Expression of Major and Trace Element Signatures of the Frasnian Duvernay Formation within a Sea Level Context: insights into the processes that control mudstone composition, paleoredox conditions and organic matter enrichment

by

Julia M. McMillan

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Department of Earth and Atmospheric Sciences
University of Alberta

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Abstract:

This study evaluates the effects of sea level on redox conditions, shale composition and sediment provenance in the Late Devonian (Frasnian) Duvernay Formation of the Western Canada Sedimentary Basin (WCSB) of Alberta, Canada, an organic-rich 'black' shale localized between the reefs and platforms of the coeval Leduc Formation. The Duvernay was deposited in two separate large sub-basins, the East Shale Basin (ESB) and West Shale Basin (WSB), separated by a nearly continuous chain of reefs. Redox conditions, shale composition and sediment provenance can control the accumulation of total organic carbon (TOC). These controls on TOC accumulation, along with the effect sea level has on them, are significant because they dictate the geographic and stratigraphic distribution of organic rich targets for unconventional oil and gas exploration. Organic geochemistry and major, minor and trace element inorganic geochemistry were utilized in order to document stratigraphic and geographic variation in shale composition. Five long cores were sampled at high resolution in order to investigate the processes controlling geochemical composition, in particular the accumulation of organic carbon.

Geochemical results were placed in the context of third order transgressive systems tract-regressive systems tract (TST-RST) sea level cycles. The Duvernay expresses three third order transgressive-regressive cycles: TST1-RST1 corresponds to the Lower and Middle Duvernay; TST2-RST2 corresponds to the lower half of the Upper Duvernay; and TST3-RST3 corresponds to the upper half of the Upper Duvernay.

Major element oxides were used as proxies for bulk mineralogy. SiO_2-Zr cross plots were used to determine the source of silica and contribution of biogenic productivity. The role of detrital input and influence of source terranes was investigated using Zr-TiO_2 cross plots; C-

Fe-S systematics and trace element ratios (Mo/ Al, U/Al and V/Al) were used in order to investigate redox conditions during sediment accumulation; Hydrogen Index (HI)-Tmax cross plots were used in order to determine organic matter (OM) type and maturity. Stratigraphic and geographic trends in proxies for silica source, source terranes and redox conditions were then tied to an independently formulated sedimentological and stratigraphic interpretation. The controls of organic matter accumulations were explore using from plots of TOC and key geochemical indicators in order to determine the relative influence of productivity, preservation and dilution.

Both sub-basins are influenced by biogenic and detrital silica. Bulk mineralogy proxies indicate that the WSB is silica-dominated and the ESB is carbonate-dominated although reef-proximal locations show carbonate influence regardless of sub-basin. Multiple source terranes were identified. Possible detrital sources include the Peace River Arch (PRA), the craton beyond the Grosmont Platform and landmasses north of the entrance to the basin. Locations proximal to detrital sources exhibited the influence of more than one source and distal or geographically isolated locations showed single source characteristics. Carbon-iron-sulfur (C-Fe-S) relationships and trace element ratios indicate that conditions were dominantly marginally oxic to dysoxic with frequent anoxia, reaching oxic or euxinic ranges only occasionally. Restricted locations were characterized by less oxic conditions than more open locations which were characterized by more oxic conditions.

Average TOC contents were higher in TSTs than in RSTs. The effect of redox conditions on TOC preservation were determined using cross plots of TOC with two redox proxies: the Fe/S and Mo/Al (ppm/%) ratios. The effect of dilution on TOC accumulation was determined using cross plots of TOC and Zr/TiO_2 ratio. The potential effect of clay enhanced preservation on

TOC accumulation was determined using cross plots of TOC with Al_2O_3. TOC accumulations were observed to be the result of a balance of redox enhanced preservation, possible clay enhanced preservation and possible nutrient delivery or productivity. The dominance of each of these controls varied between sub-basins and stratigraphic intervals.

Preface

The research conducted for this thesis forms part of a larger collaboration jointly funded by the National Science and Engineering Research Council (NSERC) and members of an industry consortium: Imperial, Devon Canada Corporation, ConocoPhillips Canada, Husky Energy Incorporated, Shell Canada Limited and Nexen (a wholly-owned subsidiary of CNOOC Limited). The collaborative project, led by Dr. Nick Harris at the University of Alberta, focused on an integrated characterization of the Duvernay Shale in the West and East Shale Basins of Alberta and the contemporaneous Horn River Group in the Horn River Basin of British Columbia. The portion of the research carried out on the Duvernay Formation was a collaborative project that integrated two independent master's theses authored by Julia M. McMillan and Levi J. Knapp. The division of responsibility was as follows: the collection of geochemical and petrophysical data and interpretation of such data was the sole responsibility of Julia M. McMillan; the collection and interpretation of sedimentological data was the sole responsibility of Levi J. Knapp. By working on the same dataset from two different perspectives, the aim was to share insights to provide context for each other's research in order to develop a unified interpretation while working towards a joint result. The scope of the project included a high resolution, integrated study of the sedimentology, stratigraphy, geochemistry and core based petrophysics of the Duvernay Formation.

The thesis is composed of the presentation and interpretation of the geochemical data in the main body of the work. Detailed methodology and examples of petrophysical data collected are provided in the Appendix A, and K-P. The author was responsible for designing and implementing a geochemical and petrophysical sampling strategy. This included cutting hand samples, photographing hand samples, cutting sample splits for various analyses, preparing

samples for analysis, ensuring quality assurance and control standards were met for the results, and interpreting the geochemical data The author was responsible for all figures required for data exploration pertaining to the geochemical and petrophysical data, interpretation of geochemical data and production of figures pertaining to presentation of the geochemical data (unless otherwise specified with appropriate attribution). Parts of this work have been previously published in conference posters and presentations (Houston Geological Society Mudrocks conference 2014, Canadian Society of Petroluem Geologists Geoconvention 2014, Canadian Society of Petroleum Geologists Geoconvention 2015 and American Association of Petroleum Geologists Annual Convention & Exhibition 2015) and various consortium meetings.

Levi J. Knapp was responsible for logging each core in order to develop a sedimentological and stratigraphic model for the Duvernay Formation. Due to the collaborative nature of the work, the base maps and stratigraphic framework developed by Levi J. Knapp were modified with permission. The base maps and stratigraphic framework were included in the author's thesis for consistency and in order to present the geochemical data and interpretations within this context as a means for developing an integrated, robust model for the Duvernay Formation.

Dedication

To my mother and grandmother for all their encouragement, wisdom and perspective.

This work could not have been completed without their support.

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I appreciate permission from: the Alberta Energy Regulator and the Canadian Society of Petroleum Geologists in order reproduce a figure of Devonian structures and lineaments from the Atlas of the Western Canada sedimentary Basin; Dr. Thomas J. Algeo in order to duplicate his paleogeographic map of the Devonian; Vicki Rocha from Weatherford for her management of our account; Levi J. Knapp for use of his sedimentological interpretation and basemap in order to provide consistent context for our readers.

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1. Introduction

Organic-rich mudstones, commonly termed "black shales," have long been recognized as source rocks for conventional petroleum systems. Petroleum source rocks in the Upper Devonian-Tournaisian interval, the Duvernay Formation of Alberta among them, account for 8% of the world's discovered original reserves of oil and gas (Klemme and Ulmishek 1991). Following the advent of hydraulic fracturing technology, these fine grained sedimentary rocks have become significant unconventional exploration targets (Bohacs et al. 2013). The widespread Duvernay Formation and its worldwide coeval counterparts (e. g. Muskwa Formation in the Horn River Basin, Woodford Shale in Oklahoma and Texas, as well as the Marcellus and Utica shales of the Appalachian Basin) were deposited in paleogeographical settings characterized by expansive epicontinental seaways and cratonic sags (Meyer and Kump 2008, Algeo et al. 2007, Roen 1984, Klemme and Ulmishek 1991) and extreme paleogeochemical conditions with limited oxygen (Harris et al. 2013, Algeo et al. 2007, Rimmer 2004, Rimmer et al. 2004, Creaney and Passey 1993).

This study provides a high resolution geochemical evaluation of the Devonian Duvernay Formation focused on explaining the variation in geochemical in the Duvernay. Establishing relationships between mudstone composition, organic matter content, sediment provenance and sea level cycles, helps identify the processes that control organic matter distribution in the Duvernay. High resolution geochemical sampling of five long cores was utilized in order to investigate the processes underlying the relationship between geochemical signatures associated with relative sea level cycles, and the conditions that promote organic matter enrichments.

Organic matter enrichment results from a complex, nonlinear interaction of variables (Arthur and Sageman 2004, Bohacs et al. 2005, Arthur and Sageman 1994) such as productivity,

preservation and dilution (Katz 2005, Pedersen and Calvert 1990, Chow et al. 1995, Schieber 2010, Macquaker et al. 2010, Algeo and Ingall 2007, Demaison and Moore 1990, Wignall 1991). Productivity is generally controlled by nutrient delivery, preservation is controlled by redox conditions, and dilution is controlled by mineral flux. Thus the highest levels of organic enrichment may not necessarily correspond to the highest levels of organic production due to dilution or lack of preservation. Instead, significant accumulations of organic material may occur in areas where there is moderate primary production and thus less dilution by biogenic silica or clay (Bohacs et al. 2005). The geographic and stratigraphic distribution of organic matter is of particular interest for identifying so-called "shale gas" targets (Bohacs et al 2013, Ross and Bustin 2008, Passey et al. 2010) and predicting reservoir properties in three dimensions (Wang and Carr 2012).

Sea level may exert a fundamental control on organic carbon enrichment by influencing: 1) the height of the water column, which may enhance or inhibit current circulation leading to the development of low oxygen conditions at the sediment water interface (redox control), 2) the communication between different parts of the basin which may allow or prevent circulation of water carrying oxygen (redox control), detrital material (dilution control) or nutrients (productivity control), 3) the input of material that may enhance organic matter burial or dilute the organic matter (dilution control). Arthur and Sageman (2005) attributed enrichment of organic matter to three mechanisms in response to a rise in sea level: 1) nutrient retention in marginal seas, 2) enhanced water column stratification and, 3) trapping of terriginous clastics in the nearshore. The retention of nutrients in marginal seas as sea level rises subsequently impacts organic productivity and is a factor in organic enrichment models for the classic settings such as upwelling zones along continental margins, cratonic sag basins, lakes or epicontinental seaways

(Arthur and Sageman 1994, 2005). Enhanced water column stratification generally leads to reduced oxygen levels. The specific mechanism of varying sedimentation rates (e.g. sediment trapping, increased erosion, or circulation patterns) is a second order control on the accumulation of organic matter. Sedimentation rate influences the degree to which organic matter dilution (Bohacs et al 2005) or isolation of organic matter from oxidizing seawater (Tyson 2005) are important.

Geochemical studies provide insight into relative sea level change, redox conditions, distribution of organic matter, and overall paleodepositional or paleohydrographic conditions (Harris et al. 2013, Dahl et al. 2012, Tribovillard et al. 2006, 2008, Algeo et al. 2006, 2007, Algeo and Rowe 2012, Algeo and Maynard 2008, Holmden et al. 1998). In black shales, geochemical studies have characterized bulk mineralogical composition (Dong et al. 2015, Ross an Bustin 2006, Chalmers et al. 2012, Wright et al. 2010) and trace element enrichment patterns (Algeo and Rowe 2012, Harris et al. 2013, Warning and Brumsack 2000) in order to investigate redox conditions. Geochemical relationships can be used to explore sediment provenance (Aplin and Mackquaker 2011), sea level changes (Hermoso et al. 2013, Arthur and Sageman 2004, Algeo et al. 2007), circulation and productivity patterns (Perkins et al. 2008, Macquaker et al. 2010) and controls on preservation of organic matter (Rimmer et al. 2004, Chow and Stasiuk 1995, Pedersen and Calvert 1990, Deamison and Moore 1980).

Mudstones are known to be compositionally heterogenous, displaying predictable physiochemical properties (Aplin and Macquaker 2011). These properties reflect variation in sediment source, primary production, clay content and hydrodynamic conditions (Aplin and Macquaker 2011, Uffmann et al. 2012, Chalmers et al. 2012, Barbera et al. 2009, 2011). The composition of shale has an impact on the storage potential of a shale gas reservoir (Ross and

Bustin 2009, Clarkson et al. 2012). By integrating geochemical properties within a stratigraphic and geographic context, the ability to identify and predict organic matter enrichments geographically and stratigraphically away from data control is improved significantly (Ver Straeten et al. 2011, Dong et al. 2015, Wang and Carr 2012, Vaughn et al. 1996).

In this study of the Duvernay Formation, geographic variation in mineralogical, provenance and redox proxies were assessed by examining wells representing varied paleogeographic settings. Each location was influenced by different sediment inputs and degrees of restriction. Stratigraphic patterns of geochemical signatures were determined by investigating the variability in geochemical and sediment provenance proxies on cross plots and ternary diagrams. Finally, the conditions that promoted organic matter accumulations were studied by exploring the relative influence of preservation and dilution. Utilizing an independently formulated sedimentological and stratigraphic study, the geochemical results are placed in the context of lithofacies classification and of sea level.

2. Geologic Setting

2.1 Climate, Paleogeography and Sea Level in the Devonian

Earth climate from the Silurian to the Late Devonian was characterized by the "mid-Paleozoic warm interval" (Brezinski et al. 2008). Evidence of glacial deposits in Brazil (Isaacson et al. 2008) and the eastern United States indicate worldwide cooling in the Late Devonian (Brezinski et al. 2008). The Late Devonian was characterized by large epicontinental seaways and to a lesser extent, cratonic sags (Klemme and Ulmishek 1991, Algeo et al. 2007). Present day Alberta occupied much of the Western Canada Sedimentary Basin (WCSB) and was

mostly flooded, except for topographic highs such as the Canadian Shield, Peace River Arch (PRA) and West Alberta Ridge (WAR) (Figure 1, Algeo et al.2007). Organic-rich marine shales were deposited widely in the WCSB and elsewhere in North America during the Devonian (Figure 1; Algeo et al. 2007, Klemme and Ulmishek 1991). The Eifelian to late Frasnian is characterized by an overall transgression which has several, smaller-scale transgressive-regressive (T-R) cycles superimposed on the main trend (Algeo et al. 2007). Restricted basins are vulnerable to even relatively minor fluctuations in sea level (Harris et al. 2013), where eustatic transgression and associated sediment starvation can result in black shale intervals that are more organic-rich than others (Algeo et al. 2007).

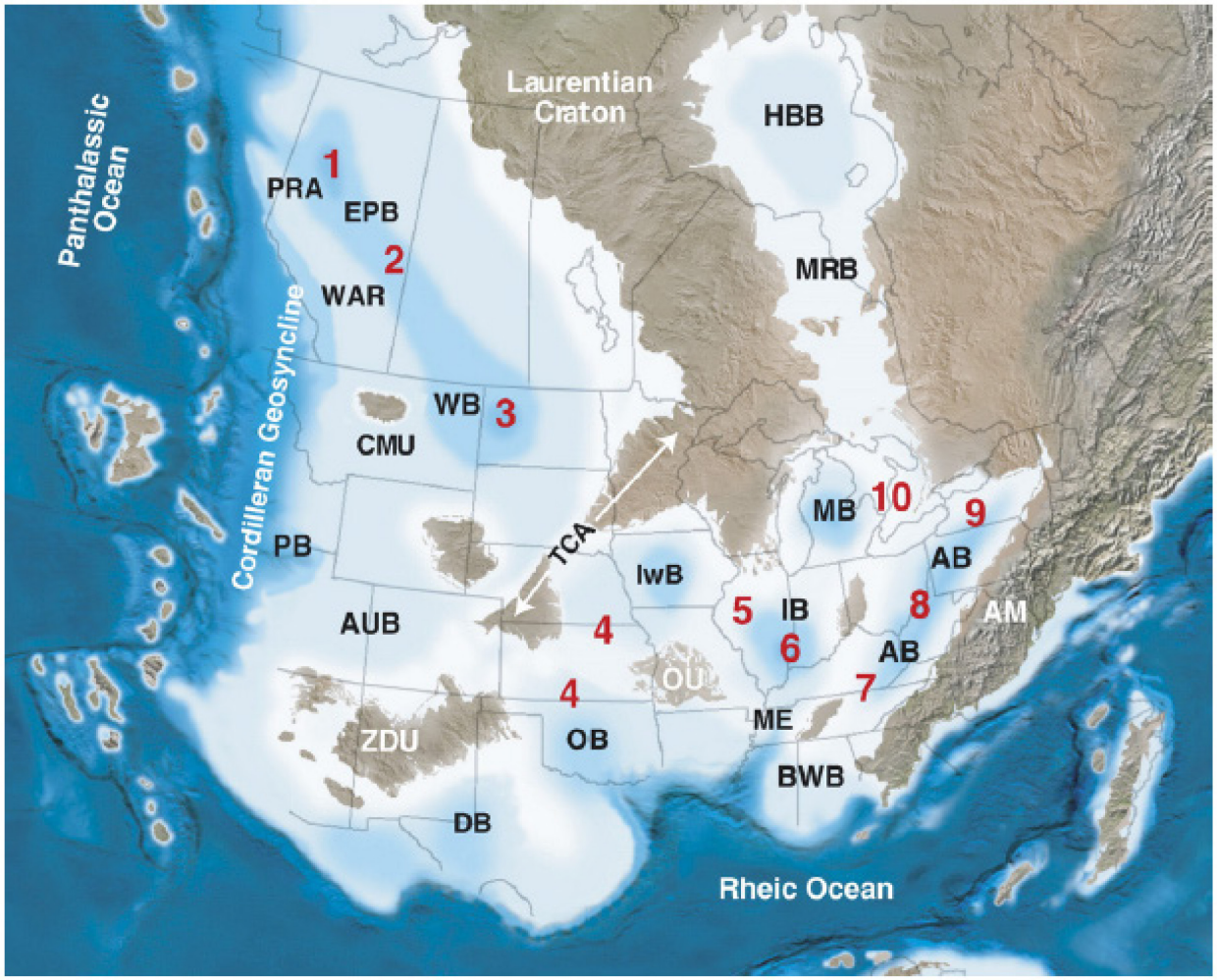


Figure 1. Paleogeography of the Upper Devonian of North America (Algeo et al. 2007, used with permission). "Geographic abbreviations: AB = Appalachian Basin, AM = Appalachian Mountains, AUB = Ancestral Uinta Basin, BWB = BlackWarrior Basin, CMU = Central Montana Uplift, DB = Delaware Basin, EPB = Elk Point Basin, HBB = Hudson Bay Basin, IB = Illinois Basin, IwB = Iowa Basin, MB = Michigan Basin, ME = Mississippi Embayment, MRB = Moose River Basin, OB = Oklahoma Basin, OU = Ozark Uplift, PB = Pilot Basin, PRA = Peace River Arch, TCA = Trans-Continental Arch,WAR = West Alberta Ridge, WB = Williston Basin, ZDU = Zuni-Defiance Uplift" Numbers correspond to stratigraphic columns in Algeo et al. 2007.

2.2 Local Paleogeography

The study area is presently located in the WCSB but at the time of deposition was located on the passive margin of North America during the Frasnian (Figure 1) (Potma et al. 2001, Weissenberger 1994, Algeo et al., 2007). During the Frasnian, the WCSB was characterized by several defining structural features: the Peace River Arch-Athabasca Arch to the northwest, the West Alberta Ridge to the southwest, the Meadow Lake Escarpment to the southeast, and the Rimbey Arc separating the basin into two sub-basins (Figure 2). The sediments that now form the Duvernay Formation were deposited in both sub-basins; 1) the West Shale Basin (WSB), and 2) East Shale Basin (ESB) which were separated by a line of more or less continuous reefs (Figure 3).

The Grosmont Platform to the northeast was connected to major reef complexes to the south two semi-continuous reef complexes extending to the south: the Killiam Barrier Reef effectively defines the eastern extent of the ESB and connects with the Bashaw Reef Complex in the south; the Morville and Rimbey-Meadowbrook Trends defines the dividing line between the WSB and the ESB and connect to the Cheddarville Reef Complex in the south (Figure 3).

Isolated platforms, pinnacle reefs and larger reef complexes including the Leduc Fringing Reefs along the PRA occur throughout both basins, although they are concentrated to the west and south. Smaller sub-basins such as the Wild River Sub-basin, and embayments such as Westerdale, Ghost Pine and Clearwater exist between reef complexes. Major reef complexes such as the Cheddarville, Bashaw, Fairholme and Southesk Cairn complexes are separated by several channels, notably the Cline Channel, although others with less well-defined extent are present (Figure 3).

An overlay of the main features for the WSB and ESB including well locations is summarized in Figure 3. Determining paleobathymetry of the Duvernay Formation is challenging. Some areas were restricted and others were connected to the open ocean. Circulation patterns and their impacts on sediment transportation, nutrient distribution and subsequent organic productivity are not well understood in this area. However, a paleoclimatic model indicates that the western margin of North America experienced oceanic upwelling events on a seasonal scale that brought nutrient rich, organic poor waters into embayments along the edge of reef complexes (Mallamo 1995). It is not clear if, or how far these upwelling currents moved nutrient-rich, oxygen-poor water into the West Shale Basin itself as outcrops and well control are limited in the south and west limiting constraints on geographic barriers (Mallamo 1995). The main connection between the West Shale Basin and the open ocean was through a narrow opening to the north of the basin between the PRA and the Grosmont Platform. Given that it is located just south of the paleo-equator on the east margin of an ocean, the WSB is potentially a candidate for an upwelling site. However, modern analogs for upwelling systems such as the Peru or Namibia margins are typically convergent or passive margins and have simple slope geomorphologies. The system of reefs along the Devonian margin of western North America may have blocked any upwelling from penetrating along the shelf. The Late Devonian paleogeography epeiric sea does not have a present-day analogue.

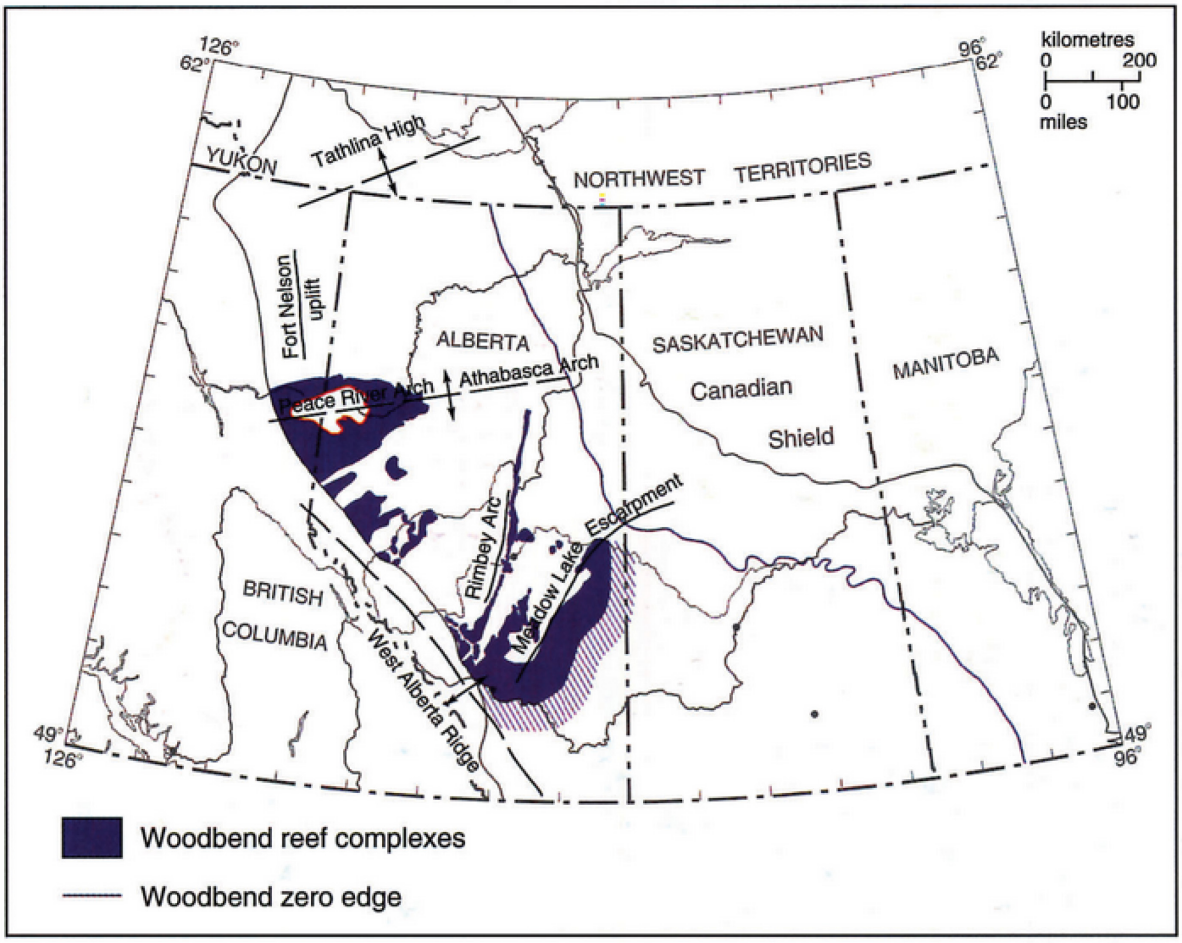


Figure 2. Structural features and lineaments during the Devonian in the WCSB (Atlas of the Western Canada Sedimentary Basin Figure 12.6, used with permission of the Alberta Energy Regulator and the Canadian society of Petroleum Geologists).

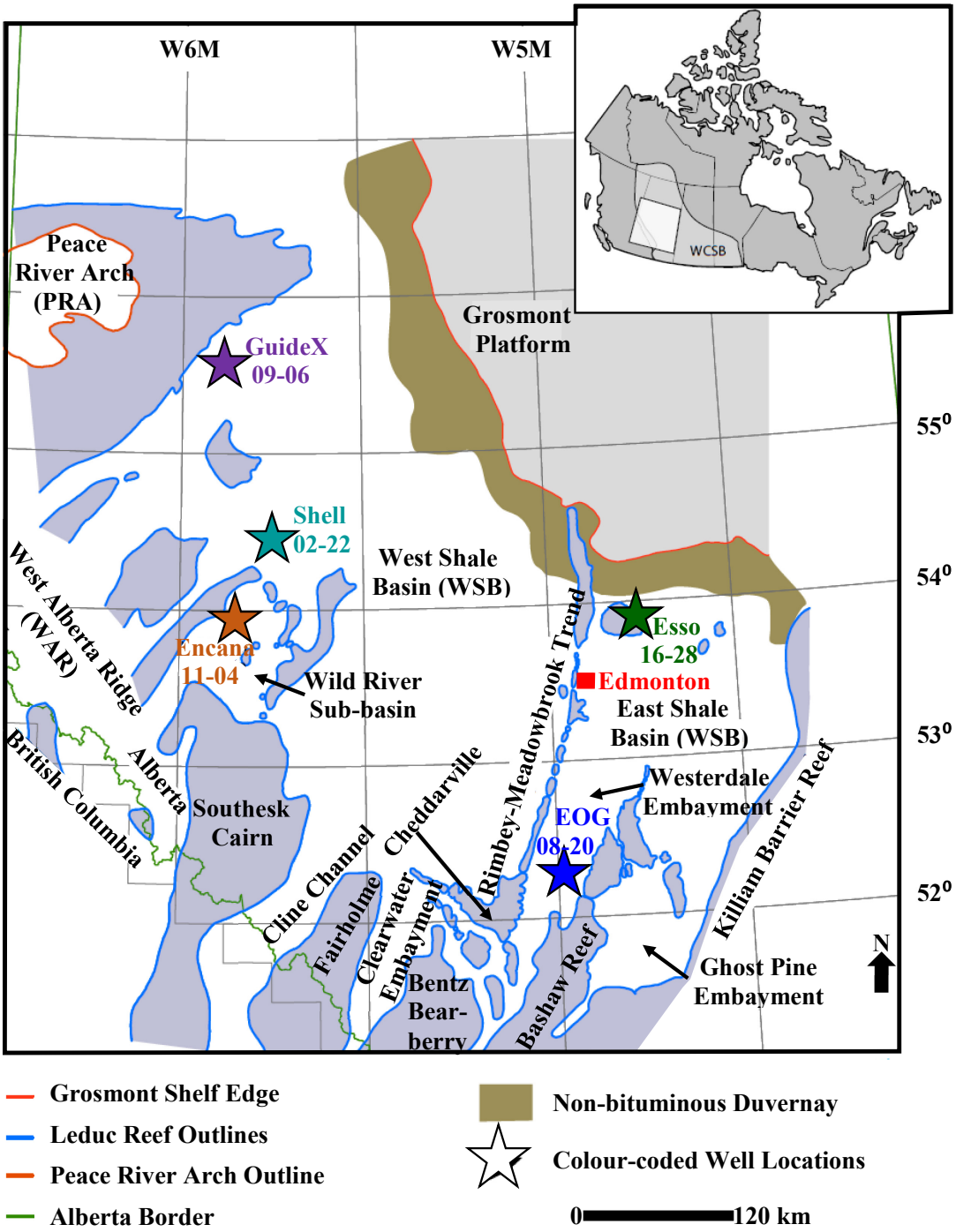


Figure 3. Summary of important features in the WSB and ESB (after Weissenberger and Potma 2001 and Atlas of the Western Canada Sedimentary Basin Figure 12.11). Base map modified from Knapp (2016) and used throughout with permission. Outlines of Woodbend Reef Complexes source from Switzer et al. (1994).

2.3 Study area and Well Locations

Three cores lie within the WSB (Figure 3): Guidex Gville 100-09-06-76-23W5 (Guidex 09-06), Shell Kaybob 100-02-22-63-20W5 (Shell 02-22) and Encana Cecilia 100-11-04-58-23W5 (Encana 11-04). Guidex 09-06, the northernmost well, is located a short distance from the Leduc platform that fringes the PRA, and is closest to the main opening of the WSB to the north. Shell 02-22, the most basinward (reef-distal) well is located to the northeast of Leduc reef complexes extending from the Southesk Cairn Complex that isolates the Wild River Sub-basin. Encana 11-04, the westernmost well, is located within the Wild River Sub-basin, which has a narrow opening to the west.

Two cores are located in the ESB (Figure 3): Esso Redwater 102-16-28-57-21W4 (Esso 16028) and EOG Cygnet 100-08-20-38-28W4 (EOG 08-20). Esso 16-28 lies near the northern margin of the ESB, located just south of the Cooking Lake platform on the edge of the Redwater pinnacle reef. This well drilled the reef and reef slope rather than the basinal facies. EOG 08-20 is located in the Westerdale Embayment just northwest of the Bashaw Reef Complex at the southern end of the ESB.

The degree to which currents can access a location dictates whether it is considered as open or restricted. If a location is completely surrounded by landmasses or reefs, it would be considered restricted. On the other hand, being located in a corner of the basin or having a reef on one side may or may not result in restriction. It is not straightforward to determine with certainty which locations are completely or partially restricted without detailed current reconstructions. If a location has unobstructed communication to the ocean or is near one of the openings into the basin, it would be considered open. Guidex 09-06, Shell 02-22 in the WSB and EOG 08-20 in the ESB all have relatively un-restricted geographic locations. On the other

hand, Encana 11-04 has a relatively restricted setting as it is enclosed on three sides by reef complexes. Esso 16-28 is somewhat restricted as it sits on the edge of a patch reef in the NW corner of the ESB. Low oxygen conditions tend to form in deeper or more restricted parts of basins.

2.4 Devonian Stratigraphy of Alberta

Guidex 09-06, Shell 02-22 in the WSB and EOG 08-20 in the ESB all have relatively un-restricted geographic locations. On the other hand, Encana 11-04 has a relatively restricted setting as it is enclosed on three sides by reef complexes. Esso 16-28 is somewhat restricted as it sits on the edge of a patch reef in the NW corner of the ESB. Low oxygen conditions tend to form in deeper or more restricted parts of basins.

The Duvernay Formation was first named in 1950 when the formalized naming convention for the Devonian was established in the WCSB (Imperial Oil Ltd Geological staff 1950). The Duvernay Formation is underlain by the carbonates of the Majeau Lake Formation and Cooking Lake Formation and overlain by the shale clinoforms of the Ireton Formation (Stoakes 1980, Potma et al. 2001, Figure 4). The Duvernay Formation is a succession of basinal shales and limestones characterized by organic-rich laminites occurring in two main intervals separated by a lean (organic matter poor) lime mudstone (Chow et al. 1995). These two organic-rich intervals merge north of the Peace River Arch (PRA) and into northeastern British Columbia forming the coeval Muskwa Formation. The upper organic-rich laminites are coeval with the Middle Leduc reefs as indicated by Duvernay sediments that intertongue with these shallow water carbonates (Figure 4) (Chow et al. 1995).

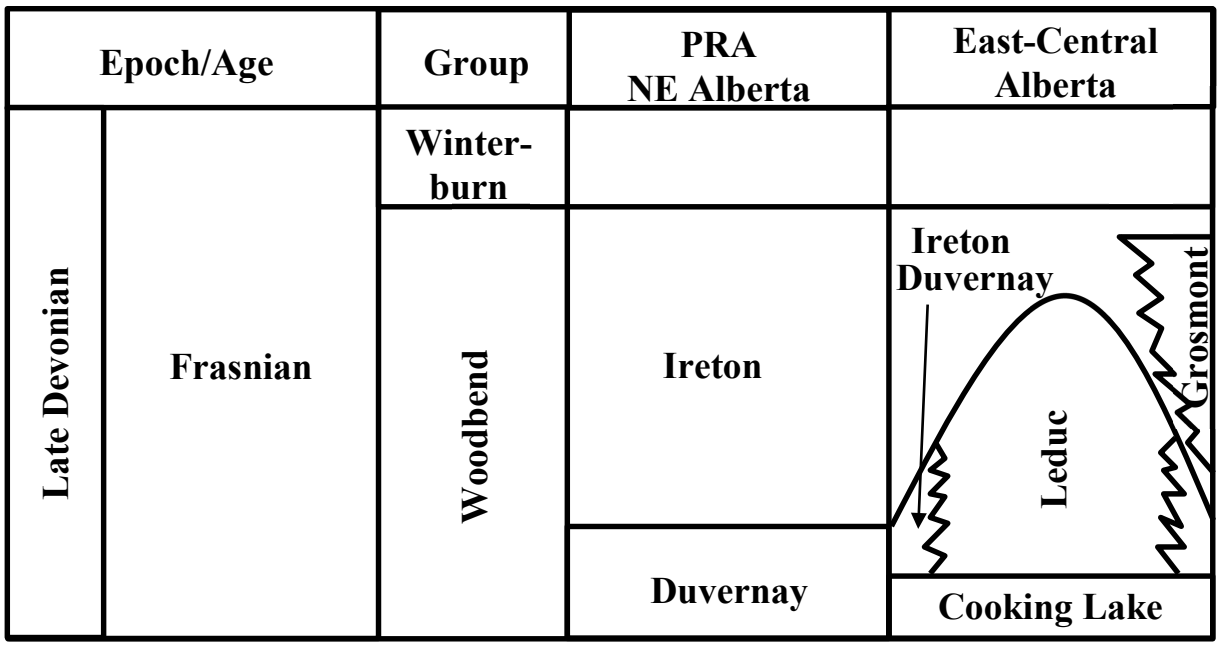


Figure 4. Stratigraphic Extent of the Duvernay Formation (redrawn after Chow et al. 1995).

2.5 Local Lithofacies and Stratigraphic Context

The Duvernay can be subdivided into three third order sea level cycles (TST-RST) (Knapp 2016). System tracts are defined on a sedimentological basis, are numbered from bottom up and subdivide the Duvernay Formation into lower, middle and upper members (Figure 5). TST1-RST1 (DS1) correspond to the lower member and middle member, the middle cycles, TST2-RST2 (DS2) correlate to the lower half of the upper member and the upper cycles, TST3-RST3 (DS3) represent the upper half of the upper member.

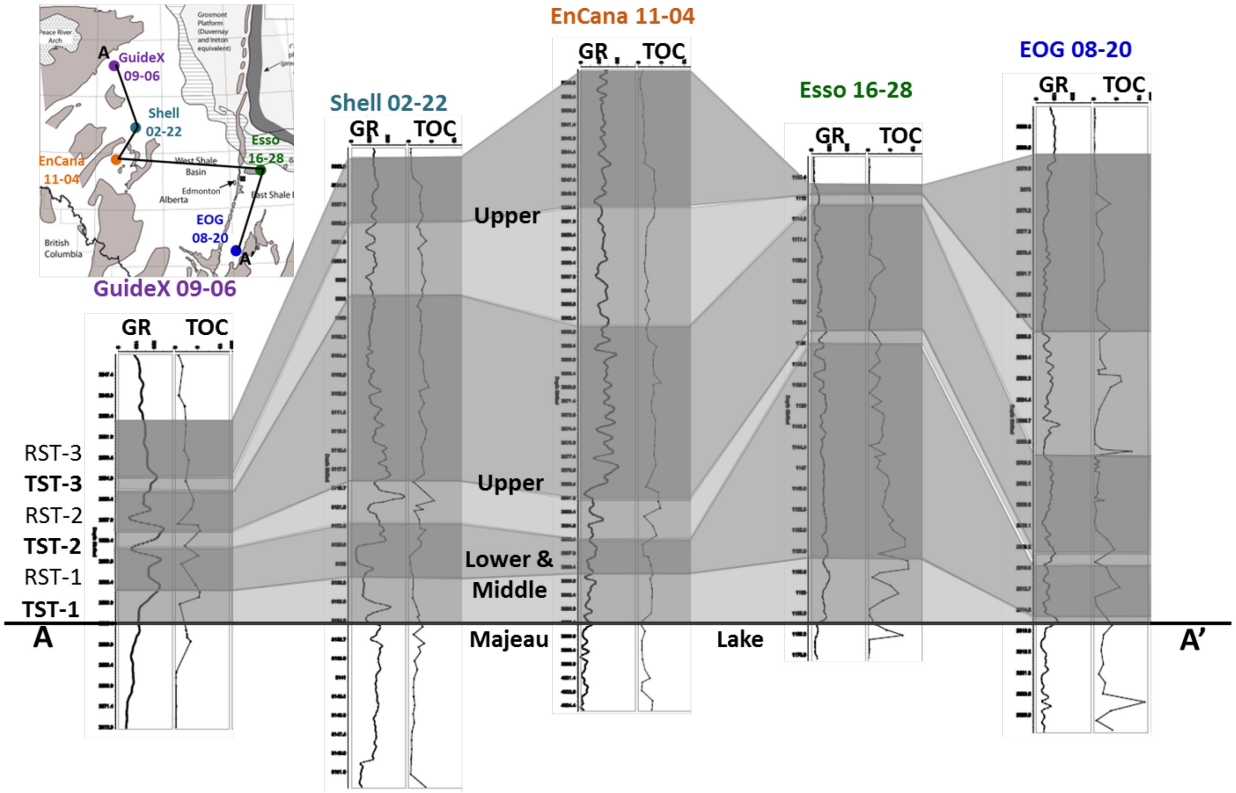


Figure 5. Local stratigraphic context as laid out in Knapp 2016: TST-RST cycles and corresponding sub-units of the Duvernay are labelled. The TST1-RST1 cycle is equivalent to the lower and middle members, the TST2-RST2 cycle is equivalent to the first half of the upper member and the TST3-RST3 cycle is equivalent to the second half of the upper member. Cross section from A to A' displays wells from north to south in the WSB (Guidex 09-06, Shell 02-22 and Encana 11-04) followed by wells in the ESB from north to south (Esso 16-28 and EOG 08-20).

2.5.1 Lithofacies Summary

Six facies associations are represented in the Duvernay Formation. A summary of the lithofacies developed is provided below as an excerpt from Knapp (2016).

FA1: Planar-laminated, organic-rich mudstones

Facies association 1 consists of planar-laminated, siliceous, organic-rich mudstones. Much of the rock consists of mud-supported laminae containing very fine calcite detritus with minor dolomite and quartz. Mud-supported laminae contain a variety of biogenic pelagic sediments including organic-matter aggregates, planktonic foraminifera, and rare clay-mineral aggregates. Thin, grain supported laminae are composed of calcite, dolomite, and quartz silt to very fine sand. Grain-supported laminae show both normal and inverse grading. Uncommonly, lamination is defined by discontinuous planar laminae consisting of framboidal pyrite and variable amounts of pyritized calcite detritus. The average TOC for FA1 is 3.4 wt% (SD=1.6, n=57).

FA2: Wavy laminated silty mudstones

Facies association 2 consist of siliceous to calcareous silty mudstones that show a variety of sedimentary structure. Laminae typically show wavy to lenticular lamination, but sedimentary structures may also include planar parallel lamination, low angle cross-lamination, starved ripples, loading structures, and flame structures. Laminae are typically grain-supported and show both normal and inverse grading. Grain size is typically fine silt to medium sand, with grains consisting primarily of carbonate with minor quartz and rare chert clasts. Laminae may contain uncommon bioclast fragments including styliolinids, tentaculitids. Bioturbation is minor to moderate. Alternating with coarse-grained laminae are mud-support organic-rich laminae with the same characteristics as those of FA1. The average TOC for FA2 is 2.4 wt% (SD=0.5, n=10).

FA3: Bioturbated pyritic mudstones

FA3 is composed of dark grey-brown poorly bedded mudstone with pyritized burrows. FA3 is more argillaceous than FA1-2. Where bedding is preserved, it appears as wispy, wavy laminae, although commonly no bedding is evident. Laminae are observed as subtle variations in color due to varying silt abundance. Silt-sized grains are dominantly dolomite and calcite silt, calcareous fossil fragments, and minor quartz. Bedding is disrupted by subhorizontal to subvertical burrows that are enriched in pyrite. Clay- and silt-sized carbonate, quartz, clay minerals, and organic matter comprise most of the rock. In-situ benthic macrofossils such as brachiopods, bivalves, and gastropods are common and in-situ benthic agglutinated foraminifera are moderately common. The average TOC for FA3 is 2.1 wt%. (SD=1.3, n=69).

FA4: Nodular limestone

FA4 is composed of nodular to burrow-mottled lime mudstone and wackestone. Light grey calcite nodules are hosted in dark grey mudstones to wackestones. Nodules range from very irregular and burrow-mottled to ovoid to near-planar, and commonly contain spar-filled, wedge-shaped fractures. Burrows are preferentially cemented with calcite. Detrital grains within nodules are predominantly clay- and silt-sized calcite and calcareous fossil fragments. Taxa are most commonly styliolinids, tentaculitids, and brachiopods. Nodules are surrounded by more ductile, uncemented mudstone, which deforms and drapes around nodules. Dark grey mudstone is massive to poorly bedded, and is calcareous to argillaceous. The average TOC for FA4 is 1.1 wt% (SD=1.2, n=34).

FA5: Organic-lean argillaceous-dolomitic mudstones

FA5 is composed of organic-lean argillaceous-dolomitic mudstones. Mudstones are laminated to thinly-bedded and bedding quality ranges from moderately well-laminated to massive. Millimeter- to centimeter-scale light grey-brown organic lean laminae/beds alternate with 1-2mm thick dark grey, more organic-rich laminae. Bedding contacts may be sharp but are most commonly gradational over 1-2mm, and are usually irregular due to bioturbation. Bioturbation ranges from moderate to intense. Horizontal to subhorizontal burrows are more common than subvertical burrows. Subvertical burrows are rarely more than a few millimeters to one centimeter long. No fossiliferous material was observed in core. FA5 was not sampled, analyzed for TOC, or thin sectioned so no microscopic detail is reported here. Relative organic richness is estimated based on color.

FA6: Nodular dolostone

FA6 is nodular to burrow-mottled buff-colored dolomitic mudstone. Bedding is nodular to irregular and burrow-mottled. Poorly bedded dolomitic-argillaceous mudstone is deformed around nodules. Fossils are rarely observable in core but include brachiopod and crinoid fragments. Anhydrite is common within burrows. Uncommonly, nodules contain wedge-shaped fractures filled with calcite, dolomite and/or anhydrite. Rarely, anhydrite nodules are observed. FA6 is organic-lean. FA6 was not sampled, analyzed for TOC, or thin sectioned so no microscopic detail is reported here. Relative organic richness is estimated based on color.

2.5.2 Sequence Stratigraphic Framework

A summary of the sequence stratigraphic framework developed is provided below as an excerpt from Knapp (2016).

> *The Duvernay Formation comprises three 3rd order depositional sequences (DS1-3). DS1 is composed of lower and middle Duvernay sediments, while both DS2 and DS3 occur within the upper Duvernay. DS1 and DS2 each consist of a transgressive systems tract (TST), followed by a highstand systems tract (HST), without any lowstand or falling stage deposits. The base of DS3 is interpreted to be a lowstand (LST) or stillstand (SST), as clastic sediments are strongly progradational but no evidence for significant sea level fall exists. Above the LST/SST, DS3 consists of a TST and HST.*
>
> *The base of DS1 marks the onset of transgression at the top of the Majeau Lake Formation. Over much of the basin, siliceous, organic-rich Duvernay mudstones of FA1 overlie more argillaceous and organic-lean mudstones of the Majeau Lake Formation. FA1 is deposited over a greater geographic extent of the basin throughout the DS1 TST. During the DS1 TST, FA6 and FA5 were deposited primarily in the northern West Shale Basin (WSB), with FA4 being deposited between the basin margin deposits of FA5-6, and basinal deposits of FA1. During the DS1 HST, FA5-6 deposits are especially thick in the northeastern part of the basin and aggrade and prograde to the south and west. FA4 becomes the dominant lithofacies across much of the WSB and ESB (middle Duvernay carbonate) and grades westward and southward in FA1. DS1 is a period of platform construction, thick deposits of FA5-6 result in strong platform aggradation in the northeast part of the basin.*
>
> *The base of DS2 is a major flooding surface at the top of the middle Duvernay carbonate. Through the DS2 TST, the geographic extent of FA1 deposition expands drastically. Northeast-derived clastic sediments are significantly backstepped and do not prograde beyond the platform slope break created during DS1, creating a zone of non-deposition. This results in especially organic-lean mudstones in the basin. During the DS2 highstand, silty mudstones of FA2 become more common as a result of highstand shedding of reef complexes. During the late DS2 HST, westerly-derived clastics begin to encroach on the basin, resulting in an increasing dominance of FA3 in the Wild River Subbasin. FA5 progrades along the eastern edge of the WSB*
>
> *The base of DS3 is marked by rapid progradation of argillaceous FA3 from the west and argillaceous-dolomitic FA5-6 from the northeast. Organic-rich, siliceous mudstones of FA1 are directly overlain by more argillaceous and organic-lean mudstones FA3 over much of the basin. This rapid progradation is the result of a sea level lowstand or stillstand. Above the DS2 LST/SST, facies backstep again through the TST, although not as significantly as in DS2. DS2 HST sees slow progradation. FA3 again becomes dominant in the Wild River Subbasin. FA5-6 prograde south along the eastern WSB.*

2.5.3 Summary of Sediment Sources

A summary of sediment sources interpreted from sedimentology and stratigraphy provided below as an excerpt from Knapp (2016).

> *Duvernay Formation lithofacies show evidence for several sediment sources. Sediments are a mixture of clastic, carbonate, and biogenic sediment, the proportions of which are variable both stratigraphically and geographically.*
>
> *Biogenic sediment is in the form of siliceous and calcareous planktonic organisms and organic matter that settled as aggregates. Biogenic sediment, specifically organic matter is most abundant where carbonate and clastic detrital flux is low. Geographically, the proportion of sediment that is biogenic increases with increasing distance from Leduc Formation reefs, Grosmont Platform carbonates, and clastic sources in the northeast and west. Stratigraphically, biogenic sediment is most abundant during transgression when detrital flux to the basin is reduced due to an increase in accommodation space. Biogenic sediment is most abundant in planar-laminated, organic-rich mudstones of FA1.*
>
> *Carbonate sediments were primarily sourced from Leduc Formation reef complexes and the Grosmont Platform, with a minor biogenic component. Carbonate detrital flux and grain size increases with increasing proximity to sources. The East Shale Basin is more calcareous than the West Shale Basin due to the abundance of reef complexes. Carbonate sedimentation is greatest during highstands of sea level, a process called highstand shedding (Droxler and Schlager, 1985; Glaser and Droxler, 1993; Schlager et al., 1994; Vecsei and Sanders, 1997; Hemmesch et al., 2014).*
>
> *There were two primary clastic sediment sources. Most clastic sediment was sourced from the northeast and was deposited as thick packages of FA5 argillaceous-dolomitic mudstones adjacent to the Grosmont Platform in both the West Shale Basin and East Shale Basin. This sediment was interpreted by Stoakes (1980) to be transported along slope from the north via contour currents. During the lower and middle Duvernay (DS1), clastic sedimentation decreases westward and southward as seen by thinning of strata and grading into nodular limestones of FA4 and planar-laminated organic-rich mudstones of FA1. Transgression at the beginning of DS2 result in significant upslope trapping of northeast-derived clastics, resulting in very clay-poor basinal deposits. Through DS2 and DS3 westward stratal thinning is generally confined to the northeastern parts of the basin where FA5 and FA6 are dominant. Significant thickening of DS2 and DS3 strata occurs towards the northwest, interpreted to be the result of Peace River Arch – derived clastic sedimentation. This stratal thickening coincides with a gradation of lithofacies from planar-laminated, organic rich mudstones of FA1 into bioturbated, pyritic, more argillaceous mudstones of FA3.*

3. Materials and Methods:

3.1 Materials

Cores were selected in order to represent both the West Shale Basin and East Shale Basin, a range in maturity, variable proximity to different sediment sources and various degrees of physical restriction. Core selection was also influenced by the quality of the core and whether permission to sample could be acquired. Hand samples were comprised of pieces of rock slabbed off the back of a whole drill core at approximately 2cm depth from the edge (Figure 6A and 6B). The cut face of each hand sample was photographed for documentation before subsequent splits were cut (Figure 6C and 6D). A total of 360 hand samples were cut from the five wells at approximately one meter intervals in order to provide a high resolution geochemical profile of the Duvernay of stratigraphic significance. Sampling locations were chosen in order to target organic rich mudstones as well as a representative cross section of lithofacies end members. The sampling protocol primarily targeted the Duvernay formation although a few samples were taken from the overlying Ireton Formation and underlying Majeau Lake Formation for context. In the case of the EOG 08-20 well, the standards sampling protocol was supplemented by three intervals of continuous intense sampling (one 10cm sample continuously for ~approximately 3m total) in an attempt to capture any geochemical changes accompanying the high frequency sedimentological variation observed. Samples were collected from the wells as follows: ninety-four samples were collected from the Shell Kaybob 02-22 by; ninety-two samples from EOG 08; thirty-one samples from Guidex 09-06; seventy samples from Esso 16-28; and seventy-three samples from Encana 11-04.

