1.3	24.8	119	71.1	63.6	9.2
223	4.3	155	1	12.7	117	75.1	50.7	9.9
225	5.5	204	1.1	17.7	136	76.9	60.8	10.3
228	6.3	211	1.1	19.4	147	82.7	64.2	11.1
230	32.2	175	0.7	186	198	69.9	322.4	7.4
233	10.6	356	0.6	23.4	182	50.6	52.3	9.3
236	8.3	381	1.1	17.3	188	48.8	49.5	11.9
238	8.9	368	0.9	14.8	206	66.7	56.9	11.1
240	7.6	278	1	15.1	227	55.5	52.3	13.1
242	4.3	235	1.2	13.2	167	65.6	59.7	15.3
246	4.2	272	1.3	15.4	133	71.6	76.7	14.1
249	17.6	324	1.2	43.3	221	83.8	96.7	18.4
251	4.5	145	1.5	19.5	138	95	88.1	17.1

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
219	8.1	5.04	2.77	1.33	18.2	5.46	4.3	0.97
221	5.8	4.65	2.62	1.21	14.9	5.23	3.5	0.98
223	5.4	2.77	1.61	0.84	17.7	3.25	3.8	0.59
225	7	3.62	2.1	1.08	16.5	4.27	3.6	0.77
228	6.5	4.13	2.38	1.11	16.2	4.96	3.8	0.87
230	2.5	33.17	16.5	8.91	13.8	42	4.9	6.55
233	4.6	4.26	2.33	1.16	11.1	5.13	2.3	0.87
236	5.4	3.41	1.77	0.93	12.4	3.71	2.3	0.7
238	5.7	3.24	1.72	0.83	15.3	4	3.4	0.63
240	6.3	3.23	1.68	0.98	13.7	3.58	2.9	0.66
242	8.4	3.26	1.76	1.03	17.1	3.39	2.8	0.6
246	9	4.32	2.6	1.29	21.3	5.07	3.5	0.9
249	6.3	7.83	4.3	1.83	17.8	8.56	4	1.68
251	6.9	5.25	2.94	1.56	21.3	6.02	5.1	1.04

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
219	40.1	0.39	14.7	32.4	9.3	< 1	116.6	6.8
221	33	0.37	11.5	30.3	7.49	< 1	91.5	5.2
223	27.3	0.26	10.4	22.2	5.61	1	81.2	3.9
225	31.9	0.33	12.1	27.3	6.96	1	107	4.8
228	34.9	0.36	13.1	29	7.4	< 1	103.2	5.1
230	170.3	1.84	8.8	181.9	41.69	< 1	47.4	39.7
233	26.4	0.29	9.4	24.9	6.29	< 1	74.7	4.6
236	25	0.29	10.3	21.6	5.79	< 1	87.2	3.9
238	28.2	0.28	12.2	25.6	6.65	< 1	87.1	4.6
242	31	0.29	15.3	27.3	7.09	< 1	123.3	4.4
246	40.2	0.38	16.8	34.5	9.01	1	138.4	6.4
249	49.9	0.58	15.2	46.6	11.81	< 1	99	9.1
251	40.1	0.43	17.2	36.4	10.11	2	111.3	6.9

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
219	215.8	1.1	0.89	14.2	0.43	6.3	199	1.8
221	298.5	0.8	0.85	9	0.42	6.4	175	1.3
223	322.8	0.9	0.47	12.1	0.24	4.8	155	1.2
225	196.4	0.8	0.7	10.1	0.37	6.4	206	1.5
228	212.8	0.9	0.79	10	0.39	8	211	1.7
230	514.7	0.6	6.74	25.8	2.32	36.1	178	1.1
233	285.4	0.5	0.76	7.3	0.37	12	343	0.8
236	305	0.6	0.58	8.8	0.29	9.8	394	1.3
238	240.5	0.8	0.6	7.6	0.28	10.5	377	1.3
240	230.7	0.7	0.61	8.3	0.32	8.8	274	1.4
242	221.1	0.7	0.62	10.2	0.3	4.9	244	1.4
246	195.2	0.9	0.81	11.7	0.4	5.5	277	1.4
249	182.3	1	1.44	15.5	0.7	19.1	310	1.3
251	171.8	1.1	1.08	14.7	0.5	4.9	132	2.3

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
219	33	2.72	134.5	13.73	754.5	0.73	0.012	
221	32	2.92	109.9	12.82	641	6.23	0.012	0.0097
223	18.4	1.72	124.2	15.5	638	1.72	0.008	0.0078
225	24.7	2.5	117.8	13.87	694	1.15	0.01	0.0112
228	27.6	2.49	132.1	12.99	660	2.47	0.01	0.0105
230	233.5	13.3	164.6	12.7	2219	8.73	0.006	0.0056
233	28.2	2.12	83.7	9.36	528	16.34	0.008	0.0088
236	21.2	1.73	79.5	9.96	566	15.32	0.009	0.01
238	19.6	1.93	96.1	11.62	541	11.45	0.009	0.0092
240	20.6	2.11	93.4	10.94	555	13.27	0.011	0.0097
242	19.4	2	97.3	13.45	640	5.48	0.011	0.0131
246	26.9	2.53	117.2	15.49	718	2.32	0.02	0.0209
249	52.4	4.27	153	13.78	584	1.53	0.008	0.0105
251	30.1	3.06	165.4	17.22	452	0.58	0.01	0.0111

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
219	4.81	2.45	17.5	1.66	0.01	1.15	31	0.2
221	5.25	2.03	17.2	1.69	0.02	1.13	34	0.24
223	4.57	1.74	17	2.16	0.02	1.73	37	0.18
225	4.5	2.34	16.9	1.8	0.02	1.14	35	0.18
228	5.28	2.18	18.3	1.65	0.01	1.05	23	0.2
230	3.41	1.33	13.3	2.3	0.03	1.69	33	3.36
233	3.57	1.87	21.1	1.42	0.02	0.78	34	0.32
236	4.28	2.05	20.2	1.32	0.02	0.71	39	0.19
238	3.46	2	22.3	1.56	0.02	0.89	56	0.18
240	4.65	2.3	20.2	1.5	0.03	0.75	32	0.17
242	4.99	2.66	18.7	1.46	0.02	0.8	40	0.17
246	4.63	2.87	15.4	1.5	0.02	0.83	50	0.2
249	6.41	2.27	21.3	1.26	0.03	0.96	63	0.42
251	6.33	2.23	13.3	1.54	0.09	1.17	43	0.16

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

							Analysis: CO2	
Element	**Sc**	**SiO2**	**TiO2**	**TOT/C**	**TOT/S**	**SUM**	**C/ORG**	**C/GRA**
LDL	**1**	**0.02**	**0.01**	**0.01**	**0.01**			
Samples	**ppm**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
219	13	56.66	0.64	5.56	3.35	99.56	5.51	0.03
221	10	52.53	0.55	6.03	3.58	99.77	5.04	0.03
223	9	54.56	0.53	3.95	2.97	99.79	3.85	0.02
225	11	57.21	0.59	5.4	3.03	99.8	5.3	0.03
228	10	55.02	0.57	6.13	3.93	99.81	5.95	0.02
230	14	52.22	0.39	3.13	2.29	99.71	2.31	0.03
233	8	44.49	0.42	8.94	3.07	99.76	6.06	0.03
236	9	45.14	0.44	8.91	3.38	99.71	6.28	0.03
238	9	45.74	0.45	9.36	3.22	99.74	9.32	0.02
240	9	45.42	0.49	8.5	4.01	99.81	8.33	0.03
242	10	51.39	0.57	6.43	3.44	99.78	6.34	0.05
246	16	55.74	0.7	4.83	2.67	99.81	4.76	0.04
249	12	51.1	0.58	7.68	4.44	99.72	7.6	0.03
251	14	56.35	0.77	1.93	2.67	99.81	1.89	< .02

Element	**CO2**	**SO4**
LDL		
Samples	**%**	**%**
219	0.09	1.7
221	3.51	4.02
223	0.31	2.27
225	0.24	1.98
228	0.6	3.35
230	2.9	2.65
233	10.43	6.14
236	9.56	5.88
238	0.11	5.15
240	0.52	8.58
242	0.15	5.24
246	0.15	2.65
249	0.21	1.78
251	0.1	0.87

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
252	00/10-22-047-03W4/0	53.070258	-110.352306	444.470	444.540	Dec. 2003
253	00/10-22-047-03W4/0	53.070258	-110.352306	445.380	445.440	Dec. 2003
254	00/10-22-047-03W4/0	53.070258	-110.352306	445.140	445.140	Dec. 2003
255	00/10-22-047-03W4/0	53.070258	-110.352306	446.390	446.450	Dec. 2003
257	00/10-22-047-03W4/0	53.070258	-110.352306	447.400	447.450	Dec. 2003
258	00/10-22-047-03W4/0	53.070258	-110.352306	448.360	448.420	Dec. 2003
259	00/10-22-047-03W4/0	53.070258	-110.352306	449.200	449.240	Dec. 2003
260	00/10-22-047-03W4/0	53.070258	-110.352306	449.410	449.480	Dec. 2003
261	00/10-22-047-03W4/0	53.070258	-110.352306	450.380	450.450	Dec. 2003
262	00/10-22-047-03W4/0	53.070258	-110.352306	450.990	451.030	Dec. 2003
263	00/10-22-047-03W4/0	53.070258	-110.352306	451.390	451.450	Dec. 2003
264	00/10-22-047-03W4/0	53.070258	-110.352306	451.730	451.740	Dec. 2003
265	00/10-22-047-03W4/0	53.070258	-110.352306	452.440	452.510	Dec. 2003
266	00/10-22-047-03W4/0	53.070258	-110.352306	453.440	453.510	Dec. 2003
267	00/10-22-047-03W4/0	53.070258	-110.352306	453.750	453.765	Dec. 2003
268	00/10-22-047-03W4/0	53.070258	-110.352306	454.420	454.480	Dec. 2003
269	00/10-22-047-03W4/0	53.070258	-110.352306	454.200	454.240	Dec. 2003
270	00/10-22-047-03W4/0	53.070258	-110.352306	454.240	454.430	Dec. 2003
271	00/10-22-047-03W4/0	53.070258	-110.352306	454.430	454.490	Dec. 2003
272	00/10-22-047-03W4/0	53.070258	-110.352306	454.830	454.900	Dec. 2003
273	00/10-22-047-03W4/0	53.070258	-110.352306	455.810	455.880	Dec. 2003
274	00/10-22-047-03W4/0	53.070258	-110.352306	456.780	456.850	Dec. 2003
275	00/10-22-047-03W4/0	53.070258	-110.352306	457.770	457.840	Dec. 2003
276	00/10-22-047-03W4/0	53.070258	-110.352306	458.680	458.750	Dec. 2003
277	00/16-12-046-03W5/0	52.957954	-114.293665	1533.430	1533.435	Dec. 2003
277	00/16-12-046-03W5/0	52.957954	-114.293665	1533.430	1533.435	April 2004
278	00/16-12-046-03W5/0	52.957954	-114.293665	1534.435	1534.440	Dec. 2003
279	00/16-12-046-03W5/0	52.957954	-114.293665	1535.425	1535.430	Dec. 2003
280	00/16-12-046-03W5/0	52.957954	-114.293665	1536.430	1536.435	Dec. 2003
280	00/16-12-046-03W5/0	52.957954	-114.293665	1536.430	1536.435	April 2004
281	00/16-12-046-03W5/0	52.957954	-114.293665	1537.435	1537.440	Dec. 2003
282	00/16-12-046-03W5/0	52.957954	-114.293665	1541.630	1541.635	Dec. 2003
284	00/16-12-046-03W5/0	52.957954	-114.293665	1542.600	1542.605	Dec. 2003
285	00/16-12-046-03W5/0	52.957954	-114.293665	1543.580	1543.585	Dec. 2003
286	00/16-12-046-03W5/0	52.957954	-114.293665	1544.610	1544.615	Dec. 2003
287	00/16-12-046-03W5/0	52.957954	-114.293665	1545.620	1545.625	Dec. 2003
288	00/16-12-046-03W5/0	52.957954	-114.293665	1546.590	1546.950	Dec. 2003
289	00/16-12-046-03W5/0	52.957954	-114.293665	1547.630	1547.635	Dec. 2003
290	00/16-12-046-03W5/0	52.957954	-114.293665	1555.285	1555.290	Dec. 2003
291	00/16-12-046-03W5/0	52.957954	-114.293665	1555.170	1555.170	Dec. 2003
292	00/16-12-046-03W5/0	52.957954	-114.293665	1556.250	1556.255	Dec. 2003
294	00/16-12-046-03W5/0	52.957954	-114.293665	1557.940	1557.945	Dec. 2003
295	00/16-12-046-03W5/0	52.957954	-114.293665	1558.050	1558.055	Dec. 2003
296	00/16-12-046-03W5/0	52.957954	-114.293665	1559.020	1559.030	Dec. 2003
297	00/16-12-046-03W5/0	52.957954	-114.293665	1560.770	1560.775	Dec. 2003
298	00/16-12-046-03W5/0	52.957954	-114.293665	1561.780	1561.785	Dec. 2003
299	00/16-12-046-03W5/0	52.957954	-114.293665	1562.780	1562.785	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
252	Known	Carlile (or overlying shale)	Broken fragments of shale, silty, fissile, some brown colouration in areas
253	Known	Carlile (or overlying shale)	Broken fragments of shale, silty, some specks visible
254	Known	Carlile (or overlying shale)	Over interval of 15 cm - glauconite? - thin section, burnt sections
255	Known	Carlile (or overlying shale)	Broken fragments of shale, some brown staining
257	Known	Carlile (or overlying shale)	Broken fragments of shale, minor silt, organic fragments
258	Known	Carlile (or overlying shale)	Dk grey shale, micas, pockets of silt
259	Known	Carlile (or overlying shale)	Halo + mineralization, brown discolouration in areas
260	Known	Carlile (or overlying shale)	Broken fragments of shale, silt
261	Known	Carlile (or overlying shale)	Broken fragments of shale, micas, some silt
262	Known	Carlile (or overlying shale)	Pyrite in shale
263	Known	Carlile (or overlying shale)	Dk grey shale, some silt
264	Known	Carlile (or overlying shale)	Pyrite nodule
265	Known	Carlile (or overlying shale)	Dk grey shale, micas, minor silt
266	Known	Carlile (or overlying shale)	Dk grey shale, some silty pockets
267	Known	Carlile (or overlying shale)	Heavy mineralized alteration (bentonite??) - thin section?
268	Known	Carlile (or overlying shale)	Broken fragments of shale, micas, minor silt
269	Known	Carlile (or overlying shale)	Shale above 'burnt horizon', dk grey, micas, small amount of silt
270	Known	Carlile (or overlying shale)	burnt horizon', reddish/brown
271	Known	Carlile (or overlying shale)	shale below 'burnt horizon', micas, some silt
272	Known	Carlile (or overlying shale)	Broken fragments of shale, micas, some silt, some brown colouration in spots
273	Known	Carlile (or overlying shale)	Dk grey shale, micas, silt, brown colouration in areas
274	Known	Carlile (or overlying shale)	Dk grey shale, some micas, minor silt
275	Known	Carlile (or overlying shale)	Dk grey shale, silt, micas, minor fish debris
276	Known	Carlile (or overlying shale)	Broken fragments of shale, redish brown colour in areas, mica, silty
277	Known	Second White Specks	Dk grey shale, micas, minor silt
277	Known	Second White Specks	Dk grey shale, micas, minor silt
278	Known	Second White Specks	Dk grey shale, micas, minor silt
279	Known	Second White Specks	Dk grey shale, micas
280	Known	Second White Specks	Dk grey shale, some silt, mica rich
280	Known	Second White Specks	Dk grey shale, some silt, mica rich
281	Known	Second White Specks	Dk grey shale, micas, some silt, some shelly/fish debris fragments
282	Probable	Second White Specks	Dk grey shale, micas, some silt, fish/shell debris
284	Possible	Second White Specks	Dk grey shale, some silt, some fish/shell debris
285	Possible	Second White Specks	Dk grey shale, fish debris, silt
286	Possible	Second White Specks	Dk grey shale, organic fragments, micas, minor silt
287	Possible	Second White Specks	Dk grey shale, micas, minor silt, some organic debris
288	Possible	Second White Specks	Dk grey shale, micas, minor silt
289	Possible	Base of SWS	Dk grey shale, micas
290	Possible	Top of Belle Fourche	Dk grey shale, micas
291	Possible	Top of Belle Fourche	Pyritized shell
292	Possible	Top of Belle Fourche	Dk grey shale, micas, fish debris, some silt
294	Possible	Top of Belle Fourche	Fish layer
295	Possible	Top of Belle Fourche	Dk grey shale, micas, concentrated fish debris
296	Possible	Top of Belle Fourche	Dk grey shale, some silt, some micas
297	Possible	Top of Belle Fourche	Dk grey shale, minor silt, micas
298	Possible	Top of Belle Fourche	Dk grey shale, fish debris, minor silt and micas
299	Possible	Top of Belle Fourche	Dk grey shale, some yellow/red discolouration in an area, black fragments, some micas and silt

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
252	83	1.4	6.2	< .2	16	108.7		0.58
253	93	1.27	10.7	0.2	16	144.8	1.3	0.55
254	82	1.26	6.5	0.5	17	146.8		0.47
255	142	1.25	11.9	0.3	16	136.8		0.56
257	136	0.97	19.3	< .2	13	120.3	0.7	0.6
258	165	1.2	9.9	0.6	14	139.1		0.59
259	164	1.05	20.6	0.9	11	19.5		0.44
260	212	1.06	12.6	0.3	16	164.2	1.1	0.61
261	151	1.19	16.8	< .2	14	133.3		0.56
262	141	1.18	15.3	0.5	14	50.1		0.53
263	138	1.04	13.1	0.4	14	152.3	0.9	0.64
264	127	1.26	8.8	< .2	15	136.1		0.57
265	123	1.1	13.5	< .2	15	131.4		0.59
266	122	1.08	13.3	0.3	13	164.5	1	0.6
267	44	0.17	204.4	0.2	< 1	4.1		0.03
268	135	1.23	11.2	0.3	18	189.9		0.59
269	136	1.2	6.9	0.7	15	164.2		0.55
270	39	0.6	7.9	0.5	8	151.8		0.14
271	143	1.2	9.3	< .2	16	156.6		0.53
272	146	1.22	6.7	0.2	21	169.2		0.57
273	139	1.12	10.6	< .2	12	184.6	1.4	0.54
274	152	1.21	9.6	< .2	17	175		0.52
275	195	1.03	8.3	0.4	13	189.8	1.2	0.59
276	152	1.28	5.9	0.3	15	210.7		0.68
277	226	0.86	34.1	0.3	8	37.3		0.28
278	274	0.87	43.8	0.2	12	32.8		0.31
279	249	0.88	42.9	0.4	10	43.7		0.3
280	236	0.78	31.3	< .2	10	40.2		0.26
281	248	0.66	37.5	0.2	8	45.8		0.24
282	194	0.53	29	< .2	6	72.6		0.19
284	266	0.58	32.6	< .2	9	59.9		0.25
285	217	0.54	19.9	< .2	5	88.1		0.2
286	315	0.51	31.4	< .2	9	62		0.23
287	337	0.67	38.1	0.4	11	47.9		0.29
288	311	0.73	36.5	0.4	7	45.3		0.31
289	311	0.71	36.6	< .2	10	35.3		0.29
290	599	0.74	51.8	0.4	8	27.7		0.42
291	431	0.75	40.6	< .2	9	29		0.32
292	272	0.77	33.7	< .2	8	40.3		0.38
294	353	0.78	38.9	1	6	30.5		0.38
295	382	0.8	34.3	< .2	7	34.7		0.44
296	372	0.88	28	0.2	9	44.7		0.41
297	613	0.95	35.8	0.5	6	32.2		0.54
298	559	0.94	40.5	0.2	8	31.8		0.49
299	492	1.02	36.9	0.6	7	30.5		0.46

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
252	0.29	0.14		14.9	19.2		30.6	2.41
253	0.31	0.24	53.4	14.8	16.7	1.16	32.45	2.23
254	0.3	0.14		12.8	16		25.96	2.11
255	0.19	1.24		12.9	15.6		40.65	2.06
257	0.17	2.19	52.3	14	11.2	1.47	38.63	2.06
258	0.15	1.81		12.8	13.8		41.9	2.03
259	0.14	1.67		12.1	12		34.09	7.3
260	0.17	2.14	47.4	13.4	12.3	1.46	43.5	1.66
261	0.14	2.37		13.5	13.7		40.75	2.11
262	0.16	2.39		10.8	13.8		35.48	3.84
263	0.16	2.11	54.4	13.5	11.7	1.53	39.15	1.71
264	0.15	1.82		12.7	14.2		40.1	2.31
265	0.15	2.19		13.3	13		38.32	2.16
266	0.17	1.93	53.3	12.6	12.9	1.55	36.93	1.73
267	0.02	0.17		9.4	2.3		4.15	34.71
268	0.16	2.02		15.8	13.7		43.52	1.6
269	0.25	1.96		14.3	14.1		40.56	4.34
270	2.58	0.52		3.8	8.4		11.05	27.35
271	0.17	1.92		14.9	14		42.92	1.78
272	0.17	1.82		14.1	15.1		44.95	1.96
273	0.34	1.7	50.5	11.3	12.5	1.51	41.92	3.26
274	0.24	1.86		12.7	13.3		49.27	2.32
275	0.23	2.4	44.8	12.7	10.8	1.48	49.88	1.23
276	0.25	2.14		8.9	8.5		40.73	1.61
277	2.78	0.59		15.4	15.4		37.53	4.12
278	2.69	0.8		17.7	16.1		44.88	3.85
279	4.25	0.78		19.2	16.4		43.54	3.69
280	3.91	0.92		16.6	15.6		40.22	4.7
281	6.5	0.94		17.4	12.2		39.84	3.13
282	8.82	0.65		14.2	15		31.8	3.65
284	9.3	1.38		17	9.9		41.65	2.71
285	9.98	1.22		12.4	14.3		34.07	2.81
286	10.65	1.59		18.8	10.9		47.29	3.1
287	7.81	1.68		20.8	14		51.61	3.7
288	4.98	1.3		18.1	15.5		51.63	3.29
289	5.19	1.14		18.6	15.5		48.26	3.67
290	2.63	3.06		27.6	16.2		72.26	4.56
291	4.1	1.6		20.6	15.2		54.55	3.67
292	1.91	1.09		15.7	14.5		44.13	3.63
294	0.72	1.58		19	15.5		49.32	3.81
295	2.35	2		18.8	14.4		49.69	3.7
296	1.44	1.59		18.1	15		47.35	2.91
297	0.39	2.91		20.8	15.9		74.63	3.51
298	0.33	3.01		22	16.6		67.47	3.92
299	0.73	2.23		23	16.8		57.4	3.75

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
252	5.5			65		0.33	23.1	
253	5.4	<.1	0.22	50	0.06	0.3	26.6	20.2
254	5.1			39		0.27	26.3	
255	5			42		0.25	23.4	
257	4.2	<.1	0.25	32	0.05	0.2	25.6	17.6
258	4.8			59		0.23	25.7	
259	4.1			103		0.2	19.7	
260	4.6	<.1	0.16	74	0.06	0.22	23.2	19.8
261	4.6			87		0.24	24.7	
262	4.5			90		0.23	23.5	
263	4.3	<.1	0.21	32	0.05	0.21	27.1	24.3
264	4.9			40		0.26	25.3	
265	4.5			53		0.22	24.4	
266	4.5	<.1	0.18	80	0.05	0.24	26.6	22.3
267	0.5			195		0.02	2	
268	4.9			72		0.26	29.8	
269	4.8			61		0.26	23.2	
270	2.3			8		0.09	11.1	
271	4.7			43		0.26	23	
272	4.8			74		0.27	26.2	
273	4.3	<.1	0.09	37	0.04	0.23	25.5	17.8
274	4.4			62		0.26	22.3	
275	3.9	<.1	0.14	70	0.05	0.22	23.4	17.4
276	4.2			89		0.24	27.9	
277	2.6			125		0.25	3.7	
278	2.6			170		0.26	3.2	
279	2.6			120		0.25	3.6	
280	2.5			155		0.24	4	
281	2			110		0.22	3.6	
282	1.5			101		0.19	3.6	
284	1.8			151		0.21	3.8	
285	1.7			93		0.19	4.7	
286	1.7			140		0.17	4.9	
287	2.2			188		0.2	5.4	
288	2.3			157		0.23	4.3	
289	2.3			127		0.22	4.6	
290	2.7			158		0.23	6	
291	2.5			176		0.23	5.2	
292	2.4			136		0.22	5.1	
294	2.4			172		0.21	3.7	
295	2.5			160		0.21	5.4	
296	2.5			168		0.24	4.3	
297	2.7			219		0.25	5.1	
298	2.8			287		0.24	4.9	
299	3.2			185		0.26	4.9	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
252	0.35	873	0.69	0.695		32.1	0.037	21.24
253	0.3	1333	1.21	0.679	0.02	31	0.065	20.26
254	0.31	2032	0.82	0.626		25.7	0.048	18.54
255	0.28	188	1.52	0.74		39	0.026	18.81
257	0.22	331	3.03	0.665	0.04	58.3	0.024	20.63
258	0.25	320	1.57	0.699		44.5	0.016	21.73
259	0.22	388	2.3	0.502		42.6	0.014	20.49
260	0.23	187	2.36	0.69	0.02	52.2	0.022	27.72
261	0.24	169	3.08	0.657		57.3	0.015	20.18
262	0.24	220	1.46	0.627		42.9	0.019	18.55
263	0.24	265	2.35	0.665	0.03	52.8	0.017	23.71
264	0.25	1028	2.88	0.651		50.3	0.017	19.28
265	0.23	552	2.37	0.654		48.8	0.018	19.85
266	0.23	806	1.89	0.623	0.02	41	0.025	19.99
267	0.01	322	0.55	0.02		133.3	0.002	26.03
268	0.25	528	2.28	0.682		49.6	0.029	21.21
269	0.41	2067	1.77	0.588		43.8	0.031	19.48
270	2.47	10005	0.8	0.139		10.3	0.404	5.31
271	0.26	713	1.7	0.623		48.1	0.023	19.16
272	0.26	1030	1.79	0.683		43.1	0.024	20.66
273	0.25	3145	1.69	0.648	0.02	38.8	0.083	19.38
274	0.27	1644	2.59	0.757		43.3	0.043	18.91
275	0.24	80	3.52	0.774	0.04	51.7	0.03	20.82
276	0.28	810	2.65	1.156		44.1	0.029	23.04
277	0.39	151	22.06	0.206		45.5	0.052	14.98
278	0.28	83	24.59	0.218		67.2	0.057	16.28
279	0.32	91	22.73	0.201		61.4	0.058	14.64
280	0.53	167	32.62	0.184		51.5	0.062	13.73
281	0.17	68	25.02	0.183		57	0.051	12.07
282	1.63	173	23.21	0.151		40.1	0.043	9.56
284	0.15	60	34.45	0.173		58	0.051	12.1
285	1.05	172	27.73	0.143		46.7	0.052	10.22
286	0.15	100	37.65	0.126		70.1	0.062	10.68
287	0.22	109	49.26	0.14		72.3	0.09	13.65
288	0.19	94	33.66	0.17		61.5	0.076	15.87
289	0.22	98	39.6	0.153		72.2	0.08	15.12
290	0.26	111	48.45	0.186		111	0.079	19.45
291	0.27	111	37.08	0.16		80.7	0.063	16.18
292	0.33	177	23.49	0.193		55.3	0.058	18.28
294	0.19	84	33.17	0.195		73.4	0.06	18.67
295	0.26	130	40.29	0.182		79.9	0.055	20.64
296	0.28	110	27.72	0.218		69.8	0.052	20.57
297	0.28	113	30.19	0.236		81.2	0.065	26.45
298	0.25	97	34.42	0.233		92.3	0.065	24.49
299	0.32	129	35.76	0.215		84.1	0.065	23.62

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
252					1.67	0.11	4.4	0.7
253	< 10	< 2	23.1	1	1.14	0.14	4.2	0.8
254					1.12	0.16	3.7	0.5
255					1.25	0.23	4.3	1.2
257	< 10	< 2	19.3	< 1	1.19	0.37	3.6	1.1
258					1.16	0.25	4.2	1.2
259					7.12	0.33	3.4	3.5
260	< 10	< 2	19.1	< 1	0.69	0.31	3.9	0.9
261					1.21	0.27	4.3	1.6
262					3.33	0.29	4.5	2.2
263	< 10	< 2	18.7	2	0.61	0.26	4	1.1
264					1.17	0.21	4.3	1.6
265					1.21	0.25	4	1.4
266	10	< 2	21	< 1	0.48	0.23	4.2	0.9
267					31.24	1.68	0.3	5.6
268					0.43	0.25	4.6	0.8
269					0.45	0.27	3.8	1.3
270					0.09	0.17	2.8	0.5
271					0.3	0.19	3.6	0.9
272					0.3	0.27	5	1.4
273	< 10	< 2	19.5	4	0.19	0.31	5.6	1.4
274					0.31	0.29	4.9	1.8
275	< 10	< 2	17.8	1	0.24	0.36	4	2
276					0.21	0.38	3.1	2.4
277					3.05	0.73	5.8	2.4
278					3.48	1.04	4.8	3.6
279					3.06	0.98	6.2	3.8
280					2.84	0.74	5.9	3.6
281					2.94	0.88	5.1	3.6
282					2.33	0.72	4.3	2.8
284					2.67	1.12	4.8	4.2
285					1.74	0.98	4.7	3.2
286					2.75	1.38	4.9	5.1
287					3.4	1.85	5.4	5.4
288					2.97	1.63	4.6	4.6
289					3.39	1.45	4.8	5.2
290					4.67	2.67	5.3	7.7
291					3.41	1.91	4.9	5.8
292					2.72	1.49	5.8	3.8
294					3.29	2.12	3	4.6
295					2.94	1.84	5.4	4.7
296					2.13	1.61	5.4	4.3
297					2.8	2.1	4	7.4
298					3.26	2.38	3.5	7.1
299					2.81	2.12	4.2	5.6

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
252		113		0.09	11.1	0.006	0.08	1.85
253	1.5	118.5	< .05	0.09	10.5	0.002	0.12	2.45
254		111.6		0.07	10.5	0.003	0.1	2.07
255		114.4		0.1	11.6	0.004	0.09	4.79
257	1.4	108	< .05	0.14	11.2	0.003	0.14	4.49
258		112.4		0.09	11.4	< .001	0.11	4.64
259		84.7		0.1	8.1	< .001	0.21	3.65
260	1.5	112.1	< .05	0.08	11.9	< .001	0.11	4.43
261		105.2		0.12	10.2	< .001	0.18	4.39
262		99.8		0.07	9.6	0.008	0.11	4.44
263	1.6	110	< .05	0.11	12.3	0.002	0.17	4.46
264		105.9		0.09	11.1	0.003	0.12	4.25
265		104.9		0.1	11	< .001	0.12	4.52
266	1.3	105.4	< .05	0.08	11.5	0.001	0.12	4.19
267		5.2		< .02	0.6	< .001	2.33	0.24
268		145.3		0.09	12	0.003	0.1	4.45
269		104.2		0.1	10.8	0.004	0.12	3.97
270		148.1		0.03	2.6	0.001	0.07	1.01
271		110.1		0.09	10.8	0.009	0.06	3.96
272		115.1		0.09	11.2	< .001	0.08	4.13
273	1.2	131.6	< .05	0.1	10.6	0.005	0.11	4.04
274		129.9		0.08	10.4	< .001	0.08	4.1
275	1.4	133.9	< .05	0.08	11.6	0.002	0.14	5.64
276		196.3		0.05	16.9	0.004	0.07	6.17
277		100.6		0.07	4.5	< .001	0.12	3.63
278		101.3		0.08	4.3	0.002	0.24	3.4
279		130.6		0.09	4.2	0.004	0.18	3.95
280		117.3		0.09	4.2	0.001	0.09	8.22
281		166.7		0.12	3.7	< .001	0.13	4.55
282		180.1		0.09	3.2	0.001	0.09	4.96
284		253.8		0.08	3.9	< .001	0.14	7.54
285		203.5		0.07	3.3	< .001	0.09	6.01
286		222.4		0.11	3.3	< .001	0.2	10.29
287		163.2		0.1	4	0.005	0.14	15.18
288		126.5		0.1	4.4	0.006	0.16	7.94
289		115.4		0.11	4.3	< .001	0.14	9.61
290		99.3		0.15	5.5	0.004	0.36	12.49
291		160		0.14	4.7	< .001	0.16	10.35
292		91.8		0.12	5.9	0.002	0.21	5.19
294		69.6		0.11	4.8	0.006	0.65	7.76
295		96.4		0.13	6.2	0.002	0.4	10.66
296		92.9		0.12	6	0.006	0.45	5.87
297		80.7		0.16	7.2	0.007	0.53	4.91
298		77.3		0.2	6.8	0.004	0.69	4.57
299		83.5		0.17	6.4	< .001	0.4	7.11

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
252	23	<.1		92.5				
253	19	<.1	18.7	87	9.6	0.1	8.11	13
254	18	<.1		87				
255	18	<.1		132.5				
257	14	<.1	17.53	156.8	10.8	0.1	8.55	21
258	18	<.1		128.7				
259	18	<.1		120.4				
260	17	<.1	14.68	157	7.8	0.2	8.62	16
261	20	<.1		149.9				
262	19	<.1		157.8				
263	15	<.1	17.13	147.6	8.7	0.2	8.82	15
264	20	<.1		134.1				
265	18	<.1		143.5				
266	18	<.1	17.57	141.8	6.9	0.2	8.41	16
267	3	<.1		11.6				
268	20	<.1		181				
269	23	<.1		147.9				
270	17	0.3		36.3				
271	20	<.1		144.4				
272	22	<.1		139.2				
273	18	<.1	23.97	126	5	0.2	8.77	13
274	18	<.1		132.4				
275	14	<.1	15.96	154.9	5.8	0.2	8.23	11
276	13	<.1		152.2				
277	42	<.1		116		0.2	7.53	35
278	42	<.1		119.1				
279	41	<.1		120.1				
280	61	<.1		131.4		0.2	7.25	31
281	37	<.1		132.1				
282	64	<.1		109.6				
284	35	<.1		175.3				
285	91	<.1		121.9				
286	49	<.1		142.6				
287	56	<.1		163.9				
288	48	<.1		142				
289	52	<.1		127.7				
290	65	<.1		246.8				
291	59	<.1		147.9				
292	55	<.1		138.6				
294	38	<.1		157.4				
295	50	<.1		192.3				
296	51	<.1		136.4				
297	50	<.1		213.1				
298	55	<.1		234.4				
299	58	<.1		187.3				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
253	<.1	383	4	0.5	0.32	0.2	58	17
257	<.1	442	1	0.5	0.21	1.9	76	16
260	<.1	467	2	0.5	0.19	1.9	71	16
263	<.1	449	2	0.6	0.17	1.8	75	16
266	<.1	467	4	0.5	0.18	1.9	76	15
273	<.1	481	4	0.5	0.35	1.8	73	14
275	<.1	487	5	0.6	0.27	2.3	58	13
277	<.1	220	2	0.3	3.18	0.7	72	16
280	<.1	246	3	0.3	4.41	1	70	16

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
253	86.8	34.3	4.19	3.7	1.72	22.7	66.8	0.82
257	80.6	38.5	3.78	3.4	1.6	31.2	62.5	0.7
260	79.7	41.9	3.27	3.8	1.61	28.6	68.4	0.67
263	76.2	39.9	3.45	4	1.66	31	69.6	0.67
266	77.6	37.8	3.45	3.7	1.67	31	69.2	0.64
273	85.9	43.3	4.86	3.6	1.62	30.2	62.1	0.69
275	82.7	51	3.12	4	1.59	22.5	57.8	0.76
277	119.9	33.3	5.25	2.6	2.2	41.5	82.5	0.73
280	110.7	38	5.74	2.2	2.06	38.3	77.3	0.84

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
253	1530	1.2	0.86	13.2	39.1	0.07	26.5	78.1
257	404	4	0.855	13.3	65	0.032	24.9	94.2
260	246	2.8	0.887	13.1	60.4	0.029	32.4	88.9
263	323	2.8	0.868	12.6	61.9	0.024	28.9	90.5
266	869	2.7	0.825	13	47	0.034	26.5	97
273	3436	2.2	0.869	11	46.9	0.093	25.4	93.6
275	130	3.5	0.992	11.8	55.8	0.035	24.6	80.3
277	173	23.8	0.395	12.4	52.1	0.075	19.4	125.5
280	177	35.8	0.358	11.7	52.4	0.08	17.9	129.6

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
253	1.3	0.4	11	2.9	153	0.9	9.9	0.459
257	1.4	1	12	2.6	151	0.9	13.5	0.402
260	0.7	0.8	11	3.3	155	1.1	13.2	0.426
263	0.6	0.7	12	3	156	1	14.2	0.421
266	0.4	0.7	11	2.8	152	1	13.3	0.439
273	0.1	1.1	13	3.1	169	0.9	12.8	0.393
275	0.1	1	11	2.8	176	1	11.8	0.377
277	3.2	1.6	14	2.6	213	0.8	11.7	0.439
280	2.9	1.9	14	2.3	215	0.8	10	0.412

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
253	4	131	1.8	18.9	107	100.6	95	16.9
257	6.1	129	1.6	23.8	177	101.7	94.4	15.7
260	5.9	131	1.8	19.8	176	102	88.8	14.7
263	5.8	129	1.9	22	163	105.2	97.7	16.3
266	5.7	135	1.9	22.8	164	107	100.7	15.4
273	5.7	135	1.9	30.8	145	97.6	87.6	13
275	6.9	145	2.5	19.6	173	90.8	83.8	14.1
277	7.6	237	1.3	21.9	137	69.5	86.1	16.3
280	13.8	270	1.4	21	160	59.2	77.6	17.7

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
253	7.1	5.69	3.24	1.63	22.5	6.63	5.8	1.2
257	7.8	6.41	3.55	1.59	21.2	6.16	5.8	1.33
260	7.3	5.13	3.32	1.39	22.1	5.96	5.8	1.1
263	7.6	6.33	3.53	1.63	23.4	6.94	5.8	1.31
266	7.8	6.8	3.68	1.66	22.8	6.94	5.6	1.4
273	7.3	6.31	3.82	1.55	20.1	7.2	4.3	1.31
275	7.8	5.31	3.18	1.55	21.9	6.21	4.7	1.07
277	10.6	5.21	2.96	1.37	22.9	5.55	4.6	1.03
280	9.1	4.36	2.65	1.2	19.9	5.09	3.6	0.93

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
253	44.1	0.46	17	40.4	10.56	3	108.7	7.5
257	43.3	0.49	18.6	40.3	10.97	2	108	7.9
260	41.1	0.47	17.7	38.7	10.31	2	102.3	7
263	44.6	0.48	18	43.5	11.28	3	104.3	8
266	46.3	0.46	19.2	43.8	11.7	3	112.1	8.6
273	40.8	0.52	16.4	40.3	10.35	3	102.4	7.8
275	39.5	0.4	16.5	38.4	9.91	3	103	7.5
277	43	0.42	16.4	36	10.21	< 1	148.2	7
280	39.3	0.37	14.3	32.6	9.02	< 1	137.2	6.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
253	172	1.1	1.1	15.6	0.52	4.5	120	2.2
257	159.6	1.1	1.16	16.7	0.63	7.3	123	2.3
260	163.4	1	1.06	16.5	0.52	7.1	124	2.1
263	162.9	1.2	1.22	16.5	0.58	6.3	121	2.6
266	170.5	1.2	1.33	17	0.58	6.8	129	2.5
273	172.4	1.1	1.32	15	0.57	6	122	2
275	194.5	1.1	1.06	15.6	0.5	7.6	135	2.7
277	245.3	1	0.87	13.9	0.42	8.8	253	1.7
280	243.2	1	0.79	11	0.4	13.2	262	1.3

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
253	33.7	3.49	198.7	17.2	462	0.52	0.011	0.0119
257	35.6	3.63	176.8	16.79	455	0.32	0.01	0.0104
260	32.1	3.19	177	17.03	469	0.31	0.01	0.0102
263	36.3	3.41	179.3	17.31	476	0.28	0.01	0.01
266	39.1	3.45	186.6	16.91	481	0.29	0.008	0.0103
273	40.8	3.54	143.2	16.82	474	0.53	0.011	0.0103
275	29.8	2.95	136.6	16.61	509	0.43	0.008	0.0103
277	32.5	2.89	139.5	15.67	934	4.57	0.015	
280	28.7	2.72	115.9	14.91	912.7	6.21	0.015	

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
253	5.68	2.25	12.7	1.5	0.18	1.21	40	0.18
257	5.14	2.1	11.4	1.28	0.05	1.15	53	0.09
260	4.46	2.07	11.3	1.22	0.03	1.19	50	0.07
263	4.72	2.06	10.8	1.22	0.04	1.22	57	0.07
266	4.63	2.12	10.3	1.18	0.1	1.12	49	0.09
273	6.99	2.05	11.9	1.22	0.39	1.11	44	0.22
275	4.22	1.99	11.5	1.38	0.02	1.33	46	0.08
277	7.1	2.57	13.9	1.39	0.02	0.59	53	0.16
280	7.88	2.6	16.3	1.58	0.02	0.49	56	0.18

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

							Analysis: CO2	
Element	**Sc**	**SiO2**	**TiO2**	**TOT/C**	**TOT/S**	**SUM**	**C/ORG**	**C/GRA**
LDL	**1**	**0.02**	**0.01**	**0.01**	**0.01**			
Samples	**ppm**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
253	14	57.54	0.8	1.58	1.52	99.82	1.53	0.02
257	13	60.65	0.78	1.48	1.52	99.81	1.45	0.02
260	13	61.24	0.78	1.73	0.9	99.77	1.69	0.03
263	14	61.17	0.81	1.53	0.77	99.77	1.51	< .02
266	14	62.17	0.84	1.75	0.67	99.81	1.61	0.04
273	15	57.75	0.75	2.22	0.29	99.8	1.68	< .02
275	13	61.55	0.66	2.47	0.37	99.84	2.4	0.04
277	16	52.61	0.74	4.2	3.58	99.34	3.03	0.04
280	16	48.58	0.68	6.29	3.4	99.45	4.52	0.08

Element	**CO2**	**SO4**
LDL		
Samples	**%**	**%**
253	0.11	0.73
257	0.05	0.41
260	0.06	0.17
263	0.03	0.17
266	0.4	0.2
273	1.95	0.26
275	0.1	0.23
277	4.14	3
280	6.22	2.97

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
300	00/16-12-046-03W5/0	52.957954	-114.293665	1563.765	1563.770	Dec. 2003
300	00/16-12-046-03W5/0	52.957954	-114.293665	1563.765	1563.770	April 2004
302	00/16-12-046-03W5/0	52.957954	-114.293665	1564.770	1564.775	Dec. 2003
303	00/16-12-046-03W5/0	52.957954	-114.293665	1565.775	1565.780	Dec. 2003
307	00/16-12-046-03W5/0	52.957954	-114.293665	1566.710	1566.715	Dec. 2003
308	00/16-12-046-03W5/0	52.957954	-114.293665	1567.690	1567.695	Dec. 2003
309	00/16-12-046-03W5/0	52.957954	-114.293665	1568.700	1568.705	Dec. 2003
310	00/16-12-046-03W5/0	52.957954	-114.293665	1570.440	1570.445	Dec. 2003
311	00/16-12-046-03W5/0	52.957954	-114.293665	1570.990	1571.030	Dec. 2003
312	00/16-12-046-03W5/0	52.957954	-114.293665	1571.440	1571.445	Dec. 2003
313	00/16-12-046-03W5/0	52.957954	-114.293665	1573.205	1573.210	Dec. 2003
314	00/16-12-046-03W5/0	52.957954	-114.293665	1574.170	1574.175	Dec. 2003
315	00/16-12-046-03W5/0	52.957954	-114.293665	1575.175	1575.180	Dec. 2003
316	00/14-29-048-06W5/0	53.176285	-114.844461	1539.450	1539.455	Dec. 2003
317	00/14-29-048-06W5/0	53.176285	-114.844461	1540.485	1540.490	Dec. 2003
318	00/14-29-048-06W5/0	53.176285	-114.844461	1541.445	1541.450	Dec. 2003
319	00/14-29-048-06W5/0	53.176285	-114.844461	1542.450	1542.455	Dec. 2003
320	00/14-29-048-06W5/0	53.176285	-114.844461	1543.490	1543.495	Dec. 2003
321	00/14-29-048-06W5/0	53.176285	-114.844461	1544.370	1544.375	Dec. 2003
322	00/14-29-048-06W5/0	53.176285	-114.844461	1545.450	1545.455	Dec. 2003
323	00/14-29-048-06W5/0	53.176285	-114.844461	1546.090	1546.095	Dec. 2003
324	00/14-29-048-06W5/0	53.176285	-114.844461	1546.975	1546.980	Dec. 2003
325	00/14-29-048-06W5/0	53.176285	-114.844461	1547.870	1547.875	Dec. 2003
326	00/14-29-048-06W5/0	53.176285	-114.844461	1548.745	1548.750	Dec. 2003
327	00/14-29-048-06W5/0	53.176285	-114.844461	1549.830	1549.835	Dec. 2003
328	00/14-29-048-06W5/0	53.176285	-114.844461	1550.880	1550.885	Dec. 2003
329	00/14-29-048-06W5/0	53.176285	-114.844461	1551.950	1551.955	Dec. 2003
330	00/14-29-048-06W5/0	53.176285	-114.844461	1552.810	1552.815	Dec. 2003
332	00/14-29-048-06W5/0	53.176285	-114.844461	1554.210	1554.215	Dec. 2003
333	00/14-29-048-06W5/0	53.176285	-114.844461	1555.010	1555.020	Dec. 2003
334	00/14-29-048-06W5/0	53.176285	-114.844461	1555.910	1555.915	Dec. 2003
335	00/14-29-048-06W5/0	53.176285	-114.844461	1557.010	1557.015	Dec. 2003
336	00/14-29-048-06W5/0	53.176285	-114.844461	1558.010	1558.015	Dec. 2003
338	00/14-29-048-06W5/0	53.176285	-114.844461	1558.885	1558.890	Dec. 2003
339	00/14-29-048-06W5/0	53.176285	-114.844461	1557.010	1557.015	Dec. 2003
340	00/14-29-048-06W5/0	53.176285	-114.844461	1561.040	1561.045	Dec. 2003
341	00/14-29-048-06W5/0	53.176285	-114.844461	1561.945	1561.950	Dec. 2003
342	00/14-29-048-06W5/0	53.176285	-114.844461	1563.135	1563.140	Dec. 2003
343	00/14-29-048-06W5/0	53.176285	-114.844461	1564.155	1564.160	Dec. 2003
344	00/14-29-048-06W5/0	53.176285	-114.844461	1565.100	1565.105	Dec. 2003
345	00/14-29-048-06W5/0	53.176285	-114.844461	1566.110	1566.115	Dec. 2003
346	00/14-29-048-06W5/0	53.176285	-114.844461	1566.660	1566.665	Dec. 2003
347	00/14-29-048-06W5/0	53.176285	-114.844461	1567.070	1567.080	Dec. 2003
348	00/14-29-048-06W5/0	53.176285	-114.844461	1567.820	1567.825	Dec. 2003
349	00/14-29-048-06W5/0	53.176285	-114.844461	1569.490	1569.495	Dec. 2003
350	00/14-29-048-06W5/0	53.176285	-114.844461	1570.365	1570.370	Dec. 2003
351	00/14-29-048-06W5/0	53.176285	-114.844461	1571.650	1571.655	Dec. 2003
352	00/14-29-048-06W5/0	53.176285	-114.844461	1572.690	1572.695	Dec. 2003
353	00/14-29-048-06W5/0	53.176285	-114.844461	1573.910	1573.915	Dec. 2003
354	00/14-29-048-06W5/0	53.176285	-114.844461	1576.470	1576.475	Dec. 2003
355	00/14-29-048-06W5/0	53.176285	-114.844461	1577.250	1577.255	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
300	Possible	Top of Belle Fourche	Dk grey shale, some silt, some micas, black fragments
300	Possible	Top of Belle Fourche	Dk grey shale, some silt, some micas, black fragments
302	Possible	Top of Belle Fourche	Dk grey shale, fish fragments, some silt
303	Possible	Top of Belle Fourche	Dk grey shale, broken, micas, minor silt, smooth
307	Possible	Top of Belle Fourche	Dk grey shale, micas, minor silt
308	Possible	Top of Belle Fourche	Dk grey shale, silt, micas
309	Possible	Top of Belle Fourche	Dk grey shale, some silt, some micas, fish debris
310	Possible	Top of Belle Fourche	Dk grey shale, some wisps of silt
311	Possible	Top of Belle Fourche	Dk grey shale
312	Possible	Belle Fourche	Dk grey shale, micas, minor silt
313	Possible	Belle Fourche	Dk grey shale, micas, wisps of silt
314	Possible	Belle Fourche	Dk grey shale, silty wisps, shelly debris
315	Possible	Belle Fourche	Dk grey shale, some silt, some micas
316	Unknown	Second White Specks	Dk grey shale, shelly debris
317	Unknown	Second White Specks	Dk grey shale, smooth, small amount of silt
318	Unknown	Second White Specks	Dk grey shale, fish fragments, shelly remains
319	Unknown	Second White Specks	Dk grey shale, shelly material, some silt
320	Unknown	Second White Specks	Dk grey shale, some shelly fragments, minor silt
321	Unknown	Second White Specks	Dk grey shale, minor silt
322	Unknown	Second White Specks	Dk grey shale, some shells, some silt
323	Unknown	Second White Specks	Dk grey shale, some micas, some silt
324	Unknown	Second White Specks	Dk grey shale, abundant shells
325	Unknown	Second White Specks	Dk grey shale, silty wisps
326	Unknown	Second White Specks	Dk grey shale, some fish fragments, minor silt
327	Unknown	Second White Specks	Dk grey shale, shell fragments, some silt
328	Unknown	Second White Specks	Dk grey shale, some fish fragments, silty
329	Unknown	Second White Specks	Dk grey shale, fish fragments, some silt
330	Unknown	Second White Specks	Dk grey shale, silt
332	Unknown	Second White Specks	Dk grey shale, small amount of micas
333	Unknown	Second White Specks	Dk grey shale, some silt, smooth
334	Unknown	Second White Specks	Dk grey shale, shelly fragments
335	Unknown	Second White Specks	Dk grey shale, silty
336	Unknown	Second White Specks	Dk grey shale, silty lams
338	Unknown	Second White Specks	Dk grey shale, shelly material
339	Unknown	Second White Specks	Dk grey shale, silt, fish fragments
340	Unknown	Second White Specks	Dk grey shale, organic fragments, some silt
341	Unknown	Second White Specks	Dk grey shale, minor silt
342	Unknown	Second White Specks	Dk grey shale, a little silt, micas
343	Unknown	Second White Specks	Dk grey shale, minor silt and micas
344	Unknown	Second White Specks	Dk grey shale, fish fragments
345	Unknown	Second White Specks	Dk grey, fish fragments, lams of silt
346	Unknown	Second White Specks	Dk grey shale, some shelly fragments
347	Unknown	Second White Specks	Pyrite lense
348	Unknown	Second White Specks	Dk grey shale, silty
349	Unknown	Second White Specks	Dk grey shale, fish scales, small amount of silt, smooth
350	Unknown	Second White Specks	Dk grey shale, fish fragments, shelly debris
351	Unknown	Second White Specks	Dk grey shale, some shelly fragments
352	Unknown	Second White Specks	Dk grey shale, minor fish fragments, minor silt
353	Unknown	Second White Specks	Dk grey shale, organic fragments, some silt
354	Unknown	Second White Specks	Dk grey shale, a little shelly fragments
355	Unknown	Second White Specks	Dk grey shale, silt, organic fragments

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
300	635	1.17	29.9	< .2	6	36.4		0.51
302	399	1.05	24.2	0.3	8	58.4		0.45
303	309	1.04	27.9	< .2	8	55.3		0.51
307	547	1.1	23.3	0.9	8	49.7		0.39
308	655	1.14	37.1	0.2	5	30		0.44
309	620	1.08	41.5	0.4	6	29.1		0.47
310	467	1.17	28.5	0.4	6	38.4		0.42
311	213	0.55	15.4	0.3	5	84.2		0.22
312	417	1.19	31.3	0.4	8	41.1		0.48
313	410	1.15	28.9	0.6	10	49.9		0.4
314	400	1.16	30.5	0.6	10	53.7		0.39
315	348	1.19	30.2	0.2	9	52.6		0.39
316	349	1.26	29.6	< .2	14	57.9	0.8	0.3
317	275	1.08	28	< .2	11	56		0.26
318	257	1.04	22.9	0.5	11	68		0.21
319	281	0.99	25.4	0.3	14	61.3		0.24
320	292	1.19	21.8	0.2	13	77.5	0.8	0.29
321	283	0.9	25.9	0.3	10	58.6		0.23
322	249	0.93	24.9	< .2	11	67.1		0.22
323	295	0.89	28.4	< .2	12	48.5		0.25
324	248	0.71	21.2	< .2	10	120		0.2
325	350	0.85	24.8	0.3	11	58.2	0.7	0.28
326	301	0.8	23.7	0.4	12	53.5		0.23
327	295	0.79	26.2	0.5	12	48.4		0.25
328	333	0.73	23.7	0.6	10	57.8		0.25
329	364	0.97	24.3	1.1	14	65	0.7	0.26
330	342	0.7	24.4	< .2	12	45.4		0.24
332	339	0.73	23.3	0.4	10	56.2		0.25
333	372	0.66	36	0.4	10	35.2		0.3
334	315	0.74	26.5	0.3	11	72.3	0.5	0.21
335	293	0.63	25.7	0.3	11	64.6		0.2
336	266	0.45	18.4	< .2	6	87.1		0.16
338	318	0.59	42.6	1.4	5	32.6		0.2
339	313	0.85	18.6	< .2	13	81.5	0.6	0.27
340	281	0.66	15.8	< .2	6	71.6		0.23
341	298	0.76	13.3	0.8	8	83		0.24
342	300	0.94	28.4	0.2	12	56.2	0.7	0.25
343	331	0.62	20.4	0.4	8	50		0.2
344	297	0.65	27.9	0.5	6	42.9		0.22
345	264	0.57	25.5	0.4	6	51.8		0.19
346	476	0.56	27.6	0.4	9	47.1		0.21
347	284	0.44	460	< .2	4	6.3		0.18
348	321	0.82	32.1	< .2	12	50.9	0.5	0.25
349	237	0.69	30.4	0.4	8	32.2		0.27
350	247	0.54	25.9	< .2	9	40.2		0.22
351	368	0.85	31.8	0.7	13	48.1	0.6	0.27
352	263	0.69	28.4	< .2	9	39.7		0.21
353	235	0.85	23.7	< .2	7	32.8		0.25
354	200	1.19	24.4	0.6	13	56.8	0.7	0.29
355	185	0.92	21.8	0.4	6	37.6		0.27

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
300	1.04	7.48		19.6	17.8		68.38	3.75
302	0.26	1.53		15.5	16.4		54	2.64
303	0.84	1.09		14.1	14.9		43.41	3.09
307	0.3	1.75		16.9	18.3		58.05	2.96
308	0.38	2.3		22.7	18.5		70.94	3.86
309	0.27	2.18		22.8	17.5		66.39	4.13
310	0.25	1.73		19.7	19.2		59.41	3.45
311	2.19	0.7		10.6	17.5		27.88	16.75
312	0.26	1		20.6	18.6		58.21	3.54
313	0.23	1.48		18.3	19.7		55.22	3.38
314	0.63	1.67		18.7	20.6		54.94	3.28
315	0.26	1.11		19.3	19.1		52.15	3.48
316	2.5	1.1	10.7	12.9	21.2	1.46	53.02	2.83
317	3.46	0.75		13.5	16.2		36.13	2.81
318	3.22	1.22		12.7	15.7		30.51	2.31
319	3.57	0.68		13.5	16.7		33.11	2.6
320	3.58	1.41	12.2	12.4	19.2	1.4	39.13	2.33
321	4.35	1		13.6	15.2		33.45	2.52
322	3.73	1.33		12.7	14.8		29.53	2.26
323	3.89	1.22		13.4	16.1		32.59	2.57
324	11.37	1.49		10.9	12.7		28.32	2.09
325	6.32	1.24	11.4	13	15.3	1.08	39.44	2.49
326	4.56	1.14		12	13.8		31.59	2.41
327	4.88	1.04		13.5	13.1		34.16	2.65
328	4.61	1.37		13.2	13.3		33.71	2.35
329	5.32	0.99	11.2	13.3	16.6	1.14	38.54	2.55
330	5.28	1.31		14	12.4		37.6	2.72
332	4.93	1.68		13	13.1		37.84	2.36
333	3.93	1.31		15.7	12.2		42.09	3.05
334	10.29	1.19	13.2	12.3	14.5	0.96	34.82	2.63
335	7.36	1.29		12.1	11.2		30.95	2.38
336	8.37	1.08		8.9	10.9		27.2	2.08
338	5.67	1.63		11.1	9.7		32.53	3.42
339	4.59	1.45	10.7	12.3	14.5	1.26	35.81	2
340	3.97	2.5		9.9	12.4		35.32	1.78
341	3.52	1.17		9.3	13.2		34.59	1.7
342	5.59	1.23	12	14.1	15.4	1.08	38.65	2.66
343	4.67	2		11	11.7		33.2	2.27
344	4.66	1.27		13.3	12.2		32.28	2.58
345	6.92	1.46		10.8	10.7		28.3	2.48
346	5.62	2.6		16.6	11.6		42.51	2.57
347	4.25	1.16		11.5	9.8		26.93	14.32
348	6.62	1.44	13.3	15	12.6	1	38.84	2.87
349	3.28	0.89		13	13.1		30.26	3.31
350	5.6	0.81		12.5	12.8		30.16	2.99
351	4.95	1.89	12.8	19.6	14.1	1.14	50.16	3.17
352	5.26	1.12		14.9	13.6		33.18	3.18
353	1.42	0.92		12.5	15.4		34.22	3.11
354	0.99	0.52	9.2	12.8	21.8	1.58	33.58	3.13
355	0.92	0.61		12.8	18.3		28.95	3.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
300	3.6			169		0.31	5.1	
302	3.1			177		0.28	3.9	
303	3.4			154		0.27	4.8	
307	3.1			365		0.28	4.5	
308	3.2			270		0.27	4.7	
309	3.2			203		0.25	3.8	
310	3.5			375		0.27	3.9	
311	1.7			90		0.12	6.9	
312	3.6			203		0.26	3.8	
313	3.4			341		0.25	3.7	
314	3.7			181		0.26	3.9	
315	3.5			196		0.26	3.6	
316	4	<.1	0.07	142	0.05	0.38	5	19.5
317	3.3			107		0.28	5.3	
318	3			149		0.3	4.7	
319	3.1			133		0.28	4.8	
320	3.8	<.1	0.08	98	0.04	0.36	5.5	19.3
321	2.8			134		0.27	4.7	
322	2.8			145		0.27	4.3	
323	2.9			207		0.28	4.5	
324	2.6			140		0.22	5.4	
325	3.2	<.1	0.05	123	0.05	0.3	5.3	10.3
326	2.7			125		0.26	5	
327	2.9			123		0.25	4.9	
328	2.4			104		0.23	4.8	
329	3.3	<.1	0.07	112	0.04	0.35	5.1	11.6
330	2.8			266		0.23	5.7	
332	2.7			99		0.24	5.2	
333	2.7			158		0.23	4.6	
334	2.9	<.1	0.06	126	0.03	0.28	6.2	8.4
335	2.6			165		0.22	5.6	
336	2			66		0.19	4.5	
338	2.4			125		0.19	4.1	
339	3	<.1	0.05	102	0.05	0.32	4.8	10.9
340	2.4			78		0.24	4.3	
341	2.6			69		0.27	4.2	
342	3.4	<.1	0.08	115	0.04	0.33	5.6	11.2
343	2.4			120		0.22	4	
344	2.6			85		0.23	4	
345	2.6			111		0.21	4.7	
346	2.6			111		0.21	4.1	
347	2.1			144		0.16	3.5	
348	3.9	<.1	0.06	178	0.04	0.27	5.8	10
349	2.8			130		0.25	4.4	
350	2.5			115		0.21	4.6	
351	3.3	<.1	0.07	107	0.05	0.32	5.6	9.3
352	2.8			99		0.24	4.4	
353	4.1			143		0.27	4.5	
354	3.8	<.1	0.09	86	0.05	0.34	4.3	23.2
355	3.2			107		0.25	3.3	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
300	0.55	178	28.9	0.251		80.8	0.06	23.36
302	0.3	103	17.8	0.254		67.5	0.06	19.81
303	0.46	153	14.54	0.231		51.7	0.059	21.98
307	0.28	104	12.55	0.214		61.3	0.068	20.52
308	0.32	130	23.6	0.204		82.9	0.061	22.1
309	0.32	122	21.11	0.237		75.4	0.057	22.73
310	0.34	142	16.99	0.231		65.2	0.062	22.4
311	3.25	2193	13.95	0.098		33.5	0.034	10.74
312	0.38	173	18.36	0.244		69.7	0.063	24.09
313	0.39	160	13.76	0.211		63	0.063	21.41
314	0.45	130	15.09	0.232		64.6	0.064	20.71
315	0.42	166	12.12	0.224		65	0.06	20.75
316	0.46	119	16.78	0.233	0.04	56.6	0.066	16.71
317	0.53	96	15.75	0.205		43.9	0.07	14.95
318	0.43	76	11.87	0.22		47.3	0.067	12.6
319	0.53	89	14.28	0.215		51	0.062	13.99
320	0.45	74	9.72	0.236	0.04	56.7	0.067	15.51
321	0.49	74	14.17	0.201		53.7	0.065	13.51
322	0.45	79	11.3	0.204		50.8	0.058	13.31
323	0.53	81	13.29	0.194		59.2	0.062	14.91
324	0.47	82	14.23	0.188		49.8	0.078	11.06
325	0.48	87	16.28	0.194	0.04	59.4	0.071	15.57
326	0.47	65	13.66	0.183		49.3	0.064	13.78
327	0.54	102	19.89	0.199		46.9	0.06	14.32
328	0.51	67	13.3	0.188		55.6	0.063	14.79
329	0.59	84	14.23	0.214	0.07	49.6	0.073	25.94
330	0.58	105	24.71	0.171		53.4	0.068	15.26
332	0.51	75	17.83	0.185		64.6	0.063	15.08
333	0.46	79	26.35	0.182		66.6	0.065	15.79
334	0.93	127	18.57	0.176	0.07	45.6	0.073	13.65
335	0.61	85	18.81	0.161		51.3	0.072	12.88
336	1.04	106	6.88	0.153		32.5	0.057	9.93
338	0.55	114	36.25	0.18		53.8	0.072	12.59
339	0.52	59	8.82	0.209	0.03	52.2	0.07	14.98
340	0.52	64	6.49	0.207		42.7	0.061	12.85
341	0.47	68	5.52	0.219		40.5	0.056	12.59
342	0.55	105	19.63	0.207	0.06	49	0.077	13.9
343	0.49	73	10.25	0.194		51.5	0.058	12.67
344	0.52	77	16.82	0.199		59.5	0.06	12.93
345	0.54	97	18.43	0.172		54.7	0.066	11.66
346	0.51	71	25.63	0.183		82.7	0.063	12.47
347	0.47	107	114.36	0.135		48.9	0.06	10.9
348	0.52	101	27.58	0.182	0.06	58.8	0.066	13.89
349	0.64	96	4.48	0.213		37.1	0.071	15.24
350	0.55	97	4.63	0.179		39.1	0.066	13.69
351	0.53	83	10.26	0.208	0.04	58	0.079	16.67
352	0.7	122	7.87	0.189		42.4	0.068	12.87
353	0.59	106	9.97	0.238		51.4	0.062	14.63
354	0.55	104	5.25	0.255	0.03	42.6	0.064	16.74
355	0.45	91	3.34	0.253		43.9	0.052	15.99

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
300					2.34	1.66	5.4	5.5
302					1.75	1.43	3.3	3.5
303					1.94	1.4	5.3	2.6
307					1.98	1.12	3.3	4.2
308					2.92	1.73	3.9	6.7
309					3.16	1.63	3.7	5.8
310					2.35	1.4	3.9	4.2
311					1.1	0.82	11.5	2.1
312					2.41	1.34	4.3	3.9
313					2.12	1.42	4.3	3.2
314					2.19	1.5	4.6	3.1
315					2.13	1.39	4.8	3
316	< 10	< 2	23.2	21	1.85	1.06	5.2	2.8
317					1.86	0.8	6	2.2
318					1.45	0.99	5.1	2.2
319					1.77	0.81	5.5	2.4
320	< 10	< 2	21.7	22	1.44	0.95	6.6	3
321					1.77	0.98	5.2	2.6
322					1.52	0.97	4.2	2.4
323					1.93	1.21	4.9	3.6
324					1.36	0.91	6	2.6
325	< 10	< 2	18.8	36	1.91	1.11	5.5	3.5
326					1.84	1.29	4.7	3
327					2.05	1.08	4.6	3.1
328					1.79	1.36	4.3	3.6
329	< 10	< 2	19.8	23	1.86	1.02	4.6	3
330					2.12	1	5	3.5
332					1.8	1.37	5.1	4.3
333					2.61	1.47	4.1	4.4
334	< 10	< 2	16.1	28	1.97	1.09	4.8	3.4
335					1.83	1.32	4.4	3
336					1.5	0.78	3.5	2.1
338					3.22	2.29	2.8	5.9
339	< 10	< 2	19.3	29	1.5	0.73	4.5	2.9
340					1.49	0.91	3.5	3
341					1.32	0.82	3.6	2.5
342	< 10	< 2	19.4	32	2.04	1.09	4.8	3.4
343					1.92	1.15	4.3	3.3
344					2.24	1.3	4.1	3.3
345					2.15	1.16	4.8	2.9
346					2.16	1.9	3.6	5.4
347					16.63	4.88	2.4	14.2
348	< 10	< 2	16.3	46	2.42	1.82	4.9	4.5
349					2.96	1.08	3.5	2.4
350					2.48	1.04	4.3	2.3
351	< 10	< 2	19.5	19	2.69	1.32	4.4	4.4
352					2.5	0.95	4.6	3
353					2.68	0.8	4.1	4.8
354	< 10	< 2	22.7	10	2	0.57	4.7	2.2
355					2.48	0.53	4.2	1.9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
300		110.7		0.12	7	0.01	0.31	3.6
302		83.6		0.07	6.3	0.004	0.4	2.13
303		103.7		0.09	7.2	0.013	0.54	2.27
307		81.5		0.1	5.7	0.001	0.53	3.15
308		76.6		0.15	6	0.004	0.53	3.66
309		77.8		0.18	5.9	0.009	0.52	3.62
310		78.8		0.14	6.3	< .001	0.4	2.97
311		87.3		0.08	3.4	0.001	0.41	4.21
312		83.5		0.09	7	0.004	0.44	2.84
313		74.1		0.12	5.7	< .001	0.38	2.42
314		99.2		0.1	6.1	0.005	0.36	2.6
315		80.9		0.11	5.8	0.005	0.36	2.33
316	0.7	84.2	< .05	0.09	4.9	0.007	0.22	3.13
317		106.9		0.05	5.1	< .001	0.16	3.61
318		107.4		0.06	4.3	< .001	0.19	3.05
319		119.3		0.06	4.6	< .001	0.21	2.93
320	0.8	111.6	< .05	0.1	5.4	< .001	0.29	2.97
321		145.7		0.09	4.6	0.006	0.26	3.16
322		155.6		0.09	4.5	< .001	0.26	2.36
323		110.8		0.09	4.7	< .001	0.37	2.65
324		395.7		0.06	3.5	0.002	0.23	7.17
325	0.6	223.5	< .05	0.08	4.7	0.01	0.22	3.75
326		184.1		0.11	4.3	< .001	0.25	2.92
327		149.4		0.06	4.5	< .001	0.18	3.67
328		124.8		0.09	4.7	0.002	0.39	2.63
329	0.6	196.4	< .05	0.09	4.7	0.001	0.21	3.51
330		141.5		0.08	4.5	< .001	0.19	5.58
332		133		0.1	4.6	0.002	0.37	3.27
333		106		0.09	4.4	0.007	0.3	3.82
334	0.4	294.5	< .05	0.08	4.1	0.003	0.17	5.24
335		204.4		0.06	4.3	< .001	0.29	5.15
336		221.6		0.07	3.5	< .001	0.17	2.65
338		162.6		0.11	4.1	< .001	0.69	2.89
339	0.6	120.5	< .05	0.09	4.9	0.002	0.27	2.36
340		108.4		0.05	4.9	< .001	0.24	1.87
341		94.2		0.05	4.9	< .001	0.21	1.62
342	0.6	144.8	< .05	0.08	4.7	0.002	0.16	4.17
343		124.6		0.09	4.5	< .001	0.45	2.24
344		138.9		0.06	4.4	< .001	0.37	2.93
345		193.5		0.07	4.3	0.005	0.25	4.41
346		135.1		0.12	3.7	< .001	0.55	4.78
347		100.3		0.11	3.6	< .001	0.39	2.76
348	0.6	157.2	< .05	0.13	4.8	0.008	0.24	6.22
349		90.2		0.09	5.2	< .001	0.12	1.9
350		136.2		0.11	4.4	< .001	0.17	2.35
351	0.5	118.8	< .05	0.2	5	0.003	0.23	2.97
352		117.7		0.1	3.8	< .001	0.16	2.86
353		58.1		0.15	5.1	0.002	0.24	2.8
354	0.6	62.9	< .05	0.11	4.8	0.004	0.15	1.96
355		60.4		0.12	5.2	< .001	0.2	1.19

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
300	75	<.1		896.9		0.6	8.3	27
302	37	<.1		157.4				
303	39	<.1		132				
307	43	<.1		162.3				
308	53	<.1		175.4				
309	46	<.1		188.1				
310	41	<.1		165.9				
311	94	<.1		82.8				
312	42	<.1		136.6				
313	43	<.1		156				
314	41	<.1		201.4				
315	42	<.1		158.2				
316	55	0.1	10.58	176.1	2.6	0.3	7.5	17
317	36	<.1		119.5				
318	46	<.1		208.6				
319	38	<.1		113.2				
320	54	<.1	11.68	165.3	2.6	0.3	7.64	13
321	40	<.1		159.6				
322	42	<.1		232.1				
323	46	<.1		162.7				
324	42	<.1		233.3				
325	49	<.1	12.02	152.7	2	0.4	6.38	12
326	48	<.1		124.5				
327	38	<.1		135.5				
328	54	<.1		139				
329	47	<.1	10.7	144.8	2.1	0.4	6.77	14
330	38	<.1		162.6				
332	52	<.1		141.4				
333	45	<.1		144.6				
334	64	<.1	11.79	119.2	2.1	0.4	5.13	12
335	47	<.1		145.7				
336	40	<.1		117.7				
338	57	<.1		131.2				
339	51	<.1	10.28	135.5	1.7	0.3	7.1	12
340	48	<.1		232.4				
341	49	<.1		131.8				
342	47	<.1	11.82	154.9	2.1	0.3	6.76	16
343	49	<.1		163.1				
344	45	<.1		133.5				
345	49	<.1		133				
346	80	<.1		170.1				
347	52	<.1		95.8				
348	70	<.1	11.31	144.9	2.2	0.4	6.38	15
349	32	<.1		172.6				
350	32	<.1		113.2				
351	44	<.1	11.9	216.4	2	0.4	6.53	12
352	40	<.1		133.6				
353	29	<.1		135.1				
354	35	<.1	10.15	122.7	2.1	0.2	7.59	15
355	28	<.1		185.6				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
300	<.1	148	2	0.6	1.06	7.4	73	21
316	<.1	102	1	0.2	2.49	0.6	55	13
320	<.1	180	2	0.2	3.71	1.3	60	13
325	<.1	100	1	0.2	6.5	1.2	56	13
329	<.1	104	4	0.2	5.45	1	58	13
334	<.1	101	1	0.1	10.64	1	46	13
339	<.1	142	1	0.3	4.74	1.2	63	12
342	<.1	102	1	0.2	5.65	0.8	56	14
348	<.1	112	1	0.3	6.77	1.2	56	15
351	<.1	98	1	0.3	5.03	1.6	56	17
354	<.1	138	3	0.3	0.86	0.4	58	13

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
300	115.3	71.5	5.07	3	2.2	40.7	87.7	0.97
316	114.9	50.3	3.78	2	2.2	23.6	69.2	0.84
320	115.9	37.9	3.26	2.3	2.11	26.5	72.5	0.85
325	102.8	38.4	3.21	1.7	1.83	26.9	49	0.82
329	103.3	36.4	3.28	2.1	2.04	27	47.8	0.95
334	80.3	33.1	3.31	1.4	1.46	20.2	34.5	1.23
339	108.3	35.7	2.72	2.2	2.1	27.8	56.7	0.91
342	99.6	37.6	3.38	2.1	1.94	26.2	52.8	0.9
348	83.2	36.8	3.57	1.9	1.63	25.6	47.6	0.83
351	85.4	47.2	3.78	1.6	1.87	31.8	43.1	0.86
354	106.4	33.5	3.82	2.3	2.23	30.1	79.5	0.94

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
300	202	32.5	0.527	14	82.3	0.084	26.5	126.5
316	153	16.1	0.418	11.9	58.2	0.077	18.4	103
320	101	10	0.451	11.4	64	0.079	18.5	106.8
325	102	14.9	0.371	11.4	54.7	0.078	17.1	111.7
329	109	14.4	0.426	11.2	52.5	0.082	26.7	121.7
334	147	18	0.308	8.9	48.6	0.074	14.1	86.4
339	84	8.8	0.4	11.9	57.3	0.081	17.2	118.5
342	126	18.9	0.373	11.4	51.7	0.087	15.9	116.6
348	114	26.6	0.328	9.5	60.1	0.072	15.5	98.3
351	106	9.4	0.358	9.8	49.9	0.085	17.1	101.4
354	129	5.3	0.442	12.7	42.2	0.076	17.4	108.3

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
300	2.9	3.4	15	3.4	213	1	12.5	0.432
316	2.1	2	11	1.9	170	0.8	8.4	0.398
320	1.6	1.9	13	2.3	204	0.8	9.1	0.392
325	2.3	2.3	10	1.9	305	0.7	8	0.341
329	2.2	2	10	1.9	275	0.7	8	0.352
334	2.3	2.1	8	1.4	337	0.5	6.7	0.276
339	1.8	1.5	11	1.9	214	0.8	8.9	0.371
342	2.4	2	9	1.8	224	0.7	8	0.356
348	2.9	3.1	9	1.6	227	0.6	7.9	0.294
351	3.1	2.2	9	1.6	220	0.6	8.2	0.33
354	2.2	1	10	2.2	170	0.8	8.2	0.417

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	9.8	411	1.7	23.5	911	84.4	82.4	19.1
316	5.1	276	1.1	15.8	190	62.4	75.9	14.5
320	5.2	282	1	18	184	60.7	76	14.3
325	5.6	242	1	18.6	168	58.5	67.1	13
329	5.6	229	0.9	17.6	161	59.5	62.7	12.4
334	6.6	216	1	16.8	132	45.6	53.5	11.5
339	4.8	281	0.8	17.9	162	62.1	69	12.7
342	6.1	232	1.1	18.4	169	61.4	64.8	14.2
348	8.9	307	0.8	17.3	160	54.9	61.9	13.4
351	4.7	235	1	14.5	227	55.5	61.5	17.5
354	4.4	229	1.2	13.8	134	68.2	77.2	13.7

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	10.3	4.69	3.09	1.28	23	4.79	4	1.02
316	8.8	4.29	2.5	1.26	20.2	5.29	3.5	0.91
320	9	4.56	2.59	1.43	19.8	4.85	3.7	0.97
325	7.2	4.09	2.42	1.15	16.7	4.1	3.2	0.85
329	7.5	3.53	2.05	1.07	16.9	4.19	3.4	0.73
334	5.3	3.25	1.94	1.05	13.4	3.84	2.7	0.68
339	7.6	3.71	2.13	1.25	17.9	4.16	4	0.77
342	6.9	3.62	2.17	1.12	16.9	4.47	3.3	0.73
348	5.9	3.9	1.94	1.1	16.5	3.71	3.2	0.79
351	8.2	3.57	2.02	0.98	16.7	4.6	3	0.77
354	10.3	4.32	2.54	1.12	22.7	5.07	4	0.9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	41	0.48	17	32.5	9.22	1	133	6
316	37.4	0.37	17.2	36.6	9.21	1	142.7	6.3
320	37.7	0.38	16.8	36.8	9.15	1	138.2	6.3
325	33.4	0.32	15.1	30.4	8.06	< 1	118.5	5.6
329	33	0.33	15.5	29.5	7.55	1	120.4	5.2
334	27	0.27	12	24.9	6.54	< 1	86	4.4
339	35.7	0.31	15.7	31	8.4	< 1	129.3	5.6
342	33.8	0.32	14.9	28.8	7.81	< 1	117.2	5
348	30.1	0.3	12.5	30.5	7.54	< 1	100.9	5.2
351	32.9	0.34	13.4	29.5	7.53	< 1	117.7	5.6
354	41.1	0.42	17.2	35.3	9.38	2	147.9	6.4

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	255.4	1.1	0.83	14.9	0.49	10.5	389	2.2
316	201.8	1.1	0.8	11.7	0.42	6.9	280	3.5
320	227.4	0.9	0.86	10.7	0.44	6.9	284	1.7
325	353	0.9	0.77	10.5	0.39	7.1	263	1.3
329	300.1	0.8	0.68	9.2	0.34	7	231	1.3
334	383.5	0.7	0.63	8.3	0.32	8.1	205	0.9
339	228.2	0.9	0.73	10.7	0.36	5.7	293	1.2
342	252.3	0.9	0.78	9.3	0.36	7.8	235	1.2
348	262.9	0.9	0.71	9.3	0.3	10.7	320	1.4
351	214.9	0.8	0.63	10.1	0.33	5.9	248	1.2
354	193.2	1.1	0.77	12.8	0.41	6.3	245	1.5

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
300	31	3.07	141.5	16.59	998	1.56	0.012	
316	25.9	2.41	120.2	15.33	1226	3.78	0.013	0.0154
320	27	2.85	122	15.06	1063	5.76	0.012	0.015
325	24.7	2.5	114.5	12.95	1069	10.37	0.013	0.0135
329	21.7	2.25	107.5	13.34	917	8.47	0.014	0.0134
334	20.4	2.03	92.5	10.37	1036	17.25	0.009	0.0102
339	22.8	2.16	118.9	14.09	934	7.3	0.011	0.0146
342	22.9	2.32	105.9	13.8	911	8.93	0.013	0.0129
348	21.9	2.07	102.6	13.3	826	11.06	0.009	0.0111
351	23.3	2.13	102.5	13.48	829	8.51	0.012	0.012
354	28.5	2.65	127.9	16.74	906	1.57	0.015	0.0145

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
300	6.67	2.53	15.2	1.73	0.02	0.71	70	0.18
316	5.28	2.86	13.5	1.57	0.02	0.6	64	0.2
320	4.5	2.77	13.7	1.56	0.01	0.58	70	0.19
325	4.6	2.45	16.6	1.55	0.01	0.49	50	0.18
329	4.63	2.64	14.6	1.77	0.01	0.6	56	0.2
334	4.39	1.95	20.6	2.22	0.02	0.49	36	0.2
339	3.83	2.69	14.3	1.68	0.01	0.55	45	0.21
342	4.74	2.54	16.5	1.67	0.02	0.55	55	0.22
348	4.99	2.21	19.4	1.57	0.01	0.49	63	0.2
351	5.47	2.49	16.6	1.64	0.01	0.53	42	0.23
354	5.44	2.95	11.5	1.78	0.01	0.61	56	0.19

							Analysis: CO2	
Element	Sc	SiO2	TiO2	TOT/C	TOT/S	SUM	C/ORG	C/GRA
LDL	1	0.02	0.01	0.01	0.01			
Samples	ppm	%	%	%	%	%	%	%
300	16	53.6	0.69	5.76	3.32	99.5	5.12	0.07
316	14	55.77	0.69	4.15	2.66	99.75	3.3	0.05
320	17	54.82	0.68	4.53	2.01	99.77	3.33	0.03
325	13	49.84	0.6	6.44	2.61	99.79	4.27	0.05
329	11	52.79	0.6	4.89	2.5	99.78	3.03	0.04
334	9	41.74	0.47	7.67	2.6	99.84	4.05	0.03
339	12	54.32	0.63	5.1	2.11	99.74	3.52	0.03
342	12	50.12	0.61	5.99	2.9	99.82	4.05	0.06
348	11	45.91	0.53	8.33	3.4	99.77	6.07	0.02
351	12	50.08	0.59	6.39	3.38	99.74	4.64	0.11
354	15	57.72	0.75	3.12	2.67	99.39	2.63	0.06

Element	CO2	SO4
LDL		
Samples	%	%
300	2.1	1.58
316	2.96	2.53
320	4.29	2.24
325	7.77	2.97
329	6.67	2.71
334	13.18	3.17
339	5.71	1.92
342	6.86	3.17
348	8.23	3.4
351	6.01	2.72
354	1.59	1.39

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
356	00/06-31-046-08W5/0	53.008381	-115.152694	1803.410	1803.430	Dec. 2003
357	00/06-31-046-08W5/0	53.008381	-115.152694	1804.400	1804.420	Dec. 2003
358	00/06-31-046-08W5/0	53.008381	-115.152694	1805.440	1805.460	Dec. 2003
359	00/06-31-046-08W5/0	53.008381	-115.152694	1806.360	1806.420	Dec. 2003
360	00/06-31-046-08W5/0	53.008381	-115.152694	1807.450	1807.520	Dec. 2003
361	00/06-31-046-08W5/0	53.008381	-115.152694	1807.620	1807.640	Dec. 2003
362	00/06-31-046-08W5/0	53.008381	-115.152694	1808.320	1808.380	Dec. 2003
363	00/06-31-046-08W5/0	53.008381	-115.152694	1809.360	1809.390	Dec. 2003
364	00/06-31-046-08W5/0	53.008381	-115.152694	1810.360	1810.420	Dec. 2003
365	00/06-31-046-08W5/0	53.008381	-115.152694	1811.360	1811.425	Dec. 2003
366	00/06-31-046-08W5/0	53.008381	-115.152694	1812.300	1812.340	Dec. 2003
367	00/06-31-046-08W5/0	53.008381	-115.152694	1813.340	1813.380	Dec. 2003
368	00/06-31-046-08W5/0	53.008381	-115.152694	1814.310	1814.360	Dec. 2003
369	00/06-31-046-08W5/0	53.008381	-115.152694	1815.250	1815.280	Dec. 2003
370	00/06-31-046-08W5/0	53.008381	-115.152694	1812.300	1812.340	Dec. 2003
371	00/06-31-046-08W5/0	53.008381	-115.152694	1813.340	1813.380	Dec. 2003
372	00/06-31-046-08W5/0	53.008381	-115.152694	1814.310	1814.360	Dec. 2003
373	00/06-31-046-08W5/0	53.008381	-115.152694	1819.145	1819.215	Dec. 2003
374	00/06-31-046-08W5/0	53.008381	-115.152694	1812.300	1812.340	Dec. 2003
375	00/06-31-046-08W5/0	53.008381	-115.152694	1813.340	1813.380	Dec. 2003
376	00/06-31-046-08W5/0	53.008381	-115.152694	1822.105	1822.175	Dec. 2003
377	00/10-31-054-18W5/0	53.711393	-116.636386	2124.510	2124.560	Dec. 2003
378	00/10-31-054-18W5/0	53.711393	-116.636386	2125.485	2125.525	Dec. 2003
379	00/10-31-054-18W5/0	53.711393	-116.636386	2126.455	2126.515	Dec. 2003
380	00/10-31-054-18W5/0	53.711393	-116.636386	2127.690	2127.760	Dec. 2003
381	00/10-31-054-18W5/0	53.711393	-116.636386	2128.665	2128.725	Dec. 2003
382	00/10-31-054-18W5/0	53.711393	-116.636386	2129.700	2129.750	Dec. 2003
383	00/10-31-054-18W5/0	53.711393	-116.636386	2130.720	2130.790	Dec. 2003
384	00/10-31-054-18W5/0	53.711393	-116.636386	2131.795	2131.845	Dec. 2003
385	00/10-31-054-18W5/0	53.711393	-116.636386	2132.590	2132.650	Dec. 2003
386	00/10-31-054-18W5/0	53.711393	-116.636386	2133.560	2133.610	Dec. 2003
387	00/10-31-054-18W5/0	53.711393	-116.636386	2134.550	2134.600	Dec. 2003
388	00/10-31-054-18W5/0	53.711393	-116.636386	2135.555	2135.610	Dec. 2003
389	00/10-31-054-18W5/0	53.711393	-116.636386	2136.630	2136.680	Dec. 2003
390	00/10-31-054-18W5/0	53.711393	-116.636386	2137.545	2137.605	Dec. 2003
391	00/10-31-054-18W5/0	53.711393	-116.636386	2138.555	2138.615	Dec. 2003
392	00/10-31-054-18W5/0	53.711393	-116.636386	2139.570	2139.640	Dec. 2003
393	00/10-31-054-18W5/0	53.711393	-116.636386	2140.605	2140.650	Dec. 2003
394	00/10-31-054-18W5/0	53.711393	-116.636386	2142.600	2142.640	Dec. 2003
395	00/10-31-054-18W5/0	53.711393	-116.636386	2143.340	2143.390	Dec. 2003
396	00/10-31-054-18W5/0	53.711393	-116.636386	2144.345	2144.390	Dec. 2003
399	00/10-31-054-18W5/0	53.711393	-116.636386	2146.290	2146.335	Dec. 2003
400	00/10-31-054-18W5/0	53.711393	-116.636386	2147.310	2147.360	Dec. 2003
401	00/10-31-054-18W5/0	53.711393	-116.636386	2148.285	2148.350	Dec. 2003
402	00/10-31-054-18W5/0	53.711393	-116.636386	2149.340	2148.390	Dec. 2003
403	00/10-31-054-18W5/0	53.711393	-116.636386	2150.300	2150.350	Dec. 2003
404	00/10-31-054-18W5/0	53.711393	-116.636386	2151.315	2151.370	Dec. 2003
405	00/10-31-054-18W5/0	53.711393	-116.636386	2152.300	2151.360	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
356	Probable	Second White Specks	Dk grey shale fragments, minor silt
357	Probable	Second White Specks	Dk grey shale, broken fragments, some silt
358	Probable	Second White Specks	Dk grey shale, minor silt and micas
359	Probable	Second White Specks	Dk grey shale, some silt, organic fragments
360	Probable	Second White Specks	Dk grey shale, some silt, smooth
361	Probable	Second White Specks	Pyrite/vitreous black
362	Probable	Second White Specks	Dk grey shale
363	Probable	Second White Specks	Broken fragments of shale, smooth, minor silt, fish fragments
364	Probable	Second White Specks	Dk grey shale, minor silt
365	Probable	Second White Specks	Dk grey shale, minor silt
366	Known	Second White Specks	Broken fragments of shale, some silt
367	Unknown	Second White Specks	Broken fragments of shale, micas
368	Unknown	Second White Specks	Dk grey shale, micas, wisps of silt
369	Unknown	Second White Specks	Dk grey shale, micas, wisps of silt
370	Unknown	Second White Specks	Dk grey shale, micas, some silt
371	Unknown	Second White Specks	Dk grey shale, micas
372	Unknown	Second White Specks	Dk grey shale, micas
373	Unknown	Second White Specks	Dk grey shale, shelly fragments, silty wisps
374	Unknown	Second White Specks	Dk grey shale, smooth, micas, some shells
375	Unknown	Second White Specks	Dk grey shale, fish fragments, micas
376	Unknown	Second White Specks	Dk grey shale, organic debris, smooth, shelly fragments, micas
377	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some silty pockets/lams
378	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt lams/pockets, smooth
379	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams
380	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams
381	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty/sandy lams/pockets
382	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, micas, silt, fish fragments
383	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams
384	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silty pockets
385	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silt pockets/lams
386	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silt, micas
387	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silty lams, organic fragments
388	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, shelly debris, minor silt
389	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, shelly fragments, fish fragments, micas, silty lams
390	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some shelly debris
391	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, fish fragments
392	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, small amount of silt, fish debris
393	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams, shelly debris
394	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, micas, a little silt
395	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt lams
396	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt, some fish fragments
399	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some silt
400	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some silt, some black organic fragments
401	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt, black organic remains
402	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, smooth, some silt, some black organic remains
403	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, some silt, some fish fragments
404	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, smooth, some silt, some fish remains
405	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, smooth, some silt, some black organic remains

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
300	635	1.17	29.9	< .2	6	36.4		0.51
302	399	1.05	24.2	0.3	8	58.4		0.45
303	309	1.04	27.9	< .2	8	55.3		0.51
307	547	1.1	23.3	0.9	8	49.7		0.39
308	655	1.14	37.1	0.2	5	30		0.44
309	620	1.08	41.5	0.4	6	29.1		0.47
310	467	1.17	28.5	0.4	6	38.4		0.42
311	213	0.55	15.4	0.3	5	84.2		0.22
312	417	1.19	31.3	0.4	8	41.1		0.48
313	410	1.15	28.9	0.6	10	49.9		0.4
314	400	1.16	30.5	0.6	10	53.7		0.39
315	348	1.19	30.2	0.2	9	52.6		0.39
316	349	1.26	29.6	< .2	14	57.9	0.8	0.3
317	275	1.08	28	< .2	11	56		0.26
318	257	1.04	22.9	0.5	11	68		0.21
319	281	0.99	25.4	0.3	14	61.3		0.24
320	292	1.19	21.8	0.2	13	77.5	0.8	0.29
321	283	0.9	25.9	0.3	10	58.6		0.23
322	249	0.93	24.9	< .2	11	67.1		0.22
323	295	0.89	28.4	< .2	12	48.5		0.25
324	248	0.71	21.2	< .2	10	120		0.2
325	350	0.85	24.8	0.3	11	58.2	0.7	0.28
326	301	0.8	23.7	0.4	12	53.5		0.23
327	295	0.79	26.2	0.5	12	48.4		0.25
328	333	0.73	23.7	0.6	10	57.8		0.25
329	364	0.97	24.3	1.1	14	65	0.7	0.26
330	342	0.7	24.4	< .2	12	45.4		0.24
332	339	0.73	23.3	0.4	10	56.2		0.25
333	372	0.66	36	0.4	10	35.2		0.3
334	315	0.74	26.5	0.3	11	72.3	0.5	0.21
335	293	0.63	25.7	0.3	11	64.6		0.2
336	266	0.45	18.4	< .2	6	87.1		0.16
338	318	0.59	42.6	1.4	5	32.6		0.2
339	313	0.85	18.6	< .2	13	81.5	0.6	0.27
340	281	0.66	15.8	< .2	6	71.6		0.23
341	298	0.76	13.3	0.8	8	83		0.24
342	300	0.94	28.4	0.2	12	56.2	0.7	0.25
343	331	0.62	20.4	0.4	8	50		0.2
344	297	0.65	27.9	0.5	6	42.9		0.22
345	264	0.57	25.5	0.4	6	51.8		0.19
346	476	0.56	27.6	0.4	9	47.1		0.21
347	284	0.44	460	< .2	4	6.3		0.18
348	321	0.82	32.1	< .2	12	50.9	0.5	0.25
349	237	0.69	30.4	0.4	8	32.2		0.27
350	247	0.54	25.9	< .2	9	40.2		0.22
351	368	0.85	31.8	0.7	13	48.1	0.6	0.27
352	263	0.69	28.4	< .2	9	39.7		0.21
353	235	0.85	23.7	< .2	7	32.8		0.25
354	200	1.19	24.4	0.6	13	56.8	0.7	0.29
355	185	0.92	21.8	0.4	6	37.6		0.27

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
300	1.04	7.48		19.6	17.8		68.38	3.75
302	0.26	1.53		15.5	16.4		54	2.64
303	0.84	1.09		14.1	14.9		43.41	3.09
307	0.3	1.75		16.9	18.3		58.05	2.96
308	0.38	2.3		22.7	18.5		70.94	3.86
309	0.27	2.18		22.8	17.5		66.39	4.13
310	0.25	1.73		19.7	19.2		59.41	3.45
311	2.19	0.7		10.6	17.5		27.88	16.75
312	0.26	1		20.6	18.6		58.21	3.54
313	0.23	1.48		18.3	19.7		55.22	3.38
314	0.63	1.67		18.7	20.6		54.94	3.28
315	0.26	1.11		19.3	19.1		52.15	3.48
316	2.5	1.1	10.7	12.9	21.2	1.46	53.02	2.83
317	3.46	0.75		13.5	16.2		36.13	2.81
318	3.22	1.22		12.7	15.7		30.51	2.31
319	3.57	0.68		13.5	16.7		33.11	2.6
320	3.58	1.41	12.2	12.4	19.2	1.4	39.13	2.33
321	4.35	1		13.6	15.2		33.45	2.52
322	3.73	1.33		12.7	14.8		29.53	2.26
323	3.89	1.22		13.4	16.1		32.59	2.57
324	11.37	1.49		10.9	12.7		28.32	2.09
325	6.32	1.24	11.4	13	15.3	1.08	39.44	2.49
326	4.56	1.14		12	13.8		31.59	2.41
327	4.88	1.04		13.5	13.1		34.16	2.65
328	4.61	1.37		13.2	13.3		33.71	2.35
329	5.32	0.99	11.2	13.3	16.6	1.14	38.54	2.55
330	5.28	1.31		14	12.4		37.6	2.72
332	4.93	1.68		13	13.1		37.84	2.36
333	3.93	1.31		15.7	12.2		42.09	3.05
334	10.29	1.19	13.2	12.3	14.5	0.96	34.82	2.63
335	7.36	1.29		12.1	11.2		30.95	2.38
336	8.37	1.08		8.9	10.9		27.2	2.08
338	5.67	1.63		11.1	9.7		32.53	3.42
339	4.59	1.45	10.7	12.3	14.5	1.26	35.81	2
340	3.97	2.5		9.9	12.4		35.32	1.78
341	3.52	1.17		9.3	13.2		34.59	1.7
342	5.59	1.23	12	14.1	15.4	1.08	38.65	2.66
343	4.67	2		11	11.7		33.2	2.27
344	4.66	1.27		13.3	12.2		32.28	2.58
345	6.92	1.46		10.8	10.7		28.3	2.48
346	5.62	2.6		16.6	11.6		42.51	2.57
347	4.25	1.16		11.5	9.8		26.93	14.32
348	6.62	1.44	13.3	15	12.6	1	38.84	2.87
349	3.28	0.89		13	13.1		30.26	3.31
350	5.6	0.81		12.5	12.8		30.16	2.99
351	4.95	1.89	12.8	19.6	14.1	1.14	50.16	3.17
352	5.26	1.12		14.9	13.6		33.18	3.18
353	1.42	0.92		12.5	15.4		34.22	3.11
354	0.99	0.52	9.2	12.8	21.8	1.58	33.58	3.13
355	0.92	0.61		12.8	18.3		28.95	3.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
300	3.6			169		0.31	5.1	
302	3.1			177		0.28	3.9	
303	3.4			154		0.27	4.8	
307	3.1			365		0.28	4.5	
308	3.2			270		0.27	4.7	
309	3.2			203		0.25	3.8	
310	3.5			375		0.27	3.9	
311	1.7			90		0.12	6.9	
312	3.6			203		0.26	3.8	
313	3.4			341		0.25	3.7	
314	3.7			181		0.26	3.9	
315	3.5			196		0.26	3.6	
316	4	<.1	0.07	142	0.05	0.38	5	19.5
317	3.3			107		0.28	5.3	
318	3			149		0.3	4.7	
319	3.1			133		0.28	4.8	
320	3.8	<.1	0.08	98	0.04	0.36	5.5	19.3
321	2.8			134		0.27	4.7	
322	2.8			145		0.27	4.3	
323	2.9			207		0.28	4.5	
324	2.6			140		0.22	5.4	
325	3.2	<.1	0.05	123	0.05	0.3	5.3	10.3
326	2.7			125		0.26	5	
327	2.9			123		0.25	4.9	
328	2.4			104		0.23	4.8	
329	3.3	<.1	0.07	112	0.04	0.35	5.1	11.6
330	2.8			266		0.23	5.7	
332	2.7			99		0.24	5.2	
333	2.7			158		0.23	4.6	
334	2.9	<.1	0.06	126	0.03	0.28	6.2	8.4
335	2.6			165		0.22	5.6	
336	2			66		0.19	4.5	
338	2.4			125		0.19	4.1	
339	3	<.1	0.05	102	0.05	0.32	4.8	10.9
340	2.4			78		0.24	4.3	
341	2.6			69		0.27	4.2	
342	3.4	<.1	0.08	115	0.04	0.33	5.6	11.2
343	2.4			120		0.22	4	
344	2.6			85		0.23	4	
345	2.6			111		0.21	4.7	
346	2.6			111		0.21	4.1	
347	2.1			144		0.16	3.5	
348	3.9	<.1	0.06	178	0.04	0.27	5.8	10
349	2.8			130		0.25	4.4	
350	2.5			115		0.21	4.6	
351	3.3	<.1	0.07	107	0.05	0.32	5.6	9.3
352	2.8			99		0.24	4.4	
353	4.1			143		0.27	4.5	
354	3.8	<.1	0.09	86	0.05	0.34	4.3	23.2
355	3.2			107		0.25	3.3	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
300	0.55	178	28.9	0.251		80.8	0.06	23.36
302	0.3	103	17.8	0.254		67.5	0.06	19.81
303	0.46	153	14.54	0.231		51.7	0.059	21.98
307	0.28	104	12.55	0.214		61.3	0.068	20.52
308	0.32	130	23.6	0.204		82.9	0.061	22.1
309	0.32	122	21.11	0.237		75.4	0.057	22.73
310	0.34	142	16.99	0.231		65.2	0.062	22.4
311	3.25	2193	13.95	0.098		33.5	0.034	10.74
312	0.38	173	18.36	0.244		69.7	0.063	24.09
313	0.39	160	13.76	0.211		63	0.063	21.41
314	0.45	130	15.09	0.232		64.6	0.064	20.71
315	0.42	166	12.12	0.224		65	0.06	20.75
316	0.46	119	16.78	0.233	0.04	56.6	0.066	16.71
317	0.53	96	15.75	0.205		43.9	0.07	14.95
318	0.43	76	11.87	0.22		47.3	0.067	12.6
319	0.53	89	14.28	0.215		51	0.062	13.99
320	0.45	74	9.72	0.236	0.04	56.7	0.067	15.51
321	0.49	74	14.17	0.201		53.7	0.065	13.51
322	0.45	79	11.3	0.204		50.8	0.058	13.31
323	0.53	81	13.29	0.194		59.2	0.062	14.91
324	0.47	82	14.23	0.188		49.8	0.078	11.06
325	0.48	87	16.28	0.194	0.04	59.4	0.071	15.57
326	0.47	65	13.66	0.183		49.3	0.064	13.78
327	0.54	102	19.89	0.199		46.9	0.06	14.32
328	0.51	67	13.3	0.188		55.6	0.063	14.79
329	0.59	84	14.23	0.214	0.07	49.6	0.073	25.94
330	0.58	105	24.71	0.171		53.4	0.068	15.26
332	0.51	75	17.83	0.185		64.6	0.063	15.08
333	0.46	79	26.35	0.182		66.6	0.065	15.79
334	0.93	127	18.57	0.176	0.07	45.6	0.073	13.65
335	0.61	85	18.81	0.161		51.3	0.072	12.88
336	1.04	106	6.88	0.153		32.5	0.057	9.93
338	0.55	114	36.25	0.18		53.8	0.072	12.59
339	0.52	59	8.82	0.209	0.03	52.2	0.07	14.98
340	0.52	64	6.49	0.207		42.7	0.061	12.85
341	0.47	68	5.52	0.219		40.5	0.056	12.59
342	0.55	105	19.63	0.207	0.06	49	0.077	13.9
343	0.49	73	10.25	0.194		51.5	0.058	12.67
344	0.52	77	16.82	0.199		59.5	0.06	12.93
345	0.54	97	18.43	0.172		54.7	0.066	11.66
346	0.51	71	25.63	0.183		82.7	0.063	12.47
347	0.47	107	114.36	0.135		48.9	0.06	10.9
348	0.52	101	27.58	0.182	0.06	58.8	0.066	13.89
349	0.64	96	4.48	0.213		37.1	0.071	15.24
350	0.55	97	4.63	0.179		39.1	0.066	13.69
351	0.53	83	10.26	0.208	0.04	58	0.079	16.67
352	0.7	122	7.87	0.189		42.4	0.068	12.87
353	0.59	106	9.97	0.238		51.4	0.062	14.63
354	0.55	104	5.25	0.255	0.03	42.6	0.064	16.74
355	0.45	91	3.34	0.253		43.9	0.052	15.99

