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THE ROLE OF SEDIMENT BYPASSING IN SILICICLASTIC FACIES VARIABILITY ON THE CONTINENTAL SHELF: EXAMPLES FROM THE FRASER RIVER DELTA FORESLOPE AND THE MIDDLE TRIASSIC DOIG FORMATION.

BY
RICHARD WENDELL EVOY

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IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOLOGY

EDMONTON, ALBERTA

FALL, 1995

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A relatively active source may supply detritus to a slowly subsiding area slightly faster than it can be assimilated in terms of a profile of equilibrium. In such instances, the excess sediment may be by-passed to other depositional sites farther removed from the source ..... there is evidence from subsurface data that sediments may be carried across a neutral area to a depositional basin where more rapid subsidence provides conditions for rapid trapping of the sediment.

Krumbein and Sloss (1951), Stratigraphy and Sedimentation

Whatever made the world ... the scientist writes its laws. Whether or not nature behaves according to law depends entirely upon whether we succeed in writing laws that describe its behaviour.

Nelson Goodman, Uniformity and Simplicity

ABSTRACT

Two examples of sediment bypassing and deposition during an abrupt fall of relative sea level on the continental shelf were examined to document facies characteristics and depositional geometries in marine sandstones associated with sediment bypassing, and to determine if criteria are available to distinguish between forced regression shorefaces and other sharp-based sand bodies.

Several models exist for the development of "sharp-based shelf sands" associated with falling sea level. The Doig represents an archetypal forced regression shoreface characterized by linear shoreface sandstones overlying offshore siltstones and shales across an erosional discontinuity demarcated by a *Glossifungites* surface, and truncation of underlying lithologies. The development of lowstand shorefaces reflects an abrupt fall in relative sea level, and represents a necessary response to decreasing accomodation space independant of the mechanism of sea level fall. The forced regression model accounts for sand bypassing by bringing the shoreface to "deep-water".

Sharp-based sands are often *assumed* to represent forced regression shorefaces. Sand deposition on the Fraser River delta foreslope is in the form of small depositional lobes where subaqueous channels debouche at the base of the foreslope. Upslope channel migration and abandonment, and coalesence of depositional lobes at the base of the delta foreslope, will result in the generation of a linear sand body. Sand bypassing is via discrete channels, and results in the transport of sediment from the shoreface, directly to "deep-water". In the absence of diagnostic sedimentologic criteria to determine the depositional environment, and documentation of a significant erosional discontinuity across the basal contact, this sand could be misinterpreted in the stratigraphic record as a forced regression shoreface. Linear, sharp-

based, shore-parallel sand bodies can be deposited in deep water, their geometry may not simply reflect fairweather wavebase scour and subsequent transgressive reworking *aka* the forced regression model.

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CHAPTER 1.
INTRODUCTION

General Overview and Objectives

The significance of sediment bypassing in the delivery of sand to "deep-water" environments has been long recognized (Eaton, 1929; Straub, 1940; Krumbein and Sloss, 1951). The resultant sand bodies provide excellent hydrocarbon targets as they are frequently encased in marine silts and shales that provide both lateral and vertical seals as well as potential source rock. Furthermore, these sands may represent the sole remaining evidence for significant fluctuations in relative sea level.

Krumbein and Sloss (1951), in discussing the relationship between sedimentation and subsidence rate, appear to have anticipated our current understanding of the significance of accomodation space in controlling sediment bypassing. Since the advent of sequence stratigraphy in the early 1980's, much of the research in this area has focussed on the role of fluvial incision, associated with eustatic sea level changes and relative fall of sea level, in cross-shelf sediment transport (eg. Galloway *et al.*, 1977; Stuart and Caughey, 1977; Vail *et al.*, 1977; Kirk, 1985; Posamentier and Vail, 1988). It is only recently that alternative methods for sand bypassing have received significant interest (eg. Plint, 1988; 1991; Posamentier *et al.*, 1992; Walker and Plint, 1992).

Previous sequence stratigraphic studies have overemphasized the role of eustatic sea level change in sediment bypassing and deposition of shelf sands. Few studies have dealt specifically with the significance of tectonically driven relative sea level falls in the initiation of bypass systems. This study was undertaken to document some of the variability in siliciclastic facies associated with sediment bypassing and deposition on the continental shelf during a non-eustatic (ie. relative) fall of sea level. Two examples were selected, each of which were associated with deposition under a relative sea level fall during a period of global eustatic sea level rise. They are: 1) the modern Fraser River delta foreslope offshore

Vancouver, British Columbia (Figure 1-1), and 2) the Middle Triassic (Anisian/Ladinian) Doig Formation in northeastern British Columbia, centered around the Buick Creek Field near Fort St. John (Figure 1-2).

The initial hypothesis, based on apparent geometric similarities, was that the subaqueous Fraser River delta might provide a process analogue with which to compare, contrast, and possibly model the Doig Formation in the Buick Creek Field. The objectives of the study were:

1) to determine the nature of lateral and vertical facies variability and geometry for subaqueous channels and lobes in the Fraser delta foreslope;

2) to document the role of sediment-gravity flow processes in the redistribution of sediment from the delta plain and foreslope to a pro-delta environment (sand bypassing); and

3) to apply these results to the reconstruction of facies relationships and internal architecture of shelf and shelf-edge sandstones, especially those deposited under similar conditions of sediment bypassing and/or mass-wasting.

As additional data were collected, several similarities which were initially considered significant, were seen to be largely superficial. This hypothesis was subsequently modified from one based on comparison to one based on contrast. However, the two examples represent variations of sediment deposition controlled by an abrupt fall in relative sea level during a period of global eustatic sea level rise.

Sediment delivery to the Fraser River delta foreslope is controlled by fluvial processes (point source), and modified by tidal redistribution. The area experiences a temperate climate, receives abundant annual precipitation, and drains a large, high-relief source area. The role of extrabasinal control (allocyclic processes) is significant. Seismic activity and slope instability may play a role in initiating the remobilization of sediment and, because of the interplay between isostatic rebound and eustatic sea level rise, the Fraser River delta has undergone a relative sea level fall followed by minimal transgression during a period of global

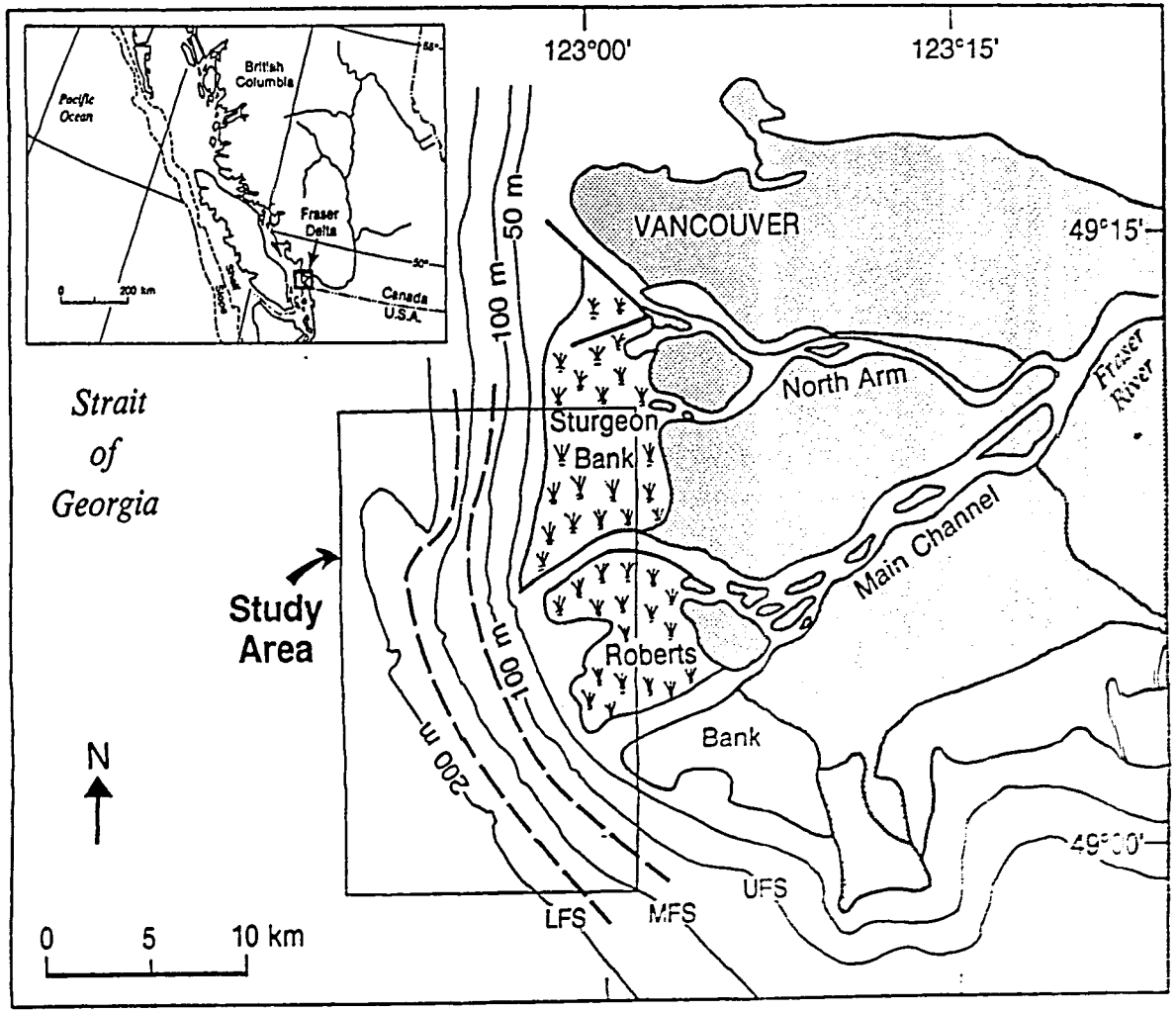


Figure 1-1. Fraser River delta study area location map with generalized bathymetry and main physiologic elements of the foreslope Grass pattern represents the tidal flat; UFS, MFS and LFS refer to upper, middle and lower foreslope areas. (modified from Evoy and Moslow, 1995a).

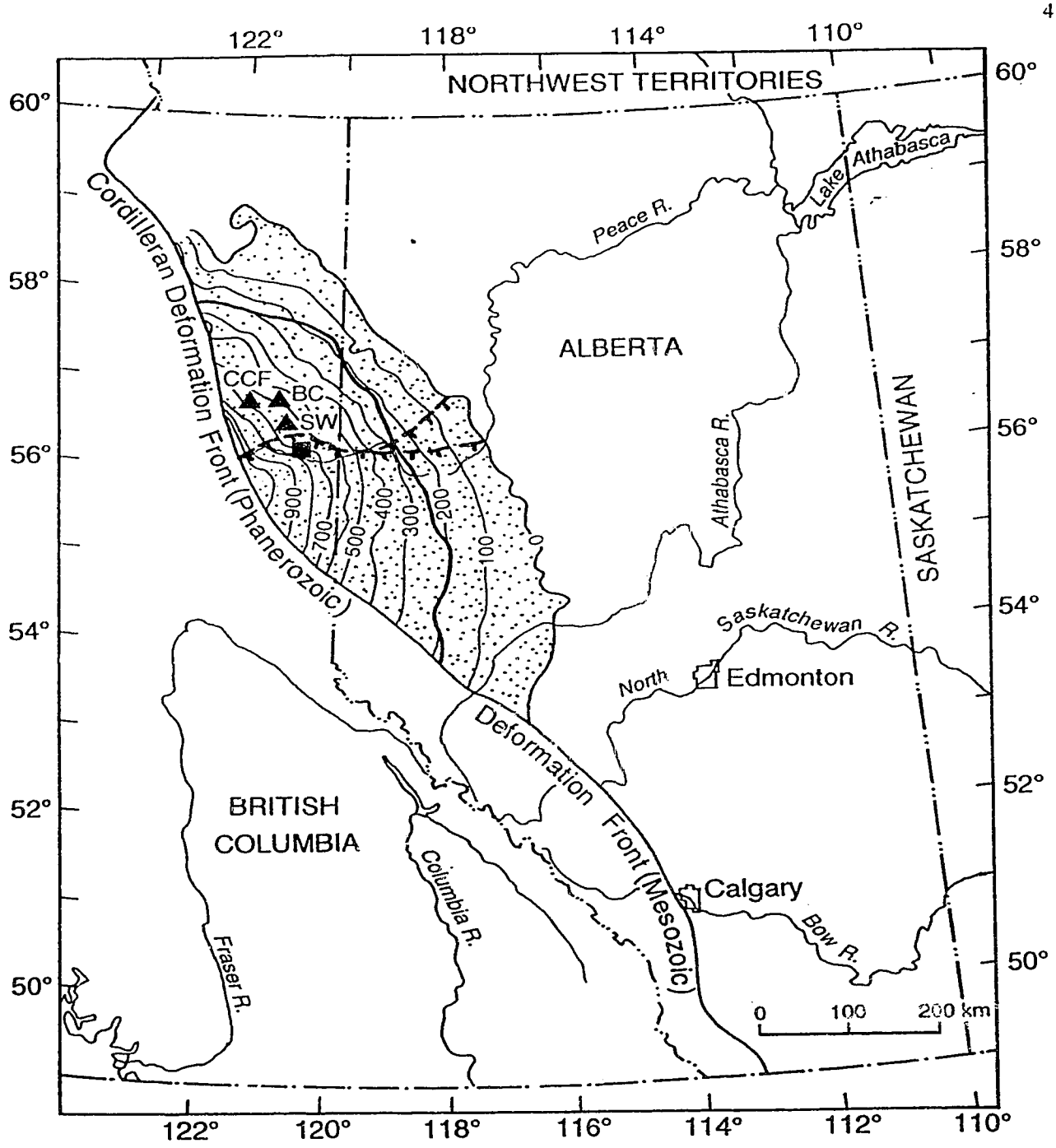


Figure 1-2. Regional Doig study location map with Triassic isopach and location of Buick Creek (BC), Cache Creek/Fireweed (CCF) and Stoddart-West (SW) fields denoted by solid triangles. Solid square marks the site of the municipality of Fort St. John. Contour interval for Triassic isopach equals 100 metres, solid heavy line approximating the 200 m contour represents the erosional edge of the Halfway/Doig interval. Heavy dashed lines represent the flanks of the Dawson Creek Graben Complex. Modified from Edwards *et al.* (1994) and Henderson *et al.* (1994).

sea level rise (ie. eustatic sea level rise has been less than isostatic uplift). The Fraser River delta is protected from significant storm-wave influence by Vancouver Island and the limited fetch across the Strait of Georgia, and progrades directly into a deep water environment.

There is no documented point source for the Doig sands. While this may be due in part to post-depositional erosion of continental facies along the subcrop edge, the generally arid climatic conditions prevailing during Triassic time are incompatible with significant precipitation and development of fluvial systems in the hinterland. The Doig Formation appears to reflect intrabasinal controls (autocyclic processes) dominated by an abrupt relative sea level fall during a larger-scale sea level rise. Evidence of soft-sediment deformation and oversteepened bedding provide evidence for substrate instability. There may be an additional tectonic control on sandstone body geometries induced by ongoing reactivation of basement faults and the Dawson Creek Graben Complex.

Fraser River Delta Foreslope

General

Sedimentary facies distributions from the Fraser River delta foreslope have been correlated with 3.5 kHz seismic data and textural parameters. This provides a large, integrated data set with which to address the questions of sediment dispersal and transport patterns, and the relative significance of sediment gravity flows in the delivery of sediment to deep water. The unique geographic setting, and the presence of sand sized clastic detritus being introduced directly into water depths in excess of 200 metres, may ultimately serve as an analogue to lowstand (shelf-edge) deltas and/or ramp-margin turbidite fans (channel/lobe complexes).

Geologic Setting

The Fraser River delta lies offshore the greater Vancouver area in Georgia Strait. It is a large delta actively prograding into water depths greater than 200 m (Figure 1-1). The Fraser River drainage basin includes 250,000 km^2 of high relief mountainous terrain. Mean

annual precipitation varies greatly throughout the basin, from less than 30 cm in the upper Fraser River valley, to greater than 450 cm in the Coquitlam Valley in the lower reaches of the drainage basin (Johnston, 1921). Peak discharge coincides with the snowmelt freshet in late spring and early summer (Milliman, 1980). A pronounced tidal influence is superimposed on the lower reaches of the Fraser River with semi-diurnal tides approaching 5 m at the river mouth (Kostaschuk *et al.*, 1992a).

Inception of sedimentation in the Holocene Fraser River delta was coupled with up to 200m of isostatically driven fall in local sea level between 13,000 and 8,000 years ago (Clague *et al.*, 1982; Figure 1-3a). The ensuing transgression during Recent time is on the order of 12 metres (Williams and Roberts, 1989; Figure 1-3b). The delta is sourced with relatively coarse-grained detritus via strongly seasonal fluvial discharge (Kostaschuk *et al.*, 1989), experiences large tidal draw down, and exists within one of the most active seismic regimes in Canada (Luternauer, 1988). The area is also protected from excessive storm - generated waves by the limited fetch across Georgia Strait.

The seaward margin of the delta consists of a series of broad tidal flats up to 9 km in width, with an average slope of less than 0.1°. The foreslope extends a further 5 to 10 km seaward at an average slope of 1.5°, and is cut by a number of broad "sea valleys" hundreds of metres wide, floored in medium sand, and up to 10 m in relief (Kostaschuk *et al.*, 1992b; Hart *et al.*, 1992; Evoy *et al.*, 1993a). Much of the coarsest sediment supplied to the mouth of the delta bypasses the delta plain and upper foreslope to be introduced directly to the lower foreslope and basin floor. Sediment bypassing is via turbidity currents within these subaqueous channels, and deposition occurs where these channels debouche onto the basin floor as a series of sand-rich depositional lobes in approximately 200 to 250 m water depth (Moslow *et al.*, 1991; 1993; Evoy *et al.*, 1993b). Development of multiple channels through time on the delta foreslope has resulted in a high degree of along-slope facies variability and sand deposition in water depths exceeding 200 metres.

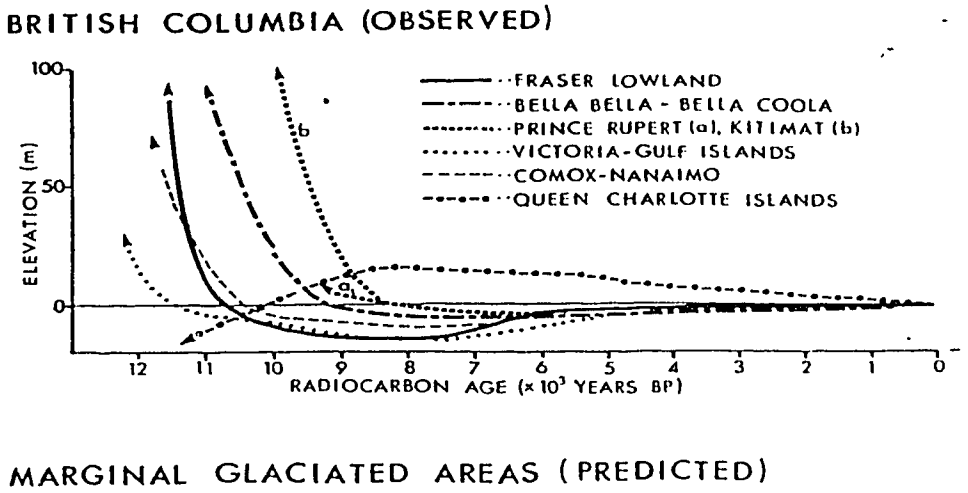


Figure 1-3a. Holocene sea level curve for the lower mainland area (Fraser River delta). (from Clague *et al.*, 1982).

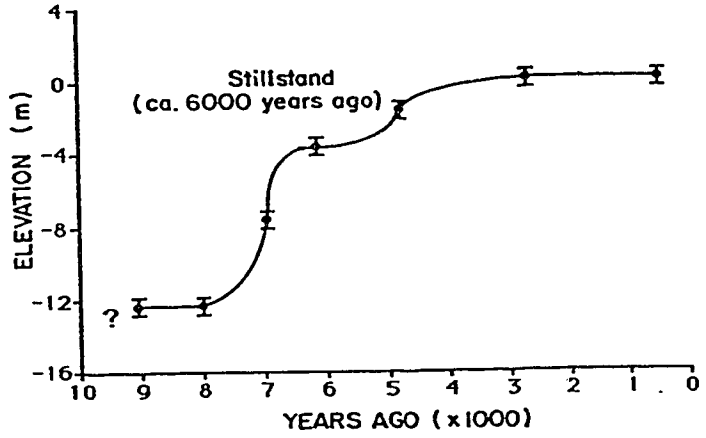


Figure 1-3b. Revised sea level curve for the Fraser Lowland showing the magnitude of Holocene transgression following the initial sea level fall. (from Williams and Roberts, 1989).

Database and Methodology

This study was undertaken in conjunction with the Geological Survey of Canada to integrate detailed sedimentologic core descriptions with sediment accumulation rates, textural analysis of selected cores, and high frequency seismic profiles in order to study the origin, geometry and variability of sedimentary facies in submarine channels ("sea valleys") and associated depositional lobes of the delta foreslope. Elements of the study have been published on an ongoing basis as follows: sediment accumulation rates (CHAPTER 2; Evoy, 1992; Evoy *et al.*, 1993a; Moslow *et al.*, 1993); grain size distribution patterns and textural analysis (CHAPTER 3; Evoy and Moslow, 1995a; Evoy *et al.*, *submitted*); sedimentary facies associations (CHAPTER 4; Evoy *et al.*, 1994); and, implications for sediment bypassing (CHAPTER 5; Evoy and Moslow, 1995a; Moslow *et al.*, 1995).

The delta foreslope is bisected by two pronounced bathymetric channels. The Sand Heads Sea Valley, off the Main Arm of the Fraser River, is the only active channel on the foreslope; consequently, most studies of sediment transport and failure on the subaqueous delta have concentrated on this area (eg. Kostaschuk *et al.*, 1989; Hart *et al.*, 1992; Kostaschuk *et al.*, 1992b; McKenna *et al.*, 1992). Due to the requirements of navigation, the Main Arm has experienced significant cultural modifications, including construction of the Steveston Jetty and continually dredging. The Roberts Bank channel is currently inactive, and predates any appreciable anthropogenic mediation. It therefore more accurately reflects the natural state of sedimentation on the subaqueous Fraser River delta, and was thus emphasized in this study.

The data set for this study consists of 86 vibrocores, piston cores and gravity cores (Figure 1-4a; Appendix A). Fifty-five of these core were described, and an additional 31 core descriptions were provided by the Pacific Geoscience Centre of the Geological Survey of Canada (Table 1-1; Appendix B). The Geological Survey of Canada also provided access to several hundred kilometers of high frequency seismic lines (Figure 1-4b), and side-scan sonar survey coverage concentrating on the immediate vicinity of the major subaqueous channels

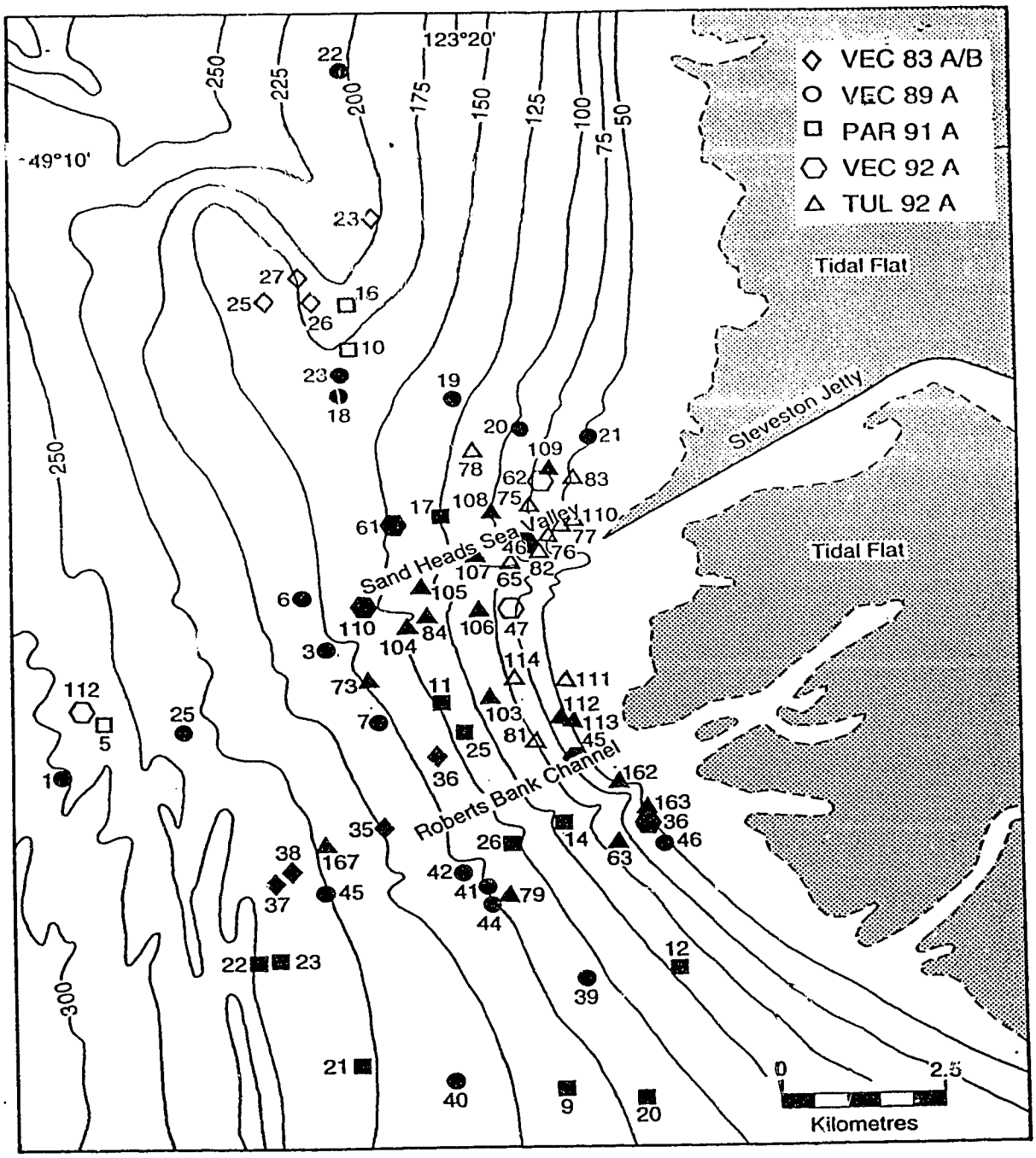


Figure 1-4a. Detailed bathymetry of the Fraser River delta foreslope in the study area with location of sediment cores collected during five separate cruises. Core sites denoted with closed symbols are presented in Appendix B.

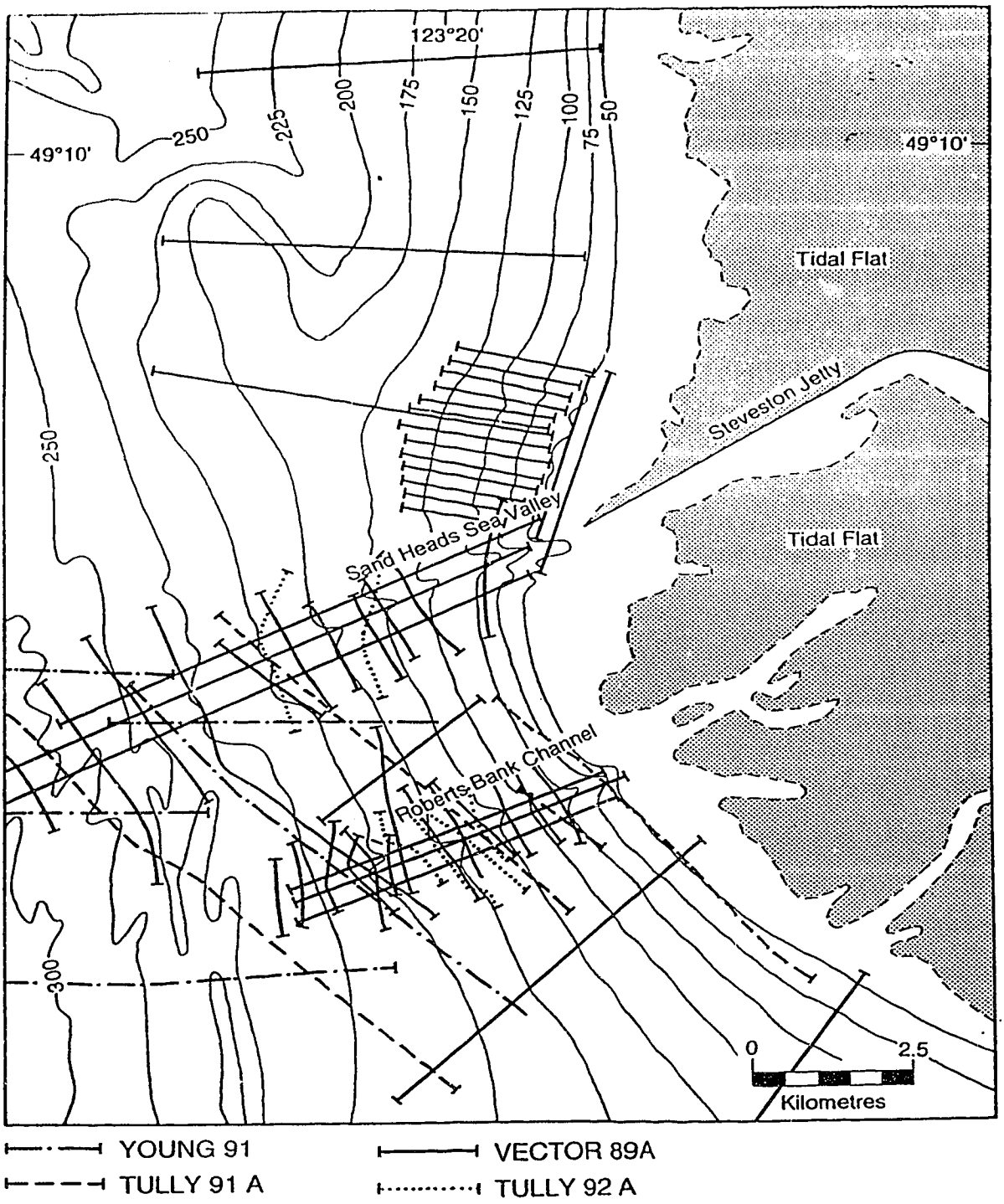


Figure 1-4b. Detailed bathymetry of the Fraser River delta foreslope in the study area with traces of high-frequency seismic lines.

Table 1-1. Table of sediment cores collected from the subaqueous Fraser River delta used in this study.

CORE I.D.	WATER DEPTH	CORE LENGTH	CORE TYPE
VEC 83A - 23	231 m	150 cm	GRAVITY
25	163 m	135 cm	GRAVITY
26	185 m	151 cm	GRAVITY
27	183 m	154 cm	GRAVITY
VEC 83B - 35	202 m	67 cm	GRAVITY
36	152 m	164 cm	GRAVITY
37	241 m	31 cm	GRAVITY
38	240 m	62 cm	GRAVITY
VEC 89A - 1	280 m	580 cm	PISTON
3	190 m	220 cm	PISTON
6		106 cm	PISTON
7		465 cm	PISTON
18	170 m	381 cm	PISTON
19	136 m	460 cm	PISTON
20	93 m	420 cm	PISTON
21	50 m	423 cm	PISTON
22	206 m	510 cm	PISTON
23	174 m	188 cm	PISTON
25	240 m	137 cm	PISTON
39	163 m	132 cm	PISTON
40	212 m	486 cm	PISTON
41		145 cm	PISTON
42	176 m	62 cm	PISTON
44	182 m	280 cm	PISTON
45	231 m	165 cm	PISTON
46	46 m	101 cm	PISTON
PAR 91A - 3	76 m	228 cm	VIBRACORE
9	188 m	372 cm	PISTON
10	175 m	212 cm	PISTON
PAR 91A - 11	143 m	438 cm	PISTON
12	120 m	362 cm	PISTON
14	120 m	402 cm	PISTON
17	126 m	437 cm	PISTON
20	173 m	290 cm	PISTON
21	228 m	503 cm	PISTON
22	249 m	374 cm	PISTON
23	239 m	387 cm	PISTON
25	145 m	340 cm	PISTON
26	160 m	468 cm	PISTON
VEC 92A - 20	174 m	230 cm	GRAVITY
34	129 m	375 cm	PISTON
VEC 92A - 35	51 m	108 cm	PISTON
36	44 m	535 cm	PISTON
45	60 m	498 cm	PISTON
46	59 m	248 cm	PISTON
47	71 m	514 cm	PISTON
61	152 m	578 cm	PISTON
62	36 m	385 cm	PISTON
104	215 m	71 cm	GRAVITY
105	268 m	80 cm	GRAVITY
106	281 m	77 cm	GRAVITY
107	343 m	88 cm	GRAVITY
108	285 m	88 cm	GRAVITY
109	253 m	75 cm	GRAVITY
110	151 m	392 cm	PISTON
112	274 m	580 cm	PISTON
TUL 92A - 62	40 m	140 cm	VIBRACORE
63	80 m	234 cm	GRAVITY
64	96 m	189 cm	GRAVITY
65	82 m	39 cm	GRAVITY
66	68 m	244 cm	GRAVITY
74	178 m	555 cm	PISTON
75	52 m	393 cm	PISTON
76	39 m	410 cm	PISTON
77	46 m	397 cm	PISTON
78	122 m	155 cm	PISTON
79	173 m	447 cm	PISTON
81	59 m	402 cm	PISTON
82	55 m	164 cm	PISTON
83	66 m	138 cm	PISTON
84	136 m	232 cm	GRAVITY
103	115 m	63 cm	GRAVITY
104	153 m	34 cm	GRAVITY
105	140 m	206 cm	GRAVITY
106	107 m	98 cm	GRAVITY
107	105 m	198 cm	GRAVITY
108	98 m	194 cm	GRAVITY
109	70 m	191 cm	GRAVITY
110	55 m	230 cm	GRAVITY
111	20 m	185 cm	GRAVITY
112	61 m	33 cm	GRAVITY
113	59 m	239 cm	GRAVITY
114	93 m	134 cm	GRAVITY
162	51 m	215 cm	VIBRACORE
163	54 m	199 cm	VIBRACORE
167	221 m	227 cm	GRAVITY

and their associated depositional lobes.

Detailed descriptions of all cores concentrated on the documentation of sedimentary textures and structure. To compliment these standard sedimentologic elements, grain size and textural analysis of 124 samples from 22 cores collected on the delta foreslope were completed (Appendix C). These data delineate facies variability trends in sands deposited as depositional lobes at the mouths of subaqueous channels, and constrain their causative depositional processes. These data were supported by an additional 135 analyses, from 20 cores, provided by the Geological Survey of Canada.

Doig Formation Sedimentology and Stratigraphy

General

Recent gas resource assessments for the Western Canada Sedimentary Basin suggest that the most promising play in the Triassic interval is the Halfway/Doig Shelf in northeastern British Columbia, with estimated reserves of 4 TCF (Bird *et al.*, 1994). Within the Doig Formation, the productive sands are preserved as narrow, elongate, shore-parallel sandstones encased in shelf siltstones and shales.

A two-phase approach has been taken to document the role of sediment bypassing in the delivery of sand to a shelfal environment in the Doig Formation. A detailed study of the largest producing Doig field in northeastern British Columbia - Buick Creek - was undertaken to document depositional processes and facies distributions in the Buick Creek Field (CHAPTER 6; Evoy and Moslow, 1995b; Evoy and Moslow, *in press*), and to establish a depositional model for the Doig sandstones. This depositional framework was then extended regionally to test for similarities between Doig facies from a number of different localities, and determine their stratigraphic relationships (CHAPTER 7).

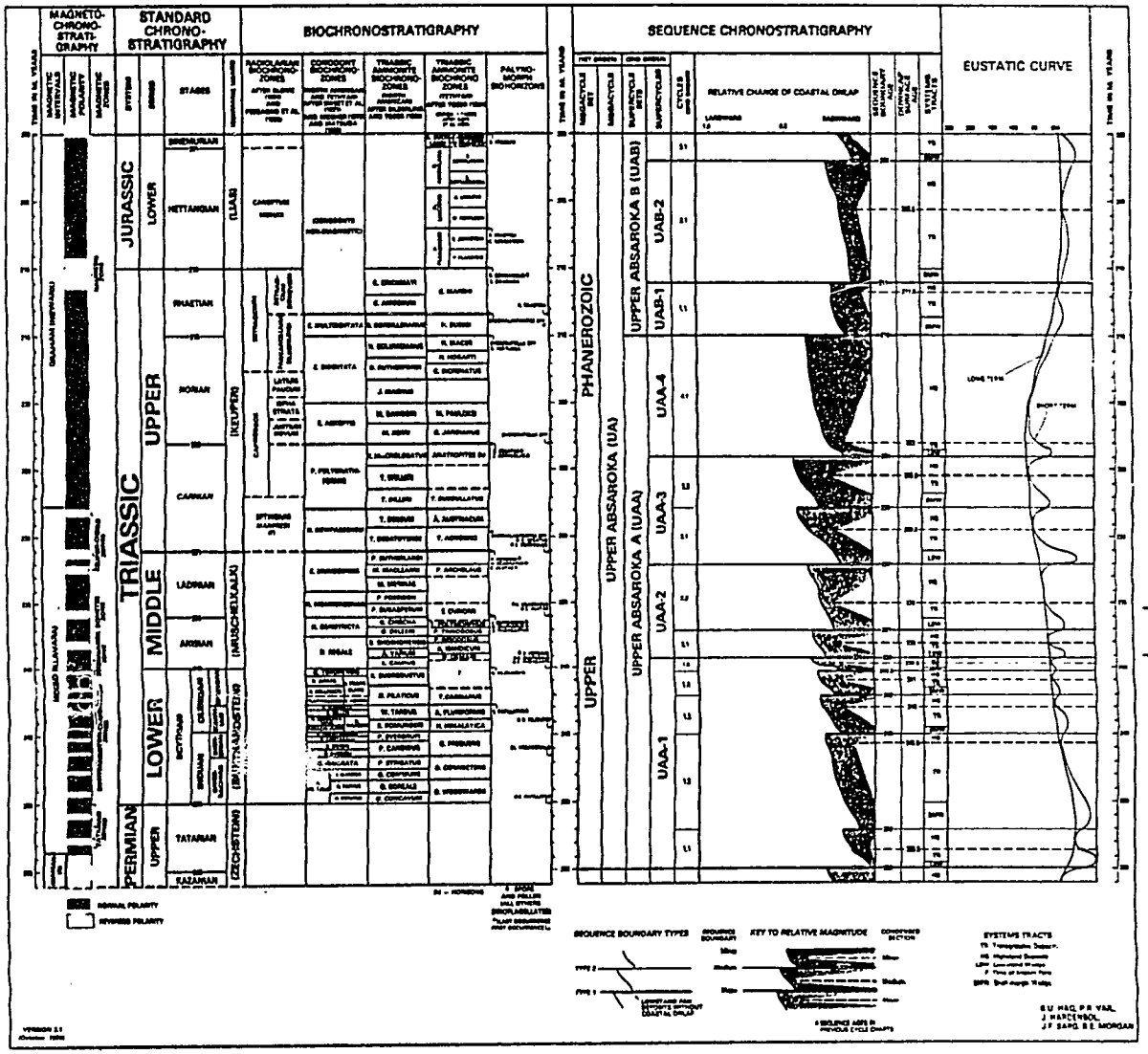
Geologic Setting

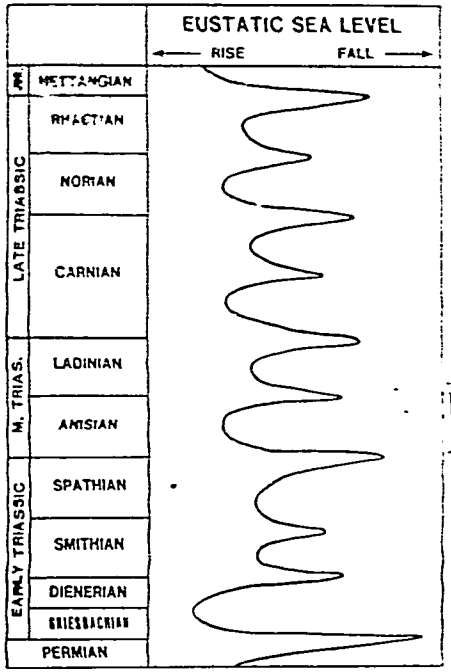
Middle Triassic strata of northeastern British Columbia represent a progradational

sequence of marine to shallow marine clastic sediments deposited on the western flank of the North American craton (Gibson and Barclay, 1989). The climate is considered to have been hot and extremely arid during this period, both locally (Campbell and Horne, 1986) and globally (Parrish, 1993). Paleolatitude was approximately 30° north of the equator (Habicht, 1979).

Although 3rd order eustatic sea level fluctuations have been recognized globally in the Anisian and Ladinian (Haq *et al.*, 1988; Embry, 1988; Figure 1-5), the validity of this curve and the relative importance of tectonics in modifying global sea level signatures in the Triassic has been questioned (Embry, 1988; van Veen *et al.*, 1992; de Zanche *et al.*, 1993; Yose, 1994). The actual number of 3rd order sequences developed during this time period, and their correlatability, is similarly under debate. Haq *et al.* (1988) recognize two 3rd order sequences in the Middle Triassic, corresponding (approximately) to the Anisian and Ladinan stages. De Zanche *et al.* (1993), working in one of the Haq *et al.* (1988) type areas in the Dolomites, Italy, document four 3rd order Anisian sequences and three Ladinian 3rd order sequences. Rasmussen *et al.* (1992) recognize five Anisian depositional sequences in the Barents Sea.

In the subsurface, middle Triassic strata are subdivided into two broad lithostratigraphic units; the Doig Formation and the overlying Halfway Formation (Hunt and Ratcliffe, 1959; Armitage, 1962). The Doig Formation is often defined as the deep water facies equivalent to the shallow marine clastics of the Halfway Formation (eg. Willis, 1992); however, such usage makes the *a priori* assumption that any sandstones completely encased within the siltstones and shales of the classic Doig assemblage must therefore represent deeper water sand deposition. The difficulty in differentiating between the basal Halfway and Doig formations is now generally accepted (eg: Edwards *et al.*, 1994; Gibson and Edwards, 1990), and the two are treated herein as a single, continuous unit (Table 1-2). These strata unconformably overlie the lower Triassic Montney Formation, and are abruptly overlain by marginal marine to non-marine clastics, evaporites and carbonates of the Charlie Lake Formation.



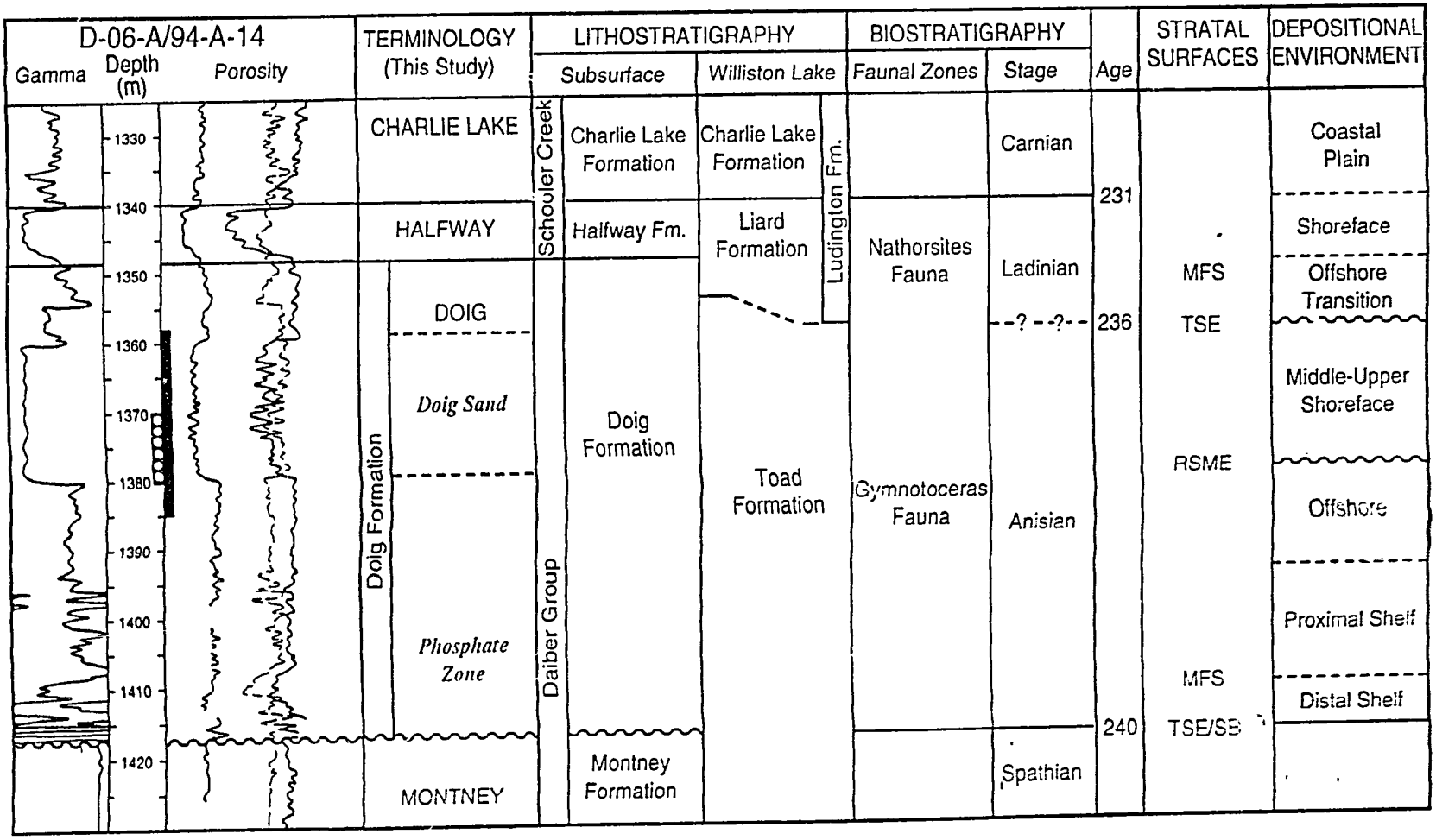


Doig Fm

Doig Fm

Figure 1-5. Triassic eustatic sea level curves from Haq *et al.*, 1988 (A) and Embry, 1988 (B).

Table 1-2. Stratigraphic correlation table for Middle Triassic strata in northeastern British Columbia.



A number of anomalously thick sandstone bodies and bioclastic sandstones and conglomerates have been recognized in the Doig Formation in northwestern Alberta and northeastern British Columbia. These sandstones form narrow, elongate trends preserved within interlaminated siltstones and shales, and have been variously interpreted as fluvial valleys (Campbell and Horne, 1986), tidal channels, barrier islands and tidal flats (Aukes and Webb, 1986), estuarine channels incised into shallow shelf sediments (Cant, 1986), and sediment-gravity flows associated with shoreface failure and deposition at the shelf-slope break (Wittenberg, 1992; Qi, 1995). In northwestern Alberta, these reservoirs are oriented sub-parallel to paleo-bathymetry, contain trace fossil assemblages indicative of marine deposition, are interbedded with thin zones of hummocky cross-stratification (HCS), and exhibit internal facies distributions compatible with sediment transport normal to the paleo-shoreline (Wittenberg, 1992).

Database and Methodology

The Buick Creek Field in northeastern British Columbia represents the largest recognized Doig reservoir in the study area, and constitutes the greatest single database available for subsurface reconstruction of a Doig pool. A total of 51 wells penetrate the Halfway/Doig interval in the immediate Buick Creek field area (Figure 1-6); 22 of these wells have been cored, and all available core has been logged (Table 1-3).

An additional 32 Lower Halfway/Doig cores are available in the regional study area, for a total of 54 cored wells totalling 1152 m (Appendix D). As most of these cores are within the immediate vicinity of producing fields, 475 wireline logs from wells penetrating the Doig Formation were used to constrain correlations between fields. To test for structural representation of the Doig sand body trends, a further 247 Halfway penetrations were checked (Appendix E). Simplified core descriptions and graphic logs for all cores are presented in Appendix F.

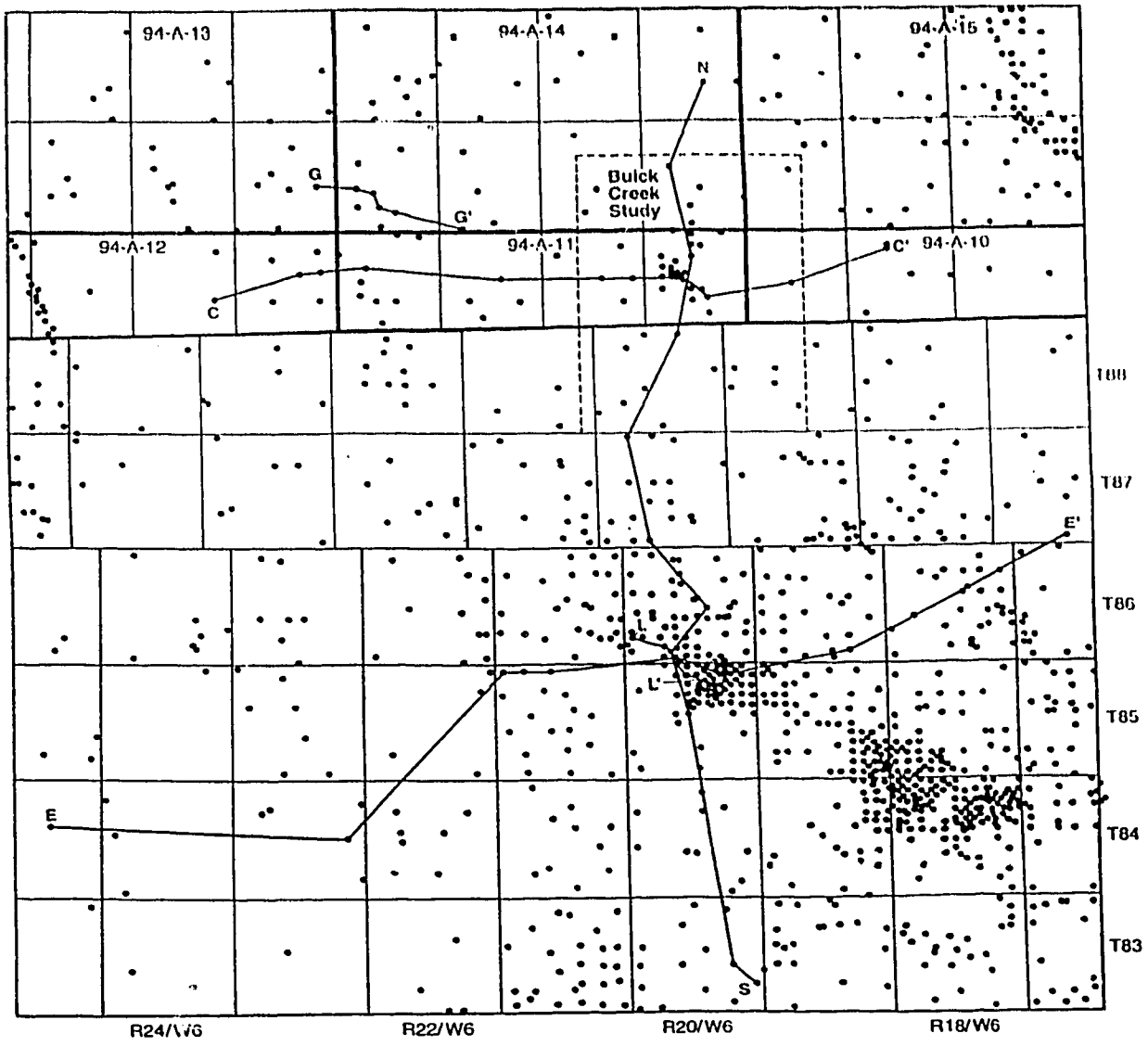


Figure 1-6. Doig study area map showing all Halfway penetrations. All wells with core recovered from the Doig and/or Lower Halfway intervals have been logged as part of this study (see also Table 1-3). Cross sections L-L', G-G', N-S, C-C' and E-E' are discussed in the Chapter 7.

Table 1-3. List of wells in the study area with core in the Lower Halfway/Doig interval.

UWI	FORMATION(S)	CORE LENGTH	AREA
8-18-80-17/w6	Doig	21.60	Regional
8-09-80-21/w6	Doig	4.00	Regional
	Doig	9.95	Regional
11-34-84-15/w6	Doig	15.00	Regional
12-24-84-21/w6	Doig	14.85	Regional
11-31-85-21/w6	Doig	17.90	Regional
(02) 6-04-86-20/w6	Doig	17.45	Stoddart
12-04-86-20/w6	Doig	17.47	Stoddart
16-15-86-20/w6	Doig	10.50	Stoddart
10-25-86-20/w6	Doig	17.30	Stoddart
10-19-87-19/w6	ChLk - Doig	37.80	Stoddart
6-22-87-20/w6	Hfwy - Doig	5.14	Stoddart
	Doig	12.40	Stoddart
(02) 6-26-87-21/w6	Hfwy	13.30	Stoddart
6-03-88-14/w6	ChLk - Doig	16.80	Regional
9-19-88-16/w6	Hfwy - Doig	18.39	Regional
6-21-88-19/w6	ChLk - Hfwy	15.00	Regional
7-24-88-20/w6	Hfwy	14.40	Buick Creek
9-34-88-20/w6	Doig	36.40	Buick Creek
a-30-L/94-A-05	Hfwy-Doig	13.10	Regional
	Doig	23.70	Regional
a-29-K/94-A-10	ChLk - Hfwy	4.80	Regional
	Hfwy +/- Doig	17.20	Regional
d-87-K/94-A-10	Hfwy	13.75	Regional
d-36-I/94-A-11	Doig (+/- Hfwy)	12.80	Buick Creek
b-44-I/94-A-11	Doig (+/- Hfwy)	18.65	Buick Creek
d-45-I/94-A-11	Doig	18.70	Buick Creek
d-46-I/94-A-11	Doig	13.50	Buick Creek
(02) d-57-I/94-A-11	Doig	25.00	Buick Creek
d-58-I/94-A-11	Doig	18.10	Buick Creek
d-68-I/94-A-11	Doig	23.90	Buick Creek
d-69-I/94-A-11	Doig	22.00	Buick Creek
d-76-I/94-A-11	Hfwy? + Doig	12.00	Buick Creek
	Doig	18.00	Buick Creek
b-77-I/94-A-11	Doig	12.10	Buick Creek
	Doig	17.10	Buick Creek
d-79-I/94-A-11	Doig (+/- Hfwy)	9.00	Buick Creek
d-85-I/94-A-11	Doig	36.40	Buick Creek
d-86-I/94-A-11	ChLk - Hfwy (Doig?)	18.10	Buick Creek
	Doig	18.20	Buick Creek
(02) d-96-I/94-A-11	ChLk	8.40	Buick Creek
	Doig	27.00	Buick Creek
(03) d-96-I/94-A-11	Hfwy/Doig	41.80	Buick Creek
d-52-J/94-A-11	Mntny	18.20	Buick Creek
b-64-I/94-A-12	Doig	17.88	Cache Creek
d-06-A/94-A-14	Hfwy/Doig	28.00	Buick Creek
a-26-A/94-A-14	Doig	22.20	Buick Creek
d-35-A/94-A-14	Hfwy/Doig	21.70	Buick Creek
d-58-A/94-A-14	Hfwy/Doig	36.00	Buick Creek
b-06-D/94-A-14	Doig	15.00	Fireweed
d-15-D/94-A-14	Doig	19.00	Fireweed
b-26-D/94-A-14	Doig	17.13	Fireweed
d-37-D/94-A-14	Doig	15.99	Fireweed
b-56-D/94-A-15	ChLk - Hfwy	18.20	Buick Creek
d-84-I/94-A-15	Doig (+/- L.Hfwy?)	25.50	Wildmint
b-10-C/94-H-01	Doig (+/- L.Hfwy?)	19.00	Regional
d-13-D/94-H-01	Doig (+/- L.Hfwy?)	9.00	Regional
	Doig (?)	9.30	Regional
b-57-D/94-H-01	Doig (+/- L.Hfwy?)	18.70	Regional
d-15-A/94-H-02	Doig (+/- L.Hfwy?)	21.00	Wildmint
b-24-A/94-H-02	Doig (+/- L.Hfwy?)	16.10	Wildmint
d-26-A/94-H-02	Doig (+/- L.Hfwy?)	18.50	Wildmint
d-34-A/94-H-02	Doig (+/- L.Hfwy?)	27.30	Regional

Description of all available cores concentrated on the documentation of process sedimentologic characteristics, with emphasis on sedimentary structures and textures indicative of specific depositional processes. These data were integrated with available down-hole logs to document the internal architecture of individual sedimentary facies. A total of nine sedimentary facies were recognized in the Buick Creek - Fireweed - Stoddart areas, and have been grouped into three environmental facies associations in ascending stratigraphic order: (1) offshore/shelf, (2) lower to upper shoreface, and (3) offshore transition. All production is from Facies Association 2, which erosively overlies Facies Association 1, and is abruptly overlain by Facies Association 3 across a pronounced transgressive lag. Facies Association 2 is interpreted to represent a lowstand shoreface within an overall progradational sequence.

Summary

The objectives of this research are to determine the nature of lateral and vertical facies variability and geometry of channels and depositional lobes in the Fraser River foreslope and prodelta, and to document the role of sediment-gravity flow processes in redistribution of sediment from the delta plain into the prodelta environment. These data will be integrated with results from studies of selected Middle Triassic (Doig Formation) reservoirs in the Western Canada Sedimentary Basin to develop a model characterizing facies relationships in marine sandstones associated with sediment bypassing during a fall in relative sea level. The ultimate goal of this research is to document some of the facies variability in siliciclastic sediments associated with sediment bypassing and deposition on the continental shelf during a relative sea level fall.

The Fraser River delta foreslope is bisected by two pronounced bathymetric channels, or "sea valleys", 100's of metres wide, up to 10 metres in relief, and floored with fine- to medium-grained sand. These channels are believed to be initiated and maintained by sediment gravity flow processes related to periodic liquifaction and failure at the head of the foreslope.

Much of the coarsest sediment supplied to the mouth of the delta bypasses the delta plain and upper foreslope to be introduced directly to the lower foreslope and basin floor where these channels debouche onto the basin floor as a series of sand-rich depositional lobes, or as a series of small, isolated slump-bound turbidite basins. Incision of multiple channels on the Fraser River delta foreslope has resulted in a high degree of along-slope facies variability.

Results from the study of the Fraser River delta foreslope will be integrated with sedimentologic and stratigraphic analysis of hydrocarbon-producing clastic reservoirs in the Doig Formation in northeastern British Columbia. A number of anomalously thick sandstone bodies and bioclastic units have been recognized in the Doig Formation in northwestern Alberta and northeastern B.C. These sandstones form narrow, elongate trends preserved within "deeper water" interlaminated siltstones and shales, are oriented sub-parallel to the paleo-shoreline, are interbedded with zones of hummocky cross-stratification, and exhibit internal facies distributions compatible with sediment transport (bypass) normal to the paleo-shoreline.

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CHAPTER 2.
PATTERNS AND VARIABILITY IN SEDIMENT ACCUMULATION RATES, FRASER RIVER DELTA FORESLOPE, BRITISH COLUMBIA[1]

Introduction

Minimum sediment accumulation rates have been calculated for selected piston cores collected from the Fraser River delta foreslope during a 1989 research cruise of the *CSS Vector* (Moslow *et al.*, 1991). In addition, a qualitative assessment of sediment remobilization has been determined through analysis of micropaleontologic assemblages from cored sediment. Objectives of this study were to present a first approximation of the sources, rates and patterns of sedimentation on the delta slope, and to analyze their implications for sediment stability conditions.

Previous studies have focused on the subaerially exposed portion of the delta, on Holocene accretion of the delta (Clague *et al.*, 1991; Hart *et al.*, 1992), and on diurnal to annual fluctuations in sediment dynamics. This study focuses on patterns and variations in sediment accumulation rates over the 36 year period from 1953 to 1989, as determined from Cesium-137 profiles. These results shed light on identifying and predicting the specific mechanisms and frequency of sedimentation events on this, and other, subaqueous deltaic environments.

Geologic Setting

The Fraser River delta, offshore Vancouver, British Columbia, is the largest delta on Canada's Pacific coast (Figure 2-1). The Fraser River drains approximately 250,000 km^2 of mountainous terrain with peak discharge during the snowmelt freshet in late spring and early summer (Milliman, 1980). Within the Fraser River estuary, a pronounced tidal influence is

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[1] A version of this chapter has been published. Evoy, R.W., Moslow, T.F., Patterson, R.T. and Luternauer, J.L., 1993. *Geo-Marine Letters*. 13: 212-218.

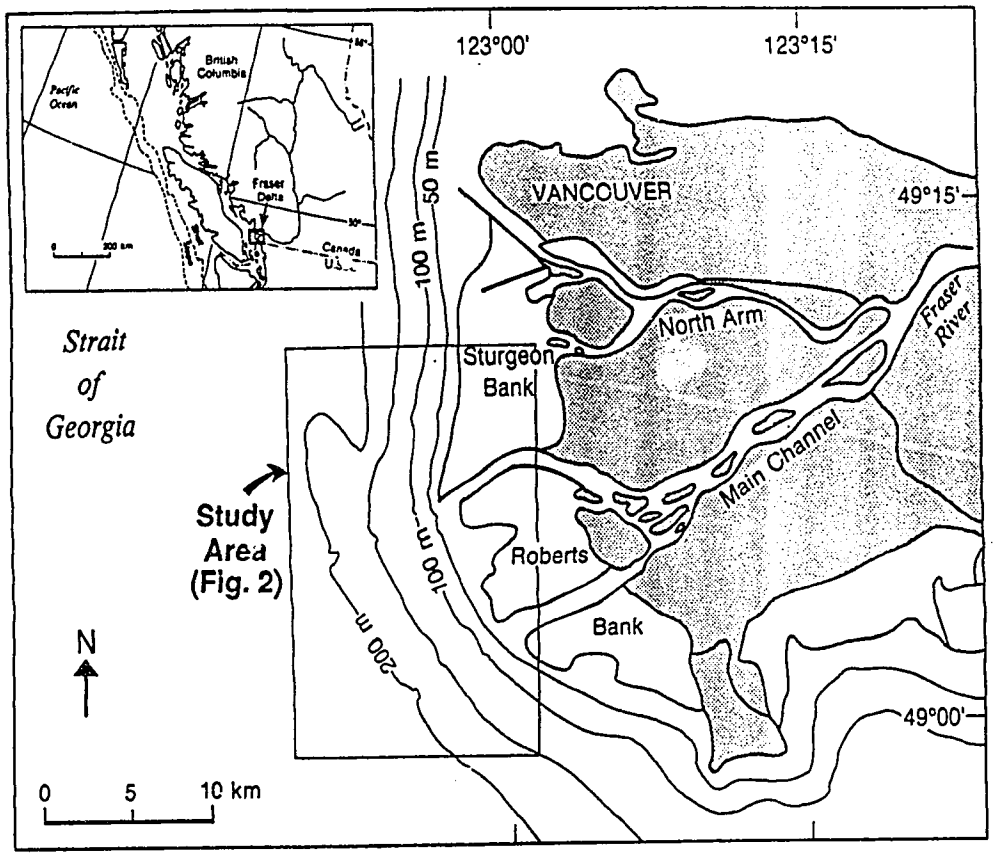


Figure 2-1. Study area location map. Area enclosed within rectangular box is detailed in Figure 2-2. (Modified from Moslow *et al.* 1991, Kostaschuk *et al.* 1992).

superimposed on the fluvial regime; semi-diurnal tides at the river mouth can approach 5 m (Kostaschuk *et al.*, 1989). Tidal range within the estuary decreases upstream and with increasing discharge; in conjunction with fluvial discharge, this produces a pronounced salt-wedge which strongly affects local sedimentation rates and mechanics (Kostaschuk and Luternauer, 1989).

The Fraser River delta plain consists of a series of broad tidal flats up to 9 km wide with average slopes of less than 0.1°. The delta foreslope extends a further 5-10 km seaward at an average slope of 1.5°. The study area consists of 150 km^2 in the delta foreslope (Figure 2-2). Water depths in the study area range from less than 50 m to greater than 250 m. Average gradient of the slope in the study area is approximately 3.0°, but locally exceeds 6°.

Several submarine channels dissect the delta foreslope. These channels have up to 10 m relief and extend from the seaward terminus of the tidal flats or distributary mouth, to water depths in excess of 200 m (Figure 2-2). The largest, and currently active, of these is the Sand Heads Sea Valley.

Database and Methodology

Cesium-137 is a radiogenic isotope produced as a byproduct of the testing of nuclear weapons. Global distribution of Cs-137 in surface sediments represents fallout from atmospheric testing. Vertical accretion rates of undisturbed recent sediments worldwide can be calculated based on the first appearance and maximum concentration of Cs-137 in recent sediments.

Detailed sedimentologic descriptions show that the cored intervals used in this study are essentially non-burrowed (Moslow *et al.*, 1991). The assumptions made in calculating sediment accumulation rates in this study were thus: 1) first appearance of Cs-137 represents the initiation of widespread atmospheric testing in 1954; and, 2) tailing effects of relatively low concentrations due to bioturbation are negligible in the cores selected.

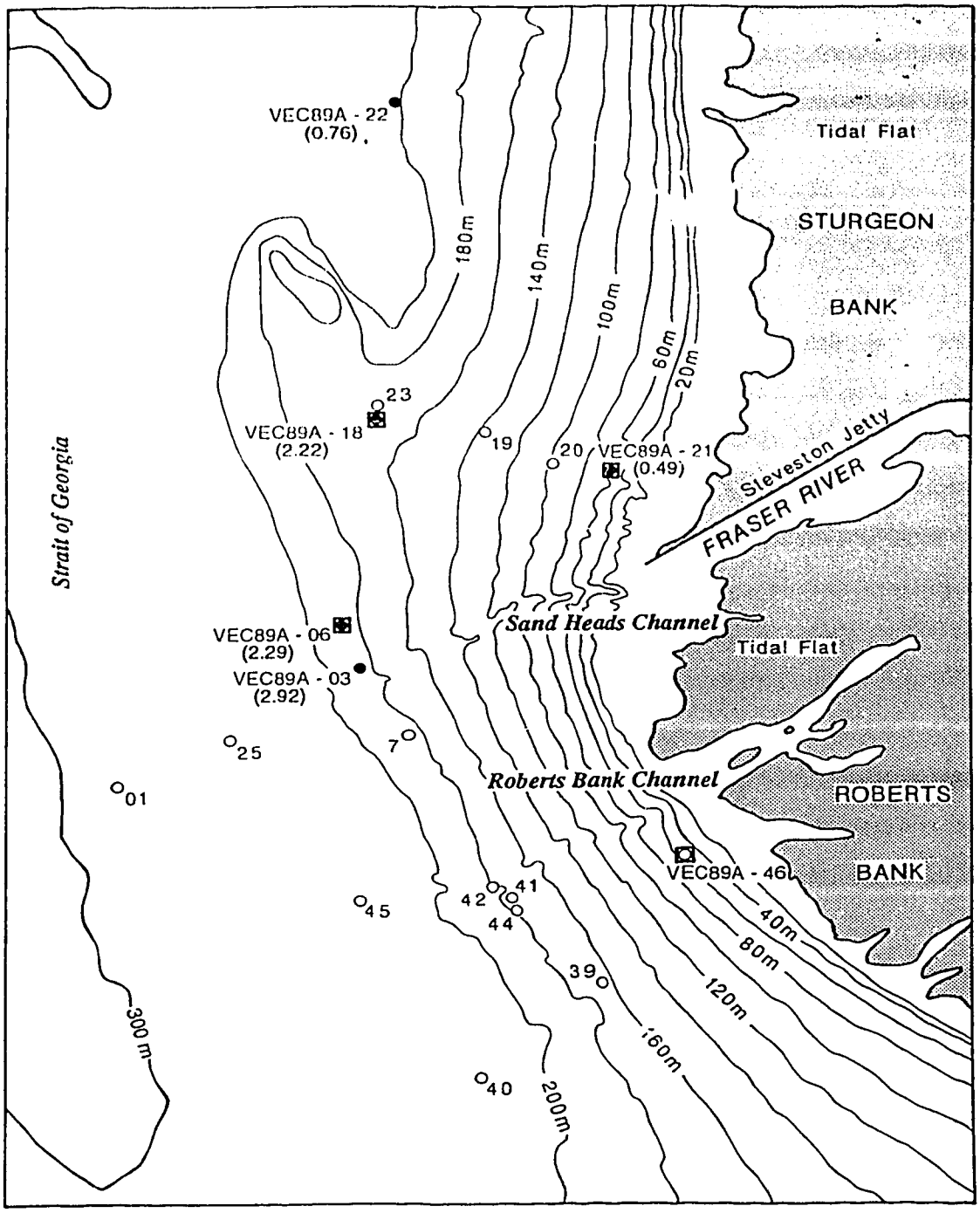


Figure 2-2. Detailed bathymetry and piston core locations (open circles) in-the study area. Piston core sites with Cs-137 data available are represented by closed circles; open squares represent sites with micropaleontologic data.

Five piston cores collected during this investigation were selected for analysis (Figure 2-2). The sites chosen represent a variety of different subenvironments believed to reflect the probable range of sedimentary processes and sedimentation rates in the area. Sedimentary characteristics of these cores are summarized in Table 2-1. Both the main cores and their trigger cores were logged to ensure that reduction of the section due to coring was minimal.

The cores were sampled continuously across 5-10 cm intervals and analyzed for Cs-137 content. With the exception of core VEC89A-03, all cores were sampled and counted from the sediment-water interface until at least one barren core increment which was not sand-rich was encountered. This ensured that the cores were sampled through the first appearance of Cs-137. This provides a quick and simple method to determine the maximum depth to which Cs-137 is present. As sample intervals exceed annual sedimentation rates, only minimum sediment accumulation rates can be calculated. Cesium analyses for this study were conducted at the Saskatchewan Institute of Pedology, University of Saskatchewan, following the methodology of DeJong *et al.* (1982).

A total of 28 subsamples were taken from 4 piston cores for micopaleontologic analysis (Figure 2-2). Arcellacean and foraminifera populations from the sampled intervals were isolated, identified and counted. The total number of specimens recovered in 19 of the 28 samples collected was too low to place statistical significance on the population counts; however, samples which contain limited populations are of qualitative value where allochthonous specimens from radically different environments are present.

Sediment Accumulation Rates

Core VEC89A-03 was collected along the flank of the Sand Heads Sea Valley (Figure 2-2). Counting was originally stopped at the 75-80 cm interval because only trace Cs-137 was noted (Figure 2-3A). Based on subsequent experience with coarser grained intervals, the remaining samples were counted; all contained significant concentrations of Cs-137. The

TABLE 2-1. SUMMARY OF SEDIMANTARY CHARACTERISTICS AND MINIMUM SEDIMENT ACCUMULATION RATES

Piston Core	Length (cm)	Sampling Depth (cm)	Sedimentary Characteristics	Accumulation Rates (cm/yr)
VEC89A-03	220	105	flank of the Sand Heads channel two coarsening/thickening upward cycles graded fine to medium-grained sands wavy and lenticular bedding, which contains rafted organics and clay-silt interbeds	>2.92
VEC89A-06	106	90	800m north of VEC89A-03 poorly defined fining upward cycle primarily massive silty-clay/clayey-silt thin, silty, very fine- to fine-grained sands with graded bases and abrupt tops	2.29
VEC89A-18	381	220	dense, compacted, black clayey-silt few shell fragments and minor disseminated organic matter	2.22
VEC89A-21	423	25	onshore background massive silty clay rare silty laminations	0.49
VEC89A-22	510	35	offshore background structureless silty-clay to clayey silt rare silty laminations minor rafted organic debris	0.76

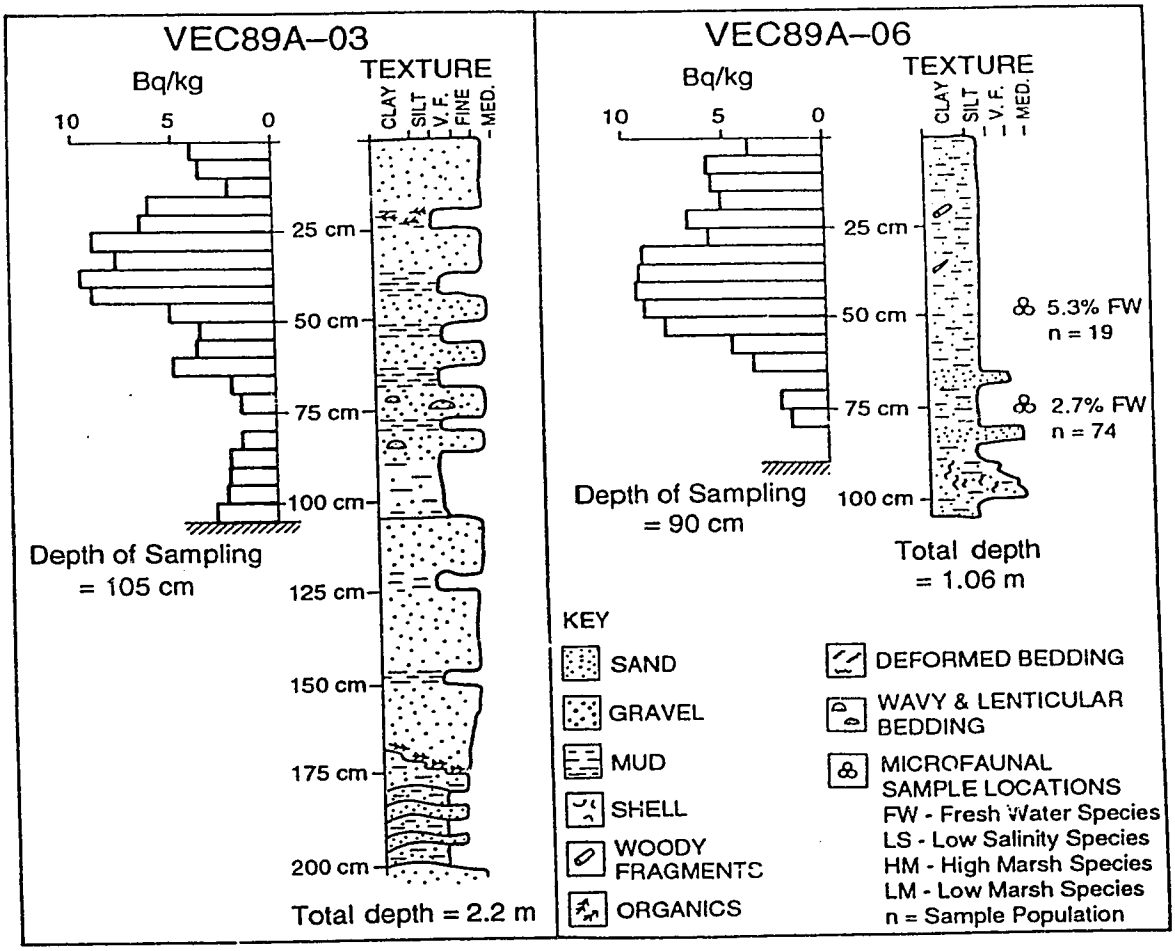


Figure 2-3. Sedimentologic logs and Cs-137 sediment profiles for piston cores VEC89A-03(A) and VEC89A-06(B) with allochthonous micropaleontologic species distribution.

trace interval at 75 to 80 cm has subsequently been found to be composed predominantly of well rounded quartz grains with minor mafic rock fragments and lesser feldspar and mica; clay minerals are virtually absent. Other intervals of similar characteristics commonly show a suppression of Cs-137 values. Accumulation of 105 cm of sediment between 1954 and 1989 requires a minimum sedimentation rate of 2.92 cm/yr.

The base of detectable Cs-137 concentration in core VEC89A-06 occurs at a depth of 80 or 85cm (Figure 2-3B). The reason for this uncertainty is that the barren interval at 80 to 85 cm is predominantly fine quartz sand. Minimum accumulation rate for the interval is 2.29 cm/yr.

Core VEC89A-18 was subsampled for Cs-137 analysis across 10cm intervals (Figure 2-4A). Base of measurable Cs-137 concentration occurs at a depth of 80 cm. Minimum accumulation rate is 2.22 cm/yr. Core VEC89A-21 (Figure 2-4B) represents a typical onshore core for the area. Minimum sedimentation rate for the period 1954 to 1989 is 0.49 cm/yr, and represents the lowest accumulation rate in the study area. Core VEC89A-22 (Figure 2-5) represents a typical offshore core for the area. Minimum sedimentation rate for the period 1954 to 1989 is 0.76 cm/yr.

Distribution of Micropaleontologic Populations

Foraminiferal fauna recovered from all samples are predominantly species common in neritic depth waters in the Strait of Georgia (Cockbain, 1963), and along the coast of British Columbia (Patterson, 1993). Allochthonous foraminiferal species in the sample set include *Ammobaculites foliaceous*, *Jadammina macrescens*, and *Miliammina fusca*. *J. macrescens* is almost exclusively restricted to the high marsh zone, with only a minor percentage in the low marsh environment; very few get washed out onto the tidal flats of the Fraser delta (Patterson, 1990). *A. foliaceous*, and *M. fusca* are characteristic of the low marsh, and are rarely transported out onto the tidal flat sands.

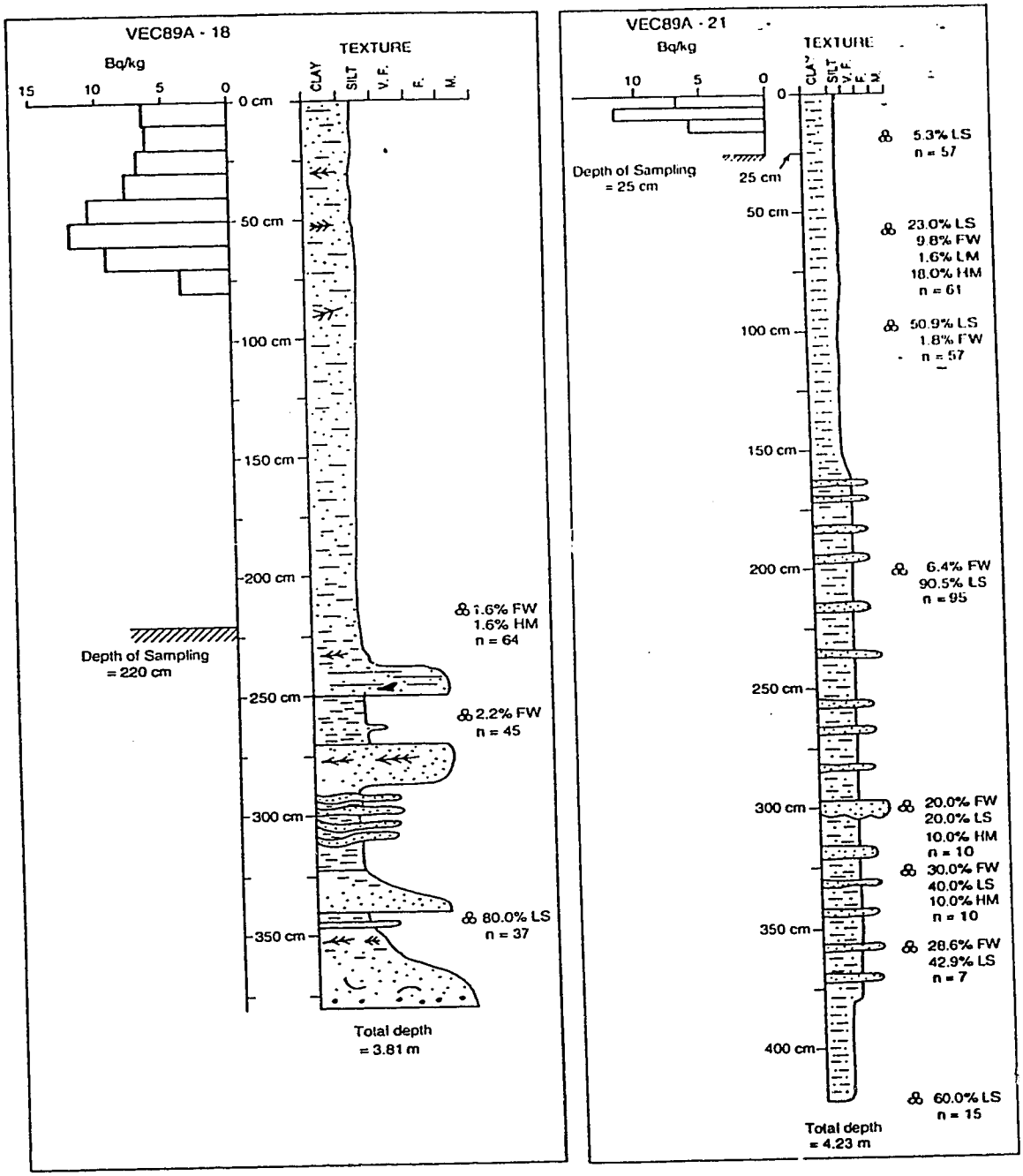


Figure 2-4. Sedimentologic log for piston cores VEC89A-18(A) and VEC89A-21(B) with Cs-137 sediment profiles and allochthonous micropaleontologic species distribution.

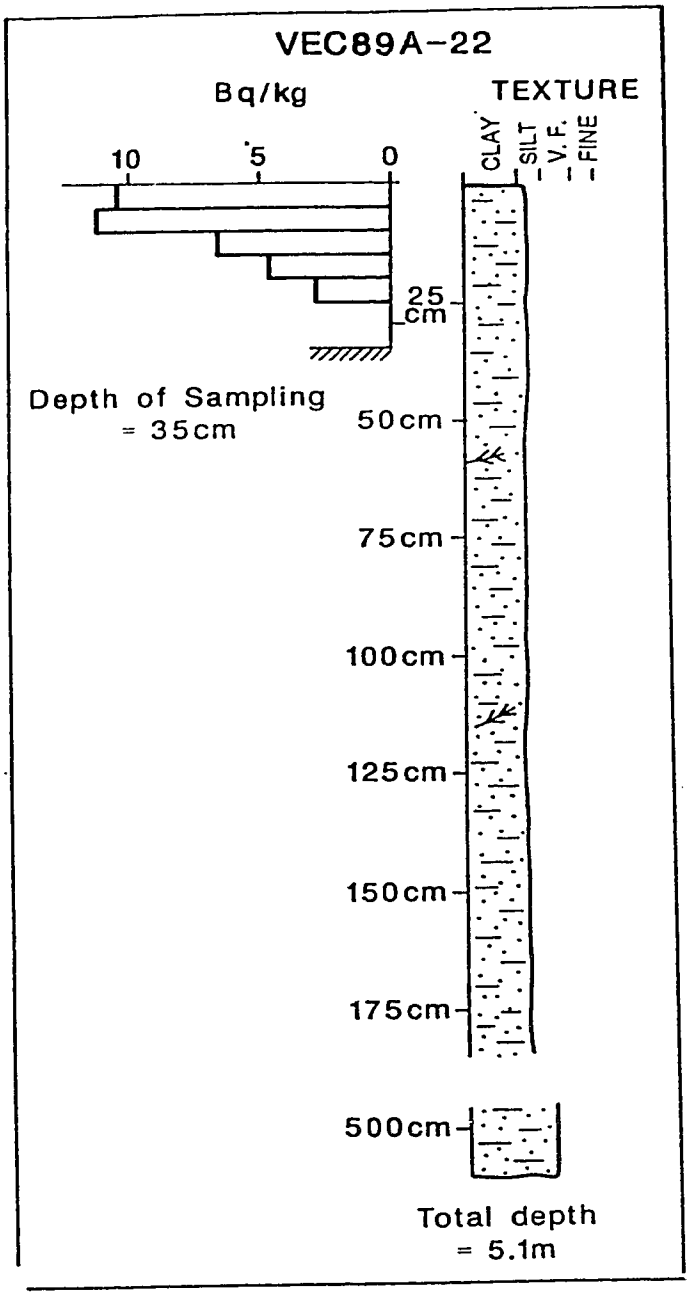


Figure 2-5. Sedimentologic log for piston core VEC89A-22 with Cs-137 sediment profiles.

Arcellaceans are generally restricted to fresh water environments in lakes or above highest tide in salt marshes (Patterson *et al.*, 1985). One exception, *Centropyxis aculeata*, is capable of withstanding very low salinity concentrations on the order of 1 to 2%, and is often found in the highest portions of salt marshes where there is limited incursion of brackish water. *C. arculeata* was encountered in cores VEC89A-21 (Figure 2-4B) and VEC89A-46 (Figure 2-6). Other arcellacean species (*Centropyxis constrictica*, *Difflugia oblonga*, and *Difflugia urceolata*) were found in samples from all cores examined.

Discussion

Sediment accumulation rates calculated for cores from the Fraser delta foreslope exhibit a wide degree of variation between locations. This trend becomes more pronounced in the vicinity of the Sand Heads Sea Valley. The general spatial pattern evident in the data set shows that accumulation rates increase towards the Sand Heads Sea Valley (Figure 2-7).

Piston core VEC89A-03 represents a thick channelized sequence (Table 2-1) and reflects the highest sedimentation rates in the study area. The Sand Heads Sea Valley is the active depocenter for the Fraser Delta, and greater accumulation rates might therefore be anticipated. The base of Cs-137 accumulation was not sampled in this interval; as a consequence the accumulation rates may be significantly greater than those calculated. The top of the interval may also have been lost due to flowage of unconsolidated sand out of the core barrel, or reduced by erosion. Evidence in support of erosional reduction of the sedimentary record includes the documentation of large scale sediment-gravity flows which have moved up to 1,000,000 m^3 of sediment in a single event approximately 5 km up-channel from the core site (McKenna *et al.*, 1992; Kostaschuk *et al.*, 1992).

An increase in Cs-137 concentration in the upper two sample increments of the core is atypical of sediment profiles in the Fraser River delta. This is interpreted to represent the reintroduction of slightly older sediment from upslope via sediment-gravity flow processes.

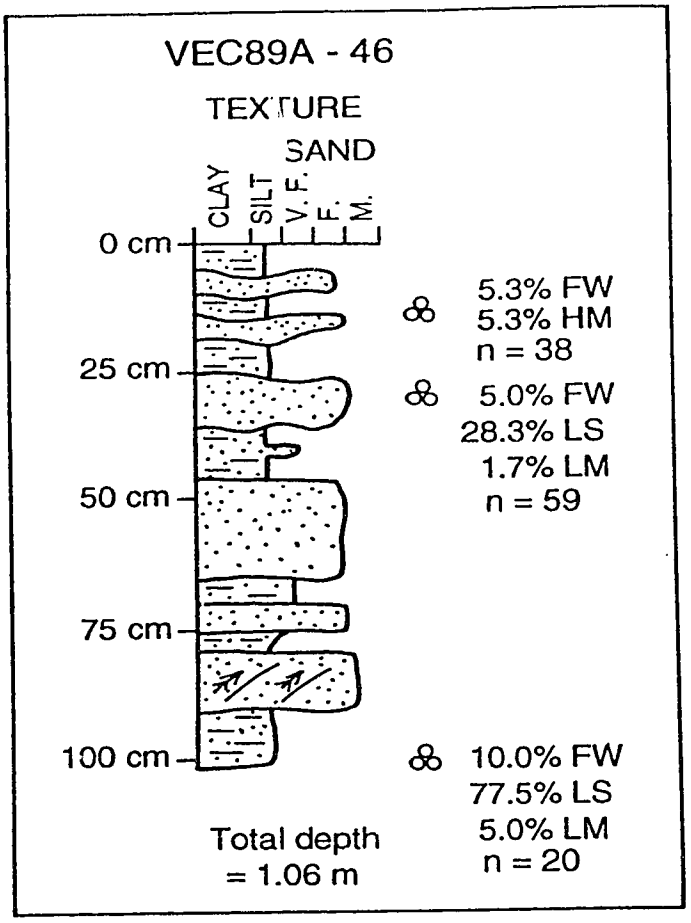


Figure 2-6. Sedimentologic log for piston core VEC89A-46 with allochthonous micropaleontologic species distribution.

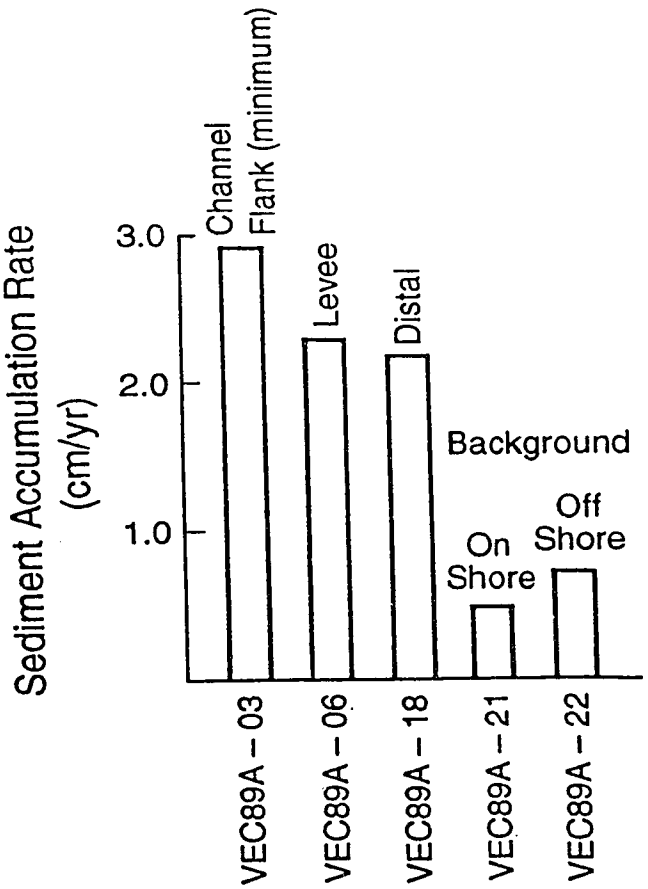


Figure 2-7. Histogram plotting variation in sediment accumulation rates from selected sites on the Fraser River delta through the period 1954 to 1989. Note decrease in sediment accumulation rates laterally away from the Sand Heads channel.

Further evidence in support of the reintroduction and remobilization of sediments in the Fraser River delta area is the presence of abundant allochthonous foraminifera and arcellacean populations in other piston cores collected in this vicinity.

The most significant concentration of arcellaceans encountered is the interval at 200 cm in VEC89A-21. Greater than 90% of the microfaunal population is comprised of *C. aculeata*, and 92 of the 95 specimens collected were arcellaceans. The overwhelming predominance of arcellaceans suggests that samples hosting these specimens moved downslope relatively intact, picking up only a few foraminifera enroute, and cannot be accounted for by simple accidental transport of a few specimens downslope due to tidal current action.

Previous attempts to determine short term rates of vertical accretion in the Fraser delta have been based on comparisons of historic sounding data and hypsographic curves (Johnston, 1921; Matthews and Shepard, 1962; Stewart and Tassone, 1989). Matthews and Shepard (1962) calculated a vertical accretion rate in excess of 33 cm/yr adjacent to the Sand Heads Sea Valley. At the closest sample site to this area, VEC89A-03, the minimum sediment accumulation rate has been calculated to be in excess of 2.9 cm/yr. Although the margin for error using historic sounding data is significant, there has been an appreciable culturally mediated decrease in net bed load discharge at Sand Heads over recent years as a result of increased dredging activity. McLean and Tassone (1991) estimate that the average bed material outflow during the period 1974 to 1983 was less than one third that of the preceding decade. Williams and Roberts (1989) used radiocarbon age dates to estimate the mean vertical accretion rate over the past 2000 years at 0.12 mm/yr.

Conclusions

Sediment accumulation rates on the Fraser delta foreslope generally increase towards the Sand Heads Sea Valley. This appears to be a function of proximity and suggests that the channel is not only an erosional feature, but a depocenter as well. Accumulation rates along

the flank of the channel indicate a minimum accumulation rate of 2.92 cm/yr, but the actual sedimentation rate in this area may be significantly greater.

The identification of large scale slope failures at the mouth of the Sand Heads Sea Valley, increased Cs-137 concentration in the upper sample increments of site VEC89A-03, and presence of abundant allochthonous microfauna in piston cores from the study area all document evidence for remobilization of sediments in the Fraser River delta. Regional distribution patterns and detailed sedimentary characteristics do not appear to be compatible with storm-related erosion and emplacement. These results suggest that slumping and sediment-gravity flow processes may account for the bulk of sedimentation in the Fraser delta foreslope and likely in the subaqueous environments of other deltas. These processes provide a mechanism for sand bypassing of the delta plain and foreslope, and delivery of coarse grained sediment directly to the prodelta environment.

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CHAPTER 3.
GRAIN SIZE DISTRIBUTION PATTERNS SUPPORTING SEDIMENT BYPASSING ON THE FRASER RIVER DELTA FORESLOPE, BRITISH COLUMBIA.[2]

Introduction

A study of grain size distribution patterns on the Roberts Bank portion of the Fraser River delta foreslope has been undertaken as part of an ongoing study into sediment distribution patterns and lithofacies associations on the subaqueous delta foreslope. This study focuses on grain size distribution patterns from 124 samples taken from 22 cores collected during three research cruises aboard the *CSS Vector* (1989), *CSS Parizeau* (1991) and *CSS Tully* (1992).

All cores were first described using a process sedimentologic approach to identify sedimentary facies and genetically related stratigraphic units. Representative samples from each facies were then taken for grain size analysis. The raw grain size data from 135 analyses from an additional 20 piston cores were subsequently provided by the Pacific Geoscience Centre of the Geological Survey of Canada.

Geologic Setting

The Fraser River delta, the largest delta on the west coast of Canada, underlies an area of rapid urban expansion, and is located in one of the most active seismic regimes in Canada. The study area for this project consists of a 150 km^2 section of the delta foreslope offshore Sturgeon and Roberts banks (Figure 3-1). Water depths in the main study area range from less than 50 m to greater than 200 m at an average gradient exceeding 3.0°. Concern over the stability of this slope in response to seismic loading has provided the impetus for this and related studies.

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[2] A version of this chapter has been submitted for publication. Evoy, R.W., Moslow, T.F and Luternauer, J.L. *Journal of Coastal Research.*

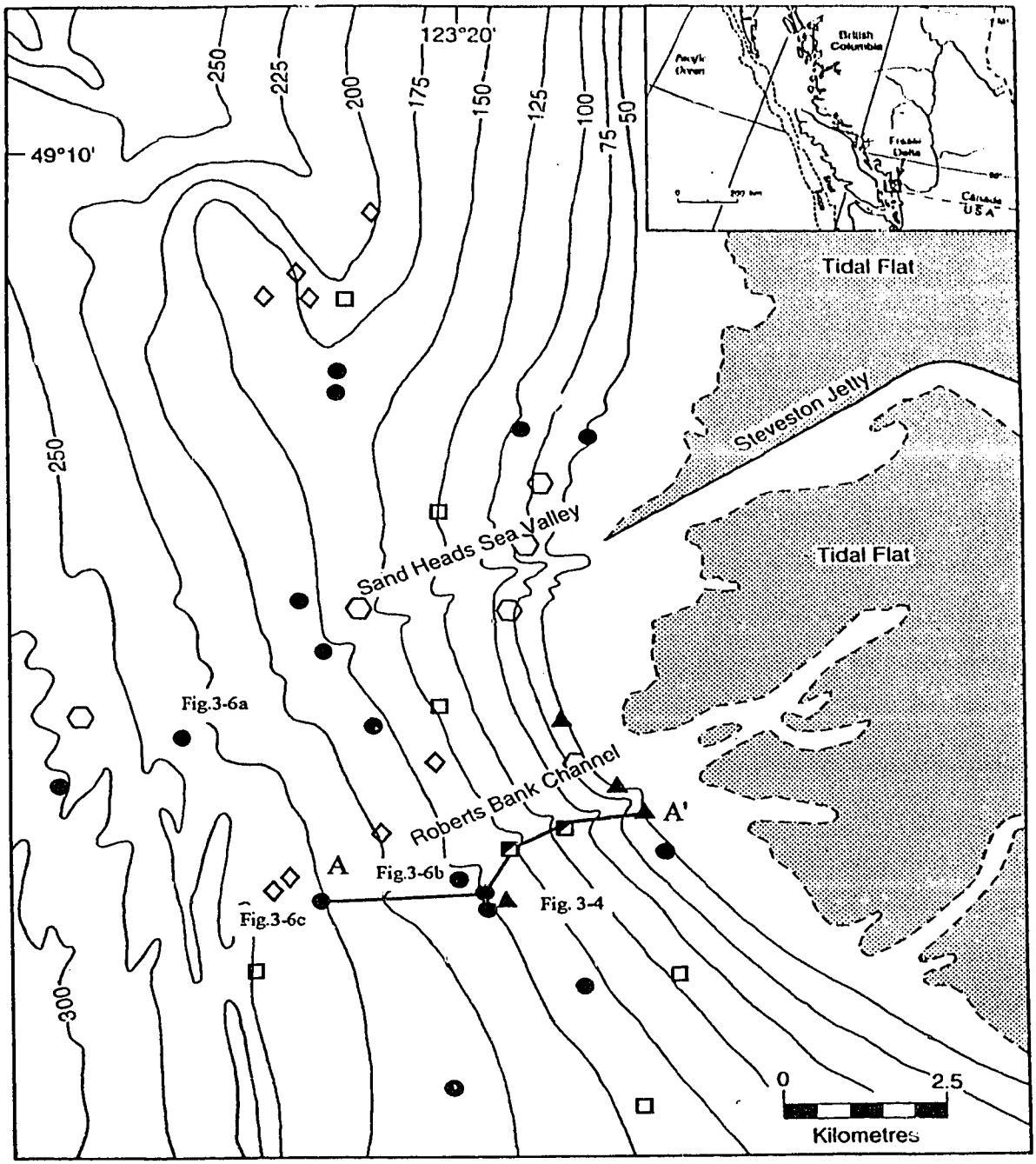


Figure 3-1. Study area location map showing bathymetry and subaqueous channels of the Roberts Bank area, Fraser River delta foreslope. Diamonds represent *Vector* 1983 core sites, circles represent *Vector* 1989 core sites, squares represent *Parizeau* 1991 core sites, hexagons represent *Vector* 1992 core sites, triangles represent *Tully* 1992 core sites. Solid symbols represent core sites subsampled for this study, open symbols represent core sites with grain size data supplied by the Pacific Geoscience Centre of the Geological Survey of Canada.

The distribution of sedimentary facies types across the subaqueous delta foreslope has been documented previously (Evoy *et al.*, 1994); however, textural parameters and the transport mechanisms responsible for sediment bypassing from the tidal flats to the lower delta foreslope are poorly documented. Specifically, the relative significance of turbidity currents and debris flows in sediment transport on the subaqueous portions of the Fraser River delta are the subject of much debate (Hart *et al.*, 1992; Kostaschuk *et al.*, 1992; Evoy *et al.*, 1994). Grain size data are integrated with the results of sedimentary facies analysis to constrain the transport mechanisms.

The delta foreslope is currently bisected by two pronounced bathymetric channels (Figure 3-1). The Sand Heads Sea Valley, off the Main Arm of the Fraser River is the only currently active channel, and most studies of the subaqueous delta have concentrated on sediment transport and failure in the vicinity of the Sand Heads Sea Valley (eg. Kostaschuk *et al.*, 1989; Hart *et al.*, 1992; Kostaschuk *et al.*, 1992; McKenna *et al.*, 1992). The position of the Main Arm of the Fraser River is culturally fixed by the Steveston Jetty and continual dredging of the main navigation channel.

A second submarine channel, the Roberts Bank Channel, is currently inactive and mantled with a thin sediment drape. Although minor coarse sediment input may be sourced by a longshore sandwave migration, the channel has likely not experienced a direct sediment source since upstream channel avulsion circa 1827 (Luternauer and Finn, 1983). As such, the Roberts Bank Channel predates any appreciable anthropogenic mediation and represents the closest approach to a natural setting on the delta foreslope. This study focuses on the immediate vicinity of Roberts Bank, and the Roberts Bank channel and fan system as the most prominent and well developed bathymetric expression of a "natural" channel on the delta foreslope.

METHODOLOGY

Sample Preparation and Analytical Techniques

Sediment samples representative of all recognized depositional subenvironments present on the subaqueous delta foreslope were collected for grain size analysis. All samples were subdivided into individual particle size class distributions on a mass (dry-weight) basis. The coarser than 4 phi fraction (sand and gravel) was determined by sieve analysis, and the finer than 4 phi fraction (silt and clay) was determined using a Micromeritics SediGraph (5100) Analyzer.

Bulk samples were first dried and dissaggregated prior to initial weighing of the sample. The entire sample was then placed in a set of sieves and agitated on a shaker table for a minimum of 15 minutes per sample. Gravel, sand, and mud (finer than 230 mesh) fractions were all isolated and weighed. The medium sand and finer fractions were all collected in 1 phi increments; the gravel and coarse sand fractions were negligible, and were not further subdivided.

Grain size distribution in the finer than 4 phi fraction (silt and clay) was determined using the 230 mesh split collected from the bulk sample during sieving. Approximately 3 g of dry sediment and 30 ml of 0.05% sodium metaphosphate were added to a beaker and mixed using a magnetic stirrer for 3 minutes. The beaker was then placed in a sonic bath for 1 minute to disperse the clays, and returned to the magnetic stirrer for an additional 3 minutes. Samples were washed from the beaker into the SediGraph mixing chamber using additional 0.05% sodium metaphosphate solution, diluting the sample concentration on the order of 50 percent.

The SediGraph determines particle sizes in the silt and clay ranges in terms of equivalent spherical diameter. This is achieved by means of X-ray absorption of a finely collimated beam, based on particle concentration at decreasing depths through time (Stein, 1985). Minimum sample concentration is not critical to the analysis, provided it is sufficient

to reduce the intensity of the transmitted X-ray beam by 40 to 60 percent (Singer *et al.*, 1988).

Six samples, with clay contents varying from less than 2% to greater than 40%, were rerun to test for data reproducibility. None of the clay size fractions in these duplicates varied by more than 1.5% of the total sample. Fractions finer than 12 phi were not further subdivided.

Statistical Reduction

Summary grain size statistics, including mean and standard deviation (sorting), have been calculated for all samples (Table 3-1). Both arithmetic and graphic methods were used to calculate these parameters. The moment method is an arithmetic approach, essentially a weighted average as modified by Krumbein and Pettijohn (1938). The resultant values appear to be high (overly fine grained) in comparison to the expected values based on visual inspection of weight percent histograms. Consequently, these parameters were re-calculated utilizing a graphical method based on cumulative percent frequency distribution (Folk and Ward, 1957; Pettijohn *et al.*, 1973), resulting in mean grain sizes that are consistently 1/2 to 3/4 phi coarser than the moment statistics.

Some discrepancy between generated statistics was introduced as a result of calculating moments based on populations that have a pronounced bimodal distribution. A more significant source of error may be the presence of an "open ended distribution" - one in which laboratory limits were placed on the coarsest and finest fractions differentiated. In general, the incomplete data represented by an open-ended frequency distribution restricts the utility of the moment method to characterization of the central part of a distribution only (Griffiths, 1967).

Treatment of the cumulative frequency curve distribution in its entirety necessitates the use of the percentile approach afforded by graphical measures (Inman, 1952). Consequently, graphically generated grain size parameters are presented and utilized in this

Table 3-1. Summary of grain size parameters and sedimentary facies designations.

Core Name	interval (1)	%sand	%silt	%clay	mean	std. dev.	Facies (2)
VEC89A-01	0 - 5	19.74	39.80	38.92	6.81	3.20	1
	573 - 580	27.26	29.60	42.19	6.70	3.20	1
VEC89A-03	8 - 12	58.33	26.84	12.75	4.41	3.25	4a
	12 - 15	87.66	9.56	1.21	2.81	0.94	4a
	30 - 31	38.08	38.33	22.35	5.40	2.75	4a
	35 - 40	44.37	38.99	13.68	4.70	2.49	4a
	70 - 72	82.94	12.85	3.14	2.85	1.22	4a
	75 - 80	65.41	26.98	5.36	3.90	1.88	4a
	95 - 97	40.59	34.82	22.76	5.10	2.81	4a
	110	92.61	5.62	1.25	2.11	1.07	4a
	116	16.08	44.64	38.52	6.51	2.71	4a
	125	97.44	*	*	1.90	0.83	4a
	145	96.56	*	*	1.95	0.83	4a
	170	89.97	8.10	1.54	2.10	1.45	4a
	173	59.01	27.09	12.46	4.30	2.45	4a
	210	98.23	*	*	1.60	0.79	4c
	220	57.98	26.77	14.41	4.06	2.73	4a
VEC89A-06	35	32.09	40.40	27.10	5.70	2.82	1/2
	66	86.85	*	*	4.30	3.03	4b
	100	59.11	22.28	18.02	4.30	3.15	2/3
VEC89A-07	285 - 295	32.27	29.12	37.79			2
	332	34.14	27.53	38.33	6.30	3.02	2
	380 - 390	26.18	37.57	34.62	6.40	3.13	1
VEC89A-18	50	12.37	42.94	42.59	7.16	2.96	1
	245	76.04	19.09	3.45	3.03	1.50	4b
	260	21.75	35.92	40.92	6.70	3.12	1
	330	86.28	10.65	2.15	2.55	1.27	4
	360	96.08	*	*	2.10	0.90	4b?/4a
	375 - 380	94.52	3.78	1.27	2.30	0.85	4b?/4a
VEC89A-20	295	27.53	45.66	26.16	5.80	2.50	2
	400	95.05	3.29	1.24	2.53	0.68	4
	420	85.35	11.18	2.61	2.75	1.15	4
VEC89A-21	50 - 55	17.86	39.67	41.81	6.88	3.13	1
	90 - 95	23.23	43.45	32.17	6.43	3.04	1
	300 - 305	28.39	41.68	29.29	5.50	2.78	4b
	307 - 310	39.37	36.38	23.04	5.35	3.01	2
VEC89A-23	127	79.09	15.33	3.99	3.02	1.61	4b
	150	18.34	38.79	42.46	6.90	3.12	1
	180	89.67	7.49	2.22	2.50	1.20	4b/4c
VEC89A-25	15	98.41	*	*	1.70	0.73	4c
	70	99.52	*	*	1.50	0.73	4c
	130	99.48	*	*	1.56	0.71	4c
VEC89A-39	17	50.82	27.15	[illegible]30	4.78	2.76	2?
	32	74.09	14.33	[illegible]	3.46	2.67	3
	70	94.49	3.64	[illegible]	2.23	0.87	4a
	100	98.00	*	*	2.01	0.73	4a
	125	84.16	8.46	6.95	2.38	1.73	4a
	basal sand	93.28	4.03	2.37	2.16	1.38	4a
VEC89A-40	20	31.11	46.29	21.76	5.60	2.50	1/2
	25	93.01	*	*			5
	30	37.56	30.77	31.20	5.80	3.13	1/2
VEC89A-41	20 - 23	67.54	17.65	14.19	3.92	2.78	3
	60 - 62	99.34	*	*	2.16	0.73	4a/4c
	90	96.68	2.48	0.49	2.10	0.88	4a/4c
	120	74.52	17.35	7.44	3.20	2.35	2?
	140	98.07	*	*	1.86	0.77	4a
VEC89A-42	0 - 5	60.56	24.25	13.96	4.25	2.50	1?
	44 - 46	92.72	5.54	0.95	2.33	0.88	4
	58 - 62	74.26	14.91	9.99	3.56	2.40	4?
	28 - 30	69.95	20.83	7.24	3.75	2.04	2?
VEC89A-44	15 - 20	44.73	24.49	30.23	5.60	3.08	1
	25 - 28	73.74	14.49	11.24	3.81	2.65	3
	28 - 32	97.09	1.91	0.81	1.83	0.80	4c
	50	98.94	*	*	1.76	0.77	4c
	100	99.14	*	*	1.75	0.74	4c
	150	99.37	*	*	1.60	0.79	4c
	200	97.90	1.57	0.40	2.08	0.74	4a/4c
	165	65.91	18.24	15.34	4.05	2.66	2?
	173	59.30	25.72	14.49	4.13	2.72	2?
	254	73.83	17.98	7.54	3.40	2.20	4a?
	259	91.55	6.23	1.66	2.43	1.05	4a
	262 - 265	51.45	23.84	23.98	4.80	3.01	1/2?

Core Name	interval (1)	%sand	%silt	%clay	mean	std. dev.	Facies (2)
VEC89A-45	10 - 15	92.78	5.45	1.26	2.66	0.81	4a
	45 - 50	55.33	22.96	21.22	4.40	3.16	4a/4b?
	60 - 65	89.75	6.56	3.54	2.40	1.18	4a
	90 - 95	87.28	8.24	3.97	2.46	1.40	4a
	103 - 105	61.94	18.49	18.69	4.21	3.22	3?
	140	97.05	*	*	2.24	0.79	4a?
	144	78.74	*	*	*	*	4a?
VEC89A-46	20	75.36	16.73	7.07	3.52	2.01	3
	35A	85.24	9.84	4.47	2.52	1.33	4b
	35B	72.93	15.40	10.94	3.75	2.43	3
	60	95.39	*	*	*	*	4a
	85	85.95	9.83	3.65	2.12	1.40	4a
	95 - 97	53.53	30.34	14.92	4.26	2.73	1
PAR91A-14	18 - 20	29.37	43.17	25.34	5.80	2.75	3/4b?
	78 - 80	19.39	45.95	33.95	6.50	2.90	2
	175 - 177	45.45	37.55	15.97	4.50	2.60	1/2
	245 - 247	23.52	37.41	35.90	6.65	3.30	1/2
	300 - 302	26.42	37.73	33.99	6.30	3.25	1
	390 - 392	43.94	30.63	23.71	5.80	3.02	1
PAR91A-26	15 - 17	32.59	29.79	34.06	6.50	3.30	2/3?
	70 - 72	30.90	27.62	38.42	6.80	3.40	1
	150 - 152	35.87	29.65	32.57	6.40	3.30	1/2
	198 - 200	42.62	22.67	31.59	6.23	3.30	1/2
	290 - 292	42.73	25.00	29.51	6.15	3.30	2?
	360 - 362	37.21	23.14	36.79	6.50	3.40	1/2
	420 - 422	43.00	23.34	30.76	6.10	3.30	2?
TUL92A-79	30 - 32	57.06	17.90	22.36	4.80	3.00	1/2
	59 - 61	55.08	19.88	23.08	4.83	3.07	1/2
	130 - 132	43.53	28.20	29.52	5.60	3.14	1
	175 - 177	98.28	*	*	1.70	0.76	4
	198 - 200	68.30	17.21	13.14	3.88	2.90	4
	220 - 222	95.99	*	*	2.06	0.82	4
	250 - 252	42.03	29.46	28.91	5.60	3.06	1
	335 - 337	65.10	16.05	18.39	4.55	2.80	2?
	375 - 377	55.31	22.01	19.33	4.60	3.10	2/3?
	425 - 427	95.57	*	*	2.55	0.70	4b
TUL92A-112	10 - 12	67.55	21.59	10.16	4.06	2.19	2/3?
TUL92A-162	15 - 17	68.33	17.24	12.81	4.10	2.77	3
	45 - 47	62.11	20.57	15.20	4.50	2.89	2
	80 - 82	42.30	27.22	17.00	*	*	1
	135 - 137	50.17	28.56	19.64	4.73	2.90	1
	170 - 172	53.37	27.46	18.04	4.65	2.90	1
	185	76.41	13.64	8.89	3.38	2.51	2/3
	213 - 215	69.14	18.15	11.53	3.75	2.84	4/4b
TUL92A-163	18 - 20	84.06	8.02	6.60	2.48	1.53	4b
	43 - 45	91.41	5.12	2.72	2.35	1.11	4
	65 - 67	80.00	9.84	8.71	3.30	2.39	4
	71 - 73	66.12	18.93	12.87	3.85	2.78	3?
	92 - 94	84.34	8.88	5.52	2.73	1.47	4
	133 - 135	40.20	34.25	22.76	5.58	2.93	3
	163 - 165	86.15	7.42	5.15	2.50	1.46	4
	197 - 199	80.40	11.76	7.20	2.93	1.96	4

Note (1) All intervals in cm below top of core

Note (2) Modified from Evoy et al. 1993_, in press.

1	silty clay
2	clayey silt with <10% discrete fine sand laminae
3	interbedded clayey silt/very fine to medium sand
4a	very fine to medium sand with <10% silty laminae
4b	very fine to fine sand beds <10cm thick
4c	massive fine to medium sand
5	debris flow

* Insufficient silt/clay size sample volume for SediGraph analysis

study. The spatial trends in grain size parameters remain consistent in either case: the selection of statistical measures of grain size parameters thus has no observable impact on the pattern of grain size distributions in any figures presented herein.

Results

General

Results of the grain size analysis have been presented in a variety of different fashions to emphasize both spatial and temporal patterns and trends. In addition, specific intervals were selected for the preparation of loose-sediment grain-mount thin sections, SEM analysis, and/or XRD analysis to determine the composition of various grain size fractions. To further simplify comparisons between individual samples, each interval was then classified by its sedimentary facies characteristics according to criteria summarized below (Table 3-2).

Sediment supply at the head of the delta can be estimated from mean annual total sediment load data collected at Mission, British Columbia. Based on 18 years of data, McLean and Tassone (1991) calculated grain size distribution of this load to consist of approximately 35% sand, 50% silt, and 15% clay-sized material.

Grain Size Distributions

Sample textures range from sand to clayey silt (Figure 3-2). Mean grain size ranges from a maximum of 1.5 phi (medium sand) to a minimum of 7.16 phi (very fine silt); sorting varies between 0.68 (moderately well sorted) and 3.40 (poorly sorted). Degree of sorting generally decreases with decreasing mean grain size throughout the medium to very fine sand intervals before flattening in the silt category. There is a slight increase in quality of sorting in the fine to very fine silt classes, with the poorest sorting present in the medium to coarse silts. Local variations in this pattern (eg: VEC89A-06 on Figure 3-3) represent overbank sedimentation laterally adjacent to the channel margins, and reflects interbedded sand and mud laminae below the resolution of sampling.

Table 3-2. Summary of main sedimentary facies characteristics from the subaqueous Fraser River delta. Modified from Evoy et al., 1994.

Facies Designation		Lithology	Sedimentary and Bedding Characteristics
Facies	Depositional Process		
1, 2	suspension sedimentation	silty clay to clayey silt; <10% silt or v.fine sand as discrete laminations.	massive to plane parallel laminated; rare wavy to lenticular beds; bedded and disseminated organics.
3	mixed traction/suspension sedimentation	interbedded clayey silt with v.fine/fine sand; silt > sand.	plane parallel laminations; lenticular bedding; contacts gradational, rarely abrupt.
4a	channel fill sands: lateral accretion, vertical aggradation, and slumping.	silty, v.fine to medium sand <10% silt/clay interbeds	massive, wavy or lenticular bedding; normal to inverse grading; convolute laminations, oversteepened bedding; rare load casts; contacts gradational or sharp, thickens/coarsens upwards.
4b	low density turbidity currents	silty v.fine to fine sand in beds <10cm thick	massive, poorly sorted; contacts sharp or gradational; erosive bases.
4c	high density turbidity currents	silty, fine to medium sand	massive, mud rip-up clasts; abrupt contacts.
5	debris flows	resedimented organics, shell fragments and sand; silt/clay matrix	poorly sorted, chaotic; mud rip-up clasts.

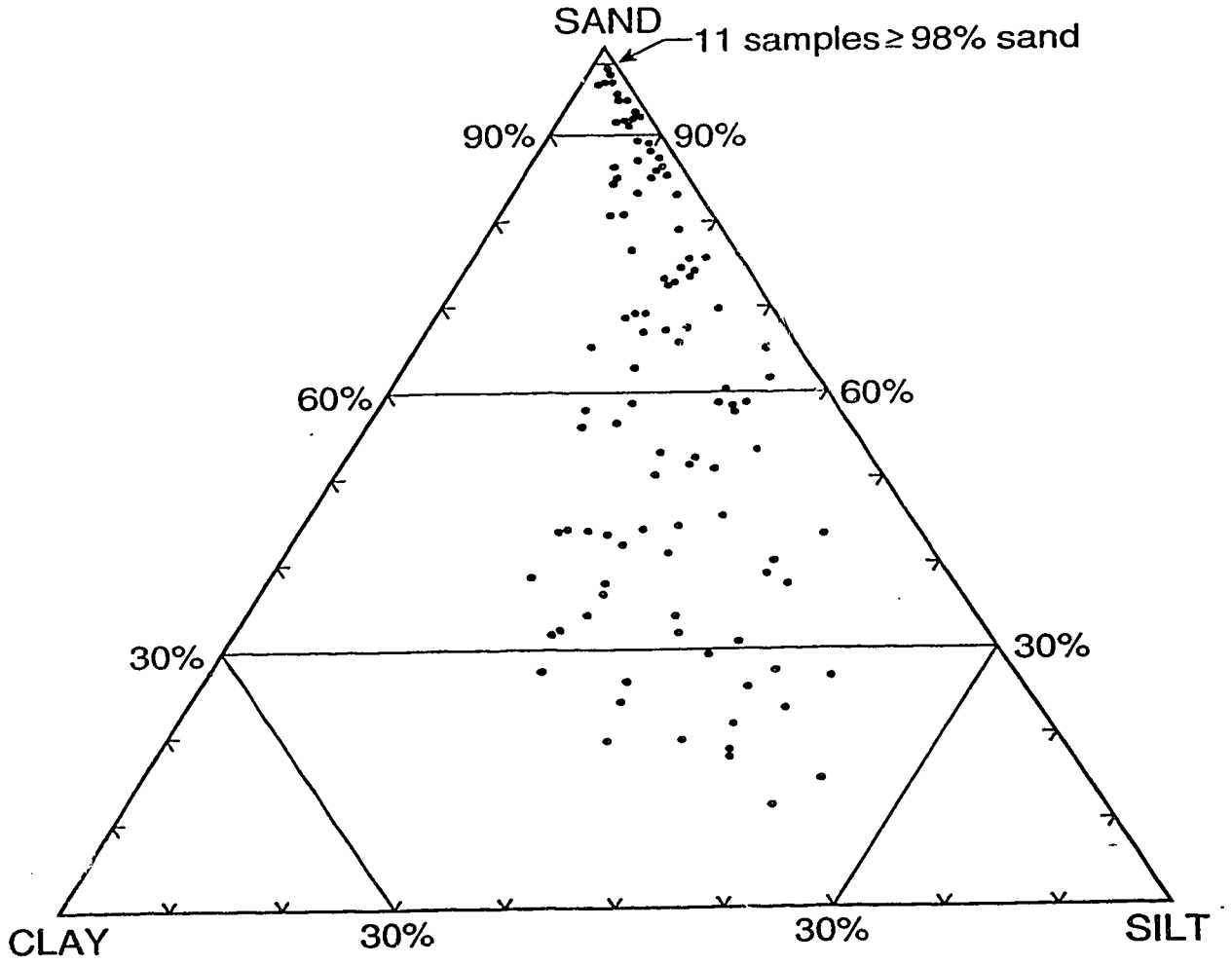


Figure 3-2. Ternary diagram of all samples collected for grain size analyses, with exception of those intervals which contained insufficient sample volumes in the combined silt and clay class intervals for SediGraph analysis. N = 115.

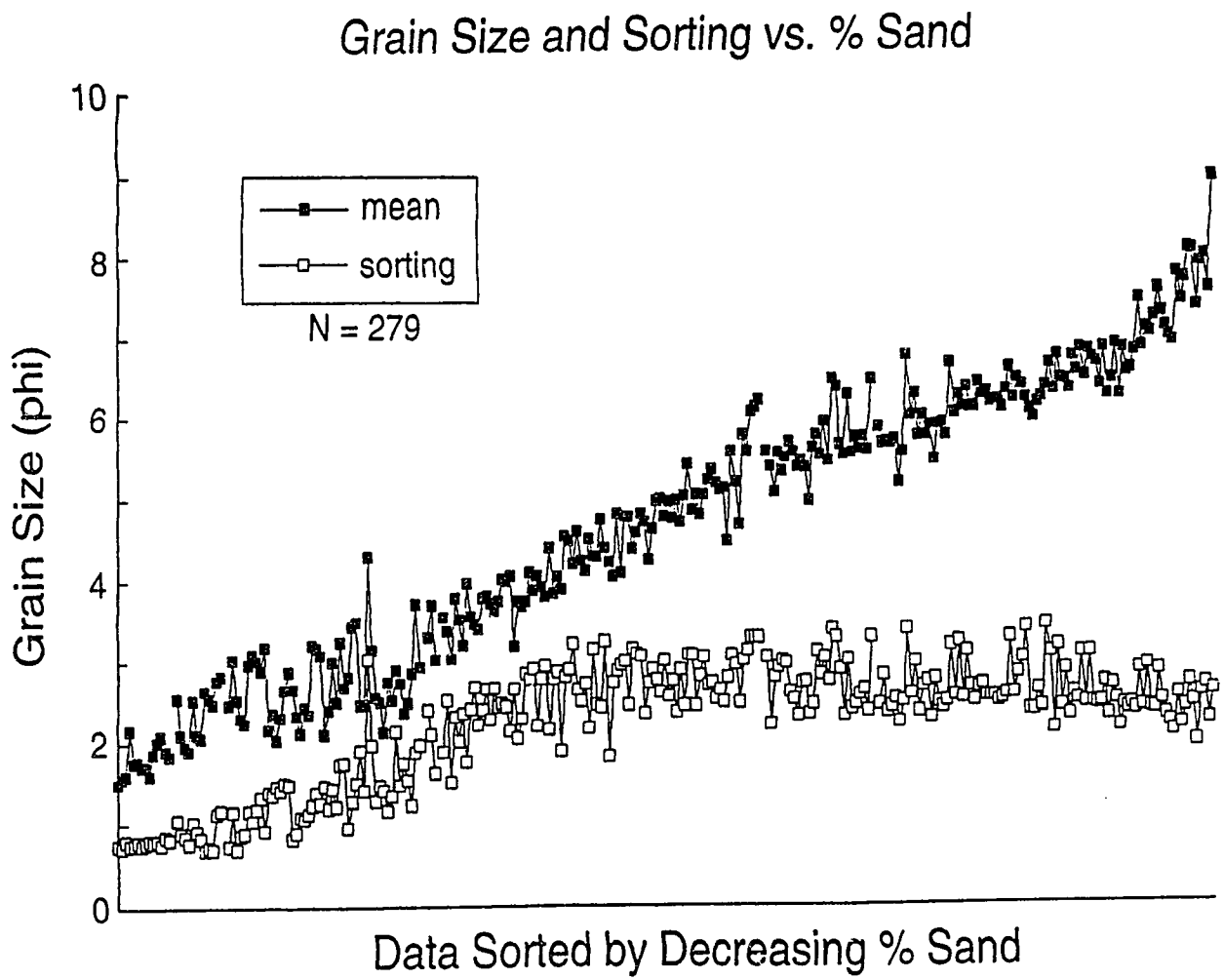


Figure 3-3. Graphical plot of mean grain size versus sorting for the entire population, ordered by total percent mud (silt plus clay). Sorting generally improves with increase in total sand, and with increasing grain size (decreasing phi) throughout the sand interval, and is poorest in the medium silt fraction. Anomaly at VEC89A-06 (66cm) represents overbank flow from the Sand Heads Sea Valley. Closed squares represent mean grain size, open squares represent sorting. Data range from > 99.5% sand to < 12.5%sand as documented on Table 3-1.

Sampling was intended to include all sedimentary facies present on the subaqueous delta, irrespective of individual volume significance. As a result, the entire population is biased towards sand-rich intervals: no attempt can be made to calculate "average" delta grain size parameters.

Representative characteristics of sedimentary facies present on the delta foreslope can be summarized as a general series of increases in depositional energy, preserved traction-related sedimentary structures and percentage sand (Table 3-2). To simplify the recognition and interpretation of patterns, all samples were identified by their facies designation. As anticipated, there is a continuous distribution between Facies 1 through Facies 4 (Figure 3-4). This reflects the increasing hydraulic regime from suspension settling in Facies 1, through mixed suspension settling and variable traction deposition in Facies 2 and 3, to turbidite deposition in Facies 4.

The continuum in grain size distributions between facies is best exemplified by cross-plotting percent sand versus percent mud (silt plus clay), as shown in Figure 3-5. Because of the general absence of gravel-sized material, data were not normalized to 100 percent; the pronounced deflection from the trend at sample VEC89A-40 (25cm) reflects the presence of significant (12.8%) gravel-sized shelly debris and wood fragments in the sole Facies 5 debris flow recovered.

The transitional nature in the distinction between Facies 1 and 2 suggests that this is a subjective differentiation, and is not texturally definable (Figures 3-4 and 3-5); consequently, they are treated as a single unit for presentation purposes. This is consistent with the interpretation of these two facies as representing deposition from suspension, with only modest influence from periodic low-velocity traction currents. The Facies 1 interval underlying the debris flow in VEC89A-40 contains a portion of a fish spine in which the vertebrae remain articulated, suggesting burial by suspension sedimentation under conditions of near complete quiescence. The break between Facies 2 and Facies 3 coincides with the first

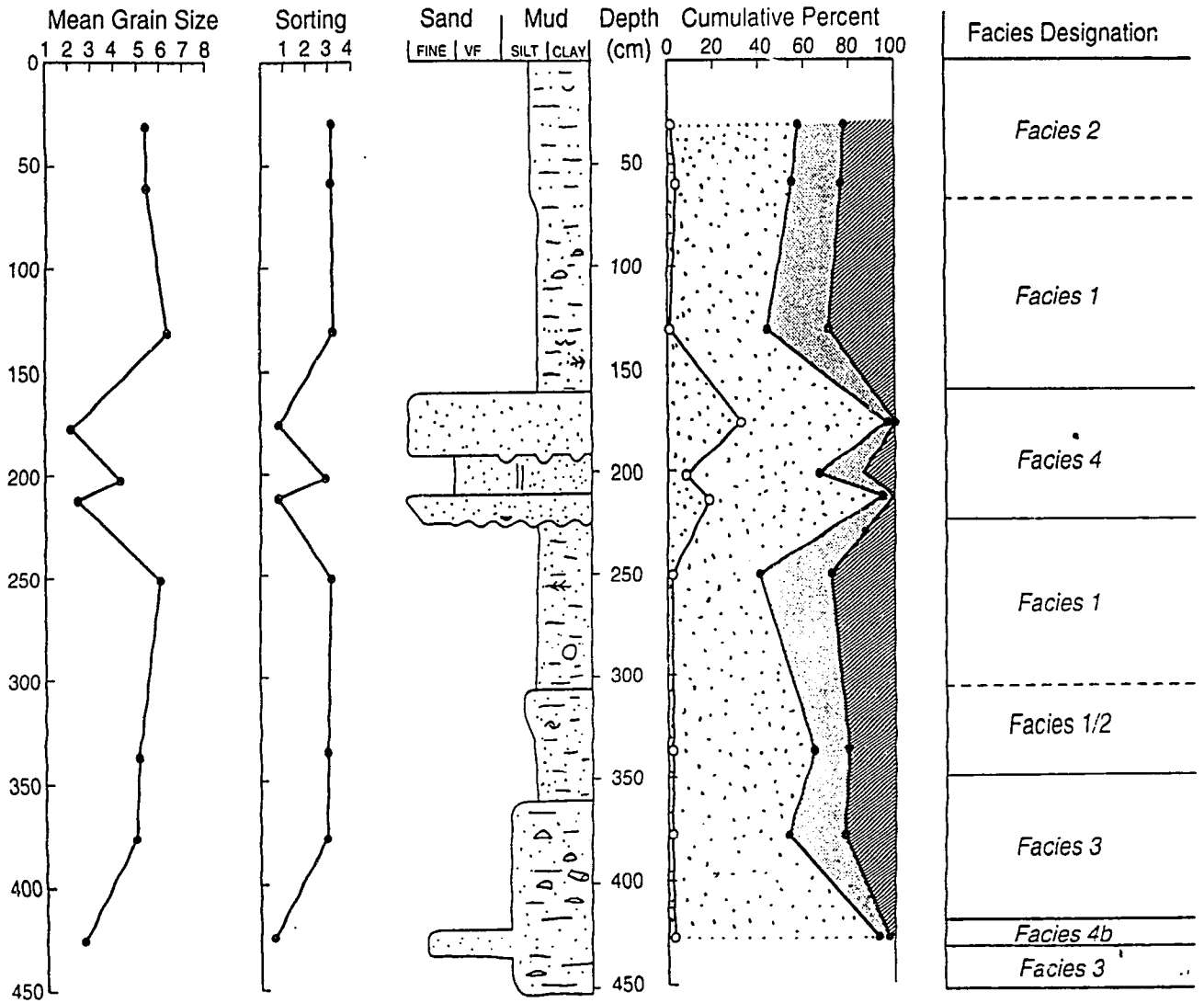


Figure 3-4. Sedimentologic log, textural characteristics and facies designations for piston core TUL92A-79. On cumulative percent distributions, textural classes represent sand (fine stipple), silt (mixed stipple and horizontal lines), and clay (diagonal lines). Open circles represent percent medium sand. See Figure 3-1 for location.

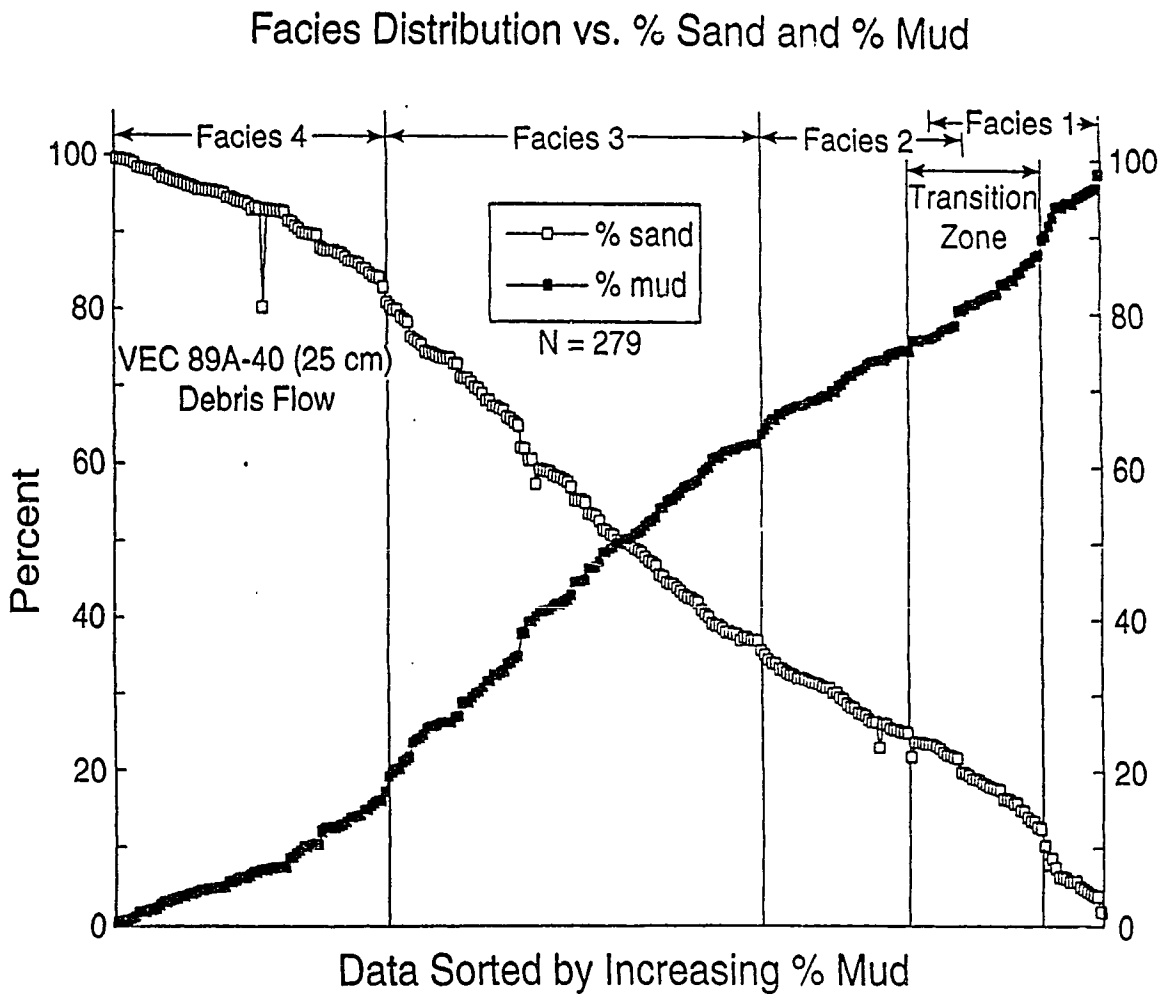


Figure 3-5. Facies distributions as a function of cummulative sand:mud percentages. Note the transitional nature of the change from Facies 1 to Facies 2, and the more pronounced (but still subtle) step between Facies 2, 3 and 4. Sample VEC89A-40 (25cm) represents the sole occurence of Facies 5 debris flow. Closed squares represent percent sand, open squares represent percent mud (silt + clay). Both data sets are presented (N=279), facies designations based on original U of A database (N=124).

appearance of distinct sand beds (very fine- to fine-grained), which are interpreted as reflecting deposition from low density turbidity currents.

Sand Distribution - Facies 4

Fifty-five of the 124 samples collected (44%) were taken from sands of Facies 4. These represent the coarsest grained, and best sorted sediments documented in the study. The majority of these samples are associated with the Roberts Bank Channel and its depositional lobe (Table 3-3), and a lesser number are from the lower portion of the Sand Heads Sea Valley and its terminus (Figure 3-6). Only limited sampling was undertaken in the vicinity of the Sand Heads Sea Valley; additional data have subsequently been provided by the Geological Survey of Canada (Figure 3-1).

Facies 4 sands contain approximately 10% mud sized material, with over one-third of these containing less than 4% mud. Facies 4C sands exhibit both the coarsest mean grain size sediment present (~1.8 phi), and the cleanest sands (~1.9% mud). Spatially, most Facies 4 sands are located along the axial trend of the two main channels crossing the foreslope (Figure 3-7), with Facies 4C restricted to the locus of deposition at the base of these channels. The distribution pattern shows that while abundant sand may be supplied to the tidal flats and the channel heads, cross-slope transport of the coarser grain sizes is limited to the main channel systems and the areally greatest sand accumulations are at the base of the delta slope in water depths exceeding 200 metres.

This trend is best illustrated in the combined facies/grain size distribution cross-section presented in Figure 3-8. The upper and middle foreslope are areas of near complete bypassing by the coarser sediment fractions. Furthermore, the depositional lobe deposited at the base of the Roberts Bank channel (VEC89A-45) contains less clay, is better sorted, and is coarser grained than any of its upslope correlative cores (Figure 3-8).

Twenty of the Facies 4 samples identified did not contain sufficient sample volumes

Table 3-3. Grain size distributions, parameters and characteristics for Facies 4 sands in the vicinity of Roberts Bank channel and Sand Heads Sea Valley. Asterix represents samples with insufficient sample volumes in the combined silt and clay sizes for Sedigraph analysis. Key to comments: m - mica flakes, s - shelly debris, w - wood fragments.

Core Name	Interval	%sand	%mud	%silt	%clay	sand:mud	mean	sorting	comments	Facies	location
VEC89A-25	70	99.52	0.48	*	*	206.81	1.50	0.73	m	4c	Sand Heads Sea Valley
VEC89A-25	130	99.48	0.52	*	*	193.08	1.56	0.71	m/s	4c	Sand Heads Sea Valley
VEC89A-44	150	99.37	0.63	*	*	157.37	1.60	0.79	s	4c	Roberts Bank Channel
VEC89A-41	60 - 62	99.34	0.66	*	*	149.79	2.16	0.73	w/m/s	4a/4c	Roberts Bank Channel
VEC89A-44	100	99.14	0.86	*	*	114.65	1.75	0.74		4c	Roberts Bank Channel
VEC89A-44	50	98.94	1.06	*	*	92.95	1.76	0.77	s	4c	Roberts Bank Channel
VEC89A-25	15	98.41	1.59	*	*	62.08	1.70	0.73	m	4c	Sand Heads Sea Valley
TUL92A-79	175 - 177	98.28	1.72	*	*	57.14	1.70	0.76	m	4	Roberts Bank Channel
VEC89A-03	210	98.23	1.77	*	*	55.44	1.60	0.79	w	4c	Sand Heads Sea Valley
VEC89A-41	140	98.07	1.93	*	*	50.90	1.86	0.77	w/m	4a	Roberts Bank Channel
VEC89A-44	200	97.90	2.10	1.57	0.40	49.60	2.08	0.74	m/s	4a/4c	Roberts Bank Channel
VEC39A-03	125	97.44	2.56	*	*	38.04	1.90	0.83	w/m	4a	Sand Heads Sea Valley
VEC89A-44	28 - 32	97.09	2.91	1.91	0.81	35.71	1.83	0.80		4c	Roberts Bank Channel
VEC89A-45	140	97.05	2.95	*	*	32.90	2.24	0.79		4a?	Roberts Bank Fan
VEC89A-41	90	96.68	3.32	2.48	0.49	32.57	2.10	0.88	w/m	4a/4c	Roberts Bank Channel
VEC89A-03	145	96.56	3.44	*	*	28.09	1.95	0.83	w	4a	Sand Heads Sea Valley
TUL92A-79	220 - 222	95.99	4.01	*	*	23.94	2.06	0.82	m/w	4	Roberts Bank Channel
TUL92A-79	425 - 427	95.57	4.43	*	*	21.57	2.55	0.70	m/w/s	4b	Roberts Bank Channel
VEC89A-42	44 - 46	92.72	7.28	5.54	0.95	14.28	2.33	0.88	m	4	Roberts Bank Channel
VEC89A-45	10 - 15	92.78	7.22	5.45	1.26	13.83	2.66	0.81		4a	Roberts Bank Fan
VEC89A-03	110	92.61	7.39	5.62	1.25	13.48	2.11	1.07	w	4a	Sand Heads Sea Valley
TUL92A-163	43 - 45	91.41	8.59	5.12	2.72	11.66	2.35	1.11	m	4	Roberts Bank Channel
VEC89A-44	259	91.55	8.45	6.23	1.66	11.60	2.43	1.05	w	4a	Roberts Bank Channel
VEC89A-03	170	89.97	10.03	8.10	1.54	9.33	2.10	1.45	w	4a	Sand Heads Sea Valley
VEC89A-45	60 - 65	89.75	10.25	6.58	3.54	8.87	2.40	1.18		4a	Roberts Bank Fan
VEC89A-03	12 - 15	87.66	12.34	9.56	1.21	8.14	2.81	0.94	w/m	4a	Sand Heads Sea Valley
VEC89A-45	90 - 95	87.28	12.72	8.24	3.97	7.15	2.46	1.40		4a	Roberts Bank Fan
TUL92A-163	163 - 165	86.15	13.85	7.42	5.15	6.85	2.50	1.46	m/w	4	Roberts Bank Channel
TUL92A-163	92 - 94	84.34	15.66	8.88	5.52	5.86	2.73	1.47	m/w	4	Roberts Bank Channel
TUL92A-163	18 - 20	84.06	15.94	8.02	6.60	5.75	2.48	1.53	m	4b	Roberts Bank Channel
VEC89A-03	70 - 72	82.94	17.06	12.85	3.14	5.19	2.85	1.22	w/m	4a	Sand Heads Sea Valley
TUL92A-163	65 - 67	80.00	20.00	9.84	8.71	4.31	3.30	2.39	m	4	Roberts Bank Channel
TUL92A-163	197 - 199	80.40	19.60	11.76	7.20	4.24	2.93	1.96	m/w/s	4	Roberts Bank Channel
VEC89A-45	144	78.74	21.26	*	*	3.70	*	*		4a?	Roberts Bank Fan
VEC89A-42	58 - 62	74.26	25.74	14.91	9.99	2.98	3.56	2.40	w/m	4?	Roberts Bank Channel
VEC89A-44	254	73.83	26.17	17.98	7.54	2.89	3.40	2.20	w	4a?	Roberts Bank Channel
TUL92A-162	213 - 215	69.14	30.86	18.15	11.53	2.33	3.75	2.84	m/w	4/4b	Roberts Bank Channel
TUL92A-79	198 - 200	68.30	31.70	17.21	13.14	2.25	3.88	2.90	m	4	Roberts Bank Channel
VEC89A-03	75 - 80	65.41	34.59	26.98	5.36	2.02	3.90	1.88	w	4a	Sand Heads Sea Valley

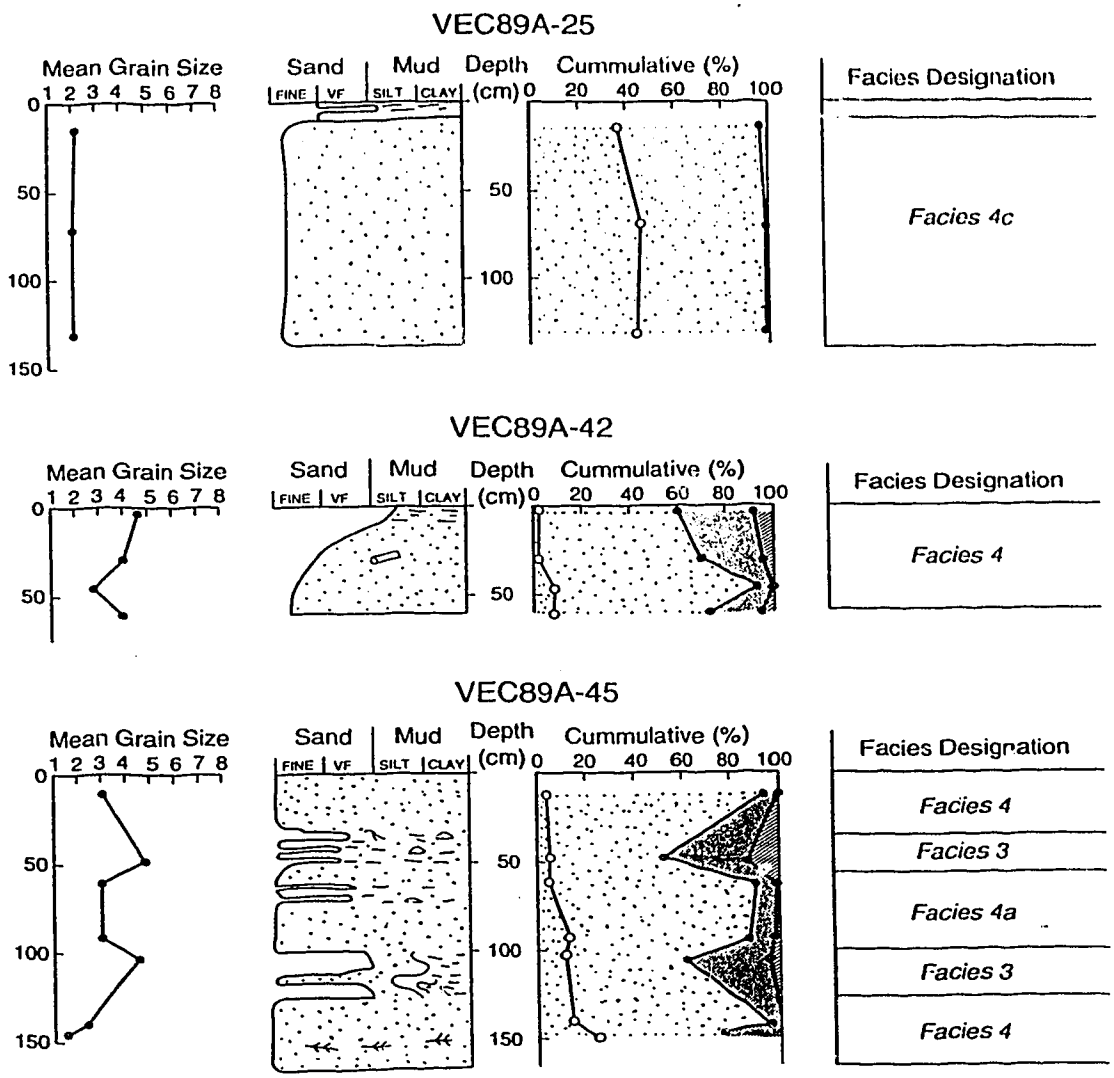


Figure 3-6. Sedimentologic log, textural characteristics and facies designations for piston cores VEC89A-25 (a), VEC89A-42 (b) and VEC 89A-45(c). Cumulative percent distribution legend as in Figure 3-4, see Figure 3-1 for location.

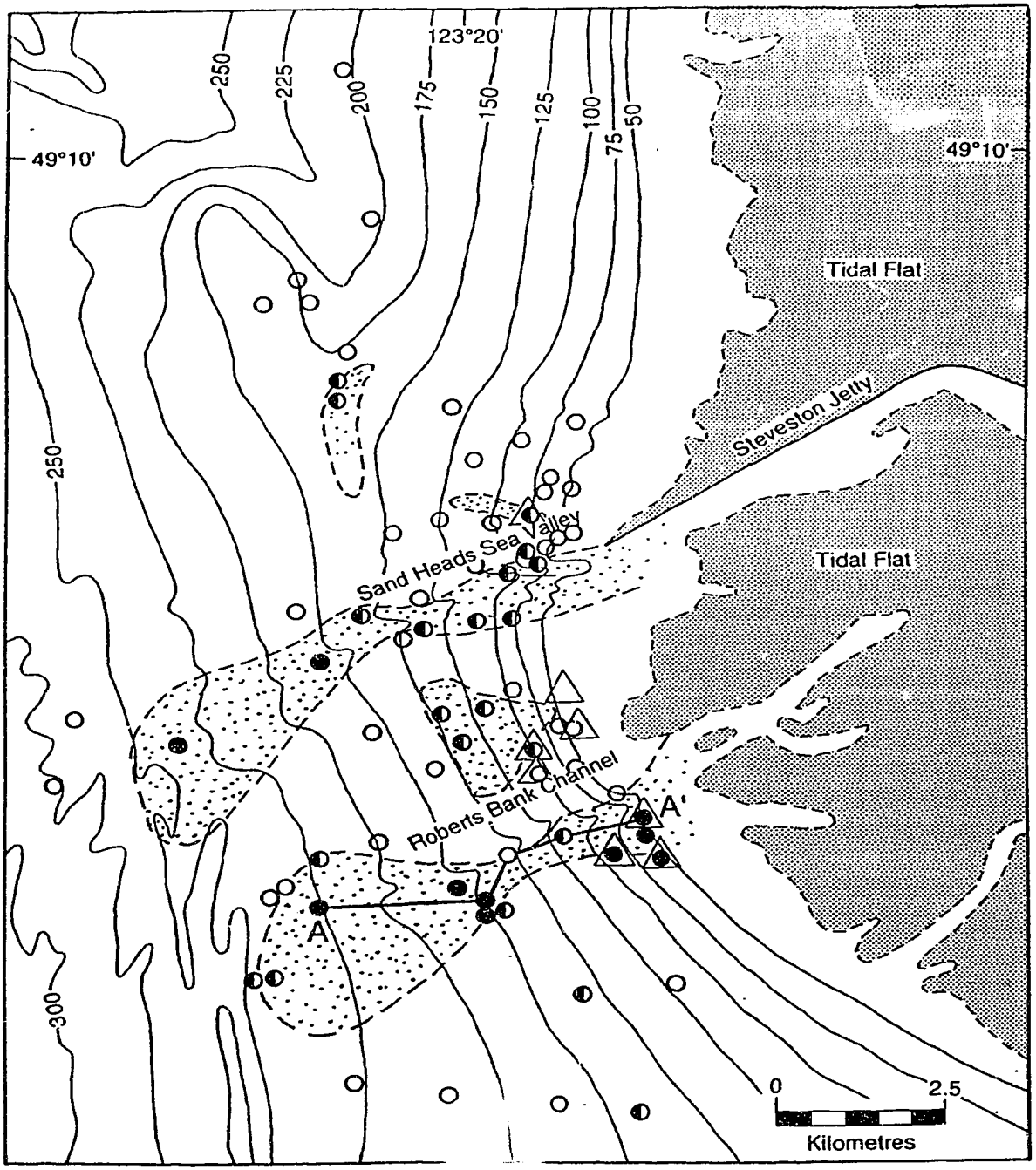


Figure 3-7. Plan view of facies distributions across the study area, showing major facies components for each core site. Solid circles represent Facies 4, half-filled circles represent minor Facies 4 within an assemblage of predominatly Facies 1 and 2. Triangles represent Facies 3. Outlines of Facies 4 assemblage highlights the degree of bypassing of the foreslope by coarser sediments. Section A-A', along the axial trend of the Roberts Bank channel/fan system, is shown in Figure 3-8.

A

A'

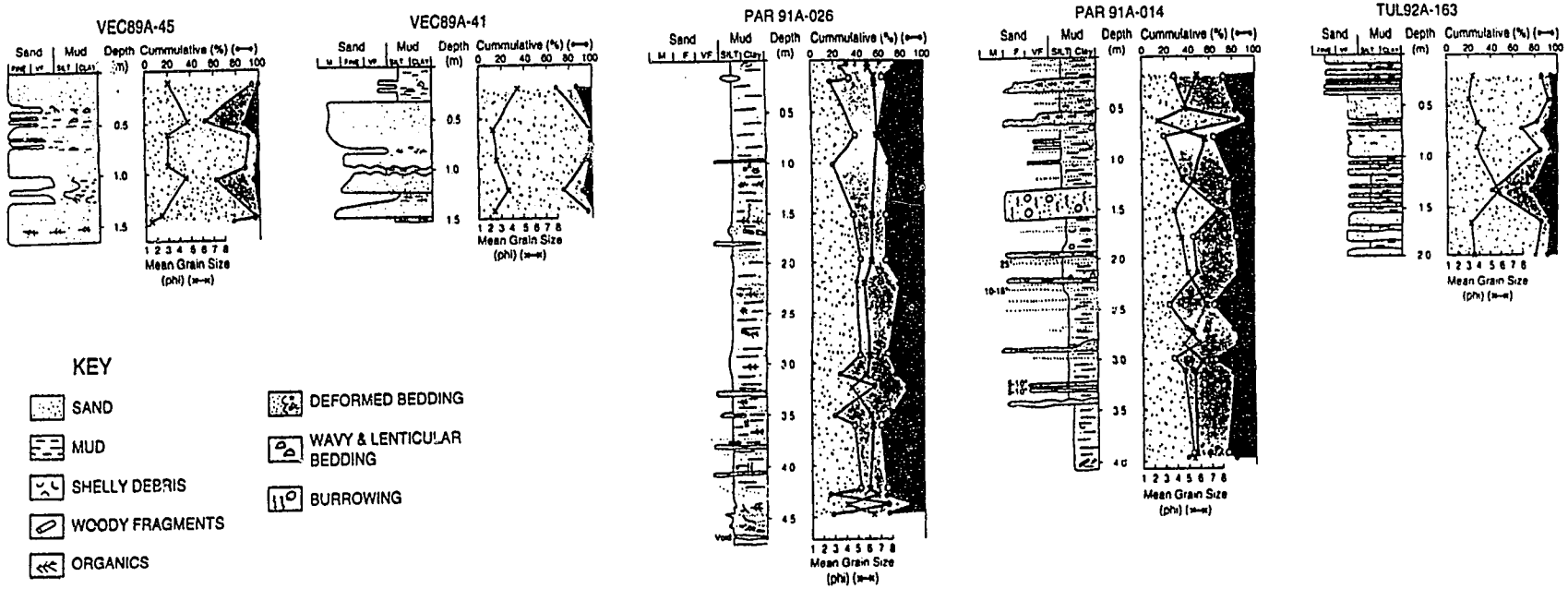


Figure 3-8. Dip oriented cross section showing variation in facies and grain size distribution patterns along the trend of the Roberts Bank channel. While abundant sand sized material is supplied to the channel head, the bulk of the channel across the foreslope is sand-poor. Mean grain size in the depositional lobe at the channel base is actually greater than the average mean grain size at the channel head suggesting a preferential bypassing of the coarsest sand fraction present.

in the mud size fraction for Sedigraph analyses, with the majority of these samples (15) containing less than 5% total mud content. Clay to silt ratio in the remaining 35 samples averages 0.357. Since clay to silt ratio decreases with increasing sand to silt ratio (Figure 3-9), the clay to silt ratio can be used to estimate maximum clay contents in the remaining samples, as shown on Table 3-3.

Additional analyses were undertaken to determine the nature and composition of the less than 4 micron (clay sized) fraction. Selected samples containing fines populations varying from less than 2% combined silt plus clay size fractions, to greater than 40% clay size material, were identified and prepared for SEM analysis. Results show that a significant proportion of the clay size fraction in Facies 4 sands (visually estimated at >> 50%), consists of extremely fine siliciclastic debris including quartzose fragments, feldspar shards, and shattered diatoms (Figure 3-10a).

Implications for Sediment-Gravity Flow Processes

The Roberts Bank Channel data afford an opportunity to test competing hypotheses regarding the rheological behaviour of the sediment gravity flows responsible for sediment transport and deposition on the lower Fraser River delta foreslope, and to constrain the mechanisms responsible for channel maintainance and, presumably, initiation and entrenchment. Hart *et al.* (1992) have argued that the Sand Heads Sea Valley and, by inference, other channels on the Fraser River delta foreslope, form as a result of debris flows originating high on the upper slope. Others present arguments that both the Sand Heads Sea Valley (Kostaschuk *et al.*, 1992) and Roberts Bank Channel (Evoy *et al.*, 1994) are maintained by mass wasting and sediment transport and deposition from turbidity currents.

Cohesive debris flows, as used by Hart *et al.* (1992) require at least 5% clay *minerals* in the interstitial fluid to provide cohesive strength. Many of the samples analysed, including all samples with mean grain sizes coarser than fine sand, do not contain this volume of fine sediment even in the combined silt + clay *textural* fractions (Figure 3-3).

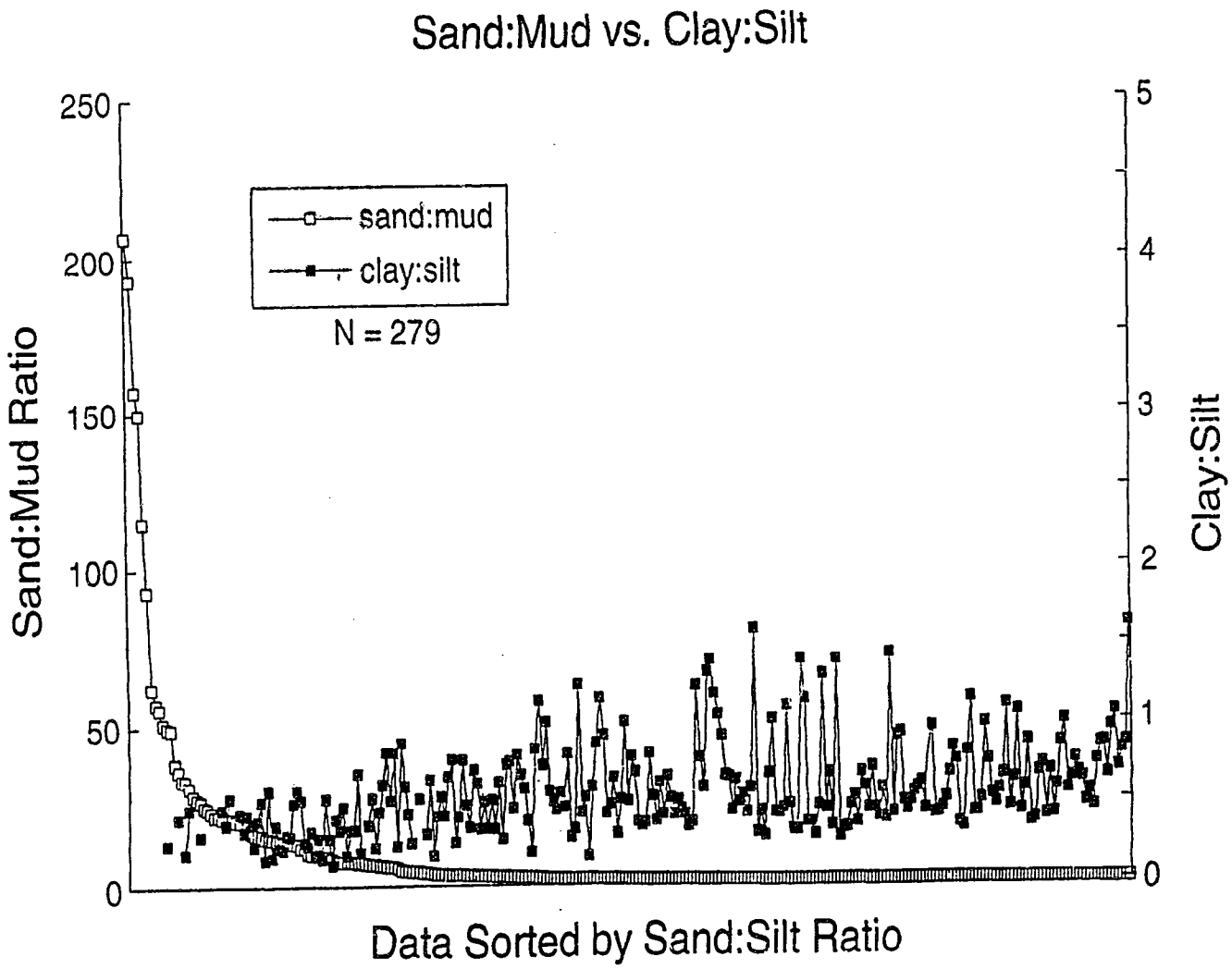


Figure 3-9. Variation in sand:mud and clay:silt ratios in the data set. A slight increase in clay:silt ratio is evident with decreasing sand:mud ratio. N=279.



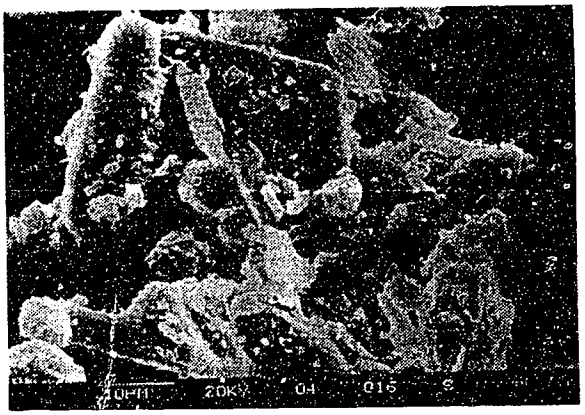


Figure 3-10. SEM photographs of finer than 4 phi (combined silt and clay) fraction from depositional lobe at the mouth of the Roberts Bank Channel, and the terminus of the Sand Heads Sea Valley. Scale bar equals 4 microns (textural clay size). The clay size fraction is composed primarily of shards of feldspar, quartz and diatoms with minor mineralogic clay and trace pyrite. Most clays present are finer than 0.5 microns.
(a) Piston core VEC89A-45, from 10 to 15cm.
(b) Piston core VEC-89A-25, at 15cm.