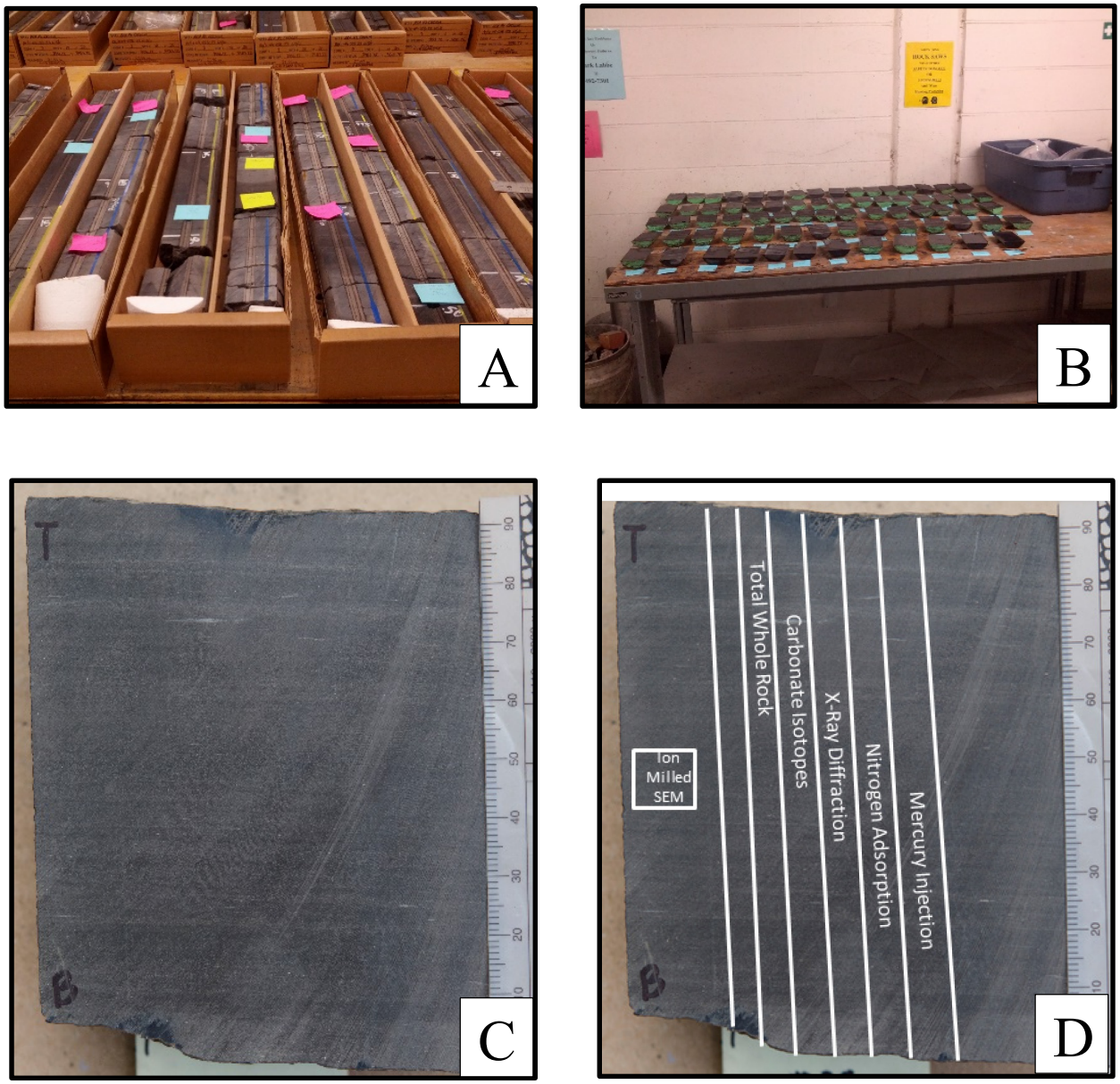


Figure 6. Sampling location laid out on core (6A). Cut hand samples (6B). Photo capturing features of cut face of a hand sample (6C). Schematic of how hand samples were sectioned by splitting along the length of the sample (6D).

3.2 Methods

Splits were cut by vertically sectioning each sample in order to send representative sub samples for various analyses (Figure 7A, 7B and 7C). One split from each sample was analyzed by Weatherford Laboratories for total organic carbon (TOC), hydrogen index (HI) and oxygen index (OI) in order to assess organic matter abundance and maturity. LECO combustion was used to determine TOC and the Weatherford Source Rock Analyzer was used to analyze the Rock-Eval parameters (HI, OI, Tmax, S1, S2, S3). A summary of additional data collection performed (hand sample photos, SEM photos, ion milling, XRD, BET, nitrogen adsorption, mercury injection, helium porosimetry, Dean Stark treatment) can be found in Appendix A, K-P.

A second split of each sample was sent to Acme Analytical Laboratories for Inductively Coupled Plasma (ICP) and ICP-Mass Spectrometry (ICP-MS) analysis in order to determine elemental abundances. Elements analyzed in the total whole rock characterization package included major oxides and major and minor trace elements. Samples were pulverized until 85% of the material passed through a 200 mesh (70 μ) and portioned into three sub-splits. Following lithium borate fusion and dilute acid digestion, one sub-split was analyzed by ICP for major oxides and a second sub-split was analyzed by ICP-MS for rare earths and refractory elements. Following aqua regia digestion, a third sub-split was analyzed by ICP-MS in order to analyze precious metals plus As, Bi, Cd, Cu, Hg, Mo, Ni, Pb, Sb, Se, Tl and Zn (Acme Analytical Laboratories Ltd., 2013).

Internal Acme Analytical Laboratories standards for the ICP and ICP-MS were analyzed along with each batch of samples: SO-18 for silicate-rich rocks including major oxides, rare earths and some metals; DS10 and OREAS45EA for trace metals; and GS311-1 and GS910-4 for total S and C.

Sample batches from the Guidex 09-06, Encana 11-04, Esso 16-28 and EOG 08-20 wells, were submitted with international shale standards as unknowns: Cody Shale for EOG 08-20 and Guidex 09-06; Brush Creek Shale and Carbonaceous Shale (Koolstofhoudende Skalle) for Esso 16-28 and Encana 11-04. Information on international shale standards and internal Acme standards is provided in Appendices A-D. A list of samples and analyzed values can be found in Appendix C.

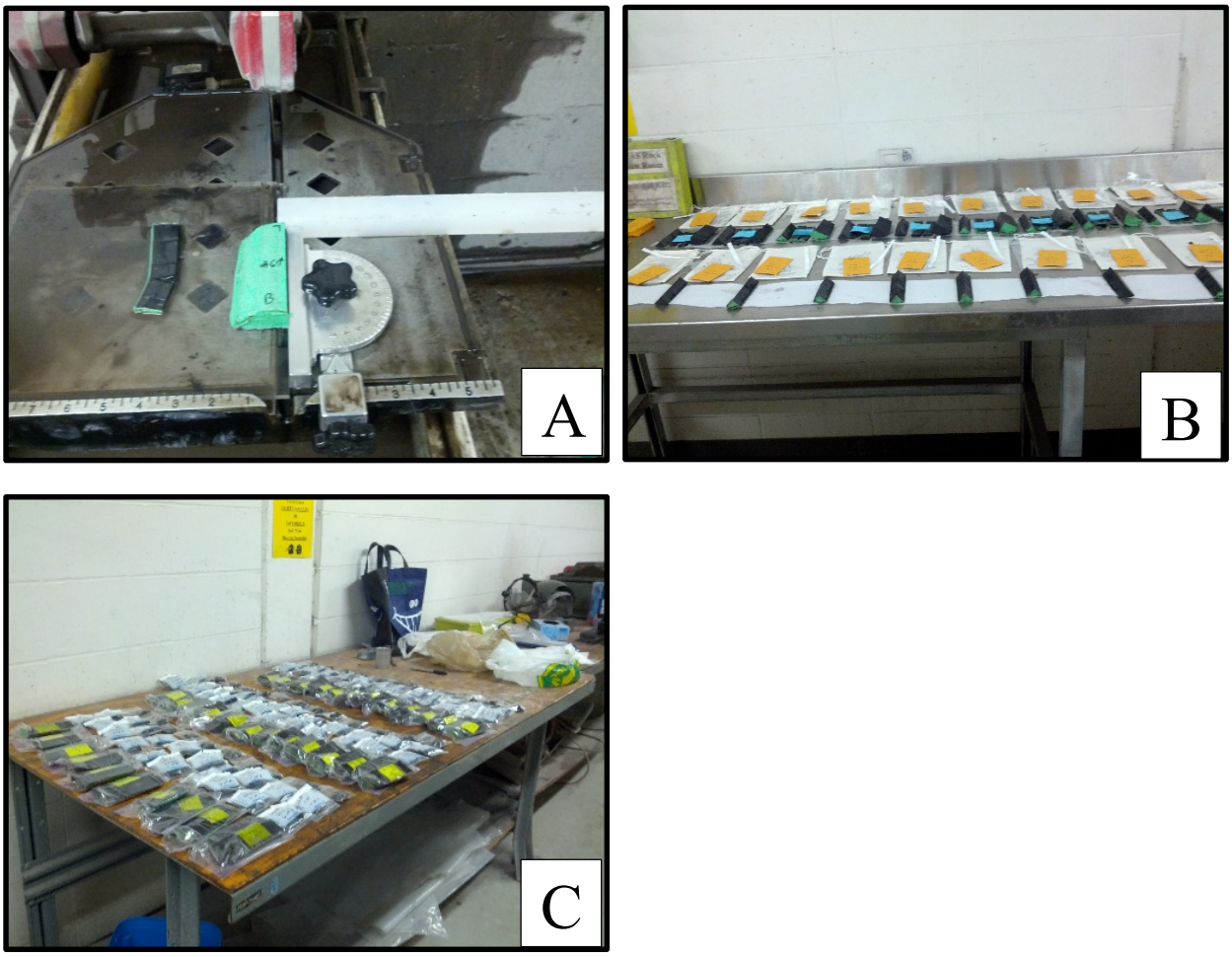


Figure 7. Cutting a split from a hand sample (7A). Multiple splits from each hand sample in order to send representative sub samples for different analyses (7B). Splits packaged for shipping and remaining sample material (7C).

4. Results in a Geographic and Stratigraphic Context:

4.1 Accuracy and Precision of International Shale Standard Analysis

Major minor and trace element data was verified using international shale standards. Table 1 shows the analyzed and published international shale standard values with standard deviation shown for relevant geochemical values. A complete table of all published and analyzed standard values can be found in Appendix D. Table 1 shows a comparison of published and analyzed standard values for relevant geochemical values. Table 2 shows the difference between the published values and the analyzed results (standard value-analyzed value) and the published standard deviation.

	Cody Sh Analy. Values	**Cody Sh Analy. Values**	**Cody Sh Stand. Values**	**Brush Creek Analy. Values**	**Brush Creek Sh Stand. Values**	**Carb. Sh Analy. Values**	**Carb. Sh Stand. Values**
Well ID	08_20	09_06	**08-20 09-06**	11_04 &16_28	**11_04 &16_28**	11_04 &16_28	**11_04 &16_28**
SiO_2 (%)	62.69	62.96	**62.8±0.66**	46.77	**47.64±.09**	54.65	**56.67**
$Al2O_3$(%)	13.39	13.85	**13.7±0.21**	21.3	**21.0±0.04**	13.26	**13.5**
Fe_2O_3(%)	5.07	5.17	**4.19±0.19**	9.86	**9.71±0.02**	4.19	**4.23**
MgO (%)	2.66	2.79	**2.72±0.18**	2.65	**2.60±0.01**	8.24	**8.10**
CaO (%)	2.57	2.66	**2.62±0.20**	3.06	**2.95±0.01**	1.5	**1.50**
TiO_2 (%)	0.57	0.58	**0.63±0.06**	0.83	**0.86±.003**	0.55	**0.55**
U (µg/g)	2.8	3.2		5.4	**5.76±0.11**	1.8	
V (µg/g)	130	126	**130 ± 13**	223	**220±1.4**	141	**139**
Zr (µg/g)	169.4	161.9	**160±30**	126.2	**134±1.6**	121.8	**1466**
Mo(µg/g)	0.6	0.7	**1.4±0.2**	1.6	**2.4±0.07**	0.9	

Table 1. Summary of the comparison between published and analyzed values of international shale standards for relevant geochemical value: Cody Shale, Brush Creek Shale and Carbonaceous Shales. Abbreviations: Sh=Shale, Analy=Analyzed, Carb=Carbonaceous, Stand=Standard

Splits of Cody Shale standard were sent along with sample batches for EOG 08-20 and Guidex 09-06. For the Cody Shale standard, there was a difference in the analyzed values when the results of the analyses were compared (Table 2). The results from Acme are very close to the published standard values. The difference between published and analyzed results was within one standard deviation for SiO_2, MgO, CaO, TiO_2, V and Zr concentrations. This indicates that for these geochemical parameters, the accuracy of the measurement was satisfactory. In general, the analyzed major element values tend to be higher than the published values, whereas the analyzed trace element values tend to be lower than the published values.

Splits of Brush Creek Shale and Carbonaceous Shale were sent along with sample batches for Encana 11-04 and Esso 16-28. For the Brush Creek Shale Standard, analyzed values were within the standard deviation of the published values for none of the geochemical parameters measured indicating that there is an issue with accuracy (Table 2). Analyzed values for major elements were generally higher than the published values. Analyzed V values were higher than published values whereas analyzed Mo values were lower. For the Carbonaceous Shale standard, no standard deviation values were available. In general, analyzed major element values for this standard were lower than published values except for CaO and TiO_2 which showed no difference between analyzed and published values. Analyzed V and Mo values were higher than published values.

	Cody Sh Stand. Values	Cody Sh Analy.	**Stand.-Analy. Diff**	Cody Sh Analy.	**Stand.-Analy. Diff**	**SD**	**Brush Ck Sh Stand. Values**	Brush Creek Analy.	**Stand.-Analy. Diff**	**SD**	**Carb. Sh Stand. Values**	Carb. Sh Analy.	**Stand.-Analy. Diff**	**SD**
Well ID		08-20		09-06				11-04 16-28				11-04 16-28		
SiO_2 (%)	**62.8**	62.69	**0.11**	62.96	**-0.16**	**0.66**	**47.64**	46.77	**0.87**	**0.09**	**56.67**	54.65	**2.02**	**NA**
Al_2O_3(%)	**13.7**	13.39	**0.31**	13.85	**-0.15**	**0.21**	**21**	21.3	**-0.3**	**0.04**	**13.5**	13.26	**0.24**	**NA**
Fe_2O_3(%)	**4.19**	5.07	**-0.88**	5.17	**-0.98**	**0.19**	**9.71**	9.86	**-0.15**	**0.02**	**4.23**	4.19	**0.04**	**NA**
MgO(%)	**2.72**	2.66	**0.06**	2.79	**-0.07**	**0.18**	**2.6**	2.65	**-0.05**	**0.01**	**8.1**	8.24	**-0.14**	**NA**
CaO(%)	**2.62**	2.57	**0.05**	2.66	**-0.04**	**0.20**	**2.95**	3.06	**-0.11**	**0.01**	**1.5**	1.5	**0**	**NA**
TiO_2(%)	**0.63**	0.57	**0.06**	0.58	**0.05**	**0.06**	**0.86**	0.83	**0.03**	**.003**	**0.55**	0.55	**0**	**NA**
U(µg/g)		2.8	**-2.8**	3.2	**-3.2**		**5.76**	5.4	**0.36**	**0.11**		1.8	**-1.8**	**NA**
V(µg/g)	**130**	130	**0**	126	**4**	**13**	**220**	223	**-3**	**1.4**	**139**	141	**-2**	**NA**
Zr(µg/g)	**160**	169.4	**-9.4**	161.9	**-1.9**	**30**	**134**	126.2	**7.8**	**1.6**	**146**	121.8	**24.2**	**NA**
Mo(µg/g)	**1.4**	0.6	**0.8**	0.7	**0.7**	**0.2**	**2.4**	1.6	**0.8**	**0.07**		0.9	**-0.9**	**NA**

Table 2. Summary of the difference between the published values and the analyzed results (standard value-analyzed value) and the published standard deviation for international shale standards: Cody Shale, Brush Creek Shale and Carbonaceous Shales. Abbreviations: Sh=Shale, Analy=Analyzed, Carb=Carbonaceous, Stand=Standard, Diff=Difference.

4.2 Organic Geochemistry

4.2.1 Tmax Values

Tmax is a thermal maturity parameter, derived from Rockeval pyrolysis analysis. Maturity ranges are defined by (Cardott 2014): immature if Tmax<435 (R_o 0.2-0.6); in the oil window if Tmax is ranges from 435-470 (R_o 0.6-1.35); in the wet gas window if Tmax ranges from 460-485 (1.35<R_o); in the dry gas window if the Tmax is ranges from 465-490; and overmature if Tmax>490. Tmax values can be affected by imbibition of oil-based drilling mud during coring, migrated hydrocarbons, changes in organic matter type, or low quality data (low TOC or low S2 values). In order to address quality control issues indicated by large variation in Tmax and values that are inconsistent with overall basin trends, samples with S2 values greater than one are in Appendix F and samples with S2 less than one are indicated in the Appendix F. Samples with S2 values less than one were excluded as per Peters and Cassa (1994). Following elimination of suspect data, Encana 11-04 had only 3 data points that met the criteria and so results from this well are less conclusive as for the other four wells.

In the Duvernay Formation, Tmax values for all wells range from 301 ^{0}C to 536 ^{0}C with an average of 442 ^{0}C (Figure 8, Table 3). Table 3 provides a summary of minimum (min), average (avg) and maximum (max) Tmax values for all five wells and key geochemical parameters explored in the data and interpretation sections. Similar tables specific to each well can be found in Appendix E and relevant subsets of these tables will be presented in the text. Tmax values increase down dip in the basin from northeast to southwest and show significant variations between ESB and WSB, as well as locally in each sub basin (Figure 8). A full list of Tmax values and excluded samples can be found in Appendix F. Tmax values for each well are as follows: Guidex 09-06 ranges from 432 ^{0}C to 448 ^{0}C with an average of 444 ^{0}C, Shell 02-22

ranges of 454 ^{0}C to 483 ^{0}C with an average of 473^{0}C, Encana 11-04 ranges from 364-377 ^{0}C with an average of 369 ^{0}C. Esso 16-28 ranges from 415 ^{0}C to 430 ^{0}C with an average of 421 ^{0}C, and EOG 08-20 ranges of 438 ^{0}C to 454 ^{0}C with an average of 448 ^{0}C (Figure 8, Table 4). Tmax values can be converted to the more familiar vitrinite reflectance. Ro values were calculated according to the formula developed by Jarvie: Ro=0.0180*Tmax-7.16 (from Raphael 2013 after Jarvie et al. 2001). Equivalent Ro values for average Tmax values for each well are (via the Jarvie equation): 0.83% for Guidex, 1.53% for Shell 02-22, -0.52% for Encana 11-04 (indicates maturity distortion of data), 0.42% for Esso 16-28, and 0.90% for EOG 08-20. Raphael et al. (2013) noted that the conversion formula developed by Jarvie in the Barnett shale should not be used in the Duvernay (as it was developed for that particular shale play and subsequently found not to be universally applicable to all shales), so Tmax values were also converted to vitrinite reflectance (Ro) according to the formula by developed specifically for the Duvernay by Raphael et al. 2013: Ro=0.0149*Tmax-5.85. Equivalent Ro values (via Raphael et al. 2013 equation) for average Tmax values for each well are: 0.77% for Guidex, 1.20% for Shell 02-22, -0.35% for Encana 11-04 (indicates maturity distortion of data), 0.42% for Esso 16-28, and 0.83% for EOG 08-20. The results calculated via the Raphael et al. (2013) equation are consistently lower than those calculated using the original Jarvie equation. The exception is Esso 16-28 where both methods yield the same converted Ro value. Ro values were calculated in order to compare the results of both formulas although the formula developed by Raphael et al. 2013 was used because it was calibrated to the Duvernay Formation. Ro values calculated using the Raphael et al. (2013) equation for each well are shown in Figure 8.

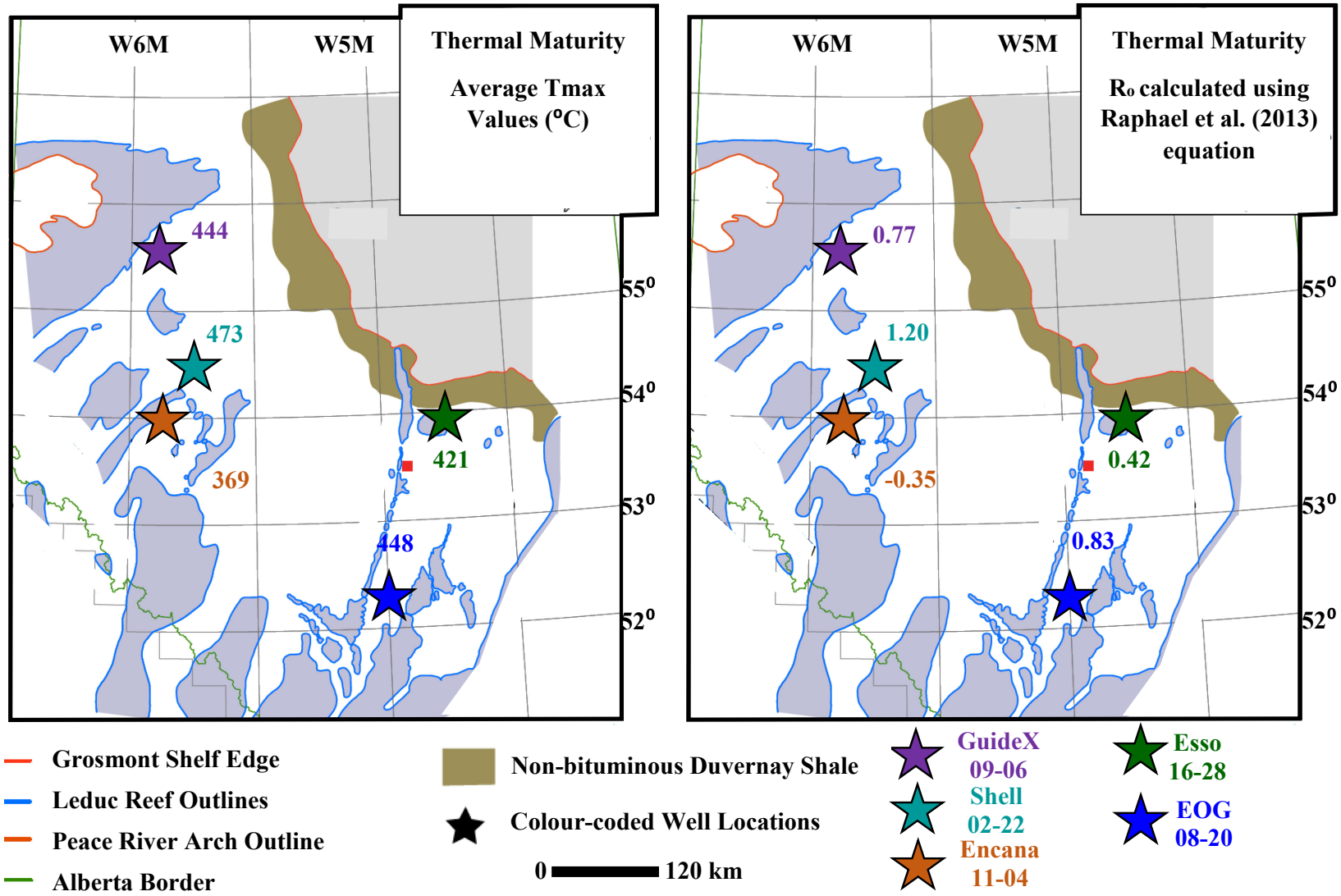


Figure 8. Average Tmax values for each well after exclusion of those samples with an S2<1 and equivalent Ro values calculated using the equation from Raphael et al. (2013). Base map modified from Knapp (2015) and used with permission. Outlines of Woodbend Reef Complexes source from Switzer et al. (1994).

	TOC (wt%)	Tmax (^{0}C)	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)	TiO_2 (%)	Zr (ppm)	TOTC (%)
MIN	0.04	301	0.7	0.15	5.0	0.01	3.1	2.47
AVG	2.37	442	32.1	6.94	28.1	0.31	62.7	8.80
MAX	9.00	536	67.1	16.4	55.1	0.73	158	14.8
	TOTS (%)	**Fe (%)**	**Mo/Al (ppm/%)**	**U/Al (ppm/%)**	**V/Al (ppm/%)**	**Zr/TiO_2 (ppm/%)**	**Fe/S**	**Al (%)**
MIN	0.13	0.14	0.04	0.31	8	140	0.16	0.08
AVG	1.28	2.11	1.74	1.74	27	215	1.84	3.67
MAX	4.03	5.33	11.0	12.6	115	900	5.97	8.67

Table 3. Summary of minimum (min), average (avg) and maximum (max) for all five wells and key geochemical parameters explored in the data and interpretation sections.

	Tmax (^{0}C)	Tmax (^{0}C)	Tmax (^{0}C)	Tmax (^{0}C)	Tmax (^{0}C)
RST3	446	473	259	No Data	448
TST3	444	474	320	433	446
RST2	441	472	441	425	446
TST2	444	470	396	420	448
RST1	443	454	445	422	446
TST3	444	468	520	418	453

Table 4. Summary of Tmax values averaged over each interval for each colour coded well: **Guidex 09-06** in purple, **Shell 02-22** in teal, **Encana 11-04** in orange, **Esso 16-28** in green and **EOG 08-20** in blue. Stratigraphic cycles indicated in leftmost column.

4.2.2 Hydrogen Index-Tmax Relationships

Cross plots of hydrogen index (HI) vs thermal maturity (Tmax) can be used to determine organic matter type. Figures 9-11 show plots for the four wells with useable thermal maturity data after eliminating samples with an S2<1: Guidex 09-06, Shell 02-22, Esso 16-28 and EOG 08-20. Terrestrial organic matter is assigned to Type III and Type IV and tends to be gas gas-prone, whereas marine or lacustrine algal/bacterial organic matter is assigned to Type I and Type II and tends to be oil-prone (Peters 1986). Samples from Guidex 09-06 lie between lines with R_o values of 0.55 and 1.0 and plot over a range of HI values from 180-450 (Figure 9). Samples from Shell 02-22 lie between lines with R_o values of 1.0 and 1.4 as well as to the right of the latter and plot over a small range of HI values from 0-120 (Figure 9). Only three points from Encana 11-04 met screening criteria, indicating that thermal maturity has severely hindered the usefulness of RockEval data from this well and the points plot near the origin in the inert region and off the standard Tmax scale (Figure 10). Samples from Esso 16-28 plot to the left of a line with an R_o value of 0.55 and generally plot over a range of HI values from 300-600 (Figure 11). Samples from EOG 08-20 lie between lines with R_o values of 0.55 and 1.0 and plot over a range of HI values from 100-350 (Figure 11). Figure 12 indicates that there was no significant variation in HI and OI as a function of stratigraphic interval, although variation was observed within specific intervals.

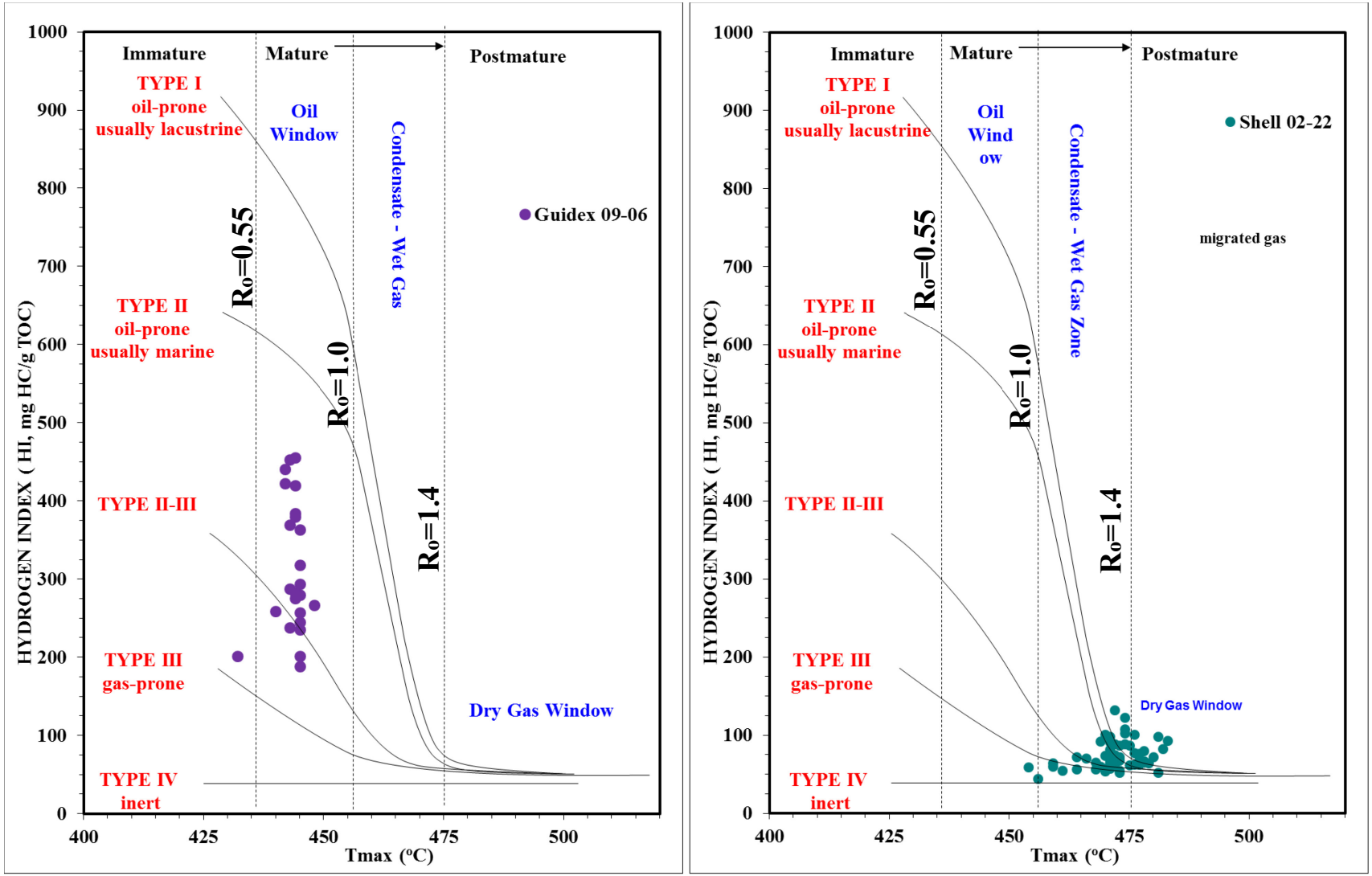


Figure 9. HI vs Tmax cross plots Guidex 09-06 (left) and Shell 02-22 (right) with equivalent Ro values indicated on vertical maturity lines. Data with S2<1 have been excluded as per quality control guidelines. Graphs modified from Weatherford Analytical results report and used with permission.

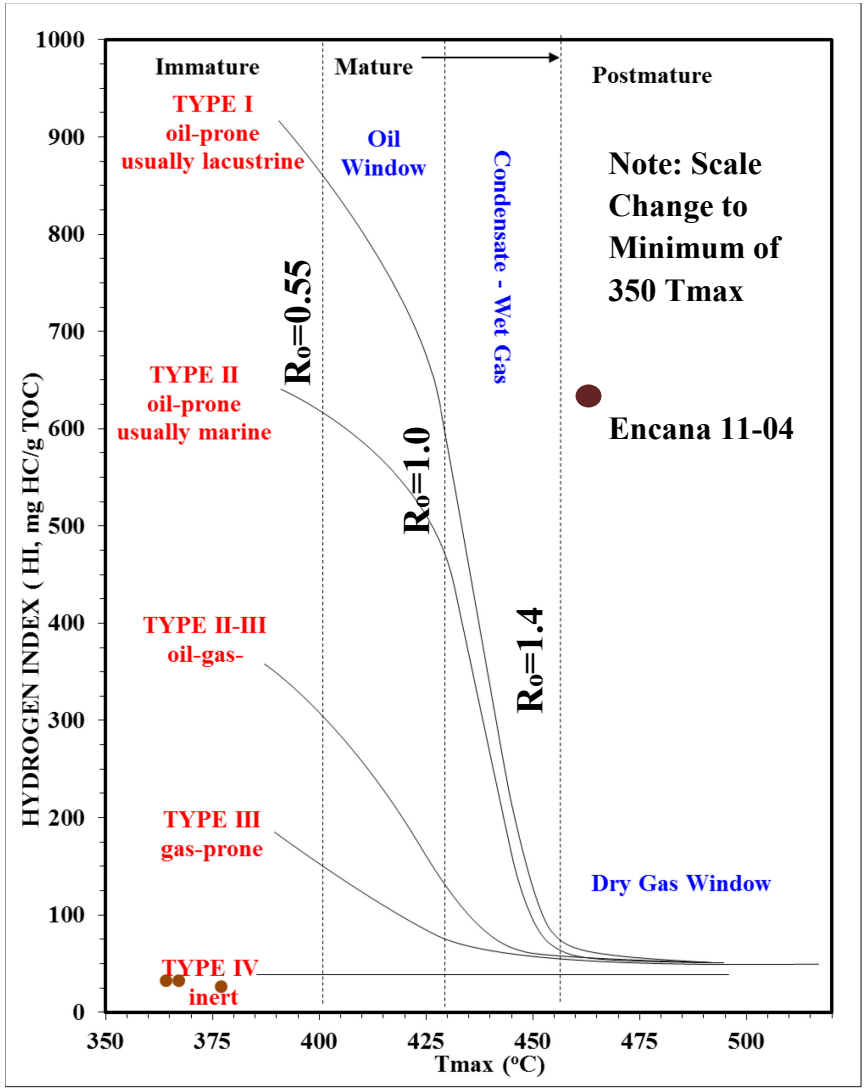


Figure 10. HI vs Tmax cross plot for Encana 11-04 with equivalent Ro values indicated on vertical maturity lines. Data with S2<1 have been excluded as per quality control guidelines. Graph modified from Weatherford Analytical results report and used with permission. Only three points were usable and plot near the origin in the inert region and off the standard Tmax scale.

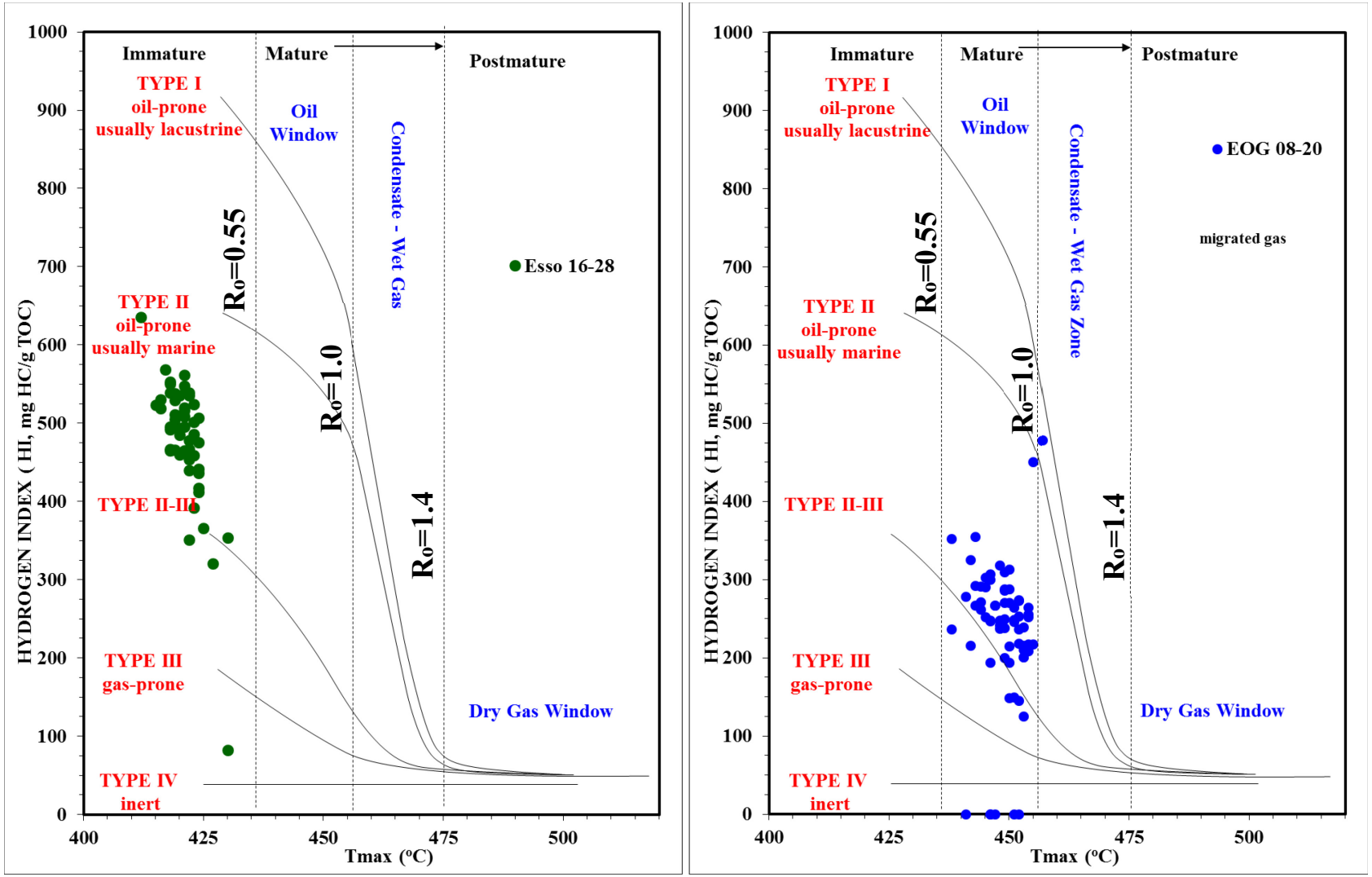


Figure 11. HI vs Tmax cross plots Esso 16-28 (left) and EOG 08-20 (right) with equivalent Ro values indicated on vertical maturity lines. Data with S2<1 have been excluded as per quality control guidelines. Graphs modified from Weatherford Analytical results report and used with permission.

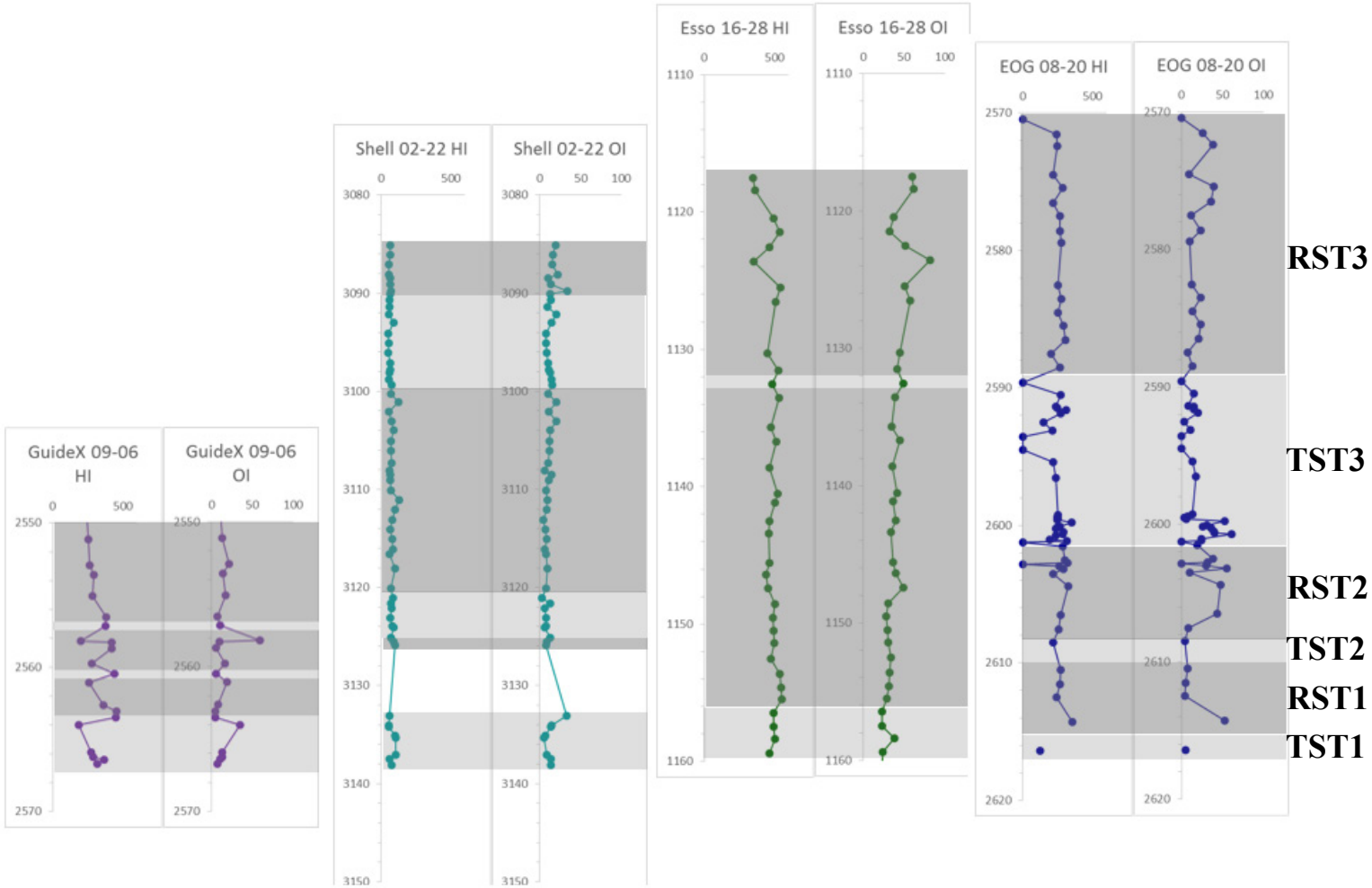


Figure 12. HI and OI depth plots for each well and interval except for Encana 11-04 (only three data points met quality assurance standards). TSTs are indicated by light grey shading and RSTs are indicated by dark grey shading.

4.3 Organic Matter Enrichment

TOC is a measure of organic matter abundance. The distribution of organic matter enrichment is of particular interest for prospect identification. Establishing a relationship between high TOC contents, redox conditions, mudstone composition and relative sea level cycles provides the opportunity to understand the controls on TOC distribution. Exploring average TOC contents within the context of TSTs and RSTs highlights relationships between organic matter content and relative sea level. In the Duvernay Formation, determining the distribution and abundance of TOC values provides critical information about redox conditions, mudstone deposition and relative sea level change.

TOC contents from all five wells in the Duvernay Formation average 2.37 wt% and range from 0.04 wt% to 9.0 wt% (Table 3). In the three WSB wells, TOC contents range from 0.25 wt% to 5.62 wt% with an average of 2.58 wt% (Table 5). TOC contents in the two ESB wells range from 0.04 wt% to 9.0 wt% with an average of 2.11 wt% (Table 5). The largest range in TOC values is observed in the ESB wells. In general, TOC contents are higher in each TST compared to its corresponding RST (Table 6) and decrease upwards overall (Figure 16). However similar upward decreases in TOC content are not seen in all wells. Although the ESB basin wells behave similarly, WSB wells show more variation. Peaks in the TOC values averaged by stratigraphic interval were recorded in different cycles in wells.

WSB	TOC (wt%)	ESB	TOC (wt%)
MIN	0.04	MIN	0.25
AVG	2.84	AVG	2.58
MAX	9.00	MAX	5.62

Table 5. Minimum (min), average (avg) and maximum (max) TOC values for the WSB (Guidex 09-06, Shell 02-22 and Encana 111-04) and ESB (Esso 16-28 and EOG 08-20).

In the TST1-RST1 cycle (Figure 13), the WSB and ESB are clearly distinguished. Both ESB wells have higher TOC contents than the WSB wells. Samples from both the Esso 16-28 and EOG 08-20 wells in the ESB describe a decreasing trend from TST to RST in TOCs averaged by interval. Esso 16-28 generally has higher average TOCs when compared to EOG 08-20. In the TST1-RST1 cycle, two out of the three WSB wells exhibit a reduction in average TOC from the TST to the RST, except Guidex 09-06 which shows an increase.

In the TST2-RST2 cycle (Figure 14), the WSB and ESB are also clearly differentiated. In this cycle, all three WSB wells have higher average TOC contents than ESB wells in contrast to the lower cycle. Samples from the ESB continue their trend of decreasing TOC from TST to RST, the Esso 16-28 samples more drastically than the EOG 08-20 samples. In the WSB data set, TOC averages also decrease from the TST to the RST except at Shell 02-22 where average TOCs are similar.

In the TST3-RST3 cycle (Figure 15), the WSB wells again have higher TOC values than the ESB wells. The one sample from Esso 16-28 is lower than earlier cycles. The EOG 08-20 average TOCs decrease from the RST to the TST in this cycle, although overall TOC contents are the same or slightly higher than in the TST2-RST2 cycle. TOC averages in WSB wells decrease from the TST to the RST except at Shell 02-22 where averages are similar.

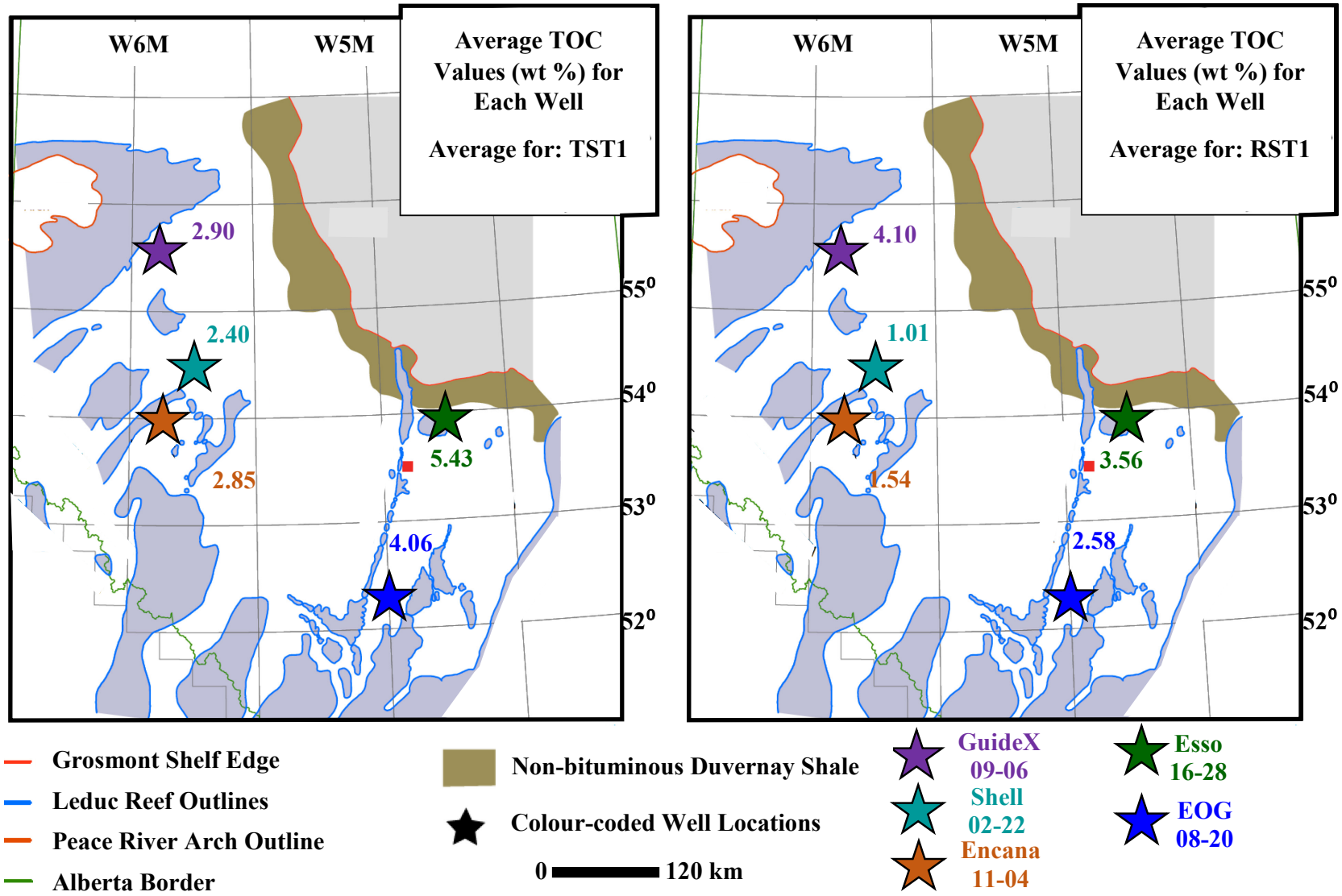


Figure 13. TOC content for each well averaged over TST1 and RST1.