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
300					2.34	1.66	5.4	5.5
302					1.75	1.43	3.3	3.5
303					1.94	1.4	5.3	2.6
307					1.98	1.12	3.3	4.2
308					2.92	1.73	3.9	6.7
309					3.16	1.63	3.7	5.8
310					2.35	1.4	3.9	4.2
311					1.1	0.82	11.5	2.1
312					2.41	1.34	4.3	3.9
313					2.12	1.42	4.3	3.2
314					2.19	1.5	4.6	3.1
315					2.13	1.39	4.8	3
316	< 10	< 2	23.2	21	1.85	1.06	5.2	2.8
317					1.86	0.8	6	2.2
318					1.45	0.99	5.1	2.2
319					1.77	0.81	5.5	2.4
320	< 10	< 2	21.7	22	1.44	0.95	6.6	3
321					1.77	0.98	5.2	2.6
322					1.52	0.97	4.2	2.4
323					1.93	1.21	4.9	3.6
324					1.36	0.91	6	2.6
325	< 10	< 2	18.8	36	1.91	1.11	5.5	3.5
326					1.84	1.29	4.7	3
327					2.05	1.08	4.6	3.1
328					1.79	1.36	4.3	3.6
329	< 10	< 2	19.8	23	1.86	1.02	4.6	3
330					2.12	1	5	3.5
332					1.8	1.37	5.1	4.3
333					2.61	1.47	4.1	4.4
334	< 10	< 2	16.1	28	1.97	1.09	4.8	3.4
335					1.83	1.32	4.4	3
336					1.5	0.78	3.5	2.1
338					3.22	2.29	2.8	5.9
339	< 10	< 2	19.3	29	1.5	0.73	4.5	2.9
340					1.49	0.91	3.5	3
341					1.32	0.82	3.6	2.5
342	< 10	< 2	19.4	32	2.04	1.09	4.8	3.4
343					1.92	1.15	4.3	3.3
344					2.24	1.3	4.1	3.3
345					2.15	1.16	4.8	2.9
346					2.16	1.9	3.6	5.4
347					16.63	4.88	2.4	14.2
348	< 10	< 2	16.3	46	2.42	1.82	4.9	4.5
349					2.96	1.08	3.5	2.4
350					2.48	1.04	4.3	2.3
351	< 10	< 2	19.5	19	2.69	1.32	4.4	4.4
352					2.5	0.95	4.6	3
353					2.68	0.8	4.1	4.8
354	< 10	< 2	22.7	10	2	0.57	4.7	2.2
355					2.48	0.53	4.2	1.9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
300		110.7		0.12	7	0.01	0.31	3.6
302		83.6		0.07	6.3	0.004	0.4	2.13
303		103.7		0.09	7.2	0.013	0.54	2.27
307		81.5		0.1	5.7	0.001	0.53	3.15
308		76.6		0.15	6	0.004	0.53	3.66
309		77.8		0.18	5.9	0.009	0.52	3.62
310		78.8		0.14	6.3	< .001	0.4	2.97
311		87.3		0.08	3.4	0.001	0.41	4.21
312		83.5		0.09	7	0.004	0.44	2.84
313		74.1		0.12	5.7	< .001	0.38	2.42
314		99.2		0.1	6.1	0.005	0.36	2.6
315		80.9		0.11	5.8	0.005	0.36	2.33
316	0.7	84.2	< .05	0.09	4.9	0.007	0.22	3.13
317		106.9		0.05	5.1	< .001	0.16	3.61
318		107.4		0.06	4.3	< .001	0.19	3.05
319		119.3		0.06	4.6	< .001	0.21	2.93
320	0.8	111.6	< .05	0.1	5.4	< .001	0.29	2.97
321		145.7		0.09	4.6	0.006	0.26	3.16
322		155.6		0.09	4.5	< .001	0.26	2.36
323		110.8		0.09	4.7	< .001	0.37	2.65
324		395.7		0.06	3.5	0.002	0.23	7.17
325	0.6	223.5	< .05	0.08	4.7	0.01	0.22	3.75
326		184.1		0.11	4.3	< .001	0.25	2.92
327		149.4		0.06	4.5	< .001	0.18	3.67
328		124.8		0.09	4.7	0.002	0.39	2.63
329	0.6	196.4	< .05	0.09	4.7	0.001	0.21	3.51
330		141.5		0.08	4.5	< .001	0.19	5.58
332		133		0.1	4.6	0.002	0.37	3.27
333		106		0.09	4.4	0.007	0.3	3.82
334	0.4	294.5	< .05	0.08	4.1	0.003	0.17	5.24
335		204.4		0.06	4.3	< .001	0.29	5.15
336		221.6		0.07	3.5	< .001	0.17	2.65
338		162.6		0.11	4.1	< .001	0.69	2.89
339	0.6	120.5	< .05	0.09	4.9	0.002	0.27	2.36
340		108.4		0.05	4.9	< .001	0.24	1.87
341		94.2		0.05	4.9	< .001	0.21	1.62
342	0.6	144.8	< .05	0.08	4.7	0.002	0.16	4.17
343		124.6		0.09	4.5	< .001	0.45	2.24
344		138.9		0.06	4.4	< .001	0.37	2.93
345		193.5		0.07	4.3	0.005	0.25	4.41
346		135.1		0.12	3.7	< .001	0.55	4.78
347		100.3		0.11	3.6	< .001	0.39	2.76
348	0.6	157.2	< .05	0.13	4.8	0.008	0.24	6.22
349		90.2		0.09	5.2	< .001	0.12	1.9
350		136.2		0.11	4.4	< .001	0.17	2.35
351	0.5	118.8	< .05	0.2	5	0.003	0.23	2.97
352		117.7		0.1	3.8	< .001	0.16	2.86
353		58.1		0.15	5.1	0.002	0.24	2.8
354	0.6	62.9	< .05	0.11	4.8	0.004	0.15	1.96
355		60.4		0.12	5.2	< .001	0.2	1.19

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
300	75	<.1		896.9		0.6	8.3	27
302	37	<.1		157.4				
303	39	<.1		132				
307	43	<.1		162.3				
308	53	<.1		175.4				
309	46	<.1		188.1				
310	41	<.1		165.9				
311	94	<.1		82.8				
312	42	<.1		136.6				
313	43	<.1		156				
314	41	<.1		201.4				
315	42	<.1		158.2				
316	55	0.1	10.58	176.1	2.6	0.3	7.5	17
317	36	<.1		119.5				
318	46	<.1		208.6				
319	38	<.1		113.2				
320	54	<.1	11.68	165.3	2.6	0.3	7.64	13
321	40	<.1		159.6				
322	42	<.1		232.1				
323	46	<.1		162.7				
324	42	<.1		233.3				
325	49	<.1	12.02	152.7	2	0.4	6.38	12
326	48	<.1		124.5				
327	38	<.1		135.5				
328	54	<.1		139				
329	47	<.1	10.7	144.8	2.1	0.4	6.77	14
330	38	<.1		162.6				
332	52	<.1		141.4				
333	45	<.1		144.6				
334	64	<.1	11.79	119.2	2.1	0.4	5.13	12
335	47	<.1		145.7				
336	40	<.1		117.7				
338	57	<.1		131.2				
339	51	<.1	10.28	135.5	1.7	0.3	7.1	12
340	48	<.1		232.4				
341	49	<.1		131.8				
342	47	<.1	11.82	154.9	2.1	0.3	6.76	16
343	49	<.1		163.1				
344	45	<.1		133.5				
345	49	<.1		133				
346	80	<.1		170.1				
347	52	<.1		95.8				
348	70	<.1	11.31	144.9	2.2	0.4	6.38	15
349	32	<.1		172.6				
350	32	<.1		113.2				
351	44	<.1	11.9	216.4	2	0.4	6.53	12
352	40	<.1		133.6				
353	29	<.1		135.1				
354	35	<.1	10.15	122.7	2.1	0.2	7.59	15
355	28	<.1		185.6				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
300	< .1	148	2	0.6	1.06	7.4	73	21
316	< .1	102	1	0.2	2.49	0.6	55	13
320	< .1	180	2	0.2	3.71	1.3	60	13
325	< .1	100	1	0.2	6.5	1.2	56	13
329	< .1	104	4	0.2	5.45	1	58	13
334	< .1	101	1	0.1	10.64	1	46	13
339	< .1	142	1	0.3	4.74	1.2	63	12
342	< .1	102	1	0.2	5.65	0.8	56	14
348	< .1	112	1	0.3	6.77	1.2	56	15
351	< .1	98	1	0.3	5.03	1.6	56	17
354	< .1	138	3	0.3	0.86	0.4	58	13

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
300	115.3	71.5	5.07	3	2.2	40.7	87.7	0.97
316	114.9	50.3	3.78	2	2.2	23.6	69.2	0.84
320	115.9	37.9	3.26	2.3	2.11	26.5	72.5	0.85
325	102.8	38.4	3.21	1.7	1.83	26.9	49	0.82
329	103.3	36.4	3.28	2.1	2.04	27	47.8	0.95
334	80.3	33.1	3.31	1.4	1.46	20.2	34.5	1.23
339	108.3	35.7	2.72	2.2	2.1	27.8	56.7	0.91
342	99.6	37.6	3.38	2.1	1.94	26.2	52.8	0.9
348	83.2	36.8	3.57	1.9	1.63	25.6	47.6	0.83
351	85.4	47.2	3.78	1.6	1.87	31.8	43.1	0.86
354	106.4	33.5	3.82	2.3	2.23	30.1	79.5	0.94

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
300	202	32.5	0.527	14	82.3	0.084	26.5	126.5
316	153	16.1	0.418	11.9	58.2	0.077	18.4	103
320	101	10	0.451	11.4	64	0.079	18.5	106.8
325	102	14.9	0.371	11.4	54.7	0.078	17.1	111.7
329	109	14.4	0.426	11.2	52.5	0.082	26.7	121.7
334	147	18	0.308	8.9	48.6	0.074	14.1	86.4
339	84	8.8	0.4	11.9	57.3	0.081	17.2	118.5
342	126	18.9	0.373	11.4	51.7	0.087	15.9	116.6
348	114	26.6	0.328	9.5	60.1	0.072	15.5	98.3
351	106	9.4	0.358	9.8	49.9	0.085	17.1	101.4
354	129	5.3	0.442	12.7	42.2	0.076	17.4	108.3

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
300	2.9	3.4	15	3.4	213	1	12.5	0.432
316	2.1	2	11	1.9	170	0.8	8.4	0.398
320	1.6	1.9	13	2.3	204	0.8	9.1	0.392
325	2.3	2.3	10	1.9	305	0.7	8	0.341
329	2.2	2	10	1.9	275	0.7	8	0.352
334	2.3	2.1	8	1.4	337	0.5	6.7	0.276
339	1.8	1.5	11	1.9	214	0.8	8.9	0.371
342	2.4	2	9	1.8	224	0.7	8	0.356
348	2.9	3.1	9	1.6	227	0.6	7.9	0.294
351	3.1	2.2	9	1.6	220	0.6	8.2	0.33
354	2.2	1	10	2.2	170	0.8	8.2	0.417

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	9.8	411	1.7	23.5	911	84.4	82.4	19.1
316	5.1	276	1.1	15.8	190	62.4	75.9	14.5
320	5.2	282	1	18	184	60.7	76	14.3
325	5.6	242	1	18.6	168	58.5	67.1	13
329	5.6	229	0.9	17.6	161	59.5	62.7	12.4
334	6.6	216	1	16.8	132	45.6	53.5	11.5
339	4.8	281	0.8	17.9	162	62.1	69	12.7
342	6.1	232	1.1	18.4	169	61.4	64.8	14.2
348	8.9	307	0.8	17.3	160	54.9	61.9	13.4
351	4.7	235	1	14.5	227	55.5	61.5	17.5
354	4.4	229	1.2	13.8	134	68.2	77.2	13.7

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	10.3	4.69	3.09	1.28	23	4.79	4	1.02
316	8.8	4.29	2.5	1.26	20.2	5.29	3.5	0.91
320	9	4.56	2.59	1.43	19.8	4.85	3.7	0.97
325	7.2	4.09	2.42	1.15	16.7	4.1	3.2	0.85
329	7.5	3.53	2.05	1.07	16.9	4.19	3.4	0.73
334	5.3	3.25	1.94	1.05	13.4	3.84	2.7	0.68
339	7.6	3.71	2.13	1.25	17.9	4.16	4	0.77
342	6.9	3.62	2.17	1.12	16.9	4.47	3.3	0.73
348	5.9	3.9	1.94	1.1	16.5	3.71	3.2	0.79
351	8.2	3.57	2.02	0.98	16.7	4.6	3	0.77
354	10.3	4.32	2.54	1.12	22.7	5.07	4	0.9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	41	0.48	17	32.5	9.22	1	133	6
316	37.4	0.37	17.2	36.6	9.21	1	142.7	6.3
320	37.7	0.38	16.8	36.8	9.15	1	138.2	6.3
325	33.4	0.32	15.1	30.4	8.06	< 1	118.5	5.6
329	33	0.33	15.5	29.5	7.55	1	120.4	5.2
334	27	0.27	12	24.9	6.54	< 1	86	4.4
339	35.7	0.31	15.7	31	8.4	< 1	129.3	5.6
342	33.8	0.32	14.9	28.8	7.81	< 1	117.2	5
348	30.1	0.3	12.5	30.5	7.54	< 1	100.9	5.2
351	32.9	0.34	13.4	29.5	7.53	< 1	117.7	5.6
354	41.1	0.42	17.2	35.3	9.38	2	147.9	6.4

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
300	255.4	1.1	0.83	14.9	0.49	10.5	389	2.2
316	201.8	1.1	0.8	11.7	0.42	6.9	280	3.5
320	227.4	0.9	0.86	10.7	0.44	6.9	284	1.7
325	353	0.9	0.77	10.5	0.39	7.1	263	1.3
329	300.1	0.8	0.68	9.2	0.34	7	231	1.3
334	383.5	0.7	0.63	8.3	0.32	8.1	205	0.9
339	228.2	0.9	0.73	10.7	0.36	5.7	293	1.2
342	252.3	0.9	0.78	9.3	0.36	7.8	235	1.2
348	262.9	0.9	0.71	9.3	0.3	10.7	320	1.4
351	214.9	0.8	0.63	10.1	0.33	5.9	248	1.2
354	193.2	1.1	0.77	12.8	0.41	6.3	245	1.5

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
300	31	3.07	141.5	16.59	998	1.56	0.012	
316	25.9	2.41	120.2	15.33	1226	3.78	0.013	0.0154
320	27	2.85	122	15.06	1063	5.76	0.012	0.015
325	24.7	2.5	114.5	12.95	1069	10.37	0.013	0.0135
329	21.7	2.25	107.5	13.34	917	8.47	0.014	0.0134
334	20.4	2.03	92.5	10.37	1036	17.25	0.009	0.0102
339	22.8	2.16	118.9	14.09	934	7.3	0.011	0.0146
342	22.9	2.32	105.9	13.8	911	8.93	0.013	0.0129
348	21.9	2.07	102.6	13.3	826	11.06	0.009	0.0111
351	23.3	2.13	102.5	13.48	829	8.51	0.012	0.012
354	28.5	2.65	127.9	16.74	906	1.57	0.015	0.0145

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
300	6.67	2.53	15.2	1.73	0.02	0.71	70	0.18
316	5.28	2.86	13.5	1.57	0.02	0.6	64	0.2
320	4.5	2.77	13.7	1.56	0.01	0.58	70	0.19
325	4.6	2.45	16.6	1.55	0.01	0.49	50	0.18
329	4.63	2.64	14.6	1.77	0.01	0.6	56	0.2
334	4.39	1.95	20.6	2.22	0.02	0.49	36	0.2
339	3.83	2.69	14.3	1.68	0.01	0.55	45	0.21
342	4.74	2.54	16.5	1.67	0.02	0.55	55	0.22
348	4.99	2.21	19.4	1.57	0.01	0.49	63	0.2
351	5.47	2.49	16.6	1.64	0.01	0.53	42	0.23
354	5.44	2.95	11.5	1.78	0.01	0.61	56	0.19

							Analysis: CO2	
Element	Sc	SiO2	TiO2	TOT/C	TOT/S	SUM	C/ORG	C/GRA
LDL	1	0.02	0.01	0.01	0.01			
Samples	ppm	%	%	%	%	%	%	%
300	16	53.6	0.69	5.76	3.32	99.5	5.12	0.07
316	14	55.77	0.69	4.15	2.66	99.75	3.3	0.05
320	17	54.82	0.68	4.53	2.01	99.77	3.33	0.03
325	13	49.84	0.6	6.44	2.61	99.79	4.27	0.05
329	11	52.79	0.6	4.89	2.5	99.78	3.03	0.04
334	9	41.74	0.47	7.67	2.6	99.84	4.05	0.03
339	12	54.32	0.63	5.1	2.11	99.74	3.52	0.03
342	12	50.12	0.61	5.99	2.9	99.82	4.05	0.06
348	11	45.91	0.53	8.33	3.4	99.77	6.07	0.02
351	12	50.08	0.59	6.39	3.38	99.74	4.64	0.11
354	15	57.72	0.75	3.12	2.67	99.39	2.63	0.06

Element	CO2	SO4
LDL		
Samples	%	%
300	2.1	1.58
316	2.96	2.53
320	4.29	2.24
325	7.77	2.97
329	6.67	2.71
334	13.18	3.17
339	5.71	1.92
342	6.86	3.17
348	8.23	3.4
351	6.01	2.72
354	1.59	1.39

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
356	00/06-31-046-08W5/0	53.008381	-115.152694	1803.410	1803.430	Dec. 2003
357	00/06-31-046-08W5/0	53.008381	-115.152694	1804.400	1804.420	Dec. 2003
358	00/06-31-046-08W5/0	53.008381	-115.152694	1805.440	1805.460	Dec. 2003
359	00/06-31-046-08W5/0	53.008381	-115.152694	1806.360	1806.420	Dec. 2003
360	00/06-31-046-08W5/0	53.008381	-115.152694	1807.450	1807.520	Dec. 2003
361	00/06-31-046-08W5/0	53.008381	-115.152694	1807.620	1807.640	Dec. 2003
362	00/06-31-046-08W5/0	53.008381	-115.152694	1808.320	1808.380	Dec. 2003
363	00/06-31-046-08W5/0	53.008381	-115.152694	1809.360	1809.390	Dec. 2003
364	00/06-31-046-08W5/0	53.008381	-115.152694	1810.360	1810.420	Dec. 2003
365	00/06-31-046-08W5/0	53.008381	-115.152694	1811.360	1811.425	Dec. 2003
366	00/06-31-046-08W5/0	53.008381	-115.152694	1812.300	1812.340	Dec. 2003
367	00/06-31-046-08W5/0	53.008381	-115.152694	1813.340	1813.380	Dec. 2003
368	00/06-31-046-08W5/0	53.008381	-115.152694	1814.310	1814.360	Dec. 2003
369	00/06-31-046-08W5/0	53.008381	-115.152694	1815.250	1815.280	Dec. 2003
370	00/06-31-046-08W5/0	53.008381	-115.152694	1812.300	1812.340	Dec. 2003
371	00/06-31-046-08W5/0	53.008381	-115.152694	1813.340	1813.380	Dec. 2003
372	00/06-31-046-08W5/0	53.008381	-115.152694	1814.310	1814.360	Dec. 2003
373	00/06-31-046-08W5/0	53.008381	-115.152694	1819.145	1819.215	Dec. 2003
374	00/06-31-046-08W5/0	53.008381	-115.152694	1812.300	1812.340	Dec. 2003
375	00/06-31-046-08W5/0	53.008381	-115.152694	1813.340	1813.380	Dec. 2003
376	00/06-31-046-08W5/0	53.008381	-115.152694	1822.105	1822.175	Dec. 2003
377	00/10-31-054-18W5/0	53.711393	-116.636386	2124.510	2124.560	Dec. 2003
378	00/10-31-054-18W5/0	53.711393	-116.636386	2125.485	2125.525	Dec. 2003
379	00/10-31-054-18W5/0	53.711393	-116.636386	2126.455	2126.515	Dec. 2003
380	00/10-31-054-18W5/0	53.711393	-116.636386	2127.690	2127.760	Dec. 2003
381	00/10-31-054-18W5/0	53.711393	-116.636386	2128.665	2128.725	Dec. 2003
382	00/10-31-054-18W5/0	53.711393	-116.636386	2129.700	2129.750	Dec. 2003
383	00/10-31-054-18W5/0	53.711393	-116.636386	2130.720	2130.790	Dec. 2003
384	00/10-31-054-18W5/0	53.711393	-116.636386	2131.795	2131.845	Dec. 2003
385	00/10-31-054-18W5/0	53.711393	-116.636386	2132.590	2132.650	Dec. 2003
386	00/10-31-054-18W5/0	53.711393	-116.636386	2133.560	2133.610	Dec. 2003
387	00/10-31-054-18W5/0	53.711393	-116.636386	2134.550	2134.600	Dec. 2003
388	00/10-31-054-18W5/0	53.711393	-116.636386	2135.555	2135.610	Dec. 2003
389	00/10-31-054-18W5/0	53.711393	-116.636386	2136.630	2136.680	Dec. 2003
390	00/10-31-054-18W5/0	53.711393	-116.636386	2137.545	2137.605	Dec. 2003
391	00/10-31-054-18W5/0	53.711393	-116.636386	2138.555	2138.615	Dec. 2003
392	00/10-31-054-18W5/0	53.711393	-116.636386	2139.570	2139.640	Dec. 2003
393	00/10-31-054-18W5/0	53.711393	-116.636386	2140.605	2140.650	Dec. 2003
394	00/10-31-054-18W5/0	53.711393	-116.636386	2142.600	2142.640	Dec. 2003
395	00/10-31-054-18W5/0	53.711393	-116.636386	2143.340	2143.390	Dec. 2003
396	00/10-31-054-18W5/0	53.711393	-116.636386	2144.345	2144.390	Dec. 2003
399	00/10-31-054-18W5/0	53.711393	-116.636386	2146.290	2146.335	Dec. 2003
400	00/10-31-054-18W5/0	53.711393	-116.636386	2147.310	2147.360	Dec. 2003
401	00/10-31-054-18W5/0	53.711393	-116.636386	2148.285	2148.350	Dec. 2003
402	00/10-31-054-18W5/0	53.711393	-116.636386	2149.340	2148.390	Dec. 2003
403	00/10-31-054-18W5/0	53.711393	-116.636386	2150.300	2150.350	Dec. 2003
404	00/10-31-054-18W5/0	53.711393	-116.636386	2151.315	2151.370	Dec. 2003
405	00/10-31-054-18W5/0	53.711393	-116.636386	2152.300	2151.360	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
356	Probable	Second White Specks	Dk grey shale fragments, minor silt
357	Probable	Second White Specks	Dk grey shale, broken fragments, some silt
358	Probable	Second White Specks	Dk grey shale, minor silt and micas
359	Probable	Second White Specks	Dk grey shale, some silt, organic fragments
360	Probable	Second White Specks	Dk grey shale, some silt, smooth
361	Probable	Second White Specks	Pyrite/vitreous black
362	Probable	Second White Specks	Dk grey shale
363	Probable	Second White Specks	Broken fragments of shale, smooth, minor silt, fish fragments
364	Probable	Second White Specks	Dk grey shale, minor silt
365	Probable	Second White Specks	Dk grey shale, minor silt
366	Known	Second White Specks	Broken fragments of shale, some silt
367	Unknown	Second White Specks	Broken fragments of shale, micas
368	Unknown	Second White Specks	Dk grey shale, micas, wisps of silt
369	Unknown	Second White Specks	Dk grey shale, micas, wisps of silt
370	Unknown	Second White Specks	Dk grey shale, micas, some silt
371	Unknown	Second White Specks	Dk grey shale, micas
372	Unknown	Second White Specks	Dk grey shale, micas
373	Unknown	Second White Specks	Dk grey shale, shelly fragments, silty wisps
374	Unknown	Second White Specks	Dk grey shale, smooth, micas, some shells
375	Unknown	Second White Specks	Dk grey shale, fish fragments, micas
376	Unknown	Second White Specks	Dk grey shale, organic debris, smooth, shelly fragments, micas
377	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some silty pockets/lams
378	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt lams/pockets, smooth
379	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams
380	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams
381	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty/sandy lams/pockets
382	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, micas, silt, fish fragments
383	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams
384	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silty pockets
385	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silt pockets/lams
386	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silt, micas
387	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, silty lams, organic fragments
388	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, shelly debris, minor silt
389	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, shelly fragments, fish fragments, micas, silty lams
390	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some shelly debris
391	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, fish fragments
392	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, small amount of silt, fish debris
393	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silty lams, shelly debris
394	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, micas, a little silt
395	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt lams
396	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt, some fish fragments
399	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some silt
400	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, some silt, some black organic fragments
401	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, silt, black organic remains
402	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, smooth, some silt, some black organic remains
403	Unknown	Belle Fourche (or underlying shale)	Broken fragments of shale, some silt, some fish fragments
404	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, smooth, some silt, some fish remains
405	Unknown	Belle Fourche (or underlying shale)	Dk grey shale, smooth, some silt, some black organic remains

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
356	279	0.79	23.8	0.6	11	75.1	0.8	0.3
357	278	0.74	27.3	0.4	5	39.8		0.25
358	288	0.76	19.1	< .2	5	46.2		0.26
359	277	0.74	23.1	0.4	7	40.7		0.25
360	298	0.72	26.4	0.6	10	74.4	0.6	0.33
361	245	1.06	28.2	< .2	8	44.1		0.87
362	266	0.65	25	< .2	6	60		0.23
363	285	0.85	27	< .2	8	47		0.31
364	261	0.8	24.3	0.2	9	48.8		0.25
365	269	0.8	25.3	0.2	10	75.1	0.7	0.27
366	277	0.77	26.4	0.9	6	47.4		0.24
367	244	0.79	26.6	< .2	9	44.2		0.25
368	263	0.77	25.2	< .2	7	47.9		0.26
369	281	0.72	26.8	0.2	10	71.2	0.9	0.25
370	289	0.78	30.6	0.5	8	45.4		0.27
371	281	0.79	28.1	0.6	7	50.7		0.26
372	314	0.79	34.4	< .2	7	41.3		0.48
373	308	0.74	29.4	0.4	10	62.7	0.9	0.27
374	298	0.83	24.8	0.2	7	46.4		0.27
375	286	0.73	25.1	< .2	10	53.5		0.23
376	315	0.73	28.3	< .2	10	67.9	0.8	0.26
377	359	0.66	31.5	< .2	9	33		0.27
378	378	0.65	31.8	0.3	9	36.6		0.26
379	321	0.59	33.2	0.4	6	51.1		0.22
380	310	0.6	32.6	0.5	7	46.4		0.23
381	314	0.55	28.4	0.4	8	48		0.21
382	331	0.62	37.3	0.3	10	36.7		0.28
383	359	0.58	29.7	0.2	8	40.4		0.23
384	314	0.64	35.8	0.2	9	40.6		0.26
385	392	0.65	37	0.4	7	42.6		0.26
386	207	0.95	20.2	0.5	13	81.1		0.28
387	182	0.91	16.4	0.2	10	53.9		0.28
388	161	0.86	16.8	0.4	7	56		0.24
389	193	0.88	18	0.4	10	52.6		0.25
390	214	0.82	27.1	0.4	9	52.1		0.25
391	210	0.85	23.4	0.2	8	58.7		0.26
392	222	0.79	28.9	< .2	7	48.9		0.26
393	348	0.64	38.5	0.3	7	39.7		0.27
394	288	0.81	28.4	0.2	6	41.6		0.25
395	273	0.84	29.5	0.2	6	41.8		0.21
396	183	0.8	20.8	0.2	8	45		0.27
399	199	0.95	20.3	< .2	7	41		0.24
400	223	0.9	21.5	0.2	6	42.5		0.27
401	215	0.85	20.8	< .2	7	42.6		0.23
402	223	0.92	21.6	0.5	9	43		0.25
403	258	0.95	20.1	0.5	9	46.1		0.25
404	195	0.95	21.7	< .2	6	47.6		0.28
405	163	0.92	22.1	0.2	6	41.2		0.26

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
356	1.9	0.67	8	11.3	13.6	1.65	34.6	2.42
357	2.84	0.71		12.7	13.5		32.73	2.71
358	2.11	0.75		10.7	13.3		32.22	2.38
359	2.77	0.66		11.8	14		31.93	2.61
360	2.5	0.67	10.1	13.2	11.9	1.76	37.23	2.48
361	1.28	0.51		10.6	11.6		25.21	2.65
362	5.4	0.67		11.8	15.1		29.49	3.29
363	1.89	0.79		12	14		33.82	2.55
364	2.4	0.79		11.6	14.2		30.91	2.52
365	2.73	0.79	10.8	12.7	12.7	1.66	33.95	2.46
366	2.69	0.78		12.2	14.4		31.24	2.74
367	2.61	0.69		11.2	14.2		29.67	2.71
368	2.42	0.83		11.1	13.5		30.3	2.54
369	3.13	0.89	8.5	12.2	11.8	1.58	33.39	2.57
370	2.83	0.8		12.4	14.2		35.03	2.73
371	2.06	1.05		11.5	13.5		32.4	2.69
372	3.11	0.77		12.4	14.1		34.31	3.1
373	2.69	0.74	8.2	13.6	11.6	1.52	37.53	2.63
374	2.16	0.87		12.4	13.9		32.83	2.61
375	4.22	1		11.5	13.2		31.14	2.51
376	4.34	0.83	9.3	13.3	12.4	1.37	35.5	2.69
377	3.53	1.28		15.3	11.3		39.34	3.26
378	3.33	1.21		15.3	10.5		38.78	3.22
379	4.61	1.1		14.4	9.6		34.88	2.73
380	5.27	1.43		13.9	11.1		34.12	3.04
381	5.46	1.15		13.6	9.8		34.46	2.61
382	3.5	1.29		18	9.7		39.53	2.91
383	4.4	1.66		16.2	9.9		37.76	2.61
384	2.98	2.08		14.6	11.1		36.34	2.85
385	3.56	1.87		17.3	11.1		39.87	2.92
386	1.8	0.56		14.3	17.5		30.57	2.93
387	1.36	0.69		12.2	15.2		28.87	2.57
388	1.96	0.41		11.2	14.9		26.46	2.5
389	1.97	0.35		12.4	15.9		28.27	2.65
390	1.88	0.65		12.7	15.6		32.65	2.6
391	2.41	0.47		13.3	15		30.44	2.67
392	2.05	0.63		13.2	14.3		32.82	2.72
393	3.15	1.06		16.5	10.9		40.41	3
394	2.56	1.4		16.3	13.7		40.61	3.35
395	2.96	1.61		15.8	13.7		34.42	3.44
396	1.91	0.67		11.8	13.2		25.87	2.78
399	1.98	0.64		13	14.3		29.18	3.21
400	1.46	0.59		12.9	14.1		30.73	3.12
401	1.6	0.65		13.2	13.8		33.62	2.95
402	1.82	0.85		13.1	14.6		30.72	3.1
403	1.56	0.67		13.8	15.3		35.15	3.08
404	1.36	0.7		13.2	15.1		29.88	2.97
405	1.69	0.39		12.8	16		26.99	3.07

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
356	2.4	<.1	0.05	84	0.05	0.24	3.5	14.2
357	2.4			102		0.23	3.5	
358	2.4			73		0.22	3.3	
359	2.3			75		0.22	3.3	
360	2.5	<.1	0.05	90	0.05	0.21	4.6	13.4
361	2.8			60		0.23	7.8	
362	2.2			77		0.22	4	
363	2.7			97		0.26	3.3	
364	2.5			88		0.24	3.4	
365	2.8	<.1	0.04	80	0.04	0.24	4.6	12.4
366	2.4			93		0.24	3.3	
367	2.5			79		0.25	3.2	
368	2.3			80		0.23	3.1	
369	2.2	<.1	0.05	71	0.04	0.2	3.4	13
370	2.6			92		0.25	3.5	
371	2.8			70		0.24	3.4	
372	2.5			87		0.24	3.8	
373	2.3	<.1	0.05	84	0.04	0.22	3.3	13.2
374	2.6			79		0.25	3	
375	2.3			73		0.24	3.4	
376	2.4	<.1	0.06	97	0.04	0.23	3.8	12.7
377	2.2			100		0.22	3.2	
378	2			114		0.23	3.1	
379	1.7			107		0.19	3.1	
380	1.6			99		0.17	4	
381	1.6			88		0.19	3.6	
382	1.7			102		0.2	3.1	
383	1.7			110		0.19	3.4	
384	1.9			117		0.2	3.2	
385	1.8			95		0.22	3.3	
386	2.7			69		0.25	3.2	
387	2.7			89		0.22	2.8	
388	2.3			81		0.22	2.9	
389	2.3			68		0.23	2.9	
390	2.3			72		0.25	2.9	
391	2.3			70		0.23	3.1	
392	2.3			77		0.23	3	
393	1.9			114		0.21	3.3	
394	2.2			84		0.22	3.4	
395	2.2			68		0.24	3.6	
396	2.2			72		0.22	3.2	
399	2.6			95		0.27	3.3	
400	2.5			78		0.24	3	
401	2.4			91		0.24	3.2	
402	2.4			87		0.24	3.2	
403	2.6			73		0.25	3.3	
404	2.6			69		0.24	3	
405	2.5			71		0.24	2.7	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
356	0.39	65	7.1	0.213	0.04	45.3	0.063	16.93
357	0.47	96	8.21	0.208		39.7	0.063	14.6
358	0.45	77	6.02	0.211		40.9	0.06	15.72
359	0.48	83	4.61	0.213		35	0.062	14.76
360	0.44	69	9.82	0.216	0.03	55.1	0.07	19.12
361	0.35	79	10.12	0.249		33.5	0.063	26.94
362	1.4	194	12.51	0.186		40.6	0.064	13.14
363	0.43	75	10.05	0.25		48.4	0.065	17.59
364	0.44	80	11.38	0.224		47.2	0.059	15.1
365	0.44	83	10.44	0.216	0.04	51	0.074	16.51
366	0.5	82	11.45	0.216		47.5	0.064	17.63
367	0.44	77	10.75	0.222		46	0.06	14.79
368	0.38	75	9.78	0.231		46.6	0.062	14.49
369	0.48	70	12.74	0.202	0.02	51.5	0.067	15.32
370	0.41	91	12.69	0.242		48.2	0.067	14.76
371	0.44	73	8.1	0.222		45.9	0.062	15.12
372	0.59	96	14.63	0.213		44	0.072	15.83
373	0.44	79	11.53	0.212	0.02	47.8	0.068	15.21
374	0.43	67	9.72	0.238		51.6	0.061	15.19
375	0.43	73	13.11	0.207		49.3	0.065	13.4
376	0.5	80	15.1	0.198	0.02	52.6	0.07	14.8
377	0.5	87	21.78	0.188		54.7	0.068	15.73
378	0.55	94	19.58	0.181		49.9	0.068	15.23
379	0.44	92	21.52	0.157		50	0.068	12.77
380	0.76	89	16.88	0.142		58	0.089	12.94
381	0.65	101	15.33	0.148		40.8	0.068	12.51
382	0.41	70	8	0.162		50.4	0.073	15.91
383	0.48	69	20.55	0.154		66.7	0.07	14.36
384	0.52	72	12.07	0.174		57.6	0.07	15.86
385	0.52	69	21.88	0.173		71.1	0.072	15.88
386	0.67	87	3.96	0.236		47.3	0.077	17.44
387	0.52	89	3.74	0.215		43.1	0.064	15.86
388	0.51	81	2.01	0.207		36.7	0.07	14.65
389	0.56	80	2.32	0.207		38.7	0.07	15.03
390	0.49	76	4.1	0.224		40.9	0.074	15.6
391	0.61	76	4.12	0.219		47	0.072	15.72
392	0.47	77	4.83	0.217		41	0.075	15.51
393	0.57	82	19.02	0.186		52.2	0.083	16.63
394	0.76	109	11.01	0.192		53.6	0.07	14.83
395	0.72	105	12.24	0.201		57.3	0.069	14.03
396	0.58	99	3.95	0.211		36.2	0.063	15.13
399	0.67	111	4.97	0.192		40.6	0.068	15.37
400	0.63	93	3.88	0.207		39.8	0.07	17.29
401	0.63	95	3.78	0.21		41.3	0.076	15.16
402	0.65	102	4	0.212		40.7	0.076	15.69
403	0.69	109	3.89	0.219		45.2	0.082	16.19
404	0.5	93	2.38	0.241		39.7	0.074	17.17
405	0.47	94	2.45	0.217		38.1	0.068	15.56

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
356	< 10	< 2	18.4	14	1.63	0.77	4.4	2.1
357					2.24	0.79	4.3	2.1
358					1.81	0.69	4.6	2
359					1.98	0.68	4.6	1.7
360	< 10	< 2	17.9	17	1.72	1.01	4.9	2.5
361					2.08	1.12	3.3	1.8
362					2	0.79	4.1	2.1
363					1.97	1.09	3.7	2.6
364					1.88	0.95	4.4	2.3
365	< 10	2	18.7	22	1.56	0.96	5.4	2.4
366					1.99	0.83	4.5	2.3
367					1.96	0.81	4.6	2.1
368					1.92	0.92	4.6	2.2
369	< 10	< 2	17	21	1.66	1.39	5.1	2.4
370					2.13	0.88	5	2.4
371					1.99	0.89	4.5	2.2
372					2.39	0.92	4.5	2.5
373	< 10	2	16.8	12	1.82	0.98	4.2	2.3
374					1.88	0.86	4.7	2.4
375					1.88	0.88	5.3	2.5
376	< 10	< 2	17	22	1.85	0.98	5.5	2.8
377					2.6	1.35	4.7	3.7
378					2.7	1.16	4.7	3.5
379					2.55	1.09	4.7	3.4
380					2.53	1.18	4.9	3.6
381					2.48	0.95	3.9	3.3
382					2.81	1.1	4.2	2.9
383					2.48	1.62	4.5	4.3
384					2.72	1.57	4.6	3.5
385					2.87	1.91	4.4	4.6
386					2.37	0.68	5.7	1.8
387					2.03	0.6	4.6	1.4
388					1.98	0.49	5.1	1.2
389					2.16	0.51	5.3	1.3
390					2.35	0.99	4.6	1.7
391					2.21	0.77	5.5	1.8
392					2.5	1.13	4.4	1.7
393					2.99	1.48	3.7	3.7
394					2.89	1.24	5.3	3.7
395					2.95	1.09	5.3	3.3
396					2.2	0.86	4.2	1.6
399					2.54	0.65	4.8	2.1
400					2.78	0.75	4.7	1.9
401					2.57	0.79	4.8	2
402					2.61	0.76	5.3	1.8
403					2.6	0.78	5	2.1
404					2.56	0.56	4.8	1.4
405					2.55	0.54	5.3	1.3

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
356	0.5	68	< .05	0.09	5	0.007	0.22	1.59
357		87.9		0.07	4.8	< .001	0.15	2.16
358		69.5		0.1	4.7	0.002	0.21	1.88
359		88.3		0.09	4.9	< .001	0.09	1.85
360	0.5	79.1	< .05	0.09	5.8	0.005	0.28	2.45
361		53.4		0.08	21.1	< .001	0.24	3.23
362		115.7		0.05	4.8	< .001	0.12	2.98
363		73.5		0.08	5	0.003	0.19	1.93
364		80.6		0.07	4.9	< .001	0.19	2.21
365	0.5	86.5	< .05	0.09	4.9	0.002	0.21	2.5
366		87.2		0.09	4.9	0.001	0.19	2.32
367		86.7		0.07	4.7	< .001	0.15	2.02
368		82.6		0.08	4.6	0.001	0.2	1.99
369	0.4	91.3	< .05	0.06	4.6	< .001	0.22	2.23
370		90.7		0.08	4.8	0.007	0.14	2.88
371		74.4		0.11	4.6	< .001	0.22	1.89
372		92.8		0.06	5.1	0.001	0.12	2.79
373	0.5	96.4	< .05	0.08	4.4	0.004	0.16	2.23
374		83		0.1	4.7	< .001	0.19	1.91
375		144.3		0.1	4.5	0.002	0.18	3.12
376	0.5	144.9	< .05	0.1	4.4	0.007	0.18	3.17
377		102.9		0.07	4.3	< .001	0.2	3.01
378		91.6		0.11	4.4	0.001	0.15	3.38
379		152.9		0.1	3.9	0.003	0.14	3.56
380		142.5		0.12	4.1	0.001	0.24	3.96
381		161.6		0.09	4	0.001	0.09	3.89
382		107.2		0.11	4.4	0.001	0.13	2.24
383		128.4		0.08	4	0.001	0.32	3.12
384		87.5		0.1	4.8	0.001	0.4	1.96
385		108.1		0.11	4.6	0.001	0.36	2.97
386		76.3		0.12	5.4	0.001	0.16	1.1
387		65.5		0.07	4.8	0.002	0.17	1.09
388		80.7		0.07	4.8	0.001	0.07	1.04
389		80.2		0.07	4.7	0.001	0.08	0.99
390		79.3		0.08	5.1	0.001	0.1	1.22
391		87.5		0.08	4.9	0.001	0.18	1.2
392		81.6		0.08	4.8	0.001	0.11	1.35
393		104.7		0.09	5.1	0.001	0.17	2.71
394		79.1		0.12	4.5	0.001	0.19	2.17
395		89.8		0.15	4.4	0.001	0.23	1.92
396		72		0.08	5	0.001	0.1	1.22
399		70.4		0.08	4.9	0.001	0.09	1.94
400		63.3		0.09	5.1	0.001	0.1	1.35
401		64.7		0.09	4.8	0.001	0.11	1.49
402		72.5		0.08	4.8	0.002	0.11	1.48
403		66.8		0.07	4.8	0.001	0.09	1.57
404		69.5		0.08	5.2	0.001	0.08	1.1
405		73.4		0.07	4.6	0.002	0.07	1.04

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
356	32	<.1	9.67	131.6	1.2	0.3	8.29	12
357	30	<.1		135.7				
358	33	<.1		150.2				
359	27	<.1		190.2				
360	27	<.1	11.13	146.1	1.2	0.3	8.62	15
361	36	<.1		100.3				
362	49	<.1		127.4				
363	37	<.1		134.3				
364	36	<.1		134.3				
365	31	<.1	11.69	123.7	1.4	0.2	8.18	12
366	34	<.1		146				
367	35	<.1		142.8				
368	34	<.1		134.7				
369	32	<.1	10.69	160.9	1.1	0.3	8.29	14
370	33	<.1		156.6				
371	33	<.1		155.8				
372	35	<.1		150.9				
373	27	<.1	9.78	148.1	1.2	0.3	8.34	18
374	35	<.1		165.4				
375	38	<.1		146.9				
376	33	<.1	11.41	132.7	1.3	0.3	7.81	14
377	37	<.1		158.3				
378	34	<.1		147.7				
379	30	<.1		137.9				
380	53	<.1		149.1				
381	34	<.1		145.3				
382	27	<.1		177.8				
383	51	<.1		146.8				
384	42	<.1		222.4				
385	49	<.1		181				
386	29	<.1		133.1				
387	27	<.1		170.6				
388	24	<.1		118.4				
389	24	<.1		111.3				
390	25	<.1		152.5				
391	29	<.1		105.4				
392	26	<.1		136.7				
393	33	<.1		153.5				
394	33	<.1		156.9				
395	37	<.1		186.2				
396	22	<.1		131.3				
399	27	<.1		106.7				
400	24	<.1		117.3				
401	26	<.1		125				
402	26	<.1		148.4				
403	28	<.1		117.8				
404	26	<.1		170				
405	26	<.1		115.7				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
356	< .1	201	4	0.3	1.93	0.8	54	12
360	< .1	163	1	0.3	2.57	1	50	15
365	< .1	259	2	0.3	2.87	1	58	14
369	< .1	169	1	0.3	3.27	0.9	46	13
373	< .1	190	3	0.3	2.93	0.9	58	15
376	< .1	205	3	0.3	4.4	0.9	48	13

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
356	108.3	34.5	3.17	2	2.12	28.6	77.8	0.83
360	107.5	38.5	3.3	2.1	2.26	26.8	74.7	0.89
365	104.3	34	3.36	2	2.26	31.6	59.5	0.9
369	106.6	35.6	3.46	1.8	2.25	24.7	63.8	0.95
373	109	40.9	3.69	1.9	2.36	30.7	71.4	0.91
376	96.8	35.8	3.44	1.7	2.06	25.4	62	0.89

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
356	75	6.7	0.423	13.9	48.8	0.076	19.1	101.8
360	88	9.8	0.428	15.1	57.9	0.087	20.8	73.9
365	99	10.6	0.427	13.2	54.6	0.09	16.9	94.6
369	83	12.3	0.418	12.1	59.6	0.082	17.7	71.3
373	96	12	0.446	13.7	54.7	0.087	19.1	107.1
376	99	14	0.361	10.9	51.6	0.081	15.8	75.4

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
356	1.9	1.3	10	1.9	177	0.9	8.3	0.41
360	2.1	1.8	10	2.2	198	1	8.1	0.4
365	1.9	2	11	2.2	196	0.8	7.9	0.41
369	2.2	2	11	2.1	194	0.8	7	0.408
373	2.4	2	11	2.3	229	0.9	8.4	0.421
376	2.3	1.8	10	1.6	236	0.7	7	0.362

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
356	4	265	1.1	13.2	154	62.7	73	12.4
360	5.1	257	1.2	14.7	166	67.3	76.6	13.5
365	4.7	258	1.2	14.8	156	60.5	76.3	13.2
369	4.7	269	1.1	13.5	180	62.6	71.9	13
373	5.1	259	1.2	14.3	181	65	70.9	15.3
376	4.8	239	1	14.2	144	54.4	65.3	13.1

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
356	10.6	4.4	2.41	1.21	21.2	4.73	3.9	0.92
360	10.6	4.48	2.52	1.27	22.3	4.87	4.2	0.86
365	10.4	4.57	2.42	1.27	23	4.91	3.6	0.88
369	10	4.27	2.38	1.05	20	4.52	3.7	0.86
373	10.3	4.03	2.37	1	21.3	4.33	4.1	0.85
376	9.1	3.69	2.17	1.03	18.7	4.48	3.3	0.77

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
356	39.4	0.4	18.4	34.1	8.7	2	141.9	6.1
360	41.6	0.41	18	32.6	9.11	2	139.7	6.1
365	40.7	0.42	17.3	35.4	9.13	2	139.4	6.3
369	38.3	0.39	17.2	32.7	8.44	2	140.1	5.9
373	38.8	0.38	17.7	34.1	8.53	2	141.8	5.6
376	34.6	0.38	15.3	29.4	7.84	1	127.2	5.5

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
356	179.9	1.2	0.7	12.1	0.38	6	292	1.5
360	201.4	1.2	0.83	11.7	0.43	6.5	275	1.4
365	202.5	1	0.76	11.6	0.42	6.6	275	1.6
369	199	1.1	0.71	11.1	0.38	6.5	294	1.3
373	217.1	1.1	0.73	10.6	0.38	6.9	260	1.4
376	253.1	0.9	0.66	9	0.38	7.5	249	1.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

				Analysis: GROUP 4A - 0.200 GM				
Element	**Y**	**Yb**	**Zr**	**Al2O3**	**Ba**	**CaO**	**Cr2O3**	**Cr2O3**
LDL	**0.1**	**0.05**	**0.5**	**0.03**	**5**	**0.01**	**0.001**	**0.001**
Samples	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**%**	**%**	**%**
356	27.2	2.62	133	15.49	1010	2.96	0.015	0.0149
360	27.7	2.92	126.2	15.68	1043	3.81	0.014	0.0142
365	27.7	2.67	119	15.56	1078	4.31	0.014	0.014
369	26.6	2.79	125	15.15	1024	4.93	0.014	0.0143
373	25.8	2.62	123.1	15.56	1019	4.28	0.015	0.0151
376	25.4	2.37	109.3	14.61	1051	7.45	0.014	0.0142

Element	**Fe2O3**	**K2O**	**LOI**	**MgO**	**MnO**	**Na2O**	**Ni**	**P2O5**
LDL	**0.04**	**0.04**	**0.1**	**0.01**	**0.01**	**0.01**	**30**	**0.01**
Samples	**%**	**%**	**%**	**%**	**%**	**%**	**ppm**	**%**
356	4.53	2.79	11	1.49	0.01	0.54	47	0.21
360	4.52	2.81	11.5	1.56	0.01	0.55	64	0.22
365	4.59	2.82	11.6	1.59	0.01	0.55	39	0.22
369	4.73	2.75	12.5	1.66	0.01	0.56	67	0.2
373	4.9	2.88	11.7	1.59	0.01	0.59	72	0.21
376	5.11	2.74	13.4	1.67	0.01	0.48	43	0.22

							Analysis: CO2	
Element	**Sc**	**SiO2**	**TiO2**	**TOT/C**	**TOT/S**	**SUM**	**C/ORG**	**C/GRA**
LDL	**1**	**0.02**	**0.01**	**0.01**	**0.01**			
Samples	**ppm**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
356	14	59.51	0.74	3.29	2.32	99.4	2.57	0.04
360	14	57.99	0.71	3.73	2.27	99.5	2.88	0.03
365	15	57.45	0.7	3.76	2.02	99.54	2.76	0.03
369	15	56.21	0.69	4.09	2.37	99.53	2.95	0.03
373	14	56.91	0.71	3.64	2.48	99.48	2.66	0.03
376	14	53.1	0.65	4.58	2.51	99.58	3.09	0.03

Element	**CO2**	**SO4**
LDL		
Samples	**%**	**%**
356	2.51	1.23
360	3.03	1.68
365	3.58	1.47
369	4.07	1.82
373	3.49	1.84
376	5.35	2.14

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
407	00/04-02-071-18W5/0	55.114423	-116.66306	759.990	760.060	Dec. 2003
408	00/04-02-071-18W5/0	55.114423	-116.66306	760.390	760.440	Dec. 2003
410	00/04-02-071-18W5/0	55.114423	-116.66306	761.370	761.380	Dec. 2003
411	00/04-02-071-18W5/0	55.114423	-116.66306	761.420	761.450	Dec. 2003
412	00/04-02-071-18W5/0	55.114423	-116.66306	761.465	761.520	Dec. 2003
414	00/04-02-071-18W5/0	55.114423	-116.66306	762.350	762.390	Dec. 2003
415	00/04-02-071-18W5/0	55.114423	-116.66306	763.430	763.480	Dec. 2003
417	00/04-02-071-18W5/0	55.114423	-116.66306	764.330	764.350	Dec. 2003
418	00/04-02-071-18W5/0	55.114423	-116.66306	764.465	764.520	Dec. 2003
419	00/04-02-071-18W5/0	55.114423	-116.66306	765.020	765.065	Dec. 2003
420	00/04-02-071-18W5/0	55.114423	-116.66306	765.445	765.495	Dec. 2003
421	00/04-02-071-18W5/0	55.114423	-116.66306	766.450	766.520	Dec. 2003
423	00/04-02-071-18W5/0	55.114423	-116.66306	767.560	767.610	Dec. 2003
424	00/04-02-071-18W5/0	55.114423	-116.66306	767.745	767.810	Dec. 2003
425	00/04-02-071-18W5/0	55.114423	-116.66306	768.505	768.575	Dec. 2003
426	00/04-02-071-18W5/0	55.114423	-116.66306	769.445	769.505	Dec. 2003
427	00/04-02-071-18W5/0	55.114423	-116.66306	770.490	770.550	Dec. 2003
429	00/04-02-071-18W5/0	55.114423	-116.66306	771.520	771.580	Dec. 2003
430	00/04-02-071-18W5/0	55.114423	-116.66306	772.440	772.510	Dec. 2003
432	00/04-02-071-18W5/0	55.114423	-116.66306	773.500	773.540	Dec. 2003
434	00/04-02-071-18W5/0	55.114423	-116.66306	774.510	774.540	Dec. 2003
435	00/04-02-071-18W5/0	55.114423	-116.66306	775.060	775.130	Dec. 2003
436	00/04-02-071-18W5/0	55.114423	-116.66306	775.550	775.595	Dec. 2003
437	00/04-02-071-18W5/0	55.114423	-116.66306	776.550	776.600	Dec. 2003
438	02/07-33-052-15W5/0	53.533243	-116.145474	1950.330	1950.350	Dec. 2003
439	02/07-33-052-15W5/0	53.533243	-116.145474	1950.370	1950.415	Dec. 2003
440	02/07-33-052-15W5/0	53.533243	-116.145474	1951.450	1951.500	Dec. 2003
442	02/07-33-052-15W5/0	53.533243	-116.145474	1952.495	1952.445	Dec. 2003
443	02/07-33-052-15W5/0	53.533243	-116.145474	1953.415	1953.470	Dec. 2003
445	02/07-33-052-15W5/0	53.533243	-116.145474	1954.440	1954.510	Dec. 2003
445	02/07-33-052-15W5/0	53.533243	-116.145474	1954.440	1954.510	April 2004
446	02/07-33-052-15W5/0	53.533243	-116.145474	1955.470	1955.535	Dec. 2003
447	02/07-33-052-15W5/0	53.533243	-116.145474	1956.380	1956.430	Dec. 2003
448	02/07-33-052-15W5/0	53.533243	-116.145474	1957.410	1957.470	Dec. 2003
449	02/07-33-052-15W5/0	53.533243	-116.145474	1958.390	1958.450	Dec. 2003
450	02/07-33-052-15W5/0	53.533243	-116.145474	1959.400	1959.445	Dec. 2003
451	02/07-33-052-15W5/0	53.533243	-116.145474	1960.500	1960.555	Dec. 2003
452	02/07-33-052-15W5/0	53.533243	-116.145474	1961.420	1961.490	Dec. 2003
453	02/07-33-052-15W5/0	53.533243	-116.145474	1962.390	1962.460	Dec. 2003
454	02/07-33-052-15W5/0	53.533243	-116.145474	1963.480	1963.550	Dec. 2003
454	02/07-33-052-15W5/0	53.533243	-116.145474	1963.480	1963.550	April 2004
455	02/07-33-052-15W5/0	53.533243	-116.145474	1964.430	1964.490	Dec. 2003
456	02/07-33-052-15W5/0	53.533243	-116.145474	1965.455	1965.520	Dec. 2003
457	02/07-33-052-15W5/0	53.533243	-116.145474	1966.460	1966.500	Dec. 2003
458	02/07-33-052-15W5/0	53.533243	-116.145474	1966.920	1966.940	Dec. 2003
459	02/07-33-052-15W5/0	53.533243	-116.145474	1967.445	1967.505	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
407	Unknown	Belle Fourche (or underlying unit)	Red Layer
408	Unknown	Belle Fourche (or underlying unit)	Dk grey shale with abundant silt, micas
410	Unknown	Belle Fourche (or underlying unit)	Red/brown layer/nodule, siderite?
411	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, silty pockets
412	Unknown	Belle Fourche (or underlying unit)	Lams of red particles within sand - thin section (?)
414	Unknown	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, silty, abundant micas
415	Unknown	Belle Fourche (or underlying unit)	Dk grey shale + sand lams and soft sed
417	Unknown	Belle Fourche (or underlying unit)	Red/brown layer/nodule, siderite?
418	Unknown	Belle Fourche (or underlying unit)	Dk grey shale with silt and micas, with red layer - siderite?
419	Unknown	Belle Fourche (or underlying unit)	Orange/red/brown layer/nodule - siderite? Surrounded by dk grey shale
420	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, silty, some brown colouration is areas
421	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, silty, abundant black organic material - fish remains?
423	Unknown	Belle Fourche (or underlying unit)	Med Sand (contact between shale and large sand), some red specks, white and black grains
424	Unknown	Belle Fourche (or underlying unit)	Med Sand , black and white grains
425	Unknown	Belle Fourche (or underlying unit)	Sand, red specks, micas
426	Unknown	Belle Fourche (or underlying unit)	Sand with red specks
427	Unknown	Belle Fourche (or underlying unit)	Sand, black, white and red coloured grains
429	Unknown	Belle Fourche (or underlying unit)	Sand, some red/brown grains, some black grains
430	Unknown	Belle Fourche (or underlying unit)	Sand, black and white grains
432	Unknown	Belle Fourche (or underlying unit)	Broken fragments of shale, silty, some areas of concentrated micas
434	Unknown	Belle Fourche (or underlying unit)	Broken fragments of dk grey shale, some silt
435	Unknown	Belle Fourche (or underlying unit)	Burnt unit? Siderite? Redish/brown rim, med brown inner area
436	Unknown	Belle Fourche (or underlying unit)	Med grey shale, very silty with some sand, mica rich
437	Unknown	Belle Fourche (or underlying unit)	Dk grey shale + black organics (thin section?), micas, some sandy lams
438	Unknown	Second White Specks	Pyrite shell (?), in dk grey slightly silty shale
439	Unknown	Second White Specks	Dk grey shale, some silt
440	Unknown	Second White Specks	Dk grey shale, minor silt, shelly fragments
442	Unknown	Second White Specks	Dk grey shale, shelly remains, some silt
443	Unknown	Second White Specks	Dk grey shale, a little silt
445	Unknown	Second White Specks	Dk grey shale, some shelly fragments and silt
445	Unknown	Second White Specks	Dk grey shale, some shelly fragments and silt
446	Unknown	Upper Belle Fourche	Dk grey shale with silty/sandy lams
447	Unknown	Upper Belle Fourche	Dk grey shale, shelly fragments, silty lams
448	Unknown	Upper Belle Fourche	Dk grey shale, some silt, abundant shelly fragments
449	Unknown	Upper Belle Fourche	Dk grey shale, shelly fragments, silty lams
450	Unknown	Upper Belle Fourche	Dk grey shale, some micas, silt
451	Unknown	Upper Belle Fourche	Dk grey shale, silty lams, smooth, abundant shelly fragments
452	Unknown	Upper Belle Fourche	Dk grey shale, some silt
453	Unknown	Upper Belle Fourche	Dk grey shale, some silt, shelly debris
454	Unknown	Upper Belle Fourche	Dk grey shale, smooth, black organic debris
454	Unknown	Upper Belle Fourche	Dk grey shale, smooth, black organic debris
455	Unknown	Upper Belle Fourche	Dk grey shale, some silt, black organic fragments
456	Unknown	Upper Belle Fourche	Dk grey shale, some silt, black organic fragments
457	Unknown	Upper Belle Fourche	Dk grey shale, some black organic debris, some silt
458	Unknown	Upper Belle Fourche	Pyrite laminations
459	Unknown	Upper Belle Fourche	Dk grey shale, smooth, some silt, black organic debris

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
407	168	1.08	10.2	0.5	10	83.1		0.24
408	235	1.46	21.1	0.8	16	102.3		0.37
410	176	0.72	8.9	0.4	8	453.1		0.12
411	374	1.58	14.7	0.9	16	429.7		0.33
412	198	0.84	14.3	0.2	9	289		0.08
414	222	1.24	11.5	1.2	16	365.1		0.25
415	193	1.03	14.2	1.3	18	305.9		0.22
417	165	0.53	4.2	0.8	12	430.3		0.12
418	293	1.11	4.5	1.8	15	348.4		0.23
419	366	1.14	2	1.4	13	389.7		0.27
420	336	1.22	16.3	1.8	15	342.2		0.27
421	333	1.17	2.7	1.6	16	378.3		0.25
423	95	0.46	8.2	1.4	8	149.3		0.08
424	102	0.44	7.1	1.2	7	149.5		0.07
425	64	0.35	5.5	0.7	6	369.2		0.05
426	63	0.33	4.1	0.5	10	589.6		0.04
427	59	0.34	4.4	1	4	531.3		0.04
429	62	0.39	3.7	1	5	706.5		0.04
430	63	0.34	5.7	< .2	4	348.1		0.03
432	381	1.26	7.5	1.5	14	471.1		0.3
434	245	1.2	18.8	1	18	384.7		0.3
435	208	0.87	3.2	0.8	12	283		0.13
436	388	1.27	2.8	1.4	15	402.6		0.28
437	426	1.08	9.7	1.4	18	360.9		0.23
438	282	0.72	29.7	0.2	6	51.7		0.25
439	312	0.62	30	0.3	7	42.9		0.25
440	374	0.56	32.9	0.2	9	47.9		0.24
442	377	0.62	30	0.4	7	41.5		0.25
443	347	0.59	35	0.3	7	42.8		0.25
445	317	0.52	33.1	< .2	8	42.9		0.23
446	109	0.21	13	< .2	1	290.3		0.07
447	298	0.58	24.9	0.4	10	58.3		0.23
448	261	0.6	22.6	0.2	5	51		0.22
449	241	0.69	23.3	0.3	6	49.9		0.23
450	245	0.68	24.2	< .2	8	51.6		0.23
451	248	0.72	25	0.2	7	45.2		0.2
452	257	0.73	24.5	0.4	6	47.4		0.22
453	225	0.75	27.6	0.3	7	45.5		0.24
454	229	0.74	28.3	1.6	9	66.3		0.27
455	210	0.76	23.8	0.4	9	72.9		0.26
456	186	0.89	20.8	0.4	8	62.2		0.24
457	169	0.81	23.2	0.5	7	55		0.26
458	165	1.12	34.3	0.3	8	22.2		0.3
459	258	0.77	22.3	0.3	8	60.5		0.25

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
407	1.48	0.13		10.9	21.4		27.42	12.03
408	0.28	0.16		17	31.1		41.66	2.72
410	2.48	0.24		6.5	18.1		18.27	17.37
411	0.81	0.58		14.8	31.6		46.8	3.63
412	3.31	0.38		8.3	20.8		14.73	8.98
414	0.26	0.2		16.7	31.3		32	1.84
415	0.27	0.15		16.1	28.6		29.41	2.08
417	2.39	0.25		8.4	19.4		21.51	17.38
418	0.68	0.38		13.6	27.9		39.72	4.68
419	0.75	0.59		15.7	28.8		47.9	5.15
420	0.38	0.4		14.9	29.9		42.59	2.27
421	0.61	0.49		13.1	29.5		43.96	3.86
423	1.03	0.43		14.9	21.2		11.68	1.62
424	1.24	0.38		10.2	21		10.37	1.43
425	10.23	0.25		7.1	15.2		7.69	1.53
426	11.06	0.18		7	12.7		5.91	1.98
427	11.93	0.22		6.9	14.7		6.43	1.89
429	11.8	0.33		7.3	18.8		7.15	1.96
430	11.25	0.21		6.2	13.6		6.71	1.49
432	0.58	0.64		12.8	26.7		49.67	3.23
434	0.34	0.21		15.6	31.1		38.79	2.11
435	0.74	0.42		11.8	27.4		24.47	4.64
436	0.44	0.75		17.5	30.8		52.58	2.88
437	0.45	2.24		14.2	26.4		48.77	2.92
438	2.91	1.03		16.2	13.3		37.91	2.85
439	4.02	1.19		16.1	10.7		39.54	2.95
440	4.88	1.41		17	10.8		43.06	3.19
442	3.8	2.15		16.6	11.9		42	2.89
443	4.57	2.1		17.8	10.9		41.16	3
445	5.33	1.38		15.5	9.3		38.6	2.86
446	16.66	0.36		5.2	9.3		13.27	4.26
447	3.8	0.97		13.5	10.3		33.78	2.55
448	2.44	0.77		12.9	10.6		31.7	2.53
449	2.1	0.66		13.2	12.3		32.41	2.66
450	2.37	1.12		14.1	13		33.71	2.75
451	2.31	0.84		14.3	13.6		31.72	2.75
452	1.86	0.68		14.2	14.1		33.04	2.77
453	2.6	1.05		13.7	14.4		31.91	2.93
454	3.84	0.62		11.6	14.5		30.39	3.13
455	4.09	0.74		12.4	13.9		29.91	2.93
456	2.21	0.42		12	15.2		26.99	2.96
457	2.36	0.44		12.3	14.1		26.02	3.05
458	1.23	0.45		10.9	9.9		35.04	5.58
459	1.9	0.84		13.8	13.1		34.38	3.15

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
407	3.4			194		0.18	14.8	
408	5.6			283		0.32	15.8	
410	2.6			58		0.13	16.4	
411	6			130		0.31	20.2	
412	3.4			122		0.13	12	
414	5.5			223		0.25	19.7	
415	5.3			229		0.22	18.5	
417	2.8			89		0.12	15.9	
418	4.7			143		0.21	16.4	
419	4.8			196		0.22	17.1	
420	5.2			258		0.25	16.4	
421	5.1			194		0.23	16.8	
423	3			179		0.1	15.7	
424	2.6			130		0.09	18.3	
425	2.3			55		0.07	13.1	
426	1.8			43		0.07	8.5	
427	1.8			31		0.07	10.2	
429	2.1			40		0.08	18.6	
430	2			59		0.07	7	
432	5.5			216		0.27	15.5	
434	5.5			187		0.25	18.1	
435	4			118		0.17	14.3	
436	6			156		0.22	17.5	
437	4.7			191		0.22	14.9	
438	2.2			99		0.24	3.2	
439	1.9			94		0.21	3.1	
440	1.9			101		0.19	3.2	
442	1.9			80		0.21	2.8	
443	1.9			90		0.2	2.9	
445	1.7			82		0.19	3.2	
446	0.7			34		0.09	2.6	
447	1.8			70		0.21	3.3	
448	1.8			71		0.2	2.8	
449	2.1			65		0.22	2.8	
450	2			86		0.21	3	
451	2.1			58		0.22	2.7	
452	2.2			67		0.22	2.7	
453	2.2			76		0.23	2.6	
454	2.2			63		0.23	3.6	
455	2.2			65		0.21	3.5	
456	2.4			59		0.26	2.8	
457	2.3			63		0.22	2.6	
458	2.4			60		0.21	2.9	
459	2.2			62		0.22	3.1	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
407	1.8	1042	0.72	0.193		24.7	0.087	12.94
408	0.53	181	0.68	0.341		43.1	0.106	19.73
410	2.6	3074	0.83	0.132		21.1	0.11	7.46
411	0.67	966	1.58	0.334		52.9	0.23	17.75
412	1.56	1144	0.73	0.116		26	0.102	10.07
414	0.47	296	0.73	0.28		49.6	0.087	15.83
415	0.44	352	0.74	0.25		43.6	0.076	14.23
417	2.55	2174	1.3	0.139		24.9	0.09	7.49
418	0.85	751	1.33	0.238		39.6	0.1	13.2
419	0.93	745	2.17	0.259		50	0.093	13.99
420	0.56	322	2.56	0.273		53.5	0.088	14.67
421	0.68	726	1.18	0.267		38.3	0.108	14.43
423	0.49	240	1.06	0.082		50	0.064	6.44
424	0.51	237	0.44	0.055		31.6	0.063	7.24
425	0.56	402	0.16	0.054		24.5	0.048	4.53
426	0.68	378	0.11	0.054		23.8	0.042	3.85
427	0.66	466	0.13	0.057		24.8	0.047	3.7
429	0.71	468	0.11	0.062		27	0.057	3.72
430	0.64	365	0.11	0.052		23.1	0.039	3.67
432	0.59	648	2.22	0.355		49	0.09	16.27
434	0.46	275	1.02	0.336		43	0.087	16.79
435	0.9	599	1.32	0.19		38.8	0.099	9.03
436	0.62	465	2.43	0.309		77	0.086	15.97
437	0.54	436	1.87	0.275		49.8	0.079	13.23
438	0.41	79	14.71	0.2		60	0.065	14.43
439	0.41	66	18.43	0.179		64.1	0.063	14.9
440	0.48	87	21.93	0.173		60.3	0.065	14.48
442	0.4	61	16.47	0.174		73.5	0.063	14.55
443	0.42	58	20.41	0.168		76.9	0.061	13.99
445	0.44	71	20.76	0.157		63.2	0.062	13.49
446	5.37	449	5.97	0.055		16.6	0.038	4.51
447	0.73	73	11.33	0.169		53.2	0.075	14.52
448	0.64	70	8.66	0.193		50.1	0.069	13.7
449	0.63	76	7.28	0.196		49.5	0.07	14.58
450	0.68	90	8.12	0.2		51.4	0.073	15.19
451	0.65	73	7.68	0.208		50.1	0.069	13.94
452	0.59	75	6.87	0.212		48.3	0.073	13.93
453	0.55	68	7.35	0.202		51.7	0.061	14.23
454	0.65	100	5.57	0.187		38.3	0.075	15.25
455	0.59	85	5.39	0.21		43.6	0.072	15.28
456	0.55	86	2.69	0.211		35.8	0.067	14.99
457	0.5	78	2.64	0.203		35.4	0.064	14.66
458	0.36	141	10.92	0.214		24	0.077	18.42
459	0.65	107	3.75	0.193		41.7	0.076	15.21

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
407					1.22	0.45	9.6	0.7
408					1.37	0.62	6.5	0.8
410					0.25	0.29	13.1	0.7
411					0.54	0.49	5.5	1.2
412					0.46	0.97	6.7	0.8
414					0.15	0.63	5	1
415					0.15	0.89	5	0.7
417					0.02	0.38	24.5	0.7
418					0.09	0.58	7.8	1.2
419					0.06	0.71	9	1.2
420					0.21	0.98	5.5	1.2
421					0.07	0.58	7.7	1.5
423					0.2	0.84	3.1	0.4
424					0.15	0.75	2.9	0.3
425					0.01	0.32	2.5	0.4
426					0.02	0.23	2.6	0.3
427					0.03	0.25	2.7	0.3
429					0.04	0.27	2.7	0.4
430					0.02	0.24	1.9	0.4
432					0.13	0.64	6.6	1.4
434					0.38	1.21	5.4	1.2
435					0.05	0.61	6.1	0.8
436					0.07	0.94	6.2	1.2
437					0.13	1.49	6.1	1.3
438					2.56	1.2	4.4	3.2
439					2.78	1.15	5.3	3.6
440					3.04	1.19	5.1	3.8
442					2.73	1.46	5.1	4.3
443					2.88	1.7	5.2	4.5
445					2.85	1.27	5	3.8
446					1.06	0.51	2.2	1.4
447					2.39	1.23	4.6	3
448					2.28	1.15	4.5	2.3
449					2.28	0.88	4.7	2.1
450					2.4	1.04	5	2.3
451					2.41	1.01	5.1	2.2
452					2.43	0.93	5.1	2.1
453					2.53	0.97	5.2	2.3
454					2.84	0.87	6	2.1
455					2.48	0.74	6	1.8
456					2.46	0.55	5.1	1.6
457					2.6	0.63	5.1	1.5
458					6.05	0.87	3.7	2
459					2.72	0.95	4.7	2.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
407		88.9		0.06	4.9	0.003	0.14	1.32
408		93.8		0.1	7.8	0.003	0.12	1.48
410		108.2		0.04	3.2	0.002	0.07	1.53
411		136.7		0.06	7.8	0.004	0.1	1.68
412		185.3		0.02	3.5	0.015	0.1	0.98
414		77.6		0.07	7.4	0.007	0.1	1.37
415		68.5		0.03	7.5	0.003	0.1	1.46
417		106		< .02	3.4	0.004	0.06	1.79
418		89.8		0.03	6.7	0.005	0.1	1.52
419		94.2		0.04	6.9	< .001	0.1	1.52
420		79.6		0.05	7.1	< .001	0.12	1.48
421		94.3		0.04	7	0.003	0.1	1.73
423		66.2		< .02	5.6	0.007	0.12	0.88
424		75.9		< .02	5.4	0.015	0.12	0.94
425		263		0.03	3.7	0.01	0.06	0.64
426		267.6		< .02	2.4	< .001	0.05	0.51
427		269.5		< .02	3	0.006	0.05	0.55
429		287.4		< .02	4.7	0.012	0.06	0.65
430		304.7		< .02	2.1	0.007	0.06	0.48
432		112.8		0.07	7	0.002	0.12	1.47
434		93		0.06	7.5	0.008	0.12	1.4
435		73.6		< .02	5	< .001	0.09	1.25
436		98.9		0.03	7.4	< .001	0.14	1.57
437		88		0.03	6.2	0.004	0.13	1.67
438		96.6		0.06	4.2	0.004	0.17	2.06
439		114.4		0.09	4.1	0.001	0.2	2.75
440		135.3		0.08	4.1	< .001	0.21	3.59
442		103.3		0.1	4.1	< .001	0.28	2.51
443		115.1		0.1	4	< .001	0.26	3
445		141.7		0.08	4	0.005	0.15	3.12
446		239.7		0.02	1.5	0.001	0.1	2.07
447		101.2		0.09	4.6	0.006	0.21	1.9
448		83.9		0.07	4.2	0.003	0.23	1.4
449		78.9		0.06	4.3	0.007	0.2	1.26
450		83.3		0.1	4.6	< .001	0.25	1.52
451		82.8		0.07	4.1	< .001	0.19	1.33
452		78		0.06	4.4	< .001	0.17	1.33
453		94.3		0.05	4.2	< .001	0.18	1.28
454		106.3		0.11	4.8	< .001	0.11	1.7
455		124.6		0.09	4.6	< .001	0.15	1.61
456		87		0.07	4.6	< .001	0.07	1.17
457		89.6		0.06	4.5	< .001	0.08	1.01
458		60.1		0.08	4.5	< .001	0.17	1.06
459		77.7		0.1	5	< .001	0.12	1.48

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

						Analysis: GROUP 1EX - 0.25 GM		
Element	**V**	**W**	**Y**	**Zn**	**Zr**	**Ag**	**Al**	**As**
LDL	**2**	**0.1**	**0.01**	**0.1**	**0.1**	**0.1**	**0.01**	**1**
Samples	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**
407	40	<.1		83.8				
408	44	<.1		141.7				
410	61	<.1		54.2				
411	50	<.1		160.6				
412	42	<.1		102.5				
414	42	<.1		140.3				
415	42	<.1		118.7				
417	64	<.1		82.8				
418	45	<.1		128.2				
419	46	<.1		137.5				
420	42	<.1		153.7				
421	45	<.1		145.1				
423	31	<.1		88.8				
424	30	<.1		82.8				
425	22	<.1		54.9				
426	21	<.1		50.1				
427	22	<.1		49.9				
429	26	<.1		60.5				
430	21	<.1		50.7				
432	44	<.1		163.4				
434	48	<.1		131				
435	41	<.1		109.9				
436	46	<.1		166.1				
437	47	<.1		176.2				
438	41	<.1		138.3				
439	38	<.1		146.7				
440	35	<.1		157.4				
442	47	<.1		181.5				
443	45	<.1		192.2				
445	36	<.1		150.2		0.4	7.06	38
446	49	<.1		49.6				
447	37	<.1		126.3				
448	31	<.1		116.8				
449	28	<.1		117.4				
450	31	<.1		172				
451	31	<.1		146.4				
452	27	<.1		125.3				
453	32	<.1		181.2				
454	29	<.1		107.3		0.3	7.13	32
455	28	<.1		143.1				
456	25	<.1		101.1				
457	23	<.1		119.1				
458	21	<.1		85.4				
459	25	<.1		140.3				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
445	< .1	118	2	0.2	6.01	1.4	63	17
454	< .1	234	2	0.3	4.13	0.6	68	14

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
445	109.6	35.8	3.95	2	1.99	37.6	54	0.78
454	116.3	31.6	4.29	1.9	2.18	41.8	74.8	1

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
445	89	23.3	0.328	12.3	65.9	0.083	17	108.5
454	107	6.2	0.382	13.3	44.2	0.097	19.5	123.1

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
445	3	2.6	12	2.2	228	0.8	9.1	0.395
454	2.8	1.5	14	2.5	208	0.9	10.7	0.425

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
445	6.9	293	1.1	18.7	192	57	75.1	18.9
454	4.5	237	1.5	20.3	129	55.7	86.2	12.6

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
445	8.7	4.27	2.42	1.11	18.8	4.31	3.3	0.8
454	9.6	4.95	2.62	1.32	20.6	5.3	3.7	1

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
445	37	0.38	16.2	29.9	8.86	< 1	126.6	5.9
454	42.1	0.37	17.4	35.9	9.66	2	140.6	6.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
445	284.4	1	0.72	10.5	0.4	8.6	305	1.5
454	239.2	1.1	0.86	12.6	0.42	5.4	240	1.9

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
445	27.5	2.46	116	14.15	1002.6	8.8	0.01	
454	29.6	2.59	130.8	14.78	938.4	5.89	0.013	

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
445	5.47	2.6	15.6	1.49	0.01	0.51	60	0.19
454	5.77	2.72	12.8	1.91	0.01	0.52	35	0.21

Analysis: CO2

Element	Sc	SiO2	TiO2	TOT/C	TOT/S	SUM	C/ORG	C/GRA
LDL	1	0.02	0.01	0.01	0.01			
Samples	ppm	%	%	%	%	%	%	%
445	13	50.11	0.65	5.54	3.23	99.6	3.53	0.09
454	15	54.17	0.69	4.29	3.22	99.49	2.8	0.05

Element	CO2	SO4
LDL		
Samples	%	%
445	7.05	2.61
454	5.29	2.3

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
460	02/07-33-052-15W5/0	53.533243	-116.145474	1968.490	1968.460	Dec. 2003
461	02/07-33-052-15W5/0	53.533243	-116.145474	1969.130	1969.180	Dec. 2003
462	00/09-09-056-19W5/0	53.827446	-116.755651	2237.600	2237.640	Dec. 2003
463	00/09-09-056-19W5/0	53.827446	-116.755651	2238.620	2238.660	Dec. 2003
464	00/09-09-056-19W5/0	53.827446	-116.755651	2239.610	2239.660	Dec. 2003
465	00/09-09-056-19W5/0	53.827446	-116.755651	2240.200	2240.220	Dec. 2003
466	00/09-09-056-19W5/0	53.827446	-116.755651	2240.590	2240.630	Dec. 2003
467	00/09-09-056-19W5/0	53.827446	-116.755651	2241.590	2241.630	Dec. 2003
468	00/09-09-056-19W5/0	53.827446	-116.755651	2242.600	2242.640	Dec. 2003
470	00/09-09-056-19W5/0	53.827446	-116.755651	2243.570	2243.610	Dec. 2003
471	00/09-09-056-19W5/0	53.827446	-116.755651	2243.580	2243.580	Dec. 2003
472	00/09-09-056-19W5/0	53.827446	-116.755651	2244.580	2244.650	Dec. 2003
473	00/09-09-056-19W5/0	53.827446	-116.755651	2245.600	2245.640	Dec. 2003
475	00/09-09-056-19W5/0	53.827446	-116.755651	2246.520	2246.580	Dec. 2003
476	00/09-09-056-19W5/0	53.827446	-116.755651	2247.570	2247.620	Dec. 2003
477	00/09-09-056-19W5/0	53.827446	-116.755651	2248.550	2248.600	Dec. 2003
478	00/09-09-056-19W5/0	53.827446	-116.755651	2248.750	2248.800	Dec. 2003
479	00/09-09-056-19W5/0	53.827446	-116.755651	2249.560	2249.600	Dec. 2003
480	00/09-09-056-19W5/0	53.827446	-116.755651	2250.560	2250.610	Dec. 2003
481	00/09-09-056-19W5/0	53.827446	-116.755651	2251.500	2251.540	Dec. 2003
482	00/09-09-056-19W5/0	53.827446	-116.755651	2252.550	2252.600	Dec. 2003
483	00/09-09-056-19W5/0	53.827446	-116.755651	2253.580	2253.640	Dec. 2003
484	00/09-09-056-19W5/0	53.827446	-116.755651	2255.790	2255.830	Dec. 2003
485	00/09-09-056-19W5/0	53.827446	-116.755651	2256.790	2256.835	Dec. 2003
486	00/09-09-056-19W5/0	53.827446	-116.755651	2256.960	2256.960	Dec. 2003
487	00/09-09-056-19W5/0	53.827446	-116.755651	2257.810	2257.850	Dec. 2003
488	00/09-09-056-19W5/0	53.827446	-116.755651	2258.810	2258.860	Dec. 2003
489	00/09-09-056-19W5/0	53.827446	-116.755651	2259.900	2259.950	Dec. 2003
490	00/09-09-056-19W5/0	53.827446	-116.755651	2260.920	2260.960	Dec. 2003
491	00/09-09-056-19W5/0	53.827446	-116.755651	2261.910	2261.960	Dec. 2003
492	00/09-09-056-19W5/0	53.827446	-116.755651	2262.900	2262.950	Dec. 2003
493	00/09-09-056-19W5/0	53.827446	-116.755651	2263.880	2263.920	Dec. 2003
494	00/09-09-056-19W5/0	53.827446	-116.755651	2264.910	2264.960	Dec. 2003
496	00/09-09-056-19W5/0	53.827446	-116.755651	2265.920	2265.960	Dec. 2003
497	00/09-09-056-19W5/0	53.827446	-116.755651	2266.870	2266.920	Dec. 2003
498	00/09-09-056-19W5/0	53.827446	-116.755651	2267.020	2267.075	Dec. 2003
499	00/09-09-056-19W5/0	53.827446	-116.755651	2267.960	2268.010	Dec. 2003
500	00/09-09-056-19W5/0	53.827446	-116.755651	2268.900	2268.950	Dec. 2003
3807	00/09-09-056-19W5/0	53.827446	-116.755651	2269.910	2269.960	Dec. 2003
3808	00/09-09-056-19W5/0	53.827446	-116.755651	2270.890	2270.940	Dec. 2003
3809	00/09-09-056-19W5/0	53.827446	-116.755651	2270.890	2270.910	Dec. 2003
3810	00/09-09-056-19W5/0	53.827446	-116.755651	2271.880	2271.930	Dec. 2003
3811	00/09-09-056-19W5/0	53.827446	-116.755651	2272.880	2271.920	Dec. 2003
3812	02/16-27-058-20W5/0	54.049053	-116.877692	1825.465	1825.525	Dec. 2003
3813	02/16-27-058-20W5/0	54.049053	-116.877692	1826.500	1826.555	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
460	Unknown	Upper Belle Fourche	Dk grey shale, smooth, some silt, black organic debris
461	Unknown	Upper Belle Fourche	Dk grey shale, some silt
462	Unknown	Second White Specks	Broken fragments of dk grey shale, minor silt, shelly fragments
463	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt and shelly debris
464	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt, shelly remains
465	Unknown	Second White Specks	Pyritized shell
466	Unknown	Second White Specks	Broken fragments of dk grey shale, pyritized shell, minor silt, shelly fragments
467	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt
468	Probable	Second White Specks	Broken fragments of shale, some silt, some shelly debris
470	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
471	Probable	Second White Specks	Pyrite lense within carbonate + unidentified fossil
472	Probable	Second White Specks	Broken fragments of dk grey shale, smooth, a little silt
473	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
475	Probable	Second White Specks	Broken fragments of dk grey shale, some silty lams/pockets - very calcareous
476	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
477	Probable	Second White Specks	Broken fragments of dk grey shale, minor silt
478	Probable	Second White Specks	Calcareous lams full of pyrite
479	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
480	Probable	Second White Specks	Broken fragments of dk grey shale, some silt and shelly debris
481	Probable	Second White Specks	Broken fragments of dk grey shale, silty lams, some shelly debris
482	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
483	Probable	Second White Specks	Broken fragments of dk grey shale, some silt, micas
484	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
485	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
486	Probable	Second White Specks	Pyrite laminations
487	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
488	Probable	Second White Specks	Broken fragments of dk grey shale, silty pockets
489	Probable	Second White Specks	Broken fragments of dk grey shale, silty pockets
490	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
491	Probable	Second White Specks	Broken fragments of dk grey shale, silty pockets
492	Probable	Second White Specks	Broken fragments of dk grey shale, some silty pockets
493	Probable	Second White Specks	Broken fragments of dk grey shale, very smooth, a little silt
494	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
496	Probable	Second White Specks	Broken fragments of dk grey shale, some silt, a few shelly fragments
497	Probable	Second White Specks	Broken fragments of smooth dk grey shale, little silt
498	Probable	Second White Specks	Calcite nodule? Pyrite rim
499	Probable	Second White Specks	Broken fragments of dk grey shale, very smooth, some silt
500	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
3807	Probable	Second White Specks	Broken fragments of dk grey shale, some silt
3808	Possible	Second White Specks	Broken fragments of dk grey shale, some silt
3809	Possible	Second White Specks	Black vitreous lenses (coal?)
3810	Possible	Second White Specks	Broken fragments of dk grey shale, some silt
3811	Possible	Second White Specks	Broken fragments of dk grey shale, some silt
3812	Possible	Second White Specks	Dk grey shale, micas, silt lams, some shelly debris
3813	Possible	Second White Specks	Dk grey shale, micas, some silt

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
460	196	0.71	24.6	0.5	7	52.8		0.28
461	197	0.7	24.2	0.3	9	71.8		0.28
462	330	0.69	33.8	0.3	9	63		0.29
463	326	0.7	34	0.4	9	67.7		0.32
464	322	0.67	35.5	0.2	9	60.7		0.29
465	288	0.9	33.7	< .2	12	65.3		0.28
466	333	0.67	33.8	0.3	9	57.1		0.36
467	297	0.68	31.5	0.8	10	73.6		0.3
468	404	0.58	37.3	< .2	11	48.6		0.31
470	308	0.55	36.2	0.5	9	55.4		0.35
471	290	0.57	35.6	0.3	10	54.5		0.28
472	399	0.66	37.5	0.4	10	57.1		0.38
473	348	0.63	39.1	0.6	9	56.6		0.32
475	352	0.57	32.8	0.6	10	56.3		0.27
476	365	0.61	46.8	< .2	8	47.4		0.3
477	375	0.56	37.3	< .2	10	55.4		0.29
478	291	0.58	39.1	0.4	11	64		0.23
479	385	0.63	33	0.3	9	54.3		0.31
480	339	0.48	34.8	0.3	9	57.1		0.25
481	336	0.49	39.3	0.3	12	55.4		0.28
482	304	0.58	35.2	0.2	11	63		0.27
483	274	0.5	35.5	0.6	8	56.5		0.23
484	196	0.81	18.4	0.5	9	70.4		0.27
485	176	0.85	16.9	< .2	10	77		0.29
486	165	1.24	17.3	0.3	12	39		0.52
487	170	0.86	19	0.7	9	62.7		0.28
488	169	0.73	21.8	0.7	9	49.7		0.26
489	176	0.75	21.8	0.2	9	58.6		0.27
490	181	0.83	22.1	0.7	10	53		0.27
491	194	0.68	22.3	0.7	8	49.9		0.24
492	209	0.74	22.1	0.3	9	47.9		0.25
493	212	0.71	19.1	0.6	9	50.8		0.26
494	205	0.67	23.1	0.2	7	45.2		0.27
496	278	0.68	30.2	< .2	9	44.9		0.23
497	279	0.67	27.5	0.2	9	45.3		0.23
498	68	0.17	26.8	< .2	3	120.3		0.05
499	281	0.66	25.2	< .2	8	45.7		0.27
500	269	0.6	25.3	0.4	7	44.8		0.25
3807	263	0.57	20.2	< .2	8	46		0.25
3808	244	0.65	22.4	0.3	7	42		0.28
3809	274	0.76	23.1	< .2	8	39.5		0.28
3810	290	0.69	24	0.3	8	37.9		0.3
3811	226	0.73	18.7	0.3	8	44.7		0.28
3812	242	0.46	29.4	0.4	8	55.2		0.23
3813	268	0.58	29.9	0.3	7	43		0.28

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
460	2.14	0.69		13.6	11.8		29.54	3.3
461	3.31	1.23		12.3	11.6		28.85	3.02
462	4.08	1.34		16.5	10.7		38.85	3.18
463	3.56	1.25		16.5	10.7		40.08	2.99
464	3.79	1.21		16.6	10.3		41.12	3.14
465	4.77	1.45		14.5	13.4		34.82	3.09
466	3.8	1.07		15.9	9.8		38.91	3.12
467	2.61	1.25		14.8	10.5		38.13	2.56
468	4.83	1.28		17.2	9.1		44.52	3.13
470	4.56	0.92		15.5	9.6		38.97	2.95
471	4.9	1.21		13.6	9.5		33.85	3.35
472	3.47	1.76		18.2	10.8		47.39	3.14
473	3.95	1.24		19	11.1		43.47	3.24
475	4.99	1.25		16	10.1		41.7	3.21
476	3.17	1.35		17.7	10.9		41.94	3.3
477	4.9	1.69		17.8	10.2		42.32	3.16
478	7.15	1.37		13.6	10.2		32.15	3.13
479	3.1	1.76		15.6	10.7		42.13	2.67
480	7.05	1.21		15.9	8.3		37.39	2.89
481	5.86	1.14		16.3	9.6		37.61	2.95
482	5.66	1.11		16	10		35.68	2.9
483	5.65	1.38		13.9	10.4		30.18	3.39
484	1.4	0.45		12.5	14.2		28.95	2.77
485	1.56	0.78		12.3	13.7		28.23	2.81
486	1.09	0.41		9.9	11.9		23	3.92
487	1.33	0.45		12.6	15.3		27.28	2.84
488	1.84	0.47		12.2	12.3		27.47	3.16
489	1.7	0.44		11.8	12.1		28.01	3.15
490	1.86	0.47		12.9	12.9		28.14	3.16
491	2.15	0.6		13	11.3		30.15	3.02
492	1.92	0.72		13	11.9		30.25	3.26
493	1.79	0.98		12.1	11.2		28.73	2.92
494	2.45	1.09		12.4	10.7		29.67	3.04
496	3.12	1.38		15.1	11.7		36.11	3.32
497	2.78	1.29		15.8	11.4		38.05	3.22
498	22.29	0.58		4.1	3.6		9.16	4.87
499	2.62	1.59		15.3	11.6		42.5	3.29
500	4.41	1.28		14.6	10.7		38.84	3.49
3807	4.21	1.23		13.7	10.2		39.62	3.14
3808	2.21	1.16		14.7	12.3		38.48	3.1
3809	2.83	1.24		15.2	13		41.95	3.42
3810	2.26	1.66		16.5	12.3		42.32	3.4
3811	1.36	0.86		14	11.5		34.73	2.97
3812	5.76	1.02		12.7	9.6		29.08	2.91
3813	3.73	0.93		15	10.7		33.86	2.96

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
460	2.1			69		0.21	2.8	
461	2.1			74		0.21	3.3	
462	2.1			106		0.21	3.1	
463	2.1			100		0.22	3.3	
464	2			111		0.21	3.2	
465	2.6			121		0.3	3.6	
466	2			101		0.2	3.7	
467	2			74		0.22	2.7	
468	1.8			105		0.21	3.7	
470	1.6			106		0.19	3.6	
471	1.6			84		0.19	3.8	
472	2			106		0.21	3.7	
473	1.9			123		0.21	3.3	
475	1.7			89		0.19	3.5	
476	1.8			101		0.21	2.8	
477	1.7			111		0.19	3.4	
478	1.7			95		0.19	5.5	
479	1.7			85		0.21	2.9	
480	1.5			89		0.18	4.2	
481	1.6			95		0.2	4	
482	1.7			103		0.22	3.8	
483	1.5			72		0.18	3.6	
484	2.4			72		0.23	2.6	
485	2.5			68		0.22	2.6	
486	2.8			48		0.24	2.2	
487	2.4			74		0.25	2.4	
488	2			83		0.2	2.4	
489	2.1			62		0.21	2.5	
490	2.3			69		0.24	2.4	
491	2.1			71		0.21	3	
492	2.2			66		0.22	2.8	
493	2.1			58		0.22	2.6	
494	2			68		0.2	2.9	
496	2			62		0.22	3.1	
497	2			80		0.22	2.9	
498	0.5			43		0.07	1.5	
499	2			92		0.21	3.2	
500	1.8			74		0.2	3.5	
3807	1.7			72		0.19	3.3	
3808	1.9			77		0.2	2.5	
3809	2.2			71		0.25	3.1	
3810	2			91		0.21	2.7	
3811	2.1			76		0.22	2.2	
3812	1.4			80		0.17	3.6	
3813	1.7			81		0.2	3.1	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
460	0.66	97	4.92	0.195		40.9	0.067	16.35
461	0.63	102	4.49	0.2		37.8	0.07	15.38
462	0.51	86	19.45	0.172		63.3	0.071	16.06
463	0.47	84	16.22	0.194		53.9	0.071	17.09
464	0.46	104	17.37	0.196		51.1	0.071	16.18
465	0.58	102	16.92	0.178		46.8	0.071	15.2
466	0.47	101	19.7	0.182		50	0.068	17.02
467	0.42	74	10.5	0.19		55.5	0.067	16.27
468	0.51	89	23.08	0.176		57.2	0.082	16.87
470	0.42	68	9.2	0.166		55	0.075	16.93
471	0.56	80	10.02	0.154		49.2	0.078	15.96
472	0.4	75	10.78	0.176		65.7	0.074	20.15
473	0.44	85	7.99	0.175		53.6	0.073	17.87
475	0.56	108	16.68	0.172		46.7	0.075	16.22
476	0.49	74	16.87	0.174		67.6	0.068	17.36
477	0.54	81	24.36	0.164		62.7	0.074	17.01
478	0.65	90	18	0.144		43.5	0.145	13.43
479	0.49	77	11.15	0.179		62.5	0.068	17.77
480	0.46	80	18.36	0.149		58.2	0.073	15.37
481	0.48	71	15.04	0.16		61	0.075	16.23
482	0.42	76	12.53	0.161		58.5	0.073	15.56
483	0.71	91	10.51	0.138		55.9	0.076	14.07
484	0.53	68	4	0.211		45.4	0.069	16.58
485	0.56	90	3.8	0.209		42.2	0.065	16.53
486	0.44	113	4.5	0.208		33.4	0.047	19.99
487	0.5	76	3.48	0.215		42	0.066	16.11
488	0.6	77	2.92	0.2		37.9	0.068	15.36
489	0.52	79	2.44	0.205		36.8	0.068	15.26
490	0.46	84	2.45	0.213		39.1	0.066	15.84
491	0.52	89	4.03	0.197		38.5	0.067	13.94
492	0.66	90	3.79	0.19		41	0.071	15.52
493	0.59	81	3.27	0.183		36.9	0.067	14.64
494	0.64	96	4.78	0.185		36.7	0.069	14.72
496	0.64	96	10.32	0.195		53.6	0.07	14.42
497	0.58	88	10.05	0.176		47.9	0.063	14.23
498	0.95	87	16.81	0.05		11.5	0.049	3.28
499	0.55	109	7.54	0.174		48.1	0.074	15.09
500	0.54	105	8.8	0.166		44.3	0.07	14.57
3807	0.61	118	5.82	0.165		42.9	0.071	14.02
3808	0.46	78	6.28	0.178		52.7	0.063	15.06
3809	0.48	92	7.38	0.181		56.4	0.068	15.49
3810	0.53	94	6.46	0.186		50.4	0.067	15.51
3811	0.5	85	4.17	0.186		44.4	0.058	15.73
3812	0.49	89	10.28	0.134		47.1	0.076	13.85
3813	0.48	73	9.93	0.156		54	0.071	15.97

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
460					2.86	0.92	4.9	2.2
461					2.59	0.97	5	1.9
462					2.81	1.57	5.8	3.7
463					2.69	1.27	4.8	3.2
464					2.89	1.04	5.7	3.1
465					2.65	0.88	5.8	2.8
466					2.85	1.13	5.3	3.2
467					2.27	1.45	4.4	3
468					3.21	1.16	4.1	4.4
470					2.98	1.09	4.8	2.9
471					3.3	0.99	5.2	3
472					3.1	1.39	5.6	3.6
473					3.18	1.15	5.3	3.2
475					3.16	1.11	4.9	3.5
476					3.31	1.64	4.9	3.9
477					3.12	1.65	4.9	4.3
478					3.08	1.27	6.7	3.3
479					2.66	1.65	4.1	4.2
480					3.05	1.99	4.3	4
481					3.17	1.91	4.2	4.1
482					3.02	1.53	4.9	3.7
483					3.27	1.55	5.6	3.4
484					2.21	0.69	4.9	1.6
485					2.11	0.61	5	1.4
486					3.74	0.58	4.2	1.7
487					2.18	0.65	4.9	1.5
488					2.52	0.66	5	1.5
489					2.46	0.58	5	1.4
490					2.63	0.6	4.9	1.5
491					2.5	0.84	4.2	2
492					2.74	0.76	4.5	1.9
493					2.34	0.75	4.6	1.8
494					2.46	0.88	4.8	2.1
496					2.88	1.24	4.8	3.5
497					2.81	1.29	4.8	3.5
498					4.44	0.8	2.9	2.1
499					3.08	1.25	5.2	3.5
500					3.17	1.18	5	3.5
3807					2.82	1	4.5	3.2
3808					2.76	0.93	4.4	3.1
3809					3.12	0.92	5.5	3.5
3810					3.03	1.04	4.9	3.5
3811					2.54	0.72	4.8	2.3
3812					2.64	1.19	5.7	2.8
3813					2.68	1.28	4.8	2.8

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
460		79.9		0.14	4.8	< .001	0.14	1.4
461		104.3		0.13	5	< .001	0.12	1.55
462		112.1		0.13	4.3	< .001	0.22	3.31
463		109.6		0.12	4.6	< .001	0.19	2.33
464		112.9		0.1	4.5	< .001	0.17	2.62
465		128.1		0.08	4.4	< .001	0.11	2.87
466		103.8		0.11	4.9	< .001	0.16	3.09
467		82.6		0.1	4.5	< .001	0.26	1.72
468		122.5		0.13	4.6	< .001	0.11	3.8
470		105.1		0.13	4.7	< .001	0.21	2.32
471		113.2		0.11	4.6	< .001	0.24	2.26
472		89.1		0.15	4.8	< .001	0.26	2.46
473		104.7		0.14	4.4	< .001	0.15	2.41
475		125.4		0.1	4.3	< .001	0.1	4.02
476		86.7		0.15	4.2	< .001	0.3	2.28
477		126.1		0.1	4.5	< .001	0.24	3.7
478		190.8		0.1	4.4	< .001	0.13	8.62
479		83.1		0.12	4.5	< .001	0.34	1.6
480		154.5		0.14	4.6	< .001	0.21	3.76
481		138.2		0.14	5	< .001	0.23	2.93
482		144.9		0.12	4.5	< .001	0.2	2.72
483		123.8		0.11	4.1	< .001	0.28	2.31
484		67		0.11	4.6	< .001	0.15	0.88
485		72.4		0.09	5.2	< .001	0.15	1.02
486		58.1		0.07	6.6	< .001	0.26	0.64
487		64.6		0.11	4.4	0.004	0.16	0.85
488		68		0.08	4.3	0.003	0.11	0.95
489		70		0.1	4.7	< .001	0.09	1.09
490		78		0.08	4.6	0.002	0.09	0.92
491		70.1		0.1	4.2	< .001	0.11	1.44
492		67.9		0.11	4.7	< .001	0.1	1.36
493		65.3		0.09	4.5	< .001	0.07	1.29
494		77.8		0.1	4.6	< .001	0.08	1.76
496		83.7		0.11	4.2	< .001	0.17	2.17
497		77.2		0.15	4	0.003	0.12	2.01
498		262.4		0.03	1	< .001	0.07	1.15
499		75.4		0.18	4.3	0.008	0.1	2.65
500		114.2		0.1	4.1	< .001	0.09	2.6
3807		112.4		0.12	4.1	0.005	0.08	2.23
3808		84.6		0.14	4.1	0.006	0.12	1.58
3809		89.7		0.12	4.1	< .001	0.1	2.24
3810		85.1		0.13	4.3	0.005	0.11	1.75
3811		62.9		0.08	4.1	< .001	0.13	1.12
3812		165		0.1	3.8	< .001	0.17	2.59
3813		109.7		0.12	4.5	< .001	0.18	1.74