A significant proportion of the clay size fraction in Facies 4 sands consists of siliciclastic debris including quartz, feldspar and broken diatom fragments. This very fine clastic detritus is estimated to constitute at least 50% of the clay-sized fraction. Mineralogic clays appear to be restricted to a portion of the finer than 2 micron fraction, with most being detrital clays on the submicron scale (Figures 3-10a and 3-10b). This includes samples collected from the terminus of both the Roberts Bank Channel and the Sand Heads Sea Valley, as well as in, or proximal to, the channels themselves.

Facies 4C sands typically contain less than 1% clay size material, and are estimated to contain less than 0.5% clay minerals. Hampton (1975) has estimated that a debris flow strong enough to carry fine sand requires 4% clay in the matrix, which represents approximately 2.3% clay in the final deposit. This calculation is based on the assumption of pure Kaolin clays; the presence of other clay mineral species would be expected increase the matrix competence (Hampton, 1970). Even using a more modest limit of 2% clay for the amount of clay minerals required to provide cohesive strength (lower limit of Middleton and Hampton, 1976), many Facies 4 sands - and all Facies 4C - contain insufficient clay mineral contents to have exhibited cohesive strength during transport (Figure 3-6).

Discussion

The grain size data presented on Table 3-3, and SEM analyses of the composition of the fines fraction include data from both major channels on the Fraser River delta foreslope. These grain size data appear to be in agreement with those presented by Kostaschuk *et al.* (1992) from inferred turbidites in the thalweg of the Snad Heads Sea Valley. This suggests that turbidity currents play a significant, and probably dominant role in the formation and maintainance of submarine channels on the Fraser River delta foreslope.

While debris flows may also be assumed to be a significant element in the mass

transfer of sediment from the subaeriel delta into deep water, the degree to which they are active is poorly constrained in the Fraser River delta. Much of the data cited to support recent debris flows are based on: (1) the documentation of large scale failures in the vicinity of Sand Heads; (2) on surface morphology in areas that have not been successfully cored; and (3) on the absence of recognizable sedimentary structures in massive appearing sands (Hart *et al.*, 1992). As previously stated, the position of the Sand Heads Sea Valley has been anthropogenically fixed and modified by dredging and jetty construction, and is not representative of the historic delta. The presence of massive appearing sand intervals as a quick bed is common in many turbidites, and should be expected to be exaggerated by coring-induced liquifaction.

The mechanism of failure at Sand Heads has been interpreted as retrogressive slope failure (McKenna *et al.*, 1992), probably due to rapid deposition and large tidal draw-down at the river mouth (Kostaschuk *et al.*, 1989). Experimental studies of grain flows in similar environmental settings (Dinger and Anima, 1989) confirm Lowe's (1976; 1982) assertion that this type of cohesionless debris flow can not exceed approximately 5cm in thickness. McKenna *et al.* (1992) argue that failure at Sand Heads results from liquifaction, which then generates a turbidity current. The transformation of liquified flows into turbidity currents via flow acceleration has been postulated previously, based on theoretical considerations (Middleton and Hampton, 1976; Lowe, 1982).

Conclusions

Samples collected from the Fraser River delta foreslope range in texture from sands to clayey silt. Mean grain size ranges between medium sand (1.5 phi) to very fine silt (7.16 phi); sorting varies from moderately well to poorly sorted. The incomplete data represented by an open-ended frequency distribution restricts the utility of the moment method in the characterization of full spectrum grain size data. Treatment of the frequency curve distribution in its entirety necessitates the use of the percentile approach afforded by graphical measures.

There is a continuous distribution between Facies 1 through Facies 4, reflecting increasing hydraulic regime from suspension settling in Facies 1, to turbidite deposition in Facies 4. Facies 4 sands represent the coarsest grained, and best sorted sediments documented in the study. The majority of these are associated with the Roberts Bank Channel, its' depositional lobe, and the lower portion of the Sand Heads Sea Valley.

The mechanism of failure at Sand Heads and Roberts Bank channel is interpreted as retrogressive slope failure. The resultant liquified flows transform into turbidity currents via flow acceleration, resulting in sediment bypassing of the upper and middle foreslope, and deposition as turbidite lobes at the base of the lower foreslope. Debris flows may also be assumed to be a significant element in the mass transfer of sediment from the delta mouth to deep water; however, the degree to which they are active is poorly constrained in the Fraser delta. Cohesive debris flows (*cf* Postma, 1986) require a minimum 5% clay minerals in the interstitial fluid to provide cohesive strength. Even using a more modest limit of 2% clay for the amount of clay required to provide cohesive strength, few Facies 4 sands contain sufficient clay to have exhibited cohesive strength during transport.

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CHAPTER 4.
ORIGIN AND VARIABILITY OF SEDIMENTARY FACIES OF THE FRASER RIVER DELTA FORESLOPE, BRITISH COLUMBIA.[3]

Introduction

The Fraser River delta is a sand rich, mixed tidal-fluvial dominated delta prograding into water depths in excess of 200 m in Georgia Strait. The delta plain consists of a series of tidal flats with an average slope of less than 0.1°. The subaqueous foreslope extends further seaward at an average slope of 1.5°, and is cut by a number of broad "sea valleys" hundreds of metres wide and up to 10 m in relief (Kostaschuk *et al.*, 1992a). These channels debouch onto the basin floor as a series of sand-rich depositional lobes in approximately 200 to 250 m water depth (Moslow *et al.*, 1991).

The Fraser River transports sand and mud to the delta via strongly seasonal fluvial discharge (Kostaschuk *et al.*, 1992b). The estuary experiences large tidal draw down and the delta exists within one of the most active seismic regimes in Canada. The area is also protected from excessive storm-generated waves by the limited fetch across Georgia Strait. As a consequence, the Fraser River delta constitutes an exceptional natural laboratory for the study of sediment stability and transport mechanisms in an actively prograding delta with large tides, seismic loading and differential rates of sand deposition. The unique geographic setting, with relatively coarse-grained clastic sediments being introduced directly into deep water, may also serve as a useful analogue to lowstand (shelf-edge) deltas.

This study documents sediment distribution patterns in the Fraser River delta foreslope, as determined from piston cores and 3.5 kHz seismic survey data, and focuses on facies associations and deposition of sands on the subaqueous delta slope.

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[3] A version of this chapter has been published. Evoy, R.W., Moslow, T.F., Kostschuk, R.A. and Luternauer, J.L., 1994. *Marine Geology.* 118:49-60.

Study Area and Methodology

Geologic Setting

The Fraser River delta is the largest and most important delta on Canada's Pacific coast. The Fraser River drains approximately 250,000 km^2 of mountainous terrain with peak discharge during the snowmelt freshet in late spring and early summer (Milliman, 1980). Within the Fraser River estuary, a pronounced tidal influence is superimposed on the fluvial regime with semi-diurnal tides at the river mouth approaching 5 m (Kostaschuk *et al.*, 1992b). Tidal range within the estuary decreases upstream and with increasing discharge (Ages and Woolard, 1976), and in conjunction with fluvial discharge produces a pronounced salt-wedge which strongly affects local sedimentation rates and mechanics (Kostaschuk *et al.*, 1992b).

The seaward margin of the Fraser River delta consists of a series of broad tidal flats, up to 9 km wide, with average slopes of less than 0.1°. The subaqueous delta slope extends a further 5 to 10 km seaward at an average slope of 1.5° (Clague *et al.*, 1991). Within the study area, water depths range from less than 50 m to greater than 200 m over a 3.0 km horizontal distance, at an average gradient of 3.0°. Locally, slopes exceed 6° (Hart *et al.*, 1992a), with maximum slope angles as high as 20°.

Data and Methods

Eighteen piston cores and approximately 160 kilometres of 3.5 kHz seismic profiles were collected from the study area during the July 1989 cruise of the *CSS Vector* across the Fraser River delta foreslope. Investigations focussed on the southern half of Sturgeon Bank and the northern half of Roberts Bank (Figure 4-1). Core sites were selected to construct a series of transects documenting along-slope facies variability across channels and depositional lobes, and to constrain across shelf variability from shallow to deep water. Target selection in the vicinity of the Sand Heads Sea Valley (Kostaschuk *et al.*, 1992a) was limited by the constraints of substrate composition and surface currents. All cores were described using a process sedimentologic approach (Siemers and Tillman, 1981) in which sedimentary processes and facies are used to delineate genetically related stratigraphic units. Five sedimentary facies

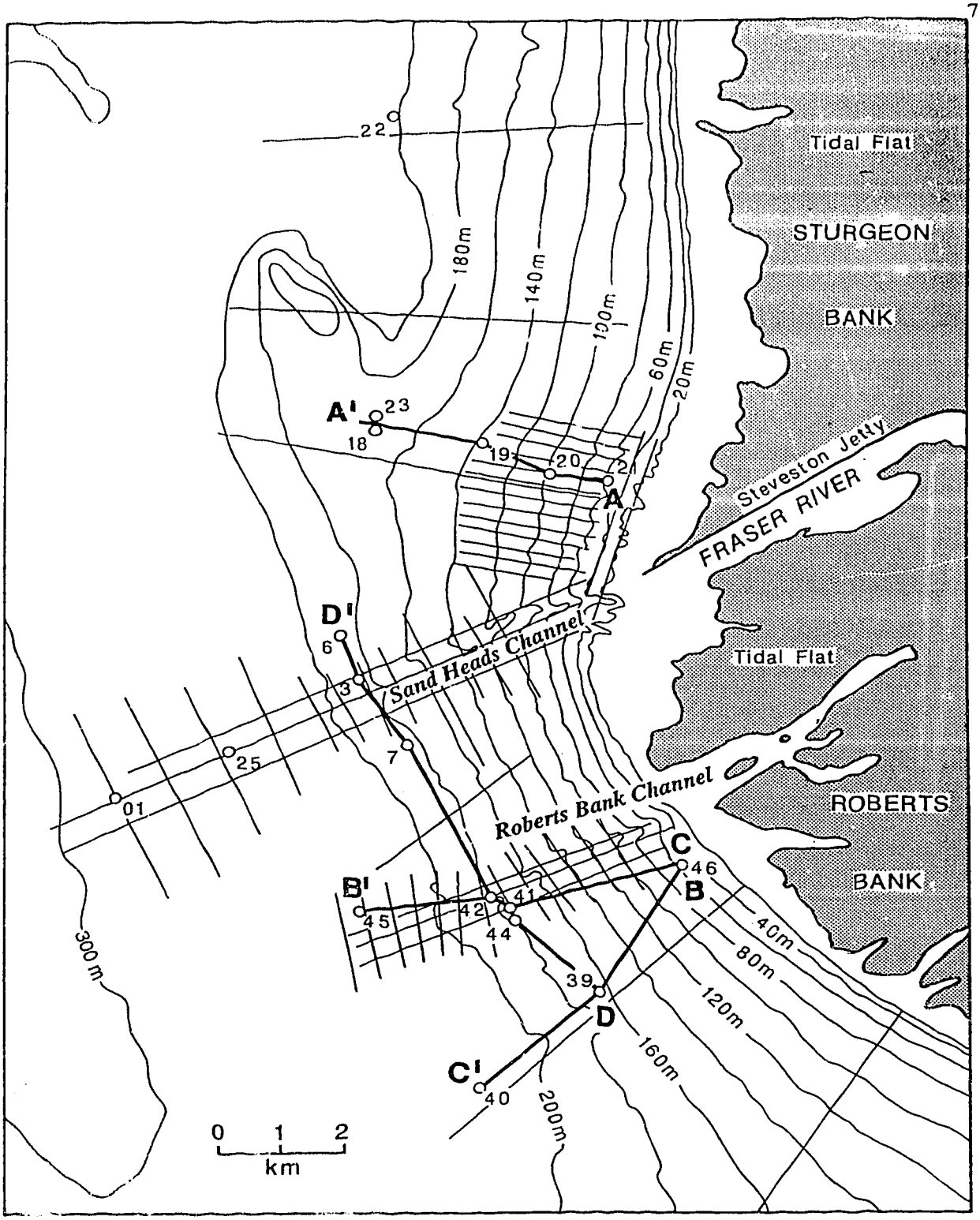


Figure 4-1. Study area location map and detailed bathymetric chart showing piston core locations and high frequency (3.5 kHz) seismic survey coverage in the study area. Sections A-A' and D-D' are discussed in the text and shown in Figures 4-4 and 4-8.

were recognized, and one was further divided into three subfacies. Facies characteristics and distributions are summarized in Table 4-1, and are shown schematically on Figure 4-2.

· lected half-slab intervals were subsequently x-radiographed to test for fine-scale structure in massive clayey-silt units, and to look for evidence of bioturb ı. Specific intervals were also subsampled for micropaleontologic analysis, textural/mineralogic analyses, and Cs-137 analysis. Results from this latter are presented elsewhere (Moslow *et al.*, 1993; Evoy *et al.*, 1993).

Facies Characteri ics

Facies 1: Massive silty clay

Facies 1 is a silty clay which is water saturated near the sediment-water interface, but dense and compacted elsewhere. A minor organic component is present consisting of rafted and disseminated plant material. The unit is black on fresh surfaces but readily oxidizes to an olive green colour upon retrieval of the core.

This facies is generally massive and internally structureless, with only rare parallel laminations (Figure 4-2). It is the most common sedimentary facies in the study area, especially in the more distal portion of the delta slope and areas that are not subject to active sedimentation. The depositional process is inferred to be simple gravitational settling from suspension in an area of restricted clastic input and extremely low current velocities.

Facies 2: Silty clay/clayey silt with rare silt laminae

Facies 2 is composed of massive silty clay to clayey silt with rare parallel silt laminations. This unit is dense, compacted and remains cohesive after dehydration. Variable contents of disseminated rafted and laminated organic material are present. Rare scaphopod and pelecypod shell fragments and weak bioturbation were noted. Burrows consist of a low diversity, low density assemblage of *Skolithos* and *Paleophycus*.

TABLE 4-1: SUMMARY OF SEDIMENTARY FACIES CHARACTERISTICS

FACIES	TEXTURE/LITHOLOGY	SEDIMENTARY STRUCTURES	BEDDING CHARACTERISTICS	DEPOSITIONAL PROCESSES
1	silty clay with minor disseminated organics.	rare plane parallel laminations; weakly burrowed.	frequently water saturated at top of core.	suspension settling.
2	silty clay to clay silt; <10% silt/very fine sand laminations; disseminated organics.	rare parallel silt laminae; wavy to lenticular bedding.	dense, compacted.	suspension settling and low-velocity traction currents.
3	clayey silt with silty, very fine- to medium sand interbeds.	plane parallel laminations; lenticular bedding.	contacts generally gradational, rarely abrupt.	suspension settling with low-density turbidity currents.
4a	silty very fine-to medium-grained sand; <10% silt/clay interbeds.	massive, or wavy to lenticular; convolute bedding; normal or inverse grading; minor load casts.	contacts sharp or gradational; oversteepened laminations; thickens/coarsens upwards.	channels: lateral accretion, vertical aggradation and slumping.
4b	silty, very fine-to fine-grained sand; poorly sorted.	massive; erosive(?) base.	contacts sharp or gradational; beds <10 cm thick.	turbidity current
4c	silty, fine-to medium-grained sand.	massive appearing;	abrupt contacts. rare rip-up clasts.	high-density turbidity current
5	resedimented organics, shell fragments; very fine-to medium sand; silt/clay matrix; poorly sorted.	poorly sorted; mud rip-up clasts.	chaotic.	debris flow or slump.

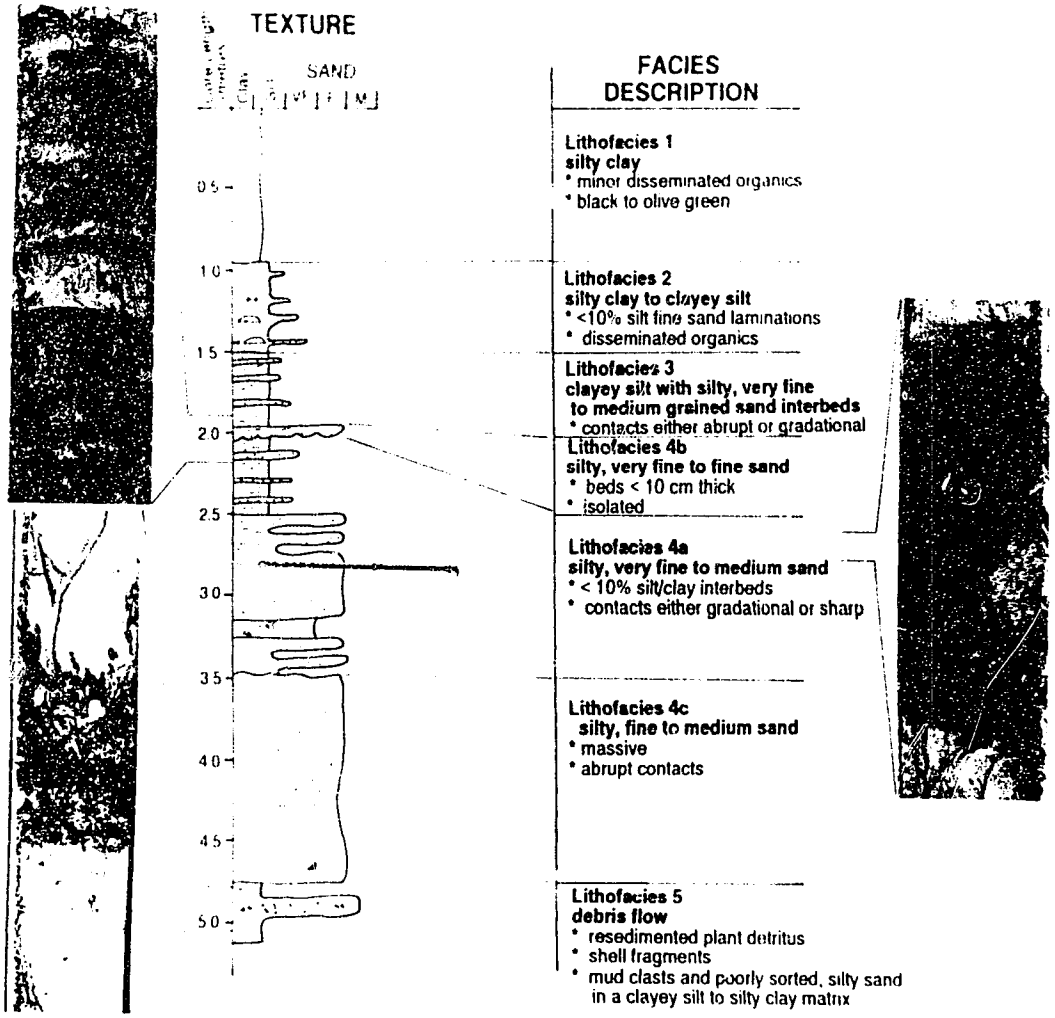


Figure 4-2. Composite vertical sedimentary sequence documenting facies types and characteristics in the Fraser River delta foreslope based on a summary of piston core observations. See Table 4-1 for additional details of sedimentary characteristics

The entire facies contains less than 10% silt and/or very fine sand laminae (Figure 4-2) but locally may consist of up to 15 to 20% of these coarser grain sizes. Silt laminae exhibit plane parallel laminations with individual laminae typically less than 5 mm in width. Fine-grained sand lenses locally exhibit wavy to lenticular bedding. Depositional processes are interpreted as suspension settling of clays, combined with silt laminae deposited directly from the entrained layer of dilute, low density turbidity currents.

This facies is the second most common facies recognized in the study area and represents part of a gradational spectrum with Facies 1. Combined, these two facies total just under 70% of all sediment recovered. The predominance of these two facies may in part be an artifact of recovery. Piston core techniques typically produce their best recoveries in silts and clays, and are less effective in penetrating sand sized material.

Facies 3: Interbedded clayey silt and very fine sand

Sedimentary Facies 3 is a massive clayey silt unit containing 25% to 50% interbedded clean silt and very fine-grained sand beds. Silt beds are less than a few cm thick and consist of plane parallel laminations. Sand lenses are silty and are typically preserved as 2 to 3 cm thick lenticular beds which contain significant concentrations of detrital organic material.

Where no sand is present, this facies varies from Facies 2 only in total silt content. Intrafacies contacts between Facies 2 and 3 are generally gradational, but may be sharp. Facies 3 is a relatively minor constituent in the study area, and is gradational with the coarser members of sedimentary Facies 2 (Figure 4-2).

Depositional mechanisms are inferred to be a combination of suspension sedimentation and deposition from the tail of low density turbidity currents. This is compatible with the restricted recovery of this facies from unchannelized environments in the upper to midule delta foreslope. All cored intervals in which this facies was noted are also contain thin turbiditic sand lenses (Facies 4b).

Facies 4: Silty, very fine-to medium sand

Sedimentary Facies 4 includes a variety of silty, very fine-to medium-grained sand units with less than 10% discrete, thin, clay or silt interbeds (Figure 4-2, Table 4-1). Three subfacies are recognized on the basis of individual sand bed thicknesses and geometry, and the presence or absence of silty-clay interbeds.

Facies 4a are sand-rich units with up to 10% silty-clay content. Individual silty-clay beds are less than 5 cm thick. Bed contacts may be either sharp or gradational in nature, and locally show some evidence of loading. Bedding may be either massive, or wavy to lenticular. Internal structures within the sand units include normal and inverse grading, and local parallel laminations marked by silty-clay and/or concentrations of rafted organic material. Soft sediment deformation occurs locally and includes both oversteepened laminations and rare convolute bedding. Sand beds are frequently poorly sorted, immature lithic sands with high matrix and organic contents. The matrix is primarily composed of very fine silt sized quartz fragments and diatom tests.

Vertical stacking is cyclic, and consists of both fining-upwards and well developed thickening and coarsening upwards sequences. This reflects a variety of depositional processes including subaqueous channel migration, avulsion and abandonment. Facies 4a is the predominant sand unit recognized in the study.

Facies 4b consists of very fine-to fine-grained silty sands, in isolated beds up to 10 cm in thickness. Sorting is poor, and beds are generally massive. Contacts may be either sharp or gradational. This facies is usually found as restricted units within sedimentary Facies 1 and 2. The Facies 4b sands are not in equilibrium with the Facies 1 and 2 silts and clays, and their abrupt contacts suggest an erosive component in the flow. Facies 4b is interpreted as deposition from unconfined turbidity currents within an environment dominated by suspension sedimentation.

Facies 4c consists of massive, fine-to medium sand beds greater than 1 m thick. Only two intervals of this facies were recognized in the piston cores, and both exhibit sharp upper contacts. The basal contact was only penetrated in a single core, and was an abrupt contact marked by a concentration of rip-up clasts. Facies 4c is interpreted as deposition from high-density turbidity currents.

Facies 5: Disorganized, chaotic beds

Facies 5 consists of a single interval of large wood fragments, shell fragments and clay clasts in a muddy matrix. The unit exhibits chaotic bedding and is internally massive. Bed contacts consist of an erosive base with an abrupt top (Figure 4-2). This facies may represent either a debris flow or a slump, and was found near the top of a thick interval of Facies 1 in 210 m of water at the base of the foreslope.

Facies Relationships and Origin

Sturgeon Bank Slope

Sturgeon Bank is a 75 km^2 depositional lobe north of the Steveston Jetty and the Sand Heads Sea Valley (Figure 4-1). The foreslope off Sturgeon Bank has not had a direct sediment source since the earliest 1900's (Clague *et al.*, 1983), and has been isolated from the Main Arm of the Fraser River since the completion of the Steveston Jetty. The area is underlain by subparallel continuous reflectors which drape relief on the underlying sediments (Hart *et al.*, 1992b). Based on sediment accumulation rates of 2.22 cm/yr (Moslow *et al.*, 1991), and accumulation of 3 to 8 m of undisturbed sediment, the slope appears to have been stable for the past 150 to 400 years (Hart *et al.*, 1992b).

Cross section A-A' was constructed across the delta slope on Sturgeon Bank immediately north of the Sand Heads Sea Valley (Figure 4-3). The upper foreslope here is dissected by numerous small-scale gullies which appear to be inactive, and have likely been dormant since completion of Steveston Jetty.

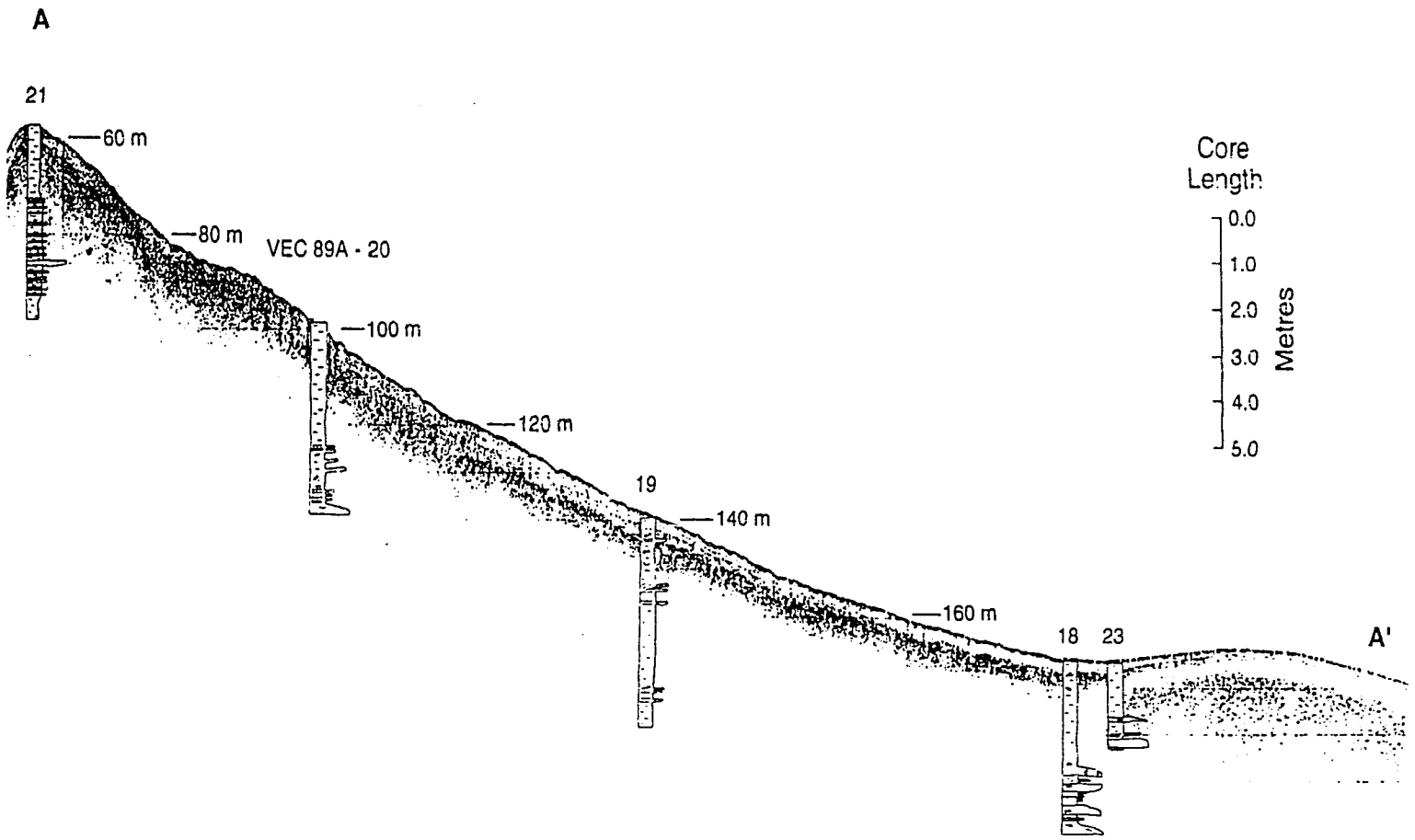


Figure 4-3. Sturgeon Bank dip-oriented cross-section A-A', projected onto a 3.5 kHz seismic survey line. Irregular surface bathymetry reflects surface creep and local small-scale slumping. Positive feature at the base of the slope represents the influence of a Pleistocence glacial ridge. Average seafloor slope between cores 21 and 18 is approximately 2°. See figure 4-1 for location.

Piston core VEC89A-21, from an interchannel environment, consists of a thick unit of Facies 3 within Facies 1 (Figure 4-3). The Facies 3 assemblage may represent a relict gully levee. One thin (7 cm) sandy interval consisting of poorly sorted immature sand with a muddy matrix, abrupt contacts and loaded base (Facies 4b) was noted at a depth of 3.0 m and may correlate to other sediment gravity flow deposits in cores immediately down slope along this section.

Piston cores VEC89A-19 and VEC89A-20 represent sedimentation within an interchannel environment on the middle foreslope, and are composed primarily of Facies 1 and 2. A thin fining-up unit of Facies 4a at the base of piston core VEC89A-20 may represent either an abandoned turbidity current channel sequence, or a series of unconfined turbidity currents. Further basinward, piston cores VEC89A-18 and VEC89A-23 represent deposition in an elevated saddle on the lower foreslope (Figure 4-3). These cores consist of Facies 1 overlying Facies 4a. Beds are both normally and inversely graded, and bed contacts are abrupt and locally loaded.

Roberts Bank Slope

Roberts Bank slope is the entire study area south of the Sand Heads Sea Valley. The delta slope here is currently subject to active sediment supply from the Fraser River. However, shallow seismic profiling off Roberts Bank suggests that the slope in this area is undergoing local sediment failure and may be primarily an area of erosion (Hart *et al.*, 1992b).

Piston core VEC89A-46 was recovered immediately seaward of two abandoned distributary channels on Roberts Bank (Figure 4-1). It consisted of a 1 m interval of Facies 3 and 4c overlying Facies 4a. A single loaded contact overlain by oversteepened lamination was found at the base of a 10 cm thick unit of Facies 4c. This suggests periods of rapid sedimentation and an associated elevation of pore fluid pressures. Larger scale oversteepened laminations are present near the base of the interval.

Piston cores VEC89A-41, VEC89A-42 and VEC89A-44 are all composed of thick sand-rich sequences (Facies 4) overlain by finer grained sediment (Figure 4-4). The sands are silty, very fine to medium-grained, moderately sorted and exhibit evidence for traction deposition and channelized flow. These units are usually massive, although well developed wavy and/or plane parallel laminations and rare clay rip-up clasts are present locally. High frequency (3.5 kHz) siesmic profiles show evidence of channel bank scour and downlap of reflectors into the channel floor along the southeast channel flank (Figure 4-4). This is interpreted to reflect northward channel migration, with piston core VEC89A-42 representing the current bathymetric expression of the channel. The channel is currently inactive, with a thin drape (10 to 15 cm) of clayey silt covering the channel floor (Figure 4-4). This channel has been named Roberts Bank Channel to distinguish it from the active Sand Heads Sea Valley (Kostaschuk *et al.*, 1992a) to the north.

The base of the foreslope at piston core site VEC89A-45 consists of greater than 80% massive, fine-to medium sand (Facies 4c); internal structure consists of oversteepened bedding and convolute laminations (Figure 4-5). The thick sand intervals have no active upslope sediment source. Deposition appears to be by traction on a depositional lobe associated with the mouth of the Roberts Bank Channel. Morphologic expression of this feature suggests that it represents a small fan associated with channel debouchment at the base of the delta foreslope. Sand deposition may be from a series of small scale constructional channels (Figure 4-5). This lobe is currently inactive.

Core VEC89A-39, in the lower-middle foreslope on southern Roberts Bank, is composed of Facies 3 overlying Facies 4. The probable depositional environment is an abandoned channel. Although there is no bathymetric evidence for a channel up slope from this site, attenuation of the seismic signal and disruption of reflector continuity (Figure 4-6) may reflect a relict channel. This suggests that sedimentation rates have been high enough to completely bury the morphologic expressions of abandoned channels or slump scars.

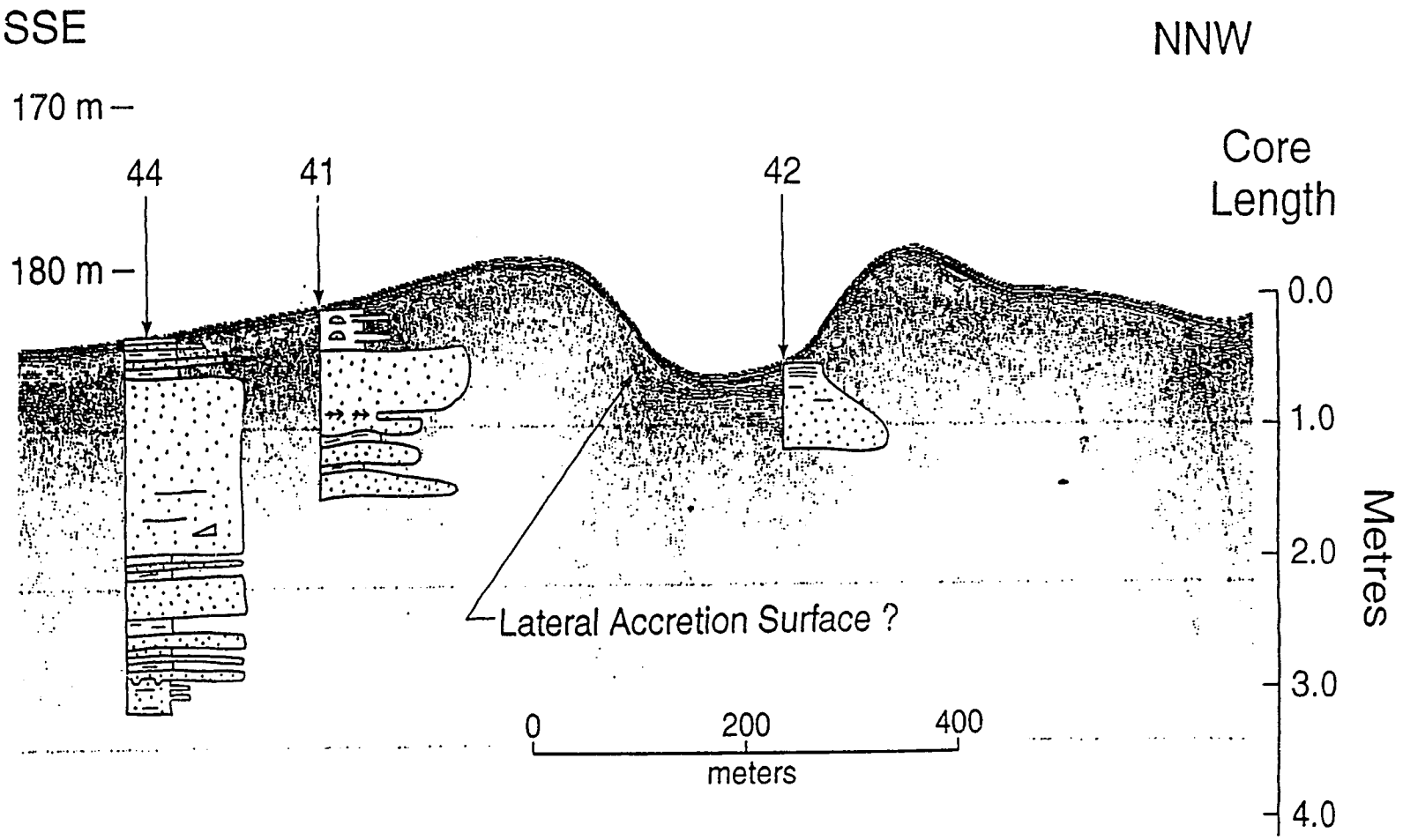


Figure 4-4. High resolution (3.5 kHz) seismic profile through the Roberts Bank Channel correlated to 3 piston cores showing lateral facies variability and seafloor morphology. Note evidence of reflector dowi. ap onto the channel floor, and channel bank scour surfaces interpreted to represent northward channel migration. Thin clayey-silt drape on the channel floor represents channel abandonment. Vertical exaggeration of piston core logs is approximately 8X. See Figure 4-1 for location.

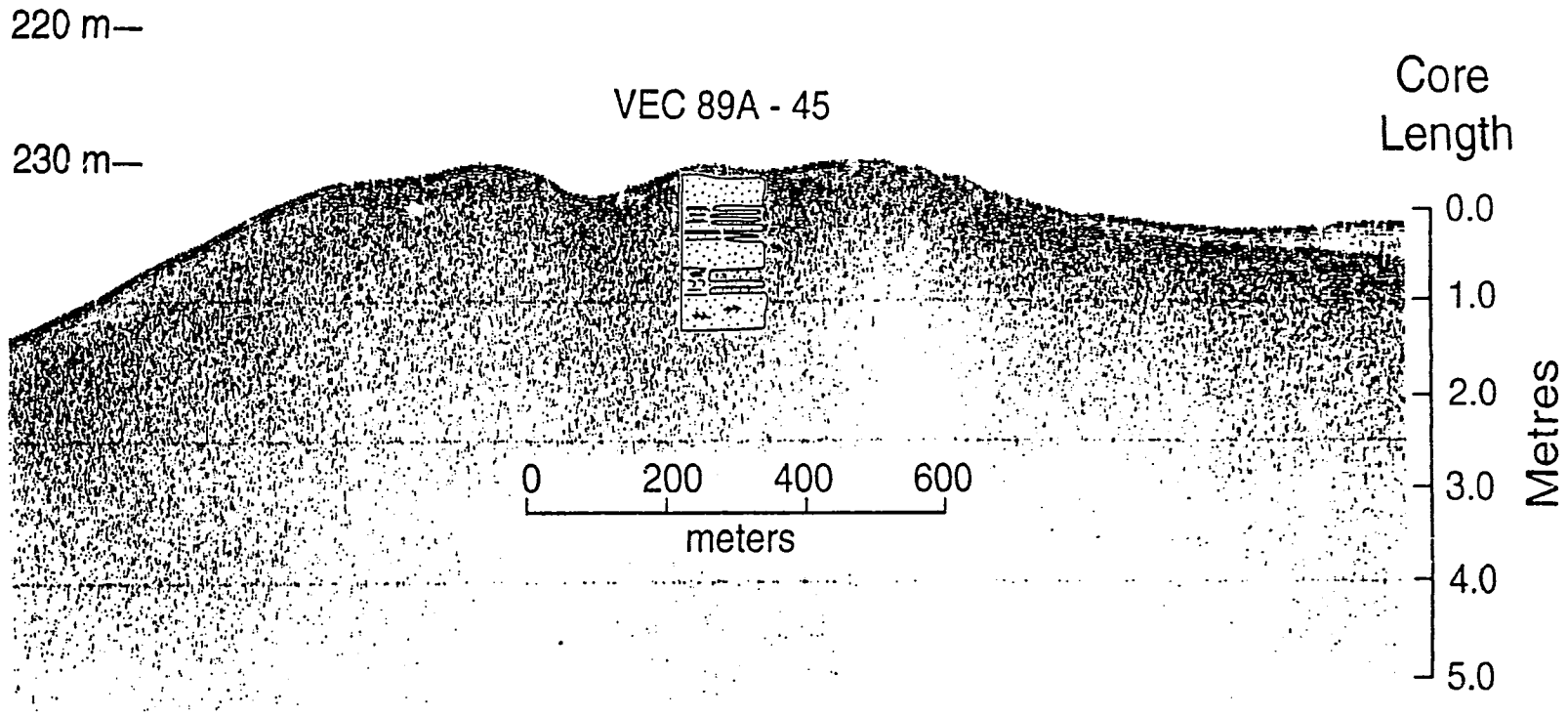


Figure 4-5. Sedimentologic character, morphologic expression, and internal seismic structure of depositional lobe at piston core site VEC89A-45. This lobe is associated with the terminus of the Roberts Bank Channel and interpreted as a small fan complex. Note the presence of constructional-depositional(?) channels on the fan surface. Vertical exaggeration of piston core logs is approximately 8X, total core length is 1.65 m. See figure 4-1 for location.

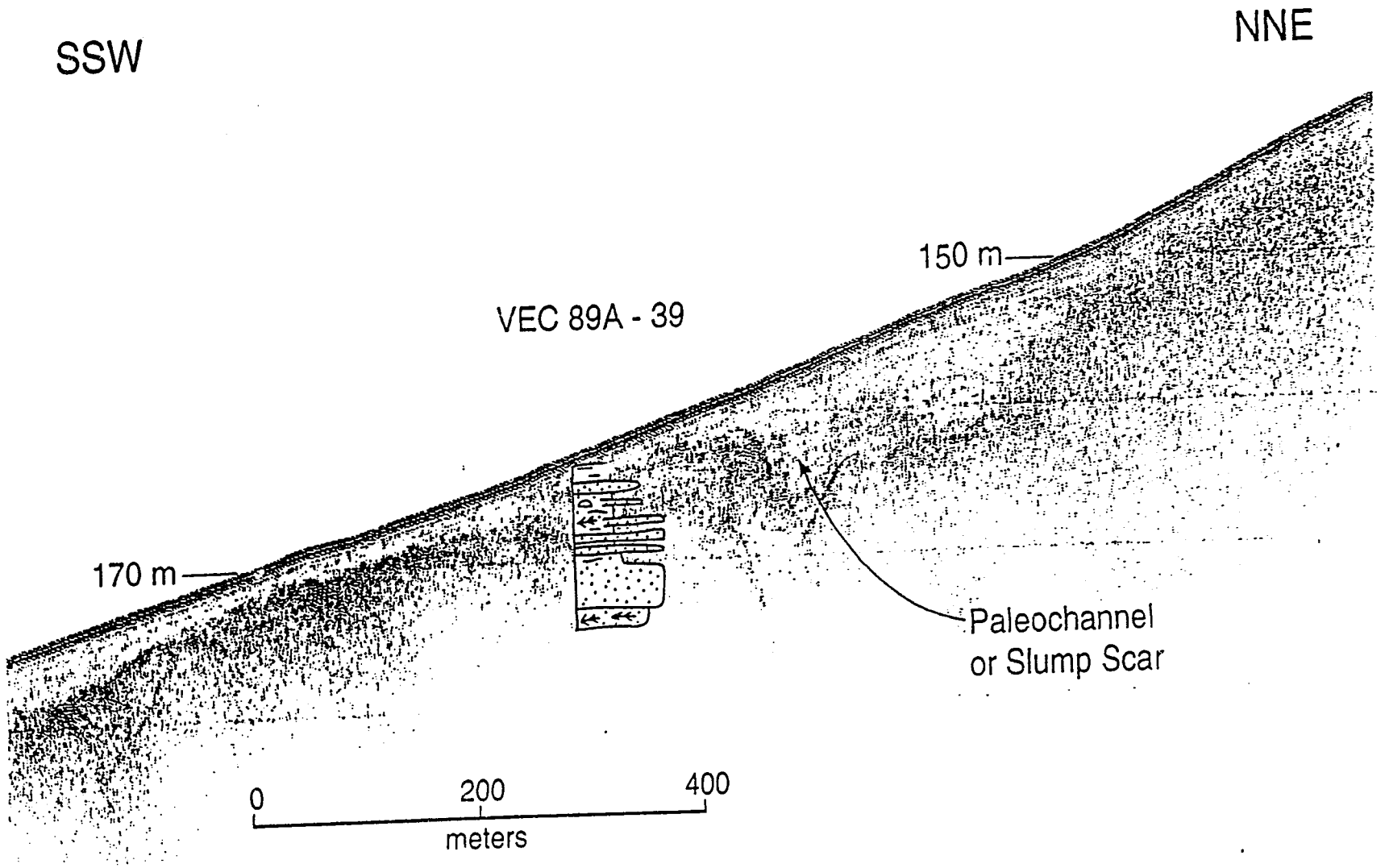


Figure 4-6. Interpreted channel-fill sedimentary sequence recovered in piston core VEC89A-39 correlated to 3.5 kHz high frequency seismic line on Roberts Bank. No bathymetric expression of this channel is preserved; however, a probable infilled channel, or slump scar, is evident on high resolution seismic records. Piston core length is 1.32 m. See figure 4-1 for location.

A thin unit of Facies 5 was encountered in the prodelta down dip from piston core VEC89A-39 in core VEC89A-40. The seismic expression of this unit is laterally continuous for a minimum distance of 700 m in a down dip direction (Figure 4-7). Although there is no evidence of active channels or channelized flow in cores collected upslope from this site, a pronounced embayment in the bathymetric contours between piston core sites VEC89A-40 and VEC89A-39 (Figure 4-1) is of appropriate scale to represent a significant slump scar on the foreslope.

Sand Heads Sea Valley

Piston core VEC89A-03 was drilled along the flank of the Sand Heads Sea Valley. The core is composed entirely of Facies 4, and represents a stacked, well developed channel sequence with normally graded beds and pronounced coarsening and thickening-up sequences (Figure 4-8). Deposition is from traction at the base of channelized turbidity currents. Piston core VEC89A-06, 800 m north of core site VEC89A-03 on the inferred levee of the Sand Heads' Sea Valley, represents a weakly defined fining upwards sequence with Facies 2 and minor Facies 4b overlain by Facies 1 (Figure 4-8). Interpreted depositional processes are channel overbank or inter-channel flow by dilute, unconfined turbidity currents and concurrent background deposition of silty clay from suspension fallout.

Lateral Facies Variability

The significance of channelized subenvironments in the development of the geometry and internal architecture of the delta front is apparent from depositional strike sections. Transverse section D - D' (Figure 4-1) demonstrates the importance of coarse grained siliciclastic material in the depositional framework of the Fraser River delta (Figure 4-8). The piston cores on this section were all recovered from water depths between 160 and 190 m. All but one of these cores contain some fine-to medium-grained sand beds (Facies 4), and Facies 4a sands are a significant component of the total recovered sediment (> 30%) in five of the seven cores.

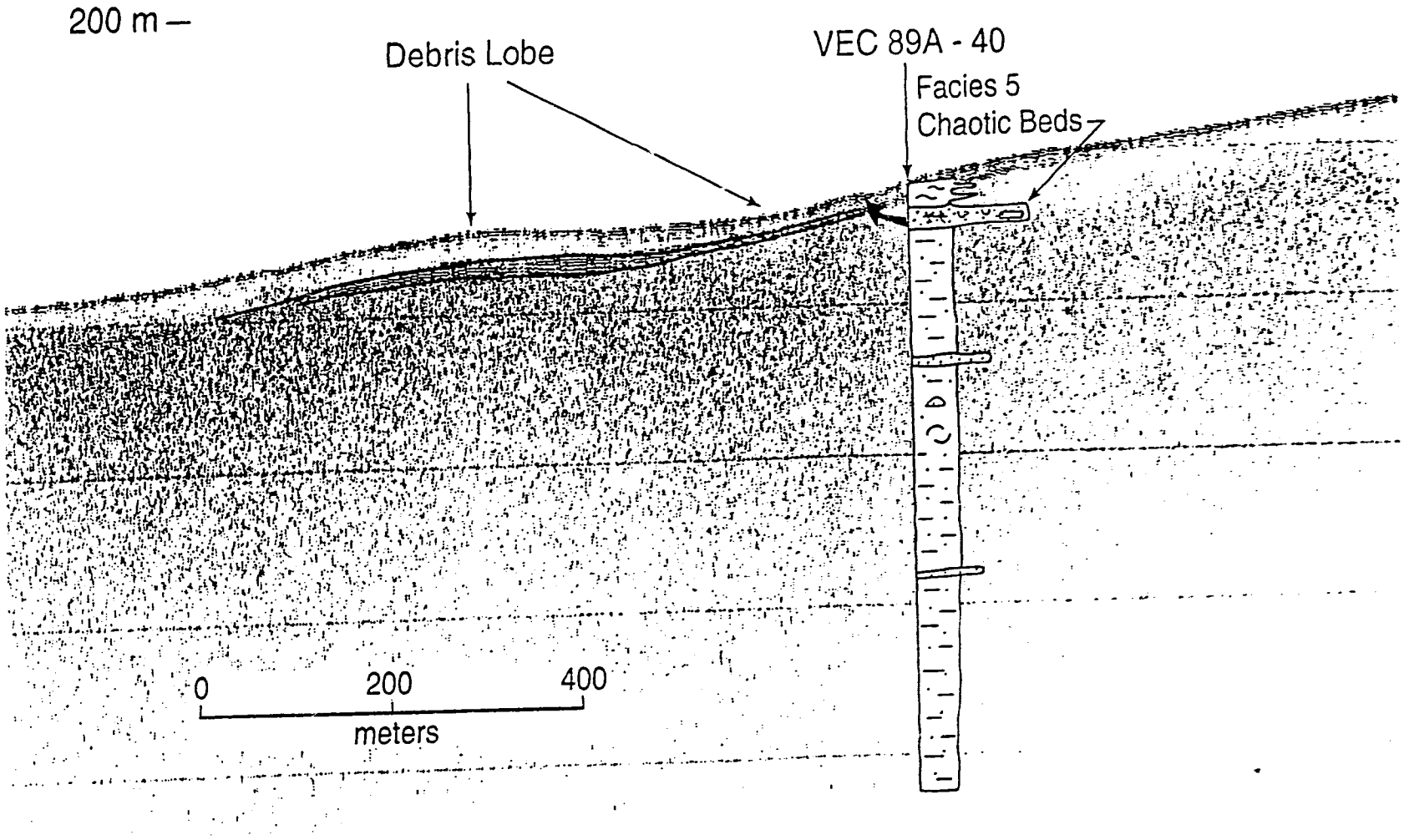


Figure 4-7. High frequency (3.5 kHz) seismic profile in vicinity of piston core VEC89A-40 showing thickness and lateral (down-dip) continuity of facies 5 chaotic beds. Vertical exaggeration of piston core is approximately 8X, total core length is 4.86 m. See Figure 4-1 for location.

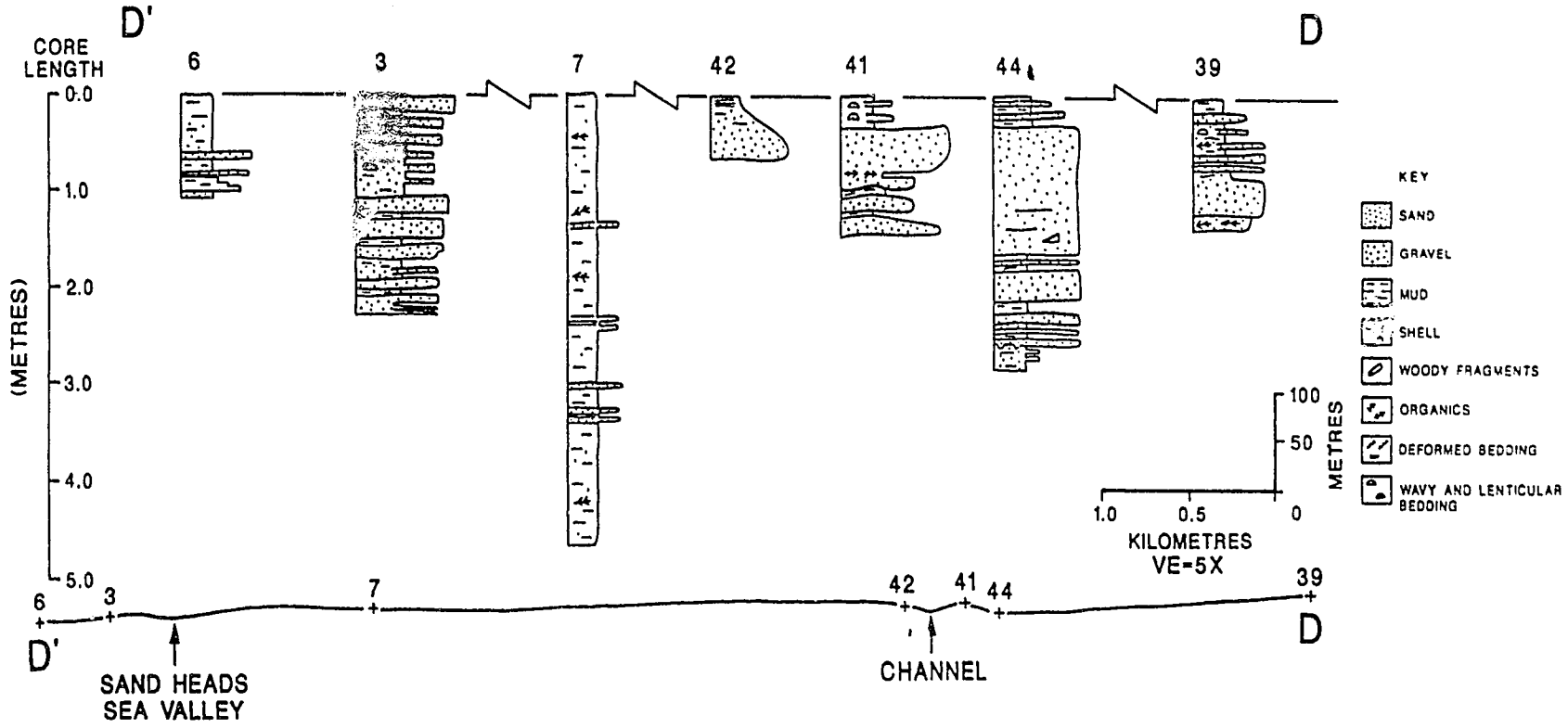


Figure 4-8. Depositional strike section D-D' near the base of the delta foreslope showing sedimentary facies variability at approx. 180 m water depth. Note the preponderance of facies 4 sands. Vertical exaggeration on bathymetric profile at the bottom of the figure equals 5X. See Figure 4-1 for location.

Piston core VEC89A-07 represents an interchannel environment on the lower foreslope between the inactive Roberts Bank Channel and the Sand Heads Sea Valley (Figure 4-8). Sediments consist primarily of silty clay (Facies 1) deposited from suspension, with minor deposition of sand from the entrained layer of unconfined turbidity currents (Facies 2). Rare *Paleophycus* burrows are associated with thin sand intervals between 2.8 and 3.4 m. Rafted organics and wood fragments, both disseminated and bedded, are present in the non-bioturbated intervals.

Summary and Conclusions

Five sedimentary facies are recognized in piston cores from channel-margin, interchannel and depositional lobe environments on the Fraser River delta foreslope. Massive to finely laminated silty clays to clayey silts of Facies 1 and 2 are interchannel sediments deposited primarily by suspension settling from the river plume and weak traction currents. Facies 3 is an interbedded clayey silt to very fine-to medium-grained sand that is planar laminated and lenticular bedded, and deposited by a combination of suspension settling and low-density turbidity currents. Facies 3 occurs primarily along the margins of foreslope channels that are likely relict levees. Silty very fine-to medium-grained sand with silty clay interbeds of Facies 4a are wavy to lenticular bedded, soft-sediment deformed, graded, and occasionally over-steepened. This facies occurs along the margins of both active and inactive channels and was deposited by suspension settling, traction and mass wasting processes during lateral channel migration and abandonment. Thin to thick bedded, massive to laminated silty very fine-to medium-grained sands of Facies 4a and 4b were deposited by high-to-low density turbidity currents along channel margins and as depositional lobes at the base of the delta foreslope at the terminus of foreslope channels. These lobes are small-scale fans deposited by channelized turbidity currents. The best example of such a fan/lobe is found in association with the inactive Roberts Bank Channel in 230 m of water (Figure 4-5). This lobe represents an important mechanism and product of "sand by-passing" across the delta foreslope.

Sedimentary evidence of possible debris flows is found in only one core, located on Roberts Bank immediately downslope of a slump scar on the foreslope (Figure 4-7). The debris flow deposit (Facies 5) is composed of resedimented organics, shell fragments and poorly sorted very fine-to medium sand with silty clay rip-up clasts in a silt/clay matrix. Even though the spatial distribution and depth of cored sediment is limited, it appears that debris flows are relatively insignificant as a process of sediment remobilization and deposition. Conversely, from sedimentologic observations, most of the foreslope sand deposits are the product of low-to-high density turbidity currents. Turbidity currents in the Sand Heads Sea Valley result from mass wasting of sediment at the mouth of the river in response to rapid sediment loading (Kostaschuk *et al*, 1992a). The Roberts Bank Channel and depositional lobe are presumed to have a similar origin.

The incision of multiple channels through time on the delta foreslope has resulted in a high degree of along-slope lateral facies variability. An along-slope facies cross-section in 180 m water depth documents the relative importance of sand deposition on the Fraser River delta foreslope. Channelized turbidity current transport of coarse sediment across the relatively steep (3°) slope ("sand by-passing") into water depths ≥ 250 m provides a process sedimentologic analogue for identification and/or reconstruction of ancient shelf-edge deltaic facies. In addition, the Fraser River delta foreslope may provide an opportunity to test theories of facies accumulation and sediment deposition during eustatic sea level low-stands.

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CHAPTER 5.
COMPARATIVE GEOMETRY OF SUBAQUEOUS CHANNEL FACIES, FRASER RIVER DELTA FORESLOPE, BRITISH COLUMBIA: IMPLICATIONS FOR THE DEPOSITION OF LOWSTAND SANDS.[4]

Introduction

The significance of sediment bypassing of the continental shelf in the delivery of sand to deeper-water environments has long been recognized. The resultant sand bodies provide excellent hydrocarbon targets as they are frequently encased by marine shales that provide both seals and potential source material. These sands may also represent the sole evidence for significant fluctuations in relative sea level.

The Fraser River delta, a coarse-grained delta prograding directly into water depths exceeding 200 m, provides a modern process analogue for sediment bypassing from shallow to "deep" water environments. Delta sedimentation was initiated during a relative sea level fall, followed by minimal transgression, due to the interplay between isostatic rebound and eustatic sea level rise. The delta slope is dominated by fluvial processes, and the role of extrabasinal control over basin geometry is significant. Earthquake activity may play a role in initiating the remobilization of sediment via seismic loading.

This study builds on the results of ongoing research documenting sediment accumulation rates (Evoy, 1992; Evoy *et al.*, 1993b), textural parameters and sedimentary fabric (CHAPTER 3), and the distribution of sedimentary facies across the Fraser River delta foreslope (Evoy *et al.*, 1993a; 1994; see also Table 5-1). The integration of vibrocoring results with high frequency seismic profiles, detailed sedimentologic descriptions, and textural and mineralogic analyses of the cores results in a unique data set with which to study the origin, geometry and variability of sedimentary facies in submarine channels and associated

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[4] A version of this chapter has been submitted for publication. Evoy, R.W. and Moslow, T.F. Journal of Sedimentary Research.

TABLE 5-1: SUMMARY OF MAIN SEDIMENTARY FACIES CHARACTERISTICS (modified from Evoy *et al.*, 1994)

Facies Designation		Lithology	Sedimentary and Bedding Characteristics
Facies	Depositional Process		
1, 2	suspension sedimentation	silty clay to clayey silt; <10% silt or v.fine sand as discrete laminations.	massive to plane parallel laminated; rare wavy to lenticular beds; bedded and disseminated organics.
3	mixed traction/suspension sedimentation	interbedded clayey silt with v.fine/fine sand; silt > sand.	plane parallel laminations; lenticular bedding; contacts gradational, rarely abrupt.
4a	channel fill sands: lateral accretion, vertical aggradation, and slumping.	silty, v.fine to medium sand <10% silt/clay interbeds	massive, wavy or lenticular bedding; normal to inverse grading; convolute laminations, oversteepened bedding; rare load casts; contacts gradational or sharp, thickens/coarsens upwards.
4b	low density turbidity currents	silty v.fine to fine sand in beds <10cm thick	massive, poorly sorted; contacts sharp or gradational; erosive bases.
4c	high density turbidity currents	silty, fine to medium sand	massive, mud rip-up clasts; abrupt contacts.
5	debris flows	resedimented organics, shell fragments and sand; silt/clay matrix	poorly sorted, chaotic; mud rip-up clasts.

depositional lobes on a delta foreslope.

The unique geographic setting, and the presence of sand-sized clastic detritus being introduced directly into water depths exceeding 200 m, may serve as an analogue to lowstand (shelf-edge) deltas. The Fraser River delta foreslope therefore represents an ideal process analogue for investigating the variability in siliciclastic facies deposited on the outer continental shelf during a relative sea level fall.

Setting

The Fraser River delta is a deep-water delta (Postma, 1990) with a pronounced foreslope developed below the influence of most surface waves (Hart *et al.*, 1992a), and is currently building out into water depths in excess of 200m. The seaward margin of the Fraser River delta consists of a series of broad tidal flats up to 9 km in width with an average slope of less than 0.1°. The foreslope extends a further 5 to 10 km seaward at an average gradient exceeding 3.0°. The delta slope can be subdivided into upper, middle and lower foreslope based on water depth and sediment delivery patterns (Figure 5-1). The delta is sourced with relatively coarse-grained detritus via strongly seasonal discharge (Kostaschuk *et al.*, 1989a), experiences large tidal draw down, is protected from excessive storm waves by the limited fetch across the Strait of Georgia, and exists within one of the most active seismic regimes in Canada (Luternauer, 1988).

Much of the coarsest sediment supplied to the mouth of the delta bypasses the delta plain and upper foreslope and is introduced directly to the lower foreslope and basin floor. The foreslope is cut by two prominant sand-floored channels hundreds of metres wide and over 10 m in relief (Kostaschuk *et al.*, 1992; Hart *et al.*, 1992a; Evoy *et al.*, 1993a). These channels debouche onto the basin floor producing a series of sand-rich depositional lobes in water depths of 200 to 250 m (Moslow *et al.*, 1991; 1993; Evoy *et al.*, 1993b). These channels are initiated and maintained by sediment gravity flow processes related to periodic liquifaction and failure at the head of the foreslope (McKenna and Luternauer, 1987;

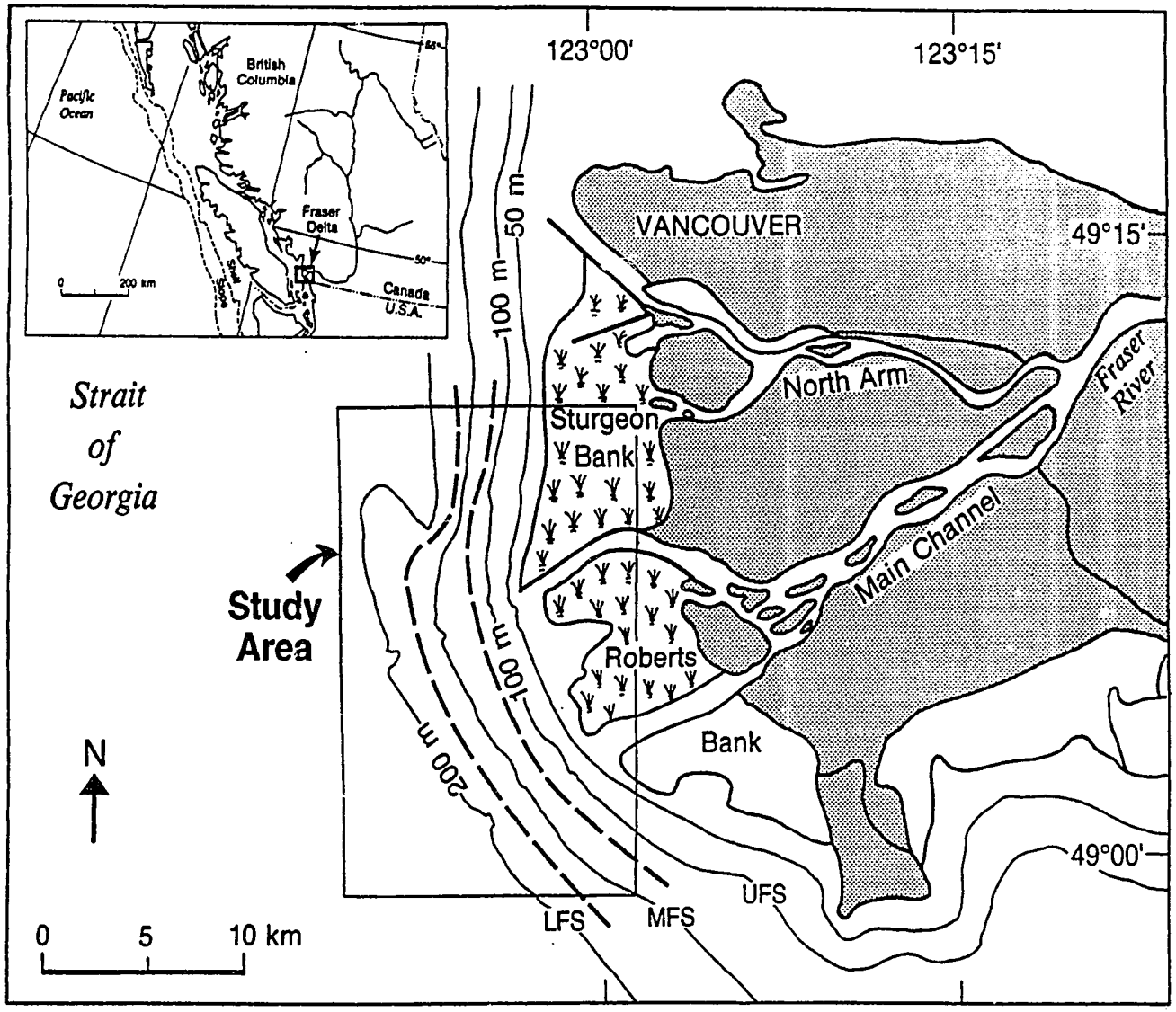


Figure 5-1. Study area location map with generalized bathymetry and main physiologic elements of the Fraser River delta foreslope. Patterned area denotes intertidal sand and mud flat; UFS, MFS and LFS refer to upper, middle and lower foreslope areas respectively.

McKenna *et al.*, 1992; Kostaschuk *et al.*, 1992; Hart *et al.*, 1992a).

Inception of sedimentation in the Fraser River delta at the beginning of Holocene time was coupled with an isostatically driven fall of local sea level exceeding 100 m (Clague *et al.*, 1982). The ensuing transgression during the past 8,000 years is on the order of 10 to 13 m (Clague *et al.*, 1983; Williams and Roberts, 1989).

The Roberts Bank Channel is located in the centre of the study area (Figure 5-2), and is currently inactive and mantled with a thin sediment drape. Although minor sand-sized sediment input may be sourced by longshore sandwave migration, the channel has likely not experienced a direct sediment source since upstream channel avulsion in the mid-1800's (Johnston, 1921; Luternauer and Finn, 1983). As such, the Roberts Bank Channel predates any appreciable anthropogenic mediation and represents the closest approach to a natural setting on the delta foreslope.

The Sand Heads Sea Valley, off the Main Arm of the Fraser River is the only subaqueous channel currently active (Figure 5-2). The position of the Main Arm of the Fraser River has been culturally fixed by the construction of the Steveston Jetty in the 1930's, and is modified by continual dredging of the main navigation channel. The impact of man-made structures has significantly altered sedimentation patterns and minimized the likelihood of future channel avulsion (Clague *et al.*, 1983).

Database and Methodology

This study integrates the results of a number of detailed vibracoring surveys with high-frequency (3.5 kHz) seismic surveys conducted by the Geological Survey of Canada. The data set for this study consists of sedimentologic descriptions of approximately 90 vibracores, piston cores and gravity cores, plus several hundred kilometers of high frequency seismic profiles (Figure 5-2). Data acquisition was concentrated on the immediate vicinity of the

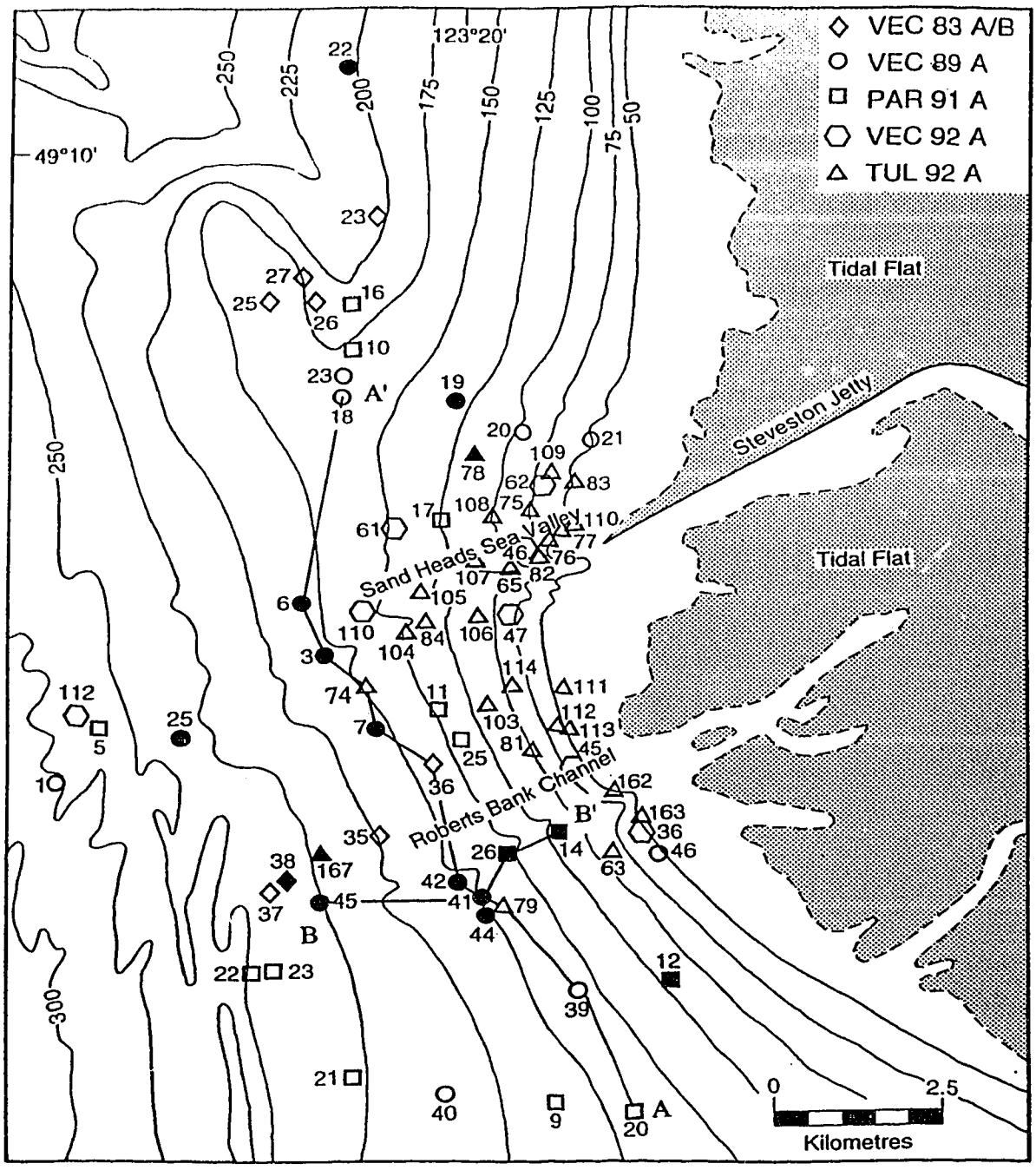


Figure 5-2A. Detailed bathymetry of the Fraser River delta foreslope in the study area with database compilation for sediment cores, as identified in the legend. Core sites denoted with closed symbols are discussed in the text.

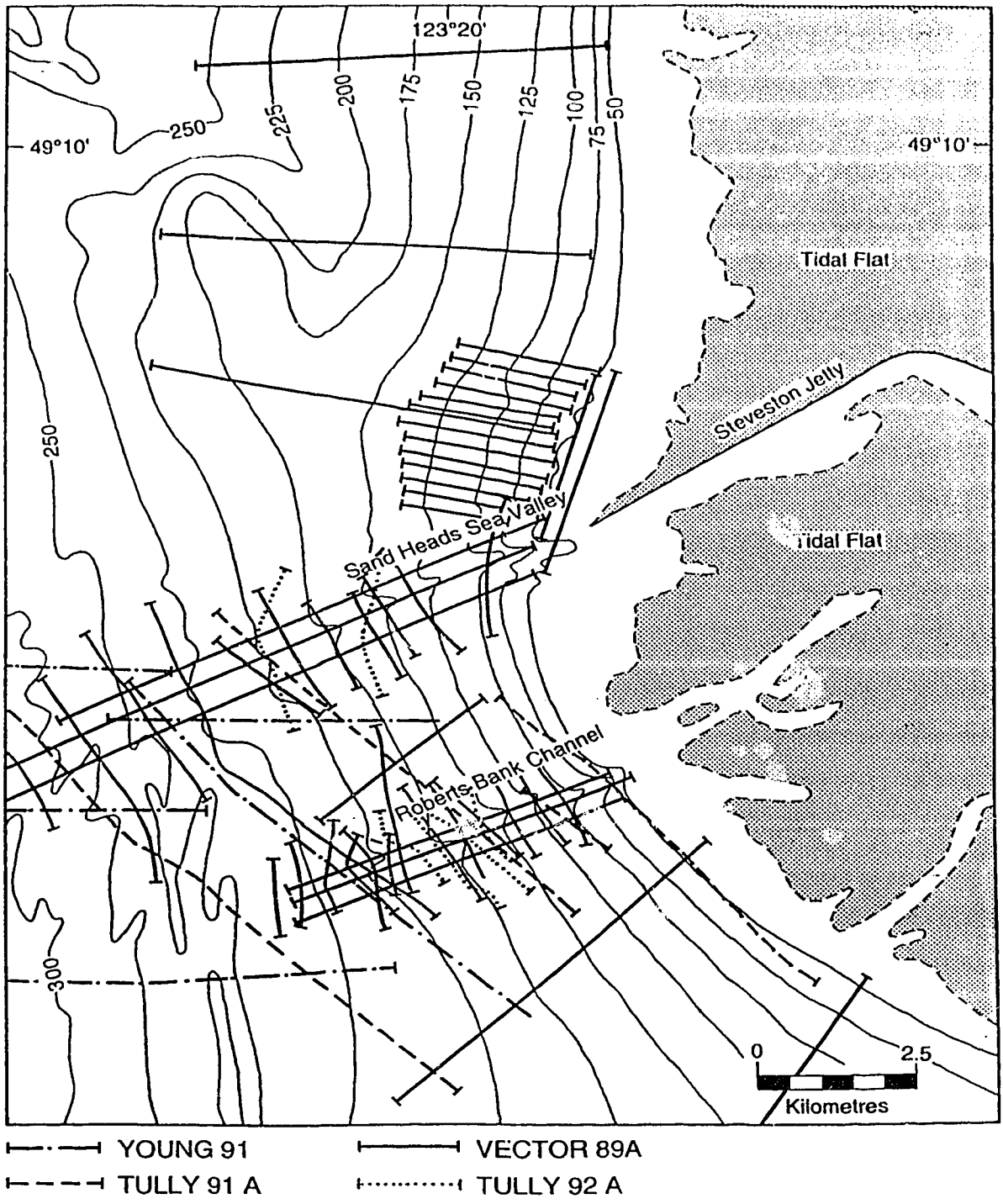


Figure 5-2B. Detailed bathymetry of the Fraser River delta foreslope in the study area with high-frequency seismic lines, as identified in the legend.

major subaqueous channels and their depositional lobes. Detailed textural analysis of vibracores delineates depositional architecture and facies variability trends in delta front sands from depositional lobes formed at the channel mouths.

Sedimentary Facies

Five sedimentary facies are recognized in piston cores collected from channel-margin, interchannel and depositional lobe environments on the Fraser River delta foreslope (Table 5-1) and have been described in detail elsewhere (Evoy *et al.*, 1994). Suspension sediments deposited directly from the river plume (Facies 1 and 2) are predominantly structureless to finely-laminated silts and mud. Suspension deposition is ubiquitous on the delta foreslope, and represents the ambient background sedimentation condition of the subaqueous delta. Mixed traction and suspension sedimentation, consisting of interbedded clayey silts and very fine- to medium-grained sands (Facies 3), occurs primarily at the head, or along the flanks, of subaqueous channels in the upper foreslope. Thick-bedded channel sands are composed of silty, fine-grained sands with less than 10% thin clay or silt interbeds, and occur along the margins of both active and inactive channels. High-density turbidites consist of massive, fine- to medium-grained sand, and are restricted to channel thalwegs or associated depositional lobes at the base of the foreslope. Thin-bedded, low-density turbidites and debris flows are volumetrically insignificant, and are not restricted by subenvironment (Evoy et al., 1994).

Background Sedimentation - Sturgeon and Roberts Banks

Sturgeon Bank is a 75 km^2 depositional lobe north of the Steveston Jetty and the Sand Heads Sea Valley (Figure 5-1). The foreslope off Sturgeon Bank is currently inactive and has not had a direct sediment source since the earliest 1900's (Clague *et al.*, 1983) being isolated from the Main Arm of the Fraser River since the completion of the Steveston Jetty. The area is underlain by subparallel continuous reflectors which drape relief on the underlying sediments (Hart *et al.*, 1992b).

Background sedimentation in the prodelta to basinal environment at the base of the foreslope is dominated by passive settling of sediment from suspension. Cesium-137 analyses have demonstrated a minimum sediment accumulation rate of 0.76 cm/yr for the period 1954 to 1989 (Evoy *et al.*, 1993a). Internal sedimentary structures in prodelta cores consist of massive, to weakly burrowed, silty clay to clayey-silt with rare silty laminations and minor rafted organic debris (Figure 5-3a). Similar characteristics are present on the foreslope of Sturgeon Bank proximal to the Sand Heads Sea Valley (Figure 5-3b and 5-3c).

The Roberts Bank foreslope encompasses the entire study area south of the Sand Heads Sea Valley, and is currently subject to active sediment supply from the Fraser River. However, shallow seismic profiling suggests that the slope in this area is undergoing local sediment failure and may be primarily an area of erosion (Hart *et al.*, 1992b). Sediment cores from interchannel areas on the foreslope exhibit sedimentologic characteristics similar to those above. The foreslope north of the Roberts Bank Channel is composed of clayey silt with minor burrows and woody organics, and rare planar laminated, silty, very fine-grained sand interbeds (Figure 5-4a). South of the channel, the foreslope consists of dark grey to black, weakly burrowed, sandy mud with minor organics, and rare planar laminated to ripple laminated silty sand (Figure 5-4b).

Results

Roberts Bank Channel/Depositional Lobe

Roberts Bank has been extensively cored, and the channel has been covered by closely-spaced, high-frequency (3.5 kHz) seismic survey lines (Figure 5-5). The Roberts Bank Channel is a broad, shallow bathymetric feature, approximately 200 m wide by 10 m deep, and bounded by gentle, well-developed depositional levees (Figure 5-6a). At the base of the foreslope, the channel debouches as a well-developed depositional lobe approximately 1000 m wide by 10 m thick, and composed predominantly of fine- to medium-grained sand. The transition from channelized environment to depositional lobe is relatively abrupt. The first

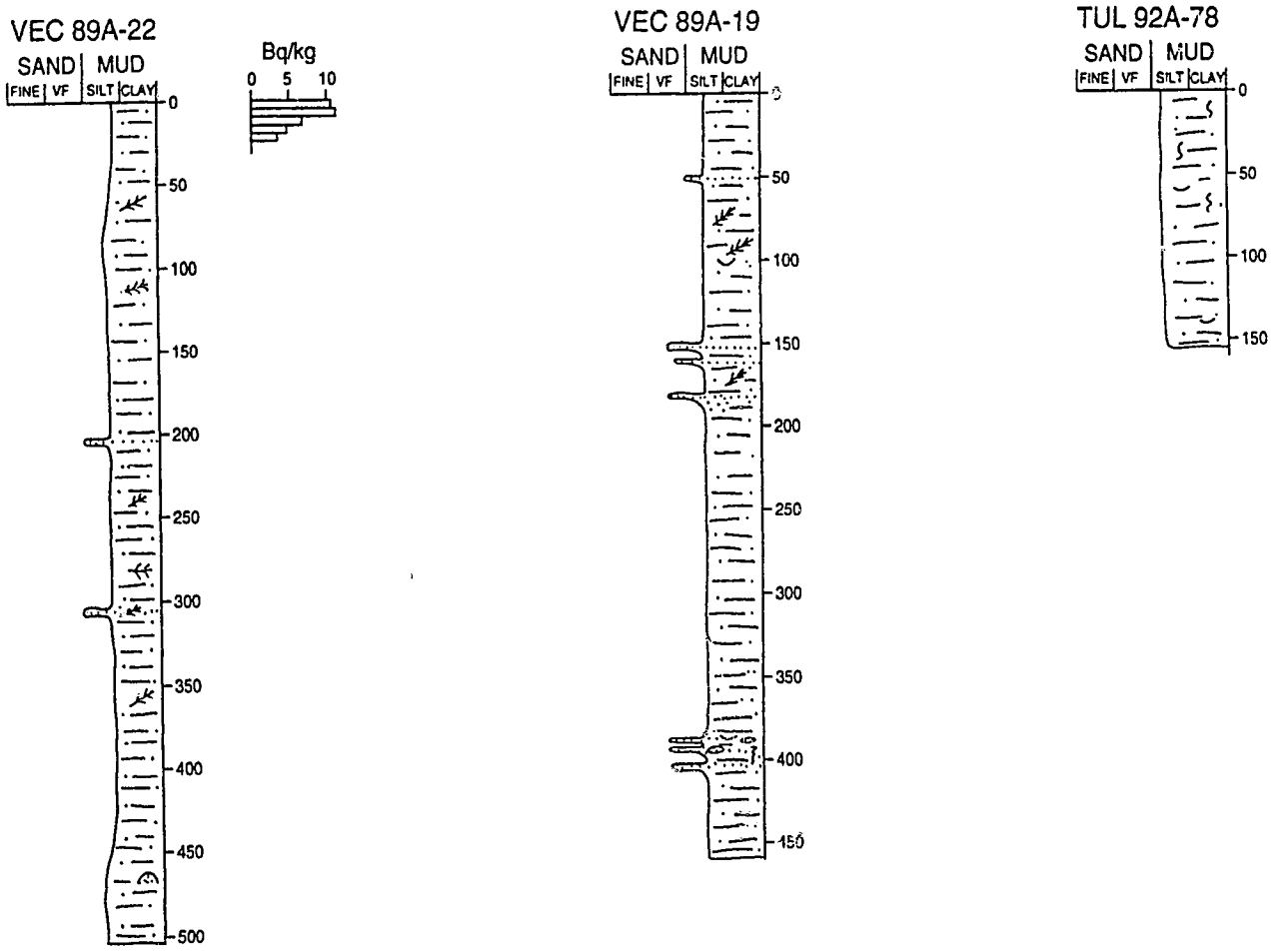


Figure 5-3. Sedimentologic logs for piston cores representative of Sturgeon Bank, see Figure 5-2A for location.
A). Sedimentologic log and Cs^{137} profile for core VEC89A-22.
B). Sedimentologic log for core VEC89A-19.
C). Sedimentologic log for core TUL92A-78.

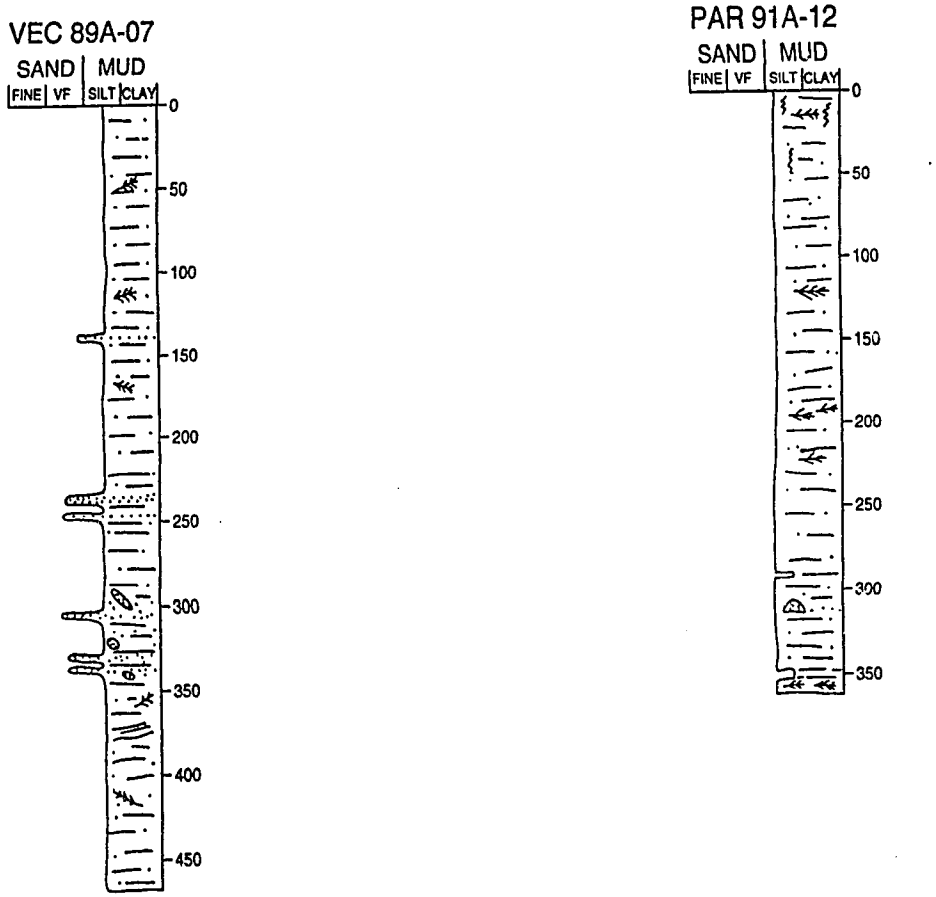


Figure 5-4. Sedimentologic logs for piston cores from Roberts Bank, see Figure 5-2A for location.
A). VEC89A-07 from the lower foreslope between Roberts Bank Channel and the Sand Heads Sea Valley.
B). PAR91A-12 from the middle foreslope south of the Roberts Bank Channel.

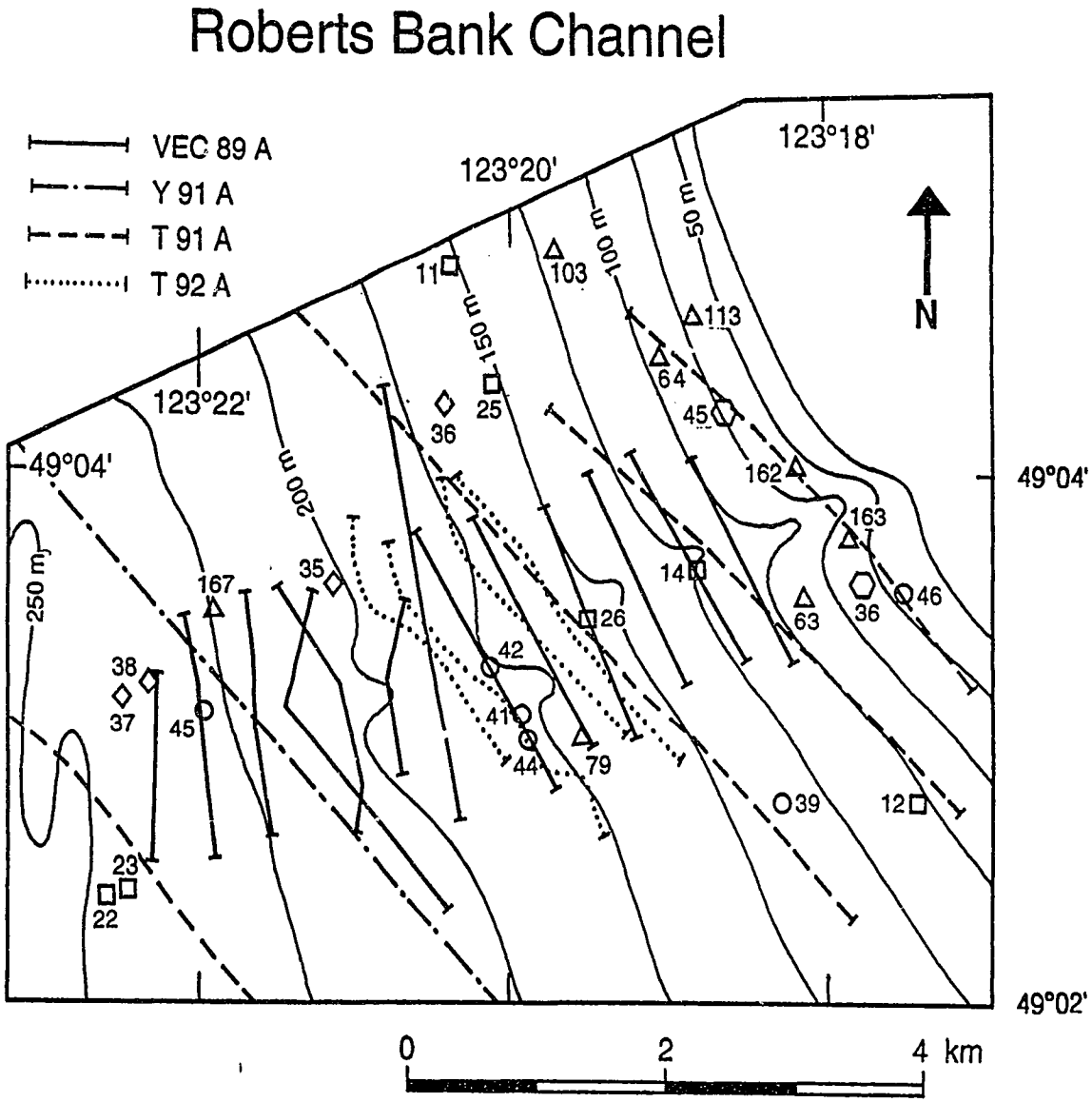


Figure 5-5. Detailed bathymetry of the Roberts Bank Channel showing location of core sites and high-frequency seismic line traces. See Figure 5-1 for location.

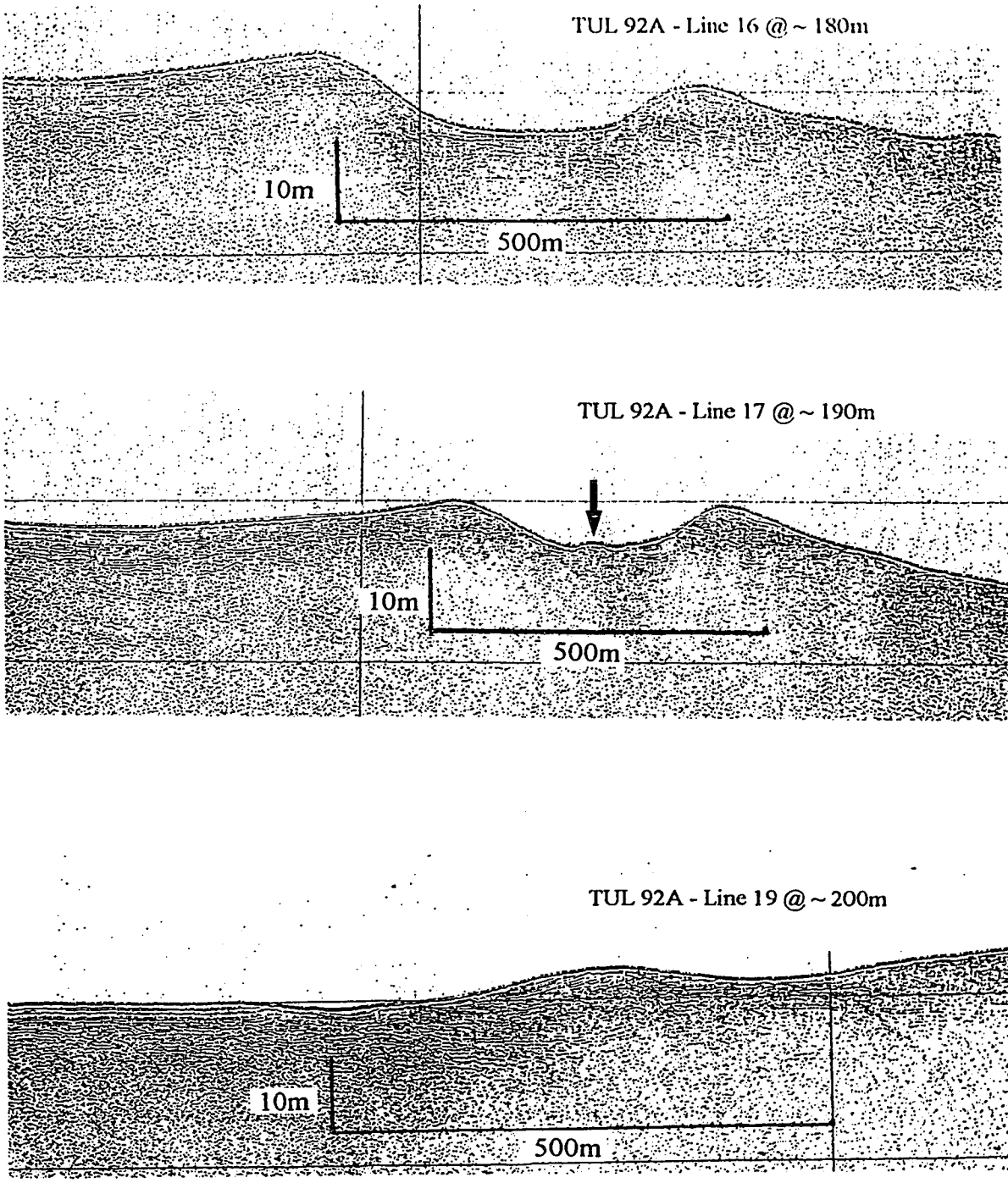


Figure 5-6. High resolution seismic line traces across the Roberts Bank Channel and depositional lobe.

A). Line TUL92A-16.

B). Line TUL92A-17. Small positive feature in channel axis (arrow) is the first bathymetric expression of lobe deposition.

C). Line TUL92A-19 transects the lobe at an acute angle. Note evidence for lobe progradation in sigmoidal clinoforms downlapping into the basin on the northwest side of the depositional lobe.

positive bathymetric expression of the depositional lobe is encountered at a water depth of approximately 190 m, within the thalweg of the Roberts Bank Channel (Figure 5-6b). By approximately 205 m water depth, all expression of the channel is lost and the depositional lobe is well developed as a positive feature. Internal seismic structure within the lobe reveals a number of sigmoidal to tangential reflectors which downlap into the basin as a result of lobe progradation (Figure 5-6c).

An abundance of very fine- to fine-grained sand is supplied to the head of the Roberts Bank Channel and the upper foreslope. Piston cores recovered immediately seaward of abandoned distributary channels on Roberts Bank consist of interbedded traction and suspension deposits and thick-bedded channel sands (Evoy et at., 1994; CHAPTER 3). Rare loaded contacts, overlain by intervals of oversteepened laminations, suggest periods of rapid and/or differential sedimentation and an associated elevation of pore fluid pressures.

The middle foreslope appears to be largely a zone of sediment bypassing (CHAPTER 3). The channel levee was cored at 120 m water depth, near the transition from the upper to middle foreslope. Piston core PAR91A-14 consists of interbedded sandy silt and mud with very fine- to fine-grained silty sand and medium-grained sand in beds up to 25 cm thick (Figure 5-7a). The channel-fill at 160 m water depth is much finer-grained than in any other channel cores recovered, as is evident in percent sand, number and thickness of discrete sand beds, and mean grain size (Figure 5-7). Piston core PAR91A-26 is characterized by weakly burrowed muddy silt with minor very fine-grained sand as thin planar laminations, ripples, or discontinuous lenses (Figure 5-7b). Shelly debris and bedded organics are common in the upper foreslope, but only constitute a minor element of the accumulated sediment on the middle foreslope.

Channel-fill sediments on the lower foreslope are predominantly composed of thick sand beds overlain by finer-grained sediment (Figure 5-7c). These sands are silty, very fine- to medium-grained, and moderately sorted. These deposits are usually massive, although well

B

B'

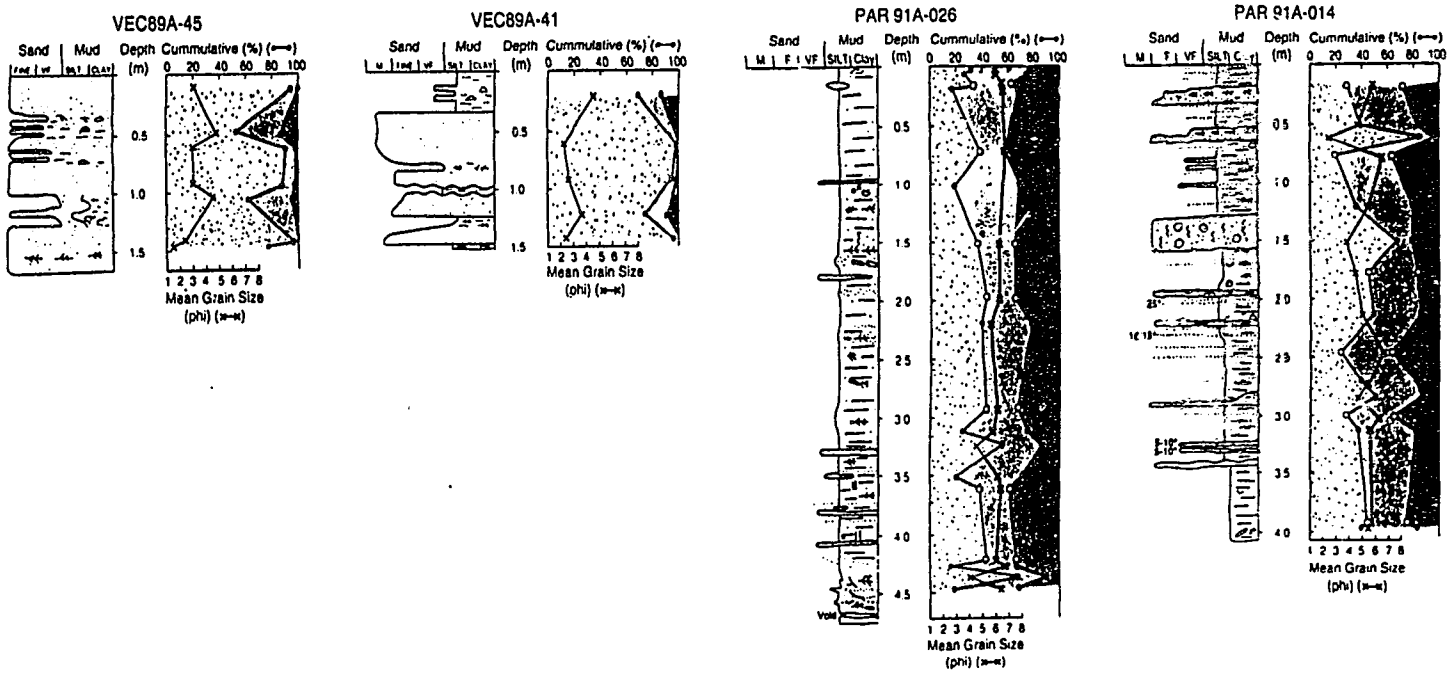


Figure 5-7. Sedimentologic logs with grain size distributions for piston cores collected along the axis of the Roberts Bank Channel documenting the degree of sand bypassing in the middle foreslope (PAR91A-26), and deposition at the base of the lower foreslope (VEC89A-45). Location shown on Figure 5-2A.

developed wavy and/or plane parallel laminations and rare clay rip-up clasts present local evidence for traction deposition and channelized flow. Seismic profiles show channel bank scour and downlap of reflectors into the channel floor along its southeast flank (Figure 5-8). This pattern is interpreted to reflect northward channel migration, with piston core VEC89A-42 representing the current bathymetric expression of the channel.

The Roberts Bank Channel debouches as a broad, depositional sand lobe at the base of the foreslope in approximately 230 m water depth (Figure 5-9). These sands represent the cleanest and coarsest sediment recovered from the foreslope on Roberts Bank (CHAPTER 3). Deposition in this lobe appears to be by traction as a series of small scale constructional channels.

The Roberts Bank lobe consists of greater than 80% massive, fine-to medium sand with oversteepened bedding and convolute laminations (Figure 5-10a). Gravity cores collected from the flanks of this depositional lobe are composed of silty muds or clayey silts with sharp based fine- to medium-grained sand beds. These sand beds are up to 15 cm thick and locally exhibit loaded bases (Figures 5-10b, 5-10c). Crudely bedded organics are common, and the basal mud-dominant portion of cores are variably burrowed to bioturbate (Figure 5-10b).

Sand Heads Sea Valley

Most studies of sediment transport and failure in the subaqueous delta have concentrated on the Sand Heads Sea Valley area (eg. Kostaschuk *et al.*, 1989b; Hart *et al.*, 1992a; Kostaschuk *et al.*, 1992; McKenna *et al.*, 1992). The Sand Heads Sea Valley consists of a number of tributary channels (Figure 5-11) which rapidly coalesce to form a single, broad channel approximately 300 m wide, and up to 18 m deep. The main channel in the middle foreslope exhibits steep erosional valley walls marked by truncation of parallel reflectors and slumping due to erosional undercutting along the channel margins (Figure 5-12a). Relief

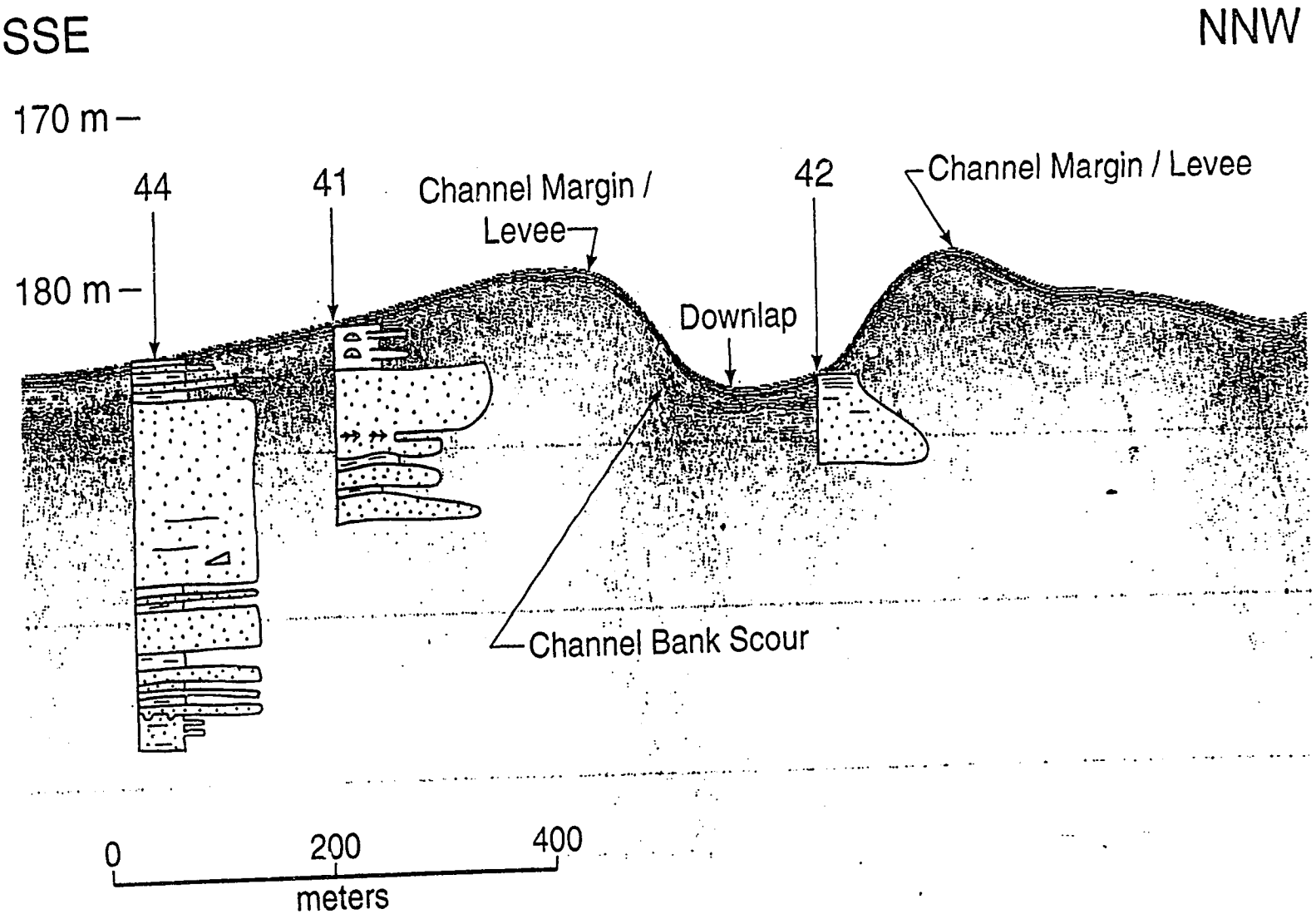


Figure 5-8. High frequency (3.5 kHz) seismic profile through the Roberts Bank Channel with piston cores showing lateral facies variability and seafloor morphology. Note evidence of reflector downlap onto channel floor, and channel bank scour surfaces. Thin clayey-silt drape on the channel floor is a product of channel abandonment. From Evoy *et al.*, 1994.

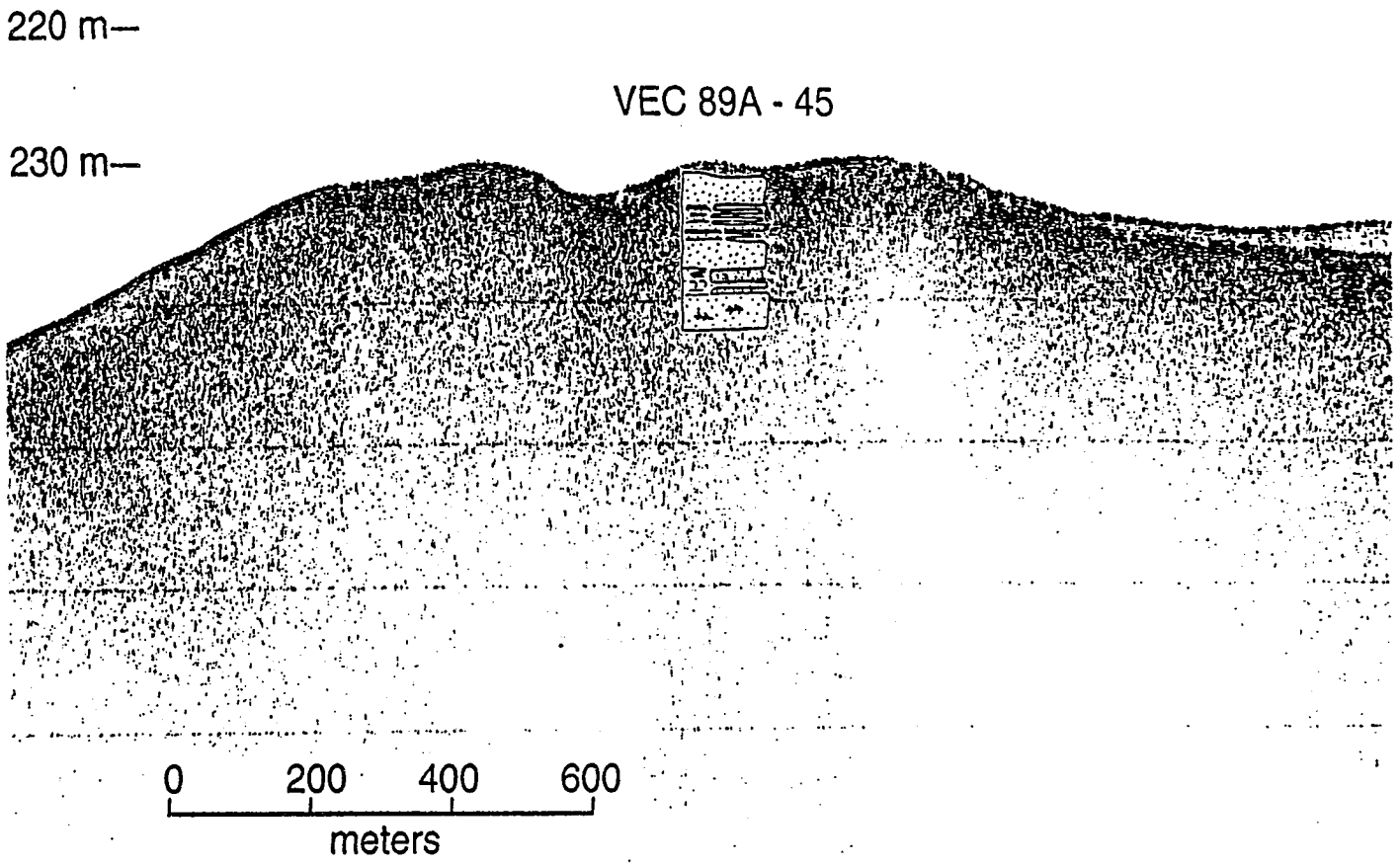


Figure 5-9 Morphologic expression and internal seismic structure of the Roberts Bank depositional lobe at piston core site VEC89A-45. Note the presence of constructional channel on the lobe surface.

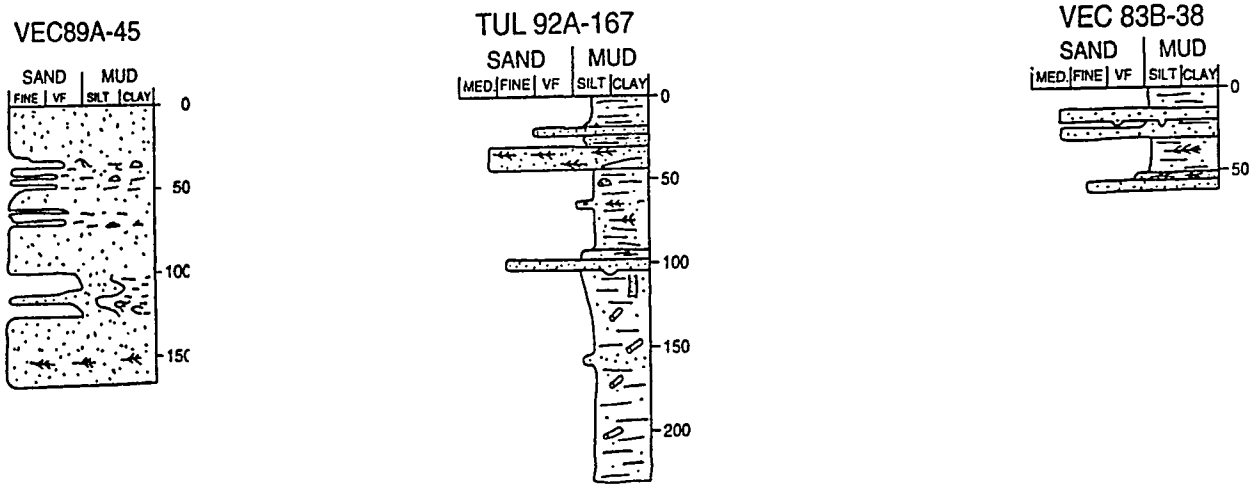


Figure 5-10. Sedimentologic logs for core collected from the Roberts Bank depositioanal lobe and lobe fringe, location on Figure 5-2A.

A). VEC89A-45 on main depostional lobe.

B). TUL92A-167 on the lobe margin.

C). VEC83B-38 on the lobe margin.

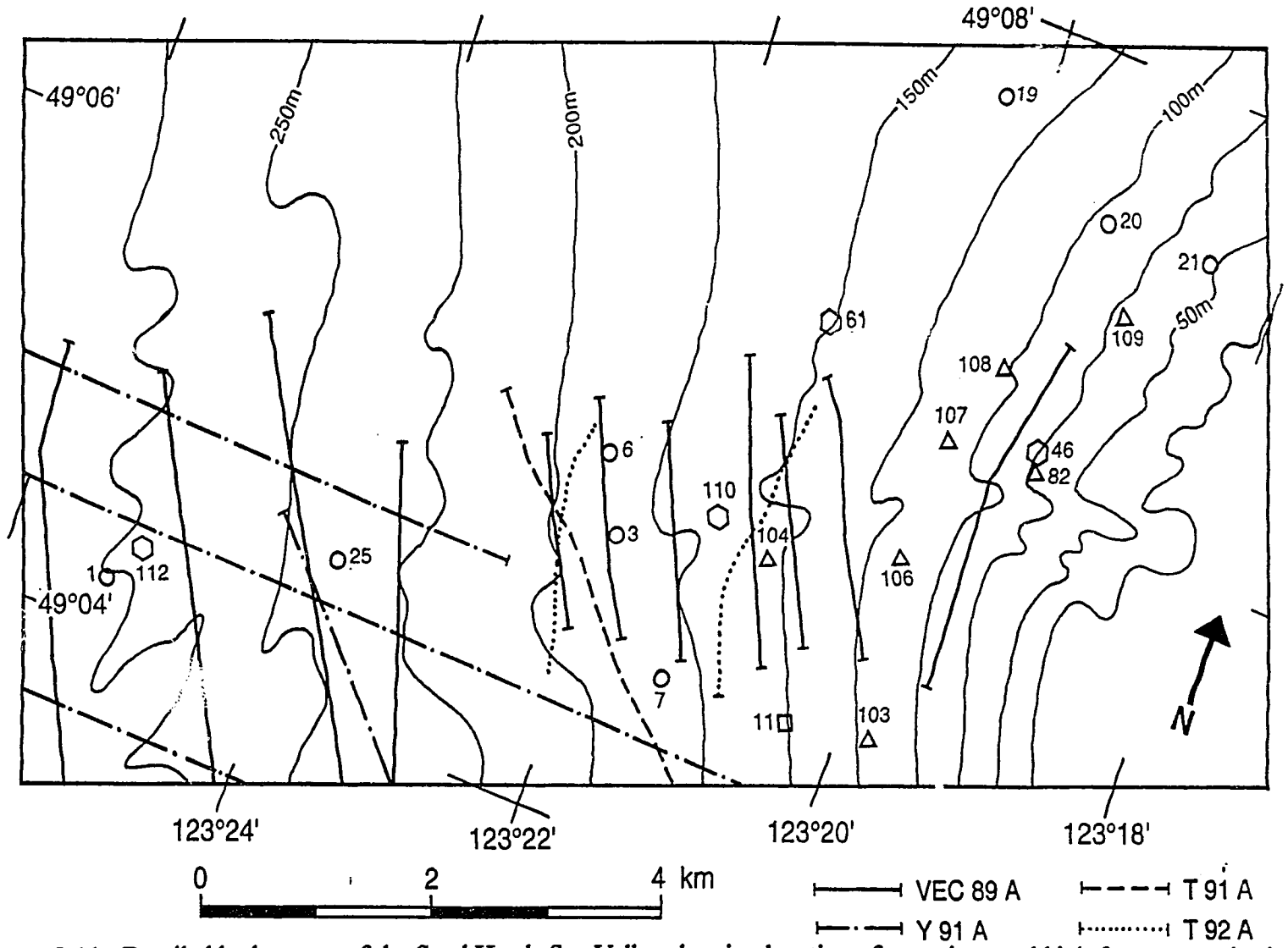


Figure 5-11. Detailed bathymetry of the Sand Heads Sea Valley showing location of core sites, and high-frequency seismic line traces. See Figure 5-1 for location.

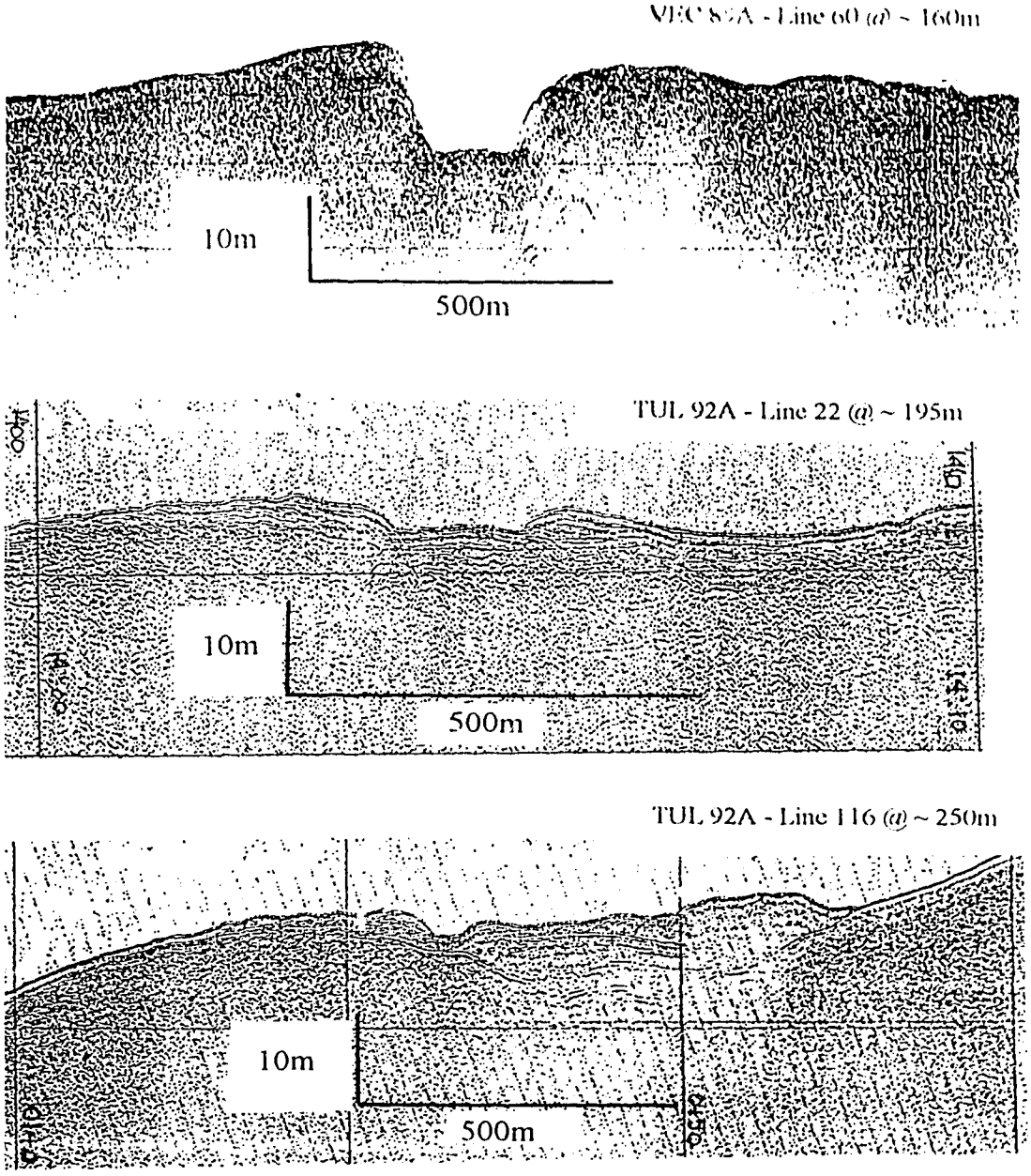


Figure 5-12. High resolution seismic line traces across the Sand Heads Sea Valley and its depositional lobe.

A). Line VEC89A-60 in the middle foreslope exhibits steep, erosional valley walls with some slumping along the southeast wall.

B). Line TUL92A-22 is from the lower foreslope. The channel here is much shallower, with better developed levees.

C). Line TUL92A-116 shows a large, poorly-defined depositional lobe with a prominent distributary channel. Apparent dip into the basin at the end of the line reflects a change in the survey orientation.

within the channel becomes more subdued downslope, reflecting increased deposition in the lower foreslope (Figure 5-12b). The main channel then bifurcates into a number of distributary channels (Kostaschuk *et al.*, 1992) which form a crudely defined depositional lobe (Figure 5-12c).

Due to the combination of strong surface currents associated with fluvial discharge, and the demands of maritime traffic for an unobstructed approach to the main navigation channel, no piston cores have been successfully obtained from within the axis of the main channel of the Sand Heads Sea Valley. However, a number of cores have been collected from the flanks of the main channel and the immediate overbank vicinity (Figure 5-11). Piston cores along the margins of the channel consist of massive to crudely bedded fine- to medium-grained sands variably interbedded with clayey to sandy silts, and containing minor rafted organic material (Figure 5-13). Individual bed thicknesses range from less than 10 cm to greater than 1 m (Figures 5-13a, 5-13b).

Piston core VEC89A-03 is representative of channel margin sedimentation along the main channel, and was recovered from the flank of the Sand Heads Sea Valley on the lower foreslope. The core is composed entirely of a amalgamated, normally graded beds that form a well developed channel sequence that coarsens and thickens up (Figure 5-13b). Deposition is from traction at the base of channelized turbidity currents.

The depositional lobe at the base of the Sand Heads Sea Valley consists of clean, upper fine- to medium-grained sands. The sands are massive, but are capped with 20 cm of well bedded silty sand and mud lamina (Figure 5-13c), the core is therefore considered to be undisturbed. The lack of internal sedimentary structures likely reflects a uniformity of grain size, and lack of a fine-grained component in the sediment. Subsamples collected from VEC89A-25 for grain size analysis contain approximately 0.5% to 1.5% combined silt and clay.

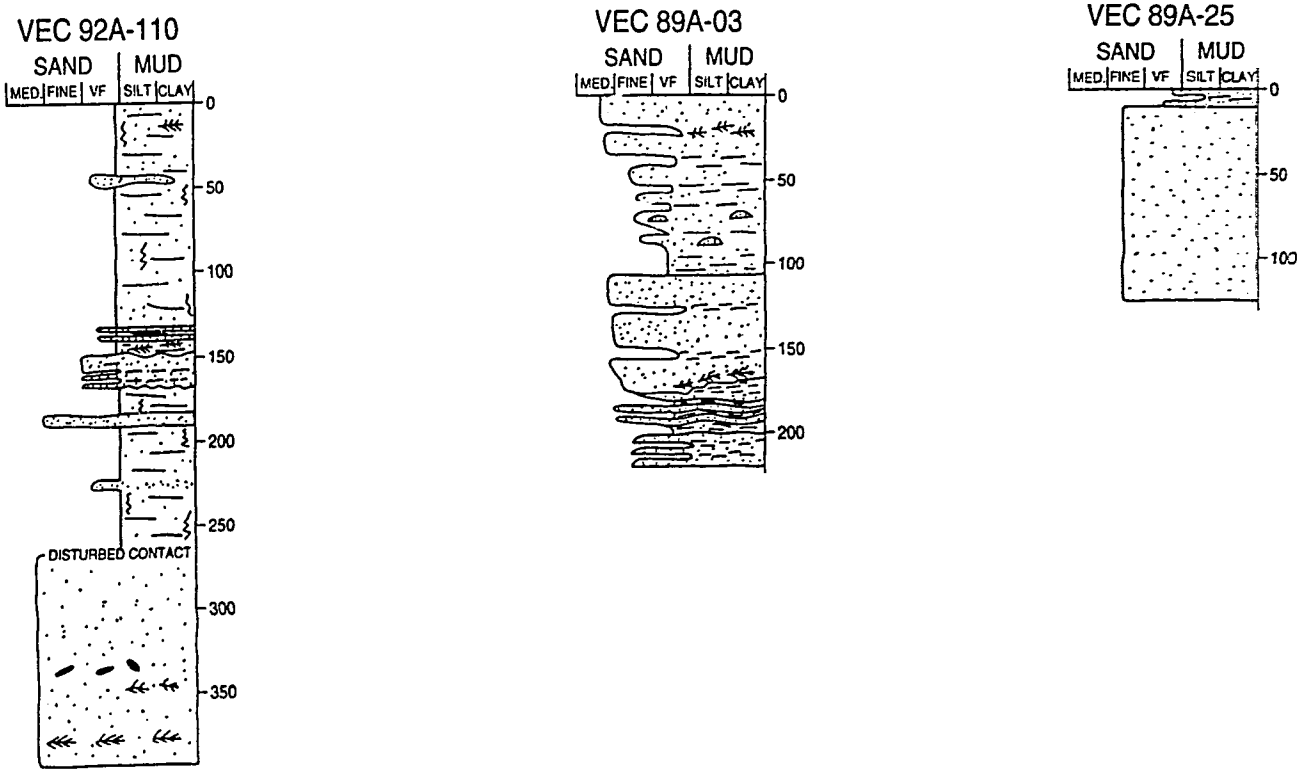


Figure 5-13. Sedimentologic logs for piston cores collected along the trend of the Sand Heads Sea Valley, locations on Figure 5-2A.

A). VEC92A-110 from the middle foreslope at 151 m.

B). VEC89A-03 from the lower foreslope at 190 m.

C). VEC89A-25 from the base of the foreslope at 240 m.

Overbank sediments proximal to the main channel consist of clayey silts with minor thin bedded very fine- to fine-grained sands. The silts contain variable organic material and rare shell fragments (Figures 5-14a, 5-14b), and exhibit minor burrowing. Sand interbeds are typically less than 5 cm thick and exhibit abrupt upper and lower contacts, or rare erosive bases (Figure 5-14a). Piston core VEC89A-06, 800 m north of site VEC89A-03 on the levee of the Sand Heads Sea Valley, represents a weakly defined fining upwards sequence with finely laminated silty muds and minor thin-bedded turbidites overlain by massive appearing muds (Figure 5-14c). Depositional processes are interpreted to represent channel overbank or inter-channel flow by dilute, unconfined turbidity currents and concurrent background deposition of silts and clay from suspension fallout.

Lateral Facies Variability

The incision, or construction, of multiple channels through time on the delta foreslope has resulted in a high degree of lateral facies variability. The significance of these channels in the development of the geometry and internal architecture of the delta front is apparent on depositional strike sections. Section A-A', from south of the Roberts Bank Channel to north of the Sand Heads Sea Valley, shows the importance of coarse-grained siliciclastic material in the depositional framework of the lower foreslope. All cores on this section are from water depths between 150 and 190 m (Figure 5-15). All but two of these cores contain some fine- to medium-grained sand beds, and sands are a significant component of the total recovered sediment (>30%).

Cores collected from south of the Roberts Bank Channel show evidence of older abandoned channels in the framework of the lower foreslope. Given the lack of available data, definitive internal correlations are not possible. The Roberts Bank Channel is the only area where coring density is adequate to correlate between sites, and shows the role of channel migration in the delivery and deposition of sands. The fine-grained sand in the upper 45 centimetres of PAR91A-20 is a product of the migration of large sandwaves (3 m high by 100 m wavelength) across the upper Roberts Bank foreslope (Kostaschuk and Luternauer, 1993).

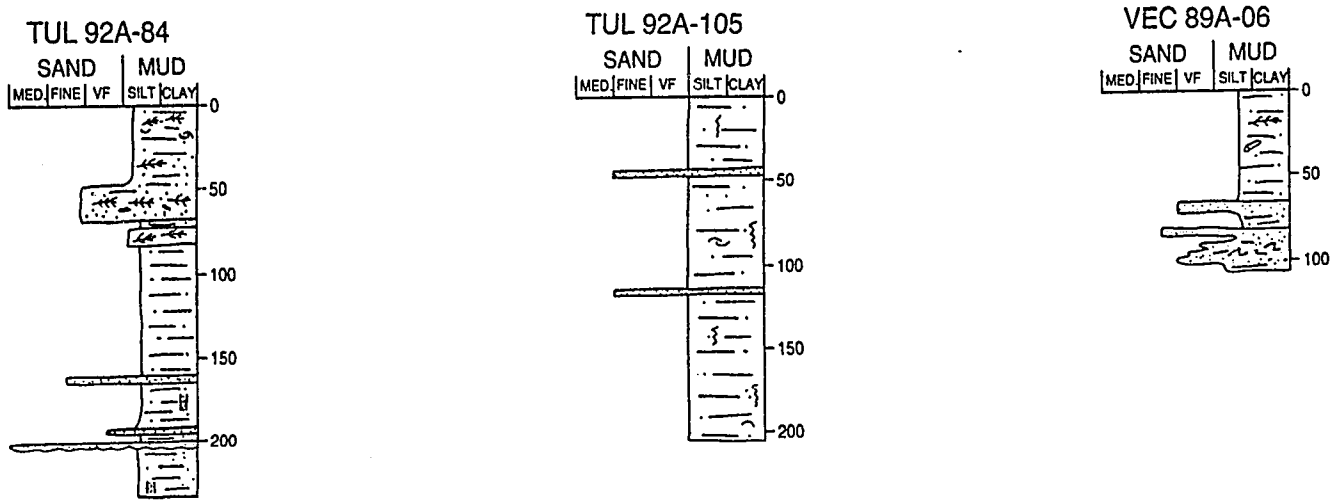


Figure 5-14. Sedimentologic logs for piston cores from levee and overbank environments proximal to the Sand Heads Sea Valley. See Figure 5-2A for locations.

A). TUL92A-84 from the middle foreslope north of the main channel.

B). TUL92A-105 from the middle foreslope south of the main channel.

C). VEC89A-06 from the lower foreslope north of the main channel.

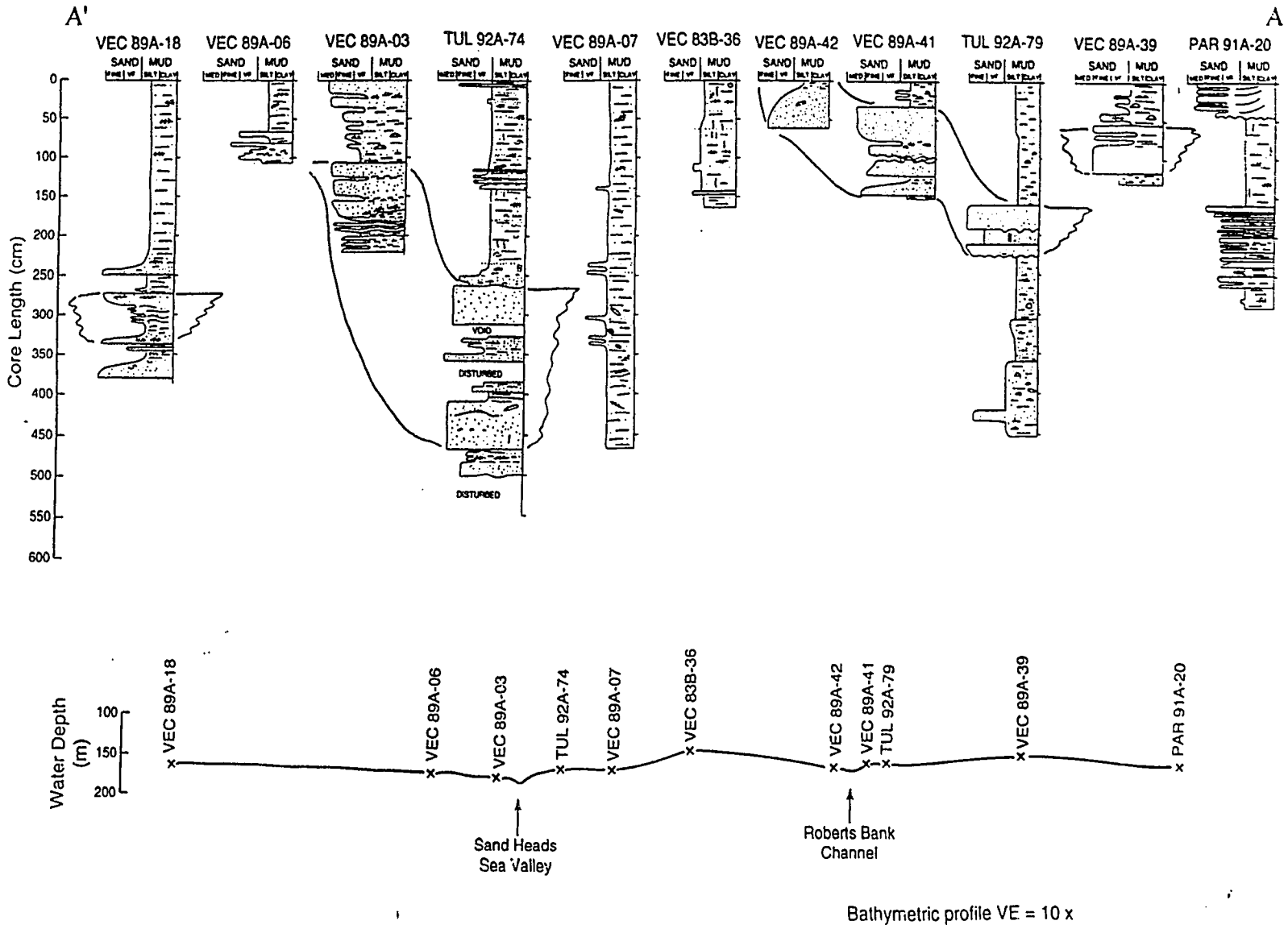


Figure 5-15. Strike section across the lower foreslope on Roberts Bank detailing lateral facies variability at approximately 180m. Note the preponderance of Facies 4 sands. Line of section denoted as A - A' on Figure 5-2A.

Although there is no evident sand source, these sandwaves are likely related to the erosion and retreat of the southern portion of Roberts Bank (Luternauer *et al.*, **in press**).

The interchannel environment between the Roberts Bank Channel and the Sand Heads Sea Valley consists primarily of silty muds deposited from suspension, with minor deposition of sand from the entrained layer of unconfined turbidity currents (Figure 5-15). Rare *Paleophycus* burrows are associated with thin sand intervals. Rafted organics and wood fragments, both disseminated and bedded, are present in the non-bioturbated intervals.

Channel-fill thickness in the Sand Heads Sea Valley is unconstrained, but exceeds a minimum of 3 m (see also Figure 5-13a). The basal 50 cm of TUL92A-74 was badly disturbed during transport or storage, and consists of admixed fine- to very fine-grained sand and silt. Neither VEC89A-03 nor VEC92A-110 penetrated the base of the channel fill. The presence of older channel-fill sequences on either side of the active channel suggests that deposition occurs from a series of meandering channels within the main valley. This supports the interpretation of channel sinuosity as a function of channelized flow (Kostaschuk *et al.*, 1992) as opposed to being an artifact of slumping.

The channel shown at the north end of section A-A' is speculative. Most of the sand beds present in piston core VEC89A-18 are discrete turbidites with sharp bases, well defined fining upwards profiles, and well developed Bouma T_{a-e} or T_{b-e} subdivisions. The interval at approximately 300 cm thickens and coarsens upwards, and may represent an older, small-scale foreslope channel.

Discussion

Sand Distribution: Process Implications

The coarsest-grained, best sorted sediments documented in the subaqueous delta are associated with the Roberts Bank Channel and its depositional lobe, and the lower portion of

the Sand Heads Sea Valley (Evoy *et al.*, 1994). Spatially, most channel sands are located along the axial trend of the two main channels crossing the foreslope, with massive, thick-bedded, high-density turbidites restricted to the locus of deposition at the base of these channels (Figure 5-16).

This distribution shows that the down-slope mass transfer of the coarser-grained sizes (fine- to medium-grained sand) is limited to the main channel systems and the aerially greatest sand accumulations are at the base of the foreslope. The upper and middle foreslope are areas of near complete bypassing by the coarser sediment fractions. Furthermore, the depositional lobe deposited at the base of the Roberts Bank Channel contains less clay, is better sorted, and is coarser grained than any of its correlative upslope cores.

Sediment distribution patterns and textural parameters can be used to constrain the depositional processes active in sand bypassing. Turbidity currents play a significant, and probably dominant, role in the formation and maintainance of submarine channels on the Fraser River delta foreslope. The mechanism of failure at Sand Heads has been interpreted as retrogressive slope failure (McKenna *et al.*, 1992), probably due to rapid deposition and large tidal draw-down at the river mouth (Kostaschuk *et al.*, 1989b). The resultant liquified flows transform into turbidity currents via flow acceleration.

While debris flows may also be assumed to be a significant element in the mass transfer of sediment from the subaerial delta into deep water, the degree to which they are active is poorly constrained in the Fraser delta. Much of the data cited to support recent debris flows are based on: (1) the documentation of large scale failures in the vicinity of Sand Heads, (2) the surface morphology of areas that have not been successfully cored, and (3) the absence of recognizable sedimentary structures in massive appearing sands (Hart *et al.*, 1992a). As previously stated, the Sand Heads Sea Valley has been fixed and modified by dredging and jetty construction, and may not be representative of the historic delta. The presence of massive-appearing sand intervals as a quick bed is common in many turbidites,

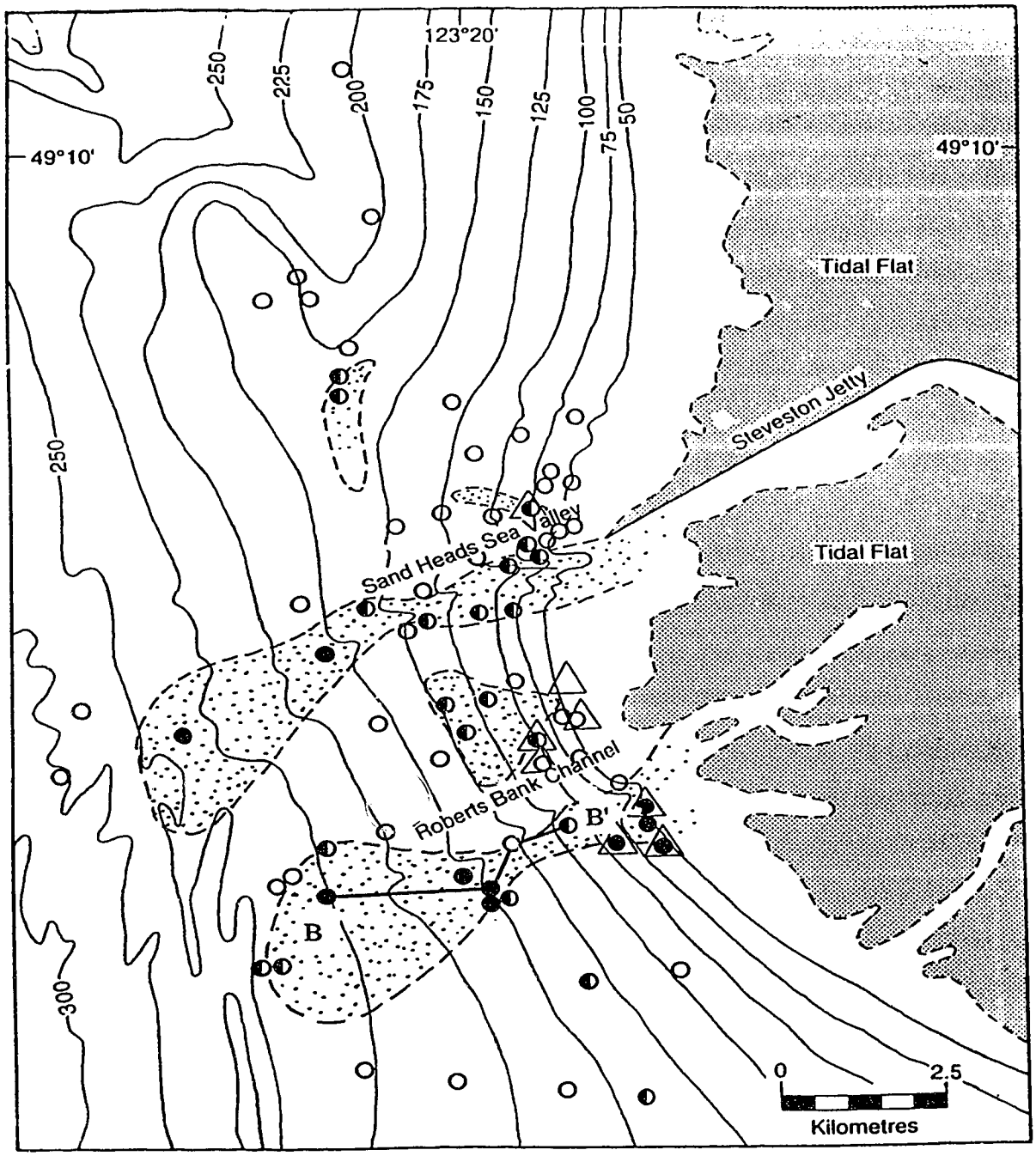


Figure 5-16. Plan view of sand distribution across the study area. The outline of the Facies 4 assemblage (stippled), highlights the degree of sediment bypassing of the foreslope by coarser grain sizes. Symbols as on Figure 3-7.

and should be expected to be exaggerated by coring-induced liquifaction.

It was shown in Chapter 3 that greater than 50% of the clay size fraction in Facies 4 sands consists of siliciclastic debris. Facies 4C sands typically contain less than 1% clay size material, and are thus estimated to contain less than 0.5% clay minerals. Hampton (1975) calculated that a subaqueous debris flow strong enough to carry fine sand requires 4% clay minerals in the matrix, which represents approximately 2% clay minerals in the final deposit. This is based on the assumption of pure Kaolin clays; the presence of other clay mineral species would be expected to increase the matrix competence (Hampton, 1970). Many Facies 4 sands, and all Facies 4C, appear to contain insufficient clay mineral contents to have provided cohesive strength during transport.

Implications of Channel Type for Deposition of Deep Water Sands

Inception of sedimentation in the Fraser River delta at the beginning of Holocene time was coupled with an isostatically driven fall of local sea level of about 200 m (Mathews *et al.*, 1970; Clague *et al.*, 1982). The ensuing transgression during the subsequent 8000 years is on the order of 12 to 13 m (Clague *et al.*, 1982; Williams and Roberts, 1989). Most of this transgression occured rapidly, with sea level rising to within a few metres of its present level by about 6200 years ago, and stabilizing at its present level *circa* 2250 BP (Williams and Roberts, 1989).

During this period of relative sea level rise, the delta experienced only minor local transgression, and underwent continual progradation of approximately 16.25 km, and vertical accretion. Rates of vertical accretion accelerated dramatically, coincident with the rate of sea level rise, as a function of increasing accomodation space. This unique geographic setting, and the presence of sand-sized clastic detritus being introduced directly into water depths in excess of 200 m, may serve as an analogue to lowstand (shelf-edge) deltas.

The Roberts Bank Channel is currently inactive and is believed to predate any

appreciable anthropogenic mediation. The channel is constructional in nature with well develped depositional levees (Figure 5-8), and lacks any evidence of either erosional downcutting or its fluvial origin. Much of the coarsest sediment supplied to the head of the channel bypasses the delta plain and upper foreslope to be introduced directly to the lower foreslope and basin floor. Sediment transport in the channel is via turbidity currents, and deposition is in the form of a small well-developed lobe, or submarine fan (Figures 5-6c, 5-9).

The resultant sand body geometry in cross-section produces a wedge which both thickens and coarsens down slope (Figure 5-17). Documented channel-fill sand thicknesses on the Roberts Bank lower foreslope do not exceed 2.5 m, and are characterized by numerous silty laminae. Down slope, the Roberts Bank depositional lobe contains fewer silty laminae, less fine-grained matrix within individual beds, and is estimated to be 10 m thick. Up slope, the channel sands thin and pinch out into the finer-grained sediments (silts and clay) of the middle foreslope bypass zone.

The sand depocentre and maximum sand thickness occurs at the base of the foreslope where turbidity currents become unconfined and deposit their bedload. In conjunction with upslope channel migration (Figures 5-8, 5-15) the depocentre can be expected to migrate. Through time, this will produce a series of linear sand bodies oriented subparallel to bathymetry (Figure 5-18; Time 1 through Time 4). Amalgamation of these sands should ultimately result in a single elongate, strike-parallel sand wedge resting conformably on deep-water muds (Figure 5-18; Time 5 and 6). In the subaqueous Fraser River delta, this process has been arrested by construction of the Steveston Jetty and anthropogenic stabilization of the distributary channels.

The position and nature of the Sand Heads Sea Valley is strongly controlled by anthropogenic modification. The main channel of the Sand Heads Sea Valley in the middle and lower delta foreslope is several hundred metres wide, and up to 18 m deep. The channel walls are steep, markedly erosional, and capped by crude depositional levees. While much of

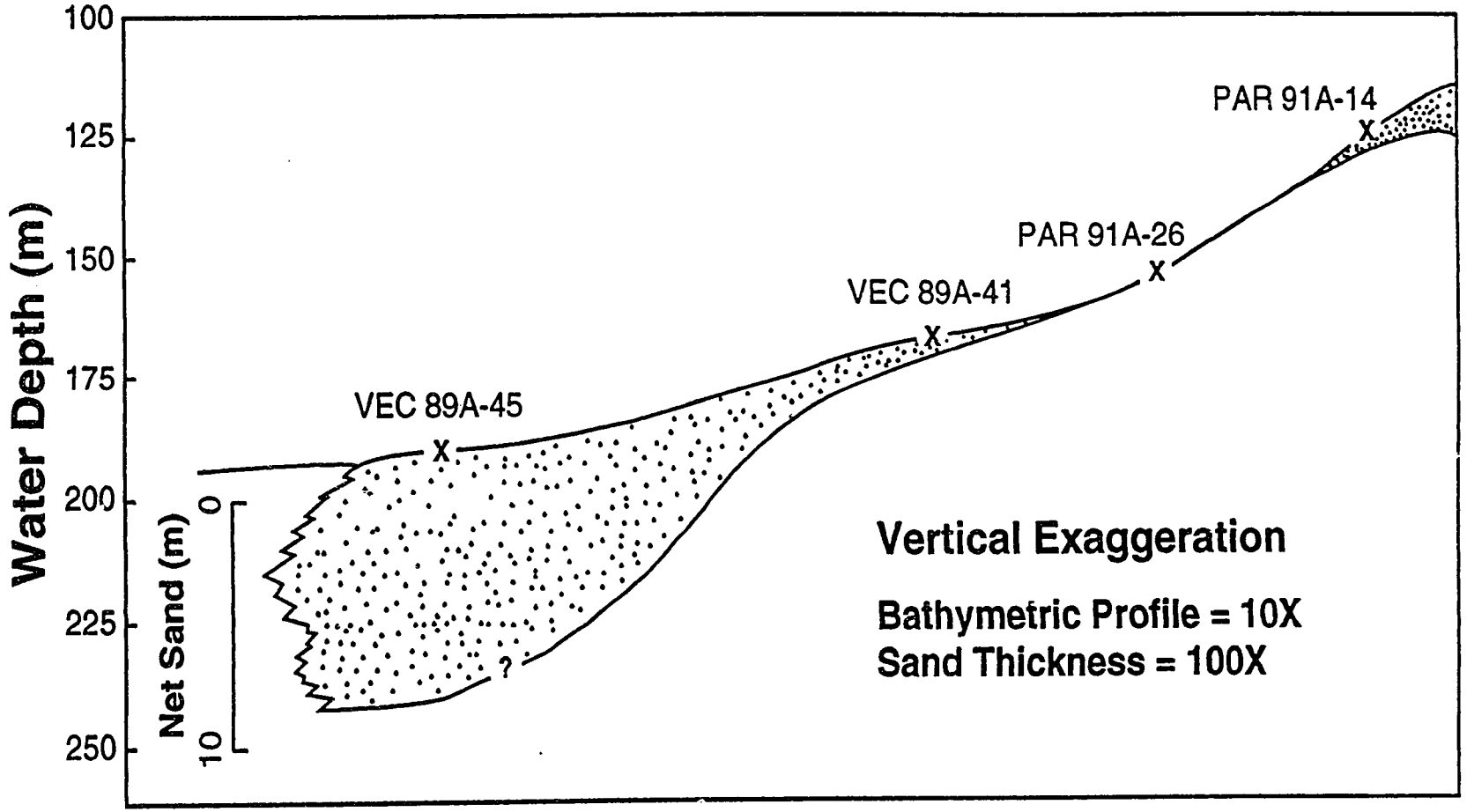


Figure 5-17. Sand bypassing model and wedge geometry redrawn from Figure 5-7. Line of section denoted as B - B' on Figure 5-2a.

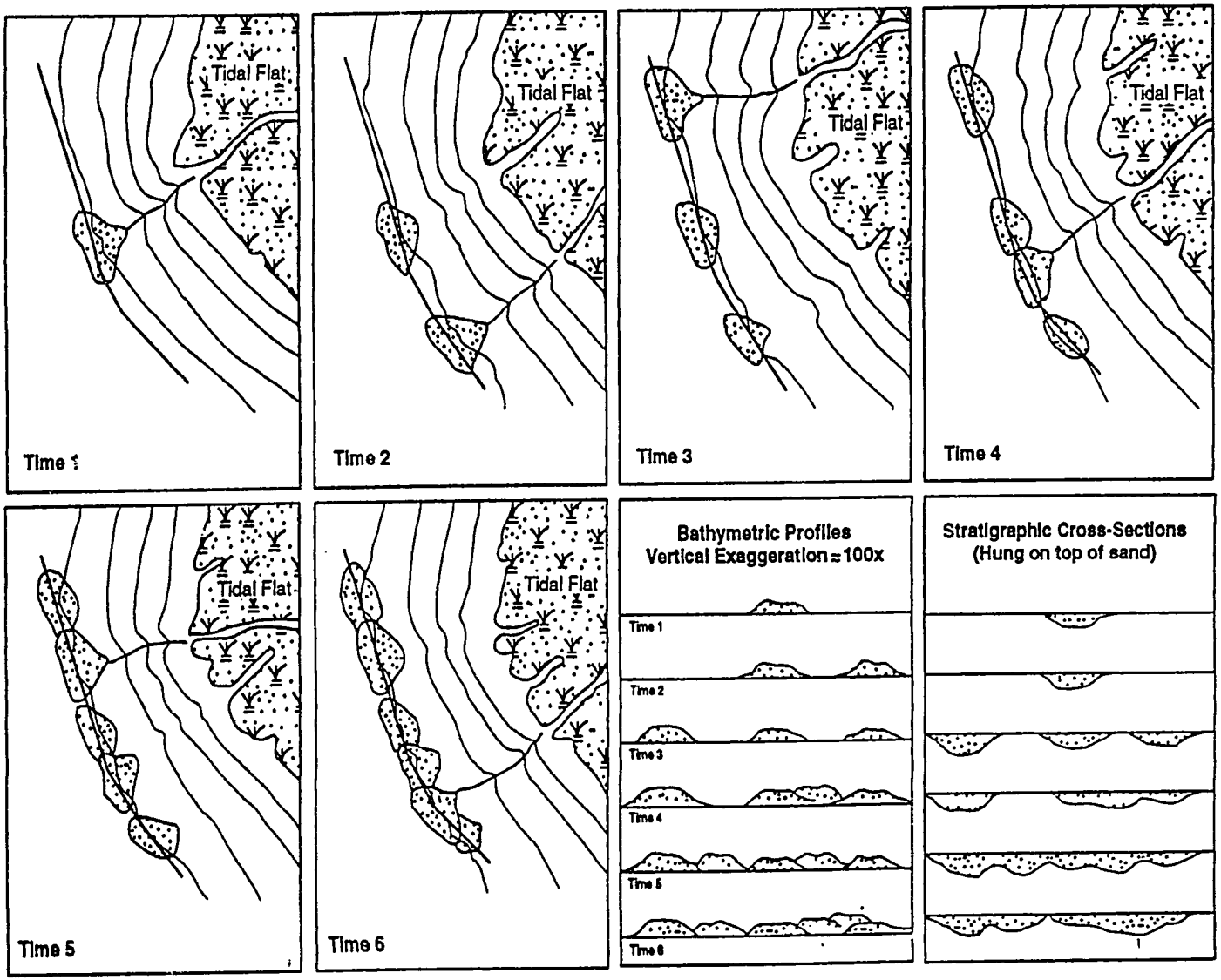


Figure 5-18. Time sequence diagram showing model for development of linear sand bodies at the base of the subaqueous delta foreslope.

the sediment supplied to the lower foreslope from the tidal flats is via turbidity currents, the significance of debris flows in the mass transfer of sediment is arguably much greater in the Sand Heads Sea Valley than it is in the Roberts Bank Channel (Hart *et al.*, 1992a; 1992b).

Unlike the Roberts Bank Channel, channel migration in the Sand Heads Sea Valley is restricted within the confines of the main valley. Sand deposition within the channel should be similarily controlled by the valley geometry. Over time, these restrictions should produce an erosional valley incised subaqueously into deep water muds, and subsequently filled with coarser sediment. Although superficially similar to an incised valley, both incision and deposition occur during the early phase of a single transgressive event. Facies on either side of the erosional surface are genetically related, and the actual sequence boundary is at the base of the deltaic section.

The implications of a fixed valley system for the development of the depositional lobe at the base of the valley is problematic. The Sand Heads Sea Valley depositional lobe is less well defined than the Roberts Bank depositional lobe, and is subject to sediment failure and remobilization. This results in a greater down dip displacement of sediment than occurs in the Roberts Bank Channel. Through time, a large submarine fan elongate in a dip direction should be anticipated, as opposed to the strike parallel wedge geometry expected from ephemeral channels.

Summary and Conclusions

The Fraser River delta foreslope is bisected by two pronounced bathymetric channels, or "sea valleys". These channels are initiated and maintained by sediment gravity flow processes related to periodic liquifaction and failure at the head of the foreslope (McKenna *et al*, 1992; Kostashuk *et al.*, 1992; Hart *et al.*, 1992a).

The two main channels on the subaqueous delta exhibit significantly different

characteristics. The Roberts Bank Channel is currently inactive and represents an ephemeral feature on the delta foreslope. The channel is constructional with well developed depositional levees. The position of the Sand Heads Sea Valley has been culturally fixed by jetty construction. The channel is erosional, with steep valley walls marked by truncation of parallel reflectors and erosional undercutting.

Much of the coarsest sediment supplied to the mouth of the delta bypasses the delta plain and upper foreslope and is introduced directly to the lower foreslope and basin floor. These channels debouche onto the basin floor to produce a series of sand-rich depositional lobes (Moslow *et al.*, 1991; Evoy *et al.*, 1993b), and small slump-bound turbidite basins (Hamilton and Wigen, 1987; Hart *et al.*, 1992b).

The incision of multiple channels through time on the Fraser River delta foreslope has resulted in a high degree of along-slope lateral facies variability. Upslope migration and abandonment of ephemeral channels results in the deposition of a strike parallel sand wedge (slope apron) formed by the coalesence of a number of small submarine fans at the base of the foreslope. Deposition from a fixed channel (point source) should be anticipated to result in the construction of an elongate submarine fan normal to depositional strike and bathymetry. Channelized turbidity current, and possible debris flow transport of coarse sediment across the relatively steep (3°) slope ("sand bypassing") into water depths ≥250 m provides a promising process sedimentologic analogue for identification and reconstruction of shelf-edge deltaic facies and lowstand wedges from the geologic record.

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CHAPTER 6.
LITHOFACIES ASSOCIATIONS AND DEPOSITIONAL ENVIRONMENTS IN THE MIDDLE TRIASSIC DOIG FORMATION, BUICK CREEK FIELD, NORTHEASTERN BRITISH COLUMBIA. [5]

Introduction

General

Recent gas resource assessments for the Western Canada Sedimentary Basin suggest that one-half (51%) of Triassic gas reserves remain undiscovered (Bird *et al.*, 1994). The most promising play within this interval is the "Halfway/Doig-Shelf" in northeastern British Columbia, with estimated reserves of approximately 4 TCF initial in-place volume. This play can be subdivided into a southern portion along the northern flank of the Peace River Arch, with an estimated one third of the total remaining potential (approximately 3.1 TCF), and an additional 0.8 TCF present in this play further north away from the main influence of the Peace River Arch.

Most emphasis on this play has focussed on the Halfway Formation. To date, no major study of a Doig reservoir within this area has been attempted. This study characterizes a significant Doig field in the area by documenting facies associations and inferred depositional processes as determined from cores and wireline logs. This characterization has allowed for the construction of a depositional model within a sequence stratigraphic framework which can be used as a possible exploration "template" for future development.

Buick Creek Field

The Buick Creek Field in northeastern British Columbia (Figure 6-1) represents the largest recognized Doig reservoir in the Fort St. John area. Since the discovery of the Doig B pool in 1976, a total of 5 oil pools (2 with economic associated gas) have been discovered.

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[5] A version of this chapter has been accepted for publication. Evoy, R.W. and Moslow, T.F., *in press*. *Bulletin of Canadian Petroleum Geology*, December, 1995.

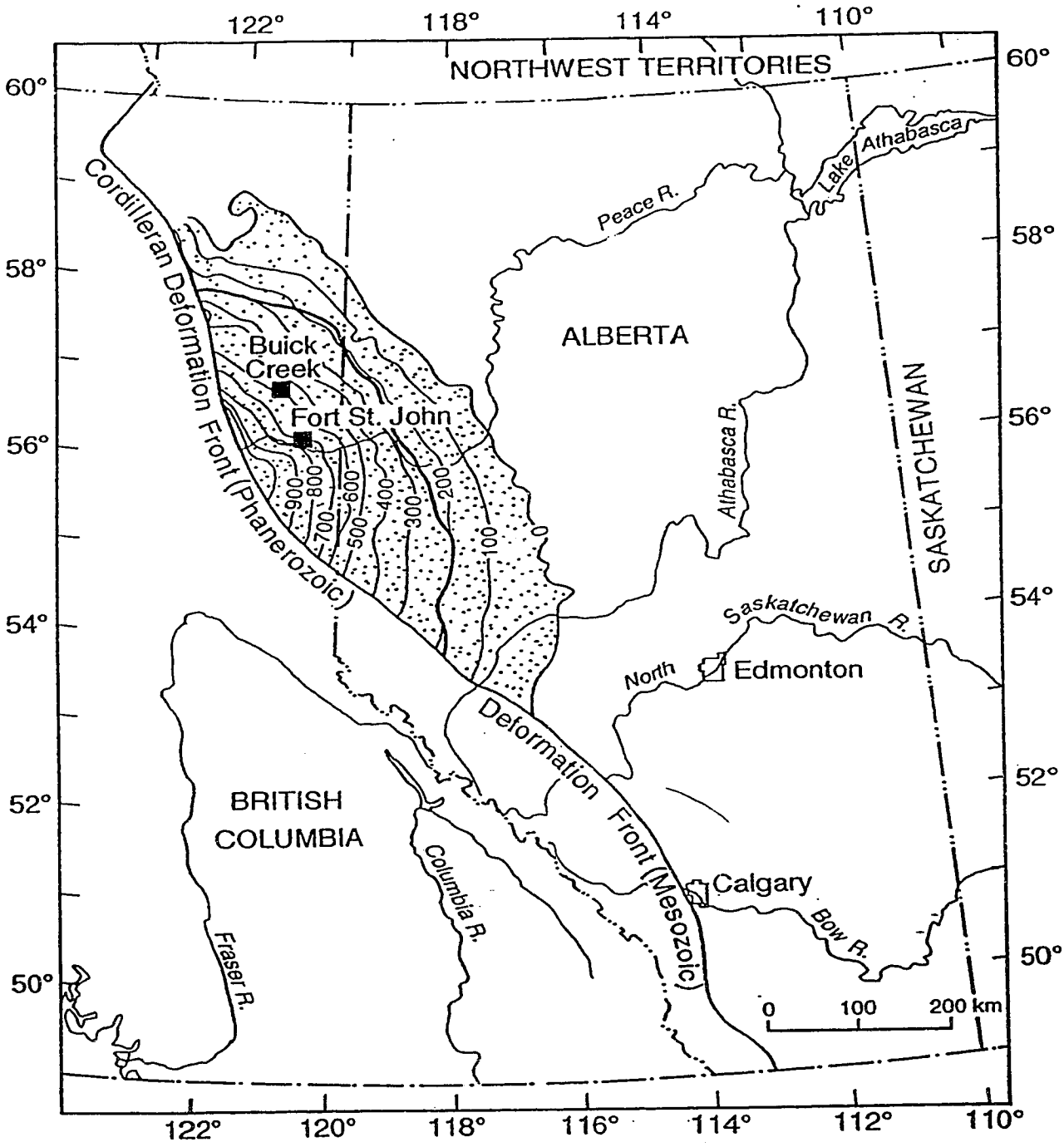


Figure 6-1. General location map for the Buick Creek Field area, with total Triassic isopach values overlain. Heavy line approximating the 200 metre contour represents the erosional edge of the Halfway-Doig interval. (After Edwards *et al.*, 1994).