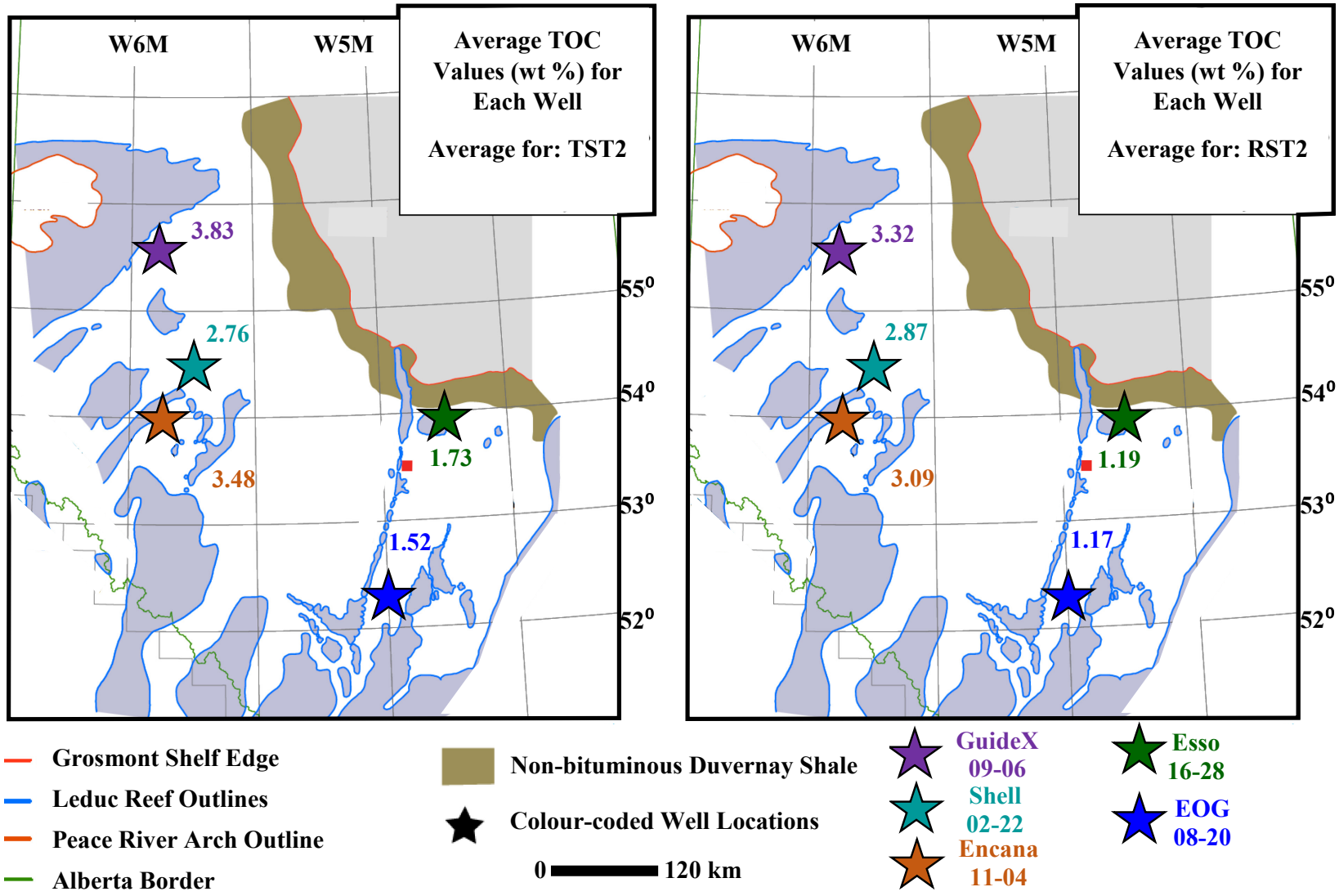


Figure 14. TOC content for each well averaged over TST2 and RST2.

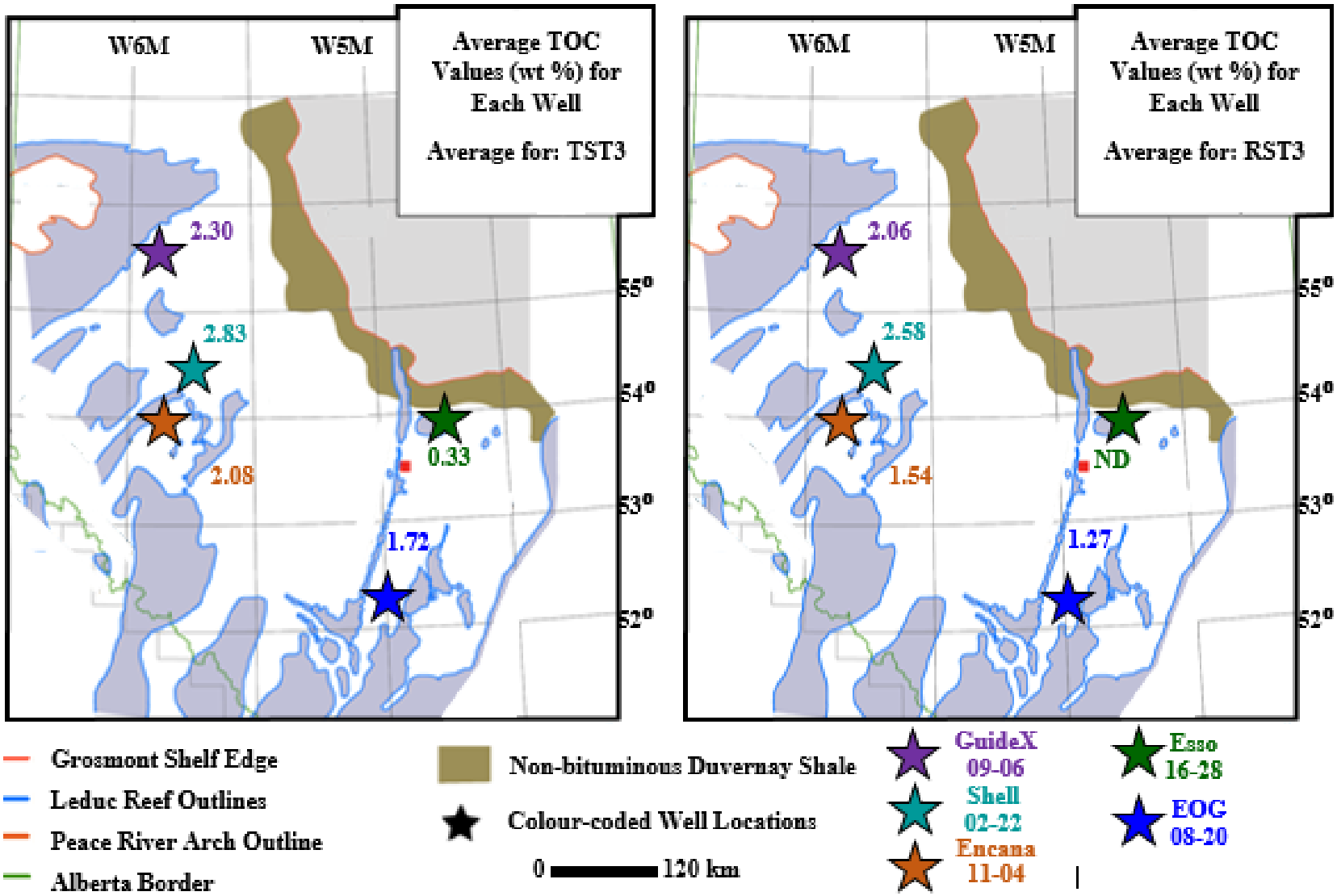


Figure 15. TOC content for each well averaged over TST3 and RST3.

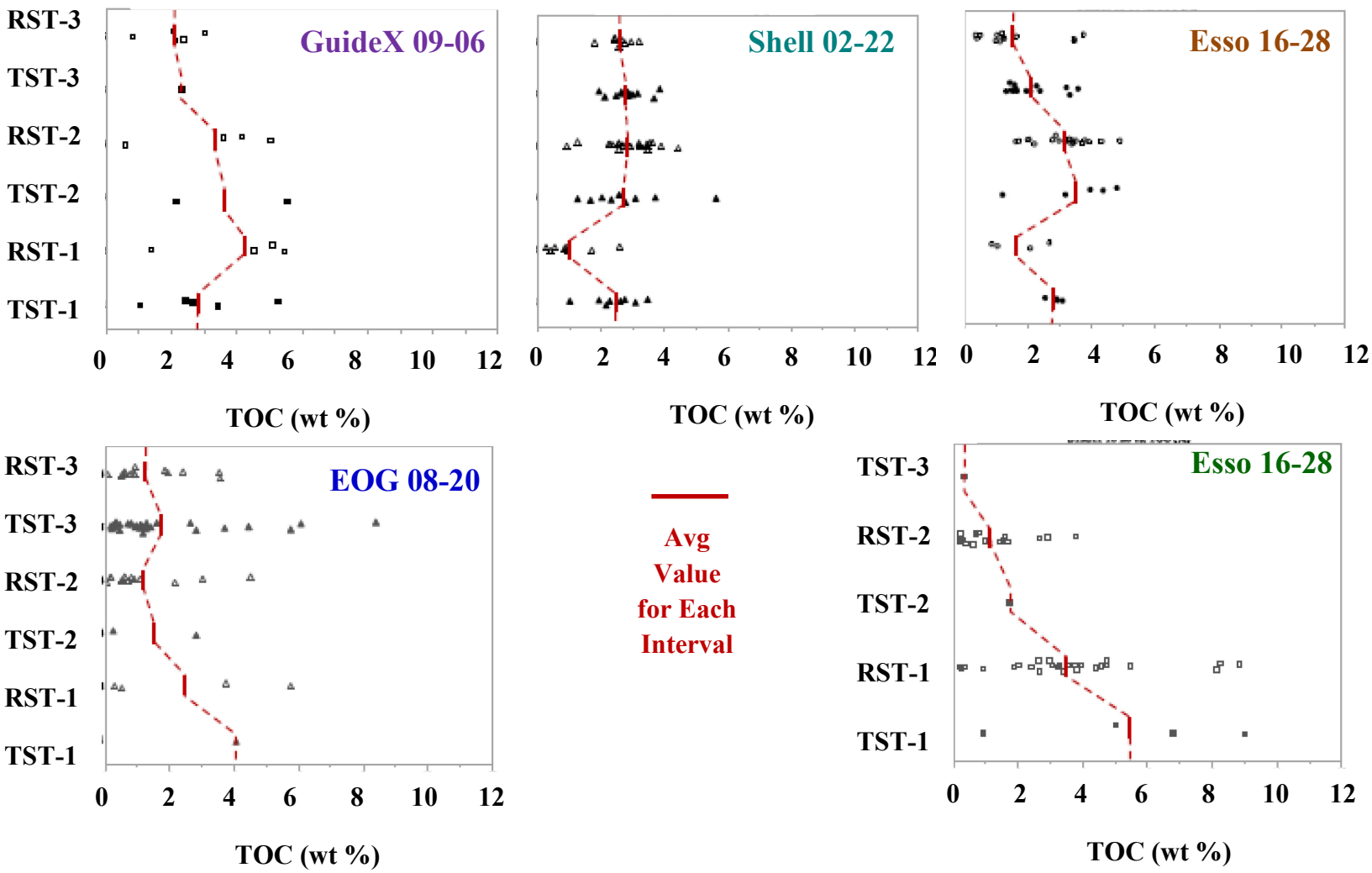


Figure 16. TOC content for each well, averaged over each TST or RST. Mean values indicated by red lines. Solid symbols indicate transgressive phases and open symbols indicate regressive phases. Stratigraphic intervals are labelled on the left side of each diagram. Well names are indicated in each corner.

	TOC (wt %)	TOC (wt %)	TOC (wt %)	TOC (wt %)	TOC (wt %)
RST3	2.06	2.58	1.54	No Data	1.27
TST3	2.30	2.83	2.08	0.33	1.72
RST2	3.32	2.87	3.09	1.19	1.17
TST2	3.83	2.76	3.48	1.73	1.52
RST1	4.10	1.01	1.64	3.56	2.58
TST3	2.90	2.40	2.85	5.43	4.06

Table 6. Summary of TOC values averaged over each interval for each colour coded well: **Guidex 09-06** in purple, **Shell 02-22** in teal, **Encana 11-04** in orange, **Esso 16-28** in green and **EOG 08-20** in blue. Stratigraphic cycles indicated in leftmost column.

4.4 Major Element Oxides

Major element oxides can be used as proxies for bulk mineralogy (Dong et al. 2015, Wright et al. 2010). Silica, clay and carbonate contents are represented by SiO_2, Al_2O_3 and CaO+MgO respectively. Represented in a ternary diagram, Duvernay samples plot within a region that extends from the CaO + MgO apex (0% SiO_2) towards the 85% SiO_2 line and up to the 25 % Al_2O_3 line. A wider range of Al_2O_3/SiO_2 ratios are present in the more quartz rich samples (Figure 17). In the Duvernay, SiO_2 values range from 0.70% to 67.1% with an average of 32.1%, Al_2O_3 values range from 0.15% to 16.4 % with an average of 6.94% and CaO+MgO values range from 5.0% to 55.1% with an average of 28.1% (Table 3). Major element oxide values for each well and cycle are shown in Figures 18-23 and Table 7.

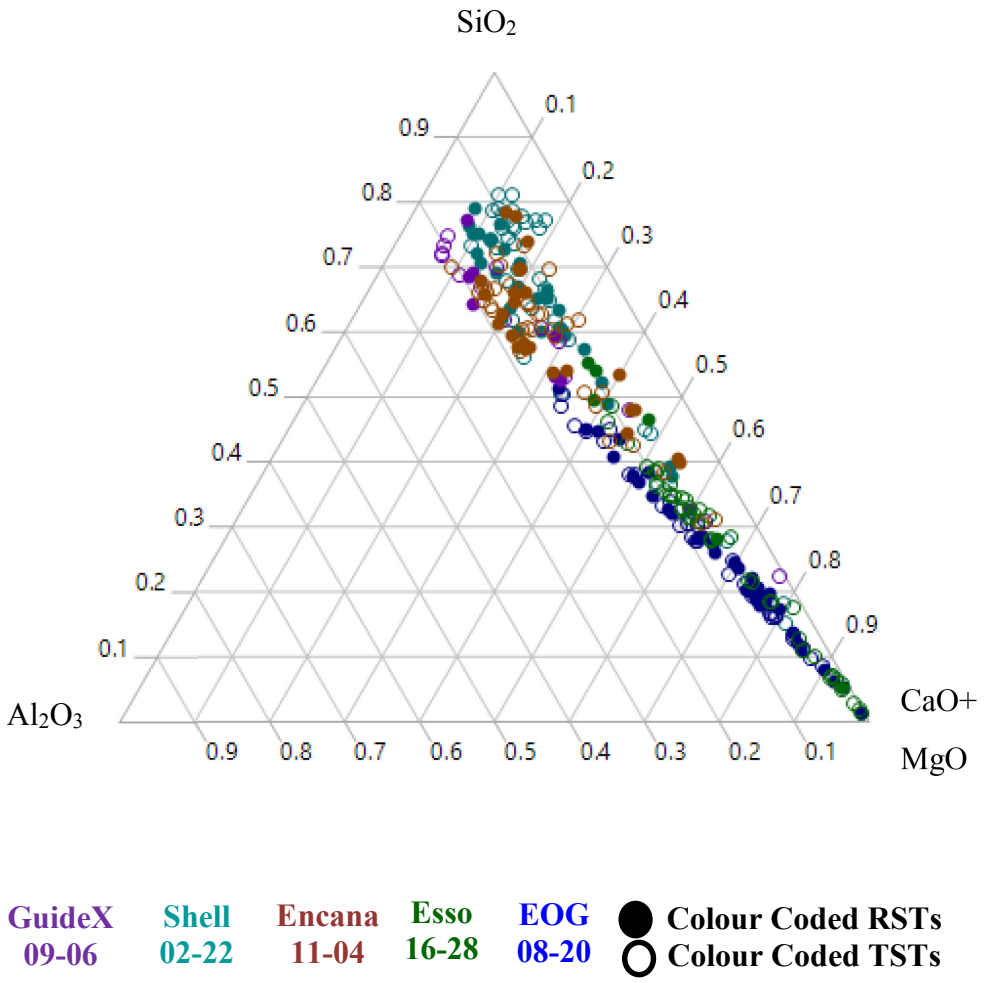


Figure 17. Summary of major element oxide ternary diagram for all wells (colour coded) in order to delineate major compositional trends. **Guidex 09-06** in purple, **Shell 02-22** in teal, **Encana 11-04** in orange, **Esso 16-28** in green and **EOG 08-20** in blue. Stratigraphic cycles indicated in leftmost column.

In the TST1-RST1 cycle (Figures 18 and 19, Table 7), the WSB and ESB are subtly distinguished in terms of SiO_2, Al_2O_3 and CaO + MgO content. WSB samples generally plot closer to the SiO_2 apex and ESB samples plot closer to the CaO + MgO apex. The exceptions are: Shell 02-22 where elevated CaO + MgO contents were noted in RST1 and Encana 11-04 which has CaO + MgO contents comparable to the ESB. Overall, Al_2O_3 content is higher in the WSB than the ESB except at Shell 02-22 where Al_2O_3 contents are comparable to ESB values.

The TST and RST in cycle 1 are not similarly distinguished in the five wells, although variation was noted in different oxides at most wells. No commonalities are noted between wells, and there are no differences between TST1 and RST1 that apply to two or more wells. TST1 samples from Guidex 09-06 are slightly more Al_2O_3 rich than in the RST. TST1 samples from Shell 02-22 are generally more SiO_2 rich than RST1 samples. Samples from Encana 11-04 do not exhibit significant variation between TST1 and RST1. Samples from Esso 16-28 are more SiO_2 rich in TST1 than in RST1. TST1 and RST1 are not significantly distinguished in samples from EOG 08-20.

In the TST2-RST2 cycle (Figure 20 and 21, Table 7), the WSB and ESB are clearly distinguished in terms of SiO_2, Al_2O_3 and CaO + MgO content. WSB samples generally plot closer to the SiO_2 apex and ESB samples plot closer to the CaO + MgO apex. The exception is Guidex 09-06, where some samples with elevated CaO + MgO contents were noted in cycle 2. Relative to cycle 1, SiO_2 content generally increased in the WSB and CaO + MgO content generally increased in the ESB. Overall, Al_2O_3 content is higher in the WSB than the ESB. In cycle 2, TSTs and RSTs are not similarly distinguished in the five wells, although variation was noted in Guidex 09-06 and Encana 11-04 samples. In general, both of these wells exhibit higher

Al_2O_3 content in RST2 as compared to TST2. Samples from the remaining three wells do not exhibit significant distinction between TST2 and RST2.

In the TST3-RST3 cycle (Figure 22 and 23, Table 7), the WSB and ESB are clearly distinguished in terms of SiO_2, Al_2O_3 and CaO + MgO content. WSB samples generally plot closer to the SiO_2 apex and ESB samples plot closer to the CaO + MgO apex. SiO_2 content generally increases relative to cycle 2 in the WSB and CaO + MgO content generally increases in the ESB. Overall, Al_2O_3 content is higher in the WSB than the ESB. In cycle 3, TSTs and RSTs are not similarly distinguished in the five wells, although variation was noted in different oxides at most wells. No commonalities are noted between wells, and there are no differences that apply to two or more wells. However, variation was noted in Shell 02-22 and Encana 11-04 samples. TST3 samples from Shell 02-22 are more Al_2O_3-rich than in RST3. TST3 samples from Encana 11-04 are slight more Al_2O_3-rich and more SiO_2-rich than in RST3. Samples from the remaining three wells do not exhibit significant distinction between TST3 and RST3.

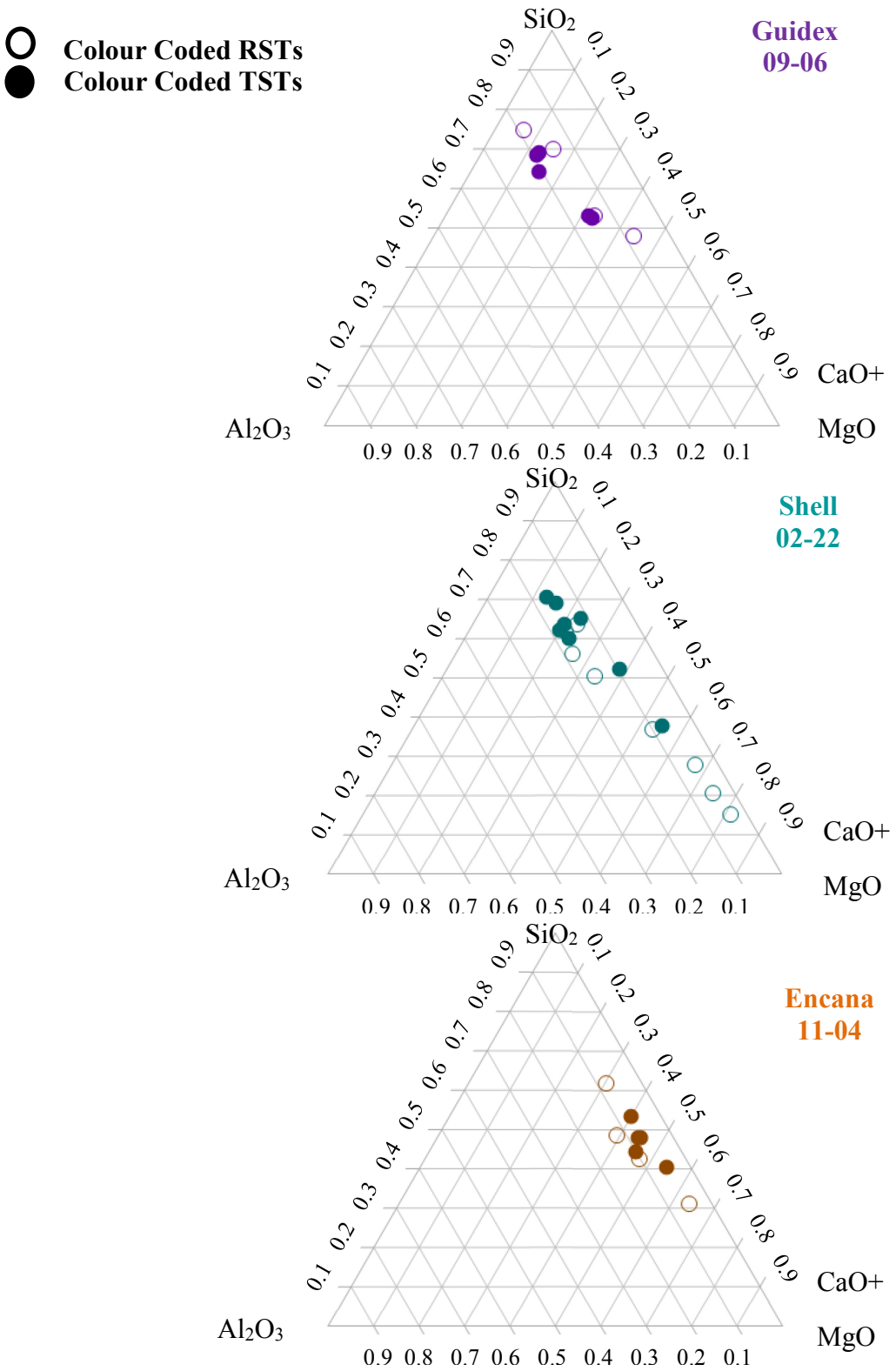


Figure 18. Summary of major element oxides for the WSB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs shown in the legend. Major element averages for each interval are located in Table 7 (SiO_2 – Al_2O_3 – CaO + MgO in %).

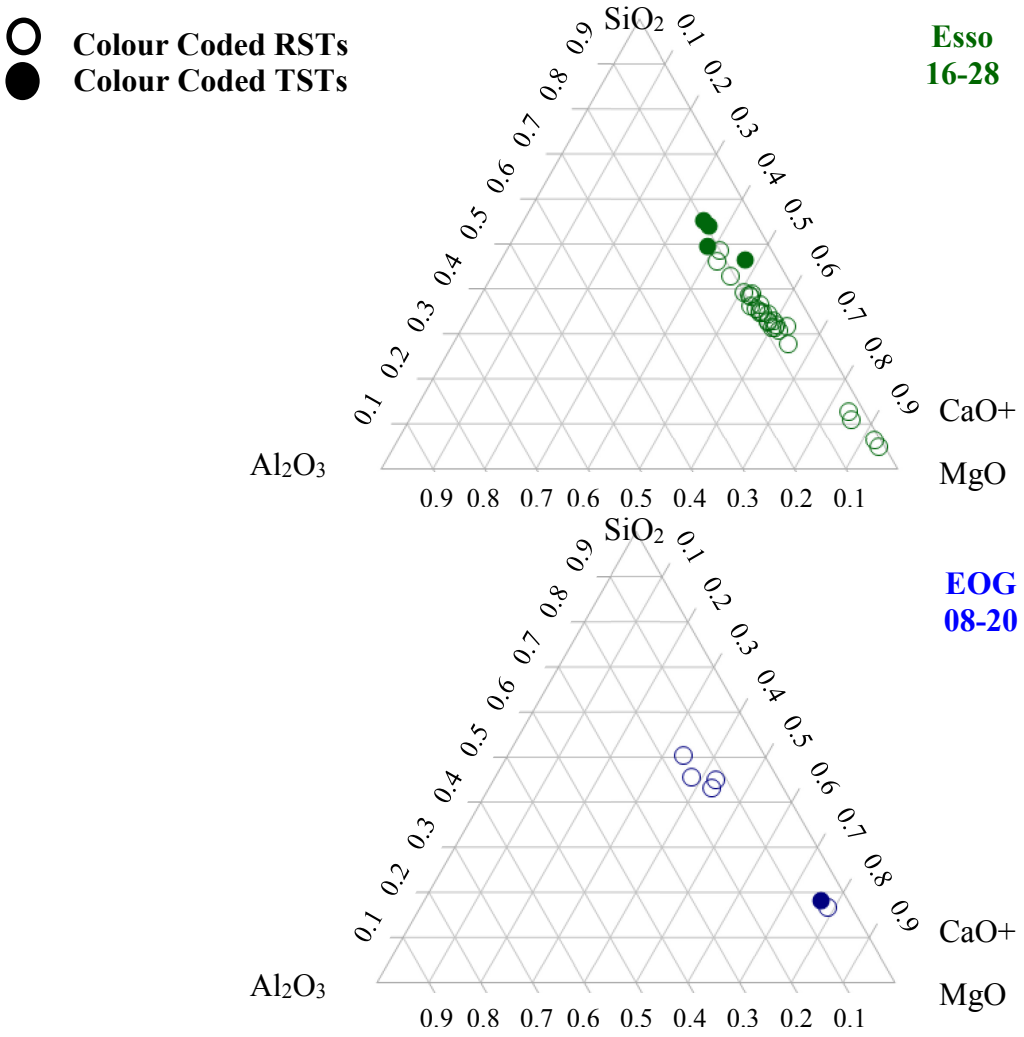


Figure 19. Summary of major element oxides for the ESB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs shown in the legend. Major element averages for each interval are located at in Table 7 (SiO_2 – Al_2O_3 – CaO + MgO in %).

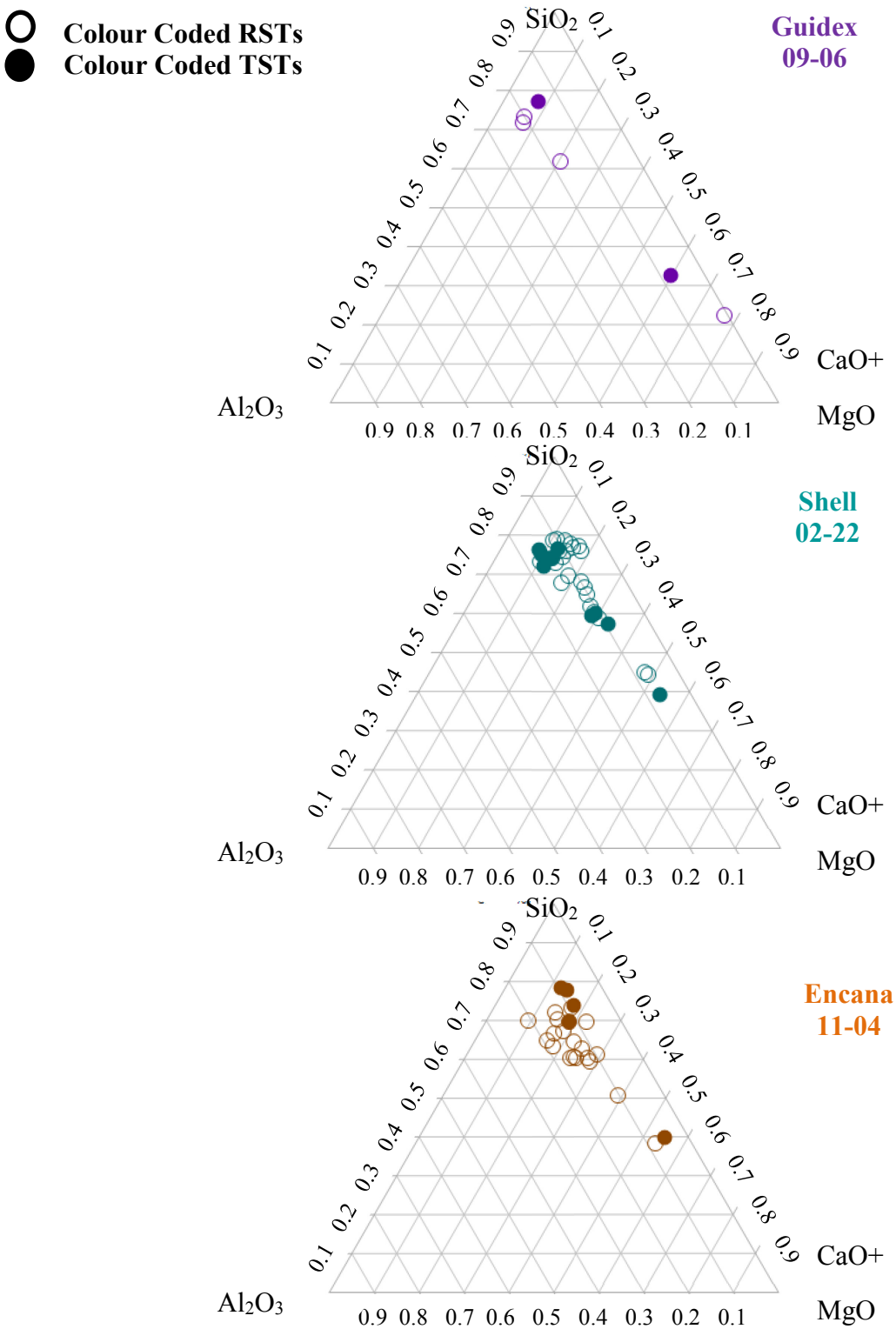


Figure 20. Summary of major element oxides for the WSB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs shown in the legend. Major element averages for each interval are located in Table 7 (SiO_2 – Al_2O_3 – CaO + MgO in %).

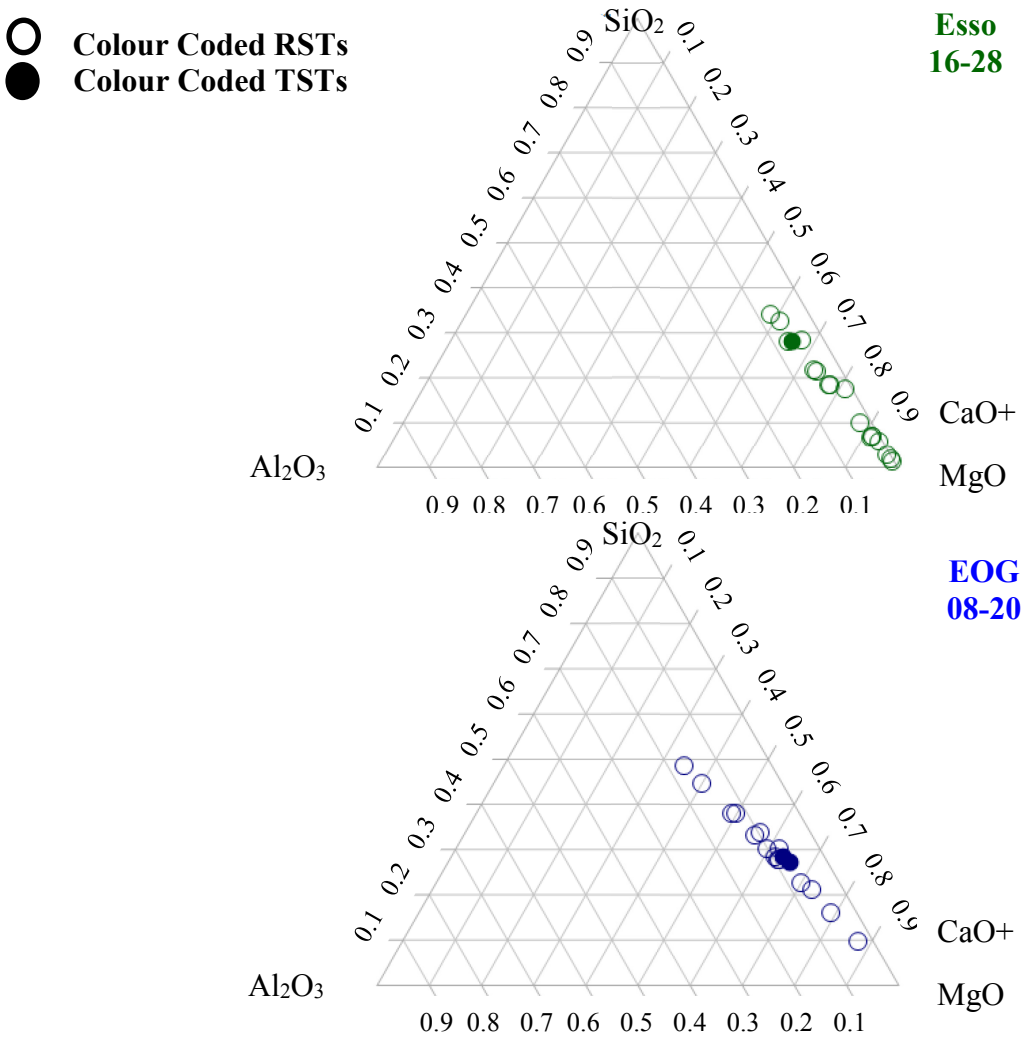


Figure 21. Summary of major element oxides for the ESB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs shown in the legend. Major element averages for each interval are located in Table 7 (SiO_2 – Al_2O_3 – CaO + MgO in %).

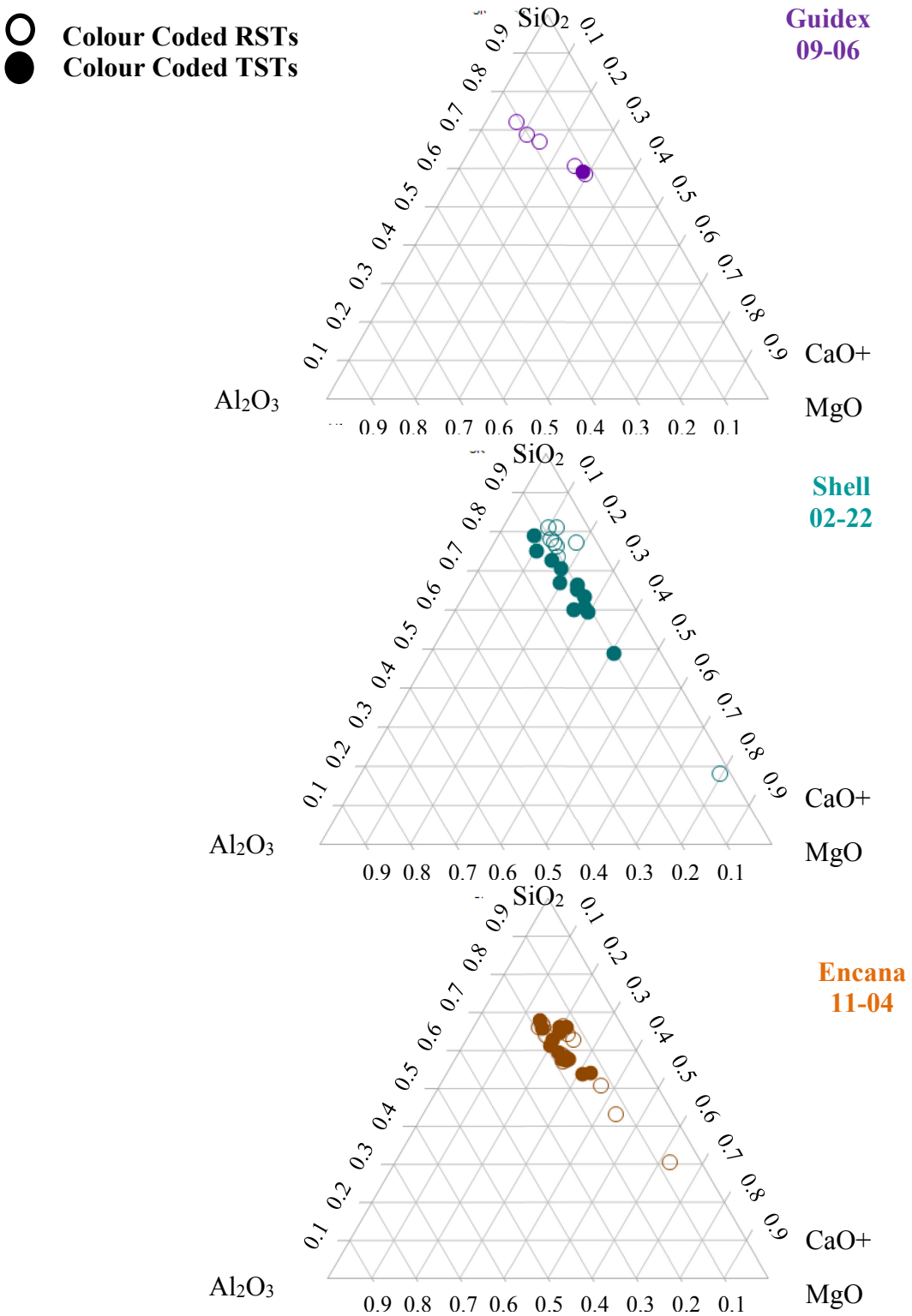


Figure 22. Summary of major element oxides for the WSB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs shown in the legend. Major element averages for each interval are located in Table 7 (SiO_2 – Al_2O_3 – CaO + MgO in %).

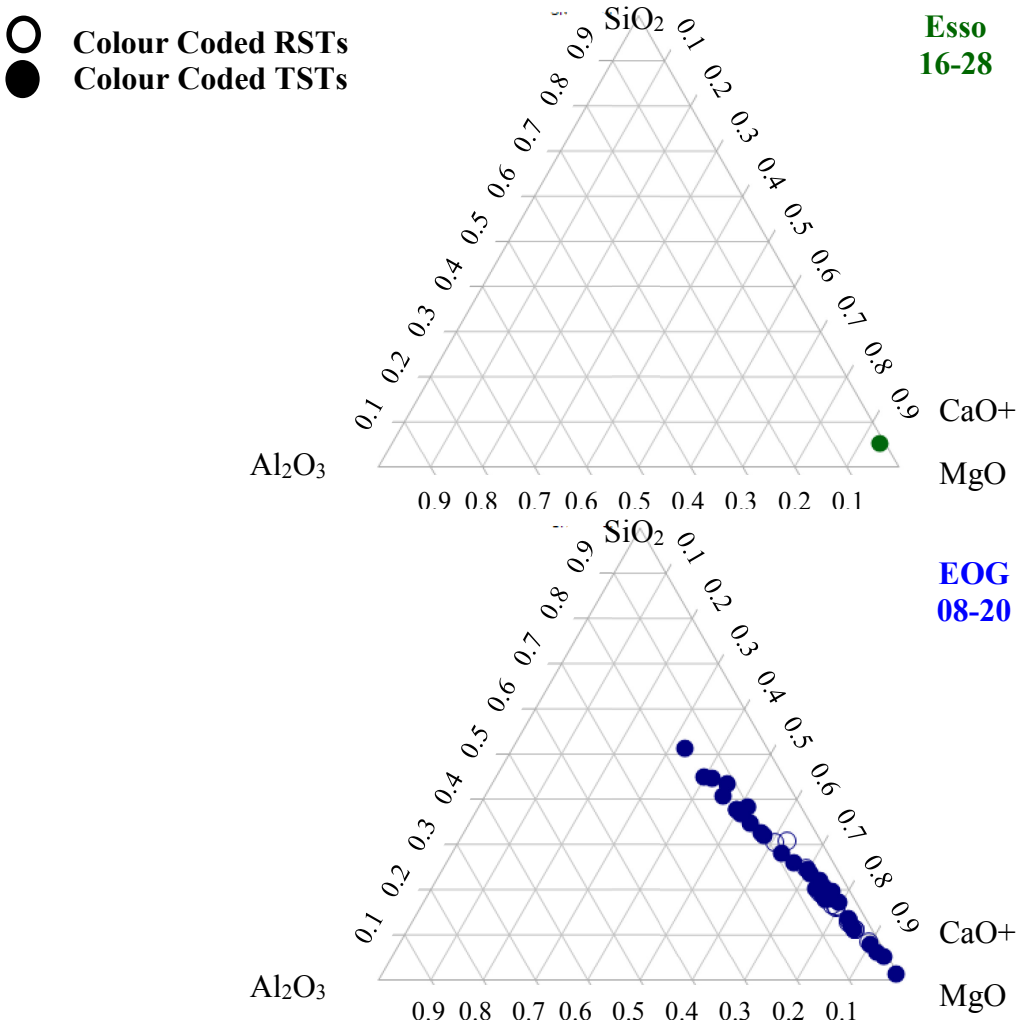


Figure 23. Summary of major element oxides for the ESB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs shown in the legend. Major element averages for each interval are located in Table 7 (SiO_2 – Al_2O_3 – CaO + MgO in %).

Guidex 09-06	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)
RST3	49.3	12.9	13.2
TST3	42.0	8.8	20.6
RST2	41.3	10.8	18.3
TST2	39.8	8.1	21.6
RST1	43.2	9.8	16.8
TST1	43.0	12.2	16.2

Esso 16-28	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)
RST3	ND	ND	ND
TST3	2.9	0.6	52.9
RST2	9.3	1.9	47.9
TST2	17.4	3.8	41.0
RST1	19.5	4.8	37.0
TST1	33.4	6.0	25.9

Shell 02-22	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)
RST3	56.2	6.2	15.3
TST3	49.4	8.7	16.8
RST2	53.4	7.7	15.2
TST2	48.7	9.0	15.9
RST1	28.8	7.6	30.6
TST1	43.4	10.1	18.4

EOG 08-20	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO
RST3	10.5	2.8	45.2
TST3	15.0	4.4	40.3
RST2	18.5	6.0	36.7
TST2	16.4	4.4	38.4
RST1	25.6	8.0	29.6
TST1	10.4	2.9	44.4

Encana 11-04	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)
RST3	**41.4**	**10.9**	**19.5**
TST3	43.9	11.8	16.5
RST2	46.2	9.9	16.8
TST2	51.6	6.4	16.7
RST1	31.7	6.0	30.5
TST1	31.5	4.9	30.9

Table 7. Summary of major element oxide values averaged over each interval for each well. Colour coded: **Guidex 09-06** in purple, **Shell 02-22** in teal, **Encana 11-04** in orange, **Esso 16-28** in green and **EOG 08-20** in blue. Stratigraphic cycles indicated in leftmost column.

4.5 Silica Source Indicators

4.5.1 Silica-Zirconium Relationship

Silica-zirconium (SiO_2-Zr) cross plots can be used in order to understand spatial and stratigraphic variation in the source of silica. SiO_2-Zr cross plots can indicate the source of silica, whether detrital or biogenic (Wright et al. 2010): in shales in which silica has a detrital origin, SiO_2 is positively correlated with Zr (the silica and zirconium have the same source); in shales in which silica has a biogenic origin, SiO_2 is negatively correlated with Zr (Wright et al. 2010). This is effectively a dilution trend in which silica and zirconium have different sources. It is important to note that variability in the source of clastic sediment may affect both the cross plots. Duvernay samples plot within a region defined by a positive linear trend (detrital trend) through the origin, a negative linear trend (which may indicate a biogenic trend or the termination of different positive trends), and a zone between these lines that is affected to varying degrees by both detrital and biogenic influences (Figure 24). In the Duvernay, the detrital trend is defined as the line of best fit for the Esso 16-28 well which characterizes samples with the lowest positive slope and lowest SiO_2 values for any given Zr value. The line of best fit for the Esso 16-28 line is SiO_2=0.27Zr with an R^2 value of 0.84. The biogenic trend is defined as the line through the population of points with the highest SiO_2 values for any given Zr value such that the line honours the points at the upper limit of SiO_2 values and intersects the detrital trend (dominated by points from the Shell 02-22 well and Guidex 09-06 well). The lower limit of the mixed zone was defined as the line parallel to the detrital trend line with nodes at 5 wt % SiO_2 and 45 wt % SiO_2. The upper limit of the mixed zone was defined as the line parallel to the biogenic trend line with nodes at 45 wt % SiO_2 and 70 wt % SiO_2.

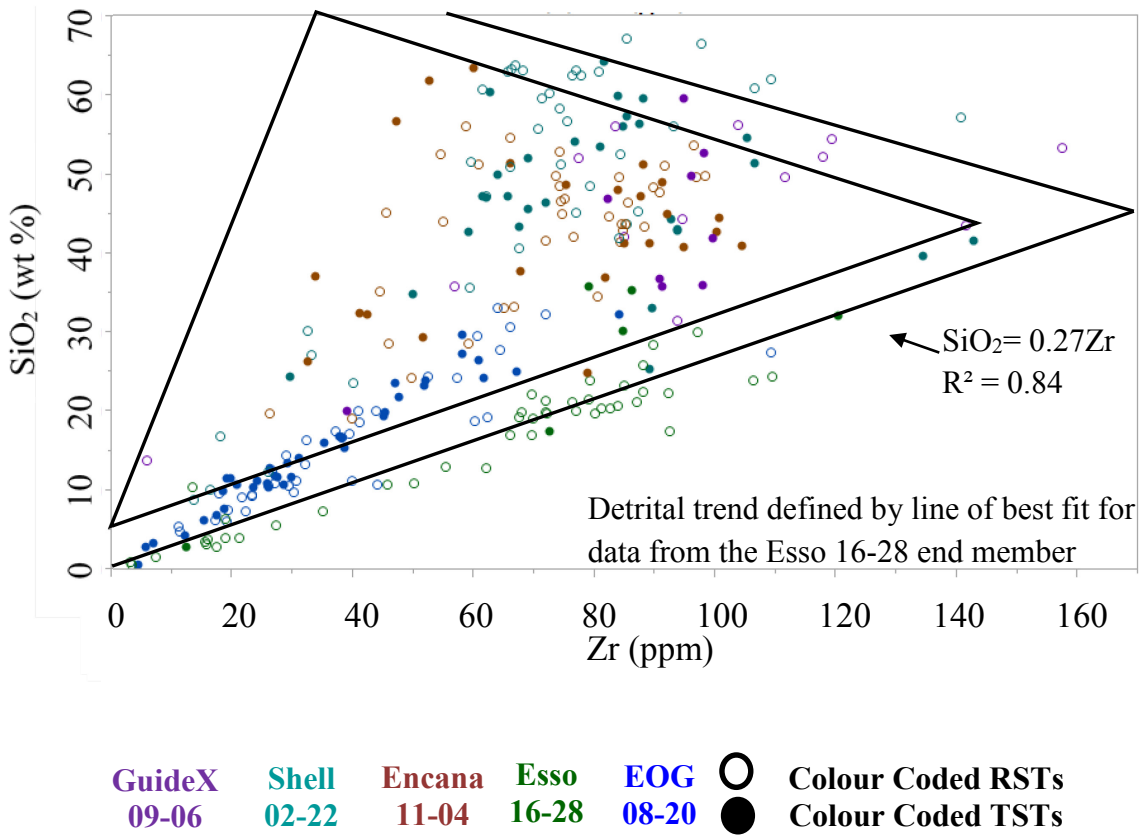


Figure 24. Summary of overall patterns in SiO_2-Zr relationships for each well (colour coded) in order to delineate trend lines and mixed zone. TSTs are indicated by filled symbols and RSTs by open symbols. Colour coded: **Guidex 09-06** in purple, **Shell 02-22** in teal, **Encana 11-04** in orange, **Esso 16-28** in green and **EOG 08-20** in blue.

The relationship between silica and zirconium for each well is depicted for each stratigraphic time slice in Figures 25-30. Both the WSB and ESB samples plot at a variety of locations on a silica-zirconium cross plot. In the Duvernay, SiO_2 values range from 0.70 % to 67.1 % with an average of 32.1 % and Zr values range from 3.1 ppm to 158 ppm with an average of 62.7 ppm (Table 3).

In the TST1-RST1 cycle (Figures 25 and 26), the WSB and ESB are clearly distinguished. Samples from both the Esso 16-28 and EOG 08-20 wells in the ESB describe a positive trend line approximately near the lower limit of the data. The WSB describe a positive trend with a steeper slope, with the Guidex samples plotting at higher SiO_2 and Zr, Encana 11-04 samples at lower SiO_2 and Zr, and samples from Shell 02-22 over a large range.

In the TST2-RST2 cycle (Figures 27 and 28), the WSB and ESB are also clearly differentiated. Samples from the ESB describe a positive trend, the Esso 16-28 samples with a low slope and the EOG 08-20 samples on a trend with a higher slope. In the WSB data set, the Guidex samples plot in two groups; one at low SiO_2 and Zr one at high SiO_2 and Zr. The Shell 02-22 and Encana 11-04 sample plot at significantly elevated SiO_2 and Zr parallel to the biogenic silica line.

In the TST3-RST3 cycle (Figures 29 and 30), the WSB and ESB data are again differentiated. The EOG 08-20 samples describe a trend with small positive slope near the lower limit of the data; no samples from the Esso 16-28 were available in this stratigraphic interval. The WSB samples from all three wells plot at relatively high SiO_2 and Zr, but the data do not display a clear trend. Shell 02-22 samples include several that plot at very high SiO_2 values, along the biogenic limit of the data.