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
460	21	<.1		122.7				
461	21	<.1		216.9				
462	39	<.1		170.9				
463	32	<.1		172				
464	30	<.1		186.9				
465	41	<.1		204.8				
466	28	<.1		153				
467	42	<.1		144.1				
468	33	<.1		154.3				
470	33	<.1		139.8				
471	34	<.1		197.7				
472	35	<.1		207.2				
473	29	<.1		183.7				
475	28	<.1		182.5				
476	39	<.1		168.3				
477	39	<.1		198.1				
478	37	<.1		181.1				
479	42	<.1		157.1				
480	41	<.1		136.1				
481	38	<.1		135.3				
482	42	<.1		133.2				
483	44	<.1		165.2				
484	27	<.1		113.5				
485	26	<.1		207.6				
486	26	<.1		105				
487	29	<.1		121.6				
488	24	<.1		122.5				
489	24	<.1		112.8				
490	27	<.1		123.6				
491	23	<.1		116.1				
492	25	<.1		133				
493	23	<.1		188.7				
494	22	<.1		163.8				
496	31	<.1		158.6				
497	28	<.1		143.4				
498	18	<.1		61.8				
499	26	<.1		185				
500	25	<.1		143.2				
3807	23	<.1		141.4				
3808	24	<.1		163.7				
3809	28	<.1		137.5				
3810	27	<.1		205.2				
3811	23	<.1		130.9				
3812	31	<.1		147.5				
3813	38	<.1		134.1				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
3814	02/16-27-058-20W5/0	54.049053	-116.877692	1827.410	1827.485	Dec. 2003
3815	02/16-27-058-20W5/0	54.049053	-116.877692	1828.510	1828.575	Dec. 2003
3817	02/16-27-058-20W5/0	54.049053	-116.877692	1829.500	1829.550	Dec. 2003
3818	02/16-27-058-20W5/0	54.049053	-116.877692	1830.490	1830.450	Dec. 2003
3819	02/16-27-058-20W5/0	54.049053	-116.877692	1831.450	1831.500	Dec. 2003
3820	02/16-27-058-20W5/0	54.049053	-116.877692	1832.330	1832.380	Dec. 2003
3821	02/16-27-058-20W5/0	54.049053	-116.877692	1832.710	1832.730	Dec. 2003
3822	02/16-27-058-20W5/0	54.049053	-116.877692	1833.440	1833.490	Dec. 2003
3823	02/16-27-058-20W5/0	54.049053	-116.877692	1834.350	1834.490	Dec. 2003
3824	02/16-27-058-20W5/0	54.049053	-116.877692	1835.440	1835.490	Dec. 2003
3825	02/16-27-058-20W5/0	54.049053	-116.877692	1836.410	1836.460	Dec. 2003
3826	02/16-27-058-20W5/0	54.049053	-116.877692	1836.270	1836.320	Dec. 2003
3827	00/10-28-059-20W5/0	54.133561	-116.932429	1876.820	1876.870	Dec. 2003
3830	00/10-28-059-20W5/0	54.133561	-116.932429	1877.410	1877.480	Dec. 2003
3831	00/10-28-059-20W5/0	54.133561	-116.932429	1878.350	1878.420	Dec. 2003
3832	00/10-28-059-20W5/0	54.133561	-116.932429	1879.390	1879.455	Dec. 2003
3833	00/10-28-059-20W5/0	54.133561	-116.932429	1880.370	1880.440	Dec. 2003
3834	00/10-28-059-20W5/0	54.133561	-116.932429	1881.380	1881.455	Dec. 2003
3835	00/10-28-059-20W5/0	54.133561	-116.932429	1882.420	1882.420	Dec. 2003
3836	00/10-28-059-20W5/0	54.133561	-116.932429	1883.450	1883.520	Dec. 2003
3837	00/10-28-059-20W5/0	54.133561	-116.932429	1884.450	1884.490	Dec. 2003
3838	00/10-28-059-20W5/0	54.133561	-116.932429	1885.430	1885.500	Dec. 2003
3839	00/10-28-059-20W5/0	54.133561	-116.932429	1886.440	1886.510	Dec. 2003
3840	00/10-28-059-20W5/0	54.133561	-116.932429	1873.410	1873.475	Dec. 2003
3841	00/10-28-059-20W5/0	54.133561	-116.932429	1880.435	1880.500	Dec. 2003
3845	00/10-09-066-23W5/0	54.700355	-117.410259	1272.710	1272.785	Dec. 2003
3846	00/10-09-066-23W5/0	54.700355	-117.410259	1273.710	1273.780	Dec. 2003
3847	00/10-09-066-23W5/0	54.700355	-117.410259	1274.710	1274.780	Dec. 2003
3848	00/10-09-066-23W5/0	54.700355	-117.410259	1275.650	1275.700	Dec. 2003
3849	00/10-09-066-23W5/0	54.700355	-117.410259	1275.700	1275.770	Dec. 2003
3850	00/10-09-066-23W5/0	54.700355	-117.410259	1276.715	1276.780	Dec. 2003
3851	00/10-09-066-23W5/0	54.700355	-117.410259	1277.710	1277.770	Dec. 2003
3852	00/10-09-066-23W5/0	54.700355	-117.410259	1278.690	1278.760	Dec. 2003
3853	00/10-09-066-23W5/0	54.700355	-117.410259	1279.670	1979.740	Dec. 2003
3854	00/10-09-066-23W5/0	54.700355	-117.410259	1279.990	1280.020	Dec. 2003
3855	00/10-09-066-23W5/0	54.700355	-117.410259	1280.670	1280.725	Dec. 2003
3856	00/10-09-066-23W5/0	54.700355	-117.410259	1281.705	1281.766	Dec. 2003
3859	00/10-09-066-23W5/0	54.700355	-117.410259	1282.640	1282.700	Dec. 2003
3861	00/10-09-066-23W5/0	54.700355	-117.410259	1283.550	1283.620	Dec. 2003
3862	00/10-09-066-23W5/0	54.700355	-117.410259	1284.690	1284.740	Dec. 2003
3863	00/10-09-066-23W5/0	54.700355	-117.410259	1285.715	1285.785	Dec. 2003
3864	00/10-09-066-23W5/0	54.700355	-117.410259	1286.630	1286.710	Dec. 2003
3865	00/10-09-066-23W5/0	54.700355	-117.410259	1287.610	1287.670	Dec. 2003
3866	00/10-09-066-23W5/0	54.700355	-117.410259	1288.540	1288.600	Dec. 2003
3867	00/10-09-066-23W5/0	54.700355	-117.410259	1289.555	1289.615	Dec. 2003
3869	02/06-30-064-01W6/0	54.565516	-118.138962	1555.500	1555.550	Dec. 2003
3871	02/06-30-064-01W6/0	54.565516	-118.138962	1556.410	1556.460	Dec. 2003
3873	02/06-30-064-01W6/0	54.565516	-118.138962	1557.390	1557.450	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
3814	Possible	Second White Specks	Dk grey shale, some silt, micas
3815	Possible	Second White Specks	Dk grey shale, some micas
3817	Possible	Second White Specks	Broken fragments of shale, some micas and silt
3818	Possible	Second White Specks	Broken fragments of shale, shelly fragments, micas, some silt
3819	Possible	Second White Specks	Broken fragments of shale, some silt, micas, some organic fragments
3820	Possible	Second White Specks	Broken fragments of shale, some silt
3821	Possible	Second White Specks	Sandy/silty lam full of pyrite - bentonite?
3822	Possible	Second White Specks	Broken fragments of dk grey shale, some silt
3823	Possible	Second White Specks	Broken fragments of dk grey shale, some silt
3824	Possible	Second White Specks	Broken fragments of dk grey shale, some silt
3825	Possible	Second White Specks	Broken fragments of dk grey shale, some silt, some black organic debris
3826	Possible	Second White Specks	Broken fragments of dk grey shale, some silt
3827	Possible	Second White Specks	Red/brown specks, dk grey shale with silty lams
3830	Possible	Second White Specks	Dk grey shale with some lams, shelly debris
3831	Possible	Second White Specks	Dk grey shale, some silty lams
3832	Possible	Second White Specks	Dk grey shale, some silt
3833	Possible	Second White Specks	Dk grey shale, some silt, very smooth
3834	Possible	Second White Specks	Dk grey shale, some shelly fragments, some micas
3835	Possible	Second White Specks	Broken fragments of shale, some silt, shelly fragments
3836	Possible	Second White Specks	Dk grey shale, broken fragments, some silt
3837	Possible	Second White Specks	Broken fragments of shale, some silt
3838	Possible	Second White Specks	Dk grey shale, some silty pockets
3839	Possible	Second White Specks	Dk grey shale, some silt, some black organic fragments
3840	Possible	Second White Specks	Dk grey shale, some silt
3841	Possible	Second White Specks	Dk grey shale, some silt, some black organic fragments
3845	Unknown	Belle Fourche (or underlying unit)	Sand - calcareous (may be good for micropaleo), white and black coloured grains
3846	Unknown	Belle Fourche (or underlying unit)	Bioturbated sand/shale, micas
3847	Unknown	Belle Fourche (or underlying unit)	Bioturbated sand/shale
3848	Unknown	Belle Fourche (or underlying unit)	Broken fragments of dk grey shale, some silt
3849	Unknown	Belle Fourche (or underlying unit)	Siderite? Med brown coloured
3850	Unknown	Belle Fourche (or underlying unit)	Broken fragments of shale, mica rich, pockets of silt
3851	Unknown	Belle Fourche (or underlying unit)	Broken fragments of dk grey shale, micas, some silt
3852	Unknown	Belle Fourche (or underlying unit)	Broken fragments of dk grey shale, micas, some silt
3853	Unknown	Belle Fourche (or underlying unit)	Broken fragments of dk grey shale, smooth, some silt
3854	Unknown	Belle Fourche (or underlying unit)	Siderite?
3855	Unknown	Belle Fourche (or underlying unit)	Dk grey shale with sandy lams, some silt
3856	Unknown	Belle Fourche (or underlying unit)	Broken fragments of dk grey shale, micas, some silt
3859	Unknown	Belle Fourche (or underlying unit)	Broken fragments of shale
3861	Unknown	Belle Fourche (or underlying unit)	Calcareous sand, some muddy lams, some red coloured grains, micas
3862	Unknown	Belle Fourche (or underlying unit)	Broken fragments of shale, micas, some silt
3863	Unknown	Belle Fourche (or underlying unit)	Sand/shale/siderite, micas
3864	Unknown	Belle Fourche (or underlying unit)	Sand/shale/siderite, some silty pockets
3865	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, some silt, some fish fragments
3866	Unknown	Belle Fourche (or underlying unit)	Dk grey shale with some sand lams
3867	Unknown	Belle Fourche (or underlying unit)	Sandy dk grey shale, micas
3869	Possible/Unknown	Belle Fourche	Dk grey shale with calcareous lams, some silty pockets
3871	Possible/Unknown	Belle Fourche	Broken fragments of shale, silty pockets
3873	Possible/Unknown	Belle Fourche	Broken fragments of shale, micas, pockets of silt

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

	Analysis: GROUP 1F1 - 1.00 GM							
Element	**Ag**	**Al**	**As**	**Au**	**B**	**Ba**	**Be**	**Bi**
LDL	**2**	**0.01**	**0.1**	**0.2**	**1**	**0.5**	**0.1**	**0.02**
Samples	**ppb**	**%**	**ppm**	**ppb**	**ppm**	**ppm**	**ppm**	**ppm**
3814	288	0.63	28.8	0.2	7	46.2		0.28
3815	322	0.68	31.2	0.2	9	44.7		0.3
3817	222	0.71	24.2	0.3	8	60.7		0.22
3818	226	0.78	23.8	0.4	7	51.8		0.24
3819	210	0.78	25.4	0.3	6	54.3		0.27
3820	211	0.79	25	< .2	7	57.5		0.27
3821	210	0.91	26.6	0.5	8	39.7		0.31
3822	207	0.86	23	< .2	6	52.5		0.26
3823	170	0.85	22	< .2	6	55.3		0.26
3824	185	0.85	21.2	0.4	7	60.4		0.29
3825	192	0.79	18.5	< .2	8	63.1		0.27
3826	170	0.77	17	< .2	8	55.8		0.24
3827	273	0.48	29.8	1.1	6	64.4		0.23
3830	263	0.58	32.9	0.6	9	52.7		0.28
3831	291	0.61	31.9	0.3	7	51.5		0.29
3832	251	0.59	30.5	0.4	8	48.7		0.26
3833	318	0.63	31.8	0.9	7	45.6		0.29
3834	296	0.68	30.5	0.5	7	50.8		0.27
3835	243	0.71	22.8	0.7	7	70.3		0.22
3836	223	0.74	23.3	0.6	7	72.7		0.24
3837	238	0.78	26.3	1.1	8	68.4		0.24
3838	232	0.8	24.4	0.4	8	78.5		0.24
3839	200	0.82	25.7	0.6	7	68.8		0.25
3840	213	0.82	23.4	0.5	10	74.2		0.26
3841	209	0.81	22.4	0.6	7	60.1		0.24
3845	81	0.28	55	0.5	3	156.5		0.04
3846	220	0.86	12.1	0.5	7	210.1		0.15
3847	270	0.92	14.6	0.6	7	185.1		0.2
3848	390	1.27	7.6	1.3	10	443.3		0.33
3849	271	0.95	8.8	1.4	11	442.1		0.21
3850	403	1.33	2	1.9	12	413.6		0.34
3851	367	1.31	1.5	1	11	452		0.32
3852	360	1.33	4.8	1.9	11	427.6		0.32
3853	360	1.4	19	1.4	12	517.7		0.39
3854	221	1.03	12.3	0.4	13	642.9		0.24
3855	309	1.21	29.2	1.8	10	265.8		0.3
3856	315	1.4	20.5	0.6	10	475.2		0.4
3859	358	1.47	15.4	1.6	13	490		0.39
3861	60	0.35	8.1	0.4	3	196.8		0.03
3862	399	1.4	5.7	1.6	11	431.4		0.38
3863	253	0.9	8.9	0.8	9	297.1		0.17
3864	307	1.15	3.4	1.3	10	338.6		0.22
3865	400	1.35	2.4	1.1	11	442.7		0.32
3866	280	1.08	7	1	8	289.6		0.2
3867	324	1.25	2.7	1.1	9	368.5		0.26
3869	184	0.98	12.9	0.7	10	67.1		0.34
3871	204	1.15	15.1	0.4	12	64		0.33
3873	214	0.96	13.8	0.4	12	64.1		0.33

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
3814	3.21	1.15		14.8	11.7		35.01	3
3815	2.96	1.35		17.5	12.6		37.95	3.39
3817	2.6	0.77		13.6	12.7		29.72	2.73
3818	1.68	0.53		13.7	12.5		31.43	2.92
3819	1.87	0.67		13.6	14.1		32.36	3.01
3820	1.94	0.67		13.6	14.1		32.09	2.99
3821	1.5	0.4		12.6	11.5		37.2	3.45
3822	1.86	0.46		13.4	14.7		30.97	3.1
3823	1.7	0.66		13.2	15		29.5	2.94
3824	1.96	0.42		13.4	15.1		31.16	3.08
3825	1.79	0.4		13.1	14.5		29.8	3.07
3826	2.21	0.31		11.7	13.7		27.18	3.26
3827	6.12	0.95		12.8	10.2		31.02	2.9
3830	3.96	0.95		14.7	10.7		34.21	2.98
3831	3.73	1.07		15.2	12.1		35.28	3.05
3832	3.42	1.01		13.7	11.3		32.3	3.18
3833	3.58	1.4		16.2	12		38.37	3.32
3834	3.46	1.26		15.8	12.1		35.77	3.26
3835	2.41	0.97		13.7	12		31.85	2.57
3836	1.8	0.65		13.4	12		30.31	2.66
3837	1.9	1.03		14.5	13.1		31.95	3.01
3838	1.55	0.65		13.8	13.6		32.47	2.83
3839	1.71	0.59		13.1	14.1		30.37	2.95
3840	1.99	0.6		13	13.3		32.54	2.89
3841	1.77	0.64		12.9	14		31.22	2.95
3845	4.72	0.09		3.8	7		4.79	1.53
3846	0.33	0.23		11.5	22.3		19.64	2.83
3847	0.28	0.26		12.4	24.7		25.02	2.67
3848	0.38	0.62		13.6	26		50.86	2.68
3849	1.11	0.4		9.7	20.9		29.58	8.06
3850	0.42	0.71		13.5	29.2		54.55	3.01
3851	0.44	0.53		15.7	27.8		50.14	3.47
3852	0.42	0.61		15.5	27.7		47.33	3.2
3853	0.31	0.49		13.2	28.5		52.8	2.83
3854	1.69	0.21		9.4	20.9		28.77	14.88
3855	0.41	0.31		15.9	27.3		38.37	3.58
3856	0.31	0.33		16.2	30		48.08	2.75
3859	0.31	0.42		16.7	30.3		49.54	2.68
3861	8.59	0.05		4.3	11.3		3.19	1.46
3862	0.5	0.56		13.5	33		55.5	3.19
3863	0.65	0.56		10.7	21.1		25.88	4.23
3864	0.54	0.49		12.7	25.4		33.78	3.32
3865	0.41	0.62		14.1	29.5		48.59	3.18
3866	0.48	0.4		13.3	23.9		29.92	2.99
3867	0.57	0.52		13.6	26.8		37.2	3.73
3869	0.39	0.15		10.8	16.6		34.06	2.83
3871	0.52	0.21		12.3	18.6		35.06	2.99
3873	0.43	0.23		11.7	16.1		33.11	2.85

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
3814	1.8			71		0.2	3	
3815	1.9			74		0.22	2.9	
3817	2			56		0.21	2.7	
3818	2.2			71		0.21	2.7	
3819	2.2			73		0.22	2.7	
3820	2.2			77		0.22	2.9	
3821	2.2			62		0.21	2.7	
3822	2.4			75		0.24	2.9	
3823	2.4			60		0.23	2.4	
3824	2.4			66		0.23	2.6	
3825	2.3			80		0.22	2.6	
3826	2.2			74		0.22	2.6	
3827	1.5			84		0.19	4	
3830	1.7			61		0.21	3.4	
3831	1.9			70		0.22	3.4	
3832	1.7			107		0.2	3.1	
3833	1.8			67		0.2	3	
3834	2			70		0.21	3.2	
3835	2			69		0.22	2.9	
3836	2			78		0.22	2.8	
3837	2.2			77		0.23	2.9	
3838	2.4			63		0.23	2.9	
3839	2.3			84		0.23	2.7	
3840	2.4			53		0.22	3.1	
3841	2.3			72		0.23	2.9	
3845	1.3			291		0.07	8	
3846	4			214		0.19	8	
3847	4.2			182		0.21	8.3	
3848	4.9			106		0.26	10.7	
3849	3.6			90		0.21	11.2	
3850	5.4			154		0.27	11.5	
3851	5.2			90		0.26	11.2	
3852	5.1			158		0.27	11.3	
3853	5.2			189		0.29	12.4	
3854	3.5			210		0.23	10.4	
3855	4.6			260		0.23	10.3	
3856	5.3			155		0.29	11.6	
3859	5.7			106		0.3	12.7	
3861	2			79		0.09	14.4	
3862	5.9			100		0.27	12.6	
3863	3.5			102		0.18	10.1	
3864	4.6			124		0.23	11.1	
3865	5.4			105		0.25	11.9	
3866	4.1			115		0.21	10	
3867	4.7			120		0.23	11.4	
3869	3.3			101		0.24	3.7	
3871	3.5			114		0.3	4.4	
3873	3			96		0.26	4.7	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
3814	0.55	79	6.43	0.165		55.2	0.076	16.45
3815	0.5	75	6.07	0.172		57.7	0.076	17.69
3817	0.57	79	7.87	0.183		46.5	0.07	14.05
3818	0.49	102	6.15	0.194		42.5	0.073	14.94
3819	0.54	80	5.45	0.192		47.7	0.069	15.22
3820	0.55	93	5.21	0.195		43.8	0.074	15.76
3821	0.45	149	5.07	0.214		32.8	0.067	18.1
3822	0.55	100	3.44	0.202		42.2	0.074	16.2
3823	0.5	89	4.55	0.204		48.6	0.066	15.68
3824	0.6	102	3.3	0.201		44.4	0.071	16.31
3825	0.56	93	2.41	0.189		41.3	0.067	15.51
3826	0.72	127	2.19	0.186		35.4	0.068	15.51
3827	0.57	89	9.68	0.145		47.5	0.072	14.37
3830	0.47	75	10.02	0.174		52.7	0.076	16.28
3831	0.45	68	9.97	0.183		60.9	0.074	16.88
3832	0.5	65	7.92	0.173		52.8	0.074	15.85
3833	0.52	74	7.9	0.184		62.7	0.074	18.69
3834	0.55	70	5.3	0.174		52.5	0.075	17.73
3835	0.49	71	9.29	0.192		50.1	0.066	14.25
3836	0.5	70	8.61	0.195		45.2	0.069	14.22
3837	0.55	89	7.56	0.201		48.7	0.069	15.33
3838	0.48	83	6.53	0.215		47.6	0.071	15.23
3839	0.52	71	5.96	0.2		47.8	0.063	18.64
3840	0.56	87	5.56	0.201		41.8	0.067	15.88
3841	0.5	81	3.64	0.205		39.4	0.068	15.39
3845	0.12	192	1.72	0.051		9.5	0.049	6.25
3846	0.44	210	0.29	0.155		32.9	0.085	10.47
3847	0.43	197	0.42	0.191		36.6	0.082	12.11
3848	0.56	490	1.49	0.275		48.6	0.103	18.48
3849	1.08	1576	1.33	0.201		30.7	0.145	11.49
3850	0.65	764	1.45	0.264		50.1	0.093	17.69
3851	0.63	617	1.87	0.261		54.7	0.089	20.13
3852	0.61	503	1.73	0.259		52.9	0.1	18.38
3853	0.53	515	1.38	0.305		45	0.091	18.9
3854	1.18	2884	0.93	0.219		30.6	0.203	15.42
3855	0.54	473	3.77	0.206		48.4	0.09	17.49
3856	0.55	393	1.17	0.285		47.9	0.093	20.68
3859	0.57	375	1.51	0.286		52.7	0.095	22.08
3861	0.44	326	0.32	0.047		10.9	0.051	4.83
3862	0.69	806	1.81	0.241		48	0.104	19.02
3863	0.66	679	1.6	0.161		34.7	0.11	11.02
3864	0.63	553	1.39	0.196		41.2	0.108	13.48
3865	0.63	659	1.26	0.251		44.7	0.086	17.56
3866	0.59	500	1.66	0.179		42.3	0.102	11.67
3867	0.71	625	1.69	0.21		44.3	0.117	14.86
3869	0.32	74	1.48	0.229		40.3	0.052	18.2
3871	0.36	83	1.82	0.236		43.1	0.06	19.03
3873	0.33	69	1.4	0.237		41.2	0.064	18.5

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
3814					2.6	1.11	4.9	2.8
3815					3.04	1.04	5.5	2.8
3817					2.14	0.9	5.1	2.2
3818					2.32	0.78	4.9	2
3819					2.29	0.87	5.3	1.9
3820					2.32	0.82	5.2	2
3821					2.89	0.83	4.8	1.8
3822					2.38	0.65	5.6	1.6
3823					2.21	0.71	5.2	1.6
3824					2.28	0.72	5.5	1.6
3825					2.16	0.6	5.4	1.5
3826					2	0.53	5.9	1.3
3827					2.67	1.25	4.9	2.8
3830					2.82	1.22	4.6	2.8
3831					2.84	1.36	5	3
3832					2.94	1.18	5	2.5
3833					2.99	1.27	5.7	3.2
3834					2.81	0.98	5.5	2.6
3835					2.03	0.94	4.6	2.5
3836					2.08	0.87	4.8	2.2
3837					2.3	0.95	5	2.2
3838					2.26	0.83	5.1	1.9
3839					2.26	0.82	4.8	1.9
3840					2.16	0.82	5.1	2
3841					2.23	0.69	4.9	1.5
3845					1.09	0.7	2.8	0.9
3846					0.95	0.39	4.1	0.7
3847					1.06	0.63	4.5	0.9
3848					0.18	0.44	5	1.5
3849					0.27	0.61	7.8	1
3850					0.04	0.38	5.4	1.4
3851					0.03	0.36	6.3	1.4
3852					0.04	0.49	5.7	1.4
3853					0.17	0.51	6	1.3
3854					0.09	0.64	15.5	0.9
3855					0.77	1.18	5.6	1.1
3856					0.21	0.89	5.8	1.3
3859					0.14	0.68	6	1.3
3861					0.06	0.64	1.9	0.3
3862					0.06	0.62	5.7	1.3
3863					0.07	0.6	6.3	1
3864					0.04	0.62	5.9	1.1
3865					0.04	0.63	6.2	1.5
3866					0.05	0.68	5.1	0.9
3867					0.05	0.7	6.2	1.2
3869					1.85	0.26	2.9	1
3871					2.08	0.37	3.7	1.3
3873					2.13	0.32	3.4	1.1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
3814		97.2		0.1	4.2	< .001	0.21	1.4
3815		97.3		0.12	4.4	< .001	0.22	1.45
3817		98.6		0.07	4	0.003	0.14	1.35
3818		82.2		0.09	4	< .001	0.12	1.3
3819		85.3		0.09	4.2	< .001	0.14	1.13
3820		88.2		0.08	4.2	< .001	0.11	1.25
3821		80.2		0.07	4.8	0.002	0.14	1.02
3822		89.2		0.12	4.4	< .001	0.07	1.11
3823		87.1		0.1	4.2	0.003	0.12	0.91
3824		89.4		0.06	4.3	< .001	0.1	0.94
3825		87		0.07	4.2	< .001	0.08	0.88
3826		90.7		0.06	4	< .001	0.05	0.95
3827		169.7		0.12	4.5	< .001	0.22	2.43
3830		124.3		0.11	4.6	0.002	0.18	2.09
3831		114.8		0.15	4.6	< .001	0.24	1.92
3832		104.3		0.11	4.2	< .001	0.22	1.68
3833		108.9		0.16	4.3	< .001	0.29	1.74
3834		109.1		0.11	4.4	< .001	0.21	1.53
3835		99		0.08	4.1	< .001	0.17	1.66
3836		82.8		0.1	4.3	< .001	0.18	1.63
3837		87.8		0.09	4.3	< .001	0.18	1.46
3838		85.4		0.08	4.5	0.003	0.18	1.44
3839		83.4		0.08	4.2	< .001	0.17	1.11
3840		91.3		0.13	4.5	< .001	0.15	1.23
3841		90.5		0.09	4.4	< .001	0.08	1.24
3845		251.3		< .02	3.2	< .001	0.27	0.55
3846		43.8		0.03	5.1	< .001	0.11	0.82
3847		47.5		0.04	5.4	0.001	0.11	0.81
3848		71.8		0.09	7.1	0.003	0.09	1.11
3849		83		0.04	5.1	< .001	0.07	1.13
3850		69.3		0.07	7.3	< .001	0.1	1.17
3851		72.5		0.08	7.1	< .001	0.08	1.08
3852		72.3		0.08	7.1	0.001	0.09	1.1
3853		79.5		0.06	7.5	< .001	0.08	1.13
3854		127.1		0.04	4.9	0.008	0.07	1.15
3855		63.9		0.06	7.1	< .001	0.15	1.05
3856		72.7		0.07	7.7	< .001	0.1	1.06
3859		75.7		0.11	8.2	< .001	0.1	1.11
3861		310.5		0.02	4.5	0.001	0.05	0.51
3862		72.1		0.06	7.8	< .001	0.1	1.33
3863		57.9		0.02	5.3	0.003	0.07	1.15
3864		61.9		0.03	6.5	0.001	0.08	1.16
3865		71.6		0.07	7	0.001	0.08	1.14
3866		55.9		0.04	5.9	< .001	0.07	0.99
3867		65		0.03	6.6	0.009	0.09	1.22
3869		41.5		0.08	4.1	0.001	0.07	0.68
3871		47.8		0.05	4.2	< .001	0.08	0.79
3873		46.5		0.07	4.5	0.003	0.08	0.74

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
3814	41	<.1		156.3				
3815	35	<.1		175.1				
3817	26	<.1		146.4				
3818	25	<.1		109.1				
3819	26	<.1		134.2				
3820	27	<.1		133.8				
3821	26	<.1		98.9				
3822	27	<.1		133.5				
3823	28	<.1		180.7				
3824	27	<.1		114.1				
3825	25	<.1		111.3				
3826	31	<.1		98.3				
3827	35	<.1		132.4				
3830	31	<.1		164				
3831	37	<.1		158.3				
3832	32	<.1		149.5				
3833	35	<.1		171.1				
3834	33	<.1		162.8				
3835	27	<.1		161.8				
3836	24	<.1		127.3				
3837	28	<.1		184.2				
3838	25	<.1		124.2				
3839	26	<.1		130.5				
3840	28	<.1		134.3				
3841	25	<.1		168.4				
3845	11	<.1		27.3				
3846	30	<.1		106.6				
3847	31	<.1		121.3				
3848	41	<.1		169.1				
3849	44	<.1		119.9				
3850	46	<.1		152.8				
3851	46	<.1		159				
3852	46	<.1		164.4				
3853	44	<.1		183.9				
3854	72	<.1		137.5				
3855	45	<.1		147.6				
3856	43	<.1		162.9				
3859	45	<.1		173.8				
3861	22	<.1		38.8				
3862	47	<.1		135.5				
3863	35	<.1		118.3				
3864	40	<.1		135.6				
3865	46	<.1		155.6				
3866	37	<.1		131.6				
3867	45	<.1		135.8				
3869	27	<.1		100.3				
3871	33	<.1		110				
3873	29	<.1		151.8				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
3875	02/06-30-064-01W6/0	54.565516	-118.138962	1558.400	1558.450	Dec. 2003
3876	02/06-30-064-01W6/0	54.565516	-118.138962	1559.330	1559.400	Dec. 2003
3877	02/06-30-064-01W6/0	54.565516	-118.138962	1560.390	1560.460	Dec. 2003
3878	02/06-30-064-01W6/0	54.565516	-118.138962	1561.375	1561.445	Dec. 2003
3879	02/06-30-064-01W6/0	54.565516	-118.138962	1562.430	1560.500	Dec. 2003
3880	02/06-30-064-01W6/0	54.565516	-118.138962	1563.480	1563.500	Dec. 2003
3882	00/14-28-062-05W6/0	54.39630	-118.689728	1875.450	1875.510	Dec. 2003
3884	00/14-28-062-05W6/0	54.39630	-118.689728	1876.450	1876.520	Dec. 2003
3885	00/14-28-062-05W6/0	54.39630	-118.689728	1877.435	1877.505	Dec. 2003
3886	00/14-28-062-05W6/0	54.39630	-118.689728	1878.455	1878.525	Dec. 2003
3887	00/14-28-062-05W6/0	54.39630	-118.689728	1879.400	1879.470	Dec. 2003
3888	00/14-28-062-05W6/0	54.39630	-118.689728	1880.310	1880.380	Dec. 2003
3889	00/14-28-062-05W6/0	54.39630	-118.689728	1881.340	1881.400	Dec. 2003
3890	00/14-28-062-05W6/0	54.39630	-118.689728	1881.560	1881.610	Dec. 2003
3891	00/14-28-062-05W6/0	54.39630	-118.689728	1882.350	1882.420	Dec. 2003
3894	00/14-28-062-05W6/0	54.39630	-118.689728	1883.220	1883.290	Dec. 2003
3895	00/14-28-062-05W6/0	54.39630	-118.689728	1884.365	1884.435	Dec. 2003
3896	00/14-28-062-05W6/0	54.39630	-118.689728	1885.275	1885.355	Dec. 2003
3897	00/14-28-062-05W6/0	54.39630	-118.689728	1886.320	1886.400	Dec. 2003
3898	00/14-28-062-05W6/0	54.39630	-118.689728	1887.290	1887.360	Dec. 2003
3899	00/14-28-062-05W6/0	54.39630	-118.689728	1888.300	1888.360	Dec. 2003
3900	00/14-28-062-05W6/0	54.39630	-118.689728	1889.230	1889.300	Dec. 2003
3901	00/14-28-062-05W6/0	54.39630	-118.689728	1890.320	1890.390	Dec. 2003
3907	00/14-28-062-05W6/0	54.39630	-118.689728	1891.360	1891.430	Dec. 2003
3909	00/14-28-062-05W6/0	54.39630	-118.689728	1892.330	1892.400	Dec. 2003
3910	02/16-18-064-02W6/0	54.541641	-118.281382	1696.480	1696.550	Dec. 2003
3911	02/16-18-064-02W6/0	54.541641	-118.281382	1697.480	1697.530	Dec. 2003
3912	02/16-18-064-02W6/0	54.541641	-118.281382	1698.470	1698.540	Dec. 2003
3913	02/16-18-064-02W6/0	54.541641	-118.281382	1699.450	1699.520	Dec. 2003
3914	02/16-18-064-02W6/0	54.541641	-118.281382	1700.410	1700.480	Dec. 2003
3915	02/16-18-064-02W6/0	54.541641	-118.281382	1701.550	1701.600	Dec. 2003
3917	02/16-18-064-02W6/0	54.541641	-118.281382	1702.440	1702.510	Dec. 2003
3918	02/16-18-064-02W6/0	54.541641	-118.281382	1703.425	1703.495	Dec. 2003
3919	02/16-18-064-02W6/0	54.541641	-118.281382	1704.400	1704.470	Dec. 2003
3920	02/16-18-064-02W6/0	54.541641	-118.281382	1705.380	1705.440	Dec. 2003
3921	00/16-22-075-08W6/0	55.518915	-119.13755	735.490	735.560	Dec. 2003
3922	00/16-22-075-08W6/0	55.518915	-119.13755	736.505	736.575	Dec. 2003
3923	00/16-22-075-08W6/0	55.518915	-119.13755	737.525	737.595	Dec. 2003
3924	00/16-22-075-08W6/0	55.518915	-119.13755	738.425	738.495	Dec. 2003
3925	00/16-22-075-08W6/0	55.518915	-119.13755	739.470	739.540	Dec. 2003
3926	00/16-22-075-08W6/0	55.518915	-119.13755	740.465	740.535	Dec. 2003
3927	00/16-22-075-08W6/0	55.518915	-119.13755	741.440	741.510	Dec. 2003
3928	00/16-22-075-08W6/0	55.518915	-119.13755	742.470	742.540	Dec. 2003
3929	00/16-22-075-08W6/0	55.518915	-119.13755	743.480	743.550	Dec. 2003
3930	00/16-22-075-08W6/0	55.518915	-119.13755	744.480	744.550	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
3875	Possible/Unknown	Belle Fourche	Dk grey shale and sand lams, micas, fish debris
3876	Possible/Unknown	Belle Fourche	Dk grey shale with some sand lams/ripples
3877	Possible/Unknown	Belle Fourche	Dk grey shale with some beige/yellow sand lams/ripples
3878	Possible/Unknown	Belle Fourche	Sand/shale lams, dk grey shale
3879	Possible/Unknown	Belle Fourche	Sand/shale lams, some white specks, some black organic debris
3880	Possible/Unknown	Belle Fourche	Dk grey shale with some sand lams/ripples
3882	Unknown	SWS?	Broken fragments of shale, sandy pockets and lams, *mica rich*
3884	Unknown	SWS?	Bioturbated sand/shale, micas
3885	Unknown	SWS?	Bioturbated sand/shale, micas
3886	Unknown	SWS?	Bioturbated sand/shale, micas
3887	Unknown	SWS?	Bioturbated sand/shale, some silt and micas
3888	Unknown	SWS?	Bioturbated sand/shale (little sand), shale is dk grey coloured, some silt
3889	Unknown	SWS?	Sandy/silty shale, a few fish remains
3890	Unknown	SWS?	Py filled burrows
3891	Unknown	SWS?	Silty/sandy dk grey shale
3894	Unknown	SWS?	Bioturbated sand/shale, white coloured sand
3895	Unknown	SWS?	Bioturbated sand/shale, micas, white coloured sand
3896	Unknown	SWS?	Bioturbated sand/shale, white coloured sand, micas
3897	Unknown	SWS?	Bioturbated sand/shale, sand is white coloured
3898	Unknown	SWS?	Bioturbated sand/shale, white coloured sand
3899	Unknown	SWS?	Rubble shale, dk grey, some silt
3900	Unknown	SWS?	Rubble , dk grey, some silty/sandy lams, micas
3901	Unknown	SWS?	Rubble shale, dk grey in colour, some pockets of silt
3907	Unknown	SWS?	Rubbly shale, dk grey, some silt, micas
3909	Unknown	SWS?	Sand/shale lams, some silt, mica rich
3910	Unknown	Second White Specks	Dk grey shale with VF sand lams, micas - slightly calcareous
3911	Unknown	Second White Specks	Dk grey shale with VF sand lams - slightly calcareous
3912	Unknown	Second White Specks	Dk grey shale with VF sand lams, some silt, some micas - slightly calcareous
3913	Unknown	Second White Specks	Dk grey shale with VF sand lams, some silt - slightly calcareous
3914	Unknown	Second White Specks	Dk grey shale and VF sand lams - slightly calcareous
3915	Unknown	Second White Specks	Dk grey shale with VF sand lams/ripples/soft sed deformation - slightly calcareous
3917	Unknown	Second White Specks	Dk grey shale with VF sand lams, some silt, and black organic debris
3918	Unknown	Second White Specks	Dk grey shale and VF sand lams
3919	Unknown	Second White Specks	Dk grey shale with VF sand lams (contorted, soft sed deformation)
3920	Unknown	Second White Specks	Dk grey shale with VF sand lams, slightly undulatory, micas
3921	Unknown	Not SWS (Below FS?)	Dk grey shale, sandy lams, micas
3922	Unknown	Not SWS (Below FS?)	Dk grey shale, mica rich
3923	Unknown	Not SWS (Below FS?)	Dk grey shale, some sandy lams, micas
3924	Unknown	Not SWS (Below FS?)	Dk grey shale, micas, silt, brown coloured fragments
3925	Unknown	Not SWS (Below FS?)	Dk grey shale, micas, shell fragments, silty/sandy pockets
3926	Unknown	Not SWS (Below FS?)	Dk grey shale, micas, shell debris
3927	Unknown	Not SWS (Below FS?)	Bioturbated sand/shale, micas
3928	Unknown	Not SWS (Below FS?)	Bioturbated sand/shale, micas
3929	Unknown	Not SWS (Below FS?)	Bioturbated sand/shale, micas
3930	Unknown	Not SWS (Below FS?)	Bioturbated sand/shale, sand is whitish coloured

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
3875	210	0.83	19.4	0.5	10	49.4		0.29
3876	200	0.57	17.6	0.2	9	64.1		0.21
3877	220	0.61	16.6	0.3	8	68.9		0.22
3878	218	0.77	18.2	0.5	11	67.6		0.27
3879	233	0.82	20	0.3	11	72.3		0.24
3880	233	0.66	19	0.4	11	77.2		0.22
3882	144	1.07	20.2	0.4	9	275.5		0.22
3884	219	0.69	12.9	< .2	9	389.4		0.14
3885	198	0.77	17	< .2	8	443.9		0.2
3886	169	0.66	10.9	0.5	9	413.9		0.14
3887	188	0.75	21	< .2	9	445.7		0.17
3888	187	0.86	10.5	0.3	10	540.7		0.17
3889	151	0.85	8.9	< .2	10	533.7		0.18
3890	164	0.83	16.8	0.5	10	194		0.17
3891	177	1.02	16.4	0.2	10	571.3		0.21
3894	161	0.65	32.9	0.2	8	378.9		0.19
3895	181	0.76	26	0.2	7	441.7		0.19
3896	159	0.89	21.6	< .2	9	487.3		0.19
3897	171	0.51	39.7	0.5	6	286.3		0.22
3898	167	0.72	17.2	0.7	8	448		0.18
3899	298	1.03	19	0.5	12	294.7		0.25
3900	217	0.83	13	0.3	10	165.9		0.19
3901	228	0.91	11.1	< .2	9	590.8		0.21
3907	205	0.79	10.9	0.3	10	528.1		0.19
3909	263	0.74	3.9	< .2	10	571.1		0.13
3910	174	0.91	18.1	0.2	11	81.4		0.3
3911	191	0.87	15.7	0.3	11	64.7		0.29
3912	199	0.96	14.6	0.4	12	67.3		0.31
3913	211	0.68	18.4	0.3	13	76.3		0.21
3914	233	0.65	14.1	0.6	11	78.2		0.19
3915	244	0.72	19	0.7	11	59		0.24
3917	212	0.58	19	0.7	8	54.4		0.2
3918	224	0.65	26.7	0.5	11	54.5		0.22
3919	223	0.67	21	0.6	12	68.4		0.22
3920	209	0.65	19	< .2	10	66.2		0.21
3921	90	1.13	17	0.6	12	376.4		0.25
3922	81	1.16	11.3	0.4	11	387		0.24
3923	78	1.13	11.1	0.3	14	354.7		0.23
3924	81	1.22	10.4	0.4	14	364		0.24
3925	68	0.94	10.2	0.5	13	395		0.19
3926	84	1.1	19.9	0.6	10	369.6		0.23
3927	80	0.63	11.2	0.2	9	217.2		0.14
3928	101	0.75	15.6	0.3	11	264.3		0.19
3929	100	0.84	14.1	0.5	10	316.5		0.18
3930	64	0.28	5.8	0.9	9	207.6		0.06

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
3875	0.41	0.27		10.9	14.7		29.93	3.02
3876	1.12	0.28		7.6	11.8		21.17	3.08
3877	0.54	0.3		8.4	13		23.6	2.51
3878	0.64	0.34		10.1	14.4		28.92	2.92
3879	0.78	0.4		10.6	14.3		28.66	3
3880	2.63	0.42		9.5	13.8		25.71	3.1
3882	0.33	0.14		11.7	19.9		23.51	2.04
3884	0.43	0.15		9	16		19.06	1.24
3885	0.29	0.17		12.1	17.4		23.65	1.59
3886	0.37	0.11		8.6	14.4		18.63	1.33
3887	0.34	0.13		10.8	15.3		21.7	1.58
3888	0.39	0.14		10.8	17.4		22.32	1.68
3889	0.25	0.12		7.9	15.6		22.54	1.42
3890	0.26	0.14		10.8	16.1		20.47	2.23
3891	0.21	0.16		12	21.8		23.1	2
3894	0.23	0.11		17.1	16.3		19.25	1.28
3895	0.22	0.12		12.1	18.3		20.48	1.49
3896	0.22	0.15		11.8	19.8		21.72	1.9
3897	0.12	0.08		19.4	16.3		17.2	1.32
3898	0.13	0.08		10.4	16.9		18.17	1.38
3899	0.52	0.19		10.7	19.1		34.73	1.88
3900	0.35	0.16		9.2	15.2		25.27	2.06
3901	0.22	0.17		9.7	17.1		28.08	1.44
3907	0.16	0.15		9.4	15.4		25.52	1.25
3909	0.6	0.25		9.9	19.3		21.04	5.71
3910	0.42	0.15		9.6	16.1		29.64	2.67
3911	0.59	0.29		10.6	15.4		29.84	2.8
3912	0.51	0.2		10.5	16.1		30.94	2.93
3913	0.59	0.26		8.1	12.7		21.45	2.58
3914	0.55	0.23		7.5	13.3		21.4	2.33
3915	0.48	0.31		9.7	14.4		25.85	2.84
3917	0.6	0.28		7.5	14.1		20.98	2.81
3918	0.43	0.29		8.9	14		24.12	2.56
3919	0.63	0.3		8.8	13.4		22.9	2.63
3920	0.55	0.31		8.3	12.4		21.75	2.59
3921	0.19	0.06		11.9	21.5		22.64	2.03
3922	0.23	0.05		12.5	22.1		20.6	2.29
3923	0.2	0.07		11.7	21.9		20.12	2.25
3924	0.16	0.07		11.5	24		21.32	1.98
3925	0.66	0.06		10.1	17.9		16.22	6.79
3926	0.18	0.05		12.4	21.3		21.39	1.88
3927	0.15	0.03		6.9	13		11.82	1.22
3928	0.14	0.03		9.2	15.7		14	1.26
3929	0.11	0.05		10.1	16.7		14.03	1.32
3930	4.82	0.03		3.6	6.7		3.82	4.36

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
3875	2.8			102		0.23	4.8	
3876	2.1			79		0.17	5.5	
3877	2.3			85		0.18	4.9	
3878	2.7			93		0.22	4.6	
3879	2.8			86		0.21	5.7	
3880	2.3			85		0.19	4.7	
3882	3.3			84		0.23	3.3	
3884	2.2			71		0.18	5.2	
3885	2.5			68		0.19	4.5	
3886	2.2			69		0.17	5.5	
3887	2.3			86		0.2	4.5	
3888	2.6			58		0.23	5.5	
3889	2.5			46		0.21	4.7	
3890	2.5			58		0.22	4	
3891	3.7			54		0.22	5	
3894	2.2			52		0.17	3.7	
3895	2.4			60		0.2	3.6	
3896	3			82		0.21	3.8	
3897	1.9			68		0.13	2.1	
3898	2.2			72		0.18	3.6	
3899	3.1			98		0.28	5.7	
3900	2.8			110		0.24	4.3	
3901	2.8			73		0.26	4.8	
3907	2.5			69		0.22	4.4	
3909	2.5			55		0.19	7.3	
3910	3			88		0.25	3.5	
3911	2.8			98		0.24	3.4	
3912	3			95		0.26	3.6	
3913	2.2			94		0.19	6.1	
3914	2.1			78		0.2	4.2	
3915	2.4			103		0.22	5	
3917	1.9			79		0.18	5.5	
3918	2.2			89		0.2	4	
3919	2.3			86		0.2	3.5	
3920	2.2			94		0.19	3.4	
3921	3.8			69		0.27	5.3	
3922	3.9			72		0.27	5.9	
3923	3.7			55		0.27	5.4	
3924	4.1			73		0.29	5.3	
3925	3.2			77		0.23	6.1	
3926	3.9			64		0.27	5.5	
3927	2.5			41		0.18	4.6	
3928	3			65		0.21	5.7	
3929	3.5			94		0.25	6	
3930	1.4			75		0.1	6	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
3875	0.29	75	3.58	0.192		40.6	0.066	17.29
3876	0.44	95	3.34	0.122		27.7	0.101	13.48
3877	0.23	68	3.35	0.136		31.6	0.074	14.13
3878	0.3	65	3.39	0.177		37.2	0.066	16.45
3879	0.34	85	5.3	0.166		36.2	0.086	15.4
3880	0.42	88	5.51	0.15		35.2	0.073	13.72
3882	0.38	55	0.97	0.163		36.7	0.067	13.82
3884	0.31	54	0.84	0.103		23.2	0.082	11.33
3885	0.28	60	2.22	0.122		29.8	0.073	14.64
3886	0.27	55	1.2	0.105		23	0.086	10.48
3887	0.31	68	2.96	0.121		32.4	0.076	13.86
3888	0.33	76	1.86	0.134		29.8	0.088	14.14
3889	0.29	60	0.91	0.138		24.1	0.068	9.99
3890	0.28	62	3.47	0.13		34	0.066	13.05
3891	0.3	60	0.5	0.143		27.7	0.062	14.45
3894	0.24	54	1.48	0.102		25.9	0.045	14.01
3895	0.25	55	0.37	0.122		26.4	0.049	12.58
3896	0.29	60	0.55	0.133		29.3	0.051	12.49
3897	0.17	59	0.51	0.08		32.1	0.031	14.14
3898	0.21	54	0.6	0.112		25	0.045	10.36
3899	0.4	93	4.53	0.181		35.1	0.12	13.28
3900	0.34	71	1.94	0.154		28	0.072	12.84
3901	0.27	60	1.11	0.157		29.1	0.076	13.32
3907	0.22	40	1.78	0.139		26.9	0.065	10.93
3909	0.52	396	1.14	0.112		29.2	0.119	12.05
3910	0.33	84	1.44	0.203		35.6	0.061	16.84
3911	0.33	75	2.04	0.199		36.8	0.06	16.56
3912	0.34	78	1.73	0.219		37.5	0.063	17.36
3913	0.21	69	3.56	0.124		27.4	0.121	14.66
3914	0.23	64	2.16	0.124		27.1	0.073	12.15
3915	0.25	77	3.93	0.144		34.8	0.085	14.94
3917	0.26	84	3.67	0.112		26.8	0.109	13.16
3918	0.23	71	3.28	0.14		31.3	0.072	14.47
3919	0.27	69	3.16	0.15		31.3	0.069	13.25
3920	0.24	58	3.11	0.142		28.8	0.069	12.93
3921	0.36	100	0.52	0.2		30.1	0.071	13.31
3922	0.38	111	0.51	0.198		30.3	0.078	13.43
3923	0.37	105	0.32	0.195		29.2	0.071	13.33
3924	0.38	71	0.36	0.199		30.5	0.067	13.61
3925	0.7	334	0.5	0.172		22.8	0.101	10.9
3926	0.33	69	0.6	0.216		29.5	0.067	19.65
3927	0.19	65	0.28	0.13		15.6	0.059	9.77
3928	0.21	58	0.3	0.148		18.8	0.064	11.61
3929	0.22	44	0.18	0.17		18.4	0.046	11.88
3930	0.4	305	0.13	0.053		4.2	0.074	6.9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
3875					2.38	0.35	2.9	1.4
3876					1.97	0.39	4.1	1.3
3877					1.99	0.4	3.2	1.3
3878					2.22	0.37	3.9	1.5
3879					2.22	0.44	3.6	1.5
3880					2.19	0.39	5.3	1.5
3882					0.65	0.67	3.3	1
3884					0.28	0.57	2.3	0.7
3885					0.36	0.67	3.2	1
3886					0.25	0.56	2.5	0.9
3887					0.43	1.04	2.7	1
3888					0.19	0.52	3.5	0.9
3889					0.16	0.34	2.8	0.7
3890					0.97	0.73	2.8	0.9
3891					0.18	0.49	3.7	0.7
3894					0.28	0.52	1.8	0.5
3895					0.38	0.64	2.3	0.8
3896					0.43	0.58	3.2	0.9
3897					0.26	0.8	2.3	0.6
3898					0.36	0.63	2.5	0.7
3899					0.6	0.82	4	1.3
3900					0.83	0.74	2.3	1.1
3901					0.35	0.54	3.2	1.1
3907					0.34	0.65	2.6	1
3909					0.21	0.45	5.9	0.9
3910					1.7	0.26	3.4	1
3911					1.89	0.31	4.3	1.2
3912					2.2	0.3	3.2	1.1
3913					2.14	0.37	3.5	1.3
3914					1.83	0.33	3.7	1.1
3915					2.41	0.38	3.5	1.4
3917					2.23	0.37	4.2	1.4
3918					2.22	0.37	3.3	1.4
3919					2.13	0.38	3.8	1.4
3920					2.12	0.35	3.9	1.4
3921					0.31	0.2	3.5	0.5
3922					0.27	0.2	3.6	0.4
3923					0.34	0.18	3.7	0.4
3924					0.43	0.2	3.6	0.5
3925					0.33	0.17	5.4	0.4
3926					0.54	0.2	3.6	0.5
3927					0.28	0.12	1.8	0.2
3928					0.29	0.14	2	0.3
3929					0.29	0.14	3.2	0.3
3930					0.05	0.09	2.7	0.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
3875		41.1		0.09	3.9	< .001	0.12	0.74
3876		50.8		0.06	3.8	0.002	0.15	1.3
3877		40.9		0.05	4	0.003	0.15	1.12
3878		46.8		0.07	4.3	0.009	0.15	1.08
3879		62.9		0.06	4.1	0.003	0.21	1.31
3880		71.2		0.06	4.2	0.001	0.18	1.86
3882		40		0.08	3.9	< .001	0.07	0.61
3884		37.5		0.06	4.8	0.002	0.07	0.69
3885		36.1		0.05	4.5	0.003	0.07	0.68
3886		34.6		0.04	5.1	0.004	0.06	0.68
3887		35.6		0.05	4.5	0.007	0.07	0.61
3888		41.7		0.06	4.9	0.001	0.05	0.8
3889		37.7		0.04	4.5	0.005	0.05	0.65
3890		32.5		0.07	3.9	0.006	0.06	0.63
3891		38.8		0.11	4.7	0.003	0.06	0.65
3894		30.2		0.11	4.1	0.008	0.06	0.49
3895		31.3		0.09	3.7	0.002	0.07	0.45
3896		33.1		0.06	3.7	< .001	0.07	0.53
3897		23.6		0.14	3.7	0.006	0.07	0.43
3898		26.4		0.06	3.8	0.002	0.07	0.48
3899		53.5		0.08	5.4	0.007	0.08	1.12
3900		34.5		0.07	3.6	0.001	0.07	0.73
3901		41.7		0.05	4.6	0.005	0.06	0.71
3907		37.4		0.08	4.1	0.004	0.06	0.63
3909		46.5		0.04	4.5	0.003	0.04	1.62
3910		39.3		0.06	3.9	0.006	0.08	0.8
3911		41.7		0.1	4.2	0.001	0.08	0.98
3912		40.4		0.06	4.2	0.008	0.08	0.8
3913		44.9		0.07	4.1	< .001	0.13	1.58
3914		38.7		0.04	4	0.002	0.09	1.12
3915		39.9		0.07	4.5	0.007	0.12	1.32
3917		40.5		0.06	4	< .001	0.14	1.36
3918		34.6		0.07	4	0.008	0.14	1.11
3919		38.6		0.08	3.8	< .001	0.14	1.23
3920		36		0.08	4	0.002	0.12	1.17
3921		41.8		0.07	5.1	0.009	0.05	0.76
3922		43.1		0.05	5.3	0.012	0.05	0.78
3923		41.6		0.05	5	0.005	0.05	0.74
3924		40.1		0.06	5	0.004	0.06	0.72
3925		52.9		0.04	4.6	0.008	0.06	0.79
3926		42.1		0.06	5	0.002	0.08	0.72
3927		27		0.04	4	0.017	0.05	0.49
3928		30.4		0.06	4.8	0.01	0.07	0.57
3929		35.1		0.03	4.6	0.01	0.08	0.52
3930		237		0.04	2.2	0.009	0.03	0.38

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
3875	28	<.1		113.3				
3876	29	<.1		87.6				
3877	25	<.1		100.9				
3878	30	<.1		117.6				
3879	29	<.1		113.7				
3880	33	<.1		119				
3882	33	<.1		131.6				
3884	31	<.1		123.8				
3885	35	<.1		141.5				
3886	28	<.1		119.2				
3887	29	<.1		118.3				
3888	32	<.1		122				
3889	31	<.1		122.1				
3890	30	<.1		120.8				
3891	48	<.1		167.8				
3894	42	<.1		150.7				
3895	35	<.1		139.5				
3896	37	<.1		134.4				
3897	38	<.1		180.2				
3898	29	<.1		115.5				
3899	36	<.1		115.7				
3900	29	<.1		132				
3901	32	<.1		137.9				
3907	27	<.1		119.8				
3909	50	<.1		125.8				
3910	29	<.1		115.1				
3911	28	<.1		157.7				
3912	31	<.1		118.4				
3913	26	<.1		111.5				
3914	29	<.1		101.6				
3915	29	<.1		111.5				
3917	29	<.1		97.8				
3918	27	<.1		105.2				
3919	29	<.1		106.4				
3920	28	<.1		120.8				
3921	31	<.1		108.1				
3922	33	<.1		103.9				
3923	31	<.1		98.6				
3924	34	<.1		102.1				
3925	36	<.1		74.7				
3926	29	<.1		98.4				
3927	18	<.1		60.8				
3928	23	<.1		72.9				
3929	23	<.1		75.6				
3930	19	<.1		30.6				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
3932	00/16-22-075-08W6/0	55.518915	-119.13755	745.475	745.545	Dec. 2003
3933	00/16-22-075-08W6/0	55.518915	-119.13755	746.450	746.500	Dec. 2003
3934	00/16-22-075-08W6/0	55.518915	-119.13755	747.440	747.490	Dec. 2003
3935	00/16-22-075-08W6/0	55.518915	-119.13755	748.455	748.525	Dec. 2003
3936	00/16-22-075-08W6/0	55.518915	-119.13755	749.450	749.500	Dec. 2003
3937	00/16-22-075-08W6/0	55.518915	-119.13755	750.425	750.495	Dec. 2003
3938	00/16-22-075-08W6/0	55.518915	-119.13755	750.745	751.615	Dec. 2003
3939	00/10-36-060-22W4/0	54.234284	-113.156881	489.955	490.025	Dec. 2003
3940	00/10-36-060-22W4/0	54.234284	-113.156881	490.960	491.020	Dec. 2003
3941	00/10-36-060-22W4/0	54.234284	-113.156881	491.925	491.980	Dec. 2003
3942	00/10-36-060-22W4/0	54.234284	-113.156881	492.910	492.975	Dec. 2003
3943	00/10-36-060-22W4/0	54.234284	-113.156881	493.995	494.065	Dec. 2003
3944	00/10-36-060-22W4/0	54.234284	-113.156881	494.945	495.015	Dec. 2003
3945	00/10-36-060-22W4/0	54.234284	-113.156881	495.985	496.030	Dec. 2003
3946	00/10-36-060-22W4/0	54.234284	-113.156881	496.955	497.025	Dec. 2003
3947	00/10-36-060-22W4/0	54.234284	-113.156881	497.940	498.000	Dec. 2003
3949	00/06-35-059-21W4/0	54.142405	-113.040407	457.500	457.560	Dec. 2003
3950	00/06-35-059-21W4/0	54.142405	-113.040407	458.485	458.555	Dec. 2003
3951	00/06-35-059-21W4/0	54.142405	-113.040407	459.515	459.585	Dec. 2003
3952	00/06-35-059-21W4/0	54.142405	-113.040407	460.500	460.555	Dec. 2003
3953	00/06-35-059-21W4/0	54.142405	-113.040407	461.490	461.560	Dec. 2003
3954	00/06-35-059-21W4/0	54.142405	-113.040407	462.540	462.595	Dec. 2003
3955	00/06-35-059-21W4/0	54.142405	-113.040407	463.530	463.600	Dec. 2003
3956	00/06-35-059-21W4/0	54.142405	-113.040407	464.480	464.550	Dec. 2003
3957	00/06-35-059-21W4/0	54.142405	-113.040407	465.490	465.560	Dec. 2003
3958	00/06-35-059-21W4/0	54.142405	-113.040407	464.960	465.020	Dec. 2003
3959	00/06-35-059-21W4/0	54.142405	-113.040407	466.010	466.080	Dec. 2003
3960	00/06-35-059-21W4/0	54.142405	-113.040407	466.995	467.065	Dec. 2003
3962	00/06-35-059-21W4/0	54.142405	-113.040407	467.900	467.970	Dec. 2003
3963	00/06-35-059-21W4/0	54.142405	-113.040407	468.975	469.045	Dec. 2003
3966	00/06-35-059-21W4/0	54.142405	-113.040407	469.935	470.005	Dec. 2003
3969	00/06-11-061-22W4/0	54.259019	-113.192286	500.975	501.035	Dec. 2003
3970	00/06-11-061-22W4/0	54.259019	-113.192286	501.920	501.990	Dec. 2003
3971	00/06-11-061-22W4/0	54.259019	-113.192286	502.940	503.010	Dec. 2003
3972	00/06-11-061-22W4/0	54.259019	-113.192286	503.910	503.980	Dec. 2003
3973	00/06-11-061-22W4/0	54.259019	-113.192286	504.850	504.920	Dec. 2003
3974	00/06-11-061-22W4/0	54.259019	-113.192286	505.900	505.970	Dec. 2003
3975	00/06-11-061-22W4/0	54.259019	-113.192286	506.885	506.955	Dec. 2003
3977	00/06-11-061-22W4/0	54.259019	-113.192286	507.940	508.000	Dec. 2003
3978	00/06-11-061-22W4/0	54.259019	-113.192286	508.920	508.990	Dec. 2003
3980	00/06-11-061-22W4/0	54.259019	-113.192286	509.985	510.050	Dec. 2003
3981	00/06-11-061-22W4/0	54.259019	-113.192286	511.010	511.080	Dec. 2003
3982	00/06-11-061-22W4/0	54.259019	-113.192286	512.010	512.080	Dec. 2003
3984	00/06-31-046-08W5/0	53.008381	-115.152694	1819.090	1819.140	Dec. 2003
4523	00/15-21-056-19W5/0	53.857979	-116.756922	2371.830	2371.900	Dec. 2003
4525	00/15-21-056-19W5/0	53.857979	-116.756922	2371.810	2371.880	Dec. 2003
4527	00/15-21-056-19W5/0	53.857979	-116.756922	2373.805	2373.875	Dec. 2003
4528	00/15-21-056-19W5/0	53.857979	-116.756922	2374.835	2374.905	Dec. 2003
4529	00/15-21-056-19W5/0	53.857979	-116.756922	2375.820	2375.890	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
3932	Unknown	Not SWS (Below FS?)	Oil stained sands, light brown in colour
3933	Unknown	Not SWS (Below FS?)	Mud with sand lams, abundant micas
3934	Unknown	Not SWS (Below FS?)	Laminated , abundant micas, calc. organic fragments
3935	Unknown	Not SWS (Below FS?)	Bioturbated sand/shale, some micas
3936	Unknown	Not SWS (Below FS?)	Sand with abundant silt, a light brown colour
3937	Unknown	Not SWS (Below FS?)	Sand/shale in ruble form, silty
3938	Unknown	Not SWS (Below FS?)	Bioturbated sand/shale
3939	Possible	Top SWS/Base Carlile	Dk grey shale, some silty lams
3940	Possible	Top SWS/Base Carlile	Dk grey shale, silty lams
3941	Possible	Top SWS/Base Carlile	Dk grey shale with sand lams
3942	Possible	Top SWS/Base Carlile	Sand/ dk grey shale lams
3943	Possible	Top SWS/Base Carlile	Sand with dk grey shale lams, some bioturbation
3944	Possible	Top SWS/Base Carlile	Sand with dk grey shale lams, some bioturbation
3945	Possible	Top SWS/Base Carlile	Sand with dk grey shale lams
3946	Possible	Top SWS/Base Carlile	Dk grey shale with sandy lams
3947	Possible	Top SWS/Base Carlile	Dk grey shale with some sandy lams/ripples
3949	Possible	Carlile (or overlying shale)	Dk grey shale, silty lams/pockets
3950	Possible	Carlile (or overlying shale)	Dk grey shale, silty
3951	Possible	Carlile (or overlying shale)	Dk grey shale, silty lams
3952	Possible	Carlile (or overlying shale)	Dk grey shale, silt lams
3953	Possible	Carlile (or overlying shale)	Dk grey shale, silty lams/pockets
3954	Possible	Carlile (or overlying shale)	Dk grey shale, silty lams/pockets
3955	Possible	SWS (straddles the Carlile border)	Dk grey shale, silty lams
3956	Possible	SWS (straddles the Carlile border)	Dk grey shale with sand lams, some micas
3957	Possible	SWS (straddles the Carlile border)	Dk grey shale with sand lams/pockets, some shell fragments
3958	Possible	SWS (straddles the Carlile border)	Bioturbated sand/shale, black organic fragments, silt lams within a sandy bed as well
3959	Possible	SWS (straddles the Carlile border)	Dk grey shale with sand lams, some silt, micas
3960	Possible	SWS (straddles the Carlile border)	Dk grey shale with sand lams/pockets
3962	Possible	SWS (straddles the Carlile border)	Med grey calcareous shale, some silt
3963	Possible	SWS (straddles the Carlile border)	Dk grey calcareous shale, silty, micas, some organic remains
3966	Possible	SWS (straddles the Carlile border)	Calcareous shale/sand lams, some silt
3969	Possible	Top of SWS	Dk grey shale, silty laminations
3970	Possible	Top of SWS	Dk grey shale, some silt, some dk organic matter
3971	Possible	Top of SWS	Dk grey shale, some silt
3972	Possible	Top of SWS	Dk grey shale, some silty pockets
3973	Possible	Top of SWS	Dk grey shale, silty, a little black organic debris
3974	Possible	Top of SWS	Dk grey shale, some silty pockets
3975	Possible	Top of SWS	Dk grey shale with sand lams
3977	Possible	Top of SWS	Dk grey shale with sand lams, a little bioturbation
3978	Possible	Top of SWS	Dk grey shale with sand lams, some bioturbation
3980	Possible	Base of Carlile?	Sand/shale bioturbated lams (calcareous)-micropaleo
3981	Possible	Base of Carlile?	Sand with dk grey shale lams - bioturbated
3982	Possible	Base of Carlile?	Dk grey shale with some sandy lams/ripples
3984	Unknown	Second White Specks	Calcareous black shale - micropaleo?
4523	Unknown	Second White Specks	Dk grey shale, sandy/silty lams/ripples filled with pyrite, some shelly debris
4525	Unknown	Second White Specks	Dk grey shale, some silt, some shelly remains
4527	Unknown	Second White Specks	Dk grey shale, silty, some shelly fragments
4528	Unknown	Second White Specks	Dk grey shale in broken fragments, some silt
4529	Unknown	Second White Specks	Dk grey shale, wisps of silt

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
3932	89	0.22	9.2	0.2	5	89.9		0.06
3933	166	1.55	90.4	1.1	16	431.2		0.34
3934	107	0.46	19.6	0.6	7	168		0.1
3935	106	0.58	11.9	0.7	11	231.9		0.13
3936	42	0.27	3.5	< .2	4	172.2		0.04
3937	87	0.71	9.9	0.3	9	250.2		0.12
3938	87	0.67	10.8	0.5	8	263.6		0.13
3939	336	0.92	25.7	1.5	15	52.2		0.4
3940	369	0.92	28.2	1.2	21	55.2		0.46
3941	312	0.86	25.8	0.9	20	70		0.35
3942	253	0.71	22.5	0.7	22	151.1		0.17
3943	193	0.37	15.5	0.9	13	268.6		0.07
3944	197	0.33	14.8	0.9	14	196.3		0.08
3945	202	0.38	12.6	0.4	14	103.7		0.08
3946	399	0.68	32.5	1.6	16	62		0.33
3947	384	0.74	37.9	3.2	20	66.2		0.43
3949	251	0.96	14.2	1.2	20	156		0.38
3950	304	0.8	21.9	1.5	19	61.2		0.31
3951	314	0.85	23	0.9	19	78.1		0.39
3952	318	0.76	27.3	1.3	19	63.2		0.35
3953	361	0.79	29	1.2	19	67.6		0.4
3954	313	0.82	24.9	1.5	19	81.8		0.41
3955	356	0.81	28.1	0.7	17	55.6		0.4
3956	341	0.78	29.5	1.3	19	58.6		0.35
3957	378	0.81	43.5	2.3	20	58		0.39
3958	144	0.28	8.9	1.1	9	134.7		0.06
3959	380	0.6	36.3	0.7	20	66.8		0.28
3960	330	0.58	25.6	1.3	18	97		0.25
3962	311	0.66	23.6	0.9	21	102.1		0.26
3963	310	0.56	24.9	1.4	18	113.1		0.23
3966	364	0.72	24.1	1.1	19	128.8		0.28
3969	311	0.88	30.6	0.8	21	58.1		0.36
3970	289	0.99	21.9	0.3	19	68.3		0.42
3971	269	0.94	15.9	0.3	19	115.9		0.42
3972	313	0.93	27.1	0.8	20	59.7		0.39
3973	344	0.86	25.8	0.6	18	63.8		0.4
3974	350	0.84	30.3	1.4	20	69.4		0.39
3975	300	0.67	27.5	0.6	19	87.8		0.34
3977	202	0.55	18.7	< .2	20	150.1		0.15
3978	315	0.58	28.3	0.7	19	100.4		0.25
3980	174	0.34	12.4	0.2	13	221.3		0.07
3981	175	0.34	11.2	< .2	13	174.4		0.07
3982	339	0.69	28.4	0.9	17	82.2		0.32
3984	310	0.83	32.5	< .2	10	53.5		0.26
4523	317	0.59	42.6	< .2	9	36.6		0.26
4525	339	0.46	37	< .2	9	45.7		0.24
4527	162	0.31	18.5	0.3	5	165.2		0.14
4528	261	0.57	33.7	0.7	6	46.8		0.25
4529	269	0.68	36	0.4	7	44.6		0.33

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
3932	0.3	0.02		8.9	7		22.81	2.49
3933	0.21	0.05		23.9	27.9		26.81	2.54
3934	0.12	0.05		8.9	10.2		5.22	1.05
3935	0.13	0.03		9.3	14.1		10.48	0.94
3936	0.21	0.03		2.2	6.8		3.44	0.48
3937	0.14	0.05		7.3	14.6		10.27	1.32
3938	0.14	0.04		8.3	14.3		11.21	1.23
3939	0.68	0.74		11.4	20		51.86	2.57
3940	0.64	0.82		12.8	20.1		54.48	2.59
3941	1.24	0.63		9.6	20.8		42.4	2.21
3942	4.33	0.64		6.2	19.8		23.37	1.71
3943	6.41	0.42		3.3	12		10.44	1.46
3944	4.69	0.43		3.7	11.2		11.68	1.14
3945	2.66	0.42		3.7	12.6		11.34	1.04
3946	0.87	1		10.3	16.7		43.27	2.38
3947	1.66	0.9		11.2	16.6		48.12	2.45
3949	0.46	0.27		7.1	19.2		49.27	1.76
3950	1.56	0.62		8.8	17		40.98	2.58
3951	0.79	0.51		10.5	17.5		48.8	2.27
3952	0.99	0.71		9.2	17		43.8	2.57
3953	0.85	0.8		10.8	17.6		52.08	2.7
3954	0.97	0.68		11.9	17.6		48.87	2.53
3955	0.87	0.71		11.4	18.6		54.54	2.46
3956	1.49	0.72		10.6	19		47.19	2.59
3957	1.08	0.84		11.4	21.1		53.2	2.55
3958	7.81	0.3		2.7	10.2		10.22	1.41
3959	2.11	1.41		13.3	16.8		42.1	2.53
3960	3.23	1.28		10.6	17.9		35.71	2.2
3962	3.9	1.52		10	18.5		35.83	2.18
3963	5.54	1.21		10.7	17.1		34.4	2.27
3966	3.27	1.33		9.8	20.7		41.37	1.83
3969	1.57	0.52		10.4	18.7		44.57	2.82
3970	0.6	0.46		11.3	19.7		47.97	2.45
3971	0.37	0.33		9.6	18.6		50.66	1.98
3972	0.9	0.7		10	18.4		47.5	2.65
3973	0.66	0.65		11.3	18.2		53.19	2.53
3974	0.77	0.66		11.4	17.6		51.27	2.48
3975	1.06	0.56		9.6	16.8		39.86	2.18
3977	4.46	0.54		4.7	15.5		18.19	1.63
3978	1.77	0.59		8.8	16.8		33.58	2
3980	7.36	0.4		3.4	12.6		9.88	1.56
3981	4.34	0.41		3.3	12.1		9.79	1.06
3982	1.06	0.75		9.7	16.5		41.05	2.07
3984	3.18	0.76		13.8	14		37.26	2.55
4523	5.27	1.4		15.4	10.4		37.08	3.34
4525	6.56	1.44		17.6	9.1		37.24	2.9
4527	12.72	0.62		9.7	12.2		20.41	3.35
4528	5.09	1		16	10.5		34.7	3.08
4529	4.26	0.98		16.2	12.1		35.46	3.21

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
3932	1.2			39		0.07	4.3	
3933	6			79		0.43	9.6	
3934	3.2			71		0.19	7.5	
3935	4.1			46		0.22	5.6	
3936	1.6			50		0.11	4.1	
3937	3			40		0.22	6.1	
3938	2.7			43		0.2	5.7	
3939	4			149		0.28	9.2	
3940	4.7			148		0.27	9.6	
3941	5.4			78		0.26	16.6	
3942	3.7			89		0.21	40	
3943	1.9			143		0.13	18.9	
3944	2			270		0.13	14.8	
3945	2			86		0.14	12.6	
3946	5			95		0.2	11.6	
3947	4.2			136		0.22	9.5	
3949	3.8			97		0.25	10.4	
3950	3.4			127		0.22	9.7	
3951	3.7			889		0.23	10.3	
3952	3.6			398		0.21	9.8	
3953	4			151		0.22	9.5	
3954	4			154		0.22	10.1	
3955	4.1			219		0.22	9.7	
3956	3.9			467		0.21	15	
3957	4.7			241		0.23	15.4	
3958	1.5			124		0.1	7.1	
3959	4			476		0.19	9.6	
3960	3.5			276		0.18	8.8	
3962	3.8			280		0.2	9.1	
3963	3.1			192		0.18	7.5	
3966	4.7			322		0.22	12.4	
3969	3.8			158		0.24	11.6	
3970	4			110		0.27	9.9	
3971	3.9			108		0.25	10	
3972	4			134		0.26	11.5	
3973	3.9			99		0.24	9.3	
3974	4.2			107		0.25	9.6	
3975	4.2			147		0.21	8.4	
3977	2.8			64		0.17	25.9	
3978	3.9			101		0.2	14.9	
3980	1.9			45		0.12	13.8	
3981	1.9			59		0.12	11.7	
3982	4.7			119		0.22	11.5	
3984	2.6			86		0.23	4	
4523	1.8			100		0.19	3.8	
4525	1.5			78		0.18	3.8	
4527	0.9			52		0.13	3.2	
4528	1.7			91		0.19	3.6	
4529	2			90		0.21	3.6	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
3932	0.21	142	0.47	0.053		4.5	0.037	10.44
3933	0.39	131	0.69	0.272		39.3	0.074	19.41
3934	0.13	54	0.46	0.083		11.2	0.048	16.56
3935	0.15	44	0.37	0.116		13.4	0.053	16.34
3936	0.08	33	0.11	0.057		3.9	0.039	9.9
3937	0.19	52	0.18	0.136		13.6	0.06	14.07
3938	0.18	44	0.15	0.133		15	0.057	9.27
3939	0.41	63	11.16	0.279		43.9	0.064	18.39
3940	0.43	79	13	0.279		47.5	0.068	18.94
3941	0.64	78	10.07	0.222		37.7	0.149	16.41
3942	1.6	108	6.76	0.134		23	0.408	9.57
3943	2.74	148	4.25	0.098		12.3	0.231	4.96
3944	1.78	103	4.13	0.116		13.6	0.154	5.66
3945	1.23	74	3.39	0.127		12.7	0.119	5.55
3946	0.54	69	11.52	0.214		40.2	0.076	15.77
3947	0.52	65	12.62	0.24		42.1	0.074	17.63
3949	0.44	60	1.46	0.289		33.1	0.061	18.17
3950	0.57	96	4.02	0.235		33	0.075	16.31
3951	0.41	79	6.13	0.275		37.7	0.071	17.59
3952	0.5	77	11.44	0.262		37.9	0.073	16.79
3953	0.4	69	12.94	0.265		42.5	0.063	18.28
3954	0.39	76	10.48	0.283		42.7	0.066	18.38
3955	0.41	69	11.15	0.277		44.9	0.066	18.55
3956	0.54	65	12.42	0.247		40.6	0.12	16.57
3957	0.49	72	12.54	0.247		44.4	0.124	17.93
3958	3.56	174	1.92	0.087		11	0.086	3.92
3959	0.67	80	17.02	0.193		45.5	0.08	12.97
3960	0.69	68	14.18	0.229		49.2	0.075	13.07
3962	0.68	67	13.33	0.24		49.2	0.076	13.19
3963	0.96	93	16.26	0.212		50.5	0.074	12.17
3966	0.64	61	11.27	0.262		48	0.075	14.18
3969	0.57	113	8.25	0.281		38.1	0.105	17.83
3970	0.4	72	7.76	0.287		42	0.067	19.3
3971	0.36	53	5.25	0.299		39.5	0.059	18.79
3972	0.45	72	10.97	0.273		42.6	0.104	18.89
3973	0.42	69	10.46	0.278		45	0.062	19.1
3974	0.47	77	10.97	0.259		43.1	0.066	18.33
3975	0.65	76	9.4	0.218		37	0.072	15.64
3977	1.75	127	5.07	0.134		17.8	0.263	8.01
3978	0.92	75	8.23	0.21		32.5	0.121	13.1
3980	3.22	182	3.8	0.117		13.2	0.177	4.53
3981	1.86	99	3.85	0.111		11.4	0.157	4.33
3982	0.63	68	8.79	0.229		36.6	0.084	14.2
3984	0.45	84	10.95	0.221		48	0.075	15.86
4523	0.56	72	20.92	0.149		50.8	0.091	15.39
4525	0.37	66	19.05	0.145		64.6	0.07	14.06
4527	4.33	234	9.01	0.092		32.8	0.043	8.01
4528	0.49	84	11.97	0.163		56.8	0.072	15.13
4529	0.56	86	12.18	0.178		63.4	0.075	16.99

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
3932					0.07	0.1	1.7	0.2
3933					0.53	0.2	4.4	0.4
3934					0.09	0.16	2	0.2
3935					0.11	0.13	1.8	0.3
3936					0.03	0.07	0.9	0.2
3937					0.18	0.11	2.5	0.2
3938					0.21	0.11	2.5	0.2
3939					2.53	0.37	4.2	3.2
3940					2.65	0.39	4.2	3.7
3941					2.18	0.43	3.2	2.8
3942					1.34	0.45	6	1.9
3943					0.73	0.35	3.1	1.1
3944					0.75	0.42	2.6	1.3
3945					0.79	0.37	2.5	1
3946					2.46	0.5	3.4	3.1
3947					2.6	0.69	3.3	3.3
3949					1.27	0.28	3.9	1.6
3950					2.27	0.42	4.9	2.2
3951					2.06	0.4	3.3	2.4
3952					2.53	0.4	4	3.2
3953					2.68	0.42	3.8	3.3
3954					2.42	0.35	4.2	2.9
3955					2.44	0.42	3.8	3.2
3956					2.68	0.47	5	3.4
3957					2.59	0.51	3.6	3.8
3958					0.58	0.25	1.7	0.8
3959					2.73	0.79	3.7	3.7
3960					2.3	0.88	2.8	3.3
3962					2.22	0.9	3.4	3.4
3963					2.25	0.98	2.9	3
3966					1.89	1.04	3.3	3.6
3969					2.71	0.39	6	2.8
3970					2.17	0.25	4.3	2.5
3971					1.59	0.23	3.8	2.2
3972					2.54	0.39	5	3.2
3973					2.42	0.38	3.9	3.1
3974					2.46	0.35	3.6	3.2
3975					2.17	0.43	1.9	2.3
3977					1.06	0.4	6.3	1.5
3978					2.02	0.48	2.8	2.1
3980					0.6	0.35	2.3	1
3981					0.63	0.32	3.4	1
3982					2.1	0.45	3.2	2.7
3984					2.21	0.88	4.9	2.2
4523					3.53	1.24	5.8	3.6
4525					3.19	1.99	4.5	4.3
4527					1.5	1.04	3.2	1.9
4528					2.75	1.35	5.3	3.1
4529					2.84	1.53	4.8	3.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
3932		18.3		0.03	2.3	0.01	0.02	0.28
3933		63.9		0.07	6.7	< .001	0.11	0.78
3934		19.9		0.05	4.5	0.016	0.05	0.51
3935		26.7		0.03	4.9	0.008	0.06	0.49
3936		21		< .02	2.6	0.009	0.03	0.31
3937		29.5		0.03	4.2	0.003	0.06	0.52
3938		31.5		0.03	4.2	0.006	0.06	0.53
3939		83.6		0.12	5.3	0.01	0.23	3.46
3940		80.4		0.12	5.4	0.011	0.3	4.26
3941		88.9		0.07	5.8	0.012	0.32	5.29
3942		165.2		0.08	5.1	0.003	0.44	7.88
3943		150.3		< .02	3.1	0.006	0.46	4.01
3944		113.3		0.04	3.2	0.012	0.52	3.63
3945		70.6		0.03	3	0.009	0.42	4.02
3946		66.8		0.1	5.8	0.003	0.57	4.57
3947		80.5		0.11	6.5	< .001	0.56	4.66
3949		87.1		0.08	5.7	0.005	0.15	1.66
3950		93.6		0.09	5.1	< .001	0.23	2.58
3951		87		0.1	5.5	< .001	0.21	3.42
3952		83.5		0.11	5.1	0.002	0.27	3.52
3953		82.3		0.12	5.3	< .001	0.32	3.99
3954		90.5		0.14	5.5	0.007	0.26	3.72
3955		87.6		0.15	5.3	< .001	0.31	4.34
3956		96.6		0.1	5.2	< .001	0.38	5.04
3957		95		0.11	5.6	0.001	0.6	5.86
3958		174.2		0.03	2.1	0.003	0.28	1.69
3959		78.6		0.1	4.3	0.002	0.83	5.94
3960		102		0.1	4.4	< .001	0.97	3.71
3962		111.3		0.08	4.6	< .001	0.95	3.5
3963		139.8		0.09	4.1	< .001	0.84	4.17
3966		114.9		0.08	5	0.003	1.01	3.89
3969		111.2		0.07	5.4	0.003	0.22	4.09
3970		91		0.06	5.6	< .001	0.19	3.06
3971		93.9		0.08	6	< .001	0.17	2.37
3972		99.8		0.11	5.4	< .001	0.27	4.22
3973		87.3		0.09	5.4	0.002	0.26	3.34
3974		81.9		0.1	5.2	0.004	0.3	3.4
3975		69.9		0.06	5.4	0.001	0.31	2.97
3977		172.7		0.06	3.8	< .001	0.36	5.73
3978		83.2		0.06	4.6	< .001	0.45	3.92
3980		174.2		< .02	2.7	0.003	0.38	4.16
3981		118.7		0.03	2.5	0.007	0.35	2.97
3982		72.6		0.08	5.5	0.012	0.42	4.24
3984		112.6		0.06	4.5	0.006	0.16	2.64
4523		148.3		0.11	4.5	< .001	0.15	5.33
4525		152.3		0.12	4.2	< .001	0.28	3.61
4527		169.8		0.04	2.6	< .001	0.19	2.34
4528		130.8		0.13	4.6	< .001	0.26	2.44
4529		107.7		0.15	5.5	0.002	0.33	2.18

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
3932	13	<.1		28.2				
3933	45	<.1		116.9				
3934	22	<.1		61.8				
3935	22	<.1		71				
3936	10	<.1		32.8				
3937	20	<.1		62.5				
3938	19	<.1		61.9				
3939	43	<.1		125.5				
3940	44	<.1		137.1				
3941	46	<.1		95.3				
3942	50	<.1		81.3				
3943	33	<.1		43.5				
3944	31	<.1		47.6				
3945	32	<.1		63				
3946	46	<.1		131.9				
3947	51	<.1		125.3				
3949	33	<.1		108.2				
3950	35	<.1		114.8				
3951	32	<.1		119.1				
3952	35	<.1		128.5				
3953	40	<.1		131.1				
3954	35	<.1		147				
3955	40	<.1		125.4				
3956	43	<.1		111.4				
3957	47	<.1		131.6				
3958	28	<.1		34.6				
3959	57	<.1		148				
3960	65	<.1		132.7				
3962	68	<.1		152.4				
3963	56	<.1		122.8				
3966	71	<.1		140.6				
3969	33	<.1		124.3				
3970	33	<.1		122.2				
3971	32	<.1		118.9				
3972	36	<.1		135.6				
3973	37	<.1		129.4				
3974	37	<.1		127.4				
3975	35	<.1		97.9				
3977	44	<.1		75.2				
3978	36	<.1		88.2				
3980	31	<.1		43.1				
3981	36	<.1		47.1				
3982	41	<.1		117.6				
3984	30	<.1		156.4				
4523	34	<.1		169.8				
4525	47	<.1		157.4				
4527	67	<.1		82.5				
4528	37	<.1		139.2				
4529	47	<.1		123.3				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
4530	00/15-21-056-19W5/0	53.857979	-116.756922	2376.790	2376.770	Dec. 2003
4531	00/15-21-056-19W5/0	53.857979	-116.756922	2377.790	2377.860	Dec. 2003
4532	00/15-21-056-19W5/0	53.857979	-116.756922	2378.875	2378.955	Dec. 2003
4533	00/15-21-056-19W5/0	53.857979	-116.756922	2379.895	2379.965	Dec. 2003
4534	00/15-21-056-19W5/0	53.857979	-116.756922	2380.870	2380.940	Dec. 2003
4535	00/15-21-056-19W5/0	53.857979	-116.756922	2381.985	2382.055	Dec. 2003
4536	00/15-21-056-19W5/0	53.857979	-116.756922	2382.975	2383.045	Dec. 2003
4537	00/15-21-056-19W5/0	53.857979	-116.756922	2383.725	2383.795	Dec. 2003
4538	00/15-21-056-19W5/0	53.857979	-116.756922	2384.815	2384.885	Dec. 2003
4539	00/15-21-056-19W5/0	53.857979	-116.756922	2385.790	2385.860	Dec. 2003
4540	00/15-21-056-19W5/0	53.857979	-116.756922	2386.780	2386.850	Dec. 2003
4541	00/15-21-056-19W5/0	53.857979	-116.756922	2387.705	2387.775	Dec. 2003
4542	00/15-21-056-19W5/0	53.857979	-116.756922	2388.795	2388.865	Dec. 2003
4543	00/05-10-051-04W5/0	53.386385	-114.514664	1252.500	1252.510	Dec. 2003
4544	00/05-10-051-04W5/0	53.386385	-114.514664	1253.500	1253.100	Dec. 2003
4546	00/05-10-051-04W5/0	53.386385	-114.514664	1254.485	1254.495	Dec. 2003
4548	00/05-10-051-04W5/0	53.386385	-114.514664	1255.500	1255.510	Dec. 2003
4549	00/05-10-051-04W5/0	53.386385	-114.514664	1256.500	1256.510	Dec. 2003
4551	00/05-10-051-04W5/0	53.386385	-114.514664	1257.500	1257.515	Dec. 2003
4552	00/05-10-051-04W5/0	53.386385	-114.514664	1258.500	1258.510	Dec. 2003
4552	00/05-10-051-04W5/0	53.386385	-114.514664	1258.500	1258.510	April 2004
4553	00/05-10-051-04W5/0	53.386385	-114.514664	1259.500	1259.510	Dec. 2003
4554	00/05-10-051-04W5/0	53.386385	-114.514664	1260.500	1260.520	Dec. 2003
4555	00/05-10-051-04W5/0	53.386385	-114.514664	1261.510	1261.520	Dec. 2003
4555	00/05-10-051-04W5/0	53.386385	-114.514664	1261.510	1261.520	April 2004
4556	00/05-10-051-04W5/0	53.386385	-114.514664	1262.500	1262.510	Dec. 2003
4557	00/05-10-051-04W5/0	53.386385	-114.514664	1263.540	1263.550	Dec. 2003
4558	00/05-10-051-04W5/0	53.386385	-114.514664	1264.500	1264.510	Dec. 2003
4559	00/05-10-051-04W5/0	53.386385	-114.514664	1265.500	1265.510	Dec. 2003
4560	00/05-10-051-04W5/0	53.386385	-114.514664	1266.500	1266.510	Dec. 2003
4561	00/05-10-051-04W5/0	53.386385	-114.514664	1267.500	1267.510	Dec. 2003
4562	00/05-10-051-04W5/0	53.386385	-114.514664	1268.500	1268.510	Dec. 2003
4563	00/05-10-051-04W5/0	53.386385	-114.514664	1269.500	1269.520	Dec. 2003
4564	00/05-10-051-04W5/0	53.386385	-114.514664	1270.500	1270.520	Dec. 2003
4565	00/05-10-051-04W5/0	53.386385	-114.514664	1271.500	1271.510	Dec. 2003
4566	00/05-10-051-04W5/0	53.386385	-114.514664	1272.500	1272.510	Dec. 2003
4568	00/05-10-051-04W5/0	53.386385	-114.514664	1273.500	1273.510	Dec. 2003
4569	00/05-10-051-04W5/0	53.386385	-114.514664	1274.500	1274.510	Dec. 2003
4572	00/05-10-051-04W5/0	53.386385	-114.514664	1275.500	1275.510	Dec. 2003
4573	00/05-10-051-04W5/0	53.386385	-114.514664	1276.500	1276.510	Dec. 2003
4574	00/05-10-051-04W5/0	53.386385	-114.514664	1277.500	1277.510	Dec. 2003
4575	00/05-10-051-04W5/0	53.386385	-114.514664	1278.500	1278.510	Dec. 2003
4576	00/05-10-051-04W5/0	53.386385	-114.514664	1279.500	1279.550	Dec. 2003
4577	00/05-10-051-04W5/0	53.386385	-114.514664	1280.500	1280.510	Dec. 2003
4578	00/05-10-051-04W5/0	53.386385	-114.514664	1281.500	1281.510	Dec. 2003
4580	00/05-10-051-04W5/0	53.386385	-114.514664	1282.500	1282.510	Dec. 2003
4581	00/05-10-051-04W5/0	53.386385	-114.514664	1283.500	1283.510	Dec. 2003
4582	00/05-10-051-04W5/0	53.386385	-114.514664	1284.500	1284.510	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
4530	Unknown	Second White Specks	Broken fragments of dk grey shale, minor silt
4531	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt
4532	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt
4533	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt, some shelly debris
4534	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt
4535	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt
4536	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt and micas
4537	Unknown	Second White Specks	Broken fragments of dk grey shale, some silty pockets, micas
4538	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt, smooth
4539	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt, some fish fragments
4540	Unknown	Second White Specks	Broken fragments of dk grey shale, some silt
4541	Unknown	Second White Specks	Broken fragments of dk grey shale, smooth, some silt
4542	Unknown	Second White Specks	Broken fragments of dk grey shale, smooth, some silt
4543	Unknown	Second White Specks	Dk grey shale, some silt
4544	Unknown	Second White Specks	Dk grey shale, silty
4546	Unknown	Second White Specks	Dk grey shale (calcareous) - micropaleo?
4548	Unknown	Second White Specks	Dk grey shale, fish remains, some silt
4549	Unknown	Second White Specks	Dk grey shale, abundant white specks
4551	Unknown	Second White Specks	Dk grey shale, fish fragments, some silt, some white specks
4552	Unknown	Second White Specks	Dk grey shale, micas, some silt
4552	Unknown	Second White Specks	Dk grey shale, micas, some silt
4553	Unknown	Second White Specks	Dk grey shale, some silt, some black organic fragments
4554	Unknown	Second White Specks	Dk grey shale, some silt and fish fragments
4555	Unknown	Second White Specks	Dk grey shale, some silt, shelly fragments
4555	Unknown	Second White Specks	Dk grey shale, some silt, shelly fragments
4556	Unknown	Second White Specks	Dk grey shale, white specks, some silt
4557	Unknown	Second White Specks	Dk grey shale, some fish debris, micas
4558	Unknown	Second White Specks	Dk grey shale, some silt
4559	Unknown	Second White Specks	Dk grey , some silt
4560	Unknown	Second White Specks	Dk grey shale, some silt, very fissile
4561	Unknown	Second White Specks	Dk grey shale, silty/sandy pockets
4562	Unknown	Second White Specks	Dk grey shale, silt, some shelly fragments
4563	Unknown	Second White Specks	Dk grey shale, some silt, some shelly remains
4564	Unknown	Second White Specks	Dk grey shale, silty pockets
4565	Unknown	Second White Specks	Dk grey shale, some shelly remains, some silt
4566	Unknown	Second White Specks	Dk grey shale, silt, white specks/sand
4568	Unknown	Second White Specks	Dk grey shale, some silt, white specks?/sand
4569	Unknown	Second White Specks	Dk grey shale, white specks
4572	Unknown	Second White Specks	Dk grey shale, abundant white specks
4573	Unknown	Second White Specks	Dk grey shale, some silt
4574	Unknown	Second White Specks	Dk grey shale, white specks,, micas, some black organic remains
4575	Unknown	Second White Specks	Dk grey shale, fish fragments, micas, silty
4576	Unknown	Second White Specks	Dk grey shale, a few micas
4577	Unknown	Second White Specks	Dk grey shale, micas, fish fragments
4578	Unknown	Second White Specks	Dk grey shale, a little silt
4580	Unknown	Second White Specks	Dk grey shale, white specks, fish remains
4581	Unknown	Second White Specks	Dk grey shale, abundant fish debris, silt
4582	Unknown	Second White Specks	Dk grey shale, fish debris, micas

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
4530	182	0.76	22.6	< .2	7	54.9		0.23
4531	164	0.86	21.6	0.3	7	57		0.25
4532	164	0.81	17.2	< .2	7	54.9		0.23
4533	171	0.87	16.2	0.2	7	62		0.26
4534	189	0.8	19	0.5	7	60.8		0.26
4535	176	0.86	17.9	< .2	7	56.8		0.28
4536	162	0.87	20.6	< .2	6	47		0.28
4537	165	0.89	21.6	< .2	6	48.5		0.27
4538	167	0.87	19.6	< .2	7	55.3		0.27
4539	168	0.9	20.9	< .2	7	46.3		0.26
4540	229	0.91	23.8	< .2	8	54		0.31
4541	259	0.89	21.6	< .2	8	50.3		0.27
4542	228	0.8	19.8	0.3	7	43.7		0.27
4543	353	0.73	23.3	0.5	16	115.8	0.8	0.24
4544	321	0.96	29.1	1	12	53.5		0.25
4546	227	0.95	30.2	0.3	11	56		0.38
4548	277	0.99	28.2	0.3	10	41.4		0.26
4549	251	0.82	27.5	0.2	16	48	0.7	0.29
4551	307	0.99	27.3	0.6	11	42.3		0.31
4552	344	1.14	32.9	0.7	13	33.9		0.31
4553	304	1.01	28.2	0.5	12	40		0.34
4554	286	0.94	25.1	0.5	15	46.2	0.5	0.31
4555	292	1.2	22.7	0.6	13	54.5		0.31
4556	224	0.87	16.6	0.8	11	62.9		0.23
4557	277	1.32	23.3	0.3	13	51.6		0.27
4558	270	0.92	26.3	0.2	14	53.4	0.8	0.3
4559	256	1.2	27.8	0.8	12	45.4		0.31
4560	216	1.25	35.7	0.7	11	39.6		0.28
4561	254	1.09	38.7	0.8	9	36.9		0.31
4562	234	1.07	32.3	0.9	15	60.2	1	0.32
4563	219	1.13	35.2	0.8	10	57.4		0.31
4564	237	1.06	36.6	0.5	10	55.3		0.33
4565	245	1.19	35.9	0.9	11	54.6		0.36
4566	240	0.86	31	0.3	13	81.5	0.9	0.25
4568	247	0.67	25.3	0.2	10	141.3		0.27
4569	91	0.45	10.5	0.4	7	242		0.08
4572	251	0.69	24.2	0.4	10	89.4		0.25
4573	299	0.97	31.4	1.8	15	65.8	0.6	0.33
4574	307	1.12	30.7	0.5	14	51.3		0.35
4575	269	0.91	30.6	0.7	13	93		0.25
4576	191	1.08	22.7	0.6	13	68.4		0.37
4577	281	1.05	24.1	0.3	16	73.1	1.1	0.32
4578	233	1.07	28.7	0.6	12	55.7		0.36
4580	300	1.18	35.7	0.8	15	51.5		0.42
4581	282	1.02	35.6	0.3	13	42.2		0.37
4582	361	1.1	42.8	0.4	17	47.2	0.9	0.41

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
4530	1.99	0.53		12.3	13.9		30.06	2.57
4531	1.73	0.51		13.1	15.8		28.78	2.69
4532	1.75	0.35		12.3	15		27.69	2.67
4533	1.92	0.46		12.3	15.1		27.73	2.72
4534	1.81	0.42		13	14.8		28.82	2.77
4535	1.4	0.5		13.5	14.1		28.83	2.82
4536	1.74	0.53		13.1	15		28.08	3.1
4537	2.02	0.41		13	15		28.3	3.27
4538	1.81	0.58		13.3	14.3		28.07	3.03
4539	1.99	0.49		13.3	14.4		28.57	3.19
4540	1.4	0.78		15.3	13.9		34.77	3.18
4541	1.75	0.78		15.2	14		34.89	3.22
4542	1.89	1.03		13.4	12.9		32.89	3.07
4543	8.58	1.61	13.4	12.1	14.1	1.05	38.82	2.12
4544	5.47	1.36		17.1	17.5		39.96	3.05
4546	4.99	1.14		12.3	13.9		30.5	2.83
4548	4.24	1.41		15.9	18.5		40.49	3.4
4549	3.47	1.1	13.1	15.8	15.9	1.37	38.31	3.32
4551	3.41	1.55		17.2	22.5		48.24	3.72
4552	2.7	2.95		19	26.3		57.51	4.41
4553	3.19	0.98		16.2	21.1		44.51	3.93
4554	2.58	1.04	12.5	15.1	18.1	1.4	43.2	3.71
4555	3.95	2.01		15.3	23.4		38.49	3.56
4556	5.62	1.16		12.6	17.7		34.12	2.99
4557	2.69	1.89		14.9	23.8		37.09	3.27
4558	1.71	1.27	13.2	14.7	17.4	1.45	40.85	3.31
4559	1.57	1.18		14.8	21.7		39.06	3.37
4560	1.59	0.73		14.8	24.2		35.58	4.35
4561	1	1.22		15.8	20.1		37.8	3.47
4562	2.94	0.79	12.6	14.6	19.6	1.56	37.52	3.19
4563	3.54	0.99		14.6	22.1		35.39	3.3
4564	3.34	0.88		15.2	20.2		34.84	3.19
4565	2.54	0.86		15.4	21.6		38.32	3.17
4566	7.69	1.06	12.2	13.4	16.9	1.32	35.58	3.06
4568	14.9	1.74		13.4	15.5		39.58	2.5
4569	14.58	0.44		4.6	10.1		14.28	4.39
4572	8.09	1.22		12.4	15.3		37.9	3.22
4573	4.89	1.24	13.1	17	19.8	1.32	49.45	2.99
4574	2.47	1.67		17.6	22.5		49.63	3
4575	8.3	1.14		14.6	18.5		38.99	3.11
4576	1.27	0.6		14	19.3		36.29	2.72
4577	3.2	0.9	34.1	13.4	22.6	1.51	38.13	3.03
4578	2.14	0.81		13.7	20.6		39.99	3.21
4580	0.7	0.79		16.9	24.4		45.63	3.51
4581	0.95	0.83		15.4	21.9		41.93	3.41
4582	2.06	1.03	14.4	19.4	21.1	1.59	50.18	4.12

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
4530	2.1			66		0.22	2.8	
4531	2.4			71		0.23	2.4	
4532	2.3			65		0.21	2.5	
4533	2.4			68		0.23	2.6	
4534	2.3			79		0.2	2.5	
4535	2.5			77		0.22	2.5	
4536	2.6			84		0.22	2.6	
4537	2.6			74		0.23	2.7	
4538	2.5			62		0.22	2.6	
4539	2.6			55		0.24	2.6	
4540	2.7			66		0.22	2.6	
4541	2.6			87		0.23	2.9	
4542	2.3			79		0.21	2.9	
4543	3.4	<.1	0.08	257	0.03	0.27	6.3	9.8
4544	4.5			156		0.32	7.9	
4546	6			145		0.28	10.4	
4548	4.5			182		0.32	8	
4549	3.8	<.1	0.1	139	0.05	0.29	6.5	13.3
4551	5.1			176		0.3	7.7	
4552	5.3			196		0.36	7	
4553	4.7			168		0.29	7.6	
4554	3.7	<.1	0.14	182	0.04	0.29	6	16.2
4555	4.8			220		0.36	7.2	
4556	4			104		0.25	8	
4557	5.7			223		0.4	8.1	
4558	4.1	<.1	0.1	247	0.05	0.26	6.5	15.7
4559	5.1			155		0.33	7.2	
4560	4.8			486		0.35	5.9	
4561	4.1			576		0.29	5.2	
4562	4	<.1	0.1	238	0.05	0.31	5.9	22.3
4563	4.4			170		0.31	6.3	
4564	4.2			236		0.28	6	
4565	5			177		0.34	6.2	
4566	4	<.1	0.09	195	0.04	0.26	5.8	15.2
4568	3.4			315		0.2	9.7	
4569	1.6			90		0.11	3.1	
4572	3.1			148		0.19	5.8	
4573	4.4	<.1	0.11	205	0.04	0.31	6.3	17.7
4574	4.9			221		0.32	7.4	
4575	4.2			293		0.23	11.7	
4576	4.4			234		0.29	6.3	
4577	4.8	<.1	0.16	180	0.05	0.28	16.8	18.7
4578	4.2			546		0.3	5.6	
4580	4.9			408		0.33	6.5	
4581	4.3			195		0.28	6.5	
4582	5	<.1	0.13	727	0.06	0.31	6.8	22.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
4530	0.48	79	3.54	0.2		39.1	0.065	14.35
4531	0.48	75	3.64	0.201		45	0.059	14.88
4532	0.53	80	2.38	0.196		38.2	0.064	14.05
4533	0.54	96	2.03	0.205		37.7	0.064	15.57
4534	0.56	87	3.69	0.194		41.2	0.065	15.61
4535	0.52	82	3.47	0.209		45.8	0.064	16.67
4536	0.58	98	2.9	0.206		39.4	0.065	15.78
4537	0.64	111	3.18	0.198		39.9	0.066	15.93
4538	0.65	86	3.48	0.201		41.9	0.065	15.69
4539	0.48	94	2.63	0.205		39	0.062	15.56
4540	0.53	93	4.14	0.21		46.3	0.062	17.71
4541	0.69	104	4.06	0.194		43.6	0.067	15.67
4542	0.6	98	3.65	0.184		41.2	0.068	15.46
4543	0.71	85	15.63	0.187	0.05	51	0.068	14.57
4544	0.56	92	10.71	0.185		52	0.061	15.02
4546	0.5	95	7.71	0.2		37.8	0.058	16.88
4548	0.71	112	8.44	0.19		53.9	0.083	17.93
4549	0.56	91	4.55	0.233	0.06	44.8	0.073	16.51
4551	0.49	98	6.37	0.205		57.2	0.07	16.36
4552	0.51	104	10.09	0.217		83	0.064	16.61
4553	0.47	104	6.47	0.213		63.4	0.066	19.7
4554	0.45	96	4.17	0.213	0.05	50.1	0.068	17.47
4555	0.55	93	3.54	0.221		49.4	0.062	17.93
4556	0.62	188	5.1	0.19		41.2	0.068	13.16
4557	0.64	139	13.29	0.216		62.3	0.067	15.58
4558	0.53	125	12.51	0.225	0.07	58.9	0.07	16.18
4559	0.62	142	9.06	0.236		53.3	0.064	17.24
4560	0.57	133	9.79	0.208		46.3	0.055	15.88
4561	0.34	81	15.54	0.218		75.2	0.048	19.04
4562	0.32	82	12.18	0.225	0.05	51.7	0.06	16.44
4563	0.34	85	15.82	0.222		51.1	0.053	16.76
4564	0.31	75	15.8	0.216		50.8	0.048	16.5
4565	0.29	80	20.84	0.227		51.7	0.049	17
4566	0.51	114	30.39	0.198	0.06	49	0.058	12
4568	0.21	136	37.45	0.141		59.8	0.083	11.89
4569	4.74	480	10.15	0.068		17.1	0.027	4.74
4572	1.63	183	25.5	0.144		51.1	0.057	12.61
4573	0.24	94	31.85	0.199	0.05	64	0.072	16.41
4574	0.31	91	30.98	0.195		64.7	0.101	17.1
4575	0.3	130	33.81	0.156		51.3	0.129	13.17
4576	0.26	102	12.62	0.233		46.3	0.068	19.08
4577	0.49	129	24.07	0.187	0.05	49.3	0.223	17.95
4578	0.23	92	19.56	0.216		48.7	0.072	19.1
4580	0.25	91	19.25	0.227		58.9	0.072	21.08
4581	0.22	99	19.39	0.198		54.1	0.078	17.81
4582	0.24	114	29.08	0.208	0.12	60.1	0.069	18.95