Initial in-place volumes exceed 20 million bbls oil with 12.5 bcf gas (Table 6-1). Differentiation of these pools is based on production characteristics, not stratigraphic discontinuities. Average net oil pay is approximately 7 m with porosities about 10%. Average gas pay and porosity is approximately 4 m and 8.5%. Water saturation levels are low, and the oil is a light crude (Table 6-1).

A total of 51 wells penetrate the Halfway/Doig interval in the immediate Buick Creek field area (Figure 6-2), and provides the greatest database available for subsurface reconstruction of a Doig pool. Twenty two of these wells have been cored, including at least one well in each pool. All available core has been logged (550 m).

Stratigraphy

Middle Triassic strata of northeastern British Columbia represent a progradational sequence of marine to shallow marine clastic sediments deposited on the western flank of the North American craton (Gibson and Barclay, 1989). These strata unconformably overlie the lower Triassic Montney Formation, and are abruptly overlain by marginal marine to non-marine clastics, evaporites and carbonates of the Charlie Lake Formation.

In the subsurface, middle Triassic strata are subdivided into two broad lithostratigraphic units (Table 6-2). The Doig Formation consists of phosphatic marine shales, siltstone and minor sandstone (Armitage, 1962), and is transitional upsection into the shallow marine sandstones and coquinas attributed to the Halfway Formation (Hunt and Ratcliffe, 1959). The contact between the two formations, in practical usage, has been defined on the basis of the slightly more radioactive gamma ray log signature of the Doig Formation (Dawes, 1990), or placed at the top of the first significant shale interval below the Halfway sandstone (Edwards *et al.*, 1994). The contact has alternatively been described as a disconformity marked by a thin lag of dolomite, quartz and chert-granule conglomerate (Dawes, 1990) or, locally, an unconformity (Chunta, 1969; Cambell and Horne, 1986), while others argue that this lag simply represents basal scour within tidal inlet channels (Willis, 1992; Caplan, 1993).

Table 6-1. Summary of reservoir production characteristics for all Doig/Lower Halfway pools in the Buick Creek Field.

Buick Creek

RESERVOIR SUMMARY - DOIG/LOWER HALFWAY POOLS

General	
Location	I/94-A-11 and A/94-A-14 - 55km north-northwest of Fort St. John, B.C..
Tectonics	Ramp type passive margin North flank Fort St. John and Dawson Creek grabens, and Hay River Fault Zone.
Trap Mechanism	Stratigraphic - overlying deep marine silts and muds.
Source Rock	Presumed Doig Phosphate Zone source.
Reservoir Rocks	
Age	Middle Traissic - Anisian/Ladinian?
Stratigraphic Unit	Doig - 1st Sand Equivalent.
Lithology	Sandstone - Fine grain.
Dep. Environment(s)	Probable lower-middle shoreface - lowstand systems tract/incised shoreface.
Productive Facies	Sands preserved within shoreface following subsequent transgressive erosion.

	OIL	GAS
Reservoir Characteristics (1)	(5 pools)	(2 pools)
Net Pay (Average)	~ 7m	~ 4m
Net Pay (Range)	6.2m - 21.4m	3.2m - 4.3m
Petrophysics		
Porosity	~ 10%	~ 8.5%
Porosity Range	9.4% - 10.4%	7.3% - 9.1%
Depth		
Thickness (2)		
Total Area (all pools)	444ha	252ha
Fluid Data (1)		
Saturation	< 10%	< 15%
API Gravity (Range)	42.8 - 45.2	43.5
Gas-Oil Ratio	< 160	
Production Data (3)		
Type	OIL	GAS
In Place Volume	20,791,742 bbls	12.6 bcf
Cumm. Production	1,145,308 bbls	9.1 bcf
Est. Reserves	2,310,753 bbls	1.7 bcf
Recovery Factor	10% - 20%	90%

COMMENTS

1 Average characteristics estimated based on all pools (5 oil, 2 gas).

2 Sand thickness based on 60 API cut-off.

3 Cummulative data based on sum of all pools.

Cores available in all pools. All discovery wells except a-67-I (Doig B Pool) cored: 22 total cored wells in field area.

Data source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

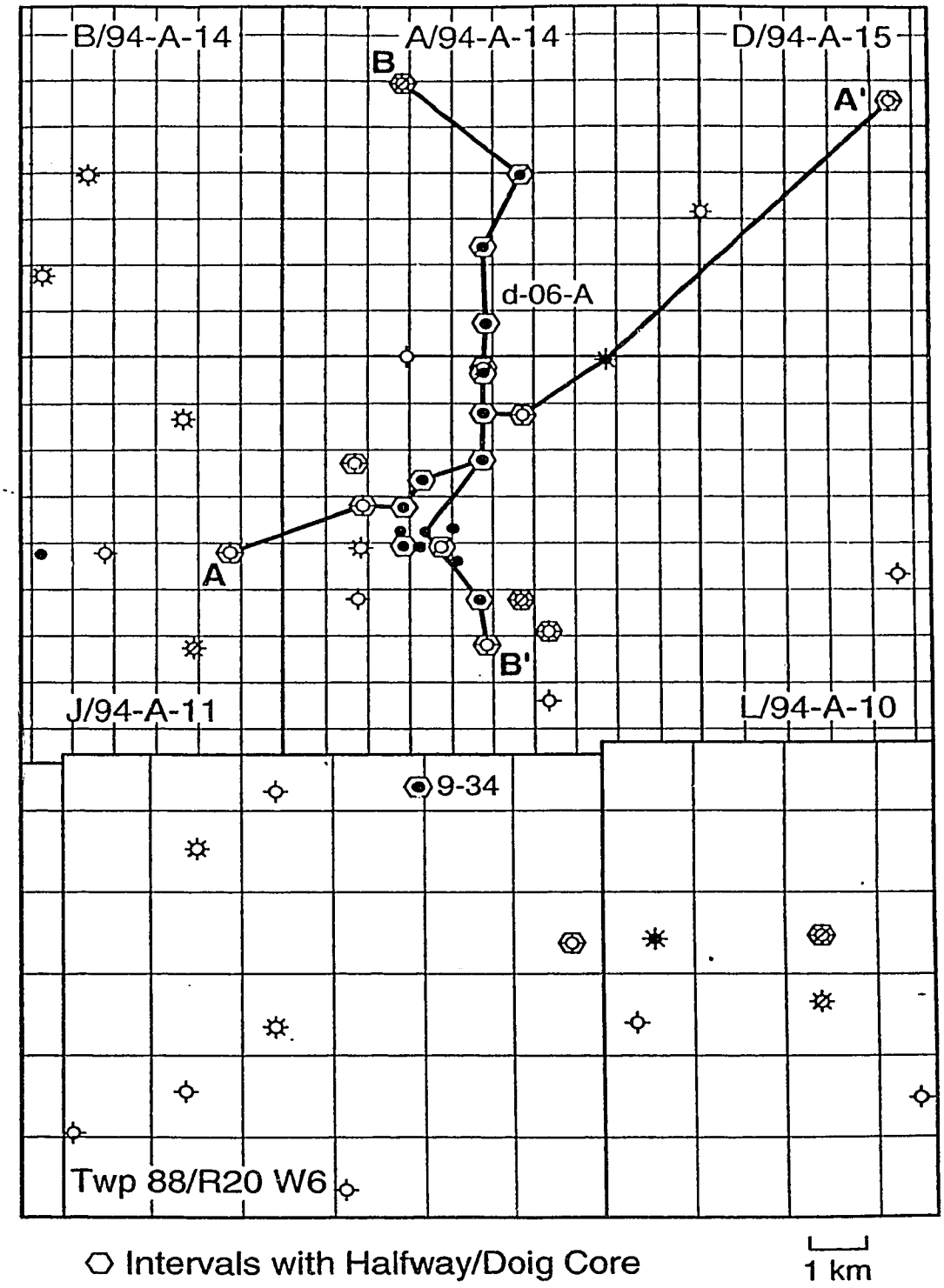


Figure 6-2. Well control in the Buick Creek Field area, showing all Halfway penetrations. Hexagons mark wells with core from the Doig Formation. Annotated wells and section lines refer to subsequent figures.

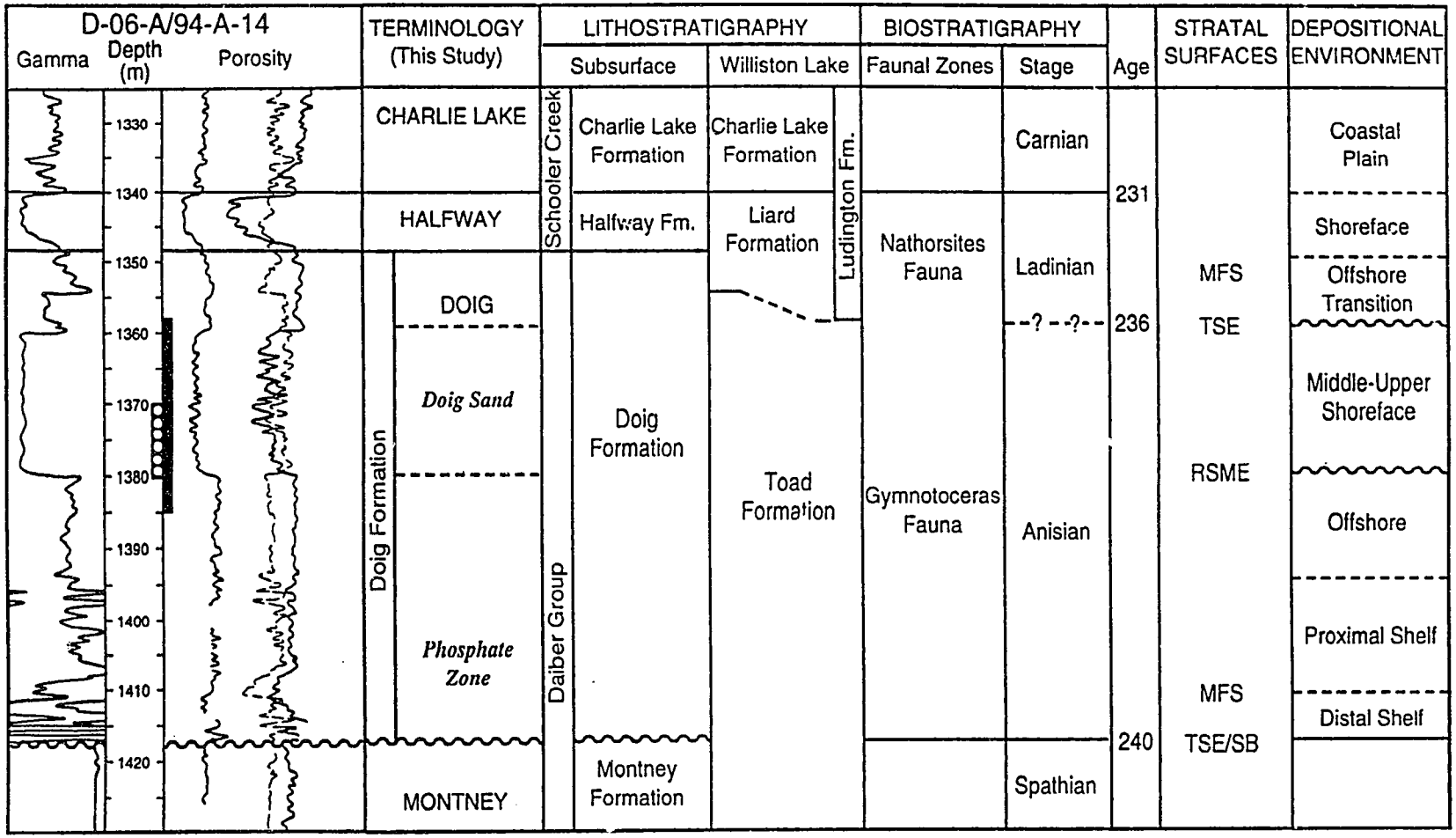


Table 6-2. Stratigraphic correlation table for the Middle Triassic in the subsurface in northeastern British Columbia, with representative wireline log signatures from the Buick Creek Field. Location of d-06-A/94-A-14 on Figure 6-2. Lithostratigraphic terminology and stages from Gibson and Barclay (1989), faunal zones from Tozer (1961).

This contact does not appear to represent a regionally correlatable stratigraphic break (Willis, 1992; Wittenberg, 1992).

The difficulty in differentiating between the basal Halfway and Doig formations is now generally accepted (eg: Gibson and Edwards, 1990; Edwards *et al.*, 1994). The two are treated herein as a single, continuous unit (Table 6-2) which constitutes the overall progradational phase of a T-R cycle (Assemblage II of Gibson and Barclay, 1989). While the Doig is often defined as the deep water facies equivalent to the shallow marine clastics of the Halfway Formation, such usage makes the *a priori* assumption that any sandstone completely encased within the siltstones and shales of the classic Doig assemblage must therefore represent deep water sand deposition.

Sedimentary Facies and Facies Associations

General

Due to the abundance of subsurface core control in the Buick Creek Field area, all facies herein are described based on their observed physical characteristics as opposed to log signature. Four major facies types were recognized based on lithology, primary physical and biogenic sedimentary structures, bedding geometry, and the nature of their bounding surfaces. Each main facies was subdivided based on texture (percent sand, maximum clast size). A final facies class was assigned for all intervals with significant degrees of apparent soft-sediment deformation. This latter facies was included to assess the style and timing of deformation and to test for correlation between stratal disruption and depositional environment.

A total of nine sedimentary facies were thus rec[illegible] Table 6-3). Commonly recurring groupings of lithofacies were classified together to define facies associations characteristic of gross depositional environments. Three facies associations were recognized, in ascending order: offshore/shelf, shoreface, and offshore transition.

Table 6-3. Summary of sedimentary facies characteristics in the Doig Formation, Buick Creek Field.

FACIES	LITHOLOGY	SEDIMENTARY STRUCTURES AND BEDDING GEOMETRY[1]	DEPOSITIONAL PROCESS(ES)	DEPOSITIONAL ENVIRONMENTS[2]
A1	SILTY MUD black,calcareous <5 to 10% vfg sand	Plane parallel lamina, rare ripple lamina, discontinuous sand lamina; beds to 6m*. Pl, Pa	SUSPENSION SEDIMENTATION Rare traction currents, turbidites/contourites.	OFFSHORE - Distal Shelf
A2	MUDDY SILT <10% vfg sand	Plane parallel lamina, minor ripple lamina, rare convolute beds; coarsens up; sands to 5cm thick, beds to 14m thick; Pa, Pl, Ch, Th(?), As(?), Te(?).	SUSPENSION SEDIMENTATION Minor traction currents, turbidites/tempestites.	OFFSHORE - Proximal Shelf
B1	INTERBEDDED SILT/SAND <30% sand	Plane parallel and ripple lamina; occasionally massive or bioturbate; rare HCS(?); Cy, He(?).	MIXED SUSPENSION/TRACTION Sediment gravity flows and rare storm beds.	OFFSHORE
B2	INTERBEDDED SAND/SILT 30% to 70% sand	Plane parallel and ripple lamina; occasional to common HCS; locally massive; fugichnia, Cy, Ro.	MIXED TRACTION/SUSPENSION Storm beds.	OFFSHORE TRANSITION
C1	SILTY VERY FINE SAND up to 30% silt	Internally massive to moderate angle cross beds at 15-20°; bed sets to 3m*; locally bioturbate.	TRACTION CURRENTS Aqueous gravity currents.	SHOREFACE - Lower to Middle
C2	FINE to MEDIUM SAND <10% silt	Internally massive; rare moderate angle cross beds, planar and (occasional) troughs; locally bioturbate.	TRACTION CURRENTS Aqueous gravity currents.	SHOREFACE - Middle to Upper
D1	CONGLOMERATE pebble/cobble, with sand,silt,shells.	Beds <20cm thick, clasts to 10cm in diameter; no evident grading; abrupt contacts; rare shell fragments.	WAVE RAVINEMENT SURFACE Erosional lag.	TRANSGRESSIVE SURFACE OF EROSION
D2	BIOCLASTIC CONGLOMERATE with sand, silt, and rare granules	Coarse bioclastic conglomerate and coquina; beds typically 20cm to 1.5m thick; rare X-beds at 10-15°; internal scour surfaces; abrupt to erosive contacts.	TRACTION CURRENTS Aqueous gravity currents, Erosional lag.	UPPER SHOREFACE Tidal Inlets(?), TSE Equivalent.
E	DISTURBED BEDS	Not a true lithofacies: includes oversteepened bedding and slumps; highly variable to discontinuous.	SOFT-SEDIMENT DEFORMATION	Not Restricted by Environment.

COMMENTS:

1. As - *Asterosoma*, Cy - *Cylindrichnus*, Pa - *Paleophycus*, Th - *Thalassinoides*, Ro - *Rosellia*, Pl - *Planolites*, He - *Helminthopsis*, Te - *Terebellina*, Ch - *Chondrites*.
2. Shelf refers to deposition below maximum storm wave base; distal and proximal are relative terms.

Sedimentary Facies

Facies A

Facies A consists of finely laminated silty shale (A1) to muddy siltstone (A2), with less than 10% very fine grained sand present as rare ripple laminae or discontinuous sand lamina. Differentiation of the two subfacies is primarily based on dominant grain size (mud vs. silt); the two facies are gradational and generally interbedded. Facies A2 also contains rare convolute bedding and a crude upwards coarsening not present in facies A1.

Burrowing is minimal in Facies A, and consists of an impoverished, distal *Cruziana* ichnofacies association comprised of *Planolites* and *Paleophycus*, with minor *Chondrites* and *Helminthopsis* being gradually replaced by minor to rare *Thalassinoides*, *Asterosoma* and *Terebellina*(?) from Facies A1 to A2. Depositional processes are dominated by suspension sedimentation directly from the water column, with minimal input from periodic tempestites or turbidity currents. Environments of deposition are proximal to distal shelf, with all deposition occuring below storm wave base.

Facies B

Facies B consists of plane parallel to ripple laminated interbedded sandstone and siltstone, with minor subordinate shale. Two subfacies are recognized based on sand:silt ratios, and represent fluctuations between suspension-dominant and traction-dominant depositional regimes. Facies B1 contains less than 30% sandstone, typically as thin rippled beds, and occasionally as massive or bioturbate horizons. Sets of low-angle, intersecting, subplanar laminae likely represent poorly developed hummocky cross-stratification deposited at lowest storm wave base. The rarity of these latter structures suggests that only the greatest magnitude storms affected the substrate to these depths.

Facies B2 is gradational with Facies B1, and contains between 30 and 70% sandstone. Sedimentary structures include plane parallel and ripple laminations, occasional massive or bioturbate beds, and occasional to common hummocky cross-stratification (Figure 6-3).

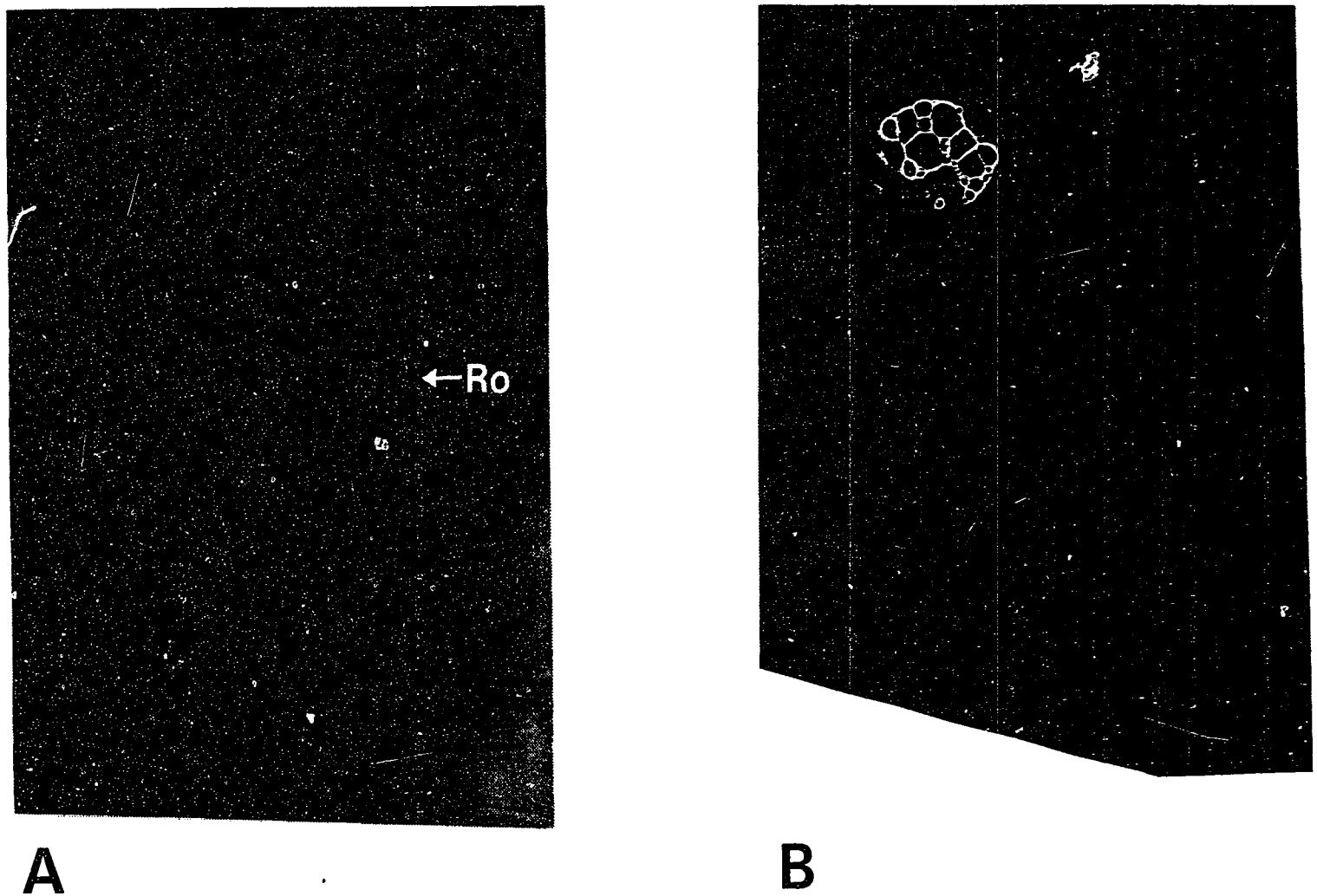


Figure 6-3. Core photographs of amalgamated storm beds and interpreted hummocky cross-stratified sand bed in facies B2.
A). 10-19-87-19/w6 at 1525.1 m with well defined *Rosellia* trace
B). d-B96-I/94-A-11 at 1388.90 m.

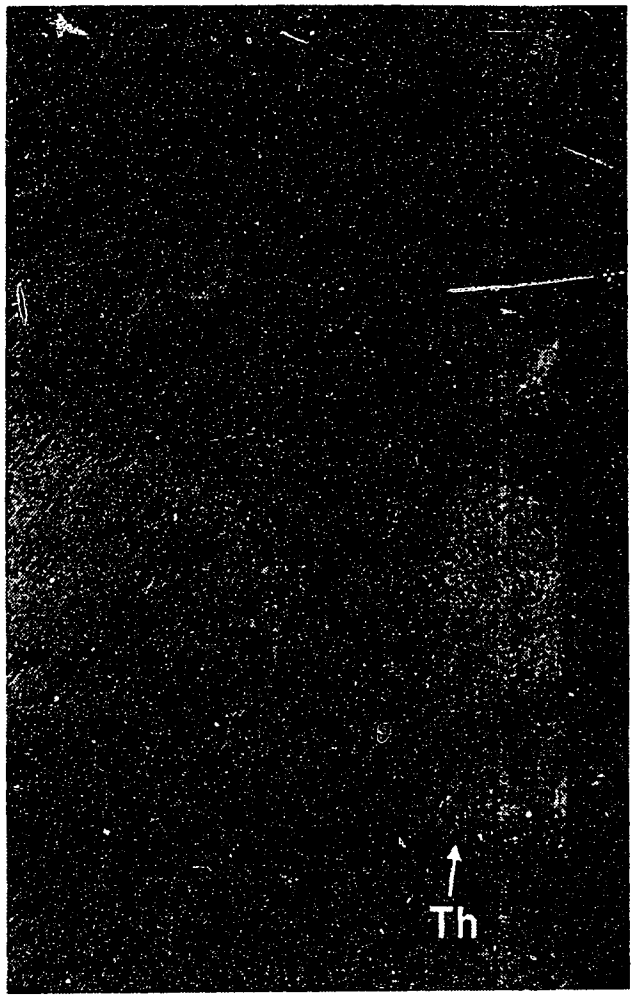
Individual storm beds are generally a few centimetres in thickness, but may locally be amalgamated into thicker units.

Burrowing is generally of weak to locally moderate intensity and consists of a two-phase assemblage. *Planolites*, *Paleophycus* and rare *Rosselia* are present in the siltier intervals, while *Paleophycus*, *Rosselia*, and *Cylindrichnus* appear in the sandier intervals. Rare *Skolithos* and escape structures are limited to very fine grained sand storm beds greater than 5 cm in thickness. The general increase in vertical elements, and the change from deposit feeding to mixed deposit feeding/suspension feeding strategies, results in a hybrid of the *Cruziana* and *Skolithos* ichnofacies which has been noted elsewhere in association with storm-dominated shelfal environments (*eg.* Pemberton and Frey, 1984; Vossler and Pemberton, 1989).

Facies C

Facies C represents the primary reservoir facies in the Buick Creek area, and varies from silty, very fine sandstone with less than 30% siltstone (Facies C1), to fine to medium sandstone with less than 10% silt (Facies C2). Both subfacies are typically massive and structureless with occasional moderate angle planar-tabular cross beds at 15° to 20°. Rare trough cross-bedding in sets less than 25 cm thick is present in Facies C2. While the massive appearance can locally be attributed to bioturbation, and less commonly to fluidization, it is often obscured by calcite cementation and/or bitumen saturation. In heterolithic intervals within Facies C, the development of a robust *Thalassinoides* network is evident (Figure 6-4a) and is highlighted by the grain size variation. Cementation patterns in the massive intervals suggests that this lack of internal structure may be, in part, a function of pervasive biogenic reworking (Figure 6-4b).

Facies C bedsets may be up to 3 m thick, and are separated by internal scour surfaces and/or thin rip-up lag concentrations. Significant accumulations of Facies C1 and C2 typically overlie Facies A and B across abrupt to erosive contacts (Figure 6-5), although locally this



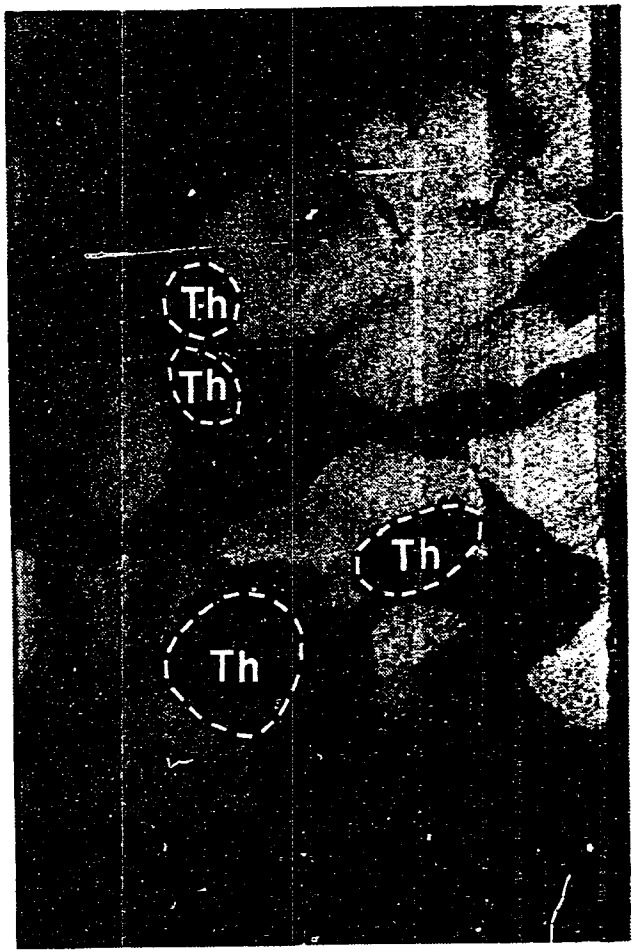


Figure 6-4. *Thalassinoides* burrows in Facies C sands.

A). *Thalassinoides* burrows in Facies C. (d-B96-I/94-A-11 at 1416.40 m)

B). *Thalassinoides* burrows marked by differential cementation. Light grey areas are calcite cemented, dark grey areas exhibit less prevasive dolomite cement and weak bitumen staining within burrows. (9-34-88-20/w6 at 1424.75 m)

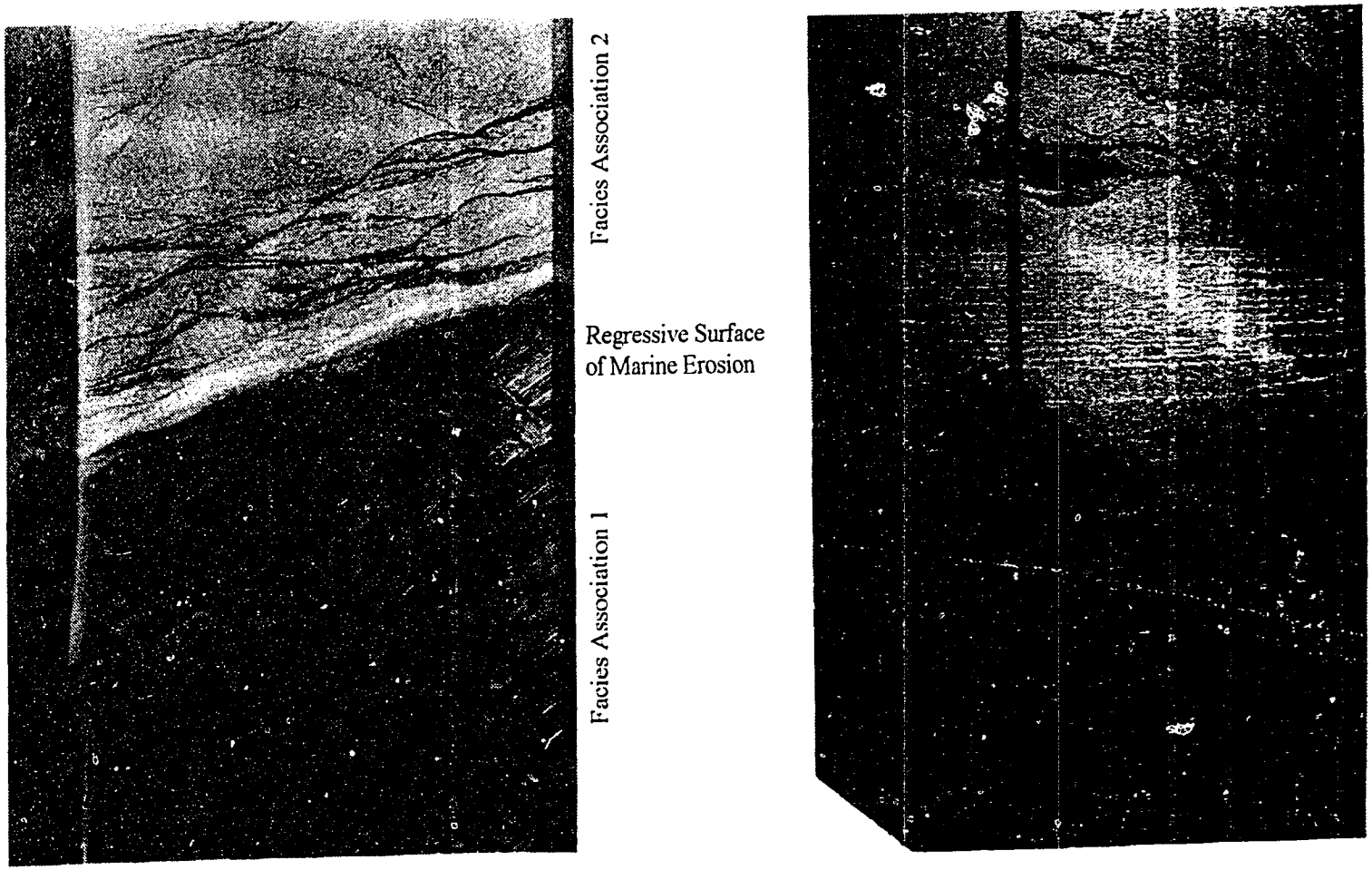


Figure 6-5. Core photographs of the base of the facies C sand in d-06-A/94-A-11. The contact is sharp, erosive and weakly pyritized.
A). Slabbed surface.
B). Whole core.

contact is partially obscured by robust *Thalassinoides* burrows and may be gradational. Deposition is from traction currents in an environment marked by significantly greater current velocities than those encountered in the offshore/offshore-transition (Facies B). In the absence of preserved, distinctive internal sedimentary structure, Facies C has been tentatively assigned to a middle shoreface (C1) to upper shoreface (C2) depositional environment.

Facies D

Facies D consists of the coarsest grained sediments present in the study area. Facies D1 is a clast-supported conglomerate containing a cobble-pebble framework with a matrix of sand, silt and rare shelly debris (Figure 6-6). Beds are less than 25 cm thick, and show no evident grading. Maximum clast size is greater than the core width (~10 cm). Facies D1 exhibits erosive bases overlying Facies C, and is abruptly overlain by deeper water sediments of Facies A and B.

Facies D2 is a bioclastic conglomerate or coquina consisting of coarse shelly debris with sand, silt and rare granules. Shell fragments range from a few mm to greater than 2 cm in length. The shelly material consists primarily of a bivalve and brachiopod hash which has been pervasively silicified and recrystallized, or is present solely as residual vugs (Figure 6-7). Beds vary from 20 cm to 1.5 m thick, with abrupt, stylolitic or erosive basal contacts, and sharp upper contacts. The thicker beds may exhibit rare cross beds at 10° to 15° and internal scour surfaces. Locally, the uppermost portion of individual beds may be marked by a predominance of granule sized rip-up clasts.

Facies D1 represents a Transgressive Surface of Erosion overlying the main reservoir facies. Facies D2 also represents erosive lag deposits; based on stratigraphic position, this facies can be equivalent to Facies D1 (TSE), or may reflect minor scours within the upper shoreface.

The Facies D2 assemblage in well 9-34-88-20/w6 is unique in both bed thicknesses



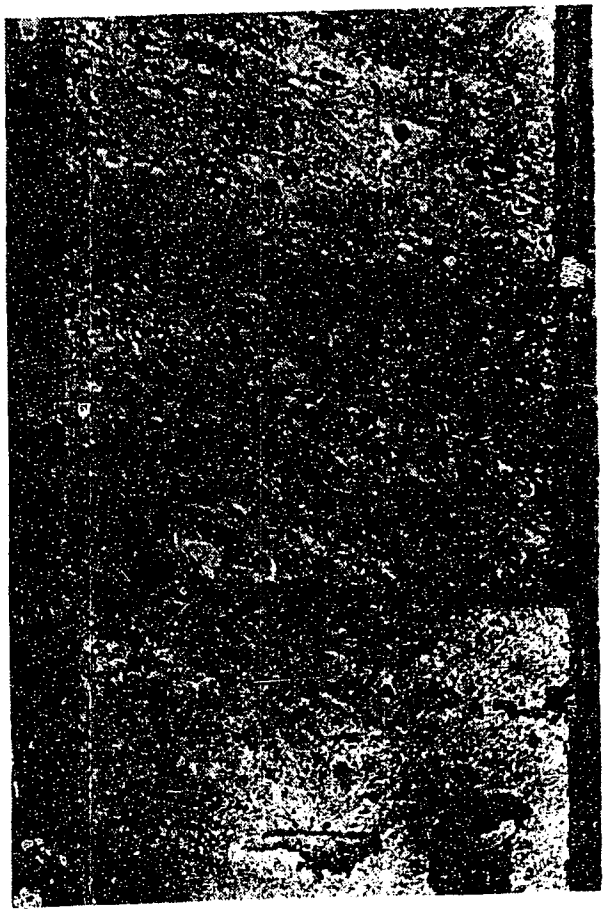


Figure 6-6. Core photographs of facies D1 transgressive lag. No grading is evident, and individual clasts are well rounded. d-76-I/94-A-11 at 1367.5 m

Figure 6-7. Core photograph of facies D2 bioclastic conglomerate. The upper contact is abrupt, but obscured by pervasive dolomitization. Note the crudely developed, low angle cross bedding marked by imbrication of the bioclasts. d-76-I/94-A-11 at 1397 m

(up to 3 m) and aggregate thickness (12 m). The bioclastic conglomerate consists of a sandy, dolomitic coquina interbedded with Facies C sandstones. The coquinas exhibit erosive bases and abrupt, planar tops (Figure 6-8). Overall bedset geometry is progradational, with bed thicknesses increasing upsection; individual beds rarely exhibit a weak fining-up marked by fine sand intercalations. The coquinas are predominantly massive; however, the development (or preservation) of moderate angle planar tabular cross beds, highlighted by a crude imbrication of bioclasts, increases with bed thickness. The abnormally thick Facies D2 assemblage in this well is interpreted as a probable tidal inlet channel within the middle to upper shoreface sequence. It represents the sole evidence for direct sediment supply in the Buick Creek Field area.

Facies E

Facies E is not a true lithofacies *per se*, but encompasses all disturbed beds in the study area. This includes oversteepened bedding, and all soft-sediment deformation. Oversteepening of Facies C sands is one of the most dramatic features present in some Doig cores, and has been used previously to argue for syndepositional slope instability (Munroe and Moslow, 1991; Wittenberg, 1992). At the Buick Creek field, additional core recovered from intervals stratigraphically above and below the Facies C interval show core angle inclinations equal to those within Facies C units. No evidence for progressive steepening of bedding down core was observed. Based on field scale correlations, some of this oversteepening was determined to be post-depositional, likely as a result of later reactivation of basement structure. Consequently, this unit is not restricted to any depositional environment, as has been implied elsewhere in the Doig (Wittenberg, 1992).

Facies Associations and Stratigraphic Relationships

Association 1 - Offshore/Shelf

The lower Doig interval, underlying the Doig sandstones present at Buick Creek, is composed of an assemblage of Facies A and B1 with a minor component of Facies B2. This assemblage is representative of deposition under quiet water conditions in an offshore/shelf

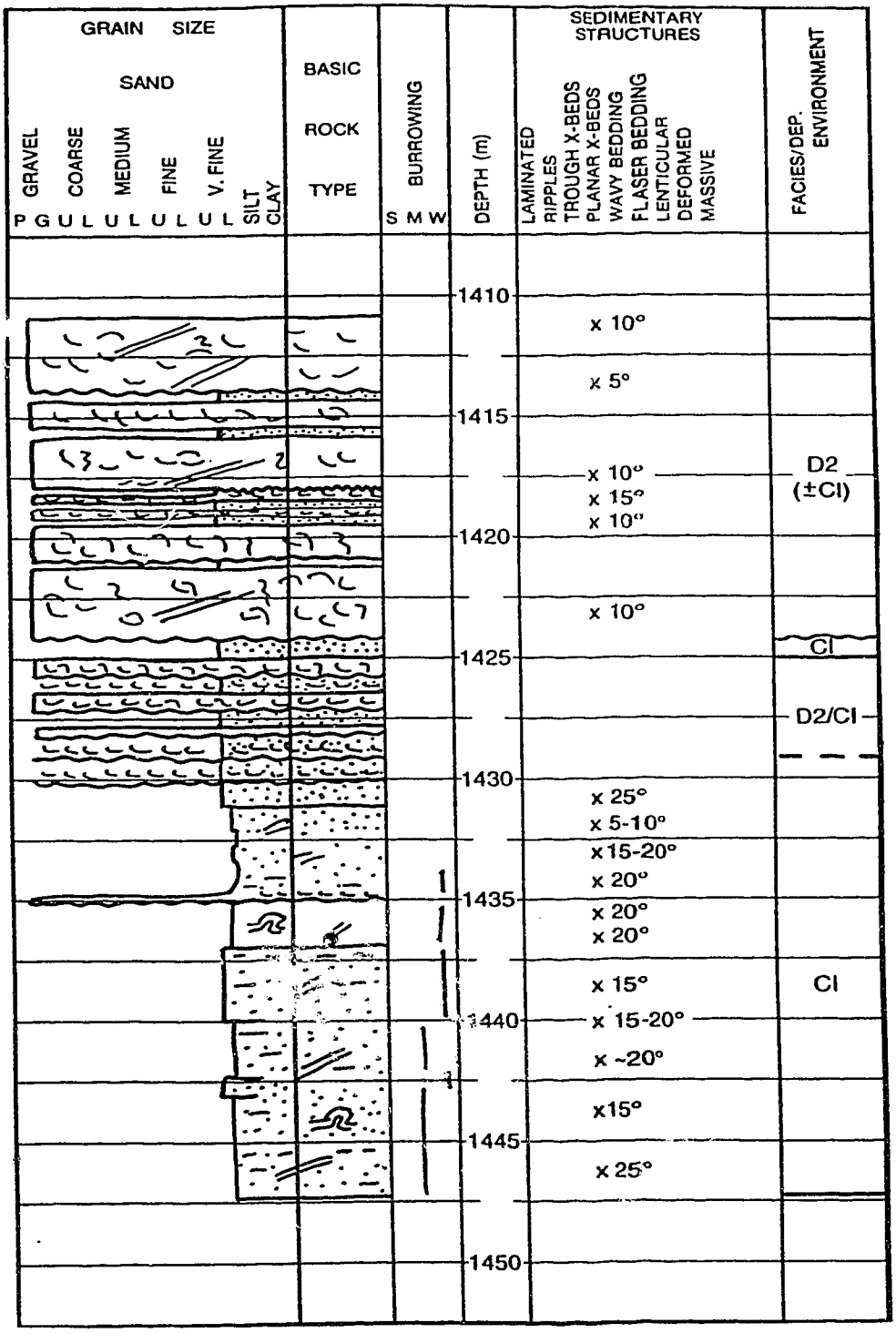


Figure 6-8. Graphic core log for 9-34-88-20/w6 at the southern end of the Buick Creek Field; the entire cored interval (37m) consists of facies D2 and C1. The productive interval lies on the same stratigraphic horizon as the rest of the Doig sands andis interpretted as a tidal inlet.

setting dominated by suspension settling. Suspension sedimentation is punctuated by infrequent storm-related traction currents (shale, siltstone and rare silty, very fine sand lamina). The overall pattern in this association is a crude coarsening upwards trend, from predominantly shale to predominantly siltstone, and reflects a gross progradational system.

The basal component of the offshore/shelf association includes a thick, highly radioactive shale interval marked by high phosphate and organic contents, and informally refered to as the "Phosphate Zone" (Edwards *et al*, 1994). The Phosphate Zone represents a classic condensed section deposited as the final phase of a transgressive systems tract. The top of the main Phosphate Zone (not cored) thus represents a maximum flooding surface, and the initiation of a highstand systems tract. The remainder of this association represents the early highstand systems tract, and includes all cores stratigraphically below the main Doig sandstone at Buick Creek.

Association 2 - Shoreface

The siltstones and shales of the offshore/shelf facies association are abruptly overlain by sandstones of the shoreface facies associations, which are informally referred to as the Doig Sand. The basal surface is sharp to erosive (Figure 6-5), and progressively truncates strata down section in a basinal direction (Figure 6-9a). This surface is frequently mineralized, weakly scoured, and may be marked by a thin shale rip-up lag. The incorporation of significant shale clasts along this horizon locally produces what appears as a gradational, coarsening-up signature on gamma ray logs (eg. b-77-I, Figure 6-9b). Similar deflections of gamma ray log signatures by included erosional debris have been documented elsewhere in the literature (Selly, 1979).

The main Doig Sand consists of Facies C1, C2 and locally D2, interbedded with subordinate Facies B2 (siltstones and dirty sandstones). Deposition represents traction sedimentation in lower shoreface through upper shoreface settings, and this association is the sole reservoir target in the Buick Creek field. The shoreface association may be up to 30 m

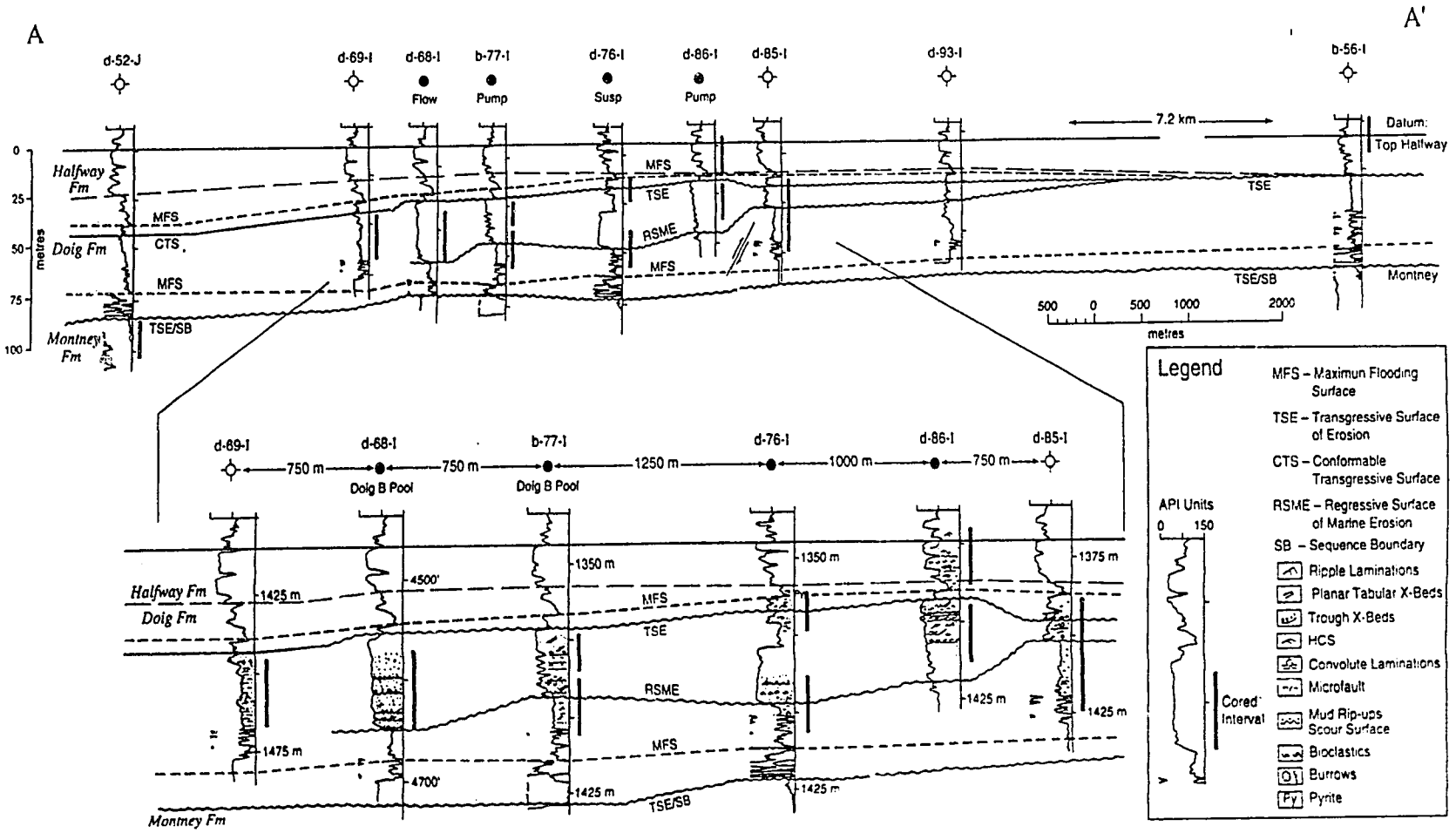


Figure 6-9. Dip-oriented stratigraphic cross-section A-A' through the centre of the Buick Creek Field.

A). Regional section with gamma-ray log profile and core control for each well. The base of the Doig sand represents a marine erosion surface (RSME) which is truncated landward by the overlying transgressive surface, progressively truncating strata down-dip in a basinward direction.

B). Field scale gamma-ray and core section showing relationships between facies associations and gross stratigraphic framework in selected wells from 6-9a. Facies association 2 sands abruptly to erosively overlie offshore silts and muds of association 1. The Doig sand is marked by rapid down-dip facies changes from oversteepened to massive sands to silt with rare rippled to convolute sand lamina over a distance of ~750m.

thick, thins rapidly both up and down dip (Figure 6-9) and is capped by Facies D conglomerates (Figure 6-6: Transgressive Surface of Erosion).

The basal contact of the shoreface association represents a regressive surface of marine erosion. This surface is truncated landward by the overlying transgressive surface, and the two merge basinward to become a correlative conformity (Figure 6-9a). The resultant sand body represents a major basinward shift in facies. The transgressive lag is capped by a pronounced flooding surface that can be correlated beyond the limits of the study area.

Association 3 - Offshore Transition

Facies Association 3 includes the upper Doig and lower Halfway lithostratigraphic units, and represents the basal portion of a larger progradational cycle that coarsens up into shoreface sandstones attributed to the Halfway formation. This basal portion consists primarily of Facies A2, B1 and B2, grading and coarsening up into Facies B2 and C. Spatially, Facies A2 and B1 become more significant to the southwest and south (basinward), with Facies B2 predominant to the north and northeast (Figures 6-9a, 6-10a); the storm-dominated offshore transition thus grades basinward into offshore and shelfal sediments deposited below the influence of storms. This association is similar to the offshore/shelf association (Association 1), but can be differentiated based on stratigraphic position, increased sand content, and prevalance of hummocky cross-stratification.

Discussion

Sand Body Geometry and Implications for Sequence Stratigraphy

Although the Doig Sand reservoir at Buick Creek has been subdivided into a number of different productive pools, along-strike correlations clearly demonstrate that these represent a single stratigraphic horizon with no evidence for significant facies changes between pools (Figure 6-10). Net sand distribution within Facies Association 2 clearly defines a pronounced linear pattern (Figure 6-11), oriented subparallel to the inferred paleoshoreline and normal to depositional dip. Sand thickness is irregular along strike, varying from less than

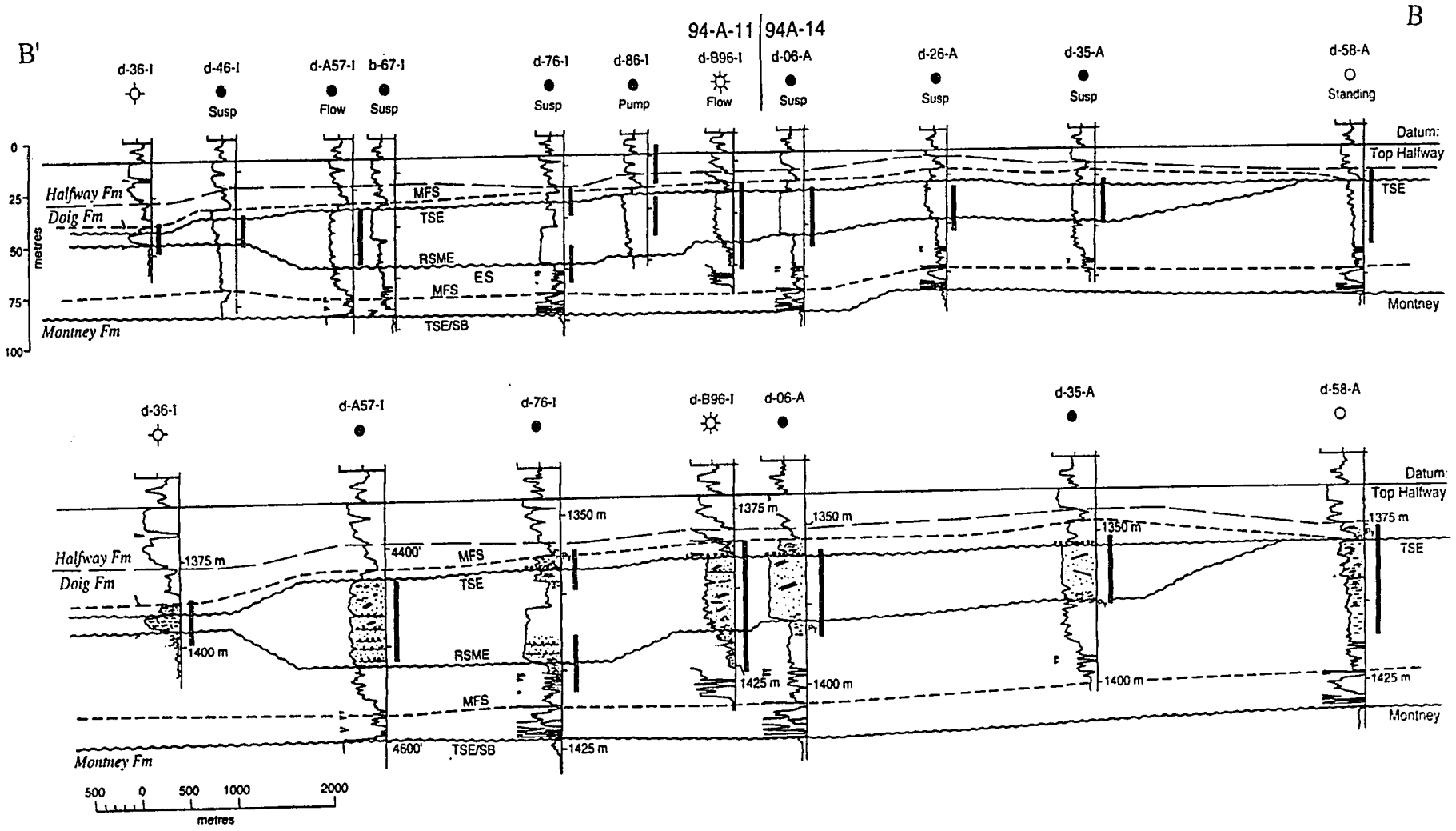


Figure 6-10. Strike-oriented stratigraphic cross-section B-B' through the axis of the Buick Creek Field.

A). Regional section with gamma-ray log profile and core control for each well. The dramatic decrease in sand thickness in the vicinity of well d-36-I/94-A-11 is partially a reflection of a dip-oriented element in the section.

B). Field scale gamma-ray and core section showing relationships between facies associations and stratigraphic framework in selected wells from 6-10a. Facies association 2 is capped by a coarse transgressive lag to the north and an equivalent bioclastic lag to the south. Where the basal contact is not obviously erosive in core it is heavily pyritized. See Figure 6-9 for legend.

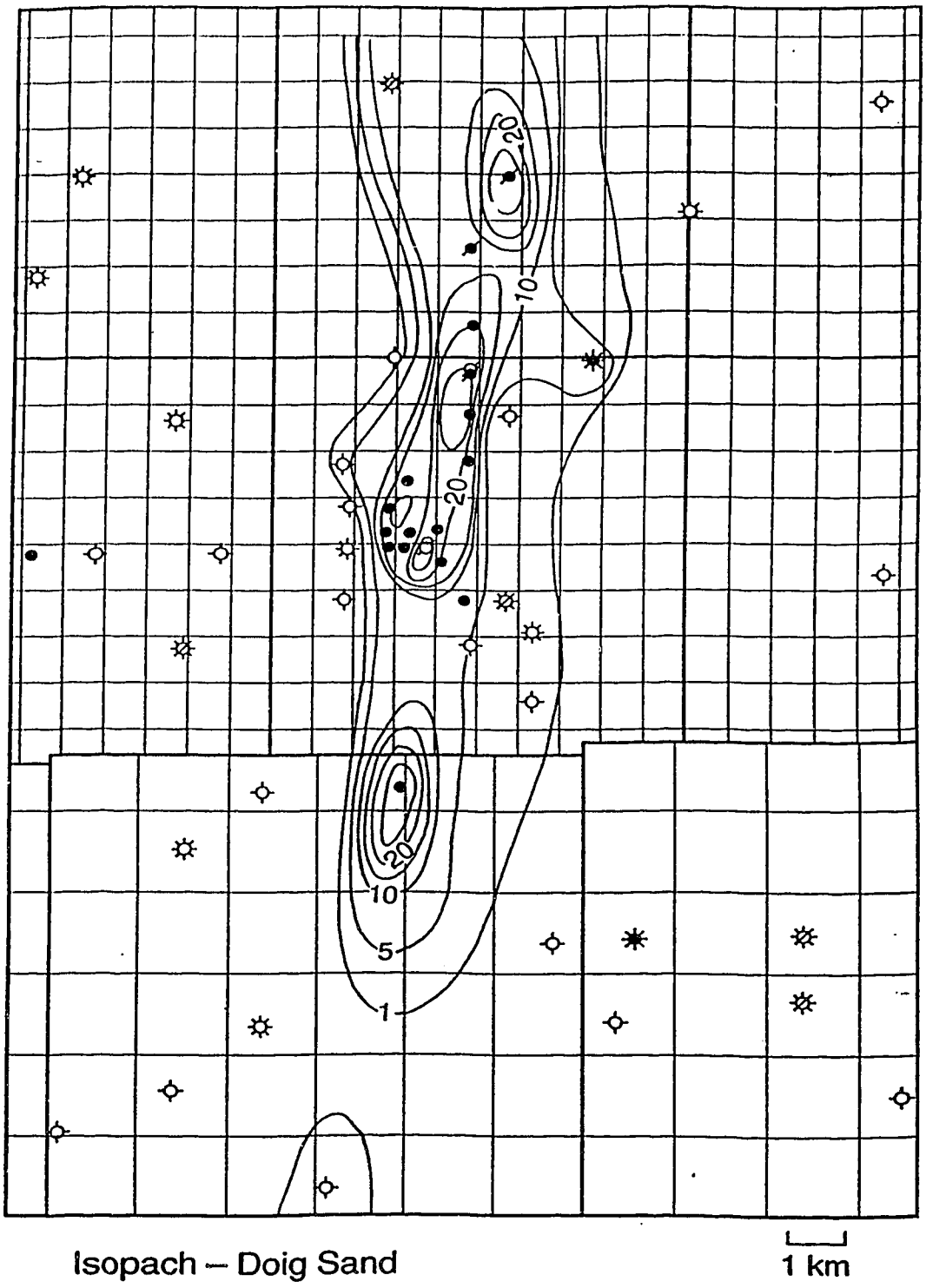


Figure 6-11. Net sand isopach for the Doig sand (facies association 2) at Buick Creek . Where no core is available, gamma-ray log sand cut-off equals 60° API based on log-core correlation in adjacent wells.

5 m to greater than 25 m. Strike length of the main sandstone body (greater than 5 m contour) exceeds 19 km, and is open to the north. Dip dimensions are variable, but average less than 2 km for a strike to dip ratio of approximately 10:1.

The thickest sandstones appear to be symmetrically distributed about the sand body axis, but a weak asymmetry is evident in the less than 5 m thick interval (Figure 6-11), with the sands spread out in a landward direction rather than basinward. This asymmetry is more pronounced in dip-oriented sections than in plan view, and is interpreted to represent reworking and backstripping of shoreface sands during a subsequent transgressive erosional event. This geometry can be generated by either shoreface erosion, or infilling of a pre-existing half-graben. Although the number of deep well penetrations are inadequate to constrain a structural control, the sharp, erosive nature of the basal surface argues against sedimentation into an existing structure.

Facies changes are abrupt, both vertically and laterally. The shoreface sandstones (Facies Association 2) abruptly overlie offshore siltstone and shales of Facies Association 1 across an erosive contact. This represents a significant basinward shift in facies, and development of a lowstand shoreface. As there is no evidence of subaerial exposure at this surface, either locally or regionally, it does not represent a sequence boundary *sensu stricto* (Van Wagoner *et al.*, 1988; 1990). This surface is interpreted as a subaqueous ravinement surface (regressive surface of marine erosion) reflecting either a higher order sea level fluctuation (high frequency sequence boundary) or a tectonically induced fall in relative sea level. This is essentially the same as similar sharp-based, shoreface sandstones found elsewhere, which have been coined "forced regression" shorefaces (Plint, 1991; Posamentier *et al.*, 1992).

A eustatically driven fall in sea level has not been documented in the Middle Triassic of the Western Canada Sedimentary Basin. However, a Late Anisian relative sea level fall has been postulated in the Sverdrup Basin of the Canadian Arctic (Embry, 1988), and is shown

on the global eustatic sea level charts of Haq *et al* (1988). Facies Association 2 is thus interpreted to represent an element of the lowstand systems tract.

The shoreface sandstones are erosionally overlain by a coarse lag deposit, followed by much finer-grained offshore to offshore transition sediments. The lag represents a transgressive surface of erosion which amalgamates with the regressive surface of marine erosion in a landward direction (Figure 6-9). The transgressive lag is overlain by a marine flooding surface and a single retrogradational parasequence which onlaps the amalgamated TSE/RSME landward. This backstepping parasequence represents the total thickness of the transgressive systems tract in the study area. The subsequent highstand systems tract reflects a renewal of the progradational architecture typical of the Halfway-Doig interval in northeastern B.C.

Exploration Significance

The geometry and stratigraphic setting of the Doig Sands at Buick Creek can be used to develop a predictive model for use in both the exploration for, and the development of, similar sandstones occuring elsewhere in the Doig Formation. The Doig Sands are narrow, linear sandstone bodies oriented with their depositional axes elongate parallel to the inferred paleoshoreline.

The interpretation of these sandstones as forced lowstand shoreface deposits makes this a necessary and predictive geometry. In the absence of significant structural relief, following a drop in sea level across a low-gradient exposed shelf, the new shoreline will develop parallel to the paleocoastline. If the subsequent transgression follows abruptly, there is little opportunity to establish a full shoreface profile. In the absence of a major fluvial discharge site, only a thin, immature shoreline will develop. Alternatively, a more mature shoreface may develop and be stripped during the subsequent transgression (Plint, 1988; Walker and Plint, 1992).

The depositional history and orientation of these sands implies that exploration should emphasize strike continuity. Dip dimensions are extremely limited; however, several possible proximity indicators can be defined. Down dip facies changes are abrupt, from shoreface sandstones to offshore transition siltstones with minor rippled sandstone and rare hummocky cross stratification. Storm-wave loading of the shoreface during the subsequent transgression may produce local liquifaction of the sand bodies, as evidenced by local oversteepening and massive sandstones, and can be predicted to result in shoreface failure. The resultant mass transport may explain thin, slightly coarser-grained intervals (stray sands) deposited downdip along the regressive surface of marine erosion (Figure 6-9b: d-52-J/94-A-11). In plan view these sandy siltstones should exhibit a lobate geometry normal to the paleoshoreline.

The weak updip assymetry to the sandstone, and the bioclastic lag which caps Facies Association 2, are both a result of shoreface reworking and backstripping during the ensuing transgression. Thin intervals of Facies D2 equivalent bioclastic sandstones should be present updip from the Doig Sands as a transgressive lag deposit. The implication of Figure 6-9b is that these lags decrease in thickness abruptly up dip away from the shoreface (d-86-I/94-A-11 to d-85-I/94-A-11), and within a few kilometres may be represented by as little as a few shells. As the lowstand and transgressive surfaces merge along strike, or updip, a compressed Facies Association 2 is preserved consisting of 2 to 4 m of Facies D2 bioclastic conglomerate (Figure 6-10b: d-36-I/94-A-11, this same bioclastic unit is present in d-44-I and d-45-I).

The trend of the paleoshoreline during the time of deposition of the Halfway-Doig interval is oriented slightly oblique to the present structural gradient. This, when combined with differential compaction over the Doig Sands, can result in the development of a subtle deflection in structural contours drawn on the top of the overlying Halfway Formation (Figure 6-12). The subtlety of this anomaly is due to the small angle of intersection between the two orientations; however, in areas of sufficient well control, fine-scale contouring produces a definite south-trending arch over the Doig Sands. The detail and control required for the resolution of these sandstones likely precludes the utility of this approach on a regional basis;

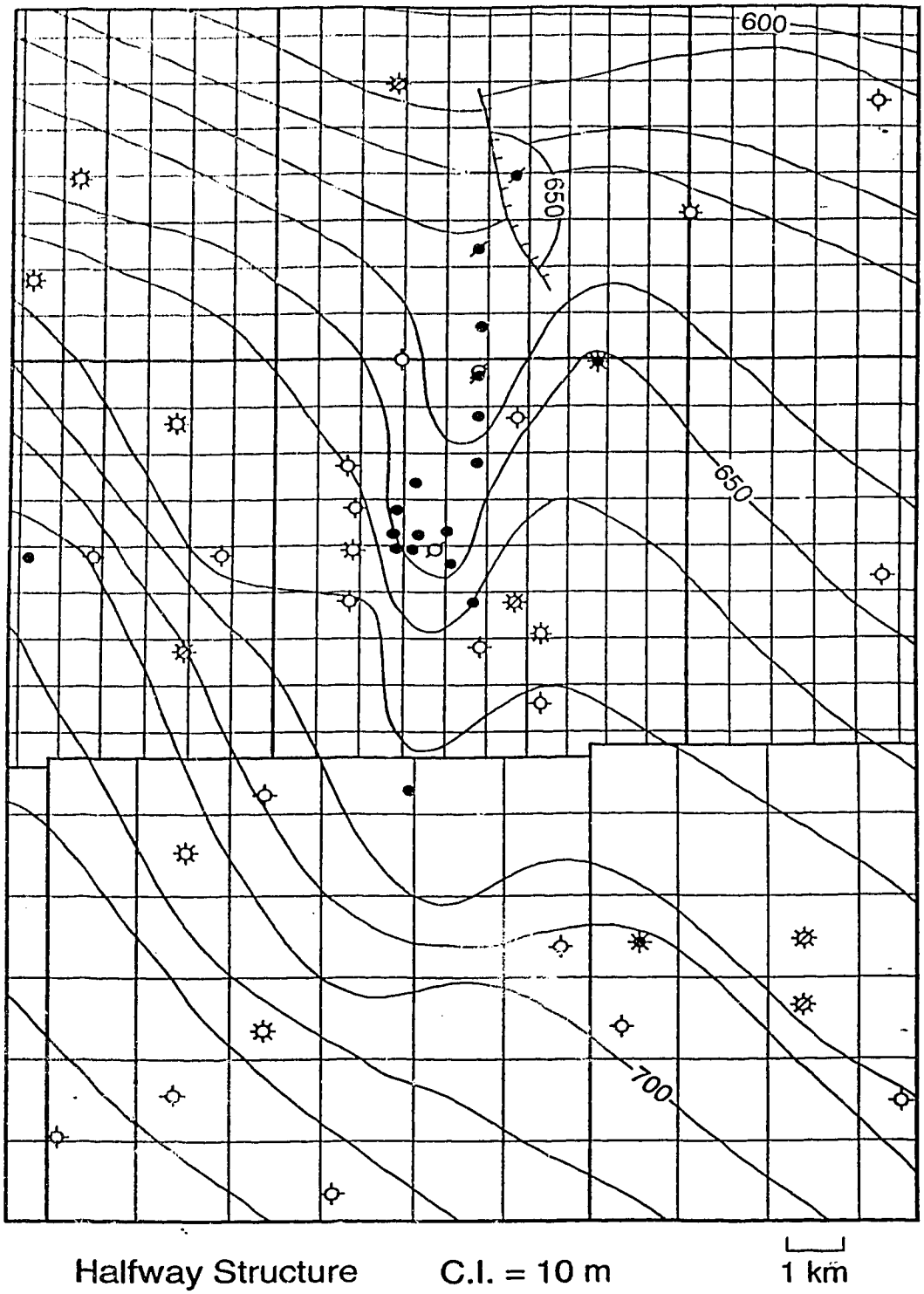


Figure 6-12. Structure map drawn on the top of the Halfway Formation. The pronounced southerly deflection in contours over Buick Creek represents differential compaction over the Doig sands. In other areas where well density of Halfway penetrations is high enough, such subtle structural anomalies may provide a significant exploration tool.

its value lies in re-examining areas of historic Halfway or basal Charlie Lake production where there is a large database of available Halfway penetrations, but relatively few Doig penetrations.

Conclusions

Sedimentary facies identified from the Doig Formation in the Buick Creek Field area can be grouped into three Facies Associations: (1) offshore/shelf, (2) shoreface, and (3) offshore transition. All production is from Facies Association 2 which consists of fine-grained, massive to structureless sandstone. Facies Association 2 erosively overlies Facies Association 1, and is abruptly overlain by Facies Association 3 across a pronounced transgressive surface of erosion. The thickest sandstones are symmetrically distributed about the sand body axis, with a weak asymmetry in the < 5 m thick interval. This asymmetry is interpreted to represent reworking and backstripping of shoreface sands during a subsequent transgressive erosional event.

The Buick Creek field represents a lowstand shoreface deposited during a Late Anisian fall in relative sea level. Although it cannot be resolved whether this sea level fall is eustatically or tectonically controlled, this characterization allows construction of a depositional model which can be used as a guide for future hydrocarbon exploration. The orientation of these sandstones implies that exploration should emphasize strike continuity.

Net sandstone distribution defines a pronounced linear pattern oriented subparallel to the paleoshoreline, exceeding 19 km in length, and open to the north. Dip dimensions are limited, but several proximity indicators can be defined including (1) abrupt down dip facies changes from shoreface sandstones to offshore siltstones and shales, (2) local storm-wave induced loading of the shoreface during transgression producing local liquifaction, oversteepening and massive sands, (3) stray sandstones downdip along the regressive surface of marine erosion, and (4) thin Facies D2 bioclastic lags immediately updip from the Doig Sands.

The Halfway/Doig paleoshoreline is oriented slightly oblique to the present structural gradient which, combined with differential compaction over the Doig Sands, results in a weak deflection of structural contours drawn on the top of the Halfway Formation. The subtlety of this anomaly likely precludes its use on a regional basis, but it may be of value in re-examining areas where a large database of Halfway penetrations is available, regardless of the number of Doig penetrations.

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CHAPTER 7.
LOWSTAND SHOREFACES IN THE DOIG FORMATION (MIDDLE TRIASSIC): HIGH FREQUENCY SEQUENCE BOUNDARIES AND IMPLICATIONS FOR HYDROCARBON EXPLORATION IN NORTHEASTERN BRITISH COLUMBIA.

Introduction

The Lower Halfway and Doig formations in northeastern British Columbia contain a number of narrow, elongate sandstone bodies oriented subparallel to the paleoshoreline. These sandstones have been described as shelf sands, and are considered to represent the greatest potential gas resource in the Triassic of the Western Canada Sedimentary Basin (Bird *et al.*, 1994). Estimated undiscovered in place volumes exceed 100 billion m^3 gas (~4 TCF). In recognition of the significance of the Halfway/Doig play, and anticipated interest therein, a sequence stratigraphic reconstruction of anomalously thick Doig sandstones was undertaken to develop a predictive depositional model. Following industry usage, these sandstones are refered to informally as the Doig Sand herein.

In this study, existing Doig fields in the Fort St. John area are characterized using a process sedimentologic approach to infer depositional processes, document facies associations, and determine depositional environments present in the Doig Formation. These data allow for the development of a depositional model within a sequence stratigraphic framework, and address the implictions of tectonics and paleogeography for exploration trends. This represents the first concerted attempt to place the Doig Formation of northeastern British Columbia within a high-frequency sequence stratigraphic context, and develops a model significantly different from those of previous authors.

General Stratigraphy

Middle Triassic strata of northeastern British Columbia represent a progradational sequence of shallow marine to marine clastic sediments deposited on the western flank of the

North American craton (Gibson and Barclay, 1989). Structurally, the continental shelf was underlain by a passive margin, but evidence indicates that syndepositional faulting exerted some degree of control over local sediment accumulation (eg. Cant, 1984; 1986; Caplan, 1992; Qi, 1995). This syndepositional deformation may reflect relaxation of individual structures associated with the Peace River Arch and Dawson Creek Graben Complex, or reactivation of basement faults.

In the subsurface, these strata are subdivided into two broad lithostratigraphic units, the Halfway and Doig formations (Table 7-1). The Doig Formation is composed of shale, siltstone, and minor sandstone, with a thick, highly-radioactive phosphatic shale section near the base (Armitage, 1962). The Doig is transitional upsection into shallow marine sandstones and coquinas attributed to the Halfway Formation (Hunt and Ratcliffe, 1959). The difficulty in differentiating the two is well established (eg. Edwards *et al.*, 1994).

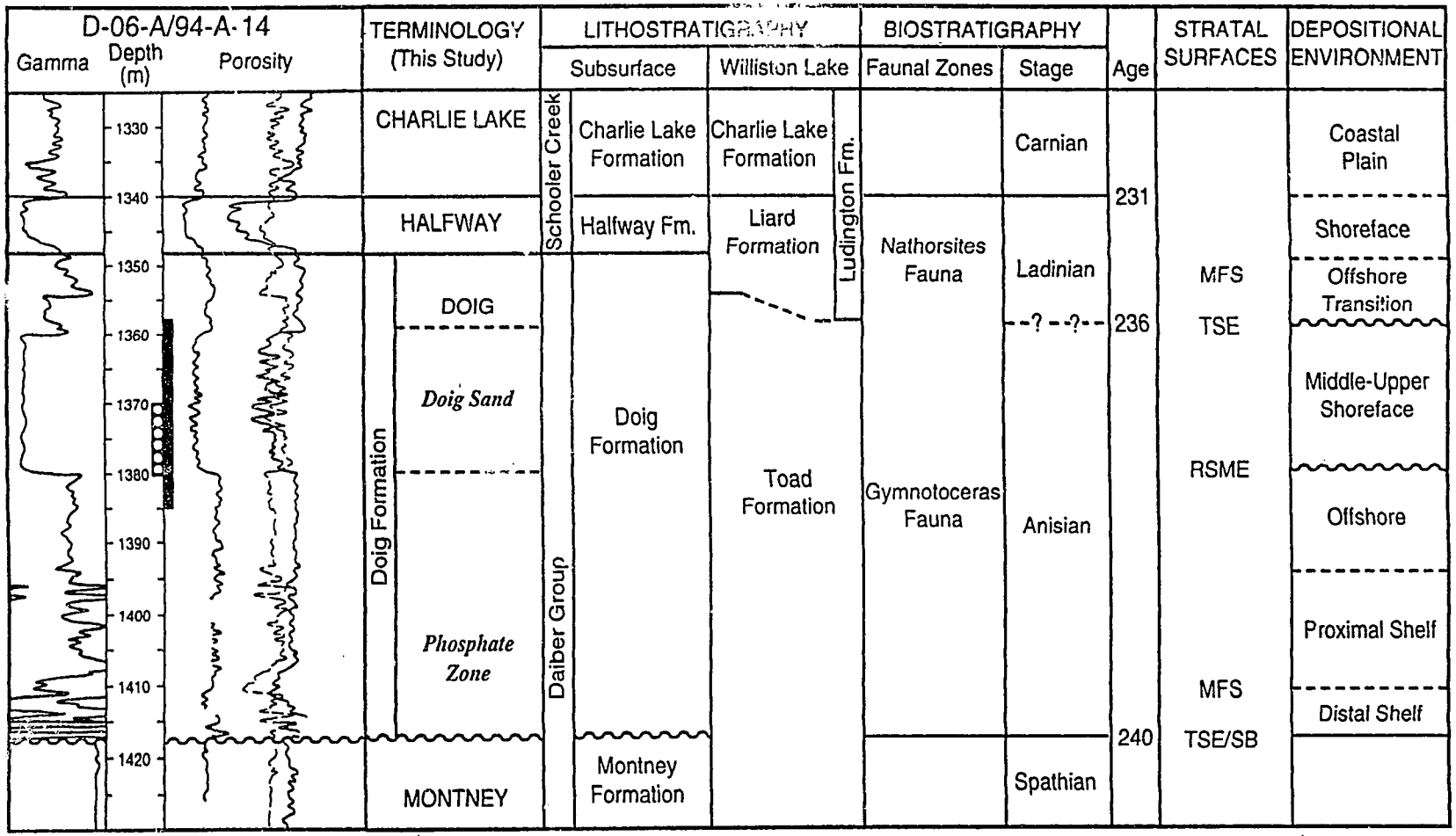
The Halfway/Doig contact has been described as a disconformity (Dawes, 1990) or, locally, as an unconformity (Chunta, 1969; Campbell and Horne, 1986). Others argue that this contact does not represent a regionally correlatable stratigraphic break (Willis, 1992; Wittenberg, 1992). The two formations are treated herein as a single, continuous unit (Table 7-1) which unconformably overlies the Montney Formation, and is abruptly overlain by marginal to non-marine clastics, evaporites and carbonates of the Charlie Lake Formation.

Database Methodology

The study area constitutes approximately 6000 km sq (75 by 80 km) in the Fort St. John area of northeastern British Columbia, and includes the Buick Creek, Cache Creek, Fireweed and Stoddart-West Doig pools (Figure 7-1). The largest of these fields is the Buick Creek field, which has been presented elsewhere (CHAPTER 6). This study represents an expansion of the earlier study.

The initial database for this study consisted of 722 wireline logs and 63 cored intervals

TABLE 7-1. Table of stratigraphic terminology for the Middle Triassic in northeastern B.C. (from Evoy and Moslow, *in press*). Lithostratigraphic terminology and stages from Gibson and Barclay (1989), faunal zones from Tozer (1961).



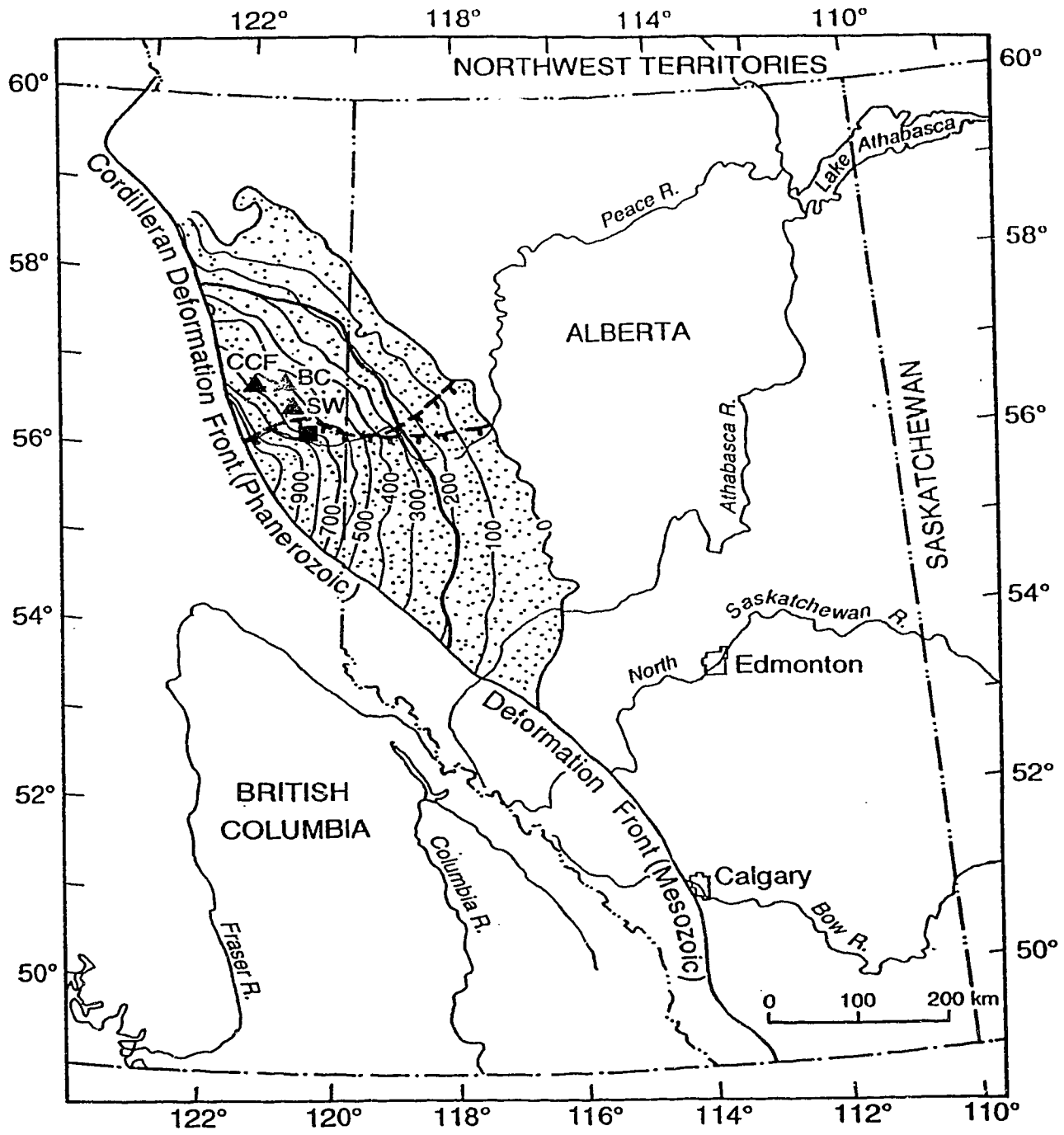


Figure 7-1. Regional Triassic location map showing location of Doig production at Buick Creek (BC), Cache Creek/Fireweed (CCF) and Stoddart-West (SW) as solid triangles. Solid square represents Fort St. John. Contour interval for Triassic isopach equals 100 metres, solid heavy line approximating the 200 m contour represents the erosional edge of the Halfway/Doig interval. Heavy dashed lines represent the flanks of the Dawson Creek Graben Complex. Modified from Edwards *et al.* (1994) and Henderson *et al.* (1994).

from 54 wells, totalling 1152 m. Thirty nine wells (846.6 m) have cored the Halfway/Doig interval within the study area (Table 7-2). All cores were described using a process sedimentologic approach (*cf* Seimers and Tillman, 1981) stressing genetically related beds and bed set characteristics, and delineation of vertical facies associations in core. Sand cut-off for isopachs was established at 60° API based on core-gamma correlation.

Documentation of major stratigraphic discontinuities was based on both core data and recognition on wireline logs. All 722 wireline logs penetrate the Halfway (Figure 7-2), with 475 of these deep enough to test for the Doig Sand. Two stratigraphically distinct sandstones were documented. The first sandstone is present in 163 wells, and has been partially cored in 23 wells. The second sandstone stratigraphically overlies the first, is located 10 to 20 km furter basinward, and is present in 52 wells. The second Doig sandstone has only been cored in 4 wells.

All pool reserves and reservoir parameters were determined as of December 31, 1991, and are summarized from publications of the Energy Resources Division of the British Columbia Ministry of Energy Mines and Petroleum Resources (EMPR, 1991).

Sedimentary Facies and Facies Associations

All facies herein have been defined previously, based on their observed physical characteristics (CHAPTER 6; Evoy and Moslow, 1995; Evoy and Moslow, *in press*). Four major facies were recognized based on lithology, primary physical and biogenic sedimentary structures, bedding geometry, and the nature of their bounding surfaces. Each facies was subdivided based on texture (percent sand, maximum clast size). A final facies class was assigned for all intervals with significant degrees of apparent soft-sediment deformation. A total of nine sedimentary facies were thus recognized (Table 7-3).

Commonly recurring groupings of lithofacies were classified together to define facies associations characteristic of gross depositional environments (Figure 7-3). Three facies

TABLE 7-2. Database Summary (see also: Figure 7-2)

UWI	Formations	Length	Area
12-24-84-21/w6	Doig	14.85	Regional
11-31-85-21/w6	Doig	17.90	Red Creek
(02) 6-04-86-	Doig	17.45	Stoddart
12-04-86-20/w6	Doig	17.50	Stoddart
16-15-86-20/w6	Doig	10.50	Stoddart
10-25-86-20/w6	Doig	17.30	Stoddart
10-19-87-19/w6	ChLk-Doig	37.60	Regional
6-22-87-20/w6	Hfwy	5.15 m	Stoddart
	Doig	12.40	(A Pool)
(02) 6-26-87-	Hfwy	13.30	Regional
6-21-88-19/w6	ChLk-Hfwy	15.00	Regional
7-24-88-20/w6	Hfwy	14.40	Buick
9-34-88-20/w6	Doig	36.40	Buick
a-29-K/94-A-10	ChLk-Hfwy	4.80 m	Regional
	Hfwy-Doig	17.20	Regional
d-87-K/94-A-10	Halfway	13.75	Regional
d-36-I/94-A-11	Hfwy/Doig	12.80	Buick
b-44-I/94-A-11	Hfwy/Doig	18.65	Buick
d-45-I/94-A-11	Doig	17.70	Buick
d-46-I/94-A-11	Doig	13.50	Buick
(02)d-57-I/94-A-	Doig	25.00	Buick
d-58-I/94-A-11	Doig	18.10	Buick
d-68-I/94-A-11	Doig	23.90	Buick
d-69-I/94-A-11	Doig	22.00	Buick
d-76-I/94-A-11	Hfwy-Doig	12.00	Buick
	Doig	18.00	Buick
b-77-I/94-A-11	Doig	12.10	Buick
	Doig	17.10	Buick
d-79-I/94-A-11	Doig	9.00 m	Buick
d-85-I/94-A-11	Doig	36.40	Buick
d-86-I/94-A-11	ChLk-Doig	18.10	Buick
	Doig	18.20	Buick
(02)d-96-I/94-A-	ChLk	8.40 m	Buick
	Doig	27.00	Buick
(03)d-96-I/94-A-	Hfwy-Doig	41.80	Buick
d-52-J/94-A-11	Mntny	18.20	Regional
b-64-I/94-A-12	Doig	17.90	Cache
d-06-A/94-A-14	Hfwy-Doig	28.00	Buick
a-26-A/94-A-14	Doig	22.20	Buick
d-35-A/94-A-14	Hfwy-Doig	21.70	Buick
d-58-A/94-A-14	Hfwy-Doig	36.00	Buick
b-6-D/94-A-14	Doig	15.00	Fireweed
d-15-D/94-A-14	Doig	19.00	Fireweed
b-26-D/94-A-14	Doig	17.15	Fireweed
d-37-D/94-A-14	Doig	16.00	Fireweed
b-56-D/94-A-14	ChLk-Hfwy	18.20	Regional
TOTALS:	40 Wells	864.8 m	

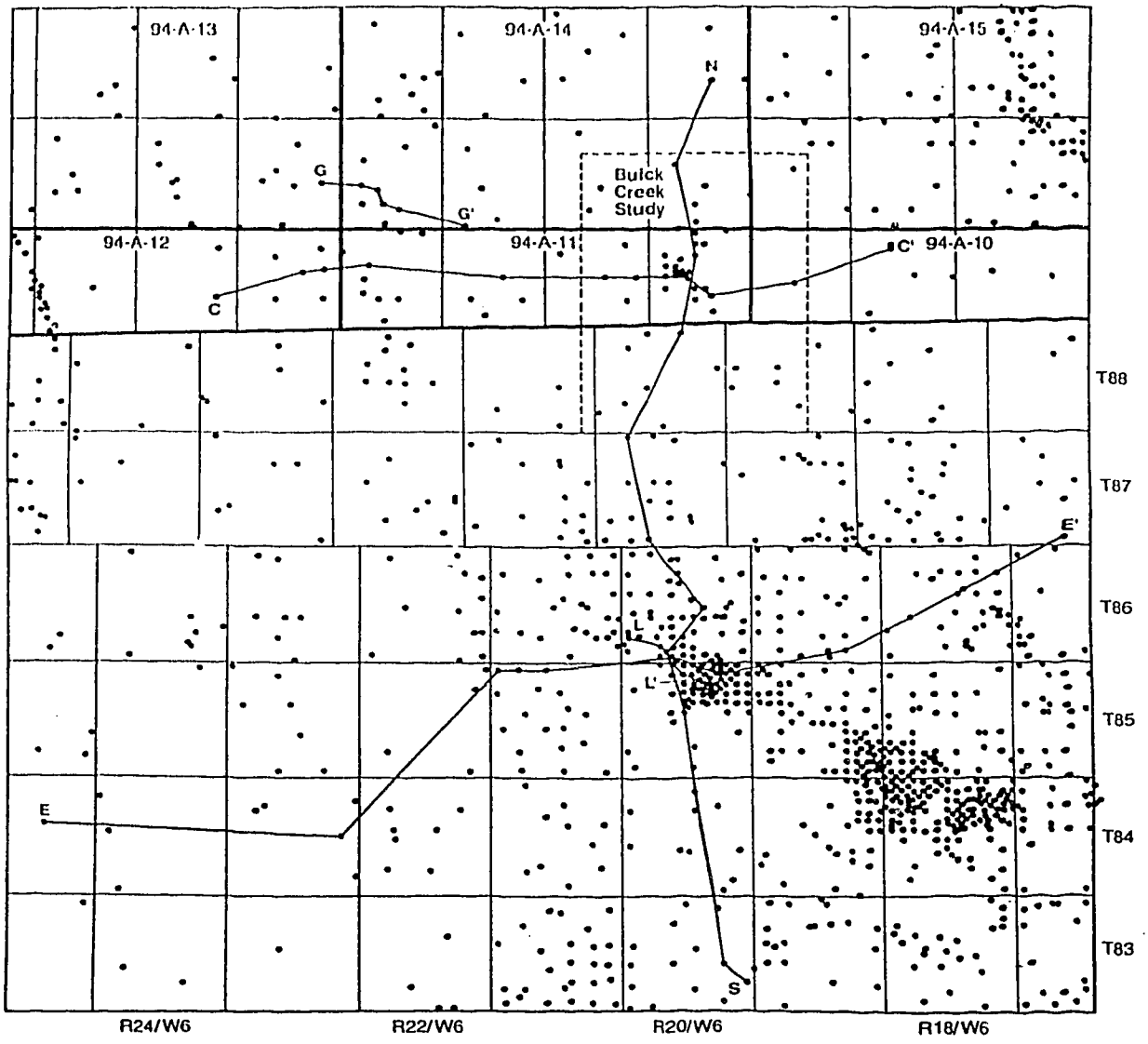


Figure 7-2. Study area outline showing all Halfway penetrations in the area. All wells with core recovered from the Doig and/or Lower Halfway intervals have been logged as part of this study (see also Table7-2). Cross sections L-L', G-G', N-S, C-C', and E-E' are discussed in the text and presented as figures 7-6, 7-7 and 7-11 through 7-13 respectively.

TABLE 7-3. Summary of facies characteristics in the Lower Halfway and Doig formations (from Evoy and Moslow, *in press*).

FACIES	LITHOLOGY	SEDIMENTARY STRUCTURES AND BEDDING GEOMETRY[1]	DEPOSITIONAL PROCESS(ES)	DEPOSITIONAL ENVIRONMENTS[2]
A1	SILTY MUD black, calcareous <5 to 10% vfg sand	Plane parallel lamina, rare ripple lamina, discontinuous sand lamina; beds to 6m*. Pl, Pa	SUSPENSION SEDIMENTATION Rare traction currents, turbidites/contourites.	OFFSHORE - Distal Shelf
A2	MUDDY SILT <10% vfg sand	Plane parallel lamina, minor ripple lamina, rare convolute beds; coarsens up; sands to 5cm thick, beds to 14m thick; Pa, Pl, Ch, Th(?), As(?), Te(?).	SUSPENSION SEDIMENTATION Minor traction currents, turbidites/tempestites.	OFFSHORE - Proximal Shelf
B1	INTERBEDDED SILT/SAND <30% sand	Plane parallel and ripple lamina; occasionally massive or bioturbate; rare HCS(?); Cy, He(?).	MIXED SUSPENSION/TRACTION Sediment gravity flows and rare storm beds.	OFFSHORE
B2	INTERBEDDED SAND/SILT 30% to 70% sand	Plane parallel and ripple lamina; occassional to common HCS; locally massive; fugichnia, Cy, Ro.	MIXED TRACTION/SUSPENSION Storm beds.	OFFSHORE TRANSITION
C1	SILTY VERY FINE SAND up to 30% silt	Internally massive to moderate angle cross beds at 15-20°; bed sets to 3m*; locally bioturbate.	TRACTION CURRENTS Aqueous gravity currents.	SHOREFACE - Lower to Middle
C2	FINE to MEDIUM SAND <10% silt	Internally massive; rare moderate angle cross beds, planar and (occasional) troughs; locally bioturbate.	TRACTION CURRENTS Aqueous gravity currents	SHOREFACE - Middle to Upper
D1	CONGLOMERATE pebble/cobble, with sand,silt,shells.	Beds <20cm thick, clasts to 10cm in diameter; no evident grading; abrupt contacts; rare shell fragments.	WAVE RAVINEMENT SURFACE Erosional lag.	TRANSGRESSIVE SURFACE OF EROSION
D2	BIOCLASTIC CONGLOMERATE with sand, silt, and rare granules	Coarse bioclastic conglomerate and coquina; beds typically 20cm to 1.5m thick; rare X-beds at 10-15°; internal scour surfaces; abrupt to erosive contacts.	TRACTION CURRENTS Aqueous gravity currents, Erosional lag.	UPPER SHOREFACE Tidal Inlets(?), TSE Equivalent
E	DISTURBED BEDS	Not a true lithofacies: includes oversteepened bedding and slumps; highly variable to discontinuous.	SOFT-SEDIMENT DEFORMATION	Not Restricted by Environment

COMMENTS:

1. As - *Asterosoma*, Cy - *Cylindrichnus*, Pa - *Paleophycus*, Th - *Thalassinoides*, Ro - *Rosellia*, Pl - *Planolites*, He - *Helminthopsis*, Te - *Terebellina*, Ch - *Chondrites*
2. Shelf refers to deposition below maximum storm wave base; distal and proximal are relative terms.

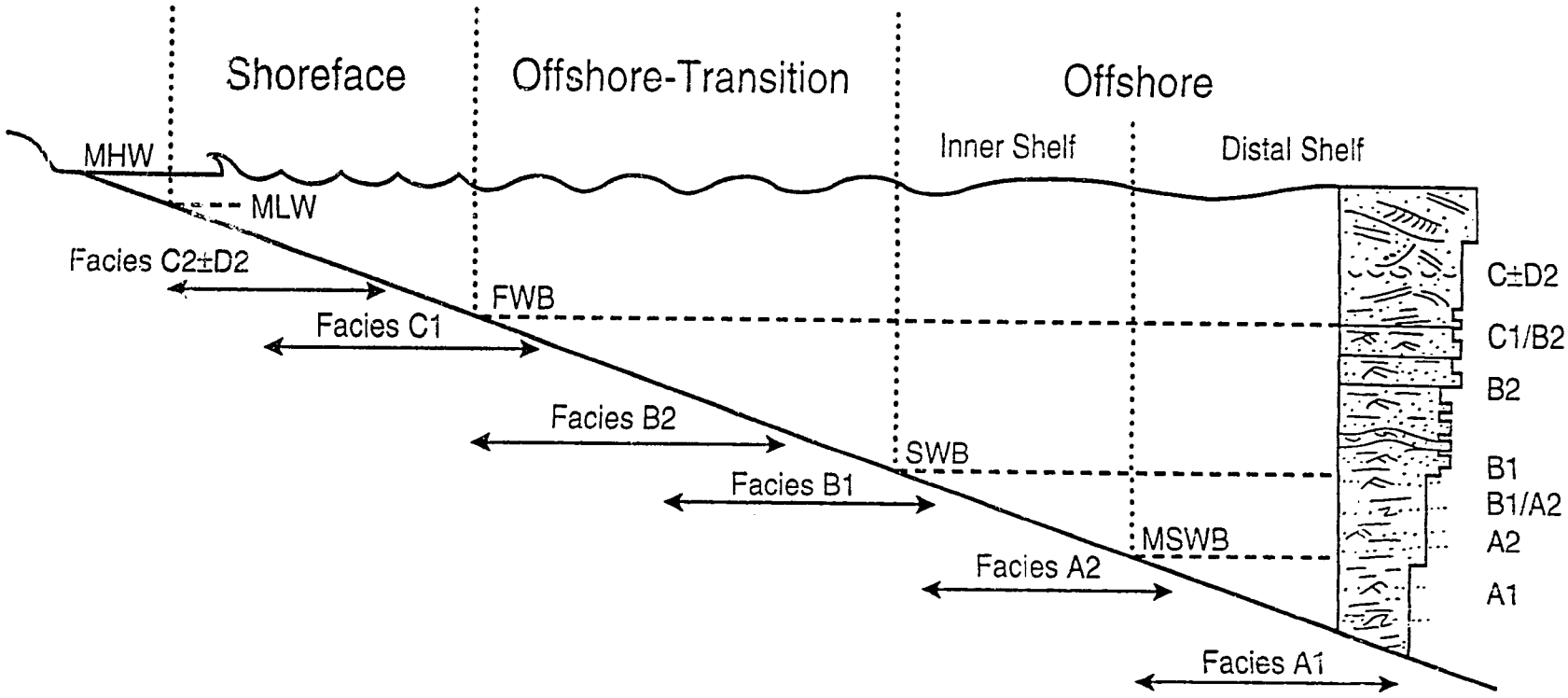


Figure 7-3. Facies distributions and depositional environments for the Doig Formation in northeastern British Columbia. (after Elliot, 1986 and Krassay, 1994). FWB - fairweather wave base, SWB - average storm wave base, MSWB - maximum storm wave base.

associations, appearing in each of the fields studied, were recognized and are presented in ascending (stratigraphic) order.

Association 1 - Offshore/Shelf

The basal Doig interval, underlying the Doig Sands, consists of phosphatic siltstone and shale with rare very fine-grained sandstone, and represents deposition under quiet water conditions in an offshore/shelf setting dominated by suspension settling. The suspension sedimentation regime is punctuated by infrequent storm-related traction currents. The overall pattern in this association is a crude coarsening upwards trend, from predominantly shale to predominantly siltstone.

Association 2 - Shoreface

Siltstones and shales of Facies Association 1 are abruptly overlain by shoreface sandstones of Facies Association 2. The basal surface is sharp to erosive, and progressively truncates strata down section in a basinal direction. This surface is frequently mineralized, weakly scoured, and may be marked by a thin shale rip-up lag. Facies Association 2 consists of very fine- to medium-grained, massive to crossbedded sandstone, and locally coquina, interbedded with subordinate siltstone. Deposition represents traction sedimentation in lower through upper shoreface settings. Where present, the shoreface association is generally less than 15 m thick, but may be up to 30 m thick locally. This unit thins rapidly both up and down depositional dip, and is capped by Facies D conglomerates.

Association 3 - Offshore Transition

Facies Association 3 consists primarily of interbedded siltstone and very fine-grained sandstone, coarsening-up into hummocky crossbedded fine-grained sandstone. This association is similar in part to the offshore/shelf association (Facies Association 1), but can be differentiated based on stratigraphic position, increased sand content and prevalance of hummocky cross-stratification up section, and a change in the trace fossil assemblage from a distal *Cruziana* ichnofacies (dominated by horizontal elements) to a hybrid of the *Cruziana*

and *Skolithos* ichnofacies (with an increasing component of vertical elements).

Doig Sand Body Geometries

Buick Creek

The Buick Creek Field in northeastern British Columbia (Figure 7-2) represents the largest recognized Doig reservoir in the Fort St. John area. Since the discovery of the Doig B pool in 1976, a total of 5 oil pools (2 with economic associated gas) have been discovered. Initial in-place volumes exceed 3 million m^3 oil (~20 million bbls), with 350 million m^3 gas (12.5 bcf). Average net oil pay is approximately 7 m with porosities about 10%; average gas pay and porosity is approximately 4 m and 8.5%. Water saturation levels are low, and the oil is a light crude. All production is from Facies Association 2.

Although the Doig reservoir at Buick Creek has been subdivided into a number of different productive pools, along-strike correlations clearly demonstrate that these represent a single stratigraphic horizon (CHAPTER 6). Net sand distribution clearly defines a pronounced linear pattern, oriented subparallel to the inferred paleoshoreline and normal to depositional dip (Figure 7-4). Length of the main sandstone body along depositional strike exceeds 19 km, and is unconstrained to the north. Dip dimensions are variable, but average less than 2 km. Sandstone thickness is irregular along strike, varying from less than 5 m to greater than 25 m. This sandstone is referred to herein as the 1st Doig Sand to differentiate it from other Doig sandstones that may occur at different stratigraphic levels.

Facies changes in the Buick Creek area are abrupt, both vertically and laterally. The sandstones of Facies Association 2 abruptly overlie offshore siltstones and shales (Facies Association 1) across an erosive contact. This succession represents a significant basinward shift in facies, and development of a lowstand shoreface. We interpret this surface as a regressive surface of marine erosion (*cf* Nummendal *et al.*, 1993), or a subaqueous ravinement surface. This surface represents the marine expression of a lowstand surface of erosion and likely reflects a tectonically induced fall in relative sea level (CHAPTER 6). The

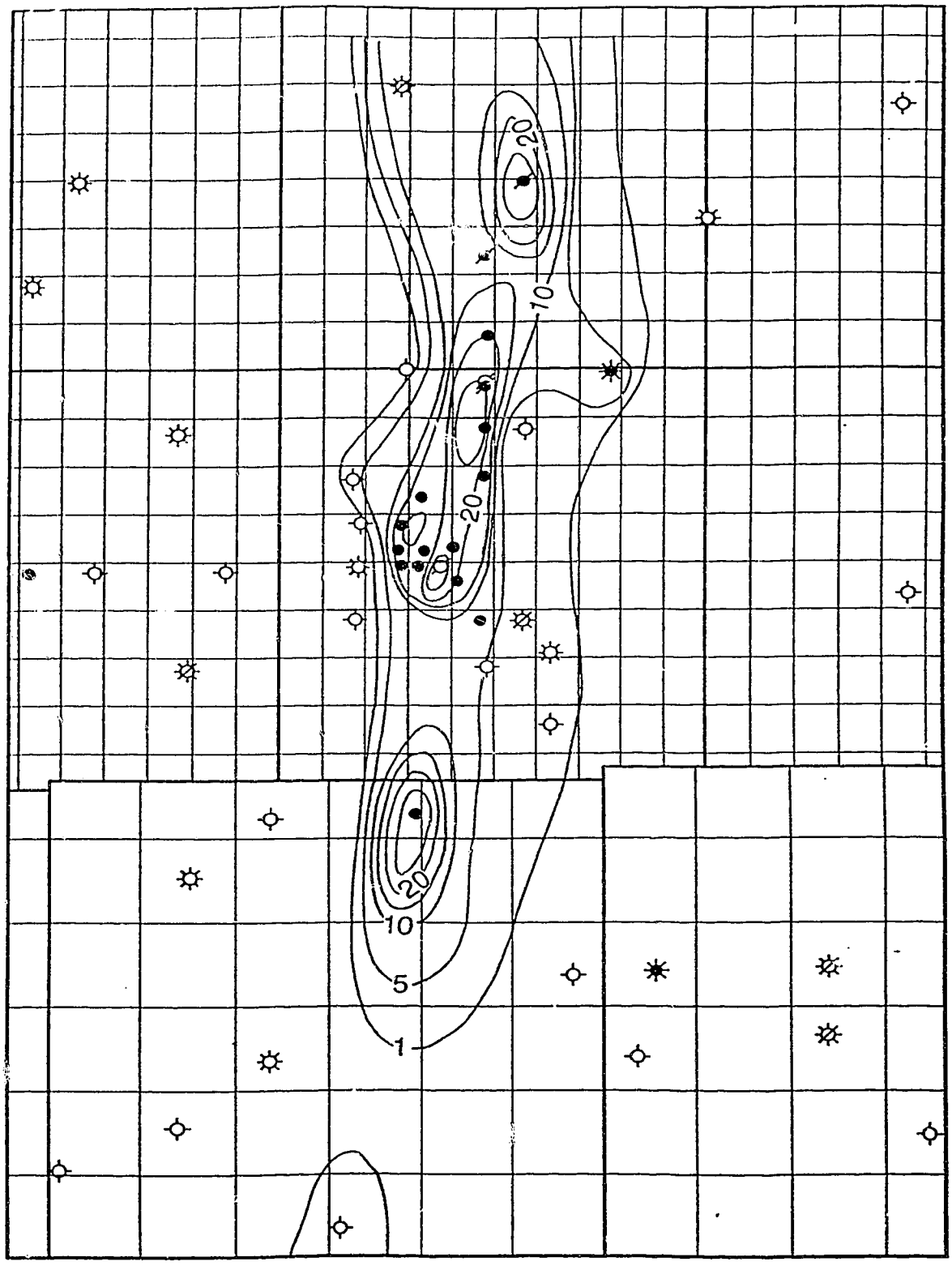


Figure 7-4. Net sand isopach for Facies Association 2 at Buick Creek. Where no core is available, gamma-ray log sand cut-off equals 60° API based on log-core correlation (from Evoy and Moslow, *in press*).

shoreface sandstones are erosionally overlain by a coarse lag deposit, followed by much finer-grained offshore to offshore transition sediments. The lag represents a transgressive surface of erosion (TSE) which amalgamates with the regressive surface of marine erosion (RSME) in a landward direction. The transgressive lag is overlain by a marine flooding surface and a single retrogradational parasequence which onlaps the amalgamated TSE/RSME landward (eg CHAPTER 6, Figure 6-9a).

Stoddart-West

Doig production from the Stoddart - West field consists of three small pools, each less than 200 ha, with combined reserves of approximately 300,000 m^3 of oil (2 million bbls). The largest of the 3 pools is the Doig B Pool with 240,000 m^3 (1.5 million bbls), 2.0 m net pay, and 10% porosity. The producing sandstone lies along the extension of the main trend at Buick Creek, and represents the strike equivalent of the 1st Doig Sand at Buick Creek.

The prospective Doig horizon has been cored in 3 wells in the Stoddart - West area, and is productive in both cored wells from the B Pool. Two regional Doig cores have also been recovered in the immediate vicinity, for a total of 80 m of available core. This area, however, is the focus of significant Belloy production; consequently a large wireline log database is available. One hundred and twenty seven wells penetrate the entire Doig interval within a 5 km radius of the Stoddart - West trend.

Facies Association 1 in the Stoddart - West B Pool is a plane-parallel laminated, weakly calcareous, silty shale to muddy siltstone unit. Rare very fine-grained sand lamina are present as starved ripples and convolute laminations, and locally exhibit microfaulting and pyritic lamina (Figure 7-5). Burrowing is generally weak and consists predominantly of *Planolites*, *Helminthopsis* and *Anchonicnus*. This interval represents deposition from suspension, punctuated by rare low-density turbidity current deposition.

Facies Association 2 at Stoddart-West, where cored, is similar in appearance to the

SCURRY ET AL
WELL NAME: STODDART A6-4 FORMATION: DOIG

LOCATION: (02) 6-4-86-20/W6 CORE INTERVAL: 1598.0-1615.45m

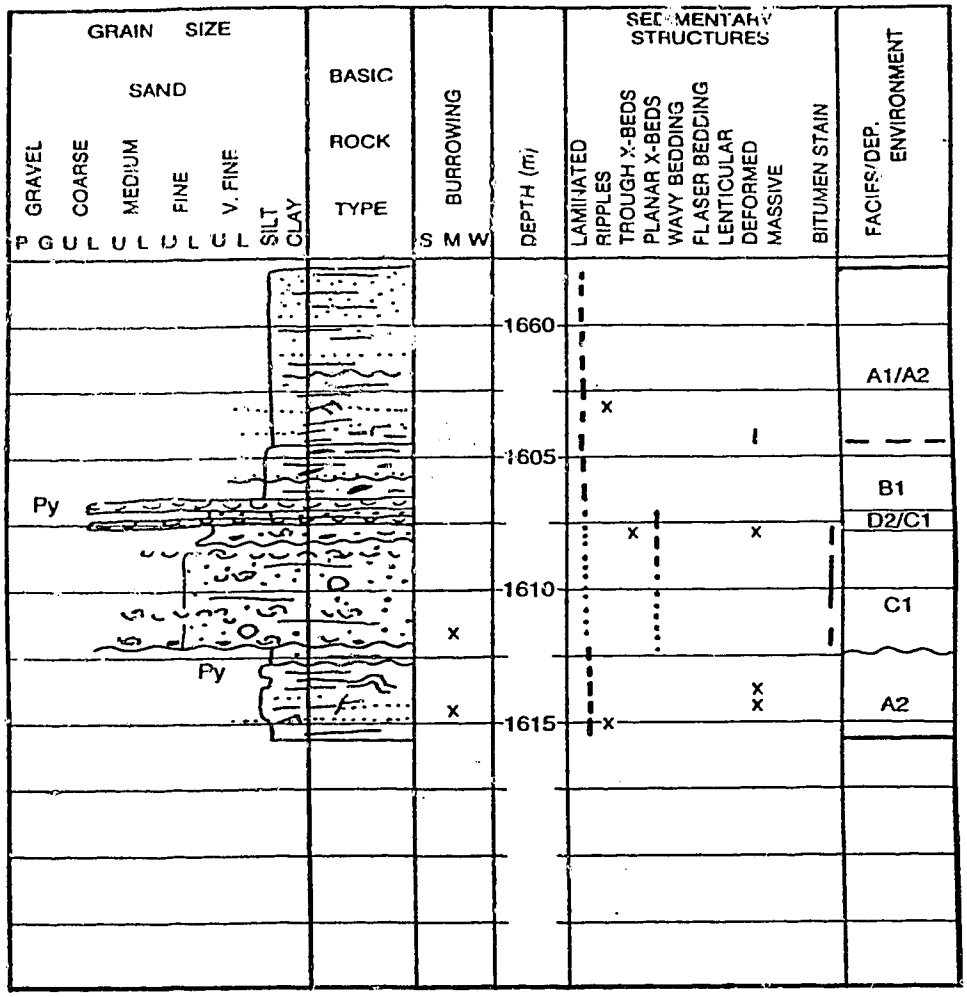


Figure 7-5. Graphic core log description for Scurry et al Stoddart (02)6-4-86-20/w6.

sandstone at Buick Creek. The sandstone is fine- to very fine-grained, dolomitic, and contains minor shelly debris; discrete bioclastic beds are volumetrically insignificant and restricted to the uppermost portion of this unit. Internally, the sandstone is generally structureless or massive bedded with minor shale partings and poorly developed low angle, planar tabular cross-beds. Burrowing is weak, and was only identified in the basal portion of cored intervals immediately overlying the basal contact where a limited assemblage of thin walled, collapsed *Paleophycus tubularis* burrows are present. The oversteepening noted at Buick Creek is not significant at Stoddart - West, and is limited to one discrete sandstone bed approximately 25 cm thick in well (02)6-4-86-20/w6 (Figure 7-5). Thickness of this unit does not exceed 6 m in the B Pool.

The base of the sandstone at Stoddart - West is sharply demarcated in wireline logs, and can be correlated to core in the Doig B Pool. The basal contact in core is sharp, weakly erosive, and contains rare rip-up clasts and shell debris. Locally, this contact is marked by a *Glossifungites* surface in well 12-04-86-20/w6. The erosive nature of the lower contact is evident in cross section and is highlighted by slight truncation of the uppermost phophate beds (Figure 7-6). This contact represents a significant basinward shift in facies across a marine ravinement surface which represents a regressive surface of marine erosion equivalent to that identified at Buick Creek.

The upper contact of the Doig Sand in the B Pool is marked by two thin (10 cm), normally graded, bioclastic units with sharp contacts, up to 10% coarse sand-sized phosphatic clasts, and disseminated pyrite. This surface coincides with a dramatic change in gamma-ray log signature as well as a pronounced change in lithology (Figures 7-5 and 7-6), and represents the initial transgressive surface. The sandstone is overlain by 2 m of a coarse siltstone with minor coarse sand-sized phosphate clasts, then fines upward into plane-parallel laminated muddy siltstone with rare, poorly developed ripples. The entire interval is marked by numerous small scale erosional discontinuities. These sediments are assigned to Facies Association 3.

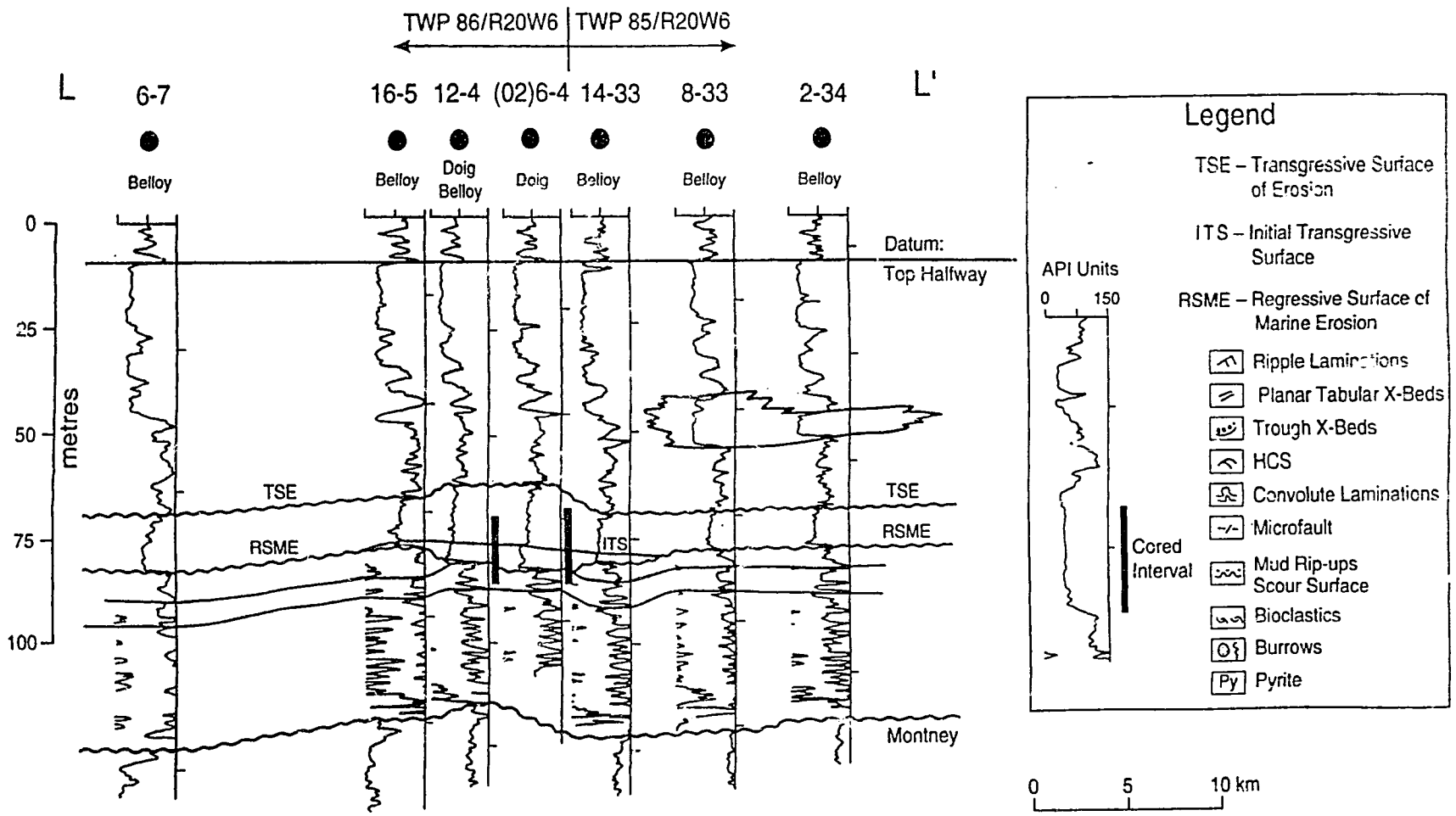


Figure 7-6. Gamma-ray dip section L-L' through the Stoddart-West field. Solid black bars represent intervals with core control. TSE - transgressive surface of erosion, ITS - initial transgressive surface, RSME - regressive surface of marine erosion. Location shown on Figure 7-2.

The flooding event associated with the initial transgressive surface is sudden, but spatially restricted to the southern portion of the study area. As a result, Stoddart - West is the only Doig pool in which sediments assigned to Facies Association 3 have been found beneath the Transgressive Surface of Erosion (Figure 7-6). In the Stoddart-West B Pool, all production is from Facies Association 2 below the initial transgressive surface.

The regional expression of the Transgressive Surface of Erosion, as determined from well log signature and cross section correlations, has not been cored in the B Pool. Where it has been cored adjacent to the pool, this surface is marked by 10 cm of coquina (16-15-36-20/w6). The Facies Association 2 sandstones and their basal contact are also progressively truncated landward by the overlying Transgressive Surface of Erosion.

The general absence of hummocky cross stratification and paucity of storm beds suggests that Facies Association 3 in the the Stoddart - West area may have accumulated under slightly deeper water conditions than at Buick Creek. This may reflect renewed subsidence along the flank of the Fort St. John Graben, and provides support for the contention that sea level fluctuations are tectonically modified in the area.

Cache Creek/Fireweed

A second Doig sandstone is present in the Cache Creek and Fireweed fields, 10 to 20 km basinward of the Buick Creek/Stoddart-West trend. At Cache Creek, the Doig A Pool contains an in place volume of 282 Mm^3 gas (10 bcf). Net gas pay is 6.3 m, porosity 9.1%, but assigned recovery factor is only 0.20%. There is no obvious sedimentologic explanation for such poor recovery.

At Fireweed, there are two 1-well oil pools, each with significant associated gas. The Doig A Pool contains in place volume of 80,000 m^3 light oil (500,000 bbls) with 44 Mm^3 associated gas (1.5 bcf). Net oil pay is 15.5 m with 9% porosity. The Doig B Pool is smaller, with 29,000 m^3 oil (180,000 bbls) and 60 Mm^3 associated gas (2.1 bcf). Net oil pay is 5.6 m

with 9% porosity.

The Doig Sand interval has been penetrated in 24 wells in the Cache Creek/Fireweed area. Nine of the wells encountered less than 3 m of sandstone, and 7 wells had no sandstone. The sandstone has been cored in 3 wells. Each of these cored intervals penetrated the basal sandstone contact, one at Cache Creek and 2 at Fireweed. Two addition wells cored the stratigraphic position of the Doig Sand at Fireweed, but did not encounter any sandstone; one of these (d-37-D/94-A-14) cored the stratigraphic equivalent of the upper contact of the Doig Sand. No significant core recovery is available in the overlying assemblage.

The basal Doig in the Cache Creek and Fireweed areas is a dark, calcareous, muddy siltstone with <5 to 10% admixed, very fine-grained sand. Bedding consists of fine plane-parallel laminations with minor silty pyritic laminations. Rare very fine-grained sand laminae may exhibit convolute laminations, thin ripples or small-scale microfaults. Burrowing is weak, to locally moderate. Identified traces are all simple horizontal elements, and consist primarily of *Anchonichus*, *Chondrites*, *Helminthopsis* and *Planolites*, with rare *Paleophycus*. This unit is equivalent to Facies Association 1 in the Buick Creek area, and represents a distal shelf environment well below the influence of any storm wave activity.

There is a weak coarsening up in the upper 1 to 2 m of Facies Association 1 in some wells, and in such cases this interval may include an increase in convolute laminations and microfaulting relative to their underlying intervals. The basal contact between the Doig Sand and this underlying unit is sharp (Figure 7-7) and locally pyritized. In core, this contact is similar to the expression of the regressive surface of marine erosion in cores from Buick Creek and Stoddart-West (Figure 7-8).

The Doig Sand in both pools is a lower fine-grained, massive to cross-bedded sandstone, with high-angle planar tabular cross beds at 15° to ~30° in poorly defined decimetre-scale bed sets. Erosive based, massive, upper fine- to medium-grained sandstones

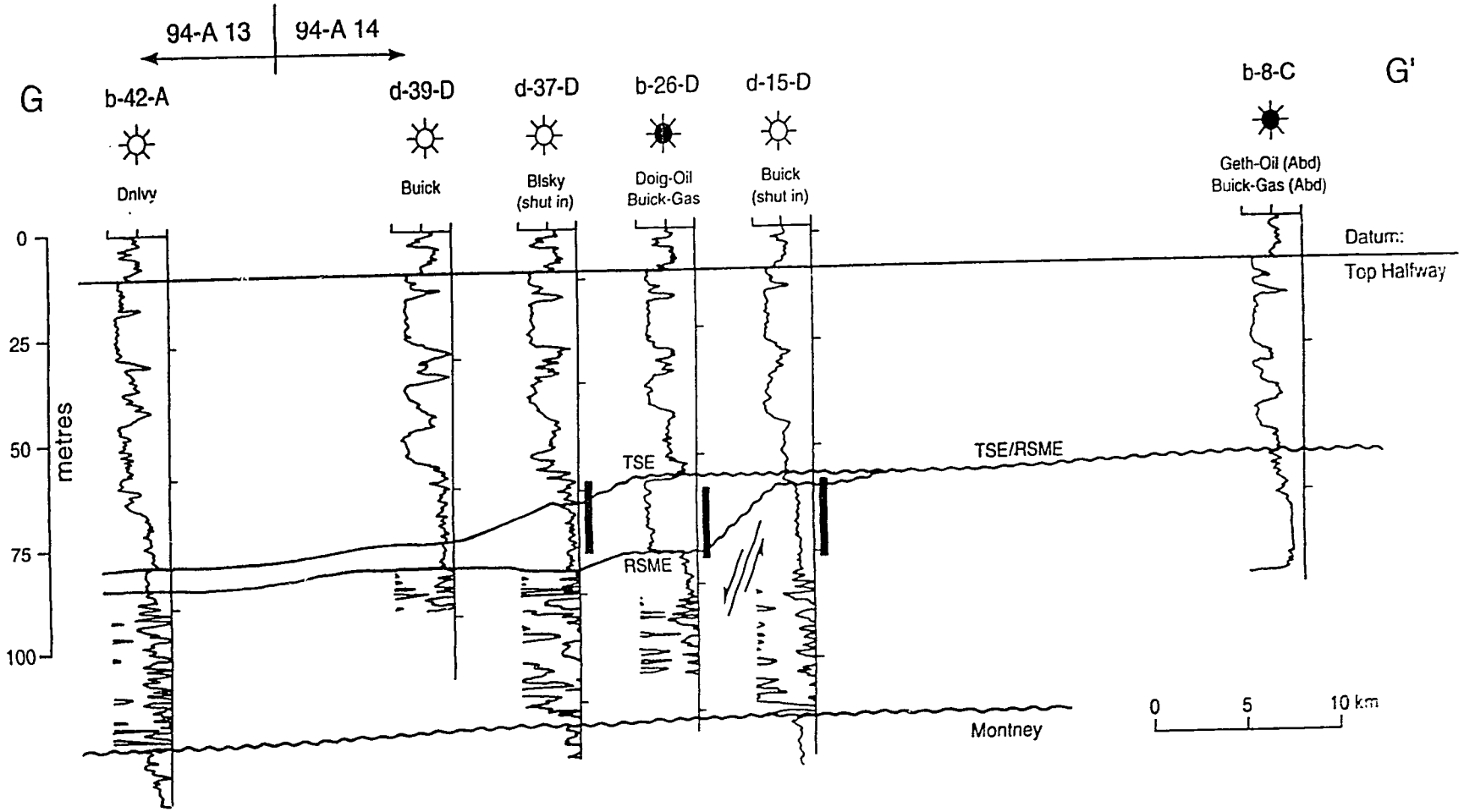


Figure 7-7. Gamma-ray dip section G-G' through the Fireweed field. Solid black bars represent intervals with core control. TSE - transgressive surface of erosion, ITS - initial transgressive surface, RSME - regressive surface of marine erosion. Location shown on Figure 7-2.

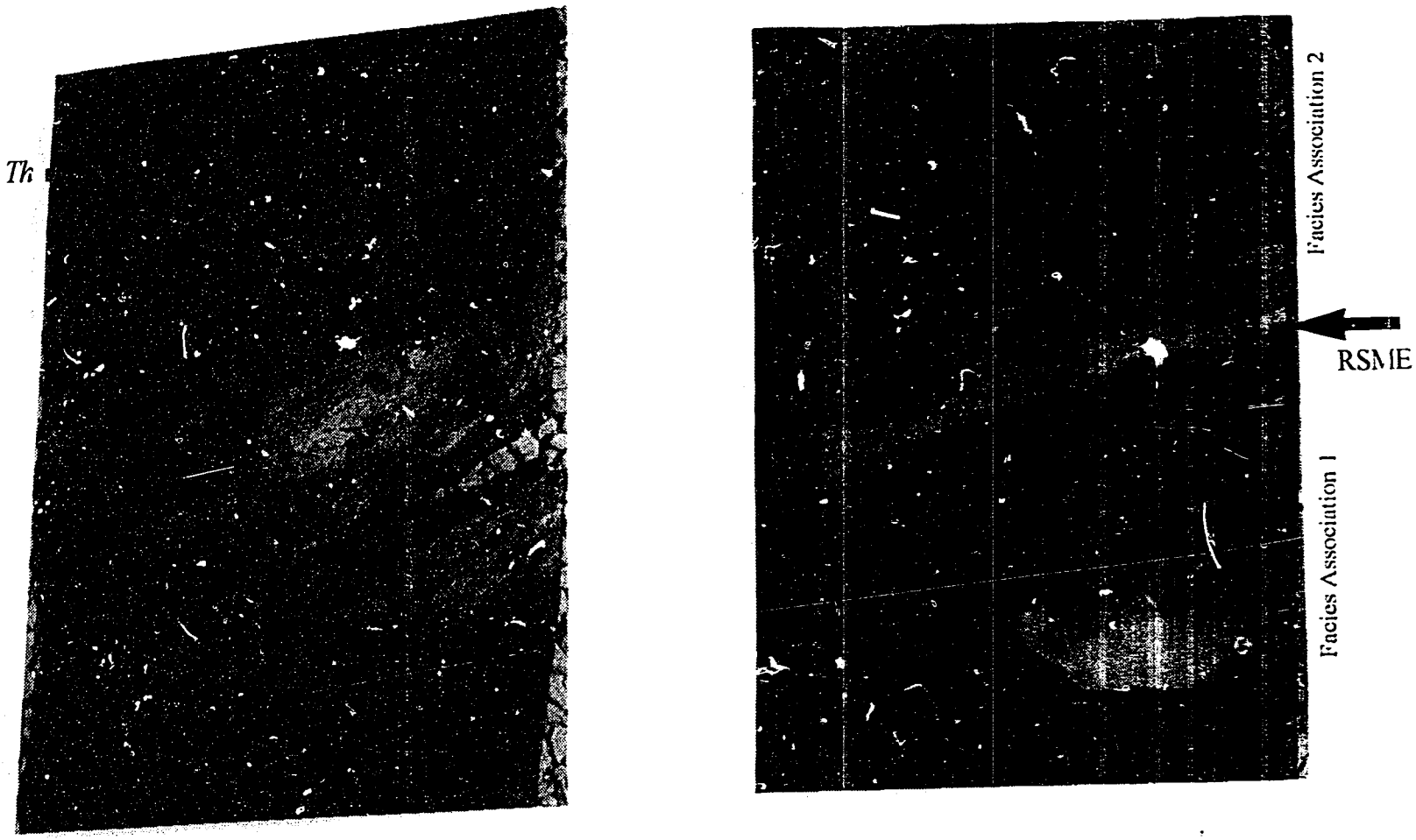


Figure 7-8. Core photographs of Facies Association 2. All cores 10 cm wide, slabbed width approximately 9 cm.
A). Base of Facies Association 2 at Cache Creek (b-64-I/94-A-12). Note robust Thalassinoides burrows.
B). Base of Facies Association 2 at Buick Creek (d-06-A/94-A-14).

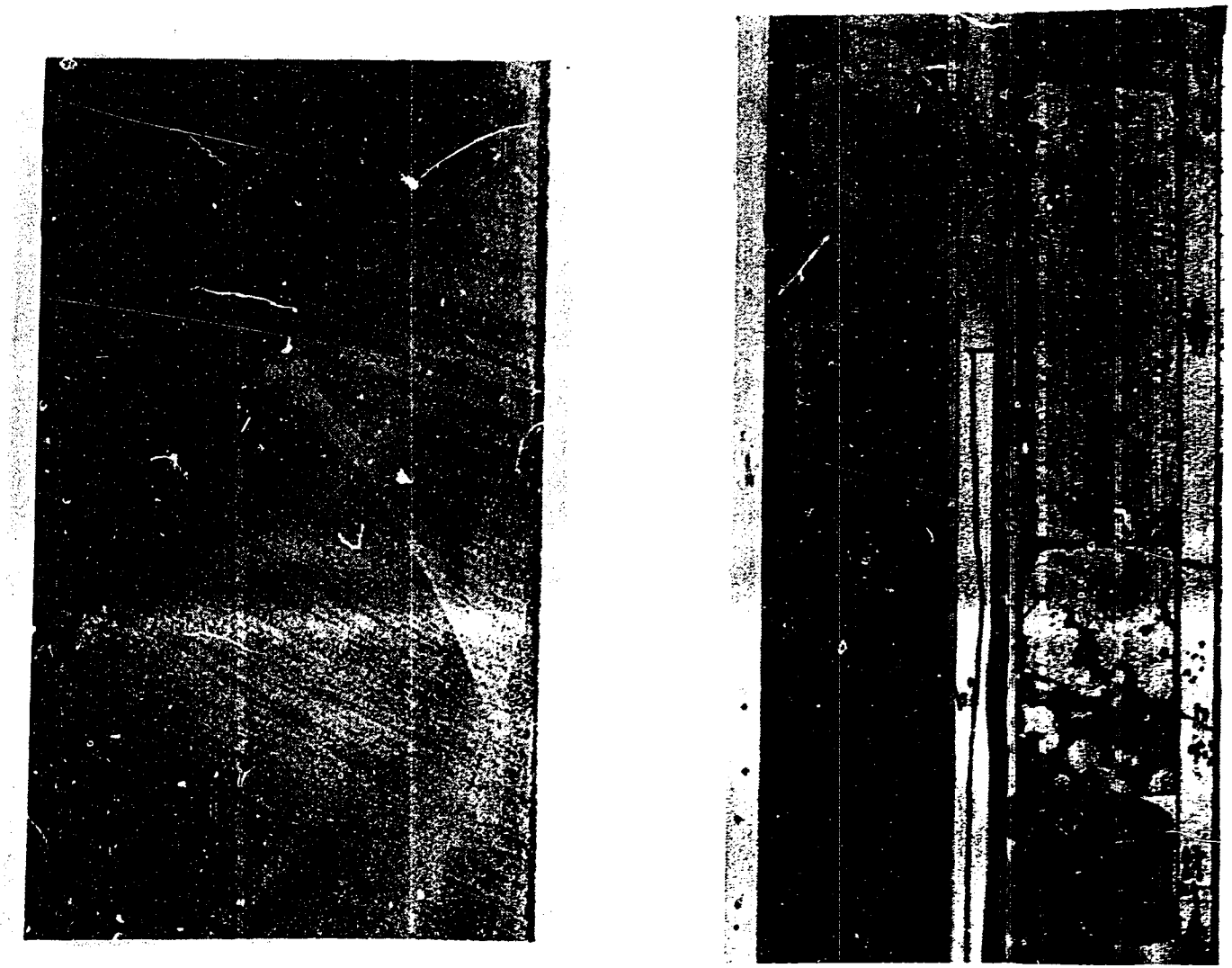


Figure 7-8. Core photographs of Facies Association 2. All cores 10 cm wide, slabbed width approximately 9 cm.
C). Core b-64-I/94-A-12 at 1646.15 m. Note control of cement type over cross-bedding inclination (arrow).
D). Base of Facies Association 2 in the Fireweed field (b-26-D/94-A-14). Note nodular calcite cementation (light grey) at top of core box.

in beds up to 10 cm thick are present locally, and may contain significant shelly debris and/or biomoldic porosity. Minor bioclastic-rich intervals or lags, and rare mud rip-ups are also present.

The Doig Sand is variably calcite cemented or bitumen stained, giving the core a mottled light and dark grey coloration pattern. The darker bitumen stained intervals are dolomite cemented. Cross bedding inclination can be seen to change with the change in cement composition (Figure 7-8C). There is no stratal dislocation associated with this change in bedding orientation; consequently this must represent structural disturbance prior to complete lithification.

The thickest sandstone recovered in core from this area is the discovery well for the Fireweed Doig A Pool (Figure 7-9). The Doig Sand here is 17 m thick, and the basal 11 m have been cored. The reservoir here is a lower to upper fine-grained sandstone with five discrete bioclastic and/or biomoldic intervals 10 to 50 cm thick. Sandstone beds are variably cross bedded with medium angle planar tabular cross beds at ~15°. Locally these inclinations steepen to greater than 20° to 25° in association with the presence of light grey calcite cement. Bioclastic bed contacts are obscured by intense calcite cementation, but are locally gradational over a 1 to 2 cm interval. Mud rip-up clasts are a minor constituent of all these intervals (Figure 7-9), and rare siderite clasts are present locally.

There is little evident burrowing within these sandstones, but a pronounced centimetre-scale 'nodular' calcite cementation pattern near the base of the Doig Sand in well b-26-D/94-A-14 at Fireweed may reflect alteration centered on a network of *Thalassinoides* burrows (Figure 7-8D). A similar interpretation has been postulated for analogous cementation patterns at Buick Creek (CHAPTER 6, Figure 6-4). Rare *Thalassinoides* burrows of a size compatible with that of this alteration pattern are present near the base of the Doig Sand at Cache Creek (Figures 7-8A).

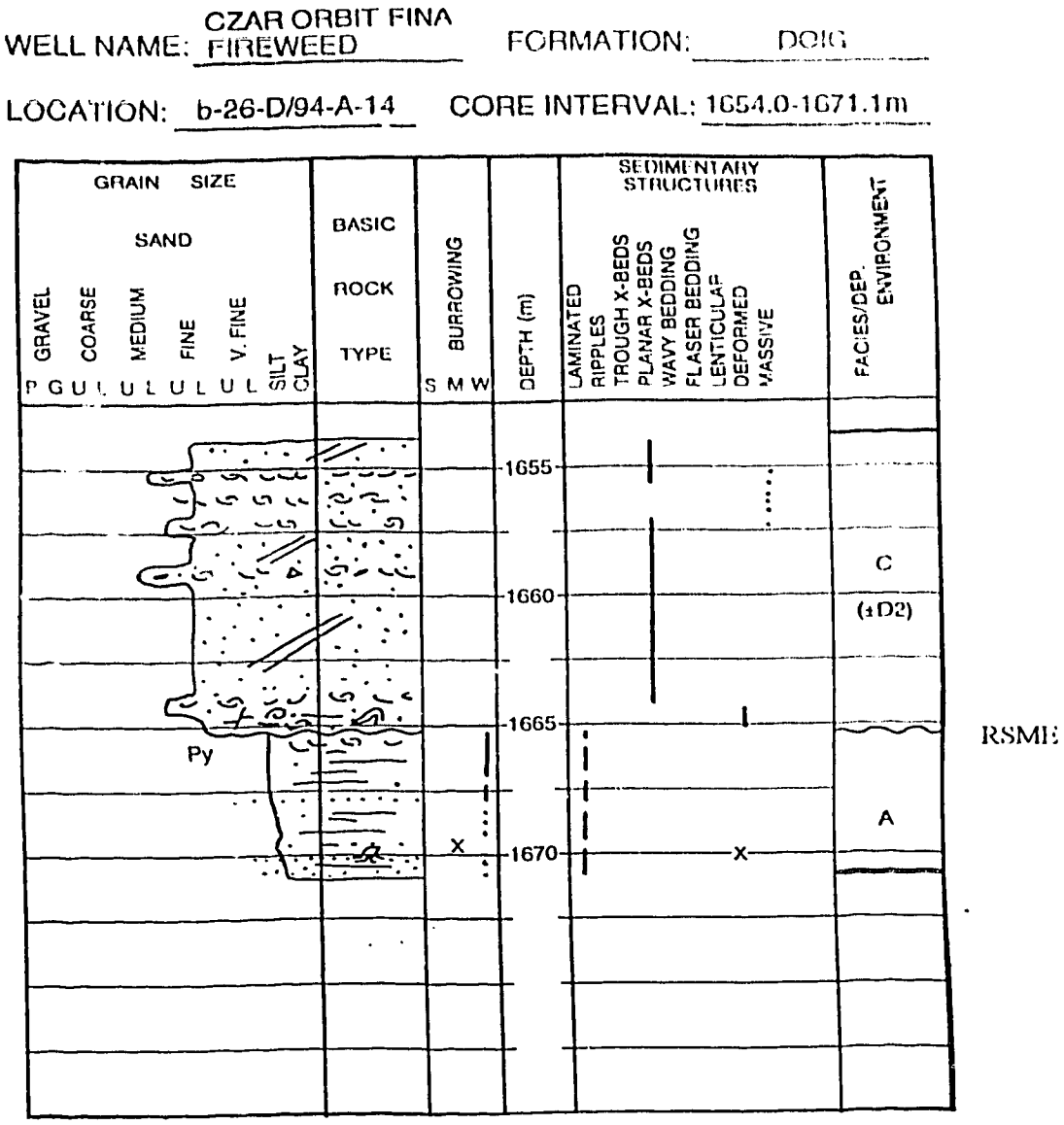


Figure 7-9. Graphic core log description for Czar Orbit Fina Fireweed b-26-D/94-A-14.

The stratigraphic equivalent to the upper contact of the Doig Sand has been cored in d-37-D/94-A-14. This interval consists of a 5 m thick interval of interbedded bioclastic conglomerate or sandy, dolomitic rudstone, interbedded with sandy siltstone containing a minor constituent of finely comminuted bioclastic debris. The coarse bioclastic units predominate in beds up to ~75 cm thick. Beds exhibit erosive bases and either sharp or gradational tops.

One intensely deformed bioclastic unit 30 cm thick was noted. This zone superficially resembles features of load induced soft sediment deformation with bed contacts near parallel to the core axis, and was initially interpreted as either a slump or fluidization phenomena. Reexamination of this interval revealed a thin, centimetre-scale polished black "mud" coating containing fine, contact-parallel calcite veins along the slump edges. This is now inferred to represent tectonically induced deformation. The entire bioclastic interval lies directly over Facies Association 1 across an erosional contact, and is overlain by a flooding surface which is marked by approximately 70 cm of silty shale. This latter represents the only core recovered from the overlying assemblage.

A net sand isopach of the Doig Sand in the Fireweed and Cache Creek field areas reveals a pronounced regional linear trend oriented northwesterly, subparallel to the inferred paleoshoreline. The continuity of this pattern is abruptly broken in the vicinity of Cache Creek where there is a sudden translation of the trend to the southwest to encompass the Cache Creek Field. Here the trend becomes lobate in character, and total sandstone thicknesses are reduced from greater than 15 m to 7.5 m.

The Doig Sand in this area is informally referred to herein as the 2nd Doig Sand to differentiate it from the sandstone in the Buick Creek/Stoddart-West areas, and is interpreted as a second lowstand shoreface based on its abrupt erosive base, wireline log characterization, and sedimentologic similarity to Buick Creek. There is an abrupt updip edge to the sandstone (Figure 7-7) and a pronounced asymmetry about the axis of maximum sand thickness (Figure

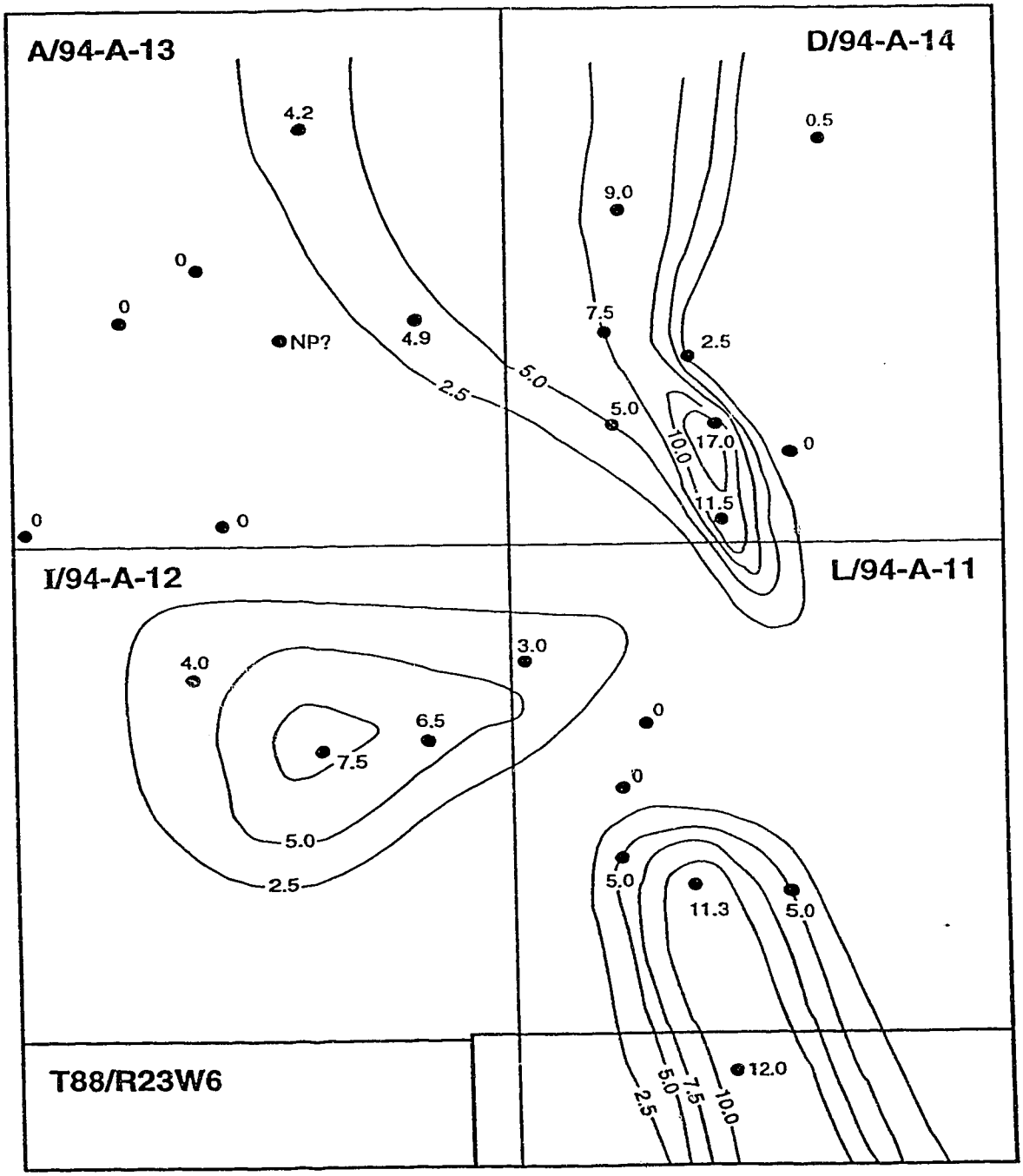


Figure 7-10. Net sand isopach for Facies Association 2 (2nd Doig Sand) in the Fireweed/ Cache Creek area. Gamma-ray log sand cut-off equals 60° API as determined in Evoy and Moslow (*in press*).

7-10). Sedimentologic data to further define the depositional environments are not available. The Cache Creek sand may simply represent shoreface failure due to a number of factors including storm wave loading, rapid sediment loading, and underconsolidation. Alternatively, the isopach trend is suggestive of a possible barrier island system present both at Fireweed and south of Cache Creek (Figure 7-10). The down-dip displacement of the isopach trend at Cache Creek may represent an associated ebb-tidal delta.

Regional Shoreface Trends

The Doig Sand in the Fort St. John area of northeastern British Columbia is preserved as a series of long, linear sandstones oriented subparallel to the paleoshoreline (Figures 7-4 and 7-10). These sandstones form narrow reservoirs, asymmetrically distributed about their axes of maximum sand accumulation, and are rapidly truncated landward by a wave ravinement surface or transgressive surface of erosion. The sandstones define regionally persistent, stratigraphically distinct trends, but individual sandstone bodies exhibit irregular thickness along strike.

Doig sandstones from four different fields show similar patterns in distribution of facies and facies associations. The sandstones (Facies Association 2) are typically very fine- to fine-grained, and are massive to planar tabular cross-bedded in bed sets up to 30 cm thick. Variably bedded bioclastic intervals are a significant component of the sandstones locally. These sandstones are interpreted to represent deposition in a lower-middle through upper shoreface environment. Stratigraphic position suggests that these sandstones are lowstand shorefaces and represent a portion of the Lowstand Systems Tract.

Facies Association 2 sandstones disconformably overlie offshore/shelf siltstones and shales with rare sandstone interbeds (Facies Association 1) which are attributed to the Transgressive Systems Tract and early Highstand Systems Tract (Figures 7-6 and 7-7). The contact between Facies Association 2 and Facies Association 1 is abrupt (Figure 7-8), locally truncates markers in the underlying assemblage across a regressive surface of marine erosion

(Figure 7-6), and is locally demarcated by development of a *Glossifungites* surface. This erosional surface represents the marine equivalent of a lowstand surface of erosion.

The Facies Association 2 sandstones are truncated by a regional Transgressive Surface of Erosion which is overlain by offshore-transition siltstones and silty sandstones punctuated by numerous storm beds (Facies Association 3). A pronounced transgressive lag deposit is present locally along this bounding discontinuity, and is especially well preserved in the Buick Creek field (Chapter 6, Figure 6-6).

The Doig Sand in the Buick Creek/Stoddart-West area is referred to as the 1st Doig Sand for the purpose of differentiating between other stratigraphically distinct sandstones. The 1st Doig Sand trend and its bounding discontinuities can be traced for a minimum 75 km along strike. The trend does not represent continuous clean sandstone, but a number of discrete sandstone bodies, all showing the same general orientation, are preserved locally (Figure 7-11). This discontinuous preservation likely reflects the nature of the original sand distribution. Sand accumulation is spatially associated with breaks in slope in the underlying subaqueous ravinement surface, implying an element of tectonic control over sandstone distribution. Similar breaks in slope are evident along the Doig/Montney contact (Figures 7-12, 7-13 and 7-14), but are generally more subdued. This implies that structural controls on sand deposition and preservation must be in part syndepositional.

At least two separate sandstones have been recognized. The 2nd Doig Sand is recognized in the Fireweed/Cache Creek area (Figure 7-15). This sandstone is 10 to 20 km basinward of, and stratigraphically overlies, the 1st Doig Sand (Figures 7-13 and 7-14). This sandstone exhibits pronounced similarities to the 1st Doig Sand in terms of its sedimentologic characteristics, facies distributions, and bounding discontinuities, and is interpreted as a second lowstand shoreface. Data control becomes progressively more limited in a basinward direction; consequently, the 2nd Doig Sand is less well constrained than the 1st Doig Sand. Minimum strike continuity for the trend exceeds 70 km, and is unconstrained in both

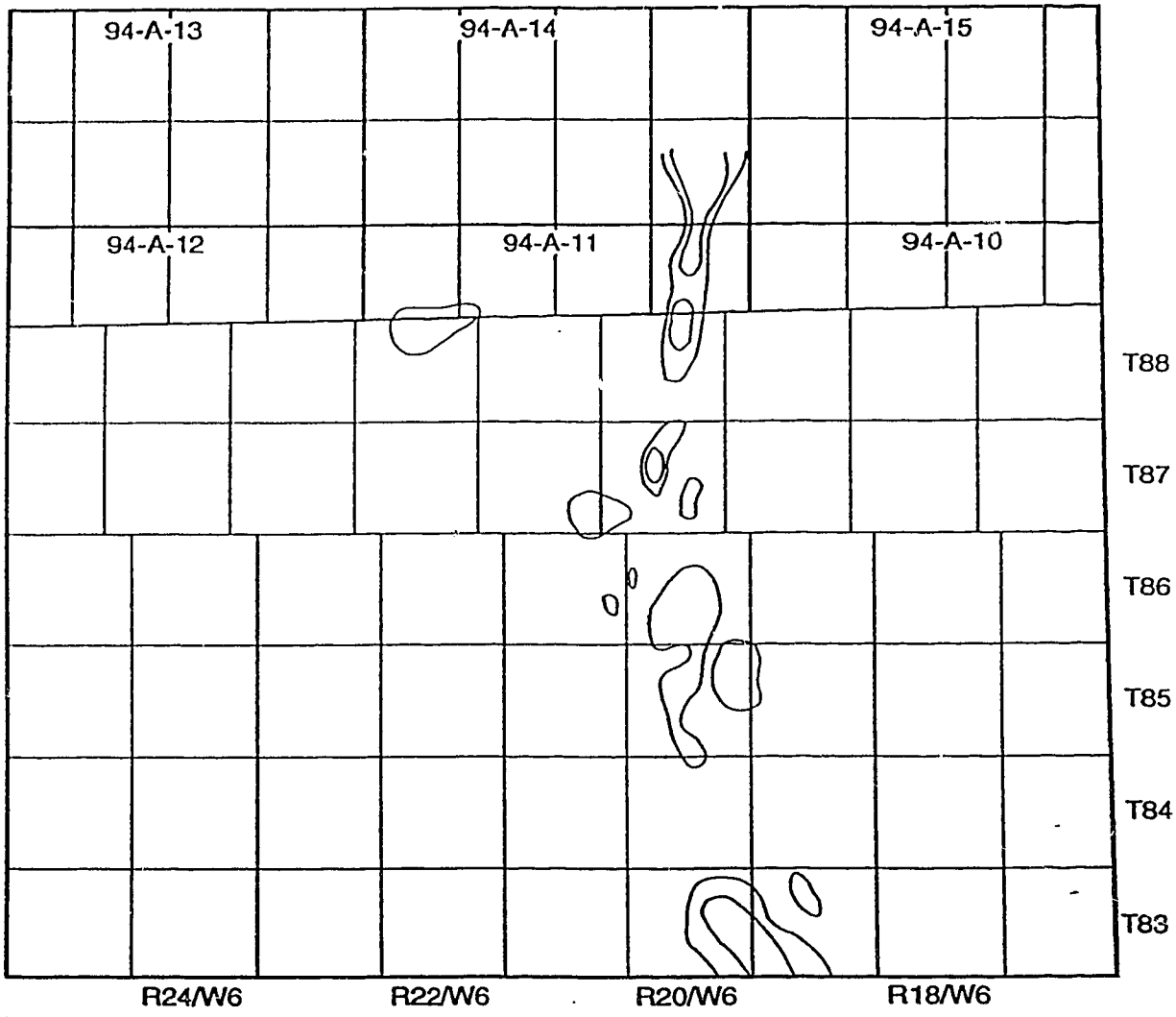


Figure 7-11. Net sand isopach for the 1st Doig sand in the study area. Contours represent the 3 and 10 metre intervals (yellow and red, respectively).

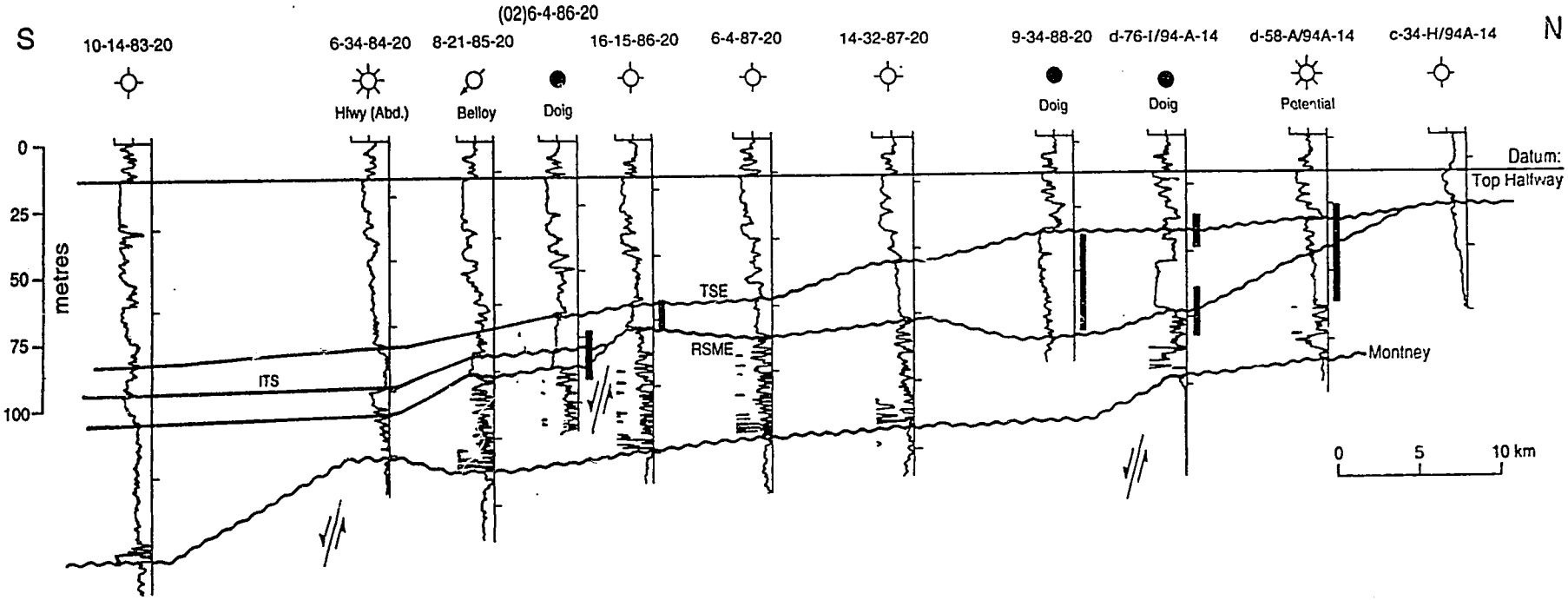


Figure 7-12. Regional stratigraphic strike section N-S along the Buick Creek/Stoddart-West sand trend (1st Doig sand). Note abrupt thickening of the basal Doig to the south, reflecting subsidence of the Peace River Arch. See Figure 7-2 for location, Figures 7-6 and 7-7 for key to abbreviations.

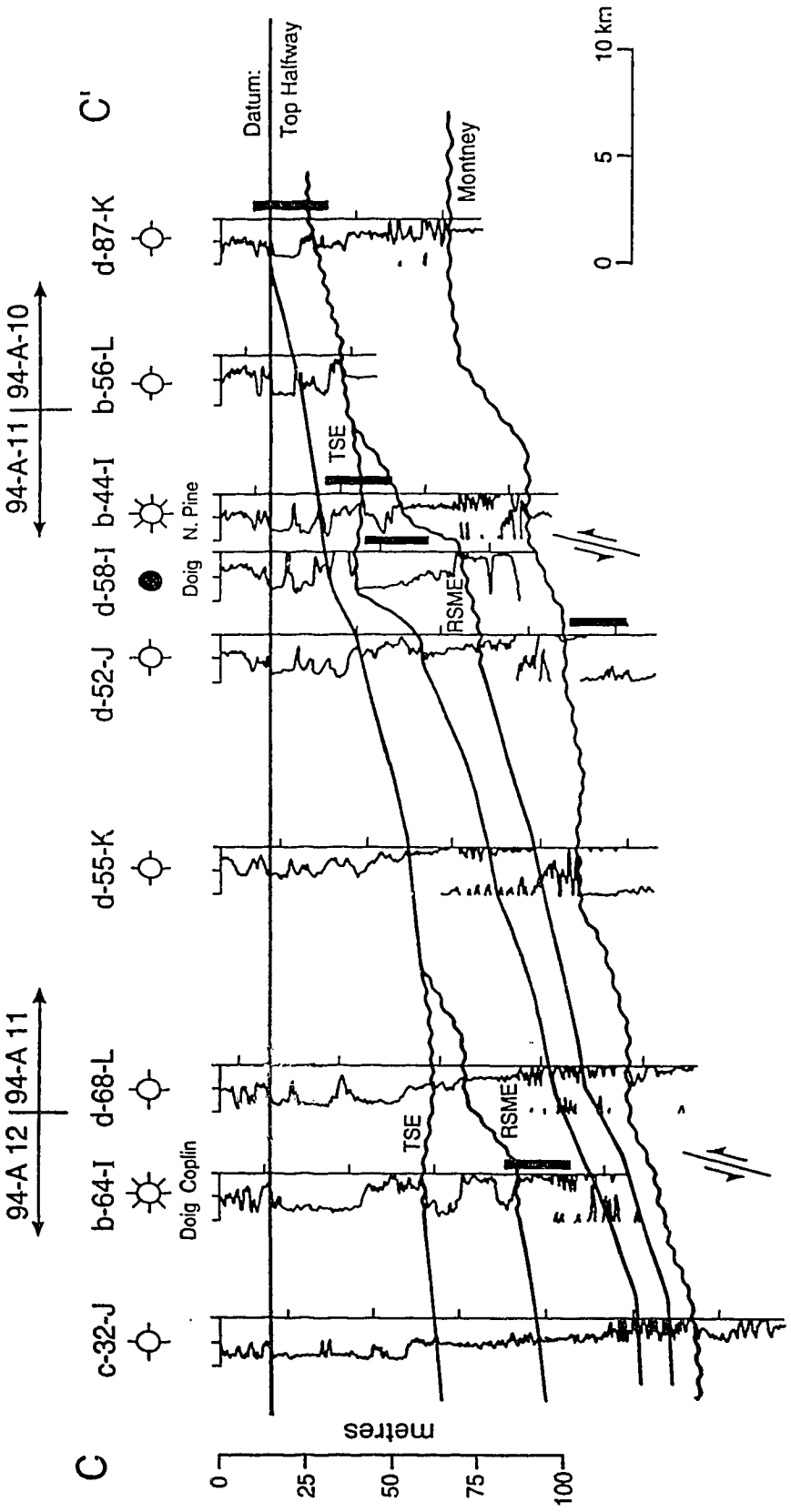


Figure 7-13. Regional gamma-ray dip section C-C' through the Cache Creek and Buick Creek field areas. Solid black bars represent intervals with core control., See Figure 7-2 for location, Figures 7-6 and 7-7 for key to abbreviatons.