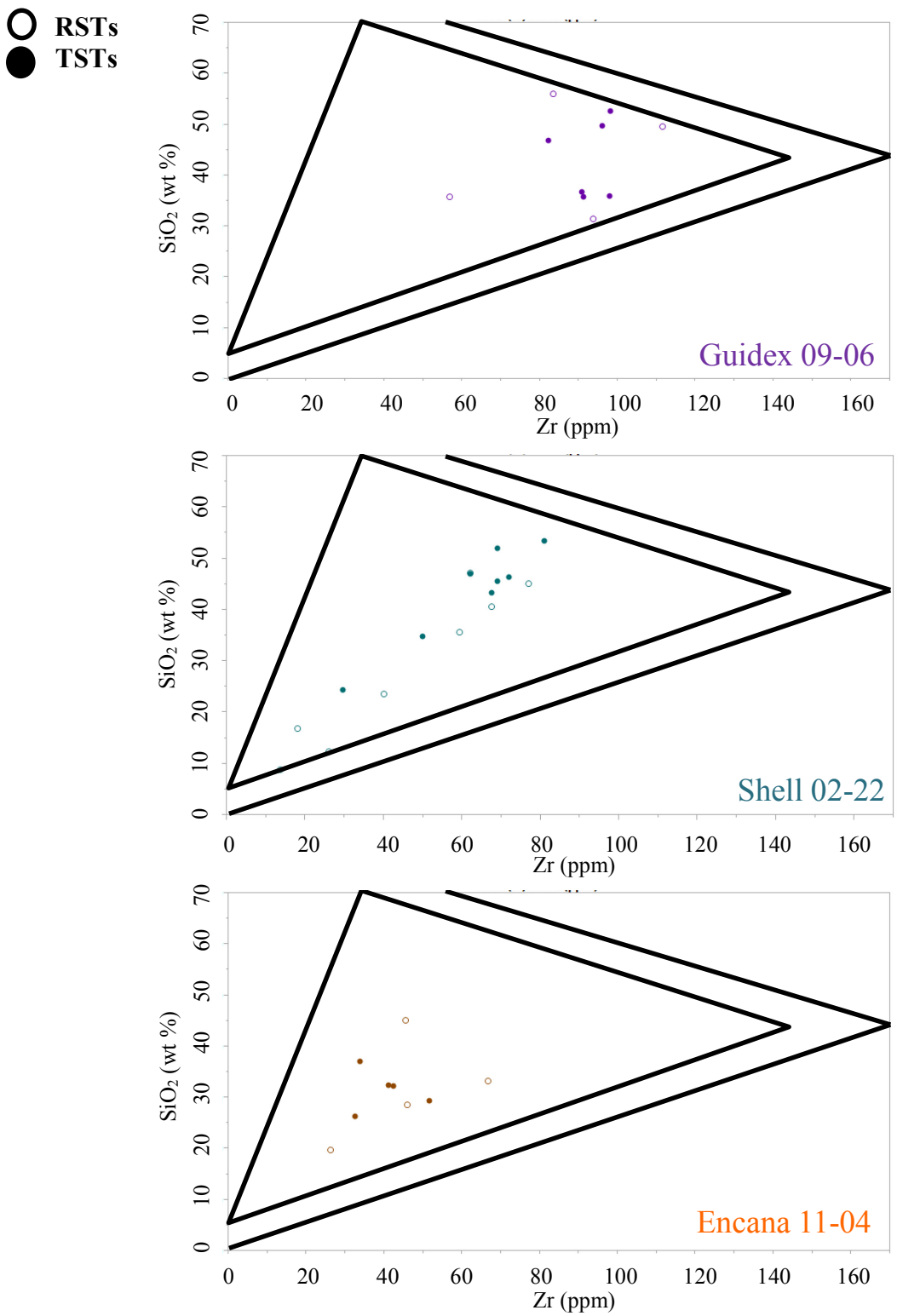


Figure 25. Summary of SiO_2-Zr relationships for the WSB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

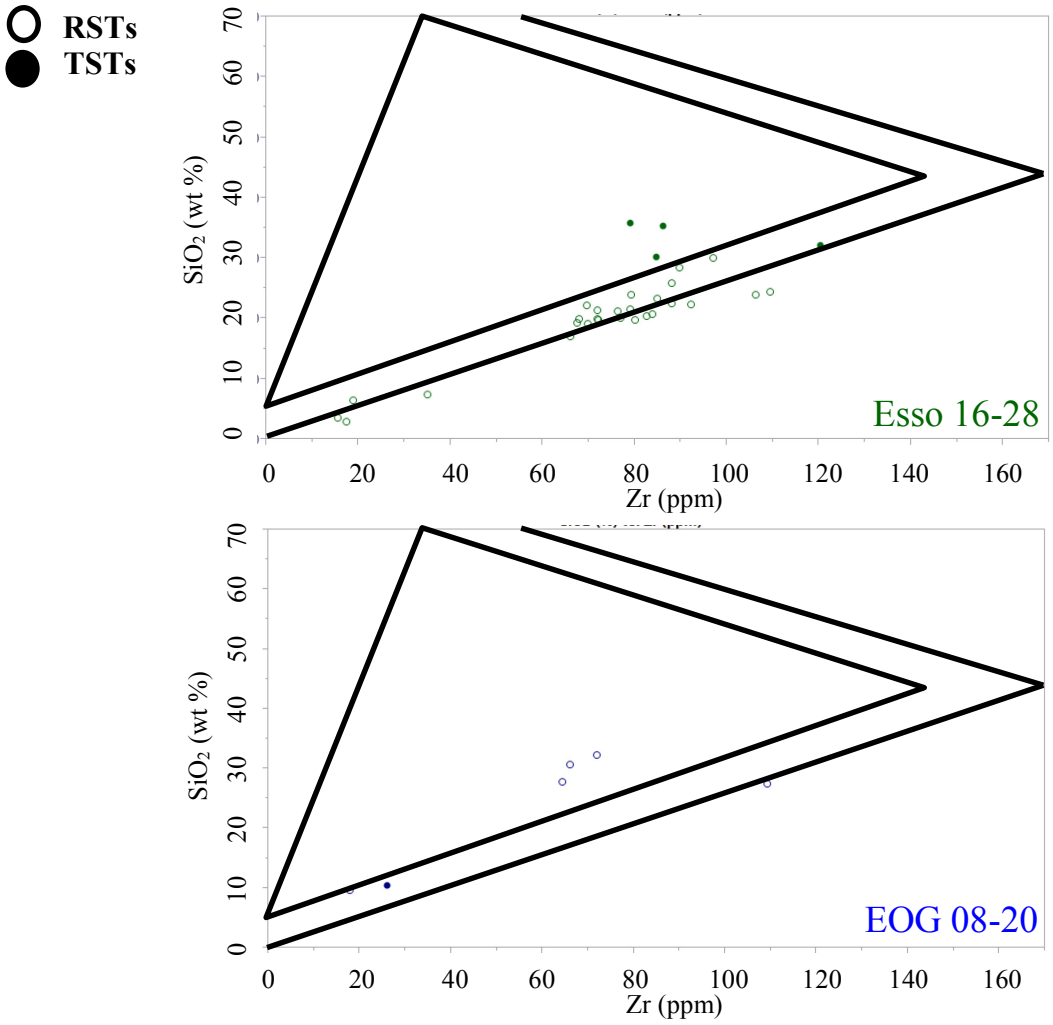


Figure 26. Summary of SiO_2-Zr relationships ratios for the ESB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

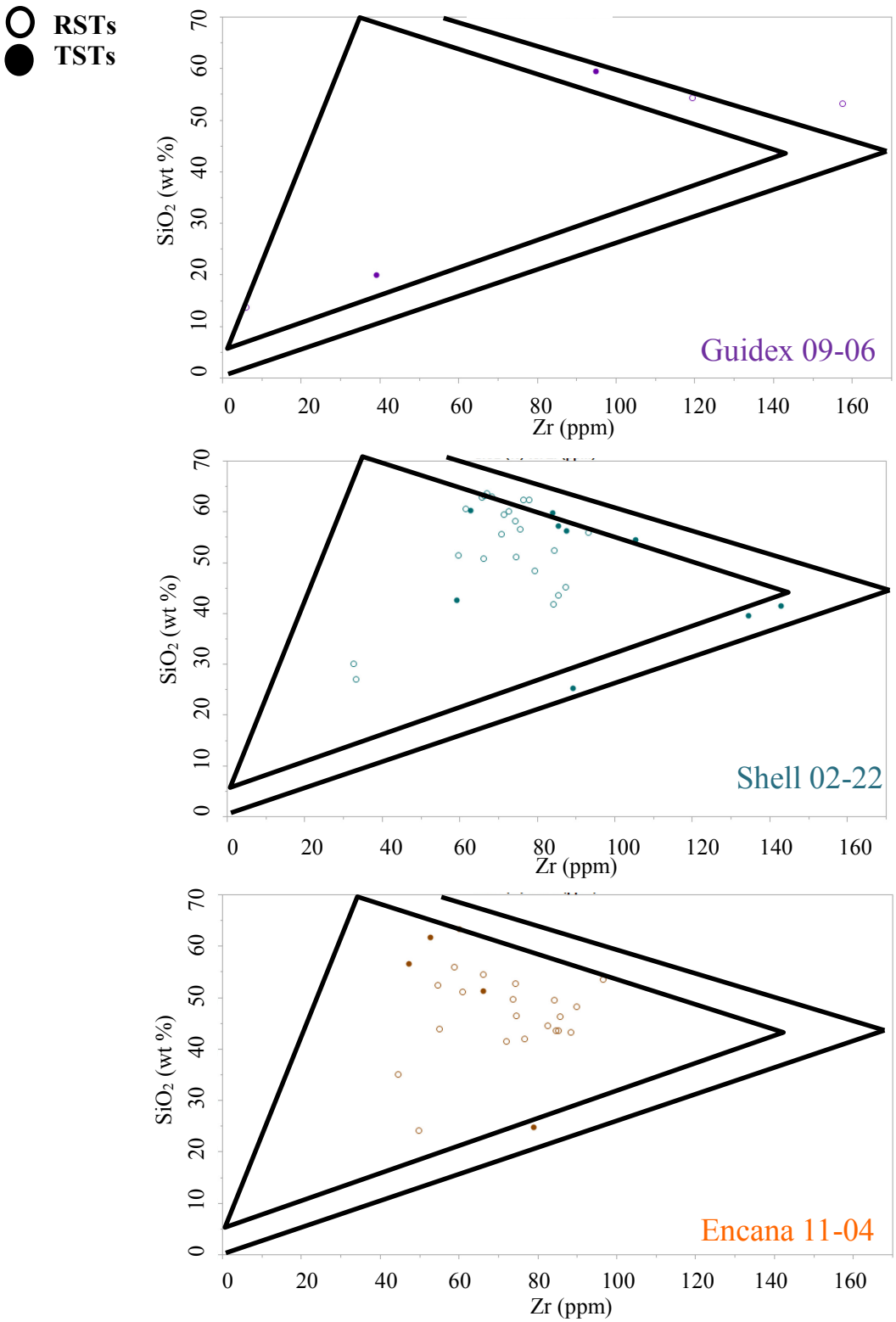


Figure 27. Summary of SiO_2-Zr relationships for the WSB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

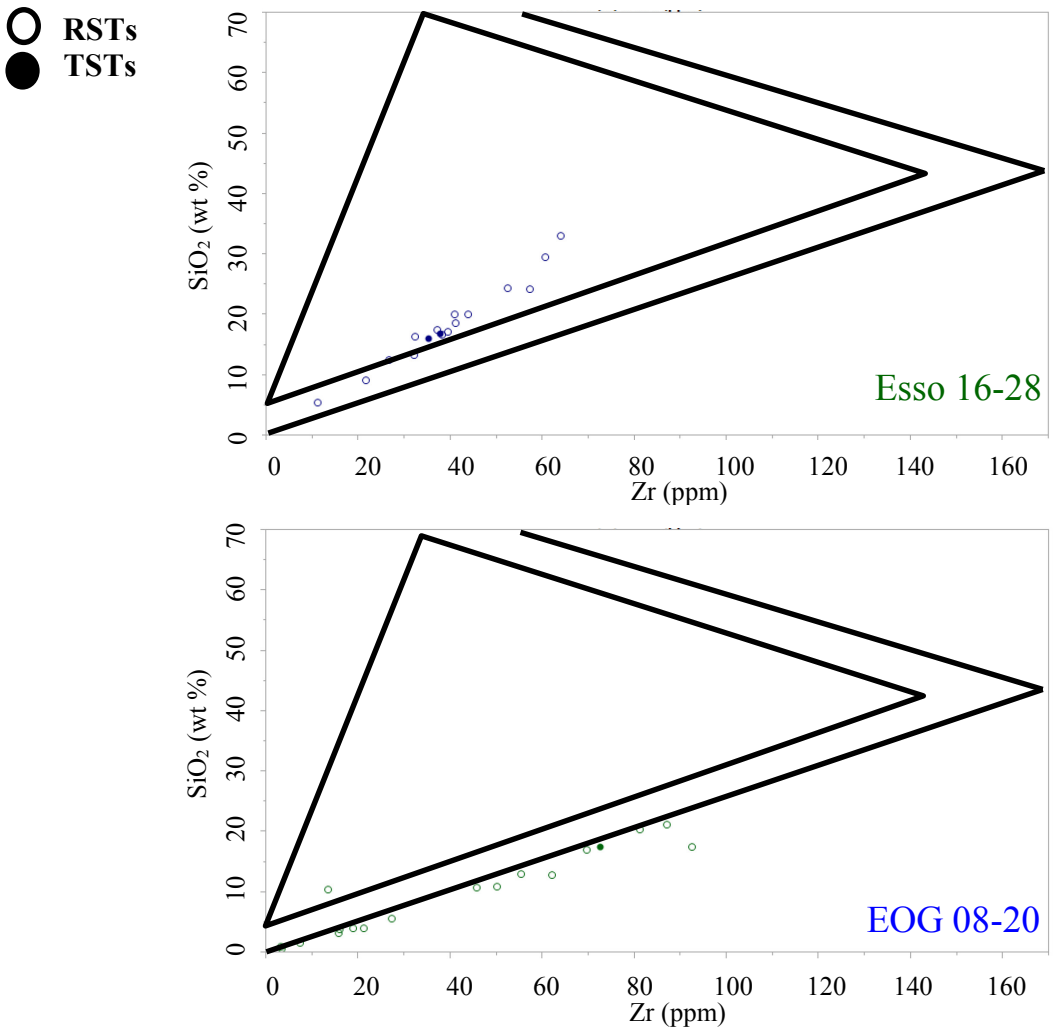


Figure 28. Summary of SiO_2-Zr relationships ratios for the ESB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

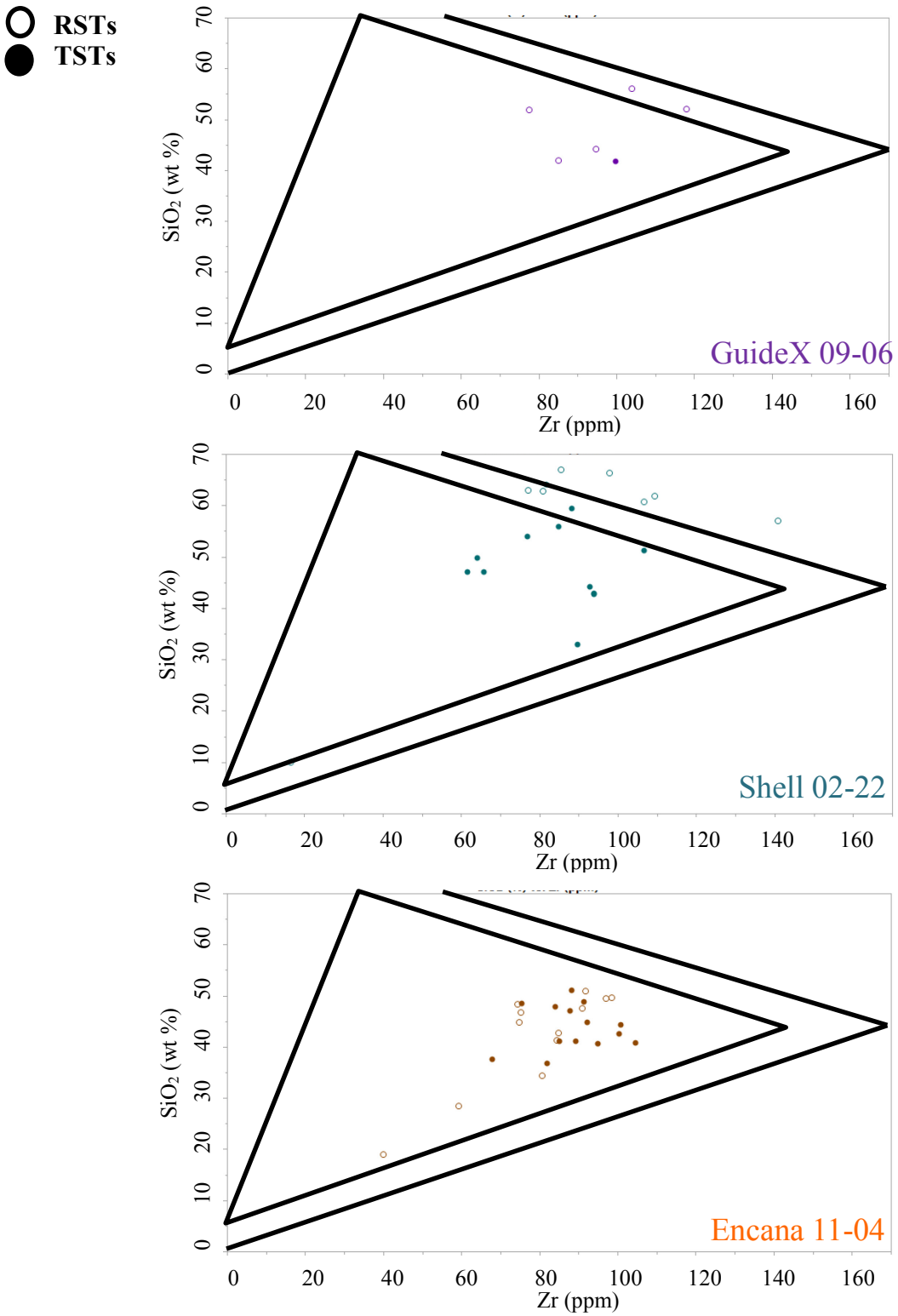


Figure 29. Summary of SiO_2-Zr relationships for the WSB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

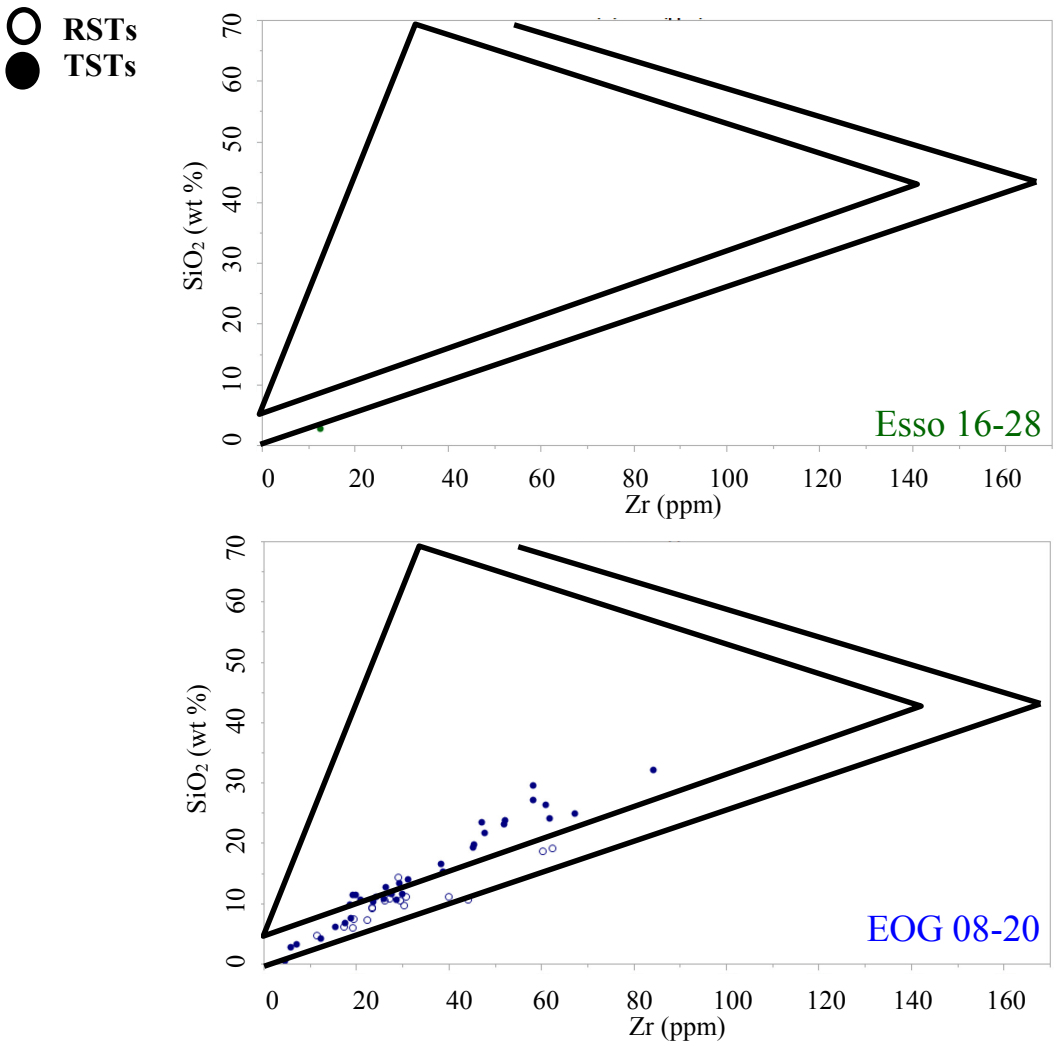


Figure 30. Summary of SiO_2-Zr relationships for the ESB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

4.5.2 Zirconium-Titanium Relationship Ratios

Zirconium-titanium oxide (Zr-TiO_2) cross plots may indicate whether one or multiple detrital sources exist. Both Zr and TiO_2 have been used previously to determine provenance (McLennan et al. 1993, Bhatia et al. 1986 and Cullers et al 1988). The aim is to assess the applicability of TiO_2-Zr cross plots for determining if single or multiple detrital sources exist. Both titanium and zirconium are of detrital origin. If the titanium oxide and zirconium originate from a common, relatively homogeneous source, there should be a linear correlation between them. If the titanium and zirconium originate from more than one source, points may have a high degree of scatter. Heterogeneity within the source terrane may be indistinguishable from a signal from multiple sources, as both would result in sample results departing from a constant Zr/TiO_2 ratio. Zr-TiO_2 relationships and ratios for all wells are shown in Figure 31. The single source line on a Zr-TiO_2 diagram is defined here as the line of positive slope through the origin that characterizes the population of points with the lowest Zr value for any given TiO_2 value. In the Duvernay, the single source trend is defined as the line of best fit through points from EOG 08-20 and Encana 11-04 endmember group with equation Zr=175TiO_2 with an R^2 value of 0.93. Points that are scattered away from this line at higher Zr values are assigned to a multiple source designation. The lower limit of the multiple source region is defined as the line parallel to the single source trend, at the upper limit of points from EOG 08-20 and Encana 11-04 with nodes at 10 ppm Zr and 130 ppm Zr. The upper limit of the multiple source polygon is drawn such that it encloses the points with the high Zr values. In the Duvernay, SiO_2 values range from 0.70 % to 67.1 % with an average of 32.1 % and TiO2 values range from 0.01 % to 0.74 % with an average of 0.31 % (Table 3).

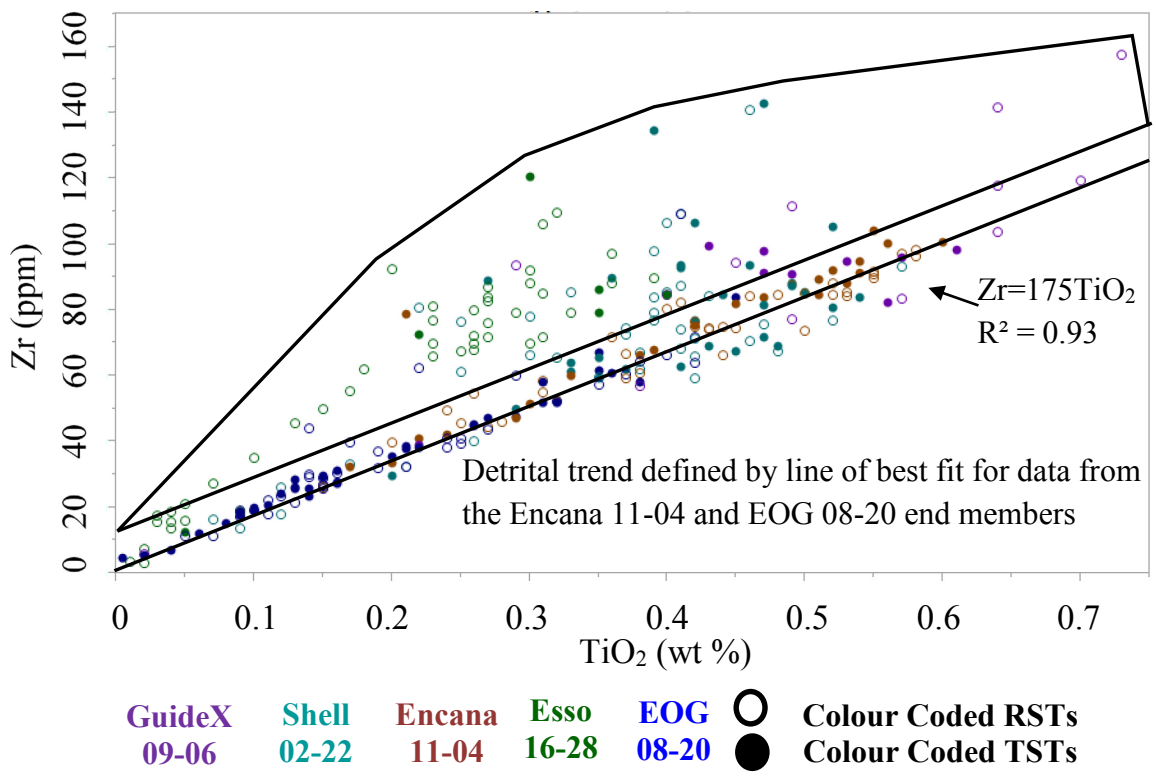


Figure 31. Summary of overall patterns in Zr-TiO_2 relationships for each well (colour coded) in order to delineate trend lines and mixed zone. TSTs are indicated by filled symbols and RSTs by open symbols.

Source terrane indicators of each of the five wells show no obvious distinction between the WSB and ESB. However, wells can be distinguished by proximity to landmasses and physical restriction. Samples from wells that are in physically restricted (Encana 11-04) or distal settings (EOG 08-20) almost exclusively plot along a single, well-defined trend with relatively low Zr/TiO_2 ratios (Fig 3 and Fig 31). Wells proximal to detrital sources such as the PRA (Guidex 09-06) and craton (Esso 16-28) show more influence of multiple sources (Fig 3 and Fig 31). Zirconium-titanium relationships for each well and cycle are shown in Figures 32-37 and Zr/TiO2 ratios averaged over each interval for each well are shown in Table 8.

In the TST1-RST1 cycle (Figures 32 and 33), the WSB and ESB are not clearly distinguished, except for the northernmost wells in each basin (Guidex 09-06 and Esso 16-28). Samples from the southern wells (Shell 02-22 and Encana 11-04 in the WSB along with EOG 08-20 in the ESB), are described by a positive trend line near the lower limit of the data. The northernmost wells, Guidex 09-06 in the WSB and Esso 16-28 in the ESB, especially the latter, are described by higher proportions of samples that plotting at higher Zr/TiO_2 values.

In the TST2-RST2 cycle (Figures 34 and 35), the WSB and ESB are also not clearly differentiated. However, the southernmost wells in each sub-basin are again differentiated from the wells to the north. The southernmost wells, Encana Cecelia in the WSB and EOG 08-20 in the ESB, plot along a line with low positive slope. Samples from Guidex 09-06 and Shell 02-22 in the WSB and the Esso 16-28 in the ESB display a range of Zr/TiO_2 ratios, many of them elevated with respect to the southern wells.

In the TST3-RST cycle (Figures 36 and 37), the WSB and ESB are also not clearly differentiated. In this cycle, the southernmost wells in each sub-basin are also differentiated from the wells to the north. The southernmost wells, Encana Cecelia in the WSB and EOG 08-20 in the ESB plot along a line with low positive slope. Only one sample was available from Esso 16-28. Samples from Guidex 09-06 and Shell 02-22 in the WSB display a range of Zr/TiO_2 ratios, many of these elevated.

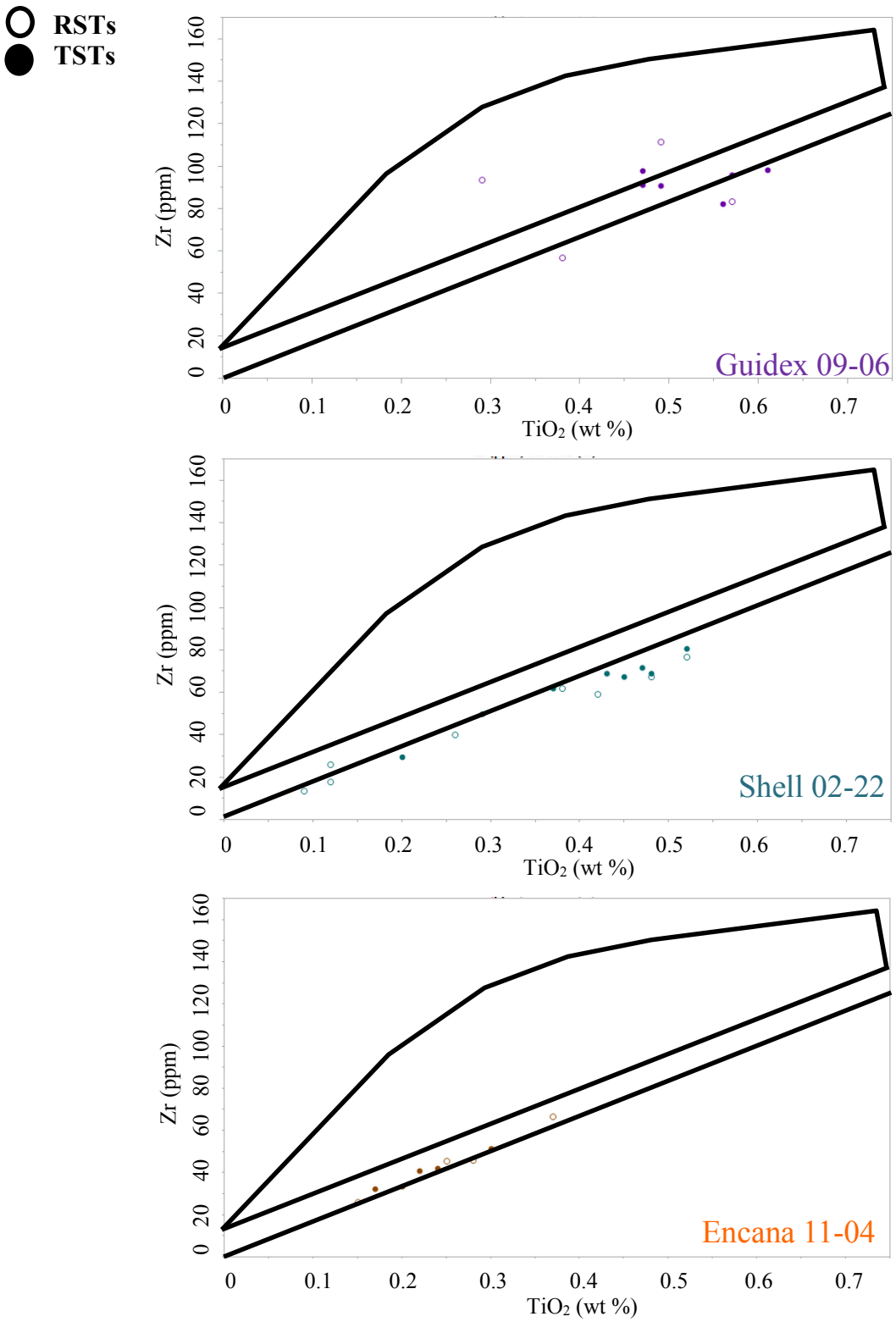


Figure 32. Summary of SiO2-Zr relationships for the WSB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

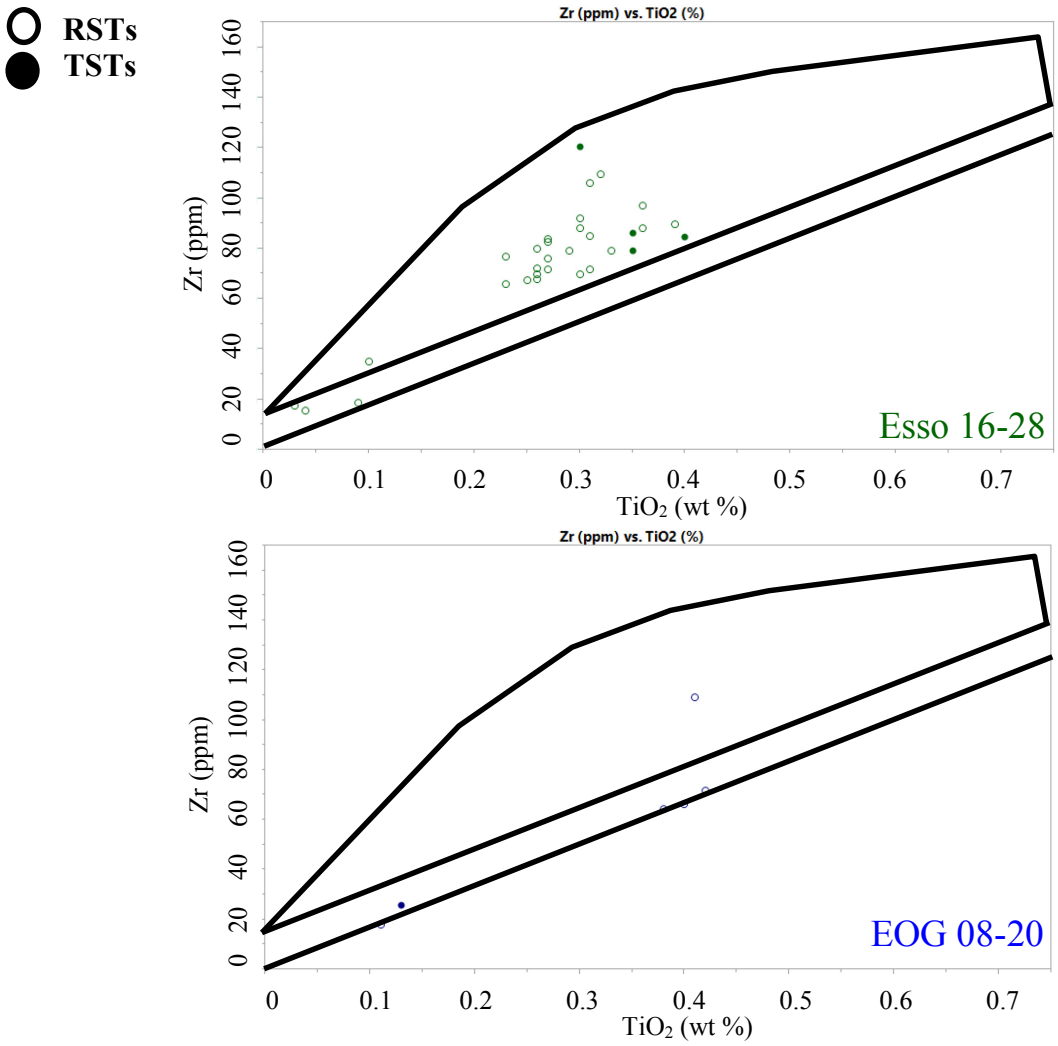


Figure 33. Summary of SiO2-Zr relationships for the ESB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

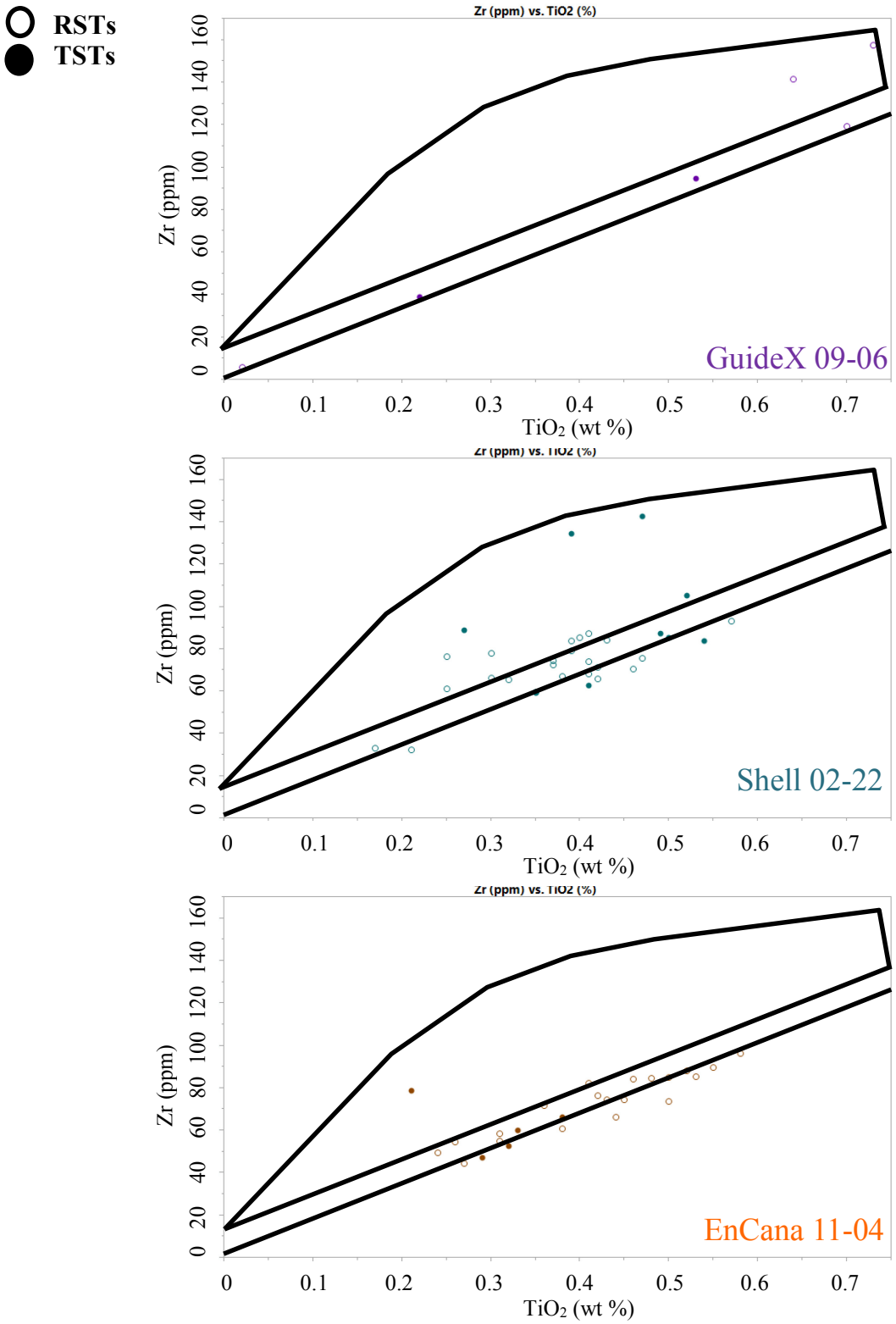


Figure 34. Summary of SiO_2-Zr relationships for the WSB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

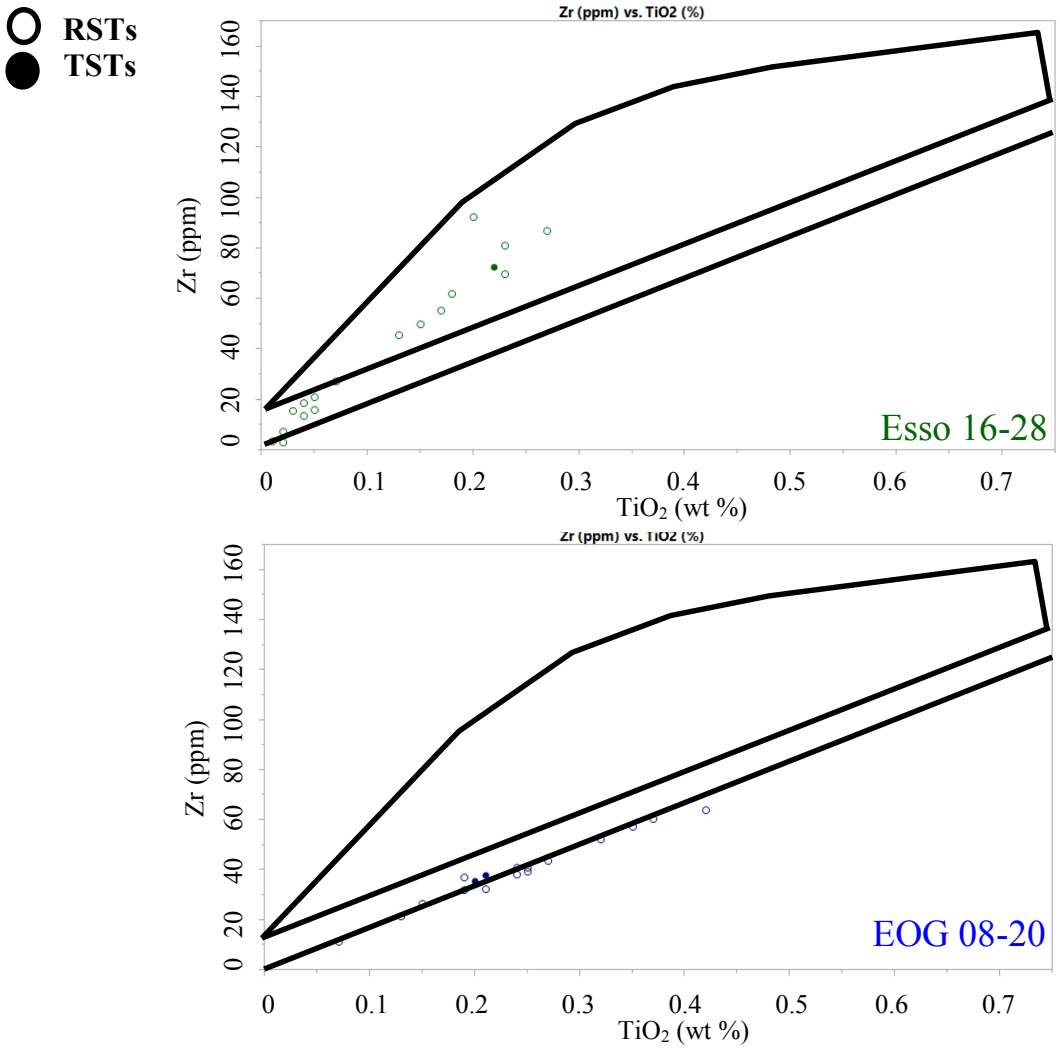


Figure 35. Summary of SiO_2-Zr relationships for the ESB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

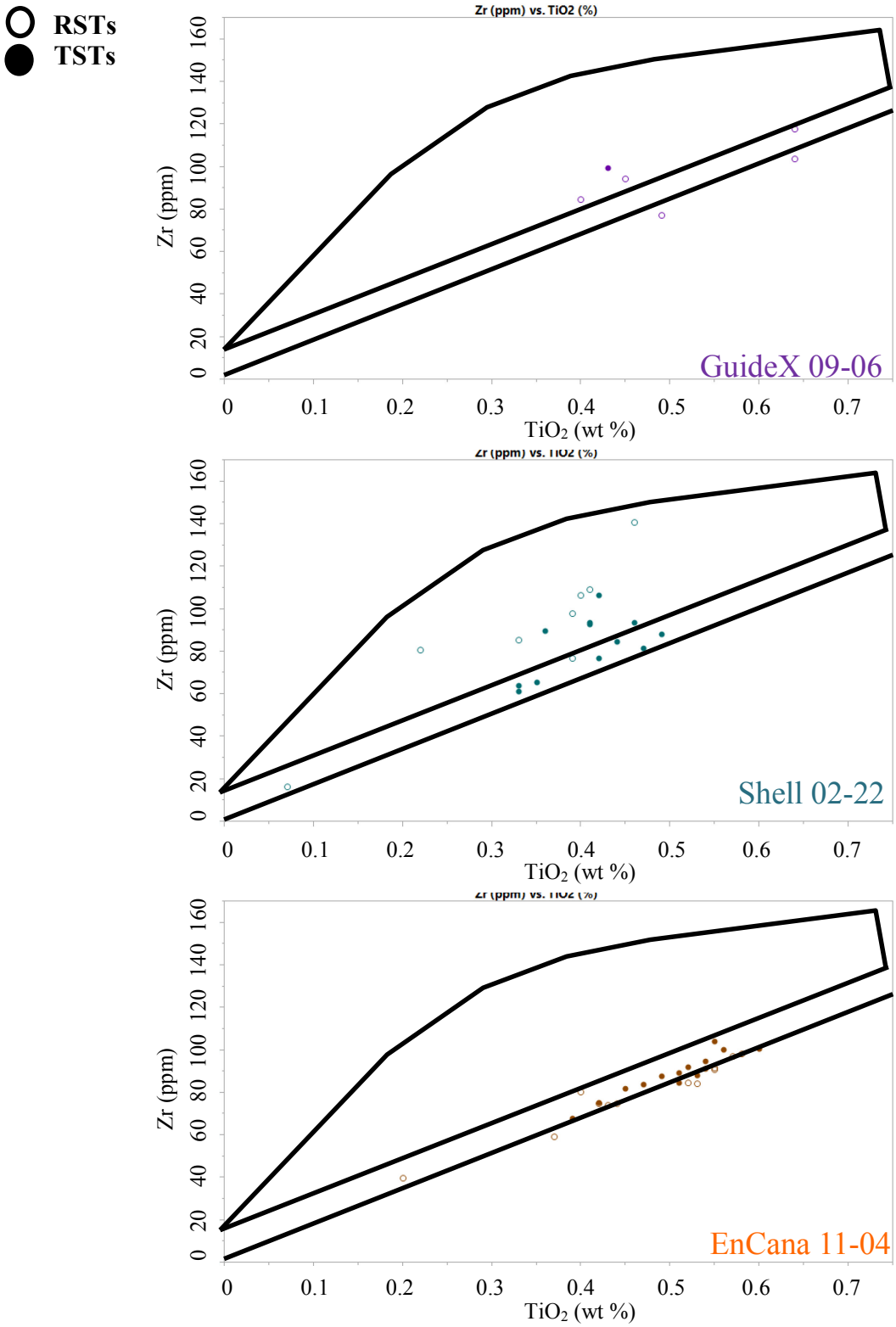


Figure 36. Summary of SiO_2-Zr relationships for the WSB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

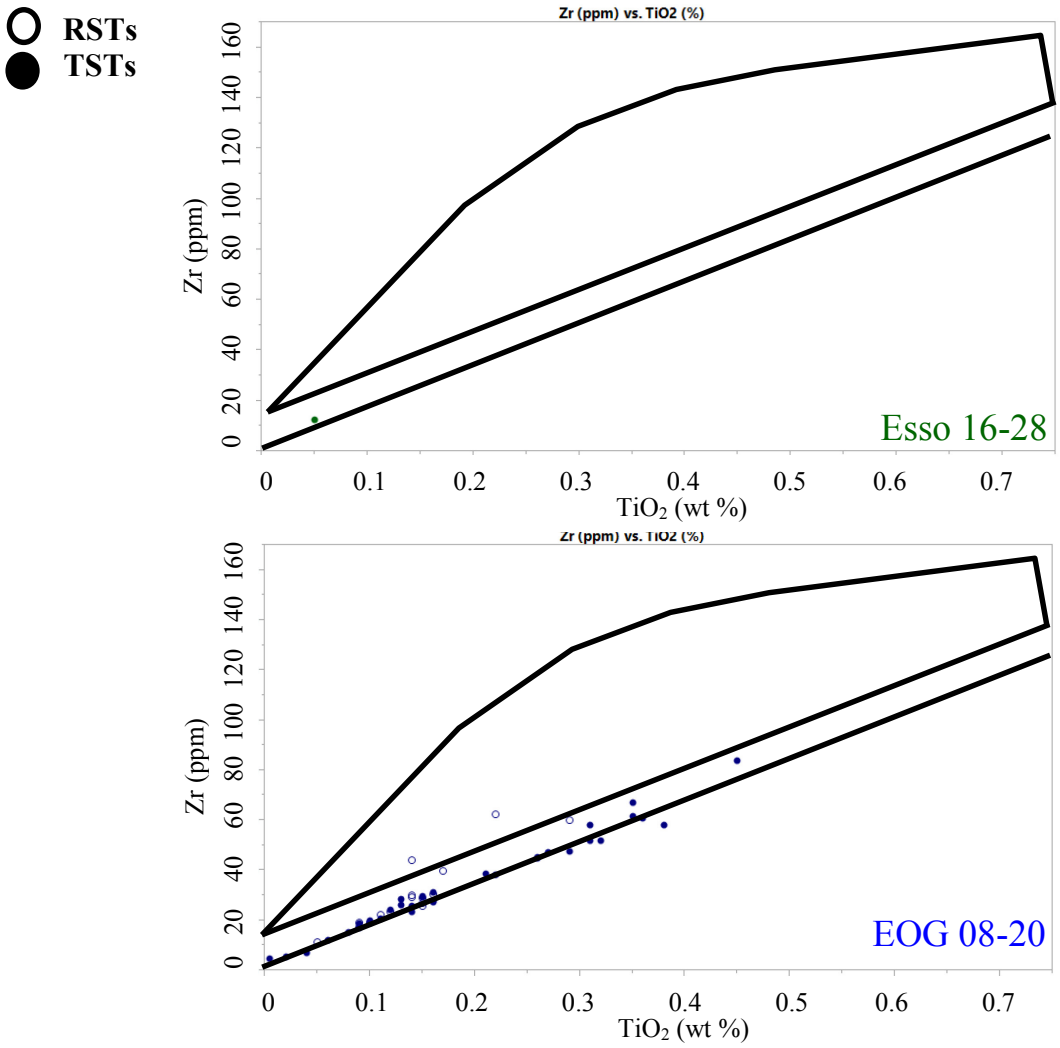


Figure 37. Summary of SiO_2-Zr relationships for the ESB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs.