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
4530					1.96	0.66	4.4	1.6
4531					1.94	0.64	4.8	1.5
4532					1.9	0.53	5	1.2
4533					1.8	0.47	4.8	1.2
4534					1.87	0.61	5.4	1.4
4535					1.92	0.62	5	1.4
4536					2.1	0.56	4.9	1.3
4537					2.22	0.55	5.4	1.4
4538					2.01	0.57	5.3	1.3
4539					2.21	0.5	5.3	1.4
4540					2.2	0.73	4.7	1.9
4541					2.2	0.83	5	2
4542					2.2	0.75	5.1	1.9
4543	< 10	< 2	17.3	42	1.51	1.1	4.2	3.6
4544					2.44	1.12	4.4	3.8
4546					2.26	1.43	4.2	2.4
4548					2.82	0.98	4.8	3.5
4549	< 10	< 2	20.5	19	2.68	0.97	4.6	3.1
4551					3.14	0.82	6	3.8
4552					3.92	0.89	4.4	6
4553					3.26	0.76	5.1	4.4
4554	< 10	< 2	20.6	21	2.84	0.77	4.9	3.1
4555					2.68	0.56	6	2.8
4556					2.03	0.72	6	2.9
4557					2.39	0.82	6.5	5.3
4558	< 10	< 2	19.6	29	2.4	1.22	4.9	5.4
4559					2.39	0.95	5.8	4.1
4560					2.6	0.73	6.5	3.6
4561					2.57	0.77	4.6	6.4
4562	< 10	< 2	21.4	21	2.07	0.76	5.1	2.9
4563					2.12	0.66	5.1	2.7
4564					2.05	0.73	5.3	2.7
4565					2.09	0.63	4.7	2.8
4566	< 10	< 2	19.2	43	1.87	0.9	6	3.2
4568					1.82	1.02	4.7	4.5
4569					0.67	0.6	1.7	1.3
4572					1.65	1.11	4	3.6
4573	< 10	< 2	19.8	86	2.12	1.43	5.1	3.8
4574					2.08	1.23	3.6	3.9
4575					2.19	1.09	5.8	3.6
4576					1.72	0.7	3.7	2
4577	< 10	2	20	46	1.83	0.95	5.3	2.5
4578					2.32	0.83	4	2.6
4580					2.53	1.08	4.5	2.7
4581					2.61	0.79	5	2.8
4582	< 10	2	22.5	56	3.23	0.98	5	3.7

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
4530		73.9		0.05	4.4	0.003	0.11	1.08
4531		71.2		0.1	4.2	< .001	0.2	0.87
4532		70.1		0.07	4.1	< .001	0.12	0.85
4533		78.6		0.07	4.4	0.001	0.1	0.89
4534		72.5		0.08	4.6	0.002	0.15	0.98
4535		65.9		0.08	4.2	0.001	0.19	0.89
4536		69.2		0.07	4.5	< .001	0.12	0.95
4537		71.7		0.08	4.4	0.004	0.11	1.09
4538		69.6		0.13	4.5	< .001	0.14	0.89
4539		78		0.1	4.5	< .001	0.1	1.06
4540		63.7		0.11	4.8	0.001	0.17	1.19
4541		63.8		0.11	4.6	< .001	0.11	1.51
4542		66.1		0.12	4.6	< .001	0.09	1.73
4543	0.5	243.8	< .05	0.08	4.3	0.003	0.43	4.3
4544		126		0.19	4.8	< .001	0.36	3.99
4546		121.1		0.15	9.2	0.004	0.45	5.63
4548		121.4		0.11	5	< .001	0.4	3.86
4549	0.5	118.7	< .05	0.11	5.2	< .001	0.2	2.06
4551		114.5		0.16	5	< .001	0.32	3.13
4552		98.6		0.19	4.9	< .001	0.49	2.42
4553		98.6		0.17	5.9	0.011	0.5	2.67
4554	0.6	96.2	< .05	0.15	5.2	0.006	0.19	1.55
4555		150		0.13	6	< .001	0.24	1.36
4556		134.3		0.14	4.8	< .001	0.15	4.11
4557		101.6		0.11	5.5	0.004	0.45	4.5
4558	0.6	83.3	< .05	0.22	5.4	0.006	0.45	3.5
4559		88.8		0.21	5.6	0.001	0.44	3.12
4560		77.6		0.14	4.8	< .001	0.22	3.54
4561		71.7		0.17	5.2	< .001	0.56	2.98
4562	0.6	119.1	< .05	0.09	5.5	0.005	0.3	3.3
4563		131.5		0.12	5.4	< .001	0.24	3.41
4564		128.4		0.09	5.6	< .001	0.29	3.37
4565		106.6		0.1	5.4	< .001	0.24	4.38
4566	0.5	196.3	< .05	0.09	4.4	< .001	0.19	8.19
4568		300.4		0.06	4.2	0.002	0.36	15.83
4569		222.3		0.02	1.5	0.002	0.14	3.47
4572		158		0.08	3.7	0.001	0.32	7.17
4573	0.6	119.1	< .05	0.09	4.6	0.008	0.27	8.2
4574		86.2		0.11	4.9	0.001	0.38	10.89
4575		204.1		0.05	4.7	0.001	0.25	16.19
4576		84		0.08	6.2	0.001	0.23	3.07
4577	0.8	129.1	< .05	0.09	6.1	0.009	0.24	20.49
4578		84.2		0.1	5.1	0.001	0.2	4.51
4580		72.8		0.08	5.7	0.001	0.33	5.13
4581		68.9		0.09	5.3	0.002	0.32	7.16
4582	0.7	85.5	< .05	0.12	5.7	0.002	0.4	9.6

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

						Analysis: GROUP 1EX - 0.25 GM		
Element	**V**	**W**	**Y**	**Zn**	**Zr**	**Ag**	**Al**	**As**
LDL	**2**	**0.1**	**0.01**	**0.1**	**0.1**	**0.1**	**0.01**	**1**
Samples	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**
4530	25	<.1		126.9				
4531	28	<.1		116.5				
4532	25	<.1		101.8				
4533	27	<.1		150.2				
4534	26	<.1		105.7				
4535	28	<.1		130.7				
4536	27	<.1		152.5				
4537	29	<.1		108.5				
4538	28	<.1		161.7				
4539	28	<.1		122.5				
4540	29	<.1		135.1				
4541	28	<.1		124				
4542	24	<.1		160.6				
4543	80	<.1	9.82	143	2.9	0.3	7.12	13
4544	63	<.1		121.7				
4546	37	<.1		124				
4548	55	<.1		164.5				
4549	37	<.1	10.41	123.4	3	0.2	8.41	17
4551	47	<.1		147.8				
4552	59	<.1		426.1		0.4	6.86	32
4553	42	<.1		134.2				
4554	34	<.1	10.93	134.2	2.8	0.3	9.23	19
4555	40	<.1		411.7		0.3	7.01	21
4556	35	<.1		119.8				
4557	53	<.1		259.4				
4558	37	<.1	10.73	143.5	2.9	0.2	8.77	15
4559	45	<.1		132.3				
4560	54	<.1		122.8				
4561	46	<.1		119.6				
4562	49	<.1	11.31	144.1	2.9	0.3	8.72	18
4563	51	<.1		162.6				
4564	49	<.1		145.6				
4565	50	<.1		159.5				
4566	62	<.1	13.32	167.4	2.8	0.2	8.28	21
4568	79	<.1		166.1				
4569	46	<.1		40.8				
4572	65	<.1		102.5				
4573	64	<.1	12.57	146.2	3.2	0.3	7.78	17
4574	60	<.1		192.4				
4575	57	<.1		133.4				
4576	36	<.1		123.1				
4577	59	0.3	31.38	137.3	3.9	0.2	7.49	13
4578	44	<.1		154.9				
4580	51	<.1		155.6				
4581	43	<.1		137.3				
4582	47	<.1	12.5	122	4	0.3	7.78	38

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
4543	<.1	212	1	0.2	8.72	1.7	52	12
4549	<.1	121	2	0.3	3.51	0.8	57	16
4552	<.1	83	2	0.3	2.87	2.6	61	19
4554	<.1	91	1	0.3	2.78	1.1	68	17
4555	<.1	182	3	0.3	3.9	1.5	67	15
4558	<.1	115	1	0.3	1.69	1.2	64	15
4562	<.1	185	2	0.3	2.96	0.7	62	14
4566	<.1	191	1	0.2	7.92	1.2	62	13
4573	<.1	168	1	0.3	4.89	1.4	62	15
4577	<.1	164	1	0.3	3.14	0.9	76	13
4582	<.1	54	<1	0.4	2.02	0.9	62	19

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
4543	80.5	39.6	2.68	1.8	1.7	30.2	40.1	1.14
4549	97.2	36.8	4.08	2.1	2.13	32.5	59.5	0.99
4552	113.6	52.4	5.4	2.4	2.02	37.8	69.4	0.78
4554	105.9	47.1	4.74	2.3	2.33	37.1	66.5	0.91
4555	115	36.5	4.24	2.2	2.19	37.8	64.9	0.78
4558	102	39.9	4.17	2.4	2.22	35.4	62.7	0.99
4562	103.4	37.5	3.98	2.3	2	33.8	80.3	0.69
4566	88.6	35.9	3.77	1.8	1.79	36	60.1	0.94
4573	95.8	47.4	3.7	1.9	1.91	35.4	61.1	0.58
4577	85.5	37.4	3.7	1.8	1.7	42.1	65.5	0.84
4582	96.2	49	4.94	2.2	1.78	33.1	77.5	0.57

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
4543	87	15.4	0.325	10.7	49.4	0.075	15.6	98.2
4549	104	4.9	0.386	12.1	44.3	0.083	17.7	100.2
4552	107	11	0.374	10.4	82.2	0.081	17.3	120.4
4554	118	4.8	0.446	12.9	55.2	0.084	20.8	121.1
4555	83	3.9	0.372	11.2	48.4	0.075	18.3	117.8
4558	143	12.7	0.407	12.4	61.4	0.08	18.5	116.6
4562	95	11.8	0.431	11.7	55.7	0.074	17.7	100.6
4566	111	28.9	0.364	9.8	50.6	0.071	13.6	109.6
4573	113	31	0.424	12.1	63.7	0.078	17.5	105.2
4577	158	22.5	0.461	10.6	57.2	0.217	18.5	96.7
4582	123	28.5	0.423	11.4	65.5	0.078	21	105.8

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
4543	2	2.2	9	1.4	357	0.6	7.3	0.312
4549	3.3	1.6	11	1.7	239	0.8	8.3	0.372
4552	4.5	2.1	11	2.3	172	0.8	9.7	0.403
4554	3.8	1.5	12	2.4	223	0.9	9.5	0.393
4555	3.1	1.4	14	2.4	224	0.8	10.9	0.394
4558	2.9	2	11	1.9	190	0.8	9.4	0.365
4562	2.6	1.6	11	2.2	238	0.9	9.2	0.403
4566	2.5	1.6	12	1.8	330	0.7	8.3	0.365
4573	2.7	2.5	11	2	224	0.8	8.4	0.375
4577	2.4	1.7	11	2	225	0.7	9.1	0.341
4582	3.9	2.1	11	2.1	196	0.8	9.2	0.384

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4543	5.8	291	1	13.2	149	58.1	56	11.1
4549	3.4	227	1.3	14.7	132	69.4	67.8	13.4
4552	4.5	272	1.2	16.5	431	68.1	72.8	17.6
4554	3.5	232	1.3	16.6	154	70	79.5	13.7
4555	3.3	228	1.1	17.9	404	66.4	82.1	15.9
4558	5.7	252	1.1	15.3	160	73.3	77.9	14.6
4562	5.2	254	1.1	17.2	154	75.4	80.6	14.5
4566	10.2	248	1	17.7	175	61.6	67.1	12.5
4573	9.7	298	1.2	16.4	157	66.9	71.8	13.6
4577	19.7	215	1.6	30.2	142	61.3	86.6	13
4582	11.1	229	1	17.6	133	74.9	69.8	14.9

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4543	7	3.18	1.86	0.94	15.8	3.59	2.7	0.65
4549	9.3	3.37	2.07	0.88	18.7	3.82	3.5	0.75
4552	8.7	3.72	2.26	1.02	18.1	3.88	3.9	0.67
4554	9.7	4.45	2.51	1.16	21.6	4.64	3.8	0.91
4555	10	4.58	2.54	1.21	21.7	4.93	3.4	0.89
4558	9.4	4.65	2.54	1.16	21.2	4.39	3.7	0.92
4562	8.9	4.71	2.76	1.18	20.8	4.79	4.5	0.96
4566	7.5	4.05	2.3	1.03	17.7	4.49	2.6	0.81
4573	8.6	4.33	2.63	1.13	18.2	4.55	3.5	0.9
4577	7.5	7.62	3.94	1.88	18.4	7.81	4.4	1.43
4582	7.9	4.44	2.81	1.05	17.9	5.09	4.4	0.88

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4543	28.4	0.3	13.4	24	6.48	2	101.2	4.4
4549	35.2	0.37	15	29.7	7.84	< 1	127.3	4.8
4552	37.5	0.37	14.7	28.7	8.36	< 1	130.4	4.8
4554	38.6	0.41	16.7	33.2	9.28	< 1	137.8	6
4555	39.9	0.38	15.2	36	9.27	< 1	137.2	6.6
4558	38.2	0.38	15.7	33.7	9.23	< 1	144	6.4
4562	36.8	0.39	16.5	34.7	9.17	1	129.1	6
4566	31.5	0.36	12.9	27.9	7.71	< 1	113.2	5.8
4573	33.5	0.37	16	27.8	8.25	< 1	121.9	5.8
4577	41.1	0.47	14.2	40.6	10.65	< 1	110.3	9
4582	34.1	0.4	15.2	30.5	8.08	< 1	117.1	6.1

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4543	331	0.7	0.54	9.4	0.28	6.8	303	1.1
4549	217.7	1	0.6	9.6	0.36	4.2	228	1.5
4552	219.8	0.9	0.63	11.8	0.31	5	275	1.4
4554	215.4	1	0.81	11.9	0.39	4.7	231	1.5
4555	270	0.9	0.72	14	0.43	4.4	222	1.6
4558	199.1	1	0.76	13.1	0.38	7.3	260	1.5
4562	239.4	1	0.77	10.7	0.45	6.2	261	1.5
4566	306.1	0.7	0.7	7.9	0.38	11.4	248	1.3
4573	224.4	0.9	0.71	11.3	0.38	11.7	303	1.6
4577	227.6	0.9	1.34	10.5	0.57	23.7	218	1.2
4582	189	0.9	0.75	10.7	0.38	12.3	219	1.3

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
4543	20.1	1.84	95.6	11.71	761	14.86	0.011	0.011
4549	22.9	2.46	117.7	14.42	755	5.3	0.013	0.0126
4552	23.4	2.31	126.9	14.36	803.6	4.16	0.014	
4554	28.4	2.62	124.4	15.38	834	4.04	0.013	0.0133
4555	27.9	2.49	125.8	15.26	860.1	5.9	0.014	
4558	27.7	2.53	123.6	15.78	796	2.6	0.014	0.0139
4562	30.2	2.56	139.9	15.08	799	4.48	0.014	0.0141
4566	26.5	2.44	101.9	13.59	742	12.81	0.012	0.0124
4573	27.6	2.42	123	14.38	793	7.76	0.013	0.0132
4577	46.8	3.48	151.1	13.69	806	4.9	0.013	0.0126
4582	29	2.63	148.7	13.98	697	3.06	0.013	0.0133

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
4543	3.96	2.18	18.5	1.91	0.01	0.46	53	0.17
4549	5.4	2.6	15.7	1.67	0.01	0.53	49	0.2
4552	7.39	2.51	17.2	1.51	0.01	0.55	69	0.2
4554	6.01	2.76	15	1.52	0.01	0.57	43	0.21
4555	6.03	2.75	14.3	1.6	0.01	0.59	40	0.18
4558	5.47	2.84	14.4	1.69	0.02	0.56	31	0.22
4562	5.51	2.53	13	1.25	0.01	0.6	43	0.19
4566	5.22	2.33	18.2	1.61	0.01	0.5	68	0.19
4573	4.78	2.55	16.5	1.12	0.01	0.62	49	0.21
4577	5.04	2.33	13.9	1.45	0.02	0.67	38	0.55
4582	6.56	2.37	19.4	1.03	0.02	0.6	37	0.21

							Analysis: CO2	
Element	Sc	SiO2	TiO2	TOT/C	TOT/S	SUM	C/ORG	C/GRA
LDL	1	0.02	0.01	0.01	0.01			
Samples	ppm	%	%	%	%	%	%	%
4543	11	45.55	0.53	6.9	1.9	99.95	3.89	0.16
4549	13	53.02	0.66	5.43	3.14	99.62	4.26	0.07
4552	13	50.99	0.67	5.79	5.1	99.58	5.01	0.04
4554	14	53.2	0.7	4.65	3.57	99.51	3.93	0.03
4555	15	52.28	0.7	4.65	3.61	99.62	3.52	0.03
4558	14	55.11	0.7	4.66	2.98	99.49	4.11	0.02
4562	14	56.01	0.75	3.93	2.74	99.52	3.06	0.04
4566	15	44.78	0.62	6.8	2.43	99.96	4.37	0.04
4573	15	50.94	0.7	6.49	3.09	99.68	5.1	0.03
4577	13	56.22	0.67	5.41	2.45	99.55	4.45	< .02
4582	14	51.55	0.71	5.23	3.74	99.58	4.93	0.06

Element	CO2	SO4
LDL		
Samples	%	%
4543	10.45	3.04
4549	4	3.6
4552	2.71	4.36
4554	2.53	3.42
4555	4.03	4.55
4558	1.94	2.43
4562	3.03	3.58
4566	8.78	4.49
4573	5	3.26
4577	3.48	2.7
4582	0.92	4.54

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
4583	00/05-10-051-04W5/0	53.386385	-114.514664	1285.500	1285.510	Dec. 2003
4584	00/05-10-051-04W5/0	53.386385	-114.514664	1286.500	1286.510	Dec. 2003
4586	00/05-10-051-04W5/0	53.386385	-114.514664	1287.500	1287.510	Dec. 2003
4587	00/05-10-051-04W5/0	53.386385	-114.514664	1288.500	1288.510	Dec. 2003
4588	00/05-10-051-04W5/0	53.386385	-114.514664	1289.500	1289.510	Dec. 2003
6002	00/05-10-051-04W5/0	53.386385	-114.514664	1290.500	1290.510	Dec. 2003
6003	00/05-10-051-04W5/0	53.386385	-114.514664	1291.500	1291.510	Dec. 2003
6004	00/05-10-051-04W5/0	53.386385	-114.514664	1292.500	1292.510	Dec. 2003
6005	00/05-10-051-04W5/0	53.386385	-114.514664	1293.500	1293.510	Dec. 2003
6006	00/05-10-051-04W5/0	53.386385	-114.514664	1294.500	1294.510	Dec. 2003
6007	00/05-10-051-04W5/0	53.386385	-114.514664	1295.500	1295.510	Dec. 2003
6008	00/05-10-051-04W5/0	53.386385	-114.514664	1296.550	1296.510	Dec. 2003
6009	00/05-10-051-04W5/0	53.386385	-114.514664	1297.500	1297.510	Dec. 2003
6010	00/05-10-051-04W5/0	53.386385	-114.514664	1298.500	1298.510	Dec. 2003
6012	00/05-10-051-04W5/0	53.386385	-114.514664	1299.500	1299.510	Dec. 2003
6013	00/05-10-051-04W5/0	53.386385	-114.514664	1300.500	1300.510	Dec. 2003
6015	00/05-10-051-04W5/0	53.386385	-114.514664	1301.895	1302.100	Dec. 2003
6016	00/05-10-051-04W5/0	53.386385	-114.514664	1302.500	1302.510	Dec. 2003
6017	00/05-10-051-04W5/0	53.386385	-114.514664	1303.500	1303.510	Dec. 2003
6018	00/05-10-051-04W5/0	53.386385	-114.514664	1305.415	1305.545	Dec. 2003
6020	00/05-10-051-04W5/0	53.386385	-114.514664	1304.500	1304.510	Dec. 2003
6021	00/05-10-051-04W5/0	53.386385	-114.514664	1305.500	1305.510	Dec. 2003
6022	00/10-22-047-03W4/0	53.070258	-110.352306	409.330	409.400	Dec. 2003
6022	00/10-22-047-03W4/0	53.070258	-110.352306	409.330	409.400	April 2004
6026	00/10-22-047-03W4/0	53.070258	-110.352306	410.440	410.510	Dec. 2003
6027	00/10-22-047-03W4/0	53.070258	-110.352306	411.480	411.550	Dec. 2003
6027	00/10-22-047-03W4/0	53.070258	-110.352306	411.480	411.550	April 2004
6029	00/10-22-047-03W4/0	53.070258	-110.352306	412.295	412.365	Dec. 2003
6030	00/10-22-047-03W4/0	53.070258	-110.352306	413.380	413.450	Dec. 2003
6030	00/10-22-047-03W4/0	53.070258	-110.352306	413.380	413.450	April 2004
6032	00/10-22-047-03W4/0	53.070258	-110.352306	414.415	414.485	Dec. 2003
6033	00/10-22-047-03W4/0	53.070258	-110.352306	415.340	415.410	Dec. 2003
6033	00/10-22-047-03W4/0	53.070258	-110.352306	415.340	415.410	April 2004
6035	00/10-22-047-03W4/0	53.070258	-110.352306	416.320	416.390	Dec. 2003
6036	00/10-22-047-03W4/0	53.070258	-110.352306	417.330	417.400	Dec. 2003
6036	00/10-22-047-03W4/0	53.070258	-110.352306	417.330	417.400	April 2004
6037	00/10-22-047-03W4/0	53.070258	-110.352306	418.360	418.430	Dec. 2003
6038	00/10-22-047-03W4/0	53.070258	-110.352306	459.430	459.500	Dec. 2003
6040	00/10-22-047-03W4/0	53.070258	-110.352306	460.150	460.250	Dec. 2003
6042	00/10-22-047-03W4/0	53.070258	-110.352306	460.480	460.550	Dec. 2003
6043	00/10-22-047-03W4/0	53.070258	-110.352306	461.500	461.570	Dec. 2003
6044	00/10-22-047-03W4/0	53.070258	-110.352306	462.500	462.570	Dec. 2003
6061	7AS01	57.49326	-111.97092	11.400	11.540	Dec. 2003
6063	7AS01	57.49326	-111.97092	12.340	12.440	Dec. 2003
6065	7AS01	57.49326	-111.97092	13.340	13.460	Dec. 2003
6067	7AS01	57.49326	-111.97092	14.340	14.460	Dec. 2003
6069	7AS01	57.49326	-111.97092	15.390	15.490	Dec. 2003
6070	7AS01	57.49326	-111.97092	16.290	16.420	Dec. 2003
6088	7BK03	57.73145	-111.87704	72.430	72.530	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
4583	Unknown	Second White Specks	Dk grey shale, micas, white specks
4584	Unknown	Second White Specks	Dk grey shale, micas, silt
4586	Unknown	Second White Specks	Dk grey shale, fish fragments, micas
4587	Unknown	Second White Specks	Dk grey shale, silt, micas
4588	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, white specks, fish remains, silt
6002	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, fish fragments, micas
6003	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, smooth
6004	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, small sample
6005	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, a few specks, some silt
6006	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, fissile, a few white specks
6007	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, fragments of shale, a few specks
6008	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, fish fragment, silt
6009	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, a few specks, some silt
6010	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, a few specks, small sample
6012	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, shelly debris, white specks
6013	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, white specks, fissile
6015	Unknown	Belle Fourche (or underlying unit)	Breccia with calcite infilling cracks/voids
6016	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, micas
6017	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, fissile, a few white specks
6018	Unknown	Belle Fourche (or underlying unit)	Breccia with calcite infilling cracks/voids
6020	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, some specks and silt
6021	Unknown	Belle Fourche (or underlying unit)	Dk grey shale, fragments of shale, a few specks
6022	Known	Belle Fourche (or underlying unit)	Dk grey shale, very mica rich, silty, brown fragments
6022	Known	Belle Fourche (or underlying unit)	Dk grey shale, very mica rich, silty, brown fragments
6026	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, silty
6027	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams/pockets
6027	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams/pockets
6029	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, silty lams
6030	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, some silt, brown fragments - fish fragments?
6030	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, some silt, brown fragments - fish fragments?
6032	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, silty
6033	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, silt, micas
6033	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, silt, micas
6035	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, lots of shelly debris
6036	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, and silty lams
6036	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, and silty lams
6037	Known	Belle Fourche (or underlying unit)	Dk grey shale with sand lams, very fissile
6038	Known	Carlile (or overlying shale)	Med grey shale with broken fragments, smooth
6040	Known	Carlile (or overlying shale)	Dk grey shale, with a silty/light coloured layer (bentonite? Burt?)
6042	Known	Carlile (or overlying shale)	Dk grey shale, very smooth, a few rust coloured spots
6043	Known	Carlile (or overlying shale)	Dk grey shale, very smooth
6044	Known	Carlile (or overlying shale)	Dk grey shale, micas, silty
6061	Unknown	Second White Specks	Dk grey shale, thin bentonite, shells
6063	Unknown	Second White Specks	Dk grey shale, broken fragments, some silt
6065	Unknown	Second White Specks	Dk grey shale, some silt
6067	Unknown	Second White Specks	Dk grey shale, very silty, a few micas
6069	Unknown	Second White Specks	Dk grey shale fragments, silty
6070	Unknown	Second White Specks	Dk grey shale fragments, some silt
6088	Unknown	Labiche	Shale above SWS, light grey, silty

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
4583	313	1.09	36.8	0.5	15	38.1		0.32
4584	300	1.03	29.3	0.5	13	43.9		0.33
4586	286	1.04	28.8	1.1	15	36.8		0.28
4587	243	0.96	28	0.6	15	59.7	0.6	0.38
4588	197	1.01	20.6	0.7	14	67.4		0.31
6002	248	1.19	25.9	0.7	12	47.5		0.34
6003	254	1.14	26.9	< .2	12	47.7		0.37
6004	226	1.02	22.6	0.4	14	65.5	0.6	0.36
6005	310	1.25	29.7	0.8	14	40.8		0.39
6006	268	1.13	28	0.8	13	43.8		0.4
6007	279	1.32	25.2	0.5	16	52.7		0.41
6008	303	1.4	19.7	0.5	18	94.3	0.9	0.45
6009	326	1.17	23.3	0.7	16	62.2		0.45
6010	373	1.7	23	0.7	17	73.9		0.48
6012	447	1.31	28	0.9	14	56.7		0.49
6013	407	1.42	23.4	2.8	14	67.4	1	0.45
6015	53	0.36	5.2	< .2	6	316.4		0.07
6016	335	1.42	25.4	0.8	15	57.9		0.45
6017	337	1.62	24.8	0.2	19	68.9		0.43
6018	86	0.36	5.4	< .2	8	496.1		0.07
6020	283	1.27	20.3	0.7	14	89.1	1.5	0.37
6021	332	1.56	22.5	0.7	16	60.2		0.39
6022	96	1.17	23.8	0.9	17	160.2		0.45
6026	86	1	26.1	2.2	15	163.9		0.33
6027	144	0.94	14.3	0.9	14	174.7		0.3
6029	102	1.02	25.5	0.7	14	92		0.33
6030	118	1.08	27.4	0.6	16	176		0.39
6032	169	1.02	18.4	1.8	15	132.8		0.32
6033	177	0.88	16.8	1.8	14	115.7		0.28
6035	506	1.05	33.3	1.8	16	32.3		0.56
6036	466	0.92	34.8	2	15	31.5		0.5
6037	411	0.97	23.2	1.3	12	41.1		0.46
6038	158	1.04	5.1	0.3	18	211.5	1.1	1.03
6040	101	0.97	6.6	0.6	10	225.4		0.29
6042	179	0.92	6.1	< .2	14	176.5		0.58
6043	173	0.97	7.8	0.8	16	186.4	1.9	0.57
6044	207	0.8	47.6	0.7	14	69		0.36
6061	820	0.91	46.9	1.8	21	71.9		0.41
6063	668	0.73	49.3	1.8	17	66.1		0.34
6065	638	1.07	60.4	2.6	17	81.1		0.34
6067	848	1.4	59.2	3.1	22	77.3		0.4
6069	943	1.71	45	2.6	32	91.2		0.37
6070	1283	1.28	29.1	6.2	25	105.9		0.54
6088	87	1.08	24.6	0.3	17	192.6		0.31

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
4583	2.24	1.44		15.9	21.1		42.49	3.77
4584	0.69	0.9		14.7	21.4		42.13	3.15
4586	2.13	0.78		13.2	20.6		36.1	3.31
4587	1.37	0.74	16.7	14.5	19.7	1.58	38.19	3.53
4588	2.31	0.52		12	20.3		33.54	3.72
6002	1.8	0.97		14.6	22.3		36.54	4.71
6003	0.46	0.83		14.1	21.5		38.28	3.12
6004	1.38	0.59	15.7	13.8	18.7	1.71	36.61	3.66
6005	0.82	0.99		15.3	21.6		38.29	3.71
6006	1.04	1.13		15.1	19.3		40.73	3.05
6007	0.72	1.1		16.2	22.3		43.36	3.06
6008	0.38	1.17	15.1	15.6	22.2	2.09	42.04	2.66
6009	0.41	1.36		16.3	20.7		46.02	2.79
6010	0.32	0.89		16.4	28.4		60.21	3.09
6012	0.36	1.6		18	24.3		61.39	3.12
6013	0.29	1.28	18.4	17.8	25.8	1.85	66.39	3.32
6015	24.46	0.17		2.8	6.9		8.78	2.27
6016	0.67	1.39		17	26.2		53.39	3.14
6017	1.06	1.25		15.6	28.8		53.52	4.04
6018	22.08	0.24		3.2	7.4		10.26	1.91
6020	0.5	0.66	14.2	14.3	21	1.87	43.37	2.59
6021	0.23	1.04		16.1	26.1		47.17	2.87
6022	0.36	0.17		10.7	15.8		35.12	2.12
6026	0.54	0.06		8.9	20.2		33.45	1.94
6027	1.17	0.42		8.9	20		33.95	1.94
6029	0.49	0.09		8.8	19.6		36.36	2.71
6030	1.92	0.12		8.9	19.3		38.51	2.15
6032	0.33	0.42		9.4	20.1		42.18	2.2
6033	0.8	0.47		9.1	16.2		39.55	1.86
6035	1.49	1.17		13.4	14.4		66.12	3.79
6036	0.5	1.23		13.9	13.8		60	3.91
6037	0.72	0.78		9.7	11.1		56.26	2.94
6038	0.24	2.19	64.6	7.4	4.9	0.77	31.19	1.16
6040	2.52	1.37		7	10.9		22.41	16.43
6042	0.2	2.23		13.2	10.7		43.89	2.17
6043	0.29	1.24	40.1	11.4	10.3	1.63	34.08	2.83
6044	0.26	1.28		13.7	9.6		38.08	2.86
6061	6.75	13.18		29.3	22.1		92.67	3.3
6063	8.2	11.65		24.6	20.5		79.8	3.91
6065	7.21	9.35		27.4	23.9		74.4	3.89
6067	3.92	13.85		25.2	29.4		92.01	3.86
6069	4.89	13.65		20.3	45.5		93.03	3.46
6070	1.39	8.09		16.6	55.9		125.43	2.87
6088	0.44	0.47		14.6	18.8		31.65	2.29

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
4583	4.7			131		0.3	7.6	
4584	4.4			481		0.28	6.4	
4586	4.3			249		0.27	12.1	
4587	4.3	<.1	0.14	429	0.05	0.27	7.4	18.3
4588	4.2			245		0.26	7.3	
6002	4.7			159		0.3	7.9	
6003	4.6			341		0.29	6.5	
6004	4.6	<.1	0.15	176	0.06	0.28	7.3	20.3
6005	4.9			380		0.32	7.8	
6006	4.6			123		0.29	7	
6007	5.2			183		0.34	7.5	
6008	5.3	<.1	0.13	160	0.06	0.35	8	31.9
6009	5			247		0.3	7.6	
6010	6.7			200		0.42	10.2	
6012	5.4			583		0.31	8.3	
6013	5.6	<.1	0.18	566	0.06	0.36	7.7	30
6015	1.1			60		0.09	3	
6016	5.9			257		0.35	8.9	
6017	6.2			173		0.41	9.6	
6018	1.1			46		0.1	3.5	
6020	5.5	<.1	0.12	139	0.06	0.34	6.2	21.1
6021	5.7			314		0.39	6.8	
6022	5.6			363		0.37	30.3	
6026	3.6			147		0.26	19.4	
6027	3.6			133		0.24	20.9	
6029	3.6			128		0.27	18.7	
6030	4.1			133		0.28	21.9	
6032	4			119		0.28	19.2	
6033	3.4			178		0.26	22.7	
6035	4.1			165		0.23	30.3	
6036	4.1			168		0.21	18.3	
6037	3.6			146		0.19	30.7	
6038	3.6	<.1	0.31	49	0.05	0.19	33.4	12.2
6040	3.2			54		0.16	26.4	
6042	3.8			45		0.22	25.2	
6043	3.6	<.1	0.17	50	0.06	0.23	20.4	16.5
6044	3.1			174		0.22	15.4	
6061	5.9			235		0.22	31.3	
6063	4.7			257		0.18	24.7	
6065	4.6			206		0.21	61.3	
6067	5.7			219		0.24	96.3	
6069	6.1			263		0.29	176.8	
6070	5.1			357		0.29	56.6	
6088	3.5			90		0.25	13	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
4583	0.27	114	27.83	0.186		53.1	0.078	15.4
4584	0.23	92	20.21	0.191		54.4	0.069	15.23
4586	0.5	149	16.2	0.168		48.1	0.155	14.46
4587	0.34	137	16.54	0.213	0.07	48.6	0.077	17.51
4588	0.48	177	11.67	0.208		43.3	0.068	14.99
6002	0.61	225	17.11	0.212		50.1	0.057	18.11
6003	0.28	100	14.45	0.238		48.9	0.059	18.17
6004	0.41	155	16.15	0.23	0.04	47.6	0.058	16.92
6005	0.36	131	18.13	0.211		54.2	0.069	18.45
6006	0.28	98	19.81	0.233		53.1	0.051	18.82
6007	0.31	108	20.72	0.254		58.1	0.055	20.31
6008	0.36	111	16.01	0.285	0.06	52.8	0.051	19.84
6009	0.3	93	18.51	0.258		58.9	0.06	22.82
6010	0.48	169	11.26	0.273		57.7	0.073	24.21
6012	0.38	126	17.3	0.277		69.5	0.07	24.44
6013	0.42	157	12.84	0.231	0.09	64.8	0.071	21.43
6015	1.75	542	4.83	0.065		8.7	0.066	4.51
6016	0.45	156	15.43	0.225		58	0.076	23.45
6017	0.7	238	13.06	0.238		53.7	0.075	21.04
6018	3.32	426	2.14	0.062		9.5	0.058	7.18
6020	0.35	109	6.64	0.31	0.07	48.3	0.062	17.64
6021	0.37	121	7.07	0.282		50.1	0.057	19.7
6022	0.46	166	0.87	0.443		25.9	0.111	24.73
6026	0.29	85	0.68	0.336		29.1	0.13	15.9
6027	0.28	124	1.7	0.325		34.6	0.109	14.55
6029	0.3	94	0.83	0.321		27.2	0.12	16.65
6030	0.34	154	0.86	0.36		27.9	0.13	18.19
6032	0.28	100	3.24	0.347		38	0.112	14.68
6033	0.25	104	2.96	0.323		34.9	0.139	12.76
6035	0.31	119	11.87	0.553		41.8	0.236	21.16
6036	0.28	114	11.99	0.549		42.6	0.083	20.75
6037	0.3	113	7.68	0.63		34.1	0.135	20.33
6038	0.24	364	4.88	1.305	0.09	46.6	0.026	27.55
6040	1.56	5609	1.91	0.395		23	0.67	10.85
6042	0.23	959	1.86	0.701		45.8	0.031	20.28
6043	0.23	1756	1.53	0.683	0.02	33.5	0.066	20.24
6044	0.21	214	5.62	0.604		49.3	0.079	15.08
6061	0.36	271	169.15	0.077		225.6	0.144	19.34
6063	0.34	220	134.85	0.065		199	0.094	15.36
6065	0.38	228	75.78	0.066		175.5	0.312	14.75
6067	0.51	201	42.76	0.104		137.7	0.41	20.94
6069	0.53	268	31.62	0.119		98.1	0.828	18.98
6070	0.46	116	24.52	0.113		84.1	0.262	20.56
6088	0.45	273	1.86	0.151		41.5	0.072	17.61

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
4583					2.99	0.8	6.5	3.2
4584					2.27	0.94	3.7	2.9
4586					2.11	0.83	7.9	2.6
4587	< 10	2	20.7	43	2.09	0.82	4.6	2.6
4588					1.62	0.59	8	2.1
6002					2.05	0.82	6.7	2.8
6003					2.05	0.87	4	2.5
6004	< 10	< 2	22.1	35	1.85	0.71	6	2.4
6005					2.49	0.82	5.1	2.8
6006					1.98	0.92	5.4	2.9
6007					1.9	0.9	5.1	3.1
6008	< 10	< 2	27.1	34	1.32	0.91	4	2.7
6009					1.67	0.84	4.5	3.1
6010					1.4	0.9	6.1	3.1
6012					1.92	1.16	4.8	4.4
6013	< 10	< 2	24.9	36	1.85	1.1	5.5	3.3
6015					0.86	0.27	2.3	0.8
6016					1.79	0.93	5.4	3.1
6017					1.47	0.85	6.9	3.2
6018					0.37	0.25	2.3	0.8
6020	< 10	< 2	25.4	13	1.45	0.75	4.4	2
6021					1.59	0.75	4.2	2.7
6022					0.9	0.61	3.2	1.7
6026					1.05	0.37	3.7	2.1
6027					1.05	0.54	3.8	2.9
6029					1.77	0.35	3.4	1.7
6030					1.2	0.42	4.2	2.2
6032					1.37	0.53	3.4	2.9
6033					1.75	0.37	3.7	3.4
6035					4.63	0.36	4.1	4.6
6036					4.67	0.34	2.9	4.6
6037					3.3	0.31	3.6	3.6
6038	< 10	< 2	11.4	1	0.11	0.55	2.3	1.9
6040					0.1	0.4	4.6	1.6
6042					0.21	0.33	4.1	2.7
6043	< 10	< 2	19.6	< 1	0.12	0.43	4.3	1.8
6044					2.76	0.83	3.7	3
6061					4.23	10.84	3.8	41
6063					5.03	9.39	3.7	37.9
6065					4.52	7.32	5.1	43.4
6067					4.14	7.34	6.6	45.1
6069					3.58	6.13	11.1	38.4
6070					2.89	3.87	4.7	40.1
6088					0.86	0.78	4.9	1.7

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
4583		88.2		0.08	4.8	0.001	0.33	10.55
4584		63.1		0.09	5.1	0.001	0.35	5.21
4586		106.2		0.08	5	0.001	0.36	10.12
4587	0.7	83.3	< .05	0.12	6	0.003	0.27	5.48
4588		103.5		0.06	5.4	0.001	0.26	5.64
6002		95.9		0.1	5.7	0.001	0.34	6.38
6003		71.2		0.07	5.4	0.001	0.29	3.96
6004	0.9	88.1	< .05	0.09	6.2	0.007	0.27	5.63
6005		83.6		0.1	6	0.001	0.46	6.29
6006		82.7		0.09	5.8	0.001	0.48	5.59
6007		85.5		0.08	6.1	0.002	0.47	5.97
6008	1	87.3	< .05	0.09	7.1	0.009	0.51	3.71
6009		80		0.09	7.2	0.001	0.56	4.64
6010		77.4		0.12	8.2	0.002	0.34	3.84
6012		75.6		0.11	7.5	0.002	0.74	3.73
6013	1	71.2	< .05	0.09	7.5	0.011	0.49	3.92
6015		487.9		< .02	1.4	< .001	0.09	1.3
6016		78.7		0.11	7.4	0.002	0.48	3.95
6017		90.7		0.07	7.1	0.002	0.42	4.11
6018		822.9		0.04	1.5	< .001	0.12	1.16
6020	0.8	86.1	< .05	0.1	5.9	0.007	0.41	2.55
6021		71		0.06	6.2	0.002	0.32	2.04
6022		88.2		0.14	9.9	0.012	0.21	5.41
6026		88.7		0.1	6.5	0.002	0.1	2.36
6027		96.3		0.07	7	0.002	0.32	3.11
6029		83.9		0.1	6.8	0.002	0.12	2.43
6030		121.2		0.11	7.9	0.003	0.14	3.01
6032		84.9		0.09	6.5	0.002	0.32	3.21
6033		101.6		0.07	7.2	0.002	0.3	4.09
6035		173.9		0.21	6.7	0.001	0.51	6.49
6036		112.2		0.16	7.8	0.001	0.53	5.34
6037		143.7		0.12	10.4	0.001	0.37	5.81
6038	3	187.7	< .05	0.06	23.6	0.003	0.1	9.02
6040		217.1		0.07	5.8	0.002	0.06	2.46
6042		124.1		0.1	12	0.001	0.07	3.98
6043	1.2	123.4	< .05	0.12	10.3	0.004	0.08	4.73
6044		111.6		0.08	6.7	0.001	0.79	6.21
6061		188.3		0.19	6.3	0.005	5.2	39.49
6063		201.8		0.15	5.3	0.003	4.54	30.04
6065		211.5		0.17	9.3	0.005	5.26	28.36
6067		188.4		0.21	14.2	0.005	5.73	29.7
6069		270.8		0.21	19.3	0.01	4.09	41.66
6070		139.3		0.19	9.7	0.004	2.34	14.47
6088		104.4		0.09	6.1	0.002	0.13	1.9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

						Analysis: GROUP 1EX - 0.25 GM		
Element	**V**	**W**	**Y**	**Zn**	**Zr**	**Ag**	**Al**	**As**
LDL	**2**	**0.1**	**0.01**	**0.1**	**0.1**	**0.1**	**0.01**	**1**
Samples	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**
4583	49	<.1		202.2				
4584	47	<.1		134.9				
4586	56	<.1		113.7				
4587	47	<.1	14.44	159	3.3	0.3	7.36	20
4588	61	0.7		99				
6002	68	<.1		142.4				
6003	46	<.1		134.5				
6004	55	<.1	12.36	99.2	3.6	0.2	7.89	12
6005	53	<.1		130.6				
6006	54	<.1		145				
6007	58	<.1		131				
6008	59	<.1	9	128.4	3.8	0.3	7.83	12
6009	52	<.1		173.9				
6010	74	<.1		137.4				
6012	60	<.1		162.8				
6013	59	<.1	13.78	147.3	4.4	0.4	7.2	19
6015	23	<.1		24.5				
6016	60	<.1		201.7				
6017	81	<.1		187.9				
6018	23	<.1		32.4				
6020	41	<.1	13.71	128.6	3.6	0.3	7.12	19
6021	53	<.1		165.4				
6022	63	<.1		139.6		0.1	6.96	23
6026	72	<.1		103.1				
6027	65	<.1		108.4		0.2	6.15	15
6029	70	<.1		93.4				
6030	63	<.1		93.9		0.1	6.31	23
6032	63	<.1		117.1				
6033	56	<.1		98.5		0.2	5.82	17
6035	33	<.1		146.4				
6036	27	<.1		148.2		0.5	6.28	36
6037	21	<.1		129.6				
6038	9	<.1	23.07	138.7	12.4	0.2	7.02	6
6040	24	0.3		130.5				
6042	15	<.1		153				
6043	16	<.1	18.48	117.7	6.8	0.4	7.37	8
6044	15	<.1		123.6				
6061	283	0.2		344.5				
6063	252	0.1		275.6				
6065	292	<.1		275.2				
6067	370	<.1		333				
6069	439	<.1		304.2				
6070	332	<.1		238.1				
6088	39	<.1		137.6				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
4587	<.1	125	1	0.3	1.18	0.9	66	14
6004	<.1	140	3	0.3	1.2	0.5	66	15
6008	<.1	375	4	0.4	0.28	1.3	56	16
6013	<.1	112	2	0.4	0.43	1.1	54	19
6020	<.1	199	3	0.3	0.42	0.8	57	15
6022	<.1	390	3	0.4	0.43	0.2	75	11
6027	<.1	193	2	0.3	1.41	0.3	68	10
6030	<.1	219	2	0.3	2.22	0.1	64	9
6033	<.1	173	3	0.3	0.81	0.4	73	9
6036	<.1	40	3	0.5	0.48	1.1	61	14
6038	<.1	383	2	0.9	0.25	2.2	54	7
6043	<.1	508	2	0.5	0.24	1.4	55	13

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
4587	96.2	37.8	4.26	2.3	1.83	35.4	71.8	0.69
6004	96.7	33.6	4.33	2.5	1.86	36	81.9	0.77
6008	118.2	38.9	3.47	2.8	2.24	28.9	113.4	0.73
6013	112.2	65.4	4.05	2.7	2.18	27.1	98	0.9
6020	101.9	41.7	3.38	2.7	2.15	31.3	61.6	0.78
6022	87.9	32.7	2.97	2.7	1.81	38	62.9	0.81
6027	101.6	33	2.54	2.6	1.91	38.7	45.5	0.57
6030	89.2	35.5	2.82	2.6	1.73	37	50.2	0.64
6033	89.5	37.9	2.49	2.7	1.75	39.4	42.6	0.55
6036	81.8	56.5	4.65	2.9	1.74	34.4	47.4	0.85
6038	35.1	28.1	2.46	3.9	0.87	26	33.8	0.98
6043	71.9	34.7	4.3	3	1.54	27.6	53.7	0.71

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
4587	135	15.1	0.476	13	51.6	0.085	19.9	113
6004	166	15.6	0.488	13.4	50.6	0.071	19.6	109.3
6008	105	16.5	0.546	14.9	62.9	0.07	22.6	120.4
6013	162	14.2	0.591	13.4	77.1	0.085	24.6	125
6020	128	6.8	0.605	17.6	51.7	0.075	20.5	129.8
6022	168	1.1	0.683	14.7	26.4	0.109	23.1	94.3
6027	117	1.8	0.575	10	33.1	0.101	15.6	94.4
6030	146	1	0.61	10.9	28.4	0.125	19.3	96.3
6033	110	3.4	0.567	10	35.4	0.143	14.8	93.1
6036	115	13	0.753	10.1	42.9	0.095	22	86.9
6038	305	5	1.396	19.5	46.1	0.027	27.6	33.3
6043	1691	1.8	0.88	13.3	41.4	0.073	24.2	92.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
4587	2.6	1.7	11	2.4	190	0.8	10	0.406
6004	2.4	1.5	12	2.2	196	0.9	9.8	0.4
6008	1.8	2.1	11	2.8	198	1	9.4	0.465
6013	2.6	2.5	13	2.7	178	0.9	10.2	0.413
6020	1.9	1.5	12	2.2	194	0.9	9.4	0.384
6022	1.1	1	10	2.4	142	1	11.8	0.474
6027	1.2	1	10	2.1	149	0.7	10.6	0.372
6030	1.4	0.8	10	2.1	165	0.8	10.7	0.357
6033	1.4	0.8	10	1.9	149	0.6	10.2	0.362
6036	4	0.9	10	2	166	0.7	10.8	0.344
6038	0.1	1.1	6	5.6	221	2.1	16.9	0.204
6043	0.2	1.1	9	2.9	183	1	10.9	0.335

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4587	7.6	227	1.3	18.8	174	73.3	79.5	14.1
6004	7.7	224	1.3	17.7	113	80	76.3	13.8
6008	7.2	291	1.6	14.4	146	86.6	77.2	15.6
6013	8	257	1.3	19.6	170	85	70.3	18.1
6020	6	224	1.8	19.7	145	82.7	66.4	13.2
6022	7.1	306	1.4	27	137	81.9	103.4	11.9
6027	4.6	301	1.4	29.9	113	79.4	82.3	9
6030	4.6	284	1.4	27.7	96	80.7	78	8.8
6033	5.8	293	1.3	36	112	79	84.1	9.7
6036	7.1	215	1.1	27.1	163	85.5	72.9	11.5
6038	8.5	70	1.3	18.9	141	96.3	83.2	8.2
6043	6.4	135	1.9	17.6	139	91.3	75.7	12.7

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4587	8.1	5.22	2.97	1.31	18.5	5.69	5.4	1.08
6004	9	5.39	3.02	1.24	20.4	5.85	5.2	0.98
6008	11.3	4.28	2.82	1.15	25.4	4.83	4.1	0.9
6013	9.9	5.41	2.88	1.33	22.5	5.62	4.1	1.07
6020	10.9	4.94	2.84	1.04	22	4.73	3.5	1.01
6022	7.1	6.79	3.45	1.89	19.5	7.25	6.8	1.3
6027	6.9	6.43	3.45	1.39	15.2	6.85	5.8	1.29
6030	6.8	5.7	3.04	1.57	14.7	6.18	5.5	1.16
6033	7	7.01	3.89	1.86	15.4	8.1	4.6	1.46
6036	7.1	4.74	2.88	1.42	17.6	5.91	3.9	1.04
6038	4	6.57	3.45	1.1	23	6.42	5.3	1.24
6043	8.5	5.22	3.02	1.14	21.5	5.23	4.3	1.06

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4587	37.7	0.46	17.4	35.9	9.41	< 1	125.3	6.8
6004	38	0.44	16.9	35.2	9.04	1	126.7	6.5
6008	40.6	0.44	18.3	33.3	8.99	1	149.4	6
6013	35.4	0.48	16.2	32.8	8.56	2	135.4	6.6
6020	34.2	0.46	19.7	29.3	7.83	1	133.9	5.9
6022	46.9	0.49	19.9	46.6	12.51	2	114.5	9.5
6027	39.2	0.42	15.5	37.1	10.46	1	108.9	7.9
6030	37.7	0.44	15.3	36.5	9.35	< 1	108.5	7.2
6033	42.1	0.48	13.9	41.3	11.04	< 1	108.8	8.5
6036	36.2	0.39	13.2	33.6	8.91	2	100.3	6.3
6038	39.1	0.52	23.3	36.7	9.79	4	56.7	7.9
6043	36.7	0.46	16.1	32.7	8.78	1	108.5	6.5

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
4587	193	1.1	0.83	11.2	0.47	9	235	1.4
6004	205.2	1	0.9	13.8	0.47	9.4	240	1.7
6008	212.2	1.3	0.69	14.4	0.42	9	298	2
6013	187.8	1.2	0.82	13.5	0.46	8.3	275	1.9
6020	183.1	1	0.8	9.7	0.45	6.4	224	2
6022	174.2	1.2	1.13	18	0.53	8.9	328	2.7
6027	175.8	0.9	1.14	12.3	0.54	5.4	266	1.8
6030	198.7	1	0.91	11.7	0.49	5.3	265	2.2
6033	174.4	0.9	1.26	11.5	0.54	6.8	284	2.2
6036	196.7	0.9	0.89	12.4	0.43	7.6	199	1.5
6038	251	2.5	1.08	27.8	0.52	11.1	79	1.5
6043	183.2	1.1	0.88	15.7	0.44	7	137	2.3

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
4587	33.6	3.11	174.6	14.67	747	2.08	0.014	0.0141
6004	32.2	2.95	163	15.19	753	2.07	0.013	0.0133
6008	28	2.99	146	17.77	966	0.63	0.016	0.0158
6013	32.7	2.96	143.7	16.58	986	0.48	0.015	0.0151
6020	31.8	2.83	135.1	15.52	912	0.79	0.014	0.0137
6022	42.5	3.35	227.2	14.94	939.7	0.7	0.01	
6027	40.9	3.06	188.7	12.02	793.9	2.06	0.014	
6030	36.8	3.24	189.2	12.73	767.6	3.33	0.011	
6033	45.4	3.55	172.8	12.03	810.5	1.31	0.012	
6036	31.4	2.42	126.8	13.47	657.4	0.82	0.012	
6038	37.4	3.55	146.1	17.26	413	0.54	0.005	0.0049
6043	32.8	3.13	131.7	15.33	504	0.48	0.009	0.0093

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
4587	5.95	2.47	13.6	1.26	0.02	0.7	64	0.21
6004	6.1	2.44	13.2	1.38	0.02	0.72	31	0.17
6008	5.1	2.81	12.2	1.37	0.02	0.75	63	0.17
6013	5.75	2.71	13.5	1.45	0.02	0.78	87	0.22
6020	4.72	2.76	11.3	1.42	0.02	0.82	46	0.17
6022	4.12	2.5	9.1	1.67	0.02	1.09	23	0.26
6027	3.62	2.45	9.3	1.15	0.02	0.94	31	0.24
6030	4.01	2.44	9.9	1.3	0.02	0.91	<20	0.29
6033	3.62	2.46	9.8	1.12	0.01	0.85	23	0.35
6036	6.52	2.34	18.8	1.67	0.02	1.03	26	0.22
6038	3.69	1.22	12.5	2.03	0.05	2.13	<20	0.07
6043	6.1	2.02	11.9	1.31	0.22	1.16	41	0.16

							Analysis: CO2	
Element	Sc	SiO2	TiO2	TOT/C	TOT/S	SUM	C/ORG	C/GRA
LDL	1	0.02	0.01	0.01	0.01			
Samples	ppm	%	%	%	%	%	%	%
4587	14	57.64	0.77	4.08	2.73	99.48	3.65	0.04
6004	16	57.2	0.77	4.3	2.44	99.37	3.68	0.02
6008	17	57.59	0.82	3.67	1.82	99.36	3.53	0.03
6013	17	57	0.74	3.49	2.64	99.37	3.47	0.02
6020	16	61.02	0.7	2.3	1.01	99.37	2.19	0.03
6022	13	64.26	0.75	1.94	1.46	99.42	1.89	0.02
6027	12	66.96	0.68	2.38	1.53	99.45	2.12	0.02
6030	12	64.14	0.66	2.56	1.75	99.75	2.01	<.02
6033	12	67.41	0.65	2.92	1.83	99.62	2.81	<.02
6036	12	54.16	0.59	5.08	4.57	99.65	5.04	0.02
6038	8	59.36	0.42	1.87	0.16	99.32	1.7	0.02
6043	13	59.95	0.66	3.29	0.22	99.36	2.75	0.09

Element	CO2	SO4
LDL		
Samples	%	%
4587	1.43	2.62
6004	2.23	2.08
6008	0.42	0.56
6013	0.02	0.35
6020	0.29	0.8
6022	0.11	0.61
6027	0.87	2.18
6030	1.97	2.12
6033	0.42	1.21
6036	0.09	1.39
6038	0.53	0.16
6043	1.66	0.13

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Hole	Latitude	Longitude	From (m)	To (m)	Analysis Date
6088	7BK03	57.73145	-111.87704	72.430	72.530	April 2004
6089	7BK03	57.73145	-111.87704	73.420	73.530	Dec. 2003
6090	7BK03	57.73145	-111.87704	74.410	74.510	Dec. 2003
6090	7BK03	57.73145	-111.87704	74.410	74.510	April 2004
6091	7BK03	57.73145	-111.87704	75.560	75.680	Dec. 2003
6092	7BK03	57.73145	-111.87704	78.690	78.710	Dec. 2003
6093	7BK03	57.73145	-111.87704	76.440	76.530	Dec. 2003
6094	7BK03	57.73145	-111.87704	77.340	77.430	Dec. 2003
6120	7BK03	57.73145	-111.87704	78.530	78.680	Dec. 2003
6121	7BK03	57.73145	-111.87704	78.820	78.920	Dec. 2003
6122	7BK03	57.73145	-111.87704	79.400	79.530	Dec. 2003
6123	7BK03	57.73145	-111.87704	80.400	80.510	Dec. 2003
6125	7BK03	57.73145	-111.87704	81.380	81.500	Dec. 2003
6126	7BK03	57.73145	-111.87704	82.350	82.480	Dec. 2003
6128	7BK03	57.73145	-111.87704	83.340	83.440	Dec. 2003
6130	7BK03	57.73145	-111.87704	84.280	84.410	Dec. 2003
6133	7BK03	57.73145	-111.87704	85.440	85.510	Dec. 2003
6134	7BK03	57.73145	-111.87704	86.360	86.480	Dec. 2003
6135	7BK03	57.73145	-111.87704	87.395	87.545	Dec. 2003
6136	7BK03	57.73145	-111.87704	89.390	89.520	Dec. 2003
6137	7BK03	57.73145	-111.87704	91.370	91.510	Dec. 2003
6138	7BK03	57.73145	-111.87704	93.400	93.530	Dec. 2003
6139	7BK03	57.73145	-111.87704	94.400	94.520	Dec. 2003
6140	7BK03	57.73145	-111.87704	95.370	95.480	Dec. 2003
6141	7BK03	57.73145	-111.87704	93.610	96.410	Dec. 2003
6142	7BK03	57.73145	-111.87704	97.530	97.680	Dec. 2003
6144	7BK03	57.73145	-111.87704	98.400	98.510	Dec. 2003
6145	7BK03	57.73145	-111.87704	99.380	99.470	Dec. 2003
6146	7BK03	57.73145	-111.87704	100.420	100.520	Dec. 2003
6149	7BK03	57.73145	-111.87704	100.540	100.590	Dec. 2003
6151	7BK03	57.73145	-111.87704	100.890	100.940	Dec. 2003
6152	7BK03	57.73145	-111.87704	100.800	100.890	Dec. 2003
6153	7BK03	57.73145	-111.87704	101.400	101.490	Dec. 2003
6153	7BK03	57.73145	-111.87704	101.400	101.490	April 2004
6154	7BK03	57.73145	-111.87704	102.400	102.450	Dec. 2003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Samples	Probability of Fm	Formation	Sample Description
6088	Unknown	Labiche	Shale above SWS, light grey, silty
6089	Unknown	Labiche	Med grey shale above SWS
6090	Unknown	Labiche	Shale above SWS, light grey, silty
6090	Unknown	Labiche	Shale above SWS, light grey, silty
6091	Unknown	Second White Specks (or younger)	Dk grey shale fragments, small amount of silt
6092	Unknown	Second White Specks (or younger)	Concretion? White coloured with red coloring in areas, brittle
6093	Unknown	Second White Specks (or younger)	Dk grey shale, crumbly, mica rich, some fish fragments
6094	Unknown	Second White Specks (or younger)	Dk grey shale, crumbly thin steel grey bentonite
6120	Unknown	Second White Specks (or younger)	Dk grey shale - silty, some thin bentonites
6121	Unknown	Second White Specks (or younger)	Dk grey shale + dominantly bentonites - blue/grey
6122	Unknown	Second White Specks (or younger)	Dk grey shale, silt, some shelly fragments
6123	Unknown	Second White Specks (or younger)	Dk grey shale
6125	Unknown	Second White Specks (or younger)	Dk grey shale, slightly silty
6126	Unknown	Second White Specks (or younger)	Dk grey shale, blocky
6128	Unknown	Second White Specks (or younger)	Dk grey shale, thin bentonite, micas, silt
6130	Unknown	Second White Specks (or younger)	Dk grey shale, thin bentonite, shelly fragments, silty
6133	Unknown	Second White Specks	Dk grey shale with shells, some silt
6134	Unknown	Second White Specks	Dk grey shale, silty, some shelly debris
6135	Unknown	Second White Specks	Dk grey shale
6136	Unknown	Second White Specks	Dk grey shale, some silt
6137	Unknown	Second White Specks	Dk grey shale, lots of silt
6138	Unknown	Second White Specks	Dk grey shale, some silt
6139	Unknown	Second White Specks	Dk grey shale, some silt
6140	Unknown	Second White Specks	Dk grey shale, silt/vf sand lams
6141	Unknown	Second White Specks	Med grey shale, fish fragments, dark micas, some silt
6142	Unknown	Second White Specks	Dk grey shale, silty lams
6144	Unknown	Second White Specks	Dk grey shale, very platey, fish fragments, silty lams, shelly debris
6145	Unknown	Second White Specks	Dk grey shale, very platey, fish fragments, silty lams
6146	Unknown	Second White Specks	Dk grey shale, silty
6149	Unknown	Second White Specks	Carbonate filled shale, fractures filled with coarse carbonate
6151	Unknown	Second White Specks	Bone Bed? Thin section?
6152	Unknown	Second White Specks	Bone Bed? Sandy, organic debris
6153	Unknown	Belle Fourche	Calcareous area of bone bed - micropaleo? Heavy, white/brown colouration, organic debris
6153	Unknown	Belle Fourche	Med grey shale below SWS, some silt
6154	Unknown	Belle Fourche	Med grey shale below SWS

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM

Element	Ag	Al	As	Au	B	Ba	Be	Bi
LDL	2	0.01	0.1	0.2	1	0.5	0.1	0.02
Samples	ppb	%	ppm	ppb	ppm	ppm	ppm	ppm
6089	91	1.22	24.5	1	18	198.7	0.9	0.3
6090	82	1.09	17.8	0.6	15	182.4		0.3
6091	560	1.78	43.9	2.3	32	25.9	1	0.5
6092	190	1.85	51.9	3.9	8	3.8		0.2
6093	469	1.61	68.8	1.8	21	26.5		0.55
6094	1331	1.95	127	3.7	26	14.9	1.5	0.37
6120	215	2	69.6	0.9	14	26.8		0.21
6121	118	1.56	21	1	21	141.6		0.52
6122	994	1.46	65.1	2.1	30	27.6	1.7	0.41
6123	801	0.96	54.5	2.2	21	41.5		0.39
6125	594	0.75	44.7	2.5	19	78.6	1.2	0.33
6126	744	1	49.4	2.1	22	58.6		0.41
6128	630	0.98	47.3	2.2	22	59.5	1	0.38
6130	592	1.08	46	3.1	19	64.3		0.38
6133	884	0.91	47.1	3.9	20	82.2	0.7	0.35
6134	1181	1.23	67.9	3.4	21	35.3		0.45
6135	1053	1.21	66.8	4.5	22	34.8	0.7	0.46
6136	1067	1.79	43.4	3.3	23	62.9	1.1	0.43
6137	437	0.99	26	2.1	19	74	0.9	0.32
6138	120	1.13	17.1	1.1	19	184.1		0.48
6139	98	1.12	21.2	1	17	173.8		0.47
6140	132	1.22	22.2	1.2	21	135.7	0.8	0.44
6141	88	1.47	21.6	1.1	25	151.2	1.3	0.41
6142	337	0.45	31.6	1.5	12	105.4	0.3	0.2
6144	519	0.71	53.1	1.8	16	78.3		0.32
6145	549	0.9	54.3	1.7	19	60.3	0.6	0.34
6146	708	0.81	100.8	2.4	19	22.5		0.47
6149	30	0.14	7.6	0.3	3	30.2		< .02
6151	639	0.33	30.5	4	11	160.8	0.5	0.11
6152	470	0.33	26.4	2.9	11	142.8		0.09
6153	118	1	16.5	0.9	17	125.9		0.3
6154	117	1.48	14.7	0.3	20	97.8	0.8	0.39

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
LDL	0.01	0.01	0.1	0.1	0.5	0.02	0.01	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
6089	0.45	0.33	24.5	15.7	21.3	1.76	31.25	2.3
6090	0.4	0.44		15.8	19.2		28.24	2.06
6091	0.67	3.2	38.2	15.2	30.2	0.57	108.76	3.35
6092	0.57	1.05		4.9	4.5		23.55	18.26
6093	1.09	3.67		23.6	35.2		114.06	3.46
6094	2.08	18.57	36.3	44	21	0.33	111.26	5.77
6120	6.56	2.54		11.8	2.6		43.45	3.47
6121	1.16	0.75		1.8	0.9		3.23	1.28
6122	4.98	16.68	111.8	36.5	24.6	0.31	94.74	4.2
6123	5.44	13.06		30	24.9		97	3.8
6125	6.46	9.64	29.3	19.2	19.1	0.33	73.82	3.04
6126	5.2	12.33		26.3	25.6		93.02	3.61
6128	4.02	9.4	36.5	22.1	18.7	0.36	69.4	3.23
6130	5.17	11.23		22.2	20.9		74.54	3.44
6133	4.78	19.09	29.8	24.1	25.8	0.47	90.68	3.44
6134	4.3	22.17		32.2	34.3		112.93	4.21
6135	3.2	20.39	76.8	30.8	34.8	0.57	109.62	4.11
6136	1.78	17.58	66.7	15.6	25.1	0.31	86.25	3.06
6137	1.07	2.85	62.6	12.5	25.8	1.07	61.32	2.6
6138	0.49	0.37		11.8	22.2		40.66	1.9
6139	0.61	0.14		12.2	21		41	1.83
6140	0.75	0.5	32.8	11.8	26.6	1.46	40.59	2.14
6141	1.02	0.1	98.1	11.3	28.5	1.46	35.3	1.86
6142	17.01	2.1	22.2	12	11.9	0.44	32.14	2.79
6144	5.19	3.16		23.7	18.3		58.55	4.06
6145	3.35	3.35	18.7	25.3	21	0.66	58.66	4.39
6146	0.7	4.45		32.6	21.1		76.07	6.77
6149	32.12	0.18		1.5	0.7		3.26	0.48
6151	6.63	2.81	81.7	7.4	7.7	0.38	19.62	2.59
6152	11.57	2.73		6.3	7.9		17.14	2.15
6153	0.57	0.3		11.1	21.6		27.15	2.5
6154	0.24	0.13	26.7	10.8	26.8	1.51	27.28	2.62

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Ga	Ge	Hf	Hg	In	K	La	Li
LDL	0.1	0.1	0.02	5	0.02	0.01	0.5	0.1
Samples	ppm	ppm	ppm	ppb	ppm	%	ppm	ppm
6089	4	< .1	0.23	83	0.04	0.28	13.1	27.9
6090	3.6			62		0.25	14.6	
6091	5.4	< .1	0.52	107	0.06	0.4	17.8	25.5
6092	1.9			113		0.21	< .5	
6093	5.7			174		0.41	71.2	
6094	5.8	0.2	0.15	234	0.06	0.42	12.8	13.1
6120	4.4			64		0.52	15.7	
6121	3.4			19		0.1	21.3	
6122	6.3	0.2	0.05	204	0.05	0.36	64.7	16.1
6123	5.2			153		0.28	24.2	
6125	4.9	0.2	0.57	121	0.03	0.16	17.3	15.2
6126	5.4			155		0.3	22.5	
6128	5.6	0.2	0.57	122	0.04	0.23	21.8	17.1
6130	6			134		0.22	23.3	
6133	5.1	0.3	0.46	147	0.05	0.2	19.3	18.3
6134	5			182		0.3	71.9	
6135	5.3	0.2	0.11	167	0.05	0.31	54.6	20.2
6136	8.2	0.2	1.16	141	0.08	0.22	33	30.7
6137	4.6	0.1	0.07	125	0.04	0.25	37.8	19.8
6138	4.3			104		0.31	22.8	
6139	4.6			113		0.3	42	
6140	4.7	< .1	0.29	106	0.05	0.34	20	27.4
6141	5.2	< .1	< .02	118	0.05	0.37	68.7	31.3
6142	3.1	< .1	0.2	68	0.02	0.13	12.8	7.6
6144	3.9			110		0.19	9.5	
6145	4.5	0.1	0.29	119	0.05	0.25	10.3	18.1
6146	5.5			151		0.19	12.9	
6149	0.5			12		0.02	3.8	
6151	1.9	0.1	< .02	180	0.03	0.09	56.8	3.3
6152	2.2			139		0.09	75.8	
6153	4.2			90		0.27	12	
6154	5.7	< .1	0.27	83	0.04	0.4	13.7	35.4

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
LDL	0.01	1	0.01	0.001	0.02	0.1	0.001	0.01
Samples	%	ppm	ppm	%	ppm	ppm	%	ppm
6089	0.49	276	2.2	0.177	0.07	39.3	0.08	17.88
6090	0.43	299	1.4	0.152		34.2	0.086	16.81
6091	0.39	166	31.89	0.411	0.4	67.4	0.161	17.09
6092	0.22	273	27.76	0.398		21.2	0.037	2.09
6093	0.44	171	18.47	0.378		74.7	0.336	22.3
6094	0.33	279	83.43	0.49	0.58	255.4	0.322	13.04
6120	0.33	592	49.59	0.77		56.6	0.078	16.93
6121	0.79	330	17.78	0.74		13	0.033	36.34
6122	0.36	260	162.67	0.425	1.05	289.5	0.462	16.87
6123	0.33	173	147.15	0.322		249.7	0.108	17.28
6125	0.35	194	120.06	0.2	1.01	168	0.068	15.66
6126	0.33	157	140.42	0.309		228.5	0.104	17.88
6128	0.38	200	108.47	0.302	0.98	166.9	0.116	18.43
6130	0.4	205	104.35	0.304		185.3	0.101	17.49
6133	0.38	139	107.45	0.212	0.72	198.1	0.077	18.12
6134	0.38	158	76.07	0.248		205	0.381	19.62
6135	0.38	126	74.83	0.264	0.76	201.5	0.321	20.51
6136	0.7	265	33.18	0.422	0.49	83.3	0.074	29.84
6137	0.34	111	16.19	0.155	0.35	48.5	0.2	16.69
6138	0.4	124	2.78	0.192		38	0.118	20.48
6139	0.39	119	1	0.183		33.6	0.172	20.03
6140	0.39	135	4.97	0.171	0.14	41.3	0.112	19.02
6141	0.41	124	1.62	0.171	0.16	29.2	0.366	20.5
6142	0.42	1372	33.24	0.096	0.28	61.9	0.076	9.58
6144	0.41	205	47.46	0.168		100.2	0.08	13.03
6145	0.38	154	58.49	0.165	0.38	106	0.073	15.03
6146	0.35	158	36.08	0.186		97.7	0.062	17.67
6149	0.42	2012	4.01	0.045		2.7	0.023	0.9
6151	0.87	255	6.74	0.034	0.27	27.8	0.358	10.06
6152	0.57	379	8.3	0.041		25.5	0.533	7.24
6153	0.37	131	3.79	0.204		36.1	0.081	15.78
6154	0.45	127	1.81	0.214	0.09	33.9	0.061	20.69

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Pd	Pt	Rb	Re	S	Sb	Sc	Se
LDL	10	2	0.1	1	0.02	0.02	0.1	0.1
Samples	ppb	ppb	ppm	ppb	%	ppm	ppm	ppm
6089	< 10	< 2	24.2	6	0.67	0.84	5.1	1.4
6090					0.63	0.67	4.7	1.4
6091	< 10	5	14.6	190	2.65	3.18	4.5	20.8
6092					22.09	1.34	1	38.4
6093					3.53	5.66	7.3	20.7
6094	16	9	10.5	1011	5.8	16.8	7	65.2
6120					3.6	7.56	2.2	12.3
6121					1.37	4.5	1.6	6.7
6122	< 10	6	11.1	673	3.79	15.33	6	47.8
6123					4.36	11.26	3.5	42.3
6125	< 10	4	9.4	363	3.3	7.47	3.5	33.5
6126					4.03	10.06	4	40.5
6128	< 10	7	10.3	425	3.52	9.16	3.4	36
6130					3.94	11.3	3.7	41
6133	14	5	12.1	483	3.88	9.13	3.4	54.8
6134					4.78	11.7	6.2	57.1
6135	17	3	15.1	526	4.71	9.28	5.8	56
6136	< 10	4	10.4	288	3.57	6.28	3.8	43.4
6137	< 10	< 2	18	109	2.29	2.43	3.8	14.5
6138					1.39	1.11	3.7	2.9
6139					1.26	0.74	4.3	2.2
6140	< 10	< 2	23.5	33	1.49	0.81	4.3	3.7
6141	< 10	2	23.8	6	1.11	0.46	7.3	2.1
6142	< 10	< 2	9.2	69	3.22	1.38	2.4	6.1
6144					5.04	3.07	3.4	7.8
6145	< 10	3	15.4	108	5.34	2.13	3.7	8.9
6146					8.65	3.01	1.9	8.6
6149					0.54	0.52	0.8	1.2
6151	10	2	5.7	35	1.62	1.76	2.6	3.5
6152					1.56	1.65	3.7	3
6153					1.94	0.51	3.3	1.5
6154	< 10	< 2	27.2	10	1.62	0.36	4.7	1.2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Sn	Sr	Ta	Te	Th	Ti	Tl	U
LDL	0.1	0.5	0.05	0.02	0.1	0.001	0.02	0.1
Samples	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
6089	0.5	106.2	< .05	0.08	5.5	0.005	0.13	1.57
6090		105.3		0.07	5.7	0.002	0.1	1.52
6091	1.2	207	< .05	0.18	3	0.01	0.87	11.26
6092		13.4		0.17	0.2	0.001	0.72	1.95
6093		252		0.17	8.7	0.005	0.72	27.02
6094	1.2	114.5	< .05	0.41	1.3	0.011	8.21	48.57
6120		459.4		0.07	4.4	0.001	2.3	24.24
6121		358.3		0.03	20.9	0.003	1.42	9.85
6122	1.8	323.2	< .05	0.22	8.5	0.012	7.38	69.58
6123		222.6		0.17	5.3	0.005	6.16	32.12
6125	0.8	148.2	< .05	0.11	4.2	0.004	4.78	22.17
6126		221.6		0.15	5.4	0.004	5.75	33.65
6128	0.9	176.4	< .05	0.14	5.6	0.003	4.77	24.4
6130		216.2		0.13	6.1	0.005	5.7	24.99
6133	0.8	153.2	< .05	0.18	5	0.002	7.6	20.48
6134		203		0.23	10.1	0.006	8.28	47.61
6135	0.8	170	< .05	0.22	8.2	0.004	8.01	35.93
6136	2.4	187.2	< .05	0.22	11.6	0.003	4.45	8.66
6137	1	104.2	< .05	0.11	7.5	0.003	1.28	10.19
6138		101.9		0.1	9.2	0.002	0.3	3.83
6139		117		0.14	9.8	0.002	0.18	6.82
6140	1.1	101.6	< .05	0.1	6.8	0.002	0.35	3.59
6141	0.9	152.6	< .05	0.11	11.6	0.003	0.15	9.11
6142	0.7	126.7	< .05	0.1	3	0.002	1.34	12.45
6144		128.9		0.17	4.4	0.001	1.64	16.99
6145	0.7	107.2	< .05	0.16	4.4	0.001	2.13	17.53
6146		74.3		0.34	5.2	0.003	1.72	10.38
6149		137.5		0.02	0.2	0.002	0.11	4.79
6151	0.5	171.7	< .05	0.22	3.4	0.006	1.73	18.57
6152		208.8		0.16	3.6	0.005	0.94	35.73
6153		82.4		0.05	6.9	0.002	0.21	3.17
6154	1.1	84.6	< .05	0.06	9.3	0.002	0.21	2.08

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM

Element	V	W	Y	Zn	Zr	Ag	Al	As
LDL	2	0.1	0.01	0.1	0.1	0.1	0.01	1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
6088						0.1	7.59	25
6089	38	<.1	13.52	121.8	10.6	0.1	7.22	21
6090	37	<.1		132.6		0.1	7.43	21
6091	158	<.1	33.43	164.5	25.3	0.6	7.37	26
6092	42	<.1		51.4				
6093	167	<.1		183.6				
6094	231	<.1	55.57	439.9	18.1	1.2	7.16	65
6120	28	<.1		129.7				
6121	51	<.1		105.8				
6122	362	<.1	82.19	468.9	8.8	0.9	6.92	21
6123	288	<.1		338.8				
6125	239	<.1	19.55	254.3	37.1	0.7	5.88	22
6126	285	<.1		325.8				
6128	191	<.1	24.44	260.7	37.7	0.7	6.68	23
6130	251	<.1		269.3				
6133	453	<.1	22.12	368.6	27	0.9	6.35	19
6134	556	<.1		463.8				
6135	527	<.1	69.9	415.4	14.1	1.1	6.13	29
6136	328	<.1	21.39	306	47.8	1.1	8.04	14
6137	137	<.1	40.71	141.6	10.5	0.5	6.4	15
6138	80	<.1		106.8				
6139	73	<.1		103.6				
6140	106	<.1	22.41	109.8	15.7	0.1	8.11	14
6141	124	<.1	76.17	86.5	2.5	0.1	7.77	14
6142	84	<.1	19.2	115	14.8	0.4	3.51	26
6144	114	<.1		216.8				
6145	121	<.1	14.12	222.9	15.4	0.6	6.77	44
6146	102	<.1		256.9				
6149	16	<.1		9.3				
6151	24	<.1	55.03	112.7	5.6	0.8	1.61	22
6152	25	<.1		119.2				
6153	35	<.1		112		0.1	7.48	16
6154	41	<.1	11.43	106.7	10.7	0.1	8.96	12

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Au	Ba	Be	Bi	Ca	Cd	Ce	Co
LDL	0.1	1	1	0.1	0.01	0.1	1	1
Samples	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
6088	<.1	782	1	0.3	0.42	0.4	59	15
6089	<.1	814	2	0.3	0.35	0.3	46	16
6090	<.1	935	2	0.3	0.41	0.4	63	16
6091	<.1	27	1	0.5	0.55	3.5	49	17
6094	<.1	16	4	0.4	2.38	17.9	64	46
6122	<.1	26	1	0.4	4.9	16.4	118	33
6125	<.1	60	2	0.5	8.01	8.9	56	23
6128	<.1	91	1	0.5	4.87	9	61	23
6133	<.1	63	2	0.4	5.4	17.5	55	24
6135	<.1	50	1	0.5	3.44	19.1	98	31
6136	<.1	72	1	0.4	1.97	15.6	84	16
6137	<.1	65	4	0.4	1.26	2.7	86	15
6140	<.1	234	1	0.5	0.85	0.5	74	14
6141	<.1	259	1	0.4	1.16	0.1	135	14
6142	<.1	237	1	0.2	18.37	1.9	31	16
6145	<.1	87	1	0.3	3.54	2.8	55	27
6151	<.1	110	1	0.1	7.24	2.5	83	7
6153	<.1	251	2	0.3	0.47	0.3	62	11
6154	<.1	230	3	0.4	0.28	0.3	69	13

Element	Cr	Cu	Fe	Hf	K	La	Li	Mg
LDL	0.1	0.1	0.01	0.1	0.01	0.1	0.1	0.01
Samples	ppm	ppm	%	ppm	%	ppm	ppm	%
6088	110.8	26.3	3.47	2.9	1.93	33.8	69.2	0.78
6089	87.2	31.4	3.37	2.4	1.85	25.3	68.6	0.85
6090	110.5	29.3	3.38	3.2	2.05	34.9	80.7	0.79
6091	107.7	106.7	4.33	3.4	1.92	24.5	74.6	0.79
6094	64.5	113.3	6.51	3.2	1.35	30.5	35.4	0.67
6122	64.3	88	4.62	2.6	1.37	75.6	34.1	0.73
6125	74.9	81.3	4	3	1.36	30.9	50.3	0.97
6128	72.7	74.6	4.02	3	1.6	35.6	51.4	0.97
6133	81.4	89.2	4.1	2.8	1.54	32.6	54.6	0.89
6135	85.8	106.4	4.81	2.4	1.81	67	45.6	0.72
6136	62.7	88.2	3.6	6.1	1.33	44.7	91.8	1.76
6137	91.7	64.8	3.51	2.7	2.1	51.9	50.9	0.72
6140	89.3	44.5	3.02	3.2	2.41	45.5	83.7	0.86
6141	98.9	41	2.69	3.7	2.3	88.7	84.3	0.82
6142	52.5	37.1	3.54	1.4	0.98	18.7	28.5	0.7
6145	65.8	62	5.2	2.1	2.05	31.3	50.7	0.8
6151	14.6	21.8	2.76	0.5	0.84	60.1	12.9	0.92
6153	110.4	26.4	3.52	2.9	2.19	35.7	78.9	0.74
6154	119.4	29.5	3.52	3.3	2.53	37.9	100.2	0.92

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
LDL	1	0.1	0.001	0.1	0.1	0.001	0.1	0.1
Samples	ppm	ppm	%	ppm	ppm	%	ppm	ppm
6088	273	2.2	0.391	11.4	43.4	0.078	20.1	125.8
6089	260	2.2	0.467	10.4	42.4	0.077	19.2	101.7
6090	314	1.9	0.451	12.7	38.5	0.096	19.9	128
6091	162	32.3	0.651	10.4	71.8	0.162	20.3	69.5
6094	280	88.2	0.825	9.1	252.7	0.34	16.8	45
6122	232	149.8	0.638	8.3	264.4	0.439	18.3	58.5
6125	244	139.9	0.443	8.1	166.1	0.08	16.9	71.5
6128	236	122.5	0.597	9	168.3	0.122	20.1	77.8
6133	161	109.8	0.497	8.6	184.9	0.079	19	82
6135	144	77.9	0.559	9.6	178	0.32	20.5	86.6
6136	286	40.1	0.625	9.1	78.6	0.081	29.2	65.2
6137	143	18.7	0.549	10.2	50.9	0.225	18.3	92.2
6140	164	5.8	0.436	12.1	45.5	0.13	21.1	128.6
6141	159	1.8	0.467	12.3	35.4	0.419	21.2	116.9
6142	1474	35	0.191	5	65.8	0.094	11.3	48.9
6145	172	65.6	0.31	9.9	102.3	0.084	15.9	112
6151	277	6.5	0.193	2.4	26.7	0.362	11.5	24
6153	126	4.1	0.426	12.3	39.5	0.083	17.4	119.5
6154	156	2.2	0.494	13.8	39.1	0.08	23.5	134.7

Element	S	Sb	Sc	Sn	Sr	Ta	Th	Ti
LDL	0.1	0.1	1	0.1	1	0.1	0.1	0.01
Samples	%	ppm	ppm	ppm	ppm	ppm	ppm	%
6088	0.7	1.6	14	2.1	150	0.7	9.7	0.458
6089	0.9	1.3	11	2.1	169	0.7	7.8	0.416
6090	0.6	1.4	15	2.2	167	0.8	10	0.464
6091	3.4	6.2	8	2.2	363	0.7	6.8	0.329
6094	6.6	32.2	11	1.6	385	0.5	5.7	0.292
6122	4.9	20.9	10	2.3	522	0.5	11.8	0.198
6125	3.5	15.2	9	2	240	0.6	7	0.256
6128	3.6	18.4	10	1.8	307	0.6	8.1	0.283
6133	3.7	19	9	1.6	240	0.5	7	0.271
6135	4.2	16.4	12	1.8	288	0.6	10.4	0.283
6136	3.3	18.8	11	3	247	0.9	14	0.267
6137	2.1	5.4	10	2	180	0.7	9.8	0.303
6140	1.4	2	13	2.6	175	0.8	10.6	0.405
6141	1	1.1	15	2.3	227	0.8	15.2	0.405
6142	3	3	6	1.3	170	0.4	3.9	0.15
6145	5.2	4.7	11	2	175	0.6	7.9	0.306
6151	1.7	2.1	3	0.4	224	0.1	4.5	0.074
6153	1.7	1.1	13	2.4	149	0.8	11	0.468
6154	1.5	1.1	14	2.8	169	0.9	13.2	0.464

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM

Element	U	V	W	Y	Zn	Zr	Ce	Co
LDL	0.1	1	0.1	0.1	1	0.1	0.5	0.5
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
6088	3.8	252	1.1	20.4	151	87.9	74.1	14.2
6089	2.9	223	1	14.4	143	79.1	62.7	17.3
6090	3.4	265	1.3	24.2	157	101.2	73.9	13.8
6091	12.2	611	1.4	29.6	193	98.3	69.9	14.2
6094	49.7	743	1.4	59.6	481	114.9	98.7	33
6122	67.2	771	1	78.1	458	93.5	125.7	26.2
6125	25.5	854	1.2	26.9	312	97.2	54.7	13.9
6128	25.8	696	1	30.6	323	98.2	62.4	13
6133	21.3	1275	1	28	395	77.4	56.2	13.8
6135	35.1	1057	1	78.8	461	88.8	105.7	20.5
6136	9.9	865	0.8	27.4	347	149.3	85.9	12.9
6137	11.7	408	1.1	50.5	174	86	90	12
6140	5.6	373	1.5	30.6	135	97.3	82.5	13.4
6141	11.2	347	1.4	91.6	116	106.9	148.3	12.1
6142	14.8	236	0.5	22.1	157	42.8	42.7	11
6145	18.9	359	1.1	20.9	258	64.8	68.3	16.6
6151	18.7	47	0.3	57.1	131	20.3	89.6	7.8
6153	5.1	209	1.3	20.2	121	86.3	82.9	11.1
6154	4.1	220	1.7	18.5	133	94.2	84.4	10.9

Element	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho
LDL	0.1	0.05	0.05	0.05	0.5	0.05	0.5	0.05
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
6088	10.7	4.64	2.87	1.2	22.2	5.47	4.2	1.01
6089	9.4	4.3	2.48	1.07	19.6	4.54	4.2	0.88
6090	10.3	5.12	2.78	1.18	20.2	4.83	4	1.07
6091	4.5	7.55	3.87	1.53	19.7	8.39	4.6	1.39
6094	2.6	11.75	5.88	2.31	15.7	12.62	4.4	2.29
6122	3.9	14.73	7.54	3.12	14.4	17.27	3.8	2.87
6125	5.3	4.72	2.75	1.17	14.5	5.15	3.3	0.93
6128	5.3	5.15	3.07	1.16	16	5.54	4.2	1.04
6133	5.9	4.88	2.78	1.11	15.8	5.59	3.4	0.97
6135	5.9	13.02	7.07	2.8	15.3	14.22	3.9	2.44
6136	4.3	5.96	2.9	1.05	21.4	6.92	7.2	1.04
6137	6	8.87	4.81	1.75	16.3	9.66	5.7	1.61
6140	10.2	5.85	3.49	1.44	20.9	6.52	5.3	1.18
6141	7.9	15.25	8.03	3.63	19.1	18.05	6.4	2.9
6142	3.5	4.07	2.33	0.84	9.8	4.14	1.7	0.8
6145	7.7	3.83	2.29	0.9	17	4.11	2.8	0.71
6151	0.6	8.52	3.73	2.34	3.7	10.56	5.1	1.36
6153	9.6	4.89	2.65	1.27	19.8	5.42	4.7	0.96
6154	9.4	4.55	2.73	1.17	21.5	5.54	4.8	0.85

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	La	Lu	Nb	Nd	Pr	Sn	Rb	Sm
LDL	0.5	0.01	0.5	0.4	0.02	1	0.5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
6088	36.3	0.4	15.7	33.5	8.74	8	150.6	5.8
6089	31.9	0.35	13.7	30.5	7.48	< 1	131.2	5.9
6090	34.8	0.39	14.5	31.8	8.59	7	129.1	5.8
6091	38	0.48	12.9	42.2	10.25	< 1	78.3	8.6
6094	58.5	0.77	10.7	61.4	14.48	< 1	48.8	13.2
6122	74.8	0.97	10.5	81.5	18.94	< 1	62.4	17
6125	29.8	0.4	10.5	30.2	7.21	< 1	69.3	5.6
6128	34.3	0.49	11.9	35.3	8.32	< 1	77.8	6.5
6133	31.5	0.44	10.9	31.2	7.31	< 1	80	5.9
6135	68.1	0.91	12	67.6	15.69	3	88.5	14.1
6136	41.3	0.43	11.4	43.9	10.57	49	62.8	8.4
6137	51.4	0.65	13.7	51.4	11.94	< 1	93.9	10
6140	44.4	0.51	17.5	42.3	9.96	1	139.3	7.3
6141	84.3	0.99	16.5	84.6	20.25	7	118.6	17.4
6142	21.4	0.34	6.5	21.9	5.1	< 1	51	3.9
6145	31.5	0.3	13.5	28	7.48	< 1	114.4	5.1
6151	53.4	0.39	3.5	49.8	11.91	< 1	23.8	10.6
6153	39.1	0.36	15.7	31.4	9.55	9	135	6.7
6154	41.9	0.4	17.5	35.1	9.48	2	138.8	6.3

Element	Sr	Ta	Tb	Th	Tm	U	V	W
LDL	0.5	0.1	0.01	0.1	0.05	0.1	5	0.1
Samples	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
6088	191	1.2	0.78	11.5	0.44	4.4	260	1.7
6089	180.2	0.9	0.74	9.8	0.43	3.4	230	1.6
6090	175.5	0.9	0.83	11.7	0.44	3.6	234	1.5
6091	475.1	0.9	1.26	10	0.56	12.5	612	1.8
6094	637.5	0.6	1.98	8.2	0.87	53.9	739	1.4
6122	594.1	0.6	2.63	13.3	1.13	72.9	832	0.9
6125	235	0.7	0.82	7.8	0.4	24.4	839	1.1
6128	328.4	0.8	0.87	9	0.42	24.6	692	1.2
6133	237.5	0.7	0.92	7.4	0.41	19.9	1172	1
6135	311.6	0.7	2.23	11.3	0.95	36.4	1026	1.4
6136	245.6	1	1.11	14	0.43	9.8	872	1.1
6137	177.9	0.9	1.62	11.5	0.67	11.6	406	1.1
6140	184.4	1.1	1.12	12.1	0.52	6.2	384	1.9
6141	223.4	1.1	2.77	17.1	1.07	12.1	338	1.8
6142	180.8	0.4	0.65	5.1	0.29	15	231	0.8
6145	183.9	0.7	0.65	10.3	0.33	19.3	345	1.6
6151	228.9	0.2	1.63	5.7	0.48	19.5	41	0.5
6153	179.3	1	0.84	12.6	0.43	5.9	215	1.6
6154	173.8	1.1	0.82	15.9	0.36	4.6	215	1.9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM

Element	Y	Yb	Zr	Al2O3	Ba	CaO	Cr2O3	Cr2O3
LDL	0.1	0.05	0.5	0.03	5	0.01	0.001	0.001
Samples	ppm	ppm	ppm	%	ppm	%	%	%
6088	30.2	2.74	147.4	16.11	1059.2	0.66	0.014	
6089	27.2	2.88	141.5	16.05	925	0.72	0.013	0.013
6090	30.4	2.77	161	15.18	948.8	0.61	0.014	
6091	42.1	3.42	133.6	15.81	5388	1.2	0.015	0.0147
6094	70.4	5.35	157.7	13.22	12054	3.8	0.008	0.0077
6122	93.6	6.61	140.9	11.32	2818	8.26	0.009	0.0093
6125	29.7	2.43	125.8	10.92	579	12.02	0.009	0.0088
6128	34.5	3.04	142.2	12.18	1181	7.07	0.009	0.0087
6133	30.8	2.63	115.2	11.66	655	7.98	0.01	0.01
6135	87.7	5.91	153.8	11.79	1415	5.22	0.012	0.0115
6136	29.6	2.64	196.9	14.92	534	2.86	0.009	0.0092
6137	55.2	4.25	209.2	11.63	748	1.75	0.011	0.0111
6140	40	3.41	174.9	15.32	909	1.21	0.014	0.014
6141	103.5	6.76	233.6	14.62	935	1.66	0.013	0.0129
6142	26.1	2.17	61.5	6.91	360	30.34	0.005	0.0053
6145	24.8	2.24	95	12.62	648	5.14	0.01	0.01
6151	63.6	2.86	196.5	2.92	781	10.62	0.003	0.003
6153	30	2.59	150.3	15.78	759.2	0.8	0.013	
6154	27	2.75	152.2	16.98	780	0.4	0.014	0.0141

Element	Fe2O3	K2O	LOI	MgO	MnO	Na2O	Ni	P2O5
LDL	0.04	0.04	0.1	0.01	0.01	0.01	30	0.01
Samples	%	%	%	%	%	%	ppm	%
6088	4.97	2.84	9.1	1.59	0.03	0.59	34	0.2
6089	4.87	2.63	9.2	1.65	0.03	0.7	31	0.22
6090	4.57	2.68	7.8	1.49	0.04	0.6	34	0.2
6091	5.72	2.58	22.6	1.45	0.02	0.95	55	0.4
6094	8.07	1.84	26.2	1.18	0.04	1.2	115	0.86
6122	6.27	1.93	24.9	1.31	0.03	1.01	176	1.18
6125	4.75	1.65	26.5	1.68	0.03	0.59	86	0.17
6128	4.85	1.89	23.3	1.66	0.03	0.75	60	0.25
6133	4.65	1.9	25.8	1.53	0.02	0.66	84	0.19
6135	5.93	2.2	22.2	1.3	0.02	0.75	104	0.74
6136	4.81	1.51	20	2.9	0.03	0.79	66	0.17
6137	4.69	2.37	12	1.21	0.02	0.68	52	0.47
6140	4.32	2.81	11.4	1.46	0.02	0.57	58	0.28
6141	3.85	2.66	9	1.4	0.02	0.6	43	0.9
6142	4.44	1.23	30.6	1.31	0.17	0.2	49	0.2
6145	6.33	2.5	25.7	1.39	0.02	0.38	28	0.19
6151	3.94	1	8.9	1.57	0.03	0.25	36	0.8
6153	4.8	2.91	9.8	1.46	0.02	0.61	24	0.21
6154	4.93	2.87	9.9	1.56	0.02	0.61	46	0.17

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

							Analysis: CO2	
Element	**Sc**	**SiO2**	**TiO2**	**TOT/C**	**TOT/S**	**SUM**	**C/ORG**	**C/GRA**
LDL	**1**	**0.02**	**0.01**	**0.01**	**0.01**			
Samples	**ppm**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
6088	16	62.9	0.78	1.47	0.99	99.78	1.3	0.02
6089	15	62.34	0.76	1.31	0.92	99.29	1.11	0.06
6090	15	65.98	0.76	1.1	0.68	99.94	0.99	< .02
6091	12	47.43	0.57	7.21	4.03	99.35	7.17	0.02
6094	13	41.2	0.51	6.66	5.66	99.48	6.42	< .02
6122	12	42.69	0.4	11.89	5.63	99.65	10.82	0.04
6125	10	40.76	0.46	12.08	4.34	99.61	10.06	0.03
6128	11	47.08	0.5	9.79	4.59	99.71	8.66	0.05
6133	11	44.57	0.49	10.87	4.65	99.54	9.51	0.06
6135	14	48.72	0.53	9.31	5.53	99.58	8.72	< .02
6136	12	51.21	0.46	5.99	3.96	99.74	5.63	0.03
6137	11	64.32	0.55	3.62	2.77	99.8	3.47	< .02
6140	15	61.63	0.75	2.96	2.01	99.89	2.81	0.03
6141	17	64.16	0.74	1.85	1.42	99.73	1.76	0.03
6142	7	24.16	0.27	12.08	3.88	99.89	6.72	0.02
6145	12	44.83	0.54	9.82	5.81	99.73	9.11	0.02
6151	3	69.6	0.13	3.01	1.88	99.86	0.74	0.03
6153	15	62.53	0.78	2.13	2.05	99.71	2.03	0.03
6154	17	61.55	0.8	1.64	1.95	99.91	1.58	0.04

Element	**CO2**	**SO4**
LDL		
Samples	**%**	**%**
6088	0.56	0.48
6089	0.48	0.27
6090	0.38	0.27
6091	0.07	0.59
6094	0.88	2.83
6122	3.78	4.01
6125	7.3	3.85
6128	3.96	3.51
6133	4.78	3.56
6135	2.15	4.3
6136	1.22	2.76
6137	0.5	1.6
6140	0.45	1.25
6141	0.22	0.48
6142	19.58	4.27
6145	2.52	6.73
6151	8.21	2.37
6153	0.27	0.52
6154	0.05	0.34

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

6.5 Precision and Accuracy Calculations

** If less than 25% of values are <LDL, the value was set to 1/2 the LDL, if more than 25% of values are <LDL, then the value was not calculated*

Diorite Gneiss Reference Material (SY-4)
Certified Values " 95% Confidence Interval
*nng = 10-9 g/g (i.e.: ppb)

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Element	Al2O3	CaO	CO2	Fe	Fe2O3 total	FeO	K2O
Values (%)	20.69	8.05	3.5	4.2	6.21	2.86	1.66
Plus/Minus (%)	0.08	0.04	0.1	0.1	0.03	0.09	0.02

	MgO	MnO	Na2O	P2O5	SiO2	TiO2	LOI
	0.54	0.108	7.1	0.131	49.9	0.287	4.56
	0.01	0.001	0.05	0.004	0.1	0.003	0.07

Element	Ba	Be	Ce	Nd	Ni	Pb	Co
Values (ug/g)	340	2.6	122	57	9	10	2.8
Plus/Minus (ug/g)	5	0.1	2	1	1	1	0.2

	Cr	Cs	Cu	Dy	Er	Eu	Ga
	12	1.5	7	18.2	14.2	2	35
	1	0.1	1	0.6	0.5	0.04	1

	Gd	Hf	Ho	La	Li	Lu	Mn
	14	10.6	4.3	58	37	2.1	819
	0.5	0.4	0.1	1	2	0.1	24

	Nb	Pr	Rb	Sc	Sm	Sr	Ta
	13	15	55	1.1	12.7	1191	0.9
	1	0.3	1.5	0.1	0.4	12	0.1

	Tb	Th	Tm	U	V	Y	Yb
	2.6	1.4	2.3	0.8	8	119	14.8
	0.1	0.2	0.1	0.1	1.6	2	0.4

	Zn	Zr
	93	517
	2	16

Provisional Values " 95% Confidence Interval

Element	Al	C	Ca	F	H2O+	H2O-	K
Values (%)	11	1	5.8	0.06	1	0.15	1.41
Plus/Minus (%)	1	0.1	0.3	0.01	0.3	0.05	0.03

	Mg	Na	S total
	0.3	5.3	0.015
	0.02	0.2	0.004

Element	Ag	Br	P	Sn
Values (ug/g)	0.6	217	532	7.1
Plus/Minus (ug/g)	0.16	14	38	0.6

Information Values (Range)

Element	Cl	SO3
Values (%)	0.3 to 0.6	0.01 to 0.08
Average Value	0.45	0.045

Element	As	B	Bi	Cd	Ge	Hg	In
Values (ug/g)	0.1 to 2	13 to 18	0.1 to 0.3	0.1 to 2	1 to 4	10 to 14*	0.04 to 0.1
Average Value	1.05	15.5	0.2	1.05	2.5	12	0.07

	Mo	Sb	Se	Ti	Tl	W
	0.2 to 3	0.01 to 0.3	0.01 to 4	1500 to 1750	0.2 to 0.5	0.2 to 15
	1.6	0.155	2.005	1625	0.35	7.6