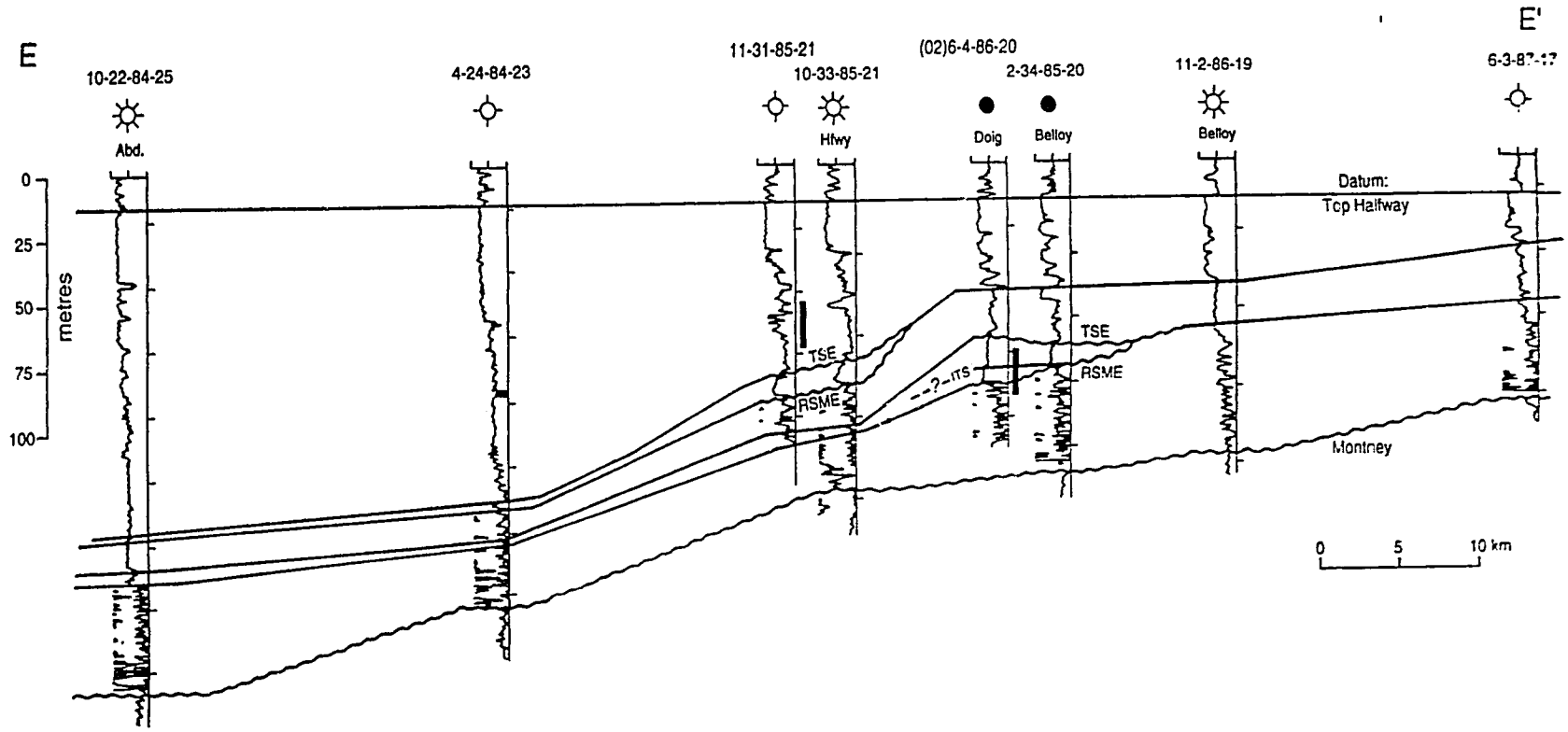


Figure 7-14. Regional gamma-ray dip section E-E' through the Red Creek and Stoddart-West areas. Solid black bars represent intervals with core control. See Figure 7-2 for location, Figures 7-6 and 7-7 for key to abbreviatons.

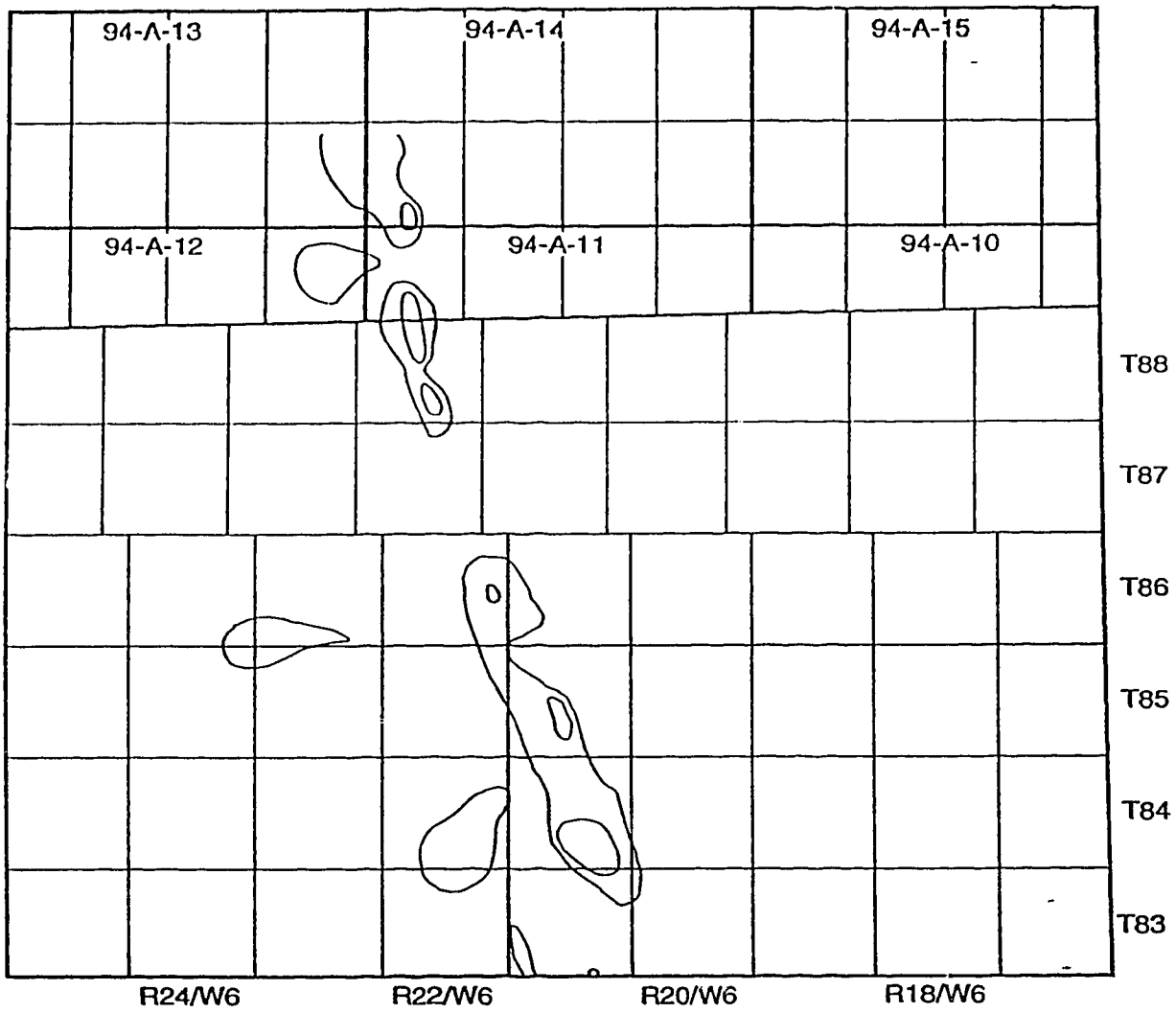


Figure 7-15. Net sand isopach for the 2nd Doig sand in the study area. Contours represent the 3 and 10 metre intervals (yellow and red, respectively).

directions (Figure 7-15).

Sequence Stratigraphic Implications and Exploration Considerations

Implications of High-frequency/High-resolution Sequence Stratigraphy

Sequence stratigraphic concepts are independant of both time and scale (Posamentier *et al.*, 1992b; Koss *et al.*, 1994), although the type of signature developed may be rate dependant (Wood *et al.*, 1993). Sequences can occur at any scale, and can be grouped into larger scale packages of sequences, composite sequences (Mitchum and Van Wagoner, 1991), or sequence sets (Brink *et al.*, 1994).

There is a strong degree of parallelism apparent in the orientation of the 1st and 2nd Doig Sands (Figures 7-14 and 7-15). The Doig sandstones represent a number of lowstand sandstones, each underlain by a regressive surface of marine erosion. When placed in a stratigraphic context, they appear to define a series of lowstand shoreface sandstones within a larger progradational composite sequence. This, however, does not necessitate a eustatic origin.

The development of a regressive surface of marine erosion is a predictive response to a fall in relative sea level. With falling sea level there is a net loss of accomodation space; as a result, the rate of sediment supply must always exceed the rate at which accomodation space is created. The shoreline response is an abrupt basinward shift in position termed a 'forced' regression (Plint, 1991; Posamentier *et al.*, 1992a). The base of the forced regression shoreface is a sharp erosional surface reflecting the impact of fairweather wave base scouring the shelf in front of the prograding shoreface (Ainsworth and Crowley, 1994). This can be contrasted with progradational events associated with a stillstand or slow rise in sea level which are characterized by gradational coarsening upwards profiles in a conformable succession (Plint, 1988; Nummendal *et al.*, 1993).

Although 3rd order sea level fluctuations have been recognized globally in the Anisian

and Ladinian (Haq *et al.*, 1988; Embry, 1988), the validity of this curve and the relative importance of tectonics in modifying global sea level signatures in the Triassic has been questioned, as has the actual number and correlatability of 3rd order sequences developed during this period (eg. Embry, 1988; van Veen *et al.*, 1992; de Zanche *et al.*, 1993; Yose, 1994). Haq *et al.* (1988) recognize two 3rd order sequences in the Middle Triassic, approximately coincident with the Anisian and Ladinan stages. However, de Zanche *et al.* (1993) document four 3rd order Anisian sequences and three Ladinian 3rd order sequences in one of the Haq *et al.* (1988) type areas, and Rasmussen *et al.* (1992) recognize five Anisian depositional sequences in the Barents Sea. At least two higher order sequences can be recognized within the upper Anisian in the study area.

The development of a series of lowstand erosional surfaces within a relatively narrow chronostratigraphic framework in the Middle Triassic in northeastern British Columbia can best be explained as a series of tectonically driven high-frequency sequence boundaries (*ie:* a non-eustatic fall in relative sea level). The most probable causative mechanism is reactivation of basement structures and the Dawson Creek Graben Complex along the north flank of the Peace River Arch. Recent seismic stratigraphic reconstructions support the interpretation of Anisian and Ladinian reactivation of basement faults in the area (Qi, 1995).

Sand Trends and Exploration Strategies

The Doig Sand in northeastern British Columbia is preserved as a series of narrow, elongate sandstones deposited in a series of lowstand shorefaces associated with abrupt sea level falls. Two lowstand shorefaces have been defined on the basis of sedimentologic characteristics (core control) and stratigraphic correlation (wireline log control) in the vicinity of producing fields, and their trends can be extrapolated for several tens of kilometres in a strike direction. At least one additional sandstone, the 3rd Doig Sand, can be inferred based on a limited number of penetrations (Figure 7-16), but has not been cored. These sandstones are all deposited as shore parallel bodies, and become progressively younger in a basinward direction as part of a 3rd order composite sequence.

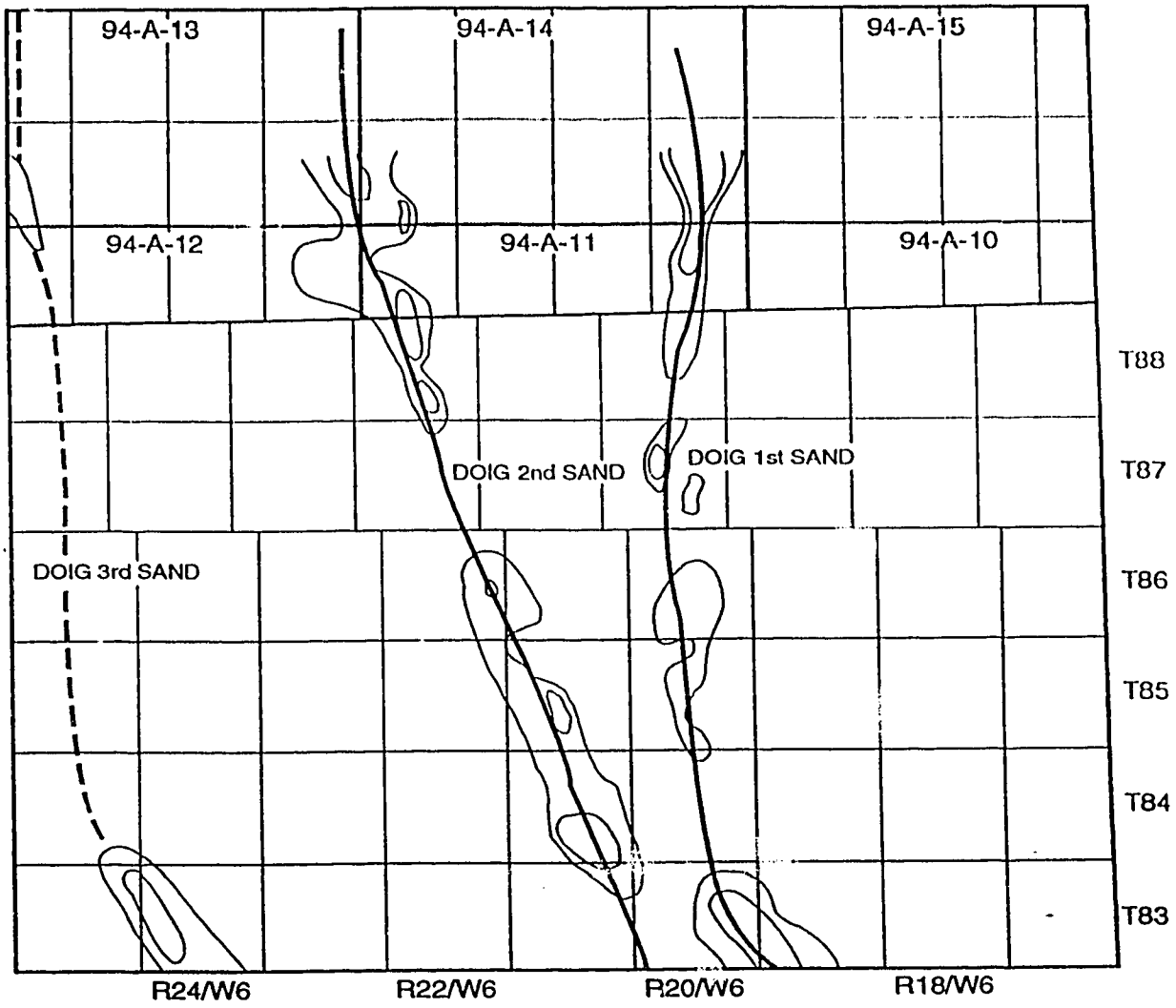


Figure 7-16. Regional Doig sand trends. The 1st and 2nd Doig sand trends are summarized from figures 7-11 and 7-15 respectively. The 3rd Doig sand trend is largely largely interpretive, with 3 and 10 m contours superimposed to show limited data control points. All sands unconstrained along strike.

Sand preservation is discontinuous along the sandstone trends, but sand accumulation appears to be restricted to these trends. No significant Doig sandstones are present in the area basinward of Buick Creek that do not fall along one of these shoreface trends. These shoreface trends therefore provide a powerful exploration model for future development of the Lower Halfway/Doig interval.

The most significant exploration implication of this study is the possibility of the discovery of additional sandstone trends. The body of evidence for tectonic activity in the Western Canada Sedimentary Basin through Lower and Middle Triassic time is significant (eg. Cant, 1984; 1986; Wittenberg, 1992; Caplan, 1993; Qi, 1995; Moslow *et al.*, 1995; CHAPTER 6). There is no reason to believe that all the tectonically induced fluctuations in sea level during the Anisian and Ladinian stages have been identified, and at least as many as five or six higher order sequences have been postulated for this period (Rasmussen *et al.*, 1992; de Zanche *et al.*, 1993).

Detailed sedimentologic analysis of available core combined with revised stratigraphic correlations may reveal evidence of additional lowstand shoreface trends. The Doig sandstones at Rigel and Wildmint (immediately east of the study area) both exhibit sharp based sandstones erosively overlying finely laminated siltstones and shales with apparent offshore/shelf affinity (eg. Talisman *et al.* Rigel 9-19). The trend defined by these two fields passes through the Pee Jay field where limited data suggests an additional Doig sandstone is present (Caplan, 1993).

The anomalously thick Doig sandstone bodies in the Sinclair field area of west central Alberta have been interpreted as shoreface-sourced sediment gravity flow deposits trapped in a series of growth faults along the shelf margin (Wittenberg, 1992; Wittenberg and Moslow, 1992). This model suffers from a lack of direct evidence for the identification of the shelf-slope break, and absence of a predictive mechanism for initiation of growth faulting. Rapid sediment loading associated with an abrupt basinward shift in depositional

environments (lowstand progradation) may be adequate to initiate growth faulting in the area, irrespective of the location of the shelf-slope break.

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CHAPTER 8.
A COMPARISON OF BYPASS GEOMETRIES IN THE FRASER RIVER DELTA FORESLOPE AND THE MIDDLE TRIASSIC DOIG FORMATION: IMPLICATIONS FOR THE RECOGNITION AND INTERPRETATION OF FORCED REGRESSION SHOREFACES.

Introduction

The sequence stratigraphic significance of sharp-based linear sand bodies deposited within "deeper-water" facies assemblages has recently received significant attention. These sandstones are typically thin, narrow bodies oriented subparallel to the paleoshoreline, and exhibit sedimentary characteristics consistent with markedly higher-energy depositional conditions and shallow-water accumulation. The abrupt nature of the basal contact has been used to infer a rapid basinward dispacement of the shoreline. These characteristics are consistent with a relative fall in sea level and attendant decrease in available accomodation space, and have given rise to the forced regression model of Plint (1988), Posamentier *et al.* (1992a), Ainsworth and Crowley (1994), and others. The documentation of a *Glossifungites*-demarcated erosional surface coincident with the basal sand contact of some of these sand bodies (eg. MacEachern *et al.*, 1992; Walker and Bergman, 1993; MacEachern, 1994), and the rejuvenation of fluvial drainage systems reflected by the dramatic grain size increase across the discontinuity provide support for the interpretation of these surfaces as sequence boundaries associated with submarine surfaces of erosion, and the placement of these sandstones within the Lowstand Systems Tract.

This model provides a powerful tool for stratigraphic interpretation and prediction. Unfortunately, the most important piece of evidence to support interpretations of this model - *the erosional nature of the discontinuity at the base of the shoreface sands* - is often the least well preserved and/or documented. Not all sharp based shoreface sandstones represent forced regressive shorelines (eg. Saunders *et al.*, 1994). Great care must be taken to determine that the basal sandstone contact represents a significant erosional discontinuity,

marked by rapid progradation and formed in response to decreasing accomodation space, as opposed to reflecting local shelf physiography and hydrodynamic conditions of the local storm regime.

Two examples of sediment bypassing and deposition during an abrupt fall of relative sea level on the continental shelf were examined to document the variability in associated siliciclastic facies. The Middle Triassic Doig Formation in northeastern British Columbia, and the modern Fraser River delta foreslope offshore Vancouver, British Columbia, were both deposited under an abrupt fall in relative sea level during a period of global eustatic sea level rise. Each case represents a sharp-based sand body of limited dip dimensions deposited as a component of a high-frequency sequence. Specifically, the Doig represents an archetypal forced regression shoreface deposited as part of the Lowstand Systems Tract, while the Fraser River delta foreslope represents sediment accumulation within the Transgressive or early Highstand Systems Tract.

In essence, the Doig forced regression model accounts for sand bypassing *by bringing the shoreface to "deep-water"*, while bypassing in the Fraser River delta foreslope is via discrete channels and results in the *physical (channelized) transport of sediment from the shoreface across the foreslope, to "deep-water"*. Ultimately, the goal of this research is to document the characteristic facies distribution in marine sandstones associated with sediment bypassing, and to determine if criteria are available to distinguish between forced-regression surfaces and other sharp-based linear sandstone bodies.

Doig Formation Sedimentology and Stratigraphy

Geologic Framework

There is no documented point source for the Doig sandstones. The climate is considered to have been abnormaly hot and arid during this period (Campbell and Horne, 1986; Parrish, 1993), and deposition occurred in a subtropical environment at a paleolatitude of approximately 30° North (Habicht, 1979). The generally arid climatic conditions during

Triassic time are incompatible with significant precipitation and development of fluvial systems in the hinterland.

Middle Triassic strata of northeastern British Columbia have been interpretted to represent a progradational succession of marine to shallow marine clastic sediments deposited on the western flank of the North American craton (Gibson and Barclay, 1989; Edwards et al., 1994). Although 3rd order eustatic sea level fluctuations have been recognized globally in the Anisian and Ladinian (Haq *et al.*, 1988; Embry, 1988), the validity of this curve and the relative importance of tectonics in modifying global sea level signatures in the Triassic has been questioned (Embry, 1988; van Veen *et al.*, 1992; de Zanche *et al.*, 1993; Yose, 1994). The Doig Formation appears to reflect intrabasinal controls (autocyclic processes) dominated by an abrupt fall in relative sea level (base level drop) superimposed on a larger-scale sea level rise.

Bypass Sand Geometry

The following discussion is summarized from observations based on four different producing Doig fields in the Fort St. John area of northeastern British Columbia; specifics have been presented elsewhere (Evoy and Moslow, 1995; Evoy and Moslow, *in press*, CHAPTER 7). Doig sandstones are preserved as a series of long, linear sands oriented subparallel to the paleoshoreline (Figure 8-1). They form narrow reservoirs, asymmetrically distributed about their axes of maximum sand accumulation. There is no direct evidence of the active bypass zone preserved in the Doig sands. The sandstones define regionally persistent, stratigraphically distinct trends, but individual sandstone bodies exhibit irregular thickness along strike.

The two major Doig sandstone trends are refered to herein as the 1st Doig Sand and the 2nd Doig Sand. Doig sandstones are typically very fine- to fine-grained, massive to planar tabular cross-bedded, with variably bedded bioclastic intervals locally. These sandstones are interpreted to represent deposition in a lower-middle through upper shoreface environment.

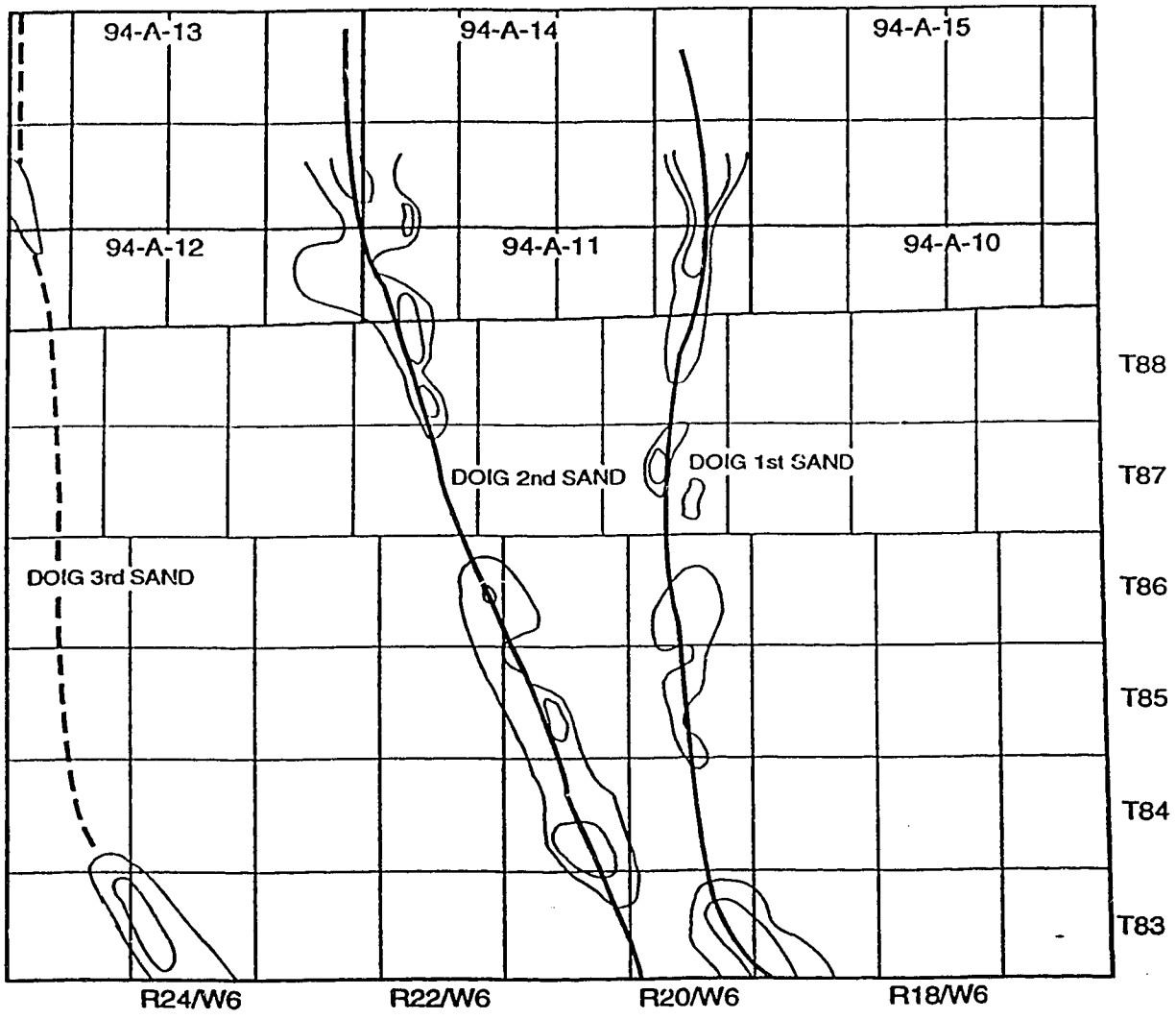


Figure 8-1. Regional Doig sand trends. The 1st and 2nd Doig sand trends are summarized from figures 7-11 and 7-15 respectively. The 3rd Doig sand trend is largely interpretive, with 3 and 10 m contours superimposed to show limited data control points. All sands unconstrained along strike. (From Figure 7-16).

Stratigraphic position suggests that the Doig sandstones are lowstand shorefaces and represent a portion of the Lowstand Systems Tract. The Doig sandstones disconformably overlie offshore/shelf siltstones and shales attributed to the Transgressive Systems Tract and early Highstand Systems Tract. This contact is abrupt, locally truncates markers in the underlying assemblage across a subaqueous ravinement surface, and is locally represented by a *Glossifungites* surface. This erosional surface represents a regressive surface of marine erosion (*cf* Nummendal *et al.*, 1993), and is the subaqueous equivalent of a lowstand surface of erosion.

Because the Doig sandstones were deposited above wave base, there is significant potential for erosion by wave base scour associated with the subsequent transgressive event. The sandstones are rapidly truncated landward by a regional wave ravinement surface, or transgressive surface of erosion, which is overlain by offshore-transition siltstones and sandstones punctuated by numerous storm beds (Figure 8-2). A pronounced transgressive lag deposit is present locally along this bounding discontinuity.

As a result of differences in local basinal geometry and sediment input, although the sandstone trend is continuous along strike, net sand thicknesses need not be (Figure 8-3). Continuity is a function of both preservation and deposition. Evidence for erosion (where present) is primarily up-dip truncation of elements, suggesting that erosion is controlled by basinal physiography and reworking. This is referred to herein as a ***transgression-dominant geometry***, or a shallow-water/ramp geometry.

Sequence Stratigraphic Implications

The development of a subaqueous ravinement surface, or regressive surface of marine erosion, is a predictive response associated with a fall in relative sea level. With falling sea level, there is a net loss of accomodation space. As a result, the rate of sediment supply must always exceed the rate at which accomodation space is created. The shoreline response is an

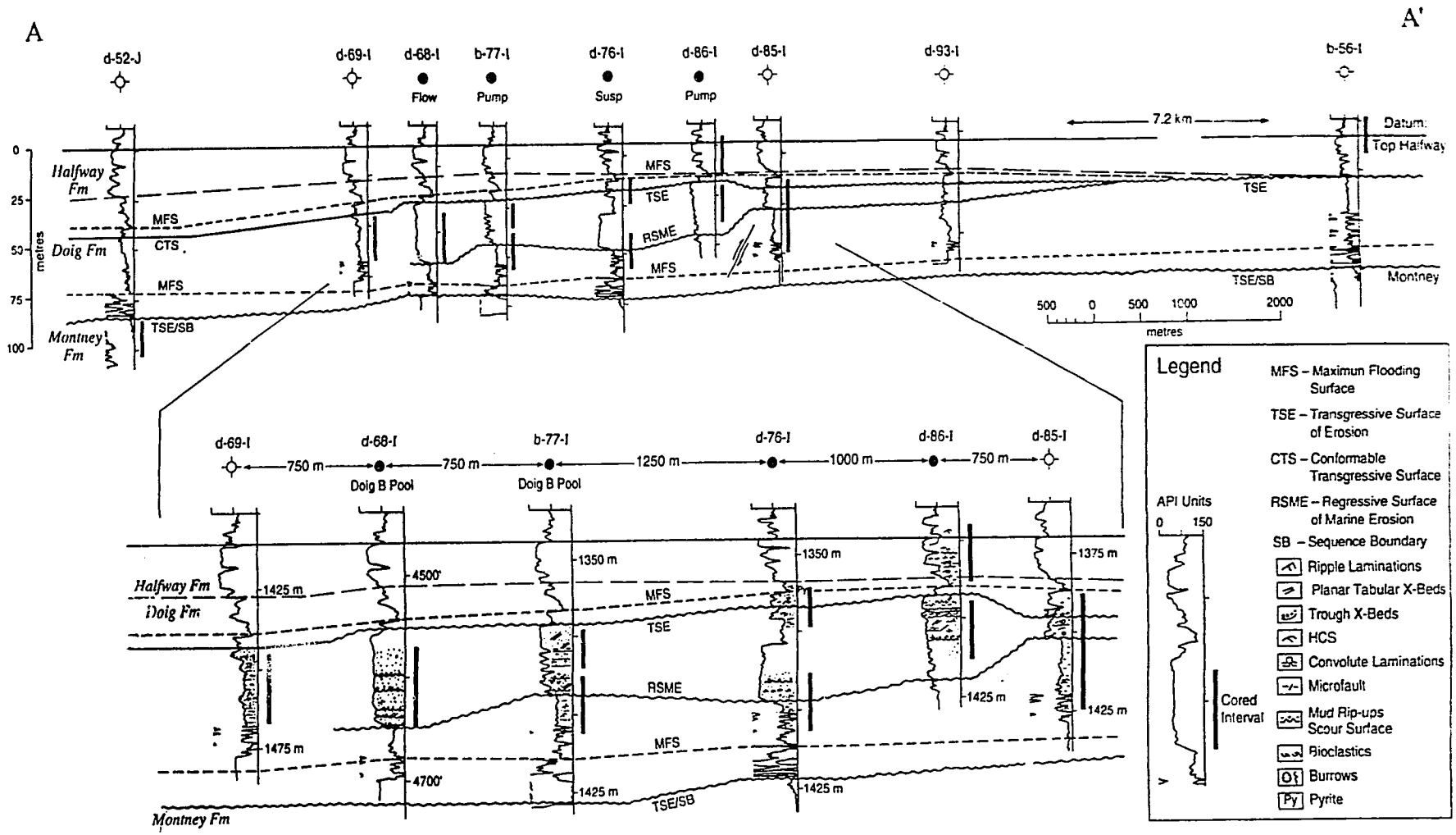


Figure 8-2. Dip-oriented stratigraphic cross-section through the centre of the Buick Creek Field. (From Figure 6-9).

A). Gamma-ray log profile section. The base of the Doig Sand represents a regressive surface of marine erosion (RSME).

B). Gamma-ray and core section showing relationships between facies associations and gross stratigraphic framework in selected wells from Figure 8-2A.

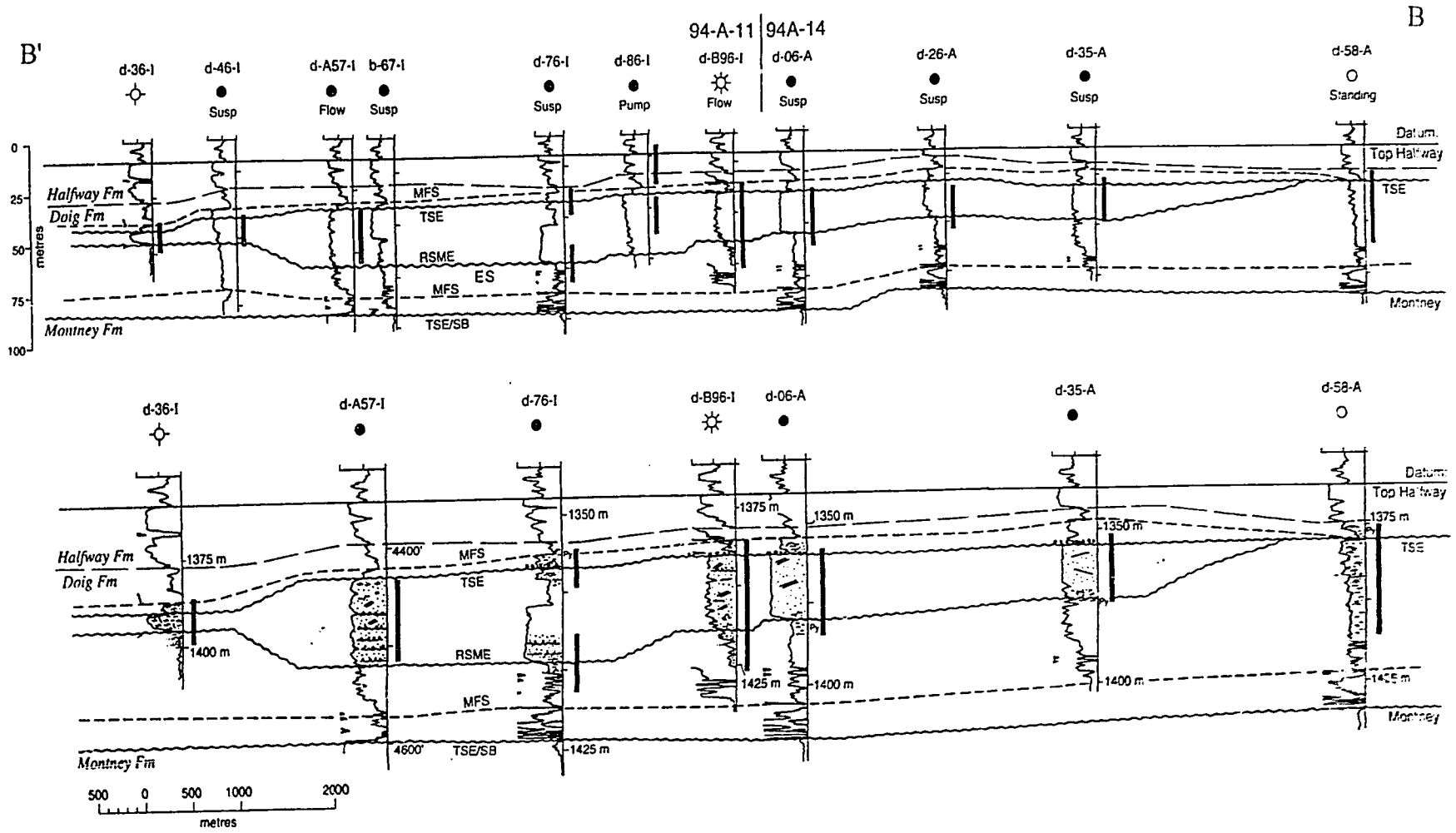


Figure 8-3. Strike-oriented stratigraphic cross-section through the axis of the Buick Creek Field. (From Figure 6-10).

A). Gamma-ray log profile section.

B). Gamma-ray and core section for selected wells from 8-3A. Facies Association 2 is capped by a coarse transgressive lag to the north and an equivalent bioclastic lag to the south. See Figure 8-2 for legend.

abrupt basinward shift in position termed a 'forced' regression (Plint, 1988; 1991; Posamentier *et al.*, 1992a). The base of the forced regression shoreface is a sharp erosional surface reflecting the impact of fairweather wave base scouring the shelf in front of the prograding shoreface (Ainsworth and Crowley, 1994). This can be contrasted with progradation associated with a stillstand or slow rise in sea level which is characterized by gradational coarsening upwards profiles in a conformable succession (Plint, 1988; Nummendal *et al.*, 1993).

The 1st Doig Sand trend and its bounding discontinuities can be traced for a minimum 75 km along strike. The trend does not represent continuous clean sand, but a number of discrete sandstone bodies, all showing the same general orientation, are preserved locally (Figure 8-1). This discontinuous preservation likely reflects the nature of the original sand distribution, modified by subsequent transgressive reworking. Sandstone accumulation is spatially associated with breaks in slope in the underlying regressive surface of marine erosion (Figures 8-2, 8-4), implying an element of tectonic control over sand distribution. This implies that structural controls on sand deposition and preservation must be in part syndepositional. Similar breaks in slope are evident along the Doig/Montney contact (Figure 8-4).

There is a strong degree of parallelism apparent in the orientation of the 1st and 2nd Doig Sands (Figure 8-1). The Doig sandstones represent a number of shoreface sandstones, each underlain by a regressive surface of marine erosion. When placed in a stratigraphic context, they appear to define a series of lowstand shoreface sandstones within a larger progradational composite sequence. This, however, does not necessitate a eustatic origin. Although 3rd order eustatic sea level fluctuations have been recognized globally in the Anisian and Ladinian (Haq *et al.*, 1988; Embry, 1988), the validity of this curve and the relative importance of tectonics in modifying sea level signatures in the Triassic is a topic of much debate (eg. Embry, 1988; van Veen *et al.*, 1992; de Zanche *et al.*, 1993; Yose, 1994).

The development of a series of lowstand erosional surfaces within a relatively narrow

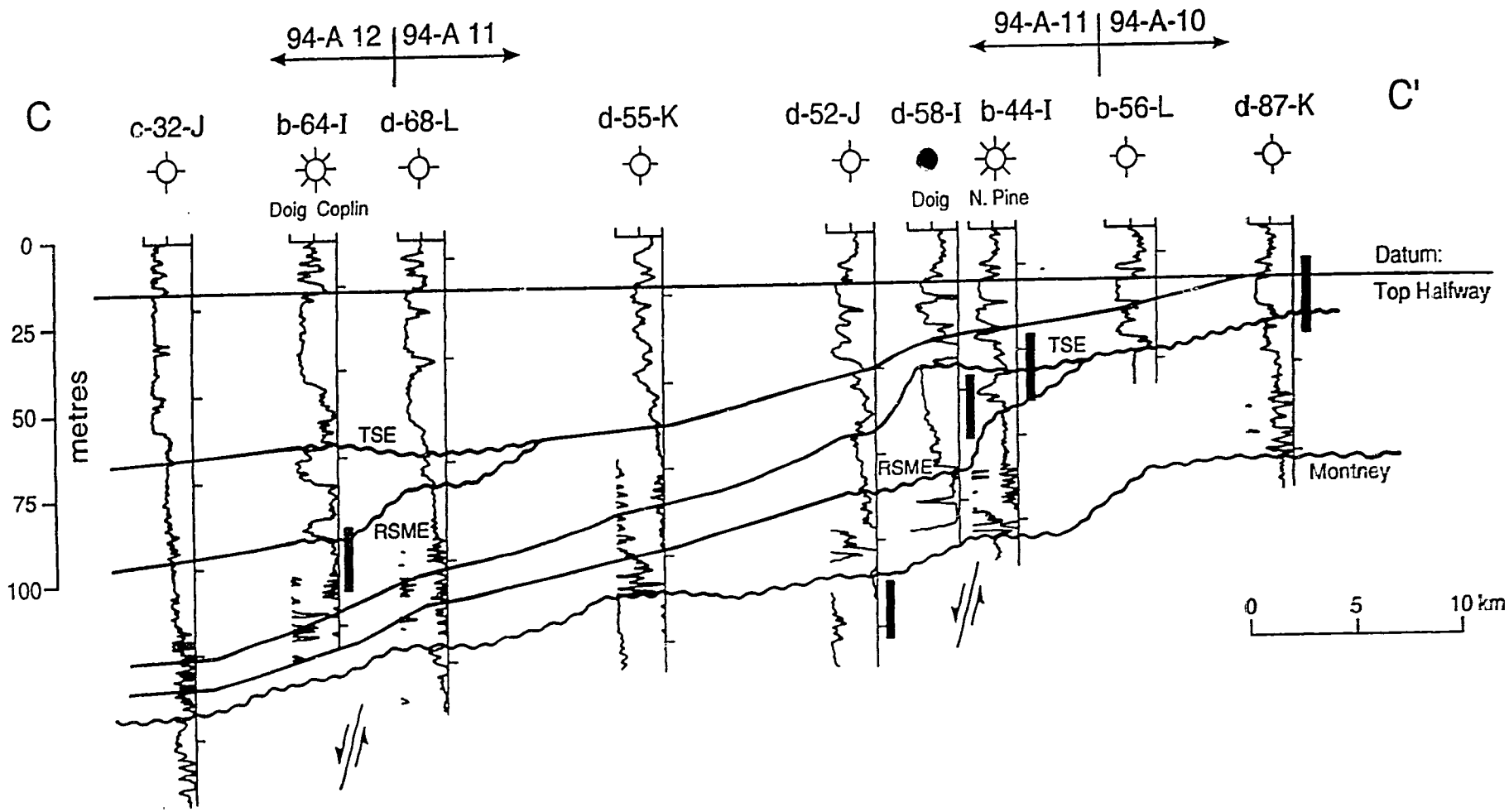


Figure 8-4. Regional gamma-ray dip section through the Cache Creek and Buick Creek field areas. Solid black bars represent intervals with core control. (From Figure 7-13).

chronostratigraphic framework in the Middle Triassic can best be explained as a series of tectonically driven high-frequency sequence boundaries (*ie:* a non-eustatic fall in relative sea level). The most probable causative mechanisms are reactivation of Paleozoic basement structures and continued subsidence of the Dawson Creek Graben Complex along the north flank of the Peace River Arch. Recent seismic stratigraphic reconstructions support the interpretation of basement fault reactivation during Anisian and Ladinian time as the dominant control (Qi, 1995).

Fraser River Delta Foreslope

Geologic Framework

The Fraser River delta foreslope is controlled by fluvial sedimentation processes (point source), modified by tidal redistribution. The delta is protected from significant storm-wave influence by Vancouver Island and the limited fetch across the Strait of Georgia, and progrades directly into a deep water environment. The area experiences a temperate climate, receives abundant annual precipitation, and drains a large, high-relief source area. The role of extrabasinal control (allocyclic processes) is significant, and seismic activity may play a role in initiating the remobilization of sediment.

Inception of sedimentation in the Fraser River delta at the beginning of Holocene time was coupled with an isostatically driven fall of local sea level of about 200 m (Clague *et al.*, 1982), followed by 12 to 13 m of transgression during the subsequent 8000 years (Clague *et al.*, 1982; Williams and Roberts, 1989). During this period of relative sea level rise, the delta experienced only local transgression, and underwent continual progradation and vertical accretion. Rates of vertical accretion accelerated dramatically, coincident with the rate of sea level rise, as a function of increasing accomodation space.

The delta foreslope is bisected by two pronounced bathymetric channels. The Sand Heads Sea Valley, off the Main Arm of the Fraser River, is the only active channel on the

foreslope; consequently, most studies of sediment transport and failure on the subaqueous delta have concentrated on this area (eg. Kostaschuk *et al.*, 1989; Hart *et al.*, 1992; Kostaschuk *et al.*, 1992; McKenna *et al.*, 1992). Due to the requirements of navigation, the Main Arm has experienced significant cultural modifications, including construction of the Steveston Jetty and continually dredging. The Roberts Bank channel is currently inactive, and predates any appreciable anthropogenic mediation. It therefore more accurately reflects the natural state of sedimentation on the subaqueous delta, and was emphasized in this study.

Bypass Sand Geometry

The Fraser River delta foreslope is an environment of active sand bypassing. Much of the coarsest sediment supplied to the mouth of the delta bypasses the delta plain and upper foreslope to be introduced directly to the lower foreslope and basin floor via turbidity currents within a number of subaqueous distributary channels. These channels are believed to be initiated and maintained by sediment gravity flow processes related to periodic liquifaction and failure at the head of the foreslope. Deposition occurs where these channels debouche onto the basin floor as a series of sand-rich depositional lobes (Moslow *et al.*, 1991; 1993; Evoy *et al.*, 1994).

Development of multiple channels through time on the delta foreslope has resulted in a high degree of along-slope facies variability and sand deposition in water depths exceeding 200 metres. Through time the location of the depositional lobes changes in conjunction with upslope channel migration and avulsion (Figure 8-5). The resultant sand body geometry is perpendicular to sediment transport direction. As a number of depositional lobes coalesce, they generate elongate, strike-parallel, shaped sands developed at the base of the delta slope in water depths of 200 to 250 metres. Without an abundance of available and preserved plant material, there would be no evidence of close proximity to the paleoshoreline.

Down slope sand termination is abrupt; up slope the sands thin more gradually into

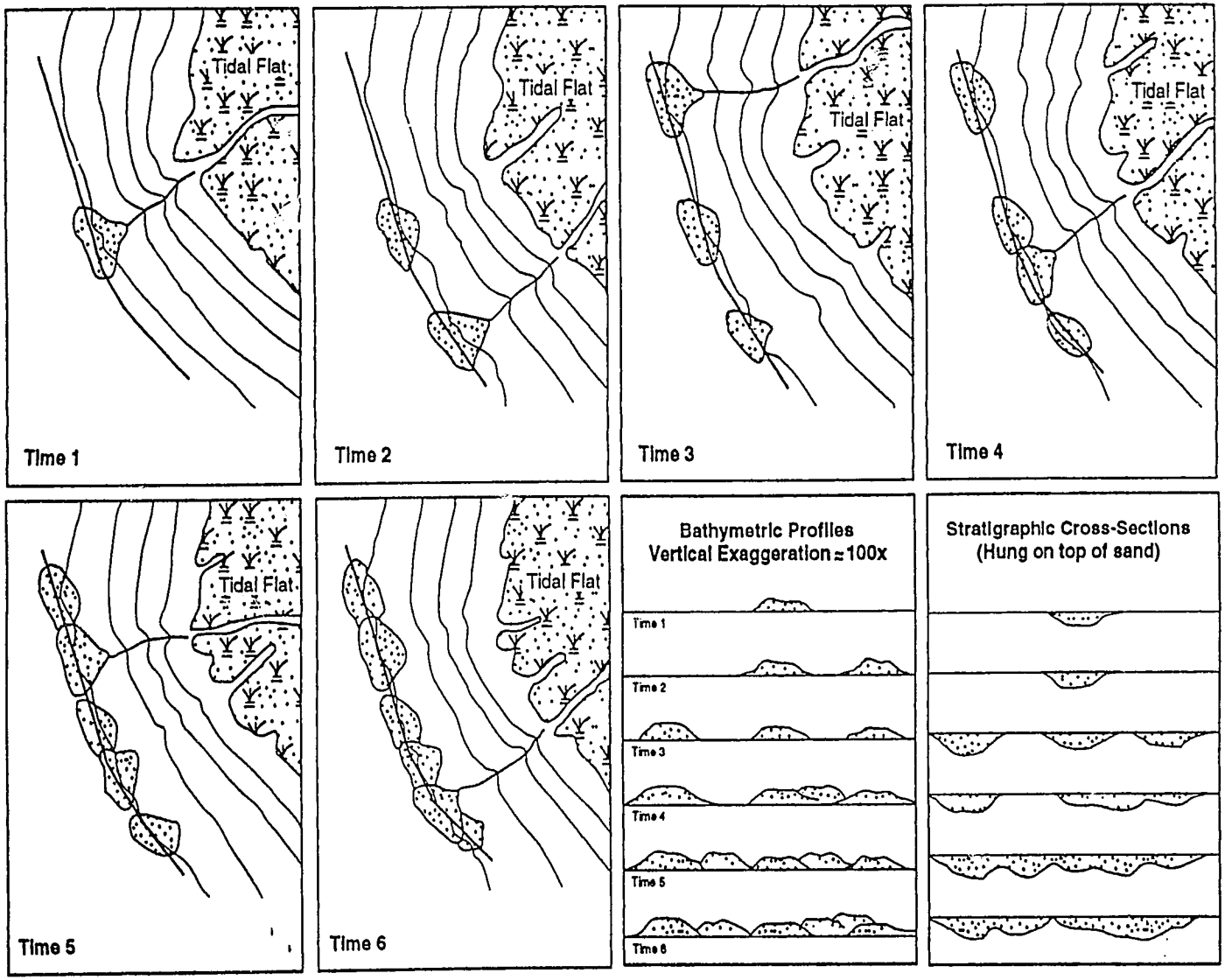


Figure 8-5. Time sequence diagram showing conceptual model for development of linear sand bodies at the base of the subaqueous Fraser River delta foreslope. (From Figure 5-18).

the bypass zone. This results in a wedge-shaped sand body geometry in dip orientation (Figure 8-6). Although the entire channel/fan system migrates, the channel is an environment of bypassing, and little sand accumulates within the channels. These *'bypass chutes'* are geologically short lived, and may not exhibit any significant evidence for either erosion or downcutting. Reduction of the stratigraphic section may only become significant after a single channel captures all available discharge.

It is worth noting that as a result of periodic avulsion, although the sand trend is continuous along strike, sand thickness need not be. While the depositional environments are different, the predictive geometry for the Fraser River delta foreslope sands is remarkably similar to that seen in the Doig sandstone at Buick Creek (Figure 8-3 *vs* Figure 8-5). Deposition and bypassing on the foreslope occur below wave base; consequently there is no evidence for transgressive erosion, *per se*. The depositional lobes themselves are not related to wave induced shoreface failure, but are a function of fluvial discharge (sediment supply) and channel switching. Evidence for erosion (where present) is limited to the truncation of strike parallel elements along the walls of the Sand Heads Sea Valley.

Implications of Channel Type for Deposition of Deep Water Sands

The Roberts Bank Channel is currently inactive and is believed to predate any appreciable cultural mediation. The channel is constructional in nature with well develped depositional levees, and lacks any evidence of erosional downcutting or its fluvial origin. Much of the coarsest sediment supplied to the head of the channel bypasses the delta plain and upper foreslope to be introduced directly to the lower foreslope and basin floor as a small well-developed depositional lobes. The resultant sand body geometry produces a wedge which both thickens and coarsens down slope (Figure 8-6). Up slope, the channel sands thin and pinch out into the finer-grained sediments (silts and clay) of the middle foreslope bypass zone.

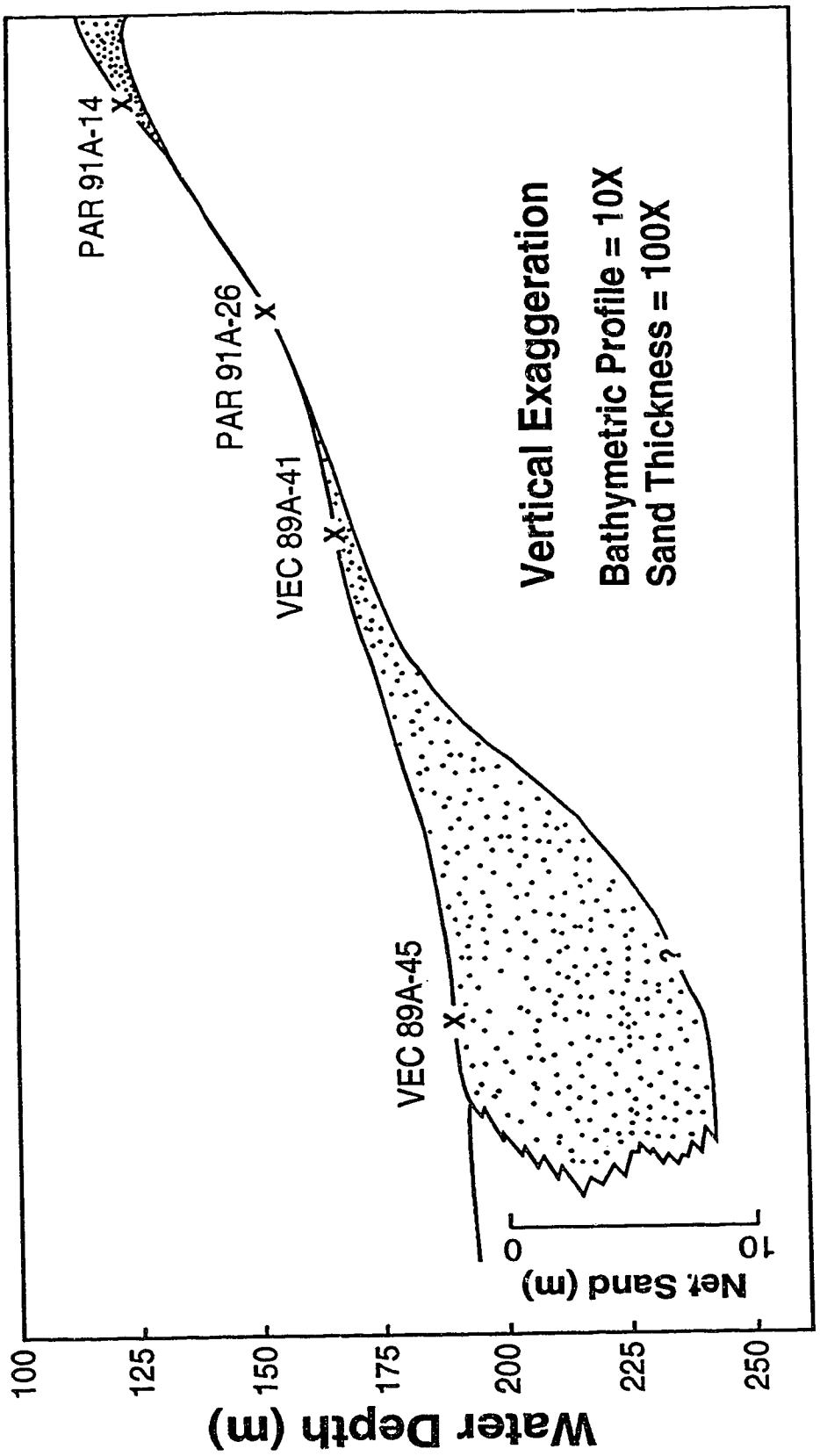


Figure 8-6. Sand bypassing model and wedge geometry for the Fraser River delta foreslope. (From Figure 5-17).

The sand depocentre and maximum sand thickness occurs at the base of the foreslope where turbidity currents become unconfined and deposit their bedload. In conjunction with upslope channel migration, the depocentre can be expected to migrate (Figure 8-5). Through time, this will produce a series of linear sand bodies oriented subparallel to bathymetry. Amalgamation of these sands should ultimately result in a single elongate, strike-parallel sand wedge resting on deep-water muds. In the subaqueous Fraser River delta, this process has been arrested by construction of the Steveston Jetty and cultural stabilization of the distributary channels.

The position and nature of the Sand Heads Sea Valley is strongly controlled by cultural modification. The main channel in the middle and lower delta foreslope is several hundred metres wide, up to 18 m deep, and exhibits steep, erosional channel walls capped by crude depositional levees. Unlike the Roberts Bank Channel, channel migration in the Sand Heads Sea Valley is restricted within the confines of the main valley. Sand deposition within the channel should be similarily controlled by the valley geometry. Over time, this should be anticipated to result in an erosional valley subaqueously incised into deep water muds, and subsequently filled with coarser sediment. Although superficially similar to an incised valley, both incision and deposition occur during the early phase of a single transgressive event, and facies on either side of the erosional surface are genetically related.

Reduction of the stratigraphic section may only become spatially/volumetrically significant after a single channel captures all available discharge (*ie. the fluvial system becomes "fixed"*). This is an important consideration. Experimental modelling of the response of fluvial systems to sea level fall shows that a significant time gap exists between fall of sea level below the shelf slope break and the development of cross-shelf bypass via incised valleys (Koss *et al.*, 1994). Further, rapid sea level fall inhibits development of incised valleys (Wood *et al.*, 1993), as does shelf gradient (Wood *et al.*, 1994).

The implications of a fixed valley system for the development of the depositional lobe

at the base of the valley is problematic. The Sand Heads Sea Valley depositional lobe is less well defined than the Roberts Bank depositional lobe, and is subject to sediment failure and remobilization. This results in a greater down dip displacement of sediment than occurs in the Roberts Bank Channel. Through time, a large submarine fan elongate in a dip direction should be anticipated, as opposed to the strike parallel wedge geometry expected from ephemeral channels.

Conclusions

The significance of sediment bypassing in the delivery of sand to "deep-water" environments has been long recognized. The resultant sand bodies provide excellent hydrocarbon targets as they are frequently encased in fine-grained marine clastics which may provide both potential source rock and seals. These sands may also represent the sole remaining evidence for significant fluctuations in relative sea level.

A number of models exist for the development of "sharp-based" sands associated with a rapid fall in relative sea level. The Doig sandstones in northeastern British Columbia are preserved as a series of narrow, elongate sandstone bodies deposited as lowstand shorefaces associated with abrupt sea level falls. Two lowstand shoreface sandstones (the 1st and 2nd Doig Sands) have been defined on the basis of sedimentologic characteristics and stratigraphic correlation in the vicinity of producing fields; their trends can be extrapolated for several tens of kilometres in a strike direction. At least one additional sandstone, the 3rd Doig Sand, can be inferred based on a limited number of penetrations, but has not been cored. These sands are all deposited as shore parallel bodies, and become progressively younger in a basinward direction as part of a 3rd order composite sequence. Sand preservation is discontinuous along the sandstone trends, but appears to be restricted to these trends. No significant Doig sandstones are present in the area basinward of Buick Creek that do not fall along one of these shoreface trends.

The Doig Sands represent archetypal forced regression sandstones deposited as a series of high-frequency lowstand shorefaces imprinted on a lower frequency sequence set or composite sequence. The processes responsible for the deposition of lowstand sands are a function of decreasing accomodation space. Consequently, they are independant of the *mechanism* of sea level fall (*ie.* eustatic *vs.* tectonic). Similarly, sediment bypassing is strongly influenced by the sense and rate of sea level displacement, magnitude of sea level change, and basin physiography.

The Fraser River delta foreslope is crossed by two bathymetric channels initiated and maintained by sediment gravity flow processes related to periodic liquifaction and failure at the head of the foreslope. Much of the coarsest sediment supplied to the mouth of the delta bypasses the delta plain and upper foreslope, and is introduced directly to the lower foreslope and basin floor where these channels debouche to produce a series of sand-rich depositional lobes. The development of a number of similar channels on the delta foreslope through time has resulted in a high degree of along-strike lateral facies variability. Upslope migration and abandonment of ephemeral channels results in the deposition of a strike-parallel sand wedge (slope apron) formed by the coalesence of a number of small submarine fans at the base of the foreslope. Deposition from a fixed channel (point source) should be anticipated to result in the construction of an elongate submarine fan normal to depositional strike and bathymetry.

The Fraser River delta foreslope represents a process analogue for the development of some lowstand sands. Forward modelling of the Roberts Bank depositional lobe results in the generation of a linear sand body which exhibits several pronounced similarities with classic lowstand forced regression shorefaces. In the absence of diagnostic sedimentologic criteria to determine the depositional environment present in the "lowstand sand", and evidence of a significant erosional discontinuity across the basal contact, this sand could be readily misinterpreted in the stratigraphic record as a forced regression, or other representation of a dramatic and abrupt sea level fall. Long, linear, shore-parallel sand bodies that are both sharp-based and narrow can develop below wave base. Their geometry may not simply reflect

fairweather wavebase scour and subsequent transgressive reworking *aka* the forced regression model; lack of strike continuity may reflect either initial depositional conditions, or subsequent transgressive reworking.

Possibly the most important implications of this research are cautionary. Sequence stratigraphy is a methodologic approach to the study of rocks relationships within a chronostratigraphic framework of genetically related strata (Van Wagoner *et al.*, 1988). As a result of the early emphasis on the recognition and documentation of of global scale sea level fluctuations (eg. Payton, 1977 and papers therein), eustatic sea level fluctuations are over-emphasized in many sequence stratigraphic reconstructions. This trend has been exaggerated by the need to assume a periodic, curvilinear sea level curve for numerical modelling (eg. Jervey, 1988; Posamentier et al., 1988; Mitchum and Van Wagoner, 1991). Sequence stratigraphic concepts, however, are both time- and scale-independant (Posamentier *et al.*, 1992b; Koss *et al.*, 1994). The processes associated with sea level change are independant of the mechanics of sea level change.

The current reinterpretation of many offshore sands and shelf ridges as lowstand shorefaces is often a significant advance in our study of basin architectures. However, the assertion that all similar shelf sand bodies must therefore also represent lowstand shorefaces (Walker and Bergman, 1993, p.851) is a gross generalization and dangerous simplification. Even though forced regressions can generate sharp-based sands, *sharp-based sands do not equal forced regressions*. An abrupt contact and sudden change in lithology simply represents a sudden change in depositional energy; of itself, it does not reveal anything about what caused that change. Such interpretations can only be made based on detailed sedimentologic observations and careful documentation of lateral and vertical facies relationships.

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CHAPTER 9.
SUMMARY AND CONCLUSIONS

Two examples of sediment bypassing and deposition during an abrupt fall of relative sea level on the continental shelf were examined to document the variability in associated siliciclastic facies. The modern Fraser River delta foreslope offshore Vancouver, British Columbia, and the Middle Triassic Doig Formation in northeastern British Columbia, were both deposited under an abrupt fall in relative sea level during a period of global eustatic sea level rise. Each case represents a sharp-based, linear sand body deposited as a component of a high-frequency sequence. The ultimate goal of this research is to use the lateral and vertical facies variability and geometry of lowstand sand bodies to document the characteristic facies relationships in marine sandstones associated with sediment bypassing during a fall in relative sea level, and to determine if criteria are available to distinguish between forced regression surfaces and other sharp-based linear sand bodies.

Fraser River Delta Foreslope

The first half of this dissertation (Chapter 2 through Chapter 5) represents a study of sedimentation styles on the Fraser River delta foreslope, and documents the significance and processes of sediment bypassing in the delivery of sand to the prodelta and basinal environment. A conceptual model is developed to explain the development of bathymetrically constrained linear sand bodies in water depths in excess of 200 m at the base of the delta foreslope.

The Fraser River delta foreslope is cut by two pronounced bathymetric channels, initiated and maintained by sediment gravity flow processes related to periodic liquifaction and failure at the head of the foreslope. Each channel exhibits significantly different characteristics: 1) the Roberts Bank Channel is currently inactive, represents an ephemeral feature on the delta foreslope, and is a constructional feature with well developed depositional

levees, and 2) the Sand Heads Sea Valley has been culturally fixed, is an erosional feature, and exhibits steep valley walls marked by truncation of parallel reflectors and erosional undercutting.

In Chapter 2, sediment accumulation rates and patterns (determined from Cs-137 profiles), and allochthonous micropaleontological assemblage distributions, are used to document the reintroduction of older sediment from upslope via slumping and sediment-gravity flow processes. Such processes of remobilization are shown to account for the bulk of sedimentation over much of the subaqueous delta slope.

Grain size distribution patterns and textural parameters are used in Chapter 3 to further document the significance of sand bypassing on the delta foreslope, and to constrain the type of sediment-gravity flows responsible for sand bypassing. Much of the coarsest sediment supplied to the mouth of the delta bypasses the delta plain and upper foreslope and is introduced directly to the lower foreslope and basin floor where channels debouche to produce a series of sand-rich depositional lobes. Subsamples of piston cores collected from depositional lobes at the base of the foreslope rarely contain sufficient clay components to have exhibited cohesive strength during transport; turbidity currents appear to be the dominant mechanism for the delivery of sand to depositional lobes at the base of the foreslope.

The variability of sedimentary facies on the delta foreslope are documented in Chapter 4 using sedimentologic descriptions of piston cores, and high frequency (3.5 kHz) seismic profiles. Facies distribution patterns show that sand-sized sediment is a significant component of the lower foreslope, and suggests that the delta foreslope has been dissected by a number of historic channels, in addition to those with current bathymetric expressions. The incision of multiple channels through time on the delta foreslope has resulted in a high degree of along-slope lateral facies variability. Sedimentologic characteristics are compatible with sediment transport as periodic turbidity currents. The bulk of the sediment deposition occurs

where these channels debouche at the base of the foreslope, and the channelized turbidity currents become unconfined.

The geometries and sedimentary characteristics of the two main bathymetric channels on the delta foreslope - one in its natural state, and one which has been culturally modified - are compared and contrasted in Chapter 5. By integrating the data from previous chapters with additional piston core descriptions and high frequency seismic profiles, a conceptual model is developed predicting the generation of linear sand bodies at the base of the delta foreslope. As a result of upslope channel migration and avulsion, a strike parallel sand wedge (slope apron) will form through the coalesence of small depositional lobes at the base of the foreslope. This process has been arrested by construction of the Steveston Jetty and dredging of the main navigation channel.

Doig Formation

The second half of this dissertation (Chapters 6 and 7) is a study of the sedimentary characteristics and geometry of a number of reservoirs producing from the Doig Formation in northeastern British Columbia. The methodology for each field study is to complete a sedimentologic analysis of all available cores using a process sedimentologic approach to infer depositional processes, document facies associations, and determine depositional environments. These data are then integrated with wireline logs to construct a depositional model within a sequence stratigraphic framework.

The Doig Sand in northeastern British Columbia is preserved as a series of narrow, elongate sandstones deposited as a series of lowstand shorefaces associated with abrupt sea level falls. Two lowstand shorefaces have been identified on the basis of their sedimentologic characteristics (core control) and stratigraphic correlation (wireline log control) in the vicinity of producing fields. The trend of these shorefaces can be extrapolated for several tens of kilometres in a strike direction; sand preservation is discontinuous along the sand trends, but

appears to be restricted to these trends. At least one additional sand body can be inferred based on a limited number of penetrations, but has not been cored. These sandstones are all deposited as shore-parallel bodies, and become progressively younger in a basinward direction as part of a 3rd order composite sequence.

The Buick Creek Field represents the largest recognized Doig reservoir in the study area, and largest subsurface database available. Due to the abundance of available core, in Chapter 6 depositional processes and facies associations for the Doig interval were determined directly, based on observed physical characteristics. Three facies associations were recognized: 1) offshore/shelf, 2) shoreface, and 3) offshore transition. All production is from Facies Association 2, a fine-grained, massive sandstone which erosionally overlies Facies Association 1 and is abruptly overlain by Facies Association 3 across a pronounced transgressive surface of erosion.

The results of the Buick Creek study were expanded regionally in Chapter 7 to test the applicability of the forced regression shoreface model to other Doig reservoirs in northeastern British Columbia. Doig sandstones from four different fields show similar patterns in distribution of facies and facies associations. The sandstones are typically very fine- to fine-grained, and are massive to planar tabular cross-bedded. The basal contact between Facies Association 2 sandstones and underlying lithologies is disconformable, and can locally be seen to truncate markers in the underlying lithologies, or is represented by a *Glossifungites* surface. This erosional surface represents a regressive surface of marine erosion (equivalent of a lowstand surface of erosion). At least two separate sandstones can be recognized. The 1st Doig Sand trend and its bounding discontinuities can be traced for a minimum 75 km along strike; the 2nd Doig Sand is recognized 10 to 20 km basinward of, and stratigraphically overlies, the 1st Doig Sand. This development of a series of lowstand erosional surfaces within a relatively narrow chronostratigraphic framework can best be explained as a series of tectonically driven high-frequency sequence boundaries.

Bypass Models

The bypass sand geometries of the Fraser River delta foreslope and the Doig Formation are compared in Chapter 8. Sand deposition on the Fraser River delta foreslope is in the form of small depositional lobes or submarine fans deposited where subaqueous distributary channels debouche at the base of the foreslope. Through time, upslope channel migration and abandonment are expected to result in a linear sand body trend at the base of the foreslope formed by the coalesence of a number of small depositional lobes. Delivery of sand is controlled by both intrabasinal and extrabasinal factors dominated by a pronounced fluvial point source, and an isostatically-induced, abrupt fall in relative sea level.

The Fraser River delta foreslope represents sediment accumulation within the Transgressive Systems Tract or early Highstand Systems Tract. Sand bypassing is via discrete channels on the foreslope, and results in the *physical (channelized) transport of sediment from the shoreface, across the foreslope, to "deep-water".*

The Doig Sand is preserved as a series of long linear sandtone bodies exhibiting all the characteristics of a forced regression lowstand shoreface. Fine- to medium-grained sandstones with lower to upper shoreface affinity directly overlie offshore siltstones and shales across an erosional discontinuity locally demarcated by the development and preservation of a *Glossifungites* surface, and truncation of underlying lithologies. Controls over sediment delivery and preservation are intrabasinal, with sediment delivered from a linear source. Structural control on sand body geometries is well established.

The Doig represents an archetypal forced regression shoreface deposited as part of a high-frequency Lowstand Systems Tract. The development of lowstand shorefaces is dominated by an abrupt fall in relative sea level, and represents a necessary response to the attendant decrease in available accomodation space. In essence, the forced regression model accounts for sand bypassing by *bringing the shoreface to "deep-water".*

Conclusions

The significance of sediment bypassing in the delivery of sand to "deep-water" environments has been long recognized. The resultant sand bodies provide excellent hydrocarbon targets as they are frequently encased in fine-grained marine clastics which may provide both potential source rock and seals. These sands may also represent the sole remaining evidence for significant fluctuations in relative sea level.

Possibly the most significant implications of this research are two cautionary observations. First, *sharp-based sands do not equal forced regressions*. Such geometries can result from either autocyclic or allocyclic mechanisms. Second, *eustatic sea level fluctuations are over-emphasized* in many sequence stratigraphic reconstructions. Conversely, the role of local tectonics is frequently underemphasized in its significance.

A number of models exist for the development of "sharp-based" sands associated with a rapid fall in relative sea level. The Doig Sands represent a number of archetypal forced regression sand bodies which were deposited as a series of high-frequency lowstand shorefaces imprinted on a lower frequency sequence set or composite sequence. The processes responsible for the deposition of lowstand sands are a function of decreasing accomodation space. Consequently, they are independant of the *mechanism* of sea level fall (*ie*. eustatic *vs*. tectonic). Similarly, sediment bypassing is strongly influenced by the sense and rate of sea level displacement, magnitude of sea level change, and basin physiography

The Fraser River delta foreslope represents a process analogue for the development of some lowstand sands. Forward modelling of the Roberts Bank depositional lobe results in the generation of a linear sand body which exhibits several pronounced similarities with classic lowstand forced regression shorefaces. In the absence of diagnostic sedimentologic criteria to determine the depositional environment present in the "lowstand sand", and evidence of a significant erosional discontinuity across the basal contact, this sand could be readily misinterpreted in the stratigraphic record as a forced regression, or other representation of

a dramatic and abrupt sea level fall. Long, linear, shore-parallel sand bodies that are both sharp based and narrow can develop below wave base. Their geometry may not simply reflect fairweather wavebase scour and subsequent transgressive reworking *aka* the forced regression model. Lack of strike continuity may thus reflect initial depositional conditions or subsequent transgressive reworking.

APPENDIX A: FRASER RIVER DELTA STUDY LIST OF CORES

CORE I.D.	WATER DEPTH	CORE LENGTH	CORE TYPE	LOGGED BY:	GZ Data	FACIES TYPE(S) Major	Minor	Rare	DEPOSITIONAL SETTING
VEC 83A - 23	231 m	150 cm	GRAVITY	GSC	*GSC*	1			Sturgeon Bank - Prodelta
25	163 m	135 cm	GRAVITY	GSC	*GSC*	1/2			Sturgeon Bank - Lower Foreslope
26	185 m	151 cm	GRAVITY	GSC	*GSC*	2/1	3?	4	Sturgeon Bank - Lower Foreslope
27	183 m	154 cm	GRAVITY	GSC	*GSC*	2/1	3?	4	Sturgeon Bank - Lower Foreslope
VEC 83B - 35	202 m	67 cm	GRAVITY	RWE	*GSC*	1/2			Roberts Bank - Lower Foreslope
36	152 m	164 cm	GRAVITY	RWE	*GSC*	1/2		4?	Roberts Bank Interchannel - Lower Foreslope
37	241 m	31 cm	GRAVITY	RWE	*GSC*	1	4		Roberts Bank - Lobe Fringe
38	240 m	62 cm	GRAVITY	RWE	*GSC*	1/2	4		Roberts Bank - Lobe Fringe
VEC 89A - 1	280 m	580 cm	PISTON	RWE	*UofA*	1			Basin Floor
3	190 m	220 cm	PISTON	RWE	*UofA*	4	1		SHSV Flank - Lower Foreslope
6		106 cm	PISTON	RWE	*UofA*	1/2	4		SHSV Levee - Lower Foreslope
7		465 cm	PISTON	RWE	*UofA*	2/1		4?	Roberts Bank Interchannel - Lower Foreslope
18	170 m	381 cm	PISTON	RWE	*UofA*	1/2, 4			Sturge nk - Lower Foreslope
19	136 m	460 cm	PISTON	RWE		2/1			Sturgeon Bank - Middle Foreslope
20	93 m	420 cm	PISTON	RWE	*UofA*	1/2		4	Sturgeon Bank - Upper Foreslope
21	50 m	423 cm	PISTON	RWE	*UofA*	2, 1		4	Sturgeon Bank - Upper Foreslope
22	206 m	510 cm	PISTON	RWE		1, 2			Sturgeon Bank - Prodelta
23	174 m	188 cm	PISTON	RWE	*UofA*	1/2, 4?	4		Sturgeon Bank - Lower Foreslope
25	240 m	137 cm	PISTON	RWE	*UofA*	4			Sand Heads Sea Valley - Lobe
39	163 m	132 cm	PISTON	RWE	*UofA*	4, 2	1		Roberts Bank - Middle Foreslope
40	212 m	486 cm	PISTON	RWE	*UofA*	1	2	5	Roberts Bank - Lower Foreslope/Prodelta
41		145 cm	PISTON	RWE	*UofA*	4	2	1	Roberts Bank Channel - Lower Foreslope
42	176 m	62 cm	PISTON	RWE	*UofA*	4	1		Roberts Bank Channel - Lower Foreslope
44	182 m	280 cm	PISTON	RWE	*UofA*	4	2	1	Roberts Bank Channel - Lower Foreslope
45	231 m	165 cm	PISTON	RWE	*UofA*	4	2?	2, 1	Roberts Bank - Lobe
46	46 m	101 cm	PISTON	RWE	*UofA*	4, 3	2, 1		Roberts Bank - Upper Foreslope
PAR 91A - 3	76 m	228 cm	VIBRACORE	GSC		4, 1, 2			Roberts Bank - Upper Foreslope
9	188 m	372 cm	PISTON	RWE		1, 2	4		Roberts Bank - Lower Foreslope
10	175 m	212 cm	PISTON	GSC		2	1	4	Roberts Bank - Lower Foreslope

CORE I.D.	WATER DEPTH	CORE LENGTH	CORE TYPE	LOGGED BY:	GZ Data	FACIES TYPE(S) Major	Minor	Rare	DEPOSITIONAL SETTING
PAR 91A - 11	143 m	438 cm	PISTON	RWE	GSC	2, 1	3	4?	Roberts Bank Interchannel - Lower/Middle Foreslope
12	120 m	362 cm	PISTON	RWE	GSC	1/2			Roberts Bank - Middle Foreslope
14	120 m	402 cm	PISTON	RWE	UofA/GSC	2, 4, 1			Roberts Bank Channel - Middle/Upper Foreslope
16	core not logged				GSC				Sturgeon Bank - Lower Foreslope
17	126 m	437 cm	PISTON	RWE	GSC	2/1			Sturgeon Bank - Middle Foreslope
20	173 m	290 cm	PISTON	GSC	GSC	4,2	1		Roberts Bank - Lower Foreslope
21	228 m	503 cm	PISTON	RWE		1/2			Roberts Bank - Prodelta
22	249 m	374 cm	PISTON	RWE	GSC	2, 1, 4			Roberts Bank - Lobe Fringe (?)
23	239 m	387 cm	PISTON	RWE		2/1, 4?	4		Roberts Bank - Lobe Fringe (?)
25	145 m	340 cm	PISTON	RWE		1, 4, 2			Roberts Bank Interchannel - Middle Foreslope
26	160 m	468 cm	PISTON	RWE	UofA/GSC	2/1		4?	Roberts Bank Channel - Middle/Lower Foreslope
VEC 92A - 20	174 m	230 cm	GRAVITY	GSC		2, 4?	4		
34	129 m	375 cm	PISTON	GSC		4		1	
35	51 m	108 cm	PISTON	GSC		4, 2		1	
36	44 m	535 cm	PISTON	RWE		4	3, 1		Roberts Bank Channel Margin - Upper Foreslope
45	60 m	498 cm	PISTON	RWE	GSC	1, 2		4?	Roberts Bank Interchannel - Upper Foreslope
46	59 m	248 cm	PISTON	RWE	GSC	4, 1/2, 3			SHSV Flank - Upper Foreslope
47	71 m	514 cm	PISTON	GSC	GSC	4, 1	3		SHSV Flank - Upper Foreslope
61	152 m	578 cm	PISTON	RWE		1/2		4?	Sturgeon Bank - Middle Foreslope
62	36 m	385 cm	PISTON	GSC	GSC	1/2		4?	Strugeon Bank - Upper Foreslope
104	215 m	71 cm	GRAVITY	GSC		2/1			
105	268 m	80 cm	GRAVITY	GSC		1/2			
106	281 m	77 cm	GRAVITY	GSC		2/1			
107	343 m	88 cm	GRAVITY	GSC		2/1			
108	285 m	88 cm	GRAVITY	GSC		2/1			
109	253 m	75 cm	GRAVITY	GSC		2/1			
110	151 m	392 cm	PISTON	RWE	GSC	2/1, 4			SHSV Flank - Lower/Middle Foreslope
112	274 m	580 cm	PISTON	GSC	GSC	2/1			Basin Floor
TUL 92A - 62	40 m	140 cm	VIBRACORE	GSC		4, 1	2		
63	80 m	234 cm	GRAVITY	RWE		4, 3			Roberts Bank - Upper Foreslope

CORE I.D.	WATER DEPTH	CORE LENGTH	CORE TYPE	LOGGED BY:	GZ Data	FACIES TYPE(S) Major	Minor	Rare	DEPOSITIONAL SETTING
TUL 92A - 64	96 m	189 cm	GRAVITY	RWE		2	1		
65	82 m	39 cm	GRAVITY	GSC		4, 1			SHSV Flank - Upper Foreslope
66	68 m	244 cm	GRAVITY	GSC		1/2			
74	178 m	555 cm	PISTON	RWE		1/2, 4			SHSV Flank - Lower Foreslope
75	52 m	393 cm	PISTON	GSC		3, 1, 4			Sturgeon Bank - Upper Foreslope
76	39 m	410 cm	PISTON	GSC		1/2	4		SHSV Flank - Upper Foreslope
77	46 m	397 cm	PISTON	GSC		1/2	4?	4	Sturgeon Bank - Upper Foreslope
78	122 m	155 cm	PISTON	GSC		1/2			Sturgeon Bank - Middle Foreslope
79	173 m	447 cm	PISTON	RWE	*UofA*	1/2, 4			Roberts Bank Channel - Lower Foreslope
81	59 m	402 cm	PISTON	GSC		3, 1	4		Roberts Bank Interchannel - Upper Foreslope
82	55 m	164 cm	PISTON	RWE		4, 1	2/3		SHSV Flank - Upper Foreslope
83	66 m	138 cm	PISTON	GSC		1/2			
84	136 m	232 cm	GRAVITY	RWE		1/2, 4?	4		SHSV Flank - Middle Foreslope
103	115 m	63 cm	GRAVITY	RWE		1/2, 4			Roberts Bank Interchannel - Middle Foreslope
104	153 m	34 cm	GRAVITY	RWE		1/2			SHSV Flank - Middle Foreslope
105	140 m	206 cm	GRAVITY	RWE		1/2		4	SHSV Flank - Middle Foreslope
106	107 m	98 cm	GRAVITY	RWE		1/2, 4	3?		SHSV Flank - Middle/Upper Foreslope
107	105 m	198 cm	GRAVITY	RWE		1/2		3?	SHSV Flank - Middle Foreslope
108	98 m	194 cm	GRAVITY	RWE		1/2			Sturgeon Bank - Upper/Middle Foreslope
109	70 m	191 cm	GRAVITY	RWE		1/2			Sturgeon Bank - Upper Foreslope
110	55 m	230 cm	GRAVITY	GSC		1/2			Sturgeon Bank - Upper Foreslope
111	20 m	185 cm	GRAVITY	GSC		3	4?		Roberts Bank Interchannel - Upper Foreslope
112	61 m	33 cm	GRAVITY	RWE	*UofA*	1/2			Roberts Bank Interchannel - Upper Foreslope
113	59 m	239 cm	GRAVITY	RWE		1/2, 3		4?	Roberts Bank Interchannel - Upper Foreslope
114	93 m	134 cm	GRAVITY	GSC		1/2	4		Roberts Bank Interchannel - Upper Foreslope
162	51 m	215 cm	VIBRACORE	RWE	*UofA*	2	3/4		Robert Bank Channel Margin - Upper Foreslope
163	54 m	199 cm	VIBRACORE	RWE	*UofA*	4, 3	1/2		Robert Bank Channel Margin - Upper Foreslope
167	221 m	227 cm	GRAVITY	RWE		1/2, 4?	4		Roberts Bank - Lobe Fringe

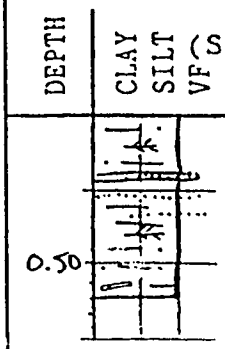
APPENDIX B: FRASER RIVER DELTA STUDY PISTONCORE/VIBRACORE LOG DESCRIPTIONS

APPENDIX B1: FRASER DELTA STUDY

Cruise VEC83B Sedimentologic Core Descriptions.

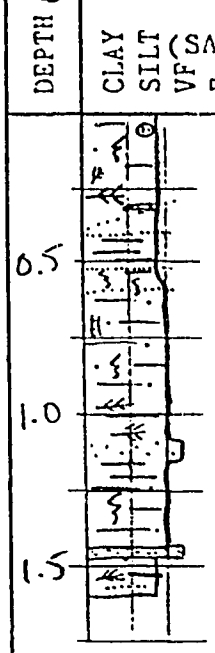
Core No. VEC83B-35 Length 67 cm
Type GRAVITY Water Depth 202m

GRAPHIC CORE LOG



Core No. VEC83B-36 Length 164 cm
Type GRAVITY Water Depth 152 m

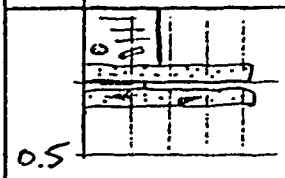
GRAPHIC CORE LOG



Core No. VEC83B-37 Length 31 cm
Type GRAVITY Water Depth 241 m

GRAPHIC CORE LOG

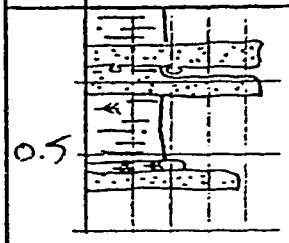
DEPTH | CLAY SILT (SAND) VF F M



Core No. VEC83B-38 Length 62 cm
Type GRAVITY Water Depth 240 m

GRAPHIC CORE LOG

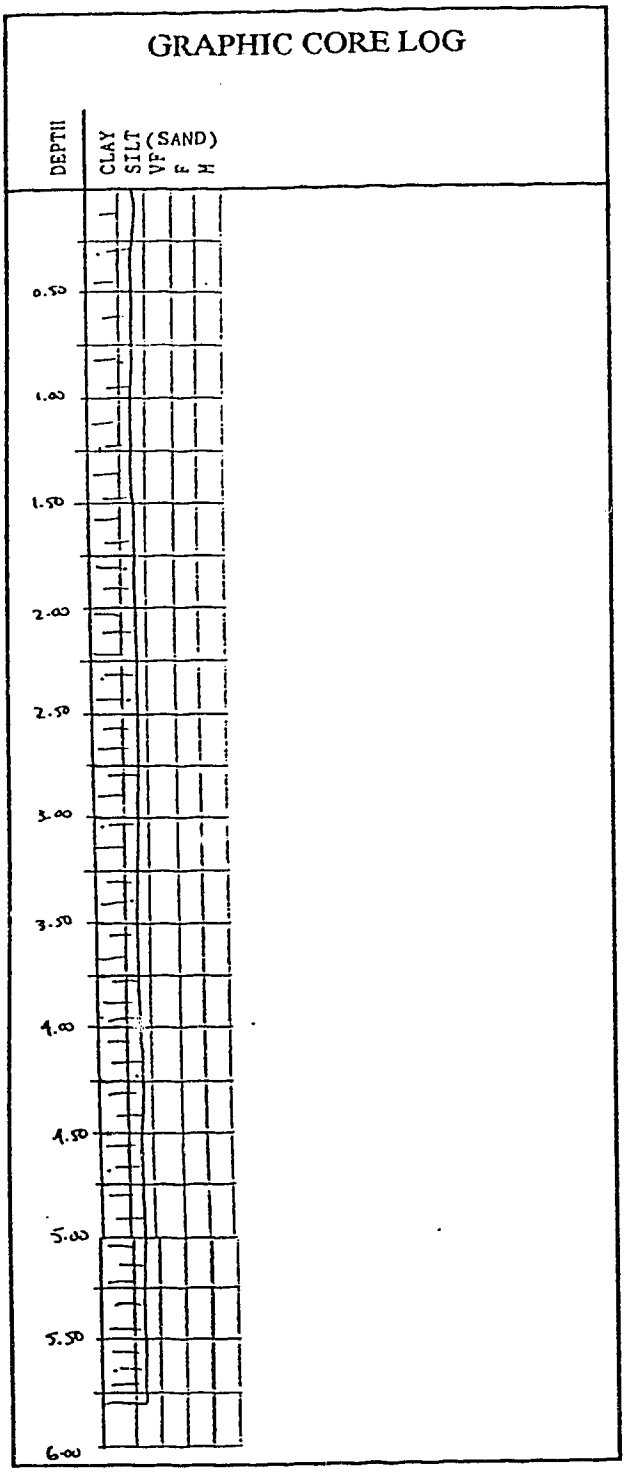
DEPTH (m) | CLAY SILT (SAND) VF F M



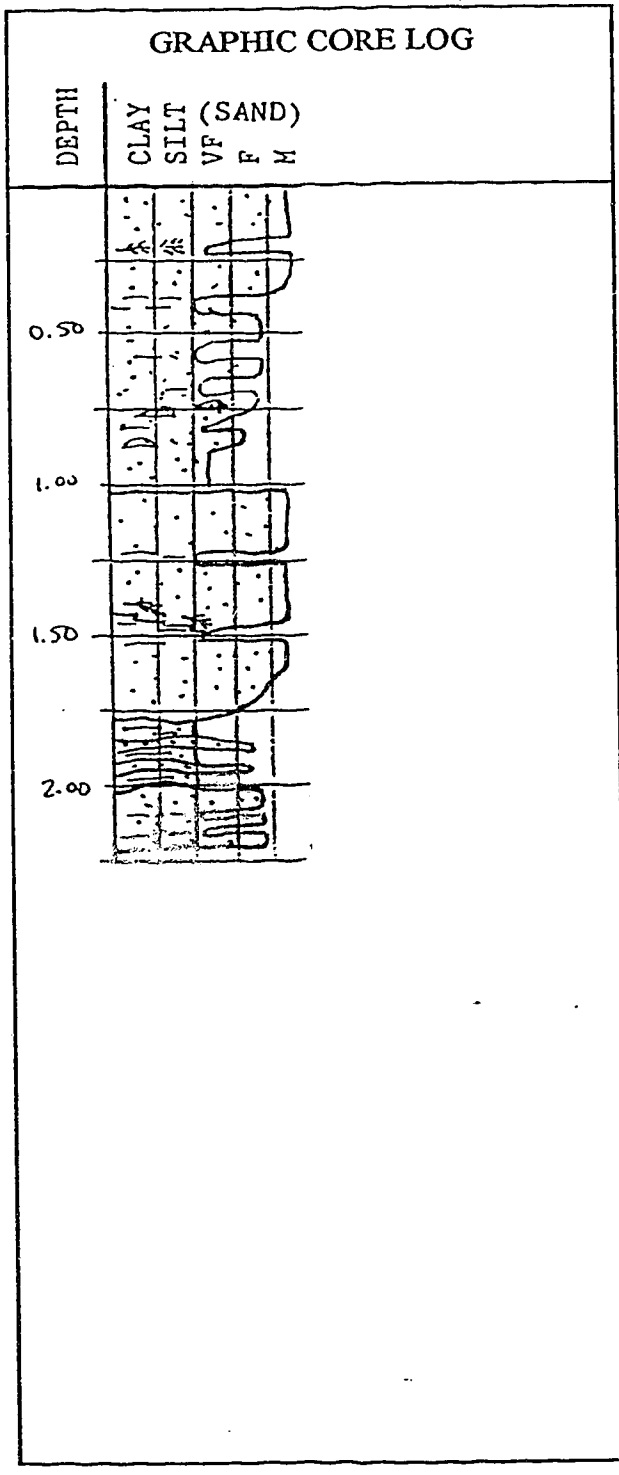
APPENDIX B2: FRASER DELTA STUDY

Cruise VEC89A Sedimentologic Core Descriptions

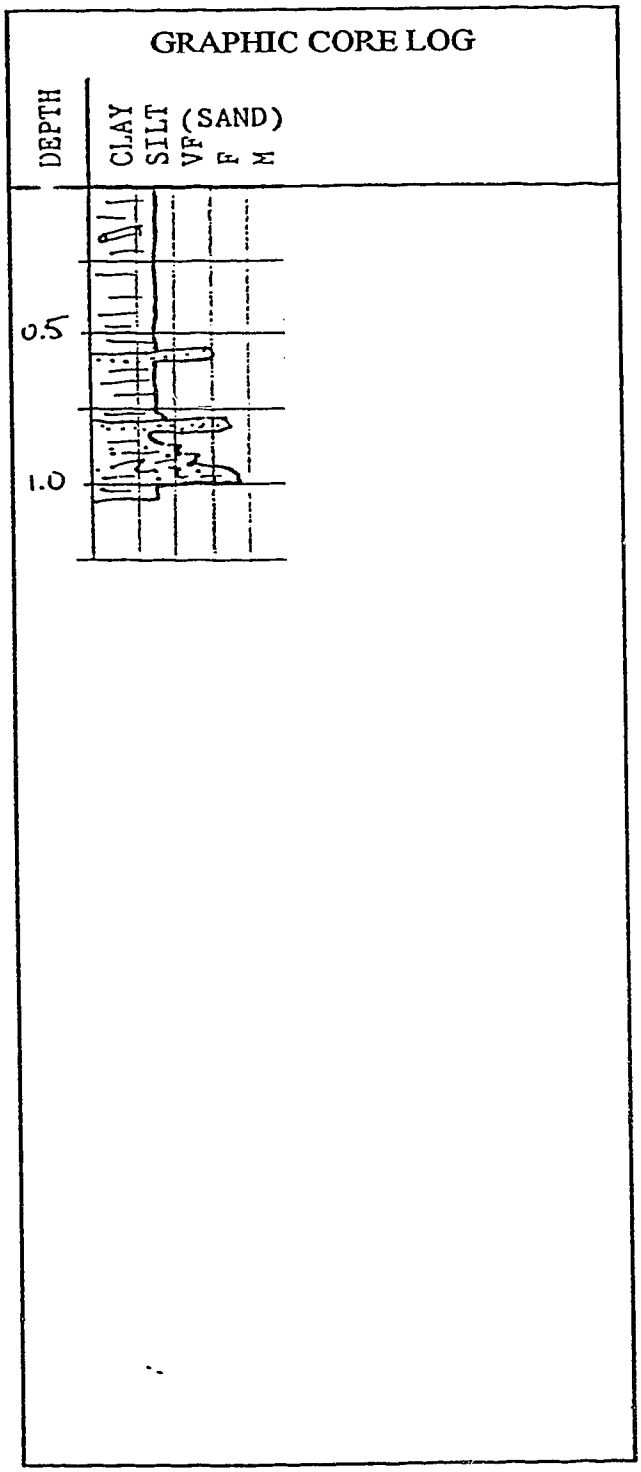
Core No. VEC89A-01 Length 580 cm
Type PISTON Water Depth 1330m



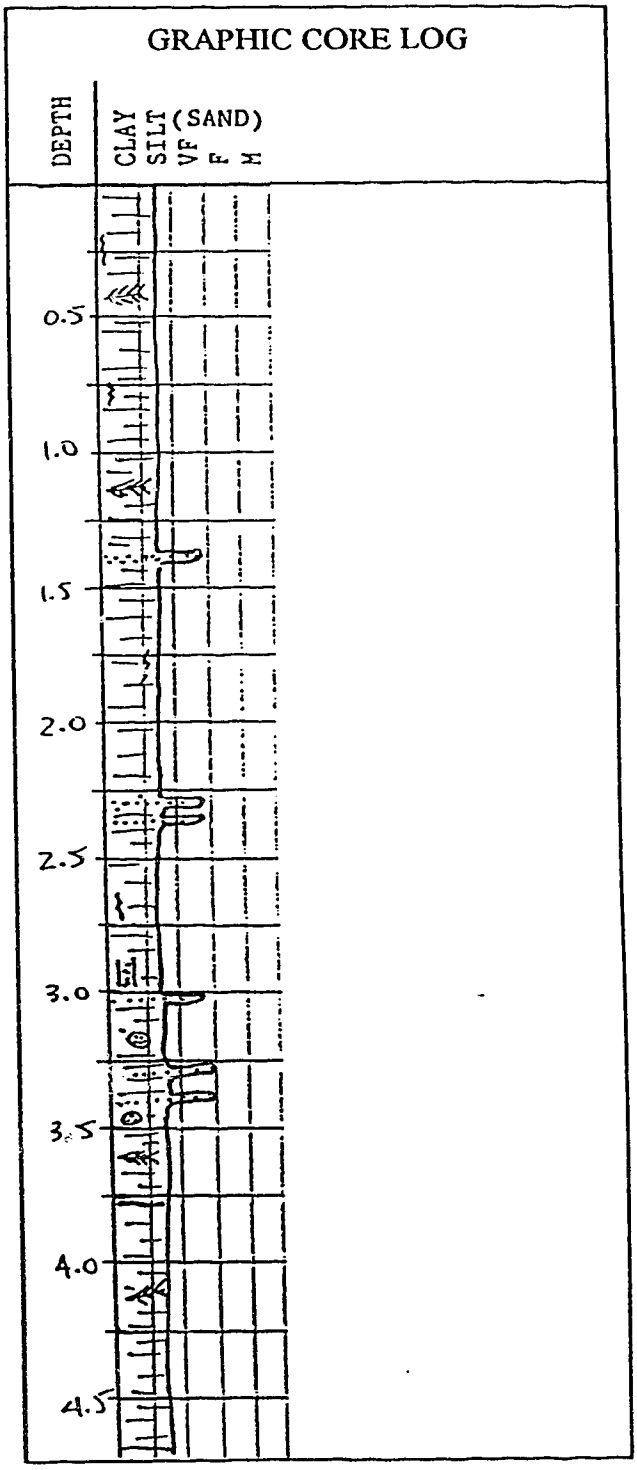
Core No. VEC.89A-03 Length 220 cm
Type PISTON Water Depth 140 m



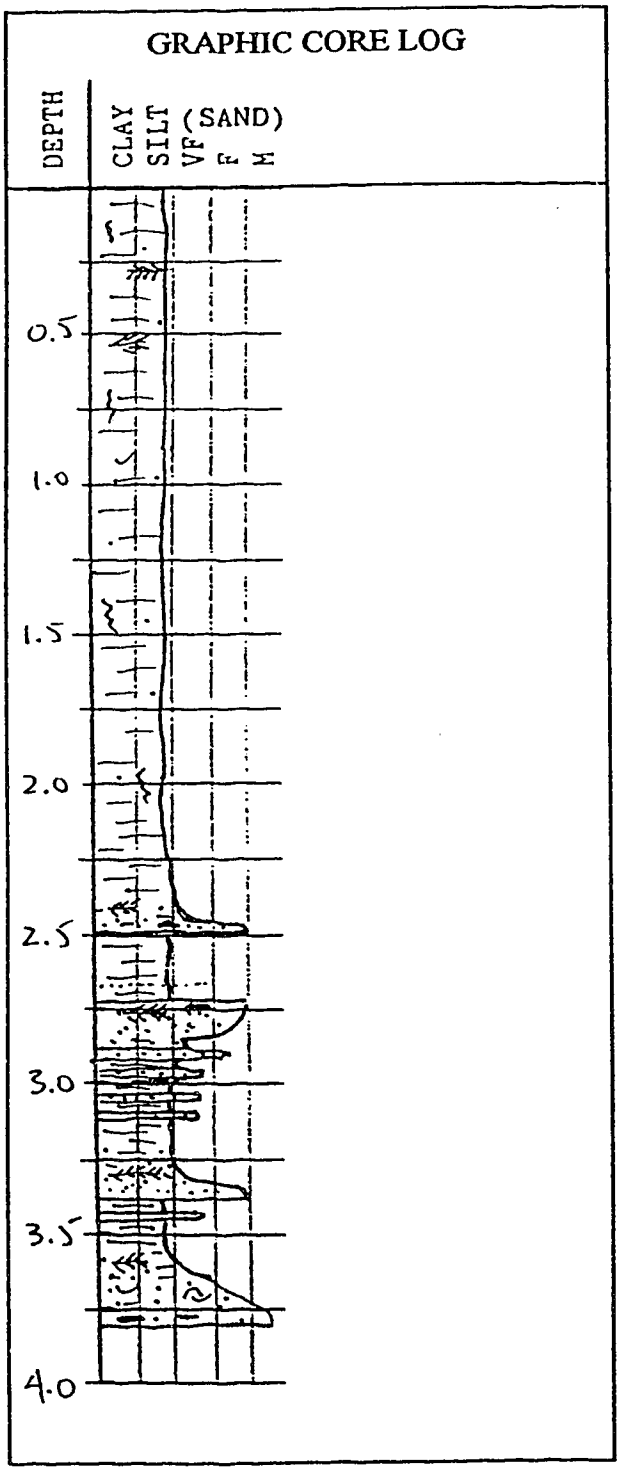
Core No. VEC 89A-06 Length 106 cm
Type PISTON Water Depth ____ m



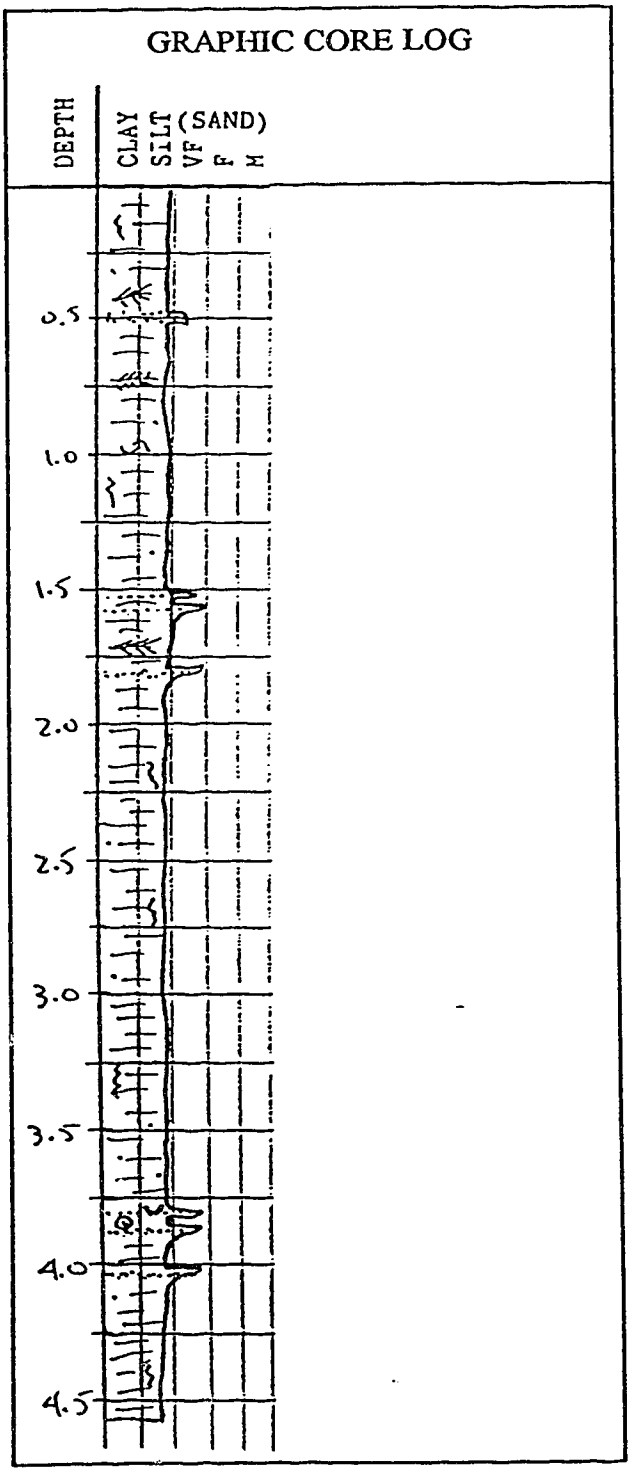
Core No. VEC 89A-07 Length 465 cm
Type PISTON Water Depth ____ m



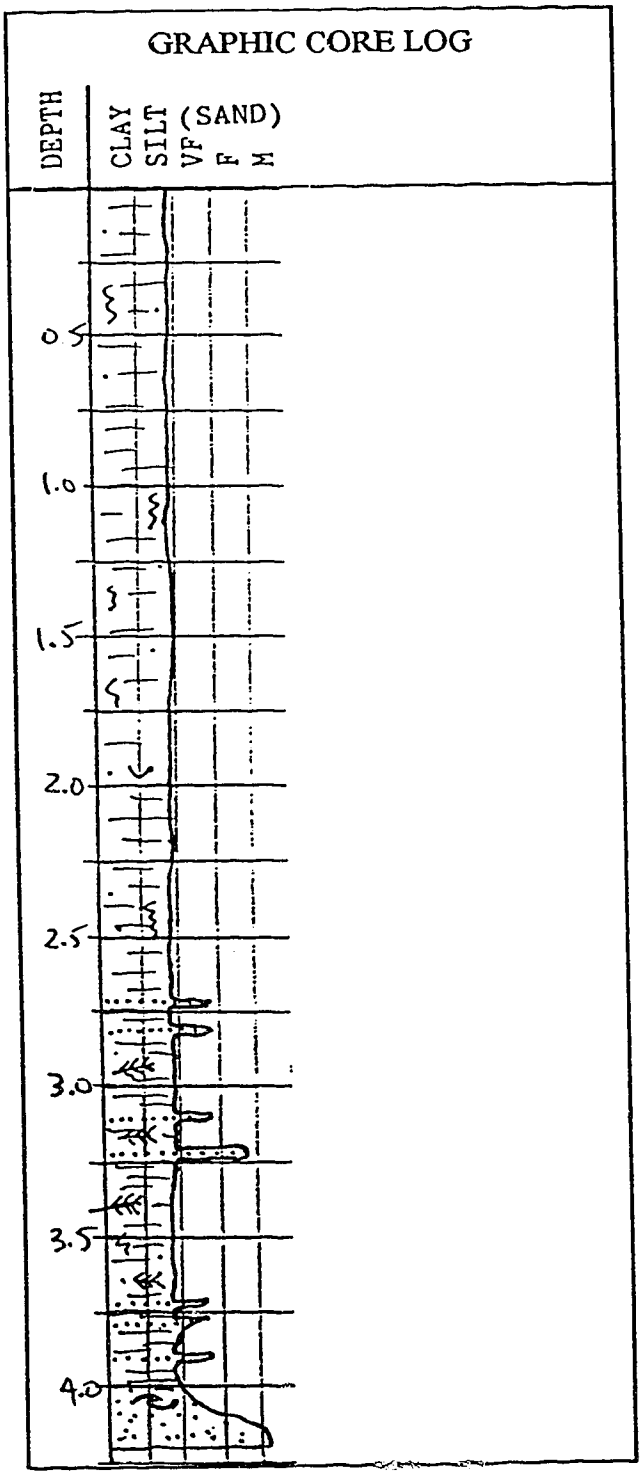
Core No. VEC89A-18 Length 381 cm
Type PISTON Water Depth 170 m



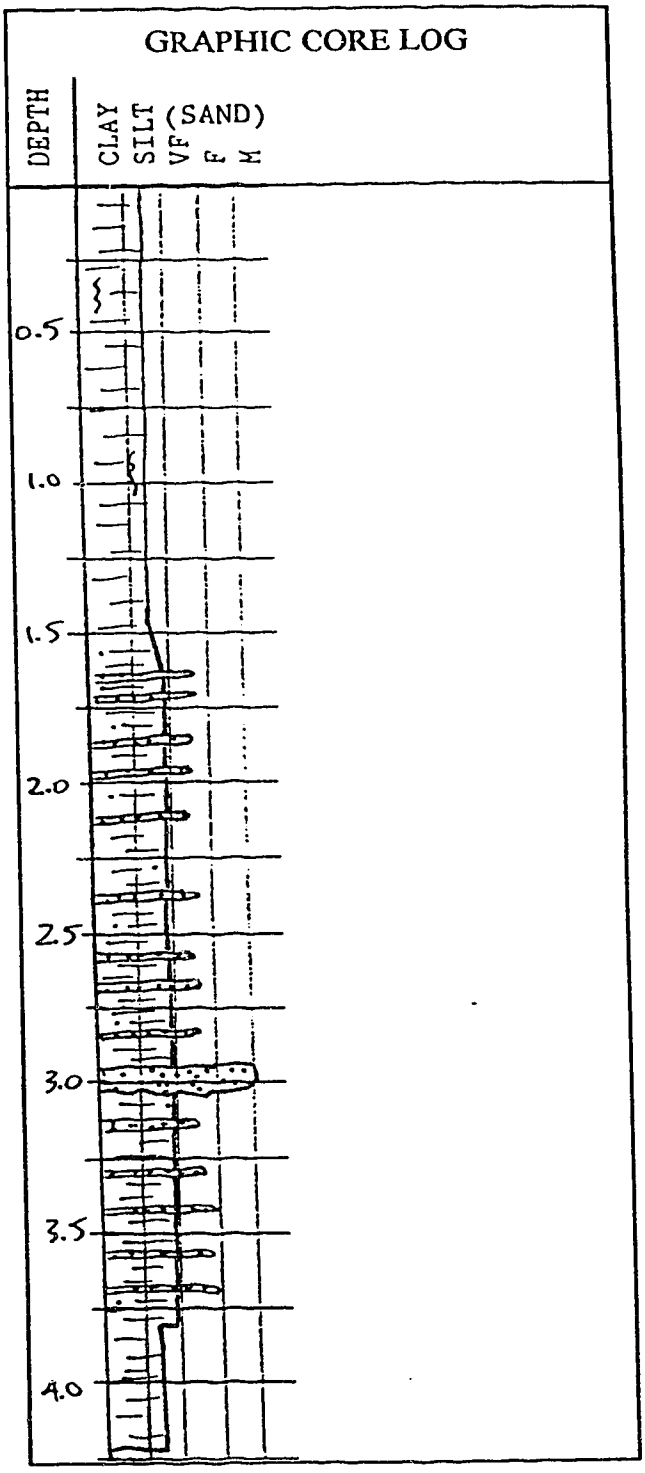
Core No. VEC89A-19 Length 460 cm
Type PISTON Water Depth 136 m



Core No. VEC89A-20 Length 420 cm
Type PISTON Water Depth 93 m

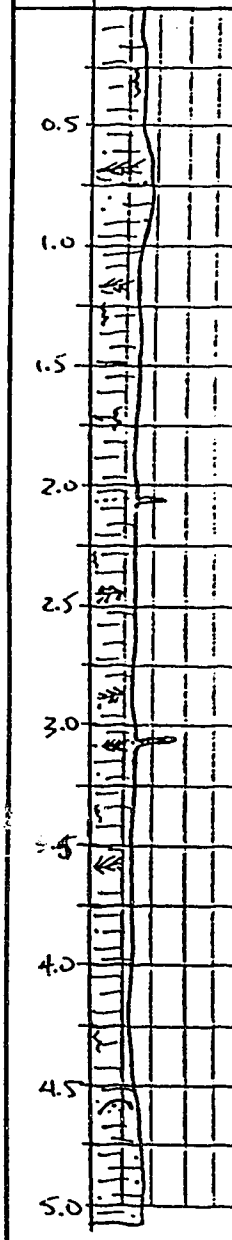


Core No. VEC89A-21 Length 423 cm
Type PISTON Water Depth 50 m



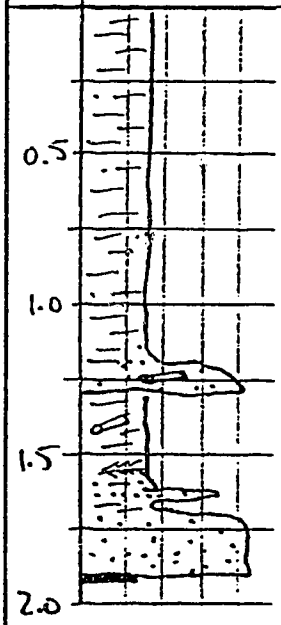
Core No. VEC 89A-22 Length 510 cm
Type PISTON Water Depth 206 m

GRAPHIC CORE LOG



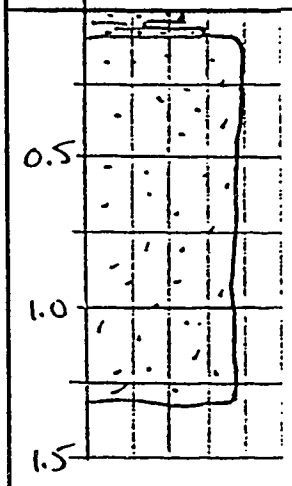
Core No. VEC 89A-23 Length 188 cm
Type PISTON Water Depth 174 m

GRAPHIC CORE LOG



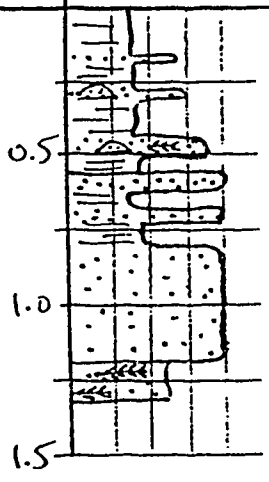
Core No. VEC 89A-25 Length 137 cm
Type PISTON Water Depth 240m

GRAPHIC CORE LOG

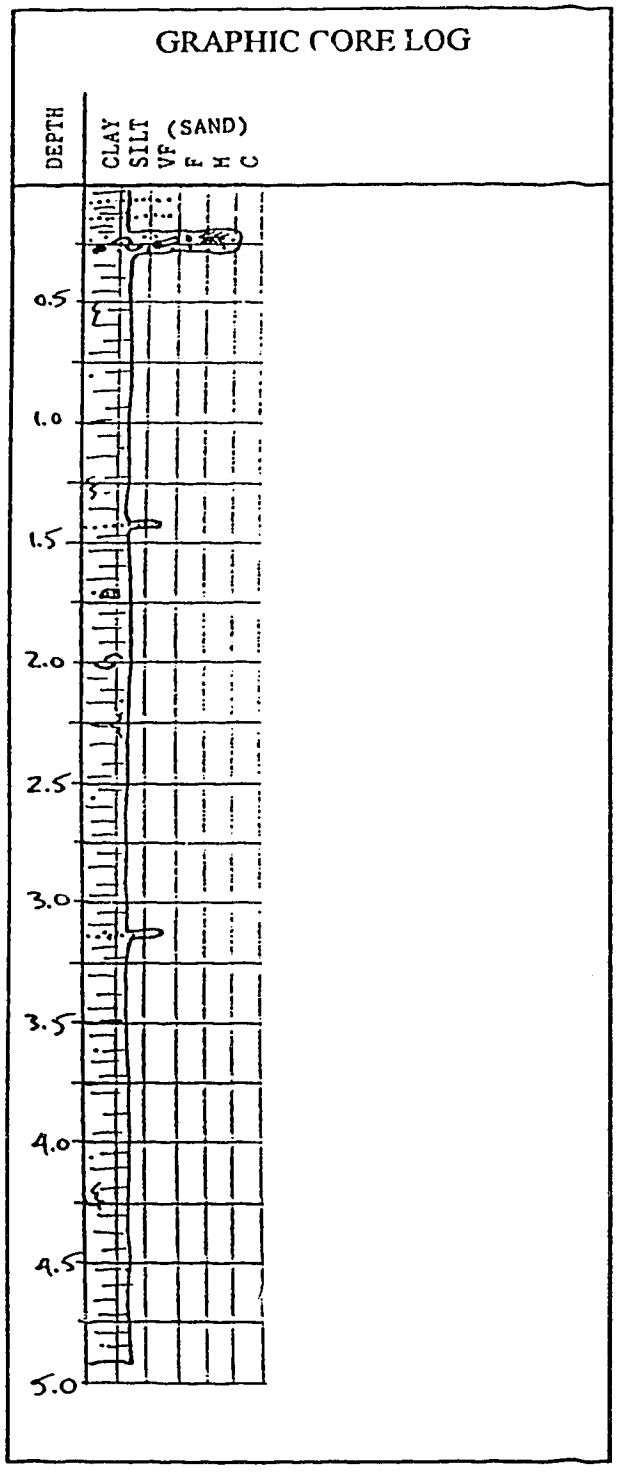


Core No. VEC 89A-39 Length 132 cm
Type PISTON Water Depth 163 m

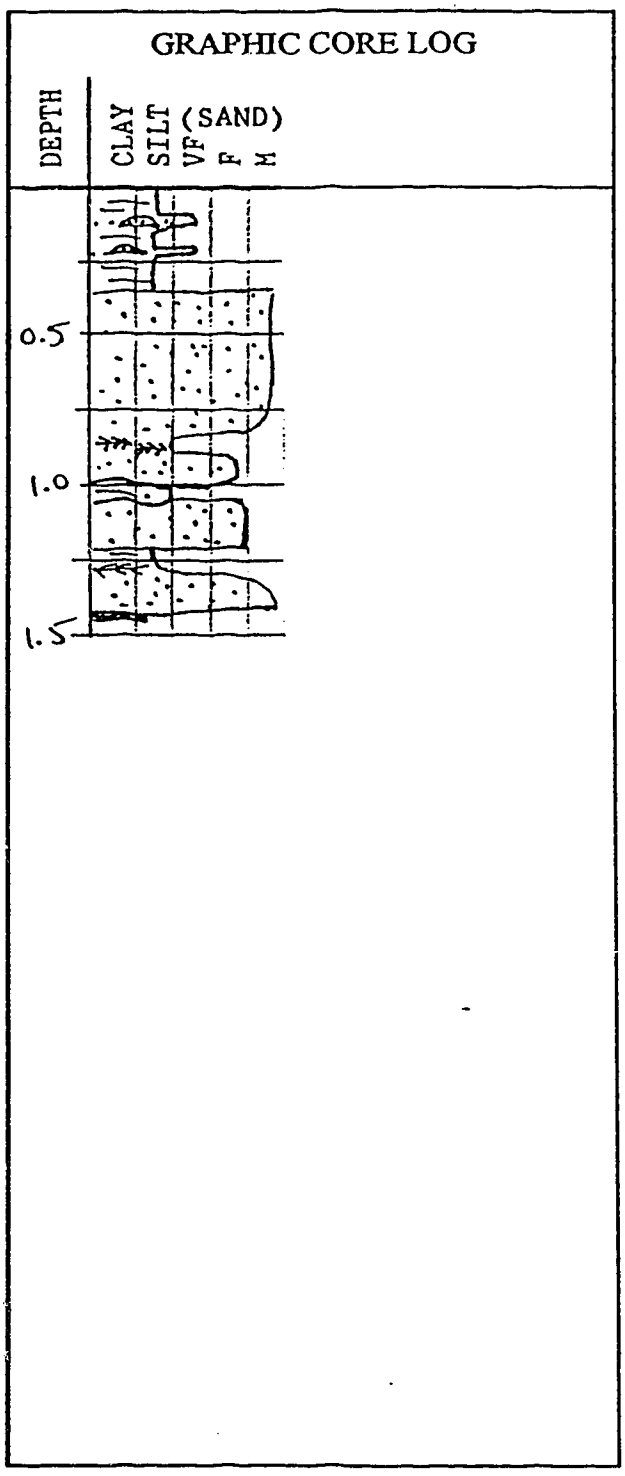
GRAPHIC CORE LOG



Core No. VEC 89A-40 Length 486 cm
Type PISTON Water Depth 212 m

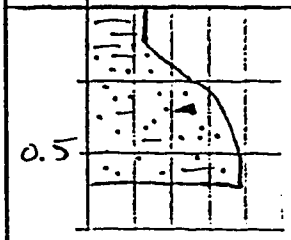


Core No. VEC 89A-41 Length 145 cm
Type PISTON Water Depth ____ m



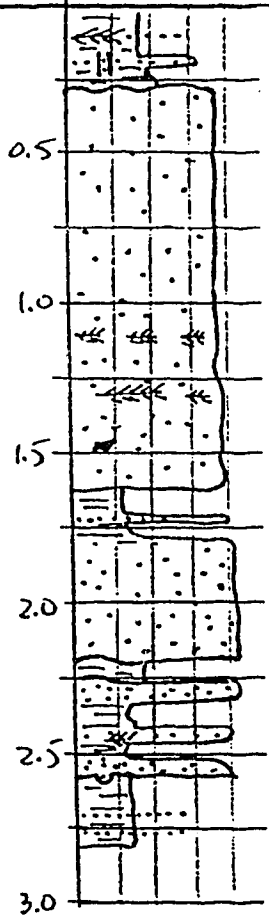
Core No. VEC89A-42 Length 62 cm
Type PISTON Water Depth 176 m

GRAPHIC CORE LOG

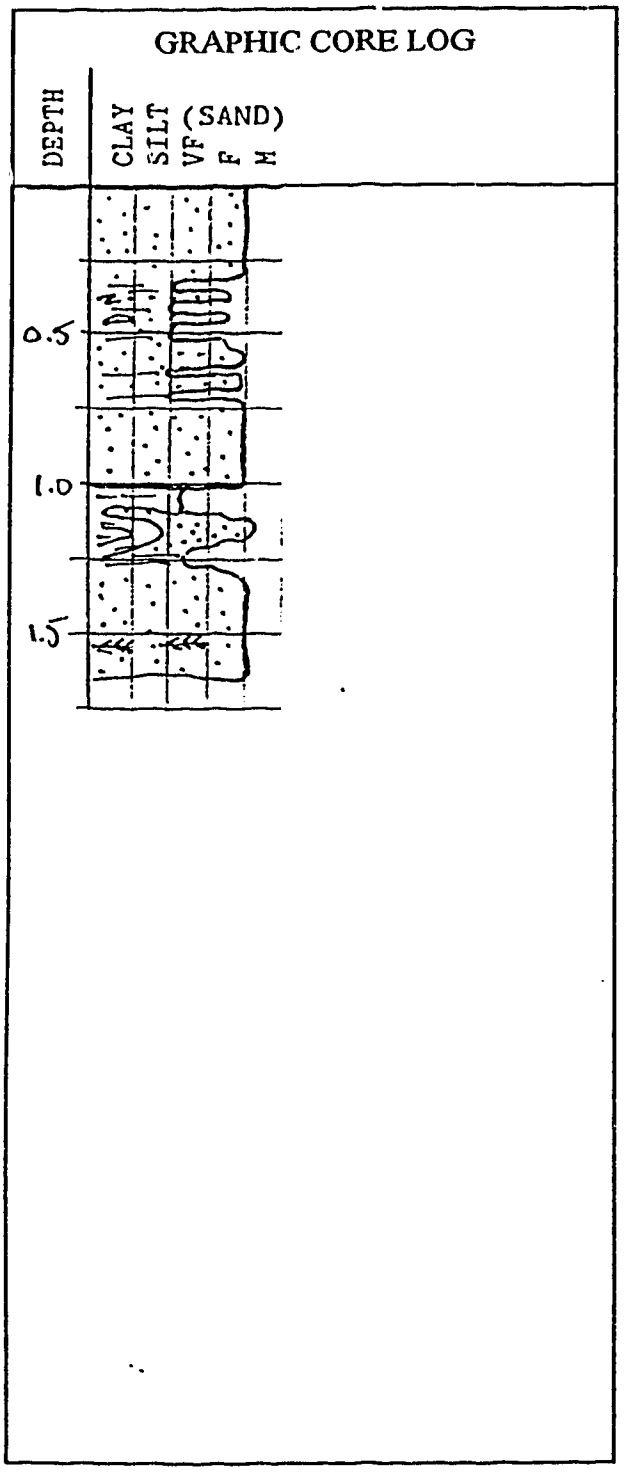


Core No. VEC89A-44 Length 280 cm
Type PISTON Water Depth 182 m

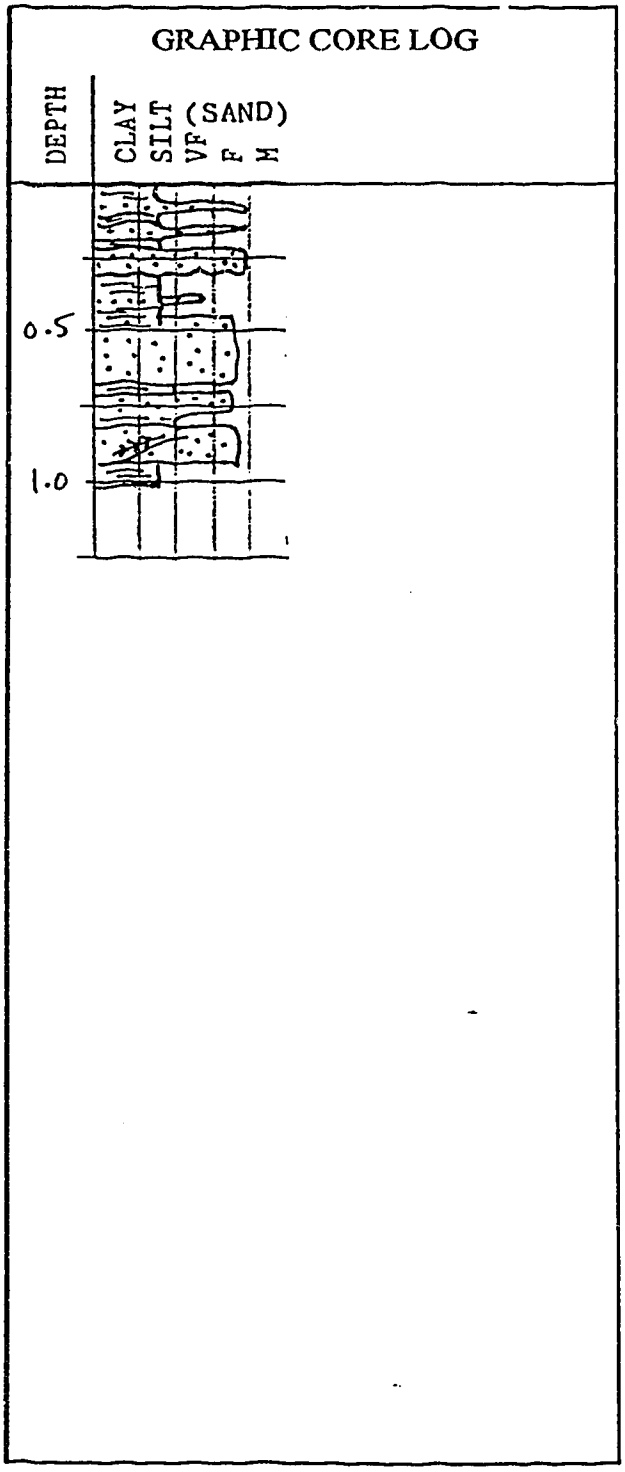
GRAPHIC CORE LOG



Core No. VEC89A-45 Length 165 cm
Type PISTON Water Depth 231 m



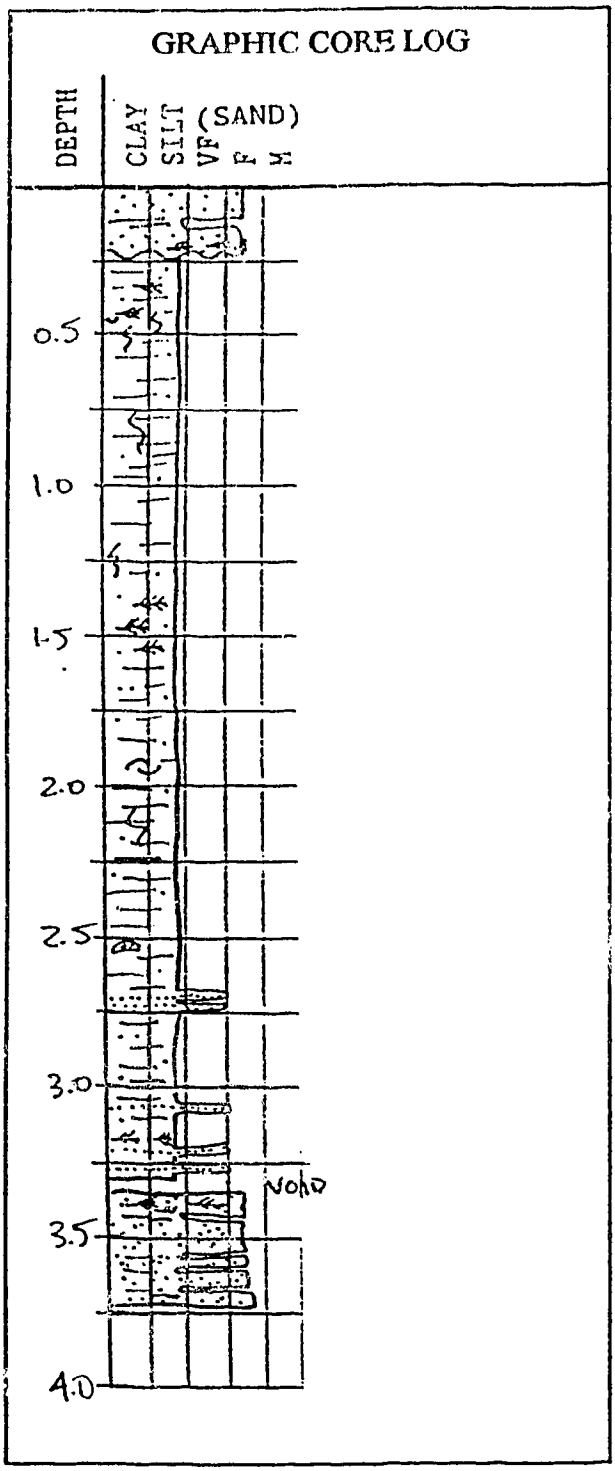
Core No. VEC89A-46 Length 101 cm
Type PISTON Water Depth 46 m



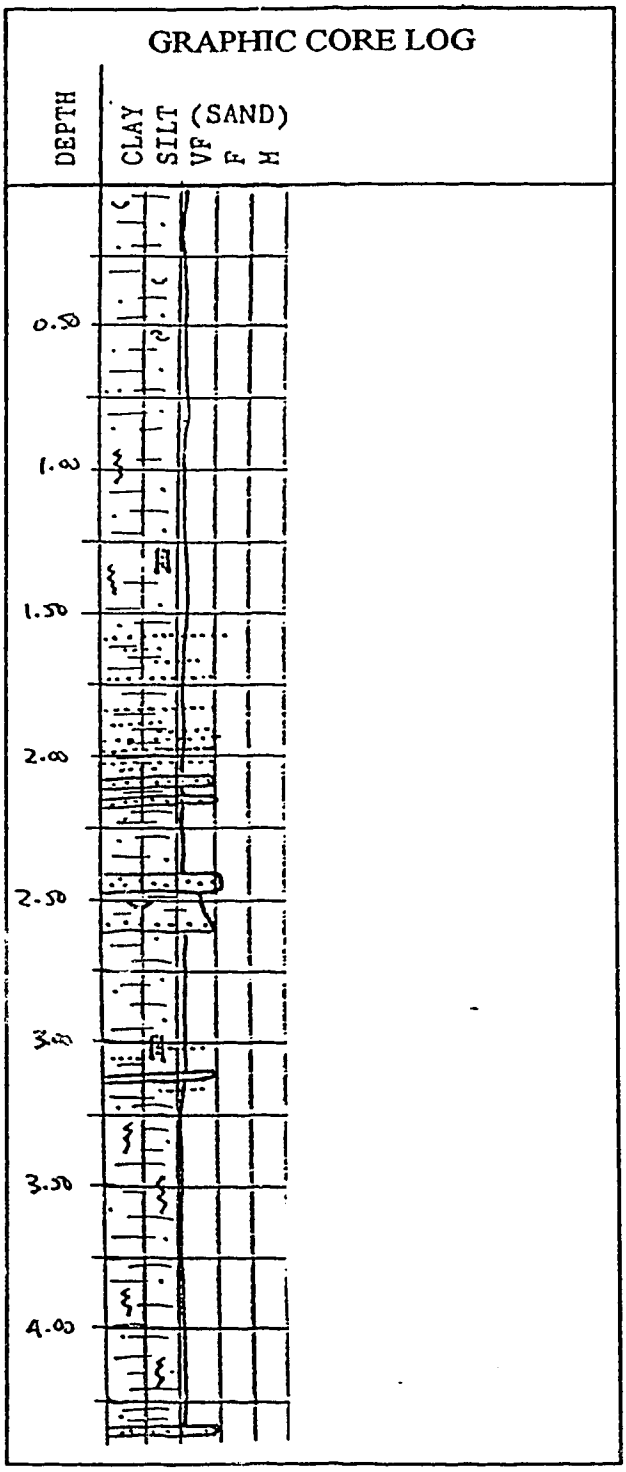
APPENDIX B3: FRASER DELTA STUDY

Cruise PAR91A Sedimentologic Core Descriptions

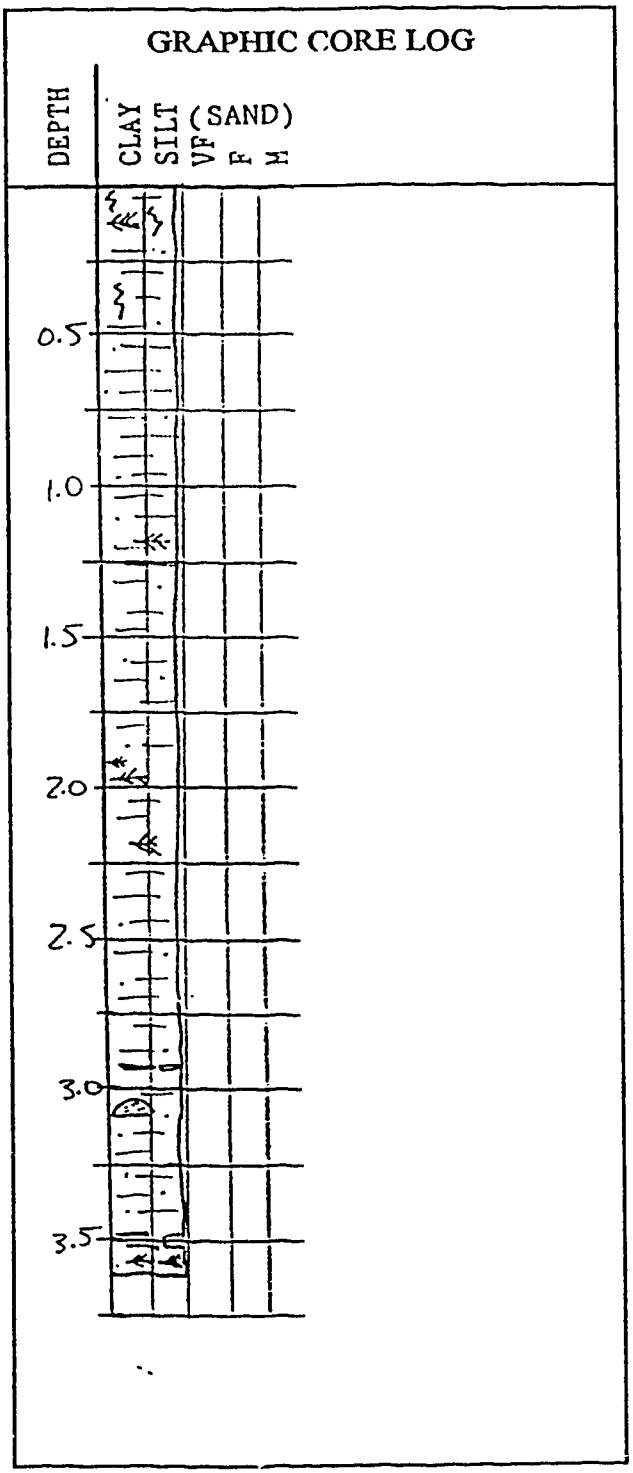
Core No. PAR91A-09 Length 372 cm
Type PISTON Water Depth 188 m



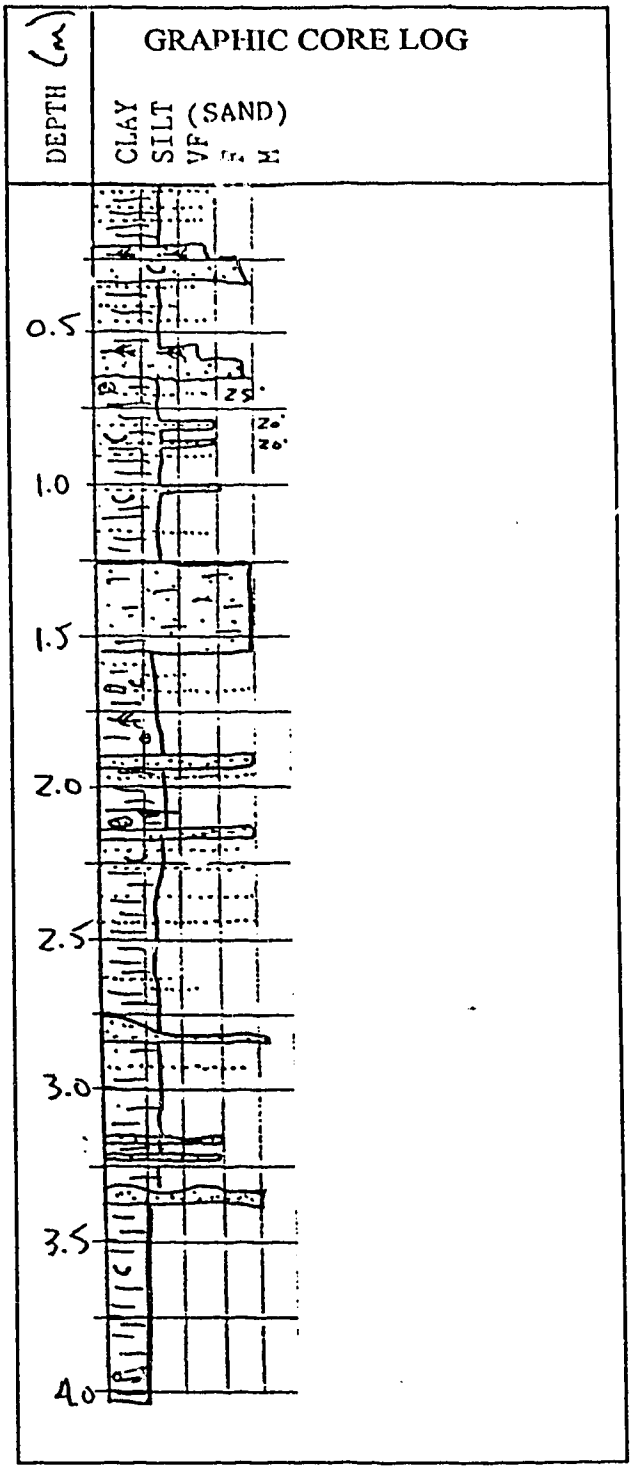
Core No. PAR91A-11 Length 438 cm
Type PISTON Water Depth 143 m



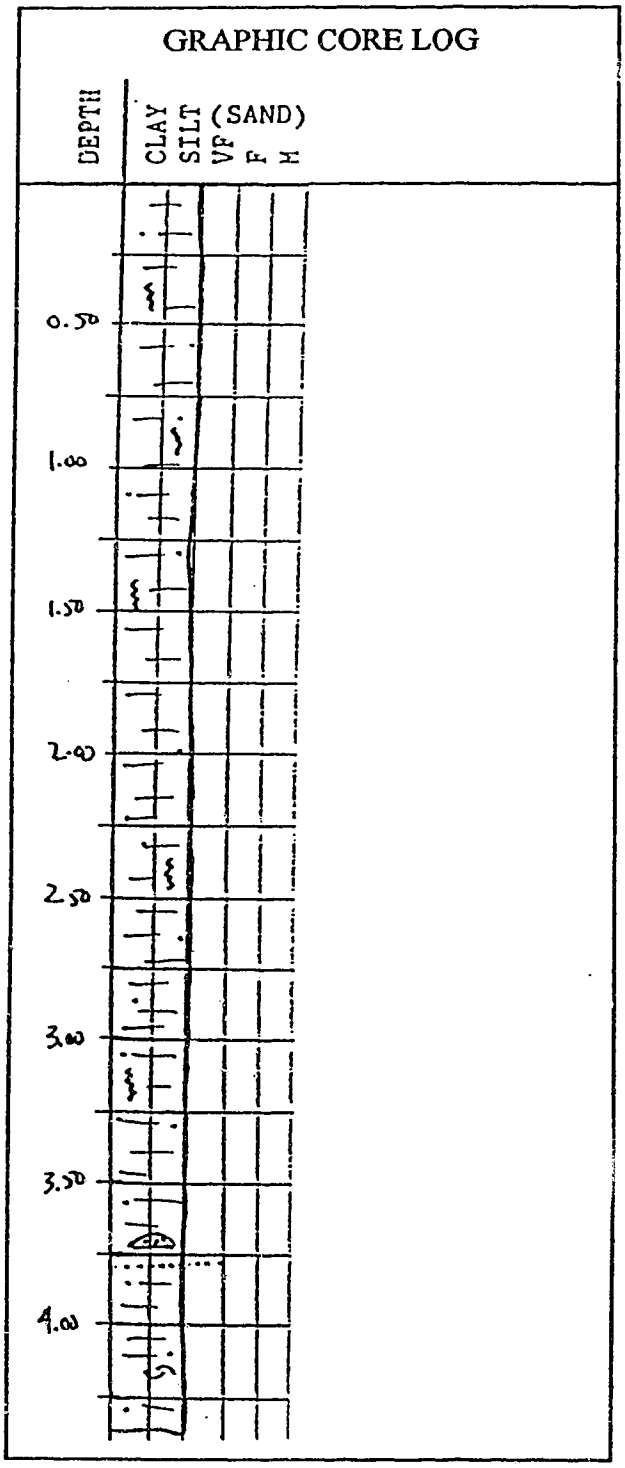
Core No. PAR91A-12 Length 362 cm
Type PISTON Water Depth 120 m



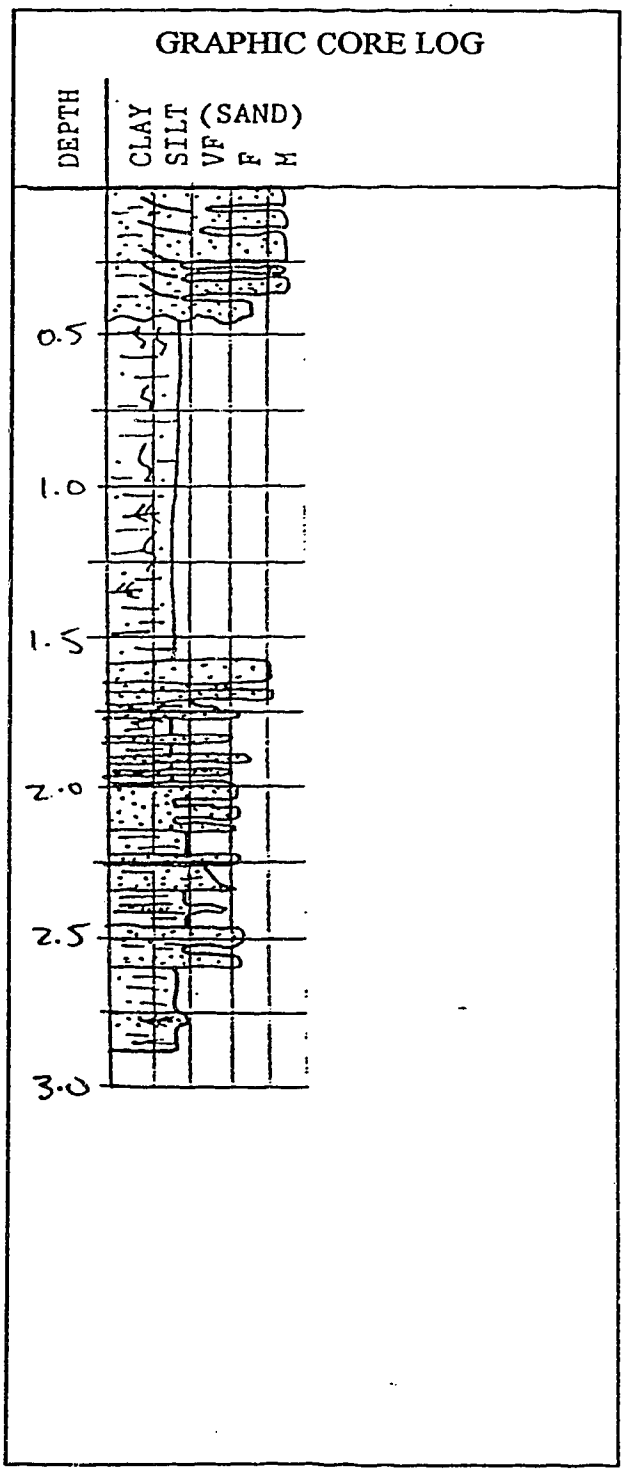
Core No. PAR91A-14 Length 402 cm
Type PISTON Water Depth 120m



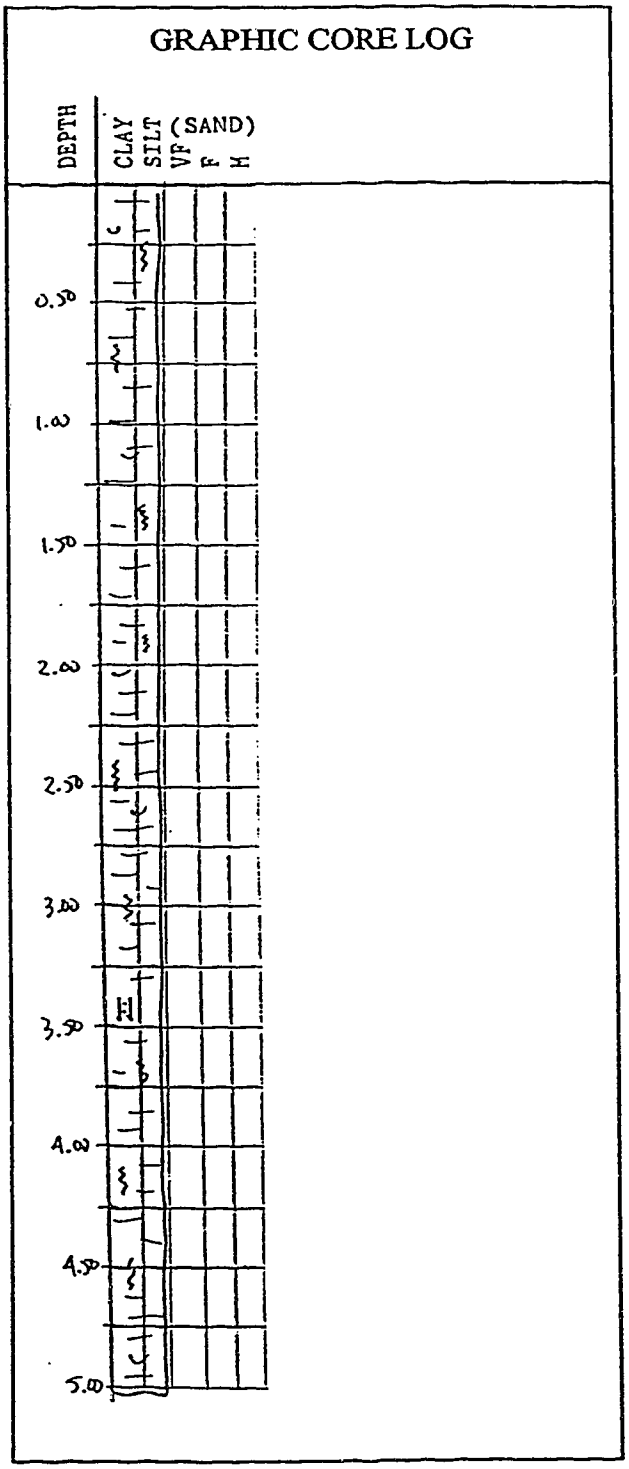
Core No. PAR91A-17 Length 437 cm
Type PISTON Water Depth 126 m



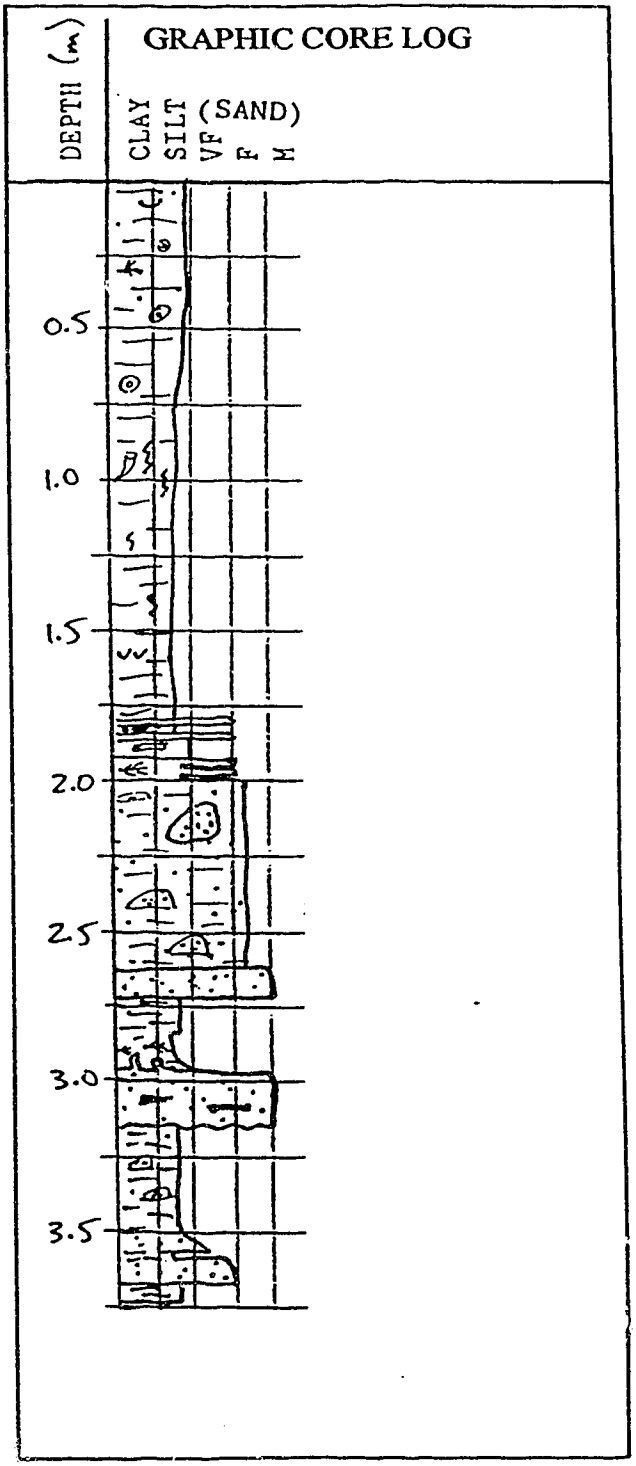
Core No. PAR91A-20 Length 290 cm
Type PISTON Water Depth 173 m



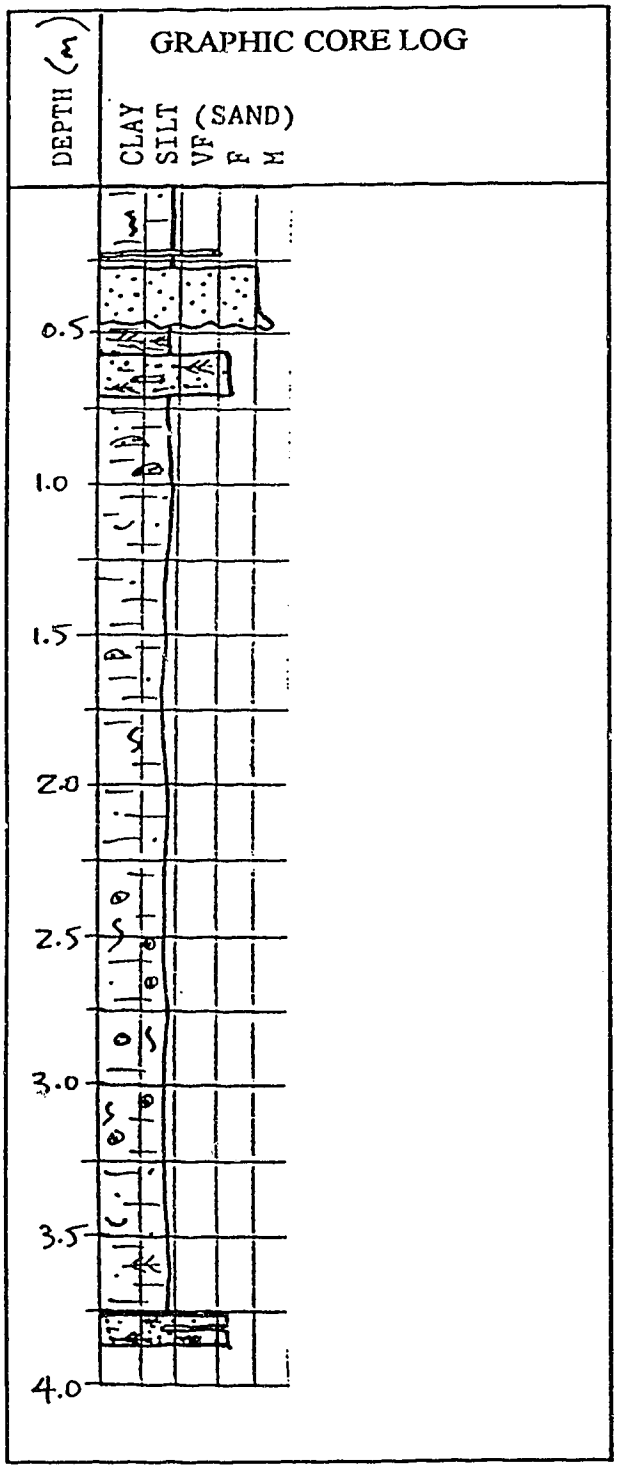
Core No. PAR91A-21 Length 503 cm
Type PISTON Water Depth 228 m



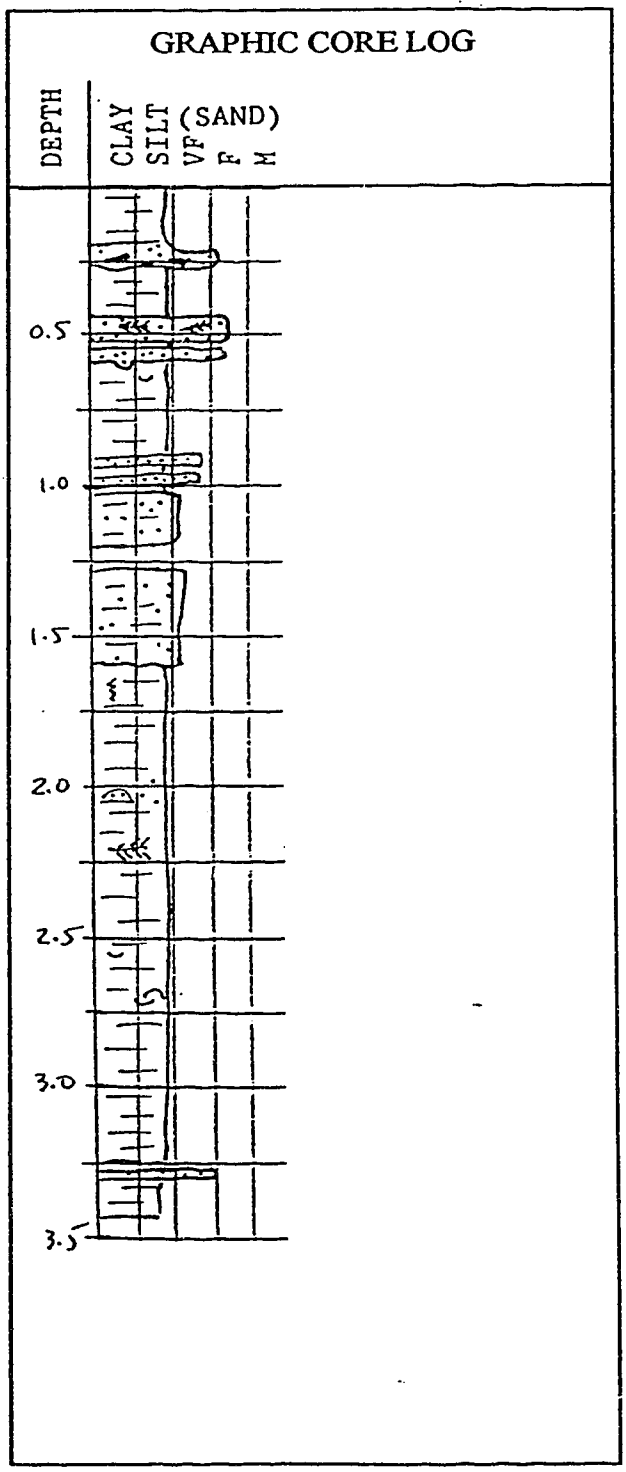
Core No. PAR91A-22 Length 374 cm
Type PISTON Water Depth 249 m