	Zr/TiO_2 (ppm/%)	Zr/TiO_2 (ppm/%)	Zr/TiO_2 (ppm/%)	Zr/TiO_2 (ppm/%)	Zr/TiO_2 (ppm/%)
RST3	185	268	171	No Data	213
TST3	232	205	175	248	208
RST2	224	197	176	360	165
TST2	178	223	212	330	178
RST1	212	158	175	296	187
TST3	177	156	179	271	199

Table 8. Summary of Zr/TiO2 ratios averaged over each interval for each well. Colour coded: **Guidex 09-06** in purple, **Shell 02-22** in teal, **Encana 11-04** in orange, **Esso 16-28** in green and **EOG 08-20** in blue.

4.6 Redox Indicators

4.6.1 Carbon, iron, sulfur systematics

C-Fe-S ternary plots provide insights into redox conditions and, used in conjunction with aluminum normalized proxies (see below), potentially provide independent corroboration of redox conditions. The Fe/S ratio in a sample defines an intercept on the Fe/S axis (Fe-S ratio) that provides an indication of carbon, iron and sulfur limitation (e.g. Dean and Arthur 1989, Rimmer 2004, Rimmer et al. 2004, Aplin and Macquaker 1993). Redox conditions are classified by Fe-S ratios as follows: a ratio of 0.30 refers to the oxic-marginally oxic boundary, a ratio of 0.35 is characterized as the marginally oxic-dysoxic boundary, and a ratio of 0.40 indicates the dysoxic-anoxic boundary (Rimmer et al. 2004). The normal marine line and pyrite line used herein were utilized from Dean and Arthur (1989) and Rimmer et al. (2004).

Duvernay samples predominantly plot within a region defined by lines with Fe-S ratios between 0.30 and 0.55 (Figure 38). Five samples from EOG 08-plot below the pyrite line (sulfur contents in excess of pyrite). In the Duvernay, total C values range from 2.47 % to 14.8 % with an average of 8.80 %, total S values range from 0.13 % to 4.03 % with an average of 1.28 % and Fe values range from 0.14 % to 11.0 % with an average of 2.11 % (Table 3). C-Fe-S data are shown for each stratigraphic interval in Figures 39-44.

Within the TST1-RST1 cycle (Figures 39 and 40), samples from all wells except the Esso 16-28 plot with intercepts between 0.20 and 0.55. The Esso 16-28 samples from this interval were consistently enriched in sulfur relative to the other wells. Fe-S ratios are also enriched in sulfur in the Encana 11-04 well, also plotting consistently in the anoxic group. No systematic differences were noted between TST and RST samples in this cycle.

In the TST2-RST2 cycle (Figures 41 and 42), the range of Fe-S intercepts was similar to TST1-RST1. The Esso 16-28 samples from this interval were also consistently enriched in sulfur relative to the other wells.

In the TST3-RST3 cycle (Figures 43 and 44), similar to cycle 2, samples in all wells except the EOG 08-20 well had Fe-S ratios ranging from approximately 0.20 to 0.55. The notable occurrence of four very sulfur-rich samples in the EOG 08-20 well was observed and all four samples were from the TST. The EOG 08-20 well also had more samples with ratios of 0.4 to 0.55 than it did in either of the cycles prior and these points were from the RST.

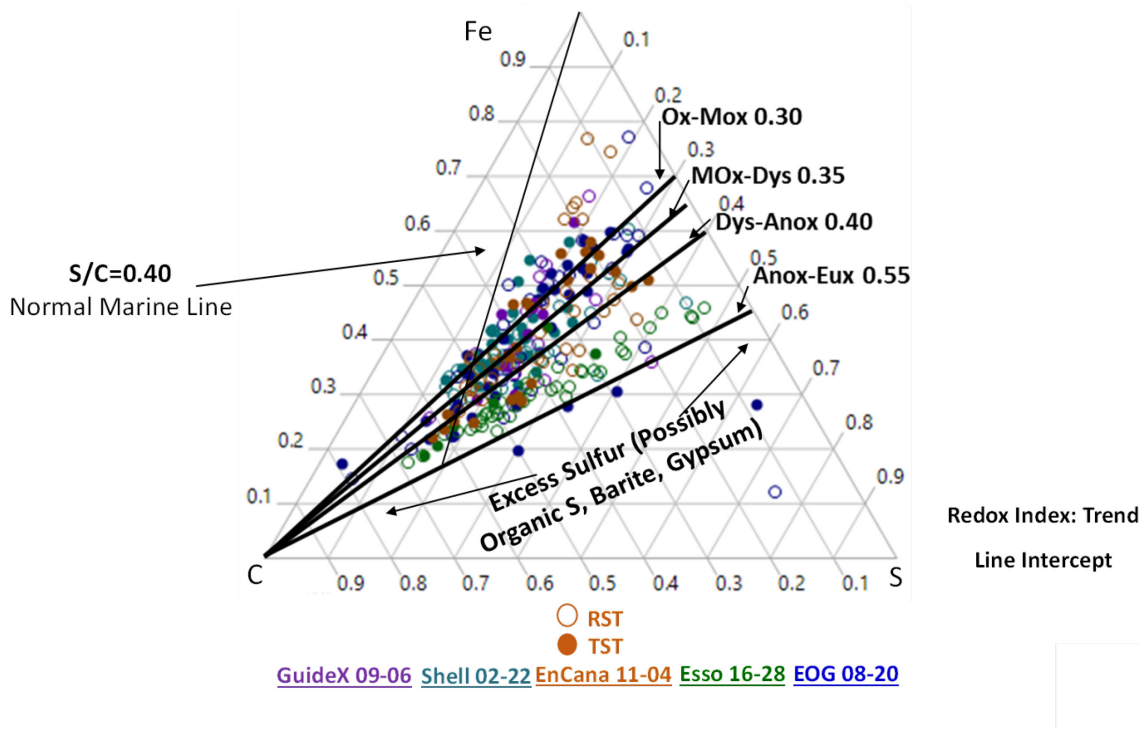


Figure 38. Summary of overall patterns in Carbon-Iron-Sulfur (C-Fe-S) systematics for each well (colour coded) in order to illustrate redox zones. TSTs are indicated by filled symbols and RSTs by open symbols.

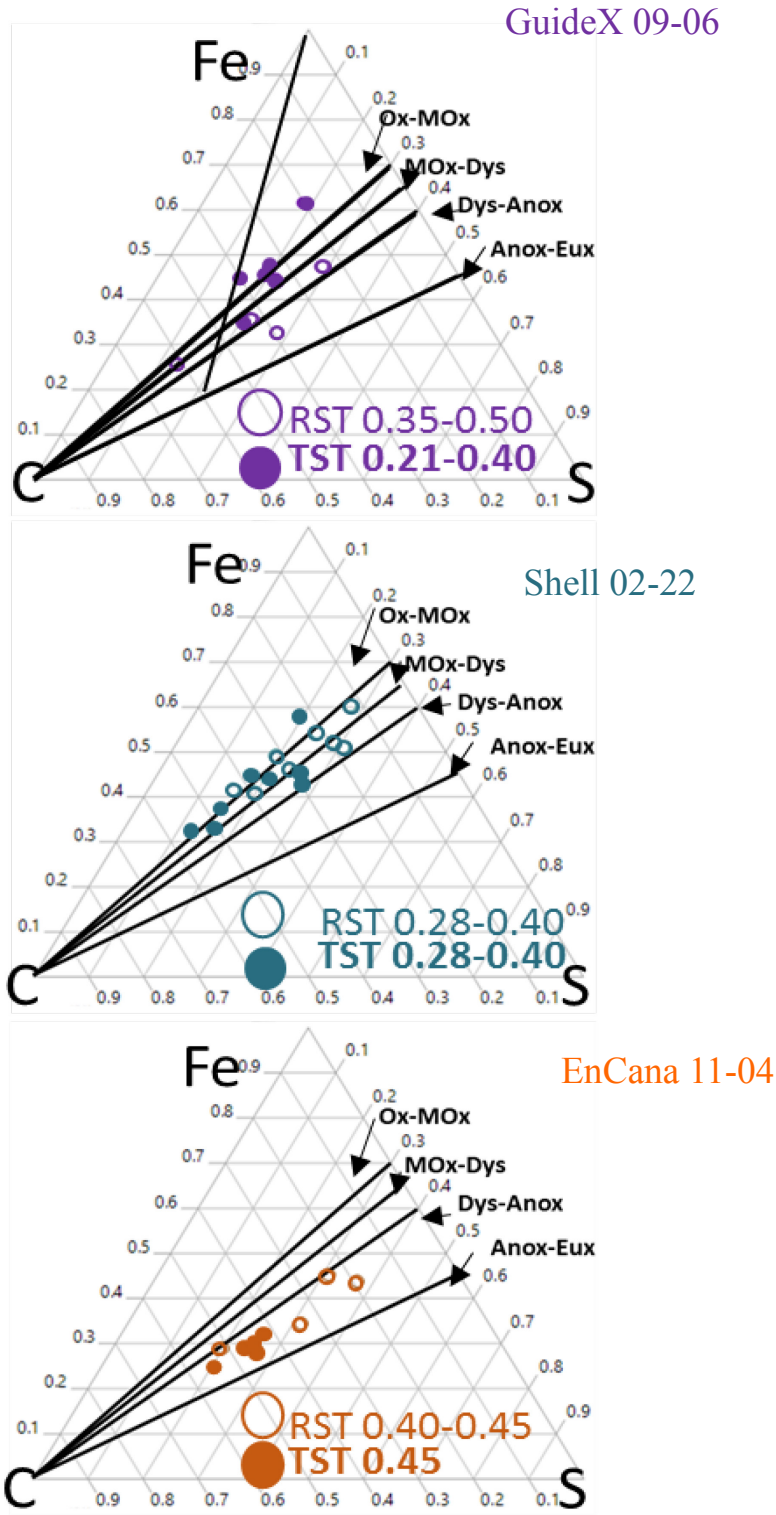


Figure 39. Summary of C-Fe-S systematics for the WSB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs. Representative Fe/S axis intercepts for each RST and TST are indicated in the lower portion of each graph.

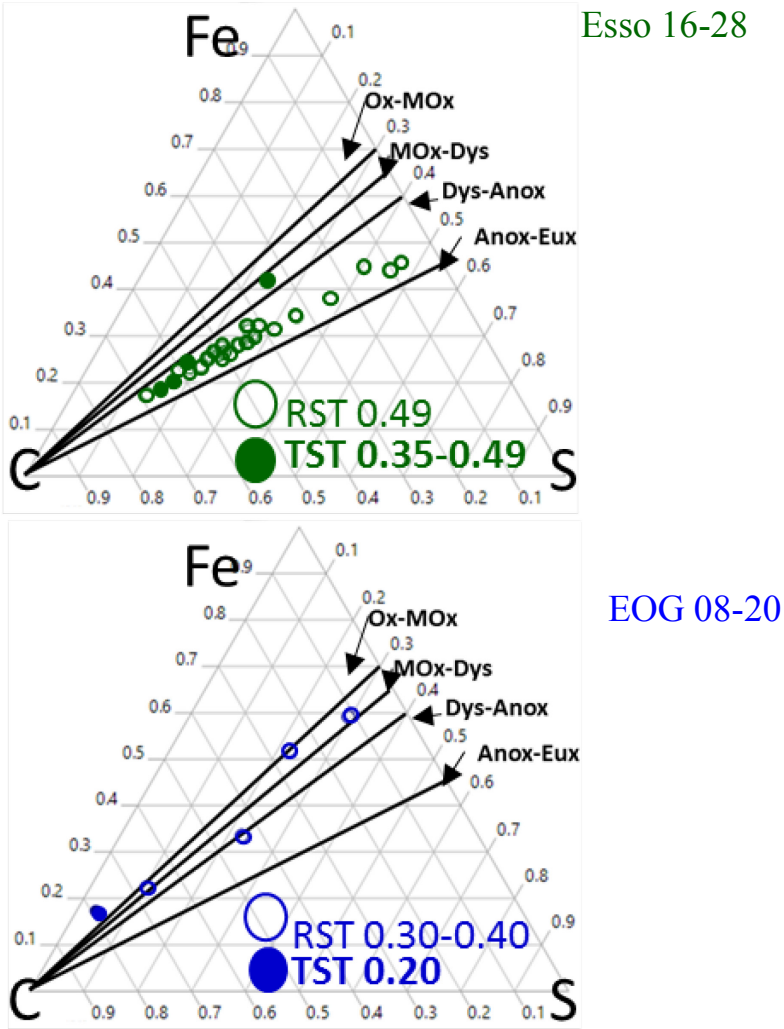


Figure 40. Summary of C-Fe-S systematics for the ESB TST1- RST1 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs. Representative Fe/S axis intercepts for each RST and TST are indicated in the lower portion of each graph.

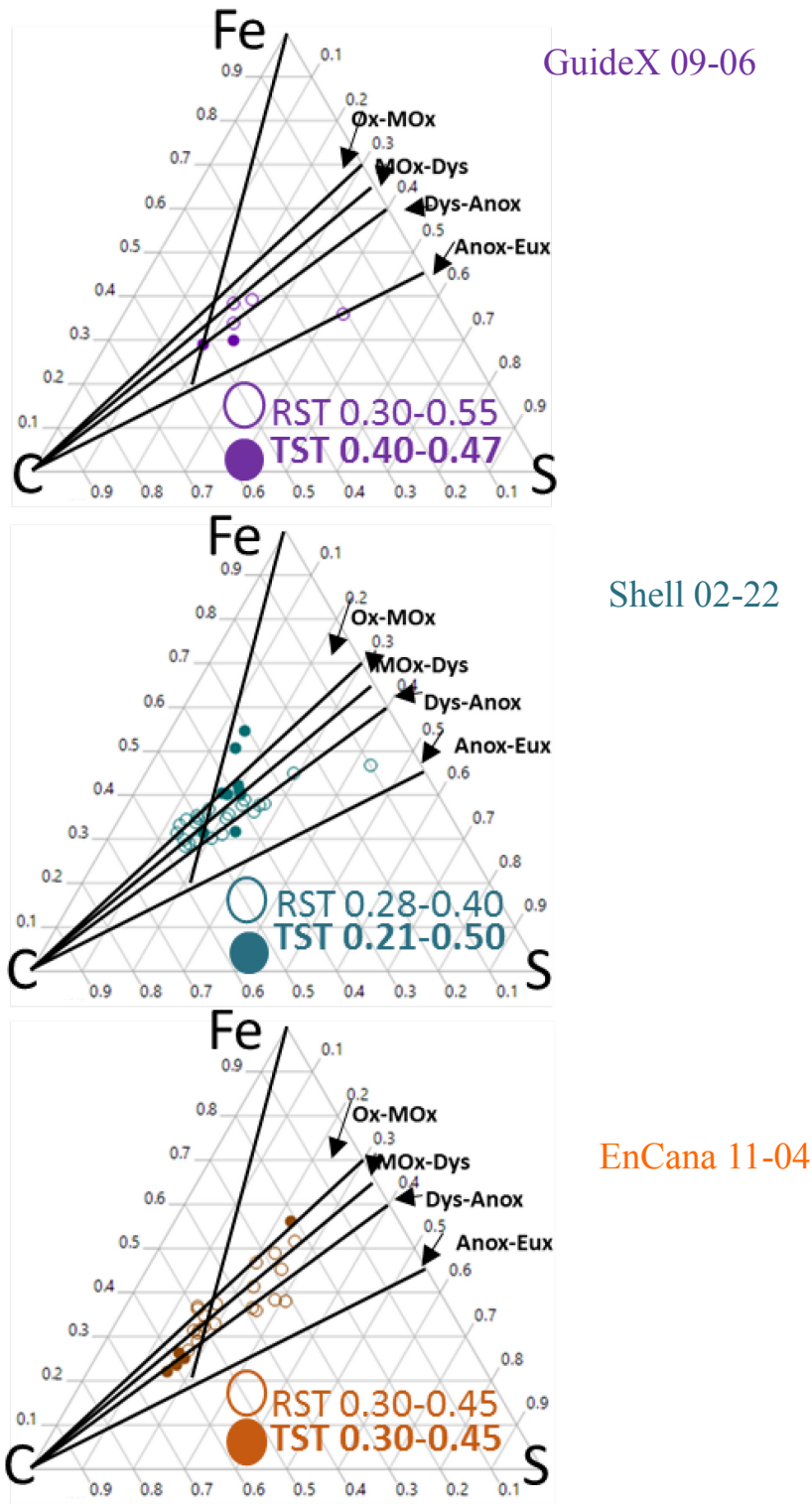


Figure 41. Summary of C-Fe-S systematics for the WSB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs. Representative Fe/S axis intercepts for each RST and TST are indicated in the lower portion of each graph.

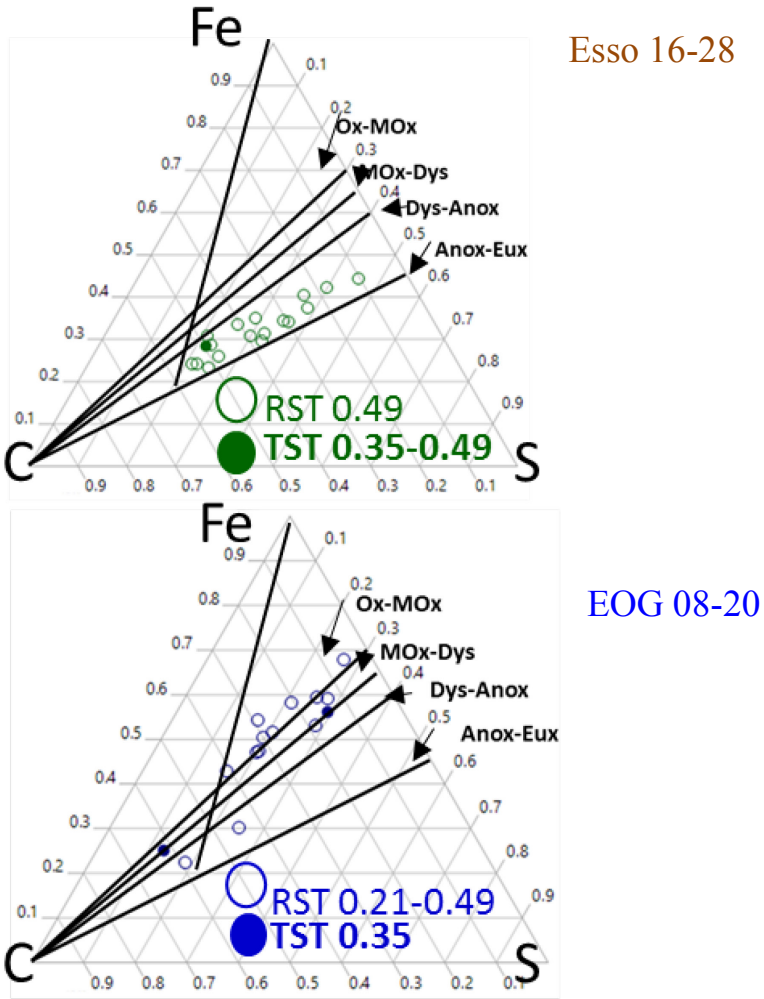
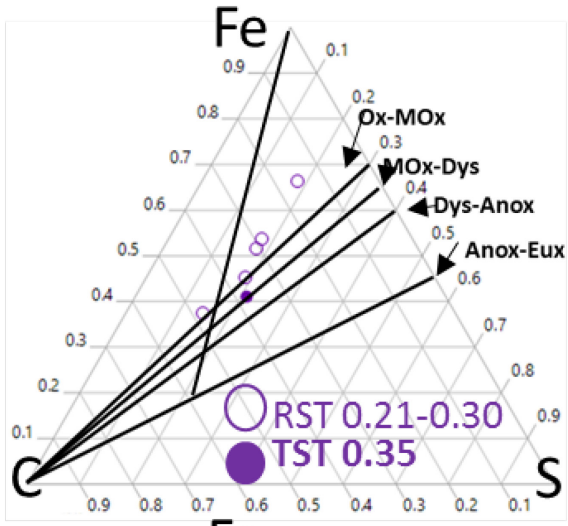
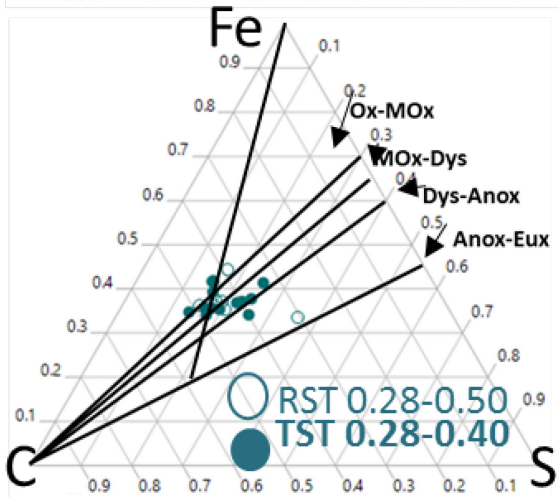


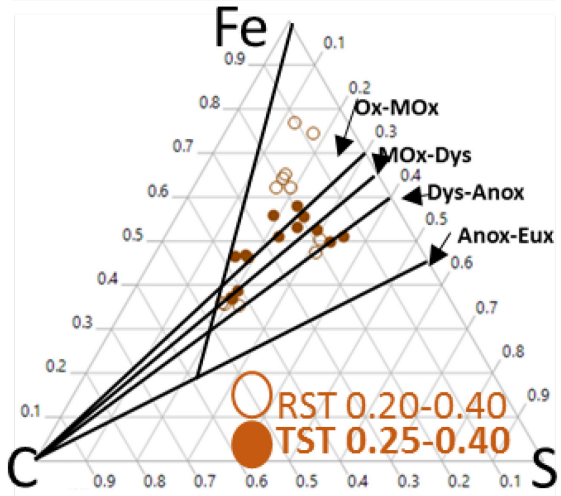
Figure 42. Summary of C-Fe-S systematics for the ESB TST2- RST2 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs. Representative Fe/S axis intercepts for each RST and TST are indicated in the lower portion of each graph.



GuideX 09-06



Shell 02-22



EnCana 11-04

Figure 43. Summary of C-Fe-S systematics for the WSB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs. Representative Fe/S axis intercepts for each RST and TST are indicated in the lower portion of each graph.

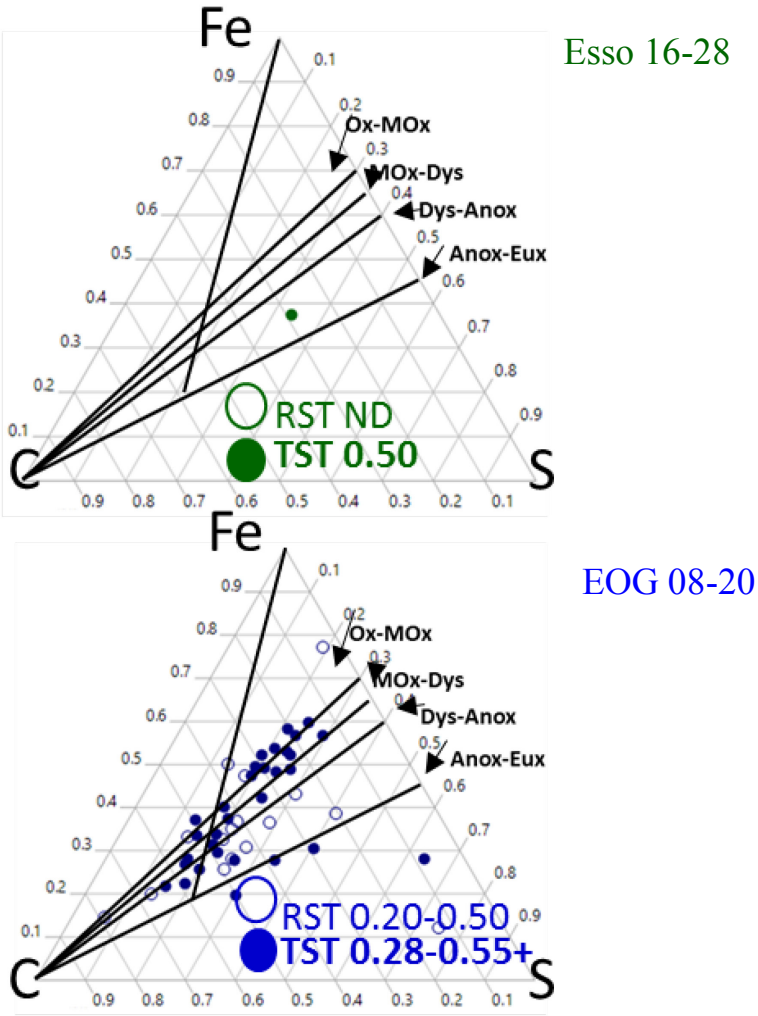


Figure 44. Summary of C-Fe-S systematics for the ESB TST3- RST3 cycle. Wells are colour coded and well names are provided in the upper corners of each plot. Filled symbols indicate TSTs and open symbols indicate RSTs. Representative Fe/S axis intercepts for each RST and TST are indicated in the lower portion of each graph.

4.6.2 Redox Sensitive Trace elements

Redox sensitive trace elements, such as molybdenum (Mo), uranium (U) and vanadium (V), are less soluble and are therefore enriched in sediments in reducing conditions (Tribovillard et al. 2006). Mo and U values are commonly normalized to aluminum (Al) in order to correct for detrital influence (Tribovillard et al. 2006). A major advantage of these proxies is that they are easily utilized to develop stratigraphic geochemical profiles. When used in conjunction with an aluminum-independent method such as C-Fe-S ternary plots, trace element proxies can provide useful paleoredox information in a stratigraphic context. Figures 45-53 summarize the average values of parameters of each well and interval in a stratigraphic and geographic context. In the Duvernay, Mo/Al values range from 0.04 ppm/% to 11.0 ppm/% with an average of 1.74 ppm/%, U/Al values range from 0.31 ppm/% to 12.6 ppm/% with an average of 1.74 ppm/% and V/Al values range from 8 ppm/% to 115 ppm/% with an average of 27 ppm/% (Table 3). Trace element values averaged over each cycle for each well can be found in Table 9.

In the TST1-RST1 cycle, the WSB and ESB are not clearly distinguished (Figures 45-47, Table 9). This cycle records the lowest average trace element ratios in Guidex 09-06 and EOG 08-20. From TST to RST, averages of all three trace element ratios (Mo/Al, U/Al and V/Al) increase at Guidex 09-06 in the WSB, whereas Shell 02-22 and Encana 11-04 averages decrease. In the ESB, averages from both wells increase from TST to RST in general, except for Mo/Al at Esso 16-28.

In the TST2-RST2 cycle (Figures 48-50, Table 9), the WSB and ESB become more differentiated. Average trace metal ratios in both the WSB and ESB have increased relative to TST1-RST1. WSB average trace metal ratios are generally higher than in the ESB. From the TST to the RST, trace element ratios decrease at Encana 11-04, Shell 02-22 and EOG 08-20

except for V/Al at Shell 02-22 which increase slightly. At Guidex 09-06 all trace element values increase from the TST to the RST.

In the TST3-RST3 cycle (Figures 51-53, Table 9), the WSB and ESB data are not clearly differentiated. A slight distinction is noticed between the two more southern WSB wells and the ESB wells: the ESB basin wells have higher trace element ratios than Shell 02-22 and Encana 11-04 but not significantly different than Guidex 09-06 values. At Guidex 09-06 and Encana 11-04 in the WSB, average trace element ratios have decreased relative to the TST2-RST2 cycle whereas all other wells experience a decrease. Some of the highest average trace element ratios are recorded in this cycle at Shell 02-22 and Esso 16-28 although no data is available in RST3 at the latter location. Additionally, well plates with depth plots of GR, TOC, Tmax, Zr/TiO2, Al/SiO_2, Mo/Al and U/Al for each well are provided in Appendix G.

Guidex 09-06	Mo/Al (ppm/%)	U/Al (ppm/%)	V/Al (ppm/%)
RST3	1.47	1.07	23.7
TST3	3.84	2.87	32.4
RST2	4.90	4.61	47.1
TST2	4.62	2.54	42.6
RST1	3.66	2.48	31.3
TST1	0.69	0.62	14.3

Esso 16-28	Mo/Al (ppm/%)	U/Al (ppm/%)	V/Al (ppm/%)
RST3	No Data	No Data	No Data
TST3	1.57	3.78	50.39
RST2	1.37	3.35	28.49
TST2	0.45	1.79	21.44
RST1	0.89	1.41	20.19
TST1	2.19	1.38	19.16

Shell 02-22	Mo/Al (ppm/%)	U/Al (ppm/%)	V/Al (ppm/%)
RST3	4.63	1.95	54.2
TST3	2.09	1.27	37.9
RST2	2.38	1.47	29.6
TST2	3.45	1.71	27.9
RST1	0.57	0.67	16.9
TST1	1.13	1.02	21.5

EOG 08-20	Mo/Al (ppm/%)	U/Al (ppm/%)	V/Al (ppm/%)
RST3	1.37	2.76	29.6
TST3	1.54	2.59	28.4
RST2	0.59	1.24	17.1
TST2	0.87	1.75	22.3
RST1	1.21	1.22	18.2
TST1	0.39	1.16	12.2

Encana 11-04	Mo/Al (ppm/%)	U/Al (ppm/%)	V/Al (ppm/%)
RST3	0.81	0.67	17.6
TST3	0.74	0.65	19.1
RST2	2.48	1.37	26.6
TST2	3.87	1.94	46.5
RST1	1.00	1.11	23.4
TST1	2.53	1.62	37.3

Table 9. Summary of trace element values averaged over each interval (Mo/Al, U/Al and V/Al). Colour coded: **Guidex 09-06** in purple, **Shell 02-22** in teal, **Encana 11-04** in orange, **Esso 16-28** in green and **EOG 08-20** in blue.

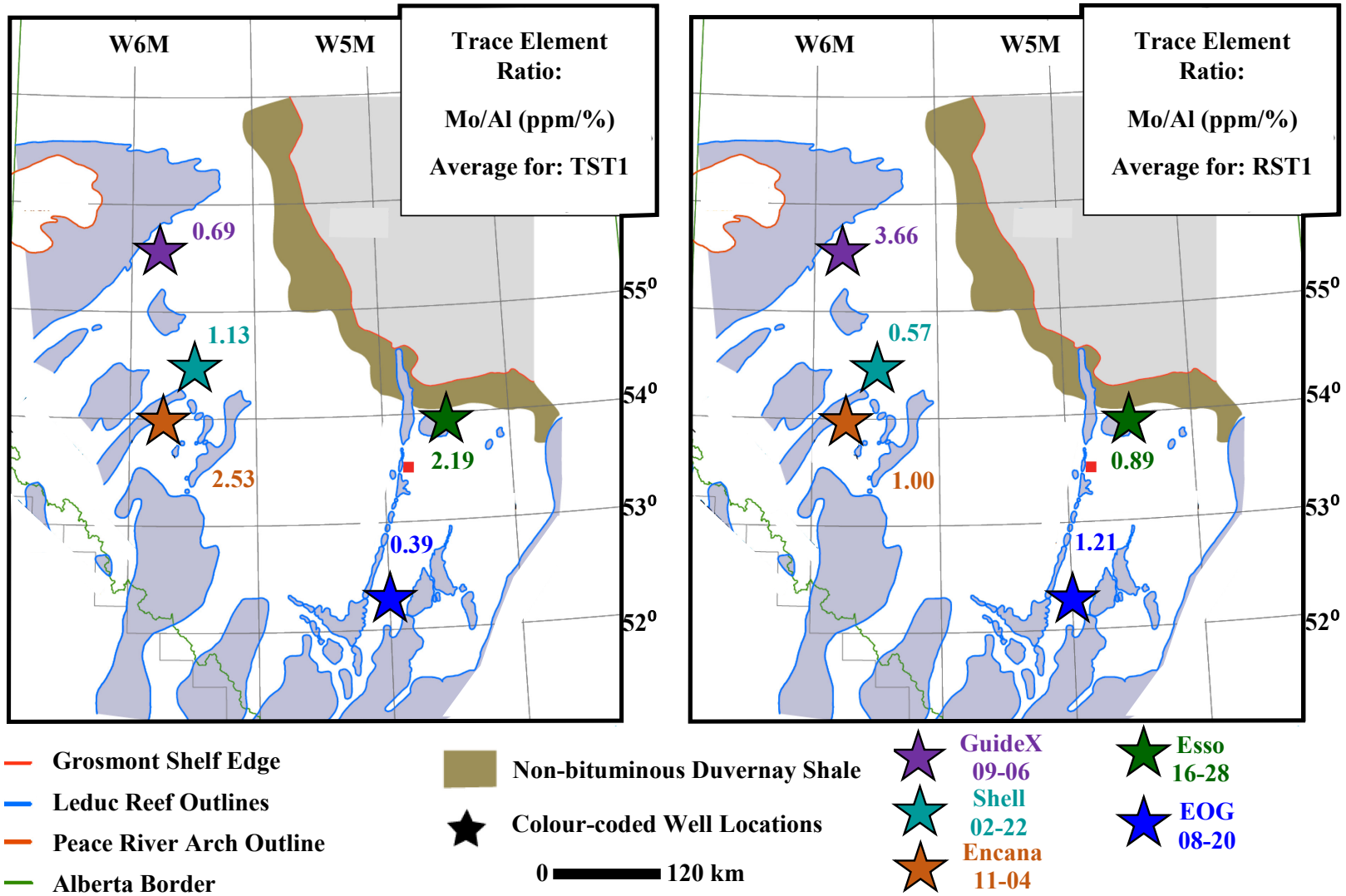


Figure 45. Summary of geographic and stratigraphic variation in Mo/Al (ppm/%) for TST1-RST1. Values are averaged for the TST and RST in each well.

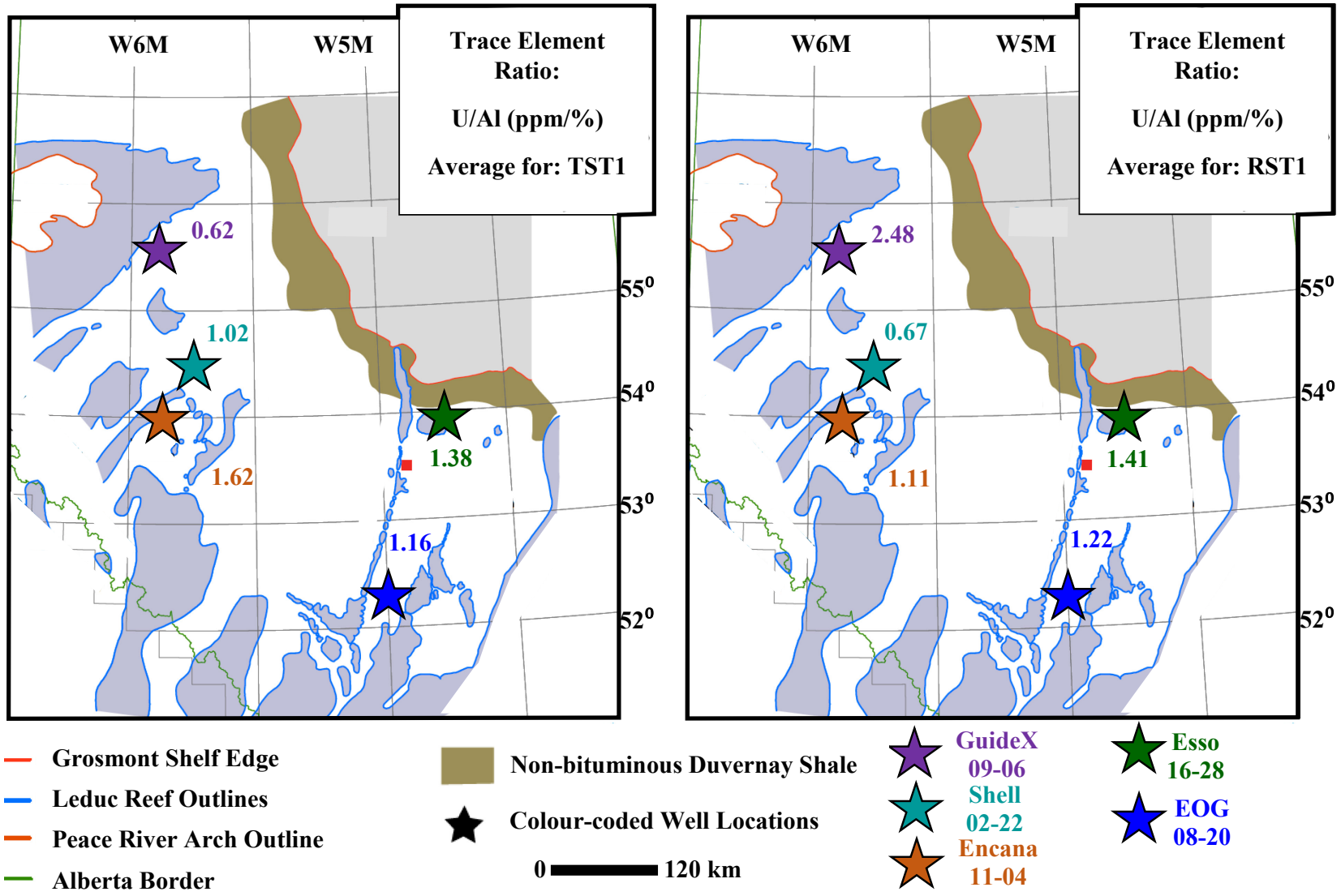


Figure 46. Summary of geographic and stratigraphic variation in U/Al (ppm/%) for TST1-RST1. Values are averaged for the TST and RST in each well.

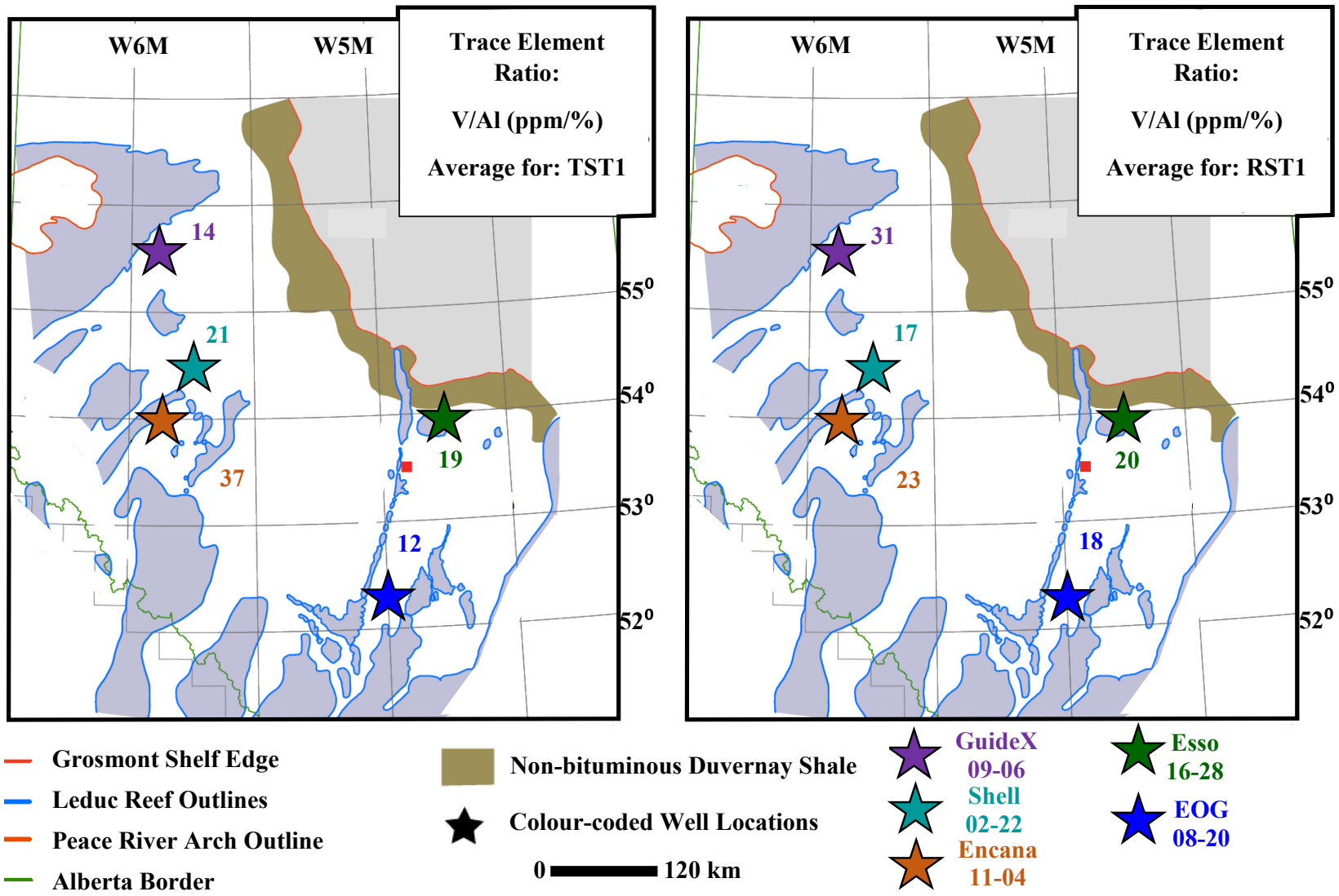


Figure 47. Summary of geographic and stratigraphic variation in V/Al (ppm/%) for TST1-RST1. Values are averaged for the TST and RST in each well.

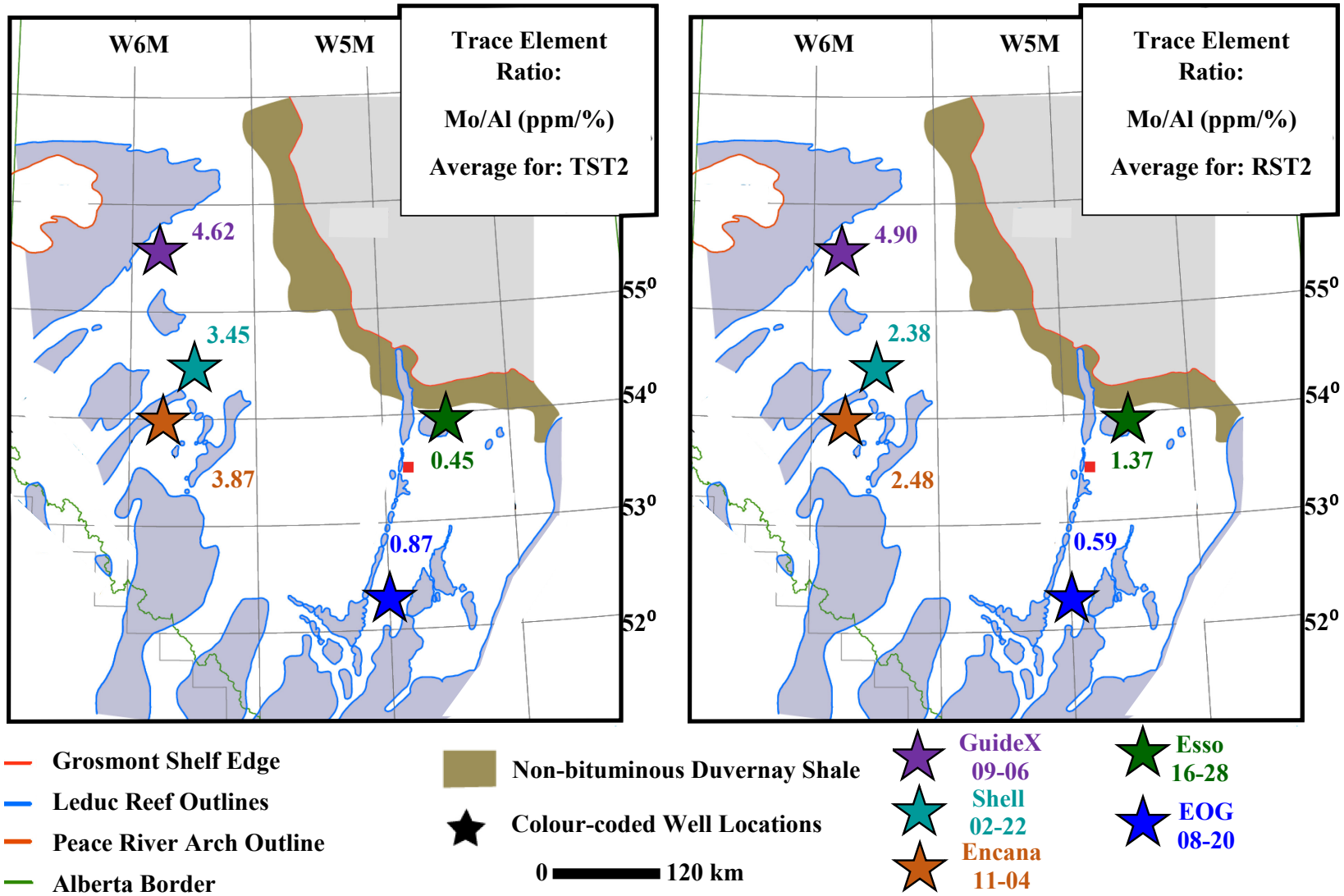


Figure 48. Summary of geographic and stratigraphic variation in Mo/Al (ppm/%) for TST2-RST2. Values are averaged for the TST and RST in each well.

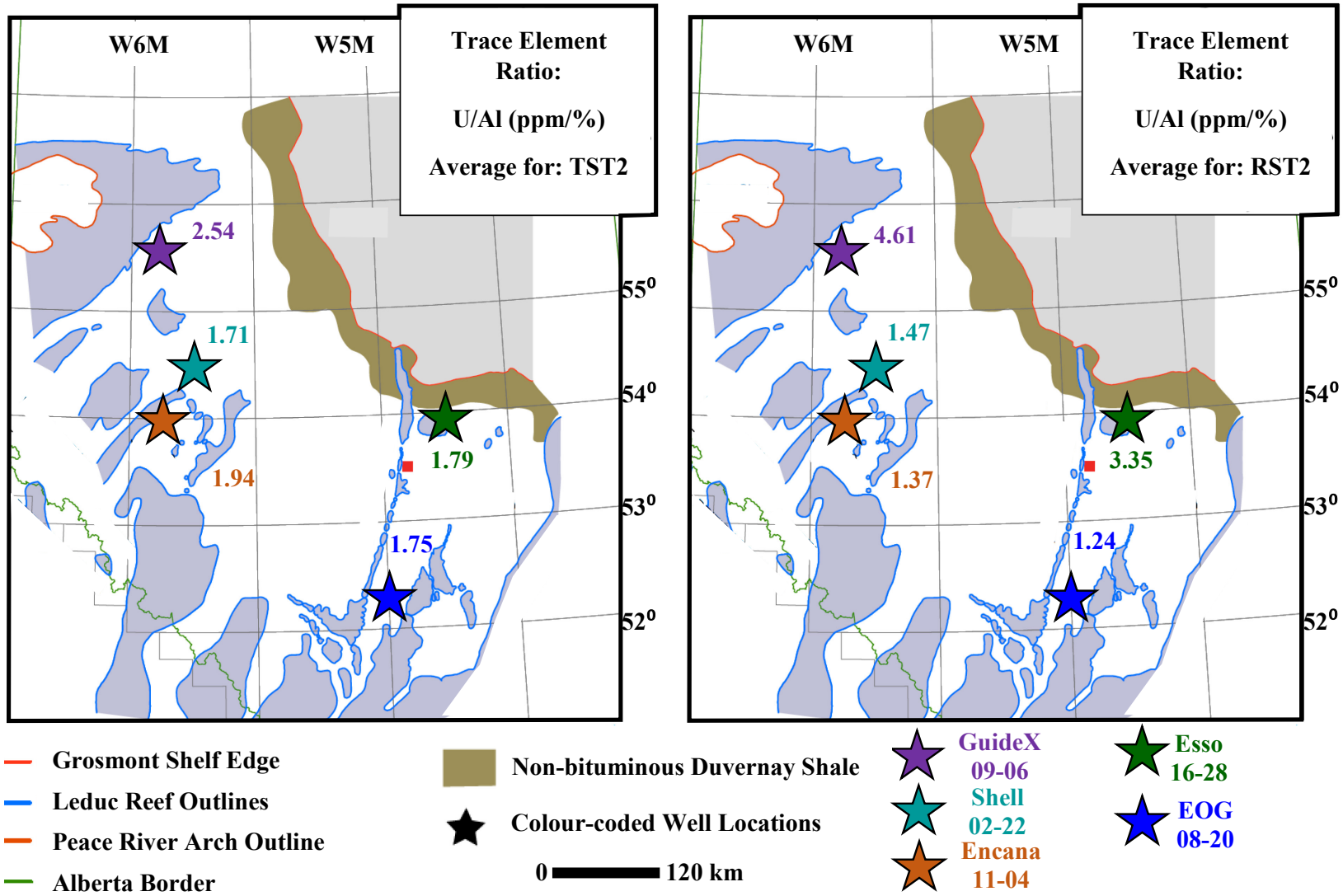


Figure 49. Summary of geographic and stratigraphic variation in U/Al (ppm/%) for TST2-RST2. Values are averaged for the TST and RST in each well.