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Analysis Date	Ag	Al	As	Au	B
SAMPLES		ppb	%	ppm	ppb	ppm
SI		10	0.02	0.1	0.2	2
LDL		2	0.01	0.1	0.2	1
212B PULP	Dec. 2003	9	1.86	<.1	<.2	4
% Recovery		0.539892	16.909091	N/A	N/A	25.806452
252B PULP	Dec. 2003	6	1.8	<.1	0.4	2
% Recovery		0.359928	16.363636	N/A	N/A	12.903226
284B PULP	Dec. 2003	3	1.74	<.1	<.2	5
% Recovery		0.179964	15.818182	N/A	N/A	32.258065
312B PULP	Dec. 2003	7	1.81	<.1	<.2	7
% Recovery		0.419916	16.454545	N/A	N/A	45.16129
344B PULP	Dec. 2003	4	1.75	<.1	<.2	4
% Recovery		0.239952	15.909091	N/A	N/A	25.806452
375B PULP	Dec. 2003	4	1.8	<.1	<.2	5
% Recovery		0.239952	16.363636	N/A	N/A	32.258065
401B PULP	Dec. 2003	5	1.79	<.1	<.2	3
% Recovery		0.29994	16.272727	N/A	N/A	19.354839
429B PULP	Dec. 2003	6	1.81	<.1	<.2	3
% Recovery		0.359928	16.454545	N/A	N/A	19.354839
458B PULP	Dec. 2003	5	1.68	0.2	<.2	5
% Recovery		0.29994	15.272727	19.047619	N/A	32.258065
484B PULP	Dec. 2003	5	1.7	<.1	0.3	5
% Recovery		0.29994	15.454545	N/A	N/A	32.258065
3815B PULP	Dec. 2003	4	1.83	<.1	<.2	3
% Recovery		0.239952	16.636364	N/A	N/A	19.354839
3846B PULP	Dec. 2003	7	1.66	<.1	<.2	4
% Recovery		0.419916	15.090909	N/A	N/A	25.806452
3876B PULP	Dec. 2003	9	1.78	<.1	<.2	4
% Recovery		0.539892	16.181818	N/A	N/A	25.806452
3909B PULP	Dec. 2003	8	1.72	<.1	<.2	5
% Recovery		0.479904	15.636364	N/A	N/A	32.258065
3935B PULP	Dec. 2003	6	1.79	0.1	<.2	4
% Recovery		0.359928	16.272727	9.5238095	N/A	25.806452
3960B PULP	Dec. 2003	8	1.86	<.1	<.2	5
% Recovery		0.479904	16.909091	N/A	N/A	32.258065
4534B PULP	Dec. 2003	13	1.76	<.1	<.2	4
% Recovery		0.779844	16	N/A	N/A	25.806452
4568B PULP	Dec. 2003	4	1.71	<.1	<.2	5
% Recovery		0.239952	15.545455	N/A	N/A	32.258065
6006B PULP	Dec. 2003	7	1.75	<.1	<.2	5
% Recovery		0.419916	15.909091	N/A	N/A	32.258065
6070B PULP	Dec. 2003	8	1.84	<.1	<.2	5
% Recovery		0.479904	16.727273	N/A	N/A	32.258065
SY-4 Value		1667	11	1.05	N/A	15.5
Average % Recovery		0.3839232	16.109091	N/A	N/A	28.064516
RSD		37.044936	3.2629824	N/A	N/A	25.044203
				Over 25% values <LDL	Over 25% values <LDL	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Ba	Bi	Ca	Cd	Co	Cr	Cu
SAMPLES	ppm	ppm	%	ppm	ppm	ppm	ppm
SI	7.5	0.03	0.39	0.01	0.1	0.7	1.15
LDL	0.5	0.02	0.01	0.01	0.1	0.5	0.01
212B PULP	183.2	< .02	3.17	0.06	2	8.8	4.82
% Recovery	53.882353	N/A	54.655172	5.7142857	71.428571	73.333333	68.857143
252B PULP	188.2	< .02	3.08	0.06	2.4	9.1	4.13
% Recovery	55.352941	N/A	53.103448	5.7142857	85.714286	75.833333	59
284B PULP	175.5	< .02	3.02	0.07	2.2	8.5	4.86
% Recovery	51.617647	N/A	52.068966	6.6666667	78.571429	70.833333	69.428571
312B PULP	163.6	< .02	2.89	0.05	2	8.2	4.84
% Recovery	48.117647	N/A	49.827586	4.7619048	71.428571	68.333333	69.142857
344B PULP	167.6	< .02	2.96	0.04	1.7	7.7	4.53
% Recovery	49.294118	N/A	51.034483	3.8095238	60.714286	64.166667	64.714286
375B PULP	175.3	< .02	3.09	0.07	1.9	7.9	4.32
% Recovery	51.558824	N/A	53.275862	6.6666667	67.857143	65.833333	61.714286
401B PULP	180.6	< .02	2.74	0.05	2.1	8.3	4.1
% Recovery	53.117647	N/A	47.241379	4.7619048	75	69.166667	58.571429
429B PULP	180	< .02	3.27	0.05	2.4	7.9	4.25
% Recovery	52.941176	N/A	56.37931	4.7619048	85.714286	65.833333	60.714286
458B PULP	173.8	< .02	3.16	0.05	1.8	7.5	4.07
% Recovery	51.117647	N/A	54.482759	4.7619048	64.285714	62.5	58.142857
484B PULP	177.5	< .02	3.2	0.06	2	8.2	4.48
% Recovery	52.205882	N/A	55.172414	5.7142857	71.428571	68.333333	64
3815B PULP	177.8	< .02	3.1	0.06	2	7.8	4.79
% Recovery	52.294118	N/A	53.448276	5.7142857	71.428571	65	68.428571
3846B PULP	173.4	< .02	3.07	0.05	2	7.8	4.12
% Recovery	51	N/A	52.931034	4.7619048	71.428571	65	58.857143
3876B PULP	188.7	< .02	3.35	0.07	2.2	9	4.18
% Recovery	55.5	N/A	57.758621	6.6666667	78.571429	75	59.714286
3909B PULP	186.4	< .02	3.23	0.06	2.1	8.3	4.97
% Recovery	54.823529	N/A	55.689655	5.7142857	75	69.166667	71
3935B PULP	180.9	< .02	3.24	0.05	2.1	8.2	4.6
% Recovery	53.205882	N/A	55.862069	4.7619048	75	68.333333	65.714286
3960B PULP	177.9	< .02	3.07	0.05	2.1	8.1	4.62
% Recovery	52.323529	N/A	52.931034	4.7619048	75	67.5	66
4534B PULP	170.5	< .02	3.2	0.05	2.2	8.3	3.56
% Recovery	50.147059	N/A	55.172414	4.7619048	78.571429	69.166667	50.857143
4568B PULP	169.4	< .02	2.85	0.06	1.9	7.8	4.8
% Recovery	49.823529	N/A	49.137931	5.7142857	67.857143	65	68.571429
6006B PULP	175.2	< .02	2.81	0.05	2	8.8	4.07
% Recovery	51.529412	N/A	48.448276	4.7619048	71.428571	73.333333	58.142857
6070B PULP	170.7	< .02	3.03	0.06	2.2	8.5	4.23
% Recovery	50.205882	N/A	52.241379	5.7142857	78.571429	70.833333	60.428571
SY-4 Value	340	0.2	5.8	1.05	2.8	12	7
Average % Recovery	52.002941	N/A	53.043103	5.3333333	73.75	68.625	63.1
RSD	3.8194	N/A	5.2668803	14.656834	8.500933	5.4059363	8.3675752
		Over 25% values <LDL					

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Fe	Ga	Hg	K	La	Mg	Mn
SAMPLES	%	ppm	ppb	%	ppm	%	ppm
SI	0.05	0.1	14	0.01	<.5	0.01	10
LDL	0.01	0.1	5	0.01	0.5	0.01	1
212B PULP	4.09	15	7	0.62	36.8	0.29	833
% Recovery	97.380952	42.857143	58.333333	43.971631	63.448276	96.666667	101.7094
252B PULP	4.06	15.8	7	0.59	37.2	0.28	806
% Recovery	96.666667	45.142857	58.333333	41.843972	64.137931	93.333333	98.412698
284B PULP	3.95	14.6	9	0.6	35.6	0.28	786
% Recovery	94.047619	41.714286	75	42.553191	61.37931	93.333333	95.970696
312B PULP	3.74	14.2	< 5	0.58	32.9	0.27	755
% Recovery	89.047619	40.571429	N/A	41.134752	56.724138	90	92.185592
344B PULP	3.85	14.6	< 5	0.59	31.5	0.27	775
% Recovery	91.666667	41.714286	N/A	41.843972	54.310345	90	94.627595
375B PULP	4.01	15.2	< 5	0.64	31.9	0.29	834
% Recovery	95.47619	43.428571	N/A	45.390071	55	96.666667	101.8315
401B PULP	3.69	14.4	< 5	0.59	35.4	0.26	719
% Recovery	87.857143	41.142857	N/A	41.843972	61.034483	86.666667	87.789988
429B PULP	4.03	15.1	< 5	0.62	33.6	0.28	804
% Recovery	95.952381	43.142857	N/A	43.971631	57.931034	93.333333	98.168498
458B PULP	3.7	14.2	< 5	0.57	34.2	0.26	747
% Recovery	88.095238	40.571429	N/A	40.425532	58.965517	86.666667	91.208791
484B PULP	3.79	14.4	< 5	0.59	34.9	0.27	773
% Recovery	90.238095	41.142857	N/A	41.843972	60.172414	90	94.383394
3815B PULP	3.77	13.9	< 5	0.57	34.8	0.27	771
% Recovery	89.761905	39.714286	N/A	40.425532	60	90	94.139194
3846B PULP	3.76	14.2	< 5	0.59	34.2	0.27	747
% Recovery	89.52381	40.571429	N/A	41.843972	58.965517	90	91.208791
3876B PULP	4.02	15.2	< 5	0.61	38	0.28	789
% Recovery	95.714286	43.428571	N/A	43.262411	65.517241	93.333333	96.336996
3909B PULP	3.93	14.4	< 5	0.58	35.5	0.27	779
% Recovery	93.571429	41.142857	N/A	41.134752	61.206897	90	95.115995
3935B PULP	3.89	14.9	5	0.62	35.8	0.27	801
% Recovery	92.619048	42.571429	41.666667	43.971631	61.724138	90	97.802198
3960B PULP	3.83	15	< 5	0.59	34.4	0.27	792
% Recovery	91.190476	42.857143	N/A	41.843972	59.310345	90	96.703297
4534B PULP	3.96	15	< 5	0.61	35.1	0.27	795
% Recovery	94.285714	42.857143	N/A	43.262411	60.517241	90	97.069597
4568B PULP	3.74	13.6	< 5	0.57	33.6	0.26	741
% Recovery	89.047619	38.857143	N/A	40.425532	57.931034	86.666667	90.47619
6006B PULP	3.82	14	< 5	0.59	34.1	0.26	746
% Recovery	90.952381	40	N/A	41.843972	58.793103	86.666667	91.086691
6070B PULP	3.95	14.7	< 5	0.62	35.6	0.27	764
% Recovery	94.047619	42	N/A	43.971631	61.37931	90	93.284493
SY-4 Value	4.2	35	12	1.41	58	0.3	819
Average % Recovery	92.357143	41.771429	N/A	42.340426	59.922414	90.666667	94.97558
RSD	3.2586671	3.6572589	N/A	3.310174	4.6838555	3.2883353	3.8932127
			Over 25% values <LDL				

Analysis: GROUP 1F1 - 1.00 GM, Standards

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

ELEMENT	Mo	Na	Ni	P	Pb	S	Sb
SAMPLES	ppm	%	ppm	%	ppm	%	ppm
SI	0.05	1.421	0.1	<.001	1.63	0.02	0.18
LDL	0.01	0.001	0.1	0.001	0.01	0.02	0.02
212B PULP	0.2	0.601	5.7	0.045	2.11	<.01	<.02
% Recovery	12.5	11.339623	63.333333	84.586466	21.1	N/A	N/A
252B PULP	0.19	0.58	5.7	0.046	2.19	0.03	<.02
% Recovery	11.875	10.943396	63.333333	86.466165	21.9	200	N/A
284B PULP	0.19	0.561	4.9	0.047	2.01	0.01	0.05
% Recovery	11.875	10.584906	54.444444	88.345865	20.1	66.666667	32.258065
312B PULP	0.16	0.547	5	0.045	1.87	0.02	<.02
% Recovery	10	10.320755	55.555556	84.586466	18.7	133.33333	N/A
344B PULP	0.16	0.591	4.4	0.044	1.84	0.01	<.02
% Recovery	10	11.150943	48.888889	82.706767	18.4	66.666667	N/A
375B PULP	0.2	0.61	4.3	0.048	1.91	<.01	<.02
% Recovery	12.5	11.509434	47.777778	90.225564	19.1	N/A	N/A
401B PULP	0.18	0.559	5.4	0.049	1.92	<.01	<.02
% Recovery	11.25	10.54717	60	92.105263	19.2	N/A	N/A
429B PULP	0.17	0.611	5.6	0.047	1.93	<.01	<.02
% Recovery	10.625	11.528302	62.222222	88.345865	19.3	N/A	N/A
458B PULP	0.15	0.545	4.5	0.048	1.88	<.01	<.02
% Recovery	9.375	10.283019	50	90.225564	18.8	N/A	N/A
484B PULP	0.16	0.555	5.3	0.05	1.96	<.01	<.02
% Recovery	10	10.471698	58.888889	93.984962	19.6	N/A	N/A
3815B PULP	0.16	0.544	4.7	0.05	1.99	<.01	<.02
% Recovery	10	10.264151	52.222222	93.984962	19.9	N/A	N/A
3846B PULP	0.18	0.538	4.7	0.048	1.94	<.01	<.02
% Recovery	11.25	10.150943	52.222222	90.225564	19.4	N/A	N/A
3876B PULP	0.17	0.596	5.5	0.055	2.1	<.01	<.02
% Recovery	10.625	11.245283	61.111111	103.38346	21	N/A	N/A
3909B PULP	0.16	0.584	5.5	0.052	2	<.01	<.02
% Recovery	10	11.018868	61.111111	97.744361	20	N/A	N/A
3935B PULP	0.18	0.614	5.3	0.053	2.13	<.01	<.02
% Recovery	11.25	11.584906	58.888889	99.62406	21.3	N/A	N/A
3960B PULP	0.17	0.545	5.2	0.05	2.07	<.01	<.02
% Recovery	10.625	10.283019	57.777778	93.984962	20.7	N/A	N/A
4534B PULP	0.18	0.591	4.6	0.048	1.96	<.01	<.02
% Recovery	11.25	11.150943	51.111111	90.225564	19.6	N/A	N/A
4568B PULP	0.17	0.536	5	0.048	1.87	<.01	<.02
% Recovery	10.625	10.113208	55.555556	90.225564	18.7	N/A	N/A
6006B PULP	0.2	0.556	5.4	0.05	1.84	<.01	<.02
% Recovery	12.5	10.490566	60	93.984962	18.4	N/A	N/A
6070B PULP	0.22	0.553	6	0.052	1.97	<.01	<.02
% Recovery	13.75	10.433962	66.666667	97.744361	19.7	N/A	N/A
SY-4 Value	1.6	5.3	9	0.0532	10	0.015	0.155
Average % Recovery	11.09375	10.770755	57.055556	91.635338	19.745	N/A	N/A
RSD	10.156482	4.6806254	9.4409957	5.7971285	5.1135825	N/A	N/A
						Over 25% values <LDL	Over 25% values <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Sc	Se	Sr	Te	Th	Ti	Tl
SAMPLES	ppm	ppm	ppm	ppm	ppm	%	ppm
SI	0.3	0.1	7.9	<.02	<.1	<.001	<.02
LDL	0.1	0.1	0.5	0.02	0.1	0.001	0.02
212B PULP	0.6	*0.05*	212.9	0.02	1	0.11	0.19
% Recovery	54.545455	2.4937656	17.875735	N/A	71.428571	67.692308	54.285714
252B PULP	0.8	0.2	213	< .02	1	0.104	0.21
% Recovery	72.727273	9.9750623	17.884131	N/A	71.428571	64	60
284B PULP	0.7	0.2	202.9	< .02	0.9	0.108	0.19
% Recovery	63.636364	9.9750623	17.036104	N/A	64.285714	66.461538	54.285714
312B PULP	0.7	0.1	198.2	< .02	0.8	0.109	0.18
% Recovery	63.636364	4.9875312	16.641478	N/A	57.142857	67.076923	51.428571
344B PULP	0.6	0.1	204.7	< .02	0.9	0.113	0.18
% Recovery	54.545455	4.9875312	17.187238	N/A	64.285714	69.538462	51.428571
375B PULP	0.5	*0.05*	214.9	< .02	1.1	0.106	0.19
% Recovery	45.454545	2.4937656	18.043661	N/A	78.571429	65.230769	54.285714
401B PULP	0.7	0.1	206.2	< .02	0.9	0.103	0.18
% Recovery	63.636364	4.9875312	17.313182	N/A	64.285714	63.384615	51.428571
429B PULP	0.7	0.3	217.5	< .02	1.2	0.108	0.19
% Recovery	63.636364	14.962594	18.261965	N/A	85.714286	66.461538	54.285714
458B PULP	0.7	0.3	198.6	< .02	0.9	0.102	0.18
% Recovery	63.636364	14.962594	16.675063	N/A	64.285714	62.769231	51.428571
484B PULP	0.7	0.4	201.8	0.02	1	0.114	0.18
% Recovery	63.636364	19.950125	16.943745	N/A	71.428571	70.153846	51.428571
3815B PULP	0.6	0.4	200.3	< .02	0.8	0.108	0.18
% Recovery	54.545455	19.950125	16.8178	N/A	57.142857	66.461538	51.428571
3846B PULP	0.6	0.4	197.4	< .02	0.9	0.106	0.18
% Recovery	54.545455	19.950125	16.574307	N/A	64.285714	65.230769	51.428571
3876B PULP	0.7	0.3	209.6	< .02	1.3	0.111	0.2
% Recovery	63.636364	14.962594	17.598657	N/A	92.857143	68.307692	57.142857
3909B PULP	0.7	0.2	206	< .02	0.9	0.11	0.19
% Recovery	63.636364	9.9750623	17.29639	N/A	64.285714	67.692308	54.285714
3935B PULP	0.7	0.4	208.1	< .02	0.9	0.104	0.18
% Recovery	63.636364	19.950125	17.472712	N/A	64.285714	64	51.428571
3960B PULP	0.6	0.3	207.6	< .02	0.9	0.107	0.18
% Recovery	54.545455	14.962594	17.43073	N/A	64.285714	65.846154	51.428571
4534B PULP	0.6	0.3	207.7	< .02	1	0.108	0.18
% Recovery	54.545455	14.962594	17.439127	N/A	71.428571	66.461538	51.428571
4568B PULP	0.7	0.3	198.2	< .02	1.1	0.1	0.18
% Recovery	63.636364	14.962594	16.641478	N/A	78.571429	61.538462	51.428571
6006B PULP	0.7	0.4	192	0.02	0.8	0.101	0.19
% Recovery	63.636364	19.950125	16.120907	N/A	57.142857	62.153846	54.285714
6070B PULP	0.7	0.5	208.5	< .02	1	0.11	0.19
% Recovery	63.636364	24.937656	17.506297	N/A	71.428571	67.692308	54.285714
SY-4 Value	1.1	2.005	1191	N/A	1.4	0.1625	0.35
Average % Recovery	60.454545	13.216958	17.238035	N/A	68.928571	65.907692	53.142857
RSD	10.087525	50.516806	3.2296673	N/A	13.563488	3.595872	4.4128101
		2 samples <LDL		Over 25% values <LDL			

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	U	V	W	Zn
SAMPLES	ppm	ppm	ppm	ppm
SI	0.01	< 2	0.7	0.8
LDL	0.1	2	0.1	0.1
212B PULP	0.34	5	< .1	51.4
% Recovery	42.5	62.5	N/A	55.268817
252B PULP	0.37	5	< .1	51
% Recovery	46.25	62.5	N/A	54.83871
284B PULP	0.36	5	< .1	47.8
% Recovery	45	62.5	N/A	51.397849
312B PULP	0.3	6	< .1	50.6
% Recovery	37.5	75	N/A	54.408602
344B PULP	0.4	6	< .1	51.1
% Recovery	50	75	N/A	54.946237
375B PULP	0.33	6	< .1	50.2
% Recovery	41.25	75	N/A	53.978495
401B PULP	0.37	5	< .1	48.1
% Recovery	46.25	62.5	N/A	51.72043
429B PULP	0.52	5	< .1	52.1
% Recovery	65	62.5	N/A	56.021505
458B PULP	0.35	4	< .1	45.8
% Recovery	43.75	50	N/A	49.247312
484B PULP	0.39	5	< .1	49.6
% Recovery	48.75	62.5	N/A	53.333333
3815B PULP	0.33	5	< .1	47.1
% Recovery	41.25	62.5	N/A	50.645161
3846B PULP	0.46	5	< .1	46.8
% Recovery	57.5	62.5	N/A	50.322581
3876B PULP	0.52	6	< .1	50.1
% Recovery	65	75	N/A	53.870968
3909B PULP	0.35	5	< .1	50.8
% Recovery	43.75	62.5	N/A	54.623656
3935B PULP	0.34	5	< .1	50.4
% Recovery	42.5	62.5	N/A	54.193548
3960B PULP	0.41	5	< .1	50.2
% Recovery	51.25	62.5	N/A	53.978495
4534B PULP	0.33	5	< .1	50.2
% Recovery	41.25	62.5	N/A	53.978495
4568B PULP	0.39	5	< .1	49.7
% Recovery	48.75	62.5	N/A	53.44086
6006B PULP	0.31	5	< .1	49.7
% Recovery	38.75	62.5	N/A	53.44086
6070B PULP	0.35	5	< .1	51.2
% Recovery	43.75	62.5	N/A	55.053763
SY-4 Value	0.8	8	7.6	93
Average % Recovery	47	64.375	N/A	53.435484
RSD	16.381088	9.5021453	N/A	3.4089942
			Over 25% values <LDL	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Analysis Date	Ag	Al	As	Au	B
SAMPLES		ppb	%	ppm	ppb	ppm
SI		4	<.01	<.1	0.6	1
LDL		2	0.01	0.1	0.2	1
230B PULP	Dec. 2003	6	1.75	<.1	<.2	6
% Recovery		0.359928	15.909091	N/A	N/A	38.709677
253B PULP	Dec. 2003	4	1.81	<.1	<.2	4
% Recovery		0.239952	16.454545	N/A	N/A	25.806452
339B PULP	Dec. 2003	6	1.78	<.1	0.2	5
% Recovery		0.359928	16.181818	N/A	N/A	32.258065
4549B PULP	Dec. 2003	9	1.77	<.1	0.4	4
% Recovery		0.539892	16.090909	N/A	N/A	25.806452
4587B PULP	Dec. 2003	7	1.74	<.1	0.5	4
% Recovery		0.419916	15.818182	N/A	N/A	25.806452
6094B PULP	Dec. 2003	13	1.79	<.1	0.9	5
% Recovery		0.779844	16.272727	N/A	N/A	32.258065
6145B PULP	Dec. 2003	9	1.8	<.1	<.2	4
% Recovery		0.539892	16.363636	N/A	N/A	25.806452
4549B PULP	March 2004					
% Recovery						
SY-4 Value		1667	11	1.05	N/A	15.5
Average % Recovery		0.4627646	16.155844	N/A	N/A	29.493088
RSD		37.95167	1.4424725	N/A	N/A	17.211158
				Over 25% values <LDL	Over 25% values <LDL	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Ba	Be	Bi	Ca	Cd	Ce
SAMPLES	ppm	ppm	ppm	%	ppm	ppm
SI	2.4	<.1	<.02	0.09	<.01	<.1
LDL	0.5	0.1	0.02	0.01	0.01	0.1
230B PULP	181.7	0.2	<.02	3.11	0.05	72
% Recovery	53.44117647	7.6923077	N/A	53.62068966	4.7619048	59.016393
253B PULP	191.5	0.5	<.02	3.26	0.05	78.6
% Recovery	56.32352941	19.230769	N/A	56.20689655	4.7619048	64.42623
339B PULP	193.3	0.2	<.02	3.29	0.06	77
% Recovery	56.85294118	7.6923077	N/A	56.72413793	5.7142857	63.114754
4549B PULP	188.6	0.6	<.02	3.22	0.06	78.3
% Recovery	55.47058824	23.076923	N/A	55.51724138	5.7142857	64.180328
4587B PULP	183.8	0.4	<.02	3.15	0.05	77.1
% Recovery	54.05882353	15.384615	N/A	54.31034483	4.7619048	63.196721
6094B PULP	187.3	0.4	<.02	3.26	0.06	77.8
% Recovery	55.08823529	15.384615	N/A	56.20689655	5.7142857	63.770492
6145B PULP	187.4	0.4	<.02	3.3	0.07	85.5
% Recovery	55.11764706	15.384615	N/A	56.89655172	6.6666667	70.081967
4549B PULP						
% Recovery						
SY-4 Value	340	2.6	0.2	5.8	1.05	122
Average % Recovery	55.19327731	14.835165	N/A	55.64039409	5.4421769	63.969555
RSD	2.154263844	37.95167	N/A	2.232468865	13.228757	5.0861885
			Over 25% values <LDL			

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Co	Cr	Cs	Cu	Fe	Ga	Ge
SAMPLES	ppm	ppm	ppm	ppm	%	ppm	ppm
SI	<.1	<.5	0.01	1.41	0.02	<.1	<.1
LDL	0.1	0.5	0.02	0.01	0.01	0.1	0.1
230B PULP	2.1	8.3	1.38	3.34	3.89	14.2	0.1
% Recovery	75	69.166667	92	47.714286	92.619048	40.571429	4
253B PULP	2.2	8.5	1.42	3.48	4.04	14.9	<.1
% Recovery	78.571429	70.833333	94.666667	49.714286	96.190476	42.571429	N/A
339B PULP	2.2	8.9	1.45	3.63	4.01	14.8	<.1
% Recovery	78.571429	74.166667	96.666667	51.857143	95.47619	42.285714	N/A
4549B PULP	2	8.3	1.45	3.41	3.95	15	<.1
% Recovery	71.428571	69.166667	96.666667	48.714286	94.047619	42.857143	N/A
4587B PULP	2.1	7.8	1.43	3.55	3.85	14.3	<.1
% Recovery	75	65	95.333333	50.714286	91.666667	40.857143	N/A
6094B PULP	2	7.9	1.4	3.87	3.99	14.7	<.1
% Recovery	71.428571	65.833333	93.333333	55.285714	95	42	N/A
6145B PULP	2.2	8.9	1.49	3.52	4.02	15.7	0.1
% Recovery	78.571429	74.166667	99.333333	50.285714	95.714286	44.857143	4
4549B PULP							
% Recovery							
SY-4 Value	2.8	12	1.5	7	4.2	35	2.5
Average % Recovery	75.510204	69.761905	95.428571	50.612245	94.387755	42.285714	N/A
RSD	4.2555053	5.1938097	2.5326502	4.8608365	1.7947007	3.3557803	N/A
							Over 25% values <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Hf	Hg	In	K	La	Li	Mg
SAMPLES	ppm	ppb	ppm	%	ppm	ppm	%
SI	< .02	< 5	< .02	< .01	< .5	0.1	< .01
LDL	0.02	5	0.02	0.01	0.5	0.1	0.01
230B PULP	0.05	< 5	0.02	0.59	35.3	27	0.27
% Recovery	0.4716981	N/A	28.571429	41.843972	60.862069	72.972973	90
253B PULP	0.06	< 5	0.02	0.62	36.3	28.1	0.28
% Recovery	0.5660377	N/A	28.571429	43.971631	62.586207	75.945946	93.333333
339B PULP	0.05	< 5	0.03	0.62	36.7	29.3	0.28
% Recovery	0.4716981	N/A	42.857143	43.971631	63.275862	79.189189	93.333333
4549B PULP	0.04	< 5	0.03	0.6	35.8	29.4	0.28
% Recovery	0.3773585	N/A	42.857143	42.553191	61.724138	79.459459	93.333333
4587B PULP	0.04	10	0.04	0.6	36.4	28	0.27
% Recovery	0.3773585	83.333333	57.142857	42.553191	62.758621	75.675676	90
6094B PULP	0.03	< 5	0.03	0.61	35.9	28.8	0.28
% Recovery	0.2830189	N/A	42.857143	43.262411	61.896552	77.837838	93.333333
6145B PULP	*0.01*	< 5	0.03	0.59	37.6	28.4	0.27
% Recovery	0.0943396	N/A	42.857143	41.843972	64.827586	76.756757	90
4549B PULP							
% Recovery							
SY-4 Value	10.6	12	0.07	1.41	58	37	0.3
Average % Recovery	0.3773585	N/A	40.816327	42.857143	62.561576	76.833977	91.904762
RSD	40.824829	N/A	24.152295	2.1056563	2.0340784	2.9340021	1.9386826
	1 value <LDL	Over 25% values <LDL					

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Mn	Mo	Na	Nb	Ni	P	Pb
SAMPLES	ppm	ppm	%	ppm	ppm	%	ppm
SI	< 1	0.03	0.422	< .02	0.1	< .001	0.27
LDL	1	0.01	0.001	0.02	0.1	0.001	0.01
230B PULP	777	0.19	0.559	0.67	4.9	0.051	1.91
% Recovery	94.871795	11.875	10.54717	5.1538462	54.444444	95.864662	19.1
253B PULP	807	0.18	0.579	0.69	5.4	0.053	2.05
% Recovery	98.534799	11.25	10.924528	5.3076923	60	99.62406	20.5
339B PULP	801	0.21	0.583	0.67	5	0.053	2.05
% Recovery	97.802198	13.125	11	5.1538462	55.555556	99.62406	20.5
4549B PULP	791	0.21	0.583	0.78	5.6	0.052	2.02
% Recovery	96.581197	13.125	11	6	62.222222	97.744361	20.2
4587B PULP	764	0.17	0.577	0.83	5.1	0.052	1.99
% Recovery	93.284493	10.625	10.886792	6.3846154	56.666667	97.744361	19.9
6094B PULP	806	0.2	0.564	0.75	5.2	0.051	1.89
% Recovery	98.412698	12.5	10.641509	5.7692308	57.777778	95.864662	18.9
6145B PULP	780	0.27	0.573	0.76	6	0.054	2.2
% Recovery	95.238095	16.875	10.811321	5.8461538	66.666667	101.50376	22
4549B PULP							
% Recovery							
SY-4 Value	819	1.6	5.3	13	9	0.0532	10
Average % Recovery	96.389325	12.767857	10.830189	5.6593407	59.047619	98.281418	20.157143
RSD	2.0748463	15.95162	1.6249789	8.2996933	7.2414518	2.1281096	5.1225762

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Pd	Pt	Rb	Re	S	Sb	Sc
SAMPLES	ppb	ppb	ppm	ppb	%	ppm	ppm
SI	< 10	< 2	0.1	< 1	0.01	0.14	< .1
LDL	10	2	0.1	1	0.02	0.02	0.1
230B PULP	< 10	< 2	41.8	3	< .01	< .02	0.6
% Recovery	N/A	N/A	76	N/A	N/A	N/A	54.545455
253B PULP	< 10	< 2	43.6	1	< .01	< .02	0.7
% Recovery	N/A	N/A	79.272727	N/A	N/A	N/A	63.636364
339B PULP	< 10	< 2	43.9	4	< .01	< .02	0.7
% Recovery	N/A	N/A	79.818182	N/A	N/A	N/A	63.636364
4549B PULP	< 10	< 2	44.2	2	< .01	< .02	0.8
% Recovery	N/A	N/A	80.363636	N/A	N/A	N/A	72.727273
4587B PULP	< 10	< 2	42.8	< 1	< .01	< .02	0.8
% Recovery	N/A	N/A	77.818182	N/A	N/A	N/A	72.727273
6094B PULP	< 10	< 2	43.3	3	< .01	0.02	0.7
% Recovery	N/A	N/A	78.727273	N/A	N/A	12.903226	63.636364
6145B PULP	< 10	< 2	45.2	< 1	< .01	< .02	0.7
% Recovery	N/A	N/A	82.181818	N/A	N/A	N/A	63.636364
4549B PULP							
% Recovery							
SY-4 Value	N/A	N/A	55	N/A	0.015	0.155	1.1
Average % Recovery	N/A	N/A	79.168831	N/A	N/A	N/A	64.935065
RSD	N/A	N/A	2.4729931	N/A	N/A	N/A	9.6609178
	Over 25% values <LDL	Over 25% values <LDL		Over 25% values <LDL	Over 25% values <LDL	Over 25% values <LDL	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Se	Sn	Sr	Ta	Te	Th	Ti
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm	%
SI	<.1	<.1	2.1	<.05	<.02	<.1	0.001
LDL	0.1	0.1	0.5	0.05	0.02	0.1	0.001
230B PULP	0.3	6.4	203.5	<.05	<.02	0.9	0.108
% Recovery	14.962594	90.140845	17.086482	N/A	N/A	64.285714	66.461538
253B PULP	0.4	6.8	212.6	<.05	<.02	1.1	0.117
% Recovery	19.950125	95.774648	17.850546	N/A	N/A	78.571429	72
339B PULP	0.3	7	212.3	<.05	<.02	0.9	0.118
% Recovery	14.962594	98.591549	17.825357	N/A	N/A	64.285714	72.615385
4549B PULP	0.2	6.2	209.4	<.05	<.02	1	0.109
% Recovery	9.9750623	87.323944	17.581864	N/A	N/A	71.428571	67.076923
4587B PULP	0.3	6.7	202.3	<.05	<.02	1.2	0.118
% Recovery	14.962594	94.366197	16.985726	N/A	N/A	85.714286	72.615385
6094B PULP	0.2	6.5	209.1	<.05	<.02	0.9	0.123
% Recovery	9.9750623	91.549296	17.556675	N/A	N/A	64.285714	75.692308
6145B PULP	0.5	7.2	205.2	<.05	<.02	1	0.11
% Recovery	24.937656	101.40845	17.229219	N/A	N/A	71.428571	67.692308
4549B PULP							
% Recovery							
SY-4 Value	2.005	7.1	1191	0.9	N/A	1.4	0.1625
Average % Recovery	15.675098	94.16499	17.445124	N/A	N/A	71.428571	70.593407
RSD	34.015067	5.2120987	1.9944788	N/A	N/A	11.547005	4.9750895
				Over 25% values <LDL	Over 25% values <LDL		

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, Standards

ELEMENT	Tl	U	V	W	Y	Zn	Zr
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	<.02	<.01	<2	<.1	0.02	0.5	0.3
LDL	0.02	0.1	2	0.1	0.01	0.1	0.1
230B PULP	0.19	0.33	4	<.1	104.6	50.2	1.5
% Recovery	54.285714	41.25	50	N/A	87.89916	53.978495	0.2901354
253B PULP	0.19	0.42	5	<.1	106.93	49.4	1.7
% Recovery	54.285714	52.5	62.5	N/A	89.857143	53.11828	0.3288201
339B PULP	0.19	0.36	5	<.1	105.03	52.3	1.5
% Recovery	54.285714	45	62.5	N/A	88.260504	56.236559	0.2901354
4549B PULP	0.19	0.36	5	<.1	105.19	50.2	1.7
% Recovery	54.285714	45	62.5	N/A	88.394958	53.978495	0.3288201
4587B PULP	0.2	0.34	5	<.1	104.36	49.6	1.7
% Recovery	57.142857	42.5	62.5	N/A	87.697479	53.333333	0.3288201
6094B PULP	0.2	0.39	5	<.1	105.93	52	1.6
% Recovery	57.142857	48.75	62.5	N/A	89.016807	55.913978	0.3094778
6145B PULP	0.2	0.35	5	<.1	100.26	48.4	1.8
% Recovery	57.142857	43.75	62.5	N/A	84.252101	52.043011	0.3481625
4549B PULP							
% Recovery							
SY-4 Value	0.35	0.8	8	7.6	119	93	517
Average % Recovery	55.510204	45.535714	60.714286	N/A	87.911164	54.086022	0.3177673
RSD	2.7512187	8.5138089	7.7816215	N/A	2.0135313	2.7903914	6.9019599
				Over 25% values <LDL			

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, Standards

ELEMENT	Ag	Al	As	Au	Ba	Be	Bi
SAMPLES	ppm	%	ppm	ppm	ppm	ppm	ppm
SI	<.1	0.89	<1	<.1	145	<1	<.1
LDL	0.1	0.01	1	0.1	1	1	0.1
230B PULP	<.1	9.53	2	<.1	306	5	<.1
% Recovery	N/A	86.636364	190.47619	N/A	90	192.30769	N/A
253B PULP	<.1	9.48	2	<.1	319	3	<.1
% Recovery	N/A	86.181818	190.47619	N/A	93.823529	115.38462	N/A
339B PULP	<.1	9.1	2	<.1	298	2	<.1
% Recovery	N/A	82.727273	190.47619	N/A	87.647059	76.923077	N/A
4549B PULP	<.1	8.84	2	<.1	290	3	<.1
% Recovery	N/A	80.363636	190.47619	N/A	85.294118	115.38462	N/A
4587B PULP	<.1	8.78	3	<.1	244	2	<.1
% Recovery	N/A	79.818182	285.71429	N/A	71.764706	76.923077	N/A
6094B PULP	<.1	8.77	1	<.1	275	3	<.1
% Recovery	N/A	79.727273	95.238095	N/A	80.882353	115.38462	N/A
6145B PULP	<.1	8.86	2	<.1	299	3	<.1
% Recovery	N/A	80.545455	190.47619	N/A	87.941176	115.38462	N/A
4549B PULP	<.1	8.23	2	<.1	368	3	<.1
% Recovery	N/A	74.818182	190.47619	N/A	108.23529	115.38462	N/A
SY-4 Value	0.6	11	1.05	N/A	340	2.6	0.2
Average % Recovery	N/A	81.352273	190.47619	N/A	88.198529	115.38462	N/A
RSD	N/A	4.7026723	26.726124	N/A	11.881883	30.86067	N/A
	Over 25% values <LDL			Over 25% values <LDL			Over 25% values <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, Standards

ELEMENT	Ca	Cd	Ce	Co	Cr	Cu	Fe
SAMPLES	%	ppm	ppm	ppm	ppm	ppm	%
SI	7.19	0.2	3	< 1	0.1	4.5	0.07
LDL	0.01	0.1	1	1	0.1	0.1	0.01
230B PULP	5.36	0.1	84	2	10.4	3.9	4.18
% Recovery	92.413793	9.5238095	68.852459	71.428571	86.666667	55.714286	99.52381
253B PULP	5.23	0.1	91	2	9.5	3.5	4.3
% Recovery	90.172414	9.5238095	74.590164	71.428571	79.166667	50	102.38095
339B PULP	5.2	0.1	81	1	8.5	3.3	4.3
% Recovery	89.655172	9.5238095	66.393443	35.714286	70.833333	47.142857	102.38095
4549B PULP	5.13	0.2	68	1	11.7	4.4	4.22
% Recovery	88.448276	19.047619	55.737705	35.714286	97.5	62.857143	100.47619
4587B PULP	5.08	0.1	58	1	11	3.9	4
% Recovery	87.586207	9.5238095	47.540984	35.714286	91.666667	55.714286	95.238095
6094B PULP	5	0.1	64	1	11.7	3.9	3.97
% Recovery	86.206897	9.5238095	52.459016	35.714286	97.5	55.714286	94.52381
6145B PULP	5.29	0.05	71	2	10.5	4.7	4.14
% Recovery	91.206897	4.7619048	58.196721	71.428571	87.5	67.142857	98.571429
4549B PULP	5.88	0.1	121	4	7	4.1	4.45
% Recovery	101.37931	9.5238095	99.180328	142.85714	58.333333	58.571429	105.95238
SY-4 Value	5.8	1.05	122	2.8	12	7	4.2
Average % Recovery	90.883621	10.119048	65.368852	62.5	83.645833	56.607143	99.880952
RSD	5.1490922	39.271669	25.004369	59.148477	16.274188	11.361473	3.8183188
		1 value <LDL					

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, Standards

ELEMENT	Hf	K	La	Li	Mg	Mn	Mo
SAMPLES	ppm	%	ppm	ppm	%	ppm	ppm
SI	0.6	0.19	2	1.8	0.14	17	0.4
LDL	0.1	0.01	0.1	0.1	0.01	1	0.1
230B PULP	0.7	1.24	34.9	38	0.26	876	0.2
% Recovery	6.6037736	87.943262	60.172414	102.7027	86.666667	106.95971	12.5
253B PULP	1.1	1.24	35.9	36.1	0.26	854	0.1
% Recovery	10.377358	87.943262	61.896552	97.567568	86.666667	104.2735	6.25
339B PULP	0.9	1.23	29.4	34.8	0.25	850	0.2
% Recovery	8.490566	87.234043	50.689655	94.054054	83.333333	103.7851	12.5
4549B PULP	0.8	1.25	32	37.5	0.24	872	0.2
% Recovery	7.5471698	88.652482	55.172414	101.35135	80	106.47131	12.5
4587B PULP	0.8	1.26	25.7	31.4	0.22	811	0.2
% Recovery	7.5471698	89.361702	44.310345	84.864865	73.333333	99.023199	12.5
6094B PULP	1	1.22	29.4	39.7	0.24	803	0.2
% Recovery	9.4339623	86.524823	50.689655	107.2973	80	98.046398	12.5
6145B PULP	1	1.27	32.6	36.3	0.25	863	0.1
% Recovery	9.4339623	90.070922	56.206897	98.108108	83.333333	105.37241	6.25
4549B PULP	1.1	1.37	65	38.8	0.23	902	0.2
% Recovery	10.377358	97.163121	112.06897	104.86486	76.666667	110.13431	12.5
SY-4 Value	10.6	1.41	58	37	0.3	819	1.6
Average % Recovery	8.7264151	89.361702	61.400862	98.851351	81.25	104.25824	10.9375
RSD	16.087001	3.7466466	34.583391	7.1472592	5.7759424	3.8738176	26.452003

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, Standards

ELEMENT	Na	Nb	Ni	P	Pb	Rb	S
SAMPLES	%	ppm	ppm	%	ppm	ppm	%
SI	9.652	0.2	<.1	0.008	11.4	2.8	0.2
LDL	0.001	0.1	0.1	0.001	0.1	0.1	0.1
230B PULP	5.053	11.2	4.2	0.05	9.2	36.2	<.1
% Recovery	95.339623	86.153846	46.666667	93.984962	92	65.818182	N/A
253B PULP	5.048	11.6	3.6	0.05	9.2	37.8	<.1
% Recovery	95.245283	89.230769	40	93.984962	92	68.727273	N/A
339B PULP	4.727	11	3.6	0.048	8.2	31.8	<.1
% Recovery	89.188679	84.615385	40	90.225564	82	57.818182	N/A
4549B PULP	5.286	12.3	3.7	0.047	8.5	25.2	<.1
% Recovery	99.735849	94.615385	41.111111	88.345865	85	45.818182	N/A
4587B PULP	4.622	11.1	4.6	0.044	7.9	30.5	0.1
% Recovery	87.207547	85.384615	51.111111	82.706767	79	55.454545	666.66667
6094B PULP	5.382	12	4	0.048	8.6	26.8	0.1
% Recovery	101.54717	92.307692	44.444444	90.225564	86	48.727273	666.66667
6145B PULP	4.905	11.1	3.8	0.051	8.7	29.2	<.1
% Recovery	92.54717	85.384615	42.222222	95.864662	87	53.090909	N/A
4549B PULP	5.212	12.5	5.5	0.06	9.2	46.4	<.1
% Recovery	98.339623	96.153846	61.111111	112.78195	92	84.363636	N/A
SY-4 Value	5.3	13	9	0.0532	10	55	0.015
Average % Recovery	94.893868	89.230769	45.833333	93.515038	86.875	59.977273	N/A
RSD	5.2997011	5.1311987	15.804127	9.4126538	5.6537792	20.947706	N/A
							Over 25% values <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, Standards

ELEMENT	Sb	Sc	Sn	Sr	Ta	Th	Ti
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm	%
SI	0.9	< 1	2.4	167	< .1	0.3	0.032
LDL	0.1	1	0.1	1	0.1	0.1	0.01
230B PULP	< .1	1	7.1	1053	0.7	1.1	0.184
% Recovery	N/A	90.909091	100	88.413098	77.777778	78.571429	113.23077
253B PULP	< .1	< 1	6.9	1031	0.6	1	0.18
% Recovery	N/A	N/A	97.183099	86.565911	66.666667	71.428571	110.76923
339B PULP	0.1	< 1	6.7	1003	0.6	0.9	0.178
% Recovery	64.516129	N/A	94.366197	84.214945	66.666667	64.285714	109.53846
4549B PULP	< .1	< 1	8.4	966	0.8	0.8	0.17
% Recovery	N/A	N/A	118.30986	81.108312	88.888889	57.142857	104.61538
4587B PULP	< .1	1	6.3	913	0.8	0.7	0.167
% Recovery	N/A	90.909091	88.732394	76.65827	88.888889	50	102.76923
6094B PULP	0.1	< 1	7.6	955	0.8	0.7	0.188
% Recovery	64.516129	N/A	107.04225	80.184719	88.888889	50	115.69231
6145B PULP	< .1	1	7.2	1022	0.6	0.7	0.173
% Recovery	N/A	90.909091	101.40845	85.810243	66.666667	50	106.46154
4549B PULP	< .1	1	8.3	1202	0.8	1.3	0.201
% Recovery	N/A	90.909091	116.90141	100.92359	88.888889	92.857143	123.69231
SY-4 Value	0.155	1.1	7.1	1191	0.9	1.4	0.1625
Average % Recovery	N/A	N/A	102.99296	85.484887	79.166667	64.285714	110.84615
RSD	N/A	N/A	10.166476	8.5617054	13.90921	24.487696	6.0919815
	Over 25% values <LDL	Over 25% values <LDL					

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, Standards

ELEMENT	U	V	W	Y	Zn	Zr
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.3	< 1	0.2	2.8	15	26.3
LDL	0.1	1	0.1	0.1	1	0.1
230B PULP	0.7	7	< .1	87	95	38.2
% Recovery	87.5	87.5	N/A	73.109244	102.15054	7.3887814
253B PULP	0.4	6	< .1	90.9	89	42.1
% Recovery	50	75	N/A	76.386555	95.698925	8.1431335
339B PULP	0.3	9	0.1	82.9	90	39.8
% Recovery	37.5	112.5	1.3157895	69.663866	96.774194	7.6982592
4549B PULP	0.4	7	< .1	78	92	45.2
% Recovery	50	87.5	N/A	65.546218	98.924731	8.7427466
4587B PULP	0.3	11	0.1	68.7	90	44.3
% Recovery	37.5	137.5	1.3157895	57.731092	96.774194	8.5686654
6094B PULP	0.2	13	< .1	75.6	95	49.9
% Recovery	25	162.5	N/A	63.529412	102.15054	9.6518375
6145B PULP	0.3	7	< .1	79.4	94	46.8
% Recovery	37.5	87.5	N/A	66.722689	101.07527	9.0522244
4549B PULP	0.7	9	0.1	119.6	96	52.9
% Recovery	87.5	112.5	1.3157895	100.5042	103.22581	10.232108
SY-4 Value	0.8	8	7.6	119	93	517
Average % Recovery	51.5625	107.8125	N/A	71.64916	99.596774	8.6847195
RSD	45.699197	27.672107	N/A	18.13851	2.9390151	11.033574
			Over 25% values <LDL			

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, ACME File #A305987, Standards

ELEMENT	Ce	Co	Cs	Dy	Er	Eu	Ga
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	3.4	<.5	<.1	0.33	0.24	0.24	1.5
LDL	0.5	0.5	0.1	0.05	0.05	0.05	0.5
230B PULP	127.9	2.4	1.4	18.95	14.6	2.01	37.2
% Recovery	104.83607	85.714286	93.333333	104.12088	102.8169	100.5	106.28571
253B PULP	125.4	2.1	1.4	18.95	14.61	2.06	35.4
% Recovery	102.78689	75	93.333333	104.12088	102.88732	103	101.14286
339B PULP	132.8	2.6	1.6	18.97	15.14	2.12	35.9
% Recovery	108.85246	92.857143	106.66667	104.23077	106.61972	106	102.57143
4549B PULP	129.6	2.1	1.7	19.34	14.43	1.82	37
% Recovery	106.22951	75	113.33333	106.26374	101.61972	91	105.71429
4587B PULP	129	2.4	1.8	19.87	14.53	1.92	37.7
% Recovery	105.7377	85.714286	120	109.17582	102.32394	96	107.71429
6094B PULP	121.9	2.2	1.4	19.02	14.31	1.82	35.1
% Recovery	99.918033	78.571429	93.333333	104.50549	100.77465	91	100.28571
6145B PULP	128.8	2.1	1.5	18.75	13.48	1.75	34.1
% Recovery	105.57377	75	100	103.02198	94.929577	87.5	97.428571
4549B PULP	135.8	2.5	1.6	19.64	14.74	2.01	36.6
% Recovery	111.31148	89.285714	106.66667	107.91209	103.80282	100.5	104.57143
SY-4 Value	122	2.8	1.5	18.2	14.2	2	35
Average % Recovery	105.65574	82.142857	103.33333	105.41896	101.97183	96.9375	103.21429
RSD	3.28593	8.6956522	9.7539219	2.0409819	3.2689692	6.8062634	3.3668066

Analysis: GROUP 4B - REE - 0.200 GM, ACME File #A305987, Standards

ELEMENT	Gd	Hf	Ho	La	Lu	Nb	Nd
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.55	2.4	0.09	1.8	0.04	<.5	2
LDL	0.05	0.5	0.05	0.5	0.01	0.5	0.4
230B PULP	15.2	10.6	4.46	57.5	2.01	13.7	61.3
% Recovery	108.57143	100	103.72093	99.137931	95.714286	105.38462	107.54386
253B PULP	15.03	10.5	4.6	54.8	1.96	13.1	61.8
% Recovery	107.35714	99.056604	106.97674	94.482759	93.333333	100.76923	108.42105
339B PULP	15.12	12.7	4.71	59	2.1	14	66
% Recovery	108	119.81132	109.53488	101.72414	100	107.69231	115.78947
4549B PULP	14.03	11.1	4.54	55.5	2.14	13.3	58.4
% Recovery	100.21429	104.71698	105.5814	95.689655	101.90476	102.30769	102.45614
4587B PULP	14.13	11	4.55	56.4	2.11	13.7	60.5
% Recovery	100.92857	103.77358	105.81395	97.241379	100.47619	105.38462	106.14035
6094B PULP	14	11	4.45	54.7	2.12	13.6	58.2
% Recovery	100	103.77358	103.48837	94.310345	100.95238	104.61538	102.10526
6145B PULP	13.89	11.2	3.96	53.6	1.98	13.6	56.4
% Recovery	99.214286	105.66038	92.093023	92.413793	94.285714	104.61538	98.947368
4549B PULP	14.97	10.6	4.64	59	2.03	13.2	58.7
% Recovery	106.92857	100	107.90698	101.72414	96.666667	101.53846	102.98246
SY-4 Value	14	10.6	4.3	58	2.1	13	57
Average % Recovery	103.90179	104.59906	104.38953	97.090517	97.916667	104.03846	105.54825
RSD	3.9738721	6.3306485	5.1390331	3.6000345	3.3787269	2.2268992	4.9235187

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, ACME File #A305987, Standards

ELEMENT	Pr	Sn	Rb	Sm	Sr	Ta	Tb
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.44	4	2.8	0.4	167.8	<.1	0.09
LDL	0.02	1	0.5	0.1	0.5	0.1	0.01
230B PULP	14.79	7	54	12.9	1195	0.8	2.9
% Recovery	98.6	98.591549	98.181818	101.5748	100.33585	88.888889	111.53846
253B PULP	15.45	8	54.1	13.5	1205.3	0.8	3.01
% Recovery	103	112.67606	98.363636	106.29921	101.20067	88.888889	115.76923
339B PULP	16.09	8	55.4	13.5	1265.1	0.7	3.13
% Recovery	107.26667	112.67606	100.72727	106.29921	106.22166	77.777778	120.38462
4549B PULP	15.17	7	54.1	13	1203	0.8	2.86
% Recovery	101.13333	98.591549	98.363636	102.3622	101.00756	88.888889	110
4587B PULP	15.45	10	56.2	13.9	1255	0.8	2.76
% Recovery	103	140.84507	102.18182	109.44882	105.37364	88.888889	106.15385
6094B PULP	14.95	6	53.9	13.8	1237.9	0.8	2.68
% Recovery	99.666667	84.507042	98	108.66142	103.93787	88.888889	103.07692
6145B PULP	14.7	5	51.7	12.7	1196.2	0.8	2.74
% Recovery	98	70.422535	94	100	100.43661	88.888889	105.38462
4549B PULP	15.58	6	55.8	13.4	1257.7	0.8	2.9
% Recovery	103.86667	84.507042	101.45455	105.51181	105.60034	88.888889	111.53846
SY-4 Value	15	7.1	55	12.7	1191	0.9	2.6
Average % Recovery	101.81667	100.35211	98.909091	105.01969	103.01427	87.5	110.48077
RSD	3.0319634	21.791544	2.6070743	3.22953	2.4483599	4.4895669	5.1660988

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, ACME File #A305987, Standards

ELEMENT	Th	Tm	U	V	W	Y	Yb
SAMPLES	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.4	<.05	0.3	<5	0.1	2.9	0.27
LDL	0.1	0.05	0.1	5	0.1	0.1	0.05
230B PULP	1.4	2.29	0.7	5	0.2	126.6	15.1
% Recovery	100	99.565217	87.5	62.5	2.6315789	106.38655	102.02703
253B PULP	2	2.44	1	< 5	4.5	120.6	15.44
% Recovery	142.85714	106.08696	125	N/A	59.210526	101.34454	104.32432
339B PULP	2.4	2.63	1.3	5	0.2	129.9	15.43
% Recovery	171.42857	114.34783	162.5	62.5	2.6315789	109.15966	104.25676
4549B PULP	2.2	2.37	1.1	< 5	0.05	129.8	15
% Recovery	157.14286	103.04348	137.5	N/A	0.6578947	109.07563	101.35135
4587B PULP	1	2.44	0.8	5	0.1	132.6	15.98
% Recovery	71.428571	106.08696	100	62.5	1.3157895	111.42857	107.97297
6094B PULP	1.3	2.4	0.8	< 5	0.1	124	14.81
% Recovery	92.857143	104.34783	100	N/A	1.3157895	104.20168	100.06757
6145B PULP	1	2.08	0.9	< 5	0.1	124	14.26
% Recovery	71.428571	90.434783	112.5	N/A	1.3157895	104.20168	96.351351
4549B PULP	1.7	2.46	0.9	6	0.05	133.9	15.07
% Recovery	121.42857	106.95652	112.5	75	0.6578947	112.52101	101.82432
SY-4 Value	1.4	2.3	0.8	8	7.6	119	14.8
Average % Recovery	116.07143	103.8587	117.1875	N/A	8.7171053	107.28992	102.27196
RSD	33.016812	6.601826	20.507838	N/A	234.21428	3.6340804	3.3399221
				Over 25% values <LDL	2 values <LDL		

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, ACME File #A305987, Standards

ELEMENT	Zr
SAMPLES	ppm
SI	85.7
LDL	0.5
230B PULP	493.4
% Recovery	95.435203
253B PULP	503.5
% Recovery	97.388781
339B PULP	565.4
% Recovery	109.3617
4549B PULP	505.8
% Recovery	97.833656
4587B PULP	527.8
% Recovery	102.08897
6094B PULP	551.3
% Recovery	106.63443
6145B PULP	525
% Recovery	101.54739
4549B PULP	515.5
% Recovery	99.709865
SY-4 Value	517
Average % Recovery	101.25
RSD	4.6974568

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM, Standards

ELEMENT	Al2O3	Ba	CaO	Cr2O3	Cr2O3	Fe2O3	K2O
SAMPLES	%	ppm	%	%	%	%	%
SI							
LDL	0.03	5	0.01	0.001	0.001	0.04	0.04
230B PULP	20.54	348	8.35	< .001	0.001	6.32	1.66
% Recovery	99.275012	102.35294	103.72671	N/A	N/A	101.77134	100
253B PULP	20.36	335	8.31	< .001	0.0009	6.28	1.67
% Recovery	98.405027	98.529412	103.22981	N/A	N/A	101.12721	100.60241
339B PULP	20.34	339	8.33	0.002	0.0012	6.3	1.66
% Recovery	98.308362	99.705882	103.47826	N/A	N/A	101.44928	100
4549B PULP	20.9	341	8.15	< .001	0.0009	6.02	1.63
% Recovery	101.01498	100.29412	101.24224	N/A	N/A	96.940419	98.192771
4587B PULP	20.96	335	8.23	< .001	0.001	6.08	1.65
% Recovery	101.30498	98.529412	102.23602	N/A	N/A	97.906602	99.39759
6094B PULP	21.02	330	8.24	< .001	0.001	6.09	1.65
% Recovery	101.59497	97.058824	102.36025	N/A	N/A	98.067633	99.39759
6145B PULP	20.64	347	8.19	< .001	0.0009	6.29	1.62
% Recovery	99.758337	102.05882	101.73913	N/A	N/A	101.28824	97.590361
4549B PULP	20.82	335.7	8.31	< .001	0.0011	6.39	1.7
% Recovery	100.62832	98.735294	103.22981	N/A	N/A	102.89855	102.40964
SY-4 Value	20.69	340	8.05	N/A	N/A	6.21	1.66
Average % Recovery	100.03625	99.658088	102.65528	N/A	N/A	100.18116	99.698795
RSD	1.289658	1.8419811	0.8700678	N/A	N/A	2.1929297	1.4800542
				Over 25% values <LDL	Over 25% values <LDL		

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM, Standards

ELEMENT	LOI	MgO	MnO	Na2O	Ni	P2O5	Sc
SAMPLES	%	%	%	%	ppm	%	ppm
SI							
LDL	0.1	0.01	0.01	0.01	30	0.01	1
230B PULP	3.8	0.53	0.1	7.6	< 20	0.12	*0.5*
% Recovery	83.333333	98.148148	92.592593	107.04225	N/A	91.603053	45.454545
253B PULP	4.2	0.53	0.1	7.6	< 20	0.11	1
% Recovery	92.105263	98.148148	92.592593	107.04225	N/A	83.969466	90.909091
339B PULP	4.4	0.53	0.1	7.69	< 20	0.13	1
% Recovery	96.491228	98.148148	92.592593	108.30986	N/A	99.236641	90.909091
4549B PULP	4.1	0.54	0.1	6.83	< 20	0.13	1
% Recovery	89.912281	100	92.592593	96.197183	N/A	99.236641	90.909091
4587B PULP	4	0.54	0.1	7.04	< 20	0.12	*0.5*
% Recovery	87.719298	100	92.592593	99.15493	N/A	91.603053	45.454545
6094B PULP	4	0.55	0.1	7.2	< 20	0.13	1
% Recovery	87.719298	101.85185	92.592593	101.40845	N/A	99.236641	90.909091
6145B PULP	4.5	0.54	0.1	7.16	24	0.11	1
% Recovery	98.684211	100	92.592593	100.84507	266.66667	83.969466	90.909091
4549B PULP	4.4	0.54	0.1	7.02	< 20	0.12	1
% Recovery	96.491228	100	92.592593	98.873239	N/A	91.603053	90.909091
SY-4 Value	4.56	0.54	0.108	7.1	9	0.131	1.1
Average % Recovery	91.557018	99.537037	92.592593	102.35915	N/A	92.557252	79.545455
RSD	5.8320139	1.3155475	0	4.413442	N/A	6.8826636	26.452003
					Over 25% values <LDL		2 values <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM, Standards

ELEMENT	SiO2	TiO2
SAMPLES	%	%
SI		
LDL	0.02	0.01
230B PULP	50.32	0.29
% Recovery	100.84168	101.0453
253B PULP	50.11	0.29
% Recovery	100.42084	101.0453
339B PULP	49.83	0.29
% Recovery	99.859719	101.0453
4549B PULP	50.85	0.29
% Recovery	101.90381	101.0453
4587B PULP	50.54	0.29
% Recovery	101.28257	101.0453
6094B PULP	50.29	0.29
% Recovery	100.78156	101.0453
6145B PULP	50.27	0.29
% Recovery	100.74148	101.0453
4549B PULP	49.78	0.29
% Recovery	99.759519	101.0453
SY-4 Value	49.9	0.287
Average % Recovery	100.6989	101.0453
RSD	0.7007408	0

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: CO2, ACME File #A305987, Standards

ELEMENT	TOT/C	TOT/S	SUM	C/ORG	C/GRA	CO2	SO4
SAMPLES	%	%	%	%	%	%	%
SI				2.34	< .02	0.06	0.26
LDL	0.01	0.01					
230B PULP	1.11	0.02	99.67	0.12	0.1	3.29	0.06
% Recovery	111	133.33333	N/A	N/A	N/A	94	N/A
253B PULP	1.08	0.02	99.6	0.09	0.09	3.29	0.12
% Recovery	108	133.33333	N/A	N/A	N/A	94	N/A
339B PULP	1.1	< .01	99.63	0.11	0.09	3.31	0.09
% Recovery	110	N/A	N/A	N/A	N/A	94.571429	N/A
4549B PULP	1.09	< .01	99.58	0.09	0.12	3.23	0.08
% Recovery	109	N/A	N/A	N/A	N/A	92.285714	N/A
4587B PULP	1.08	< .01	99.6	0.09	0.12	3.19	0.08
% Recovery	108	N/A	N/A	N/A	N/A	91.142857	N/A
6094B PULP	1.12	< .01	99.6	0.12	0.1	3.14	0.08
% Recovery	112	N/A	N/A	N/A	N/A	89.714286	N/A
6145B PULP	1.09	< .01	99.75	0.1	0.14	3.14	0.09
% Recovery	109	N/A	N/A	N/A	N/A	89.714286	N/A
4549B PULP	1.14	0.01	99.47	0.14	0.09	3.31	0.24
% Recovery	114	66.666667	N/A	N/A	N/A	94.571429	N/A
SY-4 Value	1	0.015	N/A	N/A	N/A	3.5	N/A
Average % Recovery	110.125	N/A	N/A	N/A	N/A	92.5	N/A
RSD	1.9070784	N/A	N/A	N/A	N/A	2.2562463	N/A
		Over 25% values <LDL	Over 25% values <LDL	Over 25% values <LDL	Over 25% values <LDL		Over 25% values <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

** If less than 25% of values are <LDL, the value was set to 1/2 the LDL, if more than 25% of values are <LDL, then the value was not calculated*

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Analysis Date	Ag	Al	As	Au	B	Ba
		ppb	%	ppm	ppb	ppm	ppm
SI		10	0.02	0.1	0.2	2	7.5
LDL		2	0.01	0.1	0.2	1	0.5
SAMPLES							
201	Dec. 2003	543	0.73	41	1.4	16	64.7
6155 (RE 201)		538	0.62	42.6	1.5	18	77
RPD		0.9250694	16.296296	3.8277512	6.8965517	11.764706	17.360621
220	Dec. 2003	329	1.15	14.2	1	18	88.4
RE 220		315	1.17	14.5	1	15	85.3
RPD		4.3478261	1.7241379	2.0905923	0	18.181818	3.5693725
239	Dec. 2003	306	0.62	28.6	0.3	12	122.7
6156 (RE 239)		336	0.62	31.3	1.7	12	135
RPD		9.3457944	0	9.015025	140	0	9.5459837
276	Dec. 2003	152	1.28	5.9	0.3	15	210.7
6157 (RE 276)		157	0.97	4.5	*0.1*	12	222.1
RPD		3.236246	27.555556	26.923077	100	22.222222	5.2680222
280	Dec. 2003	236	0.78	31.3	*0.1*	10	40.2
RE 280		226	0.76	30.6	0.3	7	38.5
RPD		4.3290043	2.5974026	2.2617124	100	35.294118	4.3202033
308	Dec. 2003	655	1.14	37.1	0.2	5	30
6158 (RE 308)		685	1.12	39.5	1.2	10	36.9
RPD		4.4776119	1.7699115	6.2663185	142.85714	66.666667	20.627803
310	Dec. 2003	467	1.17	28.5	0.4	6	38.4
RE 310		442	1.14	27.9	0.7	7	35.8
RPD		5.5005501	2.5974026	2.1276596	54.545455	15.384615	7.0080863
341	Dec. 2003	298	0.76	13.3	0.8	8	83
6159 (RE 341)		325	0.8	15	0.7	10	149.8
RPD		8.6677368	5.1282051	12.014134	13.333333	22.222222	57.388316
359	Dec. 2003	277	0.74	23.1	0.4	7	40.7
RE 359		279	0.77	23.5	0.3	7	46
RPD		0.7194245	3.9735099	1.7167382	28.571429	0	12.226067
371	Dec. 2003	281	0.79	28.1	0.6	7	50.7
6160 (RE 371)		296	0.94	31.3	0.5	9	65.6
RPD		5.1993068	17.34104	10.774411	18.181818	25	25.623388
396	Dec. 2003	183	0.8	20.8	0.2	8	45
RE 396		175	0.82	21.6	0.4	6	47.1
RPD		4.4692737	2.4691358	3.7735849	66.666667	28.571429	4.5602606
399	Dec. 2003	199	0.95	20.3	*0.1*	7	41
6161 (RE 399)		183	0.92	21.8	0.5	8	42.6
RPD		8.3769634	3.2085561	7.1258907	133.33333	13.333333	3.8277512

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Bi	Ca	Cd	Co	Cr	Cu	Fe
	ppm	%	ppm	ppm	ppm	ppm	%
SI	0.03	0.39	0.01	0.1	0.7	1.15	0.05
LDL	0.02	0.01	0.01	0.1	0.5	0.01	0.01
SAMPLES							
201	0.25	7.5	4.26	24.1	19.5	53.65	3.27
6155 (RE 201)	0.28	8.25	4.5	26.5	18.7	56.01	3.28
RPD	11.320755	9.5238095	5.4794521	9.486166	4.1884817	4.304213	0.3053435
220	0.55	0.4	0.53	8.1	15.2	55.18	2.07
RE 220	0.51	0.39	0.55	8.2	15.6	56.77	2.07
RPD	7.5471698	2.5316456	3.7037037	1.2269939	2.5974026	2.8405538	0
239	0.21	9.14	1.83	14.9	12.6	40.73	2.56
6156 (RE 239)	0.24	9.53	2.06	17	13	43.16	2.71
RPD	13.333333	4.1778254	11.825193	13.166144	3.125	5.7933008	5.6925996
276	0.68	0.25	2.14	8.9	8.5	40.73	1.61
6157 (RE 276)	0.7	0.38	2.14	9.1	5.7	36.94	1.29
RPD	2.8985507	41.269841	0	2.2222222	39.43662	9.7592378	22.068966
280	0.26	3.91	0.92	16.6	15.6	40.22	4.7
RE 280	0.24	3.8	0.91	15.7	15.1	37.99	4.54
RPD	8	2.8534371	1.0928962	5.5727554	3.257329	5.7025956	3.4632035
308	0.44	0.38	2.3	22.7	18.5	70.94	3.86
6158 (RE 308)	0.46	0.28	4.01	21.6	17.6	73.84	3.7
RPD	4.4444444	30.30303	54.199683	4.96614	4.9861496	4.0060782	4.2328042
310	0.42	0.25	1.73	19.7	19.2	59.41	3.45
RE 310	0.41	0.25	1.79	19.1	18.3	58.13	3.41
RPD	2.4096386	0	3.4090909	3.0927835	4.8	2.177982	1.1661808
341	0.24	3.52	1.17	9.3	13.2	34.59	1.7
6159 (RE 341)	0.28	3.35	0.96	10.4	13	39.36	1.61
RPD	15.384615	4.9490539	19.71831	11.167513	1.5267176	12.900609	5.4380665
359	0.25	2.77	0.66	11.8	14	31.93	2.61
RE 359	0.26	2.82	0.69	12.2	13.9	33.28	2.66
RPD	3.9215686	1.7889088	4.4444444	3.3333333	0.7168459	4.1404693	1.8975332
371	0.26	2.06	1.05	11.5	13.5	32.4	2.69
6160 (RE 371)	0.31	2.08	1.03	13.2	15.1	38.69	2.6
RPD	17.54386	0.9661836	1.9230769	13.765182	11.188811	17.695878	3.4026465
396	0.27	1.91	0.67	11.8	13.2	25.87	2.78
RE 396	0.28	1.96	0.71	11.5	12.7	26.2	2.85
RPD	3.6363636	2.5839793	5.7971014	2.5751073	3.8610039	1.2675245	2.4866785
399	0.24	1.98	0.64	13	14.3	29.18	3.21
6161 (RE 399)	0.27	1.59	0.56	13.7	14	29.79	3.13
RPD	11.764706	21.848739	13.333333	5.2434457	2.1201413	2.0688486	2.5236593

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Ga	Hg	K	La	Mg	Mn	Mo
	ppm	ppb	%	ppm	%	ppm	ppm
SI	0.1	14	0.01	< .5	0.01	10	0.05
LDL	0.1	5	0.01	0.5	0.01	1	0.01
SAMPLES							
201	3.6	249	0.22	7.6	0.36	97	53.59
6155 (RE 201)	3.5	206	0.2	9.2	0.36	99	54.47
RPD	2.8169014	18.901099	9.5238095	19.047619	0	2.0408163	1.6287248
220	3.6	127	0.26	16	0.34	86	6.04
RE 220	3.8	113	0.26	15.5	0.35	86	5.8
RPD	5.4054054	11.666667	0	3.1746032	2.8985507	0	4.0540541
239	2.9	163	0.2	7.8	0.42	314	23.49
6156 (RE 239)	3.1	205	0.2	8.4	0.43	320	24.26
RPD	6.6666667	22.826087	0	7.4074074	2.3529412	1.8927445	3.2251309
276	4.2	89	0.24	27.9	0.28	810	2.65
6157 (RE 276)	3.4	62	0.21	29.4	0.23	599	3.07
RPD	21.052632	35.761589	13.333333	5.2356021	19.607843	29.950319	14.685315
280	2.5	155	0.24	4	0.53	167	32.62
RE 280	2.5	142	0.23	3.9	0.51	168	31.32
RPD	0	8.7542088	4.2553191	2.5316456	3.8461538	0.5970149	4.0663122
308	3.2	270	0.27	4.7	0.32	130	23.6
6158 (RE 308)	3.5	420	0.28	5.9	0.29	121	23.6
RPD	8.9552239	43.478261	3.6363636	22.641509	9.8360656	7.1713147	0
310	3.5	375	0.27	3.9	0.34	142	16.99
RE 310	3.4	371	0.27	3.8	0.34	144	16.78
RPD	2.8985507	1.0723861	0	2.5974026	0	1.3986014	1.2437074
341	2.6	69	0.27	4.2	0.47	68	5.52
6159 (RE 341)	2.7	87	0.26	4.9	0.48	61	5.32
RPD	3.7735849	23.076923	3.7735849	15.384615	2.1052632	10.852713	3.6900369
359	2.3	75	0.22	3.3	0.48	83	4.61
RE 359	2.4	73	0.24	3.4	0.48	91	4.78
RPD	4.2553191	2.7027027	8.6956522	2.9850746	0	9.1954023	3.6208733
371	2.8	70	0.24	3.4	0.44	73	8.1
6160 (RE 371)	3.3	74	0.3	4.1	0.42	72	8.46
RPD	16.393443	5.5555556	22.222222	18.666667	4.6511628	1.3793103	4.3478261
396	2.2	72	0.22	3.2	0.58	99	3.95
RE 396	2.2	59	0.22	3.3	0.6	102	3.9
RPD	0	19.847328	0	3.0769231	3.3898305	2.9850746	1.2738854
399	2.6	95	0.27	3.3	0.67	111	4.97
6161 (RE 399)	2.6	85	0.26	3.1	0.67	93	4.06
RPD	0	11.111111	3.7735849	6.25	0	17.647059	20.155039

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Na	Ni	P	Pb	S	Sb	Sc
	%	ppm	%	ppm	%	ppm	ppm
SI	1.421	0.1	<.001	1.63	0.02	0.18	0.3
LDL	0.001	0.1	0.001	0.01	0.02	0.02	0.1
SAMPLES							
201	0.28	132.6	0.06	11.66	3.47	3.21	3.6
6155 (RE 201)	0.269	139.9	0.074	12.67	3.9	3.67	3.8
RPD	4.007286	5.3577982	20.895522	8.3025072	11.668928	13.372093	5.4054054
220	0.6	35	0.072	19.63	1.99	0.24	3.4
RE 220	0.612	35.4	0.075	18.2	2.03	0.22	3.5
RPD	1.980198	1.1363636	4.0816327	7.5601375	1.9900498	8.6956522	2.8985507
239	0.346	55	0.057	11.47	2.95	1.92	2.9
6156 (RE 239)	0.338	60.9	0.061	13.37	3.1	2.04	2.9
RPD	2.3391813	10.181191	6.779661	15.297907	4.9586777	6.0606061	0
276	1.156	44.1	0.029	23.04	0.21	0.38	3.1
6157 (RE 276)	1.184	48.1	0.027	21.91	0.15	0.41	2.6
RPD	2.3931624	8.6767896	7.1428571	5.0278087	33.333333	7.5949367	17.54386
280	0.184	51.5	0.062	13.73	2.84	0.74	5.9
RE 280	0.178	49.6	0.06	13	2.78	0.69	5.9
RPD	3.3149171	3.7586548	3.2786885	5.4620277	2.1352313	6.993007	0
308	0.204	82.9	0.061	22.1	2.92	1.73	3.9
6158 (RE 308)	0.24	83.5	0.079	22.9	3.85	1.66	4.2
RPD	16.216216	0.7211538	25.714286	3.5555556	27.474151	4.1297935	7.4074074
310	0.231	65.2	0.062	22.4	2.35	1.4	3.9
RE 310	0.235	63.1	0.061	22.29	2.36	1.35	4.1
RPD	1.7167382	3.2735776	1.6260163	0.4922802	0.4246285	3.6363636	5
341	0.219	40.5	0.056	12.59	1.32	0.82	3.6
6159 (RE 341)	0.231	45.1	0.065	14.55	1.42	0.94	4
RPD	5.3333333	10.747664	14.876033	14.443626	7.2992701	13.636364	10.526316
359	0.213	35	0.062	14.76	1.98	0.68	4.6
RE 359	0.215	37.3	0.064	15.58	2.07	0.64	4.7
RPD	0.9345794	6.362379	3.1746032	5.4054054	4.4444444	6.0606061	2.1505376
371	0.222	45.9	0.062	15.12	1.99	0.89	4.5
6160 (RE 371)	0.223	52.5	0.071	17.67	2.45	0.9	5.3
RPD	0.4494382	13.414634	13.533835	15.553522	20.720721	1.1173184	16.326531
396	0.211	36.2	0.063	15.13	2.2	0.86	4.2
RE 396	0.211	35.1	0.063	15.12	2.22	0.8	4.2
RPD	0	3.085554	0	0.0661157	0.9049774	7.2289157	0
399	0.192	40.6	0.068	15.37	2.54	0.65	4.8
6161 (RE 399)	0.213	43.8	0.064	16.73	2.74	0.77	4.8
RPD	10.37037	7.5829384	6.0606061	8.4735202	7.5757576	16.901408	0

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Se	Sr	Te	Th	Ti	Tl	U
	ppm	ppm	ppm	ppm	%	ppm	ppm
SI	0.1	7.9	<.02	<.1	<.001	<.02	0.01
LDL	0.1	0.5	0.02	0.1	0.001	0.02	0.1
SAMPLES							
201	9.1	199.9	0.15	3.3	<.001	2.68	10.26
6155 (RE 201)	10.3	213.6	0.16	4.1	0.001	2.79	11.7
RPD	12.371134	6.6263603	6.4516129	21.621622	N/A	4.0219378	13.114754
220	2.4	118.8	0.14	7.3	0.005	0.28	3.65
RE 220	2.5	119.2	0.11	7.1	<.001	0.28	3.44
RPD	4.0816327	0.3361345	24	2.7777778	N/A	0	5.9238364
239	4.7	181.6	0.14	3.4	<.001	1.18	5.72
6156 (RE 239)	5.3	185.4	0.15	3.8	<.001	1.17	6.39
RPD	12	2.0708447	6.8965517	11.111111	N/A	0.8510638	11.065235
276	2.4	196.3	0.05	16.9	0.004	0.07	6.17
6157 (RE 276)	2.4	190.8	0.11	17.9	0.002	0.09	6.37
RPD	0	2.841643	75	5.7471264	66.666667	25	3.1897927
280	3.6	117.3	0.09	4.2	0.001	0.09	8.22
RE 280	3.7	113.6	0.08	4.2	<.001	0.09	7.87
RPD	2.739726	3.2048506	11.764706	0	N/A	0	4.3505283
308	6.7	76.6	0.15	6	0.004	0.53	3.66
6158 (RE 308)	7.6	82.4	0.18	7.6	0.001	0.49	5.61
RPD	12.587413	7.2955975	18.181818	23.529412	120	7.8431373	42.071197
310	4.2	78.8	0.14	6.3	<.001	0.4	2.97
RE 310	4.1	77.3	0.12	6.3	<.001	0.38	2.93
RPD	2.4096386	1.921845	15.384615	0	N/A	5.1282051	1.3559322
341	2.5	94.2	0.05	4.9	<.001	0.21	1.62
6159 (RE 341)	3.1	99	0.08	5.6	0.001	0.28	1.67
RPD	21.428571	4.9689441	46.153846	13.333333	N/A	28.571429	3.0395137
359	1.7	88.3	0.09	4.9	<.001	0.09	1.85
RE 359	1.7	90.2	0.06	4.9	<.001	0.09	1.89
RPD	0	2.1288515	40	0	N/A	0	2.1390374
371	2.2	74.4	0.11	4.6	<.001	0.22	1.89
6160 (RE 371)	2.8	77.3	0.08	5.2	0.001	0.21	2.03
RPD	24	3.8233355	31.578947	12.244898	N/A	4.6511628	7.1428571
396	1.6	72	0.08	5	0.001	0.1	1.22
RE 396	1.6	73.8	0.07	5.1	0.001	0.11	1.23
RPD	0	2.4691358	13.333333	1.980198	0	9.5238095	0.8163265
399	2.1	70.4	0.08	4.9	0.001	0.09	1.94
6161 (RE 399)	2	68.8	0.11	5.2	0.001	0.13	1.19
RPD	4.8780488	2.2988506	31.578947	5.9405941	0	36.363636	47.923323

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	V	W	Zn
	ppm	ppm	ppm
SI	< 2	0.7	0.8
LDL	2	0.1	0.1
SAMPLES			
201	266	< .1	249.4
6155 (RE 201)	256	< .1	253.2
RPD	3.8314176	N/A	1.5121369
220	28	< .1	115.2
RE 220	28	< .1	114.2
RPD	0	N/A	0.8718396
239	87	< .1	131
6156 (RE 239)	88	< .1	147.7
RPD	1.1428571	N/A	11.984212
276	13	< .1	152.2
6157 (RE 276)	11	< .1	135.9
RPD	16.666667	N/A	11.315515
280	61	< .1	131.4
RE 280	58	< .1	126.6
RPD	5.0420168	N/A	3.7209302
308	53	< .1	175.4
6158 (RE 308)	51	< .1	217.6
RPD	3.8461538	N/A	21.475827
310	41	< .1	165.9
RE 310	41	< .1	169.1
RPD	0	N/A	1.9104478
341	49	< .1	131.8
6159 (RE 341)	46	< .1	118.5
RPD	6.3157895	N/A	10.627247
359	27	< .1	190.2
RE 359	28	< .1	184.3
RPD	3.6363636	N/A	3.1508678
371	33	< .1	155.8
6160 (RE 371)	37	< .1	179
RPD	11.428571	N/A	13.85902
396	22	< .1	131.3
RE 396	23	< .1	133.9
RPD	4.4444444	N/A	1.9607843
399	27	< .1	106.7
6161 (RE 399)	26	< .1	116.5
RPD	3.7735849	N/A	8.781362

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Analysis Date	Ag	Al	As	Au	B	Ba
		ppb	%	ppm	ppb	ppm	ppm
SI		10	0.02	0.1	0.2	2	7.5
LDL		2	0.01	0.1	0.2	1	0.5
SAMPLES							
427	Dec. 2003	59	0.34	4.4	1	4	531.3
6162 (RE 427)		62	0.43	4.4	0.2	5	548.5
RPD		4.9586777	23.376623	0	133.33333	22.222222	3.1857751
436	Dec. 2003	388	1.27	2.8	1.4	15	402.6
RE 436		393	1.29	3	0.8	16	410.3
RPD		1.2804097	1.5625	6.8965517	54.545455	6.4516129	1.894452
456	Dec. 2003	186	0.89	20.8	0.4	8	62.2
6163 (RE 456)		197	1.09	22.8	0.6	9	56.6
RPD		5.7441253	20.20202	9.1743119	40	11.764706	9.4276094
470	Dec. 2003	308	0.55	36.2	0.5	9	55.4
RE 470		305	0.54	35.5	0.4	8	58.3
RPD		0.9787928	1.8348624	1.9525802	22.222222	11.764706	5.1011434
482	Dec. 2003	304	0.58	35.2	0.2	11	63
6164 (RE 482)		321	0.76	38.6	0.2	9	44.6
RPD		5.44	26.865672	9.2140921	0	20	34.200743
500	Dec. 2003	269	0.6	25.3	0.4	7	44.8
RE 500		261	0.59	24.7	*0.1*	7	43
RPD		3.0188679	1.6806723	2.4	120	0	4.1002278
3813	Dec. 2003	268	0.58	29.9	0.3	7	43
6165 (RE 3813)		261	0.73	30.8	0.3	8	44.2
RPD		2.6465028	22.900763	2.9654036	0	13.333333	2.7522936
3838	Dec. 2003	232	0.8	24.4	0.4	8	78.5
6166 (RE 3838)		242	0.97	24.9	0.4	9	50.7
RPD		4.2194093	19.20904	2.0283976	0	11.764706	43.034056
3840	Dec. 2003	213	0.82	23.4	0.5	10	74.2
RE 3840		208	0.82	23.8	0.5	7	71.5
RPD		2.3752969	0	1.6949153	0	35.294118	3.7062457
3871	Dec. 2003	204	1.15	15.1	0.4	12	64
6167 (RE 3871)		218	1.08	15.5	*0.1*	11	56.5
RPD		6.6350711	6.2780269	2.6143791	120	8.6956522	12.448133
3880	Dec. 2003	233	0.66	19	0.4	11	77.2
RE 3880		231	0.68	19.9	0.4	13	81.7
RPD		0.862069	2.9850746	4.6272494	0	16.666667	5.6639396
3901	Dec. 2003	228	0.91	11.1	*0.1*	9	590.8
6168 (RE 3901)		223	0.87	10.8	*0.1*	11	610.9
RPD		2.2172949	4.494382	2.739726	0	20	3.3452609

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Bi	Ca	Cd	Co	Cr	Cu	Fe
	ppm	%	ppm	ppm	ppm	ppm	%
SI	0.03	0.39	0.01	0.1	0.7	1.15	0.05
LDL	0.02	0.01	0.01	0.1	0.5	0.01	0.01
SAMPLES							
427	0.04	11.93	0.22	6.9	14.7	6.43	1.89
6162 (RE 427)	0.04	11.36	0.23	5.9	12.5	6.15	1.95
RPD	0	4.8948046	4.4444444	15.625	16.176471	4.4515103	3.125
436	0.28	0.44	0.75	17.5	30.8	52.58	2.88
RE 436	0.29	0.45	0.74	17.3	31.5	52.83	2.91
RPD	3.5087719	2.247191	1.3422819	1.1494253	2.247191	0.4743383	1.0362694
456	0.24	2.21	0.42	12	15.2	26.99	2.96
6163 (RE 456)	0.26	2.53	0.41	13	17.9	29.33	3.15
RPD	8	13.50211	2.4096386	8	16.314199	8.3096591	6.2193126
470	0.35	4.56	0.92	15.5	9.6	38.97	2.95
RE 470	0.31	4.49	0.97	15.3	9.3	38.06	2.91
RPD	12.121212	1.5469613	5.2910053	1.2987013	3.1746032	2.3627158	1.3651877
482	0.27	5.66	1.11	16	10	35.68	2.9
6164 (RE 482)	0.3	5.04	1.19	17.9	11.9	40.31	3.17
RPD	10.526316	11.588785	6.9565217	11.20944	17.351598	12.185814	8.8962109
500	0.25	4.41	1.28	14.6	10.7	38.84	3.49
RE 500	0.24	4.24	1.28	13.9	10	38.09	3.35
RPD	4.0816327	3.9306358	0	4.9122807	6.763285	1.9498245	4.0935673
3813	0.28	3.73	0.93	15	10.7	33.86	2.96
6165 (RE 3813)	0.3	3.46	0.94	14.5	12.1	34.43	2.96
RPD	6.8965517	7.5104312	1.0695187	3.3898305	12.280702	1.6693513	0
3838	0.24	1.55	0.65	13.8	13.6	32.47	2.83
6166 (RE 3838)	0.23	1.62	0.63	14.8	14.7	33.04	2.89
RPD	4.2553191	4.4164038	3.125	6.993007	7.7738516	1.7401923	2.0979021
3840	0.26	1.99	0.6	13	13.3	32.54	2.89
RE 3840	0.25	2	0.6	13.1	13.3	33.11	2.9
RPD	3.9215686	0.5012531	0	0.7662835	0	1.7364813	0.3454231
3871	0.33	0.52	0.21	12.3	18.6	35.06	2.99
6167 (RE 3871)	0.33	0.63	0.25	12.4	17.2	34.16	2.85
RPD	0	19.130435	17.391304	0.8097166	7.8212291	2.6004045	4.7945205
3880	0.22	2.63	0.42	9.5	13.8	25.71	3.1
RE 3880	0.24	2.69	0.42	9.7	14.1	26.46	3.15
RPD	8.6956522	2.2556391	0	2.0833333	2.1505376	2.8752156	1.6
3901	0.21	0.22	0.17	9.7	17.1	28.08	1.44
6168 (RE 3901)	0.2	0.26	0.16	9.4	15.3	28.04	1.33
RPD	4.8780488	16.666667	6.0606061	3.1413613	11.111111	0.1425517	7.9422383

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Ga	Hg	K	La	Mg	Mn	Mo
	ppm	ppb	%	ppm	%	ppm	ppm
SI	0.1	14	0.01	< .5	0.01	10	0.05
LDL	0.1	5	0.01	0.5	0.01	1	0.01
SAMPLES							
427	1.8	31	0.07	10.2	0.66	466	0.13
6162 (RE 427)	1.8	38	0.09	10.4	0.72	478	0.16
RPD	0	20.289855	25	1.9417476	8.6956522	2.5423729	20.689655
436	6	156	0.22	17.5	0.62	465	2.43
RE 436	6.1	146	0.24	18	0.63	475	2.36
RPD	1.6528926	6.6225166	8.6956522	2.8169014	1.6	2.1276596	2.9227557
456	2.4	59	0.26	2.8	0.55	86	2.69
6163 (RE 456)	3	74	0.31	3.6	0.66	99	2.78
RPD	22.222222	22.556391	17.54386	25	18.181818	14.054054	3.2906764
470	1.6	106	0.19	3.6	0.42	68	9.2
RE 470	1.6	97	0.19	3.5	0.42	71	9.44
RPD	0	8.8669951	0	2.8169014	0	4.3165468	2.5751073
482	1.7	103	0.22	3.8	0.42	76	12.53
6164 (RE 482)	2.1	98	0.26	4.6	0.46	80	13.08
RPD	21.052632	4.9751244	16.666667	19.047619	9.0909091	5.1282051	4.2951972
500	1.8	74	0.2	3.5	0.54	105	8.8
RE 500	1.7	69	0.19	3.4	0.52	106	8.64
RPD	5.7142857	6.993007	5.1282051	2.8985507	3.7735849	0.9478673	1.8348624
3813	1.7	81	0.2	3.1	0.48	73	9.93
6165 (RE 3813)	2	92	0.23	3.7	0.49	84	9.15
RPD	16.216216	12.716763	13.953488	17.647059	2.0618557	14.012739	8.1761006
3838	2.4	63	0.23	2.9	0.48	83	6.53
6166 (RE 3838)	2.7	63	0.31	3.3	0.51	90	7.19
RPD	11.764706	0	29.62963	12.903226	6.0606061	8.0924855	9.6209913
3840	2.4	53	0.22	3.1	0.56	87	5.56
RE 3840	2.4	61	0.22	3.1	0.56	87	5.73
RPD	0	14.035088	0	0	0	0	3.0115146
3871	3.5	114	0.3	4.4	0.36	83	1.82
6167 (RE 3871)	3.3	97	0.31	4.1	0.36	78	1.97
RPD	5.8823529	16.113744	3.2786885	7.0588235	0	6.2111801	7.9155673
3880	2.3	85	0.19	4.7	0.42	88	5.51
RE 3880	2.4	84	0.2	4.9	0.43	91	5.61
RPD	4.2553191	1.183432	5.1282051	4.1666667	2.3529412	3.3519553	1.7985612
3901	2.8	73	0.26	4.8	0.27	60	1.11
6168 (RE 3901)	2.5	82	0.23	4.5	0.26	51	0.99
RPD	11.320755	11.612903	12.244898	6.4516129	3.7735849	16.216216	11.428571

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Na	Ni	P	Pb	S	Sb	Sc
	%	ppm	%	ppm	%	ppm	ppm
SI	1.421	0.1	<.001	1.63	0.02	0.18	0.3
LDL	0.001	0.1	0.001	0.01	0.02	0.02	0.1
SAMPLES							
427	0.057	24.8	0.047	3.7	0.03	0.25	2.7
6162 (RE 427)	0.063	23.2	0.055	4.17	0.04	0.23	2.4
RPD	10	6.6666667	15.686275	11.944091	28.571429	8.3333333	11.764706
436	0.309	77	0.086	15.97	0.07	0.94	6.2
RE 436	0.316	76	0.089	16.25	0.08	0.87	6.4
RPD	2.24	1.3071895	3.4285714	1.7380509	13.333333	7.7348066	3.1746032
456	0.211	35.8	0.067	14.99	2.46	0.55	5.1
6163 (RE 456)	0.227	39.2	0.077	16.53	2.93	0.54	6.1
RPD	7.3059361	9.0666667	13.888889	9.7715736	17.439703	1.8348624	17.857143
470	0.166	55	0.075	16.93	2.98	1.09	4.8
RE 470	0.16	54.4	0.073	16.59	2.85	1.11	4.7
RPD	3.6809816	1.0968921	2.7027027	2.0286396	4.4596913	1.8181818	2.1052632
482	0.161	58.5	0.073	15.56	3.02	1.53	4.9
6164 (RE 482)	0.189	65.9	0.082	17.92	3.54	1.61	5.3
RPD	16	11.897106	11.612903	14.097969	15.853659	5.0955414	7.8431373
500	0.166	44.3	0.07	14.57	3.17	1.18	5
RE 500	0.161	44.1	0.069	14.17	3.07	1.18	4.8
RPD	3.058104	0.4524887	1.4388489	2.7835769	3.2051282	0	4.0816327
3813	0.156	54	0.071	15.97	2.68	1.28	4.8
6165 (RE 3813)	0.175	53.8	0.072	17.2	3	1.27	4.8
RPD	11.480363	0.3710575	1.3986014	7.4163401	11.267606	0.7843137	0
3838	0.215	47.6	0.071	15.23	2.26	0.83	5.1
6166 (RE 3838)	0.213	48.7	0.074	15.33	2.52	0.75	5.4
RPD	0.9345794	2.2845275	4.137931	0.6544503	10.878661	10.126582	5.7142857
3840	0.201	41.8	0.067	15.88	2.16	0.82	5.1
RE 3840	0.197	42.5	0.069	15.55	2.17	0.81	5.1
RPD	2.0100503	1.6607355	2.9411765	2.0999045	0.4618938	1.2269939	0
3871	0.236	43.1	0.06	19.03	2.08	0.37	3.7
6167 (RE 3871)	0.237	40.9	0.059	19.13	2.19	0.36	4
RPD	0.422833	5.2380952	1.6806723	0.524109	5.1522248	2.739726	7.7922078
3880	0.15	35.2	0.073	13.72	2.19	0.39	5.3
RE 3880	0.153	36.8	0.075	14.23	2.22	0.38	5.2
RPD	1.980198	4.4444444	2.7027027	3.6493739	1.3605442	2.5974026	1.9047619
3901	0.157	29.1	0.076	13.32	0.35	0.54	3.2
6168 (RE 3901)	0.159	26.9	0.082	12	0.31	0.51	3
RPD	1.2658228	7.8571429	7.5949367	10.42654	12.121212	5.7142857	6.4516129

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Se	Sr	Te	Th	Ti	Tl	U
	ppm	ppm	ppm	ppm	%	ppm	ppm
SI	0.1	7.9	<.02	<.1	<.001	<.02	0.01
LDL	0.1	0.5	0.02	0.1	0.001	0.02	0.1
SAMPLES							
427	0.3	269.5	*0.01*	3	0.006	0.05	0.55
6162 (RE 427)	0.3	257.9	0.02	3	0.009	0.05	0.56
RPD	0	4.3989382	66.666667	0	40	0	1.8018018
436	1.2	98.9	0.03	7.4	<.001	0.14	1.57
RE 436	1.2	100.6	0.04	7.6	<.001	0.14	1.57
RPD	0	1.7042607	28.571429	2.6666667	N/A	0	0
456	1.6	87	0.07	4.6	<.001	0.07	1.17
6163 (RE 456)	1.8	96.4	0.1	5.2	0.001	0.06	1.33
RPD	11.764706	10.250818	35.294118	12.244898	N/A	15.384615	12.8
470	2.9	105.1	0.13	4.7	<.001	0.21	2.32
RE 470	2.9	104.1	0.11	4.5	0.002	0.22	2.18
RPD	0	0.9560229	16.666667	4.3478261	N/A	4.6511628	6.2222222
482	3.7	144.9	0.12	4.5	<.001	0.2	2.72
6164 (RE 482)	4.4	141.9	0.2	5.4	<.001	0.2	2.9
RPD	17.283951	2.0920502	50	18.181818	N/A	0	6.405694
500	3.5	114.2	0.1	4.1	<.001	0.09	2.6
RE 500	3.4	109.6	0.15	4	<.001	0.08	2.52
RPD	2.8985507	4.1108132	40	2.4691358	N/A	11.764706	3.125
3813	2.8	109.7	0.12	4.5	<.001	0.18	1.74
6165 (RE 3813)	3.1	112.3	0.13	5.3	0.001	0.21	1.87
RPD	10.169492	2.3423423	8	16.326531	N/A	15.384615	7.2022161
3838	1.9	85.4	0.08	4.5	0.003	0.18	1.44
6166 (RE 3838)	2.3	84.7	0.08	4.8	0.001	0.11	1.59
RPD	19.047619	0.8230453	0	6.4516129	100	48.275862	9.9009901
3840	2	91.3	0.13	4.5	<.001	0.15	1.23
RE 3840	2	91.3	0.07	4.6	<.001	0.13	1.25
RPD	0	0	60	2.1978022	N/A	14.285714	1.6129032
3871	1.3	47.8	0.05	4.2	<.001	0.08	0.79
6167 (RE 3871)	1.4	47.5	0.07	5.2	0.001	0.07	0.9
RPD	7.4074074	0.6295908	33.333333	21.276596	N/A	13.333333	13.017751
3880	1.5	71.2	0.06	4.2	0.001	0.18	1.86
RE 3880	1.6	72.3	0.05	4.4	0.008	0.19	1.87
RPD	6.4516129	1.533101	18.181818	4.6511628	155.55556	5.4054054	0.536193
3901	1.1	41.7	0.05	4.6	0.005	0.06	0.71
6168 (RE 3901)	1	41.9	0.06	5.2	0.001	0.06	0.79
RPD	9.5238095	0.4784689	18.181818	12.244898	133.33333	0	10.666667

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	V	W	Zn
	ppm	ppm	ppm
SI	< 2	0.7	0.8
LDL	2	0.1	0.1
SAMPLES			
427	22	< .1	49.9
6162 (RE 427)	23	< .1	46.3
RPD	4.4444444	N/A	7.4844075
436	46	< .1	166.1
RE 436	47	< .1	169.9
RPD	2.1505376	N/A	2.2619048
456	25	< .1	101.1
6163 (RE 456)	32	< .1	115.4
RPD	24.561404	N/A	13.210162
470	33	< .1	139.8
RE 470	33	< .1	136.3
RPD	0	N/A	2.5353133
482	42	< .1	133.2
6164 (RE 482)	48	< .1	146.5
RPD	13.333333	N/A	9.5101895
500	25	< .1	143.2
RE 500	25	< .1	142
RPD	0	N/A	0.8415147
3813	38	< .1	134.1
6165 (RE 3813)	40	< .1	140.5
RPD	5.1282051	N/A	4.6613256
3838	25	< .1	124.2
6166 (RE 3838)	31	< .1	124.9
RPD	21.428571	N/A	0.5620233
3840	28	< .1	134.3
RE 3840	29	< .1	129.4
RPD	3.5087719	N/A	3.7163443
3871	33	< .1	110
6167 (RE 3871)	32	< .1	124.3
RPD	3.0769231	N/A	12.206573
3880	33	< .1	119
RE 3880	36	< .1	128.6
RPD	8.6956522	N/A	7.7544426
3901	32	< .1	137.9
6168 (RE 3901)	29	< .1	136.3
RPD	9.8360656	N/A	1.1670314

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Analysis Date	Ag	Al	As	Au	B	Ba
		ppb	%	ppm	ppb	ppm	ppm
SI		10	0.02	0.1	0.2	2	7.5
LDL		2	0.01	0.1	0.2	1	0.5
SAMPLES							
3924	Dec. 2003	81	1.22	10.4	0.4	14	364
RE 3924		86	1.23	10.6	0.4	14	360.6
RPD		5.988024	0.8163265	1.9047619	0	0	0.9384488
3933	Dec. 2003	166	1.55	90.4	1.1	16	431.2
6169 (RE 3933)		216	1.5	72.5	0.4	16	516
RPD		26.17801	3.2786885	21.976673	93.333333	0	17.905405
3958	Dec. 2003	144	0.28	8.9	1.1	9	134.7
6170 (RE 3958)		146	0.51	10.9	1.3	11	165.4
RPD		1.3793103	58.227848	20.20202	16.666667	20	20.459847
3970	Dec. 2003	289	0.99	21.9	0.3	19	68.3
RE 3970		289	1	22.1	0.9	20	76.3
RPD		0	1.0050251	0.9090909	100	5.1282051	11.065007
4530	Dec. 2003	182	0.76	22.6	*0.1*	7	54.9
6171 (RE 4530)		203	0.85	23.6	0.5	8	52
RPD		10.909091	11.180124	4.3290043	133.33333	13.333333	5.4256314
4544	Dec. 2003	321	0.96	29.1	1	12	53.5
RE 4544		311	0.99	30.2	0.5	13	54.1
RPD		3.164557	3.0769231	3.7099494	66.666667	8	1.1152416
4561	Dec. 2003	254	1.09	38.7	0.8	9	36.9
6172 (RE 4561)		292	1.03	41.6	1.4	11	55.6
RPD		13.919414	5.6603774	7.2229141	54.545455	20	40.432432
4584	Dec. 2003	300	1.03	29.3	0.5	13	43.9
6173 (RE 4584)		324	0.95	30.5	0.4	10	48.6
RPD		7.6923077	8.0808081	4.0133779	22.222222	26.086957	10.162162
6033	Dec. 2003	177	0.88	16.8	1.8	14	115.7
6174 (RE 6033)		175	0.95	18.2	1.2	13	151.9
RPD		1.1363636	7.6502732	8	40	7.4074074	27.055306
6092	Dec. 2003	190	1.85	51.9	3.9	8	3.8
RE 6092		175	1.83	50.1	3.7	7	6
RPD		8.2191781	1.0869565	3.5294118	5.2631579	13.333333	44.897959
6168 (RE 3901)	Dec. 2003	223	0.87	10.8	*0.1*	11	610.9
RE 6168		229	0.89	11.2	0.5	11	630.1
RPD		2.6548673	2.2727273	3.6363636	133.33333	0	3.0942788