Core No. PAR91A-23 Length 387 cm
Type PISTON Water Depth 239 m

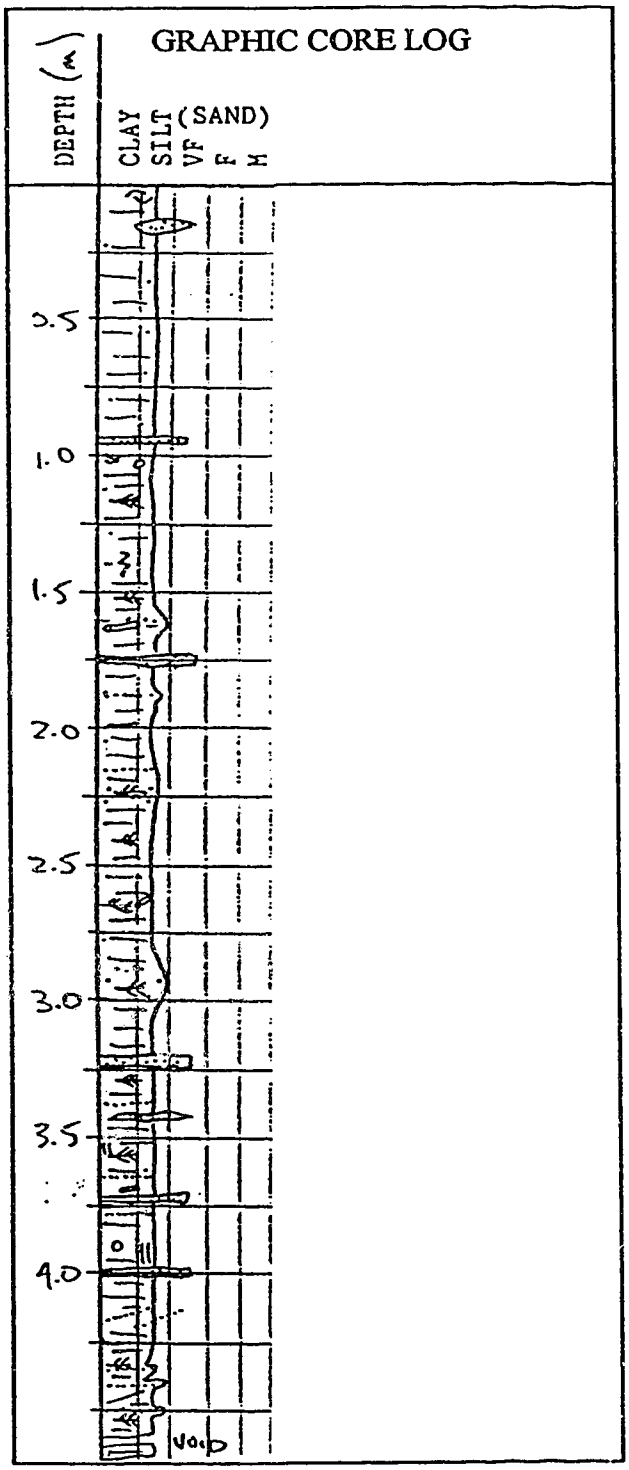


Core No. PAR91A-25 Length 340 cm
Type PISTON Water Depth 145 m



Core No. PAR91A-26 Length 468 cm

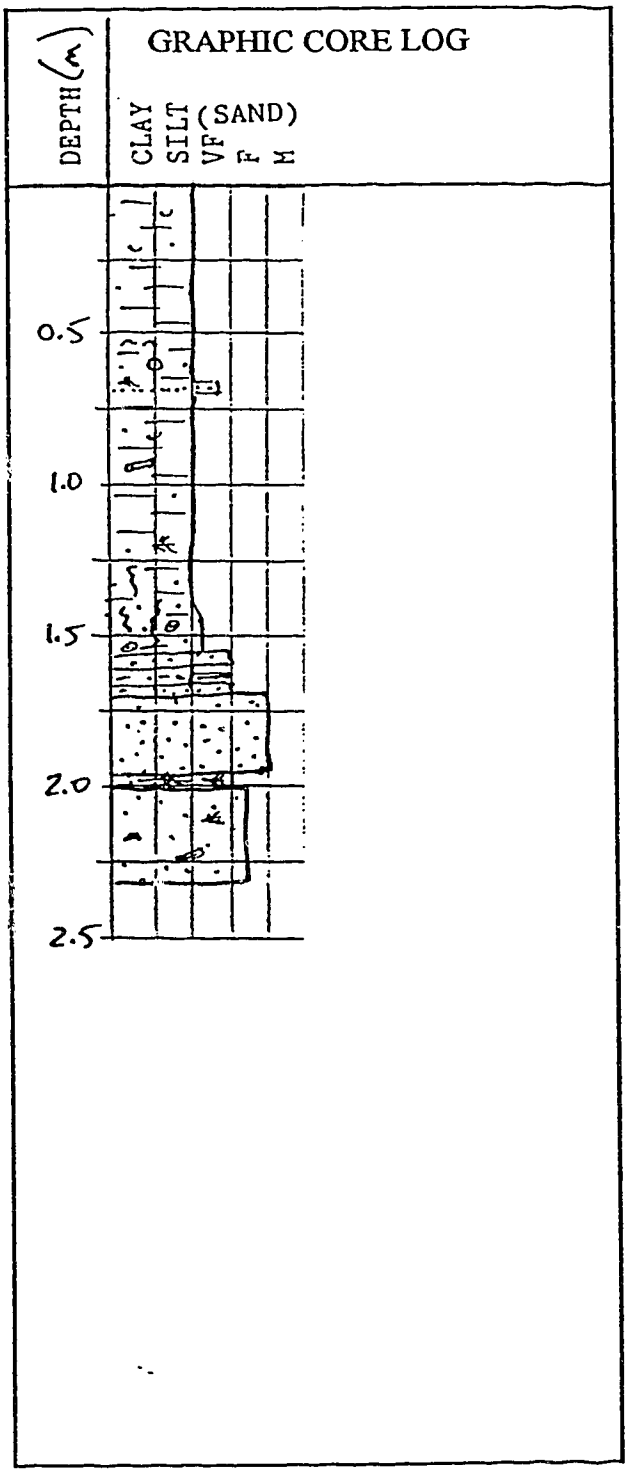
Type PISTON Water Depth 160 m



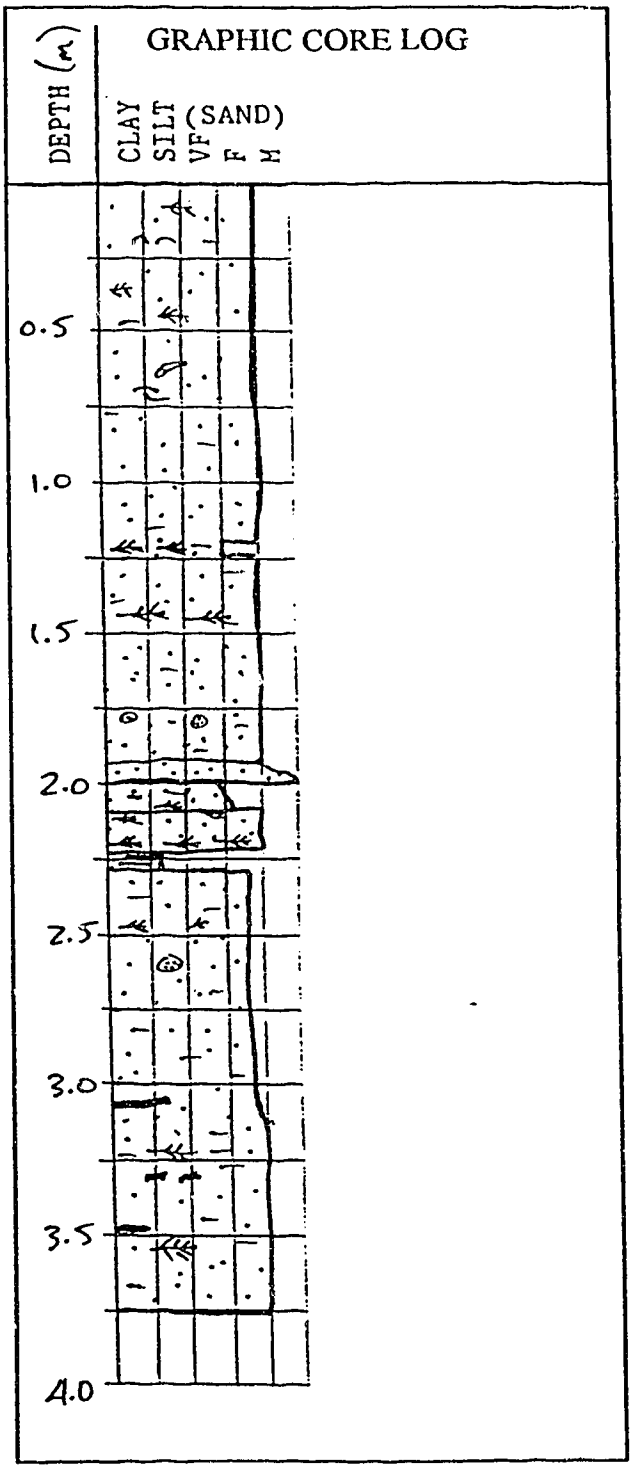
APPENDIX B4: FRASER DELTA STUDY

Cruise VEC92A Sedimentologic Core Descriptions

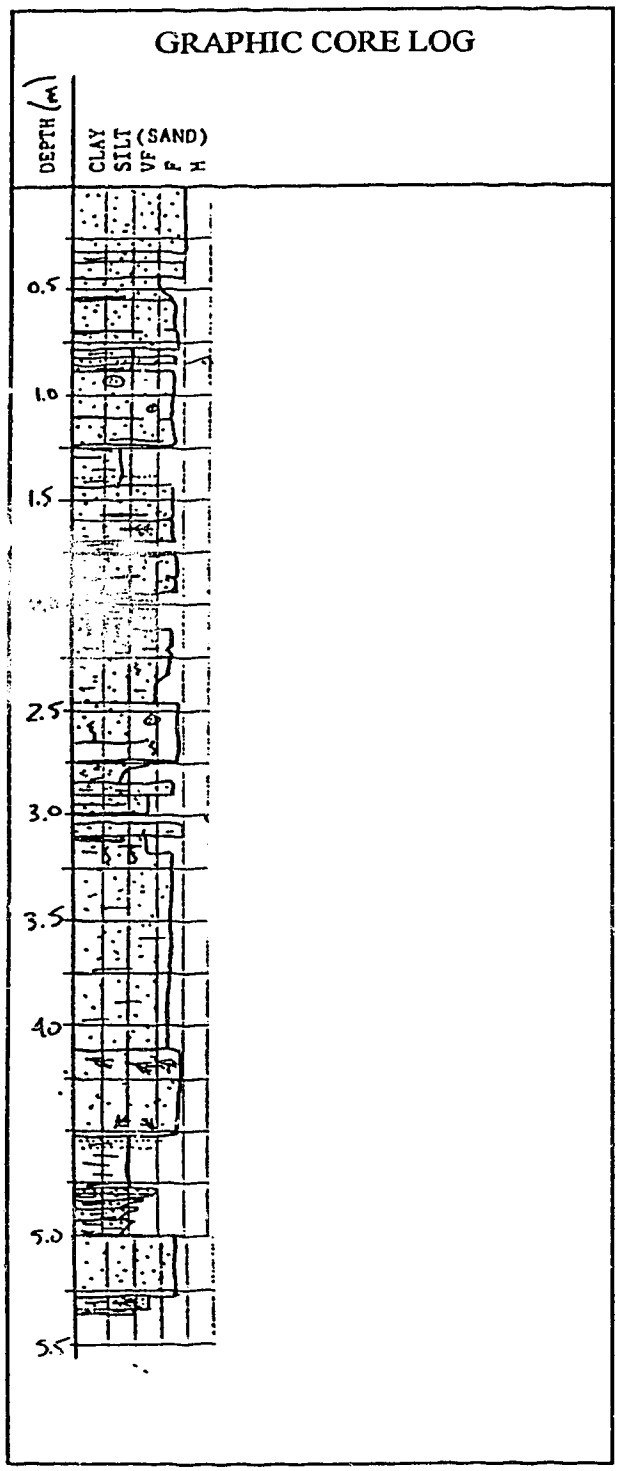
Core No. VEC92A-20 Length 230cm
Type GRAVITY Water Depth 174m



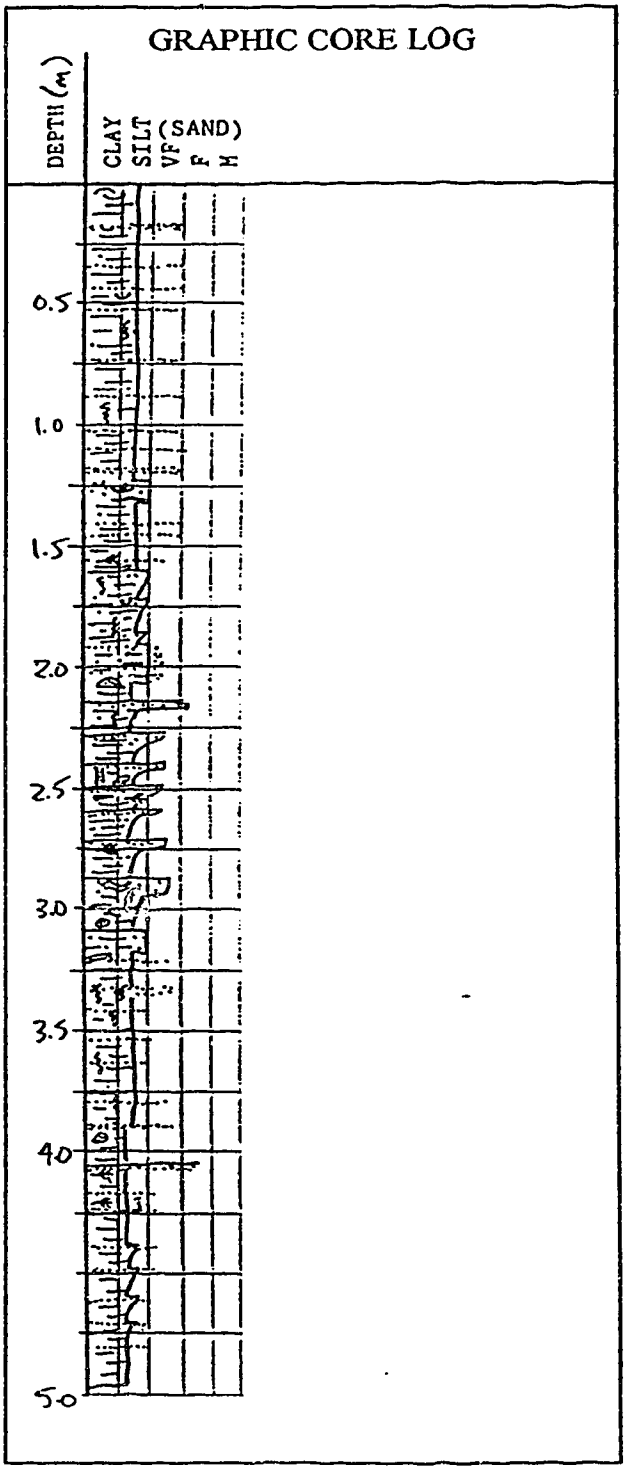
Core No. VEC92A-34 Length 375 cm
Type PISTON Water Depth 129 m



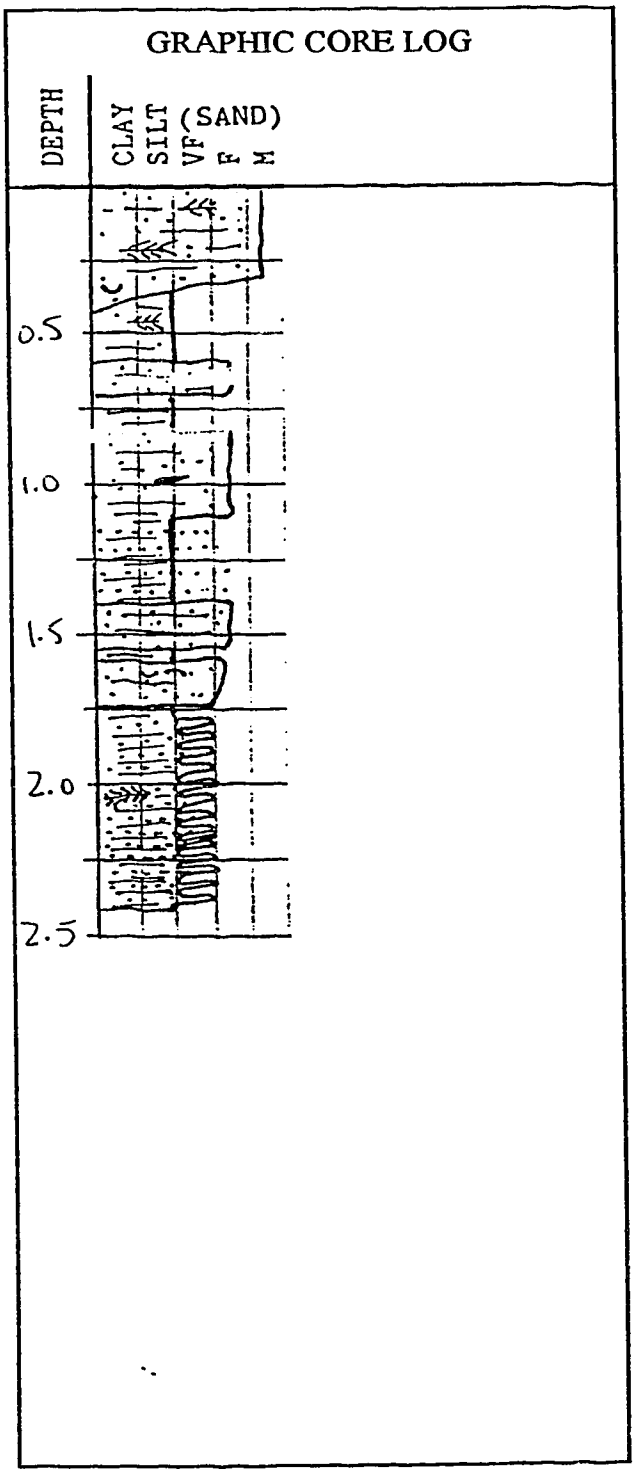
Core No. VEC92A-036 Length 500 cm
Type PISTON Water Depth 44 m



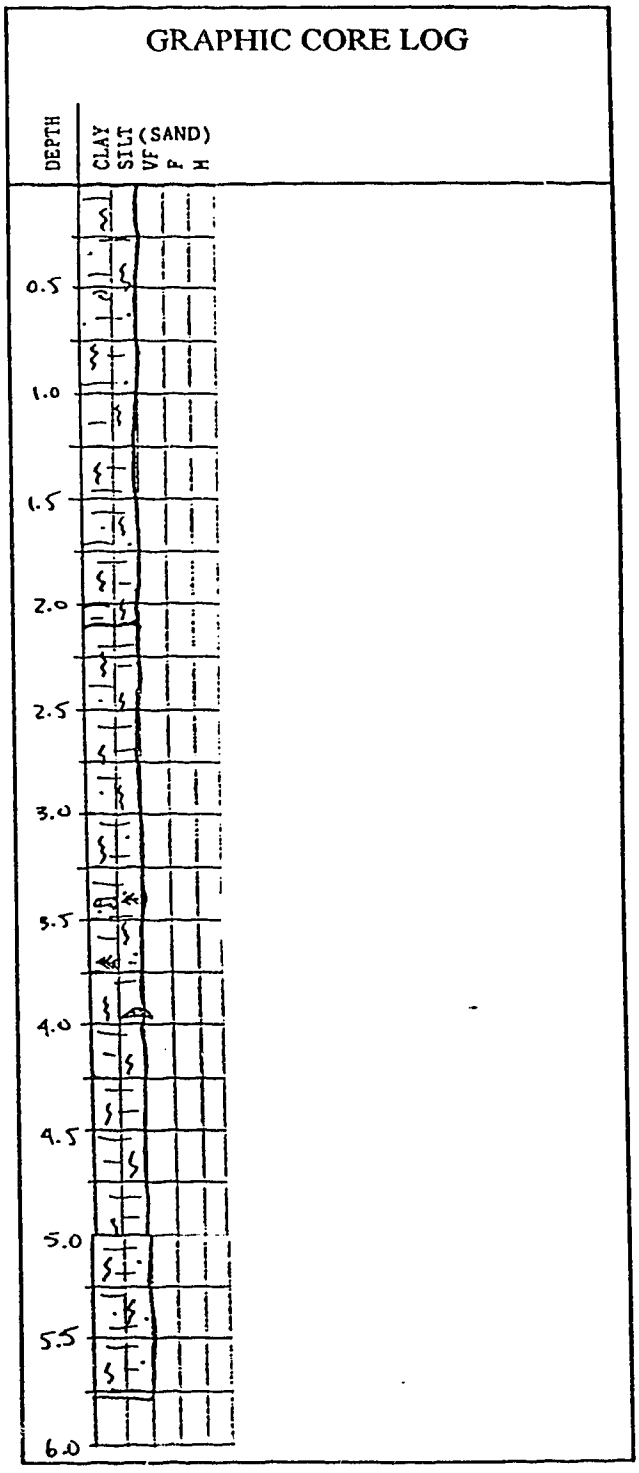
Core No. VEC92A-45 Length 498 cm
Type PISTON Water Depth 60 m



Core No. VEC92A-46 Length 242 cm
Type PISTON Water Depth 59 m

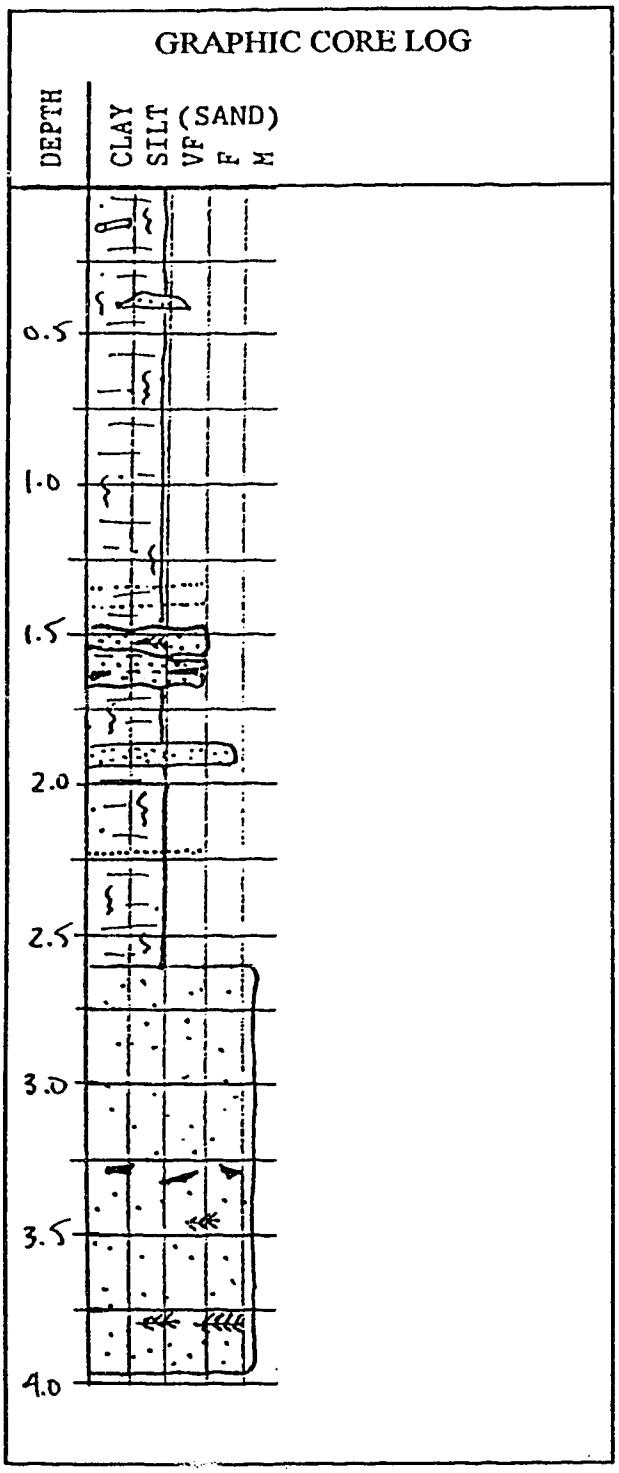


Core No. VEC92A-61 Length 578 cm
Type PISTON Water Depth 152 m



Core No. VEC92A-110 Length 392 cm

Type PISTON Water Depth 151 m

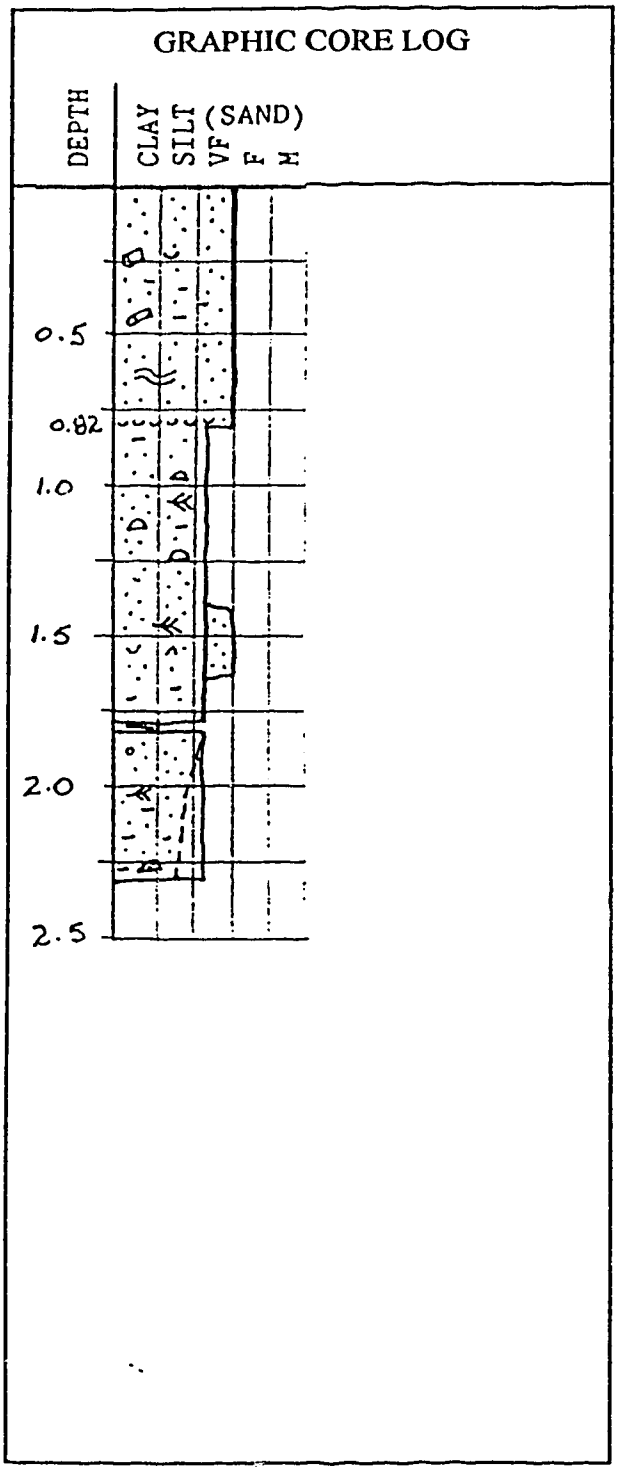


APPENDIX B5: FRASER DELTA STUDY

Cruise TUL92A Sedimentologic Core Descriptions

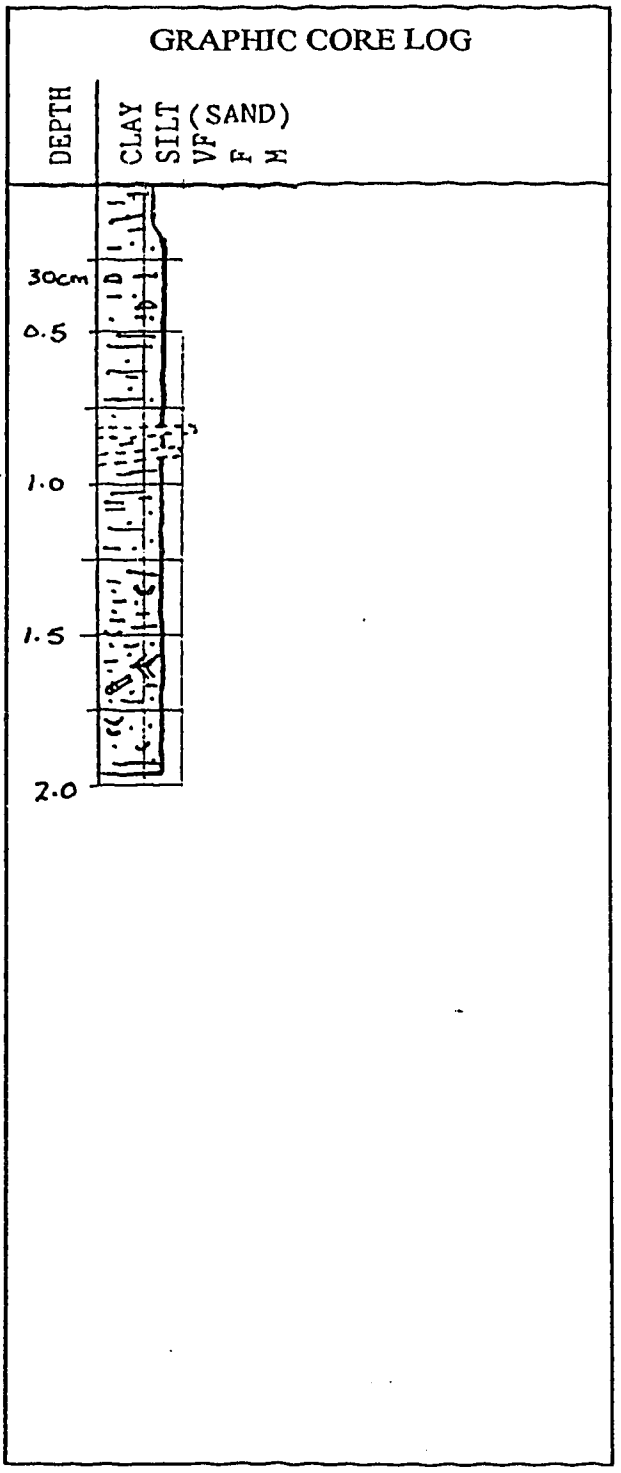
Core No. TUL92A-63 Length 234 cm
Type GRAVITY Water Depth 80 m

GRAPHIC CORE LOG

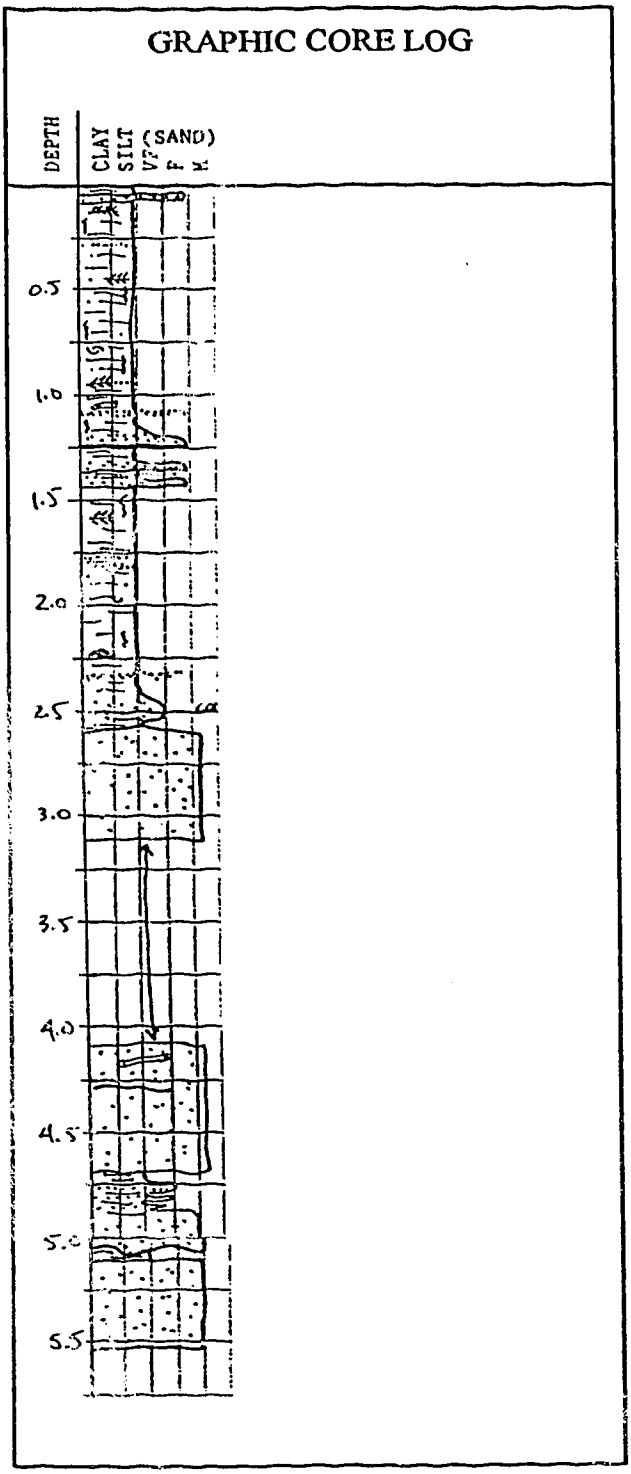


Core No. TUL92A-64 Length 189 cm
Type GRAVITY Water Depth 96 m

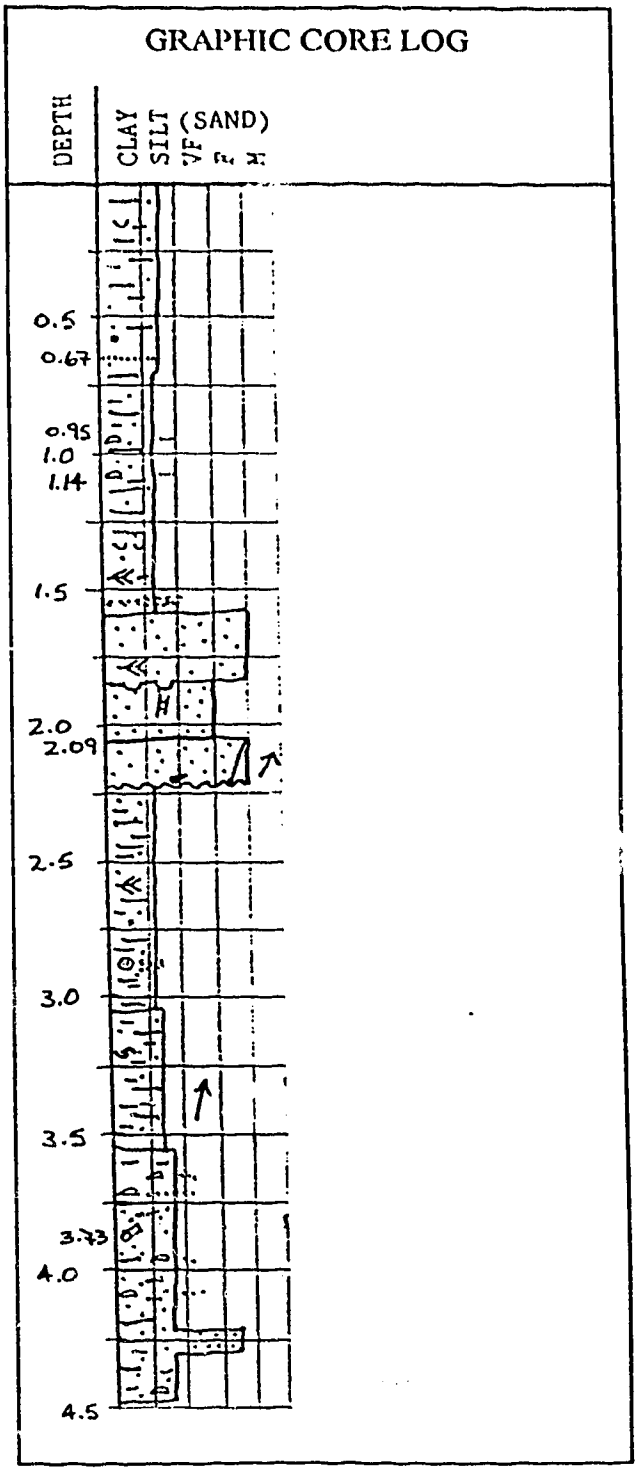
GRAPHIC CORE LOG



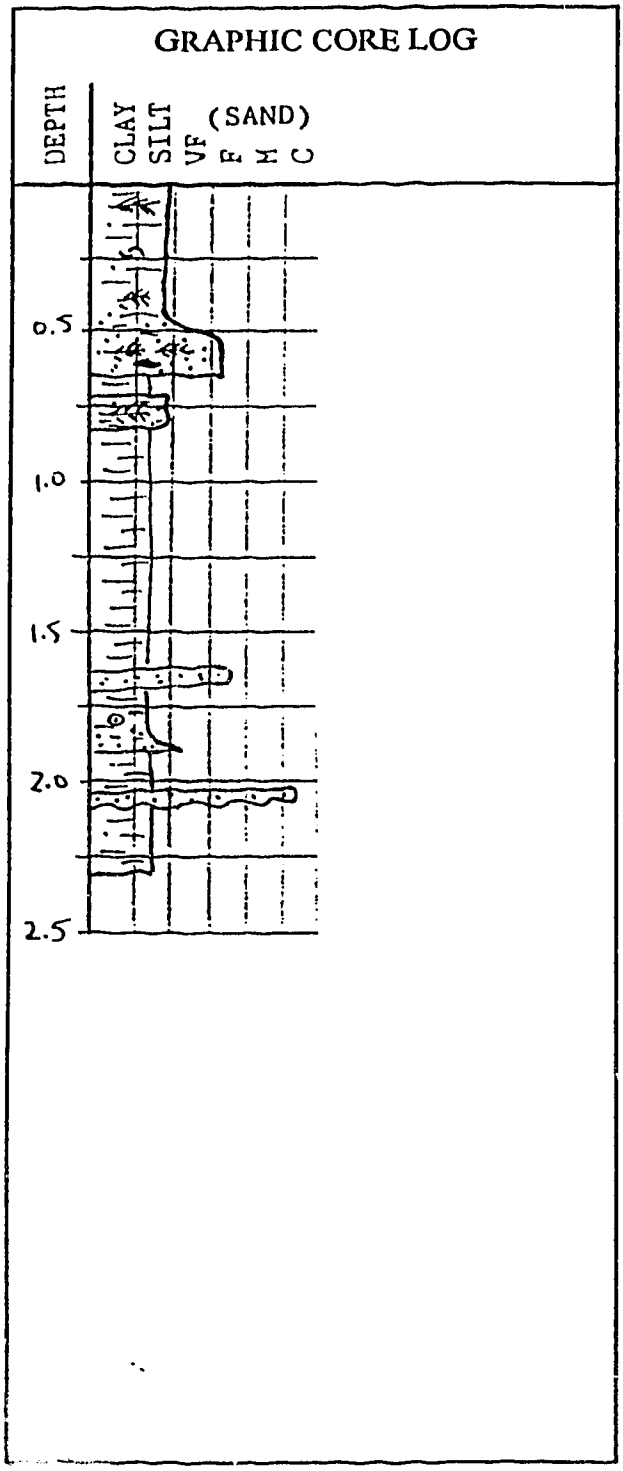
Core No. TUL92A-74 Length 555 cm
Type PISTON Water Depth 178 m



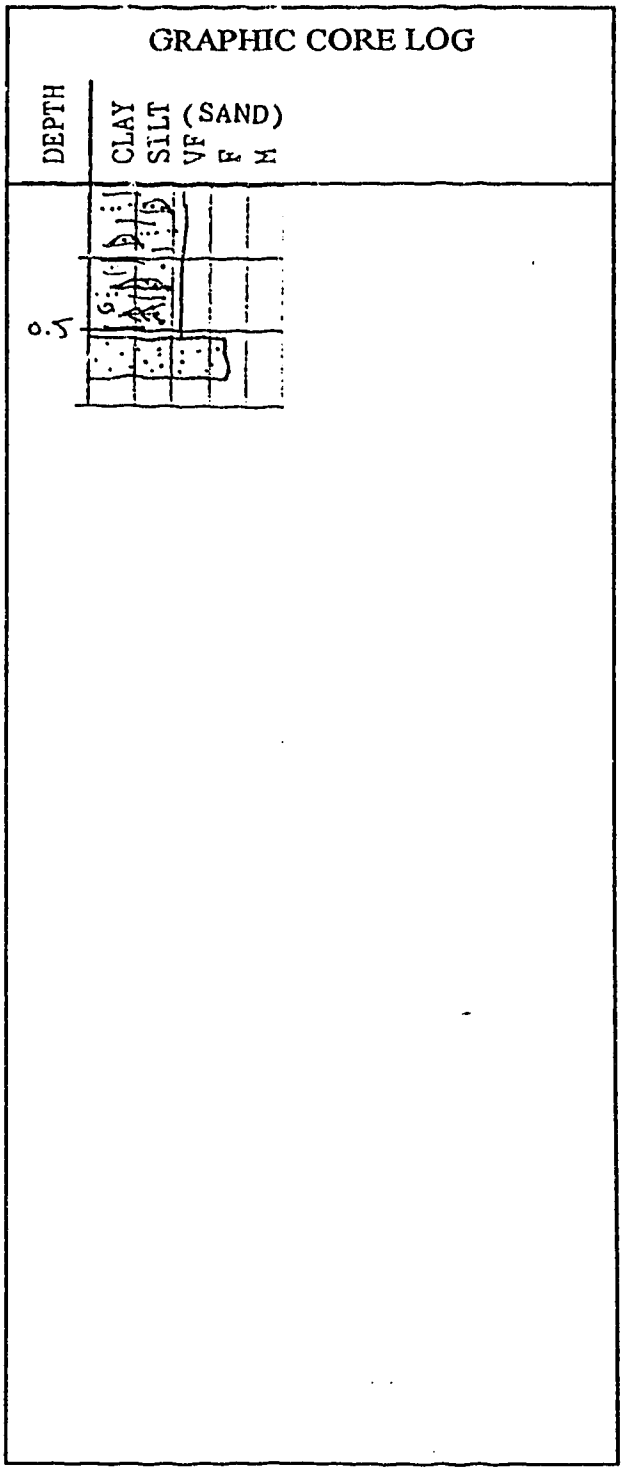
Core No. TUL92A-79 Length 447 cm
Type PISTON Water Depth 173 m



Core No. TUL92A-84 Length 232 cm
Type GRAVITY Water Depth 136 m

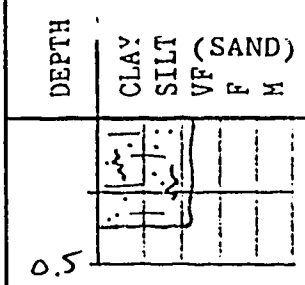


Core No. TUL92A-103 Length 63 cm
Type GRAVITY Water Depth 115 m



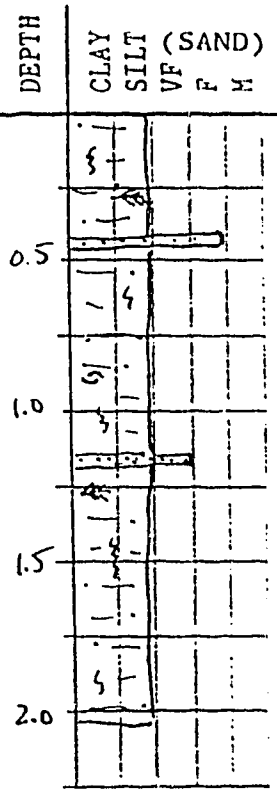
Core No. TUL92A-104 Length 34 cm
Type GRAVITY Water Depth 153 m

GRAPHIC CORE LOG



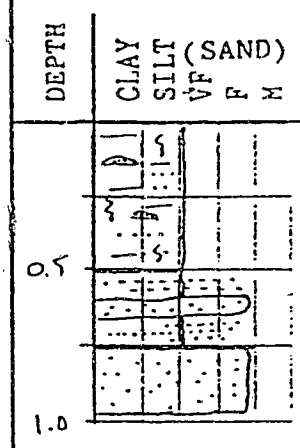
Core No. TUL92A-105 Length 206 cm
Type GRAVITY Water Depth 140 m

GRAPHIC CORE LOG



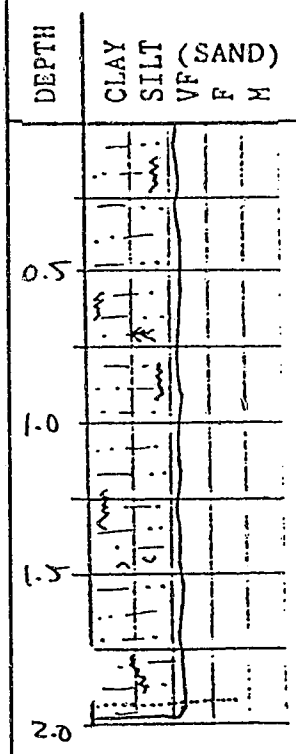
Core No. TUL92A-106 Length 98 cm
Type GRAVITY Water Depth 107 m

GRAPHIC CORE LOG

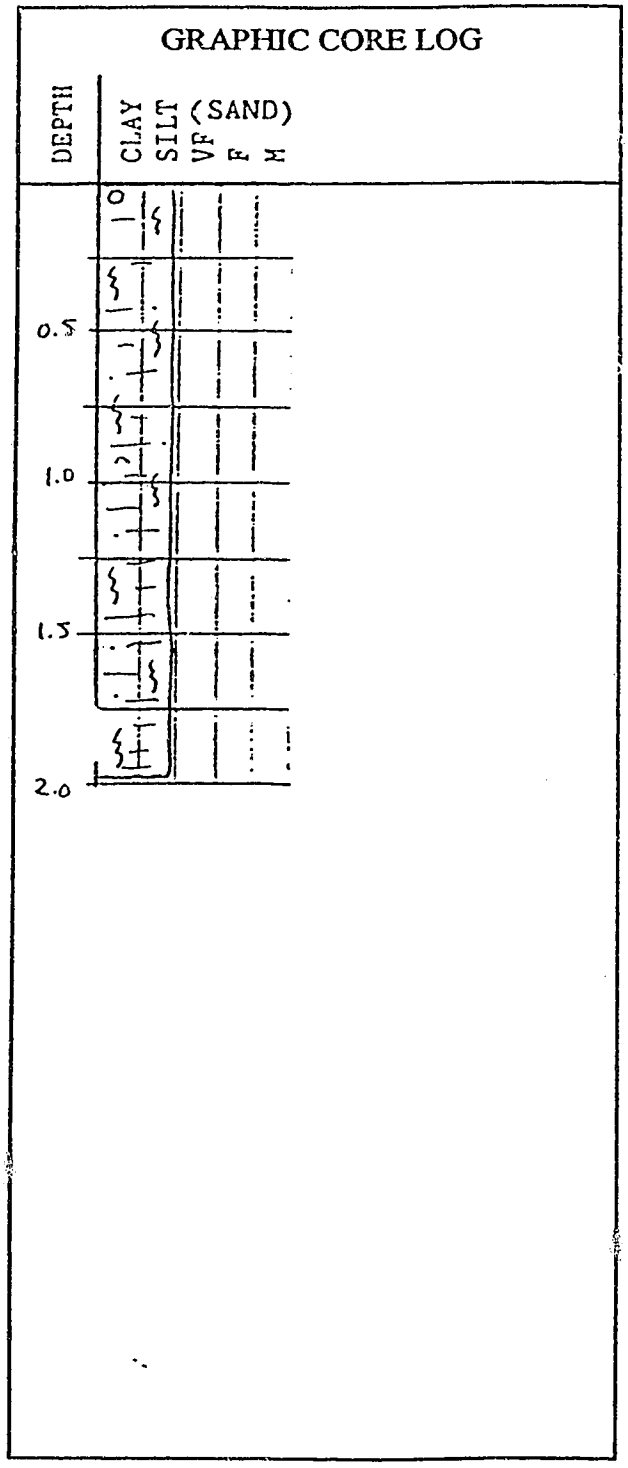


Core No. TUL92A-107 Length 198 cm
Type GRAVITY Water Depth 105 m

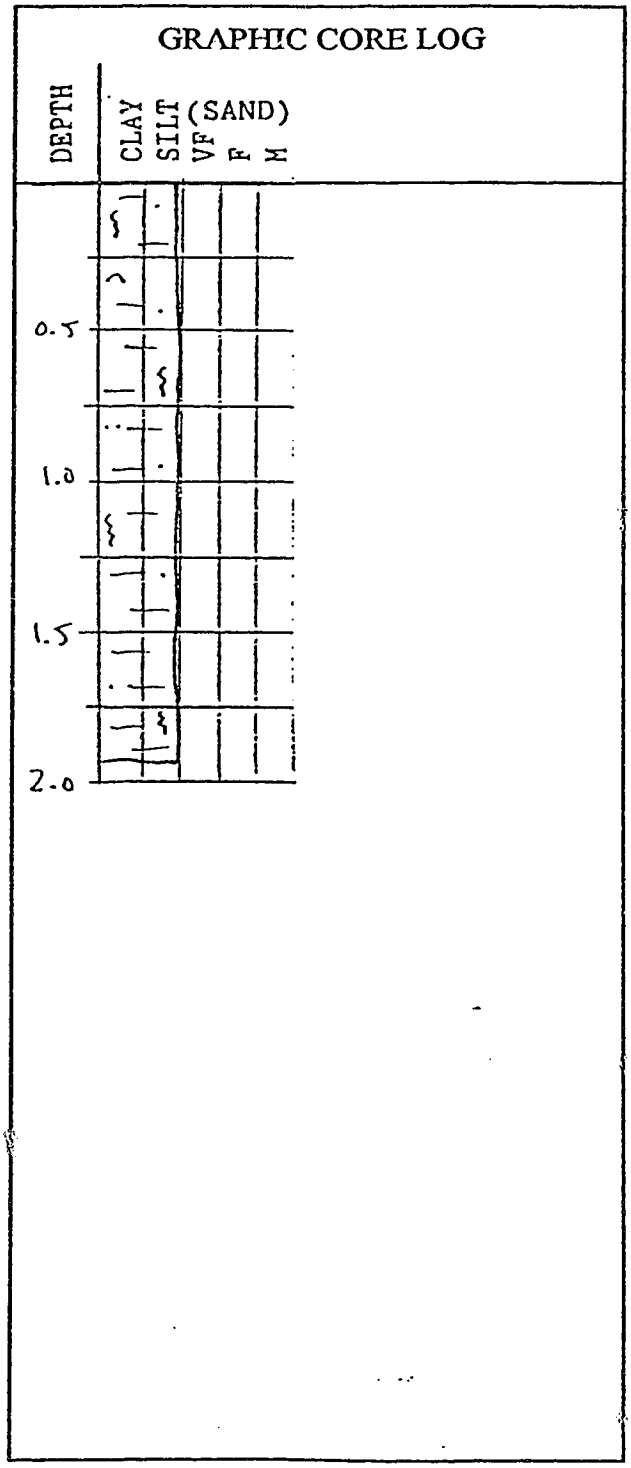
GRAPHIC CORE LOG



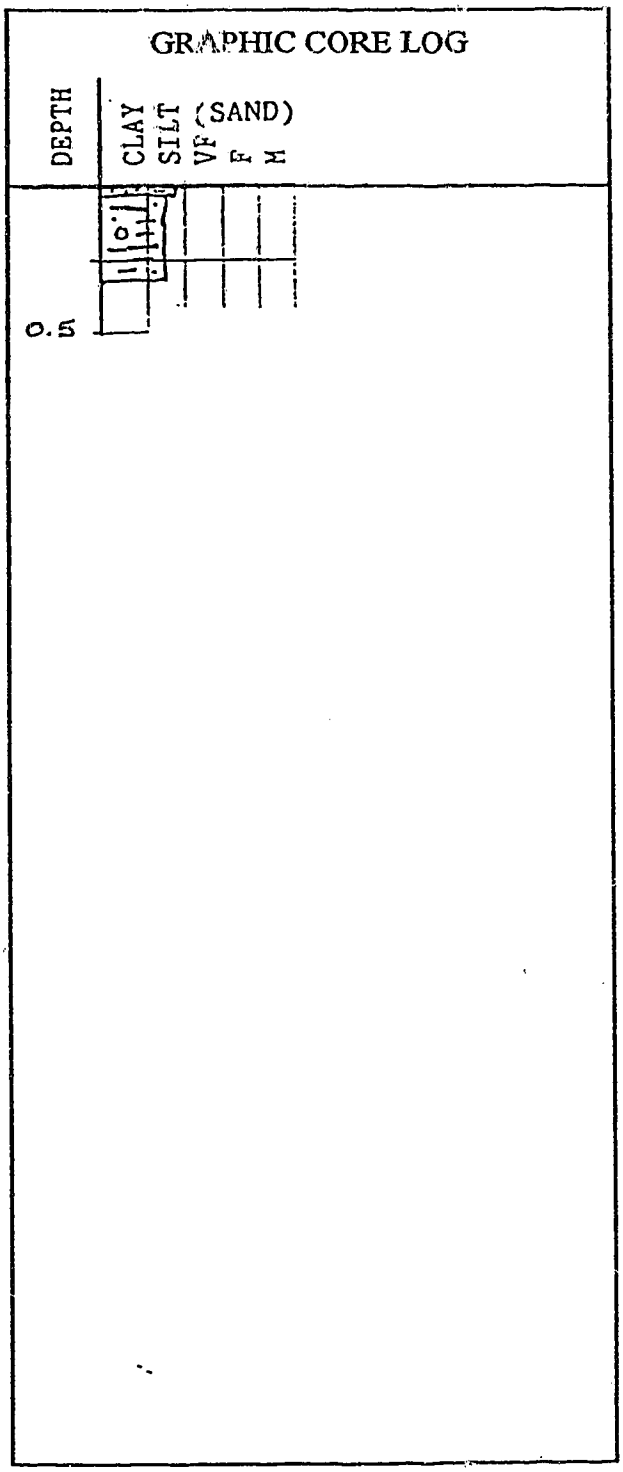
Core No. TUL92A-108 Length 194 cm
Type GRAVITY Water Depth 98 m



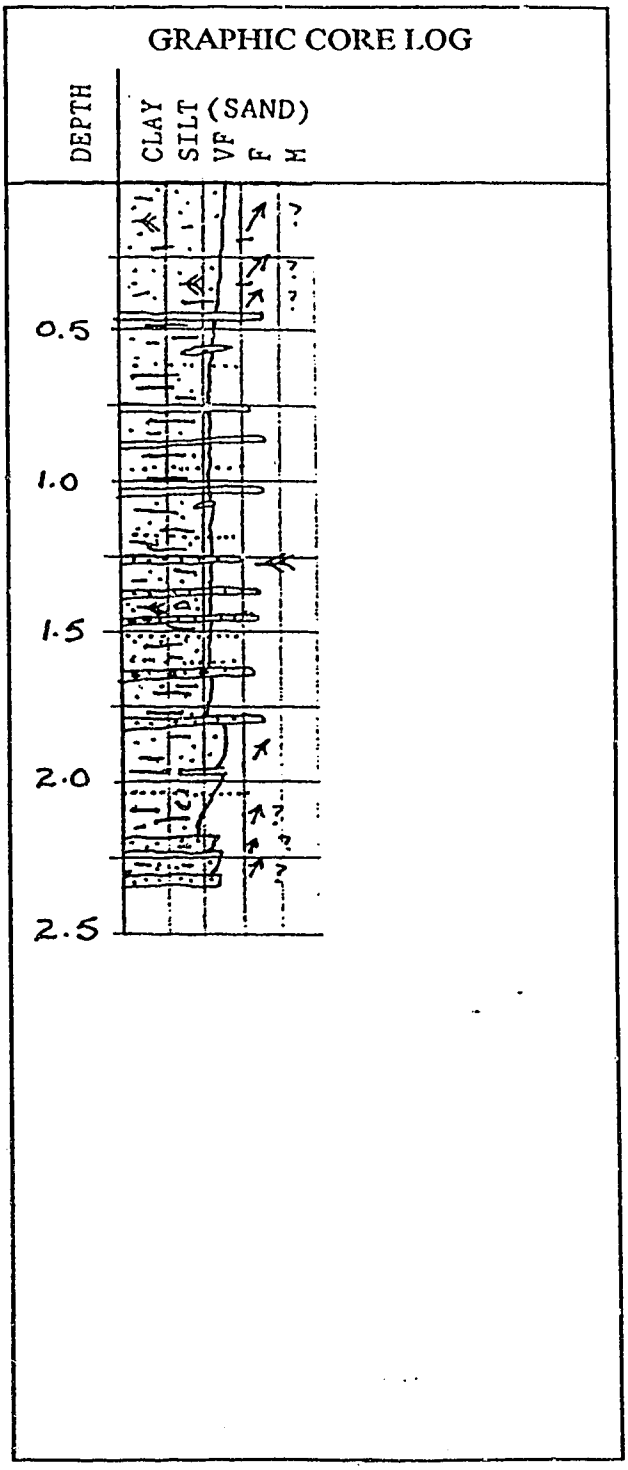
Core No. TUL92A-109 Length 191 cm
Type GRAVITY Water Depth 70 m



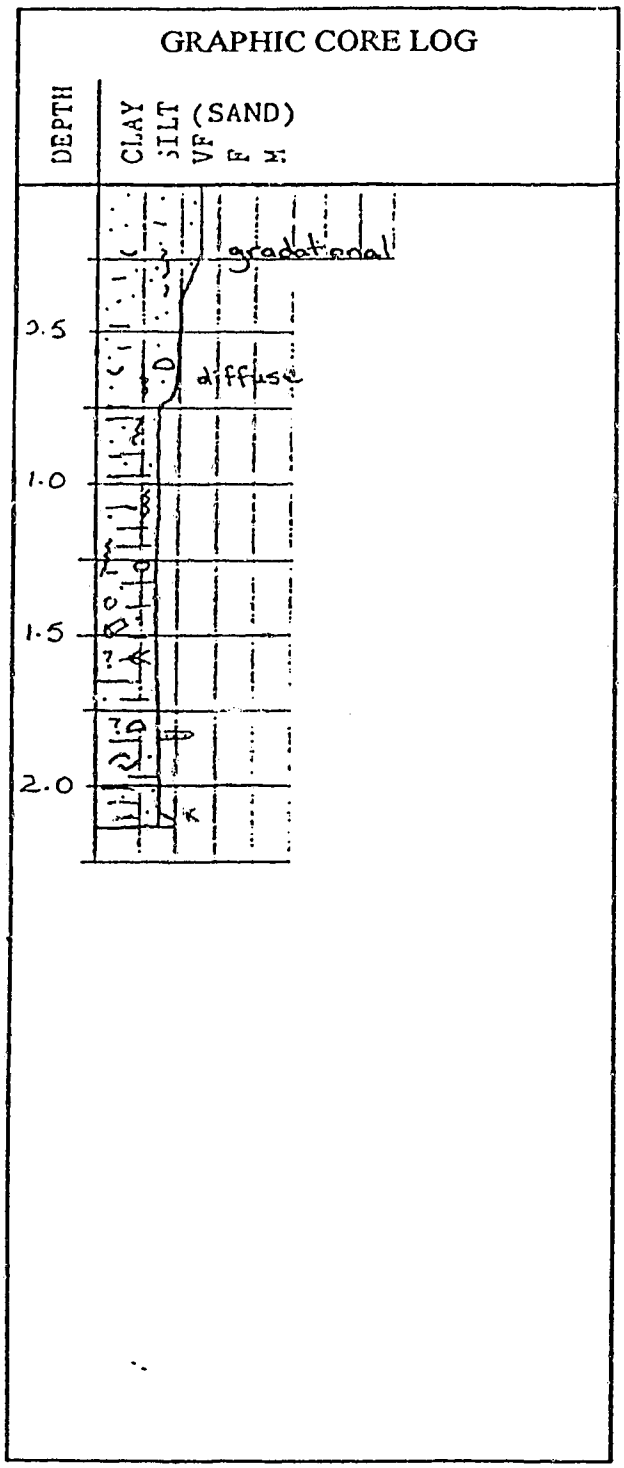
Core No. TUL92A-112 Length 33 cm
Type GRAVITY Water Depth 61 m



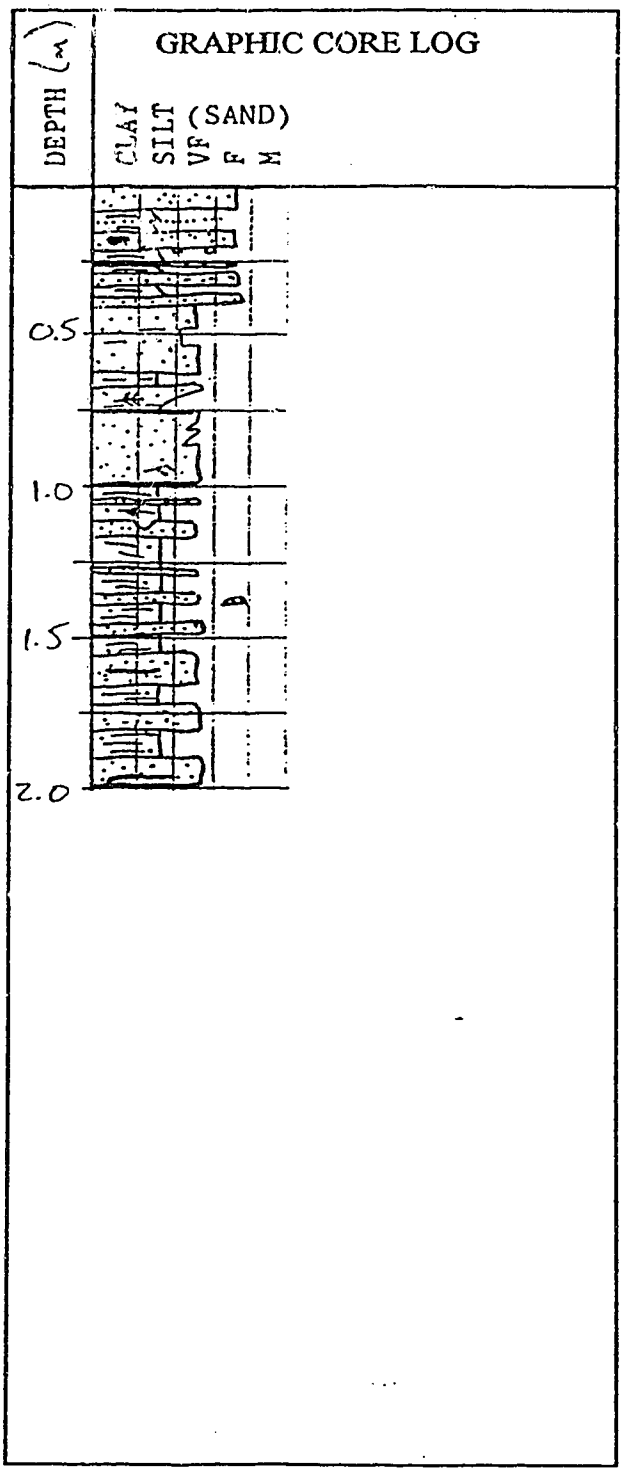
Core No. TUL92A-113 Length 239 cm
Type GRAVITY Water Depth 59 m



Core No. TUL92A-162 Length 215 cm
Type VIBRACORE Water Depth 51 m



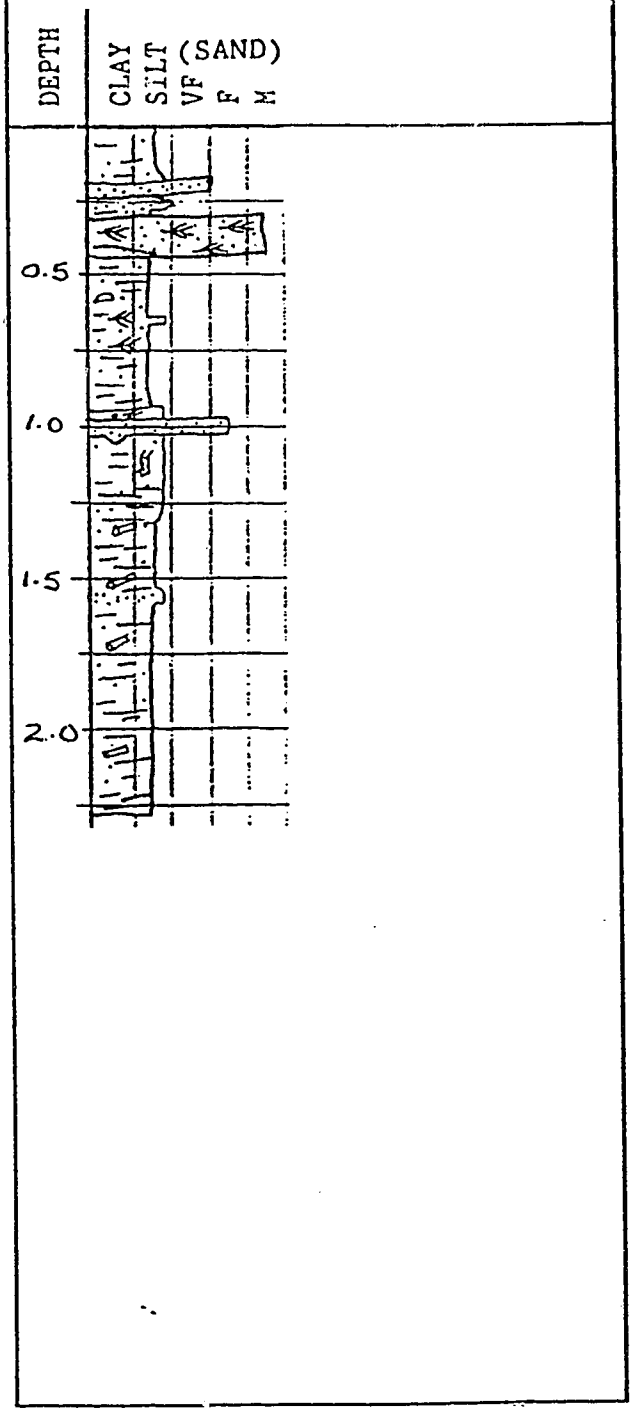
Core No. TUL92A-163 Length 199 cm
Type VIBRACORE Water Depth 54 m



Core No. TUL92A-167 Length 227 cm

Type GRAVITY Water Depth 221 m

GRAPHIC CORE LOG



APPENDIX C: FRASER RIVER DELTA STUDY SUMMARY OF GRAIN SIZE ANALYSIS DATA

APPENDIX C1: FRASER RIVER DELTA STUDY
RAW GRAIN SIZE DATA

core	interval	-1.0 phi	-1.0 - 1.0	.0 - 2.0	.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0
VEC89A-01	0 - 5		0.06	0.29	1.12	18.27	6.42	3.45
	573 - 580		0.13	0.90	1.82	24.40	4.15	2.25
VEC89A-03	8 - 12		0.13	0.50	10.42	47.28	9.08	3.29
	12 - 15	0.08	0.68	0.68	27.40	58.83	5.53	1.21
	30 - 31		0.25	0.51	5.02	32.30	9.54	3.96
	35 - 40	0.01	0.19	0.34	5.14	38.70	12.74	4.39
	70 - 72		0.57	1.06	26.00	55.32	6.38	1.67
	75 - 80	0.38	0.51	0.56	13.26	50.71	11.35	3.49
	95 - 97		0.03	2.18	7.84	30.55	9.03	3.62
	110	0.32	1.59	23.63	44.02	23.06	2.79	0.71
	116		0.31	0.35	7.67	7.75	4.45	2.69
	125		0.46	23.98	55.31	17.69		
	145		0.65	24.74	53.31	17.86		
	170	1.32	7.14	18.86	35.83	26.83	3.27	1.16
	173	0.04	0.28	3.15	13.14	42.40	8.98	3.24
	210	0.87	1.73	42.18	43.60	9.84		
	220		0.09	10.11	26.34	21.44	5.42	2.61
VEC89A-06	35			0.27	3.07	28.74	9.58	4.27
	66			1.27	22.71	62.87		
	100		0.31	5.63	27.58	25.59	4.29	2.17
VEC89A-07	285 - 295		0.07	0.35	2.25	29.60	3.52	2.30
	332		0.06	0.07	1.46	32.55	3.82	1.98
	380 - 390			0.20	0.50	25.48	7.90	3.54
VEC89A-18	50			0.06	0.48	11.83	6.84	3.59
	245		0.30	7.09	18.64	50.02	10.42	2.64
	260			0.49	2.08	19.18	5.40	2.97
	330		1.00	13.86	34.56	36.86	5.72	1.39
	360		0.65	22.11	44.88	28.45		
	375 - 380	0.03	0.66	15.84	41.65	36.33	1.74	0.43
VEC89A-20	295		0.02	0.00	1.13	26.37	8.91	4.35
	400			2.34	50.66	42.04	1.57	0.37
	420	0.11	0.47	1.34	33.35	50.09	4.98	1.42
VEC89A-21	50 - 55			0.46	1.52	15.88	6.82	3.37
	90 - 95		0.10	0.05	1.21	21.87	8.91	4.15
	300 - 305			2.58	3.22	22.59	8.45	3.72
	307 - 310			5.15	9.66	24.55	8.00	3.70
VEC89A-23	127	0.23	1.99	5.82	14.34	56.71	8.80	2.05
	150		0.06	0.67	2.80	14.81	5.55	2.86
	180		0.64	12.72	40.17	36.15	3.60	0.92
VEC89A-25	15		1.60	37.17	52.25	7.40		
	70		1.67	46.87	44.83	6.15		
	130		1.42	45.09	47.71	5.26		

core	interval	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	0.0 - 11.0	11.0 - 12.0	>12.0
VEC89A-01	0 - 5	15.25	14.68	16.21	4.01	4.90	4.25	9.55
	573 - 580	10.98	12.22	16.73	4.95	5.82	3.86	10.83
VEC89A-03	8 - 12	8.96	5.50	4.54	1.17	1.38	0.83	4.83
	12 - 15	2.10	0.73	0.56	0.10	0.25	0.15	0.16
	30 - 31	14.24	10.59	10.34	2.54	3.84	2.48	3.16
	35 - 40	13.29	8.57	7.45	1.50	2.39	1.22	1.11
	70 - 72	3.33	1.47	1.16	0.39	0.56	0.24	0.78
	75 - 80	8.16	3.98	3.39	0.62	0.97	0.38	0.00
	95 - 97	12.30	9.86	10.81	2.61	3.68	2.91	2.73
	110	1.57	0.55	0.38	0.11	0.11	0.06	0.59
	116	16.70	20.81	20.90	4.53	6.29	3.44	3.36
	125							
	145							
	170	2.55	1.12	0.82	0.14	0.24	0.16	0.18
	173	9.02	5.86	5.62	1.39	2.30	1.43	1.72
	210							
	220	10.13	8.61	7.35	1.60	2.27	1.43	1.76
VEC89A-06	35	14.26	12.29	11.34	2.92	3.06	2.11	7.67
	66							
	100	8.30	7.52	7.64	1.96	2.29	1.80	4.33
VEC89A-07	285 - 295	10.97	12.33	15.98	4.74	5.28	3.93	7.86
	332	10.08	11.66	16.47	6.72	5.93	4.08	5.14
	380 - 390	13.95	12.18	14.39	4.28	4.80	3.10	8.05
VEC89A-18	50	17.18	15.34	17.79	5.35	6.05	4.38	9.03
	245	4.46	1.58	1.13	0.36	0.31	0.19	1.46
	260	13.77	13.77	17.61	5.01	5.95	3.91	8.45
	330	2.52	1.02	0.74	0.22	0.16	0.05	0.97
	360							
	375 - 380	1.03	0.57	0.48	0.14	0.12	0.13	0.41
VEC89A-20	295	17.39	15.00	13.77	3.62	5.00	2.25	1.52
	400	0.85	0.51	0.40	0.13	0.08	0.11	0.52
	420	3.09	1.68	1.26	0.26	0.44	0.16	0.48
VEC89A-21	50 - 55	15.36	14.13	15.85	5.01	7.23	4.85	8.87
	90 - 95	17.27	13.13	12.67	3.61	4.15	3.30	8.45
	300 - 305	16.18	13.32	11.96	3.44	3.87	3.29	6.73
	307 - 310	14.01	10.67	9.64	2.67	2.91	2.55	5.27
VEC89A-23	127	3.45	1.02	0.79	0.17	0.31	0.17	2.55
	150	14.86	15.52	17.15	5.23	5.96	4.74	9.39
	180	1.97	0.99	0.82	0.23	0.25	0.18	0.75
VEC89A-25	15							
	70							
	130							

core	interval	weight	wt. sum	wt. loss	%sand	%silt	%clay	sand:mud
VEC89A-01	0 - 5	139.57	136.53	3.04	19.74	39.80	38.92	0.25
	573 - 580	148.42	146.41	2.01	27.26	29.60	42.19	0.38
VEC89A-03	8 - 12	81.04	79.72	1.32	58.33	26.84	12.75	1.47
	12 - 15	40.41	39.96	0.45	87.66	9.56	1.21	8.14
	30 - 31	28.52	27.68	0.84	38.08	38.33	22.35	0.63
	35 - 40	90.35	88.59	1.76	44.37	38.99	13.68	0.64
	70 - 72	25.37	24.62	0.75	82.94	12.85	3.14	5.19
	75 - 80	67.50	66.46	1.04	65.41	26.98	5.36	2.02
	95 - 97	38.82	38.14	0.68	40.59	34.82	22.76	0.70
	110	47.87	47.23	0.64	92.61	115.62	1.25	0.79
	116	23.21	22.57	0.64	16.08	160.64	38.52	0.08
	125	72.03	71.44	0.59	97.44			38.04
	145	71.82	71.26	0.56	96.56			28.09
	170	56.33	55.35	0.98	89.97	178.10	1.54	0.50
	173	50.05	49.55	0.50	59.01	200.09	12.46	0.28
	210	76.68	76.19	0.49	98.23			55.44
	220	22.61	22.06	0.55	57.96	246.77	14.41	0.22
VEC89A-06	35	25.65	25.71	-0.06	32.09	75.40	27.10	0.31
	66	12.36	12.55	-0.19	86.85			6.61
	100	39.13	38.69	0.44	59.11	122.28	18.02	0.42
VEC89A-07	285 - 295	144.60	141.97	2.63	32.27	29.12	37.79	0.48
	332	71.58	70.45	1.13	34.14	359.53	38.33	0.09
	380 - 390	139.54	136.82	2.72	26.18	37.57	34.62	0.36
VEC89A-18	50	31.88	31.37	0.51	12.37	92.94	42.59	0.09
	245	100.27	99.77	0.50	76.04	264.09	3.45	0.28
	260	29.12	28.41	0.71	21.75	295.92	40.92	0.06
	330	38.54	58.01	-19.47	86.28	340.65	2.15	0.25
	360	69.60	69.43	0.17	96.08			24.53
	375 - 380	123.38	123.07	0.31	94.52	3.78	1.27	18.73
VEC89A-20	295	42.53	42.32	0.21	27.53	340.66	26.16	0.08
	400	71.12	71.45	-0.33	95.05	403.29	1.24	0.23
	420	70.53	70.32	0.21	85.35	431.18	2.61	0.20
VEC89A-21	50 - 55	21.99	21.72	0.27	17.86	39.67	41.81	0.22
	90 - 95	41.37	41.29	0.08	23.23	43.45	32.17	0.31
	300 - 305	23.46	23.28	0.18	28.39	41.68	29.29	0.40
	307 - 310	31.06	31.04	0.02	39.37	36.38	23.04	0.66
VEC89A-23	127	74.55	74.4	0.15	79.09	142.33	3.99	0.54
	150	52.99	51.86	1.13	18.34	188.79	42.46	0.08
	180	78.04	77.85	0.19	89.67	187.49	2.22	0.47
VEC89A-25	15	60.41	60.56	-0.15	98.41			62.08
	70	66.19	66.5	-0.31	99.52			206.81
	130	48.31	48.52	-0.21	99.48			193.08

core	interval	mean	std. dev.	comments (2)	Facies (3)
VEC89A-01	0 - 5	7.20	2.831603	w/m	1
	573 - 580	7.16	3.078098	w/s	1
VEC89A-03	8 - 12	4.85	2.583094	w/m	4a
	12 - 15	3.38	1.153142	w/m	4a
	30 - 31	5.83	2.672164	w	4a
	35 - 40	5.12	2.28005	w/m	4a
	70 - 72	3.63	1.583072	w/m	4a
	75 - 80	4.13	1.7933	w	4a
	95 - 97	5.67	2.743211	w/m	4a
	110	2.70	1.427247	w	4a
	116	7.15	2.528486		4a
	125	2.36	0.666077	w/m	4a
	145	2.33	0.682325	w	4a
	170	2.71	1.679114	w	4a
	173	4.70	2.45723	w	4a
	210	2.05	0.777503	w	4c
	220	4.65	2.755001	w/m	4a
VEC89A-06	35	6.37	2.659925		1/2
	66	2.79	0.599368		4b
	100	4.91	2.993127	w	2/3
VEC89A-07	285 - 295	6.82	3.002436		2
	332	6.76	2.917045		2
	380 - 390	6.77	2.856992		1
VEC89A-18	50	7.49	2.619772		1
	245	3.71	1.78139	w/m	4b
	260	7.17	2.849059	m	1
	330	3.17	1.613214	w/m	4
	360	2.45	0.743855	w/m	4b?/4a
	375 - 380	2.89	1.282698	w/m	4b?/4a
VEC89A-20	295	6.34	2.426548	s	2
	400	3.09	1.144595		4
	420	3.49	1.49913	w/m	4
VEC89A-21	50 - 55	7.40	2.826851		1
	90 - 95	6.82	2.819692	s	1
	300 - 305	6.52	2.890193	s	4b
	307 - 310	5.78	2.954339		2
VEC89A-23	127	3.69	1.961962	w/m/s	4b
	150	7.43	2.851143		1
	180	3.11	1.545865	w/m	4b/4c
VEC89A-25	15	2.12	0.656513	m	4c
	70	2.04	0.657356	m	4c
	130	2.05	0.634991	m/s	4c

core	interval	-1.0 phi	-1.0 - 1.0	.0 - 2.0	.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0
VEC89A-39	17	0.02	0.09	0.46	2.70	47.54	7.33	2.75
	32	0.20	2.27	10.93	32.89	27.79	3.89	1.48
	70		0.14	15.95	54.69	23.72	1.20	0.39
	100		0.27	21.41	57.23	19.10		
	125	1.06	3.12	14.56	43.24	22.18	1.88	0.73
	basal sand	1.54	7.71	12.29	37.01	34.72	1.47	0.41
VEC89A-40	20			0.23	4.25	26.63	9.64	4.62
	25	12.80	25.90	11.35	23.44	19.50		
	30		2.65	3.66	7.04	24.21	4.62	2.68
VEC89A-41	20 - 23		0.19	13.25	24.91	29.19	3.08	1.59
	60 - 62	0.01	0.38	27.71	59.84	11.39		
	90	0.01	0.51	23.12	47.09	25.95	1.37	0.31
	120		0.16	22.85	32.57	18.95	3.85	1.76
	140		0.32	29.09	51.64	17.02		
VEC89A-42	0 - 5		0.11	2.32	16.21	41.92	6.55	2.68
	44 - 46		0.19	10.20	50.43	31.89	3.20	0.71
	58 - 62		0.29	9.00	35.67	29.29	3.48	1.57
	28 - 30		0.63	1.61	17.02	50.69	7.99	2.73
VEC89A-44	15 - 20		0.42	1.42	8.81	34.09	4.03	2.05
	25 - 28		0.34	14.14	32.79	26.47	4.07	1.47
	28 - 32		0.64	30.46	50.93	15.06	0.72	0.23
	50		0.54	31.44	52.34	14.62		
	100		0.45	29.47	55.61	13.60		
	150	0.09	1.14	44.91	44.80	8.43		
	200		0.18	18.09	58.99	20.64	0.60	0.19
	165		0.44	6.66	30.94	27.87	3.65	1.74
	173		0.08	4.30	23.86	31.05	6.51	3.05
	254	0.28	2.27	9.98	21.06	40.24	6.54	2.49
	259	0.10	1.34	13.35	38.64	38.12	3.29	0.82
	262 - 265		0.07	1.26	14.30	35.83	4.76	2.28
VEC89A-45	10 - 15		0.16	3.70	36.20	52.72	2.51	0.61
	45 - 50	3.30	0.67	5.08	24.44	21.84	3.53	2.28
	60 - 65	0.04	1.62	4.55	55.40	28.15	1.94	0.80
	90 - 95	0.03	1.40	13.36	39.93	32.56	3.36	0.99
	103 - 105		4.41	11.91	17.80	27.83	2.82	1.41
	140		0.15	15.56	52.41	28.93		
	144		7.75	24.68	31.53	14.77		
VEC89A-46	20			1.49	32.51	41.36	5.22	1.95
	35A			1.32	58.41	25.51	2.83	1.06
	35B			0.72	44.17	28.04	3.41	1.46
	60		0.24	6.54	62.15	26.46		
	85		1.22	14.66	39.98	30.08	3.44	1.14
	95 - 97			3.59	24.09	25.85	6.74	2.97

core	interval	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	0.0 - 11.0	11.0 - 12.0	>12.0
VEC89A-39	17	9.30	7.77	8.31	2.36	2.66	1.38	6.59
	32	4.92	4.04	4.25	1.06	1.43	0.49	3.94
	70	1.21	0.84	0.77	0.16	0.23	0.11	0.33
	100							
	125	3.06	2.79	2.58	0.62	0.87	0.67	2.22
	basal sand	1.24	0.91	0.81	0.22	0.27	0.13	0.94
VEC89A-40	20	17.91	14.12	11.57	2.89	3.86	1.58	1.86
	25							
	30	11.11	12.36	14.23	3.87	4.37	2.74	5.99
VEC89A-41	20 - 23	6.59	6.39	6.98	1.79	2.14	1.72	1.56
	60 - 62							
	90	0.55	0.25	0.19	0.04	0.06	0.08	0.12
	120	6.55	5.20	4.05	0.99	0.99	0.64	0.76
	140							
VEC89A-42	0 - 5	8.72	6.31	6.39	1.81	2.21	1.54	2.01
	44 - 46	1.12	0.51	0.42	0.12	0.13	0.04	0.23
	58 - 62	5.53	4.32	4.58	1.29	1.52	1.00	1.60
	28 - 30	6.55	3.55	3.37	0.93	1.14	0.93	0.87
VEC89A-44	15 - 20	9.06	9.34	12.27	3.54	4.15	3.43	6.85
	25 - 28	5.04	3.91	4.41	1.26	1.47	1.08	3.02
	28 - 32	0.60	0.36	0.34	0.09	0.13	0.07	0.17
	50							
	100							
	150							
	200	0.51	0.28	0.20	0.03	0.06	0.02	0.09
	165	6.72	6.14	6.48	1.64	1.87	1.64	3.72
	173	9.69	6.47	5.86	1.59	1.75	1.59	3.70
	254	5.99	2.96	2.88	0.79	0.86	0.84	2.17
	259	1.48	0.64	0.50	0.14	0.13	0.12	0.78
	262 - 265	9.03	7.77	9.66	2.67	3.11	2.28	6.26
VEC89A-45	10 - 15	1.44	0.88	0.77	0.14	0.14	0.09	0.12
	45 - 50	8.89	8.26	9.34	2.77	3.17	1.88	4.07
	60 - 65	2.32	1.53	1.58	0.38	0.36	0.28	0.94
	90 - 95	2.40	1.49	1.51	0.41	0.48	0.38	1.18
	103 - 105	6.55	7.73	7.76	2.25	2.89	2.13	3.65
	140							
	144							
VEC89A-46	20	5.96	3.60	3.13	0.74	1.11	0.76	1.33
	35A	3.53	2.42	2.11	0.52	0.81	0.52	0.52
	35B	5.63	4.90	4.82	1.33	1.84	1.35	1.60
	60							
	85	3.26	1.99	1.76	0.45	0.49	0.45	0.51
	95 - 97	12.13	8.50	7.06	1.77	2.32	2.04	1.72

core	interval	weight	wt. sum	wt. loss	%sand	%silt	%clay	sand:mud
VEC89A-39	17	53.91	58.45	-4.54	50.82	44.15	21.30	0.78
	32	54.28	53.72	0.56	74.09	46.33	11.17	1.29
	70	73.02	71.93	1.09	94.49	73.64	1.60	1.26
	100	97.71	97.64	0.07	98.00			49.07
	125	65.04	60.29	4.75	84.16	133.46	6.95	0.60
	basal sand	169.35	167.74	1.61	93.28	4.03	2.37	14.57
VEC89A-40	20	27.32	26.36	0.96	31.11	66.29	21.76	0.35
	25		33.74	-33.74	93.01			13.30
	30	25.81	24.87	0.94	37.56	60.77	31.20	0.41
VEC89A-41	20 - 23	25.81	24.87	0.94	67.54	17.65	14.19	2.12
	60 - 62	84.89	84.44	0.45	99.34			149.79
	90	93.01	92.77	0.24	96.68	92.48	0.49	1.04
	120	58.09	57.69	0.40	74.52	137.35	7.44	0.51
	140	85.23	85.12	0.11	98.07			50.90
VEC89A-42	0 - 5	97.75	96.79	0.96	60.56	24.25	13.96	1.58
	44 - 46	43.11	42.83	0.28	92.72	5.54	0.95	14.28
	58 - 62	79.59	78.74	0.85	74.26	14.91	9.99	2.98
	28 - 30	92.92	72.87	20.05	69.95	20.83	7.24	2.49
VEC89A-44	15 - 20	96.53	93.919	2.61	44.73	24.49	30.23	0.82
	25 - 28	121.20	119.77	1.43	73.74	14.49	11.24	2.87
	28 - 32	99.11	99.04	0.07	97.09	1.91	0.81	35.71
	50	102.77	102.41	0.36	98.94			92.95
	100	121.55	121.43	0.12	99.14			114.65
	150	95.51	95.02	0.49	99.37			157.37
	200	153.68	152.71	0.97	97.90	201.57	0.40	0.48
	165	14.05	13.67	0.38	65.91	183.24	15.34	0.33
	173	85.60	84.44	1.16	59.30	198.72	14.49	0.28
	254	91.71	90.75	0.96	73.83	271.98	7.54	0.26
	259	70.26	69.36	0.90	91.55	265.23	1.66	0.34
	262 - 265	81.43	85.75	-4.32	51.45	23.84	23.98	1.08
VEC89A-45	10 - 15	108.38	107.32	1.06	92.78	5.45	1.26	13.83
	45 - 50	67.41	66.15	1.26	55.33	22.96	21.22	1.25
	80 - 85	85.76	85.35	0.41	89.75	6.58	3.54	8.87
	90 - 95	96.68	95.591	1.09	87.28	8.24	3.97	7.15
	103 - 105	60.40	59.44	0.96	61.94	18.49	18.69	1.67
	140	122.27	121.36	0.91	97.05			32.90
	144	5.81	5.55	0.26	78.74			3.70
VEC89A-46	20	59.48	59.09	0.39	75.36	36.73	7.07	1.72
	35A	62.33	61.94	0.39	85.24	9.84	4.47	5.96
	35B	55.88	55.67	0.21	72.93	15.40	10.94	2.77
	60	62.23	62.09	0.14	95.39			20.71
	85	65.88	65.35	0.53	85.95	94.83	3.65	0.87
	95 - 97	28.45	28.43	0.02	53.53	30.34	14.92	1.18

core	interval	mean	std. dev.	comments (2)	Facies (3)
VEC89A-39	17	5.60	2.868685	w	2?
	32	4.00	2.769554	w	3
	70	2.81	1.308179	m	4a
	100	2.42	0.650528	m	4a
	125	3.32	2.433051	w	4a
	basal sand	2.79	1.802458	w/m	4a
VEC89A-40	20	6.03	2.437329	fv/s/w	1/2
	25	1.25	1.653563	s/w	5
	30	6.18	3.170472	fv/s/w	1/2
VEC89A-41	20 - 23	4.36	2.74542	w/m/s	3
	60 - 62	2.31	0.621841	w/m/s	4a/4c
	90	2.62	1.026771	w/m	4a/4c
	120	3.62	2.377704	m	2?
	140	2.32	0.682732	w/m	4a
VEC89A-42	0 - 5	4.76	2.540613	m	1?
	44 - 46	2.92	1.138993	m	4
	58 - 62	3.97	2.466401	w/m	4?
	28 - 30	4.14	2.048288	w/m	2?
VEC89A-44	15 - 20	6.08	3.151788	w/s	1
	25 - 28	3.99	2.695136		3
	28 - 32	2.45	1.099495		4c
	50	2.29	0.67927	s	4c
	100	2.31	0.655916		4c
	150	2.09	0.679075	s	4c
	200	2.60	0.90247	m/s	4a/4c
	165	4.56	2.887279		2?
	173	4.80	2.770794		2?
	254	3.90	2.382257	w	4a?
	259	3.02	1.462398	w	4a
	262 - 265	5.59	3.056212		1/2?
VEC89A-45	10 - 15	3.23	1.119121		4a
	45 - 50	5.00	3.267195	w	4a/3?
	60 - 65	3.19	1.732912		4a
	90 - 95	3.22	1.880788		4a
	103 - 105	4.69	3.178645		3?
	140	2.56	0.665269		4a?
	144	1.68	0.964963		4a?
VEC89A-46	20	3.99	2.124991		3
	35A	3.41	1.807417	w/m	4b
	35B	4.15	2.478245	m	3
	60	2.58	0.566359	m	4a
	85	3.21	1.815041	w/m	4a
	95 - 97	4.92	2.667399	w/m	1

core	interval	-1.0 phi	-1.0 - 1.0	.0 - 2.0	.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0
PAR91A-14	18 - 20		0.12	1.27	2.93	25.05	8.22	4.35
	78 - 80		0.05	2.15	1.68	15.54	7.82	4.19
	175 - 177	0.16	0.67	13.47	5.67	25.48	7.90	3.60
	245 - 247		0.14	2.59	4.91	15.88	6.36	3.37
	300 - 302		0.11	4.53	6.47	15.31	5.27	2.74
	390 - 392		0.16	5.74	10.16	27.88	4.63	2.67
PAR91A-26	15 - 17			1.17	1.86	29.56	5.58	2.73
	70 - 72			0.43	2.21	28.26	3.87	2.27
	150 - 152			0.31	1.87	33.69	5.17	2.68
	198 - 200		0.42	0.37	4.68	37.15	3.18	1.64
	290 - 292		0.14	0.35	3.50	38.74	4.06	2.27
	360 - 362			2.12	4.24	30.85	3.38	1.81
	420 - 422		0.14	0.32	4.09	38.45	4.29	2.12
TUL92A-79	30 - 32	0.12	1.75	1.05	6.59	47.55	2.55	1.48
	59 - 61	0.53	1.59	2.22	8.80	41.94	3.54	1.86
	130 - 132		0.19	0.95	5.70	36.69	5.07	2.74
	175 - 177		0.68	33.05	53.77	10.78		
	198 - 200		0.04	8.61	33.52	26.13	3.85	1.86
	220 - 222		0.91	19.95	55.60	19.53		
	250 - 252			0.67	6.08	35.28	6.33	2.77
	335 - 337			0.64	13.77	50.69	3.25	1.36
	375 - 377		0.1	0.24	21.35	33.62	4.81	2.22
	425 - 427		0.55	5.25	45.28	44.49		
TUL92A-112	10 - 12			1.21	8.19	58.15	6.78	2.52
TUL92A-162	15 - 17			0.38	27.69	40.26	3.88	1.72
	45 - 47		0.22	0.66	16.76	44.47	5.18	2.28
	80 - 82	0.02	0.03	1.24	10.05	30.96	5.83	2.87
	135 - 137			2.16	12.74	35.27	5.31	2.78
	170 - 172		0.09	2.53	14.57	36.18	7.13	3.12
	185		0.29	15.78	25.47	34.87	3.53	1.46
	213 - 215			12.13	30.50	26.51	4.28	1.98
TUL92A-163	18 - 20		0.06	7.29	59.34	17.37	1.41	0.74
	43 - 45		0.09	5.01	61.79	24.52	1.30	0.55
	65 - 67		0.07	6.43	50.25	23.25	1.79	0.92
	71 - 73		0.08	4.02	46.41	15.61	2.55	1.58
	92 - 94		0.20	2.49	36.70	44.95	2.06	0.92
	133 - 135		0.10	1.02	9.50	29.58	6.04	3.25
	163 - 165		0.03	6.65	48.78	30.69	1.80	0.77
	197 - 199		1.10	12.85	31.89	34.56	3.42	1.38

core	interval	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	0.0 - 11.0	11.0 - 12.0	>12.0
PAR91A-14	18 - 20	18.17	12.43	10.84	3.52	3.87	3.45	3.66
	78 - 80	18.30	15.64	13.71	4.43	5.89	6.05	3.87
	175 - 177	14.39	11.66	8.88	2.07	2.02	1.69	1.31
	245 - 247	14.14	13.54	14.51	4.56	6.66	6.06	4.11
	300 - 302	14.86	14.86	14.65	4.33	6.28	4.33	4.40
	390 - 392	12.59	10.74	9.76	2.94	3.98	3.60	3.43
PAR91A-26	15 - 17	10.77	10.71	12.72	4.02	5.71	3.76	7.85
	70 - 72	10.87	10.61	12.74	4.34	6.40	5.00	9.94
	150 - 152	11.46	10.34	11.27	3.55	5.11	4.36	8.28
	198 - 200	8.21	9.64	11.77	3.61	5.20	3.34	7.67
	290 - 292	9.83	8.84	9.61	3.06	4.50	3.67	8.67
	360 - 362	8.34	9.61	13.47	4.23	6.22	4.05	8.82
	420 - 422	8.41	8.52	11.24	3.52	5.27	3.37	7.38
TUL92A-79	30 - 32	6.75	7.12	8.60	2.55	3.33	2.59	5.31
	59 - 61	7.26	7.22	8.99	2.64	3.37	2.64	5.44
	130 - 132	11.01	9.38	10.13	3.61	5.07	3.38	7.33
	175 - 177							
	198 - 200	6.57	4.93	4.56	1.33	2.04	1.40	3.81
	220 - 222							
	250 - 252	10.97	9.39	10.01	3.00	3.84	3.28	6.78
	335 - 337	5.51	5.93	6.98	2.09	2.41	1.85	5.06
	375 - 377	8.08	6.90	7.53	2.18	2.59	2.01	5.02
	425 - 427							
TUL92A-112	10 - 12	7.70	4.59	3.74	1.08	1.31	1.02	3.01
TUL92A-162	15 - 17	6.53	5.11	4.40	1.14	1.79	1.11	4.37
	45 - 47	7.60	5.51	4.70	1.21	2.02	0.99	6.28
	80 - 82	10.45	8.07	6.86	1.84	2.69	1.44	4.17
	135 - 137	11.84	8.63	7.46	1.90	2.83	1.46	5.99
	170 - 172	10.26	6.95	5.78	1.77	3.22	1.40	5.87
	185	5.03	3.62	3.09	0.84	1.32	0.90	2.74
	213 - 215	7.10	4.79	3.95	1.08	1.59	0.96	3.95
TUL92A-163	18 - 20	3.07	2.80	2.85	0.83	0.99	1.07	0.76
	43 - 45	1.88	1.39	1.14	0.33	0.39	0.33	0.53
	65 - 67	3.86	3.27	2.86	0.87	1.28	1.05	2.65
	71 - 73	7.72	7.08	5.56	1.55	2.17	1.94	1.65
	92 - 94	3.29	2.61	2.28	0.70	0.83	0.73	0.98
	133 - 135	13.87	11.09	9.58	2.96	3.37	3.19	3.66
	163 - 165	2.74	2.11	1.78	0.48	0.73	0.40	1.76
	197 - 199	4.30	2.66	2.38	0.59	0.96	0.71	2.56

core	interval	weight	wt. sum	wt. loss	%sand	%silt	%clay	sand:mud
PAR91A-14	18 - 20		25.95	-25.95	29.37	43.17	25.34	0.43
	78 - 80		21.88	-21.88	19.39	45.95	33.95	0.24
	175 - 177		31.4	-31.40	45.45	37.55	15.97	0.85
	245 - 247		21.6	-21.60	23.52	37.41	35.90	0.32
	300 - 302		27.37	-27.37	26.42	37.73	33.99	0.37
	390 - 392		31.2	-31.20	43.94	30.63	23.71	0.81
PAR91A-26	15 - 17		21.45	-21.45	32.59	29.79	34.06	0.51
	70 - 72		16.31	-16.31	30.90	27.62	38.42	0.47
	150 - 152		16.62	-16.62	35.87	29.65	32.57	0.58
	198 - 200		21.37	-21.37	42.62	22.67	31.59	0.79
	290 - 292		28.29	-28.29	42.73	25.00	29.51	0.78
	360 - 362		21.72	-21.72	37.21	23.14	36.79	0.62
	420 - 422		22.03	-22.03	43.00	23.34	30.78	0.79
TUL92A-79	30 - 32		17.16	-17.16	57.06	17.90	22.38	1.42
	59 - 61		18.86	-18.86	55.08	19.88	23.08	1.28
	130 - 132		15.78	-15.78	43.53	28.20	29.52	0.75
	175 - 177		35.43	-35.43	98.28			57.14
	198 - 200		27.06	-27.06	68.30	17.21	13.14	2.25
	220 - 222		30.72	-30.72	95.99			23.94
	250 - 252		16.44	-16.44	42.03	29.46	26.91	0.75
	335 - 337		20.26	-20.26	65.10	16.05	18.39	1.89
	375 - 377		20.7	-20.70	55.31	22.01	19.33	1.34
	425 - 427		25.51	-25.51	95.57			21.57
TUL92A-112	10 - 12		24.78	-24.78	67.55	21.59	10.16	2.13
TUL92A-162	15 - 17		47.27	-47.27	68.33	17.24	12.81	2.27
	45 - 47		54.6	-54.60	62.11	20.57	15.20	1.74
	80 - 82		59.08	-59.08	42.30	27.22	17.00	0.96
	135 - 137		48.51	-48.51	50.17	28.56	19.64	1.04
	170 - 172		42.62	-42.62	53.37	27.46	18.04	1.17
	185		30.86	-30.86	76.41	198.64	8.89	0.37
	213 - 215		59.6	-59.60	69.14	18.15	11.53	2.33
TUL92A-163	18 - 20		46.63	-46.63	84.06	8.02	6.60	5.75
	43 - 45		46.37	-46.37	91.41	5.12	2.72	11.66
	65 - 67		44	-44.00	80.00	9.84	8.71	4.31
	71 - 73		38.83	-38.83	66.12	18.93	12.87	2.08
	92 - 94		50.55	-50.55	84.34	8.88	5.52	5.86
	133 - 135		30.53	-30.53	40.20	34.25	22.76	0.71
	163 - 165		45.1	-45.10	86.15	7.42	5.15	6.85
	197 - 199		55	-55.00	80.40	11.76	7.20	4.24

core	interval	mean	std. dev.	comments (2)	Facies (3)
PAR91A-14	18 - 20	6.21	2.670425	m/w	4b?
	78 - 80	6.95	2.699191		2
	175 - 177	5.12	2.727042		1/2
	245 - 247	6.70	2.876147		1/2
	300 - 302	6.60	2.931298	m	1
	390 - 392	5.66	2.976584	m	1
PAR91A-26	15 - 17	6.48	3.027764		2/3?
	70 - 72	6.84	3.128868	m	1
	150 - 152	6.50	3.06671		1/2
	198 - 200	6.15	3.136906		1/2
	290 - 292	6.14	3.143684		2?
	360 - 362	6.50	3.215062	m/w	1/2
	420 - 422	6.10	3.10269	m	2?
TUL92A-79	30 - 32	5.30	3.032307	w	1/2
	59 - 61	5.34	3.108173	w/s	1/2
	130 - 132	6.28	3.130104	w	1
	175 - 177	2.22	0.651013	m	4
	198 - 200	4.32	2.83196	m	4
	220 - 222	2.37	0.678491	m/w	4
	250 - 252	6.02	3.016267	m	1
	335 - 337	5.04	2.866554	m	2?
	375 - 377	5.07	2.926805	w	2/3?
	425 - 427	2.77	0.630464	m/w/s	3/4b
TUL92A-112	10 - 12	4.60	2.348319		2/3?
TUL92A-162	15 - 17	4.53	2.692935	m	3
	45 - 47	4.88	2.848009	s	2
	80 - 82	4.79	2.733468	w/s	1
	135 - 137	5.42	2.927643	s	1
	170 - 172	5.24	2.931832	m/w	1
	185	3.86	2.531324	m	2/3
	213 - 215	4.20	2.7798	m/w	3/4b
TUL92A-163	18 - 20	3.37	2.11574	m	4b
	43 - 45	3.07	1.524768	m	4
	65 - 67	3.71	2.47054	m	4
	71 - 73	4.28	2.721866	m/w	3?
	92 - 94	3.63	1.929138	m/w	4
	133 - 135	5.75	2.80304	m/w	3
	163 - 165	3.39	2.011348	m/w	3/4
	197 - 199	3.67	2.37467	m/w/s	3/4

Note (1) All intervals in cm below top of core

Note (2) Key to comments

m	mica flakes
s	shelly debris
w	wood fragments
fv	fish vertebrae

Note (3)

1	silty clay
2	clayey silt with <10% discrete fine sand laminae
3	interbedded clayey silt/very fine to medium sand
4a	very fine to medium sand with <10% silty laminae
4b	very fine to fine sand beds <10cm thick
4c	massive fine to medium sand
5	debris flow

APPENDIX C2: FRASER RIVER DELTA STUDY CUMULATIVE PERCENT GRAIN SIZE DATA

core	interval	<-1.0 phi	-1.0 - 1.0	1.0 - 2.0	2.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0
VEC89A-01	0 - 5	0.00	0.06	0.35	1.47	19.74	26.16	29.61
	573 - 580	0.00	0.13	1.03	2.85	27.26	31.41	33.66
VEC89A-03	8 - 12	0.00	0.13	0.63	11.05	58.33	67.41	70.70
	12 - 15	0.08	0.75	1.43	28.83	87.66	93.19	94.40
	30 - 31	0.00	0.25	0.76	5.78	38.08	47.67	51.58
	35 - 40	0.01	0.20	0.54	5.68	44.37	57.11	61.50
	70 - 72	0.00	0.57	1.62	27.62	82.94	89.32	90.99
	75 - 80	0.38	0.89	1.44	14.70	65.41	76.76	80.25
	95 - 97	0.00	0.03	2.20	10.04	40.59	49.62	53.24
	110	0.32	1.91	25.53	69.55	92.61	95.40	96.11
	116	0.00	0.31	0.66	8.33	16.08	20.53	23.22
	125	0.00	0.46	24.44	79.75	97.44	n/a	n/a
	145	0.00	0.65	25.39	78.70	96.56	n/a	n/a
	170	1.32	8.46	27.32	63.14	89.97	93.24	94.40
	173	0.04	0.32	3.47	16.61	59.01	67.99	71.23
	210	0.87	2.60	44.78	88.38	98.23	n/a	n/a
	220	0.00	0.09	10.20	36.54	57.98	63.40	66.01
VEC89A-06	35	0.00	0.00	0.27	3.35	32.09	41.67	45.94
	66	0.00	0.00	1.27	23.98	86.85	n/a	n/a
	100	0.00	0.31	5.94	33.52	59.11	63.40	65.57
VEC89A-07	285 - 295	0.00	0.07	0.42	2.67	32.27	35.79	38.09
	332	0.00	0.06	0.13	1.59	34.14	37.96	39.94
	380 - 390	0.00	0.00	0.20	0.70	26.18	34.08	37.62
VEC89A-18	50	0.00	0.00	0.06	0.54	12.37	19.21	22.80
	245	0.00	0.30	7.39	26.03	76.04	86.46	89.10
	260	0.00	0.00	0.49	2.57	21.75	27.15	30.12
	330	0.00	1.00	14.86	49.42	86.28	92.00	93.34
	360	0.00	0.65	22.76	67.64	96.08	n/a	n/a
	375 - 380	0.03	0.69	16.54	58.19	94.52	96.26	96.69
VEC89A-20	295	0.00	0.02	0.02	1.16	27.53	36.44	40.79
	400	0.00	0.00	2.34	53.00	95.05	96.62	96.99
	420	0.11	0.58	1.92	35.27	85.35	90.33	91.75
VEC89A-21	50 - 55	0.00	0.00	0.46	1.98	17.86	24.68	28.05
	90 - 95	0.00	0.10	0.15	1.36	23.23	32.14	36.29
	300 - 305	0.00	0.00	2.58	5.80	28.39	36.84	40.56
	307 - 310	0.00	0.00	5.15	14.82	39.37	47.37	51.07
VEC89A-23	127	0.23	2.22	8.04	22.38	79.09	87.89	89.94
	150	0.00	0.06	0.73	3.53	18.34	23.89	26.74
	180	0.00	0.64	13.36	53.53	89.67	93.27	94.19
VEC89A-25	15	0.00	1.60	38.77	91.02	98.41	n/a	n/a
	70	0.00	1.67	48.54	93.37	99.52	n/a	n/a
	130	0.00	1.42	46.52	94.23	99.48	n/a	n/a

core	interval	<-1.0 phi	-1.0 - 1.0	1.0 - 2.0	2.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0
VEC89A-39	17	0.02	0.11	0.57	3.27	50.82	58.15	60.90
	32	0.20	2.48	13.40	46.30	74.09	77.98	79.46
	70	0.00	0.14	16.09	70.78	94.49	95.69	96.08
	100	0.00	0.27	21.67	78.90	98.00	n/a	n/a
	125	1.06	4.18	18.74	61.98	84.16	86.04	86.77
	basal sand	1.54	9.25	21.55	58.55	93.28	94.75	95.16
VEC89A-40	20	0.00	0.00	0.23	4.48	31.11	40.75	45.37
	25	12.80	38.71	50.06	73.50	93.01	n/a	n/a
	30	0.00	2.65	6.31	13.35	37.56	42.18	44.86
VEC89A-41	20 - 23	0.00	0.19	13.44	38.35	67.54	70.62	72.21
	60 - 62	0.01	0.39	28.10	87.94	99.34	n/a	n/a
	90	0.01	0.52	23.64	70.73	96.68	98.05	98.36
	120	0.00	0.16	23.00	55.57	74.52	78.37	80.13
	140	0.00	0.32	29.41	81.05	98.07	n/a	n/a
VEC89A-42	0 - 5	0.00	0.11	2.44	18.65	60.56	67.11	69.79
	44 - 46	0.00	0.19	10.39	60.82	92.72	95.92	96.63
	58 - 62	0.00	0.29	9.30	44.97	74.26	77.74	79.31
	28 - 30	0.00	0.63	2.24	19.25	69.95	77.94	80.67
VEC89A-44	15 - 20	0.00	0.42	1.83	10.64	44.73	48.76	50.81
	25 - 28	0.00	0.34	14.49	47.27	73.74	77.81	79.28
	28 - 32	0.00	0.64	31.10	82.03	97.09	97.81	98.04
	50	0.00	0.54	31.98	84.32	98.94	n/a	n/a
	100	0.00	0.45	29.93	85.54	99.14	n/a	n/a
VEC89A-42	150	0.09	1.23	46.14	90.94	99.37	n/a	n/a
	200	0.00	0.18	18.27	77.26	97.90	98.50	98.69
	165	0.00	0.44	7.10	38.04	65.91	69.56	71.30
	173	0.00	0.08	4.38	28.24	59.30	65.81	68.86
	254	0.28	2.55	12.53	33.59	73.83	80.37	82.86
	259	0.10	1.44	14.79	53.43	91.55	94.84	95.66
	262 - 265	0.00	0.07	1.33	15.63	51.45	56.21	58.49
VEC89A-45	10 - 15	0.00	0.16	3.86	40.06	92.78	95.29	95.90
	45 - 50	3.30	3.96	9.04	33.48	55.33	58.86	61.14
	60 - 65	0.04	1.65	6.20	61.59	89.75	91.69	92.49
	90 - 95	0.03	1.43	14.79	54.72	87.28	90.64	91.63
	103 - 105	0.00	4.41	16.32	34.12	61.94	64.76	66.17
	140	0.00	0.15	15.71	68.12	97.05	n/a	n/a
	144	0.00	7.75	32.43	63.96	78.74	n/a	n/a
VEC89A-46	20	0.00	0.00	1.49	34.00	75.36	80.58	82.53
	35A	0.00	0.00	1.32	59.74	85.24	88.07	89.13
	35B	0.00	0.00	0.72	44.89	72.93	76.34	77.80
	60	0.00	0.24	6.78	68.93	95.39	n/a	n/a
	85	0.00	1.22	15.88	55.87	85.95	89.39	90.53
	95 - 97	0.00	0.00	3.59	27.68	53.53	60.27	63.24

core	interval	<-1.0 phi	-1.0 - 1.0	1.0 - 2.0	2.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0
PAR91A-14	18 - 20	0	0.12	1.39	4.32	29.37	37.59	41.94
	78 - 80	0	0.05	2.2	3.85	19.39	27.21	31.40
	175 - 177	0.16	0.83	14.3	19.97	45.45	53.35	56.95
	245 - 247	0	0.14	2.73	7.64	23.52	29.88	33.25
	300 - 302	0	0.11	4.64	11.11	26.42	31.69	34.43
	390 - 392	0	0.16	5.9	16.06	43.94	48.57	51.24
PAR91A-26	15 - 17	0	0	1.17	3.03	32.59	38.17	40.90
	70 - 72	0	0	0.43	2.64	30.9	34.77	37.04
	150 - 152	0	0	0.31	2.18	35.87	41.04	43.72
	198 - 200	0	0.42	0.79	5.47	42.62	45.80	47.44
	290 - 292	0	0.14	0.49	3.99	42.73	46.79	49.06
	360 - 362	0	0	2.12	6.36	37.21	40.59	42.40
	420 - 422	0	0.14	0.46	4.55	43	47.29	49.41
TUL92A-79	30 - 32	0.12	1.87	2.92	9.51	57.06	59.61	61.09
	59 - 61	0.53	2.12	4.34	13.14	55.08	58.62	60.48
	130 - 132	0	0.19	1.14	6.84	43.53	48.60	51.34
	175 - 177	0	0.68	33.73	87.5	98.28	n/a	n/a
	198 - 200	0	0.04	8.65	42.17	68.3	72.15	74.01
	220 - 222	0	0.91	20.86	76.46	95.99	n/a	n/a
	250 - 252	0	0	0.67	6.75	42.03	48.36	51.13
	335 - 337	0	0	0.64	14.41	65.1	68.35	69.71
	375 - 377	0	0.1	0.34	21.69	55.31	60.12	62.34
	425 - 427	0	0.55	5.8	51.08	95.57	n/a	n/a
TUL92A-112	10 - 12	0.00	0	1.21	9.40	67.55	74.33	76.85
TUL92A-162	15 - 17	0	0	0.38	28.07	68.33	72.21	73.93
	45 - 47	0	0.22	0.88	17.64	62.11	67.29	69.57
	80 - 82	0.02	0.05	1.29	11.34	42.3	48.13	51.00
	135 - 137	0	0	2.16	14.9	50.17	55.48	58.26
	170 - 172	0	0.09	2.62	17.19	53.37	60.50	63.62
	185	0	0.29	16.07	41.54	76.41	79.94	81.40
	213 - 215	0	0	12.13	42.63	69.14	73.42	75.40
TUL92A-163	18 - 20	0	0.06	7.35	66.69	84.06	85.47	86.21
	43 - 45	0	0.09	5.1	66.89	91.41	92.71	93.26
	65 - 67	0	0.07	6.5	56.75	80	81.79	82.71
	71 - 73	0	0.08	4.1	50.51	66.12	68.67	70.25
	92 - 94	0	0.20	2.69	39.39	84.34	86.40	87.32
	133 - 135	0	0.10	1.12	10.62	40.2	46.24	49.49
	163 - 165	0	0.03	6.68	55.46	86.15	87.95	88.72
	197 - 199	0	1.10	13.95	45.84	80.4	83.82	85.20

core	interval	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	0.0 - 11.0	11.0 - 12.0	>12.0
VEC89A-01	0 - 5	44.86	59.54	75.75	79.76	84.66	88.91	98.46
	573 - 580	44.64	56.86	73.59	78.54	84.36	88.22	99.05
VEC89A-03	8 - 12	79.66	85.16	89.70	90.87	92.25	93.08	97.91
	12 - 15	96.50	97.23	97.79	97.89	98.14	98.29	98.25
	30 - 31	65.82	76.41	86.75	89.29	93.13	95.61	98.77
	35 - 40	74.79	83.36	90.81	92.31	94.70	95.92	97.03
	70 - 72	94.32	95.79	96.95	97.34	97.90	98.14	98.92
	75 - 80	88.41	92.30	95.78	96.40	97.37	97.75	97.75
	95 - 97	65.54	75.40	86.21	88.82	92.50	95.41	98.14
	110	97.68	98.23	98.61	98.72	98.83	98.89	99.58
	116	39.22	60.73	81.63	86.16	92.45	95.89	99.25
	125	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	145	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	170	96.95	98.07	98.69	99.03	99.27	99.43	99.61
	173	80.25	86.11	91.73	93.12	95.42	96.85	98.57
	210	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	220	76.14	84.75	92.10	93.70	95.97	97.4	99.16
VEC89A-06	35	60.20	72.49	83.83	86.75	89.81	91.92	99.59
	66	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	100	73.57	81.09	88.73	90.69	92.98	94.78	99.11
VEC89A-07	285 - 295	49.06	61.39	77.37	82.11	87.39	91.32	99.18
	332	50.02	61.68	78.15	84.87	90.80	94.88	100.02
	380 - 390	51.57	63.75	78.14	82.42	87.22	90.32	98.37
VEC89A-18	50	39.98	55.32	73.11	78.46	84.51	88.89	97.92
	245	93.56	95.14	96.27	96.63	96.94	97.13	98.59
	260	43.84	57.66	75.27	80.28	86.23	90.14	98.54
	330	95.91	96.93	97.67	97.89	98.05	98.1	99.07
	360	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	375 - 380	97.72	98.29	98.77	98.91	99.03	99.16	99.57
VEC89A-20	295	58.18	73.18	86.95	90.57	95.57	97.82	99.34
	400	97.84	98.35	98.75	98.88	98.96	99.07	99.59
	420	94.84	96.52	97.78	98.04	98.48	98.64	99.12
VEC89A-21	50 - 55	43.41	57.54	73.39	78.40	85.63	90.48	99.35
	90 - 95	53.56	66.69	79.36	82.97	87.12	90.42	98.87
	300 - 305	56.74	70.06	82.02	85.46	89.33	92.62	99.35
	307 - 310	65.08	75.75	85.39	88.06	90.97	93.52	98.79
VEC89A-23	127	93.39	94.41	95.2	95.37	95.68	95.85	98.4
	150	41.61	57.13	74.28	79.51	85.47	90.21	99.6
	180	96.16	97.15	97.97	98.20	98.45	98.63	99.38
VEC89A-25	15	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	70	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	130	n/a	n/a	n/a	n/a	n/a	n/a	n/a

core	interval	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	10.0 - 11.0	11.0 - 12.	>12.0
VEC89A-39	17	70.20	77.97	86.28	88.64	91.30	92.68	99.27
	32	84.38	88.42	92.67	93.73	95.16	95.65	99.59
	70	97.29	98.13	98.90	99.06	99.29	99.4	99.73
	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	125	89.83	92.62	95.20	95.82	96.69	97.36	99.58
	basal sand	96.40	97.31	98.12	98.34	98.61	98.74	99.68
VEC89A-40	20	63.28	77.40	88.97	91.86	95.72	97.3	99.16
	25	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	30	55.97	68.33	82.56	86.43	90.80	93.54	99.53
VEC89A-41	20 - 23	78.80	85.19	92.17	93.96	96.1	97.82	99.38
	60 - 62	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	90	98.91	99.16	99.35	99.39	99.45	99.53	99.65
	120	86.68	91.88	95.93	96.92	97.91	98.55	99.31
	140	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VEC89A-42	0 - 5	78.51	84.82	91.21	93.02	95.23	96.77	98.78
	44 - 46	97.75	98.26	98.68	98.80	98.93	98.97	99.2
	58 - 62	84.84	89.16	93.44	95.03	96.55	97.55	99.15
	28 - 30	87.22	90.77	94.14	95.07	96.21	97.14	98.01
VEC89A-44	15 - 20	59.87	69.21	81.48	85.02	89.17	92.6	99.45
	25 - 28	84.32	88.23	92.64	93.90	95.37	96.45	99.47
	28 - 32	98.64	99.00	99.34	99.43	99.56	99.63	99.8
	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VEC89A-42	150	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	200	99.20	99.48	99.68	99.71	99.77	99.79	99.88
	165	78.02	84.16	90.64	92.28	94.15	95.79	99.51
	173	78.55	85.02	90.88	92.47	94.22	95.81	99.51
	254	88.85	91.81	94.69	95.45	96.34	97.18	99.35
	259	97.14	97.78	98.28	98.42	98.55	98.67	99.45
	262 - 265	67.52	75.29	84.95	87.62	90.73	93.01	99.27
VEC89A-45	10 - 15	97.34	98.22	98.99	99.13	99.27	99.36	99.48
	45 - 50	70.03	78.29	87.63	90.40	93.57	95.45	99.52
	60 - 65	94.81	96.34	97.92	98.30	98.66	98.94	99.88
	90 - 95	94.03	95.52	97.03	97.44	97.92	98.3	99.48
	103 - 105	72.72	80.45	88.21	90.46	93.35	95.48	99.13
	140	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	144	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VEC89A-46	20	88.49	92.09	95.22	95.96	97.07	97.83	99.16
	35A	92.66	95.08	97.19	97.71	98.52	99.04	99.56
	35B	83.43	88.33	93.15	94.48	96.32	97.67	99.27
	60	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	85	93.78	95.78	97.54	97.99	98.48	98.93	99.44
	95 - 97	75.37	83.87	90.93	92.70	95.02	97.06	98.78

core	interval	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	10.0 - 11.0	11.0 - 12.	>12.0
PAR91A-14	18 - 20	60.11	72.54	83.38	86.90	90.77	94.22	97.88
	78 - 80	49.70	65.34	79.05	83.48	89.37	95.42	99.29
	175 - 177	71.34	83.00	91.88	93.95	95.97	97.66	98.97
	245 - 247	47.39	60.93	75.44	80.00	86.66	92.72	96.83
	300 - 302	49.29	64.15	78.80	83.13	89.41	93.74	98.14
	390 - 392	63.83	74.57	84.33	87.27	91.25	94.85	98.28
PAR91A-26	15 - 17	51.67	62.38	75.10	79.12	84.83	88.59	96.44
	70 - 72	47.91	58.52	71.26	75.60	82.00	87	96.94
	150 - 152	55.18	65.52	76.79	80.34	85.45	89.81	98.09
	198 - 200	55.65	65.29	77.06	80.67	85.87	89.21	96.88
	290 - 292	58.89	67.73	77.34	80.40	84.90	88.57	97.24
	360 - 362	50.74	60.35	73.82	78.05	84.27	88.32	97.14
	420 - 422	57.82	66.34	77.58	81.10	86.37	89.74	97.12
TUL92A-79	30 - 32	67.84	74.96	83.56	86.11	89.44	92.03	97.34
	59 - 61	67.74	74.96	83.95	86.59	89.96	92.6	98.04
	130 - 132	62.35	71.73	81.86	85.47	90.54	93.92	101.25
	175 - 177	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	198 - 200	80.58	85.51	90.07	91.40	93.44	94.84	98.65
	220 - 222	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	250 - 252	62.10	71.49	81.50	84.50	88.34	91.62	98.4
	335 - 337	75.22	81.15	88.13	90.22	92.63	94.48	99.54
	375 - 377	70.42	77.32	84.85	87.03	89.62	91.63	96.65
	425 - 427	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TUL92A-112	10 - 12	84.55	89.14	92.88	93.96	95.27	96.29	99.3
TUL92A-162	15 - 17	80.46	85.57	89.97	91.11	92.90	94.01	98.38
	45 - 47	77.17	82.68	87.38	88.59	90.61	91.6	97.88
	80 - 82	61.45	69.52	76.38	78.22	80.91	82.35	86.52
	135 - 137	70.10	78.73	86.19	88.09	90.92	92.38	98.37
	170 - 172	73.88	80.83	86.61	88.38	91.60	93	98.87
	185	86.43	90.05	93.14	93.98	95.30	96.2	98.94
	213 - 215	82.50	87.29	91.24	92.32	93.91	94.87	98.82
TUL92A-163	18 - 20	89.28	92.08	95.03	95.86	96.85	97.92	98.68
	43 - 45	95.14	96.53	97.67	98.00	98.39	98.72	99.25
	65 - 67	86.57	89.84	92.70	93.57	94.85	95.9	98.55
	71 - 73	77.97	85.05	90.61	92.16	94.33	96.27	97.92
	92 - 94	90.61	93.22	95.50	96.20	97.03	97.76	98.74
	133 - 135	63.36	74.45	84.03	86.99	90.36	93.55	97.21
	163 - 165	91.46	93.57	95 35	95.83	96.56	96.96	98.72
	197 - 199	89.50	92.16	94.54	95.13	96.09	96.8	99.36

APPENDIX D: DOIG STUDY
LIST OF CORES

UWI	Formation(s)	Core Length	Top Core (Drill Depth)	Base Core (Drill Depth)	Halfway Top	Top Core (Sub - Halfway)	Base Core (Sub - Halfway)	Area	Field
8-18-80-17/w6	Doig	21.60	2034.00	2055.60	1986.00	-48.00	-69.60	Regional	
8-09-80-21/w6	Doig	4.00	2461.00	2465.00	2415.00	-46.00	-50.00	Regional	
	Doig	9.95	2466.00	2475.95	2415.00	-51.00	-60.95	Regional	
11-34-84-15/w6	Doig	15.00	1531.80	1546.80	1518.00	-13.80	-28.80	Regional	
12-24-84-21/w6	Doig	14.85	1654.00	1668.85	1616.00	-38.00	-52.85	Regional	
11-31-85-21/w6	Doig	17.90	1705.00	1722.90	1665.00	-40.00	-57.90	Regional	Red Creek ?
(02) 6-04-86-20/w6	Doig	17.45	1598.00	1615.45	1538.00	-60.00	-77.45	Stoddart	B Pool
12-04-86-20/w6	Doig	17.47	1593.00	1610.47	1533.00	-60.00	-77.47	Stoddart	B Pool
16-15-86-20/w6	Doig	10.50	1542.30	1552.80	1564.00	21.70	11.20	Stoddart	C Pool
10-25-86-20/w6	Doig	17.30	1490.24	1507.54	1474.00	-16.24	-33.54	Stoddart	
10-19-87-19/w6	ChLk - Doig	37.80	1490.80	1528.60	1502.50	11.70	-26.10	Stoddart	
6-22-87-20/w6	Hfwy - Doig	5.14	1578.86	1584.00	1582.20	3.34	-1.80	Stoddart	A Pool
	Doig	12.40	1584.96	1597.36	1582.20	-2.76	-15.16	Stoddart	A Pool
(02) 6-26-87-21/w6	Hfwy	13.30	1605.50	1618.80	1605.30	-0.20	-13.50	Stoddart	
6-03-88-14/w6	ChLk - Doig	16.80	1340.40	1357.20	u/c 1344.2	3.80	-13.00	Regional	
9-19-88-16/w6	Hfwy - Doig	18.39	1269.60	1287.99	1275.80	6.20	-12.19	Regional	Rigel ?
6-21-88-19/w6	ChLk - Hfwy	15.00	1429.00	1444.00	1438.40	9.40	-5.60	Regional	
7-24-88-20/w6	Hfwy	14.40	1465.20	1479.60	1463.20	-2.00	-16.40	Buick Creek	Regional
9-34-88-20/w6	Doig	36.40	1410.70	1447.10	1386.00	-24.70	-61.10	Buick Creek	Buick Creek
a-30-L/94-A-05	Hfwy-Doig	13.10	1788.57	1801.67	?	?	?	Regional	
	Doig	23.70	1804.11	1827.81	?	?	?	Regional	
a-29-K/94-A-10	ChLk - Hfwy	4.80	1360.00	1364.80	1363.90	3.90	-0.90	Regional	

UWI	Formation(s)	Core Length	Top Core (Drill Depth)	Base Core (Drill Depth)	Halfway Top	Top Core (Sub - Halfway)	Base Core (Sub - Halfway)	Area	Field
a-29-K/94-A-10	Hfwy +/- Doig	17.20	1368.80	1386.00	1363.90	-4.90	-22.10	Regional	
d-87-K/94-A-10	Hfwy	13.75	1276.50	1290.25	1273.50	-3.00	-16.75	Regional	
d-36-I/94-A-11	Doig (+/- Hfwy)	12.80	1388.50	1401.30	1358.00	-30.50	-43.30	Buick Creek	Buick Creek
b-44-I/94-A-11	Doig (+/- Hfwy)	18.65	1395.75	1414.40	1378.50	-17.25	-35.90	Buick Creek	Buick Creek
d-45-I/94-A-11	Doig	18.70	1406.60	1425.30	1379.50	-27.10	-45.80	Buick Creek	Buick Creek
d-46-I/94-A-11	Doig	13.50	1361.80	1375.30	1336.60	-25.20	-38.70	Buick Creek	Buick Creek
(02) d-57-I/94-A-11	Doig	25.00	1352.10	1377.10	1326.80	-25.30	-50.30	Buick Creek	Buick Creek
d-58-I/94-A-11	Doig	18.10	1367.40	1385.50	1339.60	-27.80	-45.90	Buick Creek	Buick Creek
d-68-I/94-A-11	Doig	23.90	1393.30	1417.20	1362.80	-30.50	-54.40	Buick Creek	Buick Creek
d-69-I/94-A-11	Doig	22.00	1445.00	1467.00	1411.00	-34.00	-56.00	Buick Creek	Buick Creek
d-76-I/94-A-11	Hfwy? + Doig	12.00	1363.00	1375.00	1334.00	-29.00	-41.00	Buick Creek	Buick Creek
	Doig	18.00	1391.60	1409.60	1334.00	-57.60	-75.60	Buick Creek	Buick Creek
b-77-I/94-A-11	Doig	12.10	1373.00	1385.10	1344.00	-29.00	-41.10	Buick Creek	Buick Creek
	Doig	17.10	1386.70	1403.80	1344.00	-42.70	-59.80	Buick Creek	Buick Creek
d-79-I/94-A-11	Doig (+/- Hfwy)	9.00	1391.00	1400.00	1373.00	-18.00	-27.00	Buick Creek	Buick Creek
d-85-I/94-A-11	Doig	36.40	1388.00	1424.40	1369.50	-18.50	-54.90	Buick Creek	Buick Creek
d-86-I/94-A-11	ChLk - Hfwy (Doig?)	18.10	1370.50	1388.60	1374.00	3.50	-14.60	Buick Creek	Buick Creek
	Doig	18.20	1395.00	1413.20	1374.00	-21.00	-39.20	Buick Creek	Buick Creek
(02) d-96-I/94-A-11	ChLk	8.40	1359.60	1368.00	1369.50	9.90	1.50	Buick Creek	Buick Creek
	Doig	27.00	1389.00	1416.00	1369.50	-19.50	-46.50	Buick Creek	Buick Creek
(03) d-96-I/94-A-11	Hfwy/Doig	41.80	1384.50	1426.30	1370.50	-14.00	-55.80	Buick Creek	Buick Creek
d-52-J/94-A-11	Mntny	18.20	1510.00	1528.20	1424.50	-85.50	-103.70	Buick Creek	Regional
b-64-I/94-A-12	Doig	17.88	1696.00	1713.88	1627.00	-69.00	-86.88	Cache Creek	Cache Creek
d-06-A/94-A-14	Hfwy/Doig	28.00	1357.00	1385.00	1340.00	-17.00	-45.00	Buick Creek	Buick Creek
a-26-A/94-A-14	Doig	22.20	1356.40	1378.60	1337.00	-19.40	-41.60	Buick Creek	Buick Creek
d-35-A/94-A-14	Hfwy/Doig	21.70	1351.90	1373.60	1336.50	-15.40	-37.10	Buick Creek	Buick Creek

UWI	Formation(s)	Core Length	Top Core (Drill Depth)	Base Core (Drill Depth)	Halfway Top	Top Core (Sub - Halfway)	Base Core (Sub - Halfway)	Area	Field
d-58-A/94-A-14	Hfwy/Doig	36.00	1375.00	1411.00	1362.00	-13.00	-49.00	Buick Creek	Buick Creek
b-06-D/94-A-14	Doig	15.00	1646.00	1661.00	1580.00	-66.00	-81.00	Fireweed	Fireweed
d-15-D/94-A-14	Doig	19.00	1635.00	1654.00	1588.50	-46.50	-65.50	Fireweed	Fireweed
b-26-D/94-A-14	Doig	17.13	1654.00	1671.13	1601.42	-52.58	-69.71	Fireweed	Fireweed
d-37-D/94-A-14	Doig	15.99	1623.00	1638.99	1573.00	-50.00	-65.99	Fireweed	Fireweed
b-56-D/94-A-15	ChLk - Hfwy	18.20	1273.00	1291.20	1284.00	11.00	-7.20	Buick Creek	Regional
d-84-I/94-A-15	Doig (+/- L.Hfwy?)	25.50	1105.20	1130.70	?	?	?	Wildmint	Wildmint
b-10-C/94-H-01	Doig (+/- L.Hfwy?)	19.00	1106.70	1125.70	1109.60	2.90	-16.10	Wildmint	Regional
d-13-D/94-H-01	Doig (+/- L.Hfwy?)	9.00	1109.00	1118.00	1114.70	5.70	-3.30	Wildmint	Regional
	Doig (?)	9.30	1128.00	1137.30	1114.70	-13.30	-22.60	Wildmint	Regional
b-57-D/94-H-01	Doig (+/- L.Hfwy?)	18.70	1085.40	1104.10	?	?	?	Wildmint	Regional
d-15-A/94-H-02	Doig (+/- L.Hfwy?)	21.00	1118.90	1139.90	?	?	?	Wildmint	Wildmint
b-24-A/94-H-02	Doig (+/- L.Hfwy?)	16.10	1114.30	1130.40	?	?	?	Wildmint	Wildmint
d-26-A/94-H-02	Doig (+/- L.Hfwy?)	18.50	1125.00	1143.50	1125.90	0.90	-17.60	Wildmint	Wildmint
d-34-A/94-H-02	Doig (+/- L.Hfwy?)	27.30	1084.50	1111.80	1089.90	5.40	-21.90	Wildmint	Regional

TOTAL: 1152.65 metres

APPENDIX E: DOIG STUDY STRATIGRAPHIC TOPS FILES

APPENDIX E1: DOIG STUDY
STRATIGRAPHIC TOPS FILES (DLS AREA)

	WELL ID		Top Triassic		Halfway		Doig	Montney		
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
•	100/11-11-080-17W600	719.6	1569.1	-849.5	1923.2	-1203.6	1947.6	-1228.0	2050.6	-1331.0
•	100/08-18-080-17W600	759.6	1614.5	-854.9	1986.0	-1226.4	2018.0	-1258.4	2127.0	-1367.4
•	100/14-08-080-18W600	844.2	1726.0	-881.8	2125.0	-1280.8	2147.0	-1302.8		
•	100/13-14-080-18W600	734.5	1575.7	-841.2	1955.0	-1220.5	1979.0	-1244.5	2109.0	-1374.5
•	100/01-17-080-18W600	843.5	1724.0	-880.5	2115.0	-1271.5	2137.0	-1293.5		
•	100/07-07-080-19W600	870.3	1773.0	-902.7	2221.0	-1350.7	2250.5	-1380.2	2406.0	-1535.7
	100/03-15-080-19W600	901.4	1771.7	-870.3	2204.0	-1302.6	2233.0	-1331.6		
•	100/16-36-080-20W600	919.9	1652.0	-732.1	2090.9	-1171.0	2112.3	-1192.4	2286.0	-1366.1
•	100/08-09-080-21W600	945.7	1914.0	-968.3	2415.0	-1469.3	2453.0	-1507.3		
•	100/07-32-080-21W600	472.6	1209.5	-736.9	1706.0	-1233.4	1741.0	-1268.4		
•	100/12-29-080-22W600	857.7	1694.0	-836.3	2165.0	-1307.3	2257.0	-1399.3		
•	100/06-01-080-23W600	753.0	1903.0	-1150.0	2418.0	-1665.0	2507.5	-1754.5		
	100/10-24-081-18W600	771.4	1435.6	-664.2	1783.0	-1011.6	1797.0	-1025.6		
•	100/05-26-081-18W600	818.7	1466.1	-647.4	1804.7	-986.0	1841.9	-1023.2	1956.8	-1138.1
•	100/07-27-081-18W600	814.1	1462.1	-648.0	1812.9	-998.8	1830.5	-1016.4	1955.5	-1141.4
•	100/10-29-081-18W600	782.1	1421.0	-638.9	1787.0	-1004.9	1824.0	-1041.9		
•	100/16-30-081-18W600	691.3	1320.4	-629.1	1686.7	-995.4	1706.8	-1015.5	1841.2	-1149.9
•	100/06-31-081-18W600	704.0	1323.0	-619.0	1686.5	-982.5	1706.5	-1002.5		
?	100/07-32-081-18W600	713.0	1351.0	-638.0	1712.0	-999.0	1731.0	-1018.0	1863.0	-1150.0
•	100/01-02-081-19W600	812.9	1559.0	-746.1	1971.0	-1158.1	1996.0	-1183.1	? NDE	
•	100/14-04-081-19W600	865.9	1590.0	-724.1	2009.0	-1143.1	2056.0	-1190.1	2192.0	-1326.1
•	100/06-26-081-19W600	639.2	1270.1	-630.9	1684.5	-1045.3	1701.9	-1062.7		
•	100/04-34-081-19W600	793.1	1428.6	-635.5	1822.6	-1029.5	1842.7	-1049.6		
•	100/10-36-081-19W600	636.0	1265.0	-629.0	1646.0	-1010.0	1687.0	-1051.0		
	100/11-22-081-20W600	750.0	1394.0	-644.0	1837.0	-1087.0	1872.0	-1122.0	2039.0	-1289.0
•	102/06-21-081-21W600	680.9	1284.7	-603.8	1763.0	-1082.1				
•	100/13-34-081-21W600	685.7	1243.0	-557.3	1682.0	-996.3	1715.0	-1029.3	1915.0	-1229.3
•	100/11-22-081-22W600	699.0	1146.0	-447.0	1593.5	-894.5	1649.0	-950.0	1881.0	-1182.0
•	100/11-23-081-22W600	697.1	1143.0	-445.9	1559.9	-862.8	1606.2	-909.1		
•	100/10-19-081-23W600	729.4	1263.0	-533.6	1714.0	-984.6	?		?	
?	100/11-34-081-24W600	694.5	1175.0	-480.5	1641.0	-946.5	1700.0	-1005.5		
•	100/12-26-081-18W600	809.7			1804.0	-994.3	1821.0	-1011.3		
•	100/06-02-082-19W600	803.1	1435.0	-631.9	1801.0	-997.9	1820.0	-1016.9		
D	100/07-05-082-19W600	795.0	1427.0	-632.0	1785.0	-990.0	1806.5	-1011.5	1964.5	-1169.5
•	100/05-18-082-19W600	636.6	1214.0	-577.4	1606.0	-969.4	1627.5	-990.9	1785.0	-1148.4
•	100/02-12-082-20W600	638.3	1217.0	-578.7	1618.0	-979.7	1640.0	-1001.7		
•	100/09-17-082-20W600	657.1	1161.5	-504.4	1588.0	-930.9	1611.0	-953.9	1780.0	-1122.9
	100/12-19-082-20W600	677.2	1130.0	-452.8	1519.0	-841.8	1545.0	-867.8	1720.0	-1042.8
•	100/03-20-082-20W600	654.1	1131.7	-477.6	1572.8	-918.7	1594.1	-940.0		
•	100/11-26-082-20W600	654.9	1190.0	-535.1	1578.0	-923.1	1601.0	-946.1	1743.0	-1088.1
•	100/10-27-082-20W600	656.8	1172.0	-515.2	1564.0	-907.2	?		1734.5	-1077.7
•	100/11-29-082-20W600	665.0	1105.0	-440.0	1496.5	-831.5	1520.0	-855.0	1675.0	-1010.0
	100/07-30-082-20W600	673.2	1105.0	-431.8	1491.5	-818.3	1514.0	-840.8	1678.0	-1004.8
•	102/07-30-082-20W600	673.0	1105.0	-432.0	1484.0	-811.0	NDE			
•	100/10-34-082-20W600	655.8	1130.0	-474.2	1496.5	-840.7	1520.0	-864.2		
	100/10-05-082-21W600	683.7	1031.4	-347.7	1459.4	-775.7	1485.6	-801.9		
•	100/07-06-082-21W600	673.0	1061.3	-388.3	1470.4	-797.4	1536.8	-863.8		
•	102/07-08-082-21W600	671.8	1015.6	-343.8	1392.3	-720.5	1443.5	-771.7		
•	100/11-09-082-21W600	689.2	1021.1	-331.9	1405.1	-715.9	1450.2	-761.0		
	100/11-10-082-21W600	676.4	1153.0	-476.6	1586.0	-909.6	1619.0	-942.6		
•	100/14-14-082-21W600	680.0	1115.0	-435.0	1497.0	-817.0	1556.0	-876.0		
?	100/05-15-082-21W600	674.2	1041.8	-367.6	1435.0	-760.8	1463.0	-788.8	1645.3	-971.1
•	100/14-15-082-21W600	672.1	1033.9	-361.8	1405.1	-733.0	1433.8	-761.7	1613.6	-941.5
•	100/06-16-082-21W600	668.1	1032.1	-364.0	1439.9	-771.8	1473.4	-805.3		

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/11-11-080-17W600	2386.3	-1666.7	1965.9	-1246.3	? 2.1	4.9				
100/08-18-080-17W600			2060.0	-1300.4	18.5	25.0				
100/14-08-080-18W600			2182.0	-1337.8	4.5	?	?NDE			
100/13-14-080-18W600	2433.0	-1698.5	2004.5	-1270.0	16.0	19.5	NP		0.0	0.0
100/01-17-080-18W600			2183.0	-1339.5	29.0	31.0				
100/07-07-080-19W600			2289.0	-1418.7	0.0	4.0	NP		0.0	0.0
100/03-15-080-19W600			2251.0	-1349.6	0.0	? 5				
100/16-36-080-20W600	2584.7	-1664.8								
100/08-09-080-21W600			2473.0	-1527.3	4.0	6.0	2499.0	-1553.3	35.0	35.0
100/07-32-080-21W600	2195.0	-1722.4					1781.5	-1308.9	35.0	35.0
100/12-29-080-22W600	2753.0	-1895.3	?NDE				NDE			
100/06-01-080-23W600							NDE			
100/10-24-081-18W600			1833.6	-1062.2	? 7.3	7.3	NDE			
100/05-26-081-18W600	2268.9	-1450.2								
100/07-27-081-18W600	2269.2	-1455.1	1856.1	-1042.0	? 4.0	4.0				
100/10-29-081-18W600			NDE				NDE			
100/16-30-081-18W600	2144.6	-1453.3	1728.1	-1036.8	3.1	3.1	?			
100/06-31-081-18W600			1749.0	-1045.0	> 4.0	! DE	NDE			
100/07-32-081-18W600			1769.0	-1056.0	0.0	19.0				
100/01-02-081-19W600			2028.0	-1215.1	trace	27.0				
100/14-04-081-19W600	2495.0	-1629.1	NP		0.0	0.0	NP		0.0	0.0
100/06-26-081-19W600			1737.3	-1098.1	12.8	12.8				
100/04-34-081-19W600			NDE				NDE			
100/10-36-081-19W600			NDE				NDE			
100/11-22-081-20W600	2320.0	-1570.0	NP		0.0	0.0	NP		0.0	0.0
102/06-21-081-21W600										
100/13-34-081-21W600	2173.0	-1487.3	1749.0	-1063.3	0.0	FS	?			
100/11-22-081-22W600	2082.0	-1383.0	NP		0.0	0.0	NP		0.0	0.0
100/11-23-081-22W600			NDE				NDE			
100/10-19-081-23W600	?		NDE				NDE			
100/11-34-081-24W600			NDE				NDE			
100/12-26-081-18W600			?NDE				NDE			
100/06-02-082-19W600			NDE				NDE			
100/07-05-082-19W600	2252.0	-1457.0	1839.0	-1044.0	? 41m	44.0	? NP		0.0	
100/05-18-082-19W600	2190.5	-1553.9	1660.0	-1023.4	16.0	24.0				
100/02-12-082-20W600			1675.0	-1036.7	? 6m	15.5				
100/09-17-082-20W600	2047.0	-1389.9	? NP		0.0		? NP		0.0	
100/12-19-082-20W600	1966.5	-1289.3	1579.0	-901.8	6.0	6.0	? NP		0.0	
100/03-20-082-20W600					0.0					
100/11-26-082-20W600	2027.0	-1372.1	1624.0	-969.1	6.0	6.0	? NP		0.0	
100/10-27-082-20W600	2012.5	-1355.7	1620.0	-963.2	?6.0	61.0	? NP		0.0	
100/11-29-082-20W600	1947.0	-1282.0	1564.0	-899.0	4.0	?14.0				
100/07-30-082-20W600	1944.0	-1270.8	1551.0	-877.8	19.0	21.0				
102/07-30-082-20W600										
100/10-34-082-20W600			NDE				NDE			
100/10-05-082-21W600			NDE				NDE			
100/07-06-082-21W600			NDE				NDE			
102/07-08-082-21W600			NDE				NDE			
100/11-09-082-21W600			?NDE				NDE			
100/11-10-082-21W600			NDE				NDE			
100/14-14-082-21W600			NDE				NDE			
100/05-15-082-21W600	1886.7	-1212.5	? NP		0.0		NP		0.0	0.0
100/14-15-082-21W600	1854.1	-1182.0	NP		0.0	0.0	NP		0.0	0.0
100/06-16-082-21W600			NP		0.0	0.0	NP		0.0	0.0

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/11-11-080-17W600				top 1st Doig sand = FS
100/08-18-080-17W600			D	1st Doig sand = 2 disturbed sands (50.m,13.5m)
100/14-08-080-18W600				
100/13-14-080-18W600				
100/01-17-080-18W600				
100/07-07-080-19W600				
100/03-15-080-19W600				FS at 2280
100/16-36-080-20W600				e-log
100/08-09-080-21W600		?	D	
100/07-32-080-21W600				1st and 2nd sands amalgamated?
100/12-29-080-22W600	?			
100/06-01-080-23W600				
100/10-24-081-18W600				1st Doig sand: 7.3m offscale gamma response at end of logging run
100/05-26-081-18W600				e-log
100/07-27-081-18W600				Upper sand= 2 sands
100/10-29-081-18W600				
100/16-30-081-18W600				1781.9 - 0.9m silt; 1795.9 - 0.6m silt; 1829.4 - 6.1m silt
100/06-31-081-18W600				1734 - FS; 1740 - FS
100/07-32-081-18W600				Additional Sand eqv. at 1855m
100/01-02-081-19W600				7.5m silty sand at 2116.5m
100/14-04-081-19W600				
100/06-26-081-19W600				1st Doig sand - 12.8m offscale gamma response, 7.0m silt /fs at 1726.6m
100/04-34-081-19W600				
100/10-36-081-19W600				
100/11-22-081-20W600				
102/06-21-081-21W600				no fiche
100/13-34-081-21W600				1749 - FS
100/11-22-081-22W600				
100/11-23-081-22W600				
100/10-19-081-23W600				
100/11-34-081-24W600				
100/12-26-081-18W600				not in original database
100/06-02-082-19W600				
100/07-05-082-19W600				
100/05-18-082-19W600				1st Doig = 2 distinct sands each 8m thick
100/02-12-082-20W600				
100/09-17-082-20W600				
100/12-19-082-20W600				
100/03-20-082-20W600				e-log
100/11-26-082-20W600				
100/10-27-082-20W600				silts at 1620, 1651, 1661, 1722: DOIG at 1584.5 or 1592.0
100/11-29-082-20W600				silt at 1665 (4m) ; silt at 1545 (7m) base 1st doig eqv.
100/07-30-082-20W600	X			silt at 1666.5 (7m) : additional sand at 1590 (4m) in 15 m coarsening up
102/07-30-082-20W600				
100/10-34-082-20W600				DOIG at 1520.0m or 1528.0m
100/10-05-082-21W600				
100/07-06-082-21W600				
102/07-08-082-21W600				02 well? or 00 well?
100/11-09-082-21W600				HFWY at 1419.1?
100/11-10-082-21W600				
100/14-14-082-21W600				
100/05-15-082-21W600				silt at 1602 (5.5m)
100/14-15-082-21W600				
100/06-16-082-21W600				

	WELL ID	Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
	100/07-17-082-21W600	659.5	1065.0	-405.5	1483.0	-823.5	1515.0	-855.5	1709.0	-1049.5
*	100/10-19-082-21W600	637.0	1057.0	-420.0	1469.0	-832.0	1532.0	-895.0		
*	100/07-21-082-21W600	656.0	1109.0	-453.0	1486.0	-830.0	1520.0	-864.0	1703.0	-1047.0
	100/06-22-082-21W600	665.4	1051.0	-385.6	1416.1	-750.7	1452.1	-786.7		
*	100/06-23-082-21W600	675.1	1019.9	-344.8	1377.7	-702.6	1432.6	-757.5		
	100/11-24-082-21W600	680.0	1125.5	-445.5	1505.0	-825.0	1527.5	-847.5		
*	100/06-25-082-21W600	655.9	1109.0	-453.1	1473.0	-817.1	1516.0	-860.1		
*	100/06-26-082-21W600	700.1	1057.4	-357.3	1433.2	-733.1	1460.6	-760.5		
*	100/11-26-082-21W600	640.9	1064.5	-423.6	1446.0	-805.1	1473.5	-832.6	1635.0	-994.1
*	100/07-27-082-21W600	638.9	1059.0	-420.1	1436.0	-797.1	1465.0	-826.1	1631.0	-992.1
*	100/15-28-082-21W600	640.2	1070.5	-430.3	1466.0	-825.8	1494.0	-853.8		
*	100/10-29-082-21W600	633.7	1044.5	-410.8	1458.0	-824.3	1485.5	-851.8		
*	100/09-33-082-21W600	633.9	1059.0	-425.1	1448.0	-814.1	1472.0	-838.1		
*	100/07-34-082-21W600	638.8	1066.0	-427.2	1458.5	-819.7	1486.5	-847.7		
*	100/11-35-082-21W600	636.6	1068.5	-431.9	1461.5	-824.9	1485.0	-848.4	1535.0	-898.4
*	100/07-02-082-22W600	667.2	1096.0	-428.8	1521.5	-854.3	1583.5	-916.3	1782.0	-1114.8
*	100/10-15-082-22W600	657.5	1049.4	-391.9	1480.1	-822.6	1534.4	-876.9		
*	100/06-17-082-22W600	670.6	1074.0	-403.4	1520.0	-849.4	1561.5	-890.9		
	100/11-20-082-22W600	655.3	1048.0	-392.7	1481.0	-825.7	1549.0	-893.7		
*	100/04-23-082-22W600	668.4	1058.0	-389.6	1487.4	-819.0	1540.8	-872.4		
*	100/10-23-082-22W600	660.8	1054.6	-393.8	1486.2	-825.4	?			
*	100/11-28-082-22W600	660.0	1044.5	-384.5	1476.0	-816.0	1537.0	-877.0		
*	100/07-31-082-22W600	684.6	1090.0	-405.4	1517.0	-832.4	NDE			
*	100/01-32-082-22W600	695.0	1077.0	-382.0	1503.0	-808.0	NDE			
*	100/07-33-082-22W600	660.8	1037.5	-376.7	1463.0	-802.2	1519.0	-858.2		
*	100/06-34-082-22W600	657.5	1032.0	-374.5	1457.0	-799.5	1509.0	-851.5		
*	100/11-35-082-22W600	661.4	1029.0	-367.6	1450.0	-788.6	1502.0	-840.6		
*	100/06-02-082-23W600	735.0	1155.0	-420.0	1584.0	-849.0	1655.0	-920.0	1900.0	-1165.0
*	100/06-05-082-23W600	692.4	1161.0	-468.6	1606.0	-913.6	1691.0	-998.6	1960.0	-1267.6
*	100/07-06-082-23W600	717.9	1184.0	-466.1	1634.0	-916.1	1728.0	-1010.1	1984.0	-1266.1
*	100/08-26-082-23W600	669.0	1084.8	-415.8	1509.4	-840.4	1573.1	-904.1		
*	100/10-27-082-23W600	668.5	1072.0	-403.5	1502.5	-834.0	1572.0	-903.5	1790.0	-1121.5
*	100/06-03-082-24W600	677.0	1154.0	-477.0	1615.0	-938.0	1673.0	-996.0	1993.0	-1316.0
*	100/10-01-082-25W600	667.2	1137.5	-470.3	1647.4	-980.2	1703.8	-1036.6	1890.1	-1222.9
*	100/06-05-083-19W600	646.2	1172.6	-526.4	1534.4	-888.2	1555.1	-908.9	1679.4	-1033.2
*	100/10-10-083-19W600	479.5	987.9	-508.4	1340.5	-861.0	1358.8	-879.3	1478.6	-999.1
*	100/07-12-083-19W600	478.0	988.0	-510.0	1336.0	-858.0	1353.5	-875.5	1467.0	-989.0
*	100/11-17-083-19W600	635.5	1115.6	-480.1	1463.0	-827.5	1481.3	-845.8	1595.0	-959.5
*	100/10-18-083-19W600	642.2	1102.5	-460.3	1448.5	-806.3	1466.0	-823.8	1588.0	-945.8
*	100/08-19-083-19W600	642.4	1103.0	-460.6	1451.0	-808.6	1472.0	-829.6		
*	100/10-19-083-19W600	643.1	1107.3	-464.2	1458.8	-815.7	1476.5	-833.4	1585.0	-941.9
	100/11-20-083-19W600	642.5	1108.9	-466.4	1450.8	-808.3	1469.1	-826.6	?	
	100/07-24-083-19W600	628.8	1133.9	-505.1	1467.3	-838.5	1487.4	-858.6	1591.1	-962.3
*	100/07-25-083-19W600	655.6	1150.3	-494.7	1481.3	-825.7	1499.6	-844.0	1613.6	-958.0
*	100/11-26-083-19W600	660.2	1136.0	-475.8	1470.0	-809.8	1494.0	-833.8		
*	100/10-27-083-19W600	644.7	1124.1	-479.4	1460.0	-815.3	1480.1	-835.4		
D	100/07-28-083-19W600	655.9	1138.4	-482.5	1479.2	-823.3	1497.2	-841.3	1633.7	-977.8
*	102/07-28-083-19W600	656.5	1160.5	-504.0	? NDE					
*	100/07-30-083-19W600	517.9	983.9	-466.0	1329.2	-811.3	1347.2	-829.3	1456.3	-938.4
*	100/10-31-083-19W600	660.8	1147.9	-487.1	1488.6	-827.8	1503.3	-842.5		
*	100/10-32-083-19W600	663.5	1148.8	-485.3	1487.4	-823.9	1501.4	-837.9		
?	100/11-34-083-19W600	661.4	1147.0	-485.6	1472.8	-811.4	1494.1	-832.7		
*	100/13-34-083-19W600	681.2	1166.5	-485.3	?		?		?	
*	100/10-02-083-20W600	652.1	1133.0	-480.9	1493.5	-841.4	1513.0	-860.9		

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/07-17-082-21W600	1946.5	-1287.0								
100/10-19-082-21W600			NDE				NDE			
100/07-21-082-21W600	1960.0	-1304.0	? NP		0.0		? NP		0.0	
100/06-22-082-21W600			NDE				NDE			
100/06-23-082-21W600			NDE				NDE			
100/11-24-082-21W600			NDE				NDE			
100/06-25-082-21W600										
100/06-26-082-21W600			NDE				NDE			
100/11-26-082-21W600	1905.5	-1264.6	? NP		0.0		1616.5	-975.6	0.0	11.0
100/07-27-082-21W600	1896.5	-1257.6	?NP			0.0	1585.0	-946.1	5.0	40.0
100/15-28-082-21W600			NDE				NDE			
100/10-29-082-21W600			1505.0	-871.3	1.5	4.0				
100/09-33-082-21W600			NDE				NDE			
100/07-34-082-21W600			NDE				NDE			
100/11-35-082-21W600			1507.0	-870.4	1.5	5.0	? NP		0.0	
100/07-02-082-22W600	2007.0	-1339.8	? NP		0.0		? NP		0.0	
100/10-15-082-22W600			NDE				NDE			
100/06-17-082-22W600	1989.0	-1318.4	?				?			
100/11-20-082-22W600			? NDE				NDE			
100/04-23-082-22W600			NDE				NDE			
100/10-23-082-22W600			NDE				NDE			
100/11-28-082-22W600			NDE				NDE			
100/07-31-082-22W600			NDE				NDE			
100/01-32-082-22W600			NDE				NDE			
100/07-33-082-22W600			NDE				NDE			
100/06-34-082-22W600			? NDE				NDE			
100/11-35-082-22W600			NDE				NDE			
100/06-02-082-23W600	2114.0	-1379.0	? NP		0.0		? NP		0.0	
100/06-05-082-23W600	2132.0	-1439.6	? NP		0.0		? NP		0.0	
100/07-06-082-23W600	2152.0	-1434.1					1769.0	-1051.1	6.0	
100/08-26-082-23W600			NDE				NDE			
100/10-27-082-23W600	2027.0	-1358.5	? NP		0.0		? NP		0.0	
100/06-03-082-24W600	2163.5	-1486.5	NP		0.0	0.0	? NP		0.0	
100/10-01-082-25W600	2194.3	-1527.1	? NP		0.0		? NP		0.0	
100/06-05-083-19W600	1993.4	-1347.2	1605.6	-959.4	12.5		? NP		0.0	
100/10-10-083-19W600	1795.3	-1315.8	1424.6	-945.1	7.9		? NP		0.0	
100/07-12-083-19W600	1796.0	-1318.0	1415.0	-937.0	0.0	1.0	? NP		0.0	
100/11-17-083-19W600	1917.2	-1281.7	? NP		0.0		? NP		0.0	
100/10-18-083-19W600	1910.0	-1267.8	1487.0	-844.8	10?	49.5	? NP		0.0	
100/08-19-083-19W600			? NDE							
100/10-19-083-19W600	1902.0	-1258.9	? NP		0.0		? NP		0.0	
100/11-20-083-19W600	1892.5	-1250.0								
100/07-24-083-19W600	1919.9	-1291.1								
100/07-25-083-19W600	1932.4	-1276.8								
100/11-26-083-19W600			? NDE							
100/10-27-083-19W600			NDE							
100/07-28-083-19W600	1921.2	-1265.3	1517.8	-861.9	? 3.7	3.7	? 1538.6	-882.7	?	
102/07-28-083-19W600										
100/07-30-083-19W600	1771.5	-1253.6	1374.6	-856.7	? 4.2	4.2	? NP		0.0	
100/10-31-083-19W600			NDE							
100/10-32-083-19W600			1532.5	-869.0	2.4		NDE			
100/11-34-083-19W600										
100/13-34-083-19W600	1933.3	-1252.1								
100/10-02-083-20W600			? 1543	-890.9	>2.0		NDE			

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/07-17-082-21W600				
100/10-19-082-21W600				
100/07-21-082-21W600				
100/06-22-082-21W600				
100/06-23-082-21W600				
100/11-24-082-21W600				
100/06-25-082-21W600				
100/06-26-082-21W600				
100/11-26-082-21W600				silt at 1616.5 (11m): = 2nd Doig Sand Eq?
100/07-27-082-21W600				1500 - FS(1st doig eqv.); 1585 - TSE?; 1620 - TSE?
100/15-28-082-21W600				
100/10-29-082-21W600				
100/09-33-082-21W600				
100/07-34-082-21W600				
100/11-35-082-21W600				MNTNY pick questionable
100/07-02-082-22W600				1631 - FS
100/10-15-082-22W600				
100/06-17-082-22W600				1584 - FS
100/11-20-082-22W600				
100/04-23-082-22W600				
100/10-23-082-22W600				Doig at 1527.0m or 1530.7m
100/11-28-082-22W600				
100/07-31-082-22W600				
100/01-32-082-22W600				
100/07-33-082-22W600				
100/06-34-082-22W600				
100/11-35-082-22W600				
100/06-02-082-23W600				MNTNY pick not checked
100/06-05-082-23W600				MNTNY pick not checked; DOIG at 1700m?
100/07-06-082-23W600				MNTNY pick not checked
100/08-26-082-23W600				
100/10-27-082-23W600				
100/06-03-082-24W600				MNTNY pick not checked
100/10-01-082-25W600				e-log
100/06-05-083-19W600				
100/10-10-083-19W600				
100/07-12-083-19W600				
100/11-17-083-19W600				no detail gamma ray log run through DOIG - MNTNY interval
100/10-18-083-19W600				FS at 1550m : Questionable gamma correlation (sand Cut-off at 45 API)
100/08-19-083-19W600				
100/10-19-083-19W600				
100/11-20-083-19W600				
100/07-24-083-19W600				e-log
100/07-25-083-19W600				e-log
100/11-26-083-19W600				
100/10-27-083-19W600				
100/07-28-083-19W600				
102/07-28-083-19W600				
100/07-30-083-19W600				
100/10-31-083-19W600				
100/10-32-083-19W600				
100/11-34-083-19W600				
100/13-34-083-19W600				
100/10-02-083-20W600	X			Sand at base log coverage

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
•	100/06-05-083-20W600	645.9	1116.2	-470.3	1501.4	-855.5	1521.0	-875.1		
D	100/06-06-083-20W600	635.8	1074.4	-438.6	1463.0	-827.2	1483.2	-847.4		
•	100/06-07-083-20W600	634.6	1191.5	-556.9	1451.9	-817.3	dev.			
•	100/06-10-083-20W600	637.0	1116.0	-479.0	1495.0	-858.0	1516.0	-879.0		
•	100/10-12-083-20W600	648.6	1121.5	-472.9	1480.0	-831.4	1499.0	-850.4	1627.0	-978.4
•	100/08-13-083-20W600	640.0	1101.0	-461.0	1457.5	-817.5	1477.0	-837.0		
•	100/10-14-083-20W600	641.9	1111.0	-469.1	1477.7	-835.8	1493.5	-851.6	?	
•	100/11-16-083-20W600	638.6	1088.4	-449.8	1466.1	-827.5	1486.2	-847.6		
•	100/11-18-083-20W600	633.0	1076.0	-443.0	1474.0	-841.0	1500.0	-867.0		
•	100/11-19-083-20W600	639.6	1088.0	-448.4	1481.0	-841.4	1501.0	-861.4		
•	100/06-22-083-20W600	487.7	944.9	-457.2	1318.0	-830.3	NDE			
•	100/11-28-083-20W600	470.3	949.5	-479.2	1343.0	-872.7	1362.0	-891.7		
•	100/09-33-083-20W600	635.2	1092.1	-456.9	1454.8	-819.6	1478.3	-843.1	1576.4	-941.2
•	100/06-35-083-20W600	644.3	1113.7	-469.4	1466.7	-822.4	1481.9	-837.6		
•	100/10-01-083-21W600	623.6	1050.0	-426.4	1444.0	-820.4	1466.5	-842.9		
•	100/10-02-083-21W600	626.2	1037.0	-410.8	1439.0	-812.8	1467.0	-840.8		
•	100/10-03-083-21W600	654.1	1054.3	-400.2	1464.8	-810.7	1490.1	-836.0		
•	100/10-04-083-21W600	654.7	1040.0	-385.3	1458.0	-803.3	1483.0	-828.3	1634.0	-979.3
•	100/14-05-083-21W600	656.8	1040.0	-383.2	1458.0	-801.2	1487.0	-830.2		
•	100/10-06-083-21W600	661.7	1043.0	-381.3	1470.0	-808.3	1495.0	-833.3		
•	100/07-07-083-21W600	658.7	1042.0	-383.3	1464.5	-805.8	1490.0	-831.3		
•	100/07-08-083-21W600	660.3	1050.0	-389.7	1464.0	-803.7	1490.0	-829.7		
•	100/06-10-083-21W600	662.9	1051.6	-388.7	1459.3	-796.4	1484.3	-821.4		
•	100/10-10-083-21W600	655.0	1045.0	-390.0	1447.0	-792.0	1465.0	-810.0		
•	100/10-11-083-21W600	636.3	1048.0	-411.7	1441.0	-804.7	1463.0	-826.7		
•	100/14-12-083-21W600	628.9	1056.5	-427.6	1459.0	-830.1	1493.5	-864.6		
•	100/11-13-083-21W600	635.5	1062.5	-427.0	1444.5	-809.0	1471.0	-835.5		
•	100/10-14-083-21W600	638.6	1045.0	-406.4	1430.0	-791.4	1459.5	-820.9		
•	100/10-15-083-21W600	642.2	1034.0	-391.8	1425.0	-782.8	1446.5	-804.3		
•	100/07-16-083-21W600	663.9	1050.0	-386.1	1459.0	-795.1	1483.0	-819.1		
•	100/11-19-083-21W600	662.7	1080.0	-417.3	1492.0	-829.3	1515.0	-852.3		
•	100/06-21-083-21W600	646.3	1045.0	-398.7	1440.0	-793.7	1462.0	-815.7		
•	100/10-22-083-21W600	636.7	1044.0	-407.3	1422.0	-785.3	1442.0	-805.3		
•	100/10-23-083-21W600	632.3	1055.0	-422.7	1433.0	-800.7	1457.0	-824.7		
•	102/11-24-083-21W600	633.8	1075.0	-441.2	1454.0	-820.2	1478.0	-844.2	1585.0	-951.2
•	100/06-26-083-21W600	633.8	1108.0	-474.2	?		1512.5	-878.7		
•	100/10-29-083-21W600	636.2	1038.0	-401.8	1428.5	-792.3	1448.0	-811.8		
	100/07-33-083-21W600	626.9	1050.5	-423.6	1416.0	-789.1	1437.0	-810.1		
•	100/04-34-083-21W600	628.8	1071.1	-442.3	1430.1	-801.3	1450.5	-821.7	1555.9	-927.1
•	100/06-36-083-21W600	623.3	1085.0	-461.7	1461.0	-837.7	1484.0	-860.7		
•	100/06-02-083-22W600	658.0	1034.5	-376.5	1455.5	-797.5	1504.0	-846.0		
?	100/07-03-083-22W600	665.0	1050.0	-384.0	1469.0	-803.0	1520.0	-854.0		
	100/06-09-083-22W600	674.5	1099.7	-425.2	1524.5	-850.0	1579.4	-904.9		
?	100/01-27-083-22W600	661.6	1136.0	-474.4	1537.0	-875.4	1610.0	-948.4		
•	100/06-21-083-23W600	652.9	1164.5	-511.6	1556.0	-903.1	1607.0	-954.1		
•	100/12-11-083-24W600	657.5	1212.5	-555.0	1624.5	-967.0	NDE			
•	100/06-17-083-24W600	674.0	1225.0	-551.0	1651.0	-977.0	1730.0	-1056.0	1941.0	-1267.0
	100/10-36-083-25W600	715.3	1335.5	-620.2	1783.0	-1067.7	1815.0	-1099.7	2015.0	-1299.7
•	100/11-07-084-19W600	735.8	1248.0	-512.2	1558.0	-822.2	1582.0	-846.2		
•	100/06-13-084-19W600	718.7	1212.5	-493.8	1498.1	-779.4	1531.6	-812.9	1607.5	-888.8
	100/02-18-084-19W600	762.0	1257.9	-495.9	1575.8	-813.8	1606.3	-844.3	1686.5	-924.5
	100/11-21-084-19W600	729.4	1216.2	-486.8	1513.3	-783.9	1543.8	-814.4	1615.4	-886.0
	100/13-01-084-20W600	818.7	1317.0	-498.3	1631.0	-812.3	1664.2	-845.5	1751.7	-933.0
•	100/07-02-084-20W600	755.0	1228.3	-473.3	1564.9	-809.9	1581.9	-826.9		