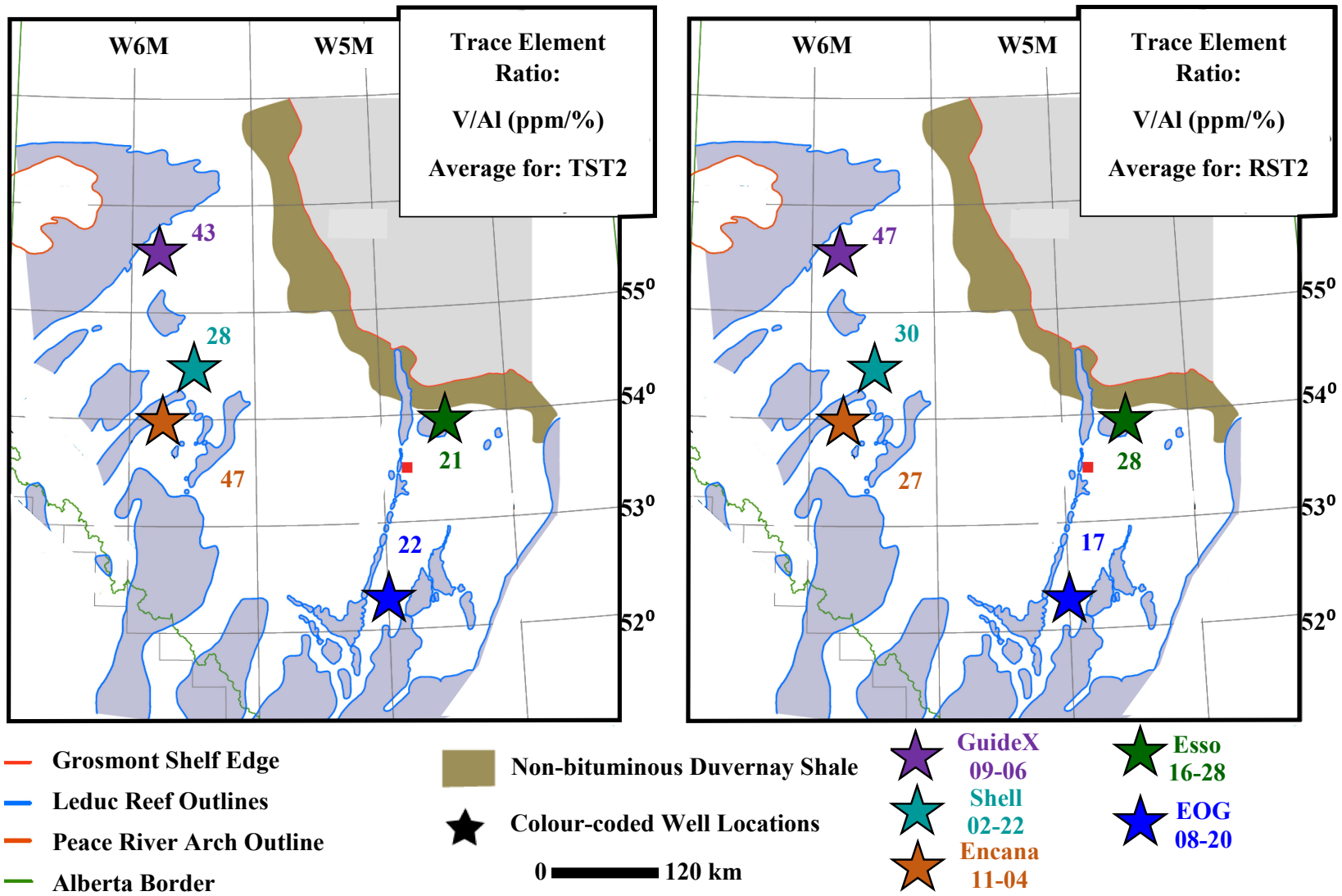


Figure 50. Summary of geographic and stratigraphic variation in V/Al (ppm/%) for TST2-RST2. Values are averaged for the TST and RST in each well.

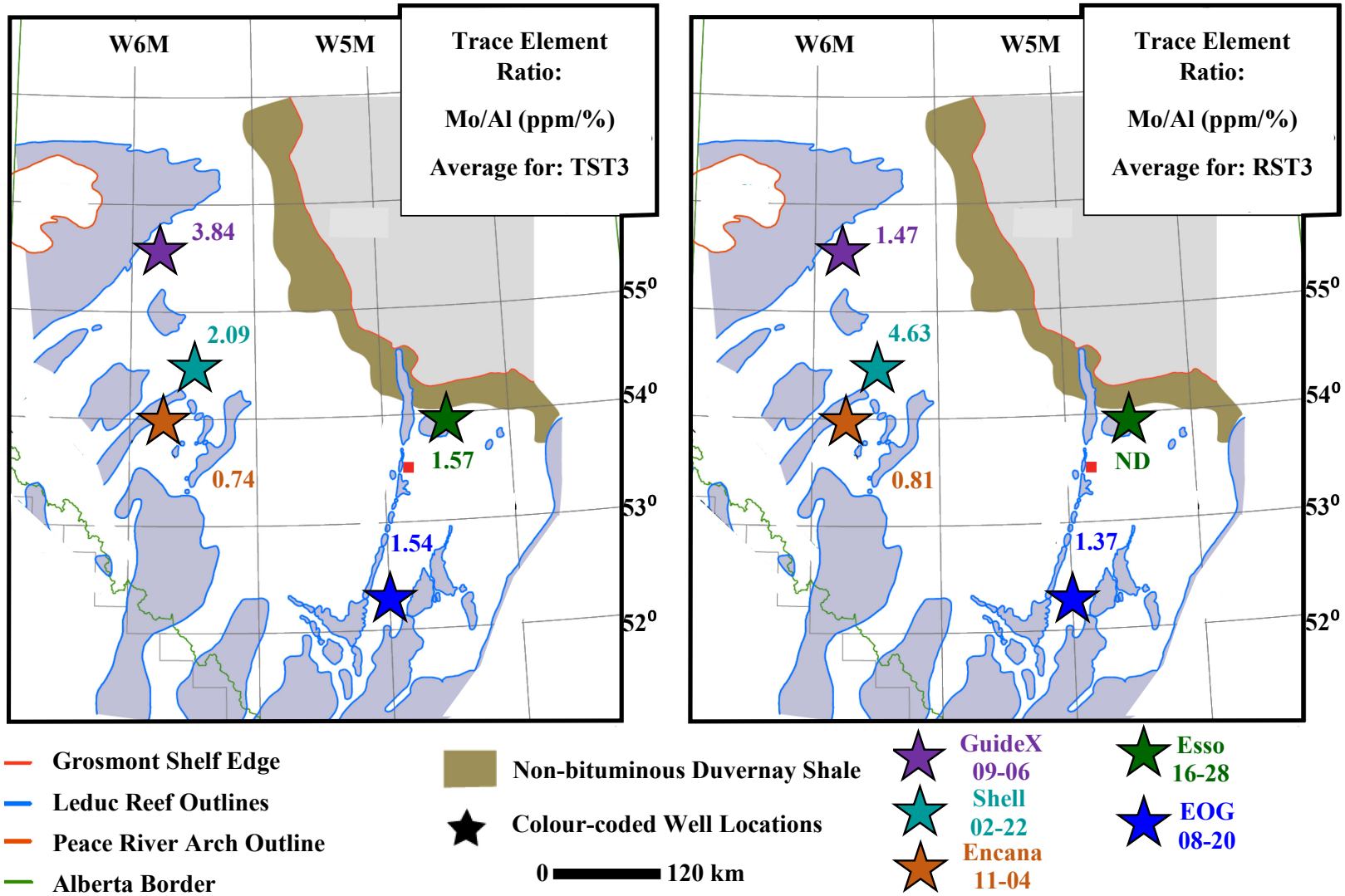


Figure 51. Summary of geographic and stratigraphic variation in Mo/Al (ppm/%) for TST3-RST3. Values are averaged for the TST and RST in each well.

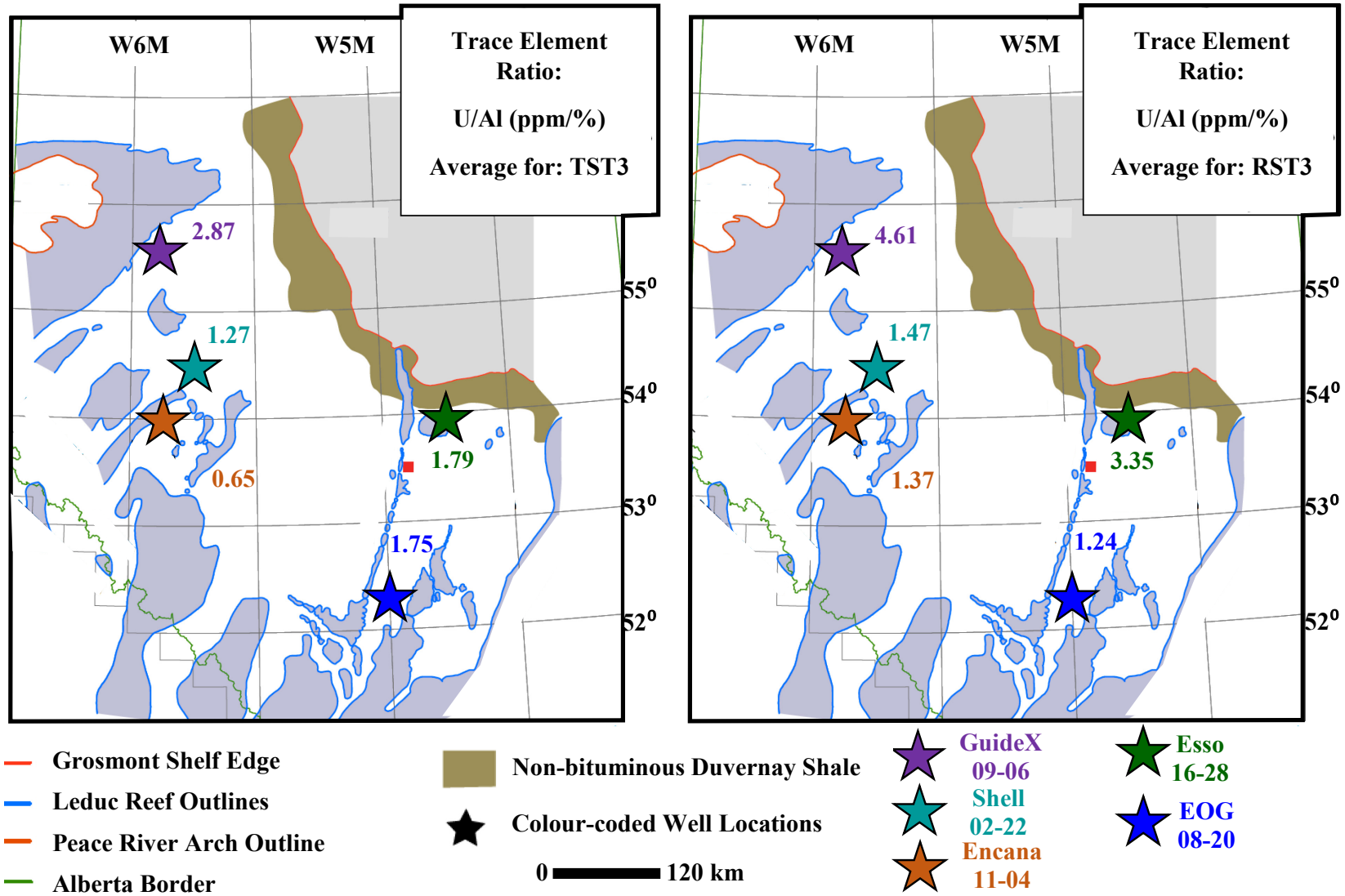


Figure 52. Summary of geographic and stratigraphic variation in U/Al (ppm/%) for TST3-RST3. Values are averaged for the TST and RST in each well.

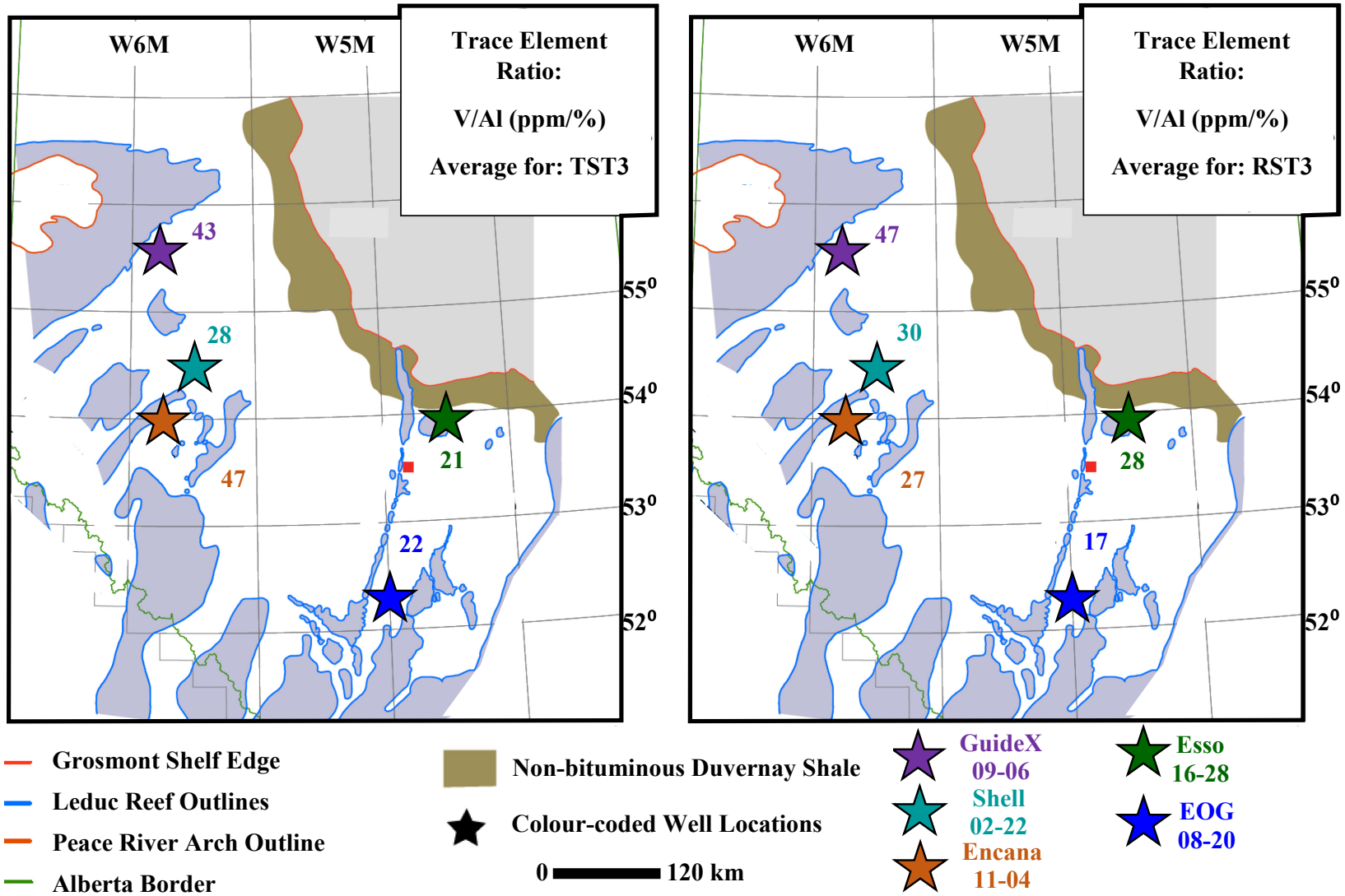


Figure 53. Summary of geographic and stratigraphic variation in V/Al (ppm/%) for TST3-RST3. Values are averaged for the TST and RST in each well.

4.7 Relationships between TOC and Key Geochemical Indicators

In the Duvernay, Zr/TiO_2 values range from 140 ppm/% to 900 ppm/% with an average of 215 ppm/%, Fe/S values range from 0.16 to 5.97 with an average of 1.84 and Al values range from 0.08 % to 8.67 % with an average of 3.67 % (Table 3). Cross plots of SiO_2 and Zr with symbol size reflecting the content TOC and Al can be used to explore relationships between these variables (Figure 54). It is evident that not every instance of high TOC is associated with high SiO_2 or aluminum (Figure 54). Cross plots of TOC content and Fe/S, Mo/Al, Zr/TiO_2 and Al can be used to identify the variables controlling TOC accumulation at each well in each interval.

The relationship between SiO_2 and Zr and TOC and Al was observed to vary depending on the well and the cycle. Plots for each cycle are shown as follows: cycle 1 (Figure 57), cycle 2 (Figure 62) and cycle 3 (Figure 67). The strength of the relationship between TOC and Zr/TiO_2, Al, Fe/S and Mo/Al was different for each well and each cycle: cycle 1 (Figures 58-61), cycle 2 (Figures 63-66) and cycle 3 (Figures 68-71). A complete set of values for each well and interval can be found in Tables 10, 12 and 14. For all cycles, intervals with R^2 values less than 0.60 or sample sizes of 3 or less were excluded for the purposes of interpretation as they are classified as relatively insignificant (Tables 11, 13 and 15).

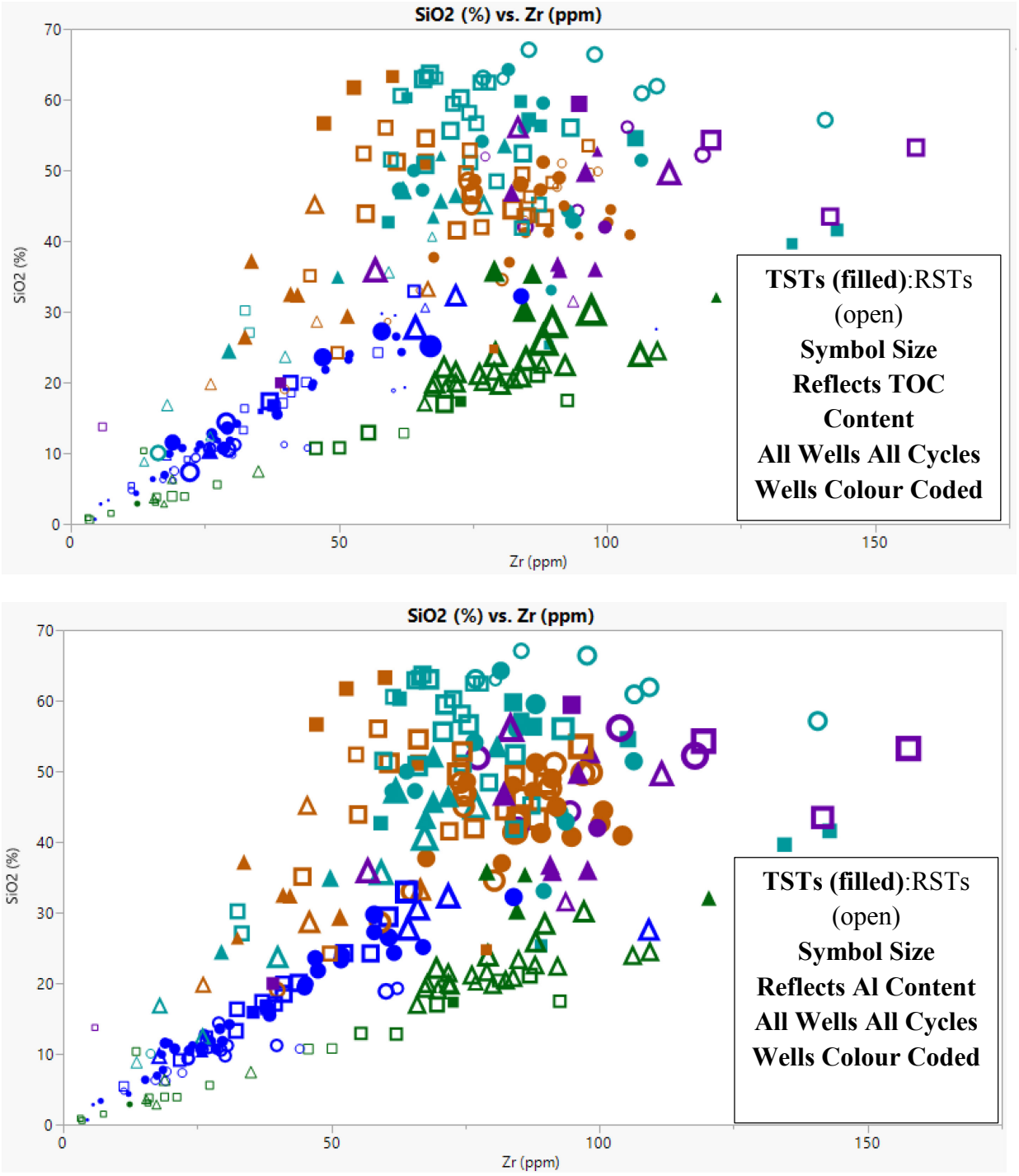
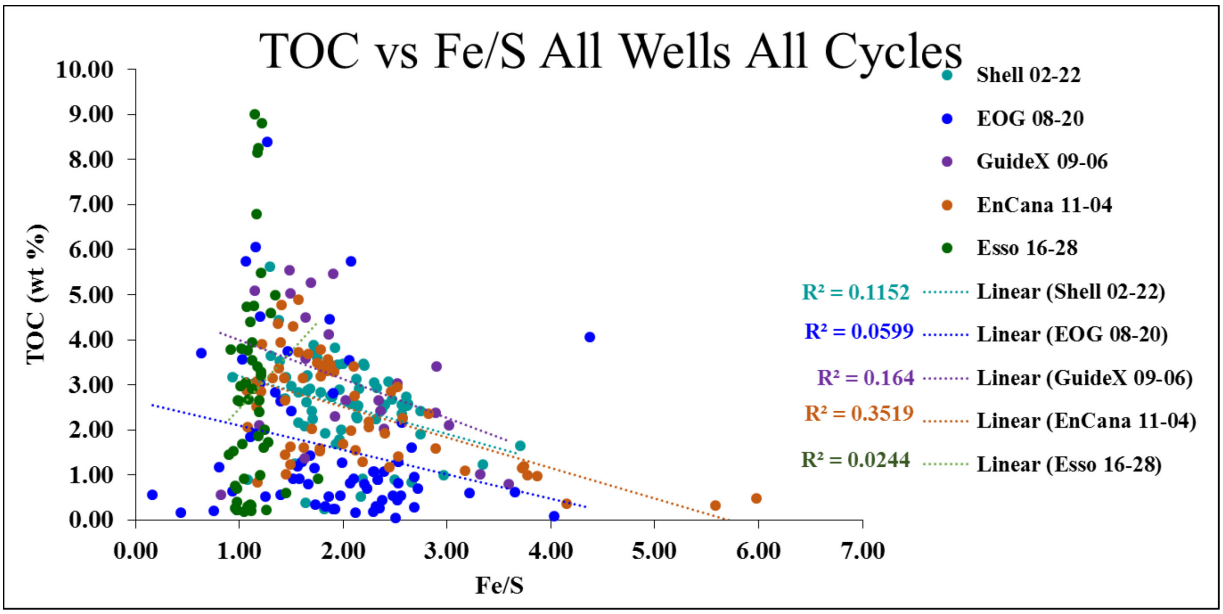


Figure 54. Summary of SiO2-Zr crossplots for all wells and intervals with symbol size reflecting TOC content (upper), and aluminum (bottom) for all wells and intervals. Wells are colour coded as follows: **GuideX 09-06**, **Shell 02-22**, **EnCana 11-04**, **Esso 16-28** and **EOG 08-20**. Cycles 1, 2 and 3 are designated by triangles, squares and circles respectively. Filled symbols indicate TSTs and open symbols indicate RSTs.



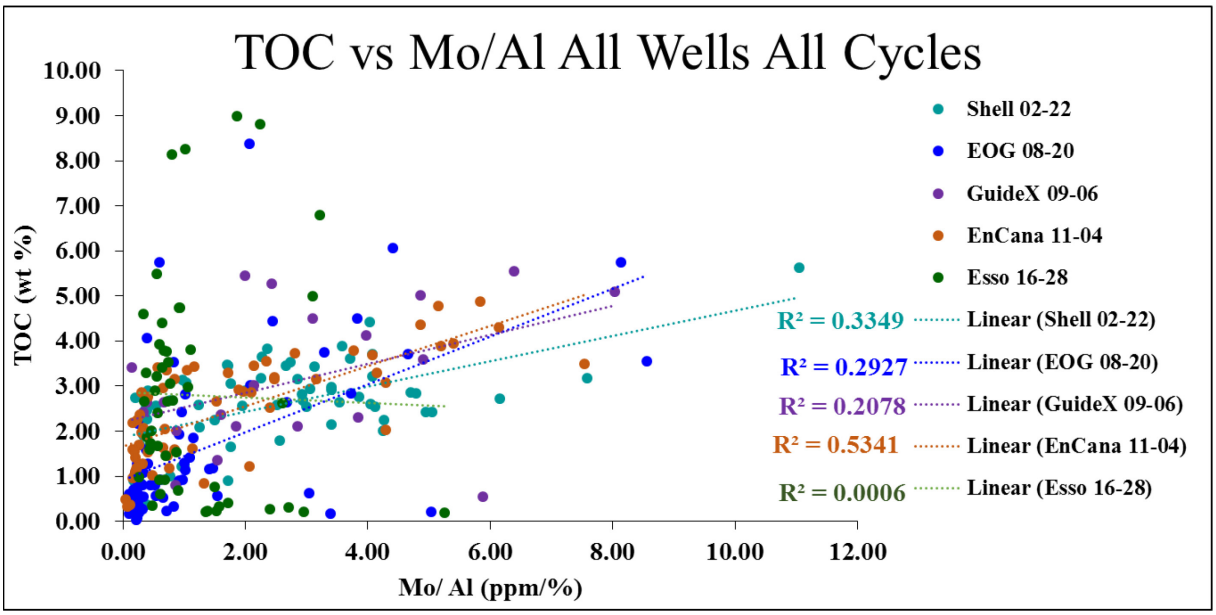
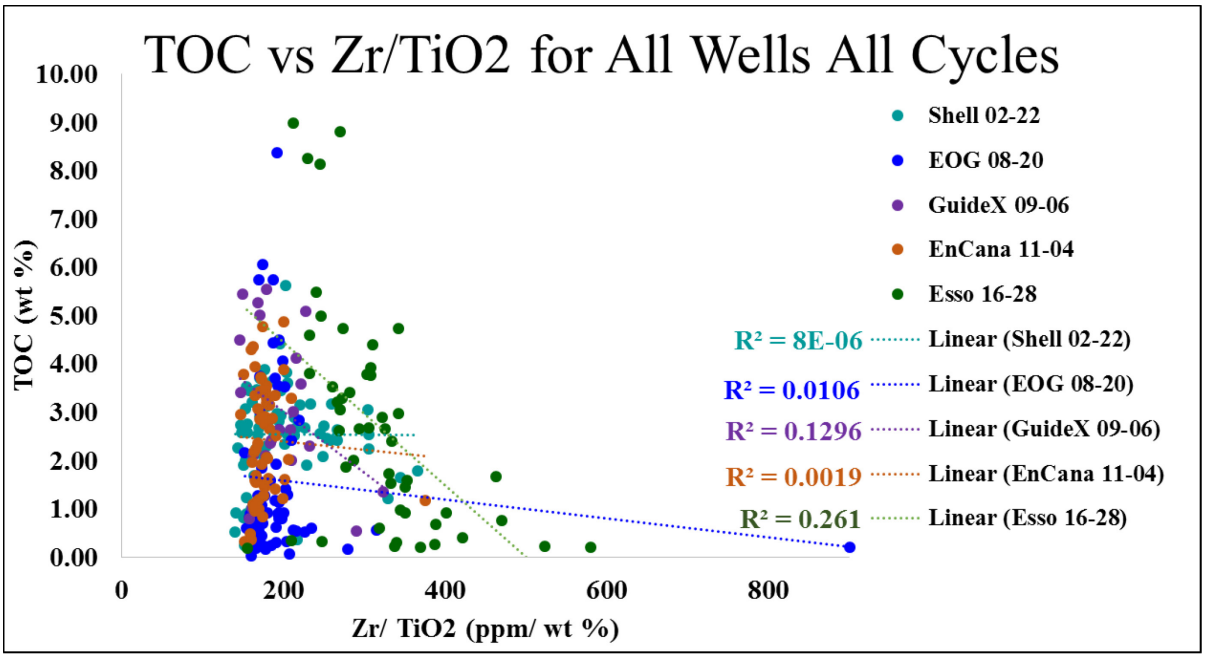


Figure 55. Summary of relationship between TOC content and Fe/S (top) and Mo/Al (bottom). TSTs and RSTs are presented together for all wells and all intervals. Colour legends complete with trend line R^2 values are to the right of each chart.



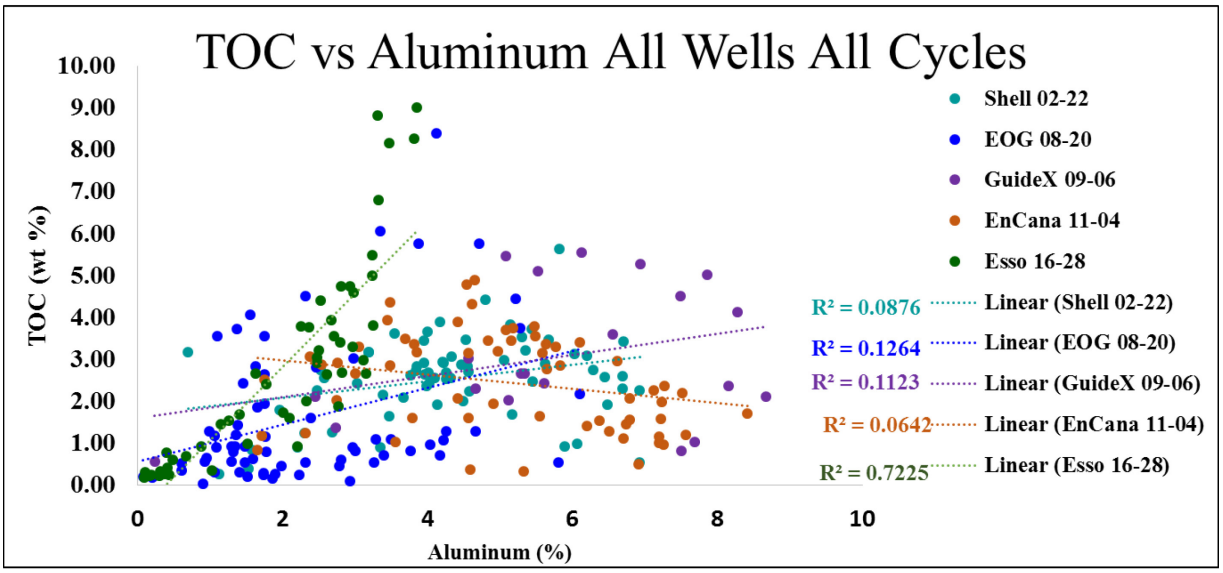


Figure 56. Summary of relationship between TOC content and Zr/TiO_2 (top) and Aluminum (bottom). TSTs and RSTs are presented together for all wells and all intervals. Colour legends complete with trend line R^2 values are to the right of each chart.

In the TST1-RST1 cycle, instances of high TOC indicated by larger symbol size in Figure 57 (top) are not always associated with low Al content indicated by smaller symbol size in Figure 57 (bottom). Some instances of high TOC are associated with high Al content. Figures 58-61 displays the relationship between TOC and key geochemical parameters. Tables 10-15 show the sample size and R_2 values for all intervals and wells respectively. Tables 11, 13 and 15 summarize those intervals that meet the statistical cutoff applied complete with R^2 value, sample size and slope.

In TST1 (Figures 58 and 59), the locations that show correlations with R^2 values of 0.6 or greater and a sample size of three or more are: Guidex 09-06 between TOC and Mo/Al; Encana 11-04 between TOC and Zr/TiO2; and Esso 16-28 between TOC and Al, Zr/TiO_2 and Fe/S (Tables 10 and 11). In RST1, the locations that show correlations with R^2 values of 0.6 or greater and a sample size of three or more are: Guidex 09-06 between TOC and Zr/TiO_2; Shell 02-22 between TOC and Mo/Al; Encana 11-04 between TOC and Zr/TiO2; and Esso 16-28 between TOC and Al; and EOG 08-20 between TOC and Zr/TiO_2 (Figures 60 and 61, Tables 10 and 11).

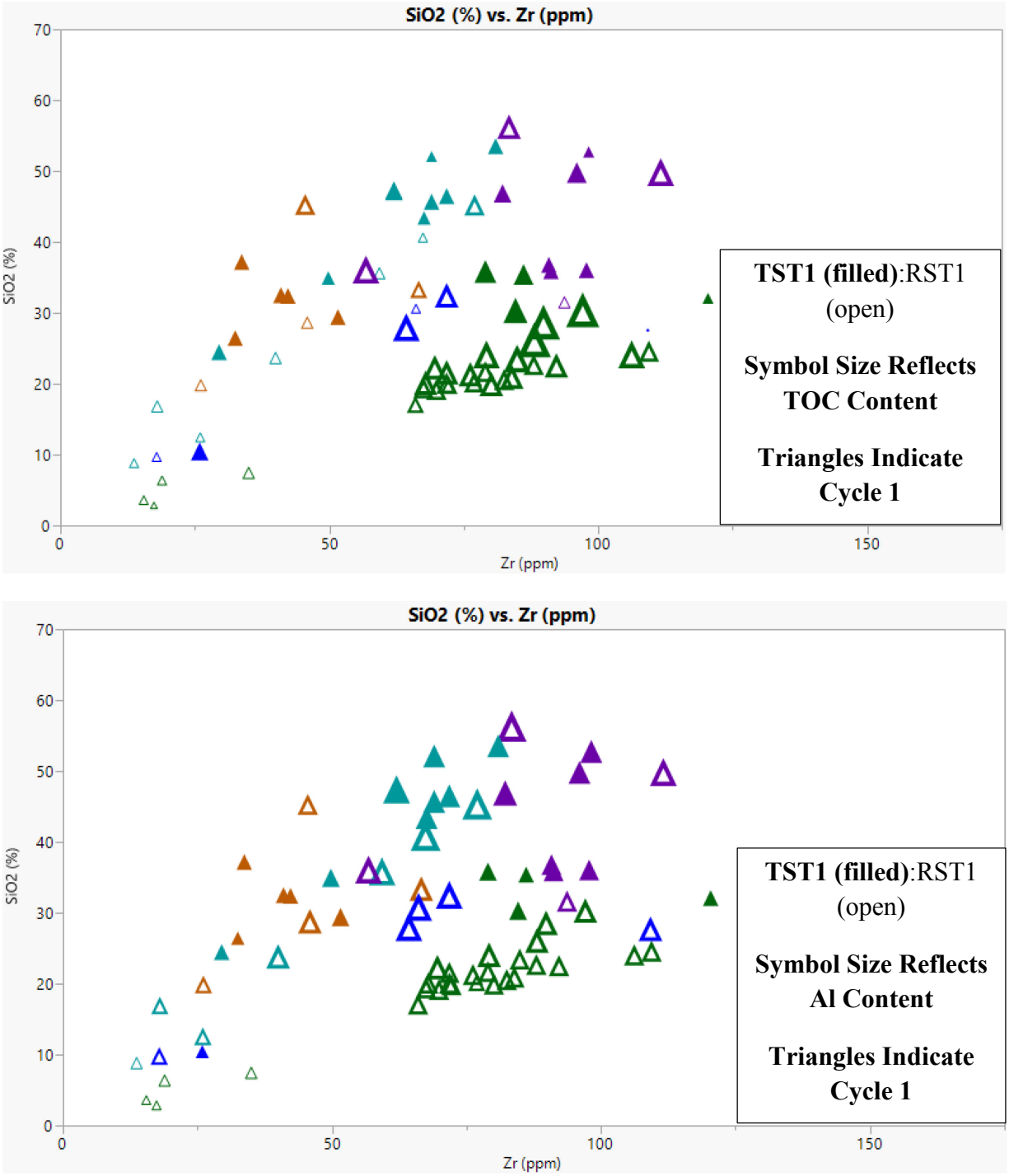
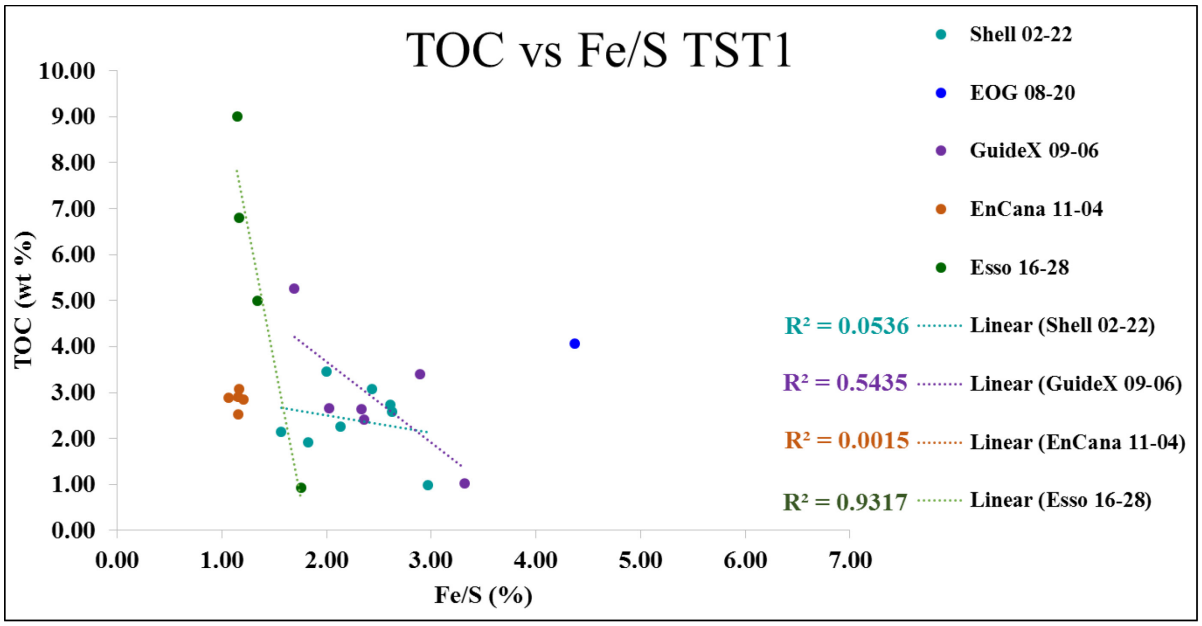


Figure 57. Summary of SiO_2-Zr cross plots with symbol size reflecting TOC content (top), and aluminum (bottom) for cycle 1 (TST1-RST1). Wells are colour coded as follows: **GuideX 09-06**, **Shell 02-22**, **EnCana 11-04**, **Esso 16-28** and **EOG 08-20**. Filled symbols indicate TSTs and open symbols indicate RSTs.



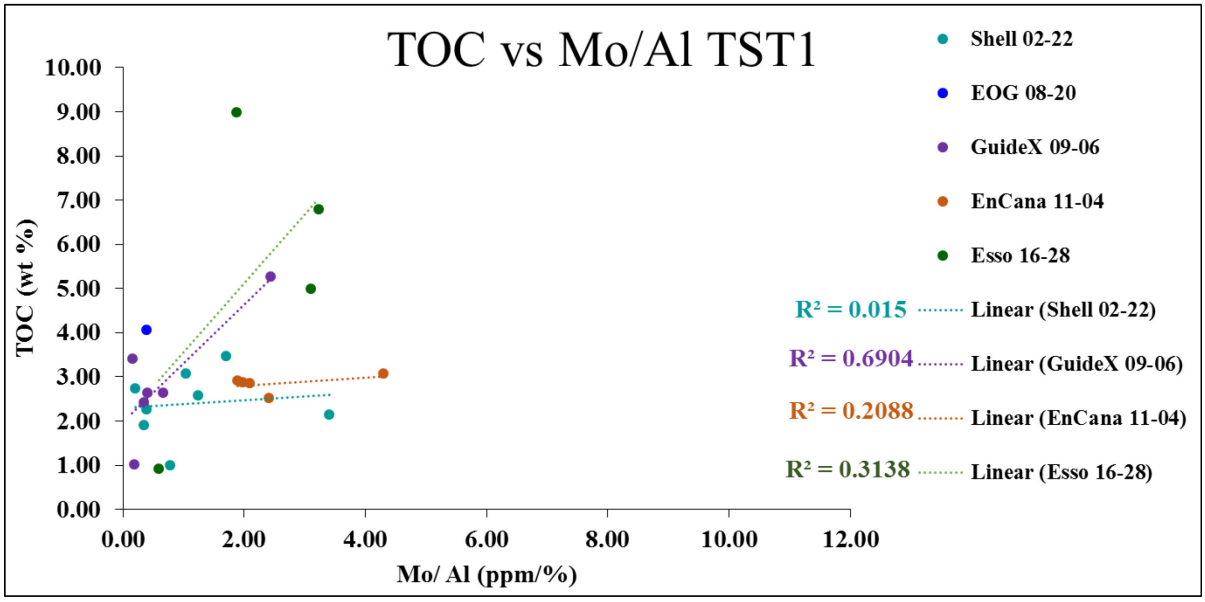
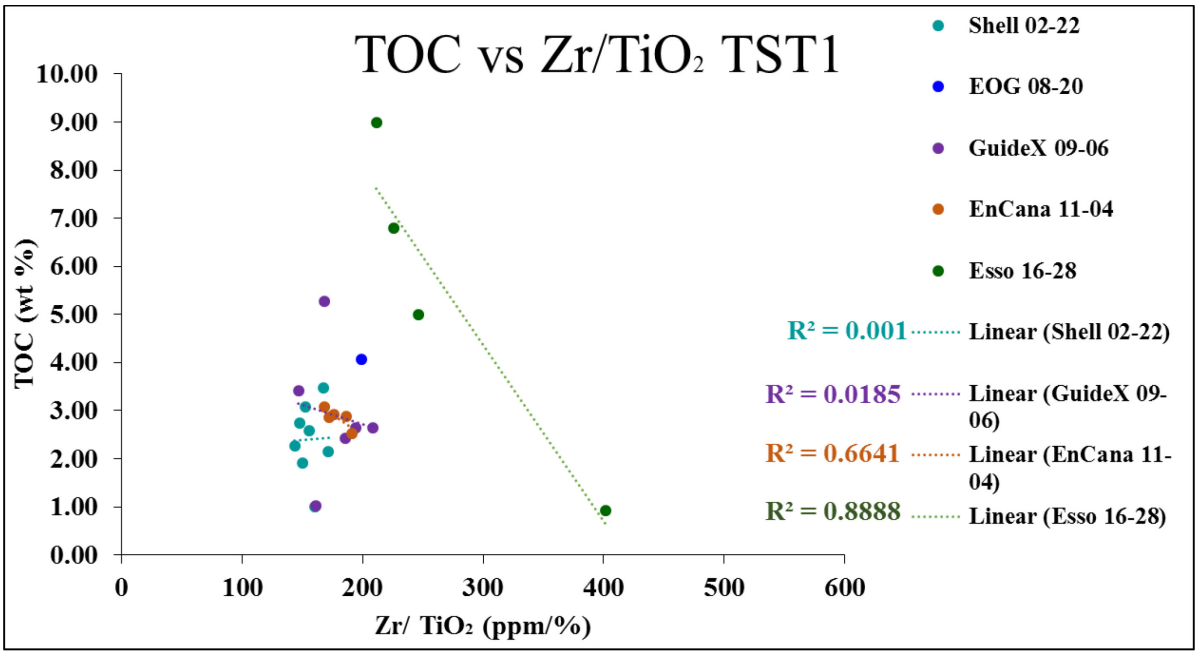


Figure 58. Summary for **TST1** of relationship between TOC content (wt %) and Fe/S and Mo/Al (ppm/%). Colour legends complete with trend line and R^2 values are to the right of each chart.



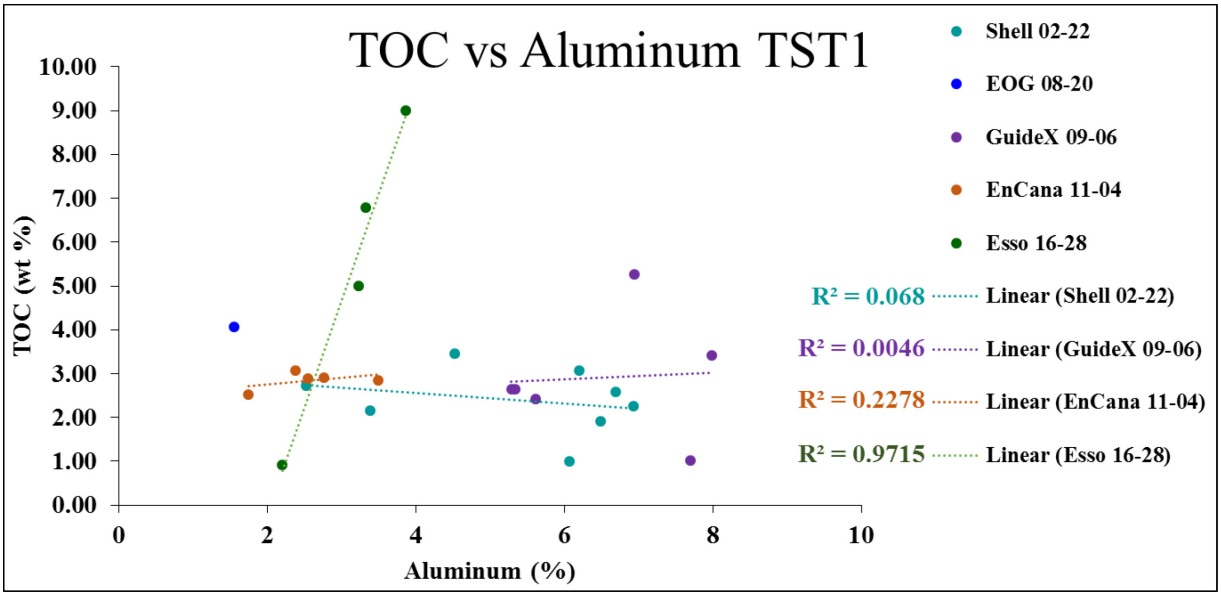
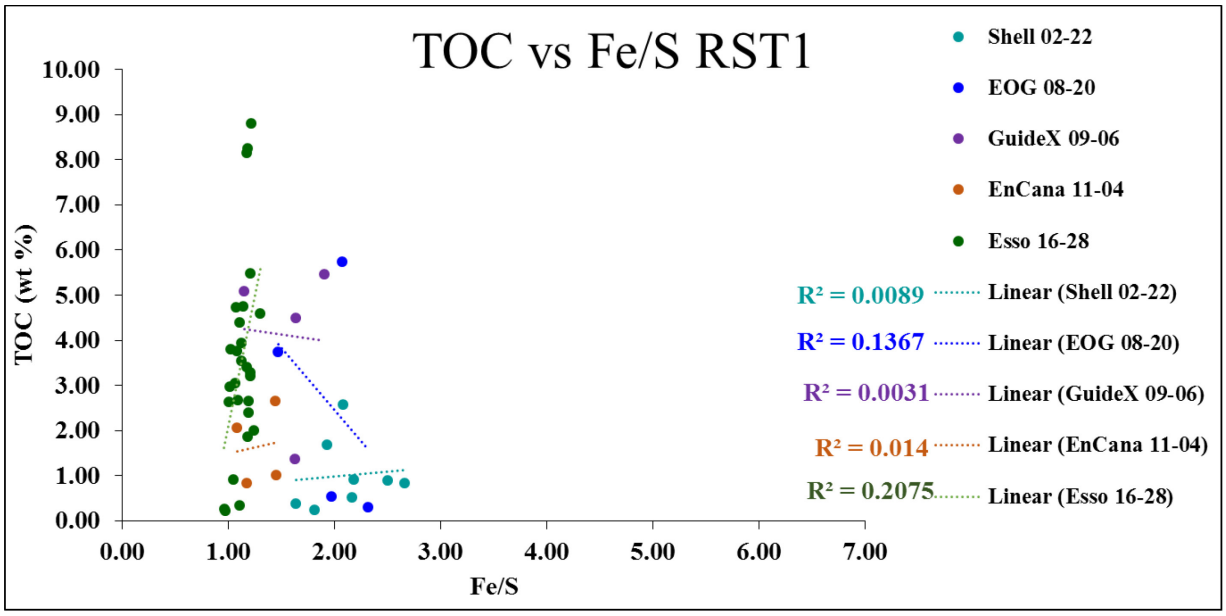


Figure 59. Summary for **TST1** of relationship between TOC content (wt %) and Zr/TiO_2 (ppm/%) and Al (%). Colour legends complete with trend line and R^2 values are to the right of each chart.



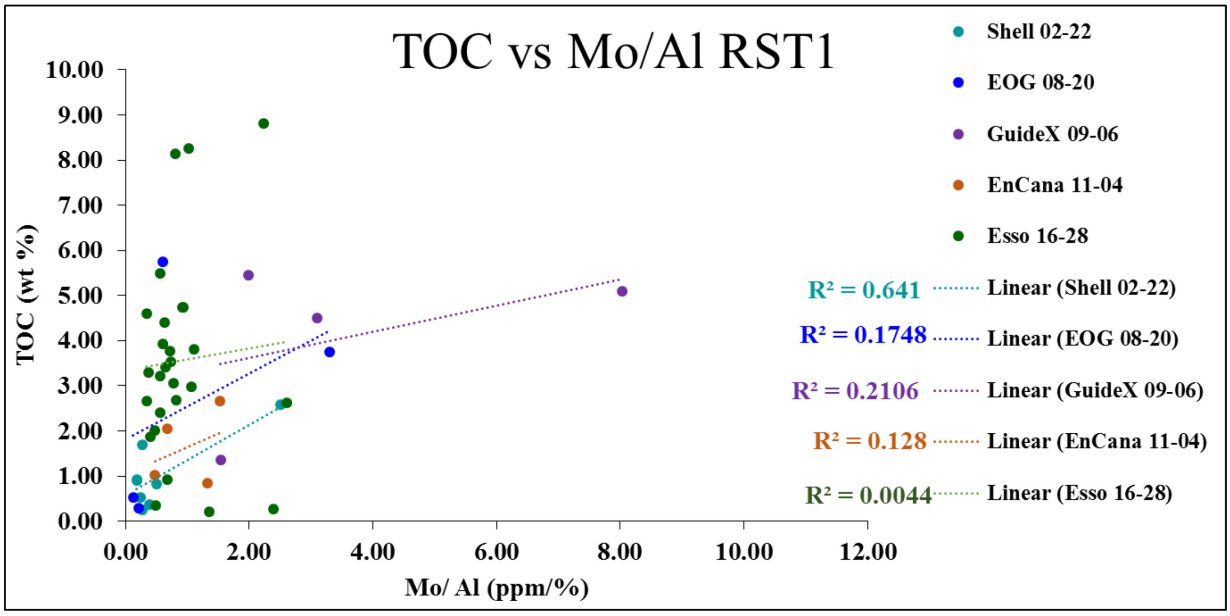
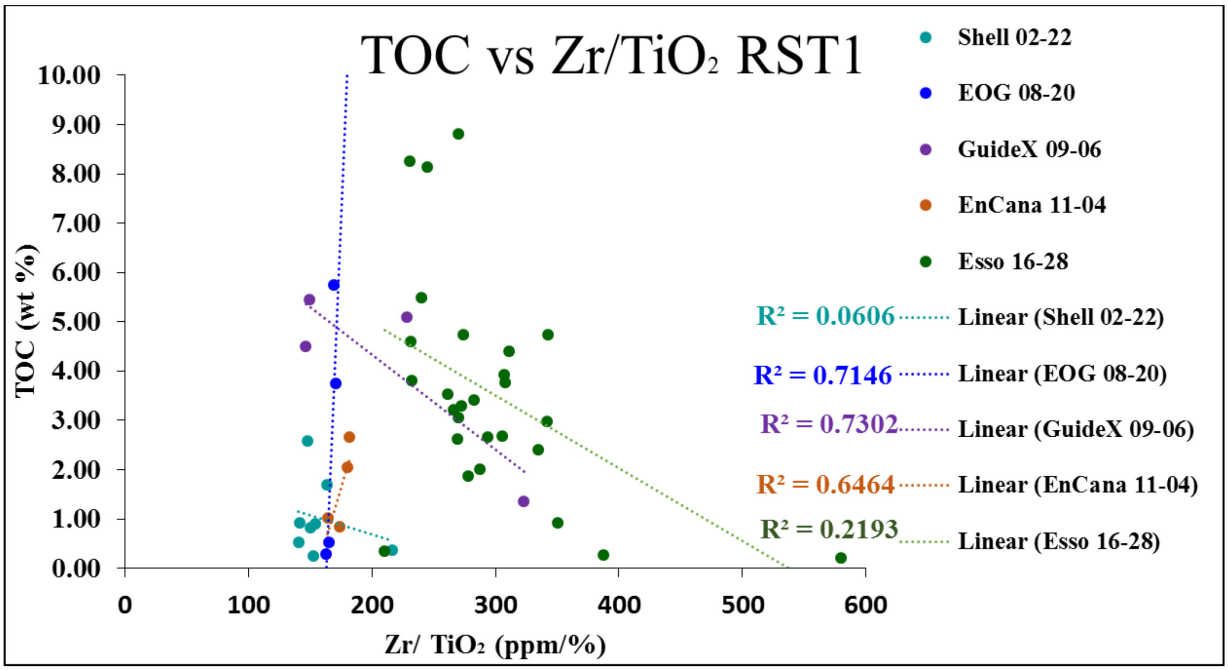


Figure 60. Summary for **RST1** of relationship between TOC content (wt %) and Fe/S and Mo/Al (ppm/%). Colour legends complete with trend line and R^2 values are to the right of each chart.