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Bi	Ca	Cd	Co	Cr	Cu	Fe
	ppm	%	ppm	ppm	ppm	ppm	%
SI	0.03	0.39	0.01	0.1	0.7	1.15	0.05
LDL	0.02	0.01	0.01	0.1	0.5	0.01	0.01
SAMPLES							
3924	0.24	0.16	0.07	11.5	24	21.32	1.98
RE 3924	0.24	0.16	0.07	11.2	24.1	21.2	1.99
RPD	0	0	0	2.6431718	0.4158004	0.5644403	0.5037783
3933	0.34	0.21	0.05	23.9	27.9	26.81	2.54
6169 (RE 3933)	0.32	0.21	0.08	29	25.6	25.31	2.25
RPD	6.0606061	0	46.153846	19.281664	8.5981308	5.7559478	12.108559
3958	0.06	7.81	0.3	2.7	10.2	10.22	1.41
6170 (RE 3958)	0.06	7.13	0.31	3.7	10.9	10.78	1.57
RPD	0	9.103079	3.2786885	31.25	6.6350711	5.3333333	10.738255
3970	0.42	0.6	0.46	11.3	19.7	47.97	2.45
RE 3970	0.38	0.59	0.46	11.4	20	47.97	2.43
RPD	10	1.6806723	0	0.8810573	1.511335	0	0.8196721
4530	0.23	1.99	0.53	12.3	13.9	30.06	2.57
6171 (RE 4530)	0.25	2.22	0.63	12.6	13.8	30.94	2.73
RPD	8.3333333	10.926366	17.241379	2.4096386	0.7220217	2.8852459	6.0377358
4544	0.25	5.47	1.36	17.1	17.5	39.96	3.05
RE 4544	0.25	5.49	1.36	16.9	18.2	40.06	3.09
RPD	0	0.3649635	0	1.1764706	3.9215686	0.2499375	1.3029316
4561	0.31	1	1.22	15.8	20.1	37.8	3.47
6172 (RE 4561)	0.32	0.96	1.68	17.2	19	41.36	3.44
RPD	3.1746032	4.0816327	31.724138	8.4848485	5.6265985	8.9944416	0.8683068
4584	0.33	0.69	0.9	14.7	21.4	42.13	3.15
6173 (RE 4584)	0.34	0.76	1.28	15.7	20.4	44.36	3.19
RPD	2.9850746	9.6551724	34.862385	6.5789474	4.784689	5.1566655	1.2618297
6033	0.28	0.8	0.47	9.1	16.2	39.55	1.86
6174 (RE 6033)	0.34	0.35	0.35	8.8	18.2	44.88	2
RPD	19.354839	78.26087	29.268293	3.3519553	11.627907	12.625844	7.253886
6092	0.2	0.57	1.05	4.9	4.5	23.55	18.26
RE 6092	0.2	0.59	1.05	4.5	4.2	21.54	18.63
RPD	0	3.4482759	0	8.5106383	6.8965517	8.9155023	2.0059637
6168 (RE 3901)	0.2	0.26	0.16	9.4	15.3	28.04	1.33
RE 6168	0.21	0.26	0.18	9.9	15.1	29.15	1.34
RPD	4.8780488	0	11.764706	5.1813472	1.3157895	3.8817975	0.7490637

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Ga	Hg	K	La	Mg	Mn	Mo
	ppm	ppb	%	ppm	%	ppm	ppm
SI	0.1	14	0.01	<.5	0.01	10	0.05
LDL	0.1	5	0.01	0.5	0.01	1	0.01
SAMPLES							
3924	4.1	73	0.29	5.3	0.38	71	0.36
RE 3924	4.1	82	0.29	5.4	0.38	74	0.35
RPD	0	11.612903	0	1.8691589	0	4.137931	2.8169014
3933	6	79	0.43	9.6	0.39	131	0.69
6169 (RE 3933)	5.3	83	0.41	9.4	0.36	105	0.91
RPD	12.389381	4.9382716	4.7619048	2.1052632	8	22.033898	27.5
3958	1.5	124	0.1	7.1	3.56	174	1.92
6170 (RE 3958)	2	190	0.16	7.3	3.39	186	1.93
RPD	28.571429	42.038217	46.153846	2.7777778	4.8920863	6.6666667	0.5194805
3970	4	110	0.27	9.9	0.4	72	7.76
RE 3970	4.1	119	0.28	10.2	0.4	72	7.68
RPD	2.4691358	7.860262	3.6363636	2.9850746	0	0	1.0362694
4530	2.1	66	0.22	2.8	0.48	79	3.54
6171 (RE 4530)	2.3	83	0.25	3.1	0.54	80	3.77
RPD	9.0909091	22.818792	12.765957	10.169492	11.764706	1.2578616	6.2927497
4544	4.5	156	0.32	7.9	0.56	92	10.71
RE 4544	4.5	144	0.33	7.8	0.57	88	10.9
RPD	0	8	3.0769231	1.2738854	1.7699115	4.4444444	1.7584452
4561	4.1	576	0.29	5.2	0.34	81	15.54
6172 (RE 4561)	4	508	0.3	5.4	0.36	77	16.4
RPD	2.4691358	12.546125	3.3898305	3.7735849	5.7142857	5.0632911	5.3850971
4584	4.4	481	0.28	6.4	0.23	92	20.21
6173 (RE 4584)	4.3	188	0.26	6.2	0.23	88	24.06
RPD	2.2988506	87.593423	7.4074074	3.1746032	0	4.4444444	17.393269
6033	3.4	178	0.26	22.7	0.25	104	2.96
6174 (RE 6033)	3.7	163	0.27	12.6	0.27	97	3.64
RPD	8.4507042	8.797654	3.7735849	57.223796	7.6923077	6.9651741	20.606061
6092	1.9	113	0.21	*0.25*	0.22	273	27.76
RE 6092	1.8	96	0.19	*0.25*	0.22	278	25.7
RPD	5.4054054	16.267943	10	0	0	1.814882	7.7066966
6168 (RE 3901)	2.5	82	0.23	4.5	0.26	51	0.99
RE 6168	2.6	87	0.24	4.9	0.26	52	1.04
RPD	3.9215686	5.9171598	4.2553191	8.5106383	0	1.9417476	4.9261084

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Na	Ni	P	Pb	S	Sb	Sc
	%	ppm	%	ppm	%	ppm	ppm
SI	1.421	0.1	<.001	1.63	0.02	0.18	0.3
LDL	0.001	0.1	0.001	0.01	0.02	0.02	0.1
SAMPLES							
3924	0.199	30.5	0.067	13.61	0.43	0.2	3.6
RE 3924	0.201	31	0.068	13.47	0.41	0.2	3.7
RPD	1	1.6260163	1.4814815	1.0339734	4.7619048	0	2.739726
3933	0.272	39.3	0.074	19.41	0.53	0.2	4.4
6169 (RE 3933)	0.239	40	0.07	18.88	0.45	0.22	3.7
RPD	12.915851	1.7654477	5.5555556	2.7683468	16.326531	9.5238095	17.283951
3958	0.087	11	0.086	3.92	0.58	0.25	1.7
6170 (RE 3958)	0.092	11.5	0.081	4.24	0.54	0.23	1.8
RPD	5.5865922	4.4444444	5.988024	7.8431373	7.1428571	8.3333333	5.7142857
3970	0.287	42	0.067	19.3	2.17	0.25	4.3
RE 3970	0.289	43.2	0.067	19.14	2.15	0.26	4.1
RPD	0.6944444	2.8169014	0	0.8324662	0.9259259	3.9215686	4.7619048
4530	0.2	39.1	0.065	14.35	1.96	0.66	4.4
6171 (RE 4530)	0.208	39.6	0.07	16.09	2.37	0.73	4.7
RPD	3.9215686	1.270648	7.4074074	11.432326	18.937644	10.071942	6.5934066
4544	0.185	52	0.061	15.02	2.44	1.12	4.4
RE 4544	0.189	51.9	0.063	15.18	2.5	1.07	4.4
RPD	2.1390374	0.1924928	3.2258065	1.0596026	2.4291498	4.56621	0
4561	0.218	75.2	0.048	19.04	2.57	0.77	4.6
6172 (RE 4561)	0.234	74.9	0.06	21.7	3.28	1.09	4.8
RPD	7.079646	0.3997335	22.222222	13.058419	24.273504	34.408602	4.2553191
4584	0.191	54.4	0.069	15.23	2.27	0.94	3.7
6173 (RE 4584)	0.202	57.7	0.067	16.8	2.91	1.11	3.8
RPD	5.5979644	5.8876004	2.9411765	9.8033094	24.710425	16.585366	2.6666667
6033	0.323	34.9	0.139	12.76	1.75	0.37	3.7
6174 (RE 6033)	0.39	38.3	0.068	16.02	1.46	0.43	2.4
RPD	18.793829	9.2896175	68.599034	22.654621	18.068536	15	42.622951
6092	0.398	21.2	0.037	2.09	22.09	1.34	1
RE 6092	0.38	19.9	0.034	1.82	20.33	1.38	0.9
RPD	4.6272494	6.3260341	8.4507042	13.810742	8.2979727	2.9411765	10.526316
6168 (RE 3901)	0.159	26.9	0.082	12	0.31	0.51	3
RE 6168	0.166	27.5	0.084	12.34	0.3	0.52	3.2
RPD	4.3076923	2.2058824	2.4096386	2.7937551	3.2786885	1.9417476	6.4516129

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Se	Sr	Te	Th	Ti	Tl	U
	ppm	ppm	ppm	ppm	%	ppm	ppm
SI	0.1	7.9	<.02	<.1	<.001	<.02	0.01
LDL	0.1	0.5	0.02	0.1	0.001	0.02	0.1
SAMPLES							
3924	0.5	40.1	0.06	5	0.004	0.06	0.72
RE 3924	0.4	40.5	0.08	4.9	0.002	0.06	0.74
RPD	22.222222	0.9925558	28.571429	2.020202	66.666667	0	2.739726
3933	0.4	63.9	0.07	6.7	<.001	0.11	0.78
6169 (RE 3933)	0.3	59.4	0.07	7.8	0.002	0.11	0.85
RPD	28.571429	7.2992701	0	15.172414	N/A	0	8.5889571
3958	0.8	174.2	0.03	2.1	0.003	0.28	1.69
6170 (RE 3958)	0.8	168	0.04	2.4	0.002	0.21	1.53
RPD	0	3.6236119	28.571429	13.333333	40	28.571429	9.9378882
3970	2.5	91	0.06	5.6	<.001	0.19	3.06
RE 3970	2.5	90.6	0.1	5.5	0.006	0.2	3.01
RPD	0	0.4405286	50	1.8018018	N/A	5.1282051	1.6474465
4530	1.6	73.9	0.05	4.4	0.003	0.11	1.08
6171 (RE 4530)	1.8	86.7	0.1	5.2	0.001	0.08	1.14
RPD	11.764706	15.940224	66.666667	16.666667	100	31.578947	5.4054054
4544	3.8	126	0.19	4.8	<.001	0.36	3.99
RE 4544	3.8	127.6	0.13	4.8	<.001	0.4	4.05
RPD	0	1.2618297	37.5	0	N/A	10.526316	1.4925373
4561	6.4	71.7	0.17	5.2	<.001	0.56	2.98
6172 (RE 4561)	7.2	75.6	0.17	5.9	0.001	0.52	3.37
RPD	11.764706	5.2953157	0	12.612613	N/A	7.4074074	12.283465
4584	2.9	63.1	0.09	5.1	0.001	0.35	5.21
6173 (RE 4584)	3.8	64.8	0.08	5.7	0.001	0.3	5.6
RPD	26.865672	2.6583268	11.764706	11.111111	0	15.384615	7.2155412
6033	3.4	101.6	0.07	7.2	0.002	0.3	4.09
6174 (RE 6033)	3.5	87.1	0.08	6.1	0.001	0.21	2.1
RPD	2.8985507	15.368309	13.333333	16.541353	66.666667	35.294118	64.297254
6092	38.4	13.4	0.17	0.2	0.001	0.72	1.95
RE 6092	36.3	12.5	0.19	0.2	0.001	0.69	1.94
RPD	5.62249	6.9498069	11.111111	0	0	4.2553191	0.5141388
6168 (RE 3901)	1	41.9	0.06	5.2	0.001	0.06	0.79
RE 6168	1.1	42.7	0.03	5.3	0.001	0.06	0.82
RPD	9.5238095	1.891253	66.666667	1.9047619	0	0	3.7267081

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	V	W	Zn
	ppm	ppm	ppm
SI	< 2	0.7	0.8
LDL	2	0.1	0.1
SAMPLES			
3924	34	< .1	102.1
RE 3924	35	< .1	103.7
RPD	2.8985507	N/A	1.5549077
3933	45	< .1	116.9
6169 (RE 3933)	44	< .1	122.8
RPD	2.247191	N/A	4.9228202
3958	28	< .1	34.6
6170 (RE 3958)	34	< .1	43
RPD	19.354839	N/A	21.649485
3970	33	< .1	122.2
RE 3970	35	< .1	123.2
RPD	5.8823529	N/A	0.8149959
4530	25	< .1	126.9
6171 (RE 4530)	27	< .1	163.2
RPD	7.6923077	N/A	25.025853
4544	63	< .1	121.7
RE 4544	65	< .1	118.7
RPD	3.125	N/A	2.4958403
4561	46	< .1	119.6
6172 (RE 4561)	41	< .1	202.9
RPD	11.494253	N/A	51.658915
4584	47	< .1	134.9
6173 (RE 4584)	43	< .1	171.8
RPD	8.8888889	N/A	24.062602
6033	56	< .1	98.5
6174 (RE 6033)	57	< .1	109.1
RPD	1.7699115	N/A	10.211946
6092	42	< .1	51.4
RE 6092	40	< .1	50.3
RPD	4.8780488	N/A	2.1632252
6168 (RE 3901)	29	< .1	136.3
RE 6168	30	< .1	141.2
RPD	3.3898305	N/A	3.5315315

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Ag	Al	As	Au	B	Ba	Bi
	ppb	%	ppm	ppb	ppm	ppm	ppm
SI	10	0.02	0.1	0.2	2	7.5	0.03
LDL	2	0.01	0.1	0.2	1	0.5	0.02
Average RPD	5.177498512	9.0967677	6.1045163	55.99574	15.711088	13.792499	6.3964738
				8 samples <LDL			

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Ca	Cd	Co	Cr	Cu	Fe	Ga
	%	ppm	ppm	ppm	ppm	%	ppm
SI	0.39	0.01	0.1	0.7	1.15	0.05	0.1
LDL	0.01	0.01	0.1	0.5	0.01	0.01	0.1
Average RPD	9.385965754	9.923144	6.4270258	6.7721355	4.786243	3.9383799	7.0675893

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Hg	K	La	Mg	Mn	Mo	Na
	ppb	%	ppm	%	ppm	ppm	%
SI	14	0.01	<.5	0.01	10	0.05	1.421
LDL	5	0.01	0.5	0.01	1	0.01	0.001
Average RPD	15.97458536	8.7344086	8.7317557	4.1174874	6.3109141	6.7283298	5.0313761
			1 sample <LDL				

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Ni	P	Pb	S	Sb	Sc	Se
	ppm	%	ppm	%	ppm	ppm	ppm
SI	0.1	<.001	1.63	0.02	0.18	0.3	0.1
LDL	0.1	0.001	0.01	0.02	0.02	0.1	0.1
Average RPD	4.653329387	8.7045429	6.9675923	10.74824	7.1636243	6.8446886	8.5793399

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Sr	Te	Th	Ti	Tl	U	V
	ppm	ppm	ppm	%	ppm	ppm	ppm
SI	7.9	<.02	<.1	<.001	<.02	0.01	<2
LDL	0.5	0.02	0.1	0.001	0.02	0.1	2
Average RPD	3.743625047	28.840159	8.3574079	N/A	11.102461	9.5220811	6.5117985
		1 sample <LDL		Over 25% samples			

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	W	Zn
	ppm	ppm
SI	0.7	0.8
LDL	0.1	0.1
Average RPD	N/A	8.7192441
	Over 25% samples	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Analysis Date	Ag	Al	As	Au	B	Ba
		ppb	%	ppm	ppb	ppm	ppm
SI		4	<.01	<.1	0.6	1	2.4
LDL		2	0.01	0.1	0.2	1	0.5
SAMPLES							
221	Dec. 2003	372	0.8	25.4	1.4	14	72.7
6175 (RE 221)		389	1.62	25	1.7	16	55.9
RPD		4.4678055	67.768595	1.5873016	19.354839	13.333333	26.127527
242	Dec. 2003	351	0.73	26.5	1.4	17	91.5
6176 (RE 242)		362	0.88	28	0.5	20	66.9
RPD		3.085554	18.63354	5.5045872	94.736842	16.216216	31.060606
263	Dec. 2003	138	1.04	13.1	0.4	14	152.3
RE 263		136	1.05	14.3	0.3	14	159.3
RPD		1.459854	0.9569378	8.7591241	28.571429	0	4.4929397
320	Dec. 2003	292	1.19	21.8	0.2	13	77.5
6177 (RE 320)		324	1.39	23.2	*0.1*	14	58.6
RPD		10.38961	15.503876	6.2222222	66.666667	7.4074074	27.773696
356	Dec. 2003	279	0.79	23.8	0.6	11	75.1
6178 (RE 356)		272	0.86	27.2	0.4	10	46.9
RPD		2.5408348	8.4848485	13.333333	40	9.5238095	46.229508
4566	Dec. 2003	240	0.86	31	0.3	13	81.5
6179 (RE 4566)		236	1.27	35.6	*0.1*	14	67
RPD		1.6806723	38.497653	13.813814	100	7.4074074	19.52862
4577	Dec. 2003	281	1.05	24.1	0.3	16	73.1
RE 4577		269	1.08	24.4	0.4	16	71.7
RPD		4.3636364	2.8169014	1.2371134	28.571429	0	1.9337017
6038	Dec. 2003	158	1.04	5.1	0.3	18	211.5
6180 (RE 6038)		164	1.28	4.5	0.4	15	217.6
RPD		3.7267081	20.689655	12.5	28.571429	18.181818	2.8431601
6136	Dec. 2003	1067	1.79	43.4	3.3	23	62.9
6181 (RE 6136)		576	1.97	32.1	3.6	20	68.8
RPD		59.768716	9.5744681	29.933775	8.6956522	13.953488	8.959757
6154	Dec. 2003	117	1.48	14.7	0.3	20	97.8
RE 6154		116	1.49	14.8	1.2	19	96.9
RPD		0.8583691	0.6734007	0.6779661	120	5.1282051	0.9244992
6027	March 2004						
RE 6027							
RPD							
Average RPD		9.234176	18.359988	9.3569237	53.516829	9.1151686	16.987401
					2 samples <LDL		

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Be	Bi	Ca	Cd	Ce	Co	Cr
	ppm	ppm	%	ppm	ppm	ppm	ppm
SI	<.1	<.02	0.09	<.01	<.1	<.1	<.5
LDL	0.1	0.02	0.01	0.01	0.1	0.1	0.5
SAMPLES							
221	0.6	0.41	3.72	0.8	26.5	9.6	10.4
6175 (RE 221)	0.8	0.43	4.97	0.88	42.7	8.9	14.9
RPD	28.57142857	4.7619048	28.7687	9.5238095	46.820809	7.5675676	35.573123
242	0.6	0.32	3.47	1.38	15.3	16.9	18.1
6176 (RE 242)	0.7	0.34	2.8	1.4	16.3	16.7	20.9
RPD	15.38461538	6.0606061	21.371611	1.4388489	6.3291139	1.1904762	14.358974
263	0.9	0.64	0.16	2.11	54.4	13.5	11.7
RE 263	0.8	0.67	0.15	2.12	56.3	14.1	11.7
RPD	11.76470588	4.5801527	6.4516129	0.4728132	3.432701	4.3478261	0
320	0.8	0.29	3.58	1.41	12.2	12.4	19.2
6177 (RE 320)	0.6	0.28	4.1	1.62	12.5	13	23.1
RPD	28.57142857	3.5087719	13.541667	13.861386	2.4291498	4.7244094	18.439716
356	0.8	0.3	1.9	0.67	8	11.3	13.6
6178 (RE 356)	0.6	0.28	1.71	0.69	8.6	11.2	16.1
RPD	28.57142857	6.8965517	10.526316	2.9411765	7.2289157	0.8888889	16.835017
4566	0.9	0.25	7.69	1.06	12.2	13.4	16.9
6179 (RE 4566)	0.7	0.25	7.83	1	16.7	14.6	23
RPD	25	0	1.8041237	5.8252427	31.141869	8.5714286	30.576441
4577	1.1	0.32	3.2	0.9	34.1	13.4	22.6
RE 4577	0.8	0.33	3.25	0.91	34	13.7	20.9
RPD	31.57894737	3.0769231	1.5503876	1.1049724	0.2936858	2.2140221	7.816092
6038	1.1	1.03	0.24	2.19	64.6	7.4	4.9
6180 (RE 6038)	1.6	1.02	0.27	2.31	68.9	7.4	6.6
RPD	37.03703704	0.9756098	11.764706	5.3333333	6.4419476	0	29.565217
6136	1.1	0.43	1.78	17.58	66.7	15.6	25.1
6181 (RE 6136)	1	0.32	1.28	9.24	76.3	6.9	10.9
RPD	9.523809524	29.333333	32.679739	62.192394	13.426573	77.333333	78.888889
6154	0.8	0.39	0.24	0.13	26.7	10.8	26.8
RE 6154	0.9	0.41	0.23	0.17	27.3	11	26.4
RPD	11.76470588	5	4.2553191	26.666667	2.2222222	1.8348624	1.5037594
6027							
RE 6027							
RPD							
Average RPD	22.77681068	6.4193853	13.271418	12.936064	11.976699	10.867281	23.355723

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Cs	Cu	Fe	Ga	Ge	Hf	Hg
	ppm	ppm	%	ppm	ppm	ppm	ppb
SI	0.01	1.41	0.02	<.1	<.1	<.02	<5
LDL	0.02	0.01	0.01	0.1	0.1	0.02	5
SAMPLES							
221	0.77	48.59	2.76	3	<.1	0.3	101
6175 (RE 221)	0.45	46.91	2.85	4.4	<.1	0.36	107
RPD	52.459016	3.5183246	3.2085561	37.837838	N/A	18.181818	5.7692308
242	0.9	66.05	2.68	3.4	<.1	0.19	134
6176 (RE 242)	0.83	63.02	2.68	3.9	0.1	0.22	136
RPD	8.0924855	4.6951267	0	13.69863	N/A	14.634146	1.4814815
263	1.53	39.15	1.71	4.3	<.1	0.21	32
RE 263	1.62	39.8	1.7	4.4	<.1	0.22	35
RPD	5.7142857	1.6466118	0.5865103	2.2988506	N/A	4.6511628	8.9552239
320	1.4	39.13	2.33	3.8	<.1	0.08	98
6177 (RE 320)	1.44	38.6	2.48	4.5	<.1	0.07	105
RPD	2.8169014	1.3636948	6.2370062	16.86747	N/A	13.333333	6.8965517
356	1.65	34.6	2.42	2.4	<.1	0.05	84
6178 (RE 356)	1.59	33.9	2.5	2.8	<.1	0.03	83
RPD	3.7037037	2.0437956	3.2520325	15.384615	N/A	50	1.1976048
4566	1.32	35.58	3.06	4	<.1	0.09	195
6179 (RE 4566)	1.43	35.01	3.51	4.9	<.1	0.08	244
RPD	8	1.6149596	13.69863	20.224719	N/A	11.764706	22.323462
4577	1.51	38.13	3.03	4.8	<.1	0.16	180
RE 4577	1.52	37.9	3.09	4.9	<.1	0.13	181
RPD	0.660066	0.6050243	1.9607843	2.0618557	N/A	20.689655	0.5540166
6038	0.77	31.19	1.16	3.6	<.1	0.31	49
6180 (RE 6038)	0.84	32.08	1.4	4.4	<.1	0.19	46
RPD	8.6956522	2.8133397	18.75	20	N/A	48	6.3157895
6136	0.31	86.25	3.06	8.2	0.2	1.16	141
6181 (RE 6136)	0.24	44.66	2.59	6.7	0.1	0.98	113
RPD	25.454545	63.539837	16.637168	20.134228	66.666667	16.82243	22.047244
6154	1.51	27.28	2.62	5.7	<.1	0.27	83
RE 6154	1.51	28.15	2.64	5.6	0.1	0.26	67
RPD	0	3.1390944	0.7604563	1.7699115	N/A	3.7735849	21.333333
6027							
RE 6027							
RPD							
Average RPD	11.559666	8.4979808	6.5091144	15.027812	N/A	20.185084	9.6873939

>25% samples
<LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	In	K	La	Li	Mg	Mn	Mo
	ppm	%	ppm	ppm	%	ppm	ppm
SI	<.02	<.01	<.5	0.1	<.01	<1	0.03
LDL	0.02	0.01	0.5	0.1	0.01	1	0.01
SAMPLES							
221	0.04	0.16	15.6	10.6	0.29	137	8.87
6175 (RE 221)	0.04	0.26	22.8	14.5	0.48	198	8.69
RPD	0	47.619048	37.5	31.075697	49.350649	36.41791	2.0501139
242	0.03	0.26	8.9	9.6	0.34	122	5.74
6176 (RE 242)	0.05	0.31	8.7	11.7	0.34	119	5.81
RPD	50	17.54386	2.2727273	19.71831	0	2.4896266	1.2121212
263	0.05	0.21	27.1	24.3	0.24	265	2.35
RE 263	0.06	0.21	28.1	20.1	0.24	258	2.51
RPD	18.181818	0	3.6231884	18.918919	0	2.6768642	6.5843621
320	0.04	0.36	5.5	19.3	0.45	74	9.72
6177 (RE 320)	0.05	0.41	5.5	21.6	0.48	83	10.1
RPD	22.222222	12.987013	0	11.246944	6.4516129	11.464968	3.8345106
356	0.05	0.24	3.5	14.2	0.39	65	7.1
6178 (RE 356)	0.04	0.26	3.6	14.8	0.38	67	6.79
RPD	22.222222	8	2.8169014	4.137931	2.5974026	3.030303	4.4636429
4566	0.04	0.26	5.8	15.2	0.51	114	30.39
6179 (RE 4566)	0.04	0.34	7.4	20.8	0.62	133	30.68
RPD	0	26.666667	24.242424	31.111111	19.469027	15.384615	0.9497298
4577	0.05	0.28	16.8	18.7	0.49	129	24.07
RE 4577	0.05	0.29	16.9	20.7	0.5	136	24.91
RPD	0	3.5087719	0.5934718	10.152284	2.020202	5.2830189	3.4299714
6038	0.05	0.19	33.4	12.2	0.24	364	4.88
6180 (RE 6038)	0.06	0.22	34.5	15.1	0.28	460	4.07
RPD	18.181818	14.634146	3.2400589	21.245421	15.384615	23.300971	18.100559
6136	0.08	0.22	33	30.7	0.7	265	33.18
6181 (RE 6136)	0.12	0.11	36.4	33.9	0.82	430	19.89
RPD	40	66.666667	9.7982709	9.9071207	15.789474	47.482014	50.084794
6154	0.04	0.4	13.7	35.4	0.45	127	1.81
RE 6154	0.05	0.42	13.7	33.8	0.45	128	1.84
RPD	22.222222	4.8780488	0	4.6242775	0	0.7843137	1.6438356
6027							
RE 6027							
RPD							
Average RPD	19.30303	20.250422	8.4087043	16.213802	11.106298	14.831461	9.235364

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Na	Nb	Ni	P	Pb	Pd	Pt
	%	ppm	ppm	%	ppm	ppb	ppb
SI	0.422	<.02	0.1	<.001	0.27	<10	<2
LDL	0.001	0.02	0.1	0.001	0.01	10	2
SAMPLES							
221	0.549	0.13	30.2	0.09	15.95	< 10	<2
6175 (RE 221)	0.714	0.13	30.4	0.137	19.1	< 10	<2
RPD	26.128266	0	0.660066	41.409692	17.974322	N/A	N/A
242	0.391	0.4	53.3	0.069	13.88	< 10	2
6176 (RE 242)	0.383	0.4	53.4	0.061	16.15	< 10	<2
RPD	2.0671835	0	0.1874414	12.307692	15.118215	N/A	N/A
263	0.665	0.03	52.8	0.017	23.71	< 10	<2
RE 263	0.671	0.02	56.1	0.017	25.18	< 10	<2
RPD	0.8982036	40	6.0606061	0	6.0134997	N/A	N/A
320	0.236	0.04	56.7	0.067	15.51	< 10	<2
6177 (RE 320)	0.223	0.04	59.9	0.065	16.97	< 10	<2
RPD	5.664488	0	5.4888508	3.030303	8.9901478	N/A	N/A
356	0.213	0.04	45.3	0.063	16.93	< 10	<2
6178 (RE 356)	0.205	0.03	43.3	0.062	17.51	< 10	<2
RPD	3.8277512	28.571429	4.5146727	1.6	3.3681765	N/A	N/A
4566	0.198	0.06	49	0.058	12	< 10	<2
6179 (RE 4566)	0.193	0.09	53.8	0.068	13.14	< 10	3
RPD	2.5575448	40	9.3385214	15.873016	9.0692124	N/A	N/A
4577	0.187	0.05	49.3	0.223	17.95	< 10	2
RE 4577	0.188	0.04	50.8	0.229	18.33	< 10	<2
RPD	0.5333333	22.222222	2.997003	2.6548673	2.0948181	N/A	N/A
6038	1.305	0.09	46.6	0.026	27.55	< 10	<2
6180 (RE 6038)	1.302	0.07	46.8	0.026	35.67	< 10	<2
RPD	0.2301496	25	0.4282655	0	25.688073	N/A	N/A
6136	0.422	0.49	83.3	0.074	29.84	< 10	4
6181 (RE 6136)	0.582	0.2	33.4	0.034	33.5	< 10	<2
RPD	31.87251	84.057971	85.518423	74.074074	11.556678	N/A	N/A
6154	0.214	0.09	33.9	0.061	20.69	< 10	<2
RE 6154	0.207	0.1	34	0.061	21.94	< 10	<2
RPD	3.3254157	10.526316	0.2945508	0	5.8644147	N/A	N/A
6027							
RE 6027							
RPD							
Average RPD	7.7104846	25.037794	11.54884	15.094964	10.573756	N/A	N/A
						> 25% samples <LDL	> 25% samples <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Rb	Re	S	Sb	Sc	Se	Sn
	ppm	ppb	%	ppm	ppm	ppm	ppm
SI	0.1	<1	0.01	0.14	<.1	<.1	<.1
LDL	0.1	1	0.02	0.02	0.1	0.1	0.1
SAMPLES							
221	12.5	41	2.53	0.28	2.7	2.9	0.7
6175 (RE 221)	13.8	42	2.83	0.21	4.4	3.4	0.8
RPD	9.8859316	2.4096386	11.19403	28.571429	47.887324	15.873016	13.333333
242	17.2	39	2.59	1.19	2.5	4.4	0.7
6176 (RE 242)	19.4	36	2.87	1.06	2.6	4.8	0.7
RPD	12.021858	8	10.25641	11.555556	3.9215686	8.6956522	0
263	18.7	2	0.61	0.26	4	1.1	1.6
RE 263	19.4	2	0.58	0.27	4	1.1	1.6
RPD	3.6745407	0	5.0420168	3.7735849	0	0	0
320	21.7	22	1.44	0.95	6.6	3	0.8
6177 (RE 320)	25.7	26	1.75	0.7	6.8	3.4	0.8
RPD	16.877637	16.666667	19.435737	30.30303	2.9850746	12.5	0
356	18.4	14	1.63	0.77	4.4	2.1	0.5
6178 (RE 356)	19.8	17	1.99	0.54	4	2.3	0.5
RPD	7.3298429	19.354839	19.889503	35.114504	9.5238095	9.0909091	0
4566	19.2	43	1.87	0.9	6	3.2	0.5
6179 (RE 4566)	23.9	33	2.56	0.72	7	3.8	0.7
RPD	21.809745	26.315789	31.151242	22.222222	15.384615	17.142857	33.333333
4577	20	46	1.83	0.95	5.3	2.5	0.8
RE 4577	20.8	50	1.84	0.96	5.2	2.5	0.8
RPD	3.9215686	8.3333333	0.5449591	1.0471204	1.9047619	0	0
6038	11.4	1	0.11	0.55	2.3	1.9	3
6180 (RE 6038)	13.5	1	0.17	0.35	2.5	2.7	3.3
RPD	16.86747	0	42.857143	44.444444	8.3333333	34.782609	9.5238095
6136	10.4	288	3.57	6.28	3.8	43.4	2.4
6181 (RE 6136)	5.2	116	2.96	6.13	3.3	31.4	2.4
RPD	66.666667	85.148515	18.683002	2.4174053	14.084507	32.085561	0
6154	27.2	10	1.62	0.36	4.7	1.2	1.1
RE 6154	27.7	3	1.63	0.36	4.8	1.1	1.2
RPD	1.8214936	107.69231	0.6153846	0	2.1052632	8.6956522	8.6956522
6027							
RE 6027							
RPD							
Average RPD	16.087675	27.392109	15.966943	17.94493	10.613026	13.886626	6.4886128

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	Sr	Ta	Te	Th	Ti	Tl	U
	ppm	ppm	ppm	ppm	%	ppm	ppm
SI	2.1	<.05	<.02	<.1	0.001	<.02	<.01
LDL	0.5	0.05	0.02	0.1	0.001	0.02	0.1
SAMPLES							
221	211.4	<.05	0.17	5.4	0.003	0.37	4.11
6175 (RE 221)	267.4	<.05	0.15	6.3	0.002	0.38	5.82
RPD	23.391813	N/A	12.5	15.384615	40	2.6666667	34.441088
242	144	<.05	0.24	4.6	<.001	0.88	2.63
6176 (RE 242)	119.5	<.05	0.23	4.7	0.001	0.84	2.59
RPD	18.595825	N/A	4.2553191	2.1505376	N/A	4.6511628	1.532567
263	110	<.05	0.11	12.3	0.002	0.17	4.46
RE 263	111.3	<.05	0.08	12.6	0.002	0.19	4.53
RPD	1.1748757	N/A	31.578947	2.4096386	0	11.111111	1.5572859
320	111.6	<.05	0.1	5.4	<.001	0.29	2.97
6177 (RE 320)	127.5	<.05	0.08	5.4	0.001	0.27	2.99
RPD	13.299875	N/A	22.222222	0	N/A	7.1428571	0.6711409
356	68	<.05	0.09	5	0.007	0.22	1.59
6178 (RE 356)	64.5	<.05	0.08	4.6	<.001	0.15	1.42
RPD	5.2830189	N/A	11.764706	8.3333333	N/A	37.837838	11.295681
4566	196.3	<.05	0.09	4.4	<.001	0.19	8.19
6179 (RE 4566)	197.4	<.05	0.07	4.5	0.001	0.25	10.69
RPD	0.5588011	N/A	25	2.247191	N/A	27.272727	26.483051
4577	129.1	<.05	0.09	6.1	0.009	0.24	20.49
RE 4577	131.3	<.05	0.08	6.2	0.007	0.24	20.95
RPD	1.6897081	N/A	11.764706	1.6260163	25	0	2.2200772
6038	187.7	<.05	0.06	23.6	0.003	0.1	9.02
6180 (RE 6038)	193.2	<.05	0.05	23.6	0.001	0.08	8.9
RPD	2.8878971	N/A	18.181818	0	100	22.222222	1.3392857
6136	187.2	<.05	0.22	11.6	0.003	4.45	8.66
6181 (RE 6136)	245.8	<.05	0.21	16.1	0.002	2.49	5.59
RPD	27.066975	N/A	4.6511628	32.490975	40	56.48415	43.087719
6154	84.6	<.05	0.06	9.3	0.002	0.21	2.08
RE 6154	84.2	<.05	0.04	9.8	0.002	0.22	2.11
RPD	0.4739336	N/A	40	5.2356021	0	4.6511628	1.4319809
6027							
RE 6027							
RPD							
Average RPD	9.4422722	N/A	18.191888	6.9877909	N/A	17.40399	12.405988
		>25% samples <LDL			>25% samples <LDL		

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1F1 - 1.00 GM, RPD

ELEMENT	V	W	Y	Zn	Zr
	ppm	ppm	ppm	ppm	ppm
SI	<2	<.1	0.02	0.5	0.3
LDL	2	0.1	0.01	0.1	0.1
SAMPLES					
221	22	<.1	19.36	105.3	13
6175 (RE 221)	40	<.1	29.59	100.9	16.9
RPD	58.064516	N/A	41.797753	4.2677013	26.086957
242	48	<.1	8.5	144.9	8.7
6176 (RE 242)	55	<.1	8.04	130.9	10.2
RPD	13.592233	N/A	5.5622733	10.152284	15.873016
263	15	<.1	17.13	147.6	8.7
RE 263	16	<.1	17.71	148	8.2
RPD	6.4516129	N/A	3.3295063	0.270636	5.9171598
320	54	<.1	11.68	165.3	2.6
6177 (RE 320)	64	<.1	12.06	203.3	2.1
RPD	16.949153	N/A	3.2013479	20.618557	21.276596
356	32	<.1	9.67	131.6	1.2
6178 (RE 356)	36	<.1	9.46	131.6	1.2
RPD	11.764706	N/A	2.1955044	0	0
4566	62	<.1	13.32	167.4	2.8
6179 (RE 4566)	82	0.1	15.78	119.5	3.2
RPD	27.777778	N/A	16.907216	33.391426	13.333333
4577	59	0.3	31.38	137.3	3.9
RE 4577	59	0.3	32.32	140.5	3.9
RPD	0	0	2.9513344	2.3038157	0
6038	9	<.1	23.07	138.7	12.4
6180 (RE 6038)	11	<.1	23.79	166.2	8.4
RPD	20	N/A	3.0729834	18.038701	38.461538
6136	328	<.1	21.39	306	47.8
6181 (RE 6136)	192	<.1	12.1	199.5	39.8
RPD	52.307692	N/A	55.479248	42.136499	18.26484
6154	41	<.1	11.43	106.7	10.7
RE 6154	41	<.1	11.89	115.8	11.1
RPD	0	N/A	3.9451115	8.1797753	3.6697248
6027					
RE 6027					
RPD					
Average RPD	20.690769	N/A	13.844228	13.935939	14.288316

>25% samples
<LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, RPD

ELEMENT	Ag	Al	As	Au	Ba	Be	Bi
	ppm	%	ppm	ppm	ppm	ppm	ppm
SI	<.1	0.89	<1	<.1	145	<1	<.1
LDL	0.1	0.01	1	0.1	1	1	0.1
SAMPLES							
221	0.4	6.34	21	<.1	67	3	0.5
6175 (RE 221)	0.4	6.55	19	<.1	50	2	0.4
RPD	0	3.2583398	10	N/A	29.059829	40	22.222222
242	0.4	6.65	20	<.1	65	5	0.3
6176 (RE 242)	0.4	6.97	24	<.1	39	2	0.3
RPD	0	4.6989721	18.181818	N/A	50	85.714286	0
263	0.2	8.82	15	<.1	449	2	0.6
RE 263	0.2	8.79	18	<.1	453	2	0.6
RPD	0	0.3407155	18.181818	N/A	0.886918	0	0
320	0.3	7.64	13	<.1	180	2	0.2
6177 (RE 320)	0.3	7.8	13	<.1	135	2	0.4
RPD	0	2.0725389	0	N/A	28.571429	0	66.666667
356	0.3	8.29	12	<.1	201	4	0.3
6178 (RE 356)	0.3	8.31	17	<.1	118	2	0.4
RPD	0	0.2409639	34.482759	N/A	52.037618	66.666667	28.571429
4566	0.2	8.28	21	<.1	191	1	0.2
6179 (RE 4566)	0.3	6.92	25	<.1	90	1	0.3
RPD	40	17.894737	17.391304	N/A	71.886121	0	40
4577	0.2	7.49	13	<.1	164	1	0.3
RE 4577	0.3	7.19	14	<.1	132	1	0.2
RPD	40	4.0871935	7.4074074	N/A	21.621622	0	40
6038	0.2	7.02	6	<.1	383	2	0.9
6180 (RE 6038)	0.2	8.74	7	<.1	402	1	0.9
RPD	0	21.827411	15.384615	N/A	4.8407643	66.666667	0
6136	1.1	8.04	14	<.1	72	1	0.4
6181 (RE 6136)	0.7	7.93	16	<.1	114	1	0.3
RPD	44.444444	1.377583	13.333333	N/A	45.16129	0	28.571429
6154	0.1	8.96	12	<.1	230	3	0.4
RE 6154	0.1	8.64	12	<.1	211	1	0.4
RPD	0	3.6363636	0	N/A	8.61678	100	0
6027	0.2	6.15	15	<.1	193	2	0.3
RE 6027	0.2	6.01	14	<.1	176	1	0.2
RPD	0	2.3026316	6.8965517	N/A	9.2140921	66.666667	40
Average RPD	11.313131	5.6124954	12.841782	N/A	29.263315	38.701299	24.184704

>25% samples
<LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, RPD

ELEMENT	Ca	Cd	Ce	Co	Cr	Cu	Fe
	%	ppm	ppm	ppm	ppm	ppm	%
SI	7.19	0.2	3	< 1	0.1	4.5	0.07
LDL	0.01	0.1	1	1	0.1	0.1	0.01
SAMPLES							
221	4.1	0.8	62	10	70.2	50.4	3.62
6175 (RE 221)	5.14	0.9	61	9	61.4	46.7	3.09
RPD	22.510823	11.764706	1.6260163	10.526316	13.37386	7.6210093	15.797317
242	3.46	1.4	51	15	93	63	3.55
6176 (RE 242)	3.06	1.2	49	17	87.1	68.2	3.39
RPD	12.269939	15.384615	4	12.5	6.5519156	7.9268293	4.610951
263	0.17	1.8	75	16	76.2	39.9	3.45
RE 263	0.18	2.2	75	17	80.5	41.2	3.58
RPD	5.7142857	20	0	6.0606061	5.488194	3.2059186	3.6984353
320	3.71	1.3	60	13	115.9	37.9	3.26
6177 (RE 320)	4.42	1.6	60	14	114	39.3	3.02
RPD	17.466175	20.689655	0	7.4074074	1.6528926	3.626943	7.6433121
356	1.93	0.8	54	12	108.3	34.5	3.17
6178 (RE 356)	1.87	0.9	62	13	113.9	37.3	3.25
RPD	3.1578947	11.764706	13.793103	8	5.0405041	7.7994429	2.4922118
4566	7.92	1.2	62	13	88.6	35.9	3.77
6179 (RE 4566)	8.36	0.9	60	15	106	36.3	4.06
RPD	5.4054054	28.571429	3.2786885	14.285714	17.882837	1.1080332	7.4074074
4577	3.14	0.9	76	13	85.5	37.4	3.7
RE 4577	3.05	0.6	75	14	88.4	37.9	3.55
RPD	2.907916	40	1.3245033	7.4074074	3.3352501	1.3280212	4.137931
6038	0.25	2.2	54	7	35.1	28.1	2.46
6180 (RE 6038)	0.38	1.7	64	8	46	33.7	2.76
RPD	41.269841	25.641026	16.949153	13.333333	26.880395	18.122977	11.494253
6136	1.97	15.6	84	16	62.7	88.2	3.6
6181 (RE 6136)	1.36	8.9	64	7	33.3	46.8	2.79
RPD	36.636637	54.693878	27.027027	78.26087	61.25	61.333333	25.352113
6154	0.28	0.3	69	13	119.4	29.5	3.52
RE 6154	0.27	0.1	62	12	117.9	27.8	3.49
RPD	3.6363636	100	10.687023	8	1.2642225	5.9336824	0.8559201
6027	1.41	0.3	68	10	101.6	33	2.54
RE 6027	1.36	0.4	68	9	97.8	31.1	2.48
RPD	3.6101083	28.571429	0	10.526316	3.8114343	5.9282371	2.3904382
Average RPD	14.053217	32.461949	7.1532285	16.027997	13.321046	11.266766	7.8072991

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, RPD

ELEMENT	Hf	K	La	Li	Mg	Mn	Mo
	ppm	%	ppm	ppm	%	ppm	ppm
SI	0.6	0.19	2	1.8	0.14	17	0.4
LDL	0.1	0.01	0.1	0.1	0.01	1	0.1
SAMPLES							
221	2.4	1.5	30.1	35.8	0.94	164	9.9
6175 (RE 221)	2.5	1.33	34	38.2	1.1	208	8.9
RPD	4.0816327	12.014134	12.168487	6.4864865	15.686275	23.655914	10.638298
242	2.2	2.02	26.6	43.4	0.78	147	5.9
6176 (RE 242)	2.2	2.09	27.6	45	0.8	142	6.2
RPD	0	3.406326	3.6900369	3.6199095	2.5316456	3.4602076	4.9586777
263	4	1.66	31	69.6	0.67	323	2.8
RE 263	3.8	1.62	29.5	73.5	0.67	327	3
RPD	5.1282051	2.4390244	4.9586777	5.4507338	0	1.2307692	6.8965517
320	2.3	2.11	26.5	72.5	0.85	101	10
6177 (RE 320)	2.4	2.23	33.8	75	0.87	99	11
RPD	4.2553191	5.5299539	24.212272	3.3898305	2.3255814	2	9.5238095
356	2	2.12	28.6	77.8	0.83	75	6.7
6178 (RE 356)	2.2	2.45	32.5	92.9	0.84	86	8
RPD	9.5238095	14.442013	12.765957	17.691857	1.1976048	13.664596	17.687075
4566	1.8	1.79	36	60.1	0.94	111	28.9
6179 (RE 4566)	2.1	1.87	34.6	64.9	0.94	144	32
RPD	15.384615	4.3715847	3.9660057	7.68	0	25.882353	10.180624
4577	1.8	1.7	42.1	65.5	0.84	158	22.5
RE 4577	1.8	1.74	43.2	64.5	0.8	134	21.7
RPD	0	2.3255814	2.5791325	1.5384615	4.8780488	16.438356	3.6199095
6038	3.9	0.87	26	33.8	0.98	305	5
6180 (RE 6038)	4.4	1.01	32.8	36.6	1.14	489	5.4
RPD	12.048193	14.893617	23.129252	7.9545455	15.09434	46.347607	7.6923077
6136	6.1	1.33	44.7	91.8	1.76	286	40.1
6181 (RE 6136)	8.4	0.68	30.7	105	2.32	452	24.5
RPD	31.724138	64.676617	37.135279	13.414634	27.45098	44.98645	48.297214
6154	3.3	2.53	37.9	100.2	0.92	156	2.2
RE 6154	3.1	2.5	33.4	100	0.91	151	2
RPD	6.25	1.1928429	12.622721	0.1998002	1.0928962	3.257329	9.5238095
6027	2.6	1.91	38.7	45.5	0.57	117	1.8
RE 6027	2.7	1.91	37.8	44.2	0.56	120	1.8
RPD	3.7735849	0	2.3529412	2.8985507	1.7699115	2.5316456	0
Average RPD	8.3790452	11.390154	12.68916	6.3931645	6.5479348	16.677748	11.728934

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, RPD

ELEMENT	Na	Nb	Ni	P	Pb	Rb	S
	%	ppm	ppm	%	ppm	ppm	%
SI	9.652	0.2	<.1	0.008	11.4	2.8	0.2
LDL	0.001	0.1	0.1	0.001	0.1	0.1	0.1
SAMPLES							
221	0.775	8.4	30.7	0.096	18.9	92.1	3.1
6175 (RE 221)	0.875	7.4	28.3	0.147	16.7	71.5	2.8
RPD	12.121212	12.658228	8.1355932	41.975309	12.359551	25.183374	10.169492
242	0.54	10.3	53.8	0.071	15.2	115.6	2.9
6176 (RE 242)	0.587	11	54	0.074	17.7	110.5	2.8
RPD	8.3407276	6.57277	0.3710575	4.137931	15.197568	4.5112782	3.5087719
263	0.868	12.6	61.9	0.024	28.9	90.5	0.6
RE 263	0.87	13.4	66.5	0.026	32.3	90.9	0.6
RPD	0.2301496	6.1538462	7.165109	8	11.111111	0.4410143	0
320	0.451	11.4	64	0.079	18.5	106.8	1.6
6177 (RE 320)	0.495	11.9	58.3	0.083	18.8	121.7	1.8
RPD	9.3023256	4.2918455	9.321341	4.9382716	1.6085791	13.041575	11.764706
356	0.423	13.9	48.8	0.076	19.1	101.8	1.9
6178 (RE 356)	0.46	14.2	50.6	0.087	20.8	123.3	2
RPD	8.380521	2.1352313	3.6217304	13.496933	8.5213033	19.102621	5.1282051
4566	0.364	9.8	50.6	0.071	13.6	109.6	2.5
6179 (RE 4566)	0.374	10.5	54	0.084	15.3	109.5	2.7
RPD	2.7100271	6.8965517	6.500956	16.774194	11.764706	0.0912825	7.6923077
4577	0.461	10.6	57.2	0.217	18.5	96.7	2.4
RE 4577	0.455	10	53.5	0.216	17.6	95.3	2.4
RPD	1.3100437	5.8252427	6.6847335	0.4618938	4.9861496	1.4583333	0
6038	1.396	19.5	46.1	0.027	27.6	33.3	0.1
6180 (RE 6038)	1.523	20.1	43.3	0.032	34.6	45.1	0.1
RPD	8.7016101	3.030303	6.2639821	16.949153	22.508039	30.102041	0
6136	0.625	9.1	78.6	0.081	29.2	65.2	3.3
6181 (RE 6136)	0.746	7	33.5	0.04	34	15.1	3.1
RPD	17.651349	26.086957	80.463872	67.768595	15.189873	124.78207	6.25
6154	0.494	13.8	39.1	0.08	23.5	134.7	1.5
RE 6154	0.484	12.4	41.2	0.079	23.6	129.8	1.5
RPD	2.0449898	10.687023	5.2303861	1.2578616	0.4246285	3.705104	0
6027	0.575	10	33.1	0.101	15.6	94.4	1.2
RE 6027	0.603	10.1	33.3	0.107	16.2	91.1	1.2
RPD	4.75382	0.9950249	0.6024096	5.7692308	3.7735849	3.5579515	0
Average RPD	6.8678887	7.7575475	12.214652	16.50267	9.7677357	20.543331	4.0466802

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, RPD

ELEMENT	Sb	Sc	Sn	Sr	Ta	Th	Ti
	ppm	ppm	ppm	ppm	ppm	ppm	%
SI	0.9	< 1	2.4	167	<.1	0.3	0.032
LDL	0.1	1	0.1	1	0.1	0.1	0.01
SAMPLES							
221	0.6	9	1.6	283	0.5	8.6	0.292
6175 (RE 221)	0.7	10	1.5	321	0.5	8.7	0.265
RPD	15.384615	10.526316	6.4516129	12.582781	0	1.1560694	9.6947935
242	2.5	10	1.9	207	0.6	7.9	0.321
6176 (RE 242)	2.7	10	2	185	0.6	8	0.32
RPD	7.6923077	0	5.1282051	11.22449	0	1.2578616	0.3120125
263	0.7	12	3	156	1	14.2	0.421
RE 263	0.8	12	3	157	1.1	15	0.417
RPD	13.333333	0	0	0.6389776	9.5238095	5.4794521	0.9546539
320	1.9	13	2.3	204	0.8	9.1	0.392
6177 (RE 320)	2.1	14	2	230	0.8	9.9	0.393
RPD	10	7.4074074	13.953488	11.981567	0	8.4210526	0.2547771
356	1.3	10	1.9	177	0.9	8.3	0.41
6178 (RE 356)	1.5	12	2.4	173	0.9	10	0.439
RPD	14.285714	18.181818	23.255814	2.2857143	0	18.579235	6.8315665
4566	1.6	12	1.8	330	0.7	8.3	0.365
6179 (RE 4566)	1.8	13	2.1	299	0.7	8.6	0.345
RPD	11.764706	8	15.384615	9.8569157	0	3.5502959	5.6338028
4577	1.7	11	2	225	0.7	9.1	0.341
RE 4577	1.5	10	1.6	235	0.7	8.9	0.345
RPD	12.5	9.5238095	22.222222	4.3478261	0	2.2222222	1.1661808
6038	1.1	6	5.6	221	2.1	16.9	0.204
6180 (RE 6038)	1.2	8	5.5	235	2	22	0.251
RPD	8.6956522	28.571429	1.8018018	6.1403509	4.8780488	26.22108	20.659341
6136	18.8	11	3	247	0.9	14	0.267
6181 (RE 6136)	18.1	9	2.6	274	0.8	14.4	0.213
RPD	3.7940379	20	14.285714	10.364683	11.764706	2.8169014	22.5
6154	1.1	14	2.8	169	0.9	13.2	0.464
RE 6154	0.9	14	2.8	161	0.9	12.6	0.463
RPD	20	0	0	4.8484848	0	4.6511628	0.2157497
6027	1	10	2.1	149	0.7	10.6	0.372
RE 6027	0.9	10	2.6	144	0.7	10.1	0.358
RPD	10.526316	0	21.276596	3.4129693	0	4.8309179	3.8356164
Average RPD	11.634244	9.291889	11.250915	7.0622509	2.3787786	7.19875	6.5507722

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 1EX - 0.25 GM, RPD

ELEMENT	U	V	W	Y	Zn	Zr
	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.3	< 1	0.2	2.8	15	26.3
LDL	0.1	1	0.1	0.1	1	0.1
SAMPLES						
221	5.8	172	1.3	24.8	119	71.1
6175 (RE 221)	6.4	170	1	33.5	117	71
RPD	9.8360656	1.1695906	26.086957	29.845626	1.6949153	0.140746
242	4.3	235	1.2	13.2	167	65.6
6176 (RE 242)	4.1	252	1.2	13.5	158	68.3
RPD	4.7619048	6.9815195	0	2.247191	5.5384615	4.0328603
263	5.8	129	1.9	22	163	105.2
RE 263	5.9	132	2.4	22.9	170	108.1
RPD	1.7094017	2.2988506	23.255814	4.0089087	4.2042042	2.7191749
320	5.2	282	1	18	184	60.7
6177 (RE 320)	5.6	289	1.4	19.1	240	64.1
RPD	7.4074074	2.4518389	33.333333	5.9299191	26.415094	5.4487179
356	4	265	1.1	13.2	154	62.7
6178 (RE 356)	4.2	297	1.1	17.1	167	67.1
RPD	4.8780488	11.3879	0	25.742574	8.0996885	6.779661
4566	10.2	248	1	17.7	175	61.6
6179 (RE 4566)	12.9	263	1.1	22.2	143	63.8
RPD	23.376623	5.8708415	9.5238095	22.556391	20.125786	3.5087719
4577	19.7	215	1.6	30.2	142	61.3
RE 4577	19.4	208	1.2	31.6	144	61
RPD	1.5345269	3.3096927	28.571429	4.5307443	1.3986014	0.4905969
6038	8.5	70	1.3	18.9	141	96.3
6180 (RE 6038)	9.4	86	1.7	25.6	168	105.1
RPD	10.055866	20.512821	26.666667	30.11236	17.475728	8.7388282
6136	9.9	865	0.8	27.4	347	149.3
6181 (RE 6136)	6.2	565	0.6	13.1	222	175.3
RPD	45.962733	41.958042	28.571429	70.617284	43.936731	16.019717
6154	4.1	220	1.7	18.5	133	94.2
RE 6154	4.2	219	1.5	18.2	134	92.2
RPD	2.4096386	0.4555809	12.5	1.6348774	0.7490637	2.1459227
6027	4.6	301	1.4	29.9	113	79.4
RE 6027	4.5	282	1.4	30.7	111	84.9
RPD	2.1978022	6.5180103	0	2.640264	1.7857143	6.69507
Average RPD	10.375456	9.3558807	17.137222	18.169649	11.947635	5.1563697

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, RPD

ELEMENT	Ce	Co	Cs	Dy	Er	Eu	Ga
	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	3.4	<.5	<.1	0.33	0.24	0.24	1.5
LDL	0.5	0.5	0.1	0.05	0.05	0.05	0.5
SAMPLES							
221	63.6	9.2	5.8	4.65	2.62	1.21	14.9
6175 (RE 221)	69.5	8.8	5	6.4	3.42	1.43	14.2
RPD	8.8655147	4.4444444	14.814815	31.674208	26.490066	16.666667	4.8109966
242	59.7	15.3	8.4	3.26	1.76	1.03	17.1
6176 (RE 242)	57.6	11.8	8.4	2.98	1.89	0.81	17.5
RPD	3.5805627	25.830258	0	8.974359	7.1232877	23.913043	2.3121387
263	97.7	16.3	7.6	6.33	3.53	1.63	23.4
RE 263	96	15.5	7.9	6.32	3.56	1.61	21.6
RPD	1.7552917	5.0314465	3.8709677	0.1581028	0.8462623	1.2345679	8
320	76	14.3	9	4.56	2.59	1.43	19.8
6177 (RE 320)	68	12.1	9	4.41	2.58	1.11	18.9
RPD	11.111111	16.666667	0	3.3444816	0.3868472	25.19685	4.6511628
356	73	12.4	10.6	4.4	2.41	1.21	21.2
6178 (RE 356)	72.1	12.3	9.6	4.23	2.51	1.07	20.3
RPD	1.2405238	0.8097166	9.9009901	3.9397451	4.0650407	12.280702	4.3373494
4566	67.1	12.5	7.5	4.05	2.3	1.03	17.7
6179 (RE 4566)	61.1	12.9	7.6	4.49	2.62	1.09	17.1
RPD	9.3603744	3.1496063	1.3245033	10.30445	13.00813	5.6603774	3.4482759
4577	86.6	13	7.5	7.62	3.94	1.88	18.4
RE 4577	87.9	12.4	7.3	7.68	3.98	1.87	17.3
RPD	1.4899713	4.7244094	2.7027027	0.7843137	1.010101	0.5333333	6.162465
6038	83.2	8.2	4	6.57	3.45	1.1	23
6180 (RE 6038)	81.5	8	4	6.39	3.39	1.1	22.7
RPD	2.0643594	2.4691358	0	2.7777778	1.754386	0	1.3129103
6136	85.9	12.9	4.3	5.96	2.9	1.05	21.4
6181 (RE 6136)	85.9	6.9	1.7	3.93	1.87	0.72	20.4
RPD	0	60.606061	86.666667	41.051567	43.186583	37.288136	4.784689
6154	84.4	10.9	9.4	4.55	2.73	1.17	21.5
RE 6154	81.6	10.9	9	4.33	2.48	1.17	20.4
RPD	3.373494	0	4.3478261	4.954955	9.596929	0	5.2505967
6027	82.3	9	6.9	6.43	3.45	1.39	15.2
RE 6027	84.3	9.9	7	6.72	3.57	1.55	15.5
RPD	2.4009604	9.5238095	1.4388489	4.4106464	3.4188034	10.884354	1.9543974
Average RPD	4.1129239	12.114141	11.369756	10.215873	10.080585	12.15073	4.2749983

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, RPD

ELEMENT	Gd	Hf	Ho	La	Lu	Nb	Nd
	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.55	2.4	0.09	1.8	0.04	< .5	2
LDL	0.05	0.5	0.05	0.5	0.01	0.5	0.4
SAMPLES							
221	5.23	3.5	0.98	33	0.37	11.5	30.3
6175 (RE 221)	7.06	3.7	1.14	35.1	0.44	10.1	34.1
RPD	29.780309	5.5555556	15.09434	6.1674009	17.283951	12.962963	11.801242
242	3.39	2.8	0.6	31	0.29	15.3	27.3
6176 (RE 242)	3.61	3.1	0.59	31.3	0.29	14.9	24.5
RPD	6.2857143	10.169492	1.6806723	0.9630819	0	2.6490066	10.810811
263	6.94	5.8	1.31	44.6	0.48	18	43.5
RE 263	7.14	6.1	1.29	44.3	0.47	18.1	42.3
RPD	2.8409091	5.0420168	1.5384615	0.6749156	2.1052632	0.5540166	2.7972028
320	4.85	3.7	0.97	37.7	0.38	16.8	36.8
6177 (RE 320)	4.91	3.7	0.82	36.1	0.39	15.8	30.8
RPD	1.2295082	0	16.759777	4.3360434	2.5974026	6.1349693	17.751479
356	4.73	3.9	0.92	39.4	0.4	18.4	34.1
6178 (RE 356)	4.78	4.2	0.8	38.1	0.4	17.4	32.6
RPD	1.0515247	7.4074074	13.953488	3.3548387	0	5.5865922	4.4977511
4566	4.49	2.6	0.81	31.5	0.36	12.9	27.9
6179 (RE 4566)	5.04	2.9	0.89	31.7	0.36	12.8	27.8
RPD	11.542497	10.909091	9.4117647	0.6329114	0	0.7782101	0.3590664
4577	7.81	4.4	1.43	41.1	0.47	14.2	40.6
RE 4577	8.65	4.5	1.54	41.5	0.48	14.5	43.4
RPD	10.206561	2.247191	7.4074074	0.968523	2.1052632	2.0905923	6.6666667
6038	6.42	5.3	1.24	39.1	0.52	23.3	36.7
6180 (RE 6038)	6.42	5.2	1.18	39.3	0.47	23.9	37.6
RPD	0	1.9047619	4.9586777	0.5102041	10.10101	2.5423729	2.422611
6136	6.92	7.2	1.04	41.3	0.43	11.4	43.9
6181 (RE 6136)	5.47	9.3	0.66	38.2	0.23	8.5	38.8
RPD	23.405973	25.454545	44.705882	7.7987421	60.606061	29.145729	12.333736
6154	5.54	4.8	0.85	41.9	0.4	17.5	35.1
RE 6154	5.17	4.4	0.81	39.5	0.37	16.6	35.3
RPD	6.9094304	8.6956522	4.8192771	5.8968059	7.7922078	5.2785924	0.5681818
6027	6.85	5.8	1.29	39.2	0.42	15.5	37.1
RE 6027	7.15	5.2	1.29	38.7	0.45	14.4	38.7
RPD	4.2857143	10.909091	0	1.283697	6.8965517	7.3578595	4.2216359
Average RPD	8.8671038	8.0268003	10.939068	2.9624695	9.9534282	6.8255367	6.7482168

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, RPD

ELEMENT	Pr	Sn	Rb	Sm	Sr	Ta	Tb
	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.44	4	2.8	0.4	167.8	<.1	0.09
LDL	0.02	1	0.5	0.1	0.5	0.1	0.01
SAMPLES							
221	7.49	< 1	91.5	5.2	298.5	0.8	0.85
6175 (RE 221)	8.61	< 1	77.9	7.1	362	0.8	1.11
RPD	13.913043	N/A	16.056671	30.894309	19.227858	0	26.530612
242	7.09	< 1	123.3	4.4	221.1	0.7	0.62
6176 (RE 242)	6.8	< 1	126	4.3	209.4	0.9	0.57
RPD	4.1756659	N/A	2.166065	2.2988506	5.4355401	25	8.4033613
263	11.28	3	104.3	8	162.9	1.2	1.22
RE 263	11.25	3	99.1	8	160.2	1.2	1.16
RPD	0.2663116	0	5.1130777	0	1.6713092	0	5.0420168
320	9.15	1	138.2	6.3	227.4	0.9	0.86
6177 (RE 320)	8.18	2	138	5.9	239.1	1	0.74
RPD	11.19446	66.666667	0.1448226	6.557377	5.0160772	10.526316	15
356	8.7	2	141.9	6.1	179.9	1.2	0.7
6178 (RE 356)	8.57	1	141.8	6	177.2	1.1	0.71
RPD	1.5055009	66.666667	0.070497	1.6528926	1.5121815	8.6956522	1.4184397
4566	7.71	< 1	113.2	5.8	306.1	0.7	0.7
6179 (RE 4566)	7.44	1	111.2	5.6	293	0.8	0.75
RPD	3.5643564	N/A	1.7825312	3.5087719	4.3732265	13.333333	6.8965517
4577	10.65	< 1	110.3	9	227.6	0.9	1.34
RE 4577	10.57	< 1	108.4	8.9	227.1	0.9	1.3
RPD	0.7540057	N/A	1.73754	1.1173184	0.2199252	0	3.030303
6038	9.79	4	56.7	7.9	251	2.5	1.08
6180 (RE 6038)	9.34	5	55.1	7.9	244.2	2.1	1.06
RPD	4.7046524	22.222222	2.862254	0	2.7463651	17.391304	1.8691589
6136	10.57	49	62.8	8.4	245.6	1	1.11
6181 (RE 6136)	10.38	2	29.2	7.7	278.1	0.9	0.77
RPD	1.8138425	184.31373	73.043478	8.6956522	12.411686	10.526316	36.170213
6154	9.48	2	138.8	6.3	173.8	1.1	0.82
RE 6154	9.28	< 1	138.9	6.3	170.1	1.1	0.73
RPD	2.1321962	N/A	0.0720202	0	2.1517883	0	11.612903
6027	10.46	1	108.9	7.9	175.8	0.9	1.14
RE 6027	10.29	1	107	8	172.4	1	1.21
RPD	1.6385542	0	1.7600741	1.2578616	1.9529006	10.526316	5.9574468
Average RPD	4.1511445	N/A	9.5280937	5.0893667	5.1562598	8.7272034	11.084637

Over 25%
samples <LDL

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, RPD

ELEMENT	Th	Tm	U	V	W	Y	Yb
	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SI	0.4	<.05	0.3	<5	0.1	2.9	0.27
LDL	0.1	0.05	0.1	5	0.1	0.1	0.05
SAMPLES							
221	9	0.42	6.4	175	1.3	32	2.92
6175 (RE 221)	9	0.44	7.7	164	1	40.4	2.96
RPD	0	4.6511628	18.439716	6.4896755	26.086957	23.20442	1.3605442
242	10.2	0.3	4.9	244	1.4	19.4	2
6176 (RE 242)	10.1	0.27	4.5	244	1.3	18.7	2.02
RPD	0.9852217	10.526316	8.5106383	0	7.4074074	3.6745407	0.9950249
263	16.5	0.58	6.3	121	2.6	36.3	3.41
RE 263	17.7	0.55	6.6	116	2.1	35	3.48
RPD	7.0175439	5.3097345	4.6511628	4.2194093	21.276596	3.6465638	2.0319303
320	10.7	0.44	6.9	284	1.7	27	2.85
6177 (RE 320)	12.3	0.36	6.9	290	1.4	26.5	2.64
RPD	13.913043	20	0	2.0905923	19.354839	1.8691589	7.6502732
356	12.1	0.38	6	292	1.5	27.2	2.62
6178 (RE 356)	11.3	0.39	5.2	282	1.7	26.2	2.58
RPD	6.8376068	2.5974026	14.285714	3.4843206	12.5	3.7453184	1.5384615
4566	7.9	0.38	11.4	248	1.3	26.5	2.44
6179 (RE 4566)	8.5	0.36	13.9	243	1.2	28.3	2.39
RPD	7.3170732	5.4054054	19.762846	2.0366599	8	6.5693431	2.0703934
4577	10.5	0.57	23.7	218	1.2	46.8	3.48
RE 4577	12.4	0.57	22.9	214	1.4	46.5	3.29
RPD	16.593886	0	3.4334764	1.8518519	15.384615	0.6430868	5.6129985
6038	27.8	0.52	11.1	79	1.5	37.4	3.55
6180 (RE 6038)	25.6	0.52	10.7	77	1.6	37	3.61
RPD	8.2397004	0	3.6697248	2.5641026	6.4516129	1.0752688	1.6759777
6136	14	0.43	9.8	872	1.1	29.6	2.64
6181 (RE 6136)	19.4	0.25	6.6	527	0.5	17.8	1.67
RPD	32.335329	52.941176	39.02439	49.320944	75	49.78903	45.011601
6154	15.9	0.36	4.6	215	1.9	27	2.75
RE 6154	15	0.35	4.4	207	1.6	25.8	2.73
RPD	5.8252427	2.8169014	4.4444444	3.7914692	17.142857	4.5454545	0.729927
6027	12.3	0.54	5.4	266	1.8	40.9	3.06
RE 6027	10.5	0.54	5.5	270	8.7	41.5	3.36
RPD	15.789474	0	1.8348624	1.4925373	131.42857	1.4563107	9.3457944
Average RPD	10.441284	9.4770999	10.732452	7.0310511	30.912132	9.1107723	7.0929933

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4B - REE - 0.200 GM, RPD	
ELEMENT	**Zr**
	ppm
SI	**85.7**
LDL	**0.5**
SAMPLES	
221	109.9
6175 (RE 221)	104.3
RPD	5.2287582
242	97.3
6176 (RE 242)	101.3
RPD	4.0281974
263	179.3
RE 263	177.1
RPD	1.2345679
320	122
6177 (RE 320)	116.1
RPD	4.9559009
356	133
6178 (RE 356)	130.2
RPD	2.1276596
4566	101.9
6179 (RE 4566)	95.9
RPD	6.0667341
4577	151.1
RE 4577	146.1
RPD	3.3647376
6038	146.1
6180 (RE 6038)	145.6
RPD	0.342818
6136	196.9
6181 (RE 6136)	217.6
RPD	9.9879373
6154	152.2
RE 6154	150.1
RPD	1.3893483
6027	188.7
RE 6027	183.1
RPD	3.0123722
Average RPD	3.7944574

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM, RPD

ELEMENT	Al2O3 %	Ba ppm	CaO %	Cr2O3 %	Cr2O3 %	Fe2O3 %	K2O %
SI LDL	0.03	5	0.01	0.001	0.001	0.04	0.04
SAMPLES							
221	12.82	641	6.23	0.012	0.0097	5.25	2.03
6175 (RE 221)	12.8	591	7.88	0.008	0.008	4.74	1.66
RPD	0.156128	8.1168831	23.387668	40	19.20904	10.21021	20.054201
242	13.45	640	5.48	0.011	0.0131	4.99	2.66
6176 (RE 242)	13.57	653	4.61	0.012	0.0119	4.4	2.61
RPD	0.8882309	2.0108275	17.244797	8.6956522	9.6	12.56656	1.8975332
263	17.31	476	0.28	0.01	0.01	4.72	2.06
RE 263	17.25	468	0.29	0.007	0.0098	4.82	2.06
RPD	0.3472222	1.6949153	3.5087719	35.294118	2.020202	2.0964361	0
320	15.06	1063	5.76	0.012	0.015	4.5	2.77
6177 (RE 320)	14.68	971	6.45	0.015	0.0149	4.53	2.67
RPD	2.5554808	9.0462144	11.302211	22.222222	0.6688963	0.6644518	3.6764706
356	15.49	1010	2.96	0.015	0.0149	4.53	2.79
6178 (RE 356)	15.7	1039	2.66	0.015	0.0153	4.72	2.85
RPD	1.3465854	2.8306491	10.676157	0	2.6490066	4.1081081	2.1276596
4566	13.59	742	12.81	0.012	0.0124	5.22	2.33
6179 (RE 4566)	13.19	762	12.69	0.013	0.0125	5.86	2.26
RPD	2.987304	2.6595745	0.9411765	8	0.8032129	11.552347	3.0501089
4577	13.69	806	4.9	0.013	0.0126	5.04	2.33
RE 4577	13.6	806	4.88	0.013	0.0126	5.01	2.33
RPD	0.6595823	0	0.408998	0	0	0.5970149	0
6038	17.26	413	0.54	0.005	0.0049	3.69	1.22
6180 (RE 6038)	16.99	428	0.58	0.005	0.0051	4	1.19
RPD	1.5766423	3.5671819	7.1428571	0	4	8.0624187	2.4896266
6136	14.92	534	2.86	0.009	0.0092	4.81	1.51
6181 (RE 6136)	16.4	373	2.05	0.005	0.0046	4.15	0.84
RPD	9.4508301	35.501654	32.99389	57.142857	66.666667	14.732143	57.021277
6154	16.98	780	0.4	0.014	0.0141	4.93	2.87
RE 6154	17.03	788	0.37	0.014	0.0143	4.94	2.91
RPD	0.2940312	1.0204082	7.7922078	0	1.4084507	0.2026342	1.384083
6027	12.02	793.9	2.06	0.0124		3.62	2.45
RE 6027	12.07	801.5	2.06	0.0124		3.62	2.42
RPD	0.41511	0.9527391	0	0		0	1.2320329
Average RPD	1.8797407	6.1273679	10.490794	15.577714	9.7295886	5.8902112	8.4484538

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM, RPD

ELEMENT	LOI	MgO	MnO	Na2O	Ni	P2O5	Sc
	%	%	%	%	ppm	%	ppm
SI							
LDL	0.1	0.01	0.01	0.01	30	0.01	1
SAMPLES							
221	17.2	1.69	0.02	1.13	34	0.24	10
6175 (RE 221)	18	1.98	0.02	1.28	27	0.33	11
RPD	4.5454545	15.803815	0	12.448133	22.95082	31.578947	9.5238095
242	18.7	1.46	0.02	0.8	40	0.17	10
6176 (RE 242)	18.6	1.45	0.02	0.81	38	0.18	12
RPD	0.536193	0.6872852	0	1.242236	5.1282051	5.7142857	18.181818
263	10.8	1.22	0.04	1.22	57	0.07	14
RE 263	10.8	1.24	0.04	1.19	55	0.06	14
RPD	0	1.6260163	0	2.4896266	3.5714286	15.384615	0
320	13.7	1.56	0.01	0.58	70	0.19	17
6177 (RE 320)	13.9	1.53	0.01	0.68	76	0.19	16
RPD	1.4492754	1.9417476	0	15.873016	8.2191781	0	6.0606061
356	11	1.49	0.01	0.54	47	0.21	14
6178 (RE 356)	10.9	1.47	0.01	0.58	67	0.19	15
RPD	0.913242	1.3513514	0	7.1428571	35.087719	10	6.8965517
4566	18.2	1.61	0.01	0.5	68	0.19	15
6179 (RE 4566)	19.1	1.66	0.02	0.48	61	0.21	15
RPD	4.8257373	3.058104	66.666667	4.0816327	10.852713	10	0
4577	13.9	1.45	0.02	0.67	38	0.55	13
RE 4577	14.2	1.44	0.02	0.66	62	0.58	13
RPD	2.1352313	0.6920415	0	1.5037594	48	5.3097345	0
6038	12.5	2.03	0.05	2.13	*10*	0.07	8
6180 (RE 6038)	12.5	1.95	0.05	2.02	64	0.06	10
RPD	0	4.0201005	0	5.3012048	145.94595	15.384615	22.222222
6136	20	2.9	0.03	0.79	66	0.17	12
6181 (RE 6136)	19.5	3.81	0.05	1.01	61	0.09	10
RPD	2.5316456	27.123696	50	24.444444	7.8740157	61.538462	18.181818
6154	9.9	1.56	0.02	0.61	46	0.17	17
RE 6154	9.6	1.56	0.02	0.63	42	0.17	16
RPD	3.0769231	0	0	3.2258065	9.0909091	0	6.0606061
6027	9.3	1.15	0.02	0.94	31	0.24	12
RE 6027	9.1	1.15	0.02	0.91	33	0.25	12
RPD	2.173913	0	0	3.2432432	6.25	4.0816327	0
Average RPD	2.0170559	5.1185597	10.606061	7.363269	27.542812	14.453845	7.9206756
					1 sample <LDL		

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: GROUP 4A - 0.200 GM, RPD

ELEMENT	SiO2 %	TiO2 %	TOT/C %	TOT/S %	SUM %
SI					
LDL	0.02	0.01	0.01	0.01	
SAMPLES					
221	52.53	0.55	6.03	3.58	99.77
6175 (RE 221)	50.52	0.48	5.51	3.3	99.78
RPD	3.9010189	13.592233	9.0121317	8.1395349	0.0100226
242	51.39	0.57	6.43	3.44	99.78
6176 (RE 242)	52.84	0.57	6.43	3.51	99.75
RPD	2.7823084	0	0	2.0143885	0.0300707
263	61.17	0.81	1.53	0.77	99.77
RE 263	61.13	0.8	1.66	0.83	99.75
RPD	0.0654129	1.242236	8.1504702	7.5	0.0200481
320	54.82	0.68	4.53	2.01	99.77
6177 (RE 320)	54.32	0.68	4.78	2.15	99.78
RPD	0.9162544	0	5.3705693	6.7307692	0.0100226
356	59.51	0.74	3.29	2.32	99.4
6178 (RE 356)	59.91	0.75	3.02	2.44	99.88
RPD	0.6699045	1.3422819	8.5578447	5.0420168	0.4817342
4566	44.78	0.62	6.8	2.43	99.96
6179 (RE 4566)	43.56	0.6	6.62	2.87	99.74
RPD	2.7620557	3.2786885	2.6825633	16.603774	0.2203305
4577	56.22	0.67	5.41	2.45	99.55
RE 4577	56.05	0.67	5.51	2.61	99.54
RPD	0.3028414	0	1.8315018	6.3241107	0.0100457
6038	59.36	0.42	1.87	0.16	99.32
6180 (RE 6038)	60.08	0.43	1.89	0.18	99.91
RPD	1.2056263	2.3529412	1.0638298	11.764706	0.5922803
6136	51.21	0.46	5.99	3.96	99.74
6181 (RE 6136)	51.54	0.34	2.65	3.36	99.83
RPD	0.6423358	30	77.314815	16.393443	0.0901939
6154	61.55	0.8	1.64	1.95	99.91
RE 6154	61.73	0.8	1.7	1.96	99.88
RPD	0.2920182	0	3.5928144	0.511509	0.0300315
6027	66.96	0.68	2.38	1.53	99.45
RE 6027	67.33	0.67	2.43	1.61	99.63
RPD	0.5510462	1.4814815	2.0790021	5.0955414	0.1808318
Average RPD	1.2809839	4.8445329	10.877777	7.829072	0.1523284

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Analysis: CO2, ACME File #A305987, RPD

ELEMENT	C/ORG	C/GRA	CO2	SO4
	%	%	%	%
SI	2.34	< .02	0.06	0.26
LDL				
SAMPLES				
221	5.04	0.03	3.51	4.02
6175 (RE 221)	4.22	0.02	4.68	5.36
RPD	17.710583	40	28.571429	28.571429
242	6.34	0.05	0.15	5.24
6176 (RE 242)	5.78	< .02	2.43	5.67
RPD	9.2409241	N/A	176.74419	7.8826764
263	1.51	< .02	0.03	0.17
RE 263	1.55	< .02	0.03	0.17
RPD	2.6143791	N/A	0	0
320	3.33	0.03	4.29	2.24
6177 (RE 320)	3.47	0.02	4.73	2.48
RPD	4.1176471	40	9.7560976	10.169492
356	2.57	0.04	2.51	1.23
6178 (RE 356)	2.4	0.03	2.19	1.6
RPD	6.8410463	28.571429	13.617021	26.14841
4566	4.37	0.04	8.78	4.49
6179 (RE 4566)	4.18	< .02	8.9	4.87
RPD	4.4444444	N/A	1.3574661	8.1196581
4577	4.45	< .02	3.48	2.7
RE 4577	4.57	< .02	3.42	2.67
RPD	2.6607539	N/A	1.7391304	1.1173184
6038	1.7	0.02	0.53	0.16
6180 (RE 6038)	1.68	0.02	0.69	0.37
RPD	1.183432	0	26.229508	79.245283
6136	5.63	0.03	1.22	2.76
6181 (RE 6136)	2.53	0.02	0.35	3.05
RPD	75.980392	40	110.82803	9.9827883
6154	1.58	0.04	0.05	0.34
RE 6154	1.67	0.02	0.03	0.37
RPD	5.5384615	66.666667	50	8.4507042
6027	2.12	0.02	0.87	2.18
RE 6027	2.18	< .02	0.88	1.97
RPD	2.7906977	N/A	1.1428571	10.120482
Average RPD	12.102069	N/A	38.18052	17.255295

Over 25%
samples <LDL

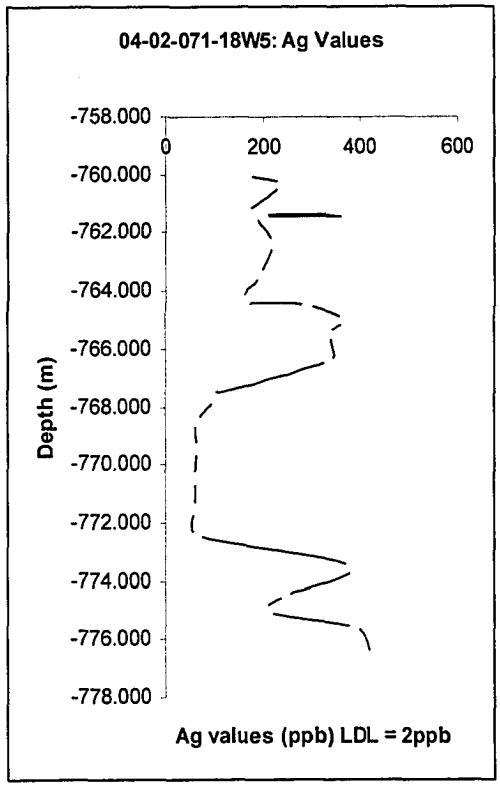
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

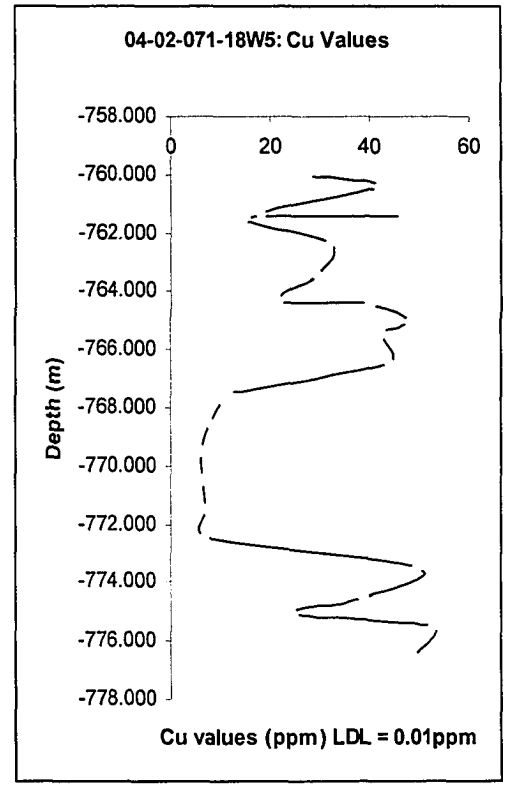
6.6 Elements vs. Depth For All Core

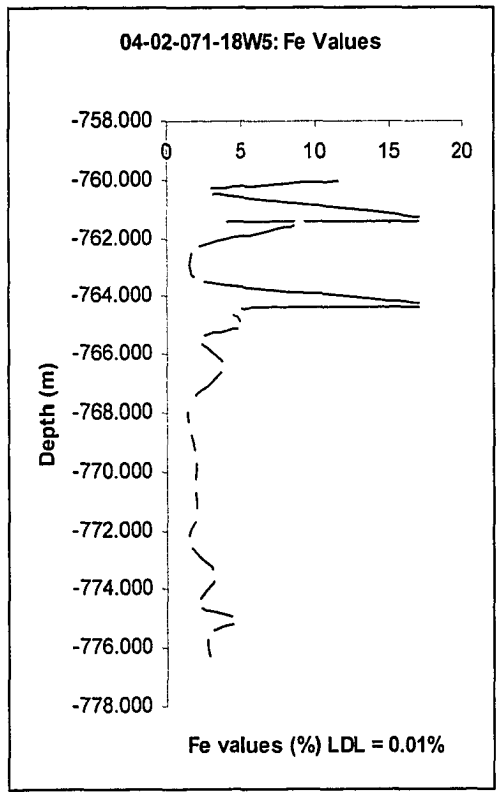
00/04-02-071-18W5/0

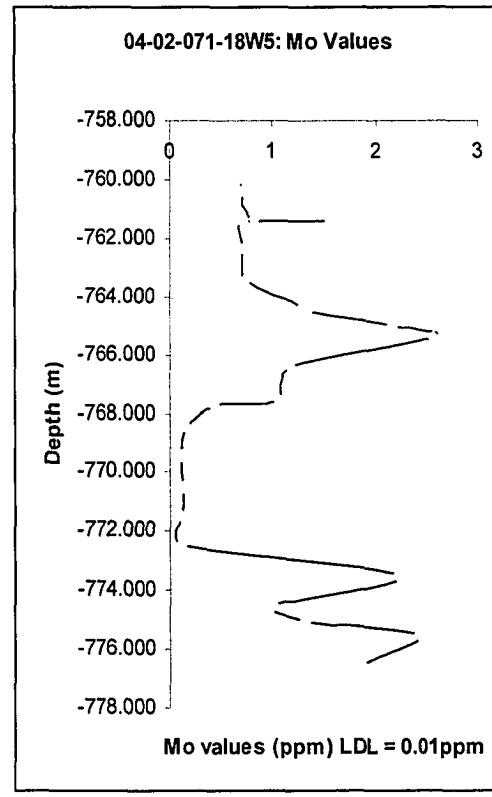
The core placement was determined based on geophysical logs and the lithology. The core does not represent an interval of the Second White Specks Formation. The core ranges form 758.92 m to 776.78 m, whereas the Second White Specks Formation interval ranges from 722 m to 740 m; therefore the core may represent the underlying Belle Fourche Formation or another underlying unit. The Ag, Cu, Fe, Ni, S and Zn values follow similar geochemical signatures with higher values at 760 to 767 m depth and again at 773 to 776.50 m depth. The lower metal values lie in between these intervals. When compared to the logged core, the first two intervals correspond to medium grey shales with sand laminations and abundant siderite nodules. The lower values correspond to a thick sand interval than ranges from approximately 767 to 773 m in depth. The peak values at 761 m depth correspond to the observation of pyrite and this is where the corresponding S peak correlates. The high values around 773 m depth correspond to an increase in organic matter.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

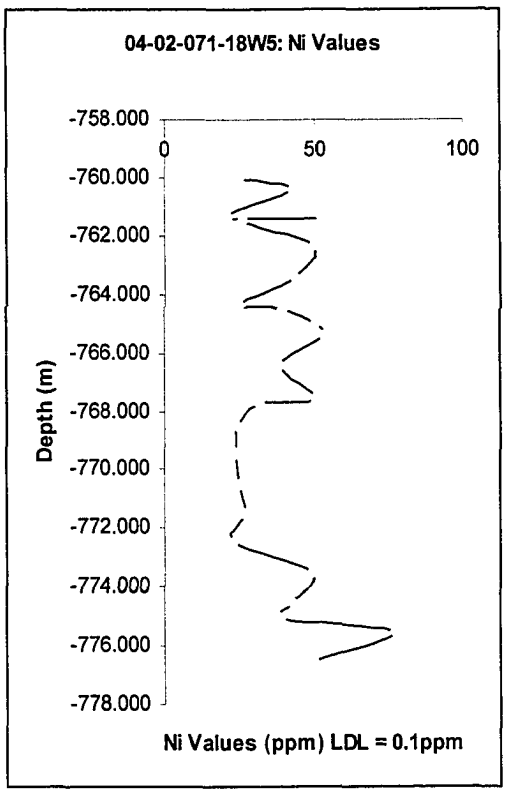


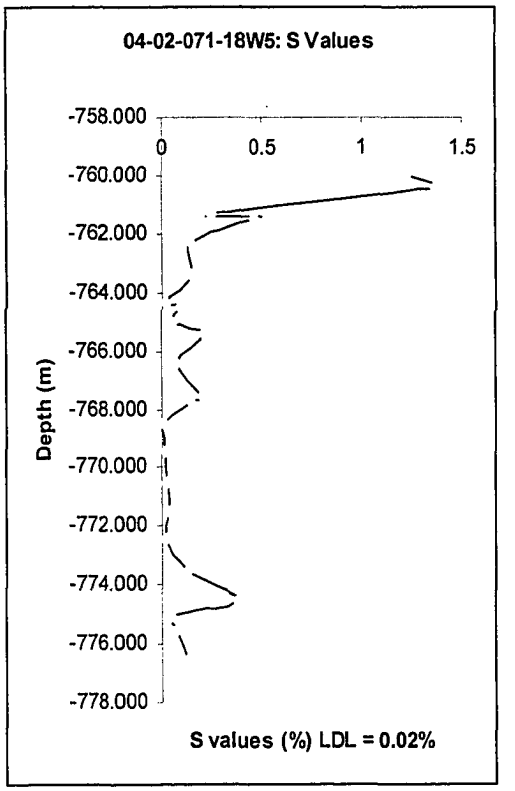


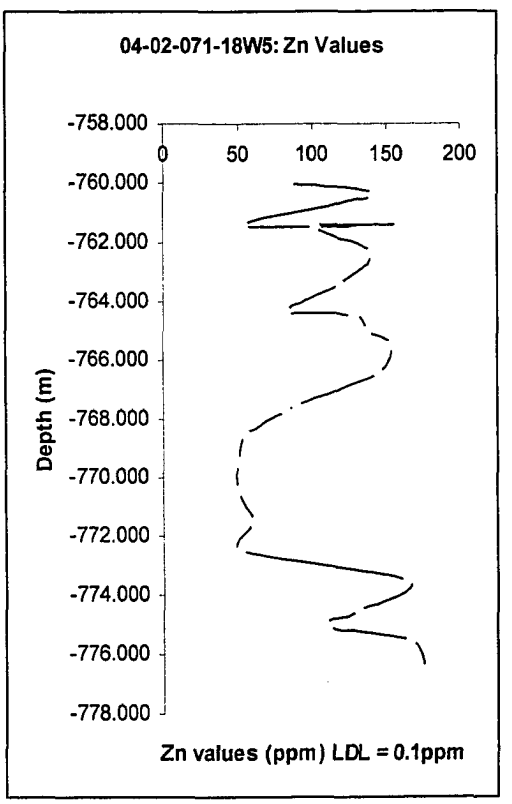




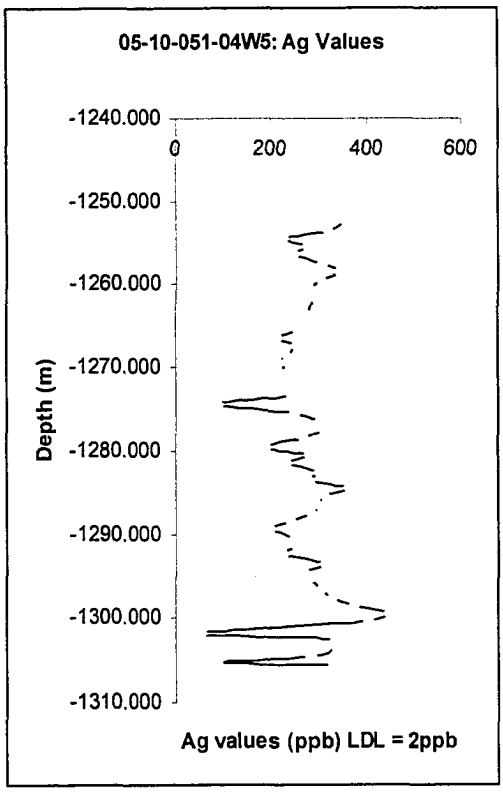
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

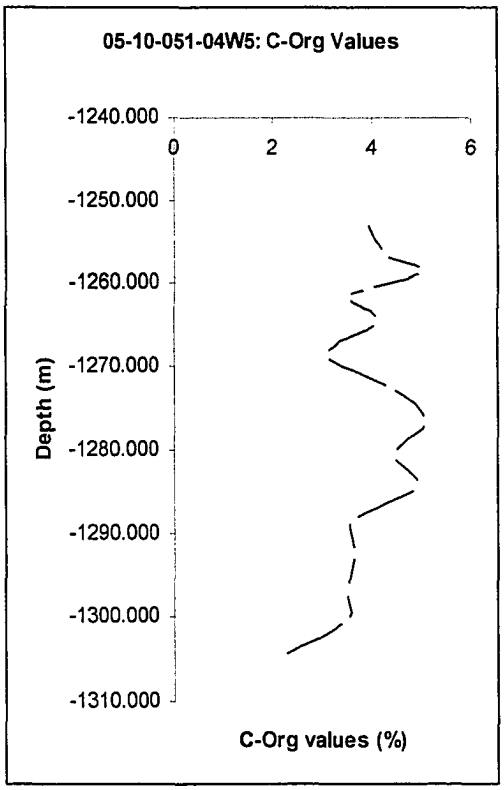


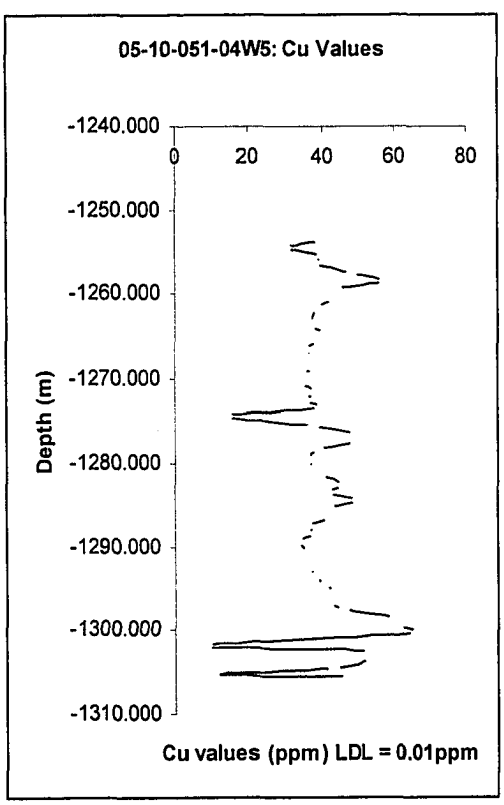


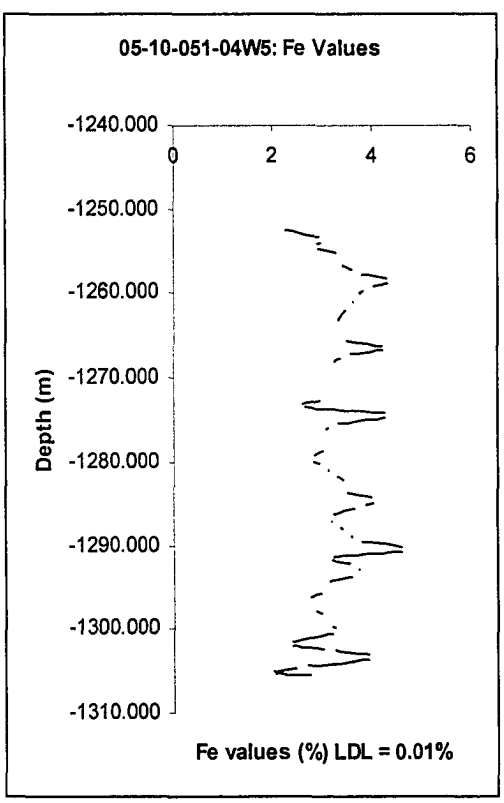


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

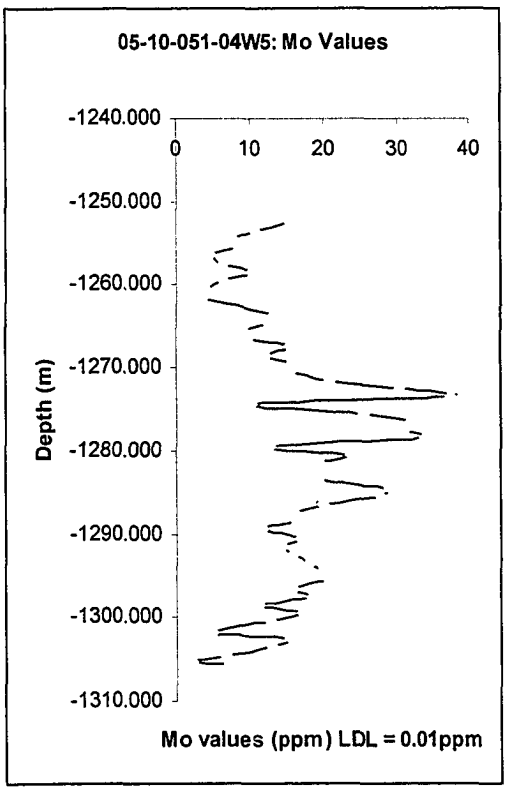


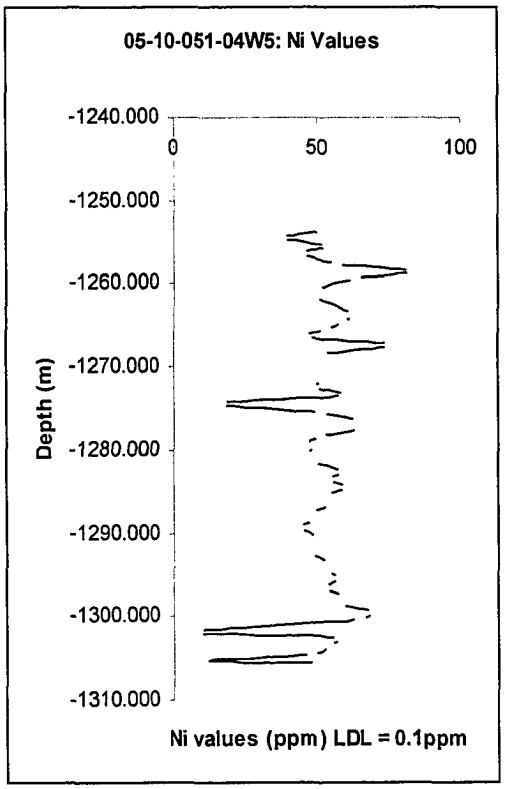


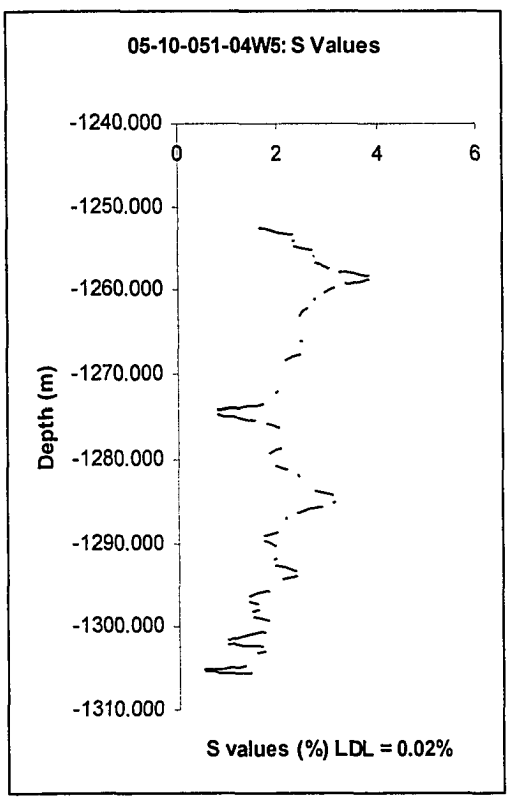


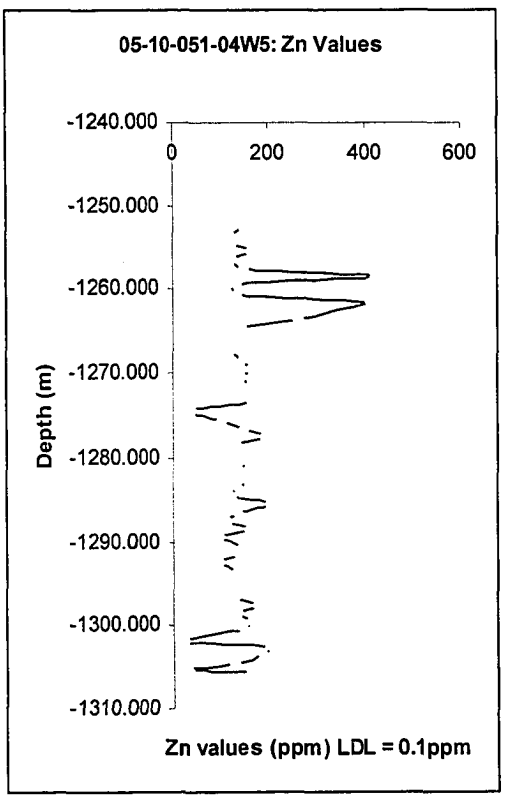


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

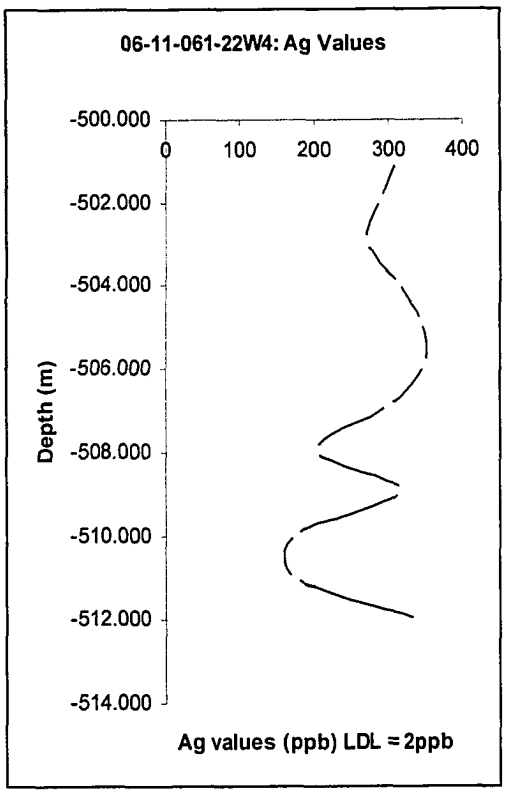


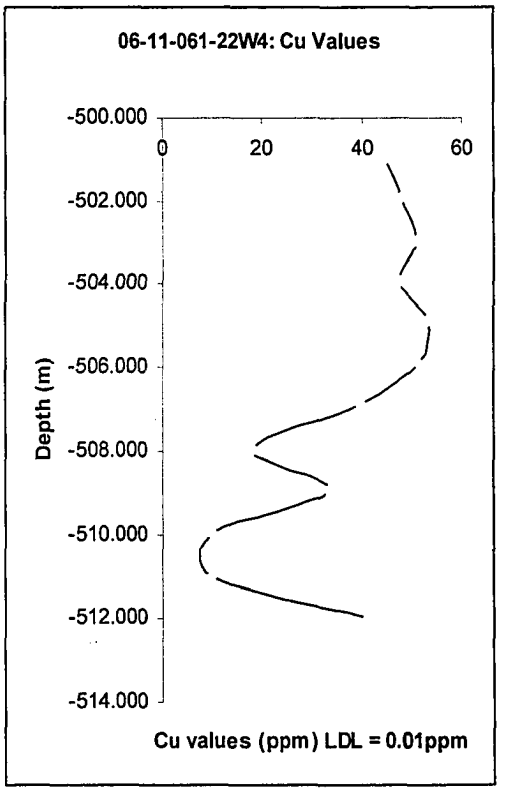


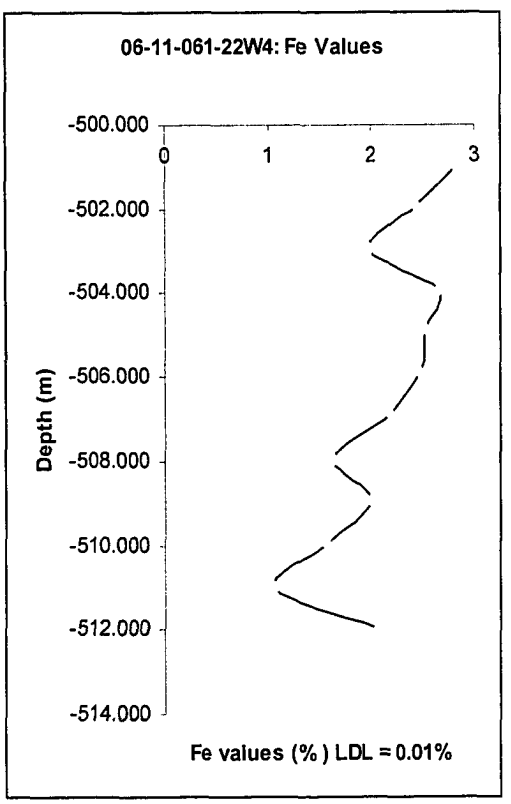


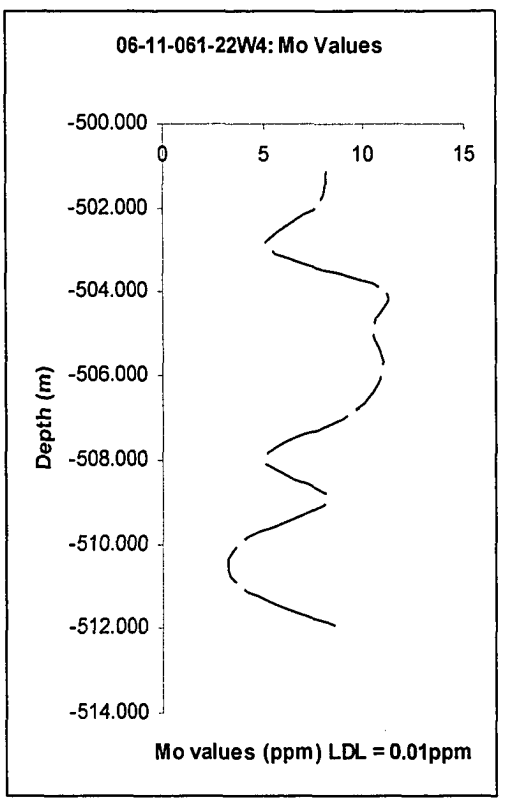


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

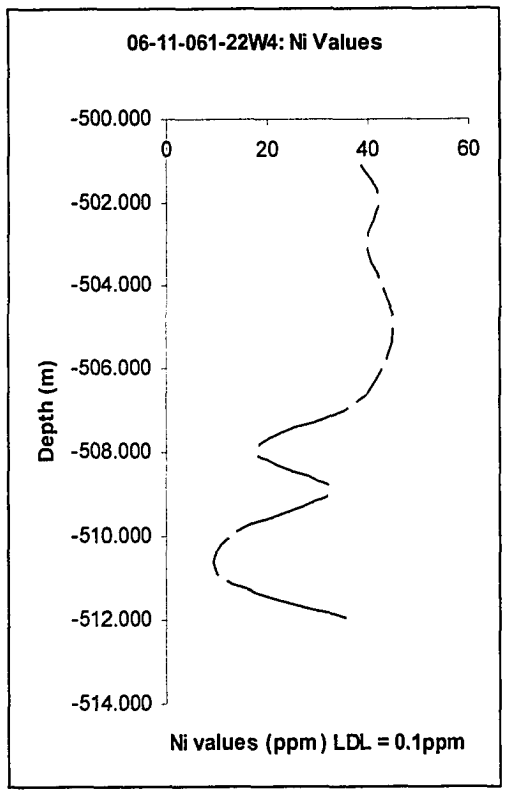


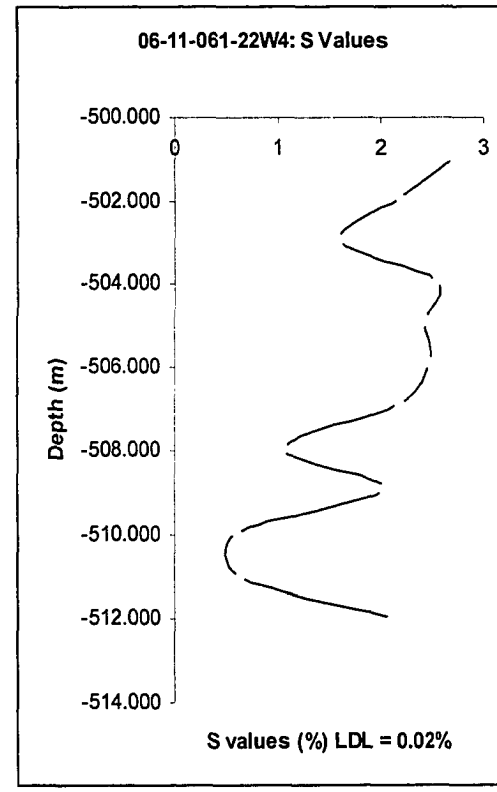


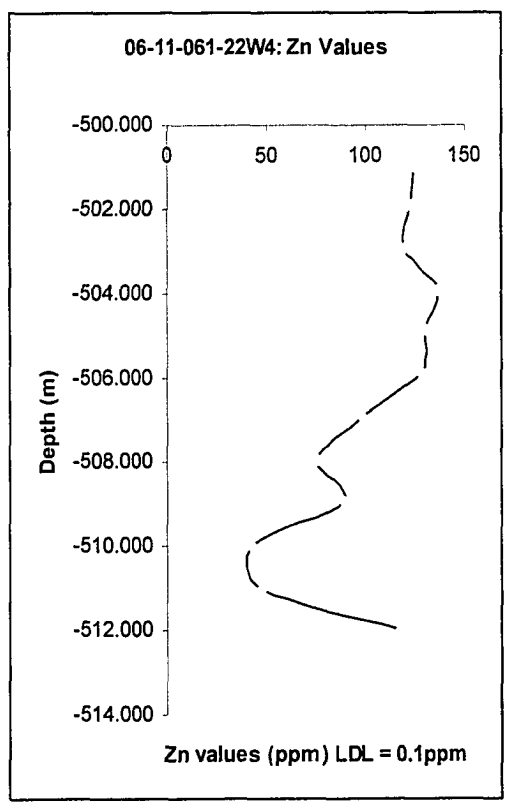




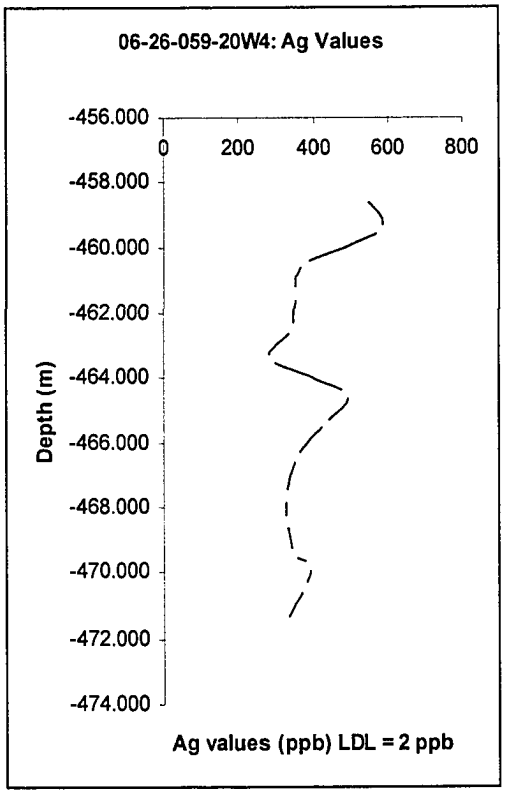
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