WELL ID	Base Triassic		1st Dolg Sand		Thickness		2nd Dolg Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/06-05-083-20W600			NDE							
100/06-06-083-20W600										
100/06-07-083-20W600										
100/06-10-083-20W600			1538.0	-901.0	7.0		NDE			
100/10-12-083-20W600	1943.0	-1294.4	1567.0	-918.4	15.5	19.0	? NP		0.0	
100/08-13-083-20W600			NDE							
100/10-14-083-20W600	1932.4	-1290.5	1548.9	-907.0	10.4	11.6				
100/11-16-083-20W600			? 1504.4							
100/11-18-083-20W600										
100/11-19-083-20W600										
100/06-22-083-20W600										
100/11-28-083-20W600			NDE							
100/09-33-083-20W600	1886.7	-1251.5	1566.1	-930.9	1.2	2.0	? NP		0.0	
100/06-35-083-20W600			1518.4	-874.1	FS	FS				
100/10-01-083-21W600			NDE				NDE			
100/10-02-083-21W600			NDE				NDE			
100/10-03-083-21W600			? NDE				NDE			
100/10-04-083-21W600	1908.0	-1253.3	? NP		0.0		? NP		0.0	
100/14-05-083-21W600							NDE			
100/10-06-083-21W600			NDE				NDE			
100/07-07-083-21W600							1580.0	-921.3	5.0	6.5
100/07-08-083-21W600			NDE				NDE			
100/06-10-083-21W600			NDE				NDE			
100/10-10-083-21W600			NDE				NDE			
100/10-11-083-21W600			NDE				NDE			
100/14-12-083-21W600			NDE				NDE			
100/11-13-083-21W600			?1594	-958.5	0.0		1527.0	-891.5	0.0	? 52
100/10-14-083-21W600			NDE							
100/10-15-083-21W600			NDE							
100/07-16-083-21W600							1566.0	-902.1	?	NDE
100/11-19-083-21W600							1586.0	-923.3	0.0	2.0
100/06-21-083-21W600			?				NDE			
100/10-22-083-21W600							? 1467.5	-830.8	?	NDE
100/10-23-083-21W600			NDE				NDE			
102/11-24-083-21W600			?NP		0.0		1509.5	-875.7	0.0	
100/06-26-083-21W600			NDE				1515.0	-881.2	2.0	
100/10-29-083-21W600			? NDE				NDE			
100/07-33-083-21W600			NDE				NDE		-	
100/04-34-083-21W600	1841.6	-1212.8	?NP		0.0		1474.6	-845.8	11.0	16.5
100/06-36-083-21W600			?1542	-918.7	>7.0	OFF-SC	1510.0	-886.7	9.0	
100/06-02-083-22W600										
100/07-03-083-22W600			NDE				NDE			
100/06-09-083-22W600			?							
100/01-27-083-22W600										
100/06-21-083-23W600			NDE				NDE			
100/12-11-083-24W600										
100/06-17-083-24W600	2265.0	-1591.0	? NP		0.0		? 1750	-1076.0	13.0	18.0
100/10-36-083-25W600	2317.0	-1601.7	? NP		0.0		1824.0	-1108.7	10.0	
100/11-07-084-19W600										
100/06-13-084-19W600	1887.3	-1168.6	? NP		0.0		? NP		0.0	
100/02-18-084-19W600	1981.2	-1219.2								
100/11-21-084-19W600	1892.8	-1163.4								
100/13-01-084-20W600	2051.9	-1233.2								
100/07-02-084-20W600			? NDE				NDE			

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/06-05-083-20W600				
100/06-06-083-20W600				
100/06-07-083-20W600				
100/06-10-083-20W600				
100/10-12-083-20W600				
100/08-13-083-20W600				
100/10-14-083-20W600				
100/11-16-083-20W600				
100/11-18-083-20W600				
100/11-19-083-20W600				
100/06-22-083-20W600				
100/11-28-083-20W600				
100/09-33-083-20W600				
100/06-35-083-20W600				
100/10-01-083-21W600				
100/10-02-083-21W600				
100/10-03-083-21W600				
100/10-04-083-21W600				
100/14-05-083-21W600				
100/10-06-083-21W600				
100/07-07-083-21W600				
100/07-08-083-21W600				
100/06-10-083-21W600				
100/10-10-083-21W600				
100/10-11-083-21W600				
100/14-12-083-21W600				
100/11-13-083-21W600				
100/10-14-083-21W600				
100/10-15-083-21W600				
100/07-16-083-21W600				
100/11-19-083-21W600				
100/06-21-083-21W600				
100/10-22-083-21W600				
100/10-23-083-21W600				
102/11-24-083-21W600				
100/06-26-083-21W600				
100/10-29-083-21W600				
100/07-33-083-21W600				
100/04-34-083-21W600				
100/06-36-083-21W600				7m officale gamma response at base log (2nd DOIG Sand?)
100/06-02-083-22W600				
100/07-03-083-22W600				
100/06-09-083-22W600				
100/01-27-083-22W600				no fiche available
100/06-21-083-23W600				
100/12-11-083-24W600				
100/06-17-083-24W600				
100/10-36-083-25W600				
100/11-07-084-19W600				
100/06-13-084-19W600				
100/02-18-084-19W600				
100/11-21-084-19W600				
100/13-01-084-20W600				e-log
100/07-02-084-20W600				

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
•	100/06-13-084-20W600	754.7	1257.0	-502.3	1580.7	-826.0	1594.7	-840.0		
•	100/05-15-084-20W600	691.5	1204.0	-512.5	1537.0	-845.5	1553.0	-861.5		
•	100/07-16-084-20W600	750.1	1253.3	-503.2	1588.3	-838.2	1604.5	-854.4	1702.9	-952.8
	100/11-18-084-20W600	857.4	1341.1	-483.7	1678.8	-821.4	1709.3	-851.9		
•	100/11-26-084-20W600	793.9	1288.0	-494.1	1604.0	-810.1	1618.0	-824.1		
	100/06-27-084-20W600	845.2	1338.4	-493.2	1655.1	-809.9	NDE			
•	100/06-30-084-20W600	810.2	1303.9	-493.7	1637.4	-827.2	1653.8	-843.6		
•	100/06-34-084-20W600	826.9	1332.0	-505.1	1644.0	-817.1	1656.0	-829.1	1752.5	-925.6
•	100/10-03-084-21W600	617.8	1083.6	-465.8	1427.7	-809.9	1449.0	-831.2		
•	100/07-08-084-21W600	507.5	965.0	-457.5	1321.0	-813.5	1340.0	-832.5	1449.0	-941.5
•	100/11-09-084-21W600	483.7	949.5	-465.8	1303.0	-819.3	1327.0	-843.3		
•	100/12-12-084-21W600	498.8	983.0	-484.2	1325.0	-826.2	1340.0	-841.2	1450.0	-951.2
•	100/10-14-084-21W600	772.5	1255.0	-482.5	1609.0	-836.5	1626.0	-853.5		
•	100/10-22-084-21W600	650.4	1148.0	-497.6	1491.0	-840.6	1512.0	-861.6		
•	100/12-24-084-21W600	782.4	1269.0	-486.6	1616.0	-833.6	1630.5	-848.1	1728.0	-945.6
•	100/11-27-084-21W600	650.7	1140.0	-489.3	1482.2	-831.5	1502.4	-851.7	1593.5	-942.8
•	100/02-28-084-21W600	622.7	1112.5	-489.8	1460.0	-837.3	1482.0	-859.3		
•	100/10-32-084-21W600	755.9	1232.9	-477.0	1588.0	-832.1	1607.5	-851.6		
•	100/06-08-084-22W600	639.5	1124.1	-484.6	1512.4	-872.9	1554.4	-914.9	1669.9	-1030.4
•	100/06-10-084-22W600	629.1	1115.0	-485.9	1491.5	-862.4	1527.0	-897.9	1641.0	-1011.9
•	100/15-17-084-22W600	636.2	1161.0	-524.8	1530.0	-893.8	1563.0	-926.8	1673.0	-1036.8
•	100/07-20-084-22W600	637.3	1144.5	-507.2	1515.5	-878.2	1552.6	-915.3	1659.9	-1022.6
•	100/07-22-084-22W600	637.0	1126.2	-489.2	1491.1	-854.1	1531.9	-894.9	1630.6	-993.6
•	100/07-26-084-22W600	698.0	1187.0	-489.0	1555.0	-857.0	1575.0	-877.0	1678.5	-980.5
•	102/07-26-084-22W600	698.0	1187.3	-489.3	1554.0	-856.0	1572.5	-874.5	1676.0	-978.0
•	100/06-29-084-22W600	636.5	1154.0	-517.5	1527.0	-890.5	1562.0	-925.5	1669.0	-1032.5
•	100/01-12-084-23W600	646.8	1133.9	-487.1	1524.0	-877.2	1569.7	-922.9	1688.6	-1041.8
•	100/04-24-084-23W600	646.8	1172.0	-525.2	1549.5	-902.7	1594.0	-947.2	1705.5	-1058.7
•	100/16-25-084-23W600	648.6	1176.5	-527.9	1543.4	-894.8	NDE			
•	100/06-29-084-23W600	662.0	1228.0	-566.0	1612.0	-950.0	1647.0	-985.0		
•	100/10-29-084-23W600	657.8	1209.4	-551.6	1589.1	-931.3	1628.5	-970.7		
•	100/05-05-084-24W600	766.6	1385.0	-618.4	? 1795.2	-1028.6	? 1833.0	-1066.4	2008.5	-1241.9
•	100/07-19-084-24W600	732.7	1310.3	-577.6	1698.3	-965.6	1754.3	-1021.6	1890.6	-1157.9
•	102/04-31-084-24W600	724.5	1272.0	-547.5	1664.5	-940.0	? 1707.0	-982.5		
•	100/10-22-084-25W600	719.9	1415.0	-695.1	1819.0	-1099.1	1847.0	-1127.1	2007.0	-1287.1
•	100/11-03-085-20W600	838.9	1338.0	-499.1	1650.0	-811.1	1776.0	-937.1	NDE	
•	100/10-06-085-20W600	765.5	1254.5	-489.0	1580.0	-814.5	1600.0	-834.5	1686.0	-920.5
	100/06-07-085-20W600	839.4	1327.7	-488.3	1650.5	-811.1	1674.3	-834.9	1757.2	-917.8
•	100/11-10-085-20W600	796.1	1289.9	-493.8	1597.7	-801.6	1617.2	-821.1	1705.6	-909.5
•	100/06-13-085-20W600	755.0	1249.7	-494.7	1545.0	-790.0	1562.3	-807.3	1651.9	-896.9
•	100/14-16-085-20W600	776.6	1272.0	-495.4	1580.0	-803.4	1600.0	-823.4	1690.0	-913.4
•	100/06-18-085-20W600	859.0	1354.0	-495.0	1667.0	-808.0	1702.0	-843.0	1785.0	-926.0
•	100/06-21-085-20W600	808.3	1309.0	-500.7	1615.0	-806.7	1634.0	-825.7		
•	100/08-21-085-20W600	756.1	1246.5	-490.4	1552.0	-795.9	1572.0	-815.9	1662.0	-905.9
•	100/16-21-085-20W600	744.5	1242.0	-497.5	NDE					
•	102/16-21-085-20W600	742.5	1238.5	-496.0	1538.0	-795.5	1557.0	-814.5	1647.0	-904.5
•	100/12-22-085-20W600	734.6	1230.0	-495.4	1528.0	-793.4	1547.0	-812.4	1637.0	-902.4
•	100/14-22-085-20W600	752.3	1248.0	-495.7	1544.0	-791.7	1561.0	-808.7	1651.0	-898.7
?	100/15-22-085-20W600	706.8	1206.0	-499.2	1501.0	-794.2				
?	100/16-22-085-20W600	703.6	1203.0	-499.4	1498.0	-794.4	1516.0	-812.4	1605.5	-901.9
•	100/08-23-085-20W600	723.4	1215.0	-491.6	1509.7	-786.3	1540.0	-816.6	1599.0	-875.6
•	100/14-23-085-20W600	735.0	1229.0	-494.0	1521.0	-786.0	1536.0	-801.0	1630.0	-895.0
•	100/16-23-085-20W600	739.7	1229.0	-489.3	1522.0	-782.3	1540.0	-800.3	1630.0	-890.3
•	100/08-24-085-20W600	800.5	1296.5	-496.0	1590.0	-789.5	1606.0	-805.5	1697.0	-896.5

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/06-13-084-20W600			? NDE				NDE			
100/05-15-084-20W600										
100/07-16-084-20W600	2009.2	-1259.1	1688.8	-938.7	0.0	4.0	? NP		0.0	
100/11-18-084-20W600										
100/11-26-084-20W600			NDE							
100/06-27-084-20W600										
100/06-30-084-20W600			NDE							
100/06-34-084-20W600	2045.0	-1218.1	1726.0	-899.1	0.0	5.0	? NP		0.0	
100/10-03-084-21W600			NDE				NDE			
100/07-08-084-21W600	1745.0	-1237.5	? 1428	-920.5	0.0	3.0	? NP		0.0	
100/11-09-084-21W600							1358.0	-874.3	10.0	offscale
100/12-12-084-21W600	1746.0	-1247.2	? 1432	-933.2	0.0	4.0	1358.5	-859.7	11.0	13.5
100/10-14-084-21W600			?							
100/10-22-084-21W600			NDE				NDE			
100/12-24-084-21W600			? 1707	-924.6	3.0		1648.0	-865.6	?5.0	27.0
100/11-27-084-21W600	1890.7	-1240.0	1566.6	-915.9	? 4.3	4.3	1520.9	-870.2	3.0	3.5
100/02-28-084-21W600			1547.0	-924.3	3.0	5.0				
100/10-32-084-21W600			1670.8	-914.9	3.0	4.0				
100/06-08-084-22W600	1973.6	-1334.1					1642.8	-1003.3	0.0	2.4
100/06-10-084-22W600	1950.5	-1321.4					1619.5	-990.4	3.5	4.0
100/15-17-084-22W600	1980.0	-1343.8	NP		0.0	0.0	? NP		0.0	
100/07-20-084-22W600	1957.7	-1320.4	? NP		0.0		? NP		0.0	
100/07-22-084-22W600	1931.5	-1294.5	? NP		0.0		? NP		0.0	
100/07-26-084-22W600	1975.0	-1277.0	? NP		0.0		1647.5	-949.5	1.5	2.0
102/07-26-084-22W600	1974.0	-1276.0	? NP		0.0		1645.0	-947.0	2.0	3.0
100/06-29-084-22W600	1975.0	-1338.5	NP		0.0	0.0	NP		0.0	0.0
100/01-12-084-23W600	1996.4	-1349.6	? NP		0.0		? NP		0.0	
100/04-24-084-23W600	2026.5	-1379.7	? NP		0.0		? 1664	-1017.2	0.0	2.0
100/16-25-084-23W600										
100/06-29-084-23W600							1678.0	-1016.0	spike at end log	
100/10-29-084-23W600			NDE				NDE			
100/05-05-084-24W600	2343.9	-1577.3	? 1975.6	-1209.0		3.7	1906.7	-1140.1		4.0
100/07-19-084-24W600	2231.7	-1499.0	? NP		0.0		? NP		0.0	
102/04-31-084-24W600			NDE				NDE			
100/10-22-084-25W600	2335.3	-1615.4	? NP		0.0		? NP		0.0	
100/11-03-085-20W600			? 1686	-847.1	4.0	4.0				
100/10-06-085-20W600	1976.5	-1211.0	? 1652.5	-887.0	trace	5.0	? NP		0.0	
100/06-07-085-20W600	2048.0	-1208.6								
100/11-10-085-20W600	1988.5	-1192.4	? NP		0.0		? NP		0.0	
100/06-13-085-20W600	1933.0	-1178.0	1611.7	-856.7	0.0	6.1	? NP		0.0	
100/14-16-085-20W600	1973.0	-1196.4	1649.0	-872.4	1.5	7.0	? NP		0.0	
100/06-18-085-20W600	2077.0	-1218.0	1745.0	-886.0	0.0	7.0	? NP		0.0	
100/06-21-085-20W600			NDE							
100/08-21-085-20W600	1942.5	-1186.4	1619.5	-863.4	1.0	6.5	? NP		0.0	
100/16-21-085-20W600										
102/16-21-085-20W600	1926.0	-1183.5	1603.0	-860.5	0.0	8.0	? NP		0.0	
100/12-22-085-20W600	1915.0	-1180.4	1594.0	-859.4	1.0	6.0	? NP		0.0	
100/14-22-085-20W600	1930.5	-1178.2	1608.0	-855.7	7.0	7.0	? NP		0.0	
100/15-22-085-20W600	1975.0	-1268.2								
100/16-22-085-20W600	1885.5	-1181.9	1559.0	-855.4	0.0	10.0	? NP		0.0	
100/08-23-085-20W600	1895.7	-1172.3	? NP		0.0		? NP		0.0	
100/14-23-085-20W600	1906.0	-1171.0	1584.0	-849.0	? 7	7.0	? NP		0.0	
100/16-23-085-20W600	1907.0	-1167.3	1582.5	-842.8	? 8.5	8.5	? NP		0.0	
100/08-24-085-20W600	1974.5	-1174.0	1650.0	-849.5	? 8	8.0	? NP		0.0	

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/06-13-084-20W600				
100/05-15-084-20W600				1554 - FS; 1582.5 - FS (Subsea: -862.5m and -891.0m)
100/07-16-084-20W600				1605.6 - FS; 1610.5 - FS; 1618.7 - FS (Subsea: -855.5m, -860.4m, -868.4m)
100/11-18-084-20W600				e-log
100/11-26-084-20W600				
100/06-27-084-20W600				
100/06-30-084-20W600				
100/06-34-084-20W600				
100/10-03-084-21W600				
100/07-08-084-21W600				
100/11-09-084-21W600				
100/12-12-084-21W600				
100/10-14-084-21W600				
100/10-22-084-21W600				
100/12-24-084-21W600			D	1675 : Erosional Break?
100/11-27-084-21W600				
100/02-28-084-21W600		X		
100/10-32-084-21W600				
100/06-08-084-22W600				
100/06-10-084-22W600				
100/15-17-084-22W600				
100/07-20-084-22W600				1.0m silt on top of 1st Phosphate
100/07-22-084-22W600				1.0m silt on top of 1st Phosphate
100/07-26-084-22W600				
102/07-26-084-22W600				
100/06-29-084-22W600				
100/01-12-084-23W600				only e-log below 2700 feet (823m)
100/04-24-084-23W600				
100/16-25-084-23W600				
100/06-29-084-23W600				
100/10-29-084-23W600				
100/05-05-084-24W600				
100/07-19-084-24W600				
102/04-31-084-24W600				
100/10-22-084-25W600				
100/11-03-085-20W600	X			
100/10-06-085-20W600				
100/06-07-085-20W600				e-log
100/11-10-085-20W600				crude quality gamma log
100/06-13-085-20W600				1579.3 - FS (Subsea: -824.3)
100/14-16-085-20W600				1615.5 - FS (Subsea: -838.9)
100/06-18-085-20W600				
100/06-21-085-20W600				
100/08-21-085-20W600				
100/16-21-085-20W600				
102/16-21-085-20W600				
100/12-22-085-20W600				
100/14-22-085-20W600				
100/15-22-085-20W600				
100/16-22-085-20W600				
100/08-23-085-20W600				
100/14-23-085-20W600				1st Doig Sand Eq. - 7m sandy silt
100/16-23-085-20W600				1st Doig Sand Eq. - 8.5m sand ?
100/08-24-085-20W600				1st Doig Sand Eq. - 8m sandy silt

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
•	100/14-24-085-20W600	750.1	1237.3	-487.2	1531.0	-780.9	1551.0	-800.9	1639.0	-888.9
•	100/16-24-085-20W600	785.7	1271.0	-485.3	1563.0	-777.3	1581.0	-795.3	1670.0	-884.3
	100/06-25-085-20W600	775.5	1261.0	-485.5	1551.0	-775.5	1579.0	-803.5	1657.5	-882.0
	100/08-25-085-20W600	759.6	1250.0	-490.4	1539.5	-779.9	1566.0	-806.4	1644.5	-884.9
	100/14-25-085-20W600	816.8	1306.5	-489.7	1595.5	-778.7	1622.0	-805.2	1702.5	-885.7
	100/16-25-085-20W600	781.3	1273.5	-492.2	1561.0	-779.7	1591.0	-809.7	1666.0	-884.7
	100/04-26-085-20W600	703.0	1198.0	-495.0	1491.0	-788.0	1519.0	-816.0	1604.0	-901.0
	100/05-26-085-20W600	717.6	1210.5	-492.9	1505.0	-787.4	1548.0	-830.4	1615.0	-897.4
	100/06-26-085-20W600	737.0	1229.0	-492.0	1521.5	-784.5	1552.0	-815.0	1630.0	-893.0
	100/08-26-085-20W600	766.3	1256.0	-489.7	1548.5	-782.2	1576.5	-810.2	1657.0	-890.7
	100/10-26-085-20W600	748.3	1235.0	-486.7	1527.0	-778.7	1555.0	-806.7	1635.0	-886.7
	100/12-26-085-20W600	710.4	1203.0	-492.6	1496.0	-785.6	1525.0	-814.6	1605.0	-894.6
	100/13-26-085-20W600	706.1	1199.5	-493.4	1500.0	-793.9	1535.0	-828.9	1610.0	-903.9
	100/14-26-085-20W600	757.2	1244.5	-487.3	1537.0	-779.8	1568.0	-810.8	1645.0	-887.8
	100/16-26-085-20W600	763.4	1251.5	-488.1	1542.0	-778.6	1569.0	-805.6	1648.5	-885.1
	100/02-27-085-20W600	765.0	1282.0	-517.0	1599.0	-834.0	1630.0	-865.0	1715.0	-950.0
•	100/04-27-085-20W600	738.6	1230.0	-491.4	1530.0	-791.4	1549.0	-810.4	1639.0	-900.4
•	100/06-27-085-20W600	769.0	1262.0	-493.0	1557.0	-788.0	1573.0	-804.0	1667.0	-898.0
	100/08-27-085-20W600	697.0	1191.5	-494.5	1485.1	-788.1	1513.0	-816.0	1596.0	-899.0
	100/09-27-085-20W600	700.1	1192.0	-491.9	1488.0	-787.9	1515.0	-814.9	1598.0	-897.9
	100/10-27-085-20W600	728.2	1220.0	-491.8	1517.0	-788.8	1550.0	-821.8	1624.0	-895.8
•	100/11-27-085-20W600	772.9	1265.0	-492.1	1561.0	-788.1	1576.0	-803.1	1671.0	-898.1
	100/14-27-085-20W600	771.1	1260.0	-488.9	1558.0	-786.9	1597.0	-825.9	1667.0	-895.9
	100/16-27-085-20W600	696.2	1185.0	-488.8	1482.0	-785.8	1510.0	-813.8	1590.0	-893.8
•	100/06-28-085-20W600	753.8	1250.6	-496.8	1556.2	-802.4	1573.9	-820.1	1663.9	-910.1
•	100/08-28-085-20W600	756.5	1250.0	-493.5	1549.0	-792.5	1568.0	-811.5	1656.5	-900.0
•	100/16-28-085-20W600	784.5	1276.0	-491.5	1573.0	-788.5	1589.0	-804.5	1683.0	-898.5
•	100/10-30-085-20W600	837.3	1334.7	-497.4	1645.2	-807.9	1677.0	-839.7	1755.6	-918.3
•	100/16-32-085-20W600	820.2	1314.5	-494.3	1612.7	-792.5	1640.0	-819.8	1725.5	-905.3
	100/06-33-085-20W600	826.0	1320.4	-494.4	1617.3	-791.3	1643.8	-817.8	1732.8	-906.8
•	100/08-33-085-20W600	803.5	1292.0	-488.5	1590.0	-786.5	1614.0	-810.5	1698.0	-894.5
•	100/14-33-085-20W600	798.3	1291.0	-492.7	1587.0	-788.7	1614.0	-815.7	1697.0	-898.7
	100/16-33-085-20W600	769.1	1256.0	-486.9	1552.5	-783.4	1578.0	-808.9	1660.0	-890.9
•	100/02-34-085-20W600	712.9	1206.0	-493.1	1502.0	-789.1	1529.0	-816.1	1610.0	-897.1
	100/06-34-085-20W600	765.7	1255.2	-489.5	1552.3	-786.6	1587.4	-821.7	1661.8	-896.1
	100/08-34-085-20W600	702.0	1190.5	-488.5	1483.5	-781.5	1510.0	-808.0	1590.0	-888.0
•	100/10-34-085-20W600	709.6	1199.0	-489.4	1495.0	-785.4	1521.7	-812.1	1603.5	-893.9
	100/14-34-085-20W600	728.1	1217.0	-488.9	1512.5	-784.4	1539.5	-811.4	1623.0	-894.9
	100/16-34-085-20W600	699.7	1187.0	-487.3	1479.6	-779.9	1512.0	-812.3	1590.0	-890.3
	100/02-35-085-20W600	770.8	1259.0	-488.2	1549.5	-778.7	1577.0	-806.2	1657.0	-886.2
	100/04-35-085-20W600	711.6	1201.0	-489.4	1492.0	-780.4	1520.0	-808.4	1600.0	-888.4
	100/06-35-085-20W600	743.1	1233.0	-489.9	1522.0	-778.9	1549.0	-805.9	1629.0	-885.9
•	100/07-35-085-20W600	748.6	1239.0	-490.4	1530.0	-781.4	1557.0	-808.4	1638.0	-889.4
	100/08-35-085-20W600	774.8	1266.1	-491.3	1558.7	-783.9	1588.6	-813.8	1664.5	-889.7
	102/08-35-085-20W600	768.1	1261.0	-492.9	1552.5	-784.4	1579.0	-810.9	1660.0	-891.9
•	100/10-35-085-20W600	755.9	1247.0	-491.1	1539.0	-783.1	1565.0	-809.1	1647.0	-891.1
•	100/12-35-085-20W600	765.2	1255.0	-489.8	1546.5	-781.3	1573.0	-807.8	1655.0	-889.8
	100/14-35-085-20W600	788.1	1280.0	-491.9	1572.0	-783.9	1598.0	-809.9	1681.0	-892.9
	100/15-35-085-20W600	773.1	1266.3	-493.2	1557.0	-783.9	1583.0	-809.9	1665.5	-892.4
	100/16-35-085-20W600	766.3	1261.0	-494.7	1550.0	-783.7	1575.0	-808.7	1656.5	-890.2
	100/04-36-085-20W600	797.8	1270.0	-472.2	1561.0	-763.2	1587.0	-789.2	1668.0	-870.2
	100/06-36-085-20W600	805.6	1299.1	-493.5	1585.6	-780.0	1612.4	-806.8	1690.7	-885.1
	100/08-36-085-20W600	822.7	1315.0	-492.3	1602.0	-779.3	1627.0	-804.3	1708.0	-885.3
•	100/12-36-085-20W600	798.2	1294.5	-496.3	1583.0	-784.8	1608.0	-809.8	1689.0	-890.8

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/14-24-085-20W600	1917.0	-1166.9	1591.0	-840.9	? 7	9.0	? NP		0.0	
100/16-24-085-20W600	1944.0	-1158.3	1623.0	-837.3	0.0	8.0	? NP		0.0	
100/06-25-085-20W600	1935.0	-1159.5								
100/08-25-085-20W600	1923.5	-1163.9								
100/14-25-085-20W600	1978.5	-1161.7								
100/16-25-085-20W600	1938.5	-1157.2								
100/04-26-085-20W600	1881.0	-1178.0								
100/05-26-085-20W600	1890.0	-1172.4								
100/06-26-085-20W600	1904.0	-1167.0								
100/08-26-085-20W600	1933.5	-1167.2								
100/10-26-085-20W600	1910.0	-1161.7								
100/12-26-085-20W600	1881.0	-1170.6								
100/13-26-085-20W600	1890.0	-1183.9								
100/14-26-085-20W600	1919.0	-1161.8								
100/16-26-085-20W600	1923.0	-1159.6								
100/02-27-085-20W600	2015.0	-1250.0								
100/04-27-085-20W600	1918.5	-1179.9	1594.0	-855.4	2.0	8.0	? NP		0.0	
100/06-27-085-20W600	1944.0	-1175.0	1620.0	-851.0	1.5	7.0	? NP		0.0	
100/08-27-085-20W600	1872.5	-1175.5								
100/09-27-085-20W600	1872.0	-1171.9								
100/10-27-085-20W600	1901.0	-1172.8								
100/11-27-085-20W600	1949.0	-1176.1	1625.0	-852.1	1.5	7.0	? NP		0.0	
100/14-27-085-20W600	1940.0	-1168.9								
100/16-27-085-20W600	1867.5	-1171.3								
100/06-28-085-20W600	1940.1	-1186.3	1618.4	-864.6	sand ?	9.8	? NP		0.0	
100/08-28-085-20W600	1932.5	-1176.0	1612.0	-855.5	1.0	8.0	? NP		0.0	
100/16-28-085-20W600	1957.5	-1173.0	1634.0	-849.5	1.5	16.0	? NP		0.0	
100/10-30-085-20W600	2036.1	-1198.8	? 1711	-873.0	sand ?	6.7	? NP		0.0	
100/16-32-085-20W600			1672.0	-851.8	2.5	14.0	? NP		0.0	
100/06-33-085-20W600	2006.2	-1180.2								
100/08-33-085-20W600	1972.0	-1168.5	1648.0	-844.5	0.0	12.0	? NP		0.0	
100/14-33-085-20W600	1970.3	-1172.0	1643.0	-844.7	0.0	12.0	? NP		0.0	
100/16-33-085-20W600	1933.0	-1163.9								
100/02-34-085-20W600	1885.0	-1172.1	1559.0	-846.1	1.0	10.0	? NP		0.0	
100/06-34-085-20W600	1937.0	-1171.3								
100/08-34-085-20W600	1866.5	-1164.5								
100/10-34-085-20W600	1878.5	-1168.9	1549.0	-839.4	2.0	11.5	? NP		0.0	
100/14-34-085-20W600	1897.0	-1168.9								
100/16-34-085-20W600	1861.0	-1161.3								
100/02-35-085-20W600	1931.0	-1160.2								
100/04-35-085-20W600	1873.0	-1161.4								
100/06-35-085-20W600	1902.0	-1158.9								
100/07-35-085-20W600	1912.5	-1163.9	1579.0	-830.4	1.0	12.0	? NP		0.0	
100/08-35-085-20W600	1939.7	-1164.9								
102/08-35-085-20W600	1934.0	-1165.9								
100/10-35-085-20W600	1920.5	-1164.6	1591.0	-835.1	0.0	12.0	? NP		0.0	
100/12-35-085-20W600	1925.0	-1159.8	1600.0	-834.8	2.0	12.0	? NP		0.0	
100/14-35-085-20W600	1952.0	-1163.9								
100/15-35-085-20W600	1937.0	-1163.9								
100/16-35-085-20W600	1927.5	-1161.2								
100/04-36-085-20W600	1941.0	-1143.2								
100/06-36-085-20W600	1950.7	-1145.1								
100/08-36-085-20W600	1980.0	-1157.3								
100/12-36-085-20W600	1960.0	-1161.8	1636.0	-837.8	? 9.5	9.5	? NP		0.0	

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/14-24-085-20W600				1st Doig Sand Eq. - 7m silty sand
100/16-24-085-20W600				
100/06-25-085-20W600				
100/08-25-085-20W600				
100/14-25-085-20W600				
100/16-25-085-20W600				
100/04-26-085-20W600				
100/05-26-085-20W600				
100/06-26-085-20W600				
100/08-26-085-20W600				
100/10-26-085-20W600				
100/12-26-085-20W600				
100/13-26-085-20W600				
100/14-26-085-20W600				
100/16-26-085-20W600				
100/02-27-085-20W600				
100/04-27-085-20W600				
100/06-27-085-20W600				
100/08-27-085-20W600				
100/09-27-085-20W600				
100/10-27-085-20W600				
100/11-27-085-20W600				
100/14-27-085-20W600				
100/16-27-085-20W600				
100/06-28-085-20W600				
100/08-28-085-20W600				
100/16-28-085-20W600				
100/10-30-085-20W600				
100/16-32-085-20W600				TSE @ top Upper Sand ?
100/06-33-085-20W600				
100/08-33-085-20W600				
100/14-33-085-20W600				
100/16-33-085-20W600				
100/02-34-085-20W600				
100/06-34-085-20W600				
100/08-34-085-20W600				
100/10-34-085-20W600				TSE @ top Upper Sand ?
100/14-34-085-20W600				
100/16-34-085-20W600				
100/02-35-085-20W600				
100/04-35-085-20W600				
100/06-35-085-20W600				
100/07-35-085-20W600				TSE @ top Upper Sand
100/08-35-085-20W600				
102/08-35-085-20W600				
100/10-35-085-20W600				TSE @ top Upper Sand
100/12-35-085-20W600				TSE @ top Upper Sand
100/14-35-085-20W600				
100/15-35-085-20W600				
100/16-35-085-20W600				
100/04-36-085-20W600				
100/06-36-085-20W600				
100/08-36-085-20W600				
100/12-36-085-20W600				TSE @ top Upper Sand

	WELL ID	Top Triassic			Halfway		Doig	Montney		
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
	100/14-36-085-20W600	806.4	1301.0	-494.6	1590.0	-783.6	1614.0	-807.6	1695.5	-889.1
•	100/06-01-085-21W600	828.8	1328.0	-499.2	1668.0	-839.2	1688.0	-859.2		
•	100/06-03-085-21W600	683.4	1171.7	-488.3	1517.8	-834.4	1535.5	-852.1		
•	100/06-05-085-21W600	825.7	1308.5	-482.8	1656.8	-831.1	? NDE			
•	100/06-08-085-21W600	813.5	1301.5	-488.0	1658.6	-845.1	1677.5	-864.0		
	100/11-10-085-21W600	698.0	1184.5	-486.5	1510.0	-812.0				
	100/14-11-085-21W600	813.8	1314.0	-500.2	1637.7	-823.9				
•	100/06-13-085-21W600	850.1	1348.0	-497.9	1674.0	-823.9	1699.0	-848.9	1783.0	-932.9
SP	100/06-14-085-21W600	726.9	1231.7	-504.8	1560.5	-833.6	1582.4	-855.5	1668.5	-941.6
•	100/11-15-085-21W600	671.8	1158.8	-487.0	1534.9	-863.1	1556.8	-885.0		
•	100/10-16-085-21W600	659.0	1164.5	-505.5	1557.0	-898.0	1583.0	-924.0	? 1651	-992.0
•	100/10-18-085-21W600	848.0	1333.8	-485.8	1688.5	-840.5	1709.8	-861.8		
•	100/07-20-085-21W600	747.1	1242.0	-494.9	1591.0	-843.9	1612.0	-864.9	? 1701	-953.9
•	100/10-22-085-21W600	771.8	1275.0	-503.2	1599.8	-828.0	1620.8	-849.0		
•	100/06-23-085-21W600	792.8	1300.9	-508.1	1594.3	-801.5	1644.6	-851.8		
	100/05-27-085-21W600	812.0	1315.5	-503.5	1634.6	-822.6				
	100/11-28-085-21W600	662.9	1173.5	-510.6	1493.5	-830.6				
•	100/06-30-085-21W600	847.0	1342.9	-495.9	1684.9	-837.9	1707.4	-860.4		
•	100/11-31-085-21W600	819.3	1316.0	-496.7	1665.0	-845.7	1684.5	-865.2		
•	100/11-32-085-21W600	770.5	1277.1	-506.6	1606.2	-835.7	1627.6	-857.1		
•	100/10-33-085-21W600	699.5	1213.7	-514.2	1531.9	-832.4	1554.4	-854.9	1642.8	-943.3
•	100/05-01-085-22W600	826.0	1318.6	-492.6	1672.7	-846.7	? 1692.2	-866.2		
•	100/06-08-085-22W600	752.6	1297.0	-544.4	1663.0	-910.4	? 1675.0	-922.4		
•	100/11-25-085-22W600	823.9	1321.9	-498.0	1659.9	-836.0	1681.8	-857.9	? NDE	
•	100/09-36-085-22W600	866.5	1363.1	-496.6	1692.5	-826.0	? 1708.0	-841.5	? 1730	-863.5
•	100/06-02-085-23W600	653.8	1193.3	-539.5	? 1553.2	-899.4	NDE			
•	100/06-04-085-23W600	662.0	1216.0	-554.0	1585.0	-923.0	1640.0	-978.0		
•	100/03-15-085-23W600	662.4	1205.0	-542.6	1578.0	-915.6	1620.0	-957.6	1732.0	-1069.6
•	100/16-19-085-23W600	699.5	1284.0	-584.5	? 1650.0	-950.5	1684.0	-984.5		
•	100/16-21-085-23W600	662.0	1203.7	-541.7	1574.5	-912.5	NDE			
•	100/06-31-085-23W600	840.9	1435.0	-594.1	NDE					
•	100/06-33-085-23W600	670.3	1214.3	-544.0	1583.1	-912.8	? NDE			
•	100/08-35-085-24W600	702.7	1363.0	-660.3	1788.5	-1085.8	? 1835.0	-1132.3		
•	100/06-10-085-25W600	696.8	1359.0	-662.2	1744.5	-1047.7	1771.5	-1074.7	? NDE	
•	100/02-12-085-25W600	708.4	1271.0	-562.6	1690.9	-982.5	1696.4	-988.0	1829.3	-1120.9
•	100/08-13-085-25W600	671.4	1195.0	-523.6	? 1621.0	-949.6	? 1634.0	-962.6		
•	100/10-18-085-25W600	750.1	1397.0	-646.9	1802.0	-1051.9	1828.5	-1078.4		
•	100/10-32-085-25W600	695.2	1375.0	-679.8	1759.0	-1063.8	1803.0	-1107.8	1942.0	-1246.8
•	100/06-04-086-19W600	710.2	1202.0	-491.8	1478.0	-767.8	1488.0	-777.8	1576.0	-865.8
	102/11-05-086-19W600	762.0	1253.6	-491.6	1530.1	-768.1	1560.6	-798.6	1627.6	-865.6
•	100/11-07-086-19W600	792.5	1280.2	-487.7	1558.1	-765.6	1569.9	-777.4	1659.9	-867.4
•	100/11-08-086-19W600	753.8	1243.9	-490.1	1517.2	-763.4	1525.8	-772.0	1612.4	-858.6
•	100/11-16-086-19W600	676.0	1157.9	-481.9	1425.2	-749.2	1436.8	-760.8	1520.3	-844.3
•	100/06-17-086-19W600	713.5	1200.0	-486.5	1473.6	-760.1	1483.4	-769.9	1566.7	-853.2
•	100/11-18-086-19W600	749.5	1233.8	-484.3	1505.6	-756.1	1516.6	-767.1	? 1569.6	-820.1
•	100/06-19-086-19W600	733.3	1210.1	-476.8	1481.3	-748.0	1492.8	-759.5	1575.7	-842.4
•	100/11-20-086-19W600	692.8	1169.0	-476.2	1438.0	-745.2	1448.0	-755.2	1529.0	-836.2
•	100/06-28-086-19W600	734.7	1214.0	-479.3	1479.0	-744.3	1484.0	-749.3	1568.0	-833.3
•	100/07-29-086-19W600	776.9	1258.2	-481.3	1519.0	-742.1	1531.2	-754.3	1611.1	-834.2
•	100/07-30-086-19W600	695.6	1167.4	-471.8	1435.5	-739.9	1446.5	-750.9	1528.8	-833.2
	100/14-31-086-19W600	742.8	1213.1	-470.3	1466.1	-723.3				
	100/16-32-086-19W600	783.9	1263.1	-479.2	1516.1	-732.2	1545.3	-761.4	1605.7	-821.8
•	100/10-01-086-20W600	800.7	1286.9	-486.2	1571.5	-770.8	? 1602.0	-801.3	1677.6	-876.9
•	100/02-02-086-20W600	786.2	1280.0	-493.8	1570.0	-783.8	? 1600.0	-813.8	1679.0	-892.8

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/14-36-085-20W600	1966.0	-1159.6								
100/06-01-085-21W600			1743.0	-914.2	0.0	4.0	1723.0	-894.2	0.0	FS
100/06-03-085-21W600			?NP		0.0		1591.0	-907.6	4.3	6.7
100/06-05-085-21W600										
100/06-08-085-21W600			NDE				NDE			
100/11-10-085-21W600										
100/14-11-085-21W600										
100/06-13-085-21W600	2070.0	-1219.9	?NP		0.0		1743.0	-892.9	2.0	7.0
100/06-14-085-21W600	1953.8	-1226.9								
100/11-15-085-21W600										
100/10-16-085-21W600			? 1636	-977.0	0.0	6.0	1604.0	-945.0	10.0	19.0
100/10-18-085-21W600			1763.2	-915.2	0.0	4.6	1727.8			11.0
100/07-20-085-21W600			1665.0	-917.9	?	NDE	1639.5	-892.4	1.5	
100/10-22-085-21W600			NDE				1629.4	-857.6	0.9	2.7
100/06-23-085-21W600			? 1683	-890.2	?		1656.2	-863.4		
100/05-27-085-21W600										
100/11-28-085-21W600										
100/06-30-085-21W600			? NDE							
100/11-31-085-21W600			1735.0	-915.7	2.0	7.0	1711.0	-891.7	1.0	8.0
100/11-32-085-21W600			NDE				1649.5	-879.0	0.0	4.9
100/10-33-085-21W600	1921.5	-1222.0	1597.1	-897.6	0.0	6.1	1572.7	-873.2	1.8	3.0
100/05-01-085-22W600			NDE				NDE			
100/06-08-085-22W600										
100/11-25-085-22W600			1710.5	-886.6	?	30.5				
100/09-36-085-22W600										
100/06-02-085-23W600										
100/06-04-085-23W600			? NDE				? NDE			
100/03-15-085-23W600	2056.5	-1394.1	? NP		0.0		? NP		0.0	
100/16-19-085-23W600			? NDE				? NDE			
100/16-21-085-23W600										
100/06-31-085-23W600										
100/06-33-085-23W600										
100/08-35-085-24W600			NDE				1845.0	-1142.3	?4.0	
100/06-10-085-25W600	2242.0	-1545.2	NDE				NDE			
100/02-12-085-25W600	2166.2	-1457.8	? NP		0.0		1715.9	-1007.5	0.0	9.8
100/08-13-085-25W600			? NDE				? NDE			
100/10-18-085-25W600			? NDE				? NDE			
100/10-32-085-25W600	2254.0	-1558.8	? NP		0.0		? NP		0.0	
100/06-04-086-19W600	1843.0	-1132.8	? NP		0.0		? NP		0.0	
102/11-05-086-19W600	1895.9	-1133.9								
100/11-07-086-19W600	1926.3	-1133.8	1598.3	-805.8	0.0	14.0	? NP		0.0	
100/11-08-086-19W600	1878.8	-1125.0	?		0.0		? NP		0.0	
100/11-16-086-19W600	1786.7	-1110.7	NP		0.0		? NP		0.0	
100/06-17-086-19W600	1835.2	-1121.7	1516.6	-803.1	2.1	5.2	? NP		0.0	
100/11-18-086-19W600	1872.4	-1122.9	? 1542.2	-792.7	0.0	12.2	? NP		0.0	
100/06-19-086-19W600	1849.8	-1116.5	1539.2	-805.9	0.0	4.3	? NP		0.0	
100/11-20-086-19W600	1801.0	-1108.2	? NP		0.0		? NP		0.0	
100/06-28-086-19W600	1841.0	-1106.3	? NP		0.0		? NP		0.0	
100/07-29-086-19W600	1883.1	-1106.2	NP		0.0	0.0	? NP		0.0	
100/07-30-086-19W600	1801.7	-1106.1	? 1476.4	-780.8		1.8	? NP		0.0	
100/14-31-086-19W600										
100/16-32-086-19W600	1874.5	-1090.6								
100/10-01-086-20W600	1948.6	-1147.9	1594.0	-793.3	0.0	10.4	? NP		0.0	
100/02-02-086-20W600	1950.0	-1163.8	1623.0	-836.8	0.0	13.0	? NP		0.0	

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/14-36-085-20W600				
100/06-01-085-21W600				
100/06-03-085-21W600				
100/06-05-085-21W600				
100/06-08-085-21W600				
100/11-10-085-21W600				e-log
100/14-11-085-21W600				e-log
100/06-13-085-21W600				2nd Doig sand or stray??
100/06-14-085-21W600				SP log
100/11-15-085-21W600		?		
100/10-16-085-21W600				
100/10-18-085-21W600				poor quality log
100/07-20-085-21W600				
100/10-22-085-21W600				
100/06-23-085-21W600				
100/05-27-085-21W600				no gamma ray log values for DOIG - MNTNY interval
100/11-28-085-21W600				e-log
100/06-30-085-21W600				
100/11-31-085-21W600			D	
100/11-32-085-21W600				
100/10-33-085-21W600				
100/05-01-085-22W600				
100/06-08-085-22W600				
100/11-25-085-22W600				
100/09-36-085-22W600	?			
100/06-02-085-23W600				
100/06-04-085-23W600				
100/03-15-085-23W600				
100/16-19-085-23W600				
100/16-21-085-23W600				
100/06-31-085-23W600				
100/06-33-085-23W600				
100/08-35-085-24W600				
100/06-10-085-25W600				
100/02-12-085-25W600				
100/08-13-085-25W600				
100/10-18-085-25W600				
100/10-32-085-25W600				
100/06-04-086-19W600				
102/11-05-086-19W600				e-log
100/11-07-086-19W600				
100/11-08-086-19W600				no gamma ray log run through DOIG - MNTNY interval
100/11-16-086-19W600				
100/06-17-086-19W600				
100/11-18-086-19W600				
100/06-19-086-19W600				
100/11-20-086-19W600				
100/06-28-086-19W600				
100/07-29-086-19W600				
100/07-30-086-19W600				
100/14-31-086-19W600				e-log
100/16-32-086-19W600				e-log
100/10-01-086-20W600				SB @ base 1st Doig ?
100/02-02-086-20W600				SB @ base 1st Doig ?: TSE @ 1631.2m

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
•	100/04-02-086-20W600	788.1	1320.0	-531.9	1629.0	-840.9	1656.0	-867.9	1748.0	-959.9
•	100/06-02-086-20W600	785.6	1275.5	-489.9	1566.0	-780.4	1591.0	-805.4	1676.0	-890.4
•	100/06-03-086-20W600	713.5	1197.9	-484.4	1489.8	-776.3	1514.8	-801.3	1596.5	-883.0
•	100/08-03-086-20W600	700.1	1190.0	-489.9	1482.0	-781.9	1506.0	-805.9	1591.0	-890.9
•	100/14-03-086-20W600	773.2	1257.5	-484.3	1552.5	-779.3	1573.0	-799.8	1653.0	-879.8
•	100/02-04-086-20W600	760.5	1248.3	-487.8	1545.7	-785.2	1570.5	-810.0	1652.3	-891.8
•	100/06-04-086-20W600	754.2	1241.0	-486.8	1538.0	-783.8	1563.0	-808.8	1645.0	-890.8
•	102/06-04-086-20W600	753.0	1240.7	-487.7	1538.0	-785.0	1563.0	-810.0		
•	100/08-04-086-20W600	727.1	1211.5	-484.4	1507.0	-779.9	1536.0	-808.9	1612.0	-884.9
•	100/12-04-086-20W600	743.2	1235.0	-491.8	1533.0	-789.8	1558.5	-815.3	1639.0	-895.8
•	100/14-04-086-20W600	721.0	1210.5	-489.5	1507.0	-786.0	1530.0	-809.0	1612.0	-891.0
•	100/16-04-086-20W600	721.1	1208.0	-486.9	1502.0	-780.9	1526.0	-804.9	1605.0	-883.9
•	100/08-05-086-20W600	794.5	1286.0	-491.5	1582.0	-787.5	1609.0	-814.5	1694.0	-899.5
•	100/16-05-086-20W600	777.5	1270.0	-492.5	1567.0	-789.5	1593.0	-815.5	1674.0	-896.5
•	100/11-06-086-20W600	836.1	1338.7	-502.6	1643.4	-807.3	1669.6	-833.5	1749.6	-913.5
•	100/06-07-086-20W600	830.3	1325.3	-495.0	1627.0	-796.7	1660.6	-830.3	1736.1	-905.8
•	100/08-07-086-20W600	820.0	1311.5	-491.5	1612.0	-792.0	1636.0	-816.0	1718.0	-898.0
	100/11-07-086-20W600	816.9	1309.7	-492.8	1613.5	-796.6	1630.6	-813.7	1722.1	-905.2
•	100/07-08-086-20W600	766.9	1264.9	-498.0	1559.3	-792.4	1575.1	-808.2	1665.7	-898.8
•	100/16-08-086-20W600	734.0	1235.3	-505.3	1523.7	-789.7	1547.0	-813.0	1630.0	-896.0
•	100/06-09-086-20W600	724.1	1217.0	-492.9	1509.0	-784.9	1531.0	-806.9	1616.0	-891.9
•	100/08-09-086-20W600	747.0	1236.0	-489.0	1527.7	-780.7	1549.0	-802.0	1630.0	-883.0
•	100/14-09-086-20W600	734.9	1230.0	-495.1	1518.0	-783.1	1537.0	-802.1	1620.0	-885.1
•	100/11-10-086-20W600	812.0	1298.4	-486.4	1582.5	-770.5	1605.4	-793.4	1688.0	-876.0
•	100/10-11-086-20W600	765.4	1251.5	-486.1	1539.2	-773.8	1551.1	-785.7	1640.4	-875.0
•	100/10-12-086-20W600	797.7	1279.6	-481.9	1561.4	-763.7	1573.9	-776.2	1663.5	-865.8
•	100/02-13-086-20W600	800.4	1280.2	-479.8	1560.6	-760.2	1584.0	-783.6	1658.7	-858.3
•	100/06-14-086-20W600	760.1	1245.7	-485.6	1524.0	-763.9	1550.0	-789.9	1626.0	-865.9
•	100/07-14-086-20W600	777.2	1253.9	-476.7	1533.8	-756.6	1557.5	-780.3	1634.9	-857.7
•	100/08-14-086-20W600	792.2	1271.0	-478.8	1550.0	-757.8	1575.0	-782.8	1650.0	-857.8
•	100/06-15-086-20W600	799.5	1286.3	-486.8	1564.0	-764.5	1585.0	-785.5	1668.5	-869.0
•	100/08-15-086-20W600	742.9	1229.3	-486.4	1509.5	-766.6	1530.0	-787.1	1612.7	-869.8
•	100/16-15-086-20W600	733.7	1219.7	-486.0	1495.3	-761.6	1517.0	-783.3	1600.0	-866.3
•	100/06-16-086-20W600	774.3	1265.0	-490.7	1554.0	-779.7	1573.0	-798.7	1656.0	-881.7
•	100/08-16-086-20W600	794.9	1279.5	-484.6	1570.0	-775.1	1580.0	-785.1	1673.0	-878.1
•	100/06-17-086-20W600	739.7	1235.0	-495.3	1529.4	-789.7	1550.7	-811.0	1634.9	-895.2
•	100/11-17-086-20W600	733.7	1226.0	-492.3	1522.0	-788.3	1543.0	-809.3	1627.0	-893.3
	100/10-18-086-20W600	773.9	1261.9	-488.0	1564.2	-790.3	1598.7	-824.8	1674.9	-901.0
•	100/11-19-086-20W600	748.3	1239.9	-491.6	1536.1	-787.8	1555.6	-807.3	1610.5	-862.2
•	100/11-20-086-20W600	732.4	1224.4	-492.0	1514.8	-782.4	1528.2	-795.8	1619.6	-887.2
•	100/11-21-086-20W600	822.9	1311.0	-488.1	1601.0	-778.1	1616.0	-793.1	1701.0	-878.1
•	100/06-22-086-20W600	772.1	1254.6	-482.5	1534.9	-762.8	1548.3	-776.2	1639.7	-867.6
•	102/06-22-086-20W600	784.9	1270.2	-485.3	1550.0	-765.1	1563.0	-778.1	1655.0	-870.1
•	100/07-23-086-20W600	791.6	1270.1	-478.5	1549.5	-757.9	1562.3	-770.7	1647.7	-856.1
•	100/04-24-086-20W600	798.0	1272.2	-474.2	1547.7	-749.7	1560.5	-762.5	1645.8	-847.8
•	100/10-25-086-20W600	734.3	1204.0	-469.7	1474.0	-739.7	1486.5	-752.2	1569.7	-835.4
•	100/07-26-086-20W600	798.6	1282.0	-483.4	1550.0	-751.4	1563.0	-764.4	1646.5	-847.9
•	100/02-28-086-20W600	811.1	1297.5	-486.4	1582.4	-771.3	1591.6	-780.5	1682.4	-871.3
•	100/06-28-086-20W600	825.1	1318.0	-492.9	1600.7	-775.6	1610.0	-784.9	1699.0	-873.9
•	100/10-28-086-20W600	812.3	1299.4	-487.1	1583.7	-771.4	1597.7	-785.4	1680.6	-868.3
•	100/11-30-086-20W600	793.1	1283.2	-490.1	1581.8	-788.7	1598.3	-805.2	1685.5	-892.4
•	100/10-31-086-20W600	805.7	1308.5	-502.8	1594.3	-788.6	1614.5	-808.8	1694.0	-888.3
•	100/11-32-086-20W600	758.0	1262.8	-504.8	1542.5	-784.5	1554.4	-796.4	1643.4	-885.4
•	100/06-33-086-20W600	806.2	1300.0	-493.8	1582.5	-776.3	1600.0	-793.8	1679.0	-872.8

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLV	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/04-02-086-20W600	2029.0	-1240.9	1688.0	-899.9	1.0	11.0	? NP		0.0	
100/06-02-086-20W600	1945.5	-1159.9	1619.0	-833.4	1.0	14.0	? NP		0.0	
100/06-03-086-20W600	1869.0	-1155.5	1543.7	-830.2	2.4	10.1	? NP		0.0	
100/08-03-086-20W600	1857.0	-1156.9	1535.0	-834.9	? 10.0	10.0	? NP		0.0	
100/14-03-086-20W600	1931.0	-1157.8	1601.5	-828.3	?	9.5	? NP		0.0	
100/02-04-086-20W600	1928.0	-1167.5	1601.0	-840.5	trace	12.0	? NP		0.0	
100/06-04-086-20W600	1921.0	-1166.8	1590.0	-835.8	? 6.0	21.0	? NP		0.0	
102/06-04-086-20W600			1590.0	-837.0	6.0	21.0				
100/08-04-086-20W600	1885.5	-1158.4	1554.0	-826.9	trace	13.0	? NP		0.0	
100/12-04-086-20W600	1917.0	-1173.8	1585.0	-841.8	6.5	20.0	? NP		0.0	
100/14-04-086-20W600	1890.0	-1169.0	1557.0	-836.0	4.5	18.0	? NP		0.0	
100/16-04-086-20W600	1883.0	-1161.9	1550.0	-828.9	3.0	21.0	? NP		0.0	
100/08-05-086-20W600	1970.0	-1175.5	1640.0	-845.5	6.0	22.0	? NP		0.0	
100/16-05-086-20W600	1952.0	-1174.5	1620.0	-842.5	?	13.0	? NP		0.0	
100/11-06-086-20W600	2030.9	-1194.8	1699.5	-863.4	0.0	> 7.3	? NP		0.0	
100/06-07-086-20W600	2017.8	-1187.5	1683.0	-852.7	0.0	9.8	? NP		0.0	
100/08-07-086-20W600	1996.0	-1176.0	1667.0	-847.0	0.0	10.0	? NP		0.0	
100/11-07-086-20W600	2001.3	-1184.4								
100/07-08-086-20W600	1945.8	-1178.9	1612.3	-845.4	? 2.4	10.7	? NP		0.0	
100/16-08-086-20W600	1908.0	-1174.0	1575.0	-841.0	trace	12.0	? NP		0.0	
100/06-09-086-20W600	1890.5	-1166.4	1555.0	-830.9	trace	14.0	? NP		0.0	
100/08-09-086-20W600	1905.0	-1158.0	1577.0	-830.0	1.0	12.0	? NP		0.0	
100/14-09-086-20W600	1896.0	-1161.1	1565.0	-830.1	3.0	10.5	? NP		0.0	
100/11-10-086-20W600	1963.5	-1151.5	1632.2	-820.2	7.3	22.2	? NP		0.0	
100/10-11-086-20W600	1912.8	-1147.4	1585.5	-820.1	1.2	9.8	? NP		0.0	
100/10-12-086-20W600	1934.9	-1137.2	1605.3	-807.6	0.0	5.8	? NP		0.0	
100/02-13-086-20W600	1933.0	-1132.6	? NP		0.0		? NP		0.0	
100/06-14-086-20W600			1569.5	-809.4	1.5	9.5	? NP		0.0	
100/07-14-086-20W600	1907.7	-1130.5	1577.0	-799.8	3.4	13.4	? NP		0.0	
100/08-14-086-20W600			1593.5	-801.3	1.0	11.0	? NP		0.0	
100/06-15-086-20W600	1944.0	-1144.5	1616.0	-816.5	4.0	15.0	? NP		0.0	
100/08-15-086-20W600			1555.0	-812.1	trace	20.0	? NP		0.0	
100/16-15-086-20W600			1542.0	-808.3	2.0	11.0	? NP		0.0	
100/06-16-086-20W600	1932.0	-1157.7	1601.0	-826.7	? 4.0	12.0	? NP		0.0	
100/08-16-086-20W600	1948.0	-1153.1	1614.0	-819.1	3.0	11.0	? NP		0.0	
100/06-17-086-20W600	1912.0	-1172.3	1580.6	-840.9	4.3	9.8	? NP		0.0	
100/11-17-086-20W600	1905.0	-1171.3	1572.0	-838.3	0.0	9.0	? NP		0.0	
100/10-18-086-20W600	1944.0	-1170.1								
100/11-19-086-20W600	1916.6	-1168.3	1584.3	-836.0	3.7	5.5	? NP		0.0	
100/11-20-086-20W600	1892.8	-1160.4	1562.3	-829.9	0.0	6.1	? NP		0.0	
100/11-21-086-20W600	1975.0	-1152.1	1642.0	-819.1	1.5	7.5	? NP		0.0	
100/06-22-086-20W600	1918.1	-1146.0	1580.0	-807.9	? 3.0	11.0	? NP		0.0	
102/06-22-086-20W600	1934.0	-1149.1	1595.0	-810.1	3.5	11.0	? NP		0.0	
100/07-23-086-20W600	1923.6	-1132.0	? NP		0.0		? NP		0.0	
100/04-24-086-20W600	1920.8	-1122.8	? 1591.6	-793.6	0.0	10.4	? NP		0.0	
100/10-25-086-20W600	1842.5	-1108.2	1513.0	-778.7	?		? NP		0.0	
100/07-26-086-20W600	1921.0	-1122.4	1588.5	-789.9	trace	7.5	? NP		0.0	
100/02-28-086-20W600	1953.8	-1142.7	1622.7	-811.6	0.0	5.2	? NP		0.0	
100/06-28-086-20W600	1970.0	-1144.9	1640.0	-814.9	0.0	4.5	? NP		0.0	
100/10-28-086-20W600	1950.4	-1138.1	1622.1	-809.8	1.2	4.3	? NP		0.0	
100/11-30-086-20W600	1956.8	-1163.7	1626.9	-833.8	? silty	4.9	? NP		0.0	
100/10-31-086-20W600	1965.0	-1159.3	1636.0	-830.3	0.0	4.0	? NP		0.0	
100/11-32-086-20W600	1913.5	-1155.5	1583.1	-825.1	2.7	3.7	? NP		0.0	
100/06-33-086-20W600	1949.0	-1142.8	1618.0	-811.8	2.0	4.0	? NP		0.0	

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/04-02-086-20W600				SB @ base 1st Doig ?: TSE @ 1634.5m
100/06-02-086-20W600				
100/06-03-086-20W600				SB @ base 1st Doig ?
100/08-03-086-20W600				SB @ base 1st Doig ?
100/14-03-086-20W600				SB @ base 1st Doig ?: TSE @ 1543m
100/02-04-086-20W600				
100/06-04-086-20W600				SB @ base 1st Doig ?
102/06-04-086-20W600		X	D	SB @ base 1st Doig ?
100/08-04-086-20W600				SB @ base 1st Doig ?
100/12-04-086-20W600		X	D	SB @ base 1st Doig ?
100/14-04-086-20W600				SB @ base 1st Doig ?
100/16-04-086-20W600		X		SB @ base 1st Doig ?
100/08-05-086-20W600		X		SB @ base 1st Doig ?
100/16-05-086-20W600				
100/11-06-086-20W600				
100/06-07-086-20W600				
100/08-07-086-20W600				
100/11-07-086-20W600				
100/07-08-086-20W600				
100/16-08-086-20W600				
100/06-09-086-20W600				
100/08-09-086-20W600				
100/14-09-086-20W600				
100/11-10-086-20W600				
100/10-11-086-20W600				
100/10-12-086-20W600				
100/02-13-086-20W600				e-log
100/06-14-086-20W600		X		
100/07-14-086-20W600				
100/08-14-086-20W600		?		
100/06-15-086-20W600				
100/08-15-086-20W600				
100/16-15-086-20W600			D	
100/06-16-086-20W600				
100/08-16-086-20W600				
100/06-17-086-20W600				
100/11-17-086-20W600				
100/10-18-086-20W600				
100/11-19-086-20W600				
100/11-20-086-20W600				
100/11-21-086-20W600				
100/06-22-086-20W600				
102/06-22-086-20W600				
100/07-23-086-20W600				
100/04-24-086-20W600				
100/10-25-086-20W600			HD	
100/07-26-086-20W600				
100/02-28-086-20W600				
100/06-28-086-20W600				
100/10-28-086-20W600				
100/11-30-086-20W600				
100/10-31-086-20W600				
100/11-32-086-20W600				
100/06-33-086-20W600				

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		Kb	BLDN	SS	BLFY	SS	DOIG	SS	MNTN	SS
•	100/07-33-086-20W600	791.0	1283.0	-492.0	1564.0	-773.0	1575.0	-784.0		
•	100/06-35-086-20W600	774.8	1255.5	-480.7	1520.3	-745.5	1533.1	-758.3	1616.0	-841.2
•	100/16-01-086-21W600	823.4	1320.0	-496.6	1625.0	-801.6	1653.0	-829.6	1739.0	-915.6
•	100/07-03-086-21W600	813.5	1318.0	-504.5	1635.5	-822.0	1659.3	-845.8		
•	100/11-07-086-21W600	819.9	1326.0	-506.1	1652.0	-832.1	1668.0	-848.1		
•	100/11-08-086-21W600	803.1	1307.9	-504.8	1632.4	-829.3	1650.7	-847.6		
•	100/06-09-086-21W600	678.5	1197.6	-519.1	1516.9	-838.4	1536.7	-858.2	? 1625.8	-947.3
•	100/16-10-086-21W600	830.6	1336.9	-506.3	1643.7	-813.1	1660.8	-830.2		
	100/08-11-086-21W600	840.9	1332.0	-491.1	1640.7	-799.8	1668.5	-827.6	1748.9	-908.0
•	100/11-11-086-21W600	832.4	1332.3	-499.9	1641.6	-809.2	1658.0	-825.6	1750.1	-917.7
•	100/06-12-086-21W600	844.1	1331.0	-486.9	1639.5	-795.4	1662.0	-817.9	1750.0	-905.9
•	100/10-12-086-21W600	818.1	1306.7	-488.6	1607.4	-789.3	1636.7	-818.6	1719.7	-901.6
•	100/06-13-086-21W600	808.0	1300.0	-492.0	1600.0	-792.0	1626.0	-818.0	1710.0	-902.0
•	100/08-13-086-21W600	784.9	1278.9	-494.0	1579.4	-794.5	1594.6	-809.7	1686.1	-901.2
•	100/14-14-086-21W600	859.0	1354.5	-495.5	1660.0	-801.0	1680.0	-821.0	1765.0	-906.0
•	100/16-16-086-21W600	801.6	1315.3	-513.7	1624.0	-822.4	1641.0	-839.4	1732.5	-930.9
•	100/11-18-086-21W600	835.0	1351.0	-516.0	1669.0	-834.0	1685.5	-850.5	1782.0	-947.0
•	100/06-22-086-21W600	818.4	1325.0	-506.6	1632.0	-813.6	1647.5	-829.1	1739.0	-920.6
	100/04-23-086-21W600	849.2	1347.2	-498.0	1652.0	-802.8	1674.0	-824.8	1758.4	-909.2
•	100/10-24-086-21W600	790.0	1285.0	-495.0	1590.1	-800.1	1609.3	-819.3	1694.6	-904.6
•	100/11-25-086-21W600	809.9	1305.0	-495.1	1605.0	-795.1	1624.0	-814.1	1709.0	-899.1
•	100/10-26-086-21W600	836.2	1325.0	-488.8	1620.0	-783.8	1640.0	-803.8	1725.0	-888.8
•	100/10-27-086-21W600	845.5	1350.0	-504.5	1652.5	-807.0	1669.0	-823.5	1756.0	-910.5
•	100/06-28-086-21W600	733.9	1250.0	-516.1	1558.0	-824.1	1574.0	-840.1	1666.0	-932.1
•	100/10-30-086-21W600	826.0	1345.5	-519.5	1654.0	-828.0	1674.0	-848.0	1761.0	-935.0
•	100/10-34-086-21W600	844.6	1348.0	-503.4	1644.0	-799.4	1664.0	-819.4	1750.0	-905.4
	100/10-35-086-21W600	822.3	1306.7	-484.4	1600.0	-777.7	1625.0	-802.7	1705.5	-883.2
•	100/10-36-086-21W600	772.6	1272.5	-499.9	1566.0	-793.4	1587.0	-814.4	1667.5	-894.9
•	100/07-01-086-22W600	805.3	1300.9	-495.6	? 1628.2	-822.9	NDE			
•	100/02-02-086-22W600	698.0	1219.2	-521.2	? 1577.0	-879.0	NDE			
•	100/07-06-086-22W600	839.4	1390.0	-550.6	1736.0	-896.6	1774.0	-934.6	1876.0	-1036.6
•	100/10-12-086-22W600	847.3	1343.0	-495.7	1667.0	-819.7	1690.0	-842.7	1784.0	-936.7
	100/11-12-086-22W600	839.4	1334.1	-494.7	1649.6	-810.2				
•	100/10-14-086-22W600	837.3	1350.3	-513.0	1686.1	-848.8	NDE			
•	100/13-16-086-22W600	856.5	1373.7	-517.2	1703.1	-846.6	? 1737.3	-880.8		
•	100/07-24-086-22W600	869.6	1380.7	-511.1	1698.7	-829.1	1721.2	-851.6		
•	100/07-25-086-22W600	892.0	1425.0	-533.0	1721.0	-829.0	1753.0	-861.0	1842.0	-950.0
	100/09-26-086-22W600	813.9	1327.0	-513.1	1649.0	-835.1	1666.0	-852.1	1756.0	-942.1
•	100/06-32-086-22W600	833.3	1352.0	-518.7	1667.0	-833.7	1703.0	-869.7	1796.0	-962.7
•	100/10-35-086-22W600	773.0	1310.0	-537.0	1619.0	-846.0	1650.0	-877.0		
	100/04-03-086-23W600	699.6	1237.0	-537.4	1603.0	-903.4	1646.0	-946.4		
	100/06-09-086-23W600	671.2	1209.8	-538.6	1565.5	-894.3	1610.6	-939.4		
	100/06-15-086-23W600	679.7	1241.5	-561.8	1569.7	-890.0	1630.7	-951.0		
	100/07-16-086-23W600	772.4	1316.7	-544.3	1664.2	-891.8	1705.7	-933.3	1814.2	-1041.8
	100/06-17-086-23W600	743.7	1307.9	-564.2	1642.9	-899.2				
	102/06-32-086-23W600	717.2	1244.0	-526.8	1582.0	-864.8	1625.0	-907.8		
	100/06-33-086-23W600	786.1	1350.0	-563.9	1691.0	-904.9	1733.0	-946.9		
	100/14-02-086-24W600	687.6	1254.0	-566.4	1618.5	-930.9	1676.0	-988.4	1786.0	-1098.4
	100/07-05-086-24W600	670.6	1313.7	-643.1	1681.9	-1011.3	1749.6	-1079.0		
	100/03-11-086-24W600	670.0	1240.0	-570.0	1610.0	-940.0	1667.0	-997.0		
	100/10-11-086-24W600	897.0	1480.7	-583.7	1837.6	-940.6				
	100/16-12-086-24W600	714.5	1315.5	-601.0	1674.0	-959.5				
	100/06-14-086-24W600	849.0	1447.0	-598.0	1807.5	-958.5	1861.0	-1012.0		
	100/10-32-086-24W600	640.1	1300.6	-660.5	1641.3	-1001.2				

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/07-33-086-20W600			1602.0	-811.0	0.0	2.0	? NDE			
100/06-35-086-20W600	1890.4	-1115.6	1558.1	-783.3	0.0	0.9	? NP		0.0	
100/16-01-086-21W600	2017.0	-1193.6	1688.0	-864.6	3.0	9.0	? NP		0.0	
100/07-03-086-21W600			1693.4	-879.9	0.0	9.1	1670.2	-856.7	0.0	4.9
100/11-07-086-21W600			NDE				1686.0	-866.1		? NDE
100/11-08-086-21W600			NDE				1666.6	-863.5	4.9	? 12.2
100/06-09-086-21W600	1905.0	-1226.5	?				?			
100/16-10-086-21W600			NDE							
100/08-11-086-21W600	2026.3	-1185.4	?				?			
100/11-11-086-21W600	2021.1	-1188.7	? NP		0.0		1700.1	-867.7	1.2	7.3
100/06-12-086-21W600	2026.7	-1182.6	? NP		0.0		1697.0	-852.9	5.5	9.5
100/10-12-086-21W600	2002.5	-1184.4	? NP		0.0		1667.2	-849.1	3.0	9.8
100/06-13-086-21W600	1990.0	-1182.0	? NP		0.0		1655.5	-847.5	7.5	10.0
100/08-13-086-21W600	1965.7	-1180.8	? NP		0.0		1633.6	-848.7	1.8	9.8
100/14-14-086-21W600	2037.0	-1178.0	? NP		0.0		1710.5	-851.5	0.0	8.5
100/16-16-086-21W600	2010.1	-1208.5	? NP		0.0		1679.0	-877.4	0.0	9.0
100/11-18-086-21W600	2056.5	-1221.5	? NP		0.0		1727.5	-892.5	3.0	9.0
100/06-22-086-21W600	2011.0	-1192.6	? NP		0.0		1686.0	-867.6	1.0	7.0
100/04-23-086-21W600	2033.0	-1183.8								
100/10-24-086-21W600	1971.8	-1181.8	? NP		0.0		1637.9	-847.9	1.2	6.7
100/11-25-086-21W600	1983.0	-1173.1	? NP		0.0		1652.0	-842.1	2.0	4.5
100/10-26-086-21W600	2004.0	-1167.8	? NP		0.0		1669.0	-832.8	1.5	4.0
100/10-27-086-21W600	2033.0	-1187.5	? NP		0.0		1701.0	-855.5	trace	6.0
100/06-28-086-21W600	1940.3	-1206.4	? NP		0.0		1610.0	-876.1	2.0	7.0
100/10-30-086-21W600	2030.0	-1204.0	? NP		0.0		1704.5	-878.5	0.0	4.5
100/10-34-086-21W600	2025.0	-1180.4	? NP		0.0		1692.0	-847.4	1.5	5.0
100/10-35-086-21W600	1982.0	-1159.7								
100/10-36-086-21W600	1936.0	-1163.4	? NP		0.0		1609.0	-836.4	? 4.0	5.0
100/07-01-086-22W600										
100/02-02-086-22W600										
100/07-06-086-22W600	2161.0	-1321.6	?NP		0.0		1824.0	-984.6	0.5	8.0
100/10-12-086-22W600	2070.0	-1222.7	1734.0	-886.7	0.0	8.0	1706.0	-858.7	7.0	10.0
100/11-12-086-22W600										
100/10-14-086-22W600										
100/13-16-086-22W600			NDE				NDE			
100/07-24-086-22W600			NDE				NDE		-	
100/07-25-086-22W600	2120.0	-1228.0	1785.5	-893.5	trace	5.0	? NP		0.0	
100/09-26-086-22W600	2033.0	-1219.1								
100/06-32-086-22W600	2075.0	-1241.7	? NP		0.0		? NP		0.0	
100/10-35-086-22W600							? 1681	-908.0	0.0	5.0
100/04-03-086-23W600										
100/06-09-086-23W600										
100/06-15-086-23W600										
100/07-16-086-23W600	2121.4	-1349.0								
100/06-17-086-23W600										
102/06-32-086-23W600										
100/06-33-086-23W600										
100/14-02-086-24W600	2112.0	-1424.4								
100/07-05-086-24W600										
100/03-11-086-24W600										
100/10-11-086-24W600										
100/16-12-086-24W600										
100/06-14-086-24W600										
100/10-32-086-24W600										

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/07-33-086-20W600				
100/06-35-086-20W600				
100/16-01-086-21W600				
100/07-03-086-21W600				
100/11-07-086-21W600				
100/11-08-086-21W600				
100/06-09-086-21W600				no gamma ray log run through DOIG - MNTNY interval
100/16-10-086-21W600				
100/08-11-086-21W600				e-log
100/11-11-086-21W600				
100/06-12-086-21W600				
100/10-12-086-21W600				
100/06-13-086-21W600				
100/08-13-086-21W600				
100/14-14-086-21W600				
100/16-16-086-21W600				
100/11-18-086-21W600				Sand at base 1st Doig Eq. TSE? @ 1697m (Subsea: -862m)
100/06-22-086-21W600				Sand at base 1st Doig Eq.
100/04-23-086-21W600				e-log
100/10-24-086-21W600				Sand at base 1st Doig Eq.
100/11-25-086-21W600				Sand at base 1st Doig Eq.
100/10-26-086-21W600				Sand at base 1st Doig Eq.
100/10-27-086-21W600				Trace sand at base 1st Doig Eq.
100/06-28-086-21W600				Sand at base 1st Doig Eq.
100/10-30-086-21W600				
100/10-34-086-21W600				
100/10-35-086-21W600				
100/10-36-086-21W600				
100/07-01-086-22W600				
100/02-02-086-22W600				
100/07-06-086-22W600				
100/10-12-086-22W600				
100/11-12-086-22W600				e-log
100/10-14-086-22W600				
100/13-16-086-22W600				
100/07-24-086-22W600				
100/07-25-086-22W600				
100/09-26-086-22W600				no fiche available
100/06-32-086-22W600				
100/10-35-086-22W600				
100/04-03-086-23W600				
100/06-09-086-23W600				
100/06-15-086-23W600				
100/07-16-086-23W600				
100/06-17-086-23W600				
102/06-32-086-23W600				
100/06-33-086-23W600				
100/14-02-086-24W600				
100/07-0[illegible]086-24W600				
100/03-[illegible]086-24W600				
100/10-[illegible]086-24W600				
100/16-12-086-24W600				
100/06-14-086-24W600				
100/10-32-086-24W600				

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
	100/16-03-086-25W600	690.7	1219.0	-528.3	1590.0	-899.3	1665.0	-974.3		
	100/06-11-086-25W600	654.1	1137.8	-483.7	1503.3	-849.2	1574.3	-920.2	1691.6	-1037.5
•	100/11-10-086-19W600	?			1481.3		1492.2		1578.5	
•	100/15-06-086-20W600	855.6			1654.0	-798.4	1680.0	-824.4	1765.0	-909.4
•	100/06-01-087-19W600	761.3	1221.5	-460.2	1474.0	-712.7	1490.0	-728.7		
	100/08-01-087-19W600	769.0	1232.0	-463.0	1472.0	-703.0	1499.5	-730.5		
	100/14-01-087-19W600	761.0	1227.0	-466.0	1478.5	-717.5	1500.0	-739.0		
	100/15-01-087-19W600	757.7	1218.0	-460.3	1466.0	-708.3	1483.0	-725.3		
	100/07-02-087-19W600	744.6	1210.0	-465.4	1458.0	-713.4	1478.0	-733.4		
•	100/11-02-087-19W600	746.0	1215.0	-469.0	1466.0	-720.0	1486.0	-740.0		
•	100/07-03-087-19W600	768.4	1239.0	-470.6	1488.0	-719.6	1504.0	-735.6		
	100/08-03-087-19W600	771.1	1235.5	-464.4	1486.0	-714.9	1510.0	-738.9		
	100/06-05-087-19W600	713.6	1202.0	-488.4	1452.0	-738.4	1478.0	-764.4		
	100/06-11-087-19W600	752.2	1242.0	-489.8	1485.0	-732.8	1508.0	-755.8		
•	100/03-12-087-19W600	761.8	1235.5	-473.7	1486.0	-724.2	1503.0	-741.2	1567.0	-805.2
?	100/10-19-087-19W600	762.0	1248.0	-486.0	1502.0	-740.0	1525.0	-763.0		
	100/06-24-087-19W600	738.0	1211.5	-473.5	1455.0	-717.0	1475.3	-737.3		
	100/06-25-087-19W600	722.0	1187.0	-465.0	1426.0	-704.0	1445.0	-723.0		
•	100/07-26-087-19W600	744.2	1213.0	-468.8	1453.0	-708.8	1461.0	-716.8		
	100/08-27-087-19W600	777.5	1250.0	-472.5	1483.0	-705.5	1506.0	-728.5		
•	100/10-27-087-19W600	778.2	1255.2	-477.0	1482.0	-703.8	1495.9	-717.7	~1554.5	-776.0
	100/14-27-087-19W600	781.8	1250.0	-468.2	1490.0	-708.2	1511.0	-729.2		
	100/10-28-087-19W600	791.6	1267.4	-475.8	1510.9	-719.3	1532.8	-741.2		
•	100/14-35-087-19W600	734.2	1203.0	-468.8	1437.0	-702.8	1453.0	-718.8		
•	100/06-04-087-20W600	782.1	1288.7	-506.6	1576.0	-793.9	1587.0	-804.9	1675.5	-893.4
•	100/07-05-087-20W600	790.3	1293.0	-502.7	1577.0	-786.7	1595.2	-804.9	?	
•	100/06-06-087-20W600	777.2	1290.0	-512.8	1576.0	-798.8	1601.0	-823.8	1681.0	-903.8
?	100/07-07-087-20W600	824.5	1324.7	-500.2	1612.9	-788.4	?		?	
	102/07-07-087-20W600	823.3	1325.9	-502.6	1614.2	-790.9	1638.6	-815.3		
•	100/10-08-087-20W600	785.2	1279.6	-494.4	1563.5	-778.3	1572.7	-787.5	1659.9	-874.7
	100/11-10-087-20W600	779.4	1283.2	-503.8	1551.4	-772.0	? 1562.0	-782.6	1642.2	-862.8
•	100/06-11-087-20W600	778.9	1285.0	-506.1	1553.5	-774.6	? 1567.0	-788.1	1651.0	-872.1
•	100/11-11-087-20W600	785.0	1289.0	-504.0	1556.0	-771.0	? 1569.0	-784.0	1656.0	-871.0
•	100/06-15-087-20W600	818.4	1306.0	-487.6	1571.0	-752.6	1586.0	-767.6	1663.0	-844.6
•	102/06-15-087-20W600	809.8	1310.3	-500.5	1574.0	-764.2	1590.0	-780.2		
•	100/06-16-087-20W600	813.5	1307.6	-494.1	1578.2	-764.7	1594.6	-781.1	1676.9	-863.4
•	100/06-20-087-20W600	818.4	1304.5	-486.1	1584.3	-765.9	1592.8	-774.4	1680.6	-862.2
•	100/07-21-087-20W600	809.9	1294.2	-484.3	1561.1	-751.2	? 1567.2	-757.3	1662.3	-852.4
•	102/07-21-087-20W600	810.7	1296.0	-485.3	1562.5	-751.8	1575.0	-764.3		
•	100/06-22-087-20W600	797.4	1286.3	-488.9	1556.8	-759.4	1566.6	-769.2	? NDE	
	100/08-25-087-20W600	752.2	1235.0	-482.8	1487.0	-734.8	1508.0	-755.8		
•	100/14-32-087-20W600	801.3	1277.0	-475.7	1547.0	-745.7	?		?	
	100/15-33-087-20W600	800.4	1270.0	-469.6	1534.0	-733.6				
•	100/10-34-087-20W600	758.0	1233.2	-475.2	1496.5	-738.5	1506.2	-748.2		
•	100/07-01-087-21W600	799.5	1297.0	-497.5	1590.5	-791.0	1617.0	-817.5	1699.0	-899.5
•	100/14-01-087-21W600	802.1	1300.0	-497.9	1592.0	-789.9	1616.0	-813.9	1698.0	-895.9
•	100/11-02-087-21W600	846.6	1370.0	-523.4	1662.5	-815.9	1681.0	-834.4	1768.0	-921.4
•	100/02-07-087-21W600	837.3	1375.0	-537.7	1680.5	-843.2	1698.0	-860.7	1787.0	-949.7
	100/10-09-087-21W600	826.6	1367.0	-540.4	1655.7	-829.1	1685.8	-859.2	1764.5	-937.9
•	100/07-11-087-21W600	814.1	1316.7	-502.6	1611.1	-797.0	1628.8	-814.7	1718.4	-904.3
•	100/11-12-087-21W600	787.3	1274.1	-486.8	1563.5	-776.2	1586.7	-799.4	1670.5	-883.2
•	100/10-14-087-21W600	825.1	1307.3	-482.2	1596.5	-771.4	1611.4	-786.3	1704.4	-879.3
•	100/07-24-087-21W600	832.7	1312.8	-480.1	1600.1	-767.4	1624.5	-791.8	1702.5	-869.8
•	100/06-26-087-21W600	849.5	1322.8	-473.3	1604.7	-755.2	1625.1	-775.6	1711.7	-862.2

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/16-03-086-25W600										
100/06-11-086-25W600	2006.2	-1352.1								
100/11-10-086-19W600										
100/15-06-086-20W600			1710.0	-854.4	3.5	12.5				
100/06-01-087-19W600			? 1499	-737.7	2.0					
100/08-01-087-19W600										
100/14-01-087-19W600										
100/15-01-087-19W600										
100/07-02-087-19W600										
100/11-02-087-19W600			? 1505	-759.0	0.0					
100/07-03-087-19W600			1533.0	-764.6	0.0	5.0				
100/08-03-087-19W600										
100/06-05-087-19W600										
100/06-11-087-19W600										
100/03-12-087-19W600			1519.5	-757.7	0.0	14.0				
100/10-19-087-19W600			1534.0	-772.0	0.0	4.0				
100/06-24-087-19W600										
100/06-25-087-19W600										
100/07-26-087-19W600			1482.0	-737.8	0.0	8.0				
100/08-27-087-19W600										
100/10-27-087-19W600			1517.2	-739.0	0.0	15.8				
100/14-27-087-19W600										
100/10-28-087-19W600										
100/14-35-087-19W600			1463.0	-728.8	TRACE	12.5				
100/06-04-087-20W600	1943.0	-1160.9	1612.5	-830.4	2.0		? NP		0.0	
100/07-05-087-20W600	1948.9	-1158.6	1617.2	-826.9	0.0	3.7	?			
100/06-06-087-20W600	1947.7	-1170.5	1622.0	-844.8	3.5		? NP		0.0	
100/07-07-087-20W600	1982.1	-1157.6								
102/07-07-087-20W600										
100/10-08-087-20W600	1924.5	-1139.3	1598.9	-813.7	0.0	2.7	? NP		0.0	
100/11-10-087-20W600	1908.7	-1129.3	1587.6	-808.2	0.0	2.1	? NP		0.0	
100/06-11-087-20W600			1595.5	-816.6	1.5		? NP		0.0	
100/11-11-087-20W600	1922.0	-1137.0	1601.0	-816.0	7.0	9.0				
100/06-15-087-20W600	1925.0	-1106.6	1606.0	-787.6	0.0	? TSE	? NP		0.0	
102/06-15-087-20W600			1609.0	-799.2	0.0	? TSE				
100/06-16-087-20W600	1941.6	-1128.1	1608.0	-794.5	0.0	? TSE	? NP		0.0	
100/06-20-087-20W600	1946.1	-1127.7	1623.3	-804.9	0.0	? TSE	? NP		0.0	
100/07-21-087-20W600	1931.2	-1121.3	1591.0	-781.1	> 14.0	18.3	? NP		0.0	
102/07-21-087-20W600			1591.0	-780.3	16.0					
100/06-22-087-20W600	1919.0	-1121.6	1592.5	-795.1	0.0	? TSE				
100/08-25-087-20W600										
100/14-32-087-20W600	1910.0	-1108.7	1579.5	-778.2	0.0	? TSE				
100/15-33-087-20W600										
100/10-34-087-20W600			1527.6	-769.6	4.3					
100/07-01-087-21W600	1976.0	-1176.5	1638.0	-838.5	3.5	6.0	? NP		0.0	
100/14-01-087-21W600	1969.0	-1166.9	1637.0	-834.9	3.5	6.5	? NP		0.0	
100/11-02-087-21W600	2036.0	-1189.4	1707.0	-860.4	2.5	5.5	? NP		0.0	
100/02-07-087-21W600	2058.0	-1220.7					1724.5	-887.2	1.5	6.5
100/10-09-087-21W600	2033.6	-1207.0								
100/07-11-087-21W600	1988.5	-1174.4	1656.8	-842.7	4.9		? NP		0.0	
100/11-12-087-21W600	1944.6	-1157.3	1607.4	-820.1	4.9		? NP		0.0	
100/10-14-087-21W600	1978.2	-1153.1	1639.1	-814.0	0.0	4.9	? NP		0.0	
100/07-24-087-21W600	1977.2	-1144.5	1637.9	-805.2	2.4	5.5	? NP		0.0	
100/06-26-087-21W600	1981.2	-1131.7	1647.1	-797.6	sand ?	2.4	? NP		0.0	

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/16-03-086-25W600				
100/06-11-086-25W600				
100/11-10-086-19W600				
100/15-06-086-20W600				
100/06-01-087-19W600				
100/08-01-087-19W600				
100/14-01-087-19W600				
100/15-01-087-19W600				
100/07-02-087-19W600				
100/11-02-087-19W600				
100/07-03-087-19W600				
100/08-03-087-19W600				
100/06-05-087-19W600				
100/06-11-087-19W600				
100/03-12-087-19W600				
100/10-19-087-19W600			CHD	
100/06-24-087-19W600				
100/06-25-087-19W600				
100/07-26-087-19W600				
100/08-27-087-19W600				
100/10-27-087-19W600				
100/14-27-087-19W600				
100/10-28-087-19W600				
100/14-35-087-19W600				
100/06-04-087-20W600				
100/07-05-087-20W600				
100/06-06-087-20W600				
100/07-07-087-20W600				
102/07-07-087-20W600				
100/10-08-087-20W600				
100/11-10-087-20W600				scale problems on gamma log
100/06-11-087-20W600				
100/11-11-087-20W600		?		
100/06-15-087-20W600				
102/06-15-087-20W600				
100/06-16-087-20W600				
100/06-20-087-20W600				
100/07-21-087-20W600		X		
102/07-21-087-20W600				
100/06-22-087-20W600			HD	
100/08-25-087-20W600				
100/14-32-087-20W600				
100/15-33-087-20W600				
100/10-34-087-20W600				
100/07-01-087-21W600				Questionable 1st sand correlation
100/14-01-087-21W600				Questionable 1st sand correlation
100/11-02-087-21W600				Questionable 1st sand correlation
100/02-07-087-21W600				
100/10-09-087-21W600				
100/07-11-087-21W600				Questionable 1st sand correlation
100/11-12-087-21W600				Questionable 1st sand correlation
100/10-14-087-21W600				poor quality log, Questionable 1st sand correlation
100/07-24-087-21W600				Questionable 1st sand correlation
100/06-26-087-21W600				Questionable 1st sand correlation

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
•	102/06-26-087-21W600	850.7	1324.0	-473.3	1605.5	-754.8	1626.5	-775.8		
•	100/07-28-087-21W600	818.7	1326.5	-507.8	1610.0	-791.3	1628.0	-809.3	1715.0	-896.3
	100/06-31-087-21W600	781.5	1271.3	-489.8	1539.5	-758.0	1571.5	-790.0		
•	100/10-32-087-21W600	820.8	1302.1	-481.3	1591.0	-770.2	1609.3	-788.5	1694.0	-873.2
•	100/12-01-087-22W600	766.9	1320.5	-553.6	1627.0	-860.1	1647.0	-880.1	1739.0	-972.1
•	100/06-09-087-22W600	879.0	1405.1	-526.1	1719.0	-840.0	1750.1	-871.1	?	
•	100/16-10-087-22W600	808.7	1356.0	-547.3	1657.0	-848.3	1686.5	-877.8	1782.0	-973.3
	100/07-13-087-22W600	842.5	1373.7	-531.2	1669.4	-826.9	1688.6	-846.1		
•	100/10-13-087-22W600	839.4	1368.9	-529.5	1653.2	-813.8	1680.6	-841.2	1772.3	-932.9
•	100/06-14-087-22W600	869.9	1414.0	-544.1	1709.0	-839.1	1738.5	-868.6	1833.0	-963.1
•	100/07-20-087-22W600	853.4	1376.2	-522.8	1681.8	-828.4	1712.9	-859.5	1813.5	-960.1
•	100/10-28-087-22W600	814.4	1326.8	-512.4	1617.8	-803.4	1646.1	-831.7	1741.0	-926.6
	100/06-01-087-23W600	766.6	1347.8	-581.2	1664.2	-897.6	1706.6	-940.0		
	100/16-07-087-23W600	890.6	1461.2	-570.6	1792.2	-901.6	1834.9	-944.3		
•	100/03-17-087-23W600	911.7	1460.0	-548.3	1798.2	-886.5	1833.6	-921.9	?	
	100/06-26-087-23W600	871.4	1425.0	-553.6	1724.5	-853.1				
	100/06-27-087-23W600	777.2	1348.7	-571.5	1661.2	-884.0	1710.5	-933.3		
	100/16-31-087-23W600	850.4	1392.0	-541.6	1690.0	-839.6	1740.0	-889.6		
	100/07-19-087-24W600	839.7	1466.0	-626.3	1795.9	-956.2				
	100/06-28-087-24W600	751.9	1405.1	-653.2	1732.8	-980.9	1778.5	-1026.6		
	100/11-31-087-24W600	775.1	1325.3	-550.2	1650.5	-875.4	1685.2	-910.1		
	100/10-02-087-25W600	730.9	1177.4	-446.5	1536.2	-805.3	1601.4	-870.5	1705.4	-974.5
	100/16-10-087-25W600	751.3	1263.7	-512.4	1617.9	-866.6	1683.1	-931.8		
	100/08-11-087-25W600	741.3	1134.5	-393.2	1472.2	-730.9	1533.1	-791.8	1652.0	-910.7
	100/09-11-087-25W600	736.0	1131.5	-395.5	1474.0	-738.0	1539.5	-803.5	1642.0	-906.0
	100/14-11-087-25W600	749.2	1191.8	-442.6	1540.2	-791.0	1591.7	-842.5		
	100/06-22-087-25W600	700.7	1209.8	-509.1	1545.3	-844.6	1603.2	-902.5		
	100/07-22-087-25W600	686.1	1180.0	-493.9	1514.0	-827.9	1571.0	-884.9		
	102/06-23-087-25W600	671.8	1129.9	-458.1	1465.8	-794.0	1529.2	-857.4		
	100/10-27-087-25W600	642.7	1123.5	-480.8	1467.5	-824.8	1530.0	-887.3	1634.0	-991.3
•	100/06-10-088-19W600	744.0	1200.9	-456.9	1426.4	-682.4	1444.1	-700.1	NDE	
	100/01-12-088-19W600	730.3	1181.1	-450.8	1407.0	-676.7	1426.5	-696.2		
•	100/11-16-088-19W600	775.4	1224.0	-448.6	1453.5	-678.1	1470.0	-694.6		
•	100/06-18-088-19W600	775.1	1229.0	-453.9	1472.1	-697.0	1490.7	-715.6	1555.6	-780.5
•	100/07-19-088-19W600	745.2	1202.0	-456.8	1436.0	-690.8	1449.5	-704.3	NDE	
•	100/06-21-088-19W600	763.0	1215.0	-452.0	1438.0	-675.0	1455.0	-692.0		
	100/11-26-088-19W600	713.2	1157.5	-444.3	1375.0	-661.8	1390.0	-676.8		
•	100/05-03-088-20W600	775.0	1246.0	-471.0	1503.0	-728.0	1524.0	-749.0		
	100/04-07-088-20W600	742.8	1205.8	-463.0	1478.3	-735.5	1502.7	-759.9		
	100/11-08-088-20W600	798.3	1268.0	-469.7	1524.0	-725.7	1552.3	-754.0	1625.8	-827.5
?	100/06-16-088-20W600	793.1	1254.9	-461.8	1509.3	-716.2	1527.6	-734.5		
	100/07-24-088-20W600	769.0	1219.8	-450.8	1460.0	-691.0	1478.3	-709.3		
•	100/10-29-088-20W600	755.0	1208.0	-453.0	1463.0	-708.0	1483.0	-728.0	1552.0	-797.0
•	100/11-33-088-20W600	709.5	1151.0	-441.5	1399.0	-689.5	1417.0	-707.5		
•	100/09-34-088-20W600	714.4	1155.0	-440.6	1386.0	-671.6	1399.0	-684.6		
•	100/06-02-088-21W600	798.9	1263.0	-464.1	1540.0	-741.1	1568.0	-769.1	1643.0	-844.1
	100/07-08-088-21W600	832.1	1325.9	-493.8	1609.3	-777.2				
•	100/06-14-088-21W600	716.9	1187.8	-470.9	1447.1	-730.2	1482.5	-765.6	1558.4	-841.5
•	100/11-10-088-22W600	808.9	1316.7	-507.8	1592.5	-783.6	1618.4	-809.5	1705.3	-896.4
	100/10-14-088-22W600	784.3	1298.1	-513.8	1576.7	-792.4				
•	100/11-15-088-22W600	786.7	1265.0	-478.3	1555.0	-768.3	1579.0	-792.3		
•	100/10-16-088-22W600	798.0	1303.9	-505.9	1584.3	-786.3	1640.7	-842.7		
	100/10-17-088-22W600	785.2	1303.0	-517.8	1587.0	-801.8	1610.0	-824.8		
	100/10-20-088-22W600	741.0	1252.7	-511.7	1535.9	-794.9				

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
102/06-26-087-21W600			NDE							
100/07-28-087-21W600	1980.0	-1161.3	1634.0	-815.3	1.0		1650.0	-831.3	0.0	2.5
100/06-31-087-21W600										
100/10-32-087-21W600	1960.8	-1140.0	1628.8	-808.0	0.0	2.4	? NP		0.0	
100/12-01-087-22W600	2018.0	-1251.1	? NP		0.0		1675.0	-908.1	1.5	
100/06-09-087-22W600	2133.6	-1254.6					1779.3	-900.3	0.0	4.9
100/16-10-087-22W600	2050.0	-1241.3	? NP		0.0		1712.0	-903.3	2.5	17.0
100/07-13-087-22W600										
100/10-13-087-22W600	2051.3	-1211.9	? NP		0.0		1705.3	-865.9	0.0	6.1
100/06-14-087-22W600	2107.0	-1237.1	? 1776.5	-906.6	0.0	3.0	1764.0	-894.1	0.0	5.0
100/07-20-087-22W600	2080.6	-1227.2	? NP		0.0		1739.7	-886.3	0.0	2.4
100/10-28-087-22W600	2008.0	-1193.6	? NP		0.0		1670.8	-856.4	0.0	4.3
100/06-01-087-23W600										
100/16-07-087-23W600										
100/03-17-087-23W600	2234.5	-1322.8					?			
100/06-26-087-23W600										
100/06-27-087-23W600										
100/16-31-087-23W600										
100/07-19-087-24W600										
100/06-28-087-24W600										
100/11-31-087-24W600										
100/10-02-087-25W600	2027.5	-1296.6								
100/16-10-087-25W600										
100/08-11-087-25W600	1987.3	-1246.0								
100/09-11-087-25W600	1974.0	-1238.0								
100/14-11-087-25W600										
100/06-22-087-25W600										
100/07-22-087-25W600										
102/06-23-087-25W600										
100/10-27-087-25W600	2008.0	-1365.3								
100/06-10-088-19W600			? 1453.8	-709.8	0.0	19.5				
100/01-12-088-19W600										
100/11-16-088-19W600			? 1482.0	-706.6	0.0	17.0				
100/06-18-088-19W600			? 1506.2	-731.1	0.0	15.2	? NP		0.0	
100/07-19-088-19W600			1466.0	-720.8	0.0	13.0				
100/06-21-088-19W600			1466.0	-703.0	0.0	17.0				
100/11-26-088-19W600										
100/05-03-088-20W600			1533.0	-758.0	1.5					
100/04-07-088-20W600										
100/11-08-088-20W600	1895.9	-1097.6								
100/06-16-088-20W600			?							
100/07-24-088-20W600										
100/10-29-088-20W600	1822.5	-1067.5	1512.0	-757.0	0.0	18.0	? NP		0.0	
100/11-33-088-20W600										
100/09-34-088-20W600			1408.0	-693.6	> 40.0					
100/06-02-088-21W600	1909.0	-1110.1	1575.0	-776.1	1.5		? NP		0.0	
100/07-08-088-21W600										
100/06-14-088-21W600	1830.3	-1113.4	? NP		0.0		? NP		0.0	
100/11-10-088-22W600	1972.1	-1163.2	1636.7	-827.8	15.0		? NP		0.0	
100/10-14-088-22W600										
100/11-15-088-22W600							1596.0	-809.3	0.0	3.0
100/10-16-088-22W600			NDE				NDE			
100/10-17-088-22W600										
100/10-20-088-22W600										

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
102/06-26-087-21W600			H	Questionable 1st sand correlation
100/07-28-087-21W600				
100/06-31-087-21W600				
100/10-32-087-21W600				Questionable 1st sand correlation
100/12-01-087-22W600				
100/06-09-087-22W600				poor quality log
100/16-10-087-22W600				
100/07-13-087-22W600				
100/10-13-087-22W600				
100/06-14-087-22W600				
100/07-20-087-22W600				poor quality log
100/10-28-087-22W600				
100/06-01-087-23W600				
100/16-07-087-23W600				
100/03-17-087-23W600				
100/06-26-087-23W600				
100/06-27-087-23W600				
100/16-31-087-23W600				
100/07-19-087-24W600				
100/06-28-087-24W600				
100/11-31-087-24W600				
100/10-02-087-25W600				
100/16-10-087-25W600				
100/08-11-087-25W600				
100/09-11-087-25W600				
100/14-11-087-25W600				
100/06-22-087-25W600				
100/07-22-087-25W600				
102/06-23-087-25W600				
100/10-27-087-25W600				
100/06-10-088-19W600				
100/01-12-088-19W600				
100/11-16-088-19W600				
100/06-18-088-19W600				
100/07-19-088-19W600				
100/06-21-088-19W600			CH	
100/11-26-088-19W600				
100/05-03-088-20W600				TSE @ 1535 ?
100/04-07-088-20W600				
100/11-08-088-20W600				
100/06-16-088-20W600				16-18-88-20/w67: poor quality log
100/07-24-088-20W600			H	e-log
100/10-29-088-20W600				
100/11-33-088-20W600				
100/09-34-088-20W600		X	D	Could Doig 1st sand at this locals
100/06-02-088-21W600				Questionable 1st sand correlation
100/07-08-088-21W600				
100/06-14-088-21W600				
100/11-10-088-22W600				
100/10-14-088-22W600				
100/11-15-088-22W600				
100/10-16-088-22W600				
100/10-17-088-22W600				
100/10-20-088-22W600				

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
	100/06-22-088-22W600	726.3	1226.8	-500.5	1496.6	-770.3	1521.6	-795.3		
	100/10-27-088-22W600	795.2	1310.6	-515.4	1581.0	-785.8				
?	100/06-28-088-22W600	729.4	1223.8	-494.4	1519.0	-789.6	1542.0	-812.6		
•	100/02-33-088-22W600	783.3	1267.0	-483.7	1532.0	-748.7	1561.0	-777.7	1652.0	-868.7
	100/11-07-088-23W600	872.0	1424.0	-552.0	1726.0	-854.0	1771.0	-899.0		
•	100/13-07-088-23W600	880.6	1435.6	-555.0	1743.4	-862.8	1779.9	-899.3	1875.0	-994.4
•	100/10-12-088-23W600	826.3	1339.3	-513.0	1636.1	-809.8	1665.3	-839.0	?	
	100/07-22-088-23W600	866.5	1382.6	-516.1	1666.6	-800.1	1699.0	-832.5		
	100/10-27-088-23W600	826.0	1337.0	-511.0	1625.0	-799.0	1655.0	-829.0		
	100/06-03-088-24W600	759.6	1366.4	-606.8	1682.5	-922.9	1726.4	-966.8		
•	100/03-06-088-24W600	732.2	1277.0	-544.8	159[illegible]	-858.1	1645.7	-913.5	1745.0	-1012.8
•	100/11-19-088-24W600	837.9	1366.1	-528.2	168[illegible]	-845.8	1735.5	-897.6	1831.8	-993.9
	100/10-25-088-24W600	859.8	1432.6	-572.8	1735.5	-875.7	1767.8	-908.0	1863.9	-1004.1
	100/08-01-088-25W600	800.7	1362.5	-561.8	1651.7	-851.0	1726.4	-925.7	1841.6	-1040.9
	100/06-02-088-25W600	806.8	1425.5	-618.7	1725.0	-918.2	1804.0	-997.2		
	100/10-04-088-25W600	692.8	1177.1	-484.3	1513.0	-820.2	1570.0	-877.2		
	100/06-10-088-25W600	712.3	1354.0	-641.7	1690.5	-978.2	1748.0	-1035.7		
	100/10-11-088-25W600	918.7	1522.0	-603.3	1850.0	-931.3	1905.0	-986.3		
	100/10-12-088-25W600	758.3	1313.7	-555.4	1633.7	-875.4	1685.5	-927.2	1783.1	-1024.8
	100/10-14-088-25W600	861.4	1452.0	-590.6	1780.0	-918.6	1830.0	-968.6		
•	100/14-20-088-25W600	749.8	1217.0	-467.2	1545.0	-795.2	1599.3	-849.5	1692.0	-942.2
	100/06-25-088-25W600	722.4	1209.4	-487.0	1520.0	-797.6	1569.1	-846.7	1667.0	-944.6
	102/06-25-088-25W600	724.0	1212.5	-488.5	1520.0	-796.0	1569.1	-845.1	1667.0	-943.0
	100/14-25-088-25W600	727.6	1207.0	-479.4	1481.6	-754.0	1554.5	-826.9	1659.3	-931.7
•	100/12-29-088-25W600	764.5	1222.3	-457.8	1546.0	-781.5	1599.0	-834.5	1691.5	-927.0
	100/06-22-088-21W600	?			1541.0	########	1565.0	########	1641.0	########

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLV	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
100/06-22-088-22W600										
100/10-27-088-22W600										
100/06-28-088-22W600			NDE				NDE			
100/02-33-088-22W600	1925.5	-1142.2	1602.0	-818.7	? 7.0	7.0	1585.0	-801.7	? 12	12.0
100/11-07-088-23W600										
100/13-07-088-23W600	2159.8	-1279.2	? NP		0.0		? NP		0.0	
100/10-12-088-23W600	2031.2	-1204.9	?				?			
100/07-22-088-23W600										
100/10-27-088-23W600										
100/06-03-088-24W600										
100/03-06-088-24W600	2045.0	-1312.8	? NP		0.0		? NP		0.0	
100/11-19-088-24W600	2136.6	-1298.7	? NP		0.0		? NP		0.0	
100/10-25-088-24W600	2151.9	-1292.1								
100/08-01-088-25W600	2142.7	-1342.0								
100/06-02-088-25W600										
100/10-04-088-25W600										
100/06-10-088-25W600										
100/10-11-088-25W600										
100/10-12-088-25W600	2084.8	-1326.5								
100/10-14-088-25W600										
100/14-20-088-25W600	1992.0	-1242.2	? NP		0.0		? NP		0.0	
100/06-25-088-25W600	1963.8	-1241.4								
102/06-25-088-25W600	1963.8	-1239.8								
100/14-25-088-25W600	1947.7	-1220.1								
100/12-29-088-25W600	1992.0	-1227.5	? NP		0.0		? NP		0.0	
100/06-22-088-21W600										

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
100/06-22-088-22W600				
100/10-27-088-22W600				
100/06-28-088-22W600				10-28-88-22/w6 ?
100/02-33-088-22W600				
100/11-07-088-23W600				
100/13-07-088-23W600				
100/10-12-088-23W600				
100/07-22-088-23W600				
100/10-27-088-23W600				
100/06-03-088-24W600				
100/03-06-088-24W600				
100/11-19-088-24W600				
100/10-25-088-24W600				
100/08-01-088-25W600				
100/06-02-088-25W600				
100/10-04-088-25W600				
100/06-10-088-25W600				
100/10-11-088-25W600				
100/10-12-088-25W600				
100/10-14-088-25W600				
100/14-20-088-25W600				
100/06-25-088-25W600				
102/06-25-088-25W600				
100/14-25-088-25W600				
100/12-29-088-25W600				
100/06-22-088-21W600				

APPENDIX E2: DOIG STUDY
STRATIGRAPHIC TOPS FILES (NTS AREA)

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
	d-28-I/94-A-10	739.7	1140.0	-400.3	1320.0	-580.3	1327.0	-587.3		
	d-33-I/94-A-10	716.6	1115.0	-398.4	1278.3	-561.7	1288.1	-571.5		
	d-57-I/94-A-10	757.7	1142.4	-384.7	1317.7	-560.0	1350.3	-592.6		
	a-63-I/94-A-10	722.5	1116.0	-393.5	1283.0	-560.5	1288.0	-565.5		
	c-07-I/94-A-10	718.1	1106.0	-387.9	1252.0	-533.9	1255.0	-536.9		
	d-74-I/94-A-10	731.1	1108.0	-376.9	1265.0	-533.9	1295.5	-564.4		
	a-83-I/94-A-10	725.7	1105.5	-379.8	1261.5	-535.8	1272.5	-546.8		
	d-95-I/94-A-10	738.0	1112.0	-374.0	1285.0	-547.0	1291.0	-553.0		
•	d-97-I/94-A-10	747.7	1123.0	-375.3	1301.5	-553.8	1303.0	-555.3	1347.5	-599.8
•	c-51-J/94-A-10	720.3	1135.0	-414.7	1321.5	-601.2	1332.5	-612.2		
•	a-67-J/94-A-10	706.5	1113.0	-406.5	1298.0	-591.5	1304.5	-598.0		
•	a-29-K/94-A-10	724.1	1155.0	-430.9	1364.0	-639.9	1377.0	-652.9		
•	d-51-K/94-A-10	686.6	1101.0	-414.4	1293.0	-606.4	1305.0	-618.4		
	c-54-K/94-A-10	578.2	997.9	-419.7	1194.8	-616.6	1208.2	-630.0		
	a-87-K/94-A-10	665.1	1082.0	-416.9	1275.3	-610.2				
•	d-87-K/94-A10	663.3	1082.0	-418.7	1273.7	-610.4	1283.0	-619.7	1339.0	-675.7
•	b-56-L/94-A-10	699.2	1137.8	-438.6	1347.2	-648.0	1365.2	-666.0		
•	b-24-I/94-A-11	726.5	1166.0	-439.5	1397.0	-670.5	1415.0	-688.5		
•	d-36-I/94-A-11	690.6	1129.0	-438.4	1359.0	-668.4	1377.0	-686.4	NDE	
•	b-44-I/94-A-11	711.3	1150.0	-438.7	1379.0	-667.7	1394.5	-683.2	1454.0	-742.7
•	d-45-I/94-A-11	681.5	1153.0	-471.5	1379.0	-697.5	1394.0	-712.5		
•	d-46-I/94-A-11	676.0	1112.5	-436.5	1335.6	-659.6	1348.7	-672.7		
•	d-49-I/94-A-11	680.0	1116.8	-436.8	1354.8	-674.8	1372.2	-692.2	1434.4	-754.4
d	b-56-I/94-A-11	671.0	1160.0	-489.0	1396.0	-725.0	1417.0	-746.0		
•	c-57-I/94-A-11	682.3	1110.0	-427.7	1331.0	-648.7	1345.0	-662.7		
•	02/d-57-I/94-A-11	678.2	1109.5	-431.3	1326.5	-648.3	1338.1	-659.9		
•	d-58-I/94-A-11	688.5	1119.5	-431.0	1339.6	-651.1	1353.3	-664.8		
	d-59-I/94-A-11	723.3	1158.2	-434.9	1386.2	-662.9	1403.9	-680.6		
•	a-67-I/94-A-11	683.4	1111.3	-427.9	1332.6	-649.2	1344.7	-661.3		
•	b-67-I/94-A-11	694.9	1125.0	-430.1	1343.0	-648.1	1355.0	-660.1		
•	a-68-I/94-A-11	706.2	1137.0	-430.8	1362.0	-655.8	1375.5	-669.3		
•	d-68-I/94-A-11	714.5	1143.0	-428.5	1362.2	-647.7	1375.3	-660.8		
•	d-69-I/94-A-11	749.0	1182.0	-433.0	1411.0	-662.0	1427.0	-678.0		
•	d-76-I/94-A-11	694.8	1122.0	-427.2	1344.0	-649.2	1360.0	-665.2	1422.0	-727.2
•	b-77-I/94-A-11	700.8	1127.0	-426.2	1349.0	-648.2	1357.0	-656.2	NDE	
•	d-79-I/94-A-11	711.3	1143.5	-432.2	1373.0	-661.7	1387.0	-675.7		
•	d-85-I/94-A-11	723.8			1369.5	-645.7	1379.0	-655.2		
•	d-86-I/94-A-11	734.9	1159.0	-424.1	1374.0	-639.1	1383.5	-648.6		
•	d-93-I/94-A-11	674.7	1117.5	-442.8	1330.0	-655.3	1341.0	-666.3		
•	02/d-96-I/94-A-11	735.1			1369.0	-633.9	1376.0	-640.9		
•	03/d-96-I/94-A-11	735.4	1158.0	-422.6	1371.0	-635.6	1378.0	-642.6		
•	d-98-I/94-A-11	708.4	1133.9	-425.5	1357.6	-649.2	1374.6	-666.2	1430.7	-722.3
•	d-33-J/94-A-11	685.8	1130.2	-444.4	1377.7	-691.9	1396.0	-710.2	NDE	
•	d-52-J/94-A-11	759.4	1187.0	-427.6	1425.0	-665.6	1448.0	-688.6	1509.0	-749.6
	d-55-J/94-A-11	695.6	1147.3	-451.7	1395.4	-699.8	1411.2	-715.6		
•	c-56-J/94-A-11	758.3	1214.3	-456.0	1466.7	-708.4	1480.1	-721.8		
	c-79-J/94-A-11	776.9	1228.3	-451.4	1480.7	-703.8				
•	d-83-J/94-A-11	775.4	1194.2	-418.8	1433.5	-658.1	1452.4	-677.0		
•	b-26-K/94-A-11	769.5	1265.0	-495.5	1536.5	-767.0	1561.0	-791.5	1637.0	-867.5
•	d-31-K/94-A-11	760.5	1219.0	-458.5	1485.0	-724.5	1503.0	-742.5	1576.0	-815.5
•	d-33-K/94-A-11	694.0	1140.7	-446.7	1406.0	-712.0	1421.3	-727.3		
	d-38-K/94-A-11	797.1	1272.2	-475.1	1542.3	-745.2				

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLV	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
d-28-I/94-A-10										
d-33-I/94-A-10										
d-57-I/94-A-10										
a-63-I/94-A-10										
c-07-I/94-A-10										
d-74-I/94-A-10										
a-83-I/94-A-10										
d-95-I/94-A-10										
d-97-I/94-A-10			1301.5	-553.8	TSE	TSE	1333.5		0.0	2.5
c-51-J/94-A-10			1332.5	-612.2	TSE	TSE				
a-67-J/94-A-10			1310.5	-604.0	FS	FS				
a-29-K/94-A-10			1387.0	-662.9	1.5	4.0		722.6		
d-51-K/94-A-10			1310.0	-623.4	3.5	6.0	1337.0	683.1	0.0	3.5
c-54-K/94-A-10										
a-87-K/94-A-10										
d-87-K/94-A10			1287.0	-623.7	9.0		? NP	654.3	0.0	
b-56-L/94-A-10			1368.2	-669.0	0.0	FS		699.2		
b-24-I/94-A-11			1425.5	-699.0	1.5	11.0		725.0		
d-36-I/94-A-11			1365.0	-674.4	5.0			685.6		
b-44-I/94-A-11	NDE		1410.0	-698.7	3.0		? NP	708.3	0.0	
d-45-I/94-A-11			1410.0	-728.5	2.0			679.5		
d-46-I/94-A-11			1358.5	-682.5	8.5			667.5		
d-49-I/94-A-11			1384.1	-704.1		4.5	? NP		0.0	
b-56-I/94-A-11										
c-57-I/94-A-11			1358.5	-676.2	15.0			667.3		
02/d-57-I/94-A-11			1350.8	-672.6	32.0	37.2		646.2		
d-58-I/94-A-11			1364.3	-675.8	15.8			672.7		
d-59-I/94-A-11										
a-67-I/94-A-11			1355.7	-672.3	20.5	23.2		662.9		
b-67-I/94-A-11			1367.0	-672.1	14.0			680.9		
a-68-I/94-A-11			1389.5	-683.3	11.5			694.7		
d-68-I/94-A-11			1389.3	-674.8	23.5	26.8		691.0		
d-69-I/94-A-11			1443.0	-694.0		3.0				
d-76-I/94-A-11			1379.0	-684.2	18.0		? NP	676.8	0.0	
b-77-I/94-A-11			1371.0	-670.2	15.0	22.0		685.8		
d-79-I/94-A-11			1401.0	-689.7	4.5	14.0		706.8		
d-85-I/94-A-11			1392.0	-668.2	22.5	14.5	? NP	701.3	0.0	
d-86-I/94-A-11			1393.0	-658.1	27.5	30.0		707.4		
d-93-I/94-A-11			1347.0	-672.3	5.5	20.0		669.2		
02/d-96-I/94-A-11			1388.0	-652.9	28.5	33.0		706.6		
03/d-96-I/94-A-11			1390.0	-654.6	23.0			712.4		
d-98-I/94-A-11			? NP		0.0		? NP	708.4	0.0	
d-33-I/94-A-11			1408.8	-723.0	0.0	3.6		685.8		
d-52-J/94-A-11			1464.0	-704.6	0.0	12.0	? NP	759.4	0.0	
d-55-J/94-A-11										
c-56-J/94-A-11			1497.2	-738.9		2.7	? NP		0.0	
c-79-J/94-A-11										
d-83-J/94-A-11										
b-26-K/94-A-11	1902.0	-1132.5	?NP		0.0		1573.0	769.5	4.0	
d-31-K/94-A-11			?NP		0.0		1519.0	760.5		6.0
d-33-K/94-A-11			NDE				NDE			
d-38-K/94-A-11										

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
d-28-I/94-A-10				questionable Doig, Main Phosphate
d-33-I/94-A-10				
d-57-I/94-A-10				
a-63-I/94-A-10				
c-07-I/94-A-10				
d-74-I/94-A-10				
a-83-I/94-A-10				
d-95-I/94-A-10				
d-97-I/94-A-10				1301.5 - erosional surface: 1st Doig sand equivalent?
c-51-J/94-A-10				1332.5 - erosional surface: 1st Doig sand equivalent?
a-67-J/94-A-10				1310.5 - flooding surface: 1st Doig sand equivalent?
a-29-K/94-A-10			HD	1st Doig sand equivalent - 4.0 m thick
d-51-K/94-A-10				1st Doig sand equivalent - 6.0 m thick
c-54-K/94-A-10				
a-87-K/94-A-10				
d-87-K/94-A10			H	
b-56-L/94-A-10				1368.2: flooding surface (TSE?)
b-24-I/94-A-11				1417.0: top Doig parasequence, 1st Doig sand equivalent 11.0 m thick
d-36-I/94-A-11			D	1362.0: TSE (?), 1st Doig sand equivalent 5.0 m thick
b-44-I/94-A-11			D	1407.0: TSE (?)
d-45-I/94-A-11			D	1399.0: top Doig parasequence(?), 1st Doig sand equivalent 2.0 m thick
d-46-I/94-A-11		X	D	1367.0: SB (?), 1st Doig sand equivalent 8.5 m thick
d-49-I/94-A-11				1st Doig sand equivalent 4.5 m silty mud
b-56-I/94-A-11		X		Deviated Well - not corrected for TVD (as of July 6th, 1994)
c-57-I/94-A-11		X		1349.0: top Doig parasequence, 1st Doig sand equivalent 15.5 m thick
02/d-57-I/94-A-11		X	D	1350.8: TSE (?), 1st Doig sand equivalent 37.2 m thick
d-58-I/94-A-11		X	D	1356.3: top Doig parasequence
d-59-I/94-A-11				
a-67-I/94-A-11		X		1346.9: top Doig parasequence, 1st Doig sand 23.2 m thick, 1378.9: SB(?)
b-67-I/94-A-11		X		1359.0: top Doig parasequence
a-68-I/94-A-11		X		1346.9: top Doig parasequence, 1405.0: SB(?)
d-68-I/94-A-11		X	D	1378.3: top Doig parasequence, 1st Doig sand 26.8 m thick, 1416.7: SB(?)
d-69-I/94-A-11			D	1430.5: top Doig parasequence
d-76-I/94-A-11		X	D	1356.0: top Doig parasequence, 1398.0: SB, 1367.5: TSE
b-77-I/94-A-11		X	D	1359.5: top Doig parasequence, 1st Doig sand 22.0 m thick
d-79-I/94-A-11			D	1392.0: top Doig parasequence, 1st Doig sand 14.0 m silt thickness
d-85-I/94-A-11			D	SB @ 1402m
d-86-I/94-A-11		X	CHD	1385.0: top Doig parasequence, 1st Doig sand 30.0 m thick
d-93-I/94-A-11				1343.0: top Doig parasequence, 1st Doig sand 22.0 m silt thickness, log character serrated
02/d-96-I/94-A-11		X	CD	1379.0: top Doig parasequence, 1st Doig sand 33.0 m thick, 1421.0: SB
03/d-96-I/94-A-11		X	HD	1380.0: top Doig parasequence, 1st Doig sand 23.0 m thick
d-98-I/94-A-11				crude quality log
d-33-J/94-A-11				Upper Sand 4.9 m total silt thickness
d-52-J/94-A-11			M	
d-55-J/94-A-11				
c-56-J/94-A-11				Upper Sand 4.8 m total silt thickness
c-79-J/94-A-11				
d-83-J/94-A-11				SP/e-log
b-26-K/94-A-11				questionable Doig, Main Phosphate, 1st or 2nd Eqv. ?
d-31-K/94-A-11				
d-33-K/94-A-11				
d-38-K/94-A-11				

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
•	d-55-K/94-A-11	696.8	1151.0	-454.2	1420.0	-723.2	1440.0	-743.2	1513.0	-816.2
	c-16-L/94-A-11	805.0	1289.3	-484.3	1557.5	-752.5	1603.2	-798.2		
•	d-35-L/94-A-11	794.1	1305.0	-510.9	1586.0	-791.9	1601.0	-806.9		
•	d-37-L/94-A-11	833.0	1320.4	-487.4	1591.7	-758.7	1613.9	-780.9		
•	b-48-L/94-A-11	788.5	1281.5	-493.0	1559.5	-771.0	1582.0	-793.5		
•	c-58-L/94-A-11	823.6	1316.7	-493.1	1588.6	-765.0	1613.0	-789.4		
•	d-68-L/94-A-11	823.9	1318.6	-494.7	1594.1	-770.2	1617.3	-793.4	1702.0	-878.1
•	c-80-L/94-A-11	770.5	1280.5	-510.0	1563.5	-793.0	1583.0	-812.5	NDE	
•	d-93-L/94-A-11	782.1	1269.2	-487.1	1549.5	-767.4	1573.6	-791.5		
•	d-95-L/94-A-11	833.3	1334.1	-500.8	1605.6	-772.3	1620.2	-786.9		
	c-32-I/94-A-12	801.9	1310.6	-508.7	1591.1	-789.2	1612.4	-810.5		
	d-37-I/94-A-12	788.5	1298.4	-509.9	1581.9	-793.4	1605.7	-817.2		
•	b-62-I/94-A-12	818.4	1313.5	-495.1	1587.0	-768.6	1611.0	-792.6	NDE	
•	b-64-I/94-A-12	853.1	1350.0	-496.9	1638.0	-784.9	1654.0	-800.9	NDE	
•	d-77-I/94-A-12	845.0	1348.0	-503.0	1636.0	-791.0	1657.0	-812.0	? 1736	-891.0
	b-82-I/94-A-12	792.5	1284.4	-491.9	1551.4	-758.9	1574.6	-782.1		
•	c-32-J/94-A-12	843.3	1355.0	-511.7	1645.0	-801.7	1677.0	-833.7	1772.0	-928.7
	b-82-J/94-A-12	831.8	1350.0	-518.2	1632.5	-800.7				
	d-09-K/94-A-12	731.5	1214.0	-482.5	1533.8	-802.3	1569.7	-838.2	1670.3	-938.8
	b-18-K/94-A-12	799.2	1275.0	-475.8	1578.3	-779.1	1625.8	-826.6	1722.1	-922.9
	b-18-K/94-A-12/02	799.2	1275.0	-475.8	1578.3	-779.1	1625.8	-826.6	1722.1	-922.9
	d-19-K/94-A-12	751.9	1235.7	-483.8	1545.3	-793.4	1587.4	-835.5	1682.5	-930.6
	c-29-K/94-A-12	781.5	1258.8	-477.3	1565.1	-783.6	1609.3	-827.8	1700.8	-919.3
	d-30-K/94-A-12	748.3	1246.6	-498.3	1555.1	-806.8	1603.2	-854.9	1699.3	-951.0
	b-39-K/94-A-12	792.5	1269.0	-476.5	1566.0	-773.5	1620.0	-827.5	1710.0	-917.5
•	d-40-K/94-A-12	755.0	1234.4	-479.4	1545.9	-790.9	1592.3	-837.3	1688.0	-933.0
	d-45-K/94-A-12	926.3	1492.6	-566.3	1789.2	-862.9	1841.0	-914.7		
	a-50-K/94-A-12	799.2	1273.0	-473.8	1575.0	-775.8	1625.0	-825.8	1717.0	-917.8
	d-50-K/94-A-12	834.5	1308.5	-474.0	1594.1	-759.6	1655.7	-821.2	1748.9	-914.4
	b-60-K/94-A-12	798.0	1288.1	-490.1	1589.8	-791.8	1639.8	-841.8	1731.3	-933.3
	c-60-K/94-A-12	796.9			1577.0	-780.1	1705.0	-908.1	1718.0	-921.1
	b-100-K/94-A-12	936.3	1472.2	-535.9	1771.5	-835.2	1818.7	-882.4	1908.0	-971.7
	d-19-L/94-A-12	759.0	1228.3	-469.3	1554.5	-795.5	1609.3	-850.3	1700.8	-941.8
•	a-39-L/94-A-12	773.4	1237.0	-463.6	1552.0	-778.6	1605.0	-831.6	1695.0	-921.6
	d-41-L/94-A-12	759.6	1259.4	-499.8	1568.5	-808.9	1621.5	-861.9	1712.4	-952.8
	a-61-L/94-A-12	865.3	1355.8	-490.5	1655.7	-790.4	1706.9	-841.6	1798.3	-933.0
	c-71-L/94-A-12	880.6	1370.4	-489.8	1660.6	-780.0	1715.1	-834.5	1804.4	-923.8
	d-82-L/94-A-12	853.1	1347.2	-494.1	1667.3	-814.2	1695.0	-841.9	1775.8	-922.7
	b-92-L/94-A-12	806.2	1307.6	-501.4	1604.8	-798.6	1658.1	-851.9	1747.1	-940.9
	d-93-L/94-A-12	801.6	1309.7	-508.1	1603.9	-802.3	1651.1	-849.5	1745.9	-944.3
•	b-06-A/94-A-13	827.2	1308.2	-481.0	1583.7	-756.5	1598.4	-771.2	1694.1	-866.9
•	b-10-A/94-A-13	818.4	1320.4	-502.0	1596.2	-777.8	1614.1	-795.7	1702.5	-884.1
	c-35-A/94-A-13	837.8			1574.0	-736.2	1585.9	-748.1		
•	b-42-A/94-A-13	835.5	1309.4	-473.9	1576.4	-740.9	1589.2	-753.7	1677.6	-842.1
•	b-48-A/94-A-13	831.5	1320.0	-488.5	1597.0	-765.5	1612.0	-780.5		
•	a-57-A/94-A-13	842.2	1305.5	-463.3	1573.6	-731.4	1589.1	-746.9	1671.8	-829.6
•	d-75-A/94-A-13	857.7	1334.1	-476.4	1592.8	-735.1	1604.7	-747.0	1693.4	-835.7
	a-05-B/94-A-13	822.7	1325.9	-503.2	1594.7	-772.0	1624.0	-801.3		
	02/a-05-B/94-A-13	813.9	1315.0	-501.1	1572.0	-758.1	1624.0	-810.1	1704.0	-890.1
	c-26-B/94-A-13	807.4	1309.0	-501.6	1561.0	-753.6	1614.0	-806.6		
	b-46-B/94-A-13	782.4	1288.1	-505.7	1543.2	-760.8	1589.5	-807.1	1679.4	-897.0
•	a-47-B/94-A-13	804.0	1306.0	-502.0	1569.0	-765.0	1609.0	-805.0	1696.0	-892.0

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
d-55-K/94-A-11	1770.0	-1073.2	?NP		0.0		1457.0	696.8		4.0
c-16-L/94-A-11										
d-35-L/94-A-11							1616.0		5.0	
d-37-L/94-A-11							1628.9		11.3	
b-48-L/94-A-11			1614.0	-825.5	0.0	4.0	1594.5	788.5	5.0	
c-58-L/94-A-11			1649.6	-826.0	2.7	6.1	1642.3	820.9	0.0	1.8
d-68-L/94-A-11	1956.2	-1132.3	?NP		0.0		1647.1	823.9	0.0	3.0
c-80-L/94-A-11							1607.0		3.0	7.0
d-93-L/94-A-11			NDE				NDE			
d-95-L/94-A-11			NDE				NDE			
c-32-I/94-A-12										
d-37-I/94-A-12										
b-62-I/94-A-12			1644.0	-825.6	0.0	4.0	1630.0	818.4		14.0
b-64-I/94-A-12			1694.0	-840.9	2.3		1673.0	850.8	7.5	12.0
d-77-I/94-A-12			NP		0.0	0.0	1670.0	845.0	4.0	11.0
b-82-I/94-A-12										—
c-32-J/94-A-12	2045.0	-1201.7	NP		0.0	0.0	NP	843.3	0.0	0.0
b-82-J/94-A-12										
d-09-K/94-A-12	1972.1	-1240.6								
b-18-K/94-A-12	2020.2	-1221.0								
b-18-K/94-A-12/02	2020.2	-1221.0								
d-19-K/94-A-12	1975.4	-1223.5								
c-29-K/94-A-12	1987.0	-1205.5								
d-30-K/94-A-12	1987.6	-1239.3								
b-39-K/94-A-12	1994.0	-1201.5								
d-40-K/94-A-12	1972.7	-1217.7	? NP		0.0		? NP	755.0	0.0	
d-45-K/94-A-12										
a-50-K/94-A-12	2004.0	-1204.8								
d-50-K/94-A-12	2030.9	-1196.4								
b-60-K/94-A-12	2020.2	-1222.2								
c-60-K/94-A-12	2008.0	-1211.1								
b-100-K/94-A-12	2188.5	-1252.2								
d-19-L/94-A-12	2002.5	-1243.5								
a-39-L/94-A-12	1987.0	-1213.6	? NP		0.0		? NP	773.4	0.0	
d-41-L/94-A-12	1994.0	-1234.4								
a-61-L/94-A-12	2097.0	-1231.7								
c-71-L/94-A-12	2086.4	-1205.8								
d-82-L/94-A-12	2069.6	-1216.5								
b-92-L/94-A-12	2026.9	-1220.7								
d-93-L/94-A-12	2023.0	-1221.4								
b-06-A/94-A-13	1945.5	-1118.3	?NP		0.0		1616.4	827.2	0.0	27.7
b-10-A/94-A-13	1953.8	-1135.4	1661.5	-843.1	0.0	FS	1636.8	818.4	0.0	3.0
c-35-A/94-A-13							1599.5		5.0	
b-42-A/94-A-13	1915.4	-1079.9	1636.8	-801.3	0.0	7.0	1602.0	835.5	18.3	
b-48-A/94-A-13										
a-57-A/94-A-13	1917.2	-1075.0	?				?			
d-75-A/94-A-13	1933.0	-1075.3	?				?			
a-05-B/94-A-13	1973.0	-1150.3								
02/a-05-B/94-A-13										
c-26-B/94-A-13										
b-46-B/94-A-13	1942.2	-1159.8								
a-47-B/94-A-13	1950.0	-1146.0	1651.0	-847.0	0.0	3.5	?NP	804.0	0.0	0.0

WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
d-55-K/94-A-11				1st or 2nd Eqv. ?
c-16-L/94-A-11				
d-35-L/94-A-11				
d-37-L/94-A-11				
b-48-L/94-A-11				
c-58-L/94-A-11				
d-68-L/94-A-11				
c-80-L/94-A-11				2ND Doig Sand Equivalent = 6.0 m thick
d-93-L/94-A-11				
d-95-L/9 -A-11				
c-32-I/94-A-12				
d-37-I/94-A-12				
b-62-I/94-A-12	X			
b-64-I/94-A-12	X	X	D	2ND Doig Sand Equivalent = 12.0 m thick: SB - 1700 (?)
d-77-I/94-A-12				2ND Doig Sand Equivalent = 14.5 m thick: SB - 1702 (?): questionable Montney pick
b-82-I/94-A-12				
c-32-J/94-A-12				
b-82-J/94-A-12				
d-09-K/94-A-12				
b-18-K/94-A-12				
b-18-K/94-A-12/02				
d-19-K/94-A-12				
c-29-K/94-A-12				
d-30-K/94-A-12				
b-39-K/94-A-12				
d-40-K/94-A-12				
d-45-K/94-A-12				
a-50-K/94-A-12				
d-50-K/94-A-12				
b-60-K/94-A-12				
c-60-K/94-A-12				
b-100-K/94-A-12				
d-19-L/94-A-12				
a-39-L/94-A-12				
d-41-L/94-A-12				
a-61-L/94-A-12				
c-71-L/94-A-12				
d-82-L/94-A-12				
b-92-L/94-A-12				
d-93-L/94-A-12				
b-06-A/94-A-13				2ND Doig sand Equivalent = thick, diffuse(?) silty mud
b-10-A/94-A-13				
c-35-A/94-A-13				
b-42-A/94-A-13				2ND Doig sand Equivalent = dirty, serrated log signature: questionable base Triassic pick
b-48-A/94-A-13				
a-57-A/94-A-13				
d-75-A/94-A-13				
a-05-B/94-A-13				questionable base Triassic Pick
02/a-05-B/94-A-13				
c-26-B/94-A-13				
b-46-B/94-A-13				questionable base Triassic Pick
a-47-B/94-A-13				questionable 1st Phosphate pick

	WELL ID		Top Triassic		Halfway		Doig		Montney	
		KB	BLDN	SS	HLFY	SS	DOIG	SS	MNTN	SS
	c-58-B/94-A-13	865.2	1378.0	-512.8	1645.0	-779.8	1684.0	-818.8	1773.0	-907.8
	c-78-B/94-A-13	825.7	1340.8	-515.1	1603.9	-778.2	1641.7	-816.0	1740.4	-914.7
	b-36-C/94-A-13	837.6	1378.9	-541.3	1645.9	-808.3	1699.0	-861.4	1785.5	-947.9
	b-38-C/94-A-13	879.0	1421.9	-542.9	1705.4	-826.4	1748.0	-869.0	1831.5	-952.5
	d-47-C/94-A-13	897.6	1439.3	-541.7	1722.1	-824.5				
	b-88-C/94-A-13	881.5	1428.0	-546.5	1691.6	-810.1	1746.2	-864.7		
	d-11-D/94-A-13	917.5	1436.3	-518.8	1727.0	-809.5	1776.0	-858.5		
	b-13-D/94-A-13	828.1	1338.1	-510.0	1631.6	-803.5	1682.5	-854.4	1777.0	-948.9
	b-22-D/94-A-13	889.4	1379.5	-490.1	1664.2	-774.8	1713.0	-823.6	1803.8	-914.4
	b-24-D/94-A-13	931.5	1450.8	-519.3	1744.1	-812.6	1794.1	-862.6	1884.6	-953.1
	d-25-D/94-A-13	954.0	1473.1	-519.1	1767.8	-813.8	1817.5	-863.5	1906.8	-952.8
	a-34-D/94-A-13	872.0	1356.4	-484.4	1649.0	-777.0	1689.5	-817.5	1780.0	-908.0
	b-35-D/94-A-13	967.1	1485.0	-517.9	1781.9	-814.8	1831.8	-864.7	1919.3	-952.2
•	d-36-D/94-A-13	955.5	1478.9	-523.4	1770.9	-815.4	1821.8	-866.3	1911.1	-955.6
	d-46-D/94-A-13	943.1	1452.4	-509.3	1740.7	-797.6	1787.7	-844.6	1869.0	-925.9
	d-57-D/94-A-13	980.8	1506.3	-525.5	1807.5	-826.7	1852.6	-871.8	1942.2	-961.4
	c-65-D/94-A-13	920.8	1388.4	-467.6	1673.4	-752.6	1713.0	-792.2	1806.9	-886.1
	d-68-D/94-A-13	935.7	1471.0	-535.3	1765.0	-829.3	1812.0	-876.3	1901.0	-965.3
	d-99-D/94-A-13	869.6	1387.4	-517.8	1676.1	-806.5	1723.6	-854.0	1813.6	-944.0
•	d-06-A/94-A-14	705.7			1340.5	-634.8	1354.0	-648.3	1417.0	-711.3
•	d-26-A/94-A-14	703.7	1130.0	-426.3	1337.0	-633.3	1347.0	-643.3	1408.0	-704.3
	a-31-A/94-A-14	729.7	1158.2	-428.5	1363.1	-633.4	1380.1	-650.4		
•	d-35-A/94-A-14	679.9	1126.0	-446.1	1336.5	-656.6	1343.0	-663.1	1403.0	-723.1
•	d-58-A/94-A-14	758.4			1362.0	-603.6	1374.0	-615.6	1434.0	-675.6
	c-16-B/94-A-14	740.1	1175.9	-435.8	1408.8	-668.7	1429.2	-689.1		
•	c-35-B/94-A-14	778.4	1192.0	-413.6	1425.5	-647.1	1442.0	-663.6	1507.0	-728.6
	c-87-B/94-A-14	773.3	1179.6	-406.3	1396.0	-622.7	1431.0	-657.7	1487.4	-714.1
	c-05-C/94-A-14	786.7	1207.0	-420.3	1463.0	-676.3				
•	b-08-C/94-A-14	700.1	1152.1	-452.0	1415.5	-715.4	1434.1	-734.0		
•	d-37-C/94-A-14	769.3	1185.7	-416.4	1450.1	-680.8	1466.7	-697.4		
	b-78-C/94-A-14	793.7	1204.0	-410.3	1450.8	-657.1	1482.9	-689.2	1550.5	-756.8
•	b-06-D/94-A-14	817.0	1311.0	-494.0	1586.0	-769.0	1602.0	-785.0	NDE	
•	d-15-D/94-A-14	821.7	1317.0	-495.3	1588.0	-766.3	1604.0	-782.3	NDE	
•	b-26-D/94-A-14	833.3	1326.5	-493.2	1608.4	-775.1	1620.9	-787.6	NDE	
•	b-28-D/94-A-14	837.0	1344.0	-507.0	1623.5	-786.5	1637.0	-800.0		
•	d-37-D/94-A-14	802.8	1304.0	-501.2	1579.0	-776.2	1592.0	-789.2	1680.0	-877.2
•	d-39-D/94-A-14	831.5	1328.9	-497.4	1599.6	-768.1	1613.9	-782.4	NDE	
•	b-68-D/94-A-14	820.2	1292.0	-471.8	1552.0	-731.8	1565.0	-744.8	1652.0	-831.8
•	c-74-D/94-A-14	718.7	1161.0	-442.3	1430.0	-711.3	1445.0	-726.3	NDE	
	b-91-D/94-A-14	787.6	1200.9	-413.3	1443.5	-655.9				
	c-02-E/94-A-14	776.6	1179.6	-403.0	1441.7	-665.1				
•	a-07-E/94-A-14	720.2	1160.0	-439.8	1414.5	-694.3	1432.0	-711.8		
•	d-17-E/94-A-14	727.9	1164.9	-437.0	1412.7	-684.8	1426.5	-698.6		
	b-23-E/94-A-14	785.8	1182.6	-396.8	1434.7	-648.9	1449.3	-663.5		
•	c-32-E/94-A-14	808.3	1231.4	-423.1	1476.4	-668.1	1499.5	-691.2	1569.7	-761.4
	c-34-E/94-A-14	818.7	1230.8	-412.1	1470.7	-552.0	1488.6	-669.9		
•	a-41-E/94-A-14	832.4	1252.1	-419.7	1492.2	-659.8	1512.4	-680.0		
	c-87-E/94-A-14	797.1	1228.3	-431.2	1453.9	-656.8	1466.7	-669.6		
	b-06-F/94-A-14	808.9	1235.0	-426.1	1475.0	-666.1	1495.0	-686.1		
	d-33-F/94-A-14	786.4	1194.2	-407.8	1413.7	-627.3	1444.8	-658.4		
	d-79-F/94-A-14	781.8	1204.0	-422.2	1426.0	-644.2	1450.5	-668.7		
•	b-56-D/94-A-15	671.0			1284.0	-613.0	1292.5	-621.5		

WELL ID	Base Triassic		1st Doig Sand		Thickness		2nd Doig Sand		Thickness	
	BLLY	SS	1st Sand	SS	Sand	Silt Eq.	2nd Sand	SS	Sand	Silt Eq.
c-58-B/94-A-13	2025.0	-1159.8								
c-78-B/94-A-13	1986.7	-1161.0								
b-36-C/94-A-13	2053.1	-1215.5								
b-38-C/94-A-13	2109.2	-1230.2								
d-47-C/94-A-13										
b-88-C/94-A-13										
d-11-D/94-A-13										
b-13-D/94-A-13	2050.7	-1222.6								
b-22-D/94-A-13	2148.8	-1259.4								
b-24-D/94-A-13	2161.6	-1230.1								
d-25-D/94-A-13	2182.1	-1228.1								
a-34-D/94-A-13	2058.0	-1186.0								
b-35-D/94-A-13	2197.3	-1230.2								
d-36-D/94-A-13	2187.2	-1231.7	1865.4	-909.9		SONIC	1845.9		?3	3.5
d-46-D/94-A-13	2158.0	-1214.9								
d-57-D/94-A-13	2211.0	-1230.2								
c-65-D/94-A-13	2092.8	-1172.0								
d-68-D/94-A-13	2176.0	-1240.3								
d-99-D/94-A-13	2090.9	-1221.3								
d-06-A/94-A-14			1360.0	-654.3	19.5		? NP	686.2	0.0	
d-26-A/94-A-14	1655.0	-951.3	1353.0	-649.3	14.0	19.0	? NP	689.7	0.0	
a-31-A/94-A-14										
d-35-A/94-A-14			1355.0	-675.1	31.0		? NP	648.9	0.0	
d-58-A/94-A-14			1380.0	-621.6	? 12	12.0	? NP		0.0	
c-16-B/94-A-14										
c-35-B/94-A-14			1463.5	-685.1		11.0	? NP		0.0	
c-87-B/94-A-14										
c-05-C/94-A-14										
b-08-C/94-A-14			?NDE				1445.4		4.9	
d-37-C/94-A-14			NDE				1482.5		0.0	1.5
b-78-C/94-A-14	1789.2	-995.5								
b-06-D/94-A-14			? NP		0.0		1633.0	817.0	11.5	
d-15-D/94-A-14			NP		0.0	0.0	1625.0	821.7	0.0	8.0
b-26-D/94-A-14							1650.8		17.0	
b-28-D/94-A-14							1658.0		5.0	
d-37-D/94-A-14			NP		0.0	0.0	1615.5	802.8	2.5	
d-39-D/94-A-14							?1631.3	-779.8	7.5	
b-68-D/94-A-14	1894.0	-1073.8	NP		0.0	0.0	?1580	-759.8	9.0	
c-74-D/94-A-14			NDE				?1466	-747.3	0.5	4.0
b-91-D/94-A-14										
c-02-E/94-A-14										
a-07-E/94-A-14			?							
d-17-E/94-A-14			?							
b-23-E/94-A-14										
c-32-E/94-A-14	1795.3	-987.0	?1504.4	-696.1	1.2			807.1		
c-34-E/94-A-14										
a-41-E/94-A-14			?1516.3	-6883.9	2.1			830.3		
c-37-E/94-A-14										
b-06-F/94-A-14										
d-33-F/94-A-14										
d-79-F/94-A-14										
b-56-D/94-A-15			1296.3	-625.3	1.0	6.0	? NP	670.0	0.0	

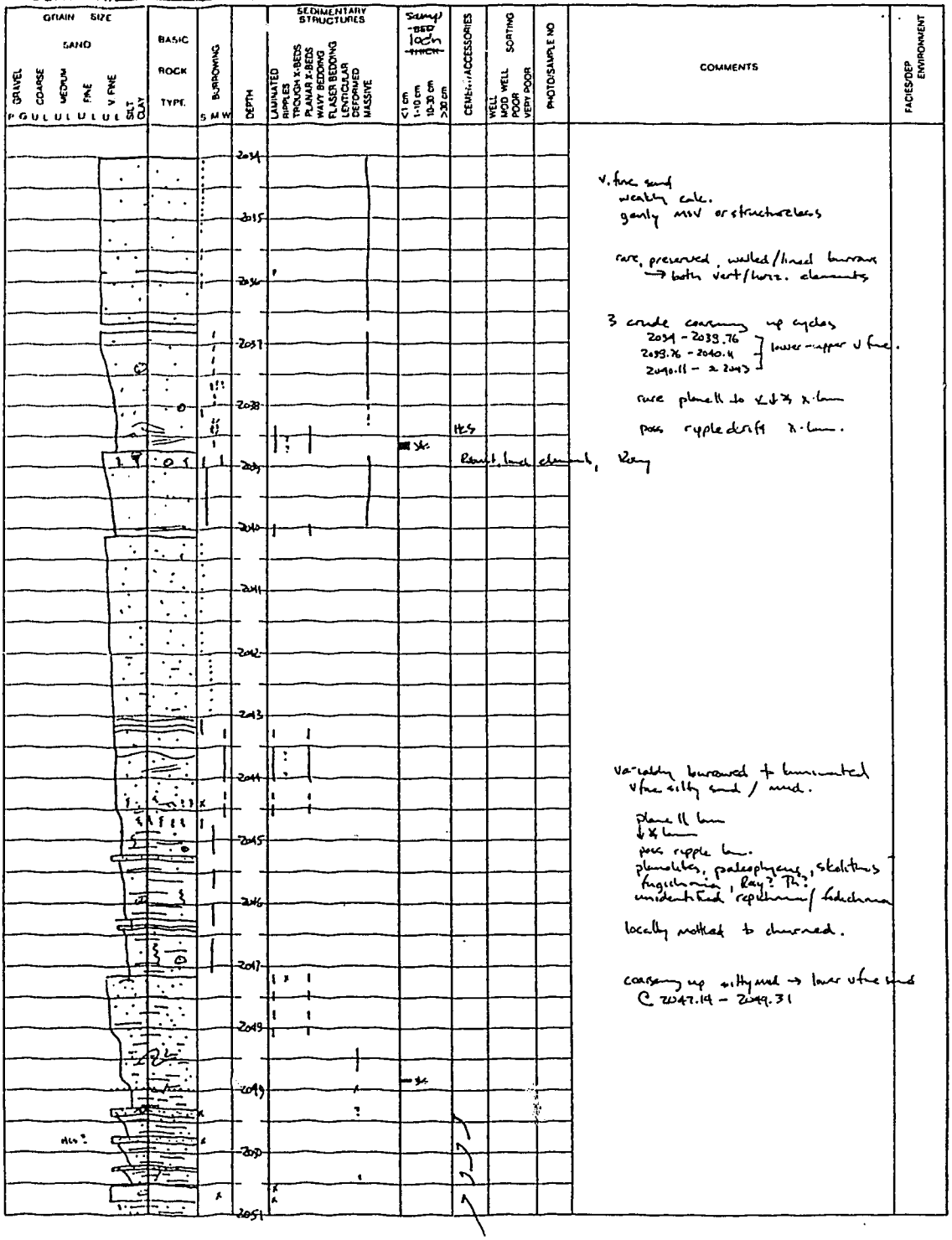
WELL ID	DOIG GAS	DOIG OIL	CORE	COMMENTS
c-58-B/94-A-13				
c-78-B/94-A-13				questionable base Triassic Pick
b-36-C/94-A-13				
b-38-C/94-A-13				
d-47-C/94-A-13				
b-88-C/94-A-13				
d-11-D/94-A-13				
b-13-D/94-A-13				
b-22-D/94-A-13				
b-24-D/94-A-13				
d-25-D/94-A-13				
a-34-D/94-A-13				
b-35-D/94-A-13				
d-36-D/94-A-13				
d-46-D/94-A-13				
d-57-D/94-A-13				
c-65-D/94-A-13				
d-68-D/94-A-13				
d-99-D/94-A-13				
d-06-A/94-A-14		X	D	1380.0: SB(?), 1360.0: TSE
d-26-A/94-A-14		X	D	Upper Sand silty, 1st Doig sand total 19.0 m silty equivalent
a-31-A/94-A-14				
d-35-A/94-A-14		X	D	1381.5: SB(?), 1355.0: TSE
d-58-A/94-A-14			D	
c-16-B/94-A-14				
c-35-B/94-A-14				1st Doig sand equivalent totals 27.0 m silty mud
c-87-B/94-A-14				
c-05-C/94-A-14				
b-08-C/94-A-14				1ST OR 2ND EQV. ?
d-37-C/94-A-14				2ND Doig sand contains 2 discrete intervals, 1st or 2nd Eqv. ?
b-78-C/94-A-14				questionable base Triassic pick
b-06-D/94-A-14		X	D	SB - 1648.5: TSE - 1633.5 (?)
d-15-D/94-A-14			D	questionable 2ND Doig sand
b-26-D/94-A-14		X	D	SB - 1669.1: TSE - 1659.8 (?): questionable 1st Doig Sand
b-28-D/94-A-14				
d-37-D/94-A-14			D	questionable Upper Sand
d-3[illegible]4-A-14				questionable Main Phosphate pick
b-58-D/94-A-14				questionable Montney, base Triassic picks
c-74-D/94-A-14				questionable Upper Sand pick (=1452?): 2ND Doig sand= 4.0 m silt
b-91-D/94-A-14				
c-02-E/94-A-14				
a-07-E/94-A-14				
d-17-E/94-A-14				
b-23-E/94-A-14				
c-32-E/94-A-14				Questionable base Triassic pick, 1st or 2nd Eqv. ?
c-34-E/94-A-14				
a-41-E/94-A-14				1st or 2nd Eqv. ?
c-87-E/94-A-14				
b-06-F/94-A-14				
d-33-F/94-A-14				
d-79-F/94-A-14				
b-56-D/94-A-15			CH	TSE(?) @ 1292.5m: SB @ 1303m

APPENDIX F: DOIG STUDY
DRILL CORE DESCRIPTIONS

p. 14 2

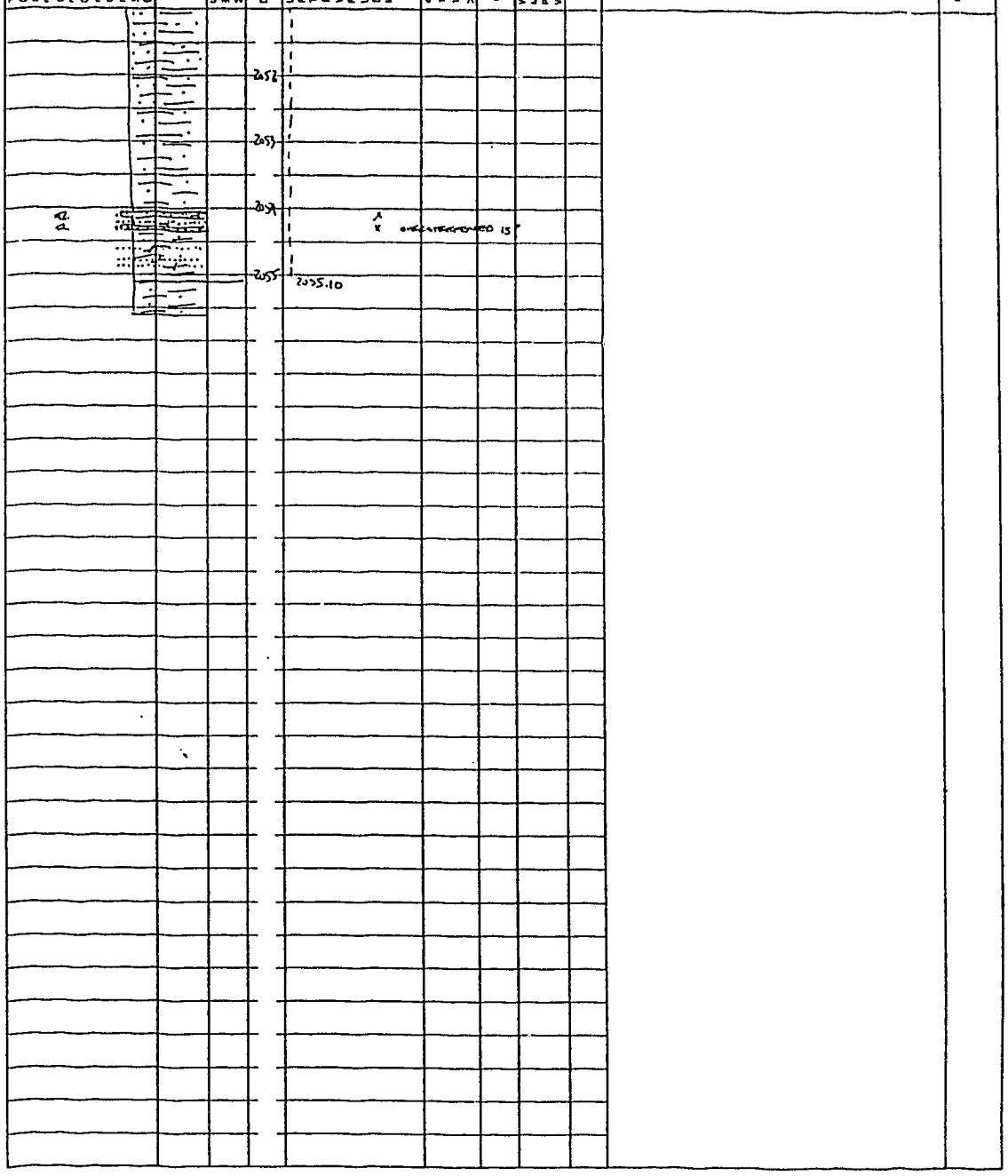
WELL NAME: Esso et al Scott 3-18 FORMATION: Dolla DATE: June 21/94

LOCATION: B-18-90 17 /W6 CORE INTERVAL: 2034 - 2055.62 KB: 759.6



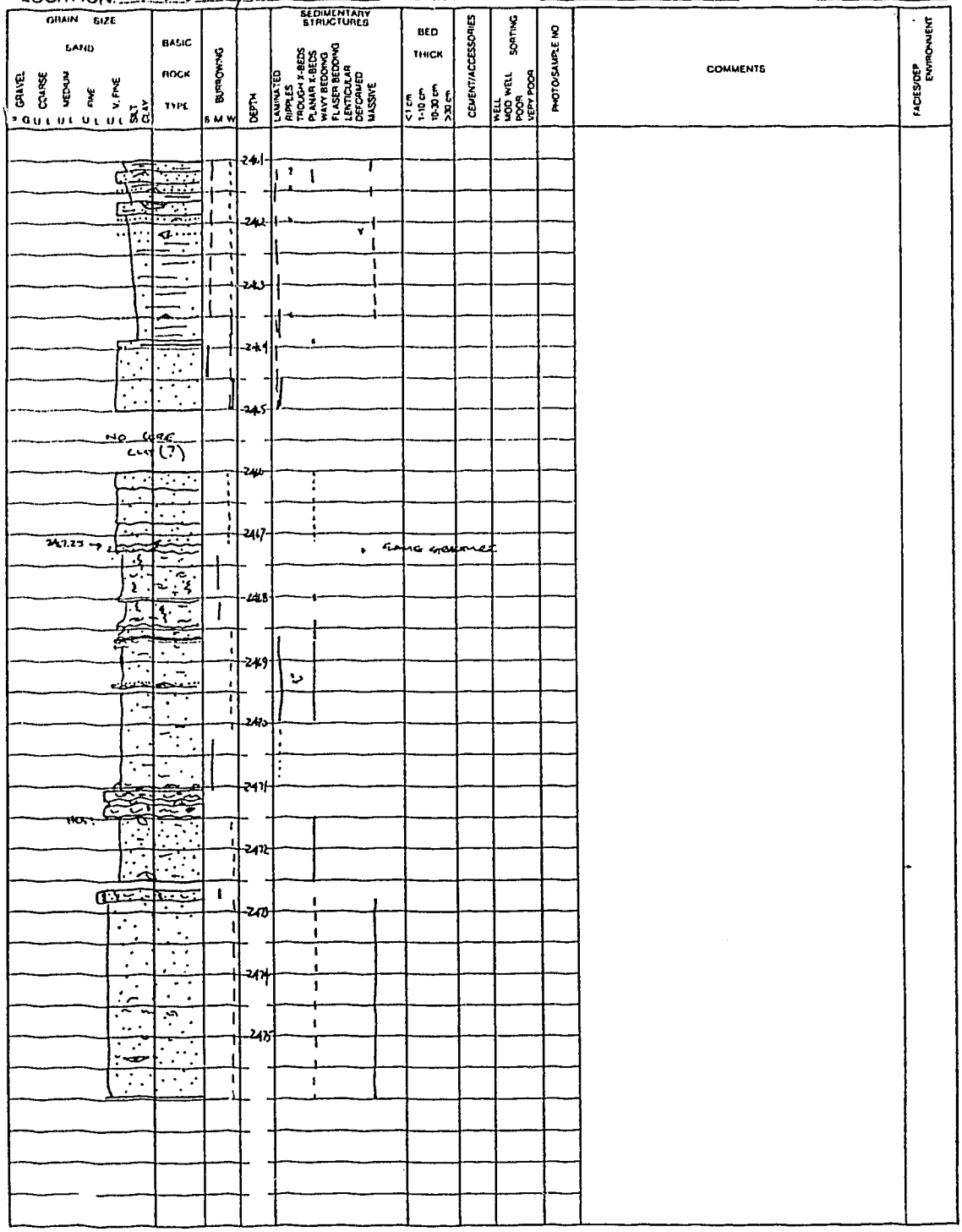
WELL NAME:_____ FORMATION:_____ DATE:_____