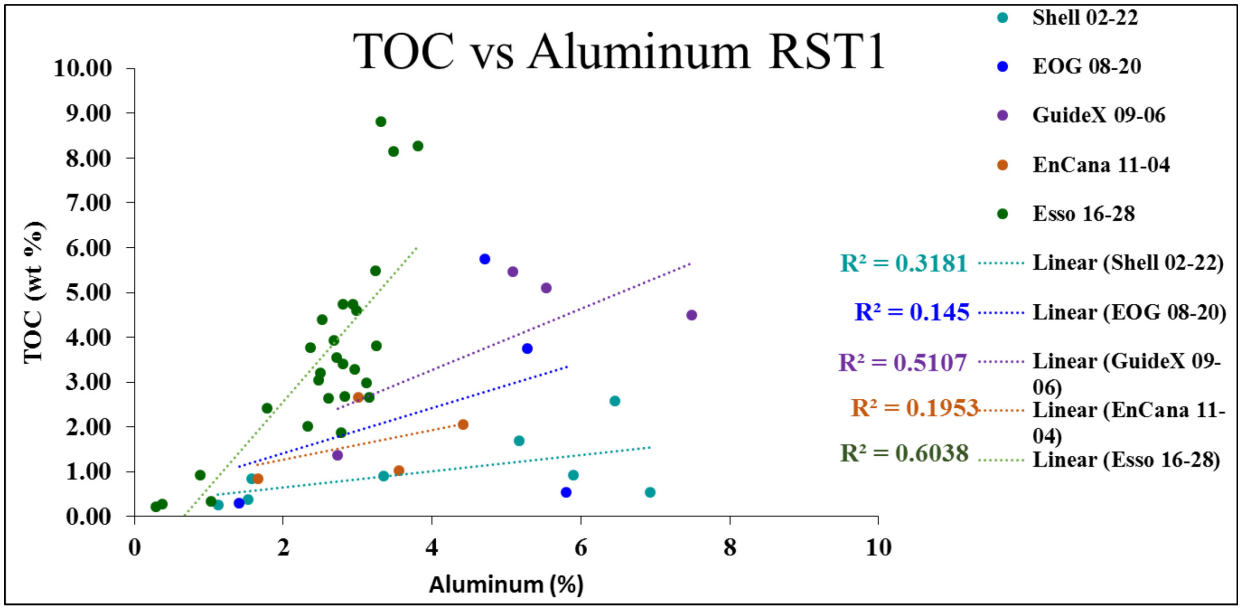


Figure 61. Summary for **RST1** of relationship between TOC content (wt %) and Zr/TiO_2 (ppm/%) and Al (%). Colour legends complete with trend line and R^2 values are to the right of each chart.

RST 1 Sample Size & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum	4	0.5107	8	0.3181	4	0.1953	27	0.6038	5	0.1450
TOC vs Zr/TiO_2	4	0.7302	8	0.0606	4	0.6464	27	0.2193	5	0.7146
TOC vs Fe/S	4	0.0031	8	0.0089	4	0.0140	27	0.2075	5	0.1367
TOC vs Mo/Al	4	0.2106	8	0.6410	4	0.1280	27	0.0044	5	0.1748

TST 1 Sample Size & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum	6	0.0046	8	0.0680	5	0.2278	4	0.9715	1	NA
TOC vs Zr/TiO_2	6	0.0185	8	0.0010	5	0.6641	4	0.8888	1	NA
TOC vs Fe/S	6	0.5435	8	0.0536	5	0.0015	4	0.9317	1	NA
TOC vs Mo/Al	6	0.6904	8	0.0150	5	0.2088	4	0.3138	1	NA

Table 10. Summary for **TST1-RST1** of sample size (N) and R^2 values for each well

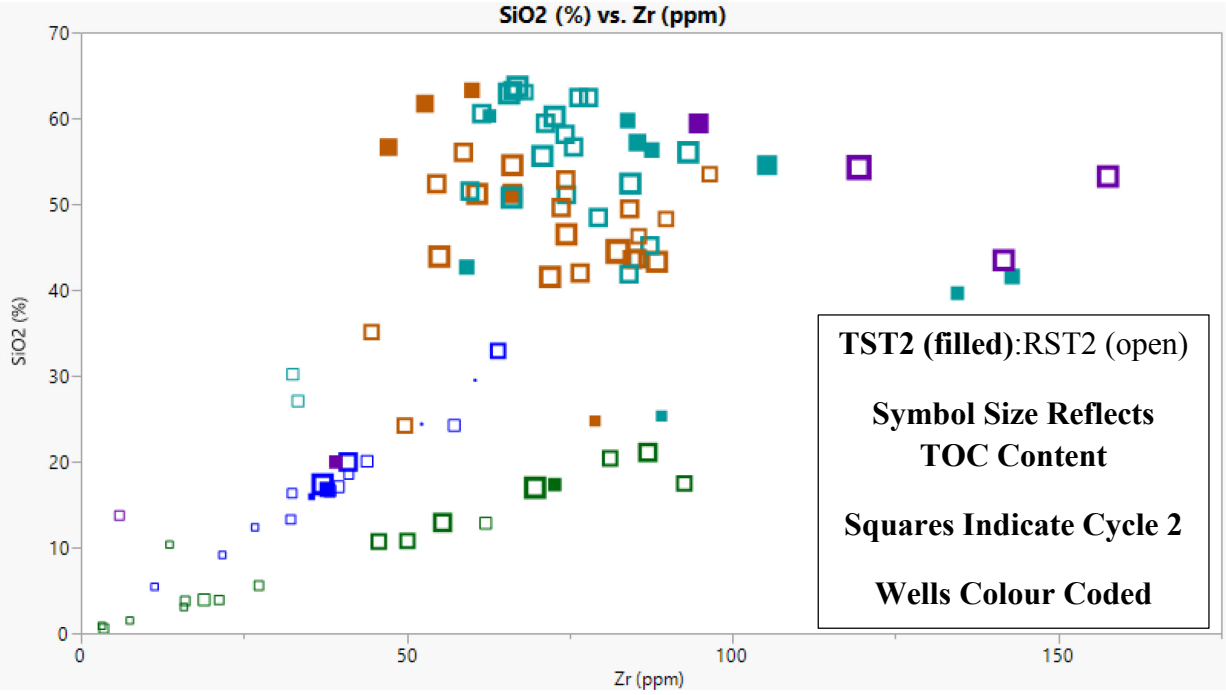
RST 1 N, Slope & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum							27	0.6038 +		
TOC vs Zr/TiO_2	4	0.7302 -			4	0.6464 ~vert			5	0.7146 ~vert
TOC vs Fe/S										
TOC vs Mo/Al			8	0.6410 +						

TST 1 N, Slope & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum							4	0.9715 +		
TOC vs Zr/TiO_2					5	0.6641 -	4	0.8888 -		
TOC vs Fe/S							4	0.9317 -		
TOC vs Mo/Al	6	0.6904 +								

Table 11. Summary for **TST1-RST1** of sample size (N), slope (positive or negative) and R^2 values for each well. Intervals with N<=3 and or R^2<0.6 excluded (not statistically significant).

In the TST2-RST2 cycle (Figures 62-66, Tables 12 and 13), instances of high TOC indicated by larger symbol size in Figure 62 (top) are not always associated with low Al content indicated by smaller symbol size in Figure 62 (bottom). Some instances of high TOC are associated with high Al content. Figures 63-66 display the relationship between TOC and key geochemical parameters. Table 12 shows the sample size and R_2 values for all intervals and wells respectively. Table 13 summarizes those intervals that meet the statistical cutoff applied complete with R2 value, sample size and slope.

In TST2, the locations that show correlations with R^2 values of 0.6 or greater and a sample size of three or more are: Shell 02-22 between TOC and Fe/S and Mo/Al; Encana 11-04 between TOC and Zr/TiO_2, Al, Fe/S and Mo/Al (Figures 63 and 64, Tables 12 and 13). In RST2, the locations that show correlations with R^2 values of 0.6 or greater and a sample size of three or more are: Guidex 09-06 between TOC and Zr/TiO_2, Al, Fe/S and Mo/Al; Esso 16-28 between TOC and Al; and EOG 08-20 between TOC and Mo/Al (Figures 65 and 66, Tables 12 and 13).



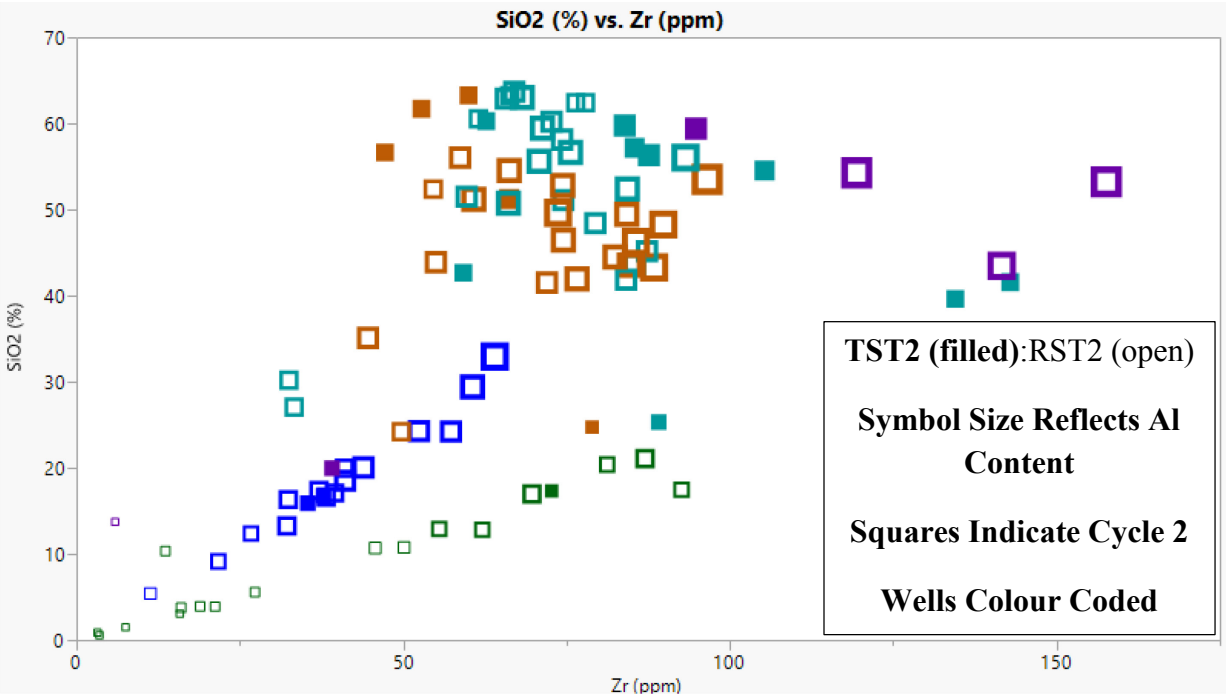
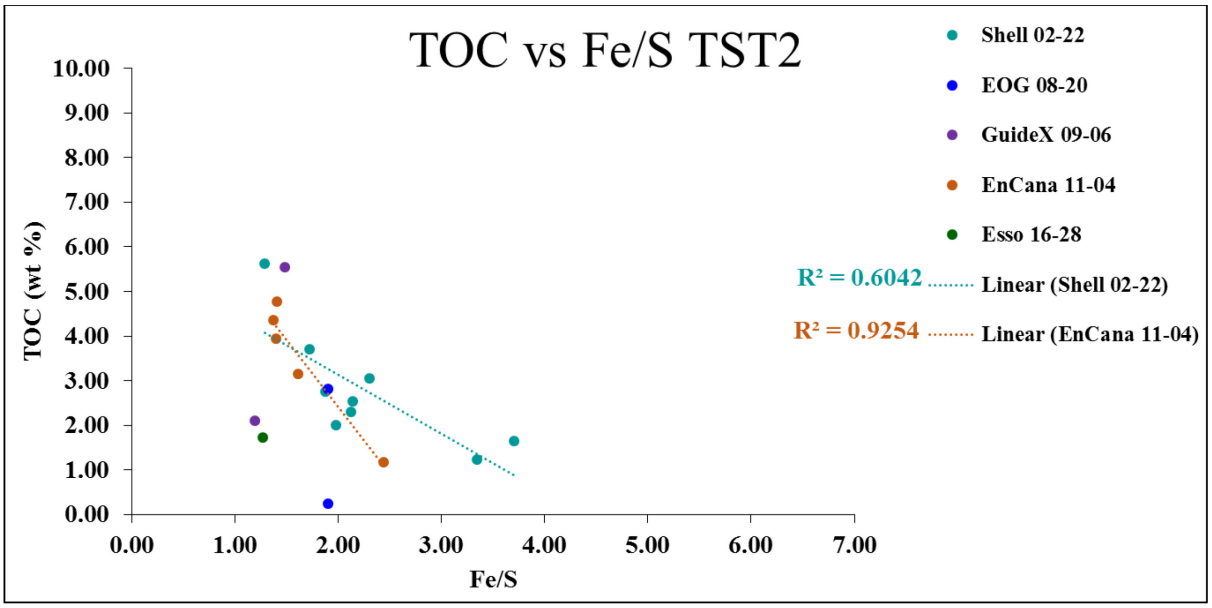


Figure 62. Summary of SiO2-Zr cross plots with symbol size reflecting TOC content (top), and aluminum (bottom) for cycle 2 (TST2-RST2). Wells are colour coded as follows: **GuideX 09-06**, **Shell 02-22**, **EnCana 11-04**, **Esso 16-28** and **EOG 08-20**. Filled symbols indicate TSTs and open symbols indicate RSTs.



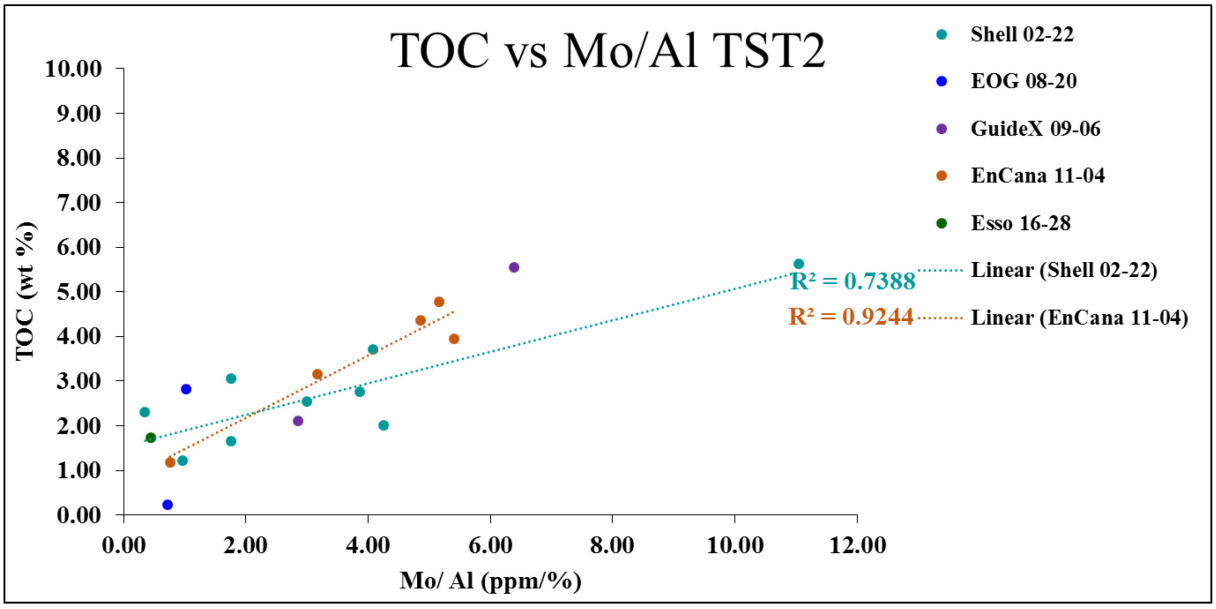
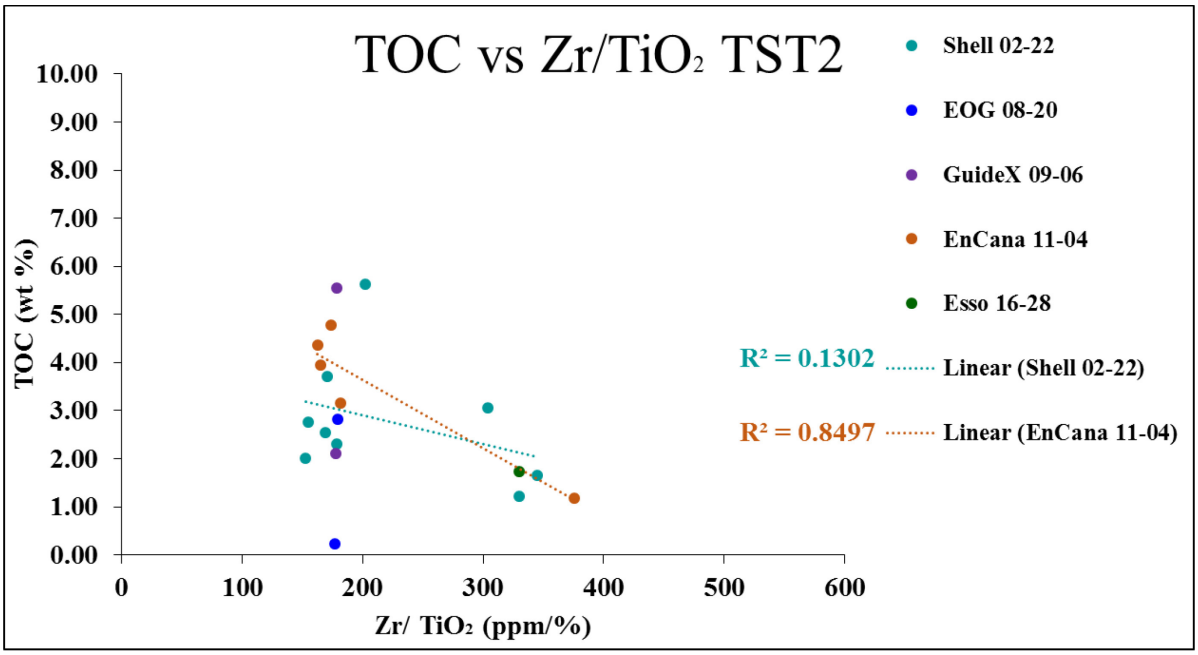


Figure 63. Summary for **TST2** of relationship between TOC content (wt %) and Fe/S and Mo/Al (ppn/%). Colour legends complete with trend line and R^2 values are to the right of each chart.



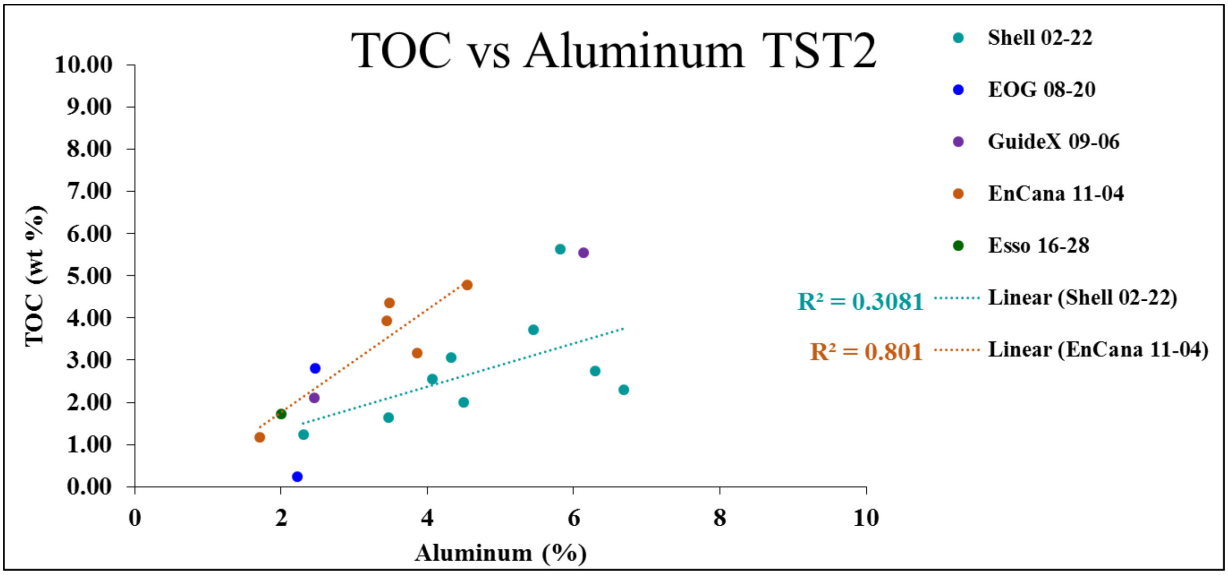
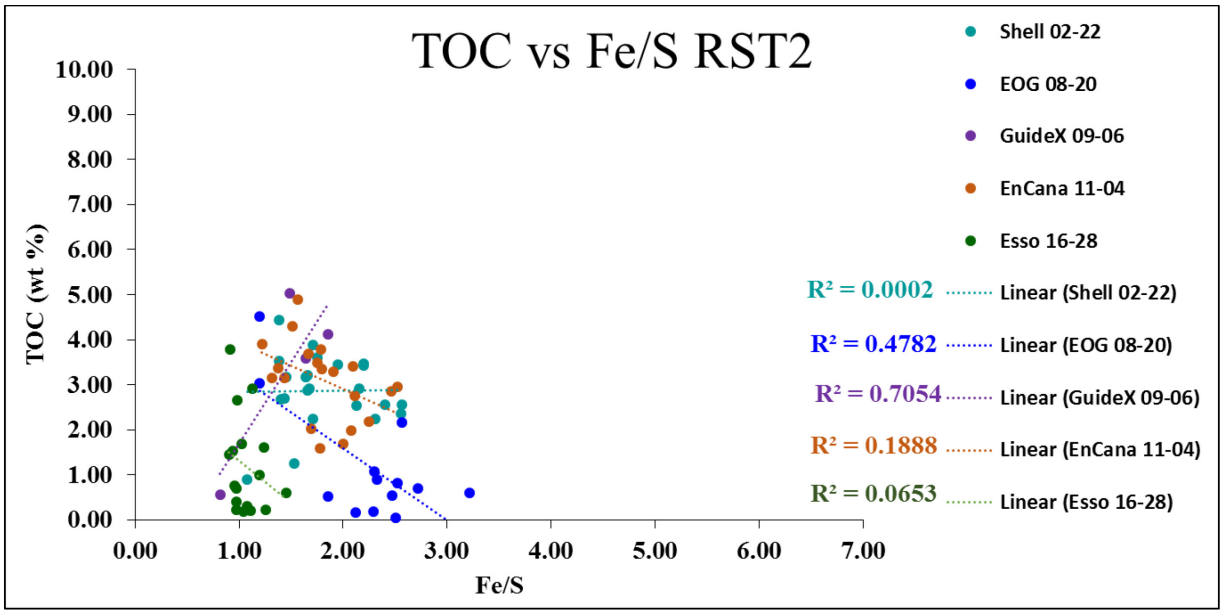


Figure 64. Summary for **TST2** of relationship between TOC content (wt %) and Zr/TiO_2 (ppm/%) and Al (%). Colour legends complete with trend line and R^2 values are to the right of each chart.



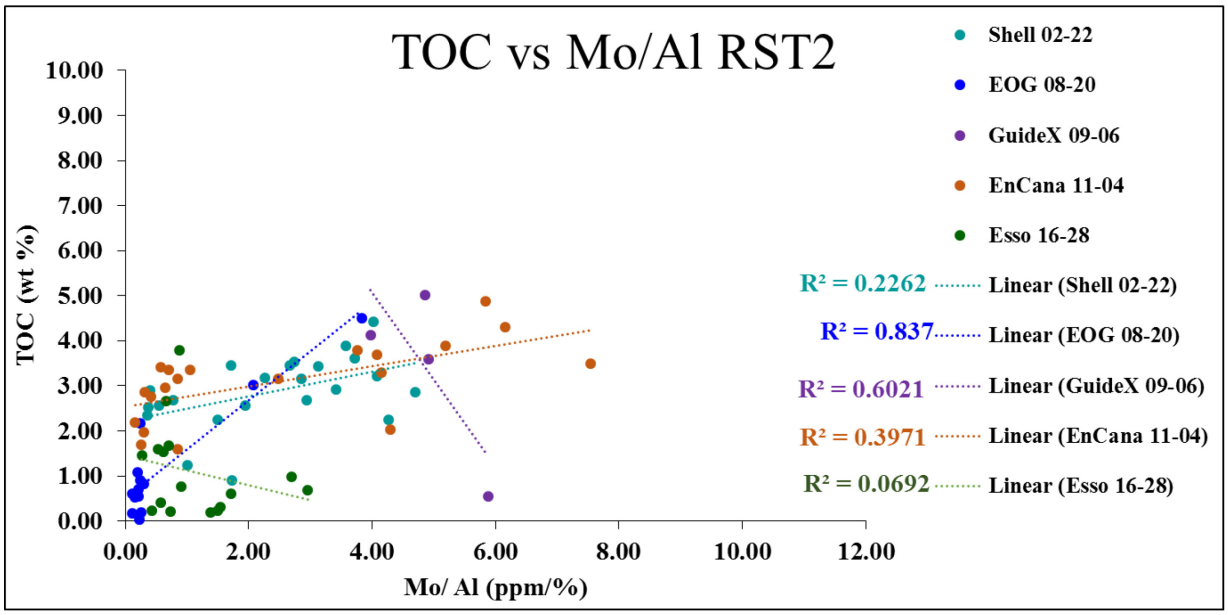
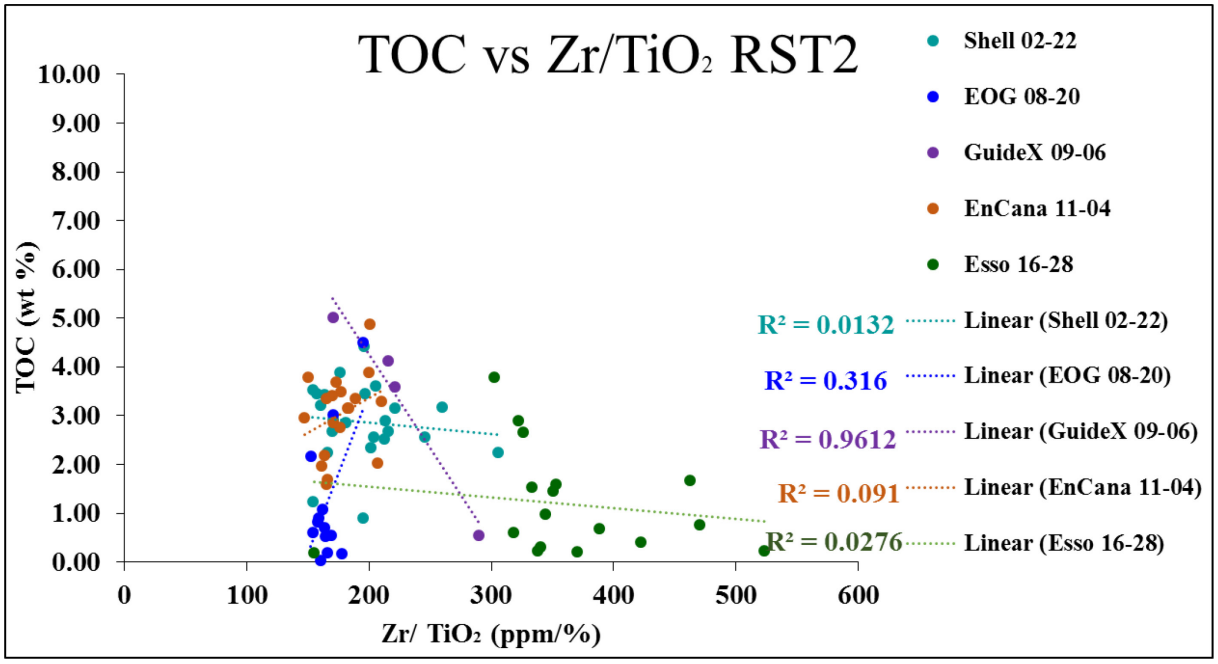


Figure 65. Summary for **RST2** of relationship between TOC content (wt %) and Fe/S and Mo/Al (ppn/%). Colour legends complete with trend line and R^2 values are to the right of each chart.



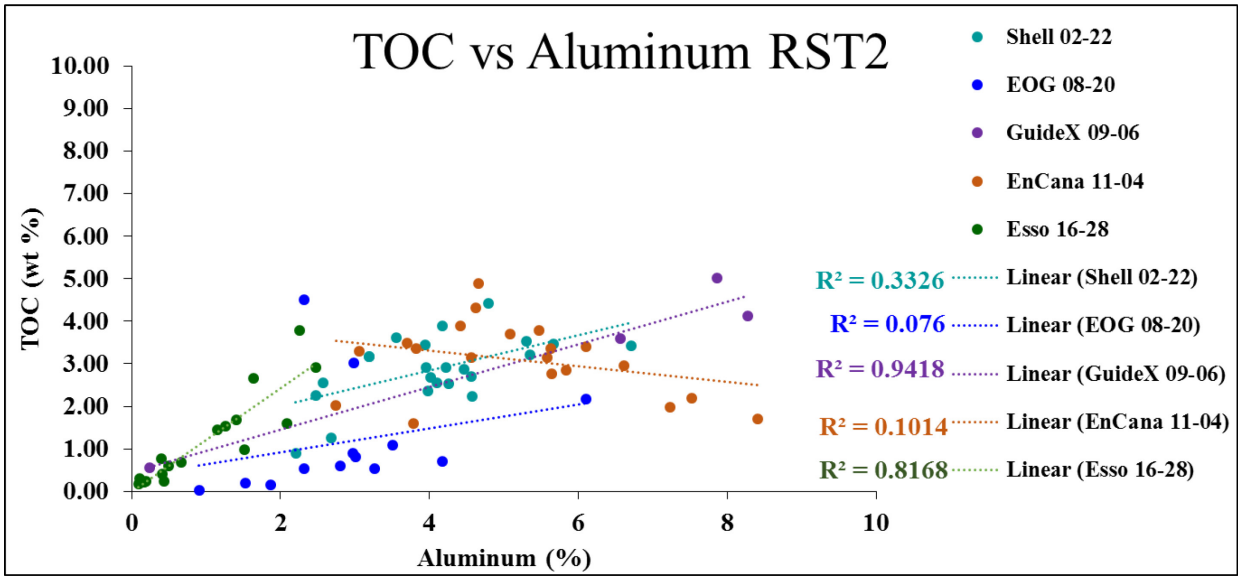


Figure 66. Summary for **RST2** of relationship between TOC content (wt %) and Zr/TiO_2 (ppm/%) and Al (%). Colour legends complete with trend line and R^2 values are to the right of each chart.

RST 2 Sample Size & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum	4	0.9418	23	0.3326	20	0.1014	17	0.8168	15	0.0760
TOC vs Zr/TiO_2	4	0.9612	23	0.0132	20	0.0910	17	0.0276	15	0.3160
TOC vs Fe/S	4	0.7054	23	0.0002	20	0.1888	17	0.0653	15	0.4782
TOC vs Mo/Al	4	0.6021	23	0.2262	20	0.3971	17	0.0692	15	0.8370

TST 2 Sample Size & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum	2	NA	9	0.3081	5	0.8010	1	NA	2	NA
TOC vs Zr/TiO_2	2	NA	9	0.1302	5	0.8497	1	NA	2	NA
TOC vs Fe/S	2	NA	9	0.6042	5	0.9254	1	NA	2	NA
TOC vs Mo/Al	2	NA	9	0.7388	5	0.9244	1	NA	2	NA

Table 12. Summary for **TST2-RST2** of sample size (N) and R^2 values for each well.

RST 2 N, Slope & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum	4	0.9418 +					17	0.8168 +		
TOC vs Zr/TiO_2	4	0.9612 -								
TOC vs Fe/S	4	0.7054 -								
TOC vs Mo/Al	4	0.6021 +							15	0.8370 +

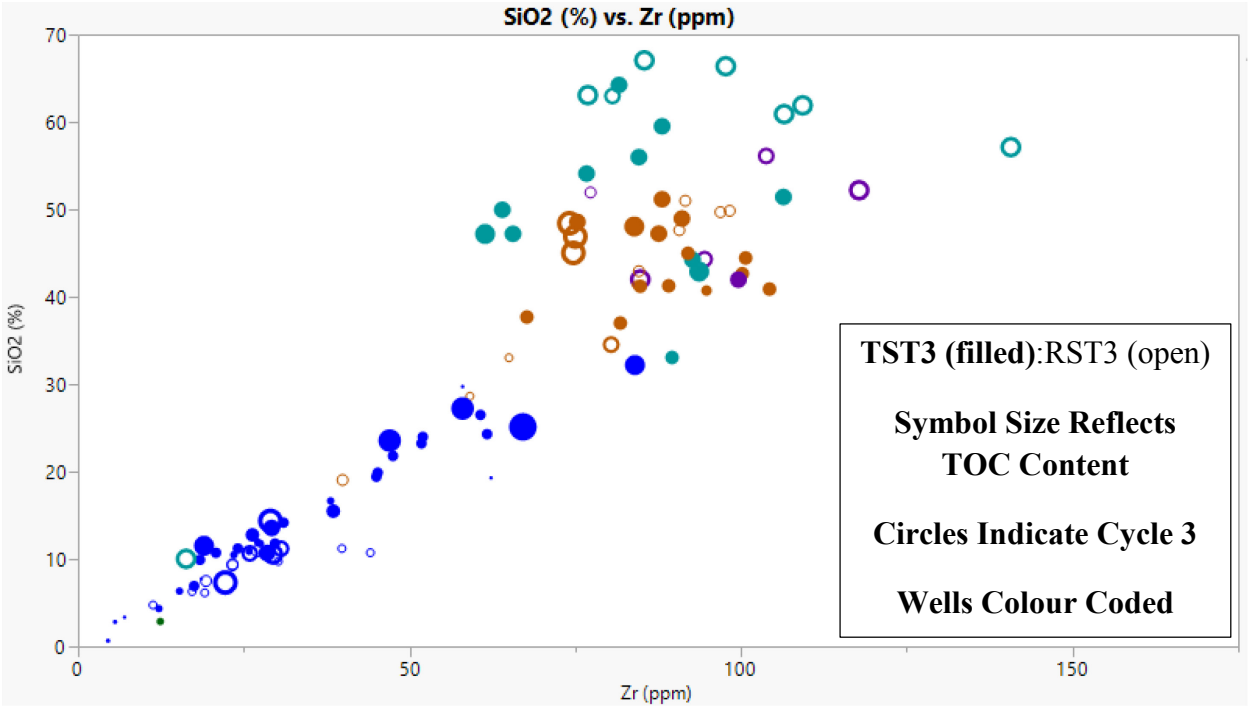
TST 2 N, Slope & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum					5	0.8010 +				
TOC vs Zr/TiO_2					5	0.8497 -				
TOC vs Fe/S			9	0.6042 -	5	0.9254 -				
TOC vs Mo/Al			9	0.7388 +	5	0.9244 +				

Table 13. Summary for **TST2-RST2** of sample size (N), slope (positive or negative) and R^2 values for each well. Intervals with N<=3 and or R^2<0.6 excluded (not statistically significant).

In the TST3-RST3 cycle, instances of high TOC indicated by larger symbol size in Fig 67 (top) are not always associated with low Al content indicated by smaller symbol size in Fig 67 (bottom). Some instances of high TOC are associated with high Al content. Figures 68-71 display the relationship between TOC and key geochemical parameters. Table 14 shows the sample size and R_2 values for all intervals and wells respectively. Table 15 summarizes those intervals that meet the statistical cutoff applied complete with R_2 value, sample size and slope.

In TST3, the only location that show correlations with R^2 values of 0.6 or greater and a sample size of three or more is Shell 02-22 between TOC and Mo/Al (Figures 68 and 69, Tables 14 and 15). In RST3, the locations that show correlations with R^2 values of 0.6 or greater and a sample size of three or more are: Guidex 09-06 between TOC and Fe/S and Mo/Al; Shell 02-22 between TOC and Zr/TiO_2; and Encana 11-04 between TOC and Mo/Al (Figures 70 and 71, Tables 14 and 15).

In general, instances of higher TOC were associated with lower Fe/S ratios and negative slopes and higher Mo/Al ratios with positive slopes. Instances of good agreement between TOC and Zr/TiO_2 were generally characterized by strong negative relationship between TOC and Zr/TiO_2 indicated by negative slopes. In instances where the slope was not negative the range of TOC values were distributed over a very small range of Zr/TiO_2 values such that the data points were aligned vertically. Instances of good agreement between TOC and Al are characterized by positive slope.



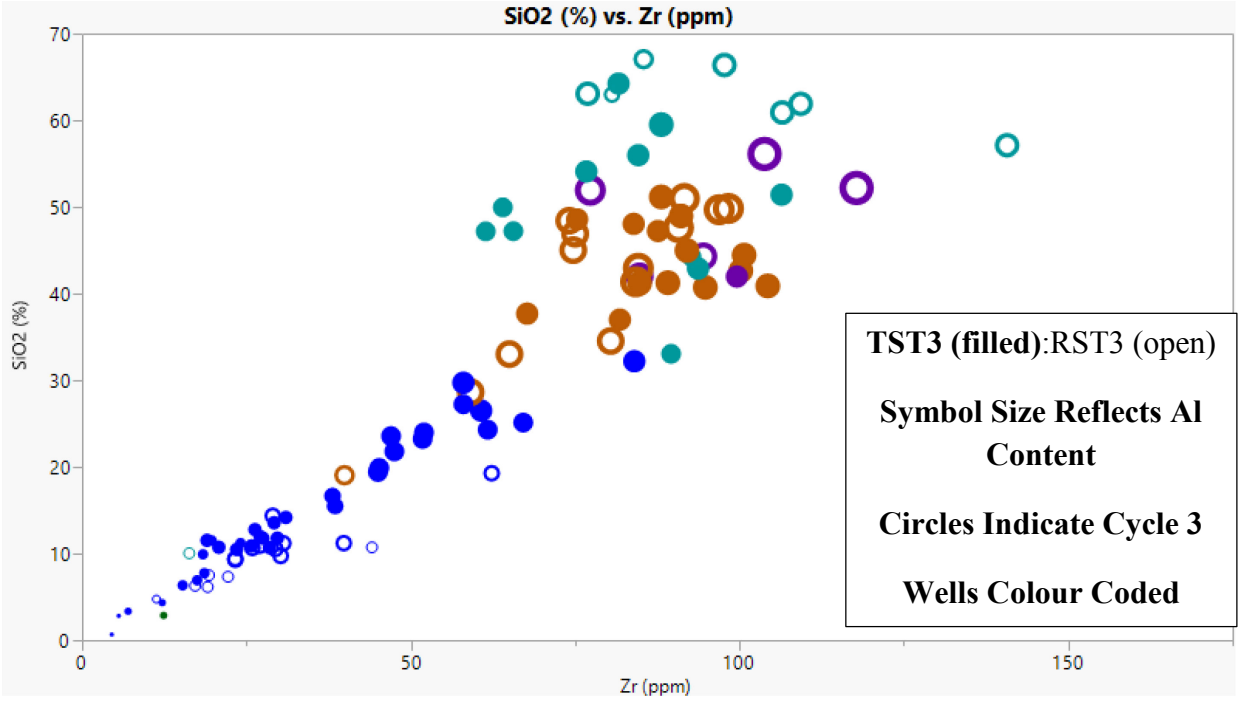
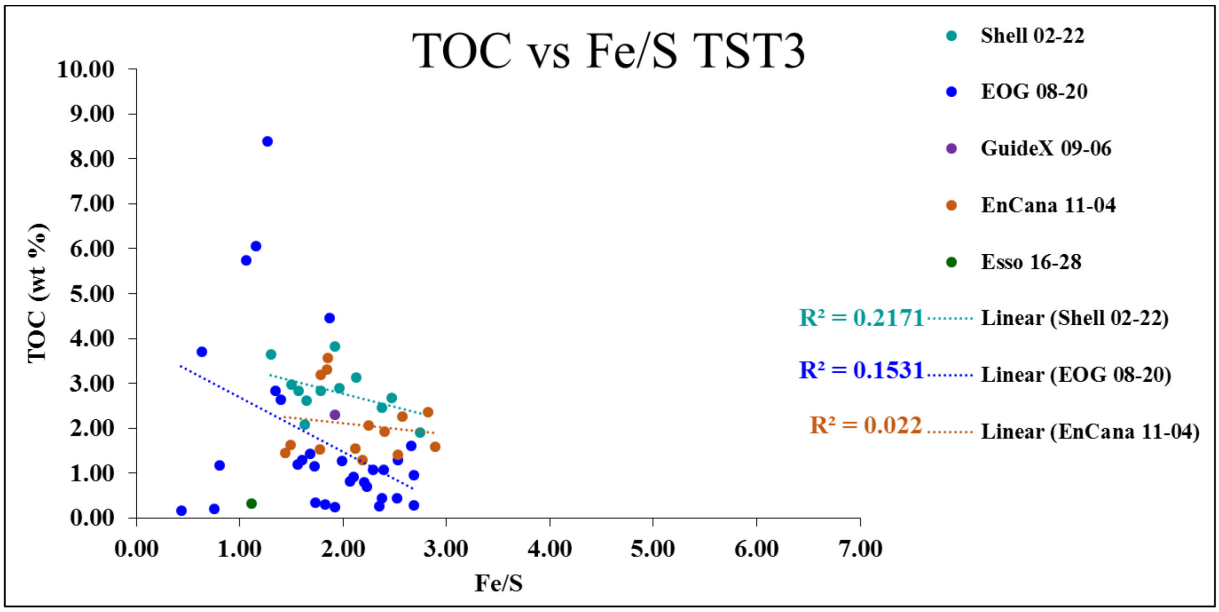


Figure 67. Summary of SiO2-Zr cross plots with symbol size reflecting TOC content (top) and aluminum (bottom) for cycle 3 (TST3-RST3). Wells are colour coded as follows: **GuideX 09-06**, **Shell 02-22**, **EnCana 11-04**, **Esso 16-28** and **EOG 08-20**. Filled symbols indicate TSTs and open symbols indicate RSTs.



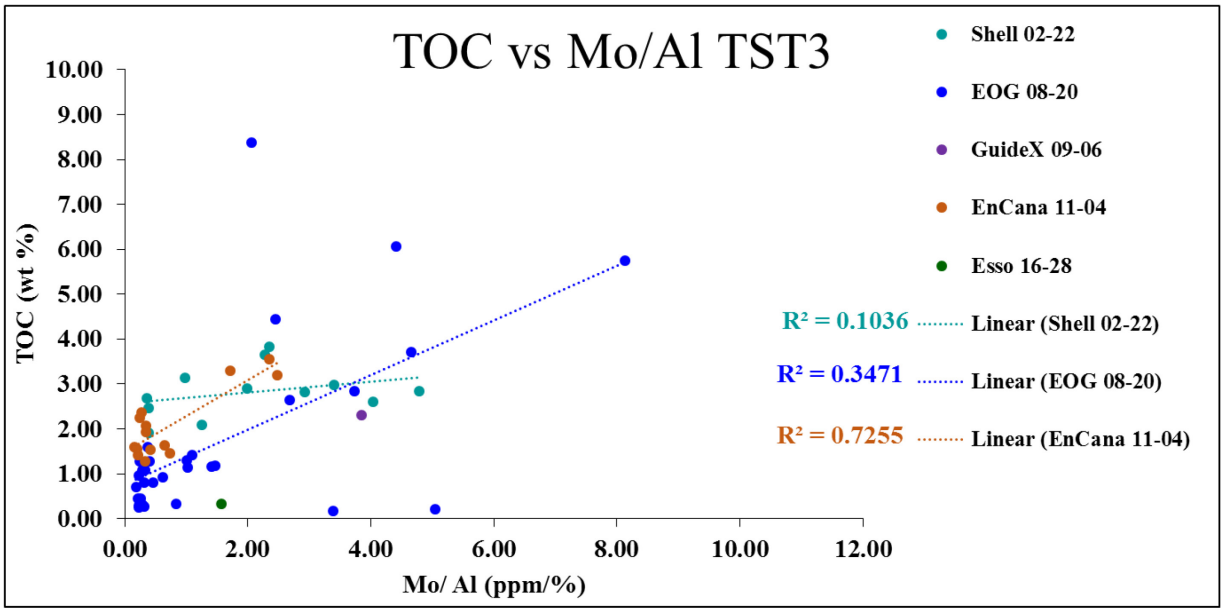
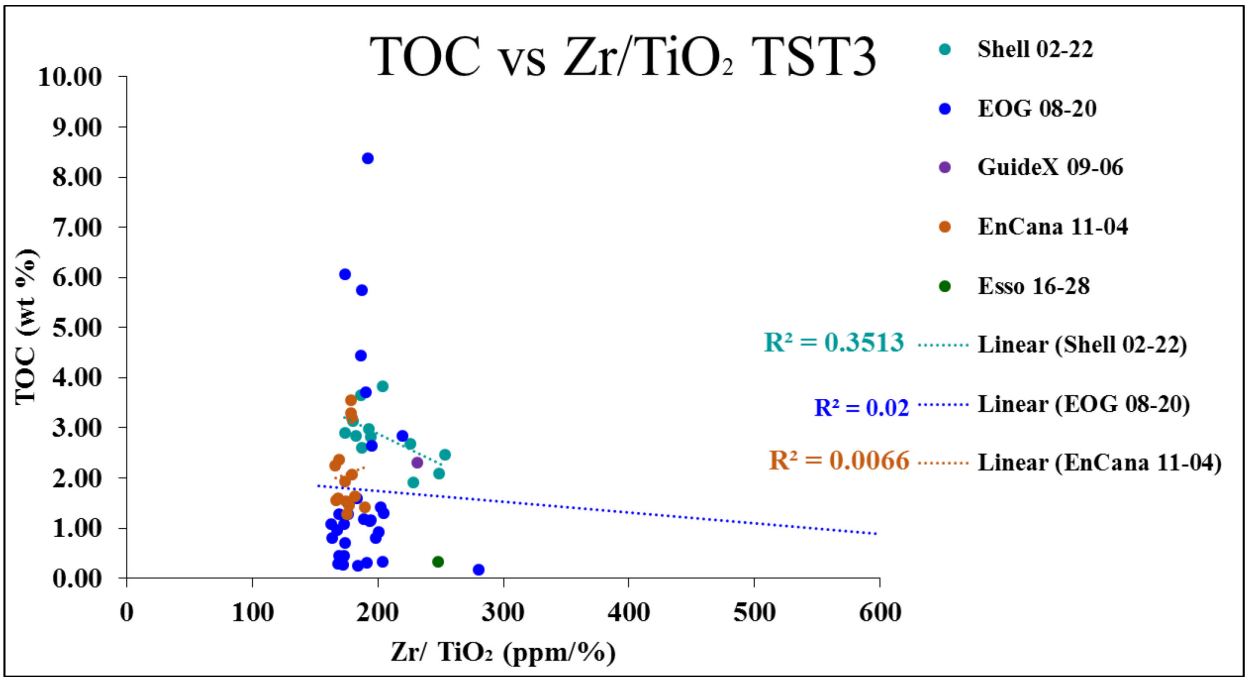


Figure 68. Summary for **TST3** of relationship between TOC content (wt %) and Fe/S and Mo/Al (ppm/%). Colour legends complete with trend line and R^2 values are to the right of each chart.