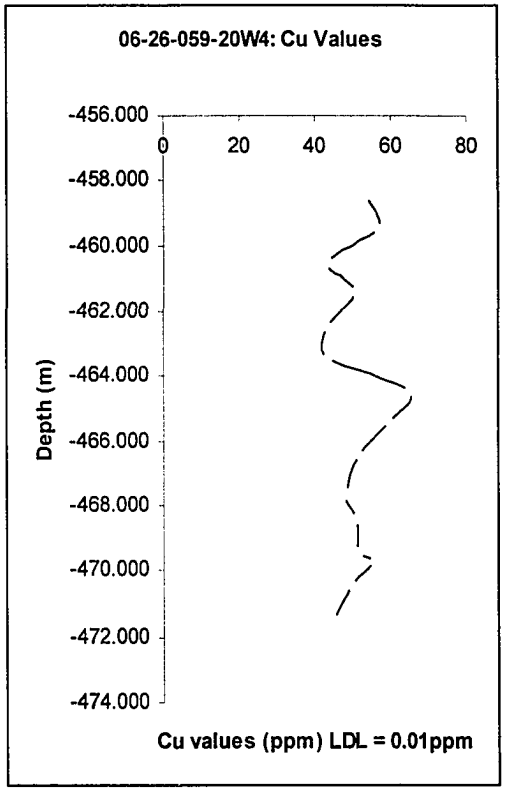


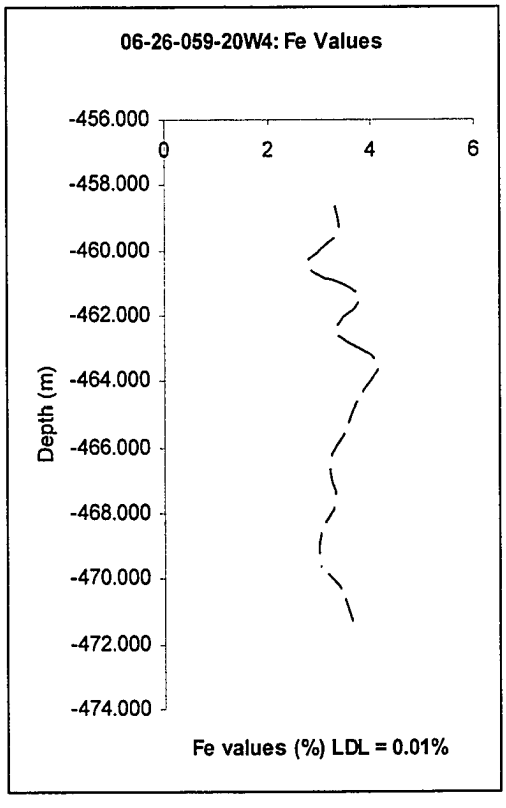


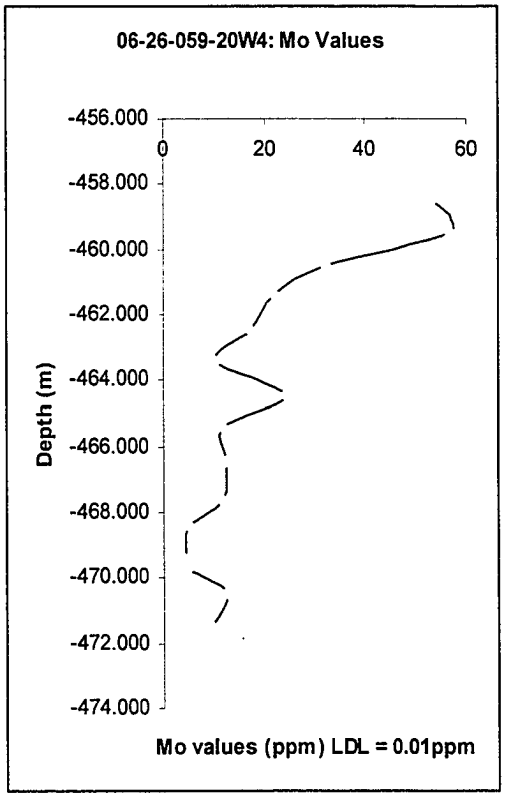


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

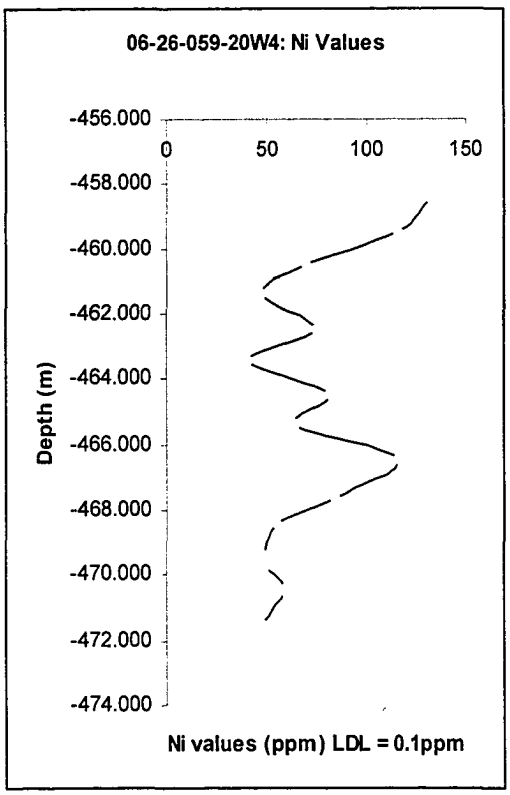


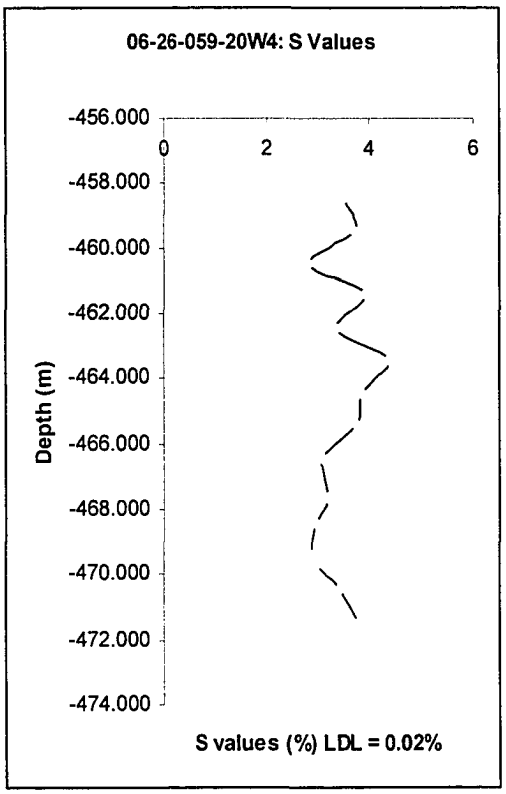


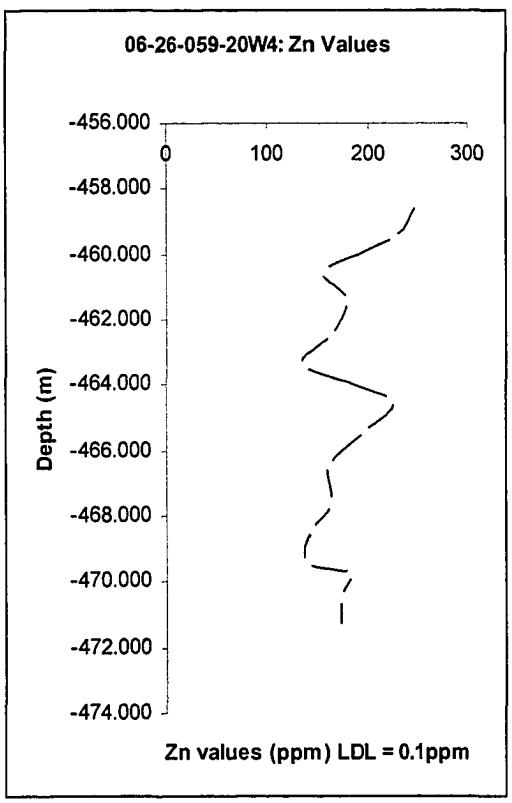




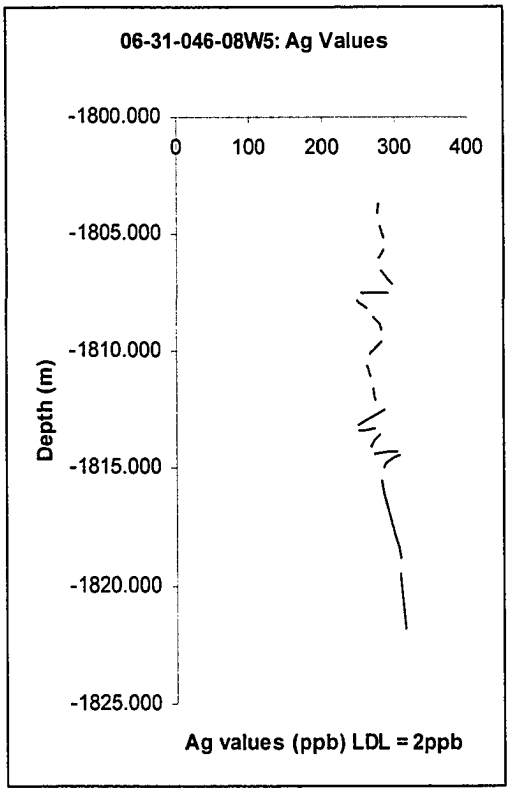
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

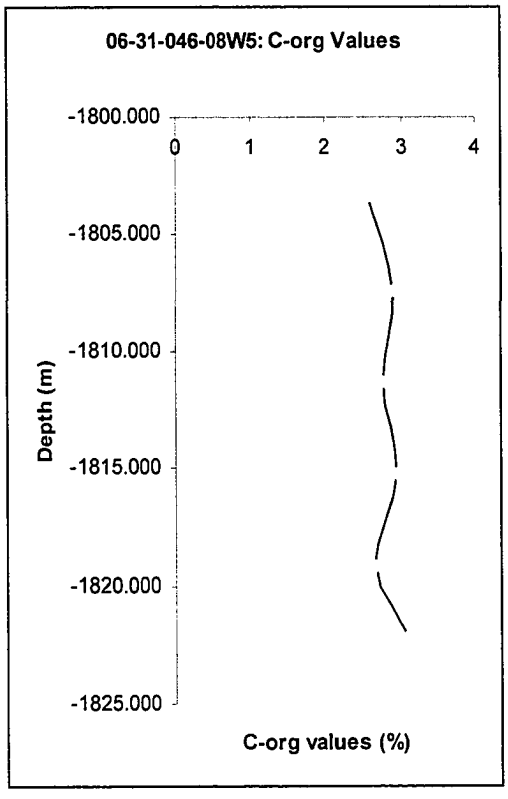


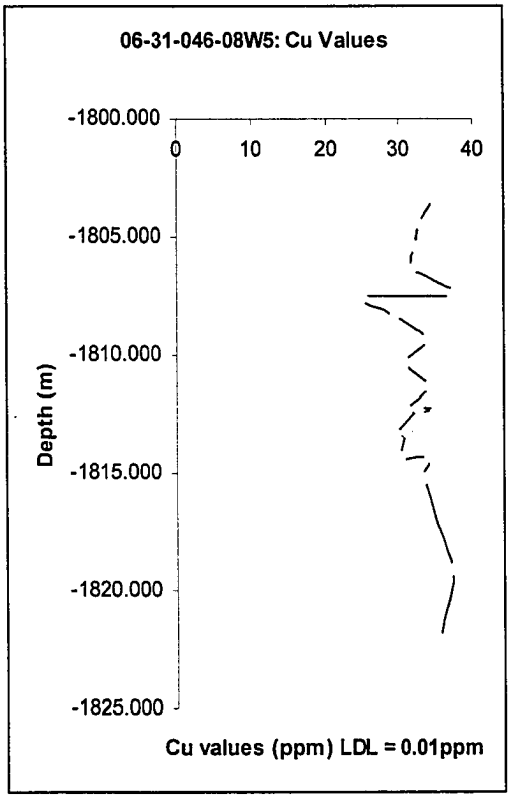


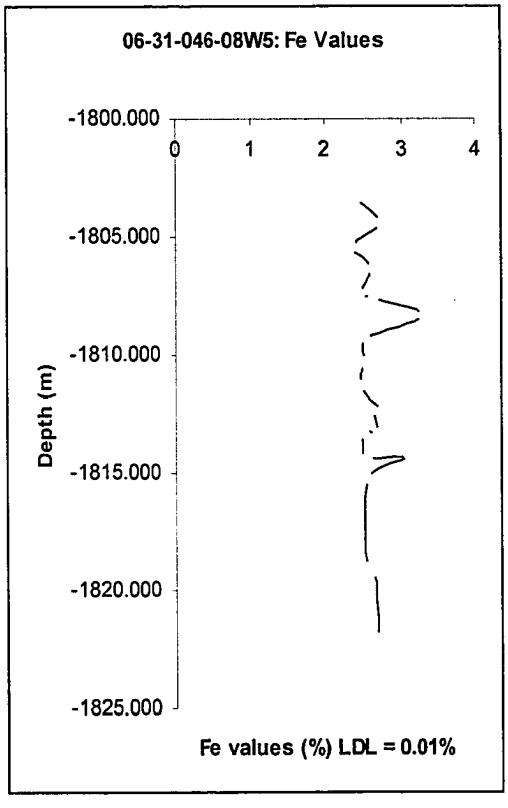


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

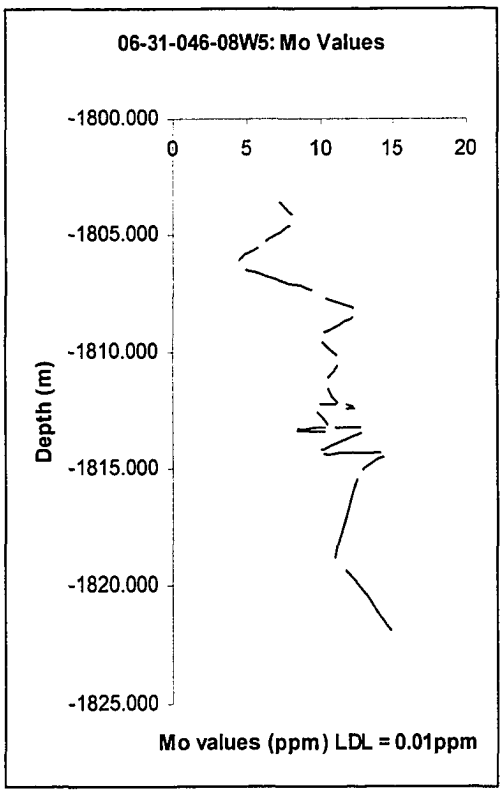


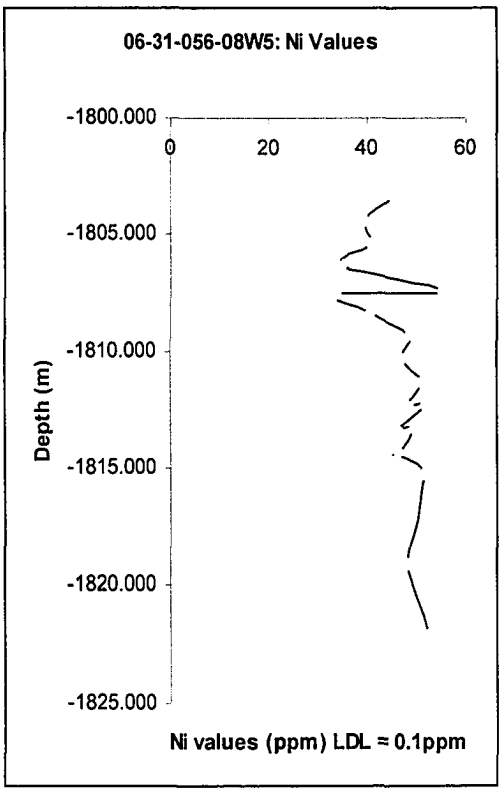


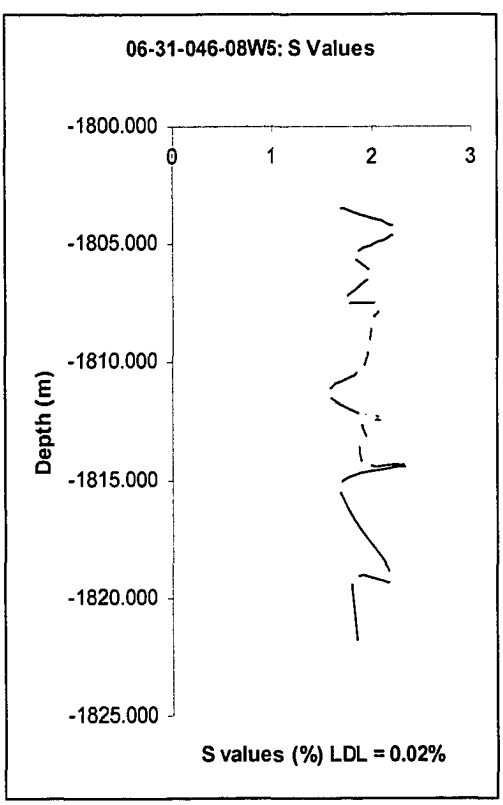


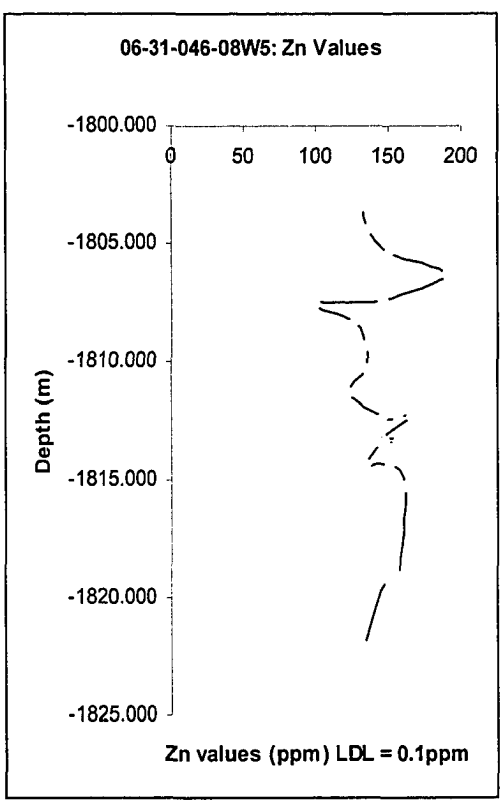


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

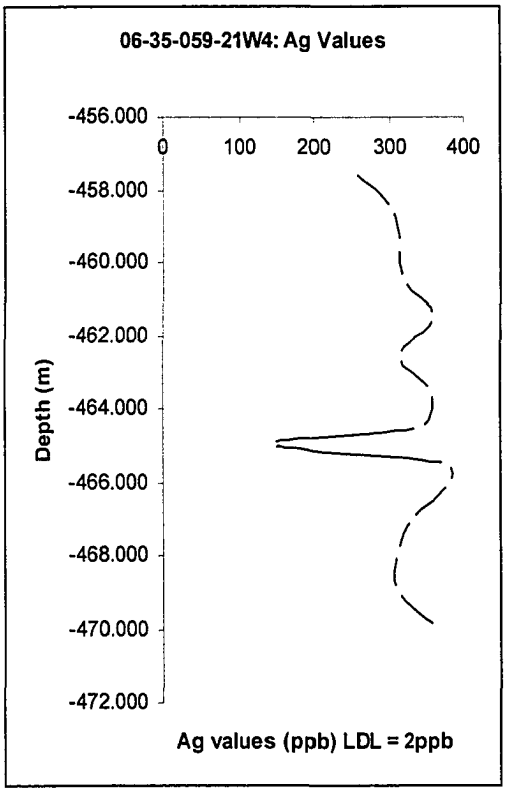


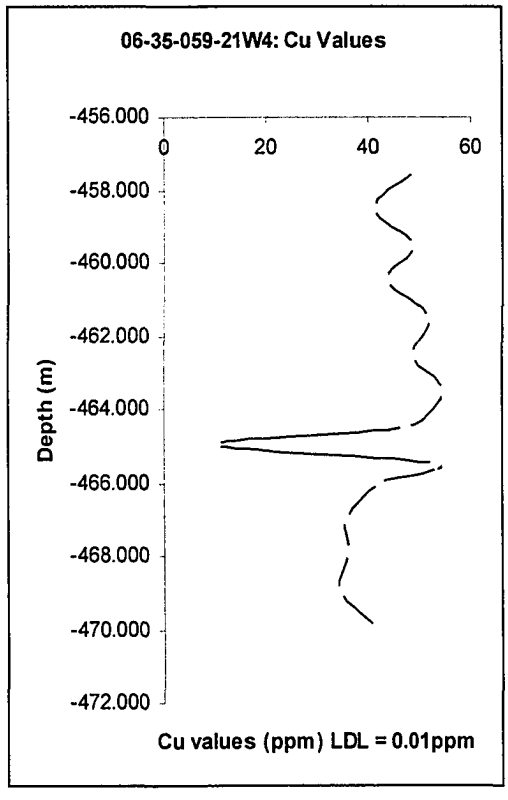


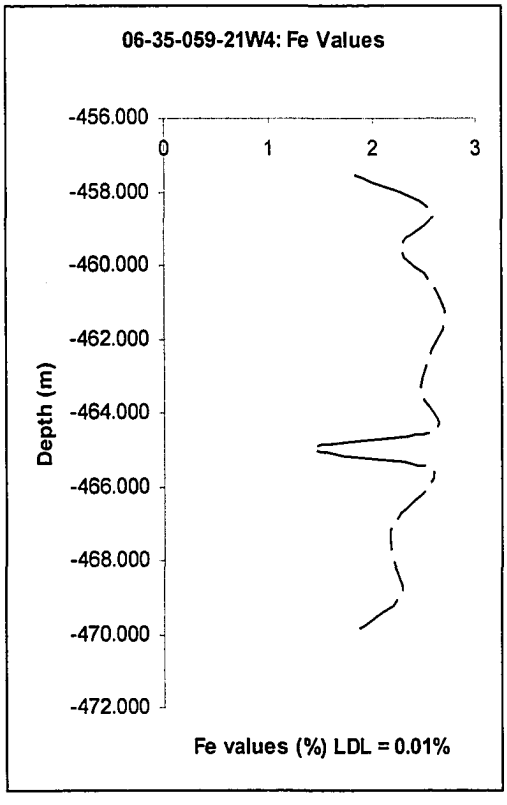


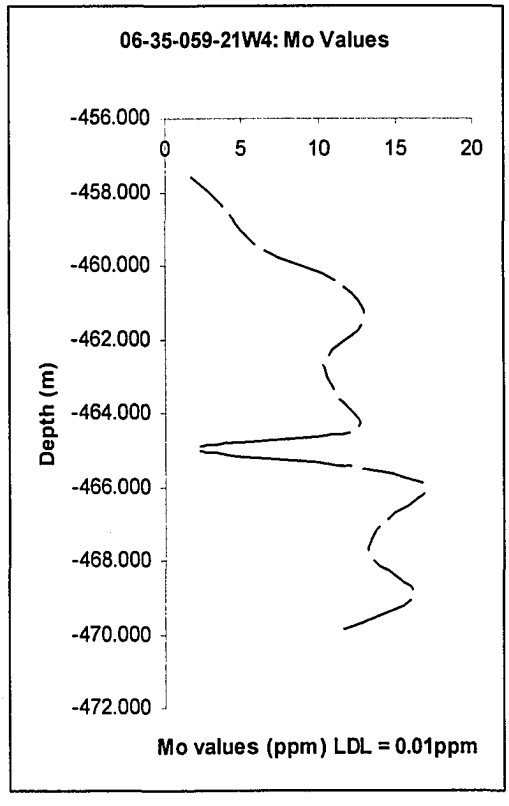


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

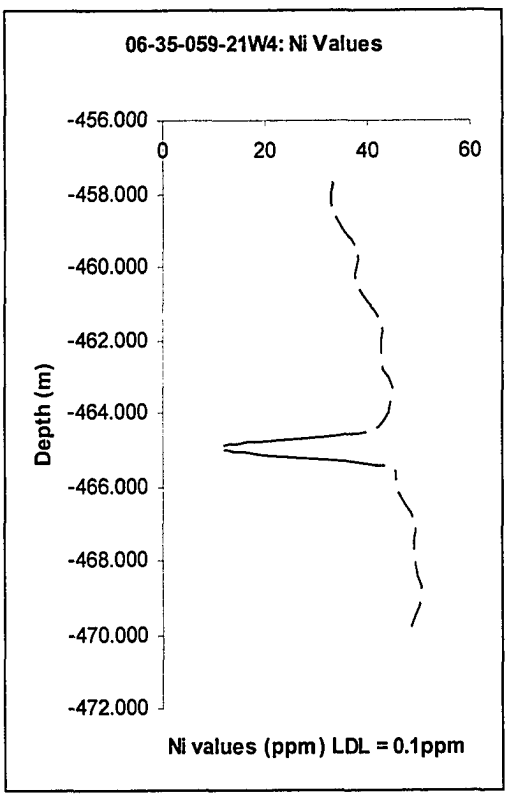


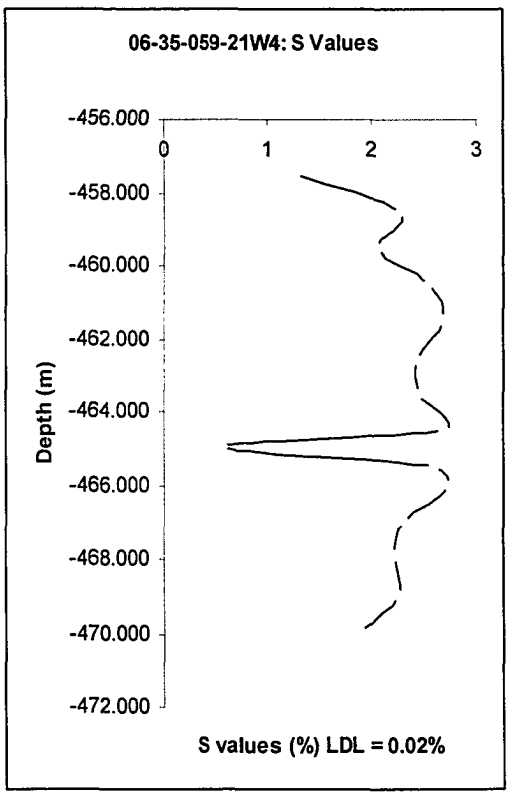


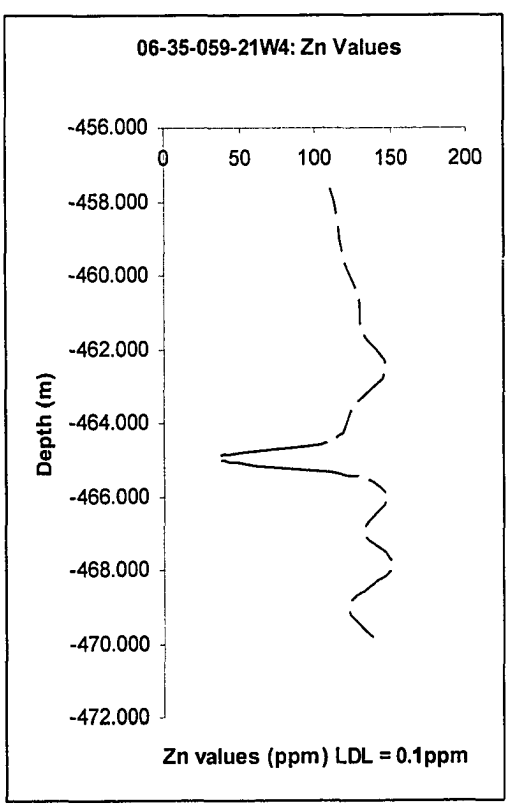




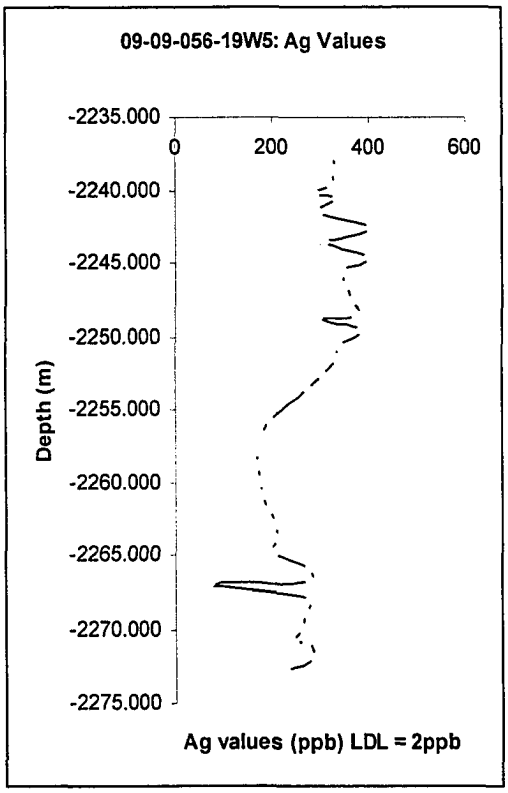
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

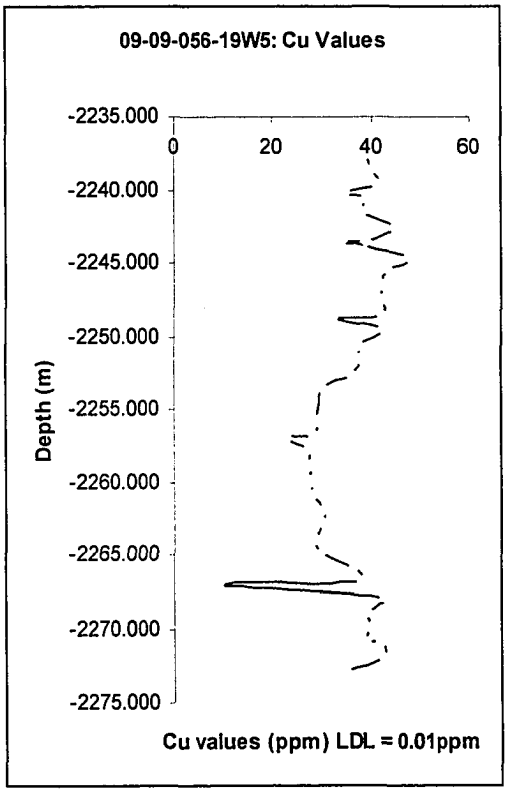


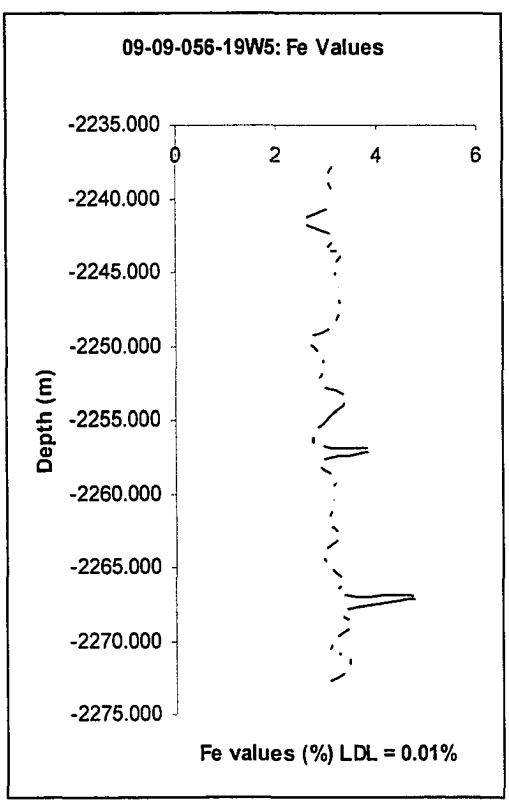


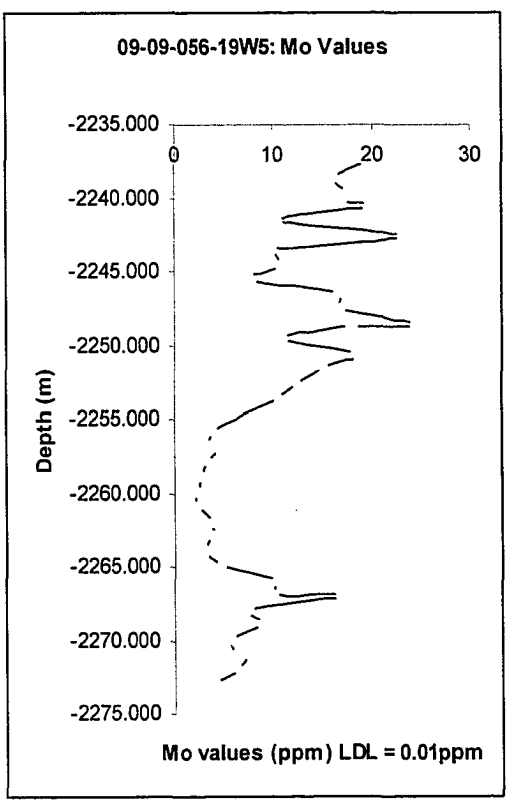


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

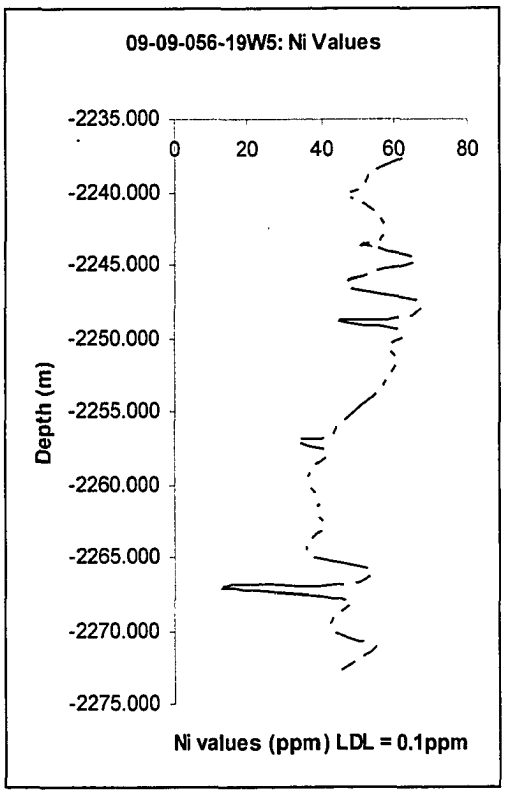


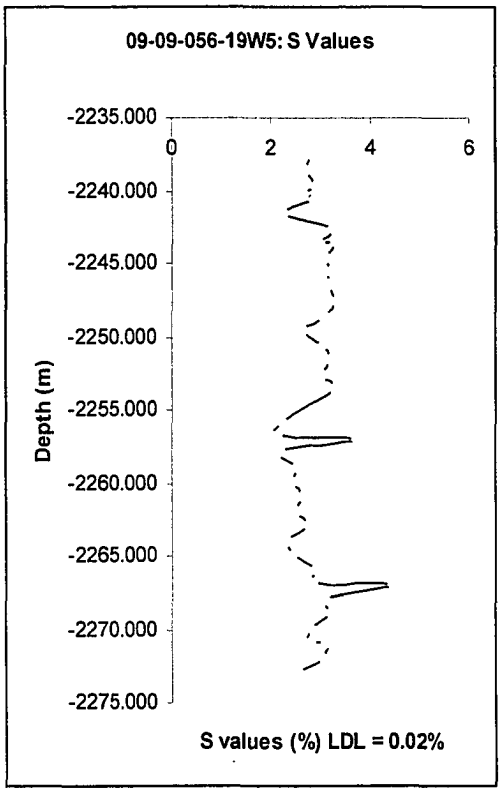


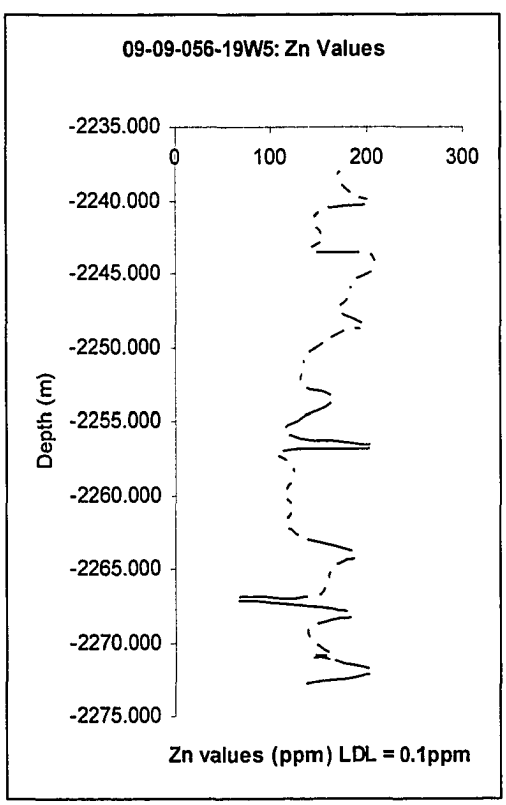




Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

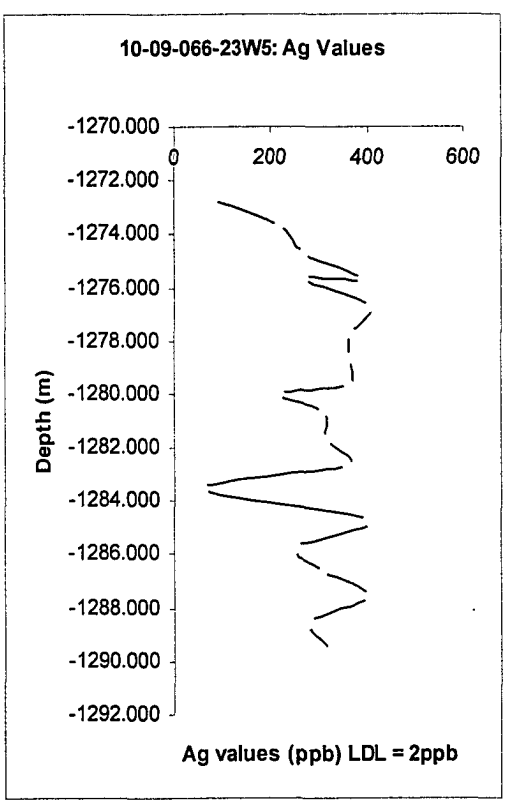


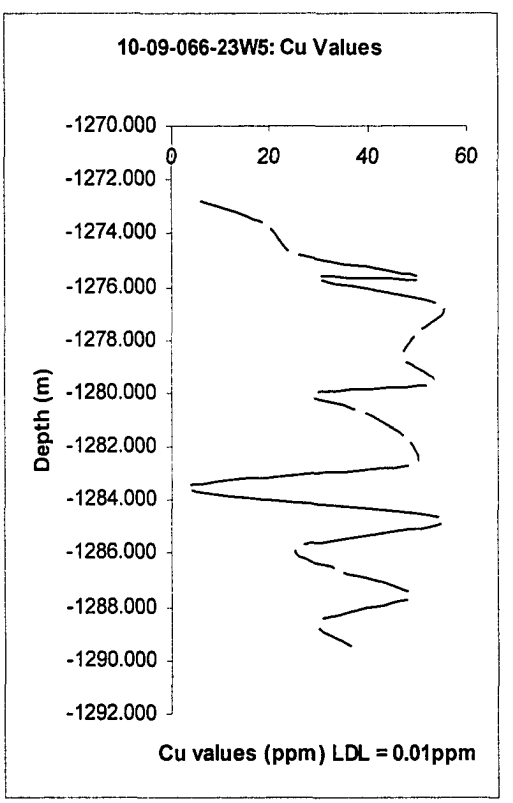




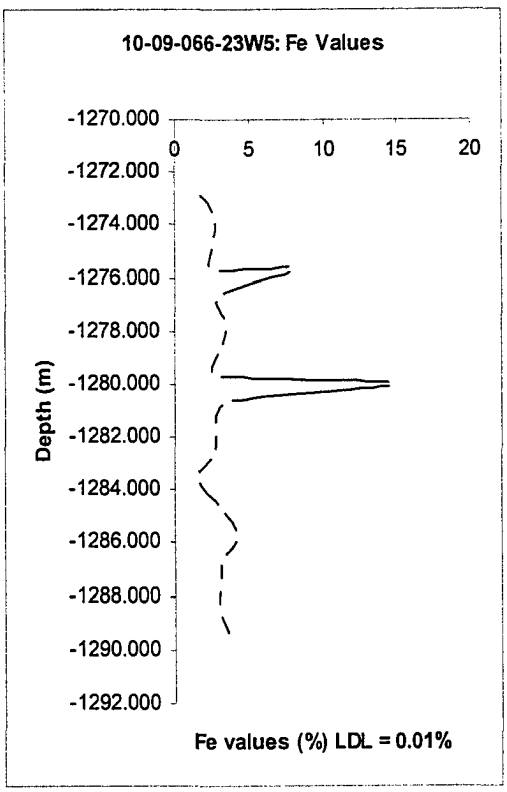
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

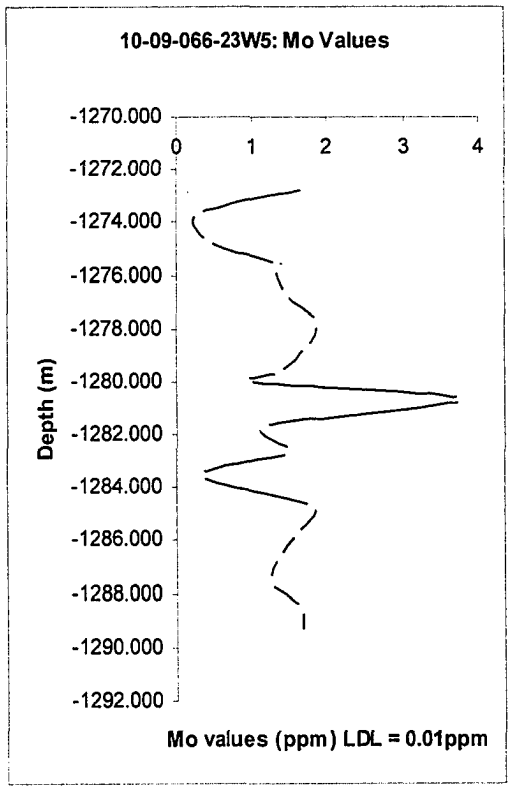
The core placement was determined based on micropaleontology and lithology. The core ranges from 1272.48 m to 1290.46 m, whereas the Second White Specks Formation appears to have a range from 1106 m to 1235 m. Therefore, this core does not represent the Second White Specks Formation, but instead represents a formation that is stratigraphically lower, perhaps the Belle Fourche or another underlying formation. The geochemical responses are very variable, but have low values at approximately 1283.5 m for Ag, Cu, Ni and Zn which corresponds to a sandy interval. Otherwise, all of these values are fairly high. The variations in signatures appear to correspond with varying amounts of sand and siderite nodules. The values of S, Mo and Fe are fairly low compared to the Second White Specks Formation values observed in other core and show a high value at approximately 1281 m depth, but does not appear to correlate to anything observed within the core.

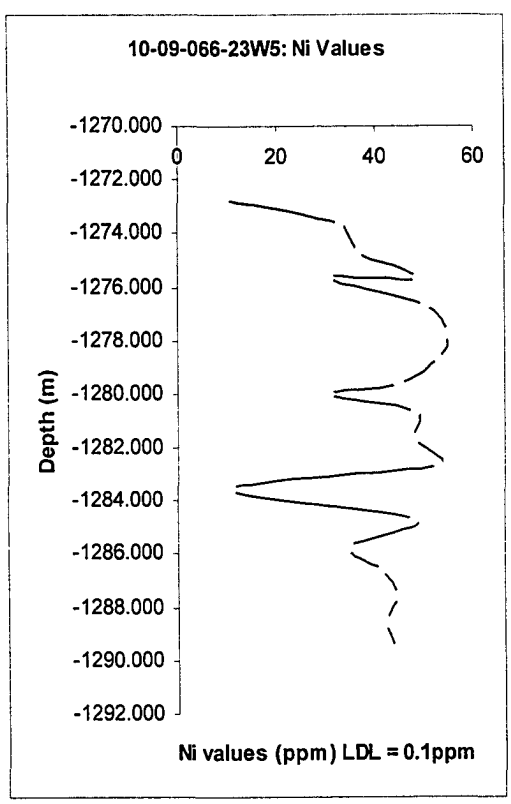


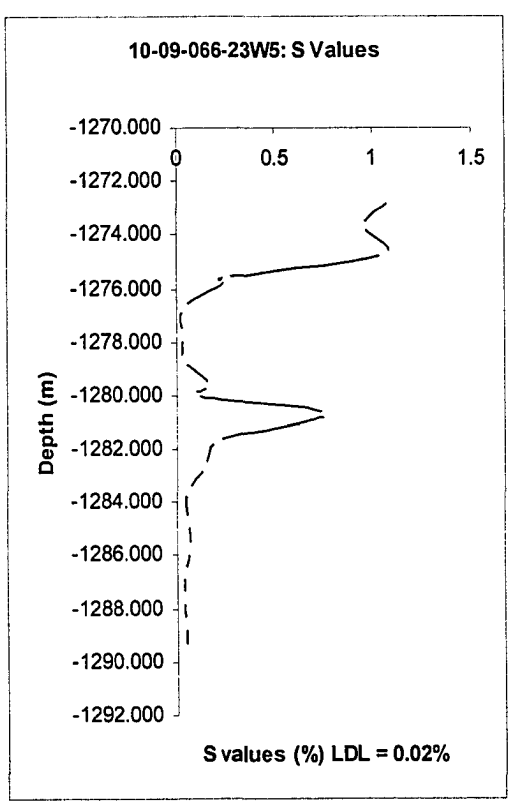


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

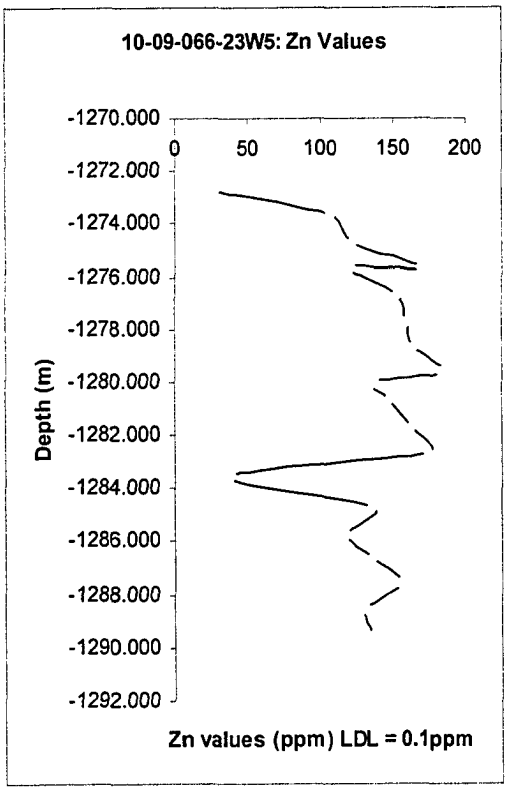


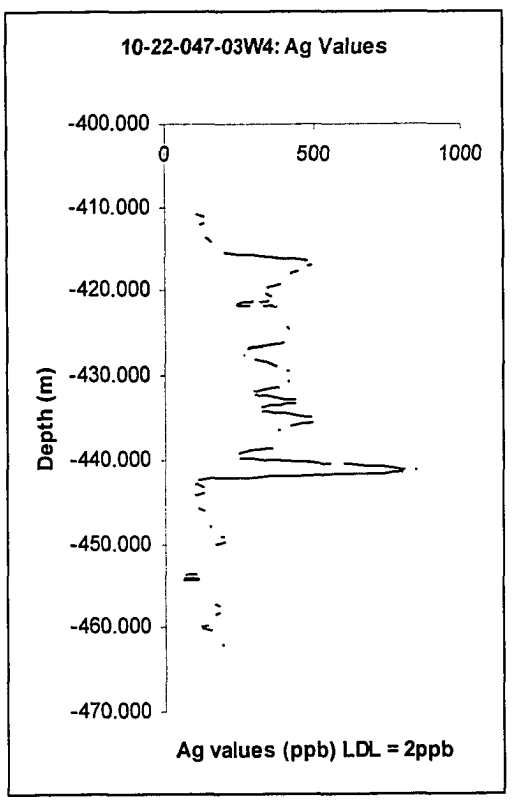


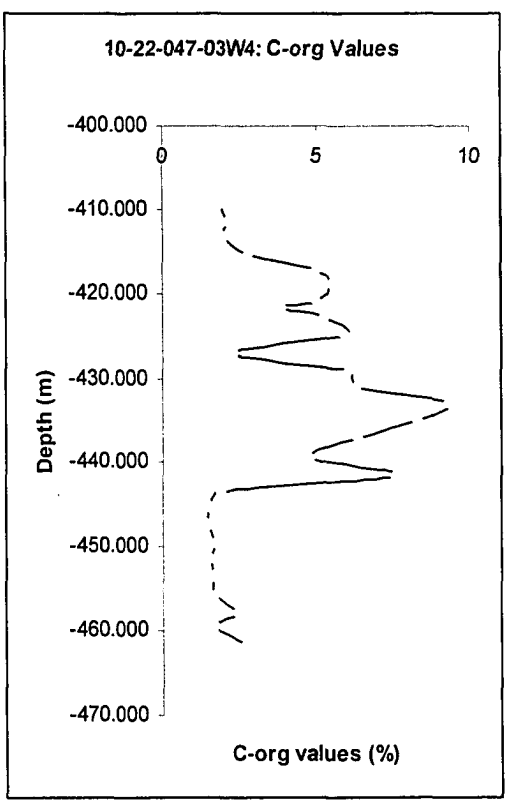




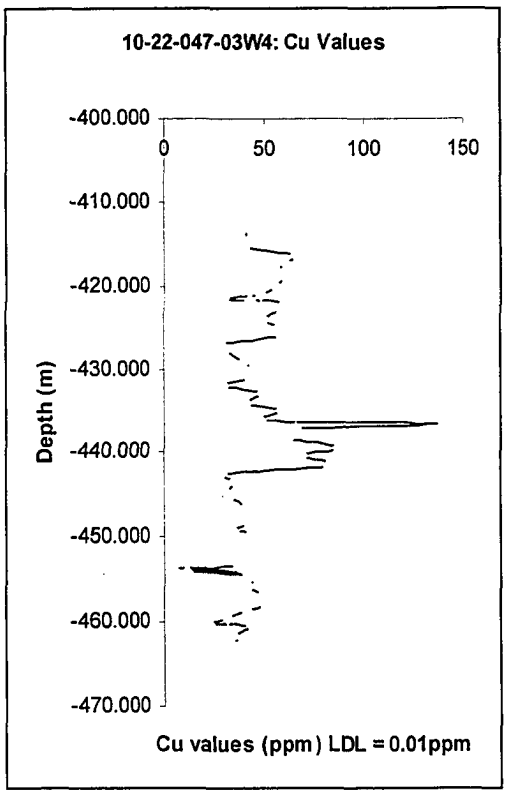
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

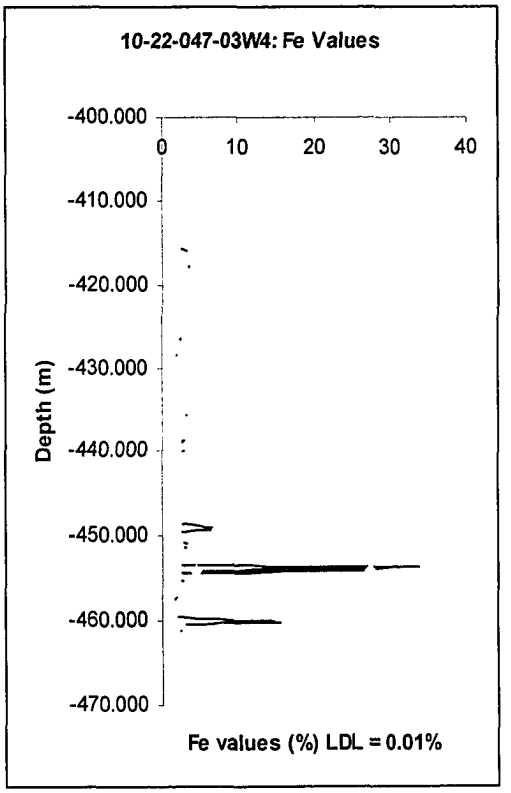


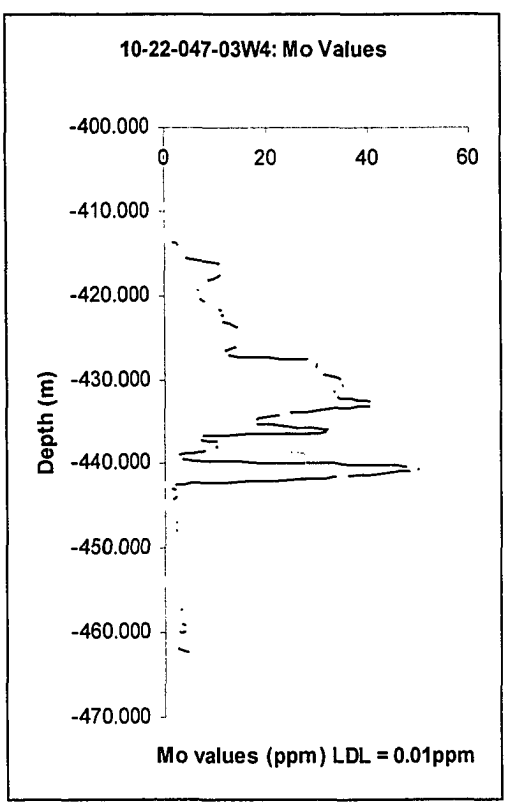


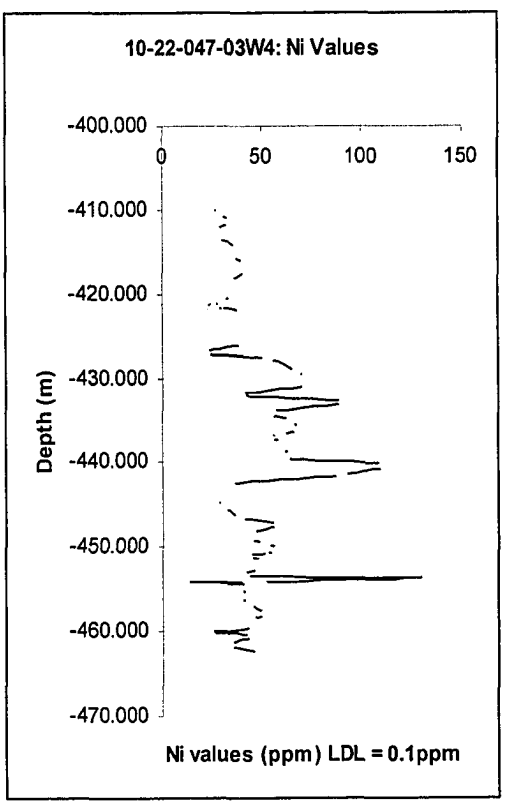


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

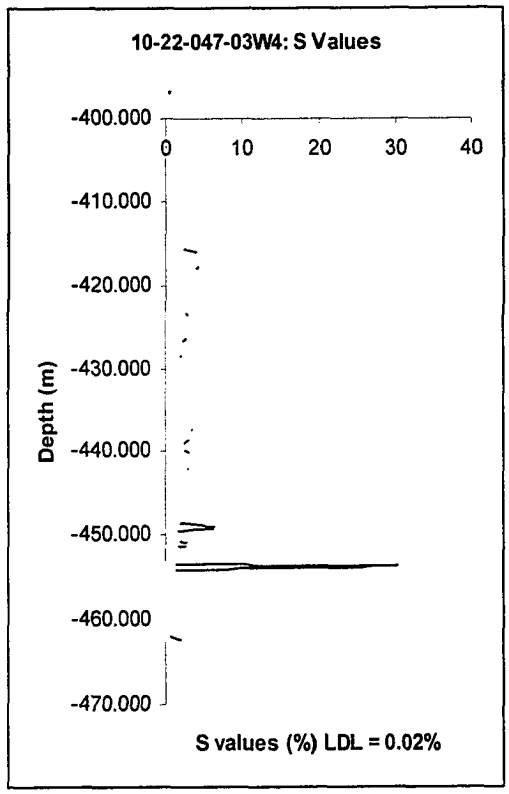


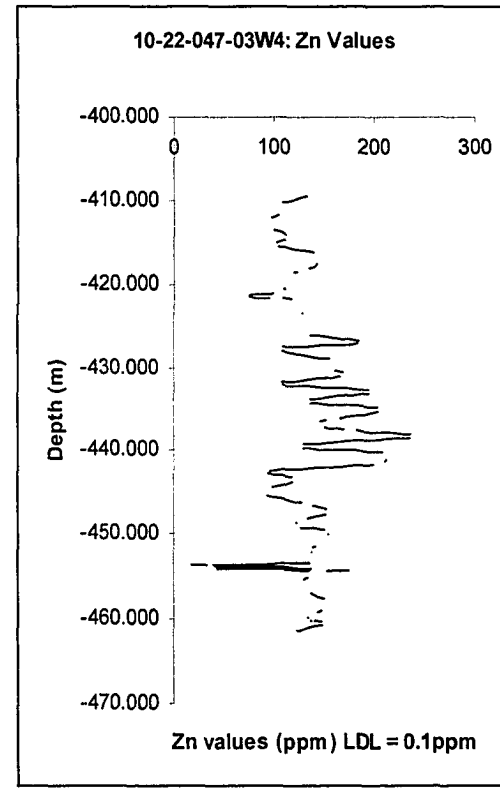


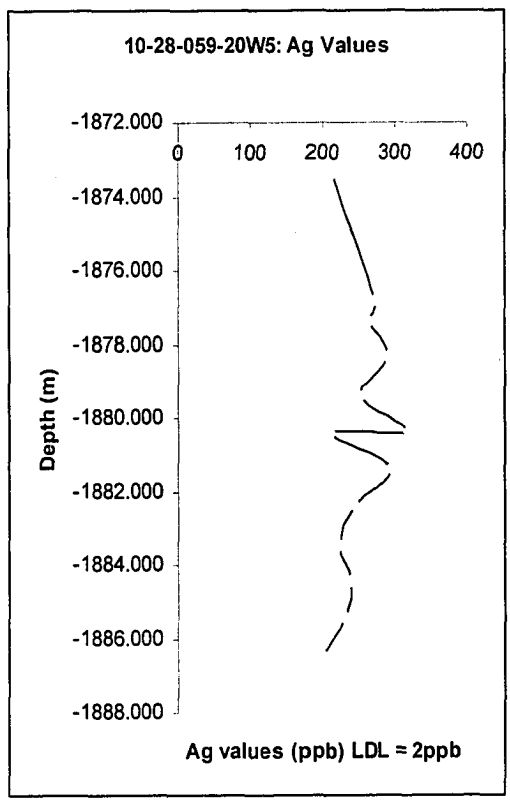


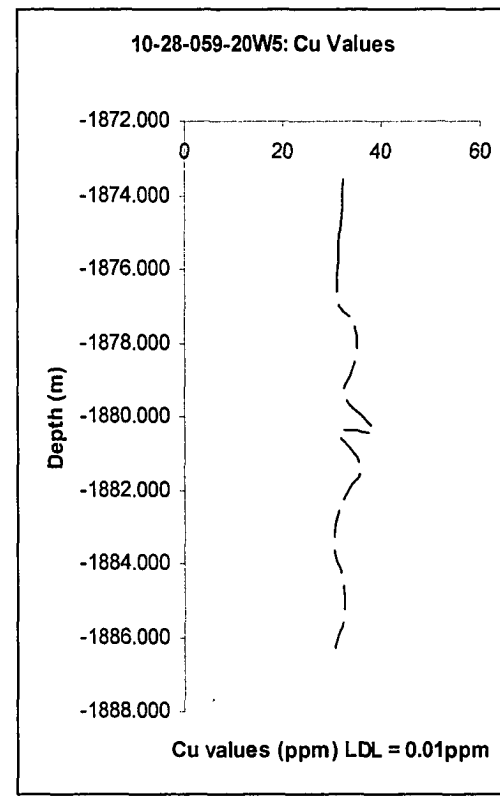


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

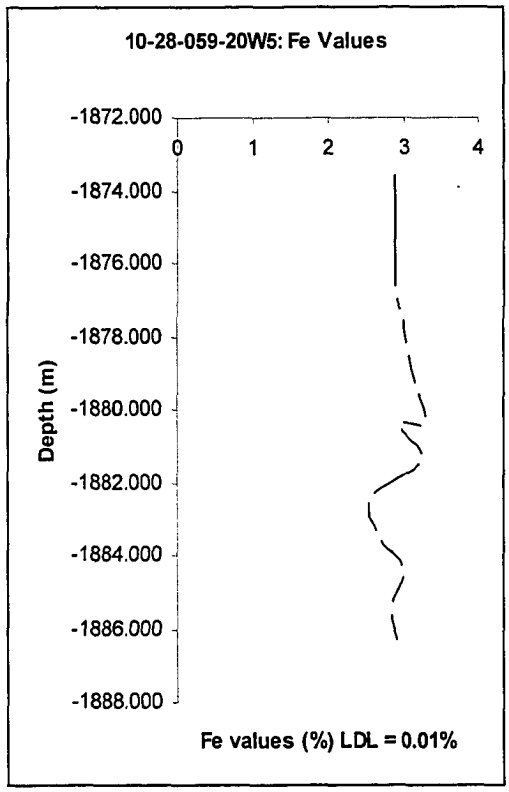


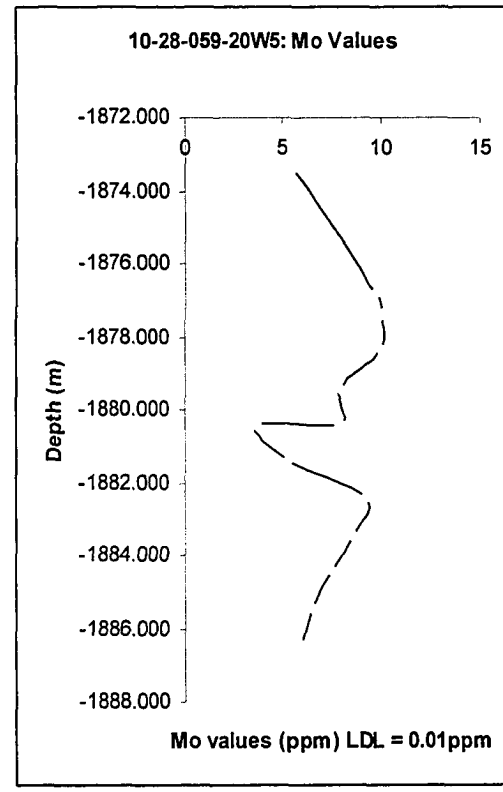


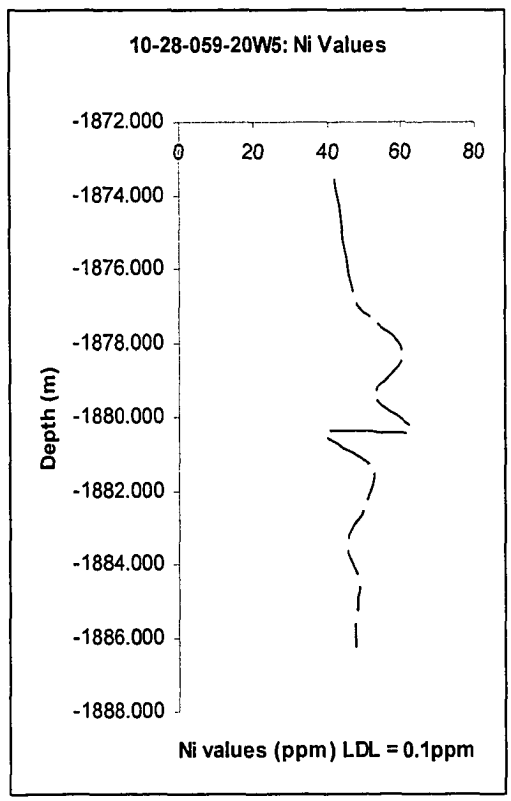


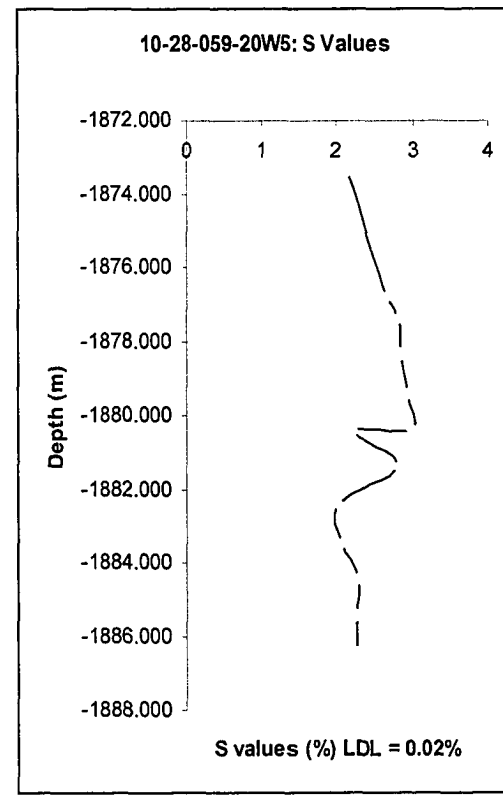


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

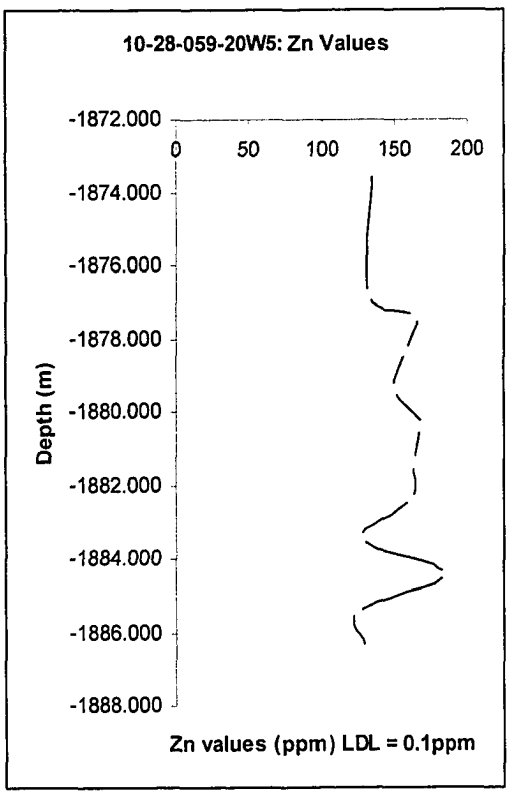








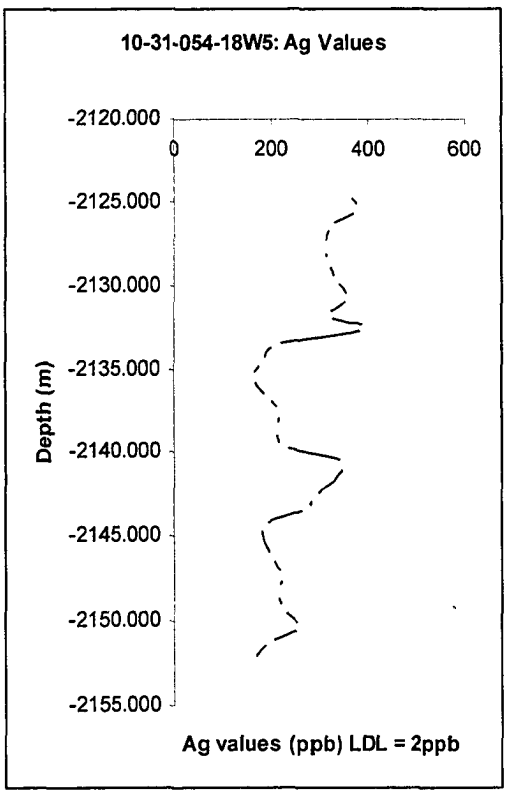
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

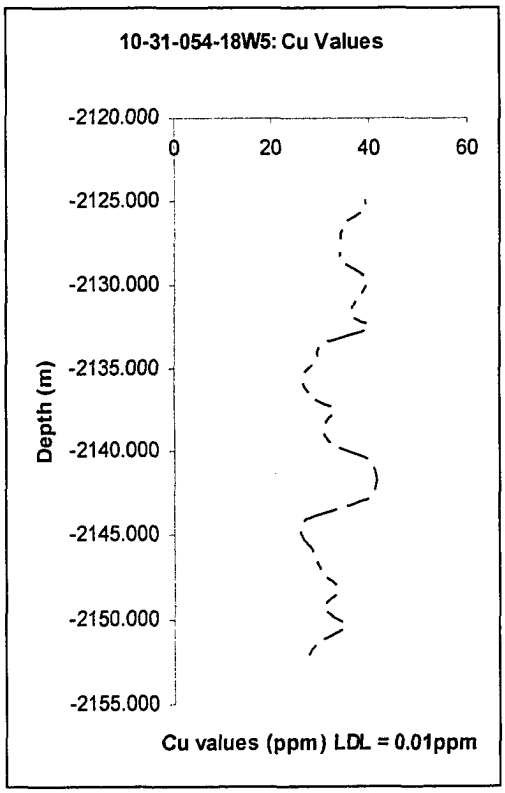


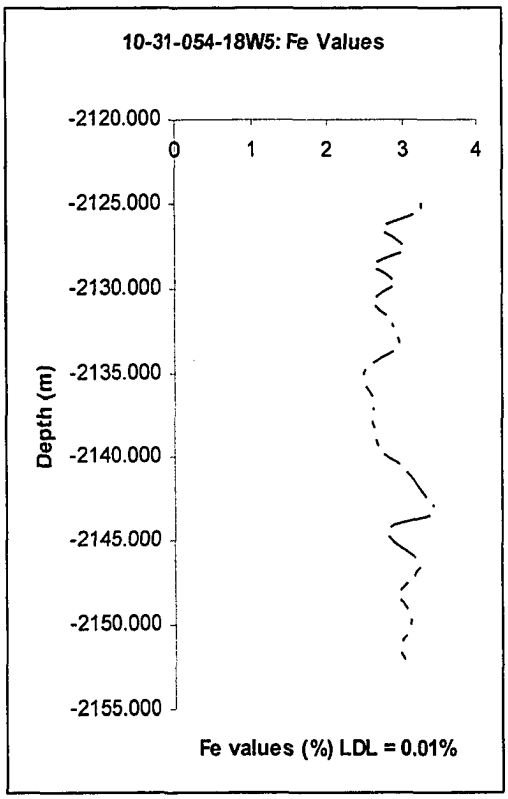
00/10-31-054-18W5/0

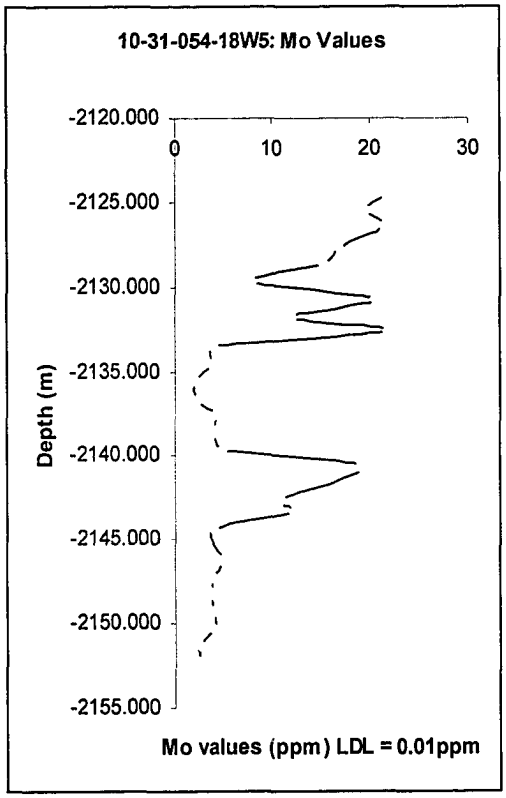
The core placement was based on geophysical log signatures. The core ranges from 2124 m to 2151.5 m depth, whereas the Second White Specks Formation interval ranges from 2037 m to 2075 m depth. The core therefore represents a unit that is stratigraphically below the Second White Specks Formation and may represent the Belle Fourche Formation or another underlying unit. It not analyzed here due to the lack of stratigraphic placement.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

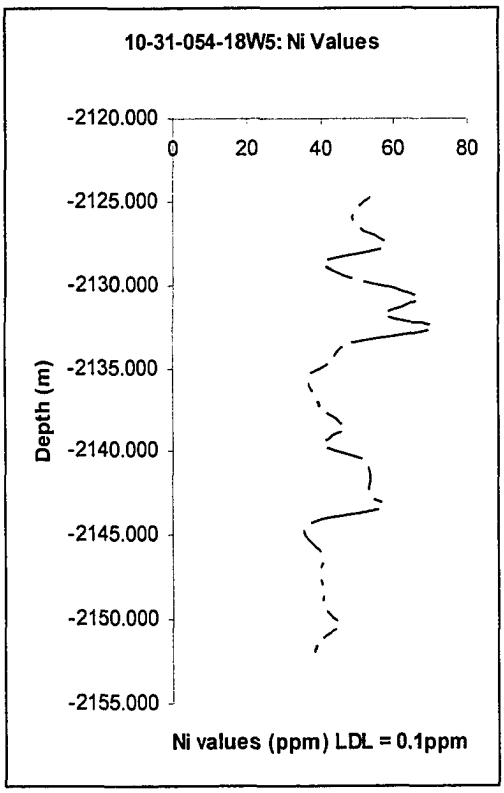


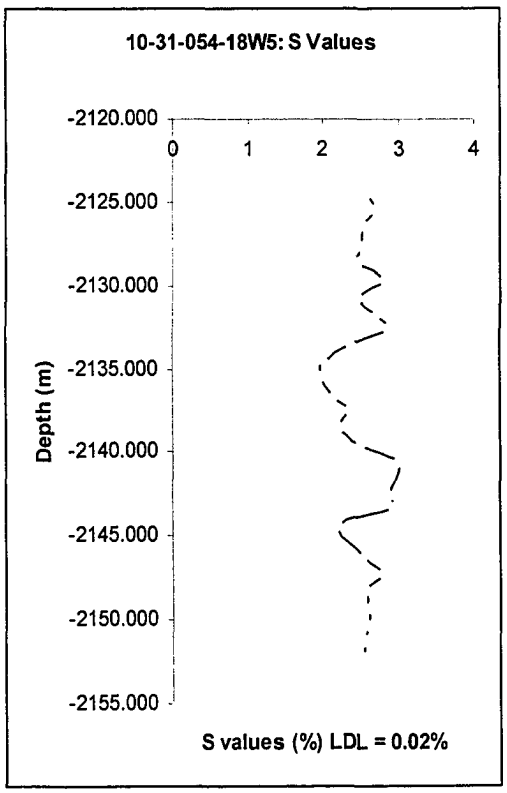


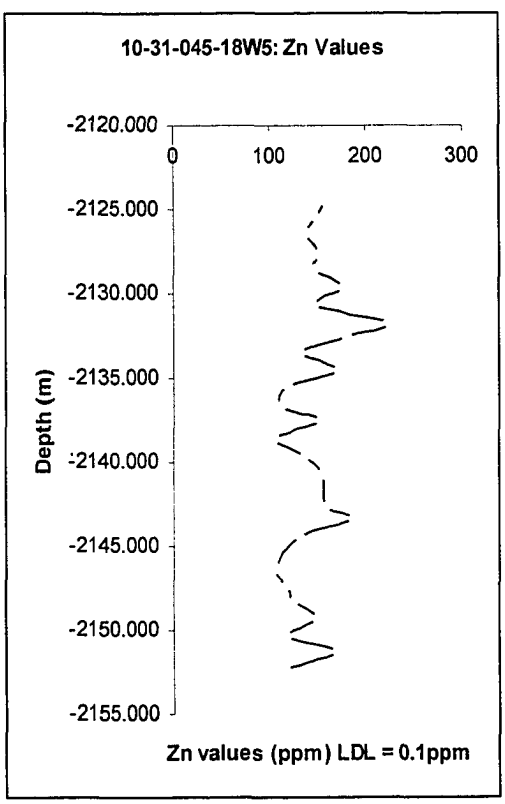




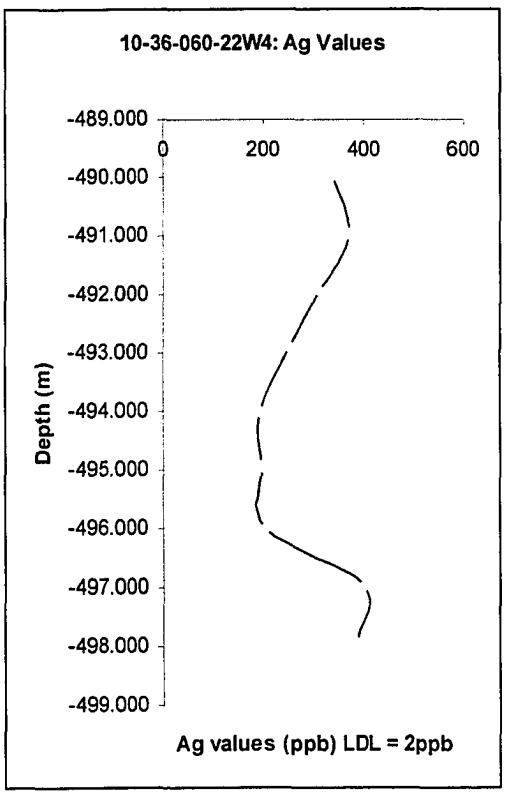
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

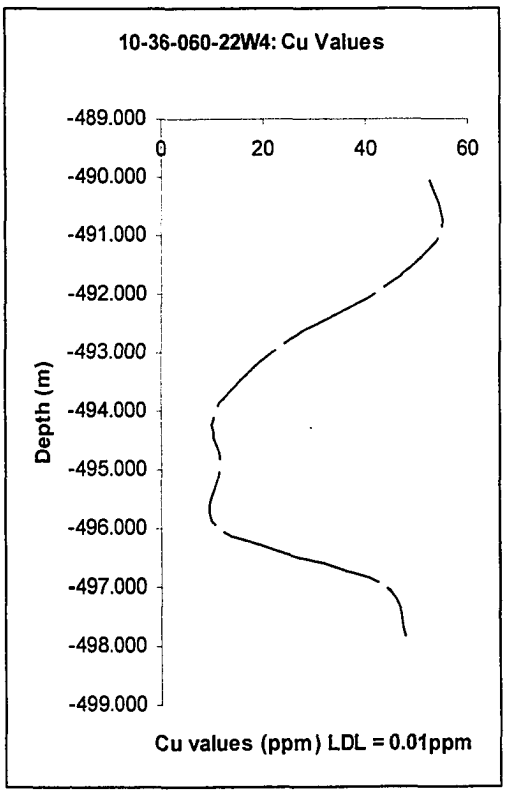


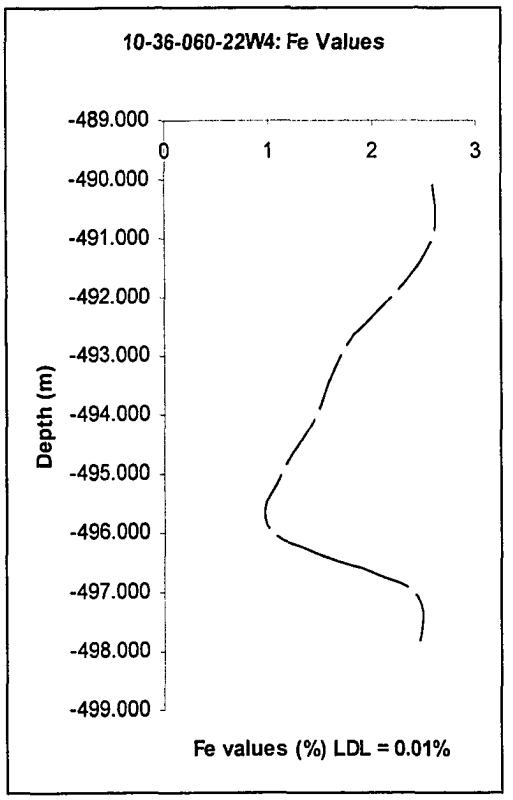


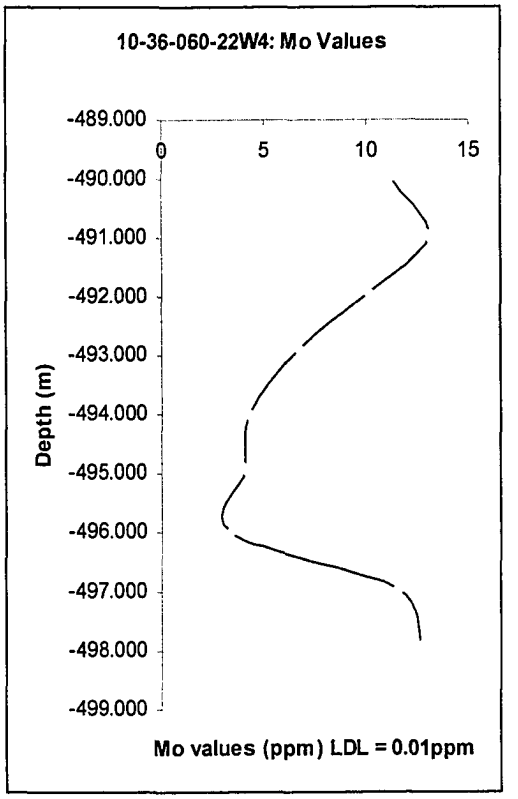


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

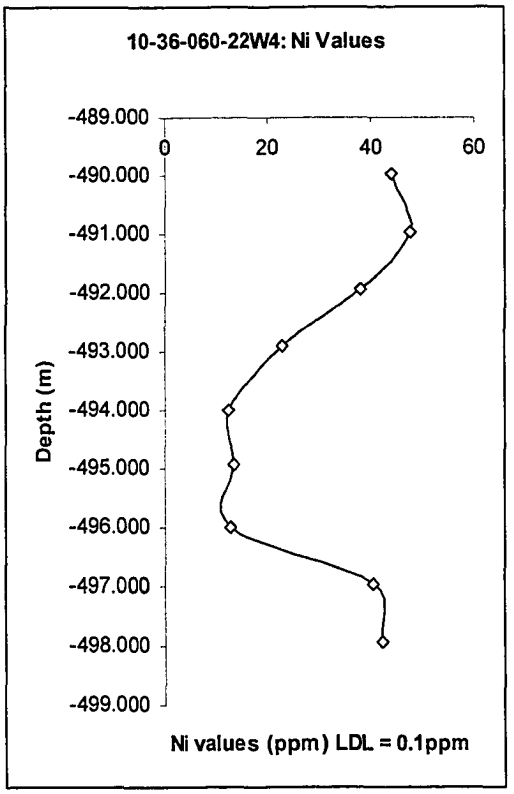


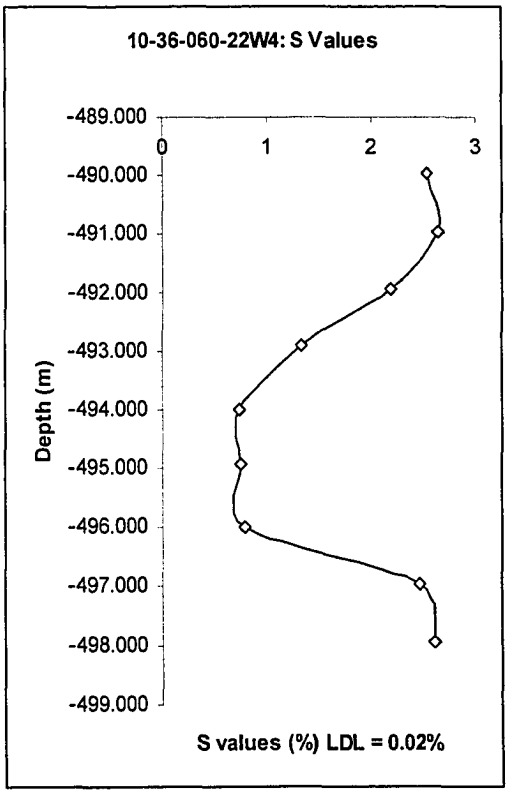


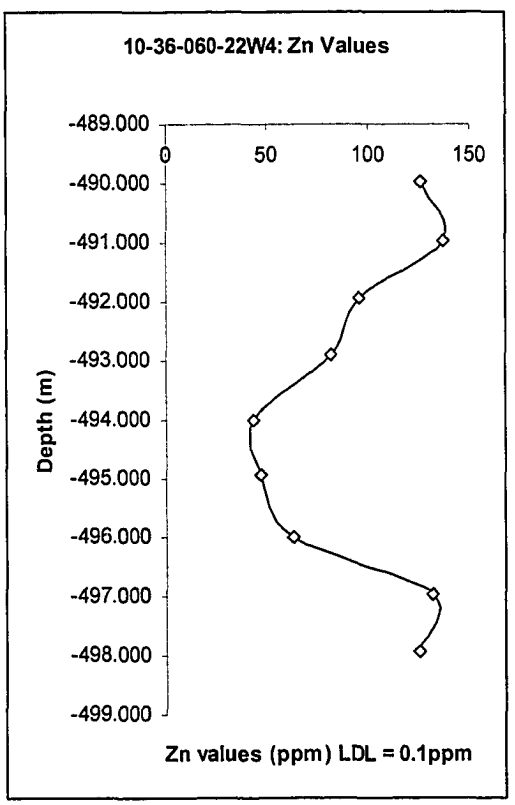




Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

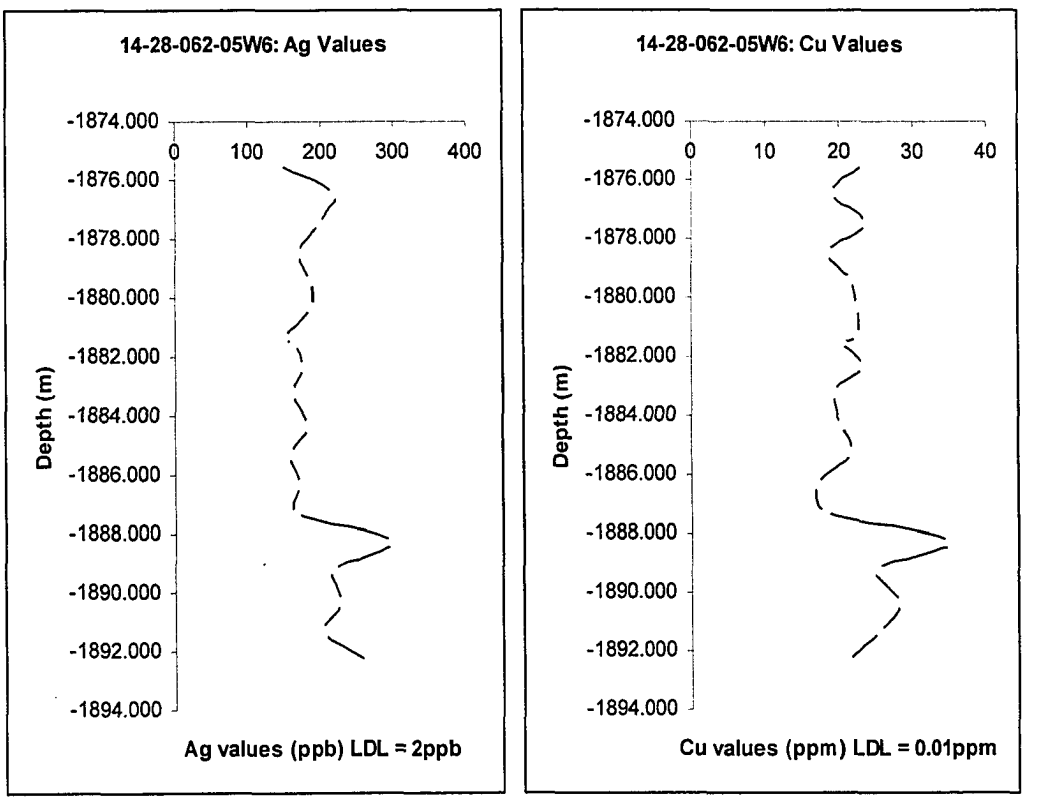




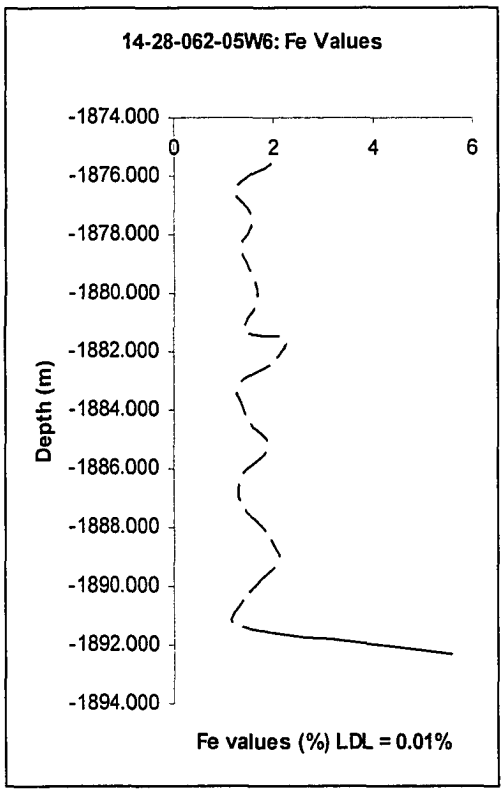


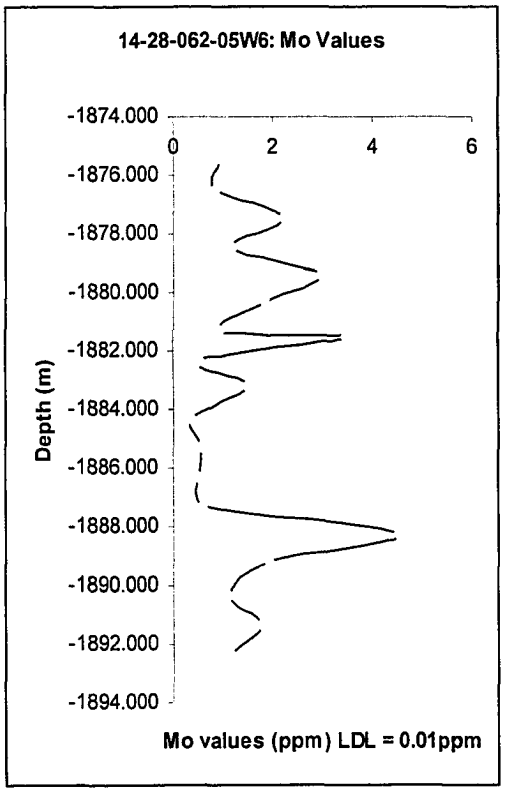
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

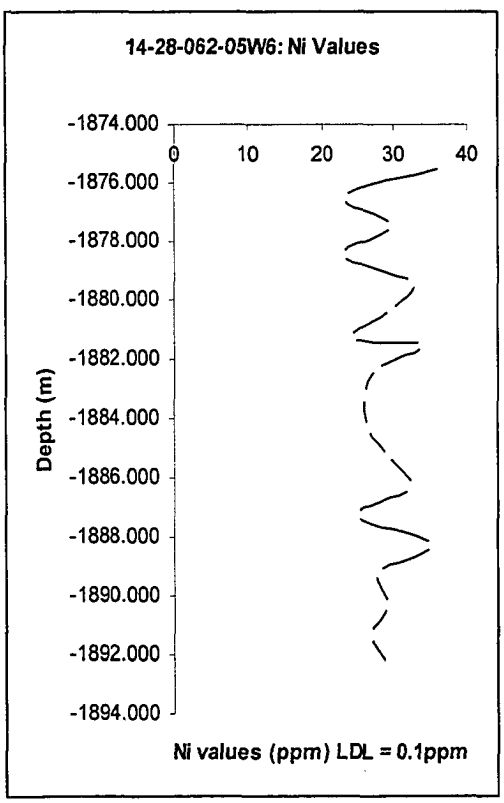
The core placement could not be done with certainty using any of geophysical logs, micropaleontology or lithology. The core interval ranges from 1875 m to 1893 m, but the range for the Second White Specks Formation could not be determined. It is not analyzed here due to the lack of stratigraphic placement.