LOCATION: 8-18-80 17 1W6 CORE INTERVAL:_____ KB:_____



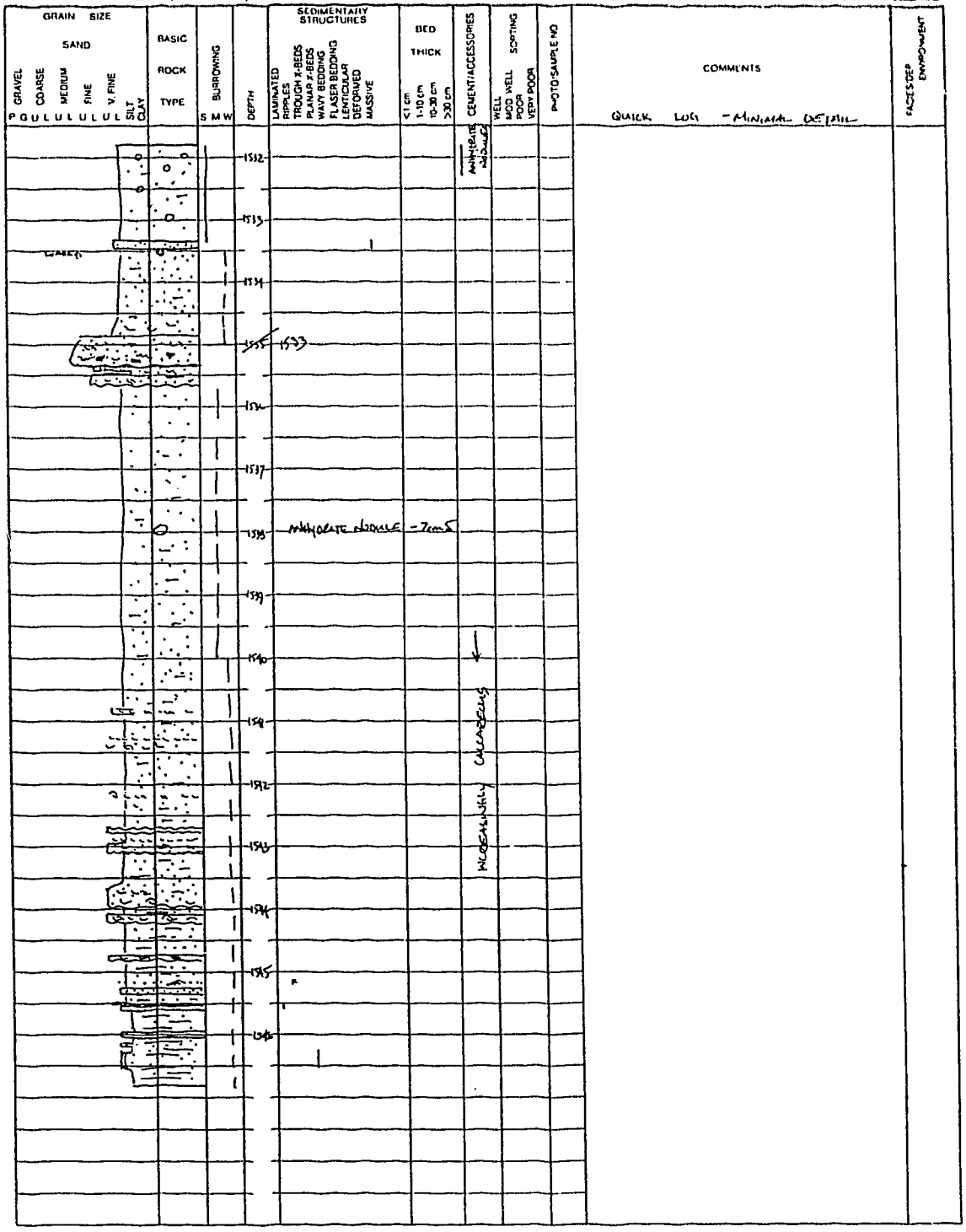
WELL NAME: Esso et al. Grandbrook 8-4 FORMATION: Dalla DATE: June 20th/94

LOCATION: B-4-90-21 / W4 CORE INTERVAL: 2461 - 2475.2 KB: 945.7



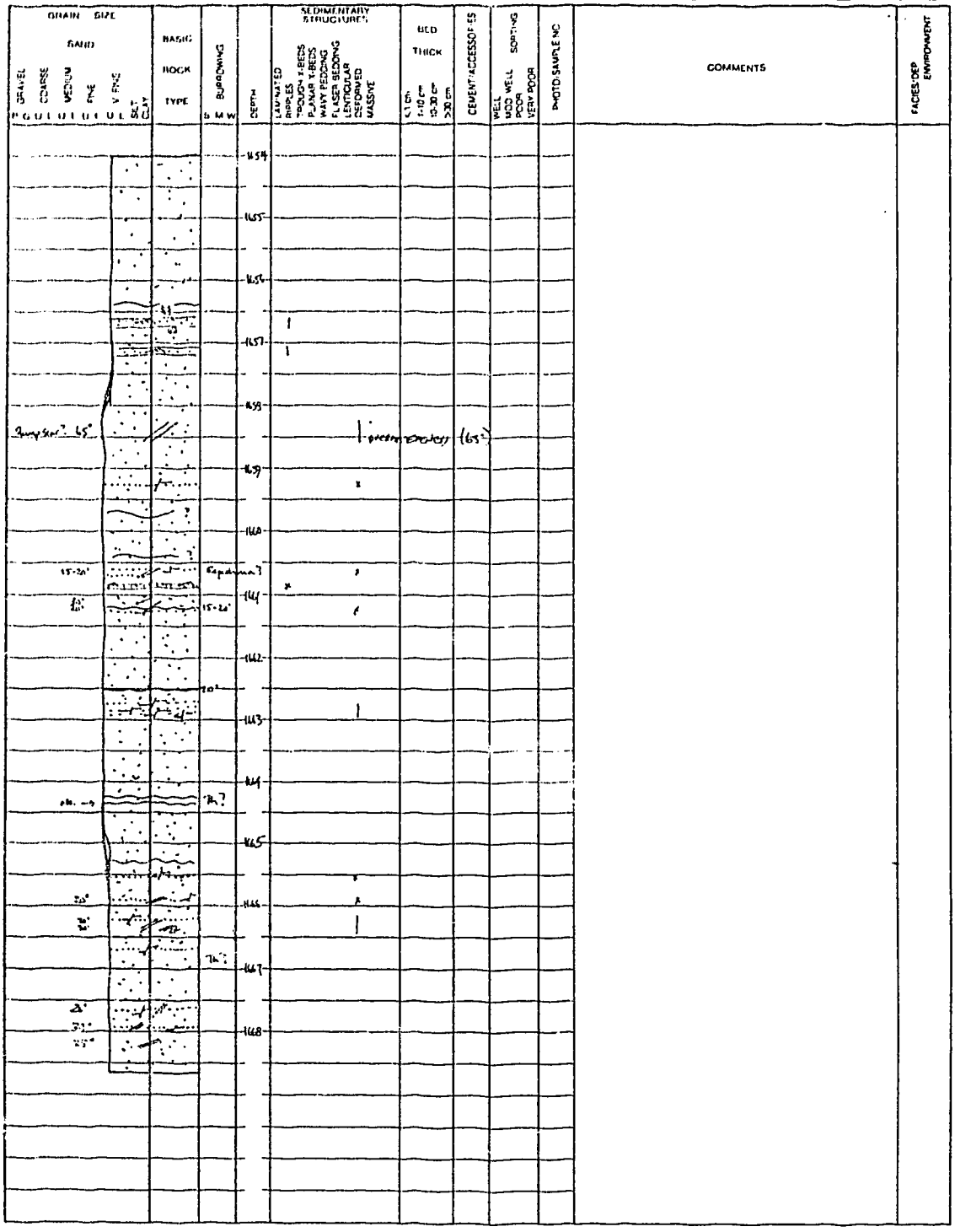
WELL NAME: Dome W. Boundary 11-34 FORMATION: Rolla DATE: June 21/94

LOCATION: 11-34-84-15 / W6 CORE INTERVAL: 1529.5 - 1531.3 1539.8 - 1541.3 KB:



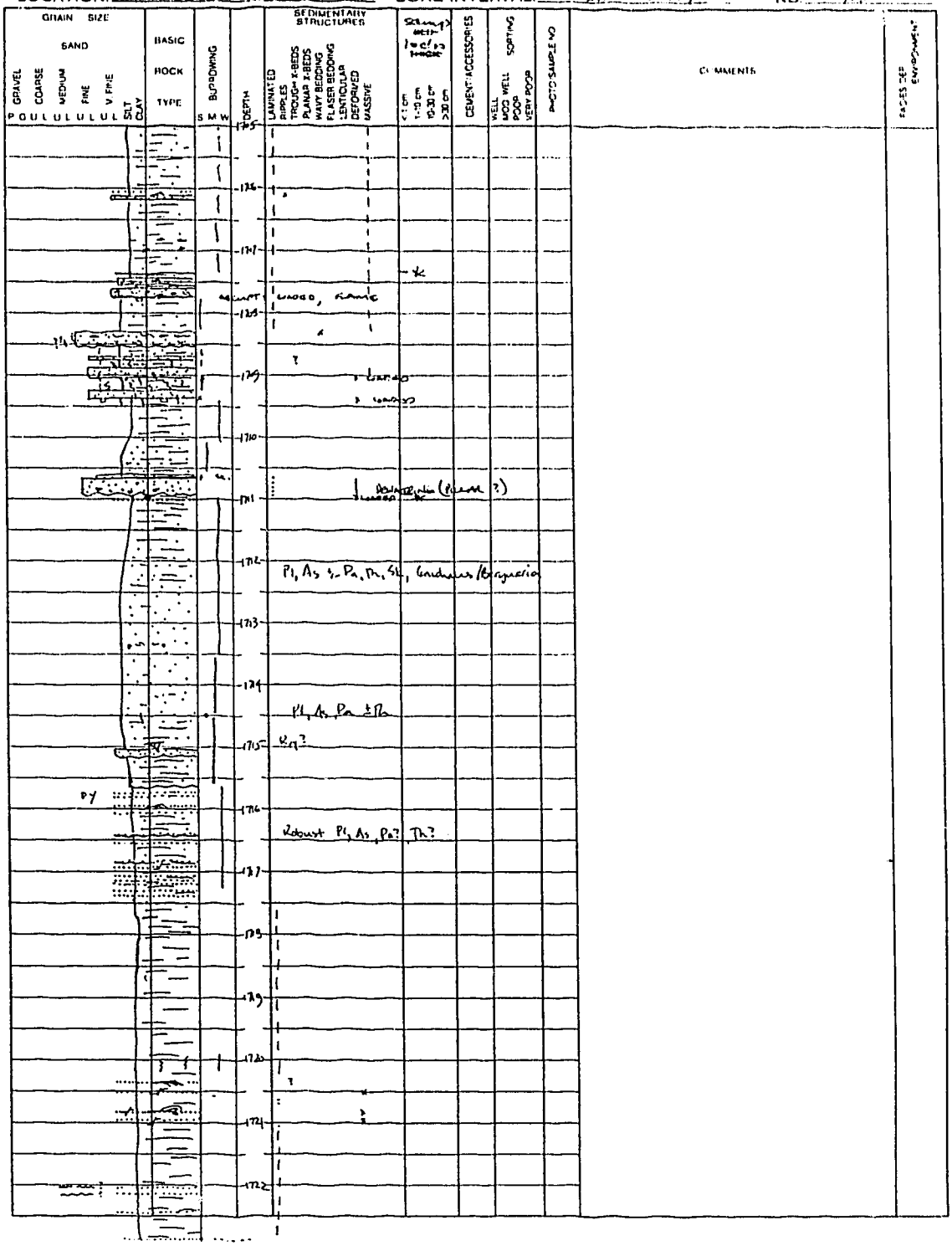
WELL NAME: Tuna Bear Flat (12-21) FORMATION: Doki DATE: June 21st, 1994

LOCATION: 12-21-84-21 (-16 CORE INTERVAL: 1659 - 1668,65 KB:



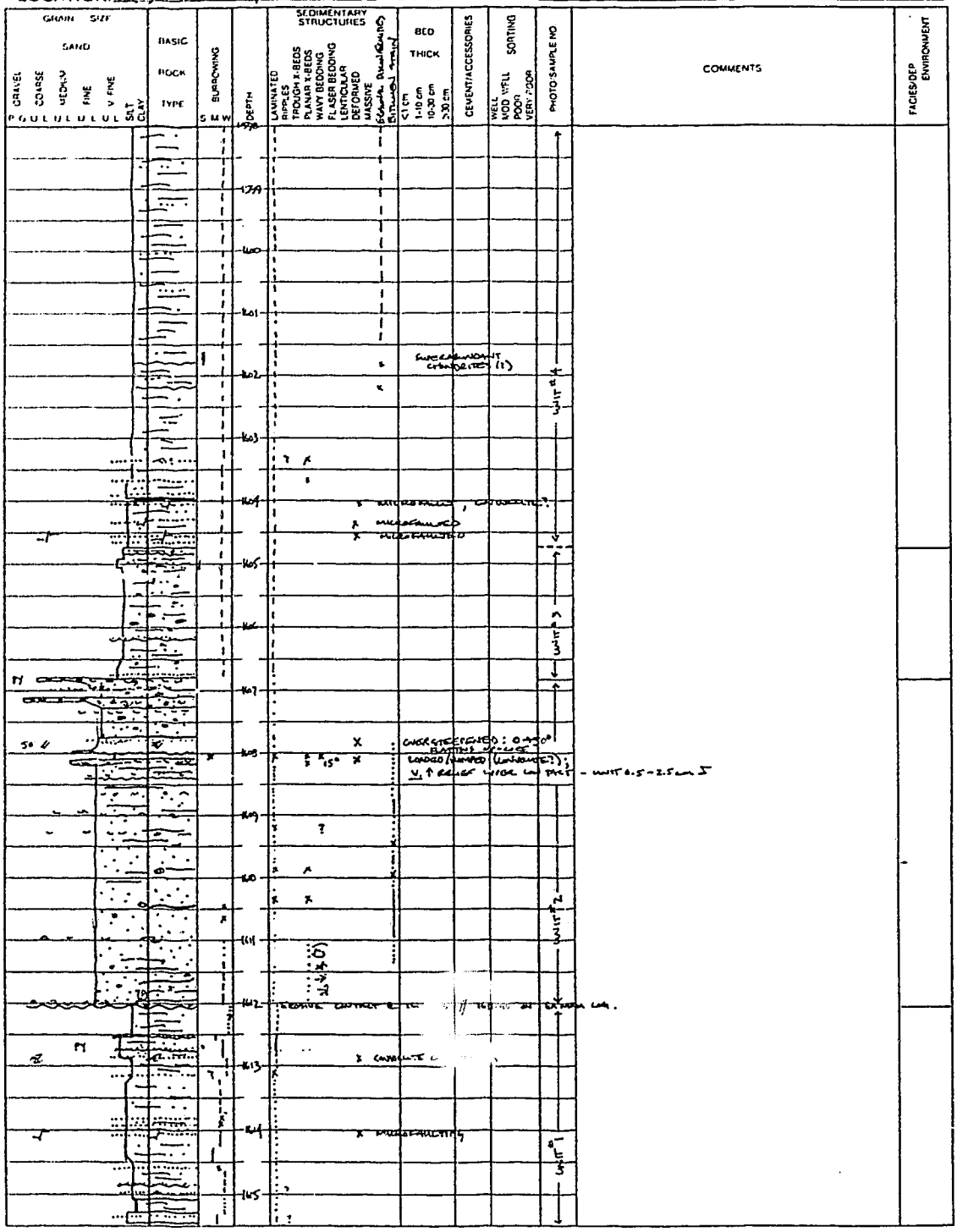
WELL NAME: Rowe et al Bonanza 11-31 FORMATION: Dolli DATE: June 22nd 94

LOCATION: 11-31-85-21 W6 CORE INTERVAL: 1705.0 — 1722.5 KB: 1949.5



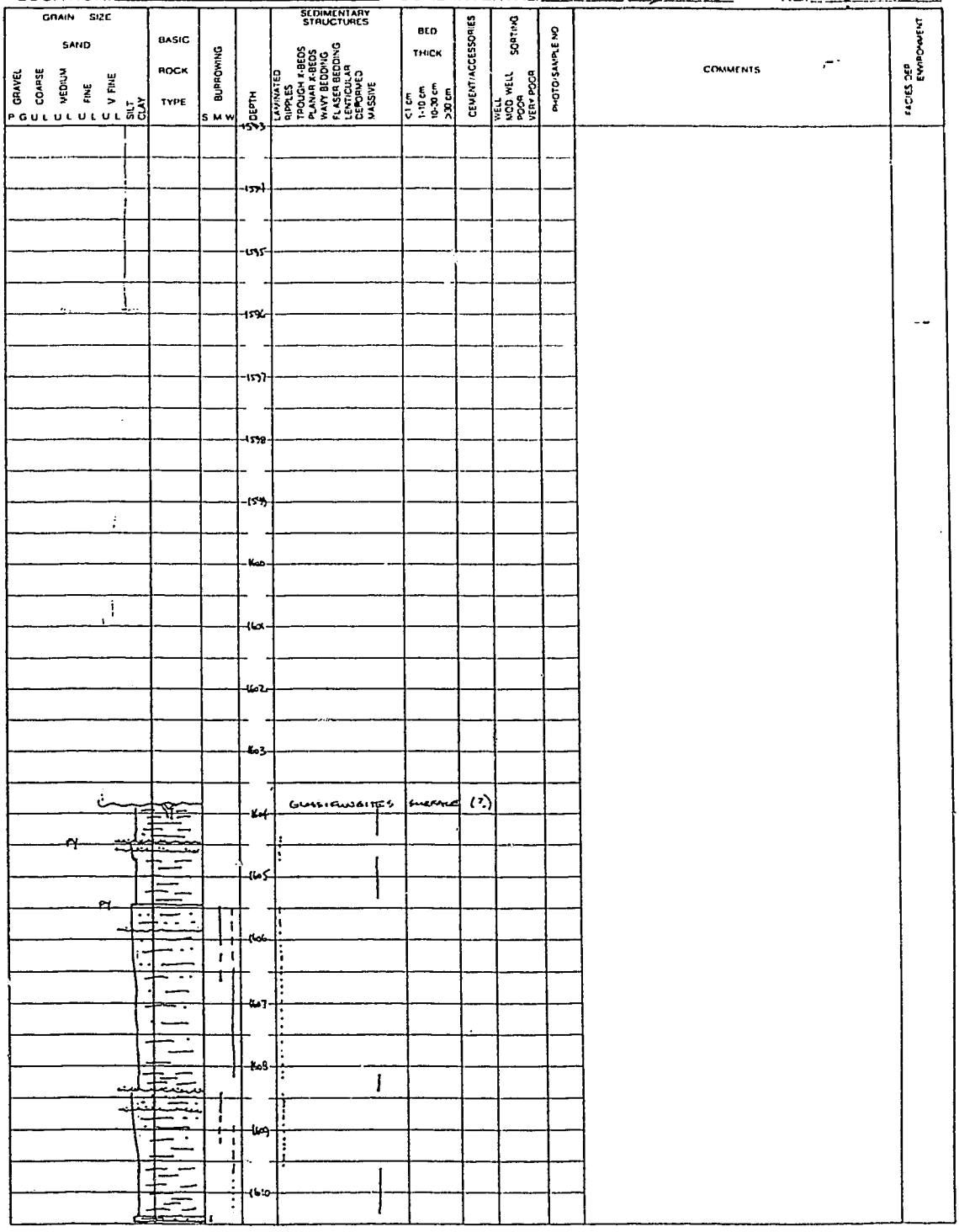
WELL NAME: Summers ET AL STRUCTURE #6-9 FORMATION: Dolo DATE: June 16,17 / 1994

LOCATION: (02) 6-4-9S-20 / W6 CORE INTERVAL: 1598 - 1615.45 (measured) KB: 753m



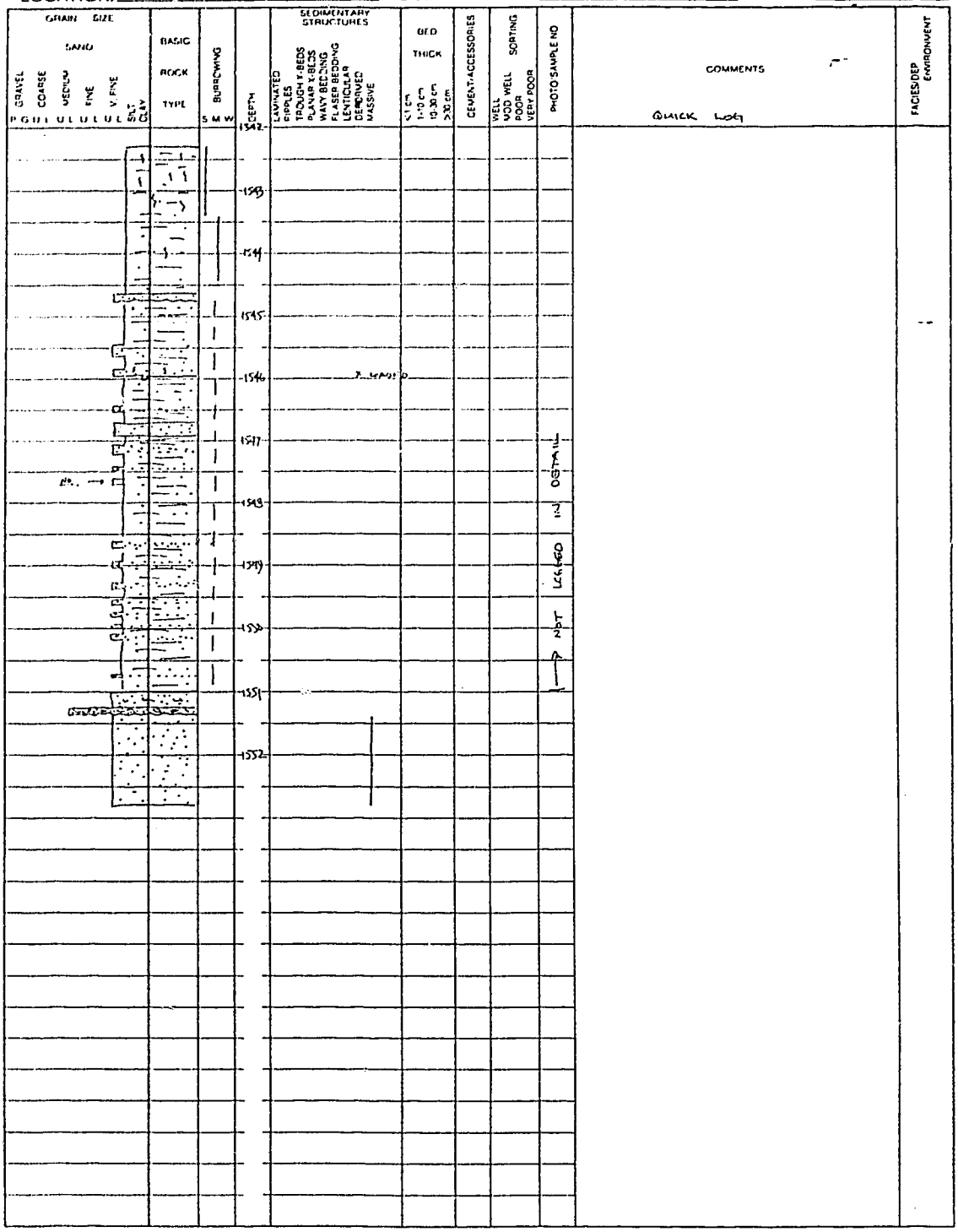
WELL NAME: Sunray ET AL W SOOCONY 12-4 FORMATION: Dog DATE: June 17th

LOCATION: 12-4-86-20 / W6 CORE INTERVAL: 1593.0 - 1610.97 measured. KB: 743.2 m



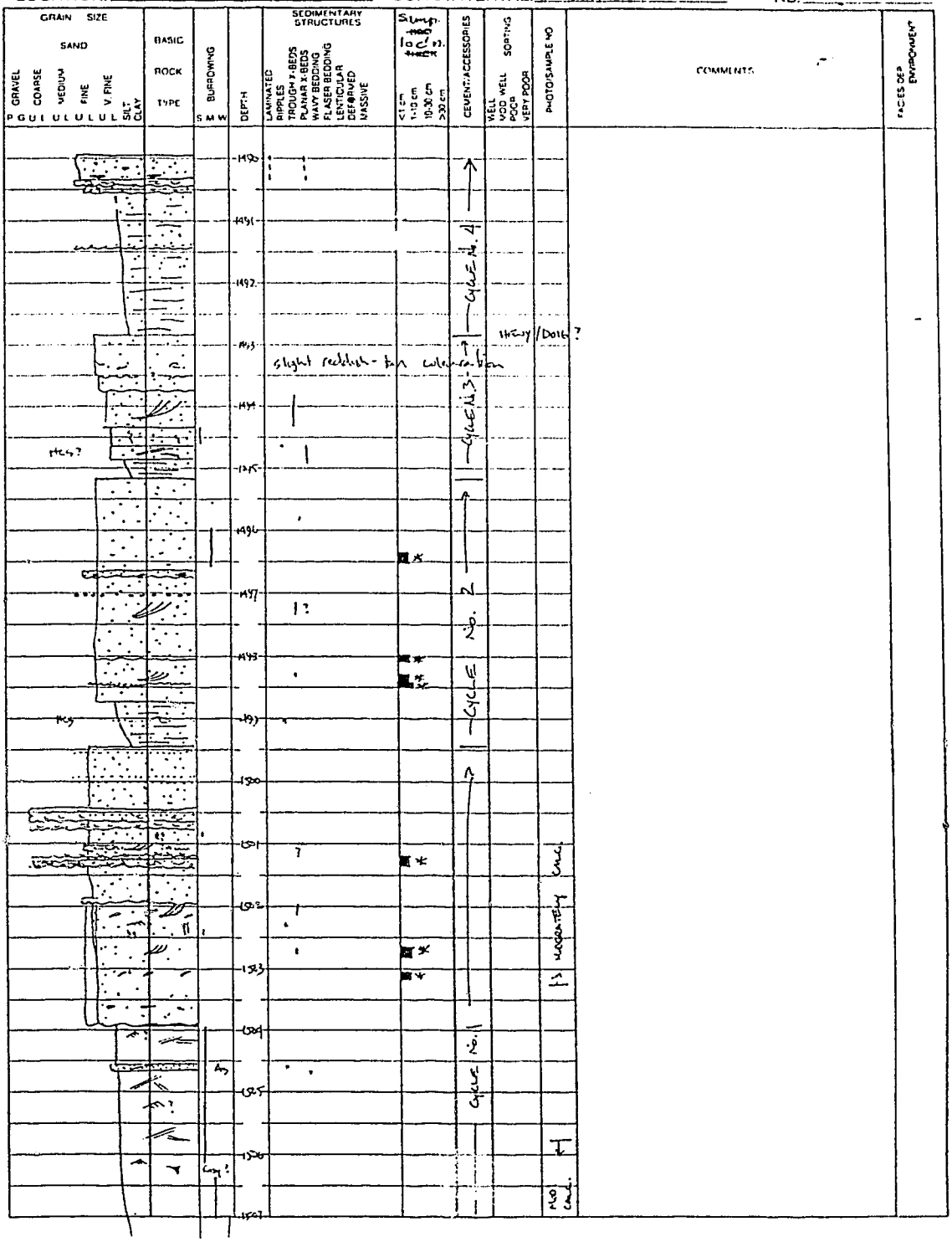
WELL NAME: MARK W. STODDART 16-15 FORMATION: Dalh DATE: June 22nd/94

LOCATION: 16-15-86-20 W6 CORE INTERVAL: 1542.3 - 1552.8 KB:



WELL NAME: Kerr Lake et al 8100DACT 10-25 FORMATION: HFNY / Dutch DATE: June 22,23/94

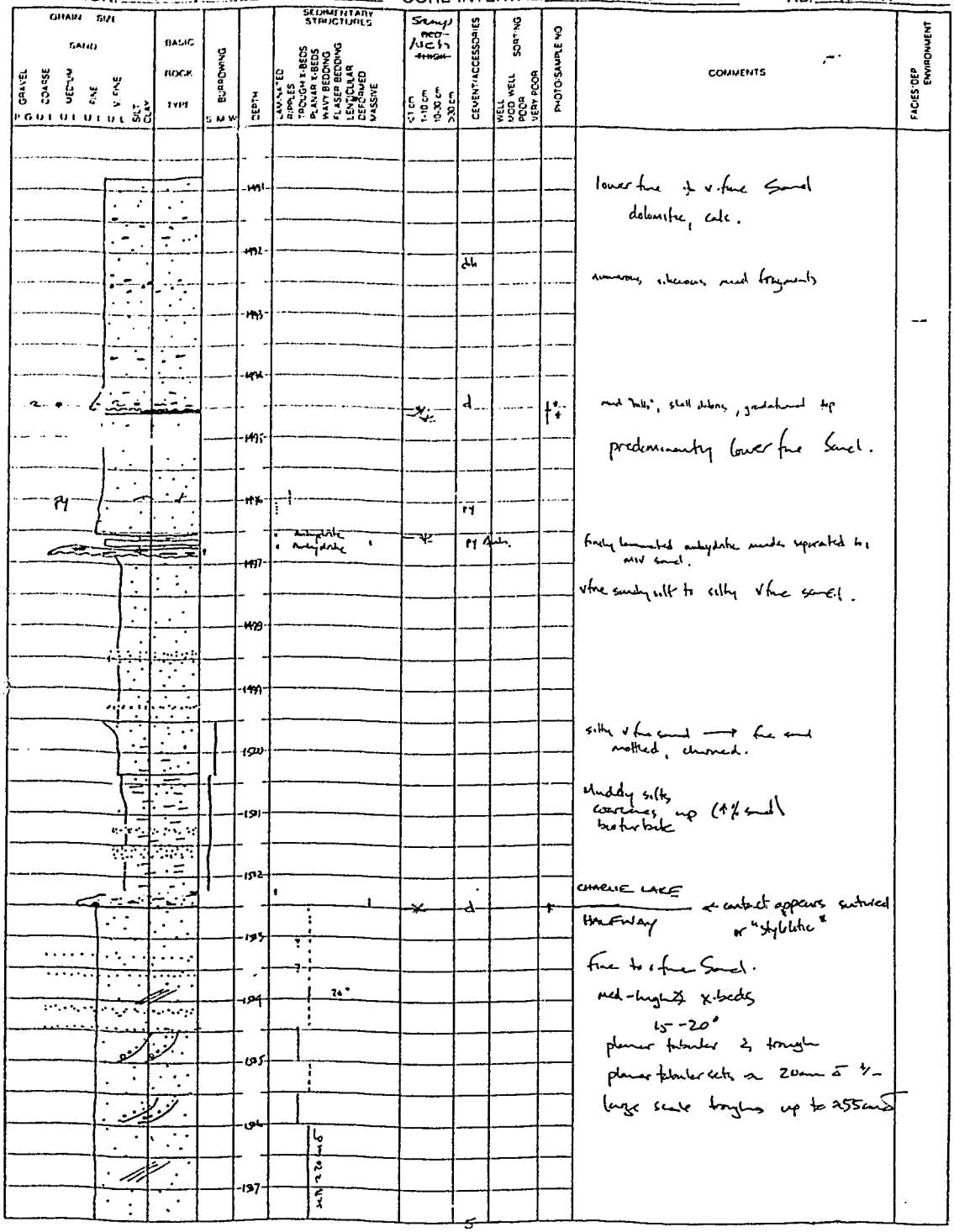
LOCATION: 10-25-86-20 / w6 CORE INTERVAL: 1489.94 - 1507.60 KB:



1 of 3

WELL NAME: BP Murdale 10-19 FORMATION: CHLK - HENRY - DOIG DATE: 01/24/94

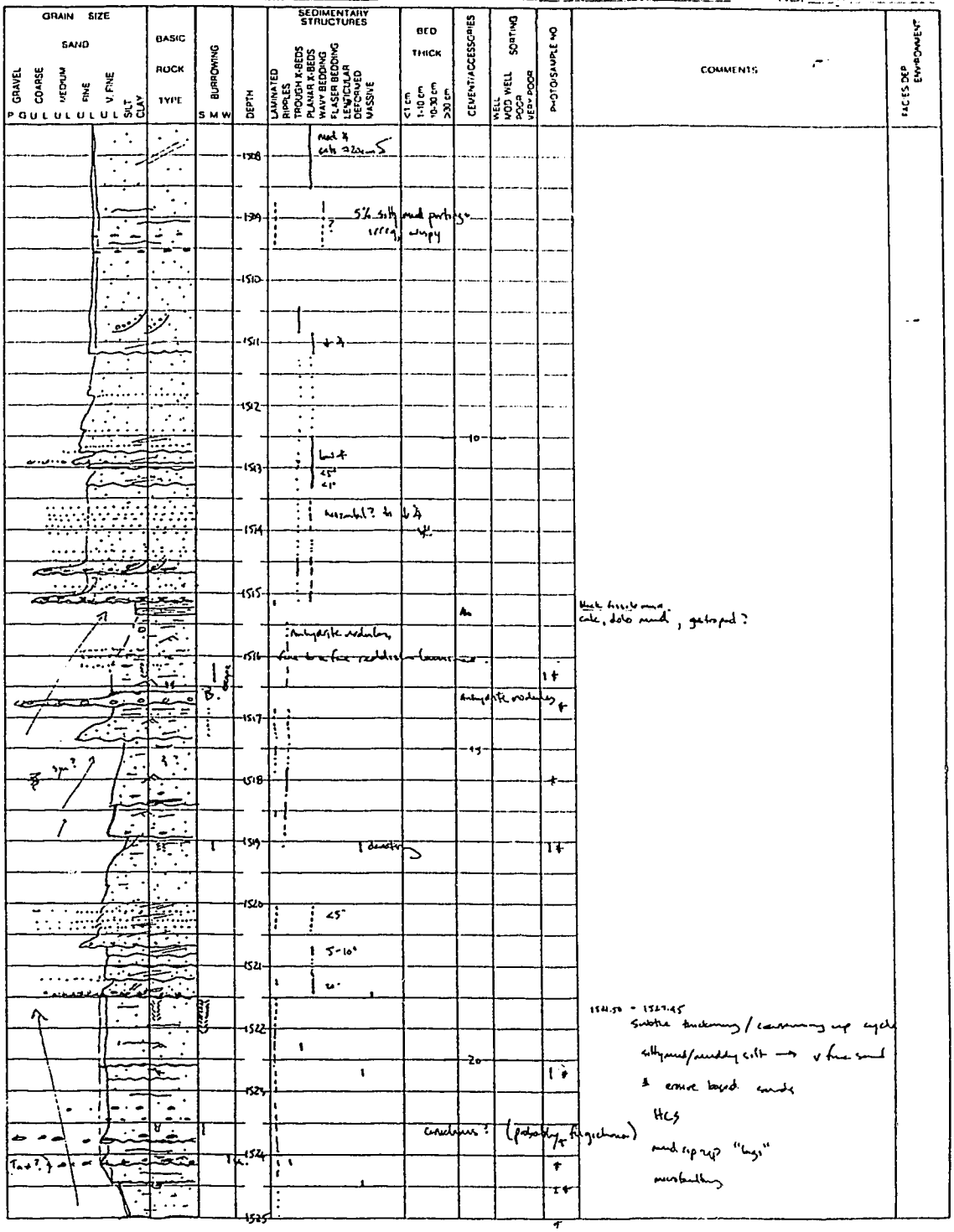
LOCATION: 10-19-87-19 /W5 CORE INTERVAL: 1490.8 - 1509.8 / 1509.5 - 1528.6 KB: 762.1m



2 of 3

WELL NAME: BP Murdale 10-19 FORMATION: CH.LK. - HFWY - Dolo DATE: 01/24/94

LOCATION: 10-19-87-19 W6 CORE INTERVAL: 1490.9 - 1529.5 1489.3 - 1528.6 KB: 762.1 m



343

WELL NAME: BP Mundale 10-19 FORMATION: CHLK - HERN - DOLO DATE: 01/24/94

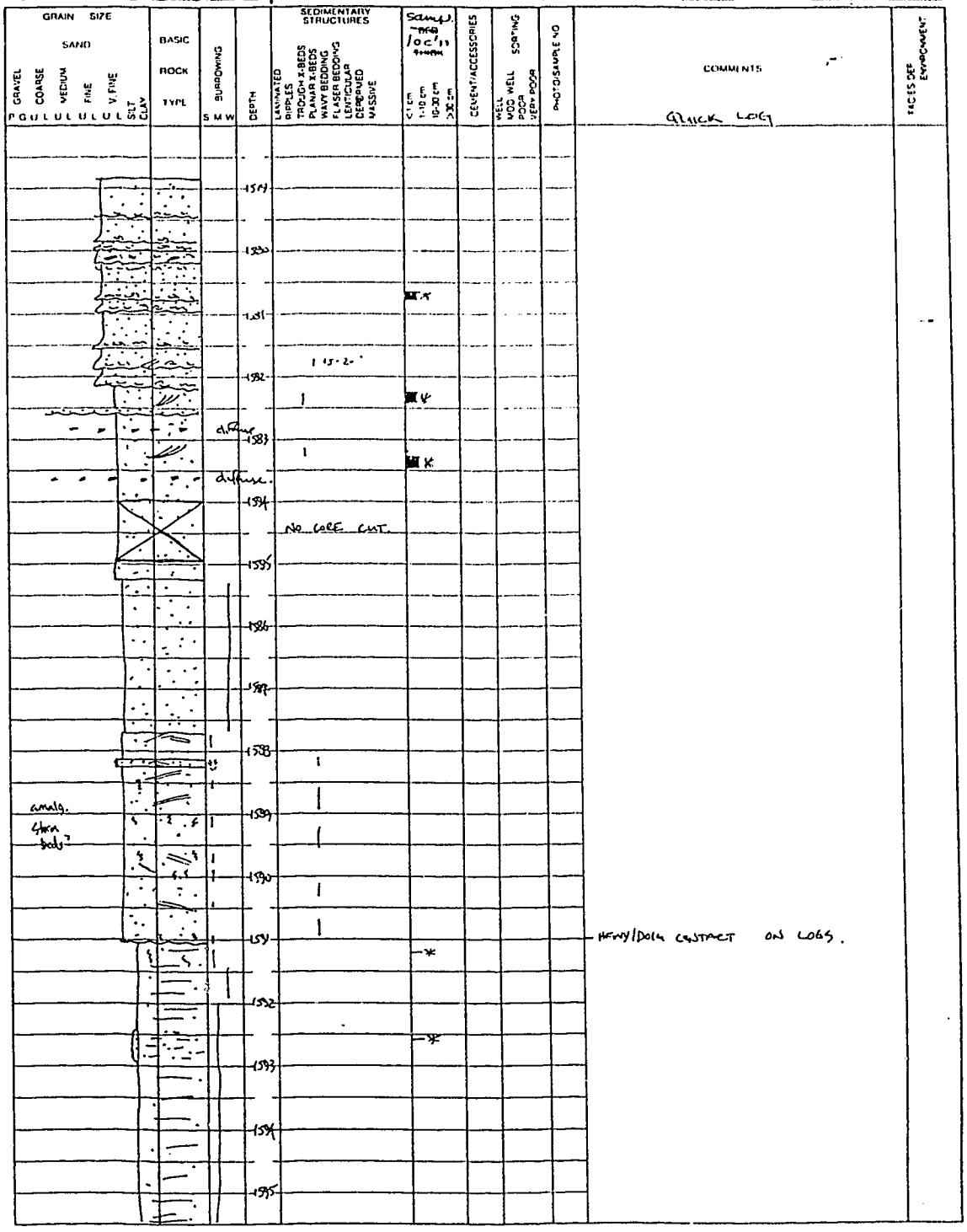
LOCATION: 10-19 - B7 - 19 / W6 CORE INTERVAL: 1490.0 - 1503.9 / 1529.5 - 1528.6 KB: 762.1 m

GRAIN SIZE (GRAVEL, SAND: COARSE, MEDIUM, FINE, V FINE, SILT, CLAY)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR BEDDING, DISRUPTED, MASSIVE)	BED THICK (<1 cm, 1-10 cm, 10-30 cm, >30 cm)	CEMENT-ACCESSORIES	SORTING (WELL, MOD WELL, POOR, VERY POOR)	PHOTO-SAMPLE NO	COMMENTS	FACIES DEP ENVIRONMENT
		Palaeophycus						1		
			1526							
					1cm - 5cm	ram	?			
			1527							
						15				
			1528							

p.1 of 2

WELL NAME: HUBER W. STODDART 6-22 FORMATION: HELLMAN / IDDLE DATE: June 26 / 94

LOCATION: 6-22-87-20 W6 CORE INTERVAL: 1510.86 - 1584.0 / 1584.36 - 1597.36 KB:



I-42

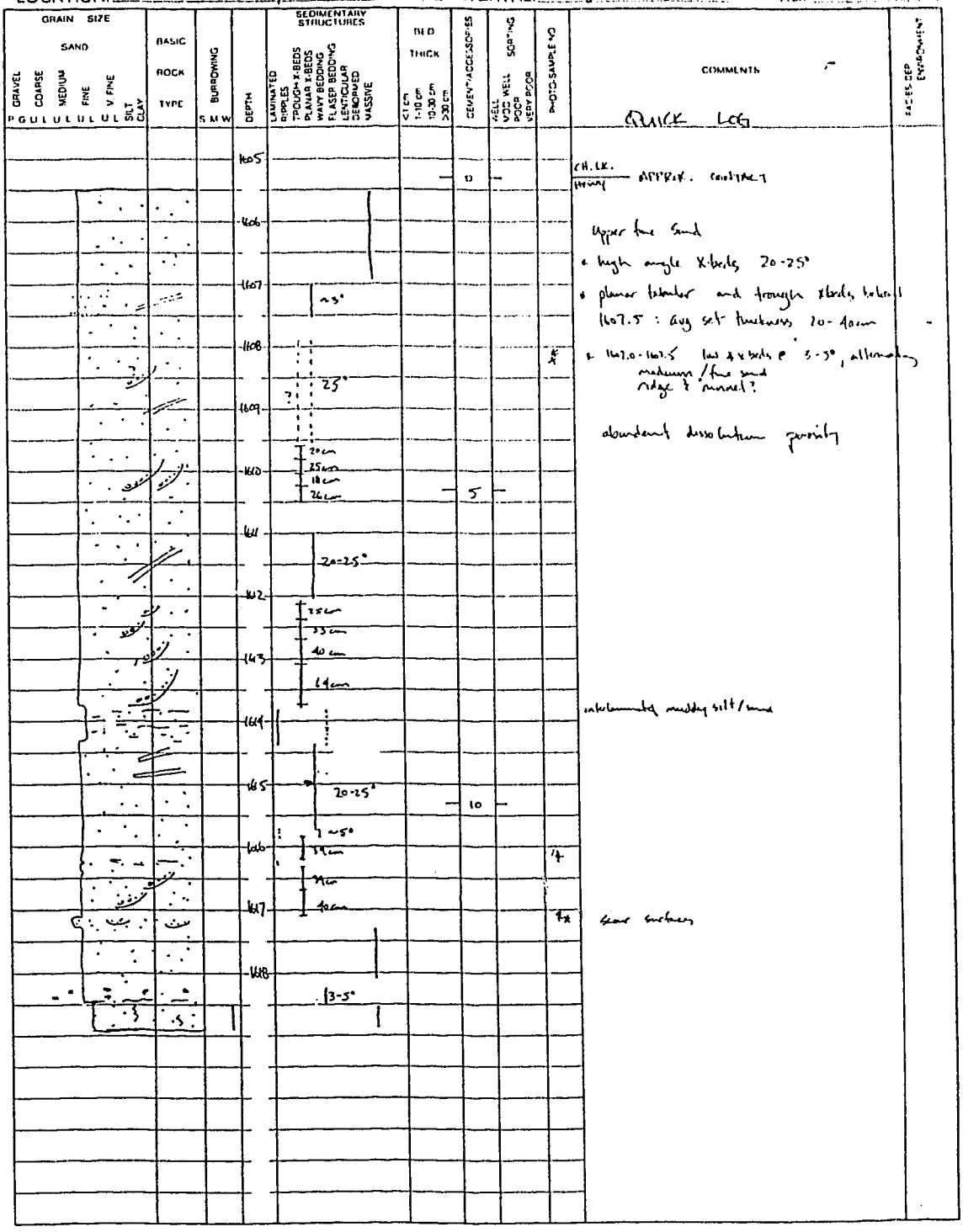
WELL NAME: _____ FORMATION: _____ DATE: _____

LOCATION: 6-22-87-25 W6 CORE INTERVAL: _____ KB: _____

GRAIN SIZE: GRAVEL / SAND: COARSE, MEDIUM, FINE, V FINE / SILT, CLAY	BASIC ROCK TYPE	BURROWING: S, M, W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE	BED THICK: <1 cm, 1-30 cm, >30 cm	CEMENT/ ACCESSORIES	SORTING: WELL, MOD WELL, POOR, VERY POOR	PHOTO SAMPLE NO	COMMENTS	FACIES DEP ENVIRONMENT
			1578							
			1577							
			1575							
			1574							
			1565							

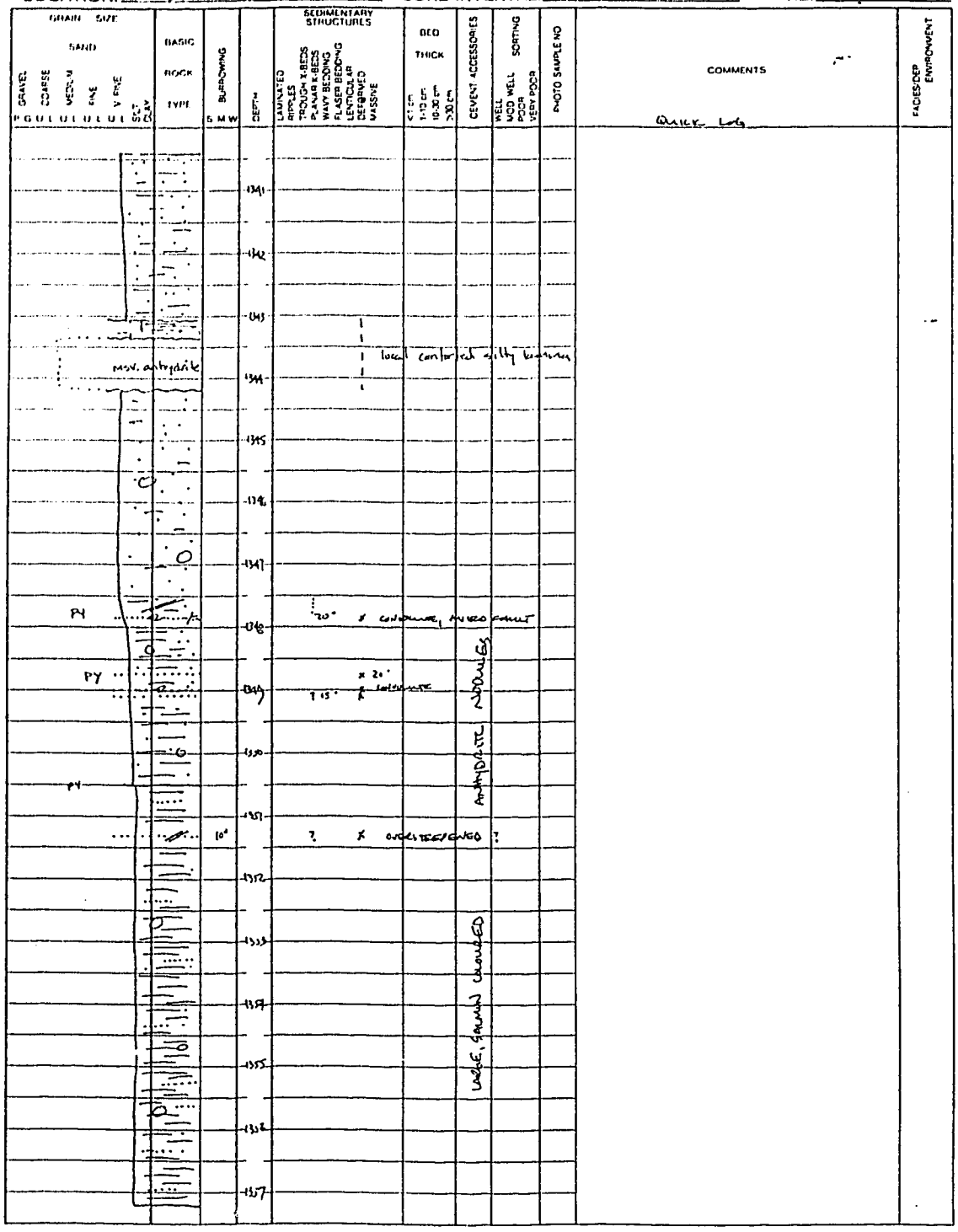
WELL NAME: DIASHAM N. STUDY AREA A6-26 FORMATION: HFW4 DATE: 02/02/94

LOCATION: A6 - 26 - 87 - 21 /W6 CORE INTERVAL: 1605.5 - 1618.8 KB: 850.7



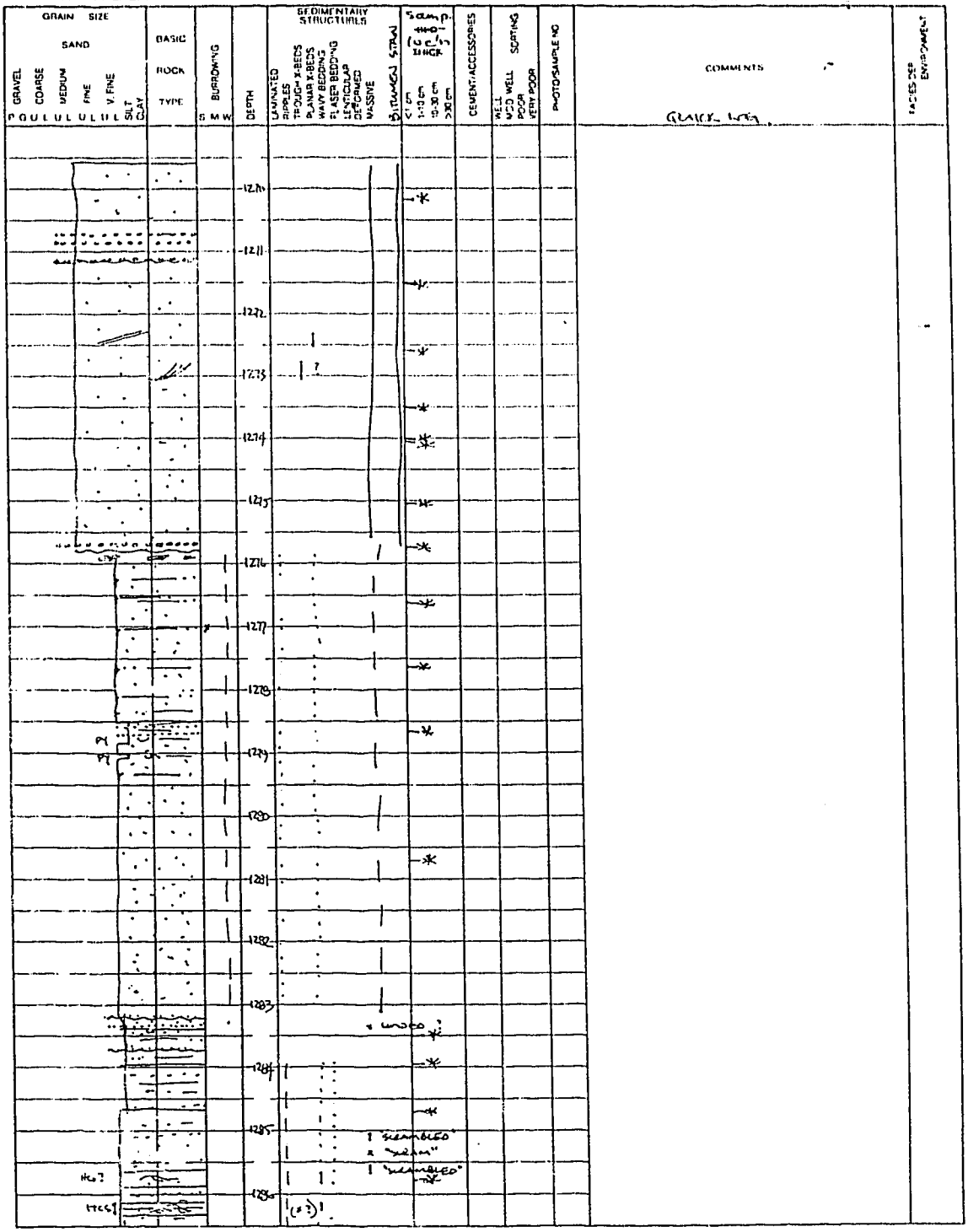
WELL NAME: Atlantic et al. Boundary 6-3 FORMATION: A.Mkr – Duck DATE: June 23 1974

LOCATION: 6-3-88-14 /W6 CORE INTERVAL: 1340.4 – 1357.2 KB:



WELL NAME: Talisman et al Ridge 9-19 FORMATION: Nikanassin / Bullhead DATE: June 24 / 99

LOCATION: 9-19-88-16 /W6 CORE INTERVAL: 1269.6 - 1287.99 KB:



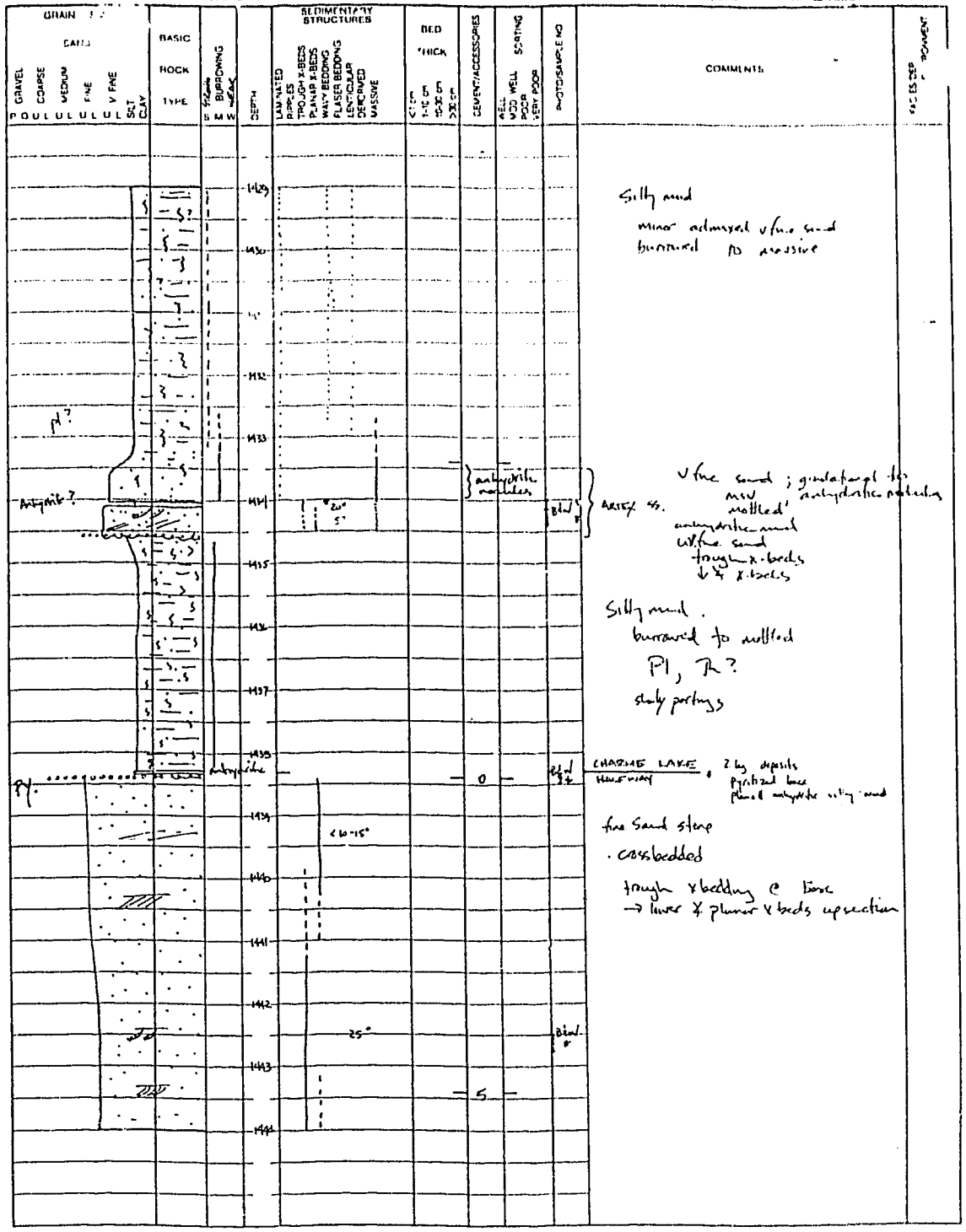
WELL NAME: _____ FORMATION: _____ DATE: P. 2 of 2

LOCATION: 9-19-83-16 W6 CORE INTERVAL: _____ KB: _____

GRAIN SIZE (GRAVEL, COARSE, MEDIUM, FINE, VF, SILT, CLAY)	BASIC ROCK TYPE	BURROWING (S, M, W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE)	BED THICK (<1 cm, 1-30 cm, >30 cm)	CEMENT/ACCESSORIES	SORTING (WELL, MOD, POOR, VERY POOR)	PHOTO SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1257							
			1258							

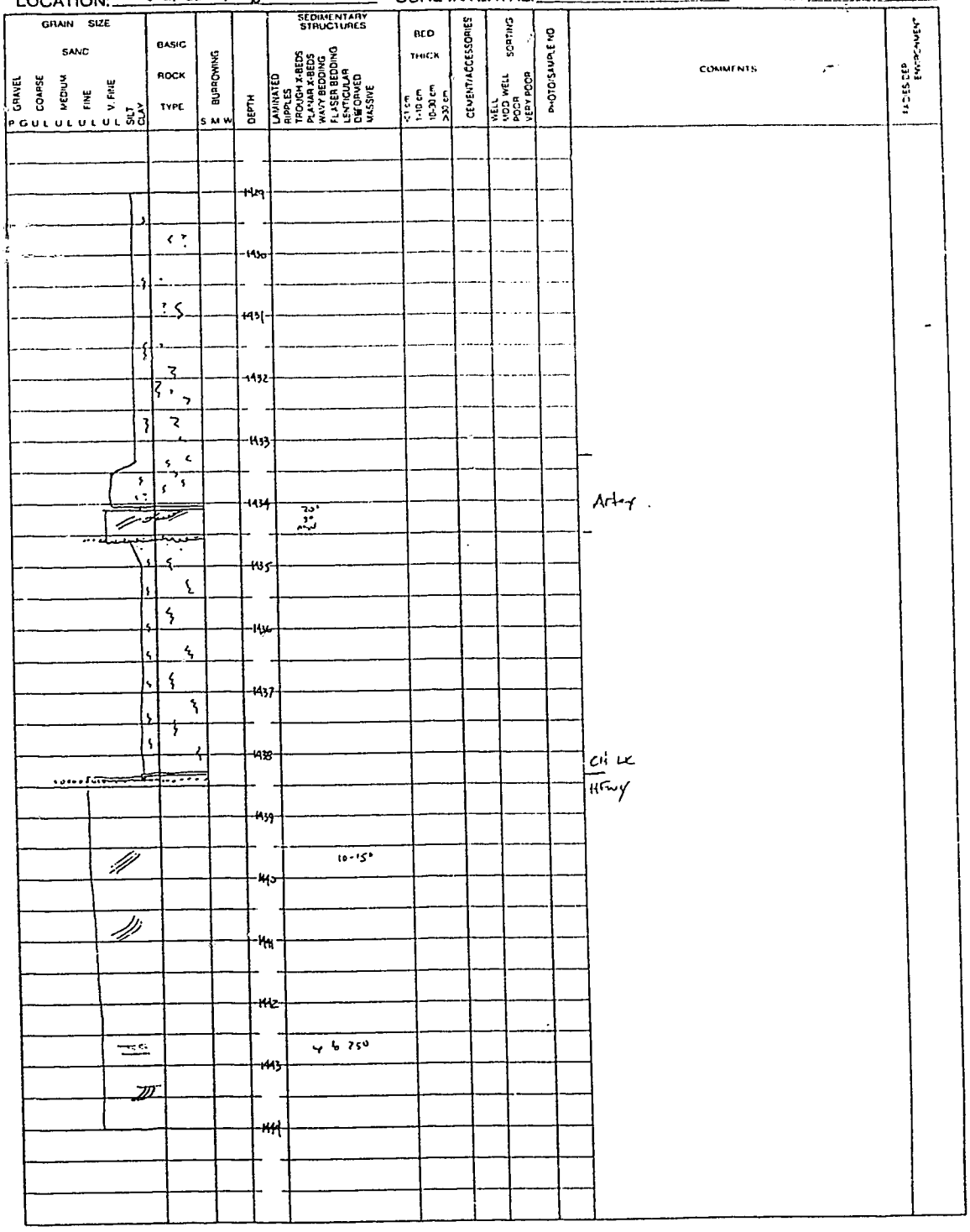
WELL NAME: Ricoh Murphy Rock 6-21-88-19 FORMATION: CHARLIE LAKE / HALFWAY DATE: 01/24/94

LOCATION: 6-21-88-19/W6 CORE INTERVAL: 1429.0 - 1444.0 KB: 763.0 m



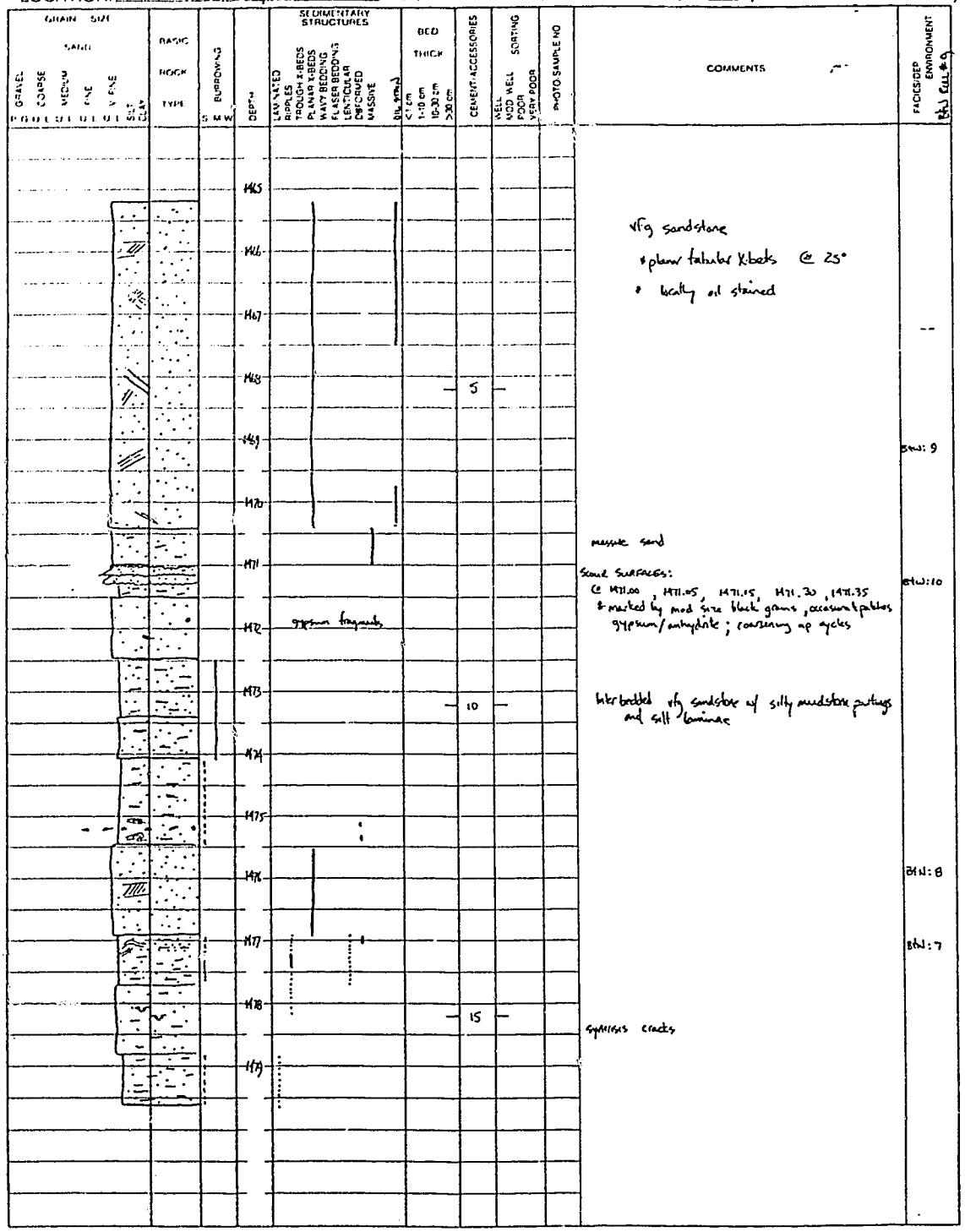
WELL NAME: Ryerson Murphy Brook 6-21-88-19 FORMATION: CHARLIE LAKE - HALFWAY DATE: 91/24/94

LOCATION: 6-21-88-19 w6 CORE INTERVAL: 1429.0 - 1444.0 m KB: 763.0 m



WELL NAME: TEXACO HTR BLACK CREEK #5 FORMATION: HALFWAY DATE: 03/03/93

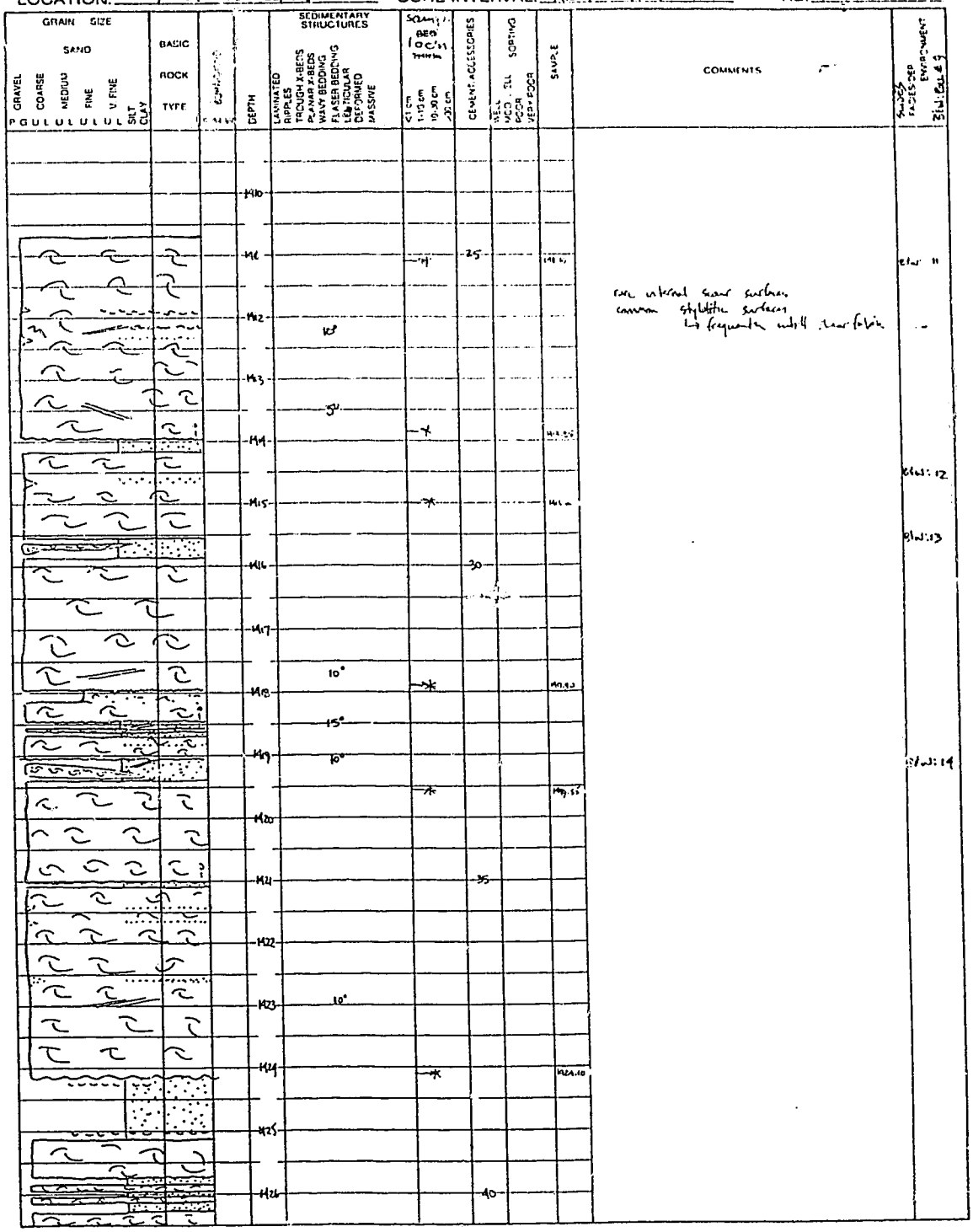
LOCATION: 7-29-88-20 W6 CORE INTERVAL: 1806 ft - 1853 ft. (H65.2 - H79.6) KB: 2523 ft. (769.2m)



1 of 3

WELL NAME: Esso Buick 9-34-88-20 FORMATION: Dunvegan DATE: 03/04/93 June 2nd/93

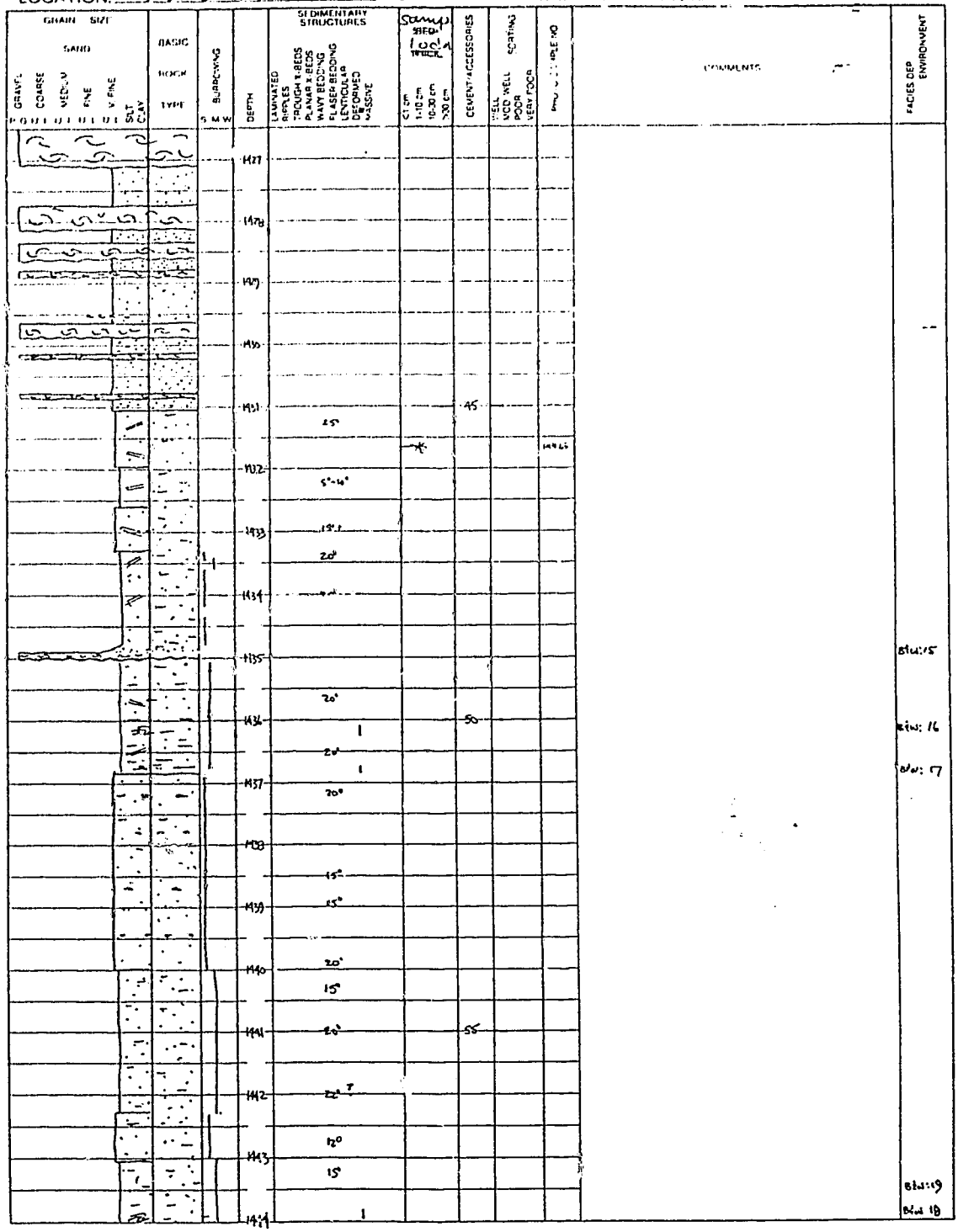
LOCATION: 9-34-88-20/W6 CORE INTERVAL: 1910.7 - 1947.1 KB: 714.5'



2 of 3

WELL NAME: Exxo Buick 9-34-68-20 FORMATION: Dunvegan DATE: 03/04/93

LOCATION: 9-34-68-20/W6 CORE INTERVAL: 1410.7 - 1447.1 KB: 714.5



3(3)

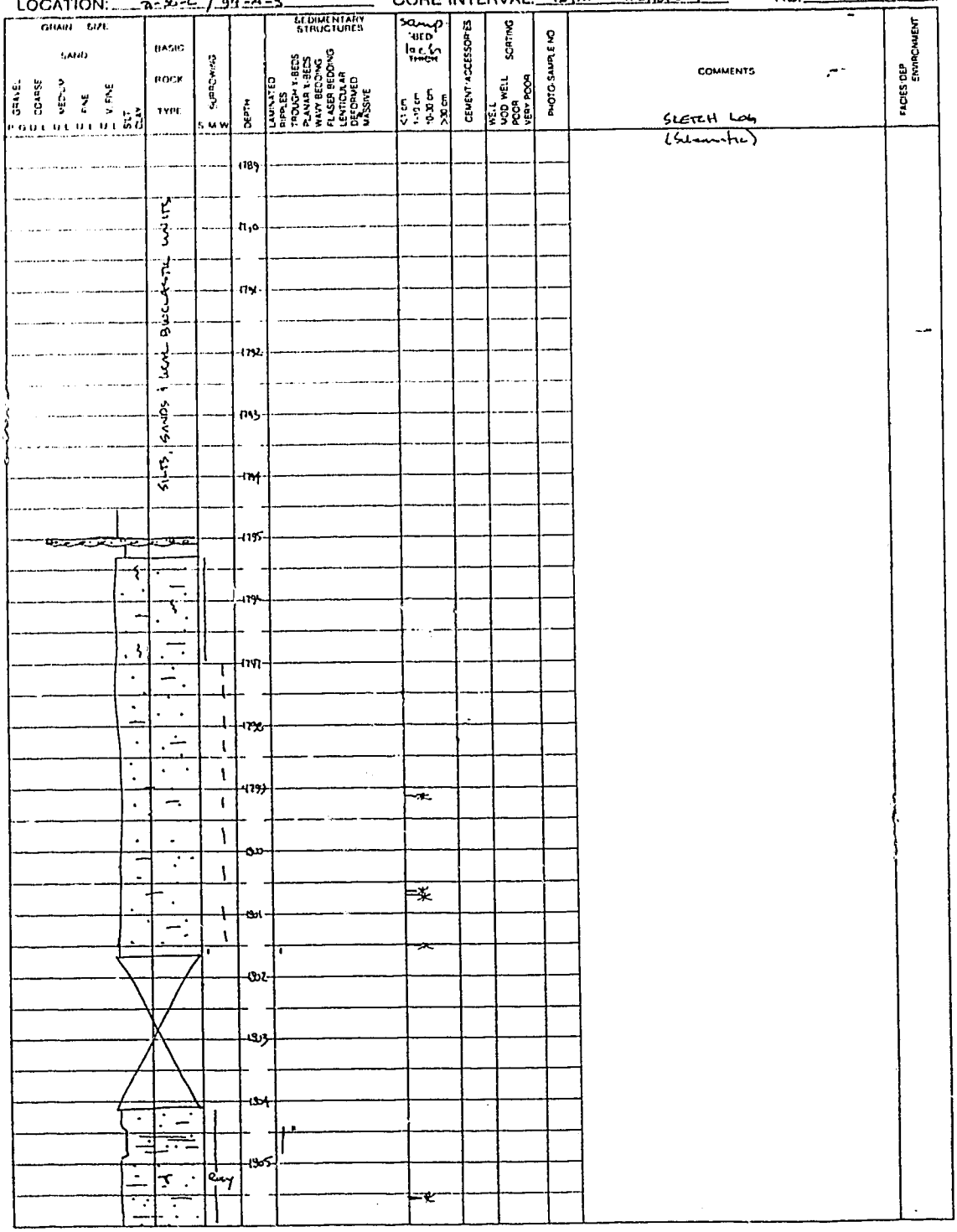
WELL NAME: Esso Buick 9-34-88-20 FORMATION: Dunvegan DATE: 03/01/93

LOCATION: 9-34-88-20/W6 CORE INTERVAL: 1910.7 - 1997.1 KB: 714.5

GRAIN SIZE: GRAVEL	SAND: COARSE	SAND: MEDIUM	SAND: FINE	SAND: V. FINE	SILT	CLAY	BASIC ROCK TYPE	BURROWING: S	BURROWING: M	BURROWING: W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED	SEDIMENTARY STRUCTURES: RIPPLES	SEDIMENTARY STRUCTURES: TROUGH X-BEDS	SEDIMENTARY STRUCTURES: PLANAR X-BEDS	SEDIMENTARY STRUCTURES: WAVY BEDDING	SEDIMENTARY STRUCTURES: FLASER BEDDING	SEDIMENTARY STRUCTURES: LENTICULAR	SEDIMENTARY STRUCTURES: DEFORMED	SEDIMENTARY STRUCTURES: MASSIVE	BED THICK: <1 cm	BED THICK: 1-10 cm	BED THICK: 10-30 cm	BED THICK: >30 cm	CEMENT/ACCESSORIES	SORTING: WELL	SORTING: MOD WELL	SORTING: POOR	SORTING: VERY POOR	PHOTO SAMPLE NO	COMMENTS	FACIES DEP ENVIRONMENT
													20°																			
											1945																					
Cored →											1946		35°												60							
											1947																					

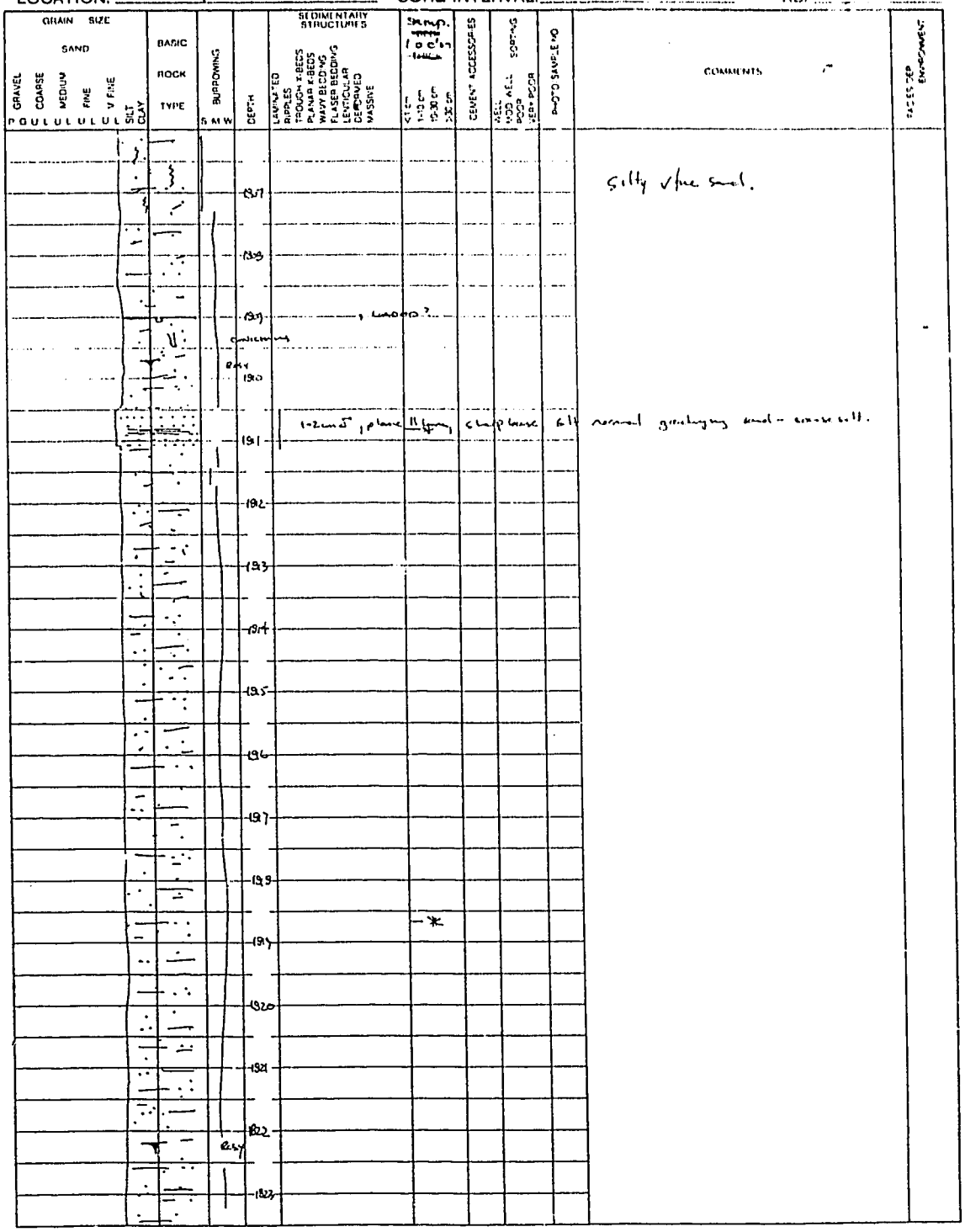
WELL NAME: Central at al Farrell 7-36-6 FORMATION: Wainwright / Dunvegan DATE: June 24th

LOCATION: 7-36-6 / 91-A-5 CORE INTERVAL: 1138.51 - 1151.67 (1145.11 - 1127.81 (?)) KB:



WELL NAME: _____ FORMATION: _____ DATE: _____

LOCATION: 2-32-L/94-A-5 CORE INTERVAL: _____ KB: _____



p.343

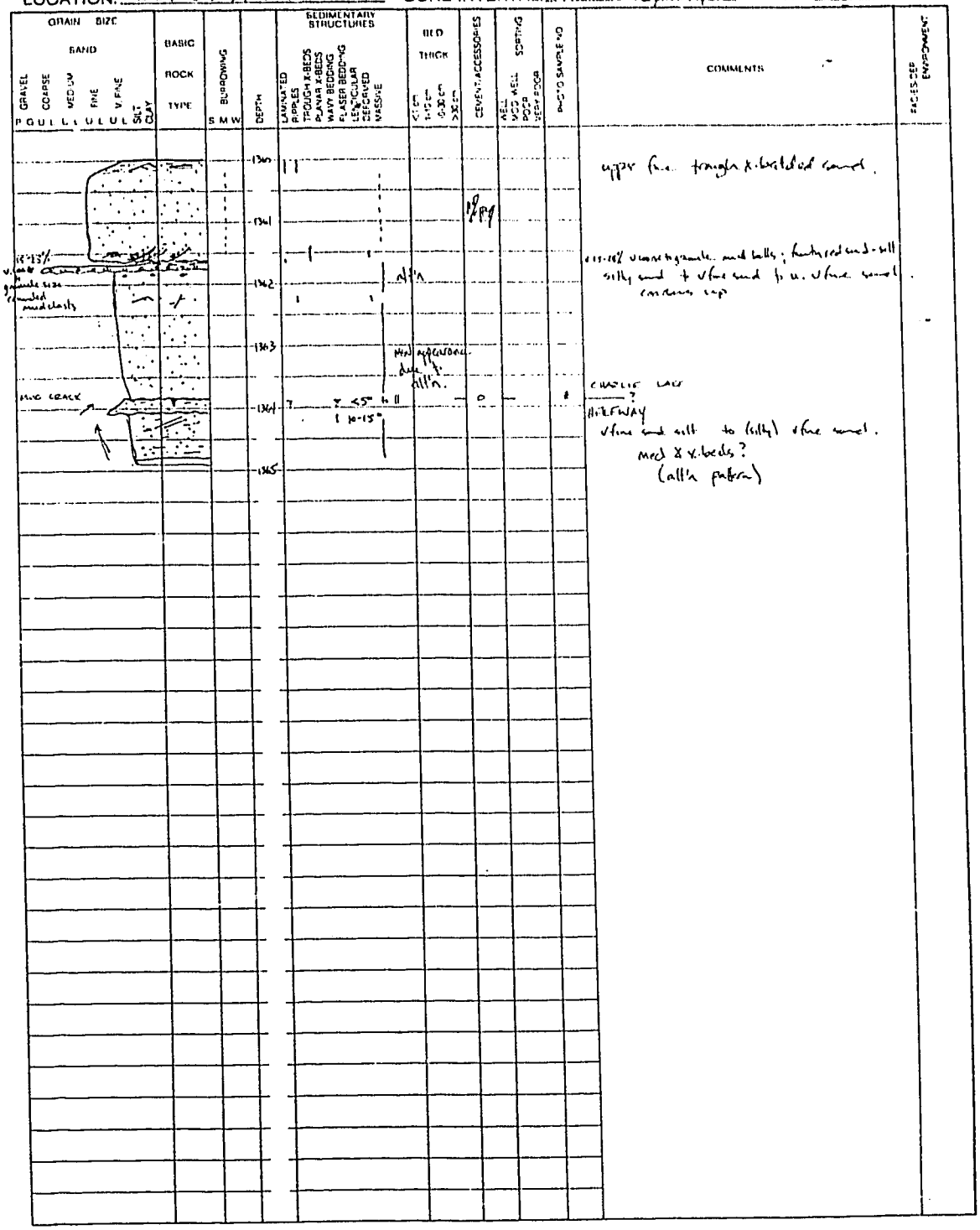
WELL NAME: _____ FORMATION: _____ DATE: _____

LOCATION: 4-32-1/94-A-5 CORE INTERVAL: _____ KB: _____

GRAIN SIZE (GRAVEL / SAND: COARSE, MEDIUM, FINE, V FINE / SILT / CLAY)	BASIC ROCK TYPE	BIOTURBATION (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR BEDDING, MASSIVE)	BED THICK (<1cm, 1-10cm, 10-30cm, >30cm)	CEMENT / ACCESSORIES	WELL SORTING (MOD WELL, POOR, VERY POOR)	PHOTO SAMPLE NO	COMMENTS	FACIES DEP ENVIRONMENT
	U	sl bioturb	1914	11						
			1925							
			1930							
	?									
	slightly fract		1937	MOST CORE REMOVED BY CLIENT						
			1943							

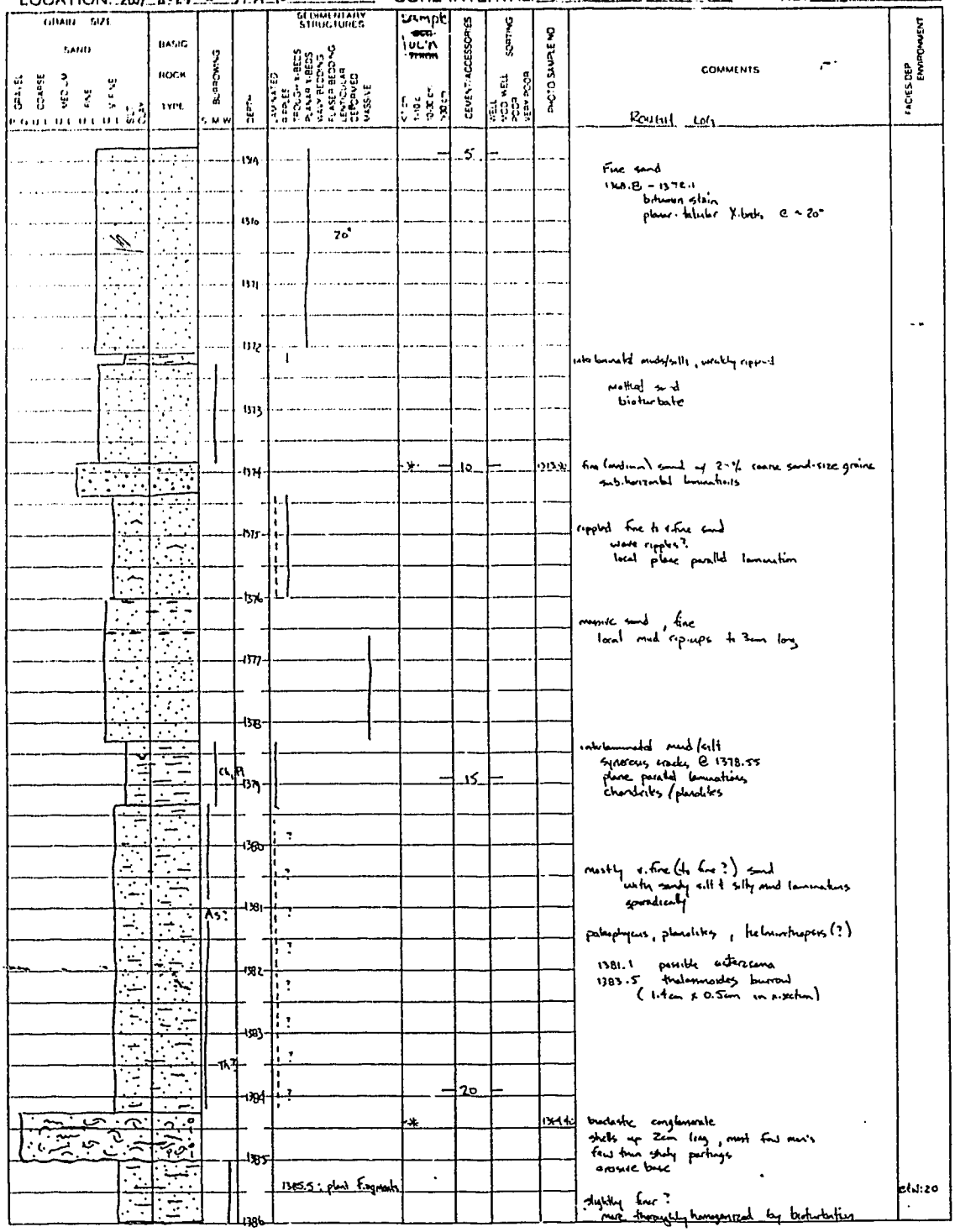
WELL NAME: Encal et al Rigel A-29-K FORMATION: 1360.0 - 1365.6 m DATE: 01/26/94

LOCATION: A-29-K / 94-A-10 CORE INTERVAL: CHARLIE LAKE / HALFWAY KB: 724.1 m



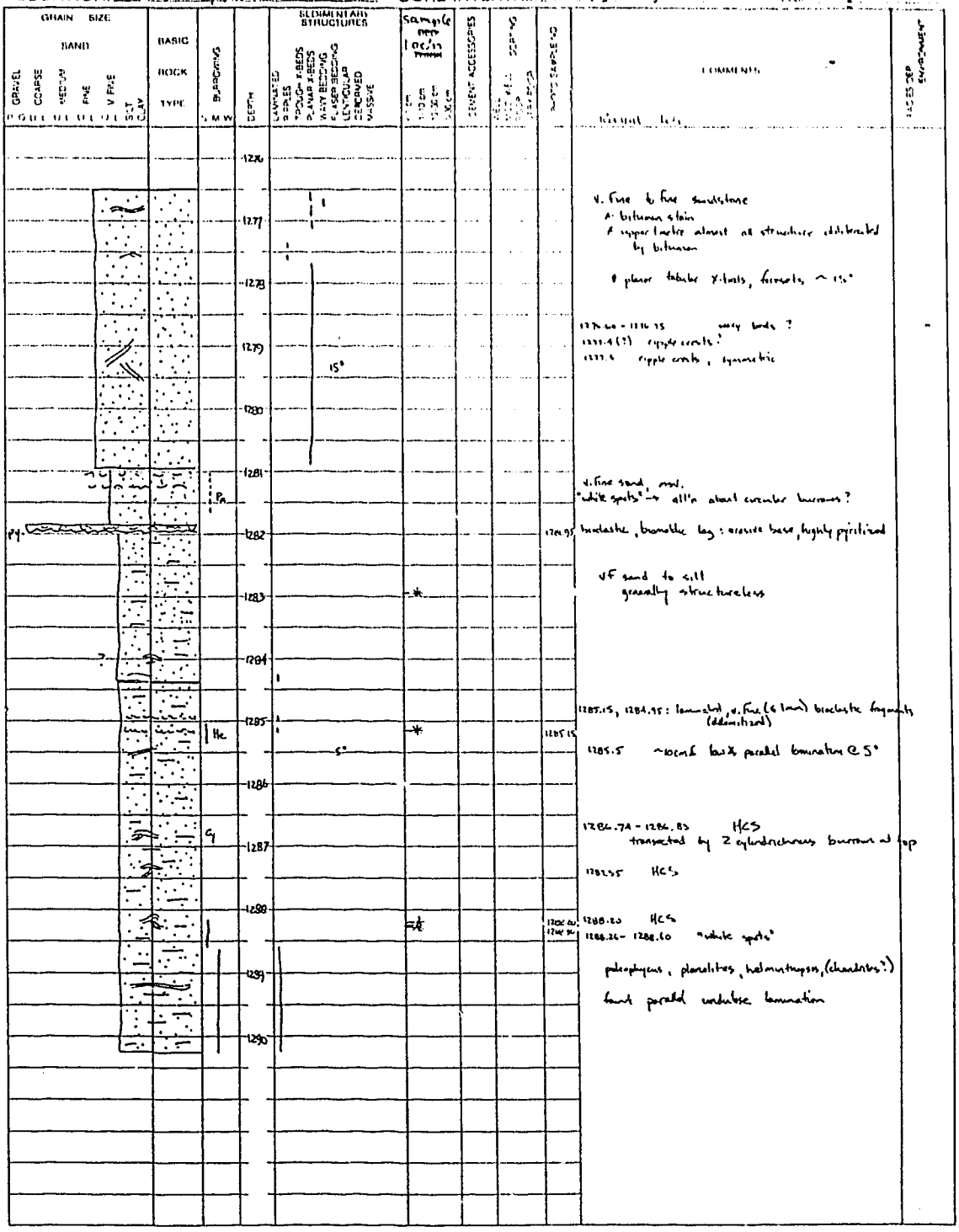
WELL NAME: Enkor Pt. A. Rigel 8-29-K FORMATION: DATE: 03/04/93

LOCATION: 2w/8-29-K 91-A-10 CORE INTERVAL: 1368.8 - 1386.0 KB: 724.1



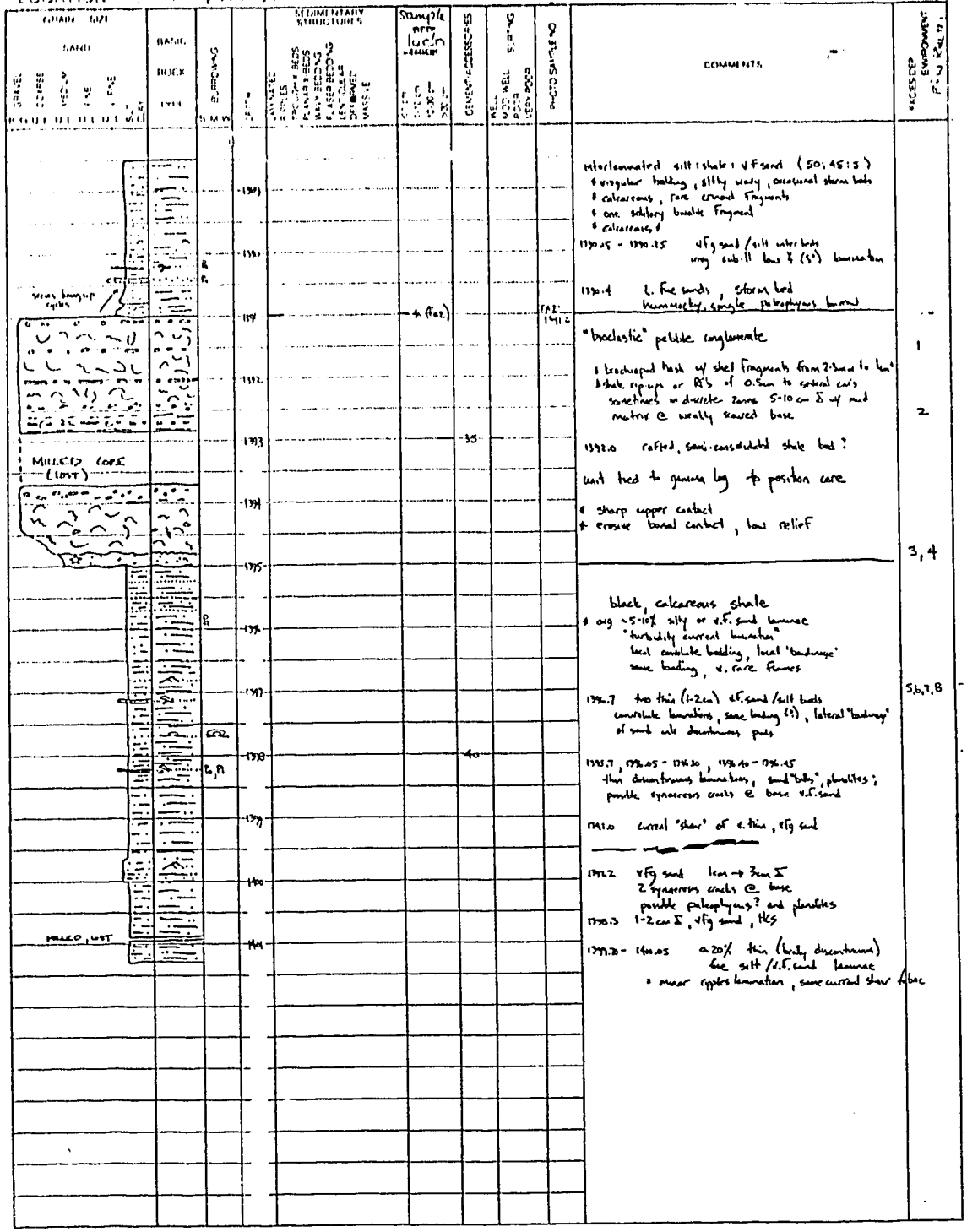
WELL NAME: Home et al. Rigel d-87-K FORMATION: DATE: 03/04/93

LOCATION: d-87-K /94-A-10 CORE INTERVAL: 1276.5 - 1290.75 KB



WELL NAME: SAVE ET A. Bank FORMATION: Dean DATE: 02/22/93

LOCATION: A-34-I/94-A-11 CORE INTERVAL: 1358.5 - Hol.) 1396.5 - 1397.0 KB: 6910



interlaminated silt : shale : v.f sand (50:45:5)
- irregular bedding, silty wavy, occasional storm beds
- calcareous, rare crinoid fragments
- one solitary bivalve fragment
- calcareous #

1390.45 - 1390.85 vfg sand / silt interbeds very sub-ll low X (5°) lamination

1391.4 L. fine sands, storm bed burrowed, single paleophycus burrow

1391.6

"bioclastic" pebble conglomerate

- 1 brachiopod hash of shell fragments from 2-5mm to 1cm
- shale rip-ups or R's of 0.5cm to several cm's sometimes w discrete zones 5-10 cm Σ of mud matrix @ weakly sauced base

1392.0 rafted, semi-consolidated shale bed ?

unit tied to gamma log to position core

- sharp upper contact
- erosive basal contact, low relief

black, calcareous shale

- org ~5-10% silty or v.f. sand laminae "turbidity current lamination" local convolute bedding, local 'loadcasts' some loading, v. rare flames

1396.7 two thin (1-2cm) v.f. sand / silt beds convolute laminations, some loading (?), lateral "loadcasts" of sand into discontinuous pods

1397.7, 1398.05 - 1398.30, 1398.40 - 1398.45 thin discontinuous laminations, sand "balls", pleurolites; possible synaeresis cracks @ base v.f. sand

1399.0 current "shear" of v. thin, vfg sand

1399.2 vfg sand 1cm → 3cm Σ
2 synaeresis cracks @ base
possible paleophycus? and pleurolites

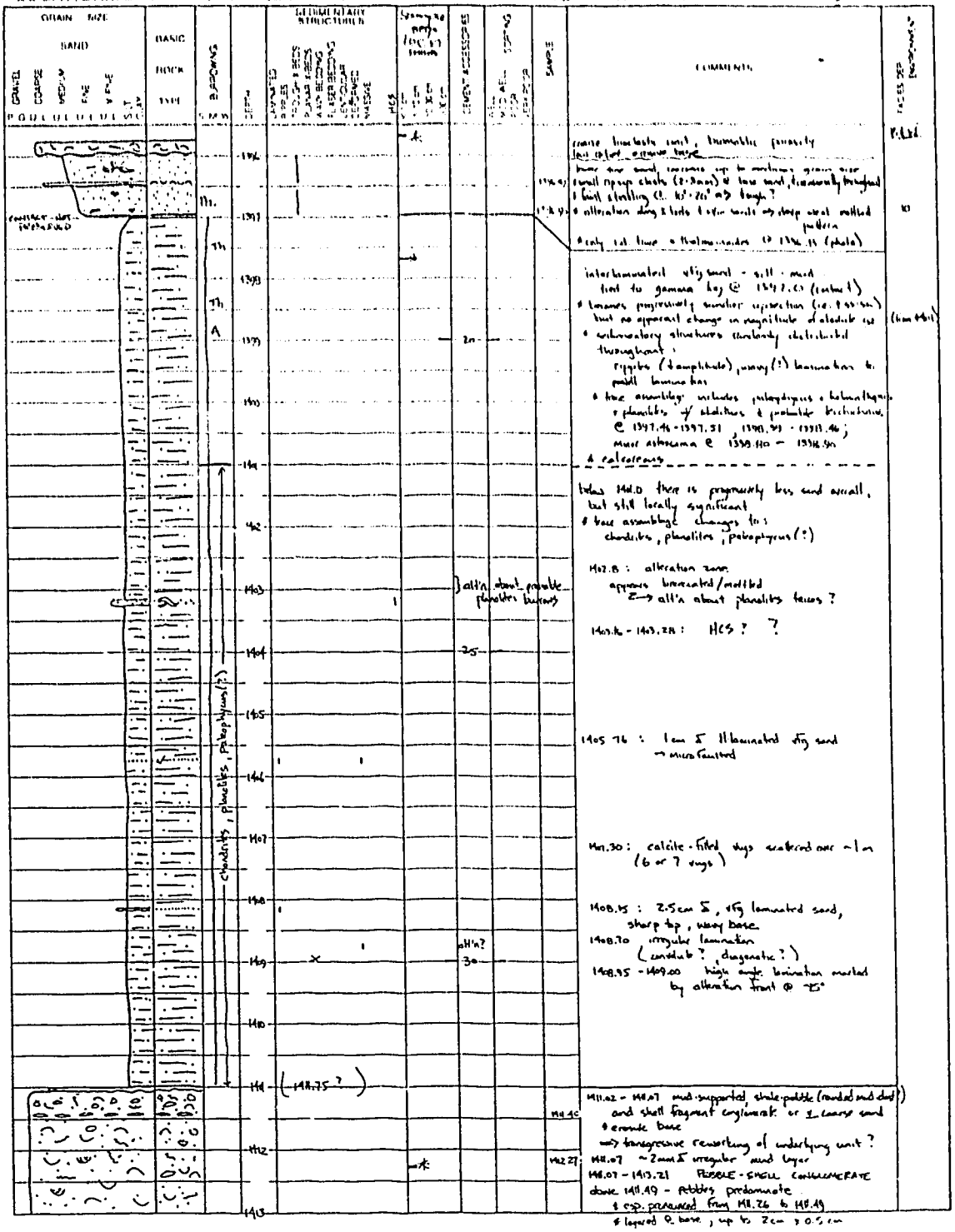
1399.3 1-2 cm Σ, vfg sand, HCS

1399.9 - 1400.05 ~20% thin (locally discontinuous) fine silt / v.f. sand laminae
- minor ripples lamination, some current shear fabric

ENVIRONMENT P-Z
1
2
3, 4
5, 6, 7, 8

WELL NAME: CANADA SUPERIOR BIGLY FORMATION: Dvd DATE: 02/23/93

LOCATION: b-44-I /94-A-11 CORE INTERVAL: 1395.00 - 1415.40 KB 714.3



1395.00 - 1395.40: coarse lithoclastic unit, thrombolitic granularity
last object: extraneous lithic

1395.40 - 1396.40: lower fine sand, increases up to medium to coarse grain size
small upsp chalcedony (2-3mm) & lithic sand, texturally bimodal
limit stratified Cl. b1°-20° ab tough?
alteration zone & birds & vein walls ab steep coal mottled pattern
only 1st time & thalassinoides @ 1396.15 (photo)

1396.40 - 1397.40: interlaminated dty sand - silt - mud
first to gamma log @ 1397.00 (contact)
becomes progressively sandier upsection (i.e. ↑ ss/ss)
but no apparent change in magnitude of clastic int
subvertical structures randomly distributed throughout:
ripples (? amplitude), wavy (?) laminations &
mottled laminations
trace assemblage includes palaeophycus + helminthopsis
+ planolites ab abundance & probable bioturbation
@ 1397.46 - 1397.51, 1398.91 - 1399.46;
minor asterosoma @ 1395.40 - 1395.50
& calcareous

1397.40 - 1398.40: below 1398.0 there is progressively less sand overall,
but still locally significant
trace assemblage changes to:
chondrites, planolites, paleophycus (?)

1402.8: alteration zone
appears bioturbated/mottled
→ all'n about planolites fabric ?

1403.6 - 1403.28: HCS ? ?

1405.76: 1cm S ll laminated dty sand
→ microfaulted

1411.30: calcite-filled clays scattered over ~1m
(6 or 7 clays)

1408.15: 2.5cm S, vfg laminated sand,
sharp top, wavy base
1408.70 irregular lamination
(convolute ? , diagenetic ?)
1408.95 - 1409.00 high angle lamination marked
by alteration front @ 25°

1411.02 - 1411.07 mud-supported shale-pebble (rounded mud clast)
and shell fragment conglomerate or ± coarse sand
erosive base
→ transgressive reworking of underlying unit ?
1411.07 ~2cm S irregular mud layer
1411.07 - 1413.21 PEBBLE - SHELL CONGLOMERATE
above 1411.49 - pebbles predominate
esp. preserved from 1411.76 to 1411.49
layered & bare, up to 2cm ± 0.5 cm

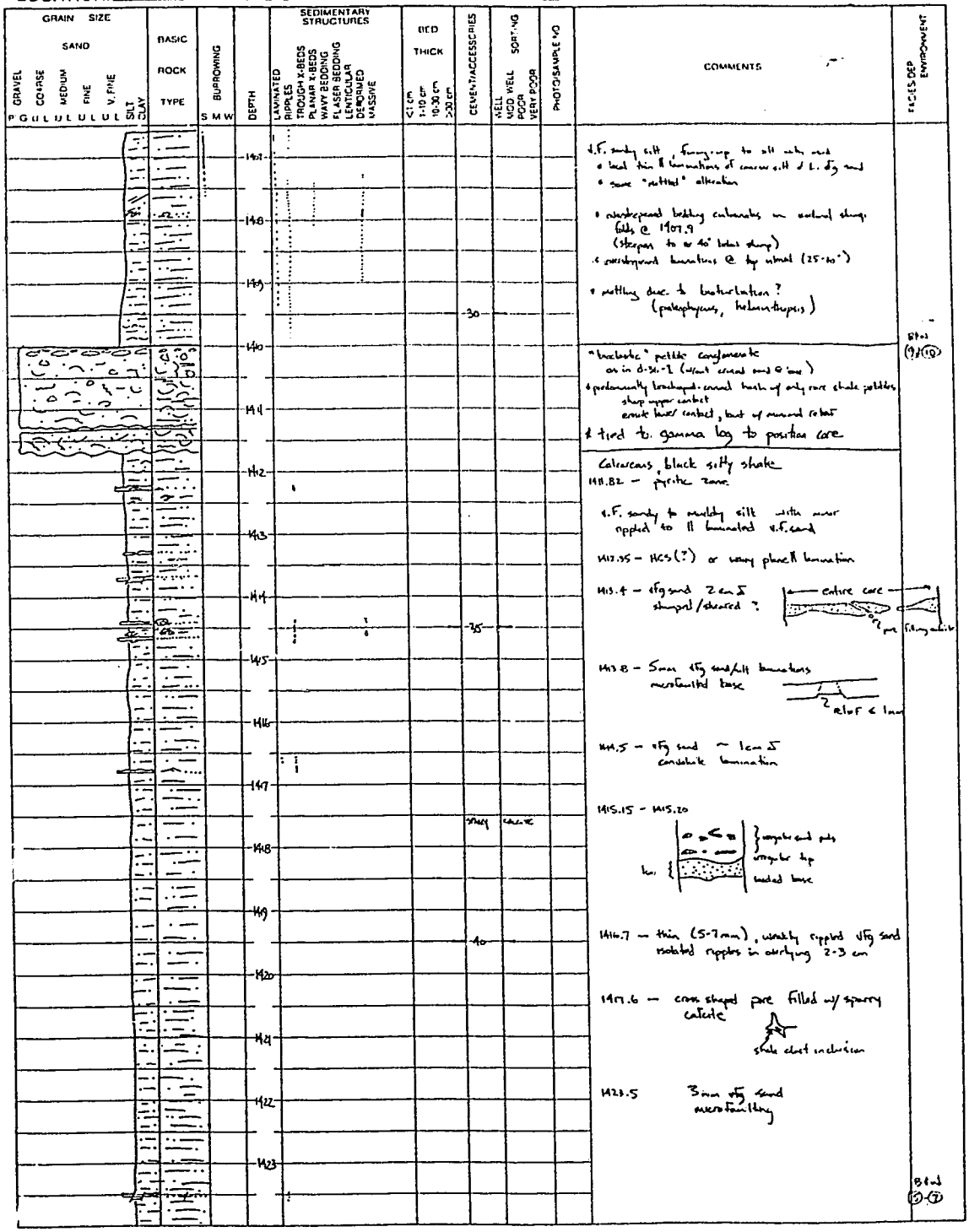
WELL NAME: CANADIAN SUPERIOR BLACK FORMATION: DOIG DATE: 02/23/93

LOCATION: b-44-I/94-A-11 CORE INTERVAL: 1395.00 - 1415.40 KB: 711.3 m

GRAIN SIZE: GRAVEL / SAND: COARSE, MEDIUM, FINE, V FINE / SILT / CLAY	BASIC ROCK TYPE	BURROWING: S M W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR BEDDING, DEFORMED, MASSIVE	Sample and location number: <1 cm, 1-10 cm, 10-30 cm, >30 cm	CEMENT/ACCESSORIES	SORTING: WELL, MOD WELL, POOR, VERY POOR	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1414			35			1414.49 - 1413.21 Bioclastic material. Dominantly often passively infilled w/ sediment mostly brachiopods, crinoids & crinoids(?) abundant calcite & 1413.80 - 1413.21 coarse pebroyed "lag" shells up to 5 cm long (2cm common) rare vertically oriented shells 1413.21 - 1413.26 interlaminated fine grain (<5mm) shelly hash (brachiopods) w/ silty mud laminae few mm ø NB there is no pronounced basal erosive contact to above bioclastic conglomerate & contact located btwn 2 core fragments w/ do not fit perfectly, but do not appear to be rolled or reduced in volume 1413.26 - 1414.37 interlaminated vfg sand - silt - mud; ~20% sand dark grey - black calcareous & ripple X-stratification locally dist. -> locally minors HCS	
			1415							

WELL NAME: ANADARKO BUICK FORMATION: DOLY DATE: 02/22/93

LOCATION: d-45-I /94-A-11 CORE INTERVAL: 1408.0 - 1427.0 (m. KB) KB: 690.6



2 of 2

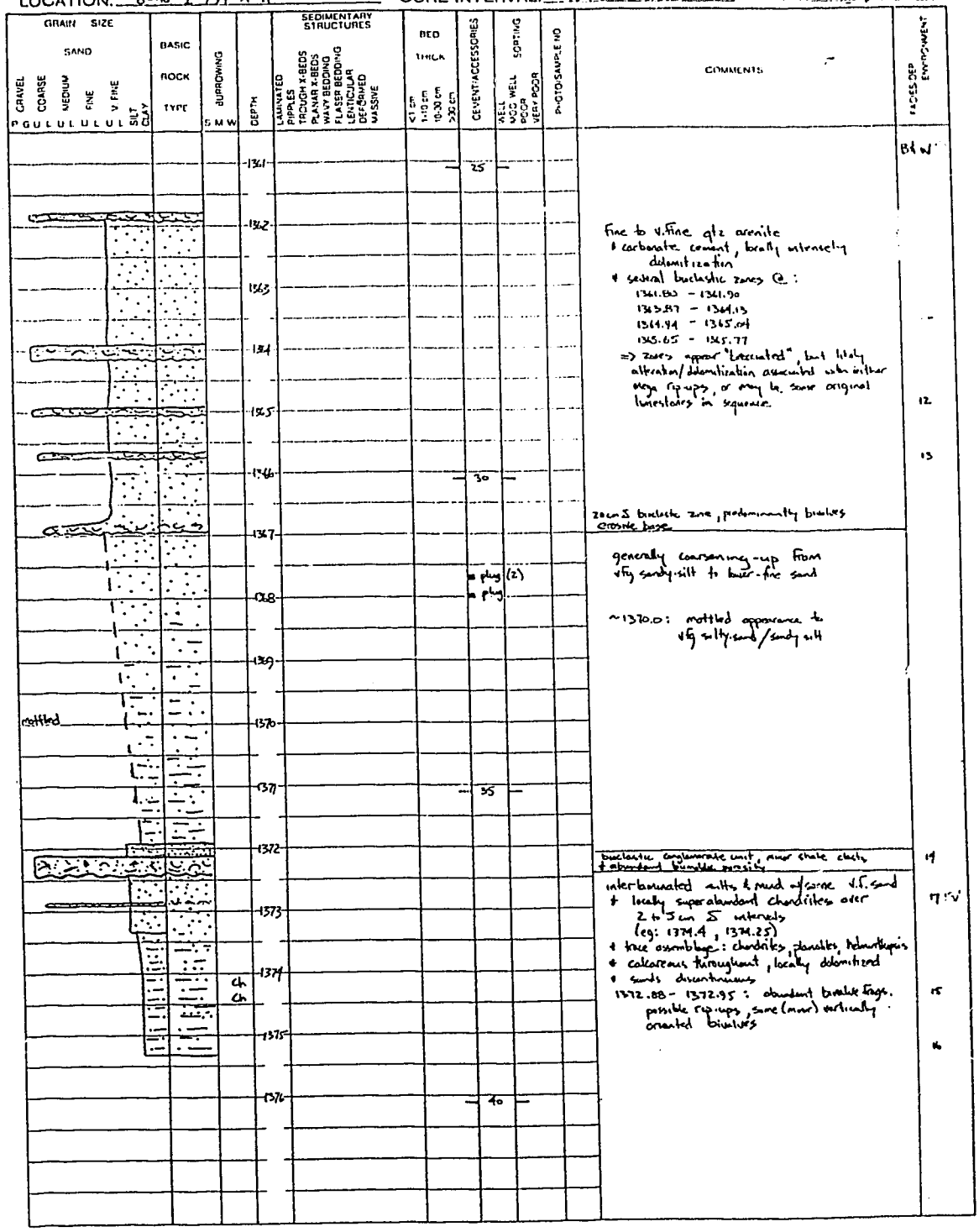
WELL NAME: Amauligak Bluff FORMATION: Dolo DATE: 02/22/93

LOCATION: d-45-I/94-A-11 CORE INTERVAL: 1406.6 to 1425.3 1408.0 - 1427.0 KB: 690.6

GRAIN SIZE: GRAVEL / SAND: COARSE, MEDIUM, FINE, V FINE / SILT, CLAY	BASIC ROCK TYPE	BURROWING: S, M, W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DISTURBED, MASSIVE	BED THICK: <1 cm, 1-10 cm, 10-30 cm, >30 cm	CEMENT/ACCESSORIES	SORTING: WELL, MOD, POOR, VERY POOR	PHOTO-SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1424						section becomes progressively finer down section	
						45				
			1425							

WELL NAME: Shell et al. Burck d-46-I FORMATION: Dolly DATE: 08/23/93

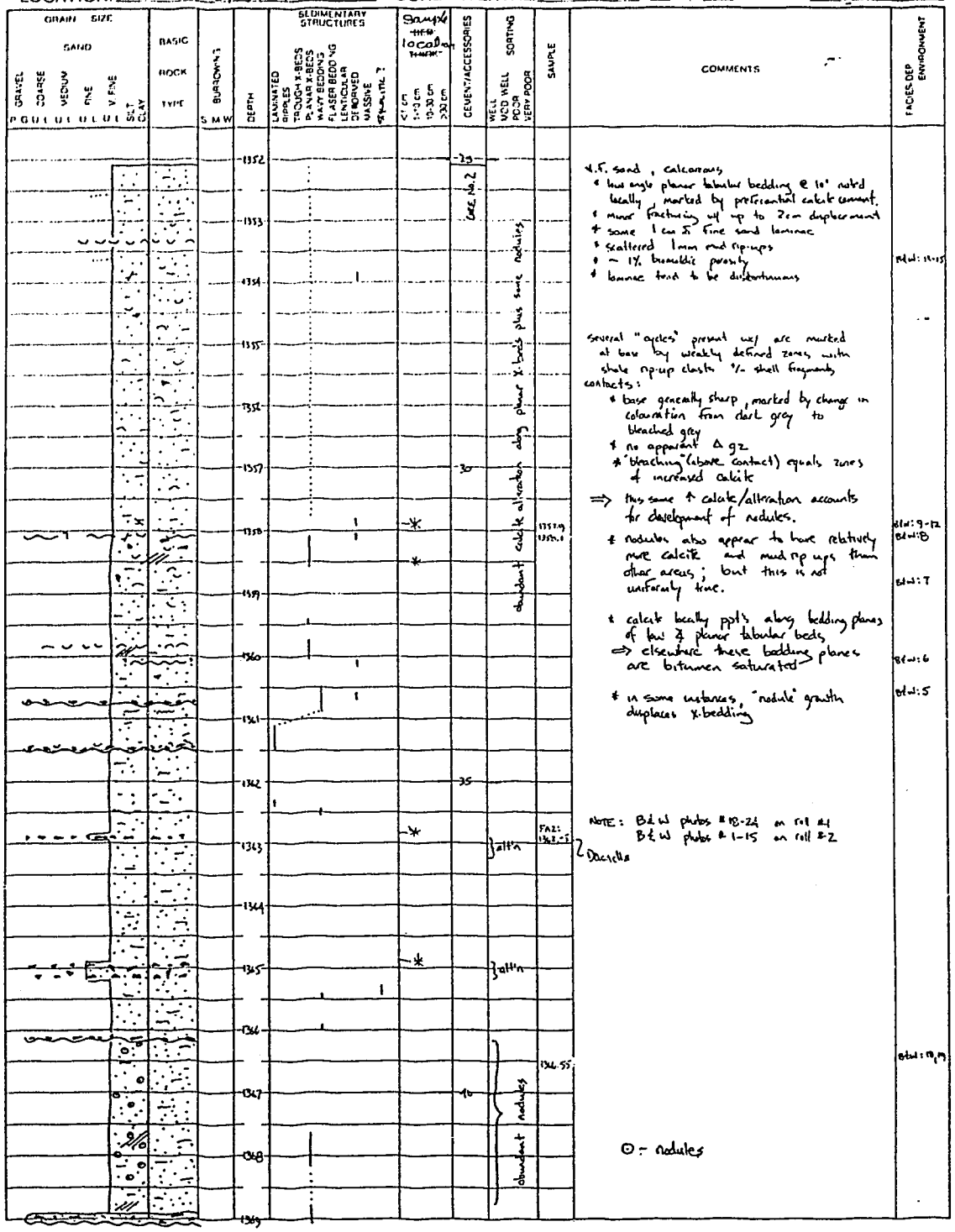
LOCATION: d-46-I /94-A-11 CORE INTERVAL: 1361.8 - 1315.3 KB: 675.9



1 of 2

WELL NAME: Pisco Bluff FORMATION: Dolg DATE: 02/24/93

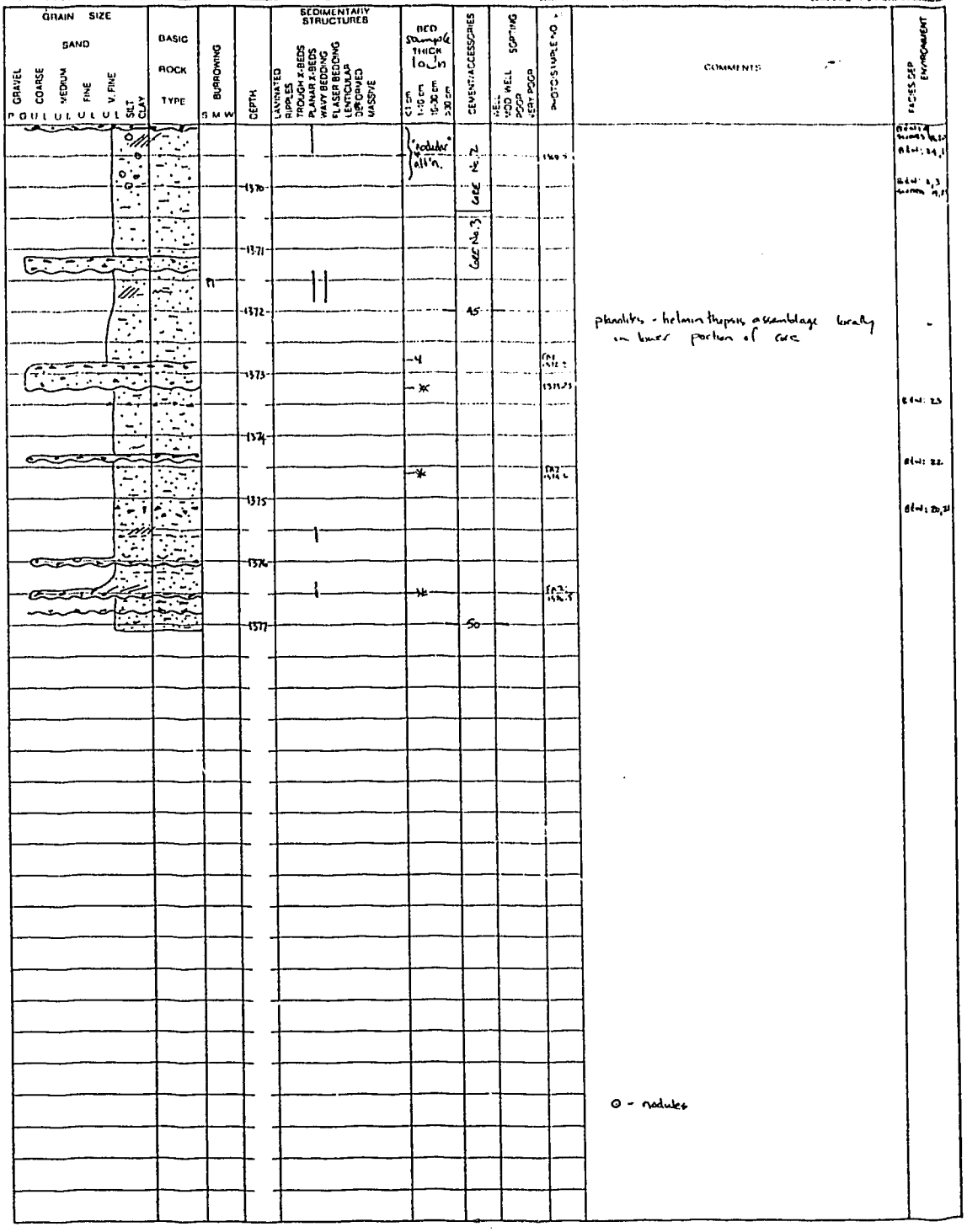
LOCATION: d-A57-I/94-A-11 CORE INTERVAL: 1352.1 - 1377.1 KB: 678.96



2 of 2

WELL NAME: Pan Border FORMATION: Dunkard DATE: 02/24/93

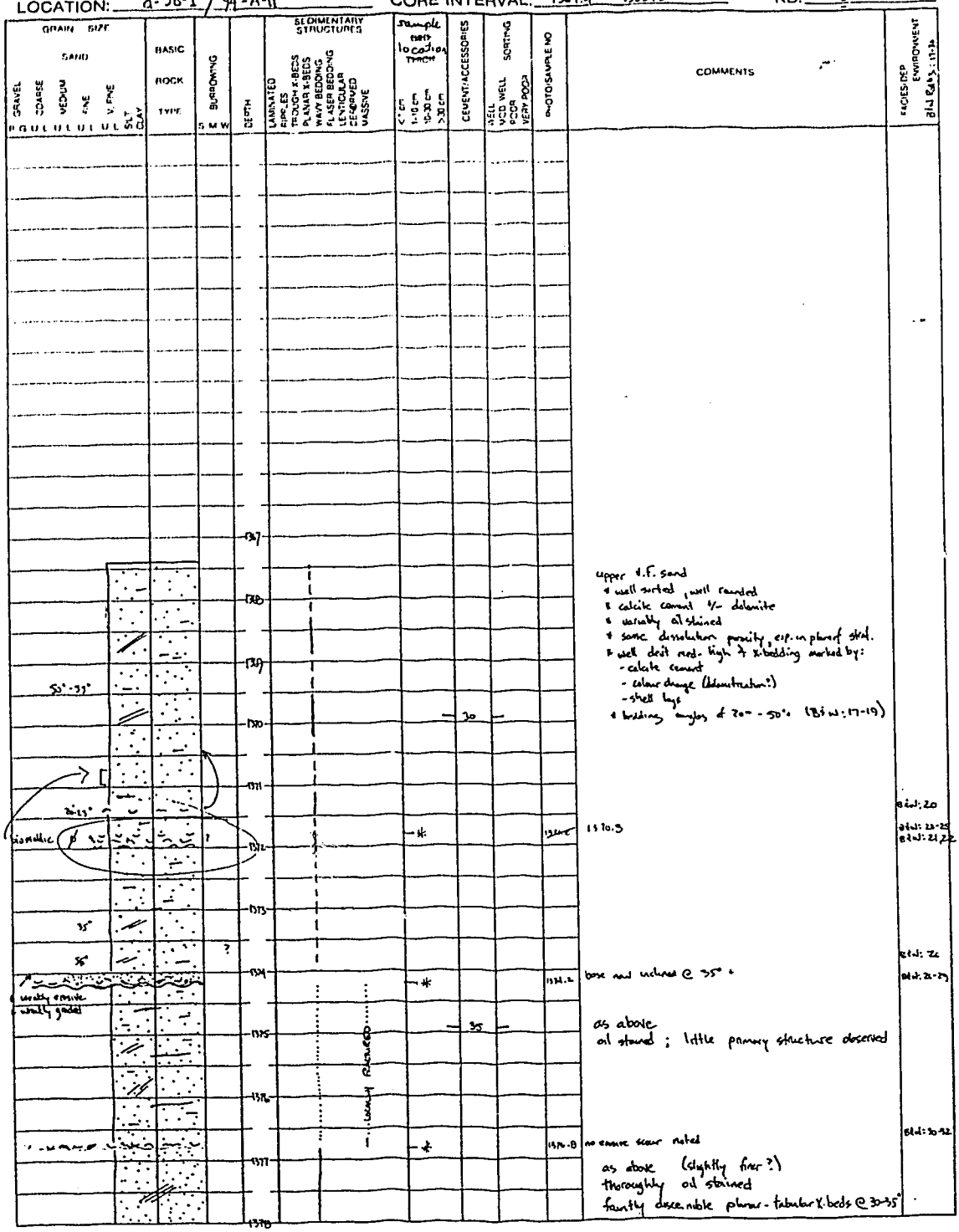
LOCATION: d-AS7-I /94-A-11 CORE INTERVAL: 1352.1 - 1377.1 KB: 678.96'



1 of 2

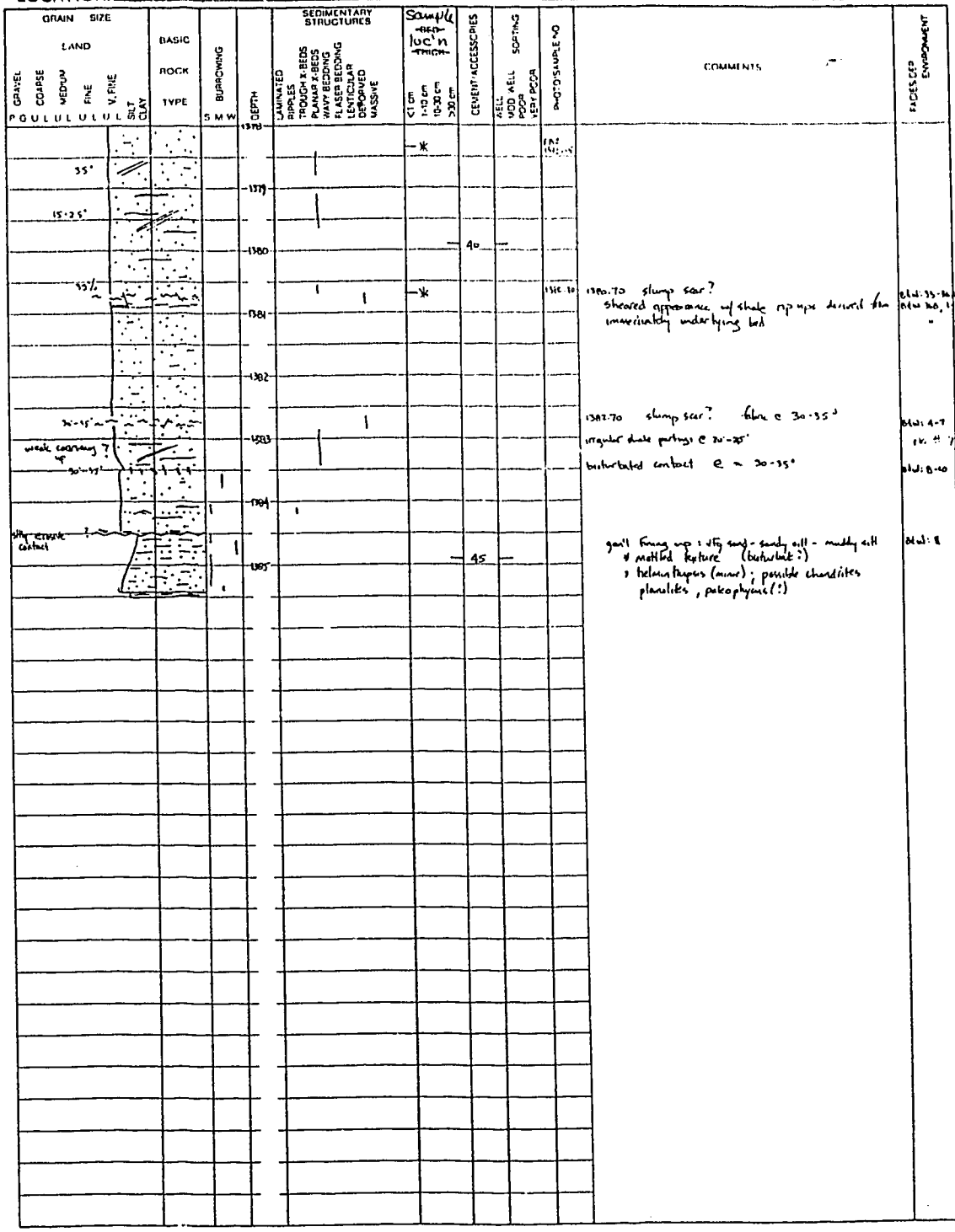
WELL NAME: Paxo Bluck d-58-I FORMATION: Dolg DATE: 02/26/93

LOCATION: d-58-I / 94-A-11 CORE INTERVAL: 1367.1 - 1385.5 KB: -



WELL NAME: Poco Pauck d-58-I FORMATION: Dvg DATE: 02/26/93

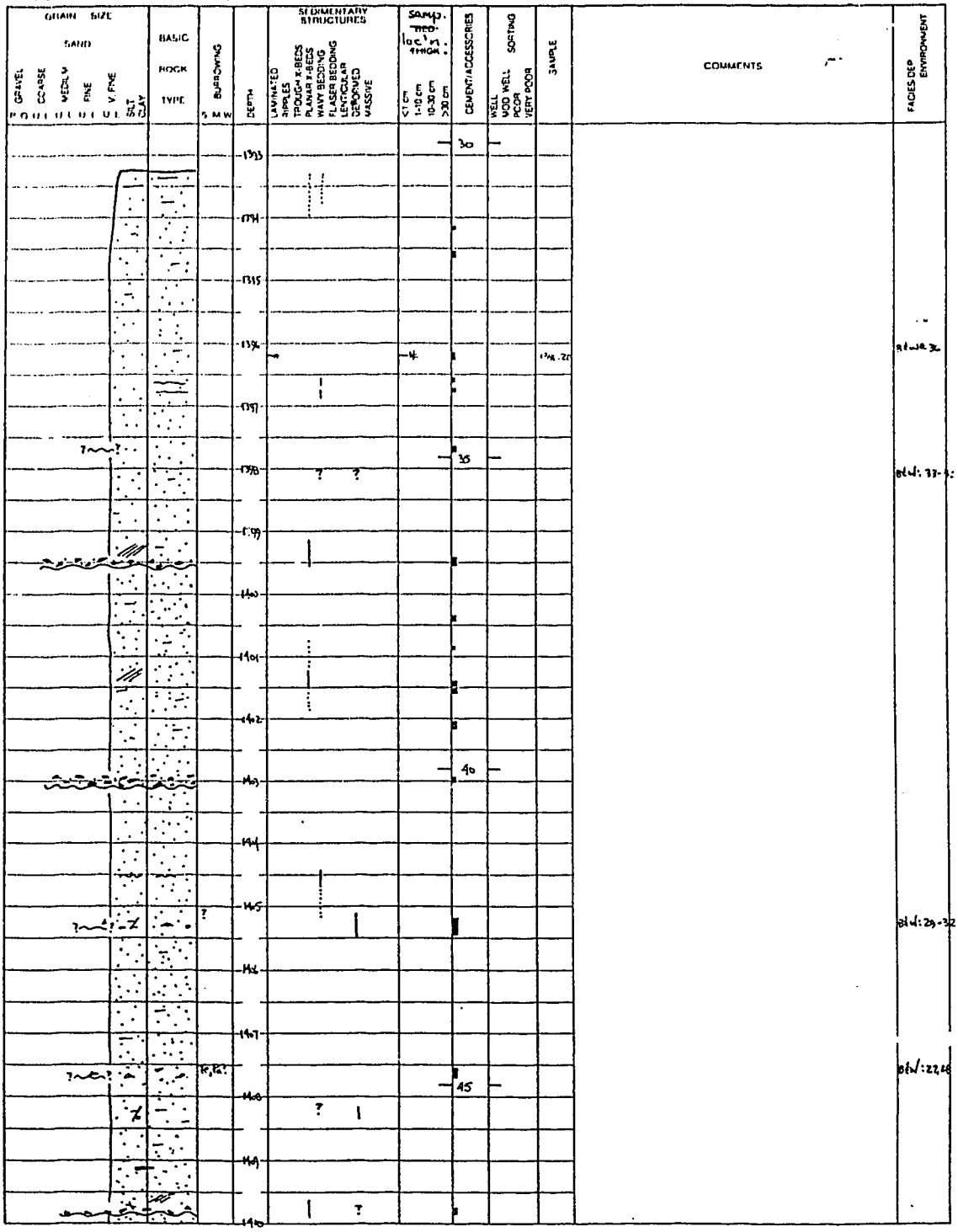
LOCATION: d-58-I /94-A-11 CORE INTERVAL: 1367.4 - 1305.5 KB:



1 of 2

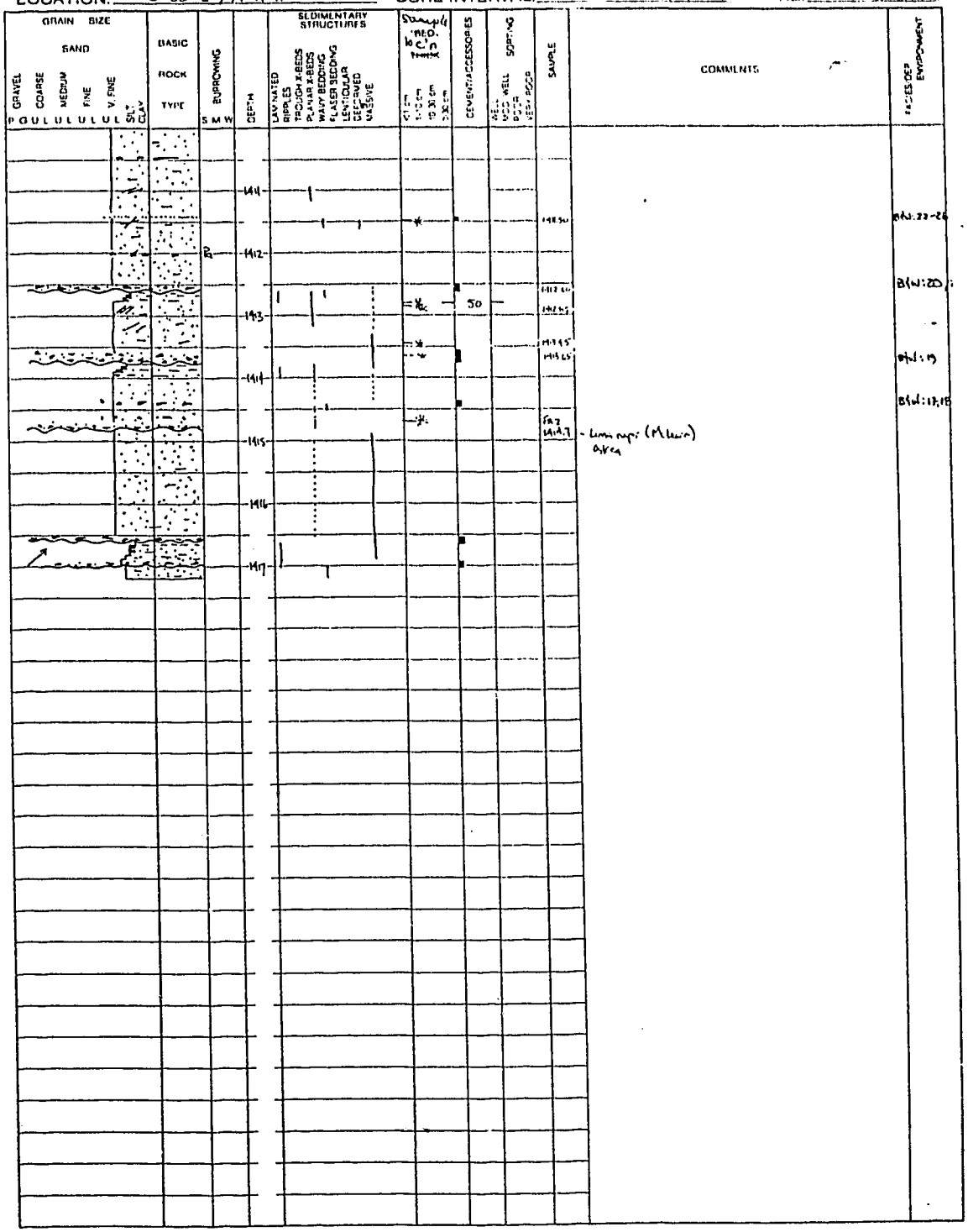
WELL NAME: Kwo Burick d-68-I FORMATION: Doig DATE: 02/25/93

LOCATION: d-68-I/94-A-11 CORE INTERVAL: 1393.3 - 1417.4 KB: 714.63 m



WELL NAME: Kelly Bush d-68-I FORMATION: Doig DATE: 02/25/93

LOCATION: d-68-I /94-A-11 CORE INTERVAL: 1393.3 – 1417.9 KB: 714.63



1 of 2

WELL NAME: Kuo Bruce d-69-I FORMATION: Paq DATE: 02/26/93

LOCATION: d-69-I / 94-A-11 CORE INTERVAL: 1445 - 1467 (2 runs) KB: 748.5'

DEPTH	BASIC ROCK TYPE	B. BROWSING S M W	SEDIMENTARY STRUCTURES	Samples <1 cm 1-10 cm >10 cm	CEMENT ACCESSORIES	SORTING WELL MOD V.ELL POOR VERY POOR	PHOTO SAMPLE NO	COMMENTS	FACIES DEP ENVIRONMENT BSW Rpt #4
1445							1445	reworked HCS, partly to thoroughly reworked. paleophycus, fugichnia, . . . ?	
1446					25				B(d):22
1447									
1448								black, calcareous (lines), silty mudstone + local (but minor) paleophycus, helminthopsis, possible chondrites and "micro-paleophycus" ↳ burrows ≤ 2-4mm Σ	
1449									
1450								core locally has a "tiger stripe" appearance where it is med grey w/ darker, discontinuous stripes ⇒ this may be diagenetic w/in ⇒ or thoroughly reworked storm beds?	
1451				*			1450.10		B(d):23
1452					40			1451.15 - 1451.35: 6 x 3-8mm Σ rippled beds	B(d):20,21
1453								" "	B(d): 17-19 Pl.t: 16
1454									B(d): 15
1455									
1456									
1457									
1458					45				
1459									
1460									
1461									B(d):13,14
1462					} "capped spots"				
1463									
1464									
1465					50				
1466									
1467									

WELL NAME: Kuo Buick d-69-I FORMATION: Dog DATE: 01/26/93

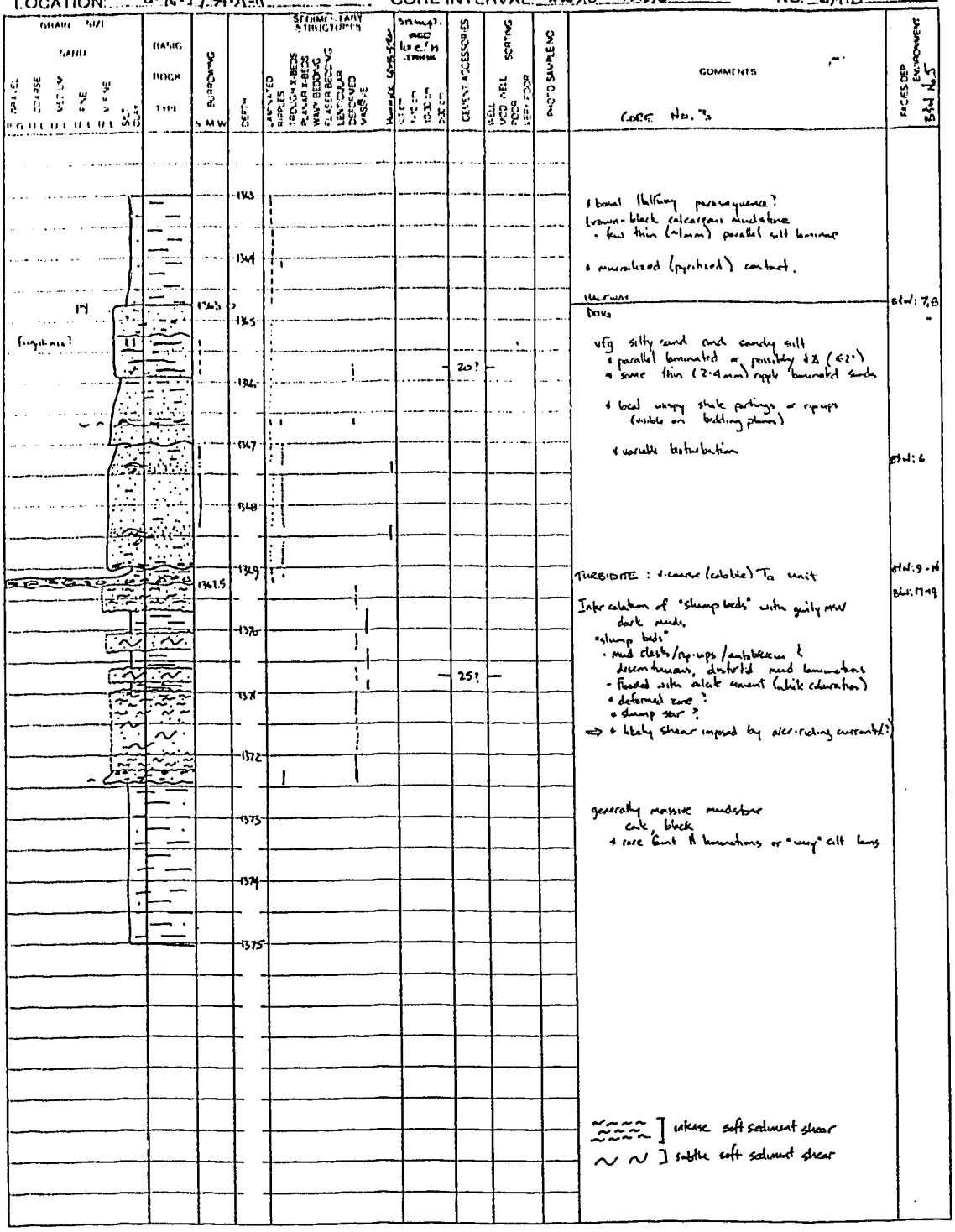
LOCATION: d-69-I/94-A-11 CORE INTERVAL: 1445 - 1467 KB: 748.5

GRAIN SIZE: GRAVEL	SAND: COARSE	SAND: MEDIUM	SAND: FINE	SAND: V FINE	SILT CLAY	BASIC ROCK TYPE	BURROWING S	BURROWING M	BURROWING W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED	RIPPLES	TROUGH X-BEDS	PLANAR X-BEDS	WAVY BEDDING	FLASER BEDDING	LENTICULAR	DEFORMED	MASSIVE	BED THICK: <1 cm	1-10 cm	10-30 cm	>30 cm	GEVENT-ACCESSORIES	SORTING: WELL	MOD WELL	POOR	VERY POOR	PHOTO SAMPLE NO	COMMENTS	FACIES SEP ENVIRONMENT
										1442																					
																													DST #1	black calcareous silty mudstone + peaty mud. + laml, but minor, heterolithpsies and possible chondrites + unidentified horizontal burrows: probable paleophycus, but linings not visible due to alteration "shale" (phenolites?)	
										1453																					
																													CORE #1-2		
										1464																					
										1475																					
										1486														55							
																														+ locally silty streaks or silty sand bases, ⇒ possibly rippled	
										1497																					

1 of 3.

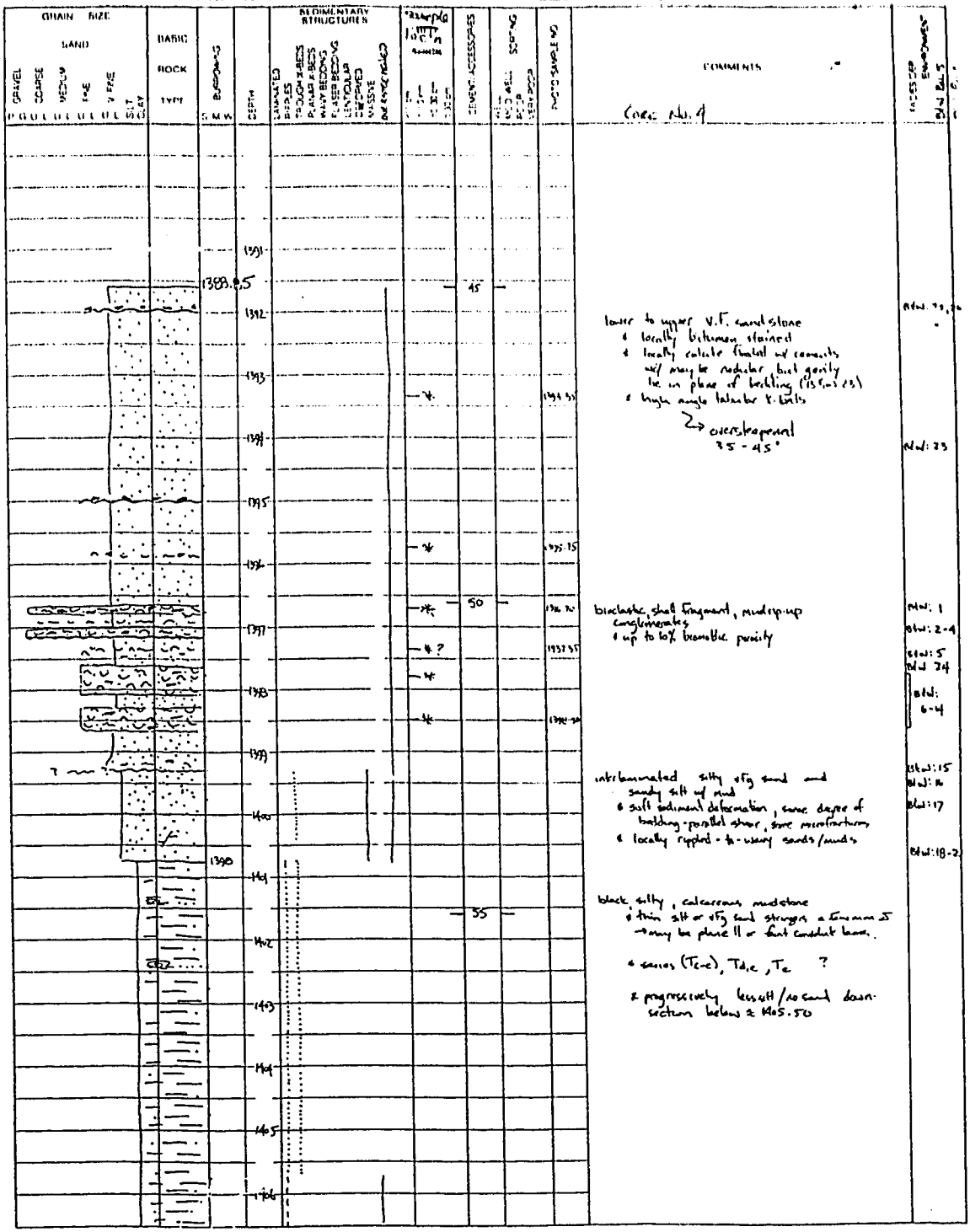
WELL NAME: Esso Gulf Banff d-76-I FORMATION: Ivish DATE: 03/01/93

LOCATION: d-76-I/94-A-11 CORE INTERVAL: 1361.25 - 1379.25 KB: 604.8



WELL NAME: Esso Gunter Bunt FORMATION: Dawson DATE: 05/01/93

LOCATION: d-76-I /94-A-01 CORE INTERVAL: 1399.85 – 1402.6 KB: 624.8'



3 1 3

WELL NAME: Esso Gulf Basse d-76·I FORMATION: Delta DATE: 03/01/93

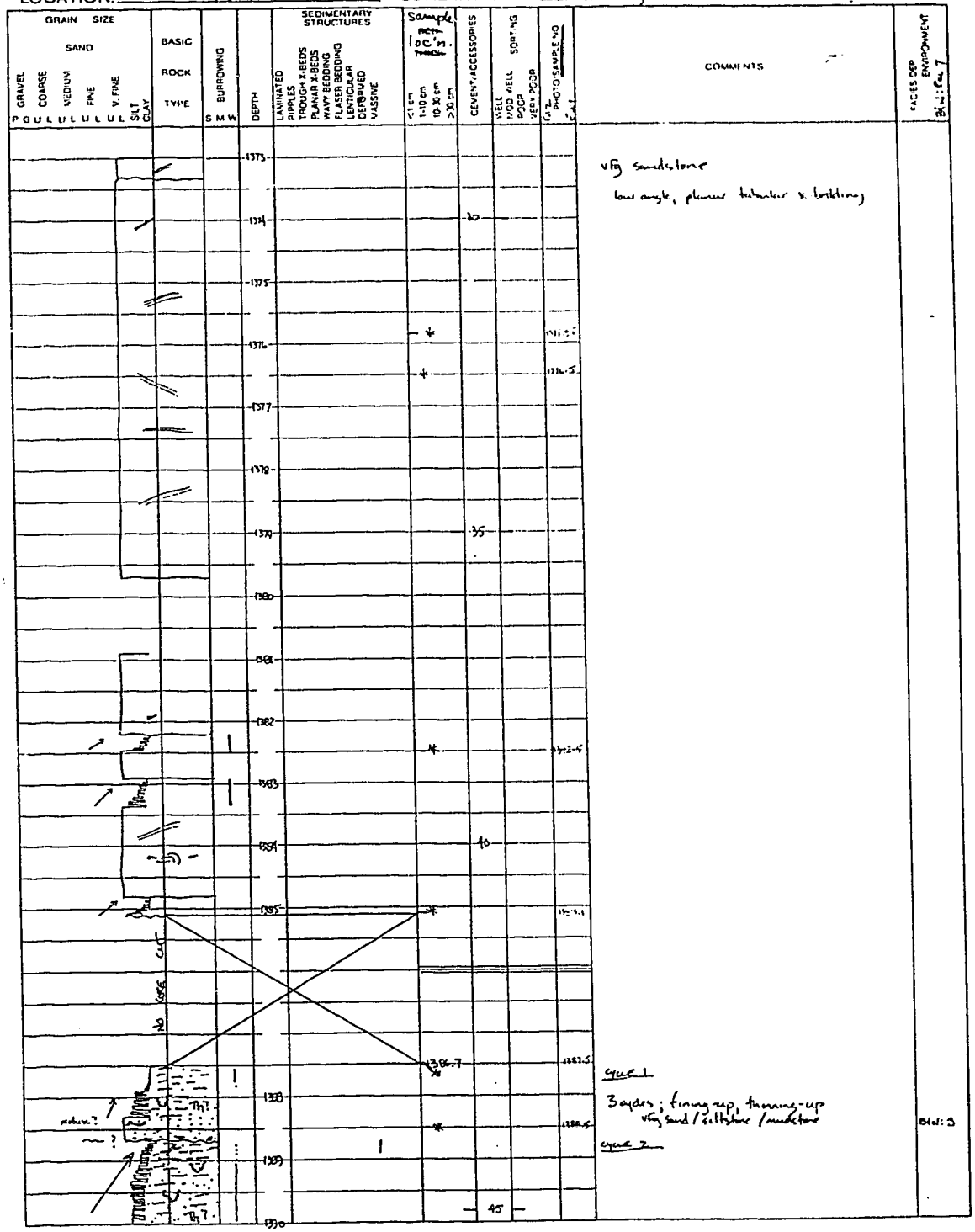
LOCATION: d-76:I /94-A-11 CORE INTERVAL: _____ KB: 694.8

GRAIN SIZE (GRAVEL / SAND: COARSE, MEDIUM, FINE, V FINE / SILT / CLAY)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE)	BED THICK (<1 cm, 1-10 cm, 10-30 cm, >30 cm)	CEMENT/ACCESSORIES	SORTING (WELL, MOD WELL, POOR, VERY POOR)	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
						60			CORE No. 1	
			1407						black, calc. mudstone	
			1408							
			1409							
		14/6	85							

12 2

WELL NAME: TEXACO ET AL. BAILEY b-77-I FORMATION: Dally DATE: 03/01/93

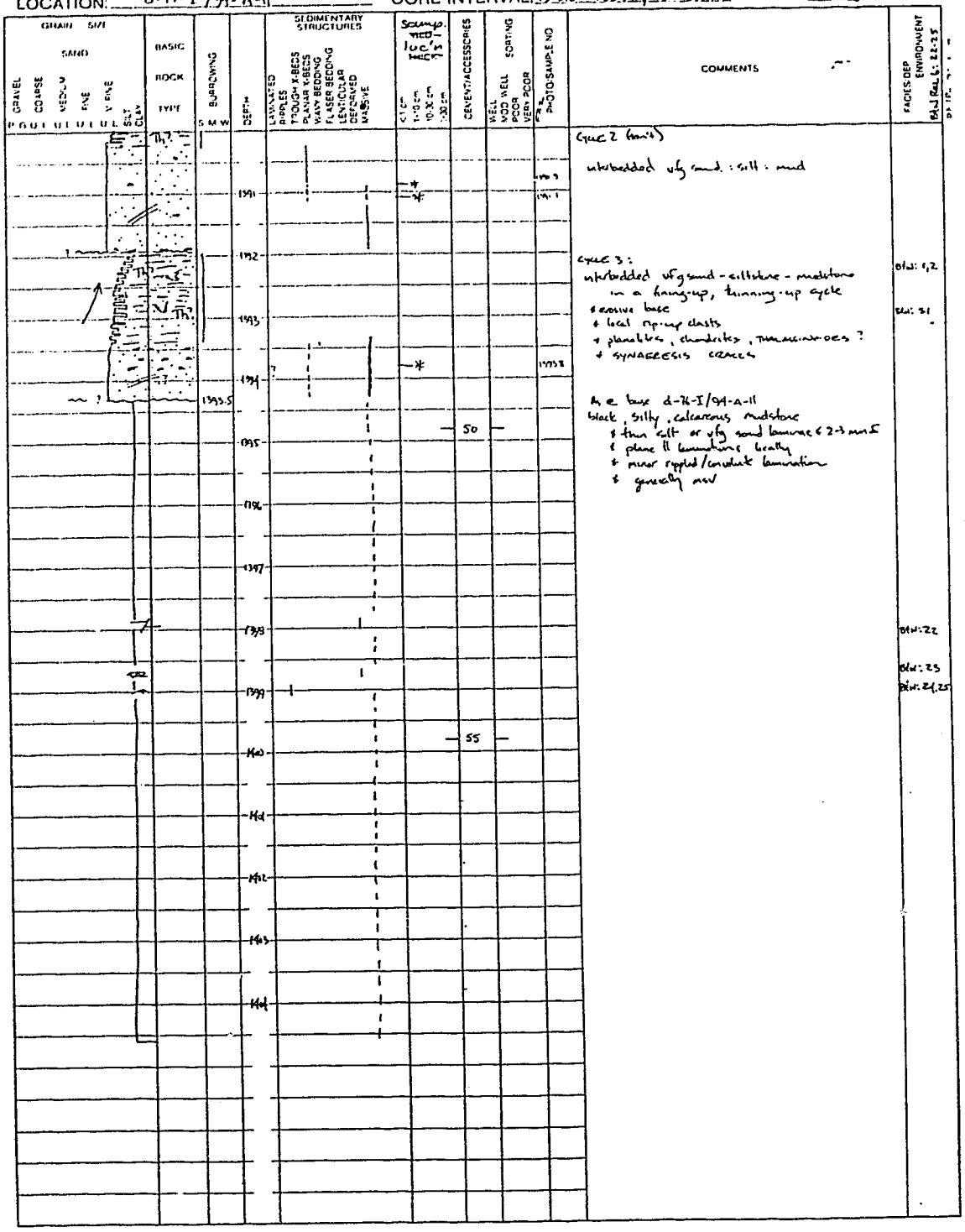
LOCATION: b-77-I / 94-A-11 CORE INTERVAL: 1375.0 - 1385.1 ; 1396.7 - 1401.6 KB: 700.8'



2 of 2

WELL NAME: TENCO ET AL. ZUICK b-77-I FORMATION: Dolg DATE: 03/01/93

LOCATION: b-77-I/94-A-11 CORE INTERVAL: 1373.0-1385.1 ; 1387.5-1404.6 KB: 708.8



Cycle 2 (cont'd)

interbedded vfg sand : silt : mud

Cycle 3 :
interbedded vfg sand - siltstone - mudstone
in a fining-up, thinning-up cycle
* erosive base
* local rip-up clasts
* planolites, chondrites, trace animal ?
* SYNAERESIS cracks

@ base d-76-I/94-A-11
black, silty, calcareous mudstone
* thin silt or vfg sand laminae < 2-3 mm ±
* plane ll laminations locally
* minor rippled/convolute lamination
* generally rare

BLW: 1,2

BLW: 31

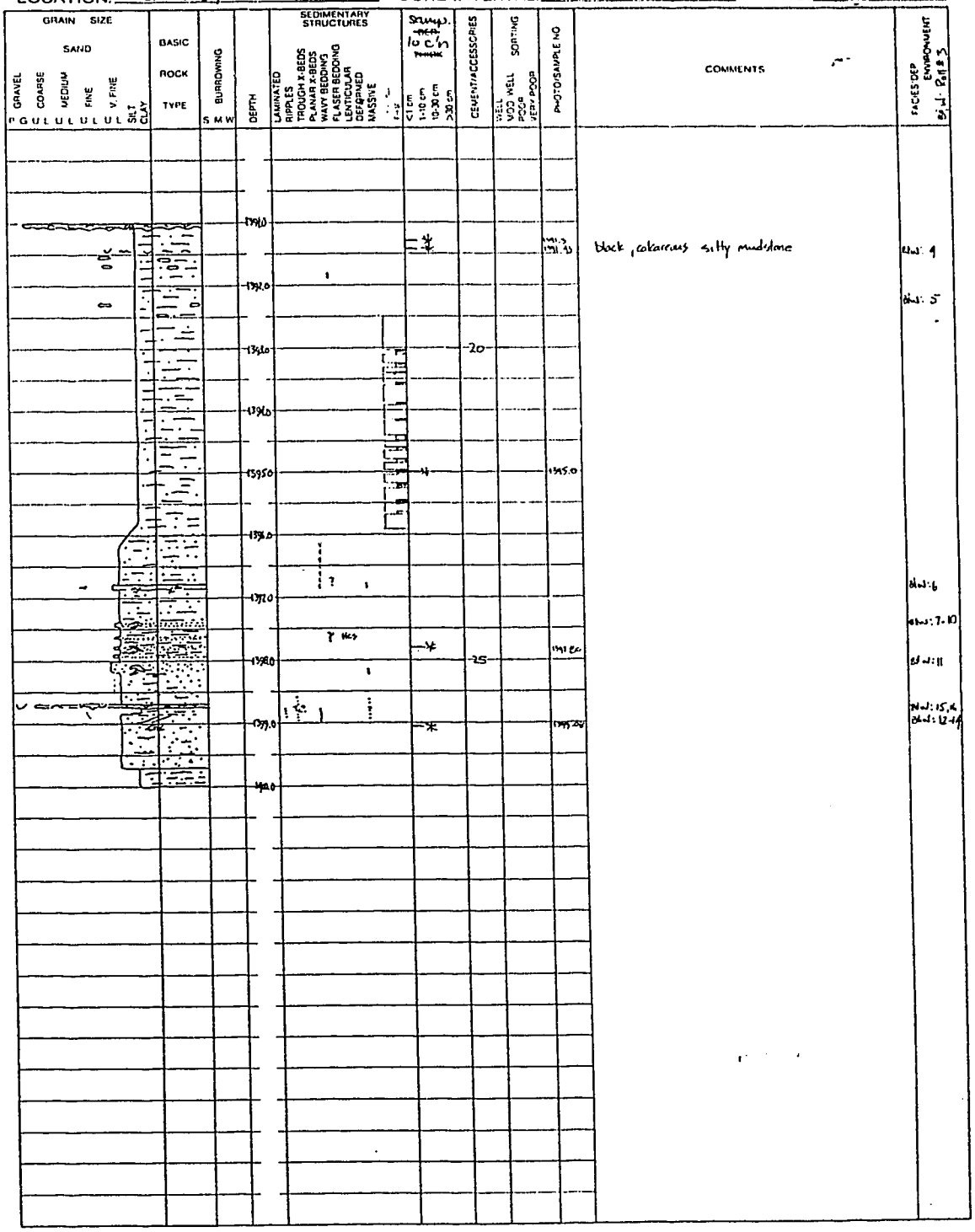
BLW: 22

BLW: 25

BLW: 24,25

WELL NAME: TEXACO ET AL. BUICK FORMATION: DOLA DATE: 02/25/93

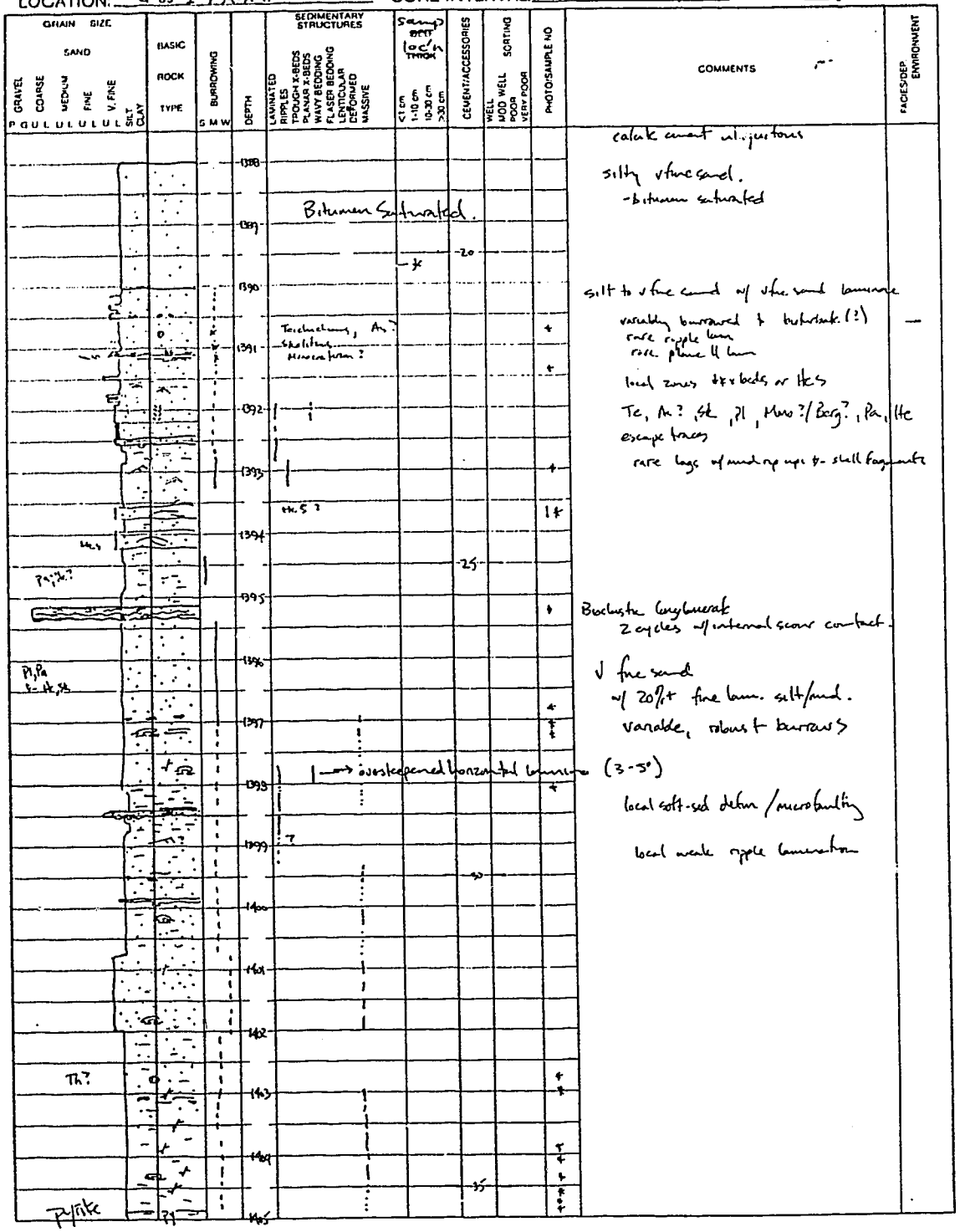
LOCATION: d-79-I/94-A-11 CORE INTERVAL: 1391.0 - 1400.0 KB: 711.5



p 1 of 3

WELL NAME: Esso Gulf Brack d-85-I FORMATION: base HFWY / Dolly DATE: 01/26/94

LOCATION: d-85-I /94-A-11 CORE INTERVAL: 1388.0 - 1424.4 KB: 723.8



WELL NAME: Esso Gulf Brucie d-85-I FORMATION: basic Iffley / Dolby DATE: 01/27/99

LOCATION: d-85-I / 94:A-11 CORE INTERVAL: 1388.0 - 1424.4 KB: 723.8

GRAIN SIZE (SAND: V. FINE, FINE, MEDIUM, COARSE; GRAVEL; SILT/CLAY)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DISRUPTED, MASSIVE)	BED THICK (1-5 cm, 5-30 cm, >30 cm)	CEMENT/ACCESSORIES	SORTING (WELL, MOD, POOR, VERY POOR)	PHOTO/SAMPLING	COMMENTS	FACIES DEP ENVIRONMENT
			1406						v fine. sandy silt - thoroughly bioturbated structure - no preserved structure - slt. less saturated from below 1406.3' w/ ↑ calcite - calcareous	—
			1407							
			1408							
			1409							
			1410			-40-				
			1411							
			1412							
			1413							
			1414							
			1415			-45-				
			1416							
			1417							
			1418							
			1419							
			1420			-50-				
			1421							
			1422							

convolute.