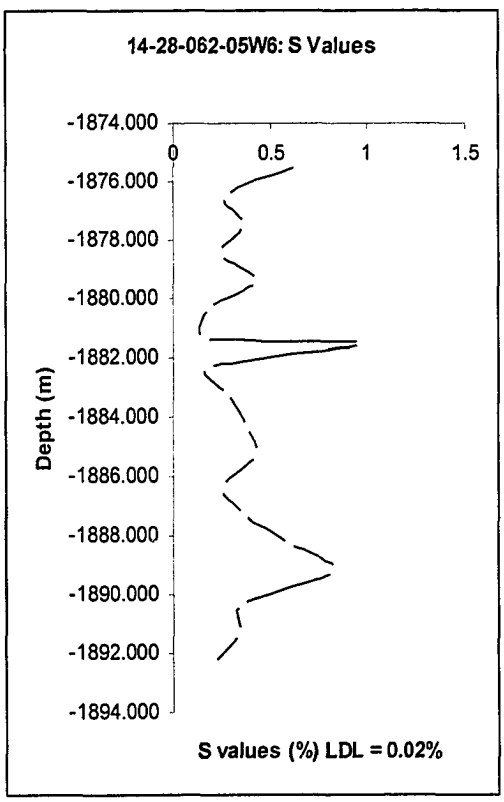


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

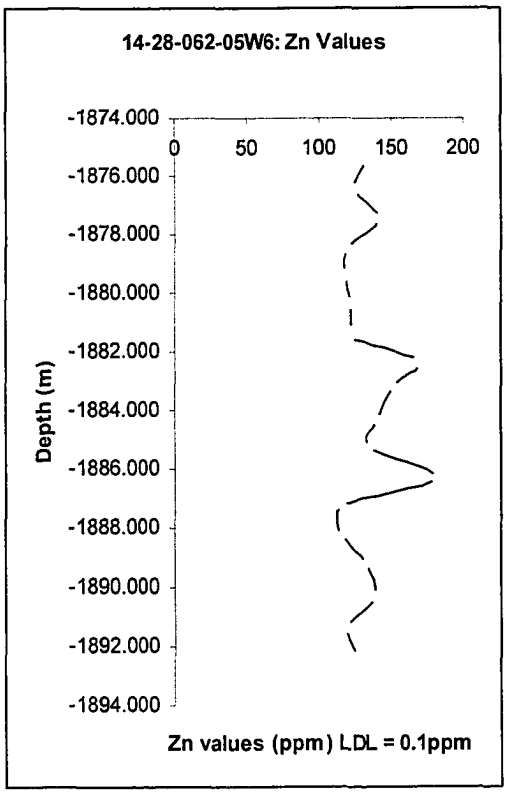


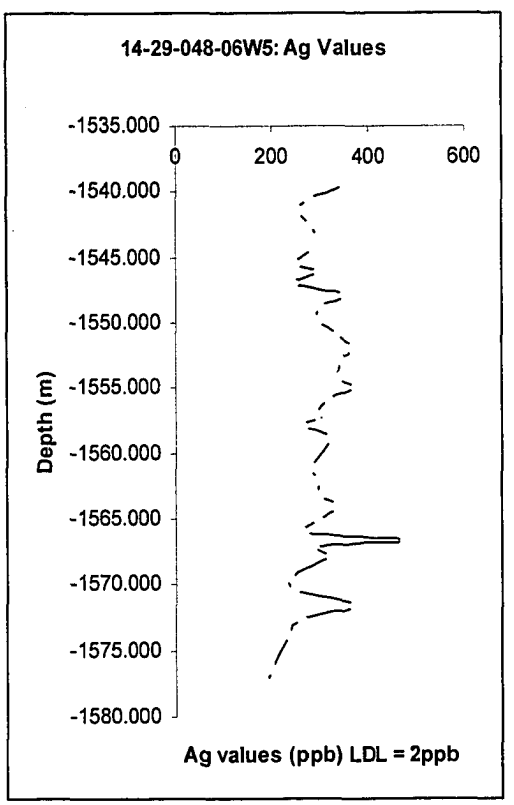


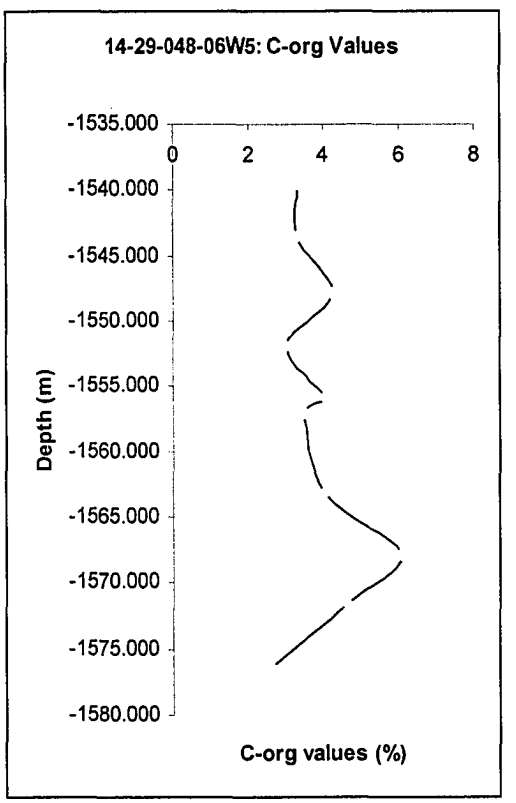




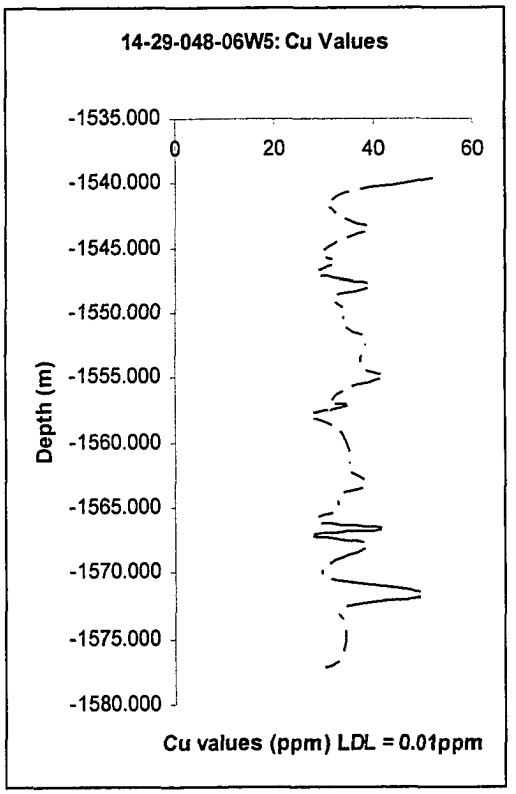
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

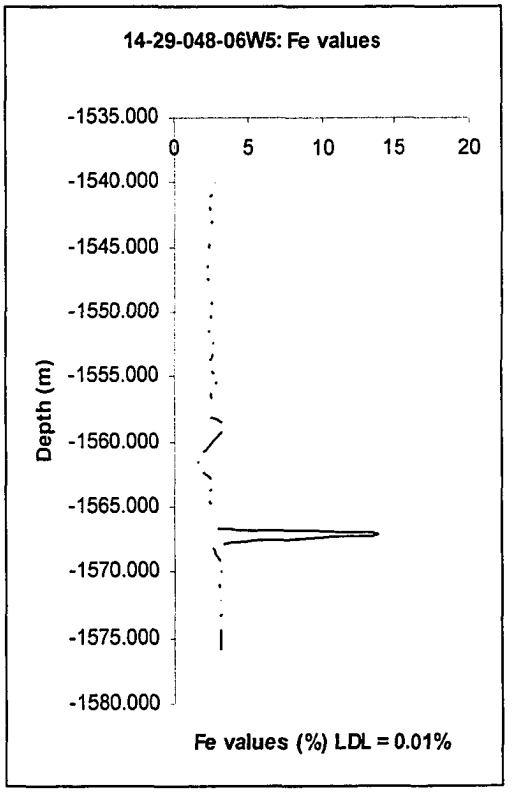


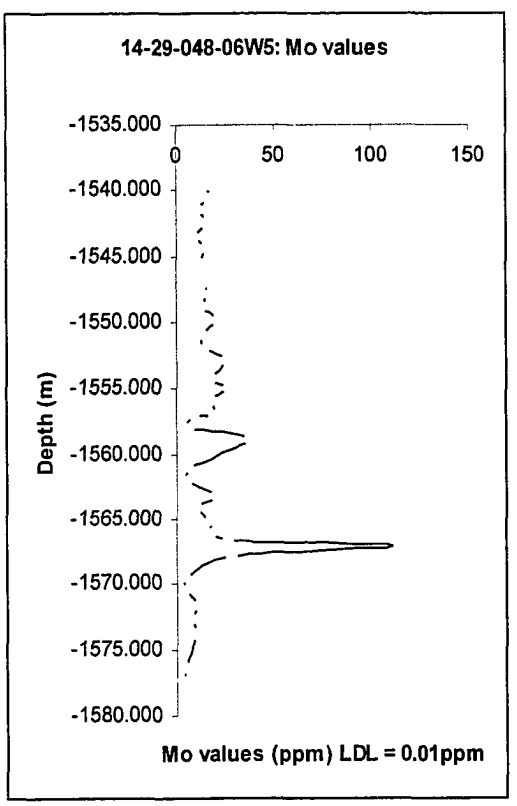


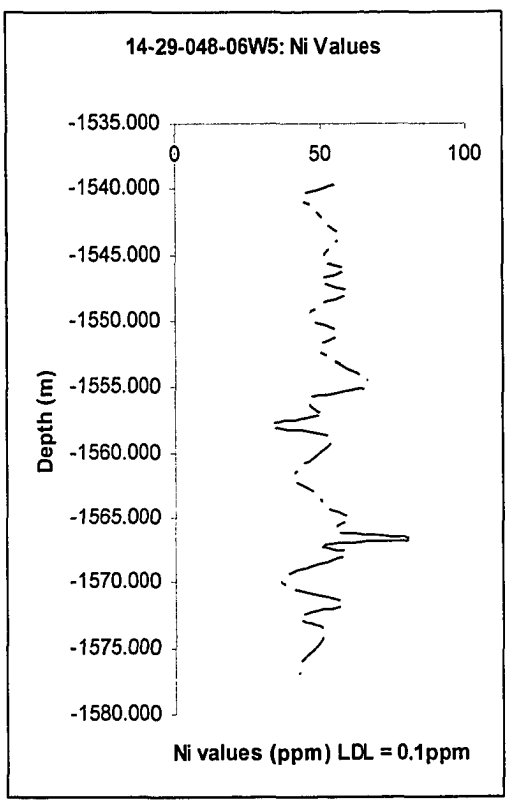


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

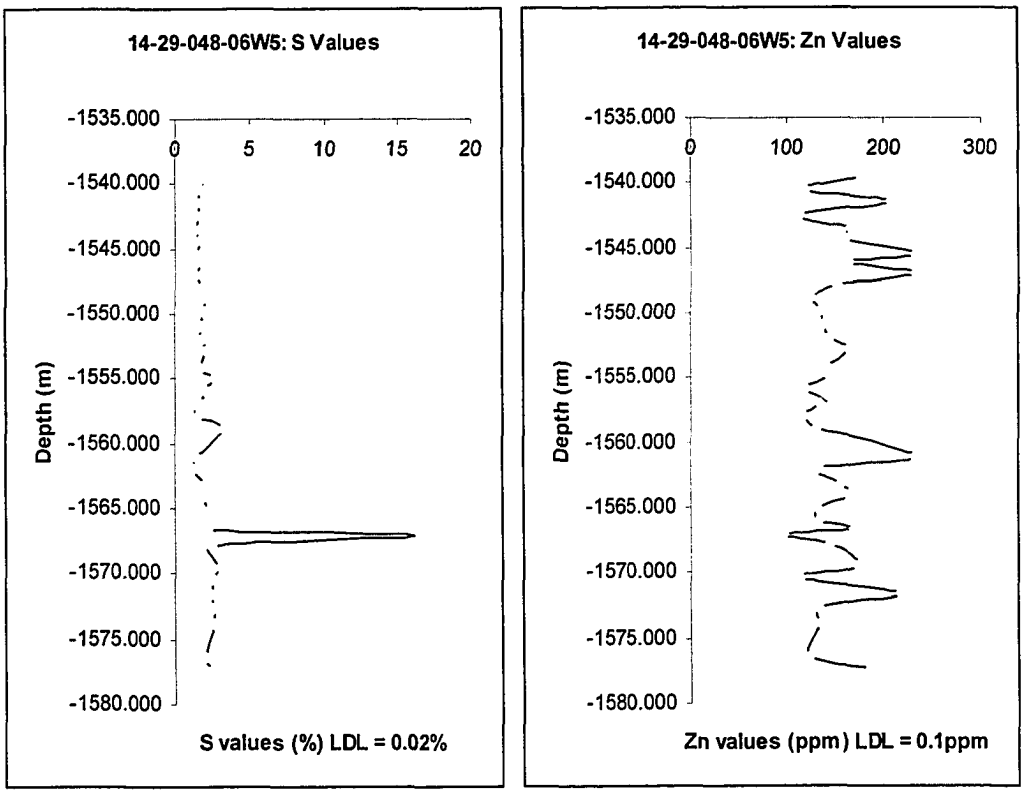








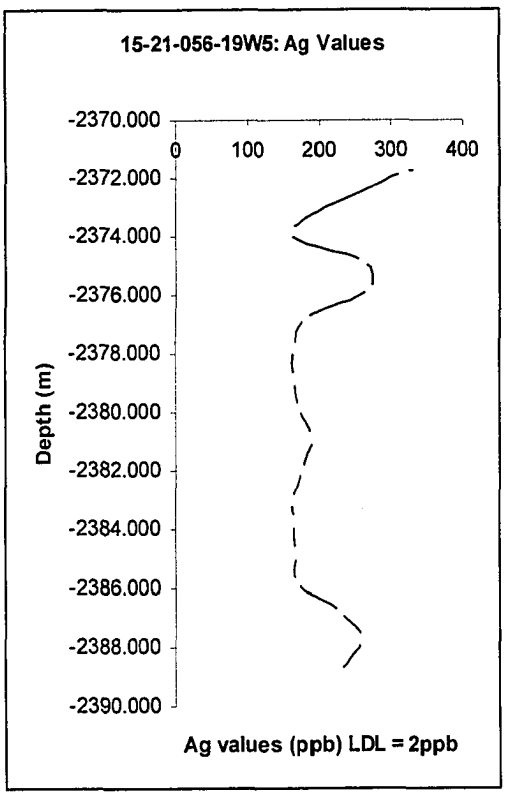
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

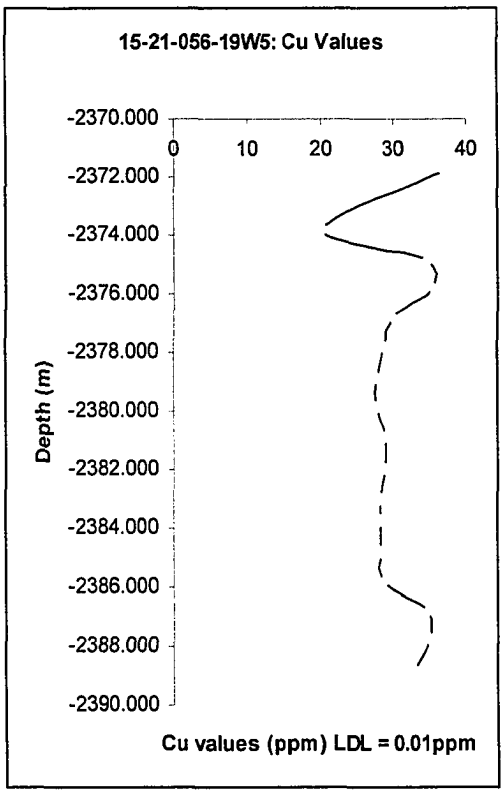


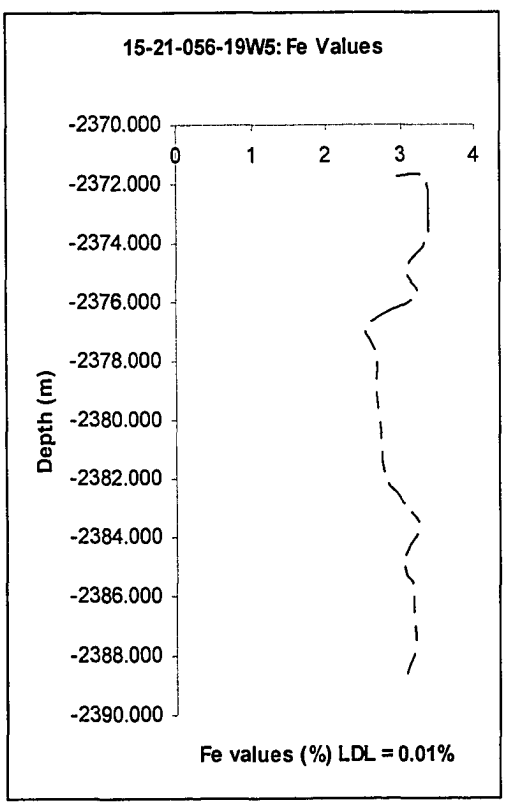
00/15-21-056-19W5/0

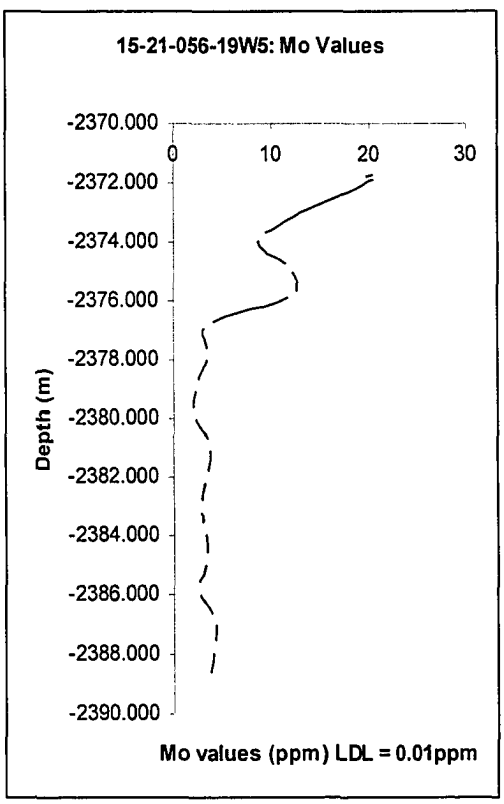
The core placement could not be made with certainty using any of geophysical logs, micropaleontology or lithology. The core ranges from 2371.23 m to 2389.52 m depth and the interval of the Second White Specks Formation could not be confirmed. It is not analyzed here due to the lack of stratigraphic placement.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

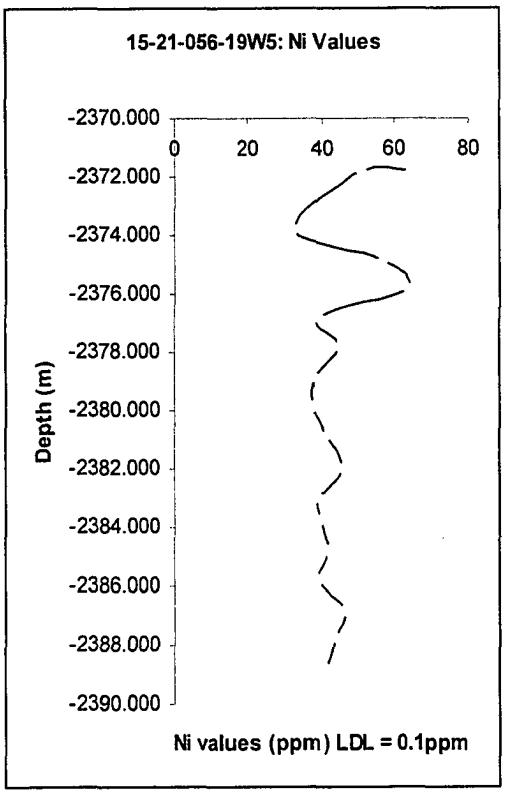


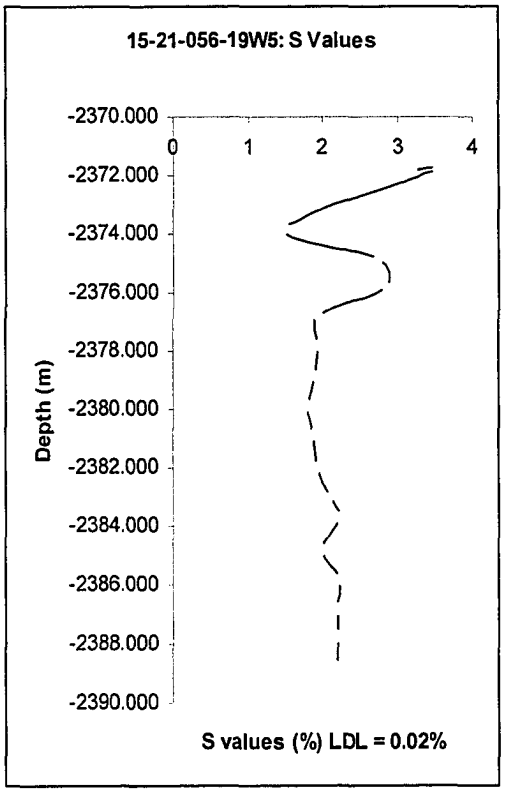


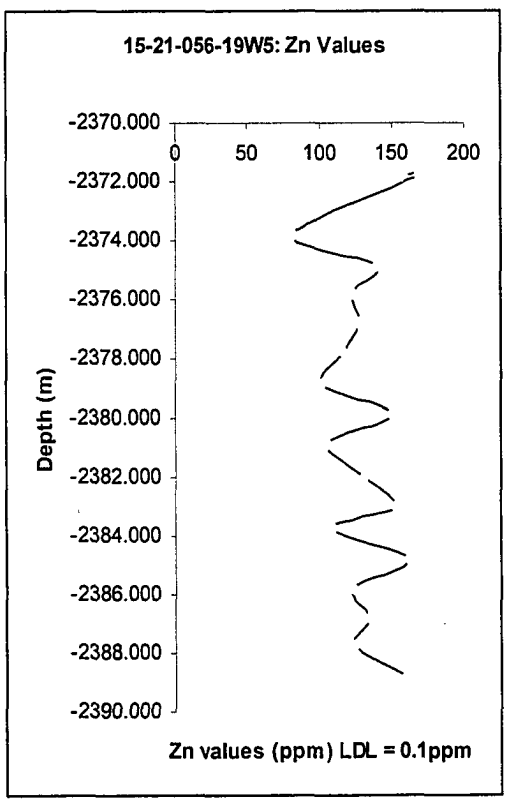




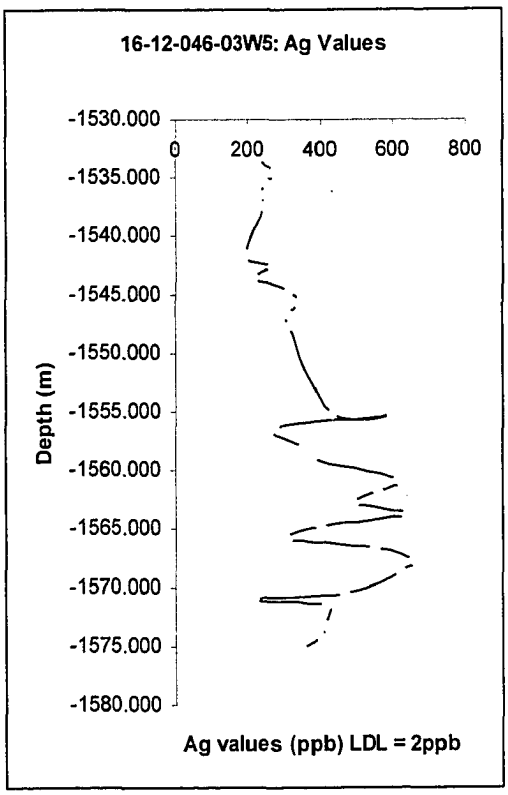
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

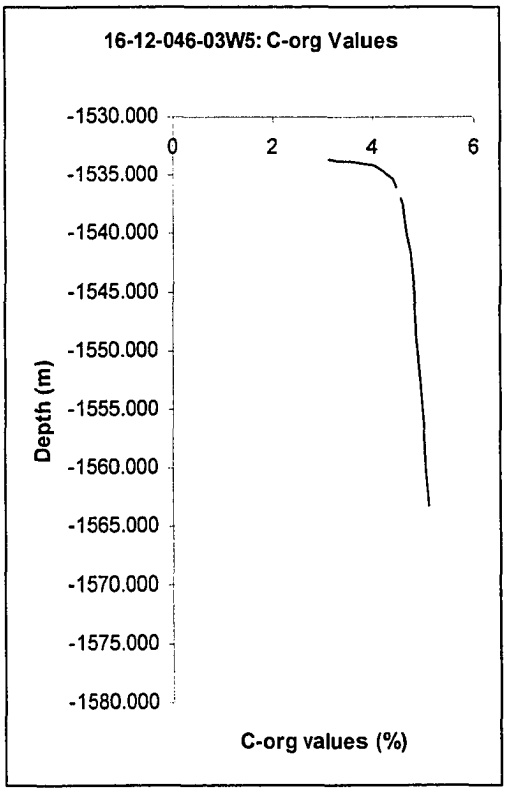


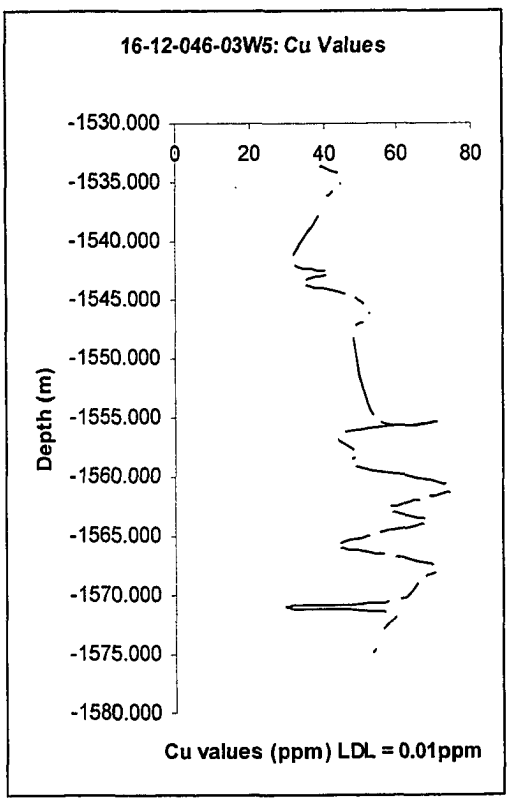


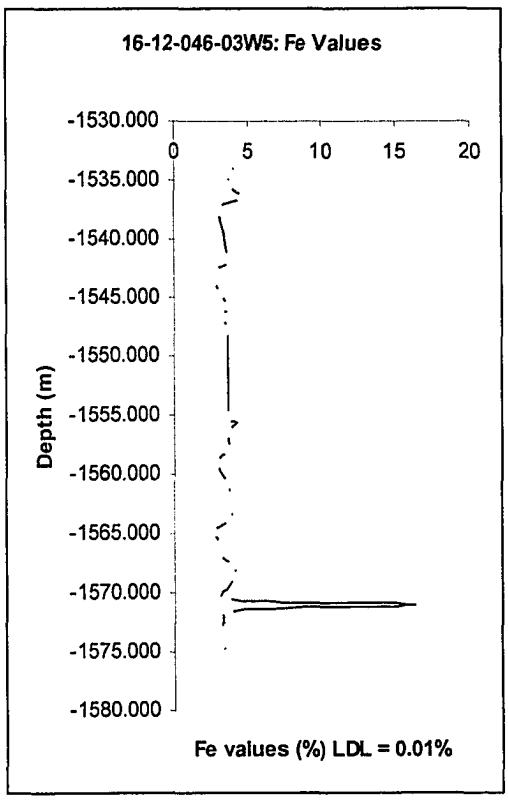


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

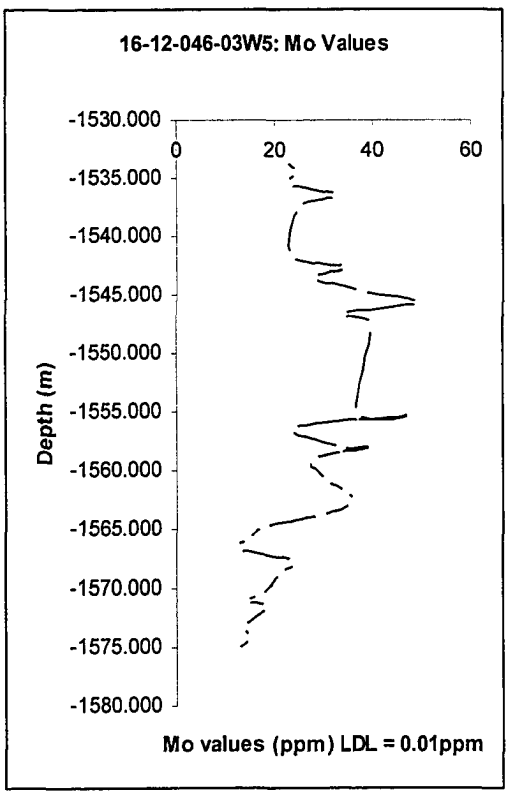


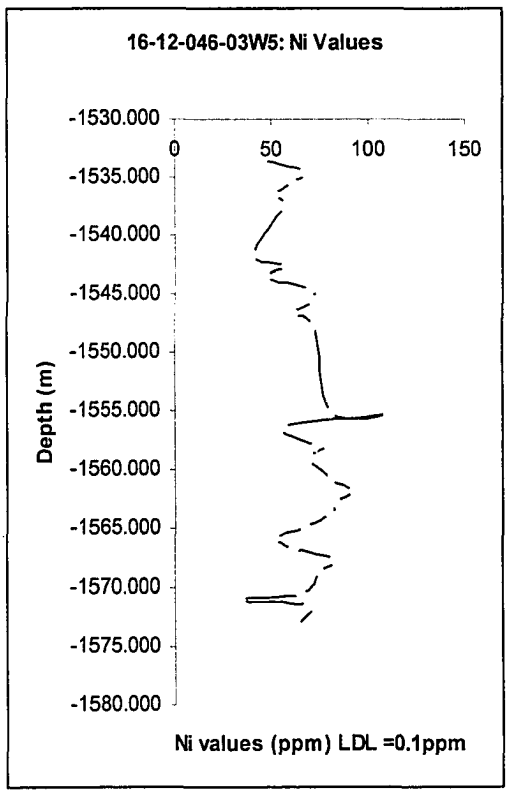


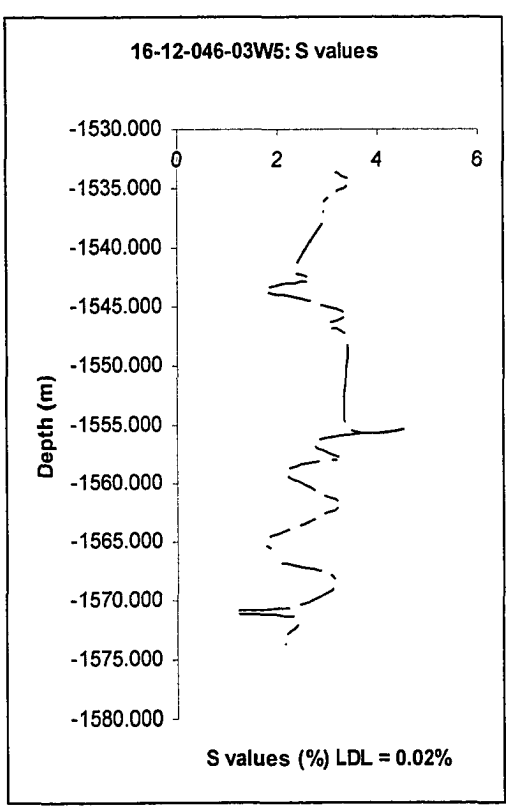


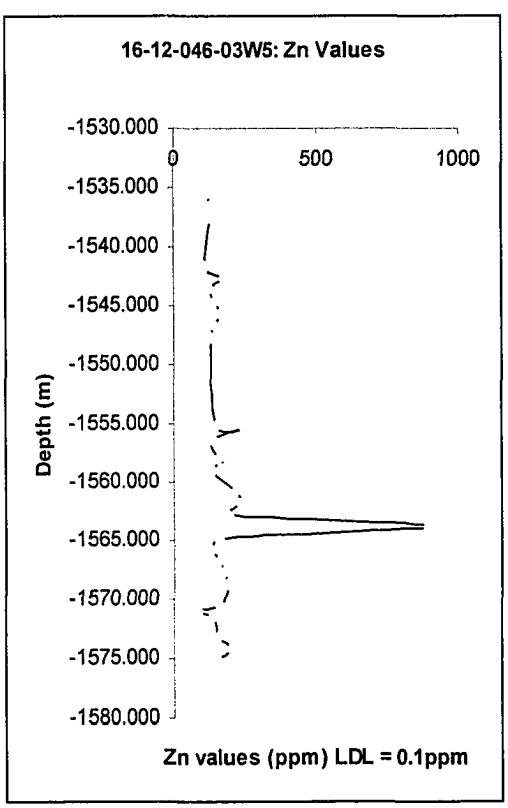


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.



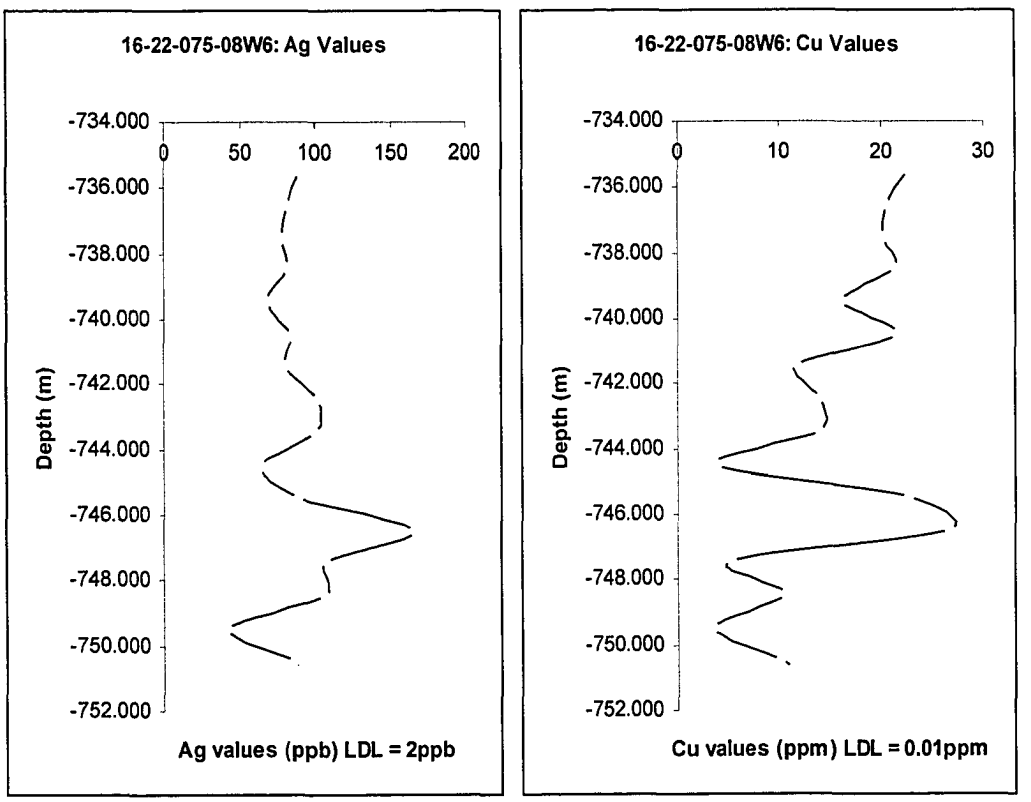




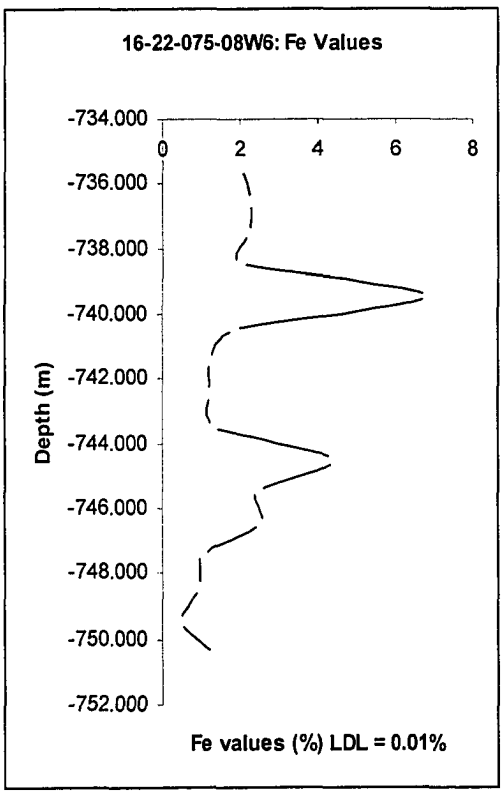


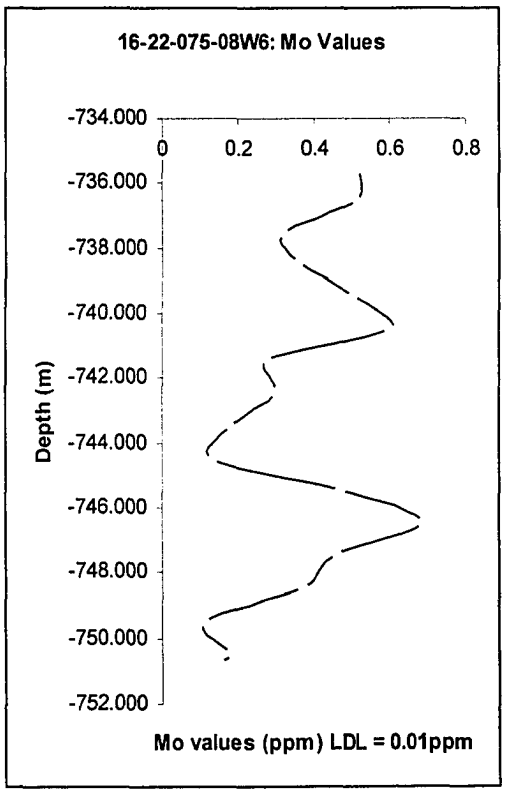
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

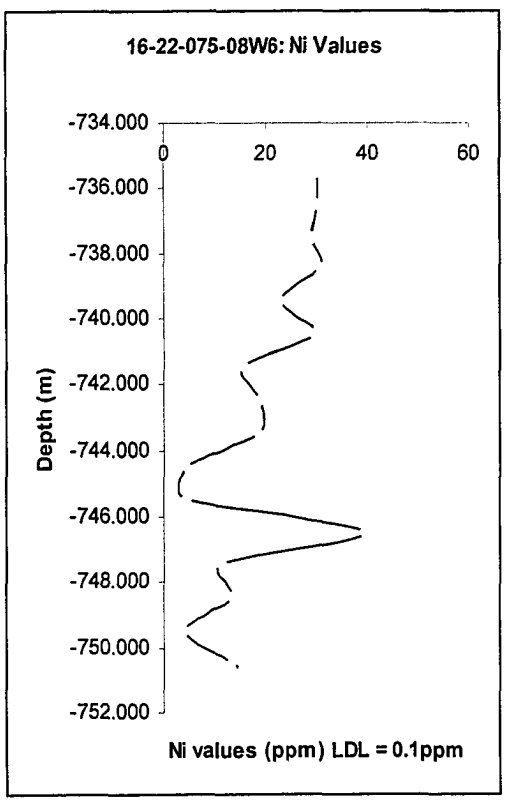
The core placement could not be made with certainty using any of geophysical logs, micropaleontology or lithology. The core interval ranges from 735 m to 752.1 m, but the range for the Second White Specks Formation could not be determined. The core may represent an underlying formation, but could not be confirmed. It is not analyzed here due to the lack of stratigraphic placement.

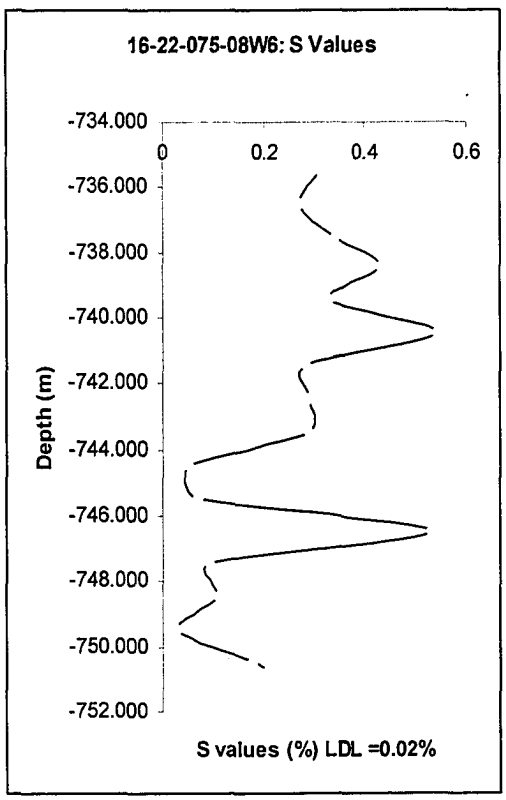


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

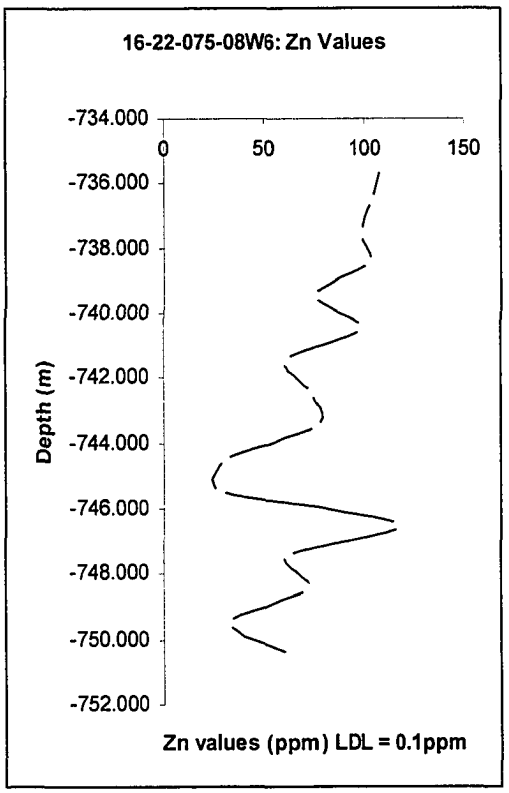


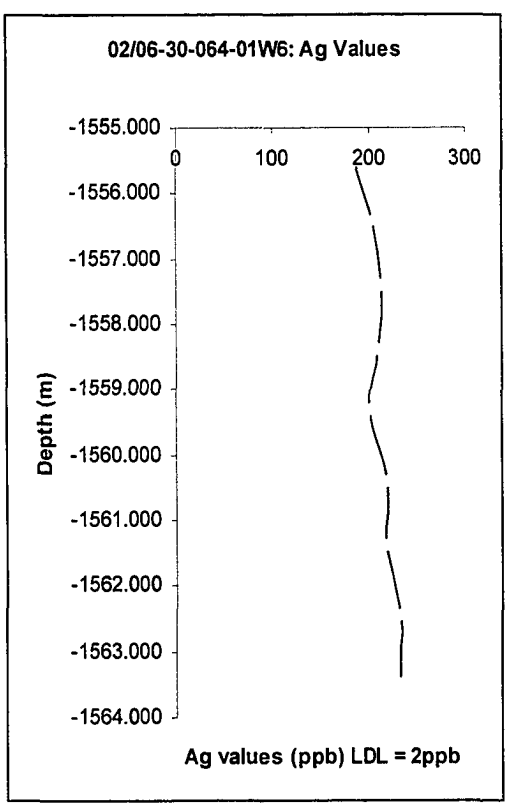


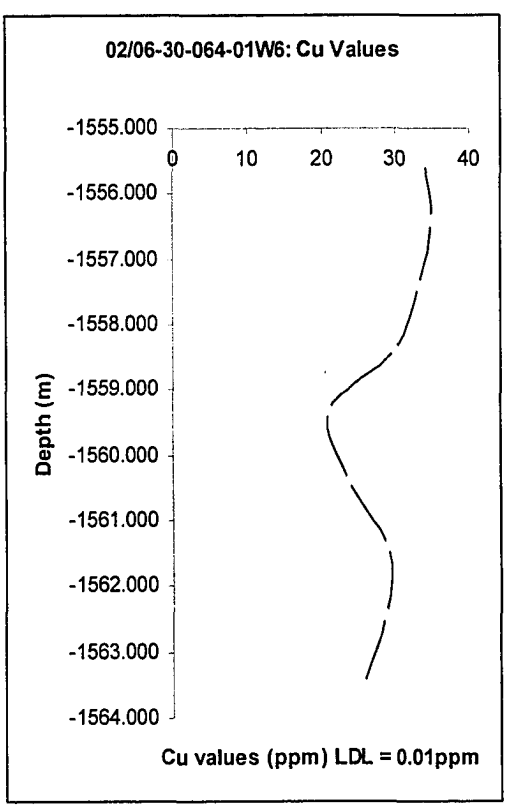




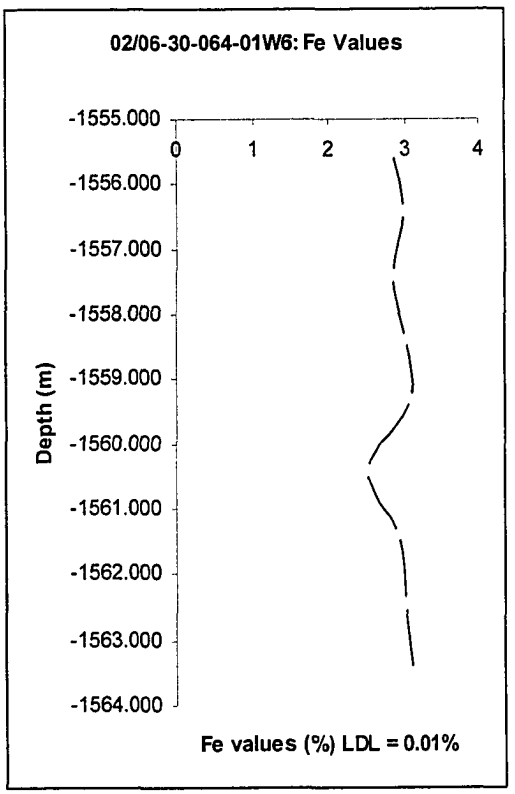
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

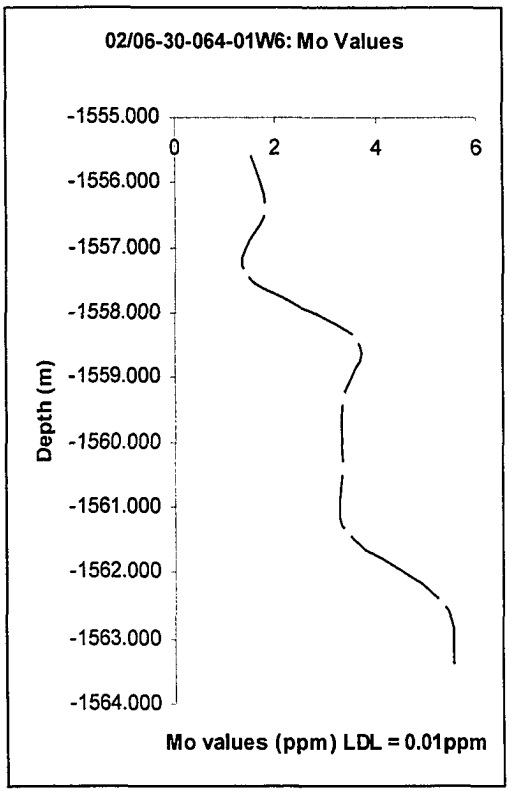


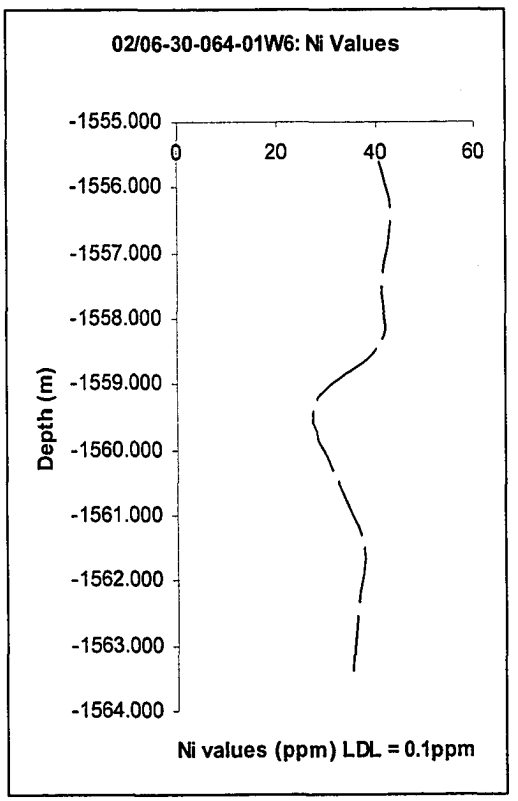


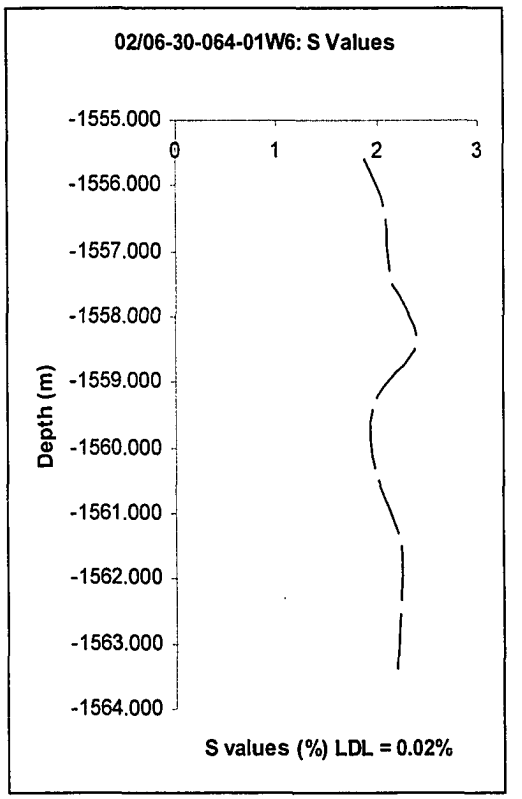


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

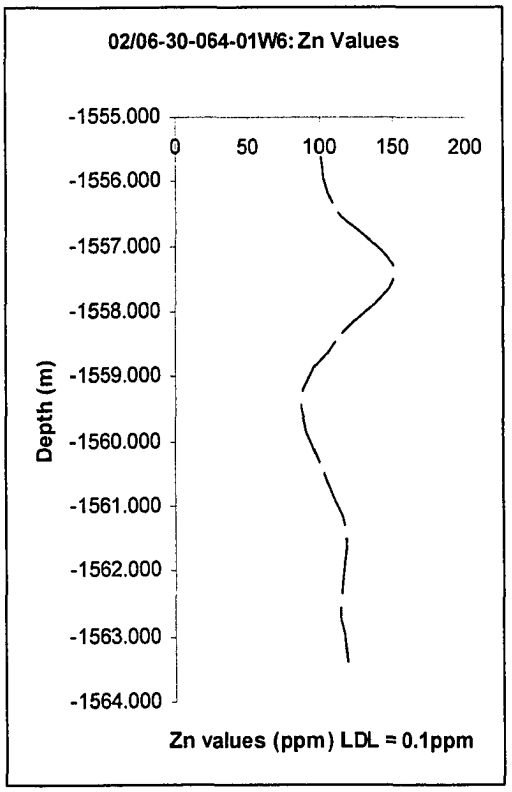


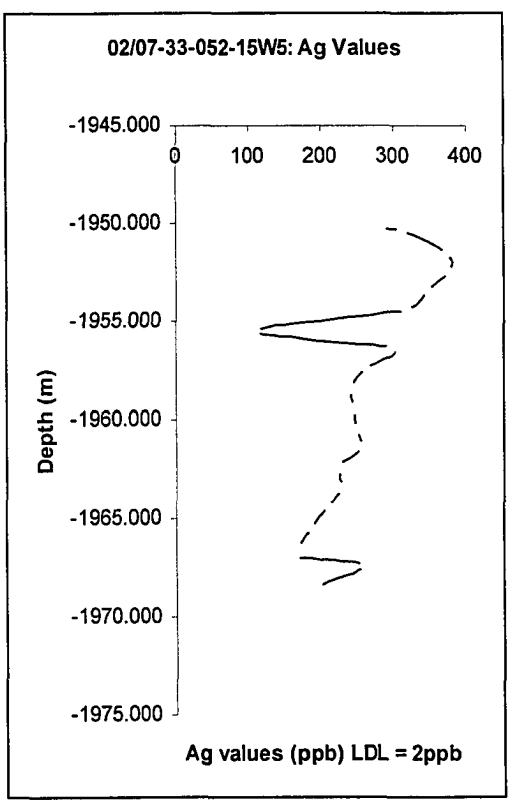


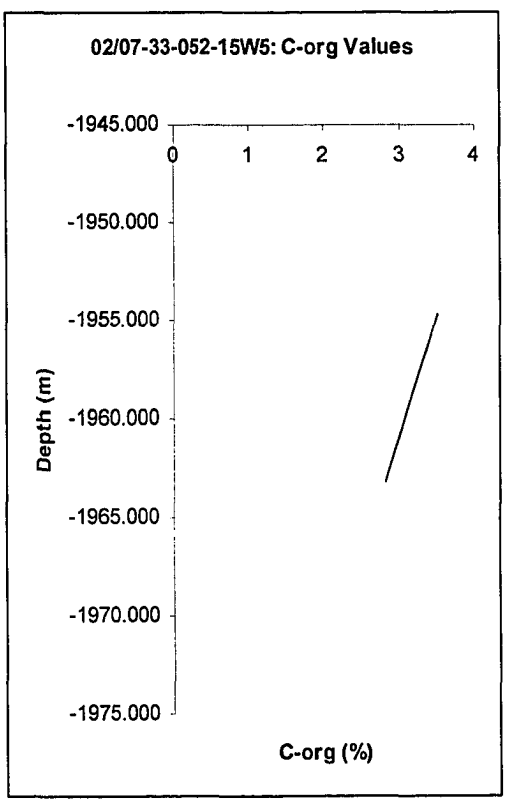




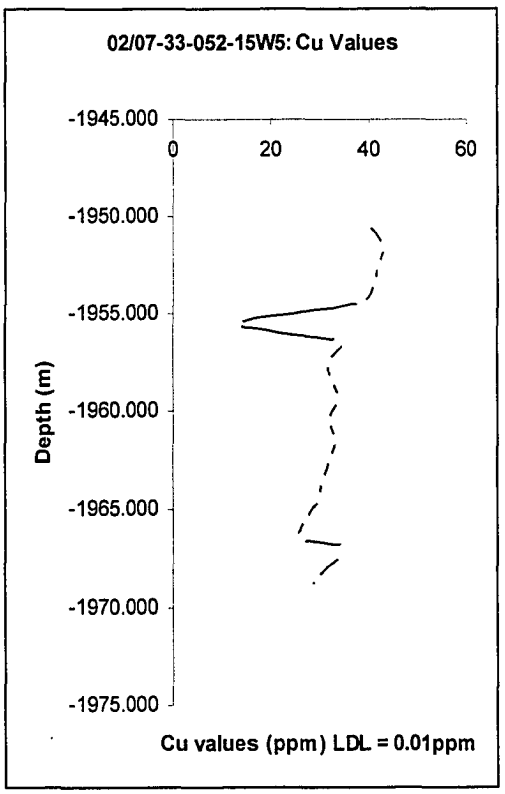
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

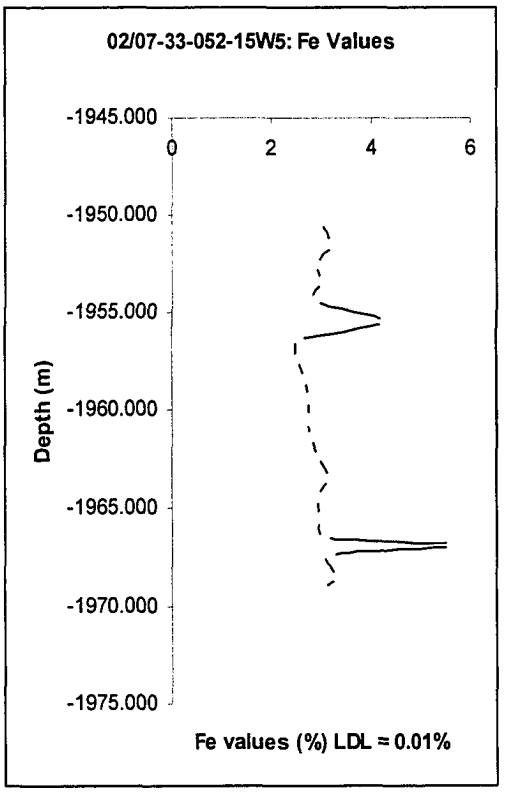


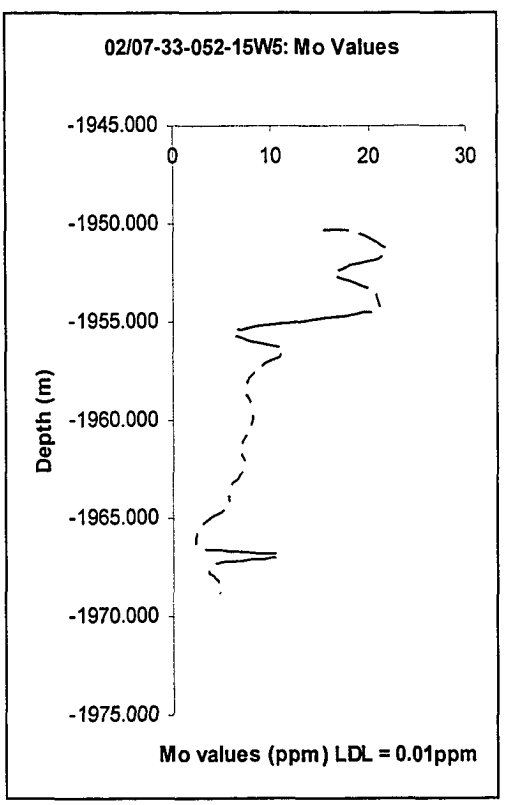


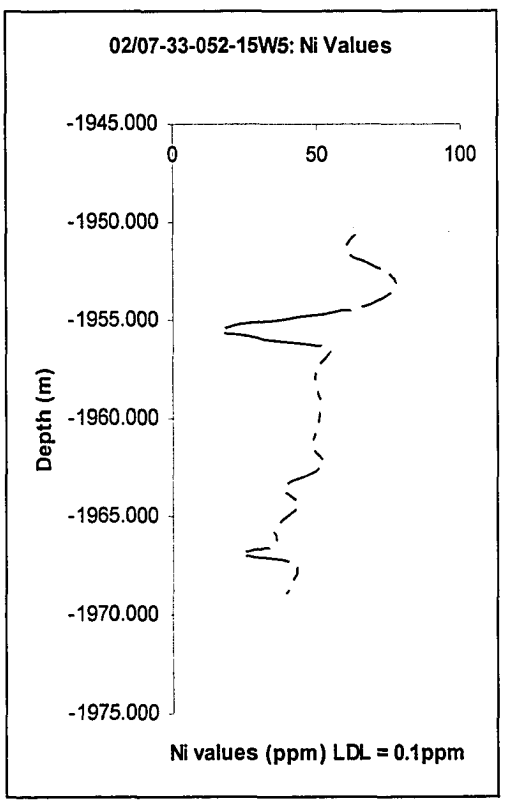


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

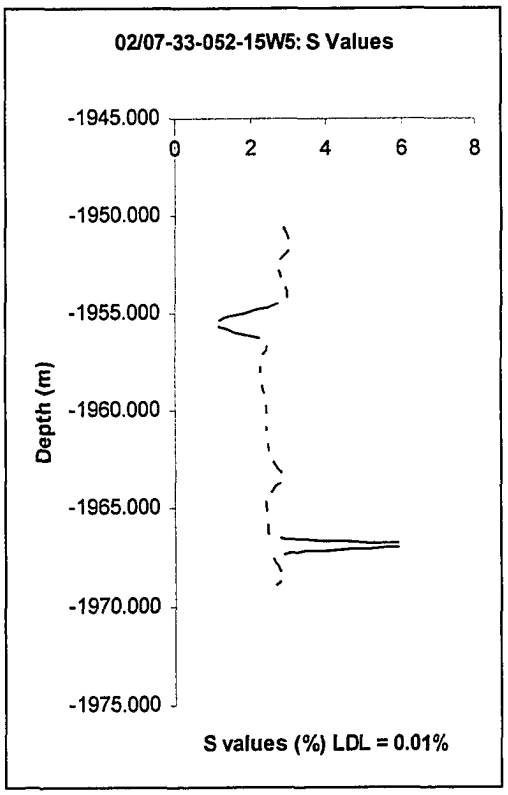


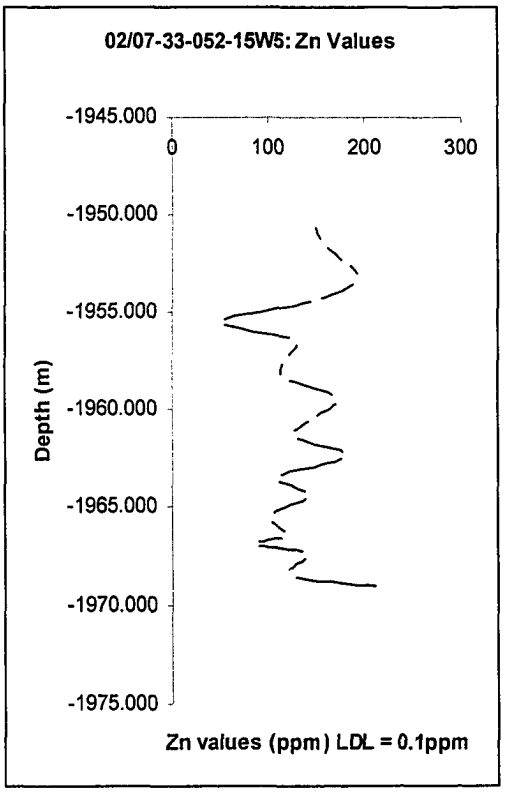


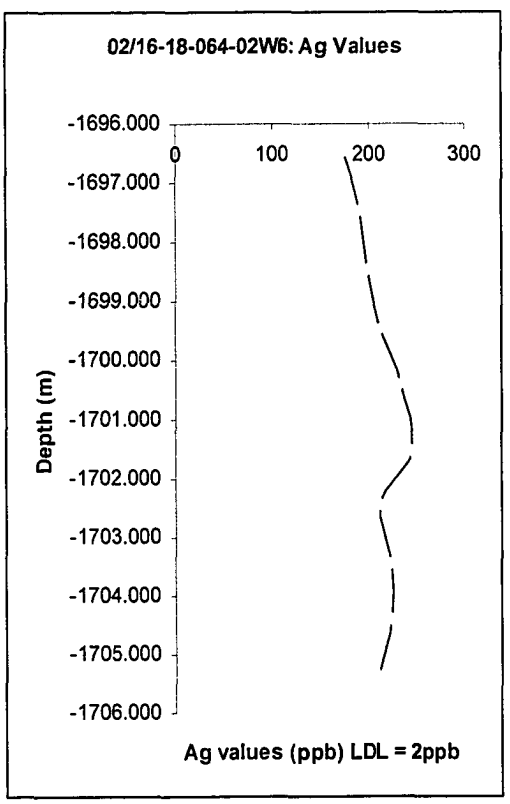


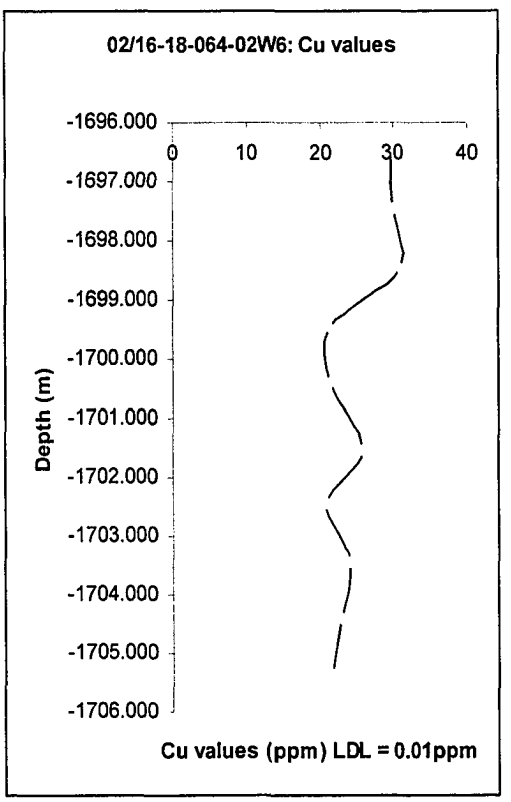


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

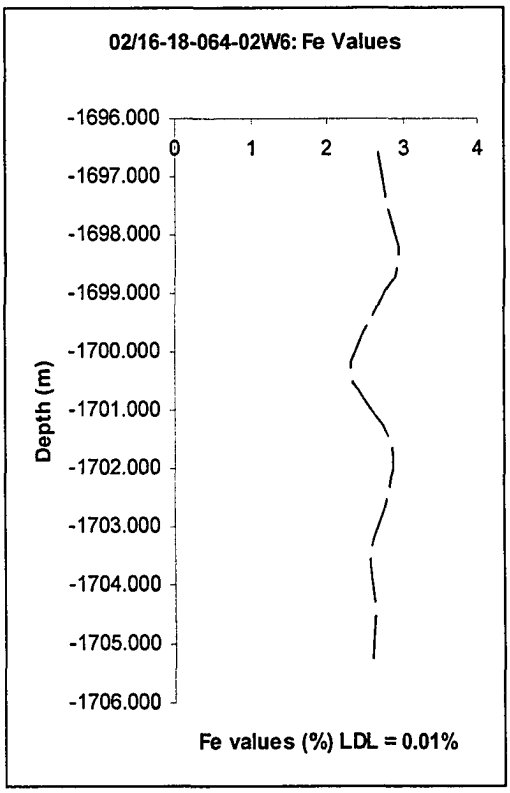


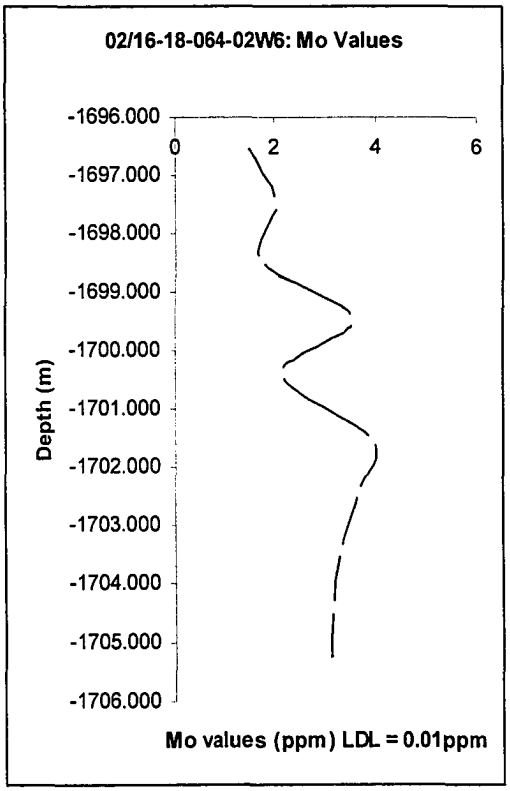


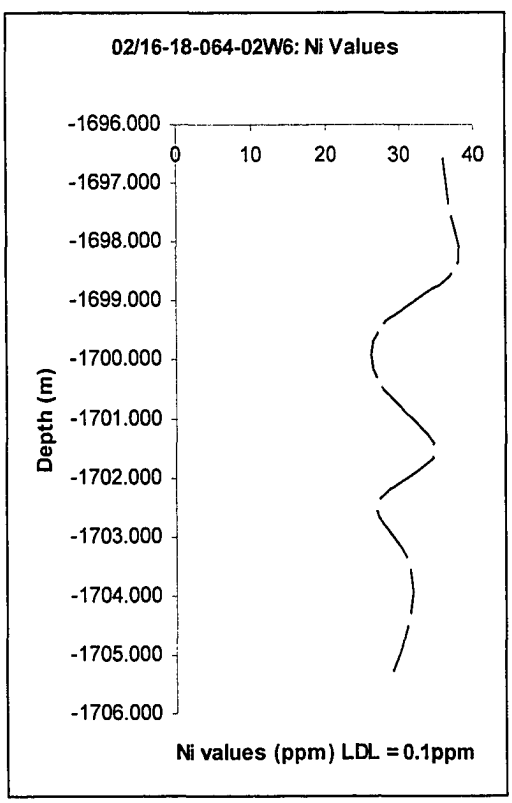


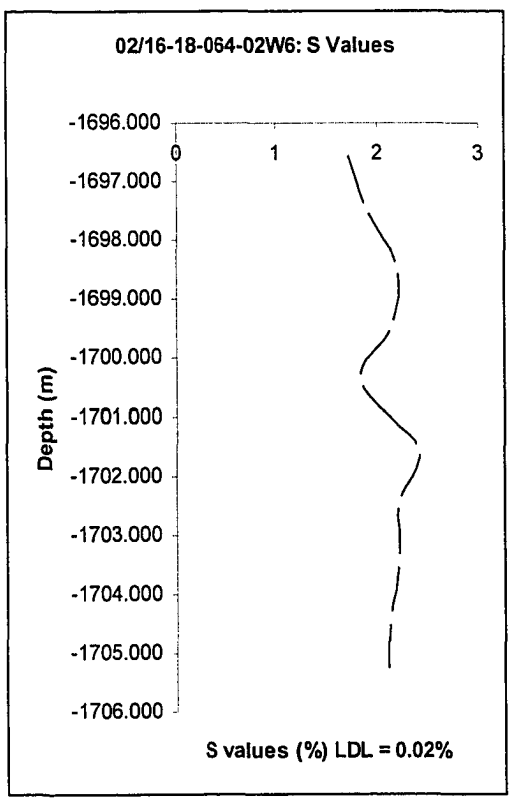


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

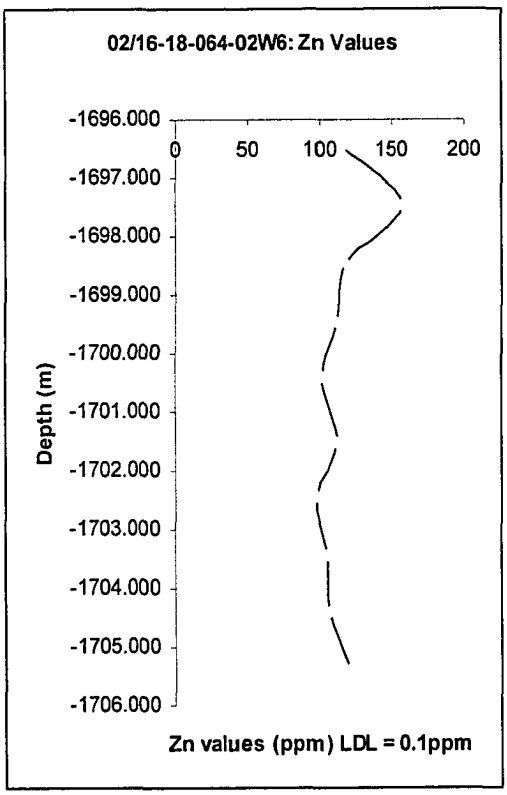


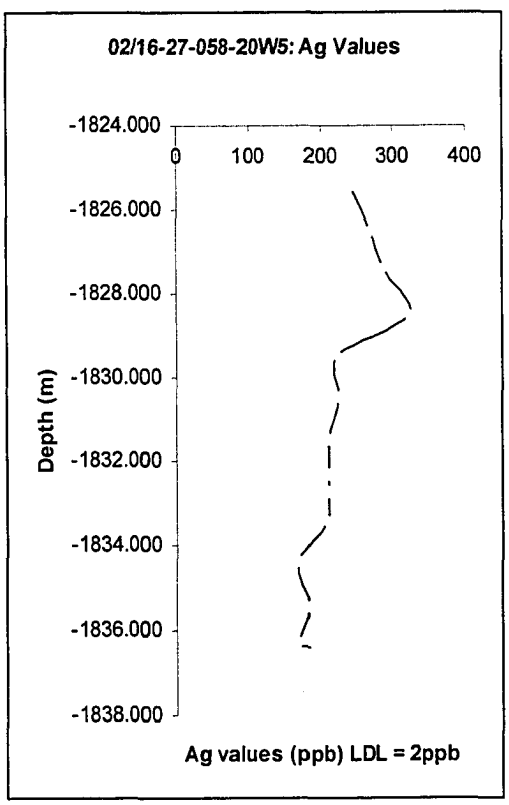


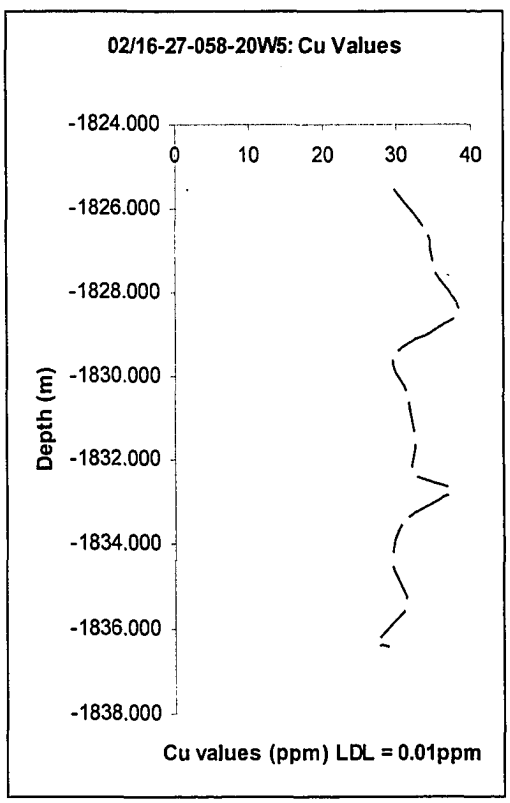




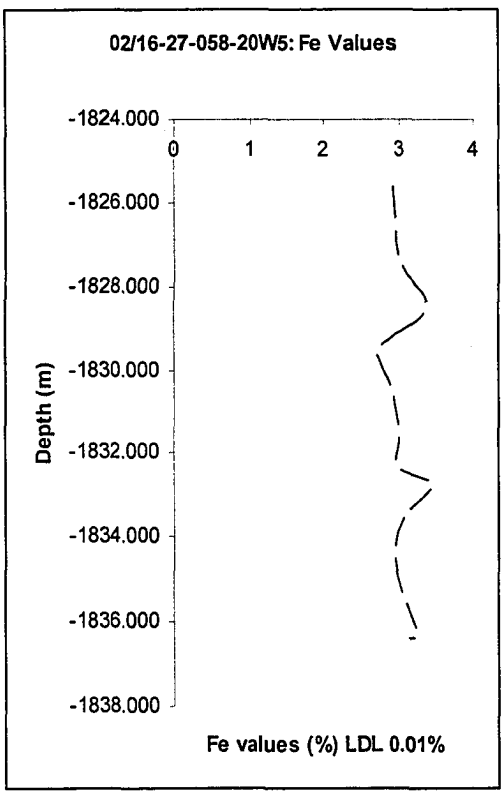
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

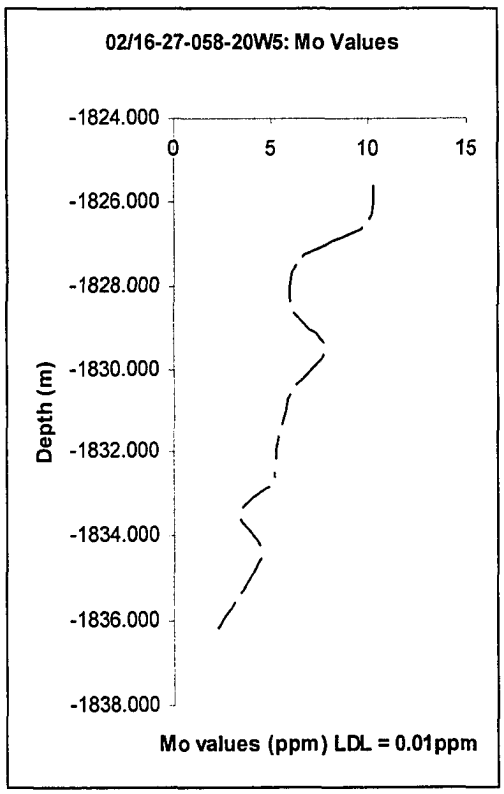


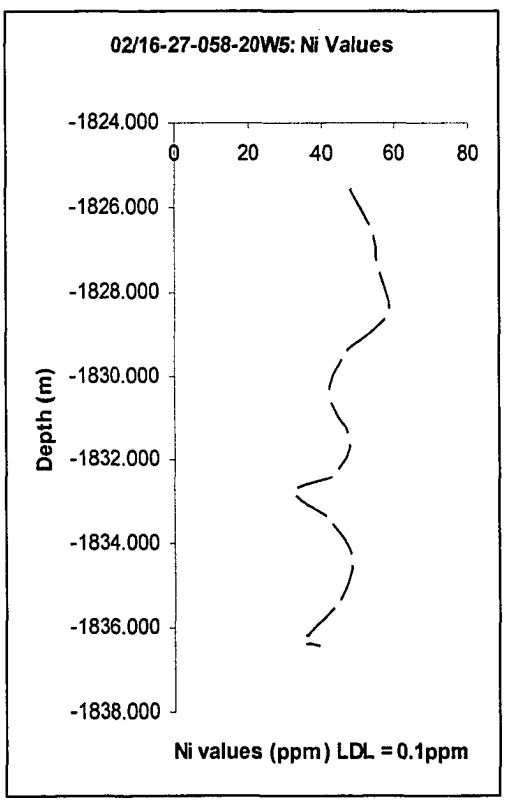


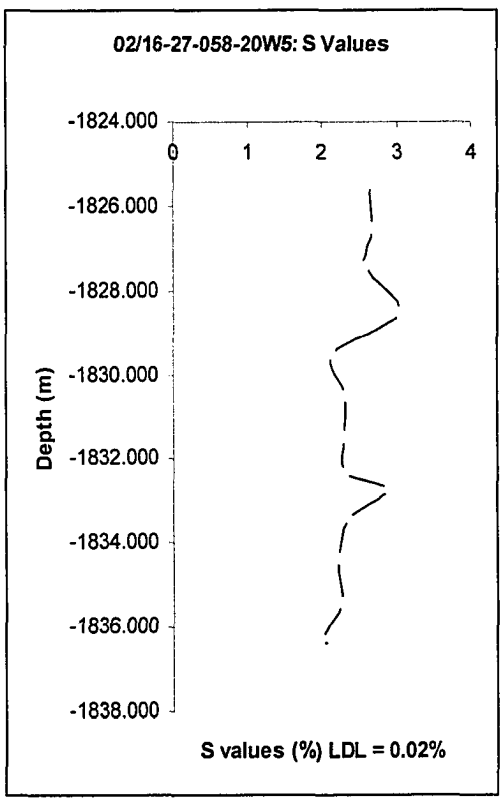


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

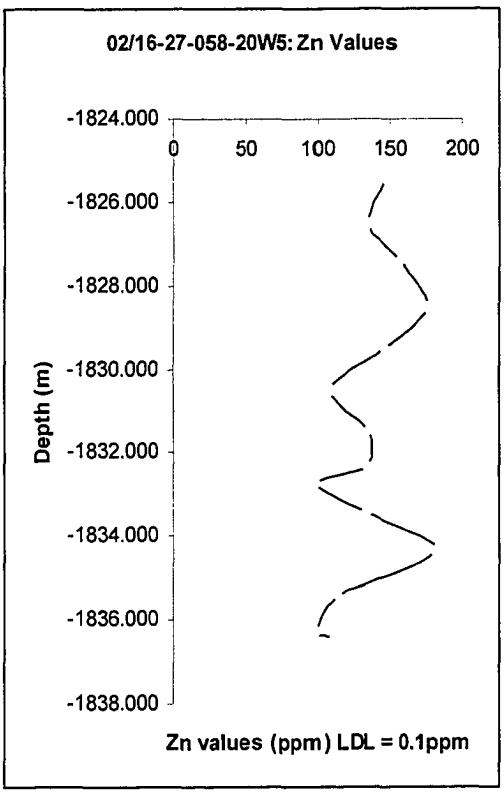


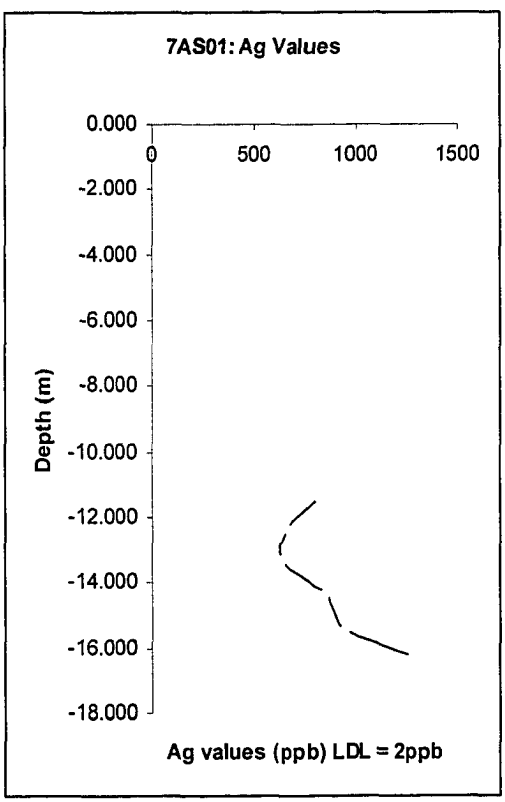


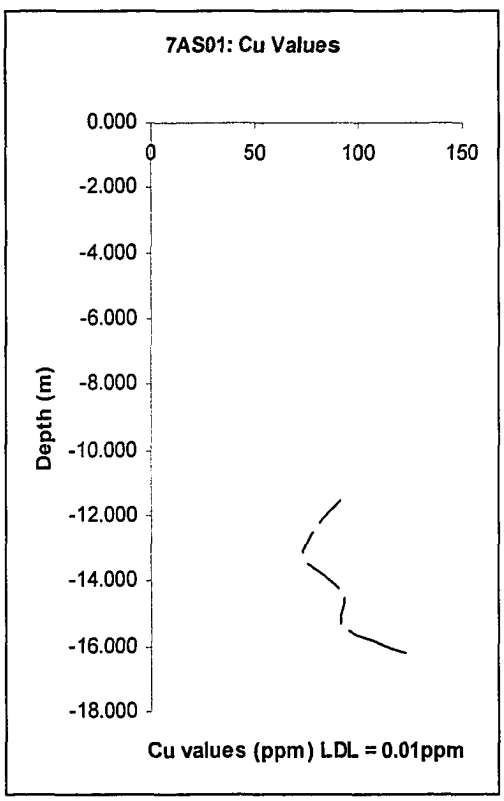




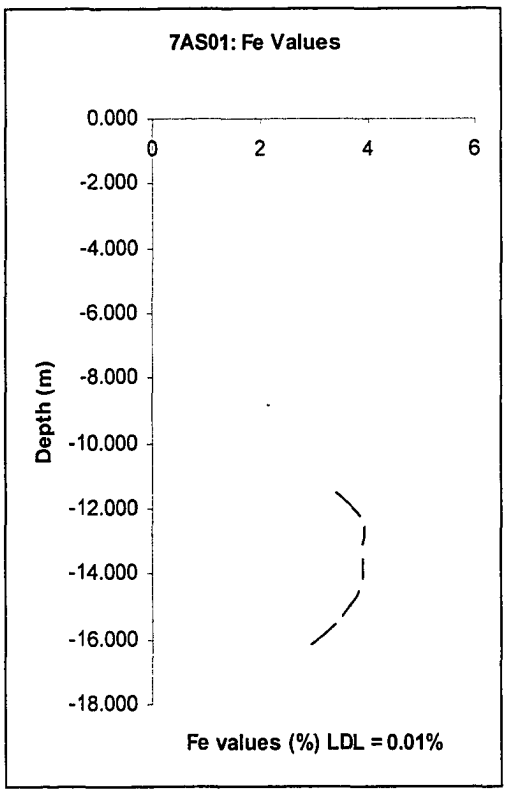
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

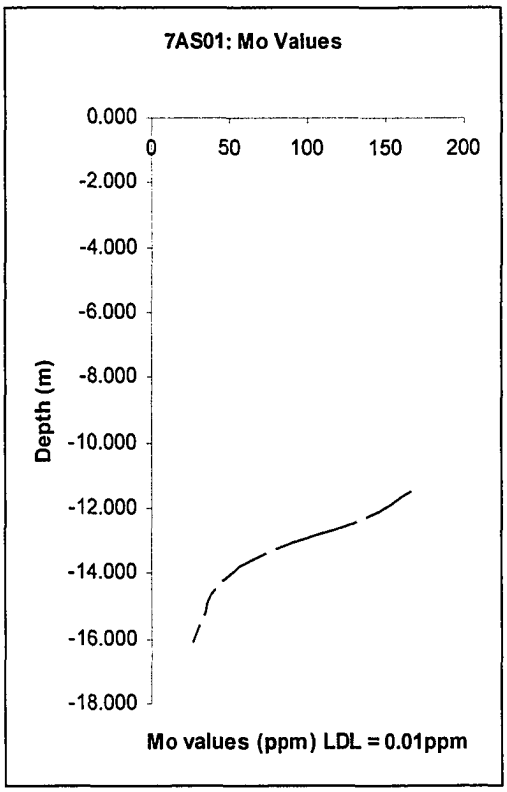


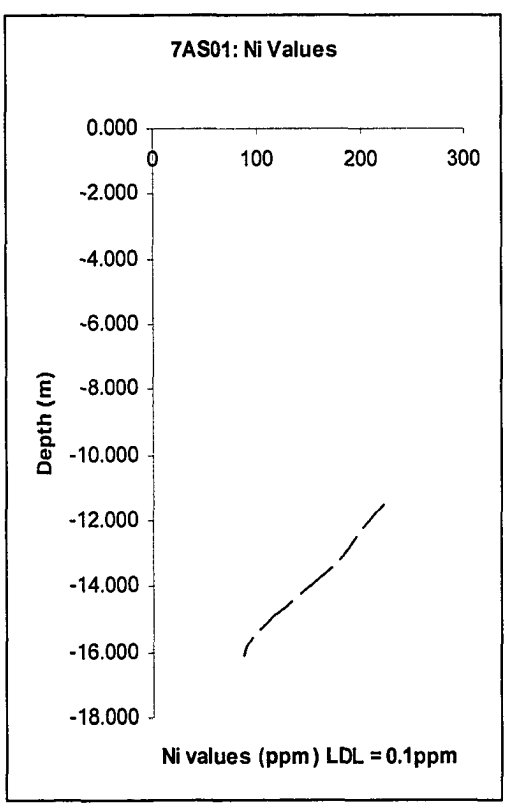


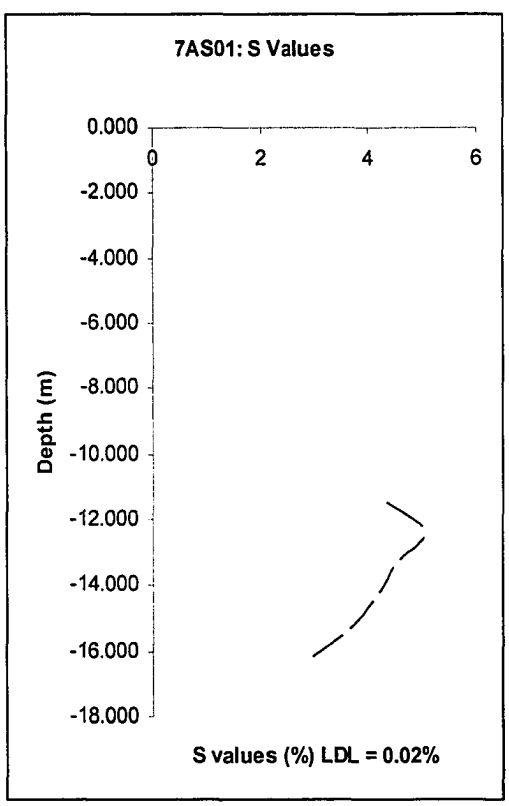


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

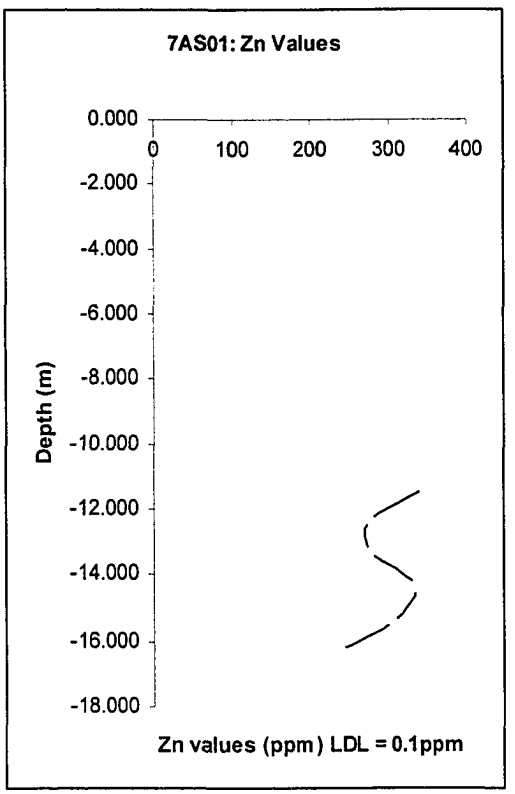




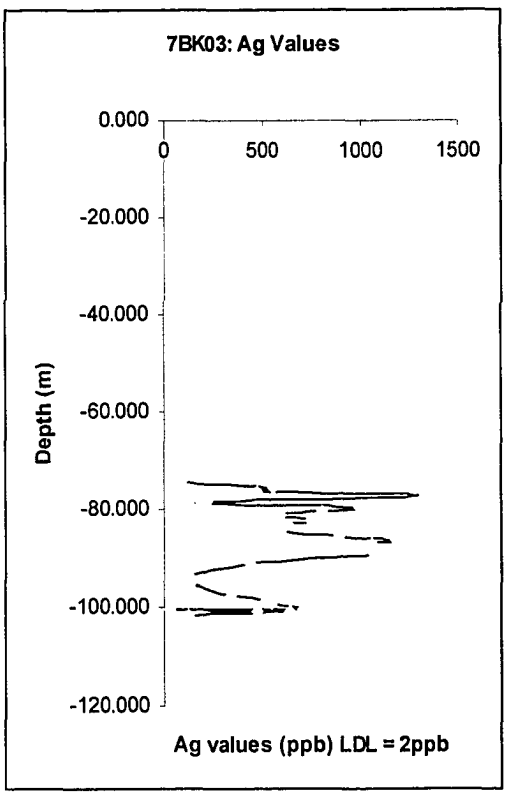


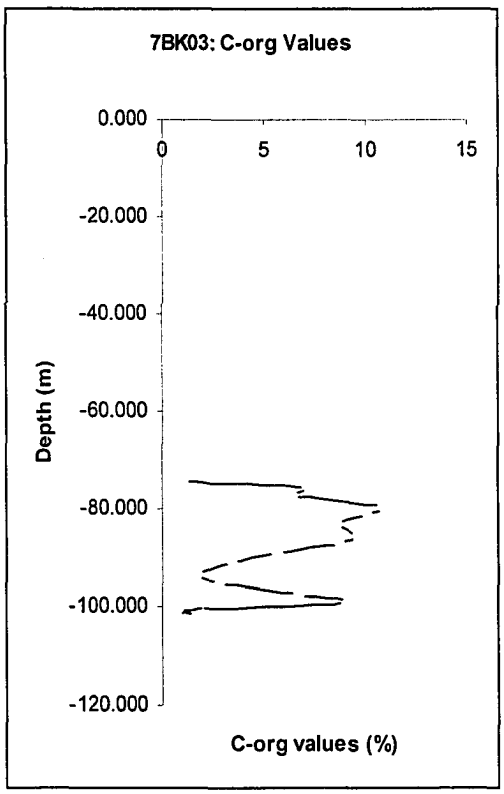


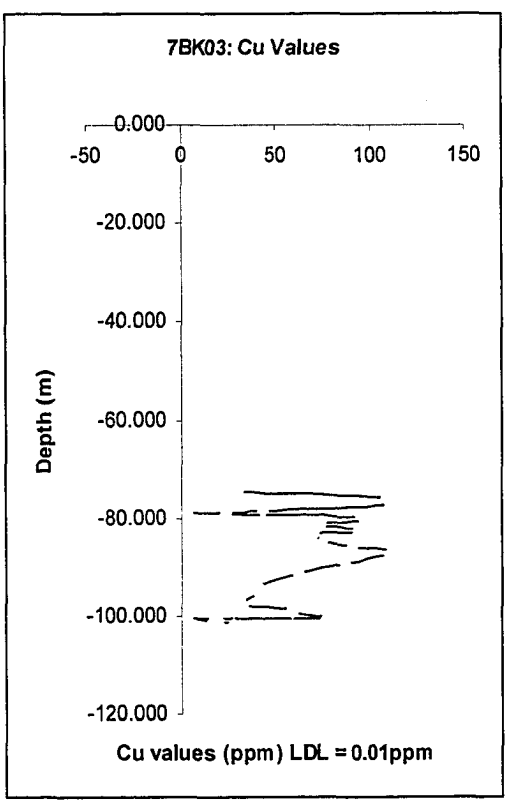
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

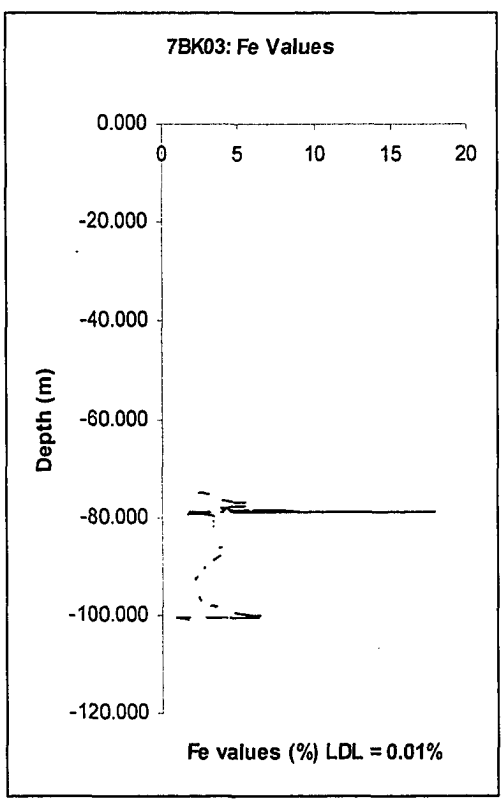


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

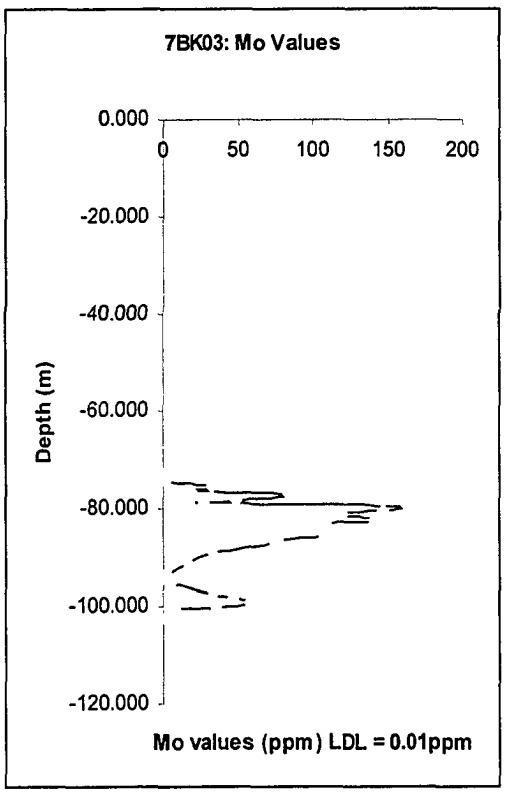


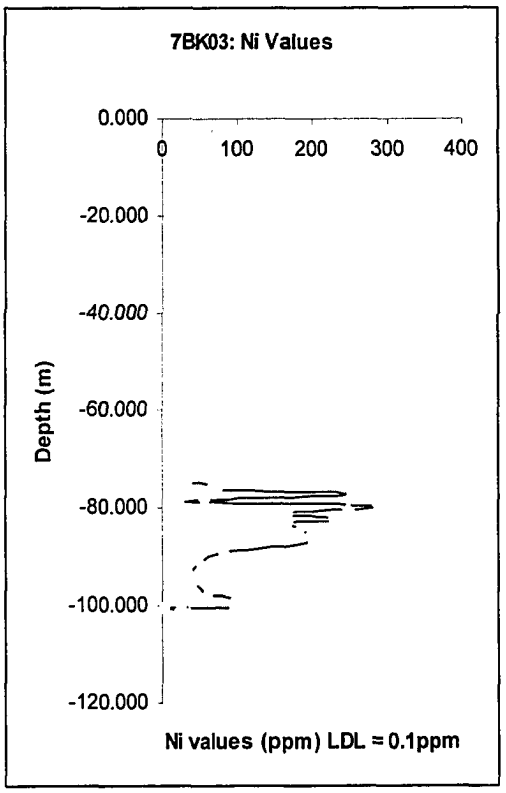


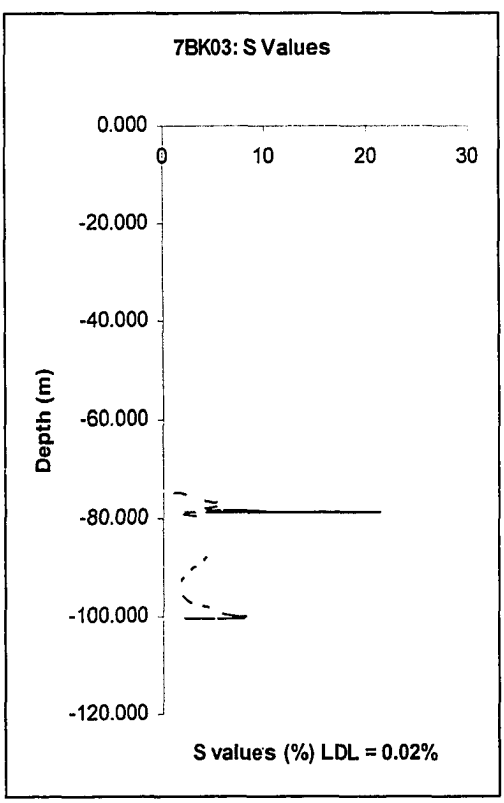


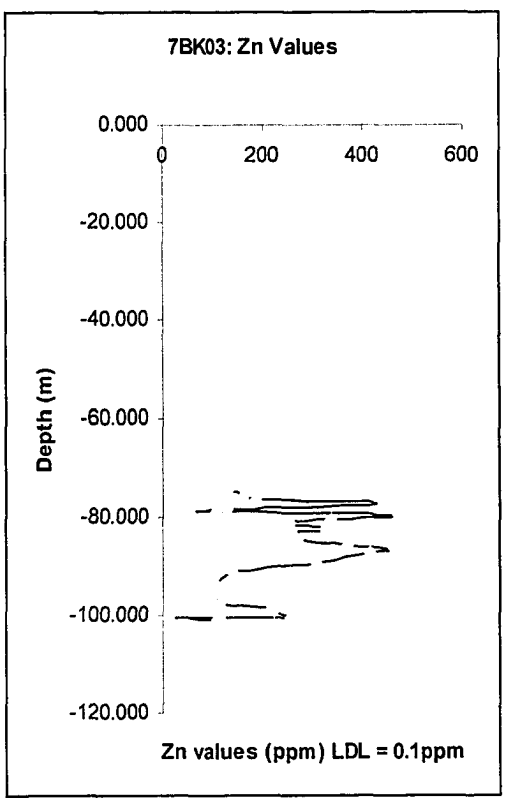


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.









Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.