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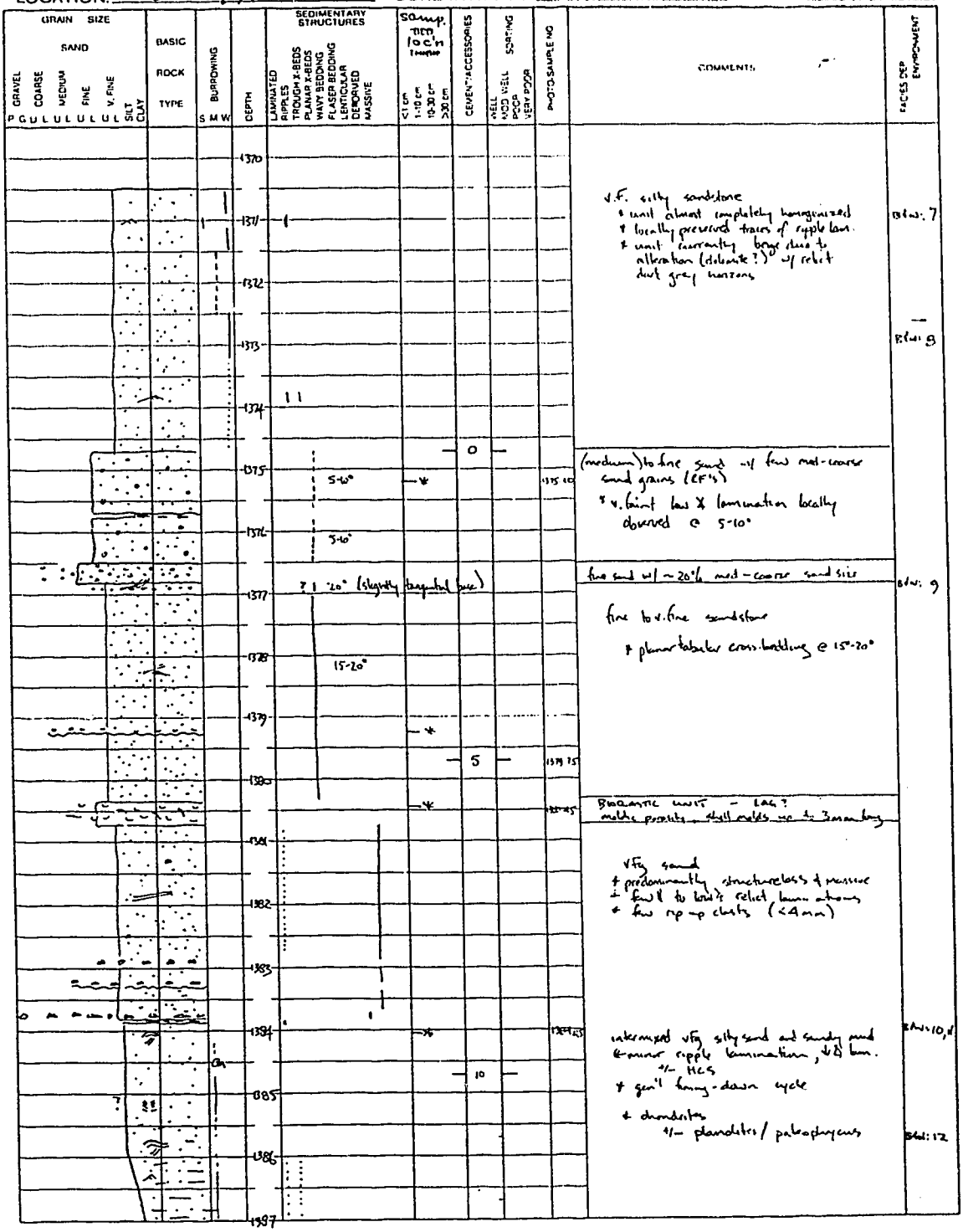
WELL NAME: Esso Gulf Buck d-85-I FORMATION: base Hibernia / Dorig DATE: 01/27/94

LOCATION: d-85-I /94-A-11 CORE INTERVAL: 1389.0 - 1424.4 KB: 72.38 m

GRAIN SIZE (SAND: GRAVEL, COARSE, MEDIUM, FINE, V. FINE; SILT, CLAY)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE)	BED THICK (<1 cm, 1-10 cm, 10-30 cm, >30 cm)	CEMENT/ACCESSORIES	SORTING (WELL, MOD, POOR, VERY POOR)	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1423							
Ar, Pl, He									sandier interval, moderately burrowed bioturbate	
?CLAY?			1424						possible tuff stained ripples.	

WELL NAME: Esso Gulf Buick d-86-I FORMATION: Halfway / Doig DATE: 03/02/93

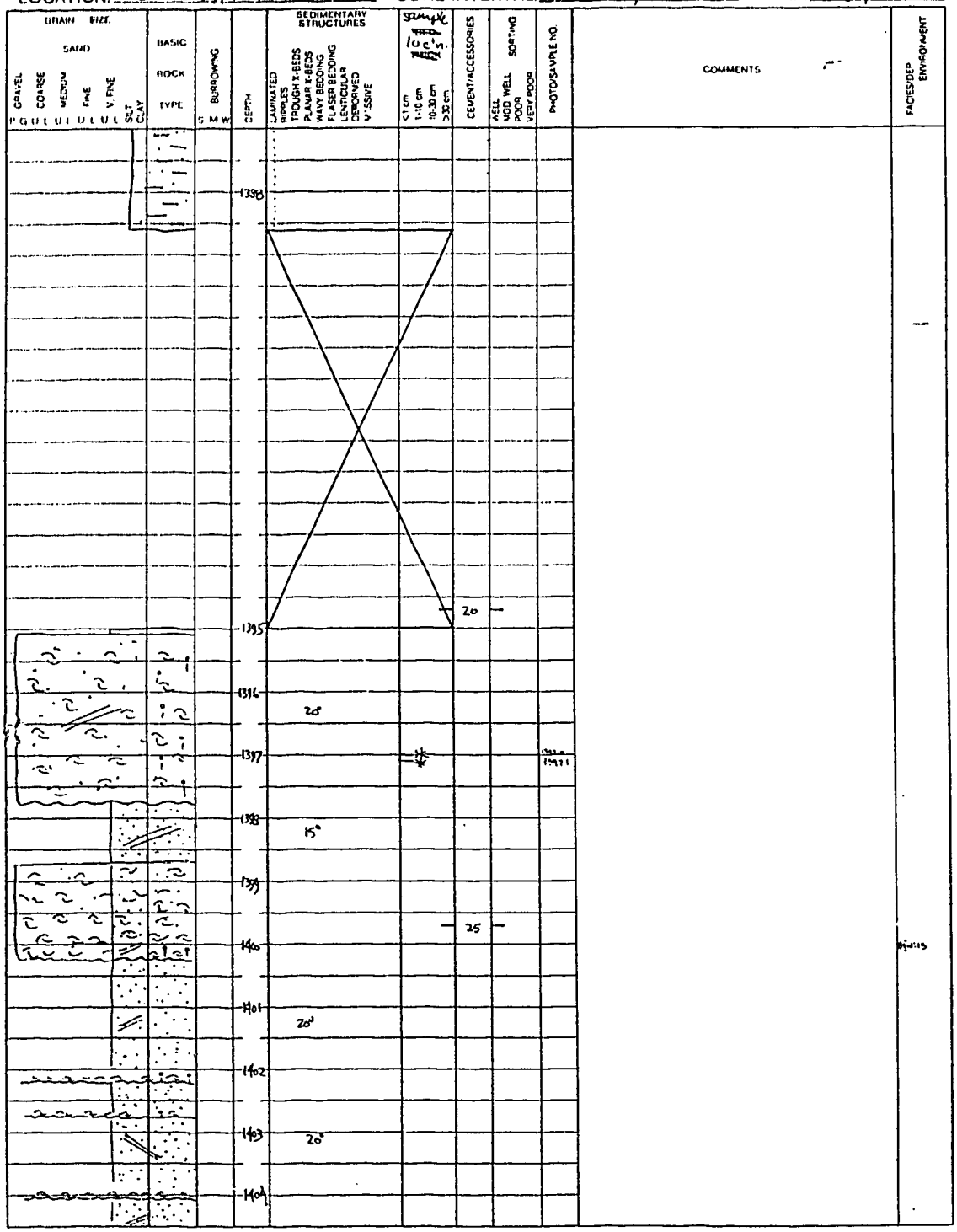
LOCATION: J-86-I/94-A-11 CORE INTERVAL: 1370.5 - 1388.4 KB: 134.9'



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WELL NAME: ESSO GULF BUICK d-86-I FORMATION: Dolg DATE:

LOCATION: d-86-I /94-A-11 CORE INTERVAL: 1386.5-1388.6 ; 1395.0-1413.2 KB: 734.9



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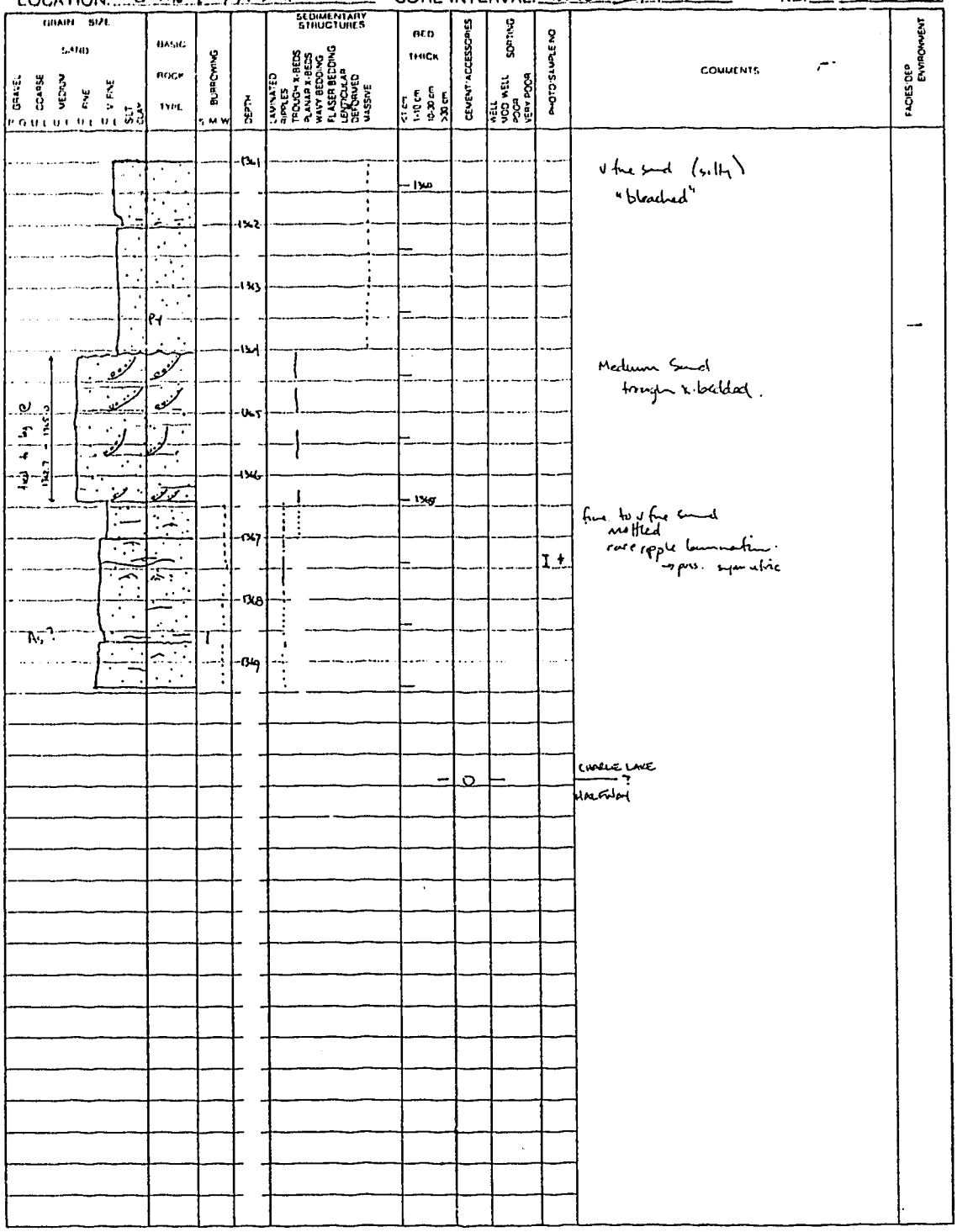
WELL NAME: Esso Gulf Bruce d-86-I FORMATION: Dolg DATE:

LOCATION: d-86-I / 94-A-11 CORE INTERVAL: 1395.0 - 1913.2 KB: 734.9'

GRAIN SIZE (SAND: V. FINE, FINE, MEDIUM, COARSE; GRAVEL; SILT CLAY)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR BEDDING, DEFORMED, MASSIVE)	Samp 10 feed typical <1 cm, 1-10 cm, 10-30 cm, >30 cm	CEMENT/ACCESSORIES	SORTING (WELL, MOD, POOR, VERY POOR)	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1405	15°	4	30		4m 15		
			1406							
			1407							
			1408							
			1409							
			1410			35				
			1411							
			1412							

WELL NAME: Esso Gulf Beaux d-A96-I FORMATION: Charlie Lake ?/- Halfway DATE: 01/24/94

LOCATION: d-A96-I /94-A-11 CORE INTERVAL: 1359.6 - 1363.0 / 1361.0 - 1369.4 KB: 735.1



1 of 2

WELL NAME: Esso Gulf Bruce d-96-I FORMATION: Dolg DATE 03/03/93

LOCATION: 2a/d-96-I/94-A-11 CORE INTERVAL 1380.0 - 1416.0 KB: 735.1

DEPTH	BASIC ROCK TYPE	BURROWING	SEDIMENTARY STRUCTURES	SAMPLE	CEMENT & ACCESSORIES	POR.	SAMPLE NO	COMMENTS	FACIES DEP ENVIRONMENT
1380			20°		20			vfg sandstone + variable bitumen stain + predominantly structureless + locally depositional structure preserved by cementation pattern → inclined // lamination	
1390									
1391			15°						
1392			20°						
1393			25-30°? 15°						
1394					25				
1395		P, B, Ll?	20°						
1396							1395.35		
1397			15° 35°						
1398			25°						
1399			15°		30				Rdw: 24
1400									
1401			? 35°/15°						
1402									
1403									
1404			55°		35		1404.2		Rdw: 0
1405									
1406									

2 of 2

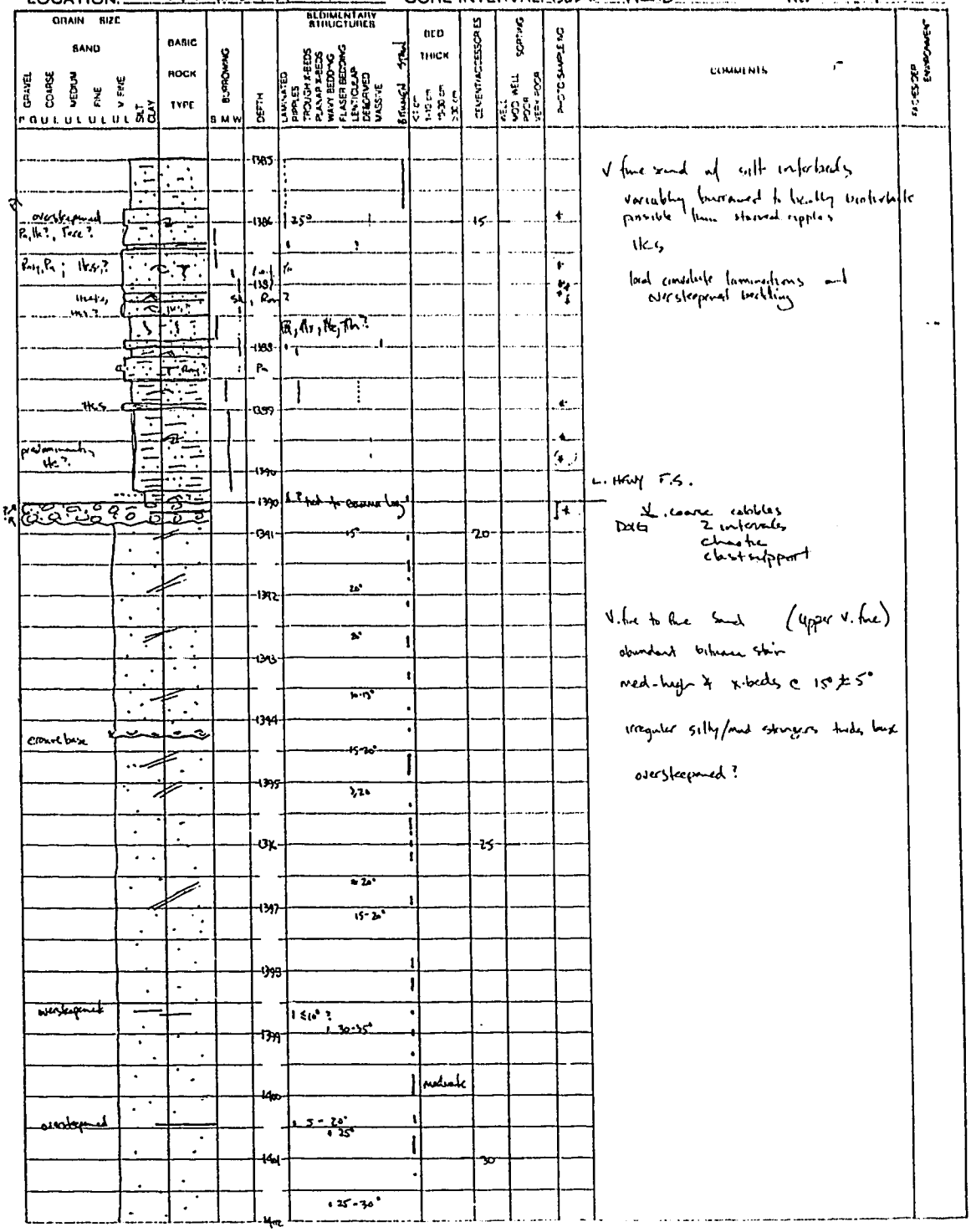
WELL NAME: Esso Gulf Brick d-A96:I FORMATION: Dolg DATE: 03/03/93

LOCATION: 202/d-96:I/94:A-14 CORE INTERVAL: 1389.0 - 1416.0 KB: 735.1

GRAIN SIZE (GRAVEL, COARSE, MEDIUM, FINE, V FINE, SILT, CLAY)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X BEDS, PLANAR X BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR BEDDING, DEFORMED, MASSIVE)	Samp. loc'n. (<1 cm, 1-10 cm, 10-30 cm, >30 cm)	CEMENT ACCESSORIES	SORTING (WELL, MOD WELL, POOR, VERY POOR)	PHOTO-SAMPLE NO	COMMENTS	FACIES DEP ENVIRONMENT BMR Bull 9
									vfg sand	
			1407		*			1406.0		
			1408							
			1409			40			interbedded vf sand - silt - mud * bioturbation * discontinuous shale partings * irregular wavy surfaces	Bull: 1,2
			1410						v.f.g. sand calcareous	
			1411	30°						
			1412							
			1413							
			1414			45			vfg sandstone & silty mud intense bioturbation: fair shaly/silt facies, helminthopsis, chondrites(?), planolites(?)	
			1415							
			1416							

WELL NAME: Imp. Gulf Bunch d-B96-I FORMATION: Dolg DATE: 01/28/94

LOCATION: 205/d-96-I/94-A-11 CORE INTERVAL: 1383.0 – 1426.8 KB 735.4



√ fine sand w/ silt interbeds
variably burrowed to locally unidentifiable
possible llam. starved ripples
Ikcs
local crossbed laminations and oversteepened bedding

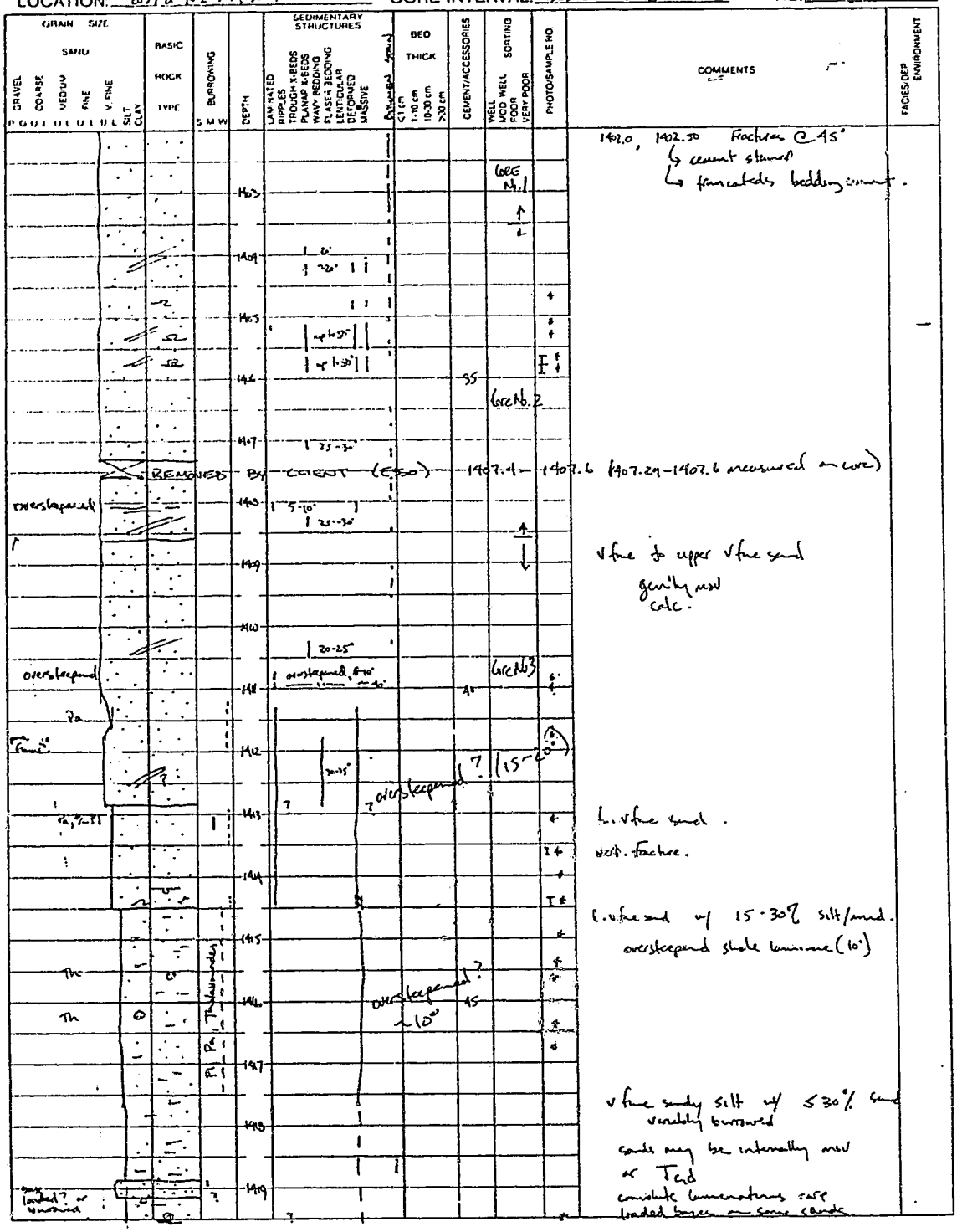
L. Hrwy F.S.
L. coarse cobbles
Dolg 2 intervals
chaotic
clast support

V. fine to fine Sand (upper v. fine)
abundant bitumen stain
med-high ϕ x-beds @ 15° ± 5°
irregular silty/mud stringers finds base
oversteepened?

p. 2 of 3

WELL NAME: Imp. Gulf Buck. d-B%-I FORMATION: Doig DATE: 01/31/94

LOCATION: 203/d-%-I /94-A-4 CORE INTERVAL: 1385.0 - 1426.8 KB: 735.4



WELL NAME: WP, Bluff Bluff d-86-I FORMATION: Dolo DATE: 1 of 3 01/11/94

LOCATION: 203/ d-86-I /94-A-11 CORE INTERVAL: 1385.0 - 1426.8 KB: 735.4

GRAIN SIZE (SAND: GRAVEL, COARSE, MEDIUM, FINE, V. FINE; SILT CLAY)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE; Sand)	RED THICK (<1 cm, 1-10 cm, 10-30 cm, >30 cm)	CEMENT/ACCESSORIES	SORTING (WELL, VOD WELL, POOR, VERY POOR)	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1420	14.5°						
			1421			50				
			1422							
			1423							
			1424							
			1425							
			1426			55				

p.1 of 2

WELL NAME: Dome CDA Buick d-52-J FORMATION: MONTNEY DATE: 02/02/94

LOCATION: d-52-J/94-A-11 CORE INTERVAL: 1510.0 - 1528.2 KB: 759.4 m

GRAIN SIZE (GRAVEL, SAND: COARSE, MEDIUM, FINE, V. FINE, SILT, CLAY)	BASIC ROCK TYPE	BURROWING (S, M, W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE)	BED THICK (<1 cm, 1-10 cm, 10-30 cm, >30 cm)	CEMENT/ACCESSORIES	SORTING (WELL, MOD WELL, POOR, VERY POOR)	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP. ENVIRONMENT
						85				
			1510					+	muddy coarse silt	
									+/- rare admixed v fine sand	
			1511						ll to cmudmk to rippled sand laminae (≤1m	
									calcareous	
			1512						locally microbrecciated (→ sands)	—
			1513					+		
			1514							
						90				
			1515							
			1516							
			1517					+		
Pj										
			1518							
			1519							
						45				
			1520							
			1521							
			1522							
			1523							
			1524							
						100				
			1525							
			1526							

p.2 of 2

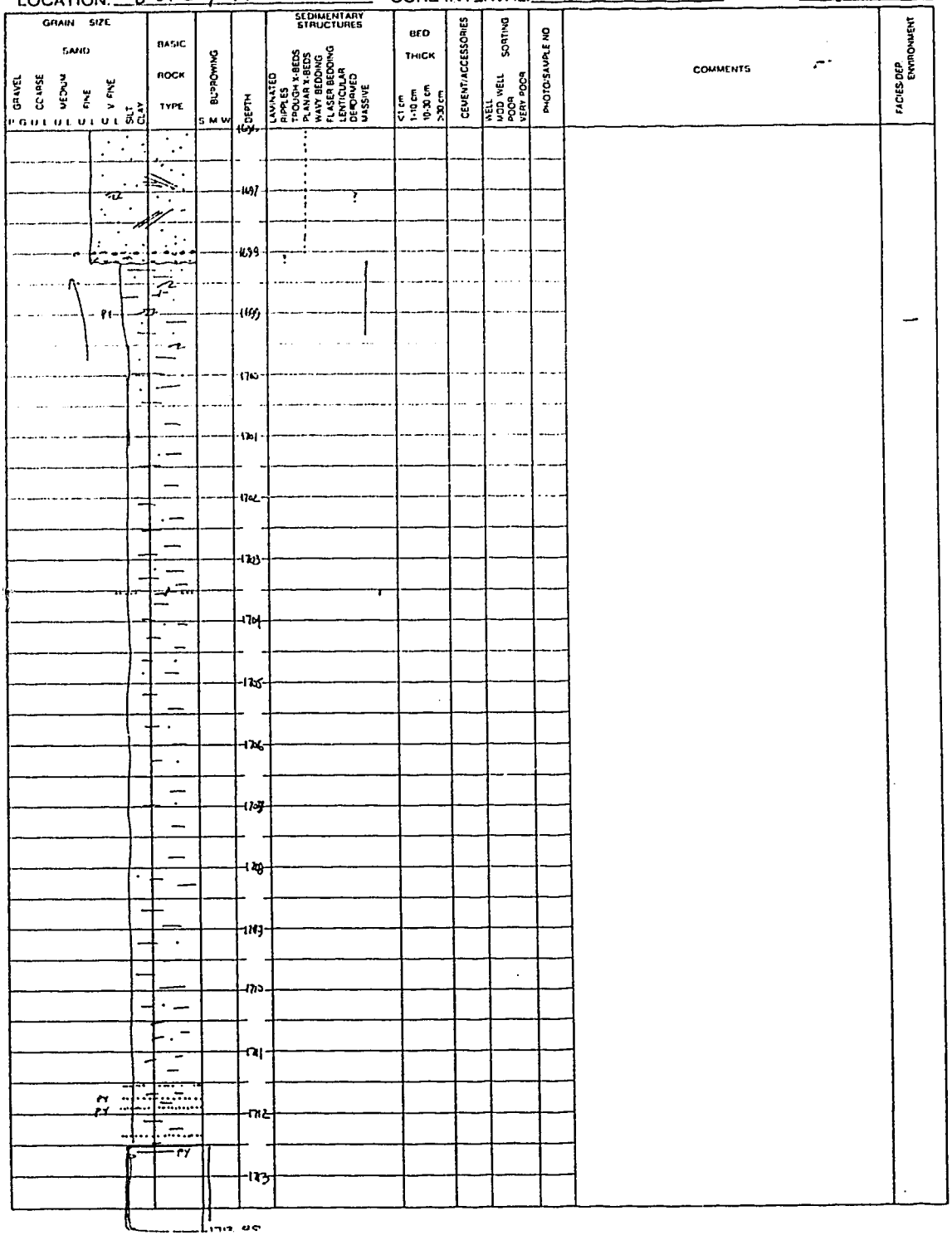
WELL NAME: Dome CDA Bank d-52-J FORMATION: MONTNEY DATE: 02/02/99

LOCATION: d-52-J / 94-A-11 CORE INTERVAL: 1510.0 - 1528.2 KB: 759.4

GRAIN SIZE (SAND: GRAVEL P, COARSE G, MEDIUM U, FINE L, V. FINE U, SILT L, CLAY U)	BASIC ROCK TYPE	BURROWING (S M W)	DEPTH	SEDIMENTARY STRUCTURES (LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR BEDDING, DEFORMED, MASSIVE)	BED THICK (<1 cm, 1-10 cm, 10-30 cm, >30 cm)	CEMENT/ACCESSORIES	SORTING (WELL, MOD WELL, POOR, VERY POOR)	PHOTO SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1527							
			1528							

WELL NAME: CZAR W. CALCITE b-64-I FORMATION: Dolg DATE: JUNE 3rd /94

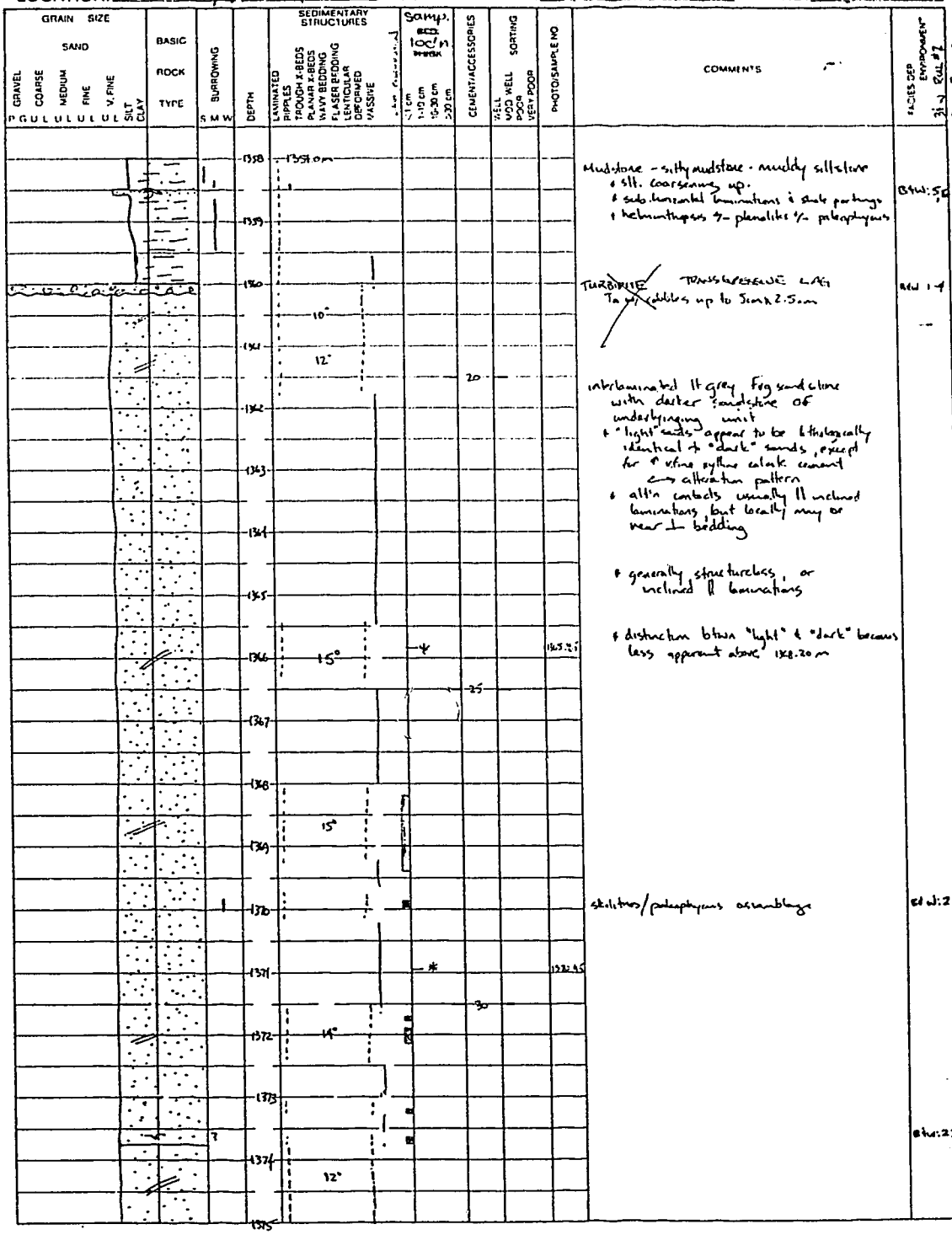
LOCATION: b-64-I / 94-A-12 CORE INTERVAL: 1696.0 - 1713.98 KB: 853.2



1 of 2

WELL NAME: Esso Sable Basin d-96-A FORMATION: Dolly DATE: 03/02/93

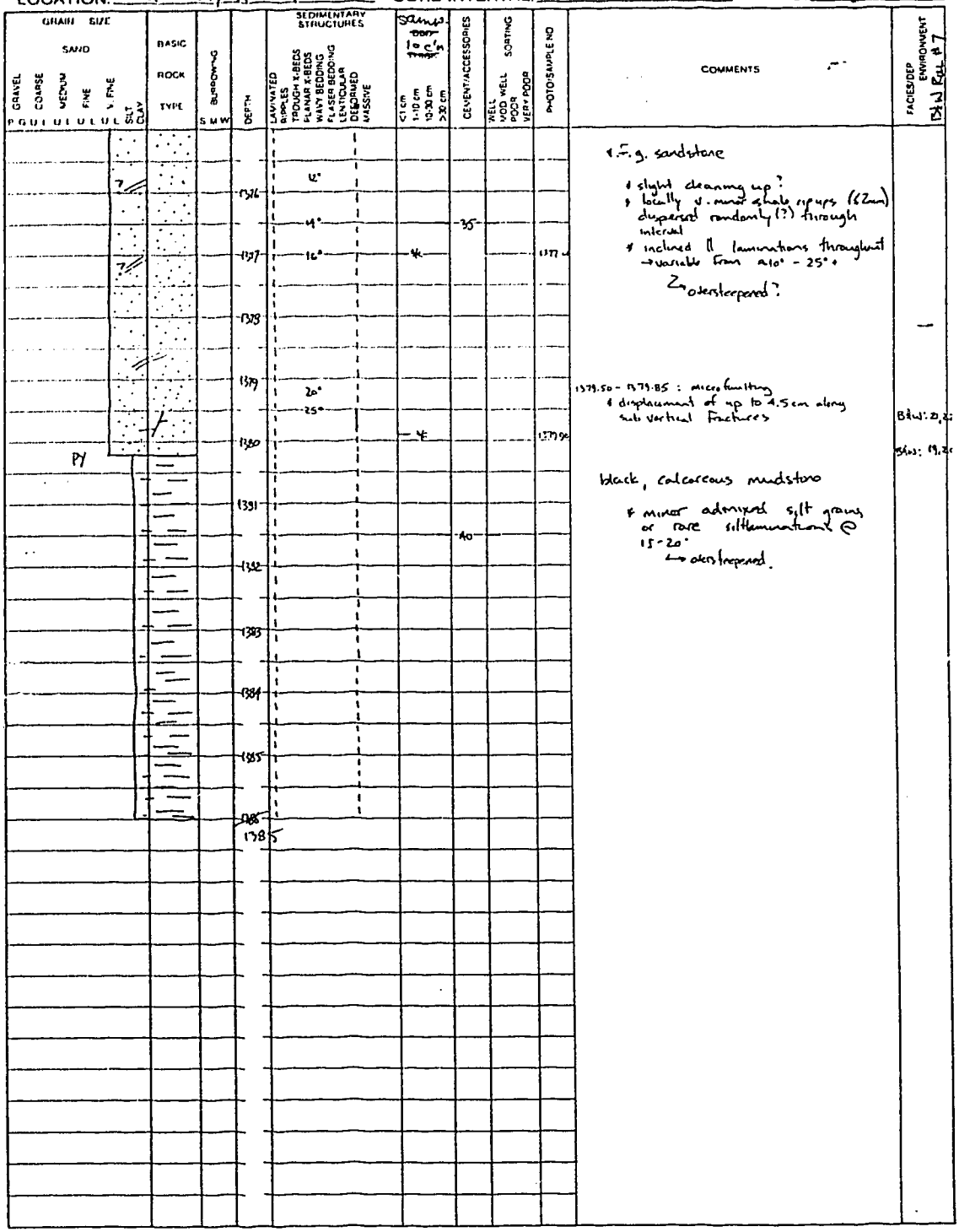
LOCATION: d-06-A / 94-A-14 CORE INTERVAL: 1357.0 - 1385.0 KB: 105.6'



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WELL NAME: Esso Canada Bluesky d-06-A FORMATION: Dold DATE: 03/02/93

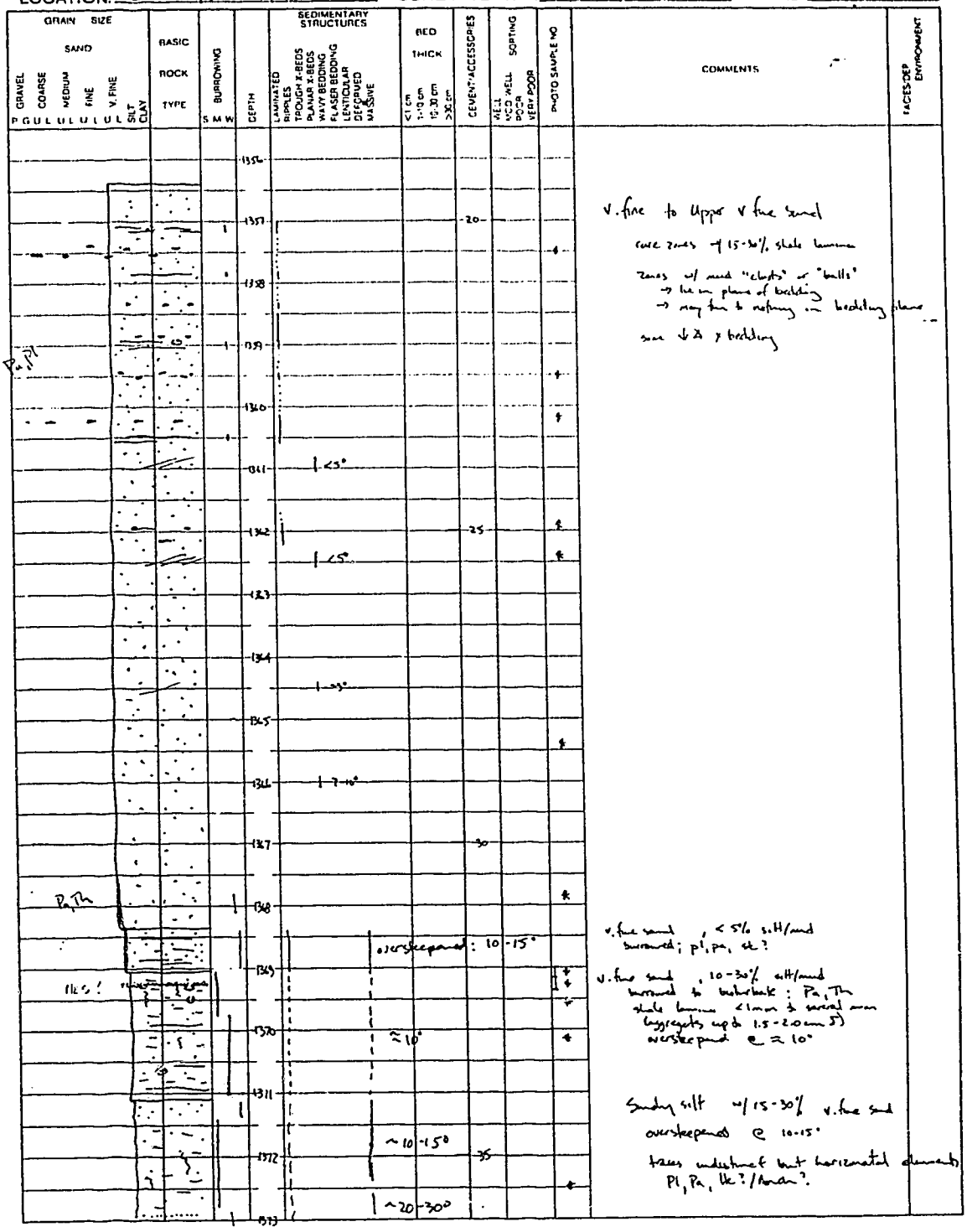
LOCATION: d-06-A/94-A-14 CORE INTERVAL: 1358.0 — 1386.0 KB: 705.6



p. 1 of 2

WELL NAME: Esso Gulf Brack 2-26-A FORMATION: Dolo DATE: 01/31/94

LOCATION: 2-26-A /94-A-14 CORE INTERVAL: 1358.4 – 1378.6 KB: 705.6



v. fine to upper v fine sand

rare zones of 15-30% shale laminae

zones w/ mud "clasts" or "balls"
→ lie in plane of bedding
→ may have a preferred orientation in bedding plane

some ↓Δ ∥ bedding

v. fine sand, < 5% silt/mud
burrowed; pl, Pa, sh?

v. fine sand, 10-30% silt/mud
burrowed to bioturbated : Pa, Th
shale laminae < 1 mm & sandy mm
laggregates up to 1.5-2.0 cm ∅)
oversteepened @ ≈ 10°

Sandy silt w/ 15-30% v. fine sand
oversteepened @ 10-15°

traces undistinct but horizontal elements
Pl, Pa, lk? / Amalgam?

p2of2

WELL NAME: Esso Gulf Bunde A-26-A FORMATION: Dolg DATE: 02/01/94

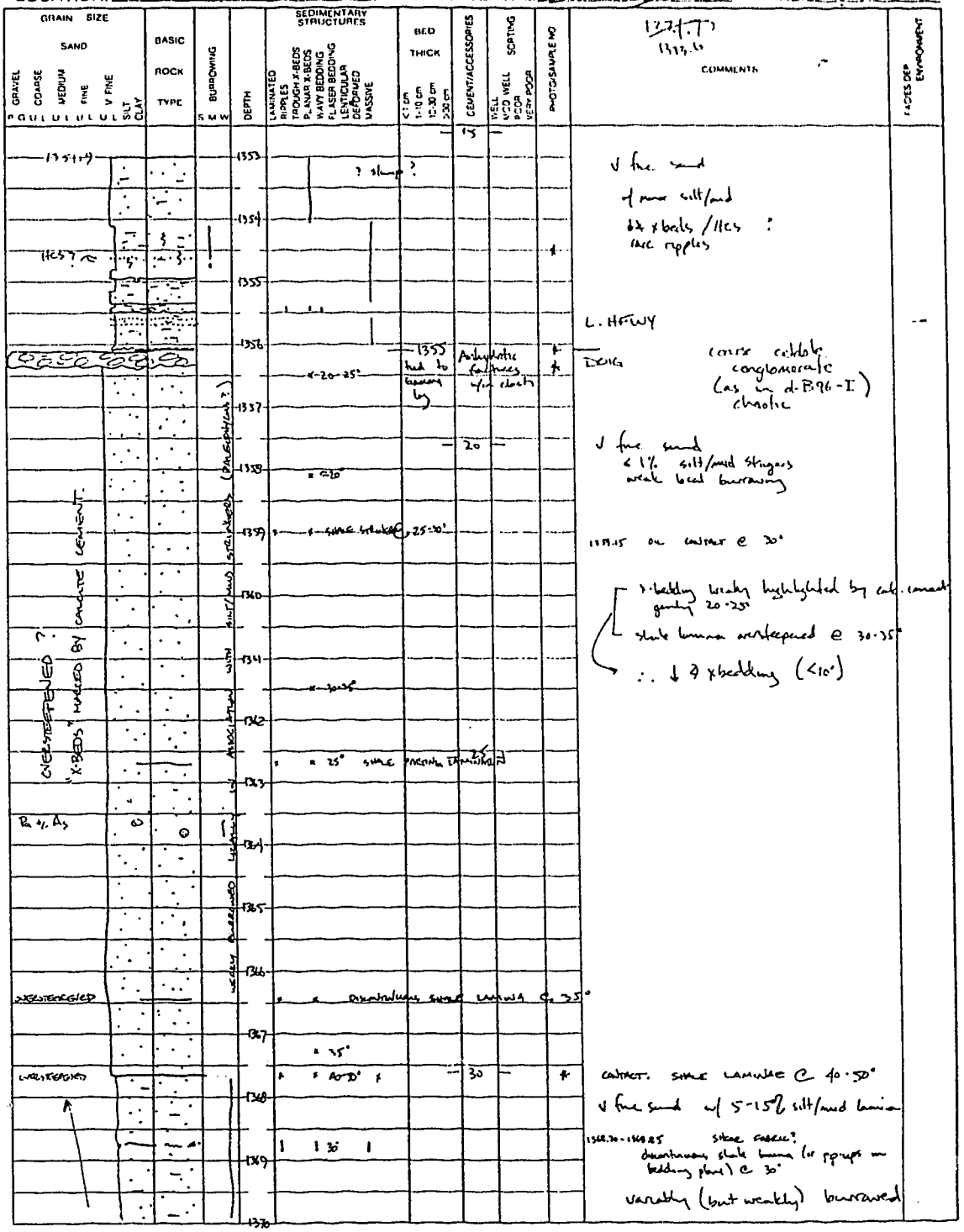
LOCATION: A-24-A /94-A-14 CORE INTERVAL: 356.4 - 378.6 KB: 723.6

GRAIN SIZE: GRAVEL / SAND: COARSE, MEDIUM, FINE, V FINE / SILT, CLAY	BASIC ROCK TYPE	BURROWING: S M W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE	BED THICK: <1 cm, 1-10 cm, 10-30 cm, >30 cm	CEMENT/ACCESSORIES	SORTING: WELL, MOD WELL, POOR, VERY POOR	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
PY			1374	<5°				1	silt & mud finely laminated.	
			1375							
			1376					2		
			1377			qp				
			1378							

p 1 of 2

WELL NAME: Esso Gulf Bunch d-35-A FORMATION: Dolg (4-Hfwy) DATE: FEB 16 / 94

LOCATION: d-35-A / 94-A-14 CORE INTERVAL: 1351.0 - 1375.0 KB: 679.9



p 1 of 2

WELL NAME: Esso Gulf Brucks d-35-A FORMATION: Dolo (1/- Hrs) DATE: 02/01/94

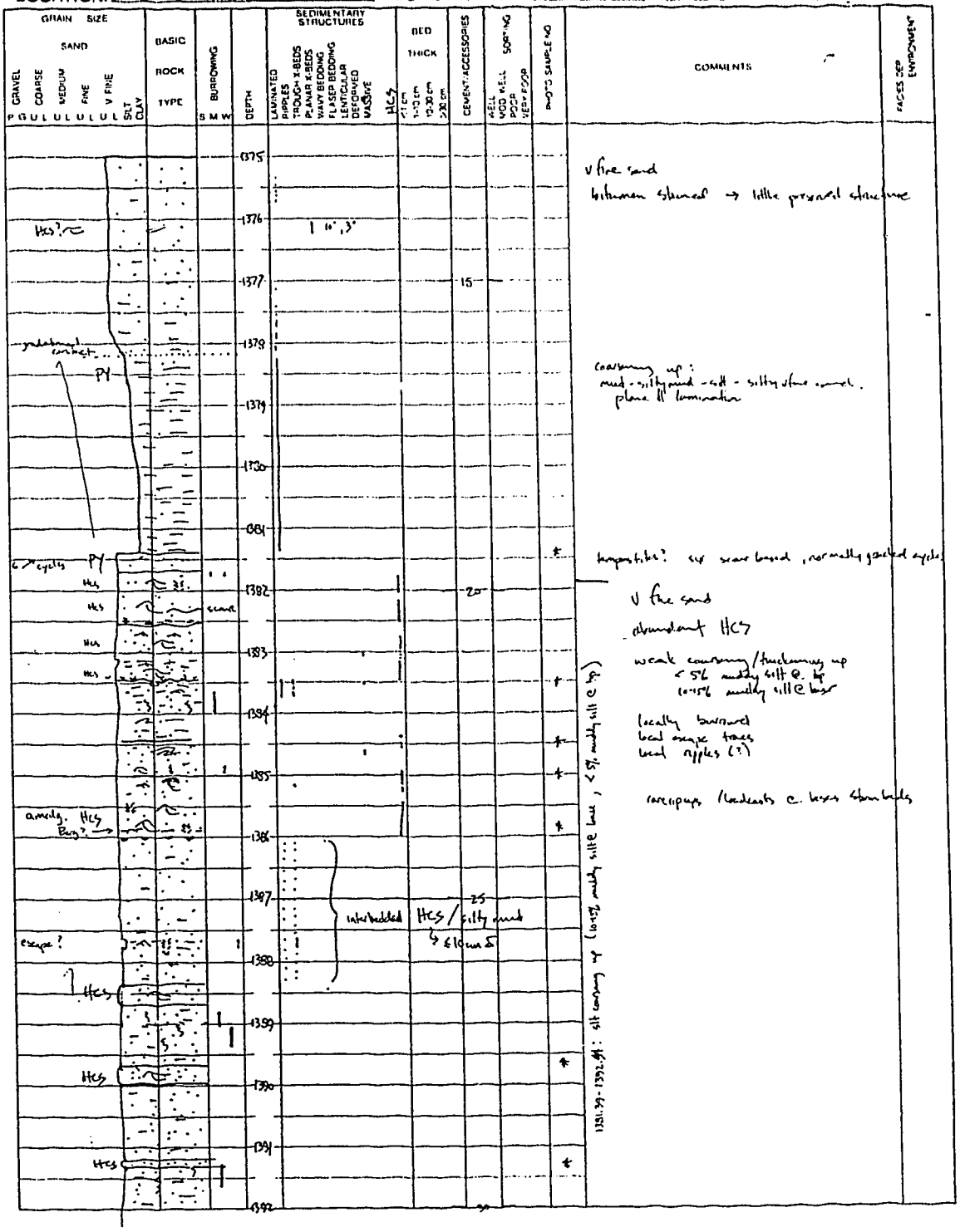
LOCATION: d-35-A /94-A-14 CORE INTERVAL: 1353.0 - 1379.90 KB: 679.9

GRAIN SIZE: GRAVEL / SAND: COARSE, MEDIUM, FINE, V FINE, SILT, CLAY	BASIC ROCK TYPE	BURROWING: SLIGHT, MOD, HEAVY	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DISRUPTED, MASSIVE	BED THICK: <1 cm, 1-10 cm, >10 cm	CEMENT/ACCESSORIES	SORTING: WELL, MOD WELL, POOR, VERY POOR	PHOTO-SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1371	25°						
				30°						
			1372							
				~35°		35				
			1373	~45°						
				15°-20°						
			1374	Finely Laminated @ 1320'					CONTACT: SHARP, IRREGULAR, ∠ 10° silt w/ v fine sand admixed pervasively burrowed (moderate)	
PY 1373.0			1375							

p. 1 of 5

WELL NAME: Gulf et al Buick d-5B-A FORMATION: Henry / Doig DATE: 02/02/94

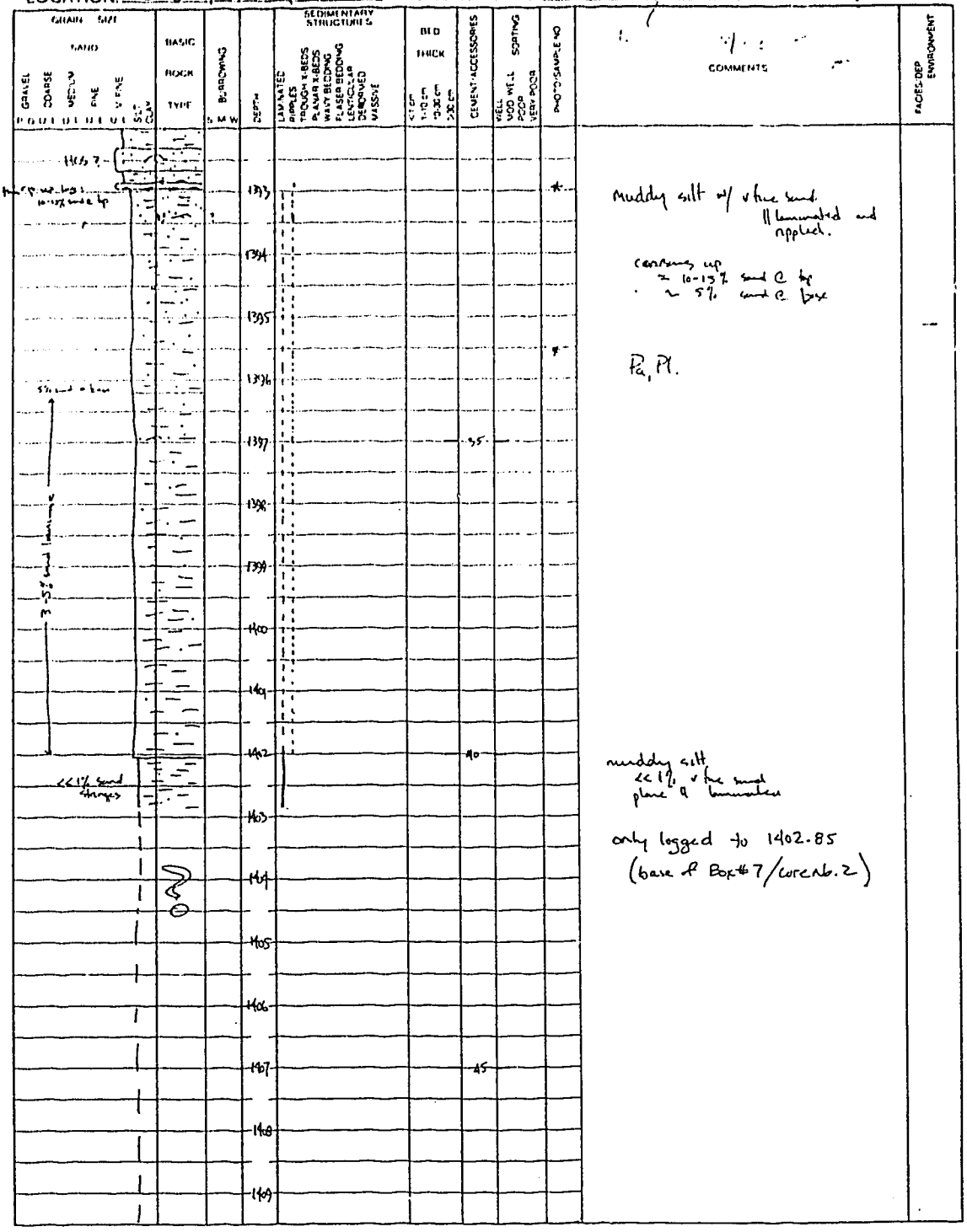
LOCATION: d-5B-A / 94-A-14 CORE INTERVAL: 1375.0 - 1411.0 KB: 758.4



p. 2 of 3

WELL NAME: Gulf et al. Buick d-38-A FORMATION: MFNY / DX6 DATE: 02/03/94

LOCATION: d-38-A / 94-A-14 CORE INTERVAL: 1375.0 - 1411.0 KB: 758.4



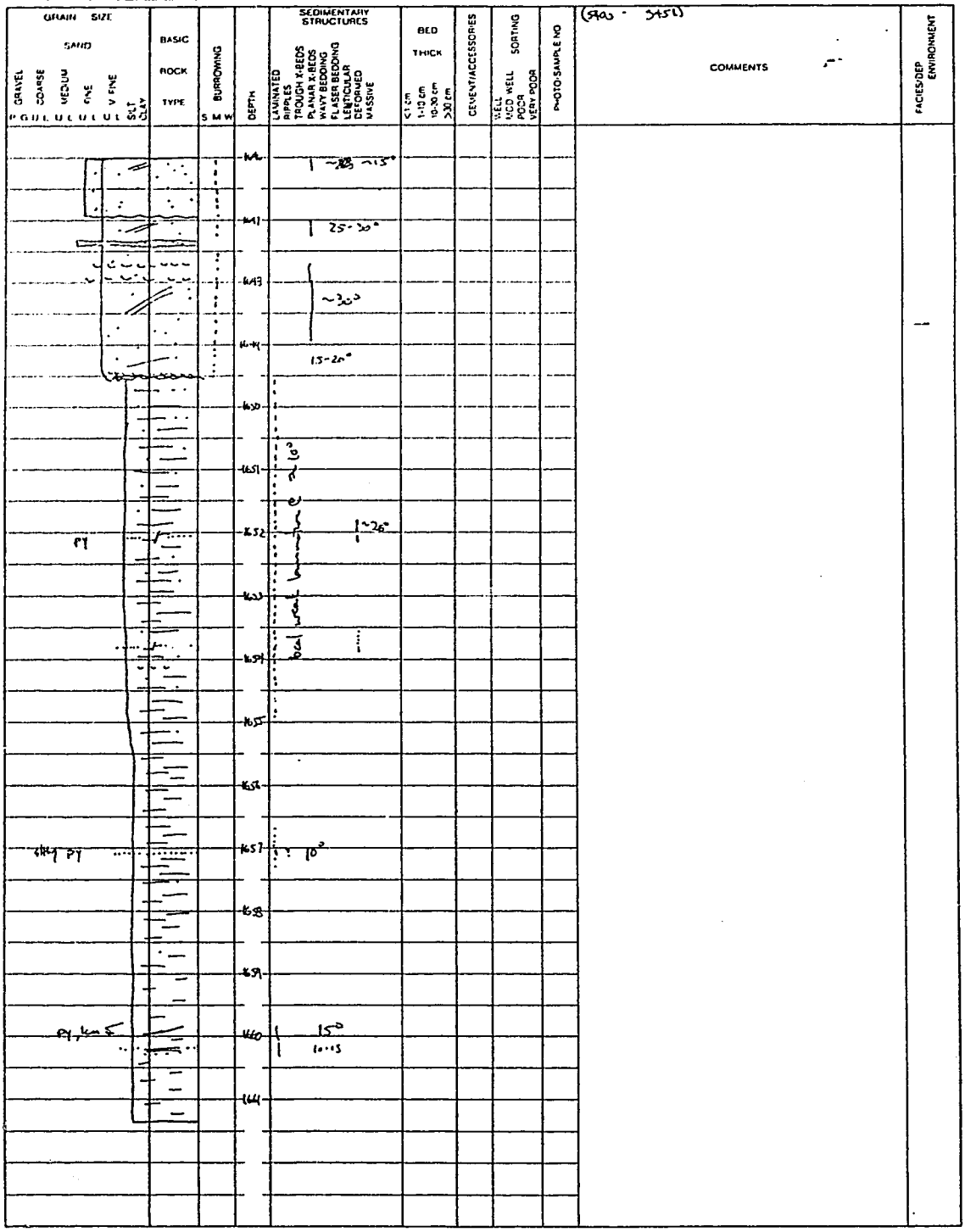
WELL NAME: Gulf et al Buck d-58 1 FORMATION: HFMV/ZUG DATE: 08/03/91

LOCATION: d-58-A / 99-A-14 CORE INTERVAL: 1375.0 - 1411.0 KB: 758.4'

DEPTH	BASIC ROCK TYPE	BIOTURBATION S M W	SEDIMENTARY STRUCTURES	BED THICK	DIAGENETIC ACCESSORIES	WELL SORTING	PHOTO SAMPLE NO	COMMENTS	DEPOSITIONAL ENVIRONMENT
1410									
1411									

WELL NAME: Petrofunda et al Fireweed FORMATION: Doig DATE: June 6th /94

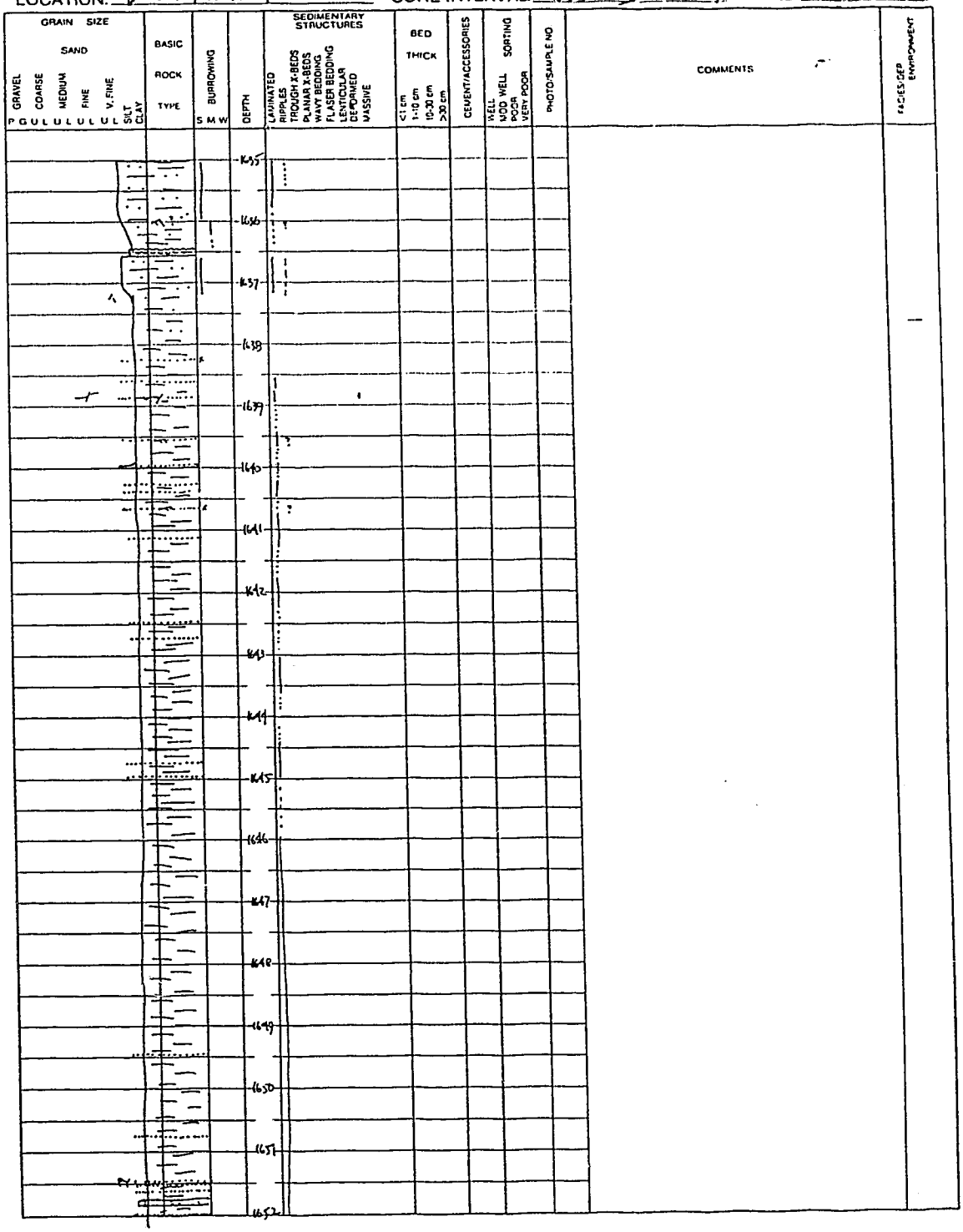
LOCATION: b-6-D /94-A-14 CORE INTERVAL: 1646.0 — 1661.0 KB: 816.9 m



p 1 of

WELL NAME: Fna Firewood d-15-D FORMATION: Dolq DATE: June 6 / 199-

LOCATION: D-15-D /94-A-14 CORE INTERVAL: 1635 - 1653 1654 KB: 821.8'



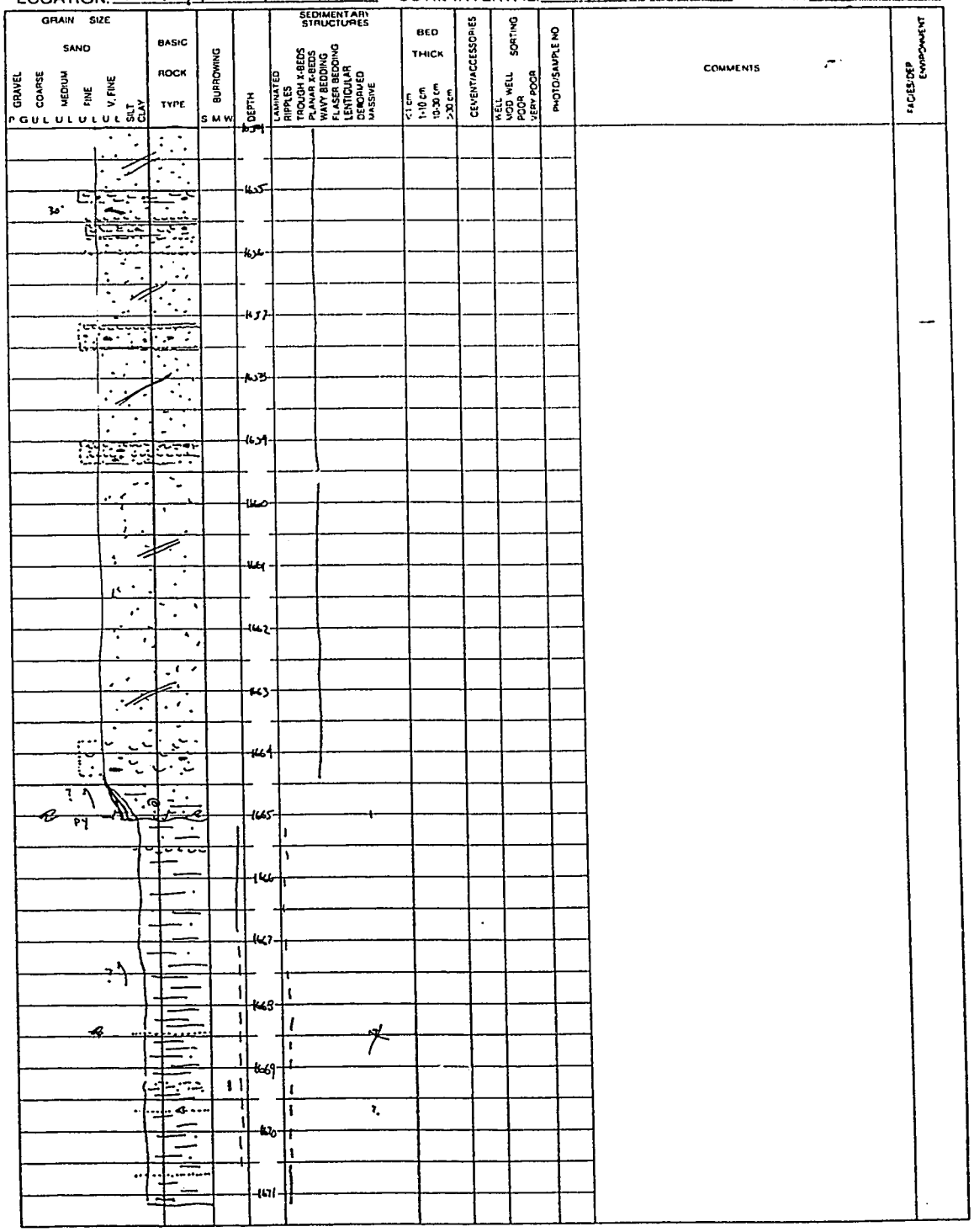
WELL NAME: Fna Trenton d-15-D FORMATION: Dolo DATE: June 6th / 94

LOCATION: d-15-D / 94-A-14 CORE INTERVAL: 1635 - 1655 1654 KB: -

GRAIN SIZE: GRAVEL	SAND: COARSE	SAND: MEDIUM	SAND: FINE	SAND: V. FINE	SILT	CLAY	BASIC ROCK TYPE	BURROWING: S	BURROWING: M	BURROWING: W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED	RIPPLES	TROUGH X-BEDS	PLANAR X-BEDS	WAVY BEDDING	FLASER BEDDING	LENTICULAR	DEFORMED	MASSIVE	BED THICK: <1 cm	1-10 cm	10-30 cm	>30 cm	CEMENT/ACCESSORIES	SORTING: WELL	SORTING: MOD WELL	SORTING: POOR	SORTING: VERY POOR	PHOTO SAMPLE NO	COMMENTS	FACIES/DEP. ENVIRONMENT
											1652																					
											1653																					
											1654																					

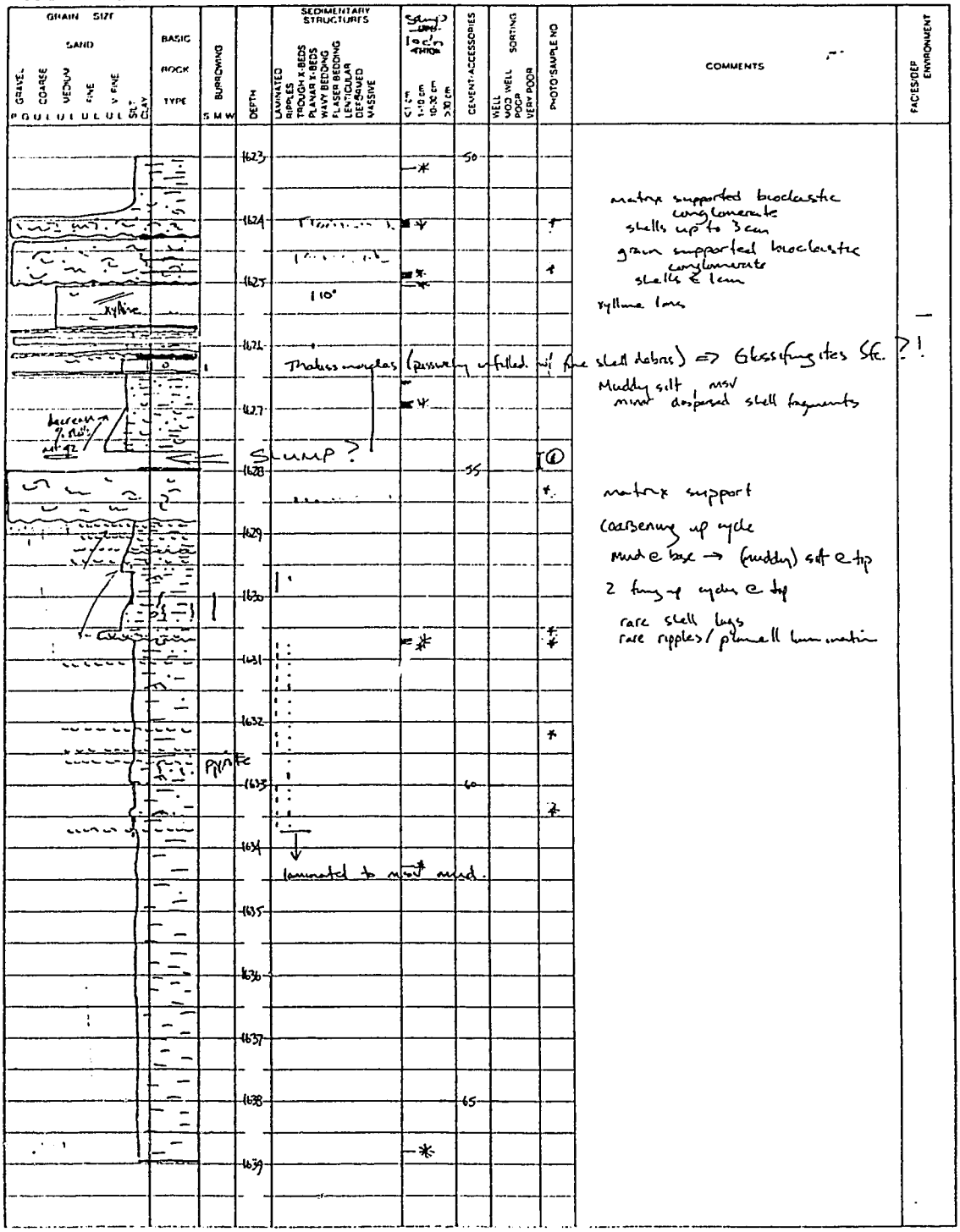
WELL NAME: Gear Orbit Fm Fmread b-26-D FORMATION: Delta DATE: June 6th/7th, 9[illegible]

LOCATION: b-26-D / 94-A-14 CORE INTERVAL: 1671.13m - 1671.13m / 5425' - 5482' KB: 2735'



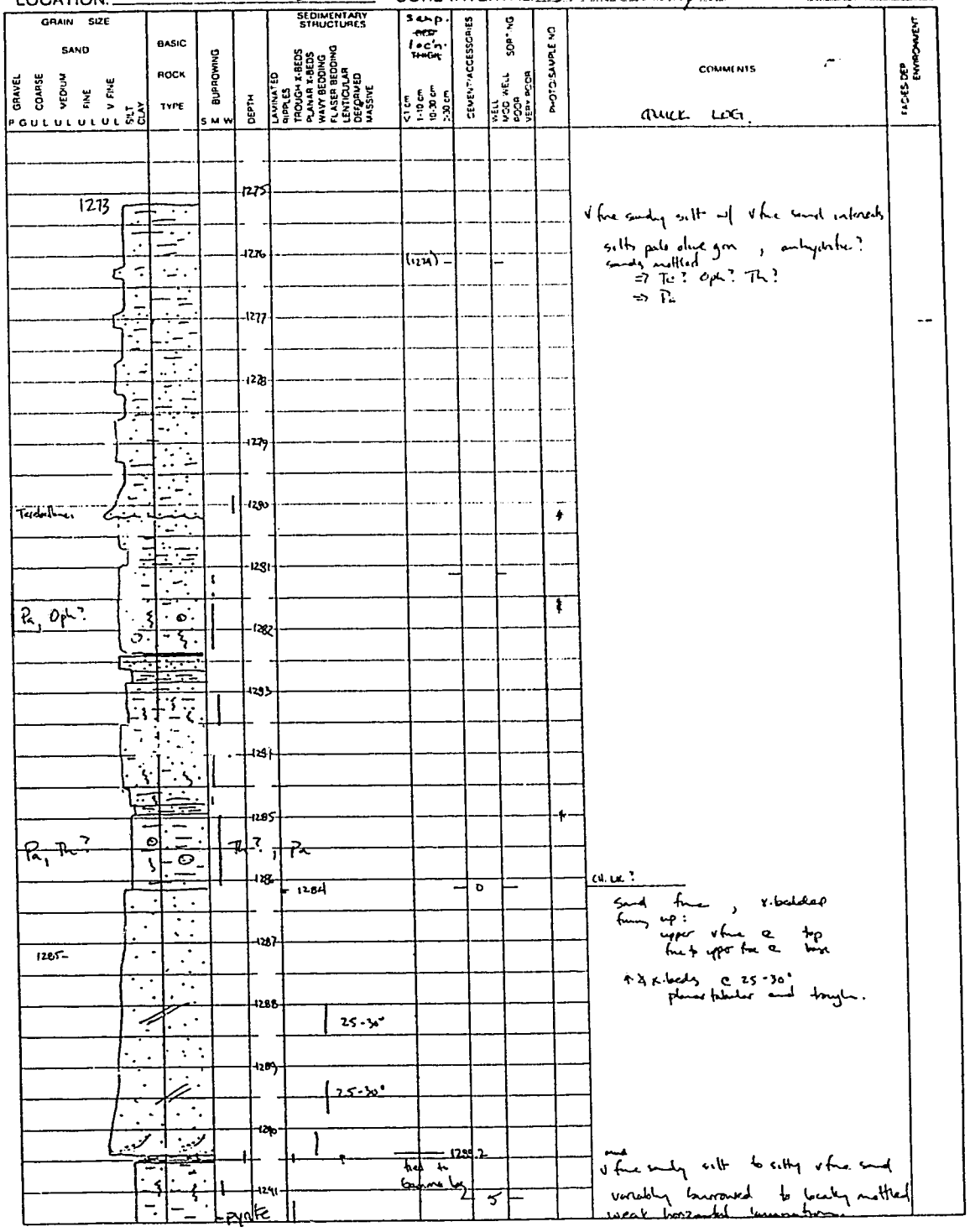
WELL NAME: Can Sup Frenzoo d-37-D FORMATION: Dolg DATE: 02/04/94

LOCATION: d-37- D/ 94-A-14 CORE INTERVAL: 1623 - 1638.99 KB: Bolm



WELL NAME: Total Canada Pouce b-38-D FORMATION: CHIK - HFWY ½ DIG DATE: 02/03/94

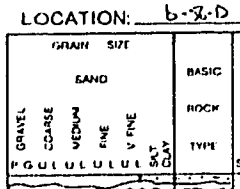
LOCATION: b-38-D /94-A-15 CORE INTERVAL: 1275.2 - 1293.2 (1273 / 1291.2) KB:



p c+ c

WELL NAME: _____ FORMATION: _____ DATE: 02/03/94

LOCATION: b-8-D /94-A-15 CORE INTERVAL: CORE NO. 2 1225.2 m 1293.2 m KB: -



*NOTE: Photos labelled 1292.61, 1292.69

upper v fine + fine sand.

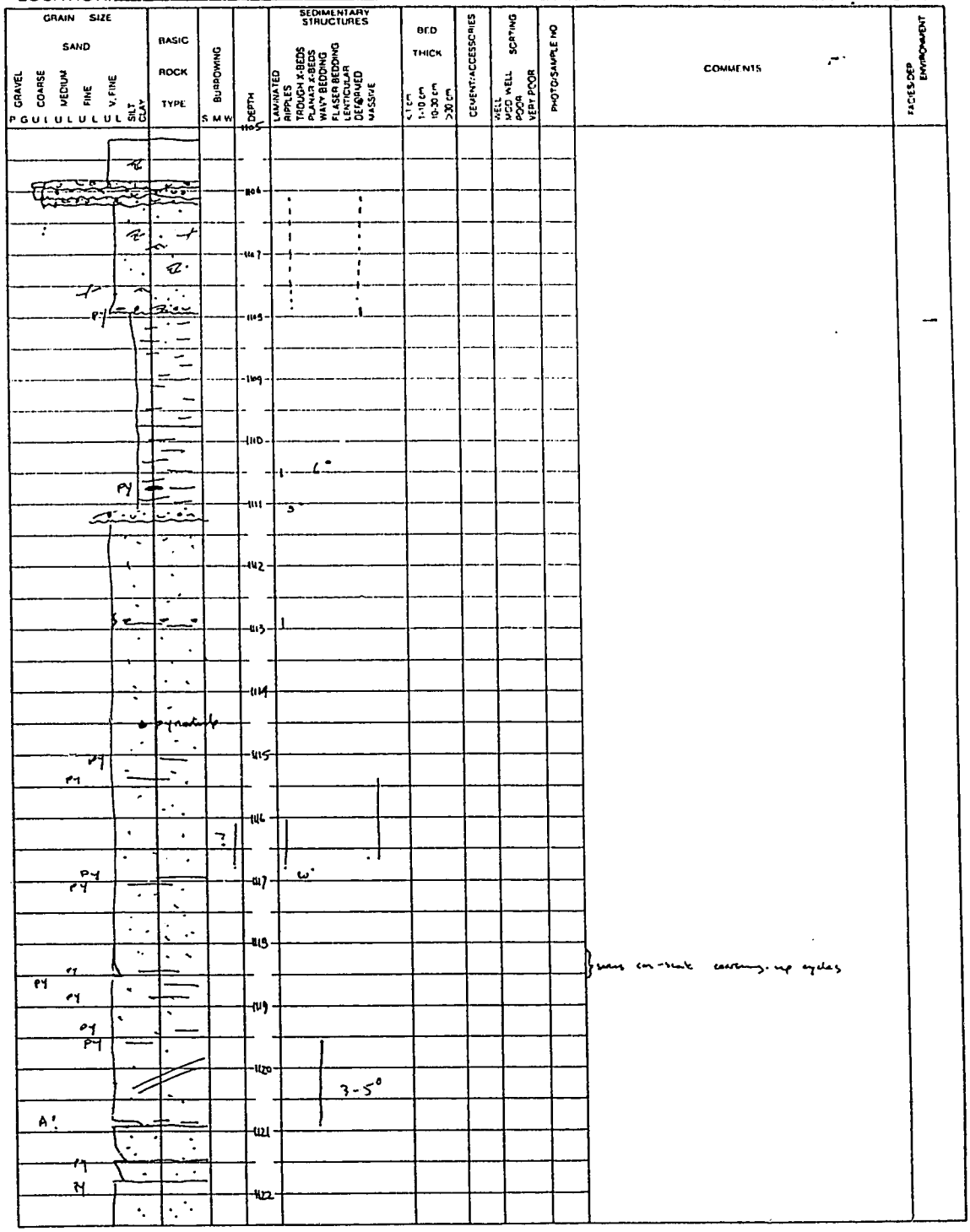
muddy silt
horizontal to silty wavy

p1 of 2

WELL NAME: Pacific Sr Gundel Wilkinst FORMATION: Dolq DATE: June 7th/94

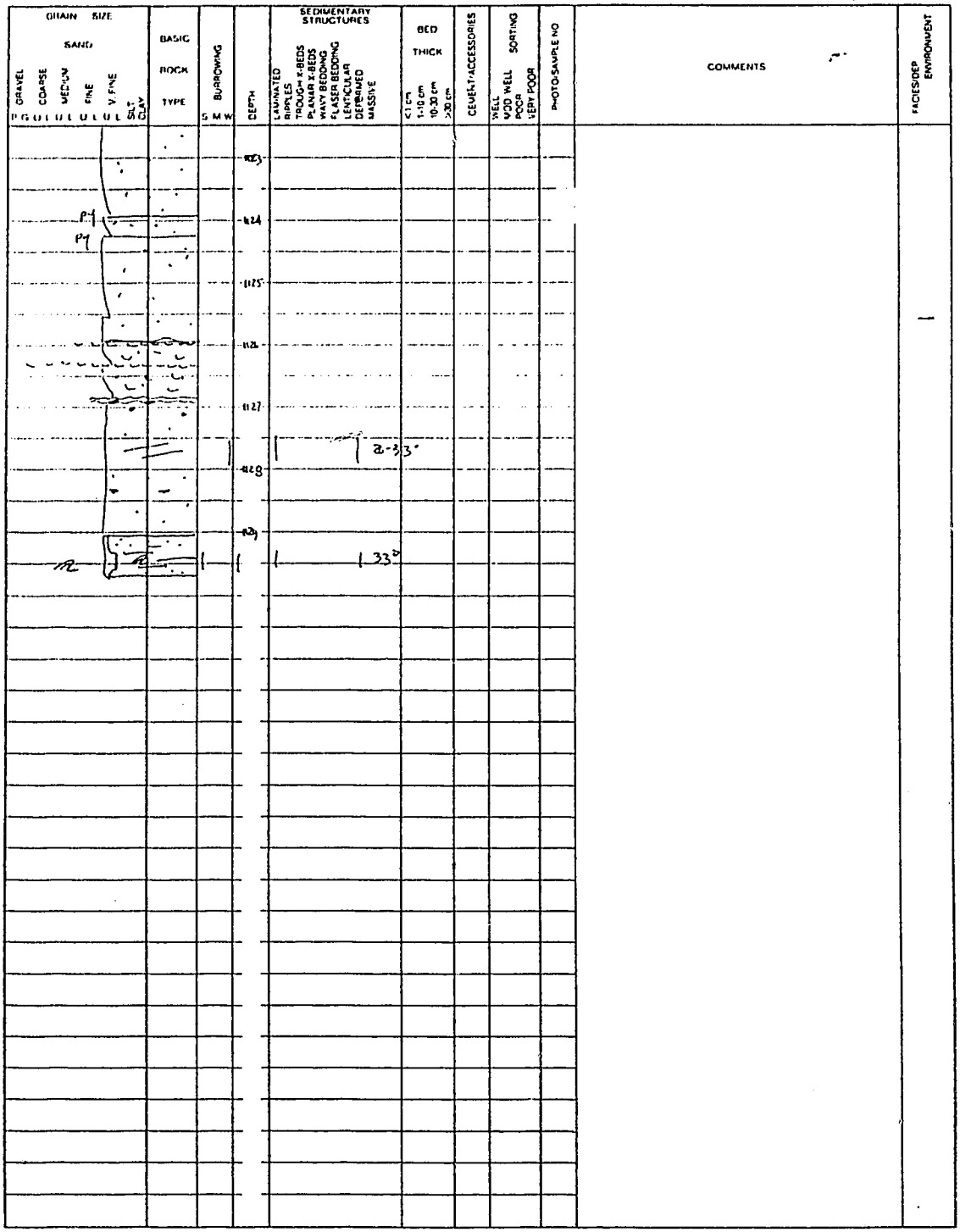
1105.2m - 1129.7m (measured)

LOCATION: d-84-I /94-A-15 CORE INTERVAL: 3625' to 3714' KB: 2334'



WELL NAME: _____ FORMATION: _____ DATE: June 7th/94

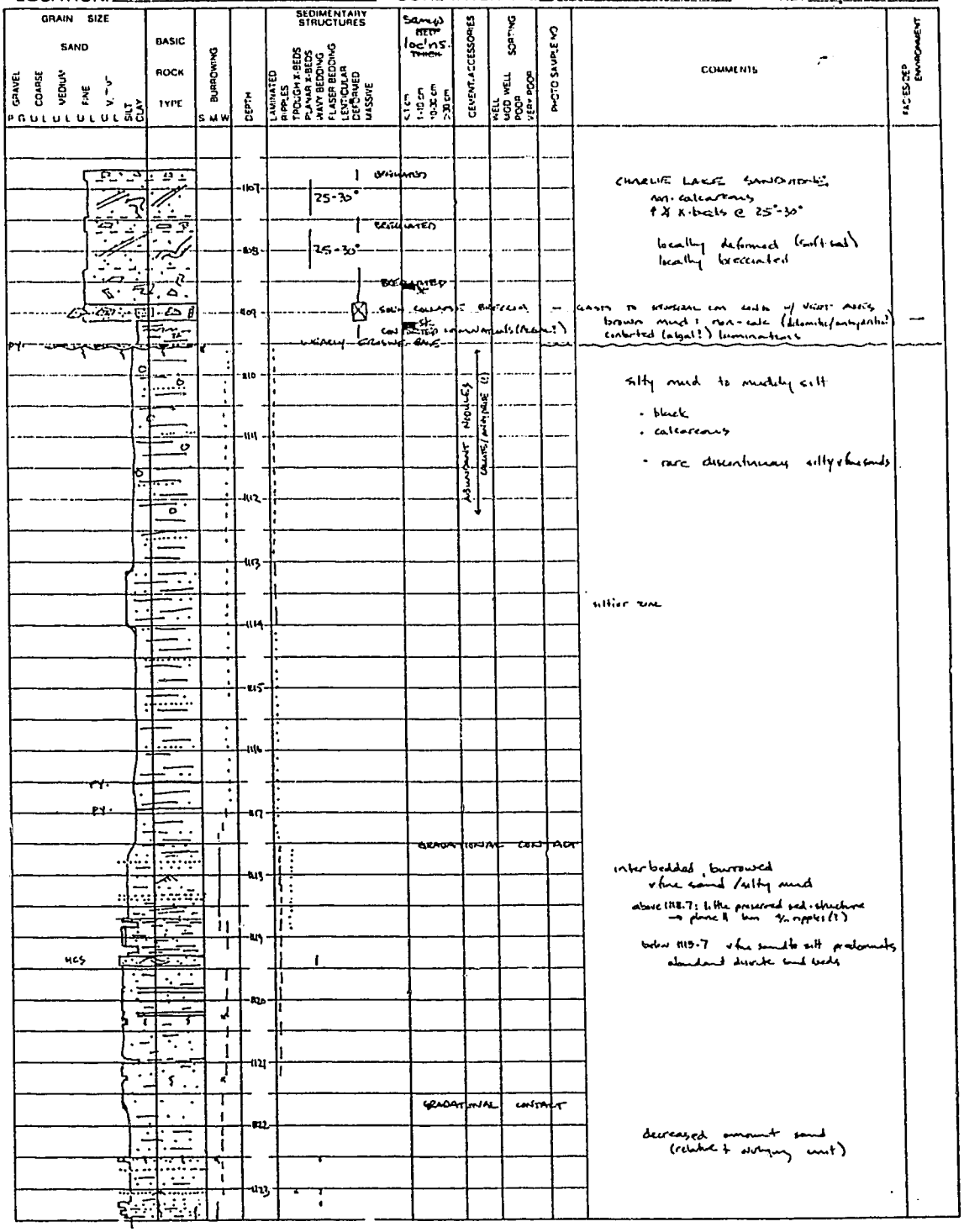
LOCATION: d-81-I /94-A-15 CORE INTERVAL: _____ KB: 2334



p. 1 of 2

WELL NAME: _____ FORMATION: Charlie Lake – Doig DATE: June 9th, 1994

LOCATION: b-10-C /94-H-1 CORE INTERVAL: 1106.7m – 1115.65m KB: _____



p. 2 of 2

WELL NAME:_____ FORMATION:_____ DATE:_____

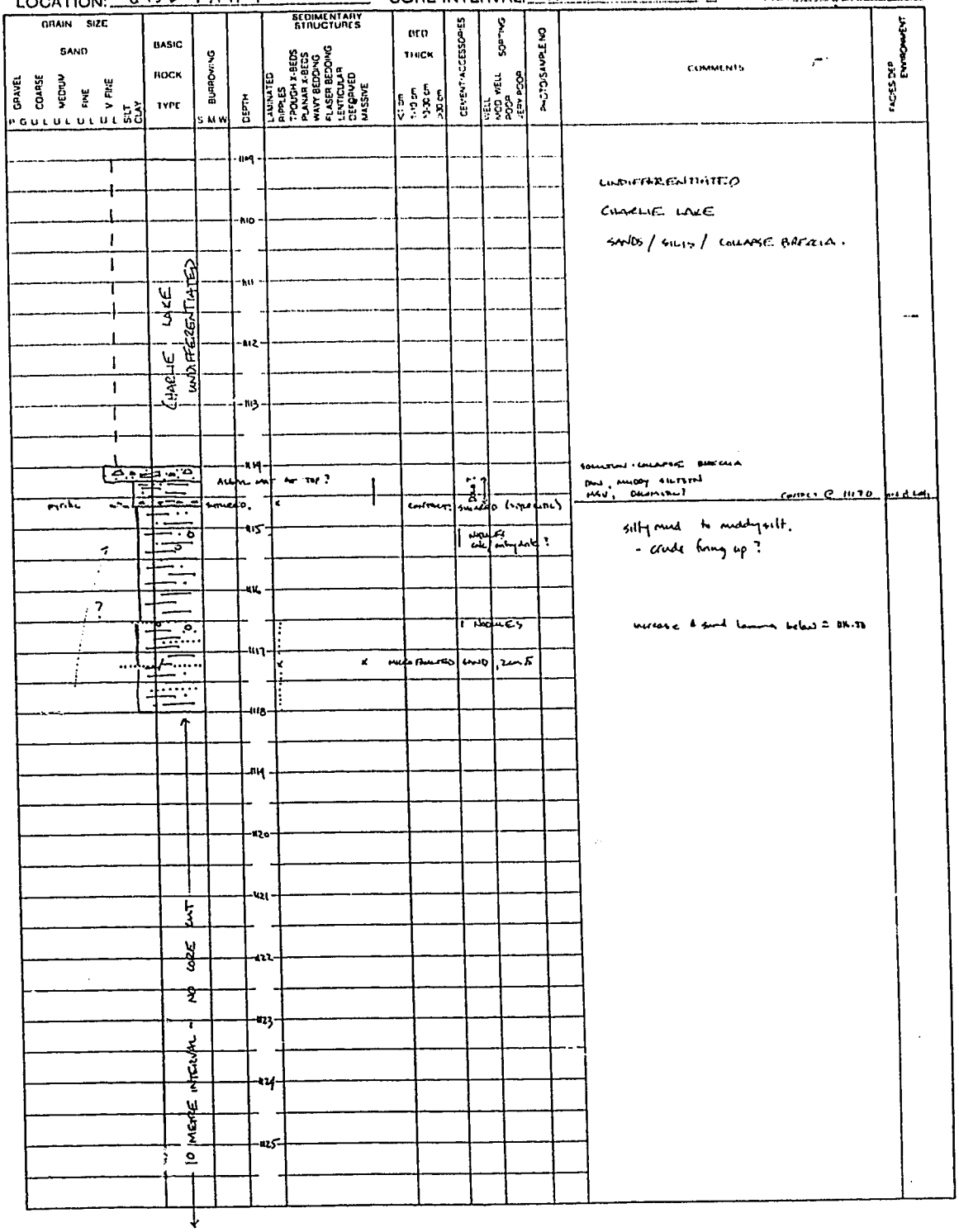
LOCATION: b-10-c /94-H-1 CORE INTERVAL:_____ KB:_____

GRAIN SIZE: GRAVEL / SAND: COARSE, MEDIUM, FINE, V. FINE / MUD: SILT, CLAY	BASIC ROCK TYPE	BURROWING: S, M, W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR BEDDING, DEFORMED, MASSIVE	BED THICK: <1 cm, 1-10 cm, 10-30 cm, >30 cm	CEMENT/ACCESSORIES	SORTING: WELL, MOD WELL, POOR, VERY POOR	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			1124						predominantly silty-muddy below 1123.45	—
				1 sample						
			1125							

p 1 of 2

WELL NAME: 118 et al Slubberly d-13-D FORMATION: CHARLIE LAKE ? DATE: June 9, 1994

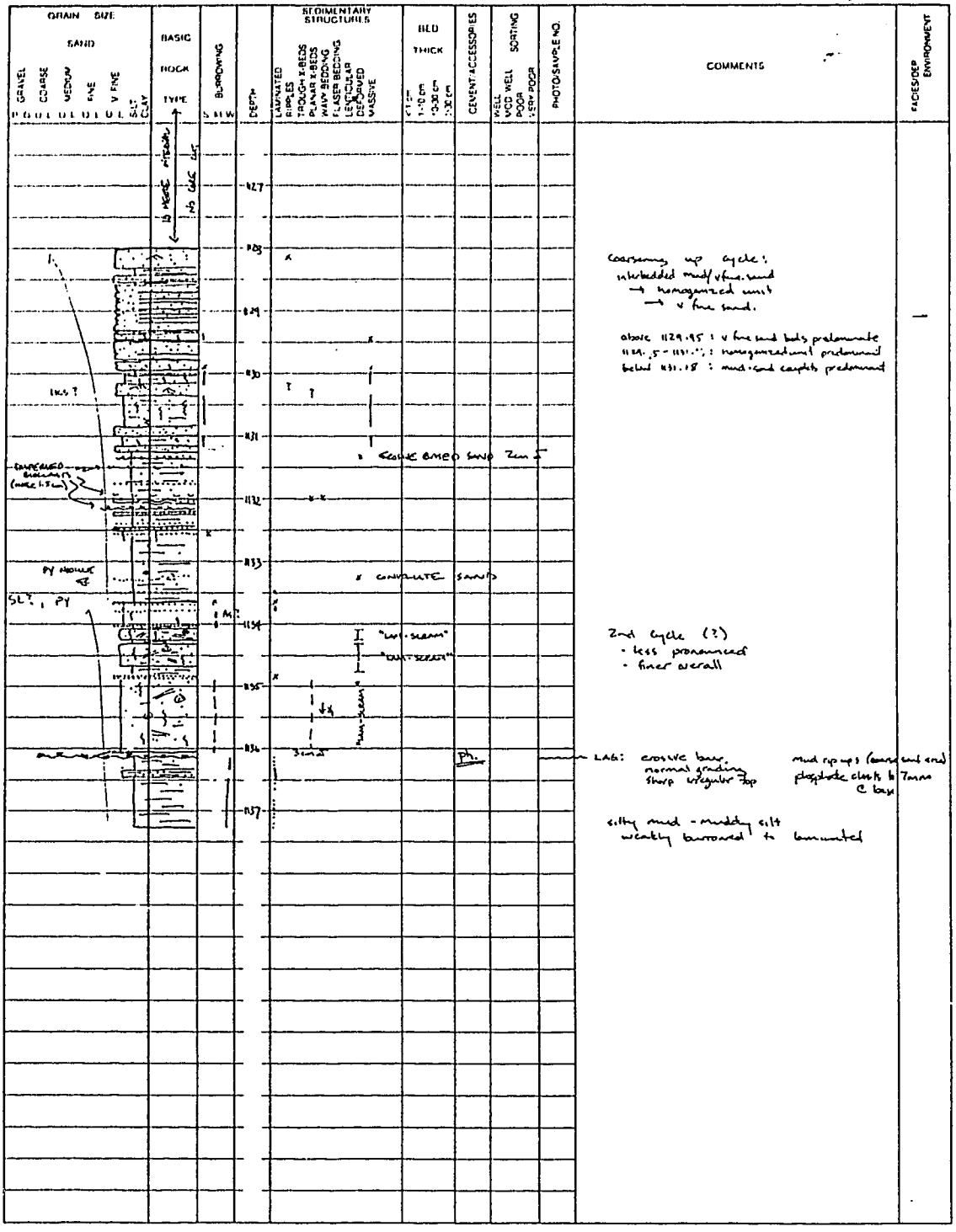
LOCATION: d-13-D /94-14-1 CORE INTERVAL: Core No. 1: 1109 - 1118 KB: 737.8 ft



p. 1 of 2

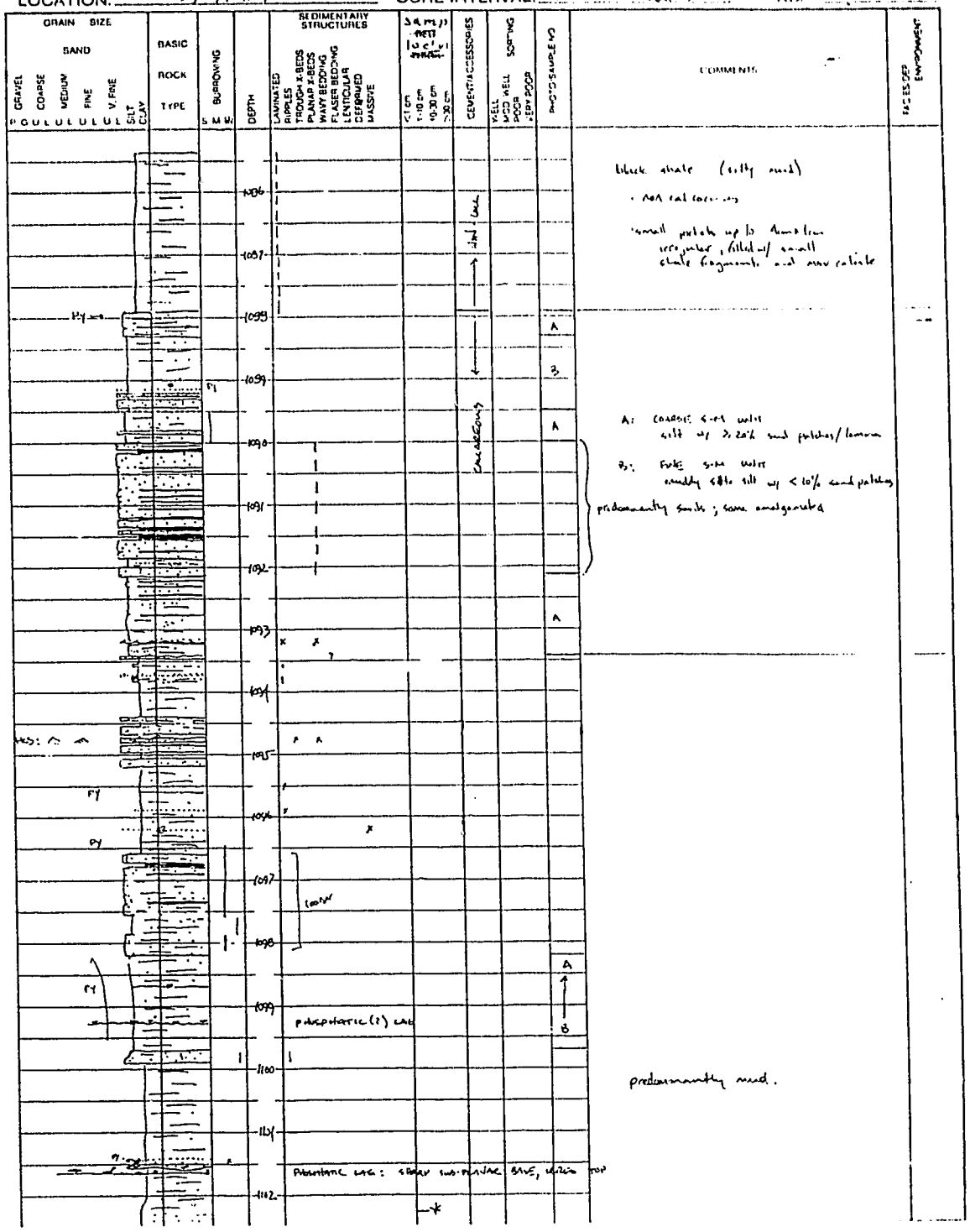
WELL NAME: _____ FORMATION: Dalk DATE: _____

LOCATION: d-13-D /94-H-1 CORE INTERVAL: Core No. 2: 1128 – 1137.28 KB: _____



WELL NAME: Ashland Ck. #3 Shawberry FORMATION: Dolly DATE: June 9th-14th, 1994

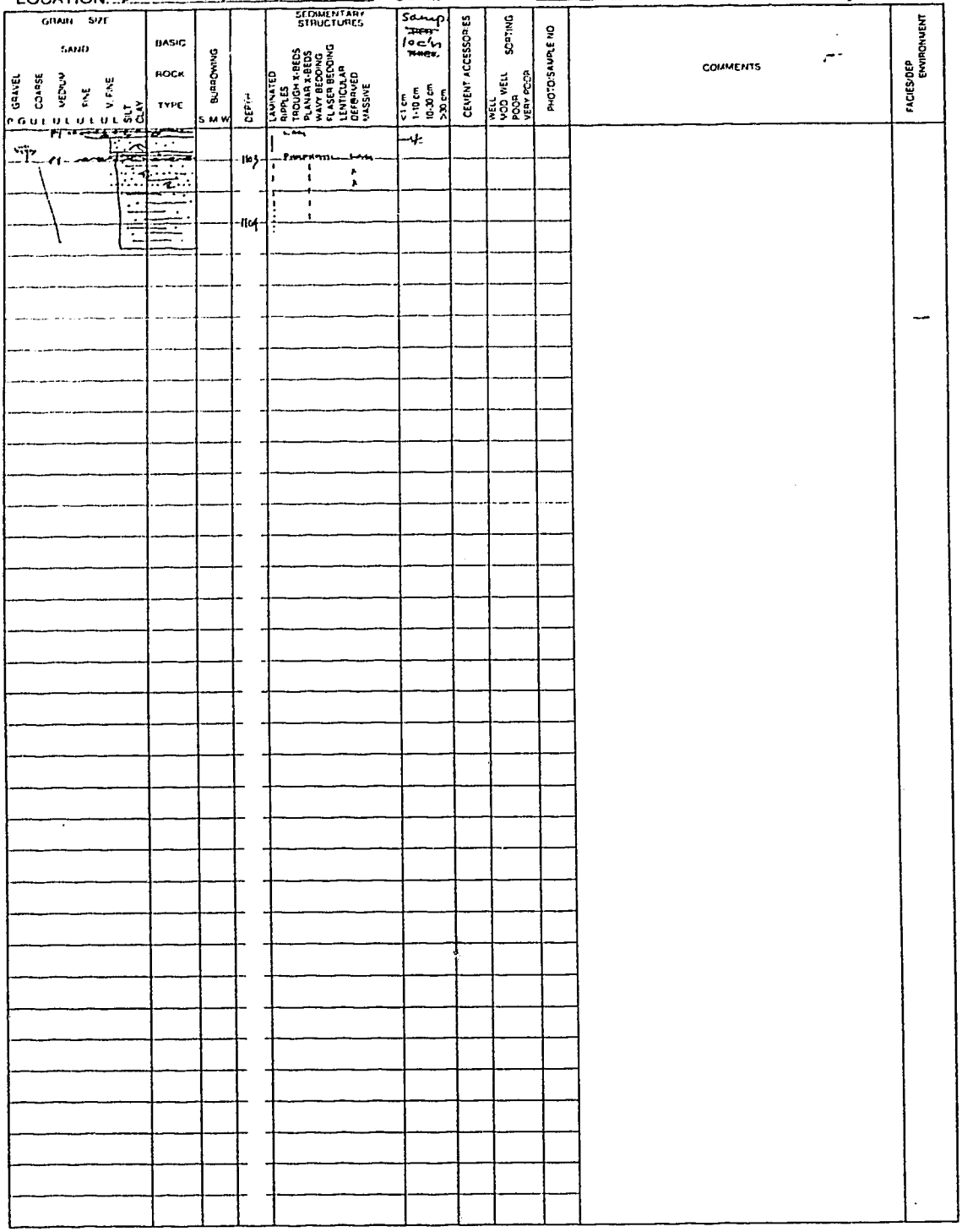
LOCATION: b-57 D / 94-11-1 CORE INTERVAL: 3510' to 3621'3" KB: 2345'



p.242

WELL NAME: _____ FORMATION: Dk4 DATE: June 9th, 1994

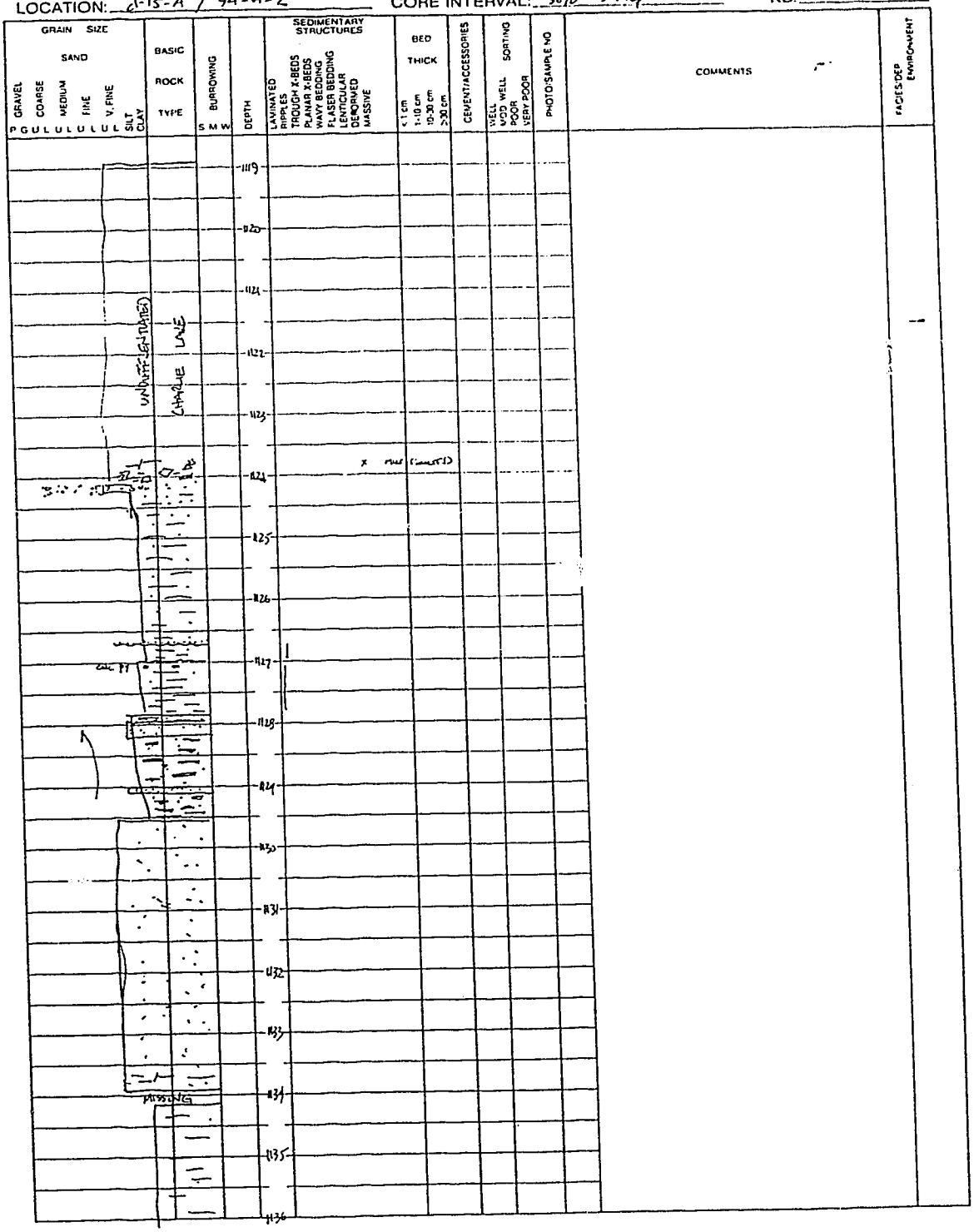
LOCATION: b-51-D /94-H-1 CORE INTERVAL: 3560' - 3621' 3" KB: _____



p. 1 of 2

WELL NAME: UNION HB WILLIAMS NT d-15-A FORMATION: Dog DATE: June 6th (94

LOCATION: d-15-A / 94-d-2 CORE INTERVAL: 3670 - 3739 KB: 2345'



p. 2 of 2

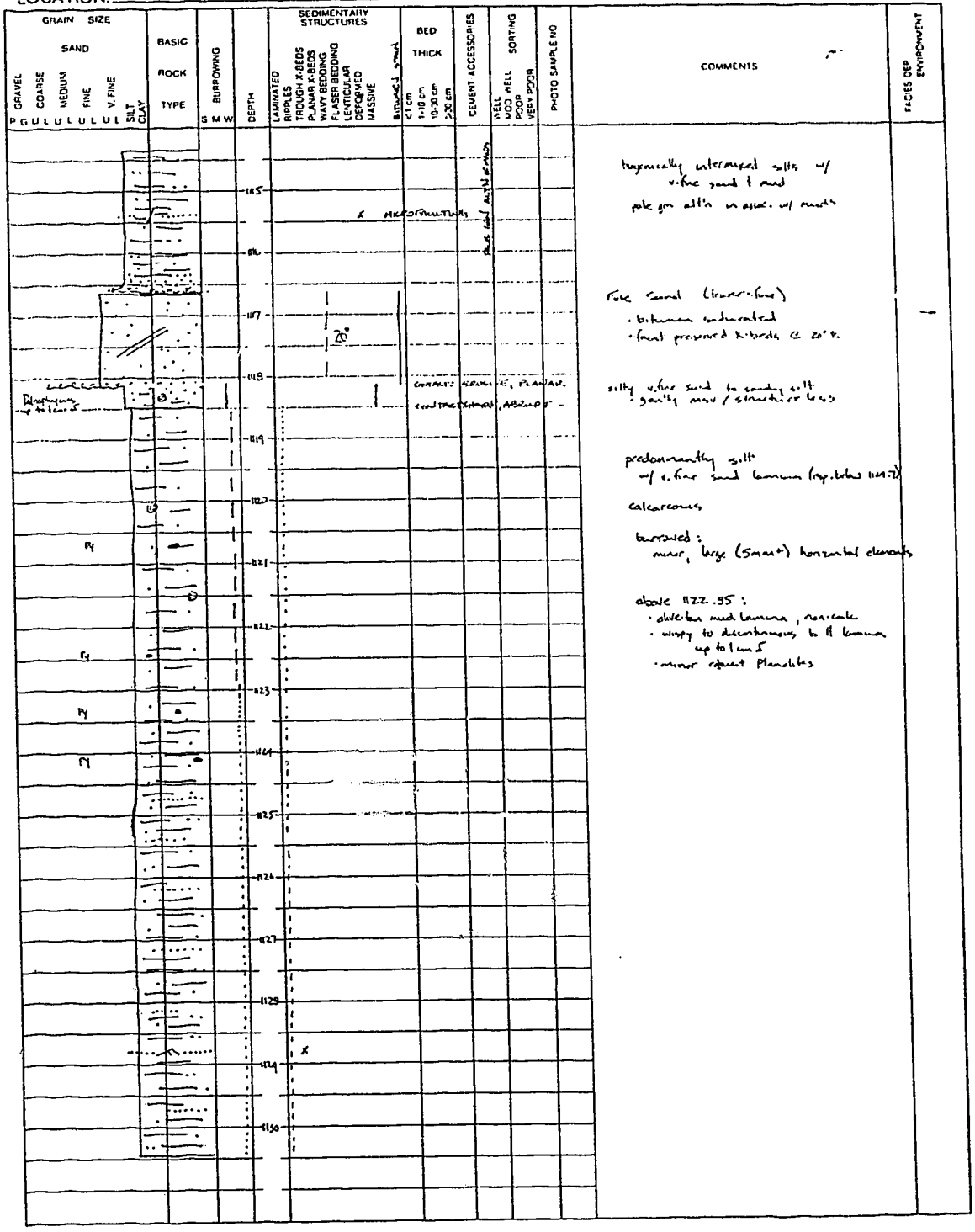
WELL NAME: _____ FORMATION: Dunlin DATE: Jan 8th /99

LOCATION: A-15-A /99-A-2 CORE INTERVAL: 3670 - 3728, 5739' KB: _____

GRAIN SIZE: GRAVEL / SAND: COARSE, MEDIUM, FINE, V. FINE / SILT / CLAY	BASIC ROCK TYPE	BURROWING: S M W	DEPTH	SEDIMENTARY STRUCTURES: LAMINATED, RIPPLES, TROUGH X-BEDS, PLANAR X-BEDS, WAVY BEDDING, FLASER BEDDING, LENTICULAR, DEFORMED, MASSIVE	BED THICK: <1 cm, 1-10 cm, 10-30 cm, >30 cm	CEMENT/ACCESSORIES	SORTING: WELL, MOD. WELL, POOR, VERY POOR	PHOTO/SAMPLE NO	COMMENTS	FACIES/DEP ENVIRONMENT
			4137	X						
		1								
			4138							
		21								
			4139							
				X						

WELL NAME: Union HB Wildmint b-24-A FORMATION: Dolly DATE: June 14th, 1994

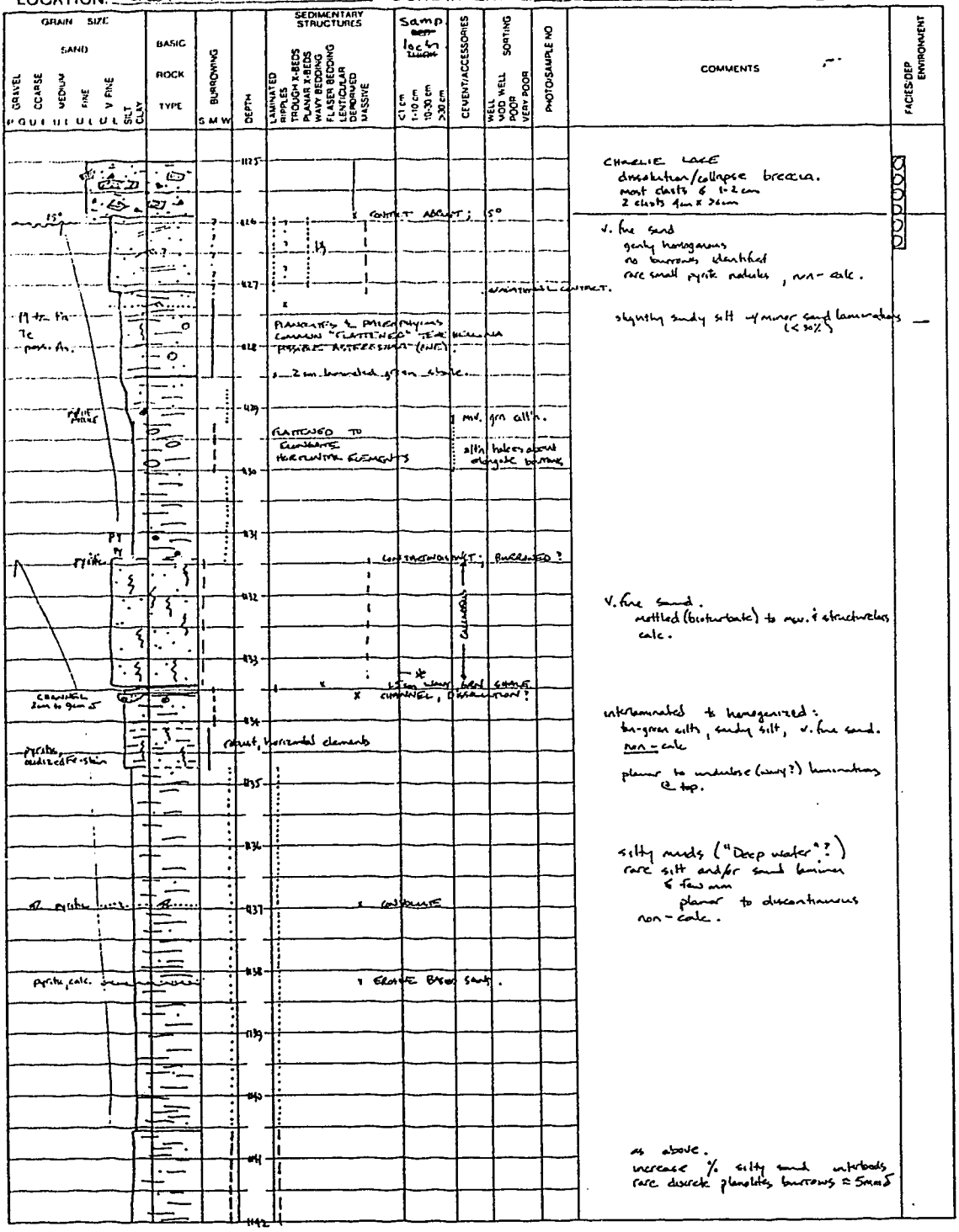
LOCATION: b-24-A / 94-11-2 CORE INTERVAL: 1114.35m – 1130.45m KB: 2264'


GRAIN SIZE
SAND
GRAVEL
COARSE
MEDIUM
FINE
V. FINE
SILT
CLAY
BASIC ROCK TYPE
BURROWING
DEPTH
SEDIMENTARY STRUCTURES
LAMINATED
RIPPLES
TROUGH X-BEDS
PLANAR X-BEDS
WAVY BEDDING
FLASER BEDDING
LENTICULAR
DEFORMED
MASSIVE
BED THICK
CEMENT ACCESSORIES
SORTING
WELL
MOD WELL
POOR
VERY POOR
PHOTO SAMPLE NO
COMMENTS
FACIES DEP ENVIRONMENT
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
20°
Bioturbated sand
Ry
Ry
Ry

7.142

WELL NAME: UNOCAL HB WILDMINT d-26-A FORMATION: CHARLIE LAKE - D01C DATE: June 10th, 1994

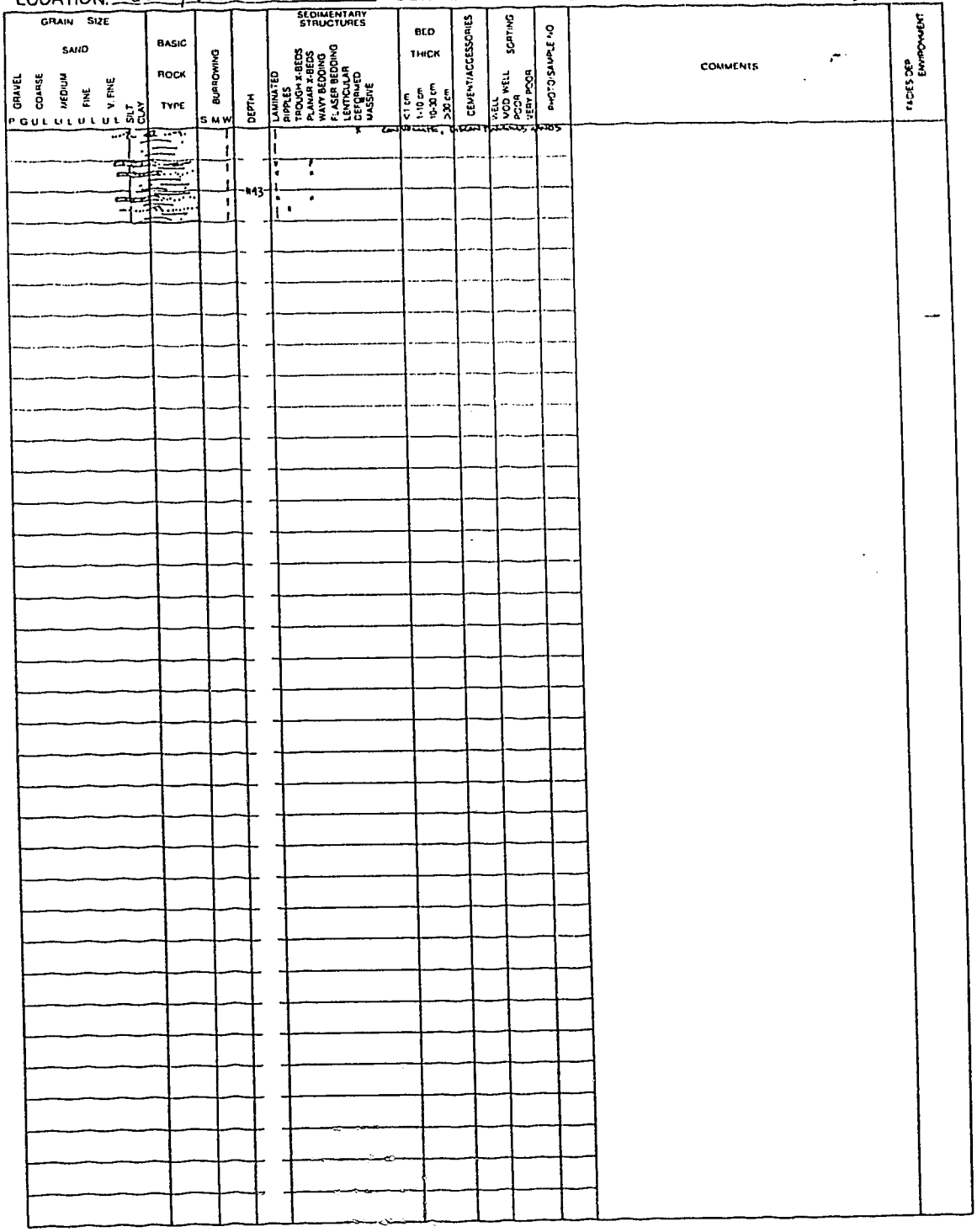
LOCATION: d-26 A /94-11-2 CORE INTERVAL: 1125m - 1143.5m (3690' - 3750'9") KB: 731.7m



p. 2 of 2

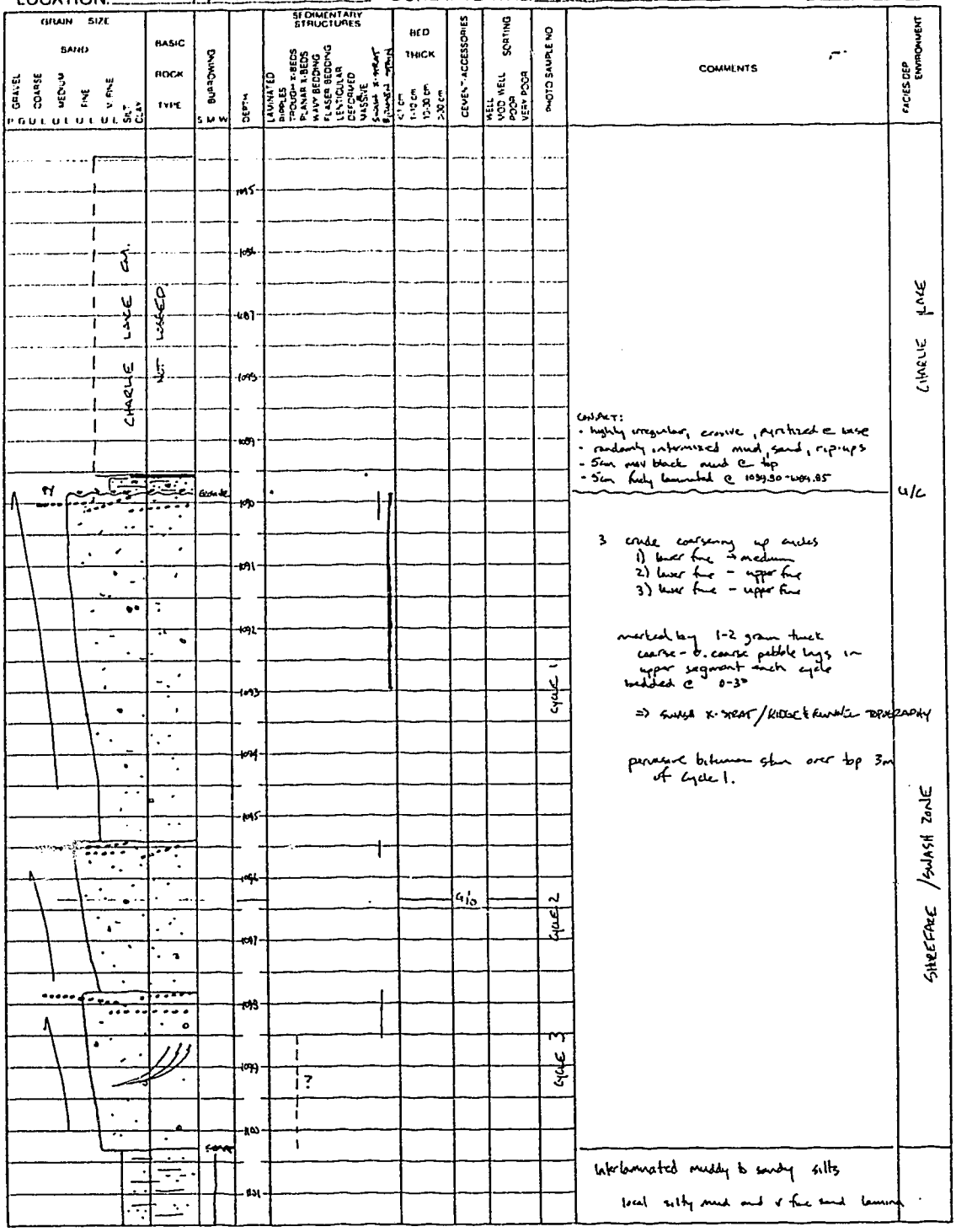
WELL NAME: _____ FORMATION: _____ DATE: _____

LOCATION: d-24-A/94-11-2 CORE INTERVAL: _____ KB: _____



WELL NAME: United HB WILDMINT d-34-A FORMATION: CHARLIE LAKE - DOLO DATE: June 10th, 1994

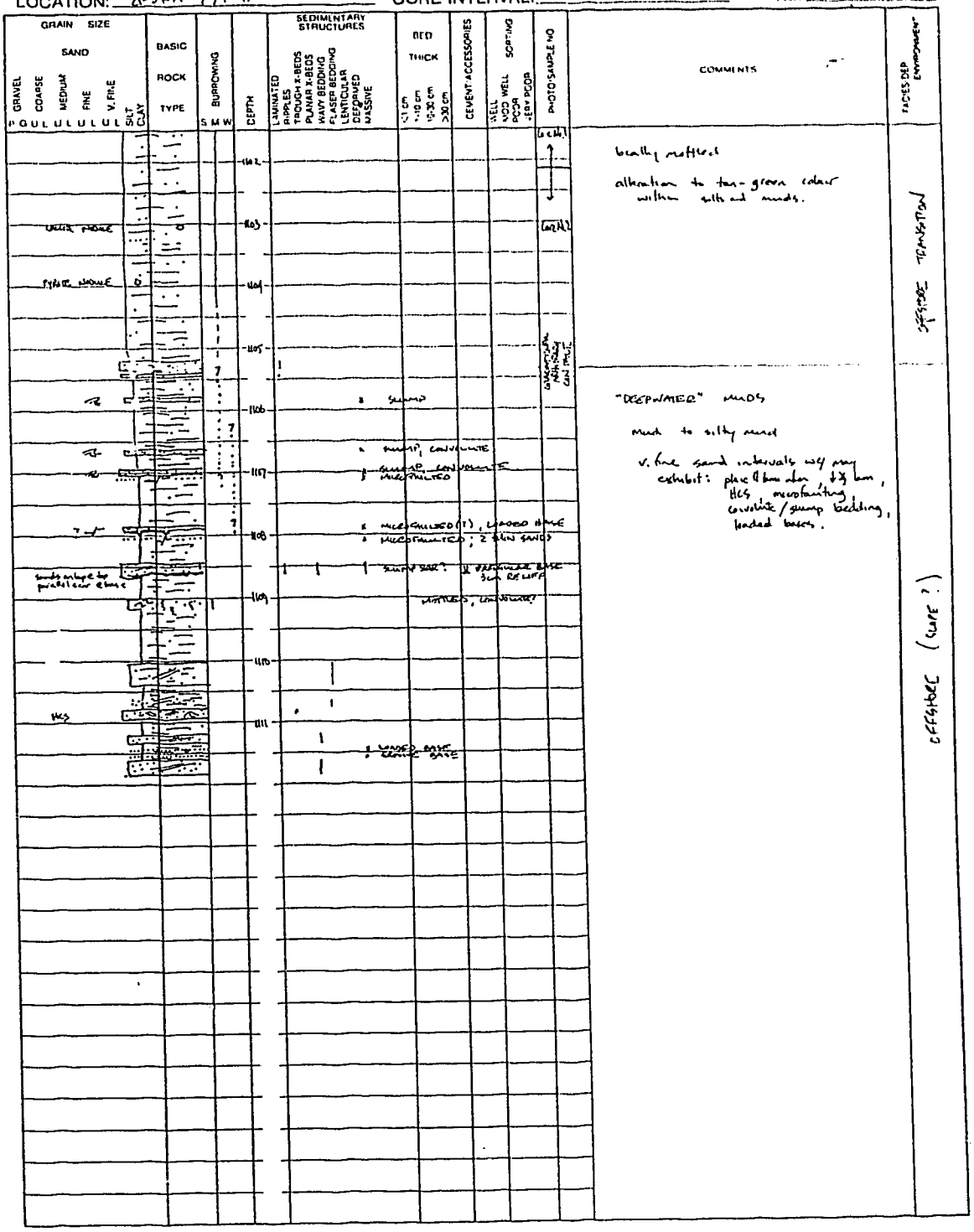
LOCATION: d-34-A / 94-H-2 CORE INTERVAL: 1084.95m - 1111.95m KB: 7+12



p 1 of 2

WELL NAME:_____ FORMATION:_____ DATE:_____

LOCATION: d-34-A /94-H-2 CORE INTERVAL:_____ KB:_____


GRAIN SIZE
SAND
GRAVEL
COARSE
MEDIUM
FINE
V. FINE
SILT
CLAY
BASIC ROCK TYPE
BURROWING
S M W
DEPTH
SEDIMENTARY STRUCTURES
LAMINATED
RIPPLES
TROUGH X-BEDS
PLANAR X-BEDS
WAVY BEDDING
FLASER BEDDING
LENTICULAR
DEFORMED
MASSIVE
BED THICK
<1 cm
1-10 cm
10-30 cm
>30 cm
CEMENT ACCESSORIES
SORTING
WELL
MOD WELL
POOR
VERY POOR
PHOTO/SAMPLE NO
COMMENTS
FACIES DEP ENVIRONMENT
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
HCS
burrowed by predominantly vertical burrows
burrowed
slumped, convolute
slumped, convolute
bioturbated
bioturbated (?), loaded base
bioturbated; 2 thin sands
slumped?
loaded base
loaded base
scour
burrowed, convoluted
burrowed
burrowed
burrowed

APPENDIX G: DOIG STUDY

DOIG POOL SUMMARIES AND PRODUCTION STATISTICS

Buick Creek

POOL SUMMARY

	Doig A Pool Inverness Project		Doig B Pool Poco Project	
	OIL	GAS	OIL	GAS
Reservoir Characteristics				
Net Sand	6.2m Oil Pay	7.3m Gas Pay	6.7m Oil Pay	4.3m Gas Pay
Petrophysics				
Porosity Type				
Porosity	9.40%	7.30%	10.20%	9.10%
Depth				
Thickness (1)				
Area	65 ha	26ha	249ha	226ha
Fluid Data				
Saturation	8.50%	12.20%	7.90%	8.80%
API Gravity	43.5		43.5	
Gas-Oil Ratio	159.6			
Production Data				
Type	OIL	GAS	OIL	GAS
In Place Volume	1,504,003 bbls	1.7 bcf	6,796,332 bbls	10.9 bcf
Cumm. Production	276,888 bbls	0.6 bcf	748,855 bbls	8.4 bcf
Est. Reserves	24,542 bbls	0.3 bcf	269,965 bbls	1.4 bcf
Recovery Factor	20%	90%	15%	90%
Remarks				
Discovery Date	1977		1976	
Discovery Well	d-46-I/94-A-11		a-67-I/94-A-11	
Operator	Skye		Poco	
Last Update	Mar-93		Aug-92	
Initial Classification	Lower Halfway A Pool		Lower Halfway B Pool	

COMMENTS

Buick Creek

POOL SUMMARY

	Doig D Pool	Doig - Undesignated	Doig - Undesignated
Reservoir Characteristics			
Net Pay	6.8m Oil Pay	21.4m Oil Pay	11.9m Oil Pay
Petrophysics			
Porosity Type			
Porosity	10.40%	9.60%	10.10%
Depth			
Thickness (1)			
Area	0	65ha	65ha
Fluid Data			
Saturation	5.80%	6.10%	4.20%
API Gravity	42.8	45.2	44.9
Gas-Oil Ratio		129	166
Production Data			
Type			
In Place Volume	3,649,882 bbls	5,802,054 bbls	3,039,470 bbls
Cumm. Production	75,515 bbls	18,879 bbls	25,172 bbls
Est. Reserves	291,361 bbls	1,140,273 bbls	584,610 bbls
Recovery Factor	10%	20%	20%
Remarks			
Discovery Date	1990	1990	1991
Discovery Well	d-86-I/94-A-11	9-34-88-20W6	d-76-I/94-A-11
Operator	Esso	Esso	Esso
Last Update	Jan-94	Aug-92	Aug-92
Initial Classification	Lower Halfway C Pool	Lower Halfway E Pool	Lower Halfway F Pool

COMMENTS

Cache Creek

RESERVOIR SUMMARY

General	
Location	I/94-A-12 - 65 km northwest of Fort St. John, B.C.
Tectonics	Ramp-type passive margin.
	North flank of the Fort St. John Graben and Hay River Fault Zone.
Trap Mechanism	Stratigraphic - overlying deep water silts and mud
Source Rock	Presumed Doig Phosphate Zone source
Reservoir Rocks	
Age	Middle Triassic - Anisian/Ladinian?
Stratigraphic Unit	Doig - 2nd sand equivalent
Lithology	Sandstone - fine to very fine grained
Dep. Environment(s)	Lower shoreface - lowstand systems tract?
Productive Facies	Sands associated with toe of slope below incised shoreface

	Doig A Pool	Doig B Pool
Reservoir Characteristics		
Net Sand	6.3m Gas Pay	2.0m Oil Pay
Petrophysics		
Porosity Type	intergranular	intergranular
Porosity	9.10%	9.20%
Depth to Producing Sand	1643m	1694m
Thickness	6.5m	5.0m
Area	259 ha	48 ha
Fluid Data		
Water Saturation	21.40%	19.20%
API Gravity	41	45.8
Gas-Oil Ratio		227
Production Data		
Type	GAS	OIL
In Place Volume	10 bcf	27, 689 bbls
Cumm. Production	0	
Est. Reserves	0.007 bcf	0
Recovery Factor	0.20%	0.30%
Remarks		
Discovery Date	1978	1979
Discovery Well	b-62-I/94-A-12	b-64-I/94-A-12
Operator	Cdn Roxy	Czar
Last Update	May-88	Sep-85

COMMENTS

Both pools represent 1-well pools. Depleted.

Core available and logged through base of sand in Doig B Pool (b-64-I/94-A-12).

Data Source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

Fireweed

RESERVOIR SUMMARY

General	
Location	D/94-A-14 - 67 km northwest of Fort St. John, B.C.
Tectonics	Ramp-type passive margin. North flank of the Fort St. John Graben and Hay River Fault Zone.
Trap Mechanism	Stratigraphic - overlying deep water silts and mud
Source Rock	Presumed Doig Phosphate Zone source
Reservoir Rocks	
Age	Middle Triassic - Anisian/Ladinian?
Stratigraphic Unit	Doig - 2nd sand equivalent
Lithology	Sandstone - fine to very fine grained
Dep. Environment(s)	Lower shoreface - lowstand systems tract?
Productive Facies	Sands associated with incised shoreface.

	Doig A Pool		Doig B Pool	
Reservoir Characteristics				
Net Sand	15.5m Oil Pay		5.6m Oil Pay	
Petrophysics				
Porosity Type	Intergranular		Intergranular	
Porosity	9.00%		9.00%	
Depth to Producing Sand	1650.7m		1639m	
Thickness (1)	17m		11m	
Area	0		0	
Fluid Data				
Water Saturation	10.00%		10.70%	
API Gravity	42		42	
Gas-Oil Ratio	212.8		212.8	
Production Data				
Type	OIL	GAS	OIL	GAS
In Place Volume	503,432 bbls	1.56 bcf	182,494 bbls	0.567 bcf
Cumm. Production	18,879 bbls	0.57 bcf	6,293 bbls	0.035 bcf
Est. Reserves	32,094 bbls	1.090 bcf	11,327 bbls	0.394 bcf
Recovery Factor	10.00%	90%	10.00%	90%
Remarks				
Discovery Date	1978		1978	
Discovery Well	b-26-D/94-A-14		b-06-D/94-A-14	
Operator	Czar ?		PetroCanada	
Last Update	Dec-78		Dec-78	

COMMENTS

1 Sand thickness based on 60 API cutoff.
Both pools represent 1-well pools.
Core available and logged through base of sand in both pools.
Data Source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

Red Creek/Red Creek - North

RESERVOIR SUMMARY

General		
Location	Twp 85N/R21w6 (Red Creek) - 27km northwest of Fort St. John, B.C.	
	Twp 86N/R21w6 (Red Creek North) - 35km northwest of Fort St. John, B.C.	
Tectonics	Ramp-type passive margin	
	Due north of Peace River arch, Fort St. John Graben, and Dawson Creek Graben	
Trap Mechanism	Stratigraphic - overlying massive silts and muds	
Source Rock	Presumed Doig Phosphate Zone source	
Reservoir Rocks		
Age	Middle Traissic - Anisian/Ladinian?	
Stratigraphic Unit	Doig - 2nd sand equivalent (?)	Red Creek - North now classified as Halfway pool
Lithology	Sandstone - very fine to fine grain	
Dep. Environment(s)		
Productive Facies		

	Red Creek (Doig B)	Red Creek - North (reclassified as Halfway pool)
Reservoir Characteristics		
Net Sand	13.4m Oil Pay	3.3m Gas Pay
Petrophysics		
Porosity Type	Intergranular ?	Intergranular ?
Porosity	8.20%	8.80%
Depth to Producing Sand	1536m	n/a
Thickness (1)	19.5m	n/a
Area	0	2350 ha
Fluid Data		
Saturation	15%	33%
API Gravity	42.8	42.8
Gas-Oil Ratio	159.6	n/a
Production Data		
Type	OIL	GAS
In Place Volume	352,402 bbls	25.38 bcf
Cumm. Production	18,879 bbls	0
Est. Reserves	0	20.29 bcf
Recovery Factor	5%	80%
Remarks		
Discovery Date	1976	1976
Discovery Well	11-15-85-21	11-8-86-21
Operator	Peace Petroleum	Pacific Petroleums
Last Update	Dec-78	Mar-91

COMMENTS

1 Sand thickness based on 60 API cutoff.

Both pools represent one-well pools; Red Creek - North has subsequently been reclassified as a Halfway pool.

Core available in 11-31-85-21/w6. No core in either pool.

Data Source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

Rigel

RESERVOIR SUMMARY - DOIG A POOL

General		
Location	NE/4 Twp 88N/R16 w6 - 51km northeast of Fort St. John, B.C.	
Tectonics	Ramp type passive margin North flank Peace River Arch, Fort St. John and Dawson Creek grabens.	
Trap Mechanism	Stratigraphic - overlying deep marine silts and muds.	
Source Rock	Presumed Doig Phosphate Zone source.	
Reservoir Rocks		
Age	Middle Traissic - Anisian/Ladinian?	
Stratigraphic Unit	Doig sand - pre 1st Sand Equivalent?	
Lithology	Sandstone.	
Dep. Environment(s)	unknown	
Productive Facies	unknown	
Reservoir Characteristics		
Net Pay	4.5m Oil Pay	
Petrophysics		
Porosity Type	intergranular ?	
Porosity	6.70%	
Depth to Producing Sand	1251m	
Thickness (1)	6.0m	
Area	65 ha	
Fluid Data		
Saturation	36.00%	
API Gravity	39.6	
Gas-Oil Ratio	74.4	
Production Data		
Type	OIL	
In Place Volume	648,169 bbls	
Cumm. Production	0	
Est. Reserves	129,004 bbls	
Recovery Factor	20%	
Remarks		
Discovery Date	199[illegible]	
Discovery Well	15[illegible]-88-16	
Operator	[illegible]	
Last Update	[illegible]	

COMMENTS

1 Sand thickness based on 60 API cutoff.
Core available, not logged. Less than 0.5m of reservoir cored (?) - remainder Halfway/Charlie Lake core.
Data Source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

Stoddart - West

RESERVOIR SUMMARY - DOIG A POOL

General	
Location	Twp 87N/R20 w6 - 37km north-northwest of Fort St. John, B.C.
Tectonics	Ramp type passive margin
	North flank Peace River Arch, Fort St. John and Dawson Creek grabens.
Trap Mechanism	Stratigraphic - overlying deep marine silts and muds.
Source Rock	Presumed Doig Phosphate Zone source.
Reservoir Rocks	
Age	Middle Traissic - Anisian/Ladinian?
Stratigraphic Unit	Doig - 1st Sand Equivalent.
Lithology	Sandstone - Fine grain.
Dep. Environment(s)	Probable lower-middle shoreface - lowstand systems tract/incised shoreface.
Productive Facies	Sands preserved within shoreface following subsequent transgressive erosion.

Reservoir Characteristics	
Net Pay	11.9m Oil Pay
Petrophysics	
Porosity Type	intergranular ?
Porosity	8.20%
Depth to Producing Sand	1591m
Thickness (1)	18.3m
Area	65 ha
Fluid Data	
Saturation	20.40%
API Gravity	45.8
Gas-Oil Ratio	133
Production Data	
Type	OIL
In Place Volume	44,050 bbls
Cumm. Production	0
Est. Reserves	0
Recovery Factor	1%
Remarks	
Discovery Date	1977
Discovery Well	7-21-87-20
Operator	J.M.Huber
Last Update	Jan-87

COMMENTS

1 Sand thickness based on 60 API cutoff.
One-well pool.
Core available in 06-22-86-20/w6. No core in pool.
Data Source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

Stoddart - West

RESERVOIR SUMMARY - DOIG B & C POOLS

General	
Location	Twp 86N/Range 20 w6 - 25km north-northwest of Fort St. John, B.C.
Tectonics	Ramp type passive margin North flank Peace River Arch, Fort St. John and Dawson Creek grabens.
Trap Mechanism	Stratigraphic - overlying deep marine silts and muds.
Source Rock	Presumed Doig Phosphate Zone source.
Reservoir Rocks	
Age	Middle Traissic - Anisian/Ladinian?
Stratigraphic Unit	Doig - 1st Sand Equivalent.
Lithology	Sandstone - Fine grain.
Dep. Environment(s)	Probable lower-middle shoreface - lowstand systems tract/incised shoreface.
Productive Facies	Sands preserved within shoreface following subsequent transgressive erosion.

	Doig B Pool		Doig C Pool	
Reservoir Characteristics				
Net Pay	2.0m Oil Pay		0.7m Oil Pay	
Petrophysics				
Porosity Type	intergranular		intergranular	
Porosity	10%		11.30%	
Depth to Producing Sand	1567m		1578m	
Thickness (1)	3m	(19m silt eq.)	1.5m	(9.5m silt eq.)
Area	195 ha		117 ha	
Fluid Data				
Saturation	13.90%		12.10%	
API Gravity	43		41.5	
Gas-Oil Ratio	133		138.2	
Production Data				
Type	OIL		OIL	
In Place Volume	1,516,589 bbls		364,988 bbls	
Cumm. Production	201,373 bbls		62,929 bbls	
Est. Reserves	103,833 bbls		10,698 bbls	
Recovery Factor	20%		20%	
Remarks				
Discovery Date	1980		1987	
Discovery Well	16-4-86-20		6-14-86-20	
Operator	Scurry Rainbow		Mark Resources	
Last Update	Mar-93		May-91	

COMMENTS

1 Sand thickness based on 60 API cut-off.
Cores available in (02)6-4-86-20 and 12-4-86-20 (B Pool), 16-15-86-20, and 10-25-86-20.
Data Source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

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RESERVOIR SUMMARY - DOIG/LOWER HALFWAY POOLS

General

Location	A/94-H-02 and I/94-A-15 - 87km north-northeast of Fort St. John, B.C.
Tectonics	Ramp type passive margin North flank Fort St. John and Dawson Creek grabens, and Hay River Fault Zone.
Trap Mechanism	Stratigraphic/erosional - lateral seal against deep water silts/mud; updip seal against internal Charlie Lake unconformity.
Source Rock	Presumed Doig Phosphate Zone source.

Reservoir Rocks

Age	Middle Traissic - Anisian/Ladinian?
Stratigraphic Unit	Mixed Doig/Halfway, depending on depth of erosion.
Lithology	Sandstone - Fine grain.
Dep. Environment(s)	Probable middle shoreface/upper shoreface.
Productive Facies	Variable erosional remnants of shoreface sands.

	OIL	GAS
Reservoir Characteristics (1)	(3 pools)	(2 pools)
Net Pay (Average)		
Net Pay (Range)	1.0m - 5.5m	5.8m - 15.0m
Petrophysics		
Porosity	~ 14%	~ 14%
Porosity Range	9% - 14%	10.8% - 14.2%
Depth		
Thickness (2)		
Total Area (all pools)	376ha	130ha
Fluid Data (1)		
Saturation	18.7% - 34.4%	<15%
API Gravity (Range)	40	40
Gas-Oil Ratio	< 60	
Production Data (3)		
Type	OIL	GAS
In Place Volume	3,372,994 bbls	4.8 bcf
Cumm. Production	295,766 bbls	1.1 bcf
Est. Reserves	118,936 bbls	2.9 bcf
Recovery Factor	0.3% - 20%	90%

COMMENTS

1 Average characteristics estimated based on all pools (3 oil, 2 gas).

2 Sand thickness based on 60 API cut-off.

3 Cummulative data based on sum of all pools.

Discovery wells cored and logged in Doig B, Doig C/Halfway G, and Doig F pools: 8 cores logged in general field area.

Data source: Hydrocarbon and By-Product Reserves in British Columbia - 1993.

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POOL SUMMARY

	Doig A Pool	Doig B Pool (plus UNOCAL Project)		Doig D Pool	Doig F Pool
		Oil	Gas		
Reservoir Characteristics					
Net Sand	2.0m Oil Pay	1.0m Oil Pay	5.8m Gas Pay	5.5m Oil Pay	15.0m Gas Pay
Petrophysics					
Porosity Type					
Porosity	10%	14%	14.20%	9.10%	10.80%
Depth					
Thickness (1)					
Area	130ha	181ha	130ha	65ha	0
Fluid Data					
Saturation	18.70%	34.40%	34.10%	24%	12.40%
API Gravity	40	40		40	
Gas-Oil Ratio	58.5	45.9		45.9	
Production Data					
Type	OIL	OIL	GAS	OIL	GAS
In Place Volume	1,113,843 bbls	975,400 bbls	4.4 bcf	1,283,752 bbls	0.3 bcf
Cumm. Production	195,080 bbls	100,686 bbls	1.0 bcf	0	0.1 bcf
Est. Reserves	25,801 bbls	91,876 bbls	2.9 bcf	1,259 bbls	0.03 bcf
Recovery Factor	20%	20%	90%	0.30%	40%
Remarks					
Discovery Date	1963	1962		1965	1965
Discovery Well	d-94-I/94-A-15	d-15-A/94-H-02		d-13-A/94-H-02	d-84-I/94-A-15
Operator	Esso	Union Oil		Medallion	Pacific Petroleums
Last Update	Apr-89	Mar-91		Apr-89	Jul-89

COMMENTS

1 Sand thickness based on 60 API cutoff.

Doig C Pool reclassified as Halfway G Pool - not included in summary.

No data available for Doig E Pool (oil?) - not included in summary.