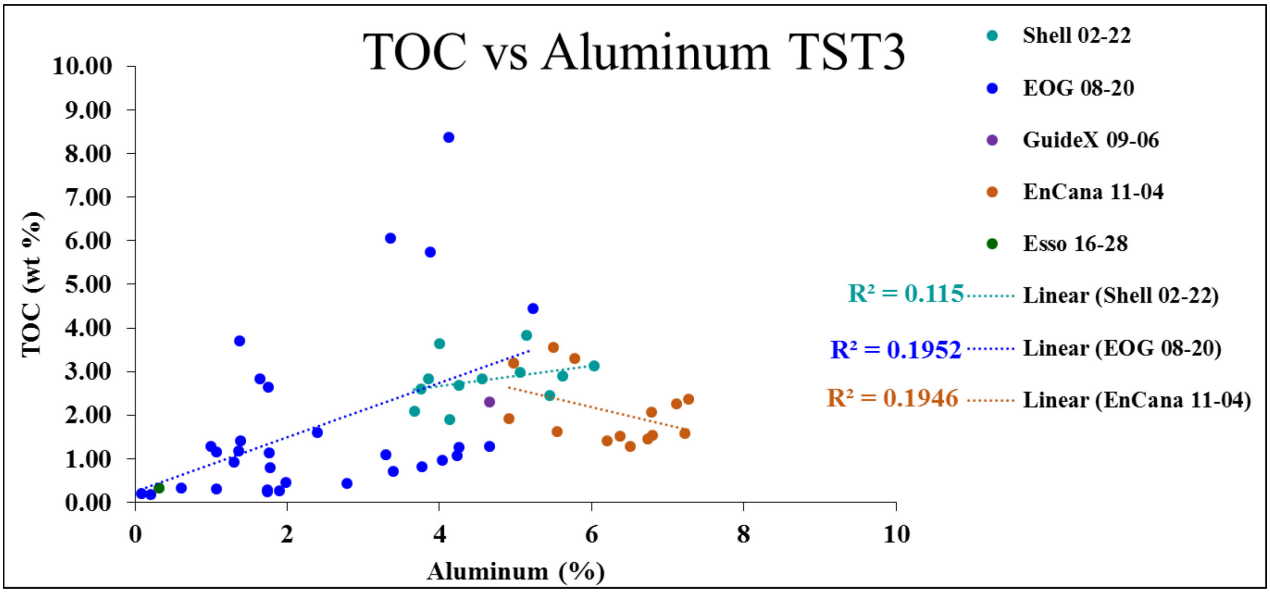
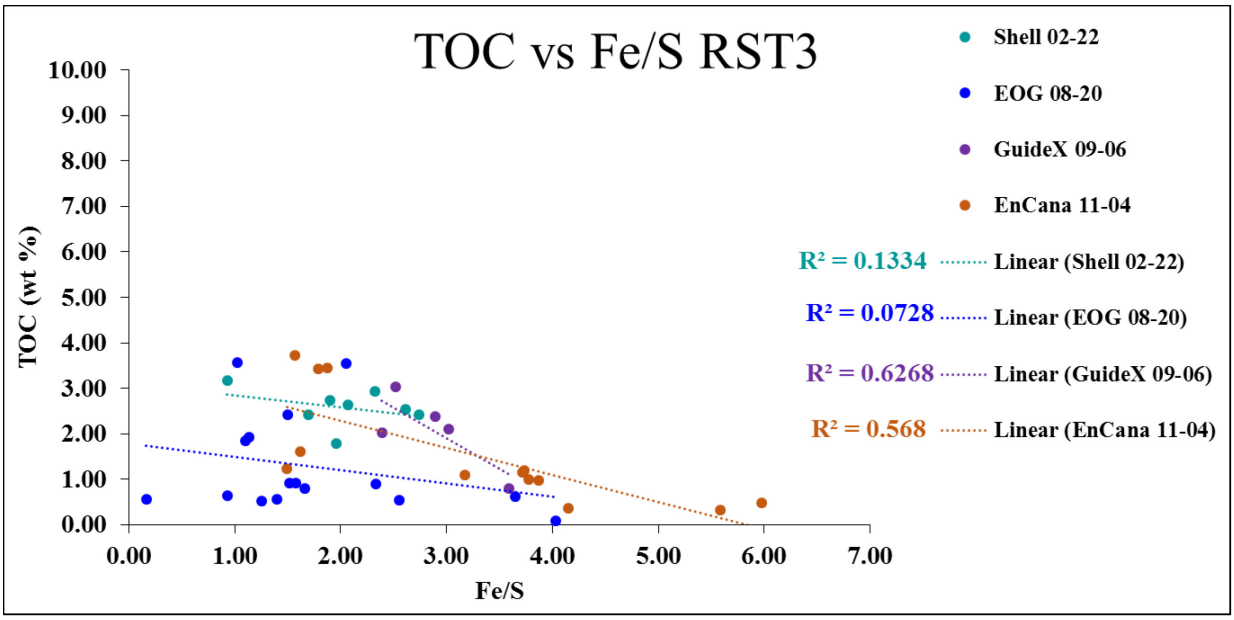


Figure 69. Summary for **TST3** of relationship between TOC content (wt %) and Zr/TiO_2 (ppm/%) and Al (%). Colour legends complete with trend line and R^2 values are to the right of each chart.



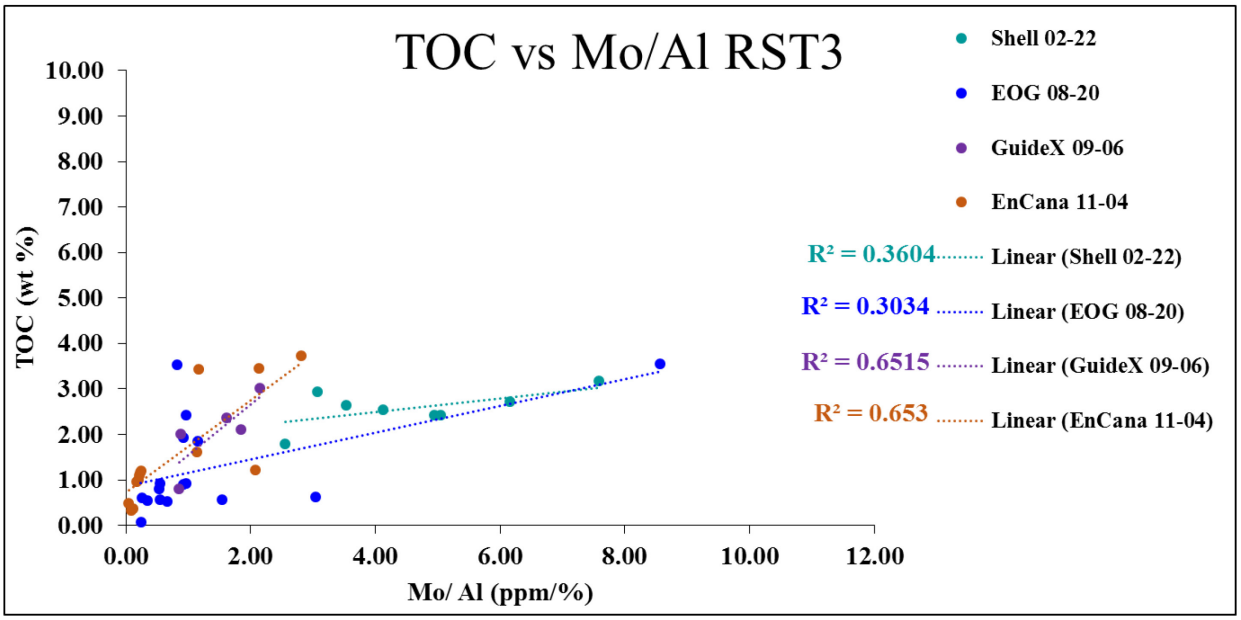
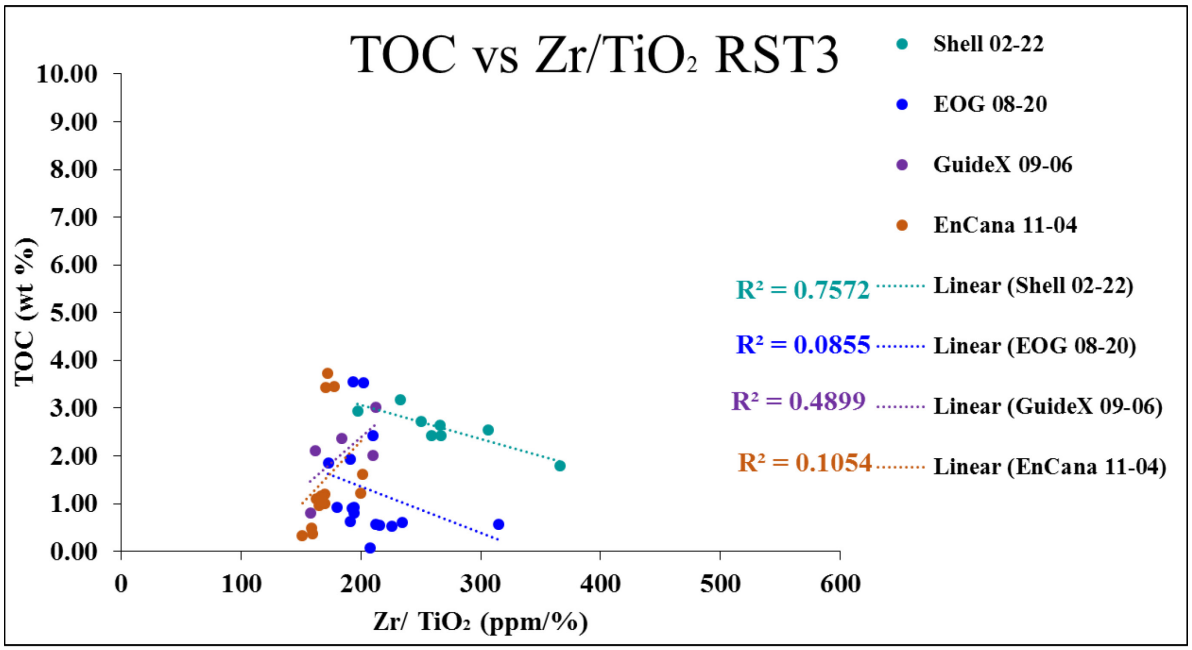


Figure 70. Summary for **RST3** of relationship between TOC content (wt %) and Fe/S and Mo/Al (ppm/%). Colour legends complete with trend line and R^2 values are to the right of each chart.



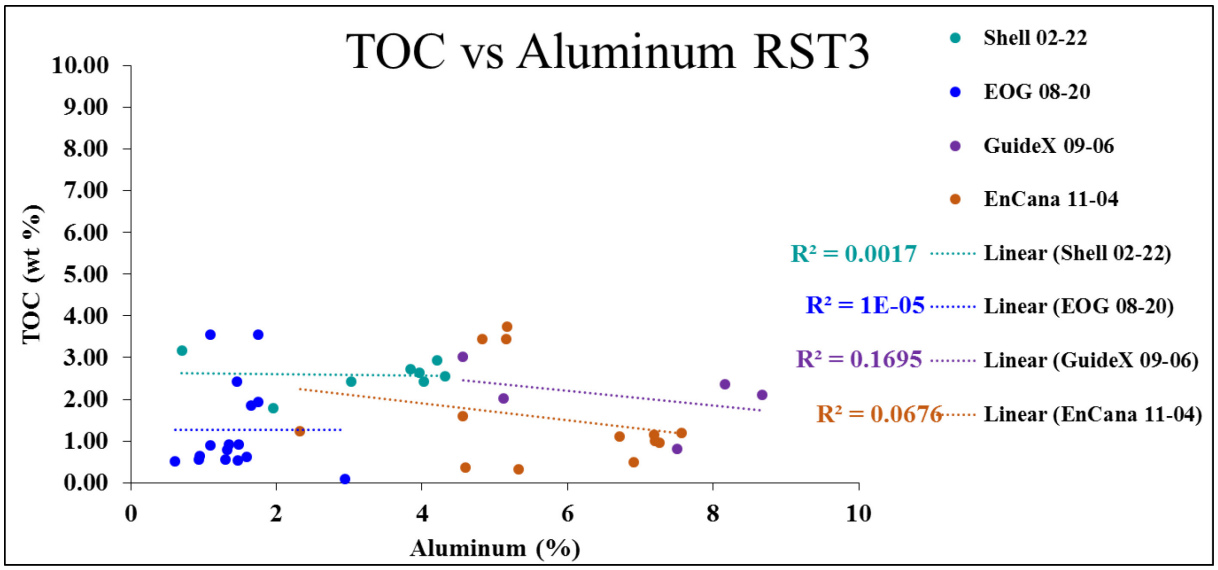


Figure 71. Summary for **RST3** of relationship between TOC content (wt %) and Zr/TiO_2 (ppm/%) and Al (%). Colour legends complete with trend line and R^2 values are to the right of each chart.

RST 3 Sample Size & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum	5	0.1695	8	0.0017	13	0.0676	ND	NA	17	1E-05
TOC vs Zr/TiO_2	5	0.4899	8	0.7572	13	0.1054	ND	NA	17	0.0855
TOC vs Fe/S	5	0.6268	8	0.1334	13	0.5680	ND	NA	17	0.0728
TOC vs Mo/Al	5	0.6515	8	0.3604	13	0.6530	ND	NA	17	0.3034

TST 3 Sample Size & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum	1	NA	12	0.1150	14	0.1946	1	NA	35	0.1952
TOC vs Zr/TiO_2	1	NA	12	0.3513	14	0.0066	1	NA	35	0.0200
TOC vs Fe/S	1	NA	12	0.2171	14	0.0220	1	NA	35	0.1531
TOC vs Mo/Al	1	NA	12	0.1036	14	0.7255	1	NA	35	0.3471

Table 14. Summary for **TST3-RST3** of sample size (N) and R^2 values for each well.

RST 3 N, Slope & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum										
TOC vs Zr/TiO_2			8	0.7572 -						
TOC vs Fe/S	5	0.6268 -								
TOC vs Mo/Al	5	0.6515 +			13	0.6530 +				

TST 3 N, Slope & R^2 Values	GuideX 09-06 N	GuideX 09-06 R^2	Shell 02-22 N	Shell 02-22 R^2	EnCana 11-04 N	EnCana 11-04 R^2	Esso 16-28 N	Esso 16-28 R^2	EOG 08-20 N	EOG 08-20 R^2
TOC vs Aluminum										
TOC vs Zr/TiO_2										
TOC vs Fe/S										
TOC vs Mo/Al					14	0.7255 +				

Table 15. Summary for **TST3-RST3** of sample size (N), slope (positive or negative) and R^2 values for each well. Intervals with N<=3 and or R^2<0.6 excluded (not statistically significant).

5. Discussion

Placing patterns of organic matter enrichment into a stratigraphic context highlights relationships between organic matter content and transgressive seas. This has implications for predicting the lateral and vertical distribution of quality source rock intervals (Creaney and Passey 1993, Arthur and Sageman 1994, Bohacs et al. 2005, Algeo et al. 2007, Flynn and Cheadle 2012, Ver Straeten et al. 2011, Slatt and Rodriquez 2012). Integrated studies of basins widely separated in geologic time (the Black Sea, the Western Interior Basin and the Appalachian Basin) highlight the linked roles of three other important factors that contribute to source rock development, namely: 1) sedimentation rate 2) nutrient supply and subsequent primary production and 3) microbial metabolism (Arthur and Sageman 2005). Other research attempted to clarify whether productivity or preservation was the dominant control on the deposition of organic carbon (Pedersen and Calvert 1990, Chow et al. 1995, Schieber 2010, Macquaker et al. 2010, Algeo and Ingall 2007, Demaison and Moore 1990).

Based on the above new insights, models for organic matter (OM) accumulations represent a variety of optimized, nonlinear interactions of three variables: production, destruction and dilution with many possible combinations resulting in significant OM enrichment (Arthur and Sageman 2005, Rimmer et al. 2004, Rimmer 2004, Bohacs et al. 2005). Identifying the bulk mineralogy, silica source, source terranes, and redox conditions constrains interpretations of the influence of each factor on TOC content in the Duvernay and has implications for predicting quality source rock intervals stratigraphically and geographically.

Inferences from silica source indicators, source terrane indicators and redox indicators will each be explored in turn. Causes of geochemical variation will be proposed (Sections 5.1, 5.2, and 5.3 respectively). Interpreted cause of the variation of geochemical proxies will then be

explored and tested within the context of basin evolution (Section 5.4). Controls on TOC accumulation in relation to these factors will be investigated (Section 5.5).

5.1 Inferences about Thermal Maturity from Tmax Values

Average Tmax values indicated in Figure 6 result in the following maturity assignments for each well: Guidex 09-06 is assigned to the oil window, Shell 02-22 is assigned to the wet gas window, Encana 11-04 is assigned to the oil window (which is counterintuitive based on the location being the furthest down dip in the basin), Esso 16-28 is assigned to the immature window, and EOG 08-20 is assigned to the oil window. The assignment of oil window maturity for Encana 11-04 is interpreted to be an artifact and the true maturity is higher. At high thermal maturity, hydrogen loss occurs during kerogen cracking resulting in maturities that appear lower than they actually are. While this phenomenon affects the results of all five wells, the impact is greater with greater maturity. For example less hydrogen loss would be expected at Esso 16-28 than at Encana 11-04.

5.2 Inferences about Organic Matter Type and Maturity from HI vs Tmax Relationships

Figure 7 indicated little variation in HI and OI values for Shell 02-22 and Esso 16-28 and only slight variation for Guidex 09-06 and EOG 08-20, indicating consistent OM type (determined from HI vs OI or HI Tmax plots) vertically through the Duvernay Formation. Terrestrial organic matter is assigned to Type III and tends to be gas-prone (Peters 1986). Decomposed organic matter in which the labile compounds have reacted leaving only polycyclic compounds are assigned to Type IV (commonly has an algal or bacterial origin) (Peters 1986).

Marine and lacustrine algal/bacterial organic matter are assigned to Type I and Type II and tend to be oil-prone (Peters 1986). Samples from Guidex 09-06 plot in Type II (marine, oil-prone) and Type III (marine-terrestrial, oil-gas-prone) regions. Samples from Shell 02-22 lie within the condensate-wet gas zone (mature) window and plot in inert region indicating that hydrogen loss during kerogen cracking has resulted in an inability to identify organic matter type for some samples. Samples from Esso 16-28 plot in the immature window and generally plot in Type II (marine, oil-prone) and Type III (marine-terrestrial, oil-gas-prone) regions. Samples from EOG 08-20 lie between lines with Ro values of 0.55 and 1.0 (mature, oil window) and plot over a range of HI values from 100-350 between the Type II (terrestrial, gas-prone) and Type II-III (marine-terrestrial, oil-gas-prone) regions.

5.3 Implications of bulk mineralogy proxies

Table 4 and Figure 72 summarize the relative input of quartz, clays and carbonates into the system at each well location in each interval. Input of silica into the systems depends on clastic silica flux and biogenic silica flux. Transport of carbonate material to the basin is a function of carbonate productivity and accommodation space on the platforms. As accommodation space is decreased, either because reefs outgrow their accommodation space or because sea level falls, transport to the basin increases.

In the TST1-RST1 cycle, the WSB is silica-dominated except for Encana 11-04 which shows a distinct carbonate influence. High silica input in the WSB could be attributed to increased biogenic silica input as a result of more nutrients in the basin or increased detrital silica input due to basin infilling. The origin of silica will be explored in section 5.4. Shell 02-22 also

shows the influence of increased carbonate input in RST1. Encana 11-04 is the most reef proximal well location in the WSB and is therefore interpreted to be subject to an influx of reef debris during TSTs and RSTs. Shell 02-22 is somewhat reef proximal and is interpreted to be influenced by reef input in RSTs due to increased reef shedding as accommodation space decreases. The ESB is geochemically interpreted to be a carbonate-dominated depositional system based on CaO + MgO contents although this is biased because both well locations are proximal to reefs, with one on the reef edge or slope. The WSB show more input of clays into the system than in the ESB except for Shell 02-22 which has similar clay input to ESB wells. This is interpreted to be the result of physical restriction and lack of circulation of currents from the north carrying clay. The ESB wells are interpreted to be more physically restricted when compared to the WSB because of the Rimbey Meadowbrook Trend is interpreted to provide a barrier to the circulation of the currents coming in to the basin from the north through the opening between the PRA and Grosmont platform.

In the TST2-RST2 cycle, the WSB is once again silica-dominated and the ESB is carbonate-dominated. The exception is Guidex 09-06, where increased carbonate input was noted in cycle 2 and interpreted to be the result of shedding from Leduc fringing reefs in this interval as the basin shallows overall. Relative to cycle one, siliceous input has increased in the WSB and carbonate input has increased in the ESB. Increased nutrient input leading to increased biogenic silica production or increased detrital silica could be the cause of increased silica input in the WSB. The origin of silica will be explored in section 5.4. This interval also shows more influence of clays in the WSB than in the ESB, again interpreted to be the result of better circulation of currents from the north carrying clays into the system.

In the TST3-RST3 cycle, the WSB is once again silica-dominated and the ESB is carbonate-dominated. Relative to cycle 2, siliceous input has increased in the WSB and carbonate input has increased in the ESB. Increased silica input in the WSB could be attributed to increased biogenic silica input as a result of more nutrients in the basin or increased detrital silica input due to basin infilling. The origin of silica will be explored in section 5.4. The WSB exhibits more influence of clays than the ESB, again interpreted to be the result of better circulation of currents from the north carrying clays into the system.

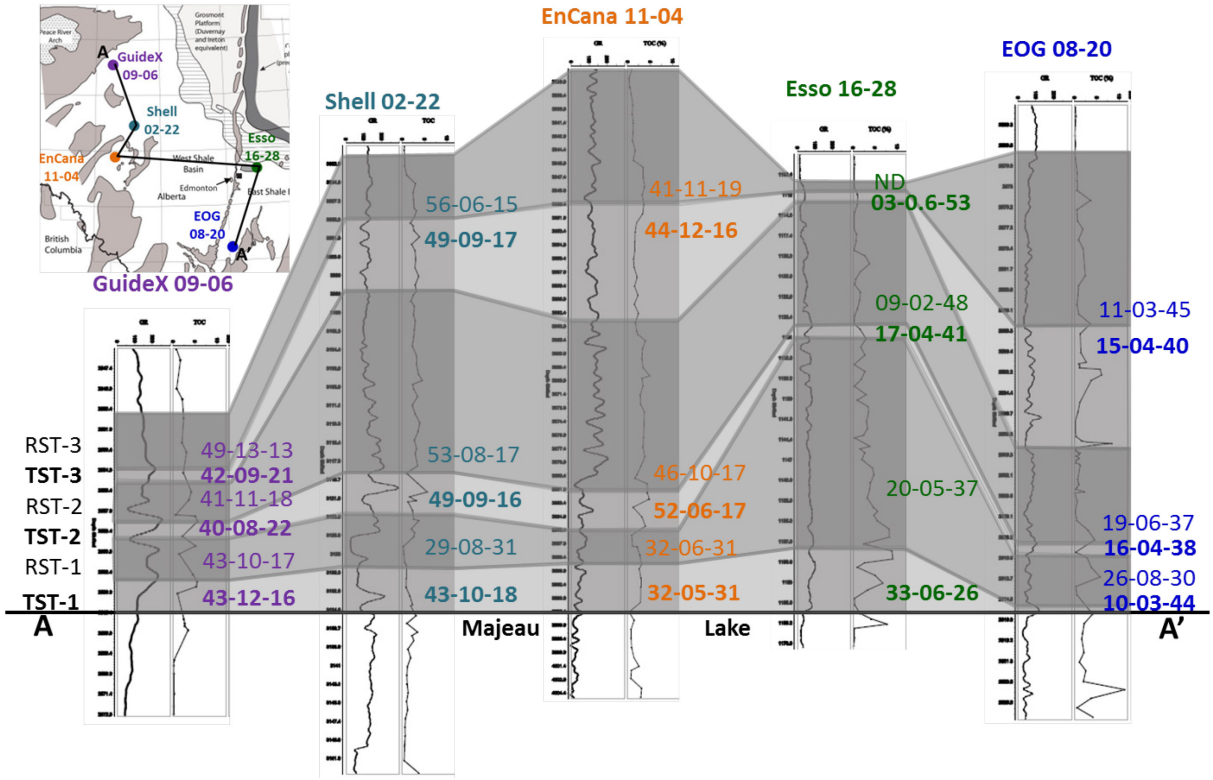


Figure 72. Summary of relative input of quartz, clay and carbonates: SiO_2 - Al_2O_3 - CaO+MgO respectively with values in percent (%).

5.4 Implications of silica source indicators

Biogenic quartz can dilute organic matter accumulations where organic matter productivity is dominated by siliceous plankton that also contribute organic matter to the system (Tyson 2001). Abundant biogenic silica should reflect organic productivity, however, the converse is not necessarily true. In some cases, biogenic silica can dilute organic matter (Tyson 2001, Bohacs et al. 2005). Biogenic silica might provide information about auto dilution and, indirectly, productivity controls (Bohacs et al. 2005). Figures 73-75 summarize the interpretations of silica source determined from silica-zirconium cross plots. A negative slope on a silica-Zirconium cross plot trend is an argument for biogenic silica, however, distinct negative trends do not occur in most of the wells or intervals. At the same time, compelling evidence for a pure detrital signal only occurs in some intervals. The Duvernay Formation is therefore inferred to be characterized by mixing of detrital and biogenic sources. However, the alternative hypothesis that multiple detrital Zr/SiO_2 ratios are present, cannot be ruled out.

In the TST1-RST1 cycle (Figure 73), the WSB and ESB are clearly distinguished. All three WSB wells display a mixed silica source signal. The ESB wells have a stronger detrital signal than the WSB. In the TST2-RST2 cycle (Figure 74), the WSB and ESB are also clearly differentiated. The WSB is dominated by mixed silica sources including some intervals where biogenic silica is dominant. The ESB wells display a strong detrital influence, almost exclusively so at Esso 16-28. In the TST3-RST3 cycle (Figure 75), the WSB and ESB are also clearly differentiated. The WSB is dominated by mixed silica sources including some intervals where biogenic silica is likely dominant. The ESB wells display a strong detrital influence with minimal biogenic input. These patterns suggest that the WSB was biogenic silica-dominant. On the other hand, the strong detrital influence in the ESB suggests that clastic dilution may have

affected TOC accumulation. The biogenic silica flux is interpreted to be higher in the WSB than in the ESB. The ESB is interpreted to have a higher detrital silica flux.

In the WSB, Guidex 09-06 is characterized by low carbonate content throughout, fluctuations in clay, and an increasing influence of biogenic silica from cycle 1 through cycle 2 to cycle 3. This implies a silica-dominated system, periodic input of clays into the system being carried by currents from the north, and potentially increased organic productivity. Shell 02-22 is characterized by a silica-dominated system throughout. The lack of carbonate could indicate low carbonate productivity or less transport of carbonate material to the basin. Flux of carbonate to basinal settings can be associated with highstands (lack of accommodation space, called highstand shedding) or with lowstands, as the reef is undercut and breaks up. Moderate clay contents throughout implies consistent detrital input throughout basin evolution. Overall the Shell 02-22 location seems to be affected by a balance of inputs from reefs, contour currents and biogenic silica. Encana 11-04 is characterized by a decrease in carbonate content upwards indicating a shift from a carbonate dominated system to a silica dominated system, increasing clay content overall reflecting infilling of the basin over time, and increasing silica content implying increased organic productivity.

In the ESB, Esso 16-28 is characterized by low silica content throughout suggesting a carbonate dominated system, low clay contents overall despite proximal location to detrital sources implying dilution of detrital material by high influx of carbonate material. The increase in carbonate content from cycle 1 through cycle 2 to cycle 3 may indicate either reef shedding or reef undercutting. EOG 08-20 is characterized by low silica content throughout reflecting a carbonate-dominated system, variable clay content suggesting periodic influx of detrital material and an increase in carbonate content upwards.

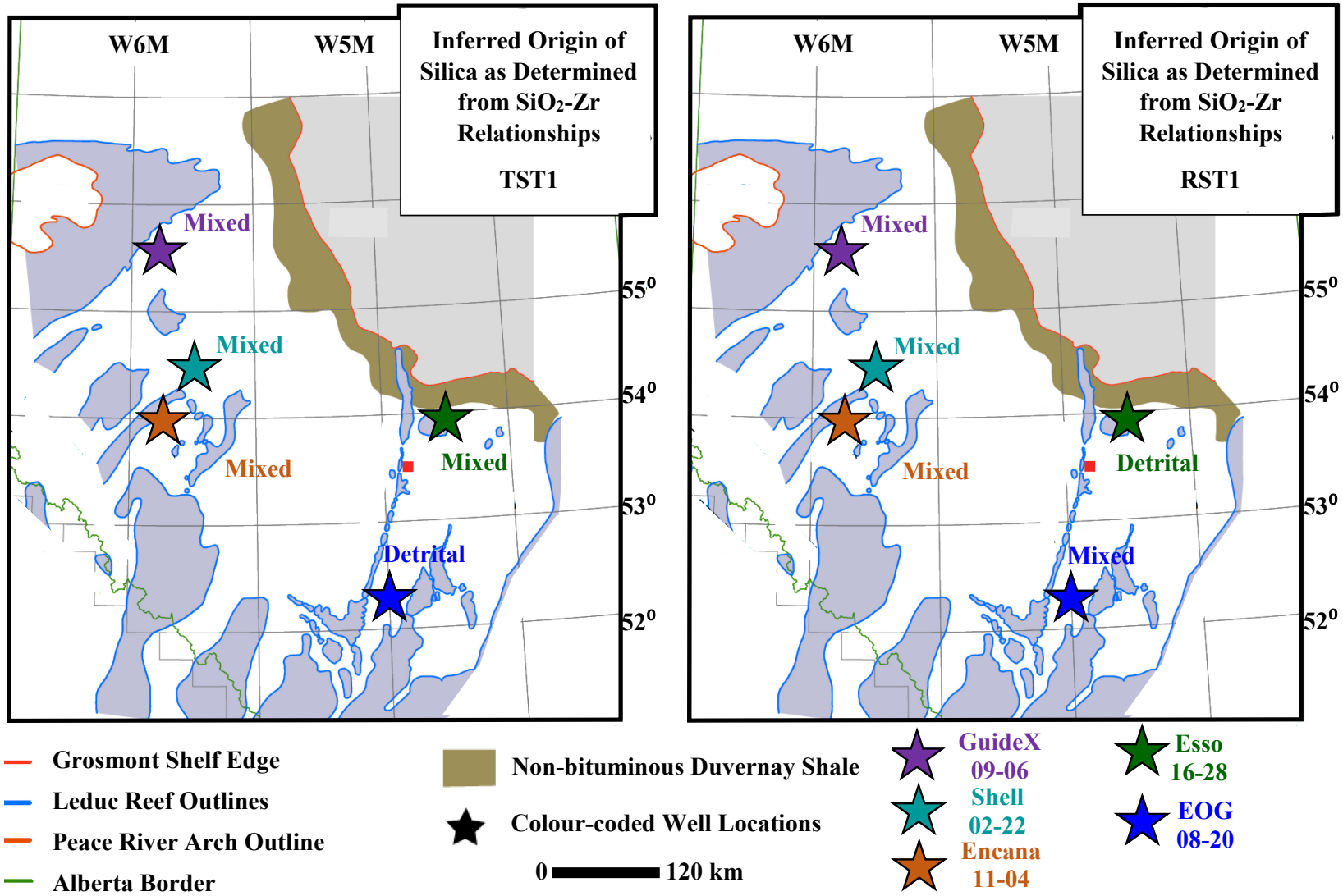


Figure 73. Summary of geographic and stratigraphic variation in inferred origin of silica TST1-RST1 (biogenic, detrital or mixed) as determined from SiO_2-Zr relationships. Stratigraphic interval indicated in upper right of each map.

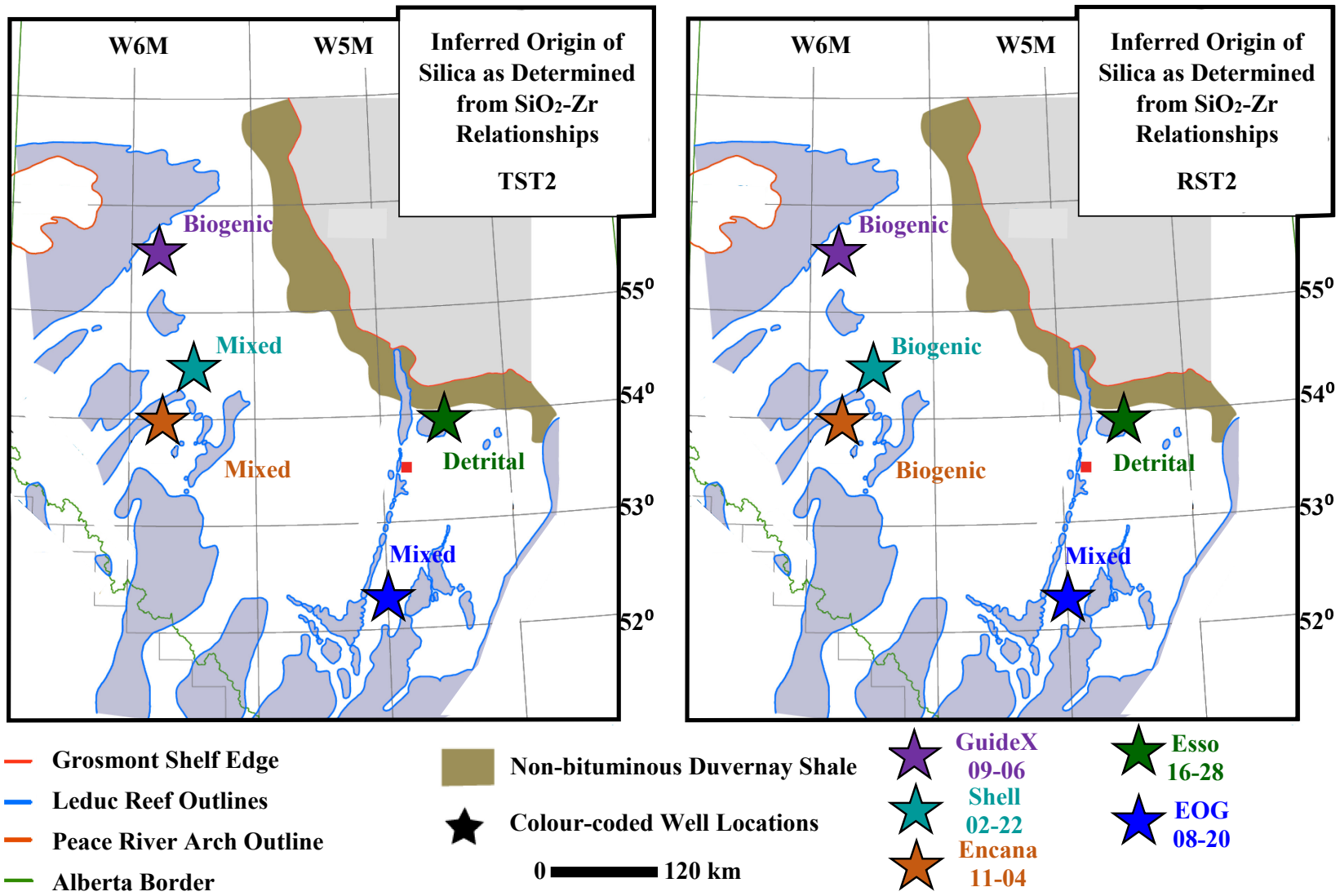


Figure 74. Summary of geographic and stratigraphic variation in inferred origin of silica for TST2-RST2 (biogenic, detrital or mixed) as determined from SiO_2-Zr relationships. Stratigraphic interval indicated in upper right of each map

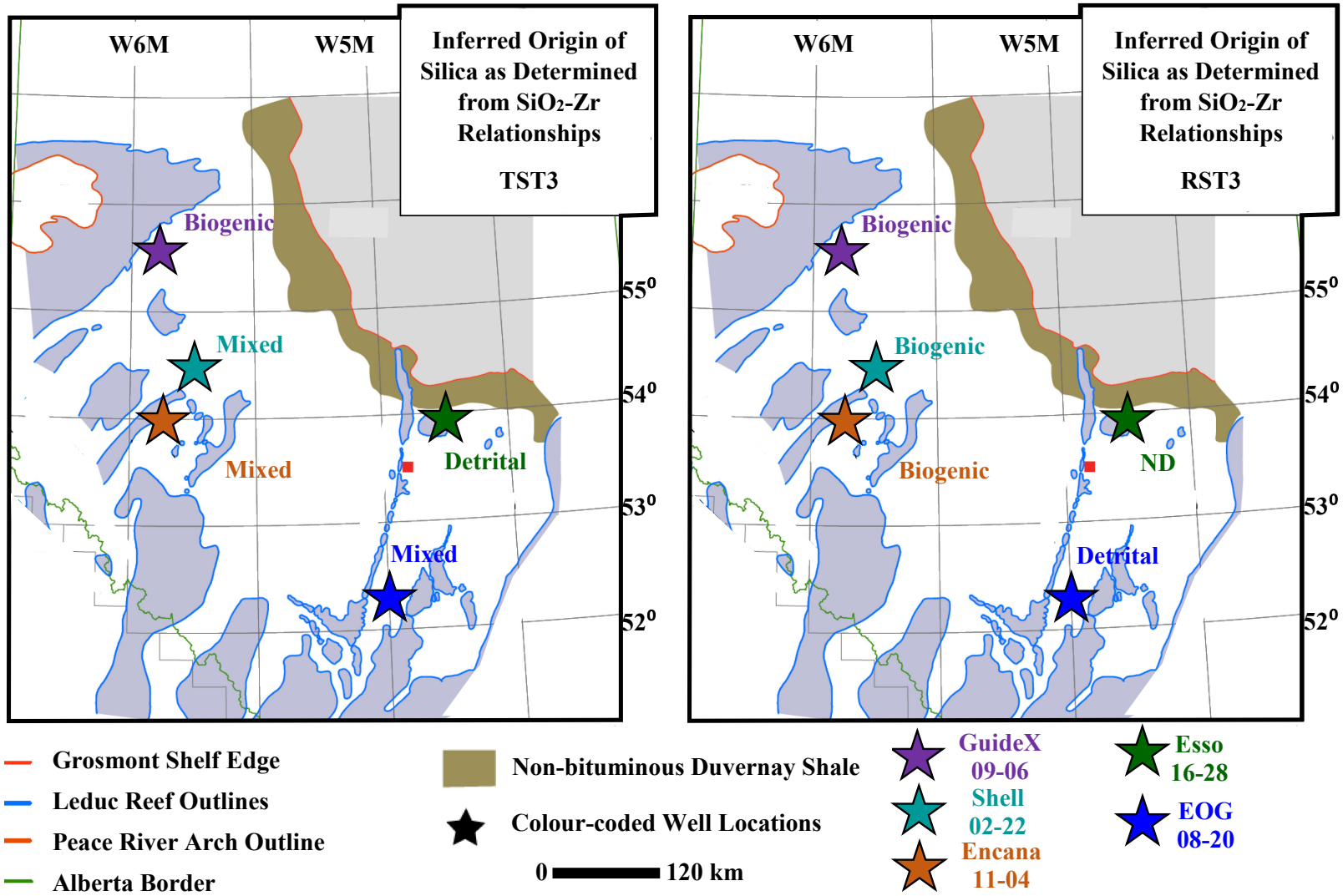


Figure 75. Summary of geographic and stratigraphic variation in inferred origin of silica for TST3-RST3 (biogenic, detrital or mixed) as determined from SiO_2-Zr relationships. Stratigraphic interval indicated in upper right of each map.

5.5 Inferences from detrital provenance indicators

Source terrane indicators provide information about whether single or multiple sources of sediment were influencing a given location within the basin. The aim is to discriminate between possible sources. Figures 76-78 summarize the interpretations of detrital determined from zirconium-titanium cross plots. The three possible sources of detrital sediment are: the PRA to the northwest, the craton beyond the Grosmont Platform to the east and northeast and a northern source (Figure 79). Based on the geographic location of each well, interpretations can be made about the most probable sources. These interpretations are based on the following observations: 1) the WSB and ESB are not clearly differentiated in general; instead relative geographic position of wells in each basin (northern or southern) exhibit distinctions, 2) locations proximal to the PRA and craton showed the influence of multiple sources (Guidex 09-06, Shell 02-22 and Esso 16-28), and 3) relatively distal locations (Encana 11-04 and EOG 08-20) showed single sources almost exclusively**.** Source terrane indicators for the five wells show unique stratigraphic patterns.

In the TST1-RST1 cycle, the WSB and ESB are not clearly distinguished (Figure 76). However, a geographical distinction can be made for the northernmost wells in each basin (Guidex 09-06 and Esso 16-28). These two northernmost wells exhibit the influence of multiple sediment sources, whereas the remaining wells indicate a single source influence. Based on geographic location, the most plausible sources for each of the other three wells are: the PRA for Encana 11-04, the northern source for Shell 02-22 and the craton for EOG 08-20. However, it is possible that the PRA and craton are genetically related and therefore indistinguishable on a Zr-TiO_2 cross plot.

In the TST2-RST2 cycle (Figure 77), the WSB and ESB are also not clearly differentiated. However, a geographical distinction can once again be made. In this interval Shell 02-22 in addition to Guidex 09-06 and Esso 16-28 indicates the influence of multiple sources although whether that source is the craton or the PRA is not clear. On the other hand, the two remaining wells furthest to the south only have a single source indicated.

In the TST3-RST3 cycle (Figure 78), the WSB and ESB are also not clearly differentiated. All but one well (Encana 11-04) shows at least some influence of multiple sources in this cycle, although the influence of multiple sources in EOG 08-20 is very minor and no data were available from Esso 16-28. The very minor influence of multiple sources in the EOG 08-20 well is interpreted to be the result of basin filling over time and sediment from the northern source, gradually prograding further into the basin.

Table 16 summarizes inferred sediment sources and geochemical indicators in the context of the evolution of the basin. A northern source of clastic sediment (1) is associated with currents from the north, transporting sediment into the basin (Section 2.2 and Knapp 2016) along with nutrient-rich waters, indicated by the large fraction of biogenic silica in the northern wells. The material is progressively deposited along the edge of the Grosmont Platform and RMT. An east/northeast (the craton is either east or northeast of any given well location) source (2) is interpreted to originate from the craton and bring sediment into the basin over the Grosmont Platform. This source is associated with the west-tapering wedge of sediment identified in the sedimentological model. A third source from the WNW (3) is interpreted to originate from the PRA. This source is associated with the east-tapering wedge identified in the sedimentological model.

Dominant Source Summary	GuideX 09-06	Shell 02-22	EnCana 11-04	Esso 16-28	EOG 08-20
TST3-RST3	Northern & PRA	Northern & PRA	PRA	No Data in RST3	Craton
TST2-RST2	Northern & PRA	Northern & PRA	PRA	Craton & increased Northern	Craton
TST1-RST1	Northern & PRA	PRA	PRA	Craton + minor Northern	Craton

Table 16. Summary of sediment sources for each well and interval. (1) is associated with currents from the north, transporting sediment into the basin (2) is interpreted to originate from the craton and bring sediment into the basin over the Grosmont Platform. (3) PRA

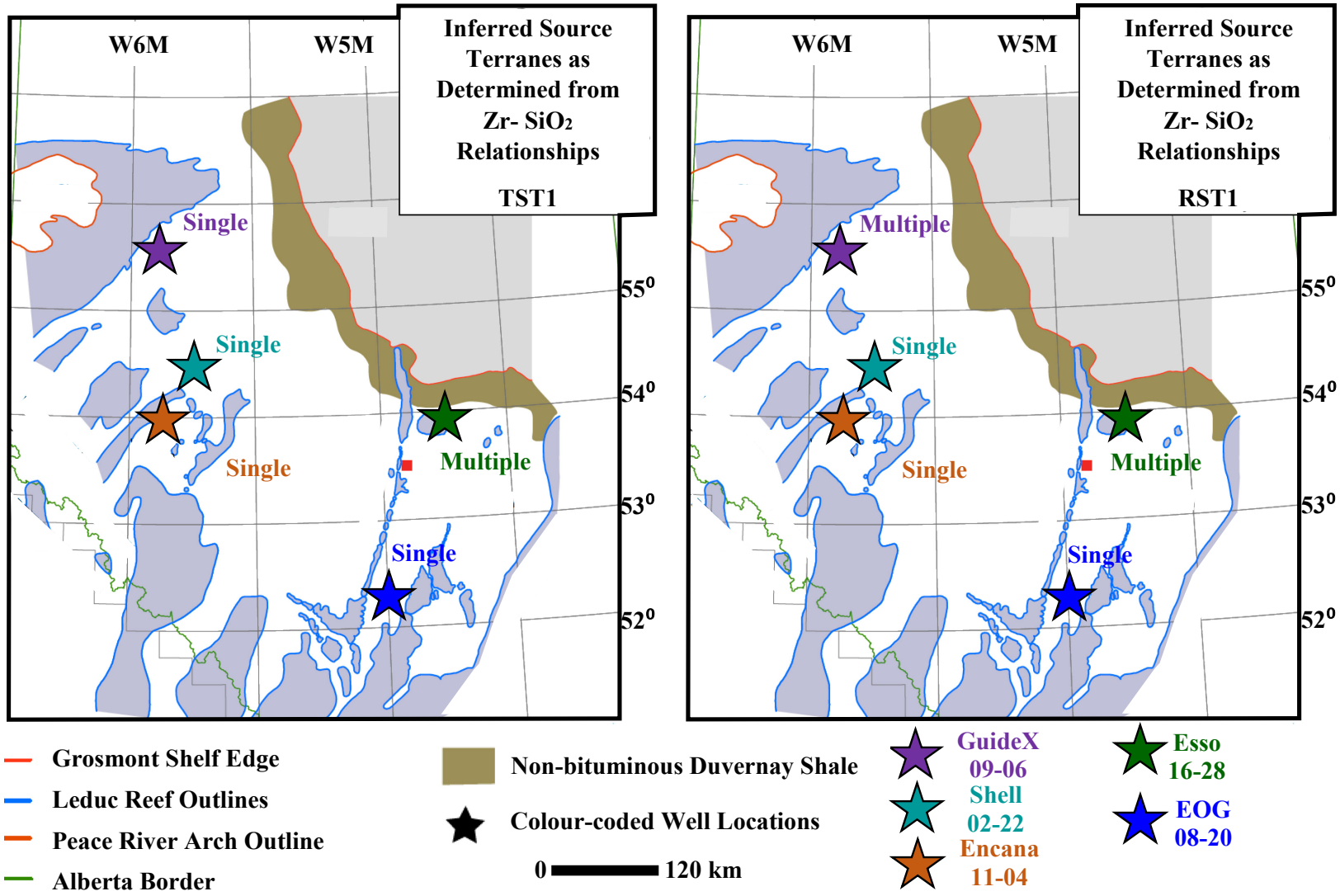


Figure 76. Summary of geographic and stratigraphic variation in inferred source terranes for TST1-RST1 (single or multiple) as determined from Zr-TiO_2 relationships. Stratigraphic interval indicated in upper right of each map.

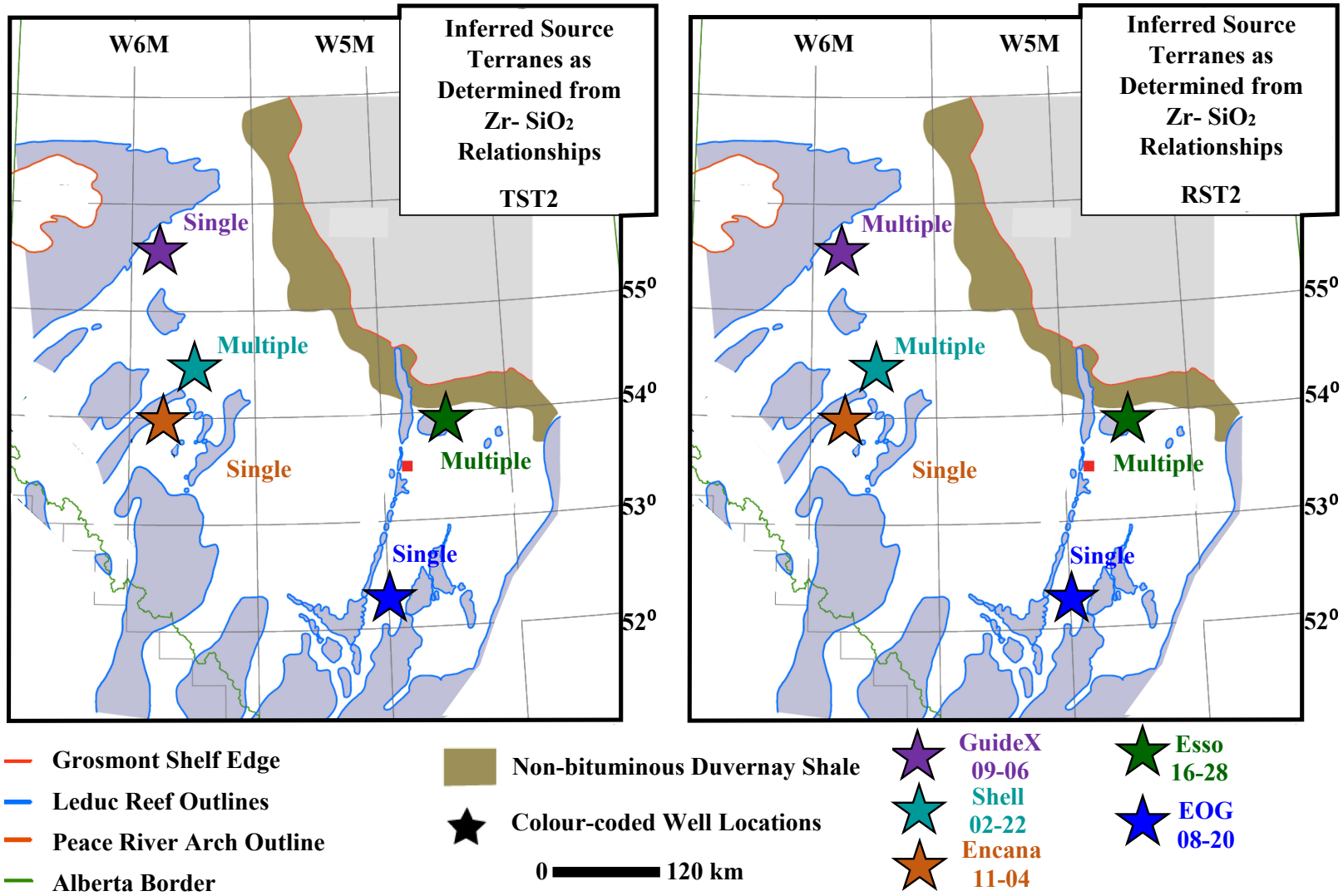


Figure 77. Summary of geographic and stratigraphic variation in inferred source terranes for TST2-RST2 (single or multiple) as determined from Zr-TiO_2 relationships. Stratigraphic interval indicated in upper right of each map.

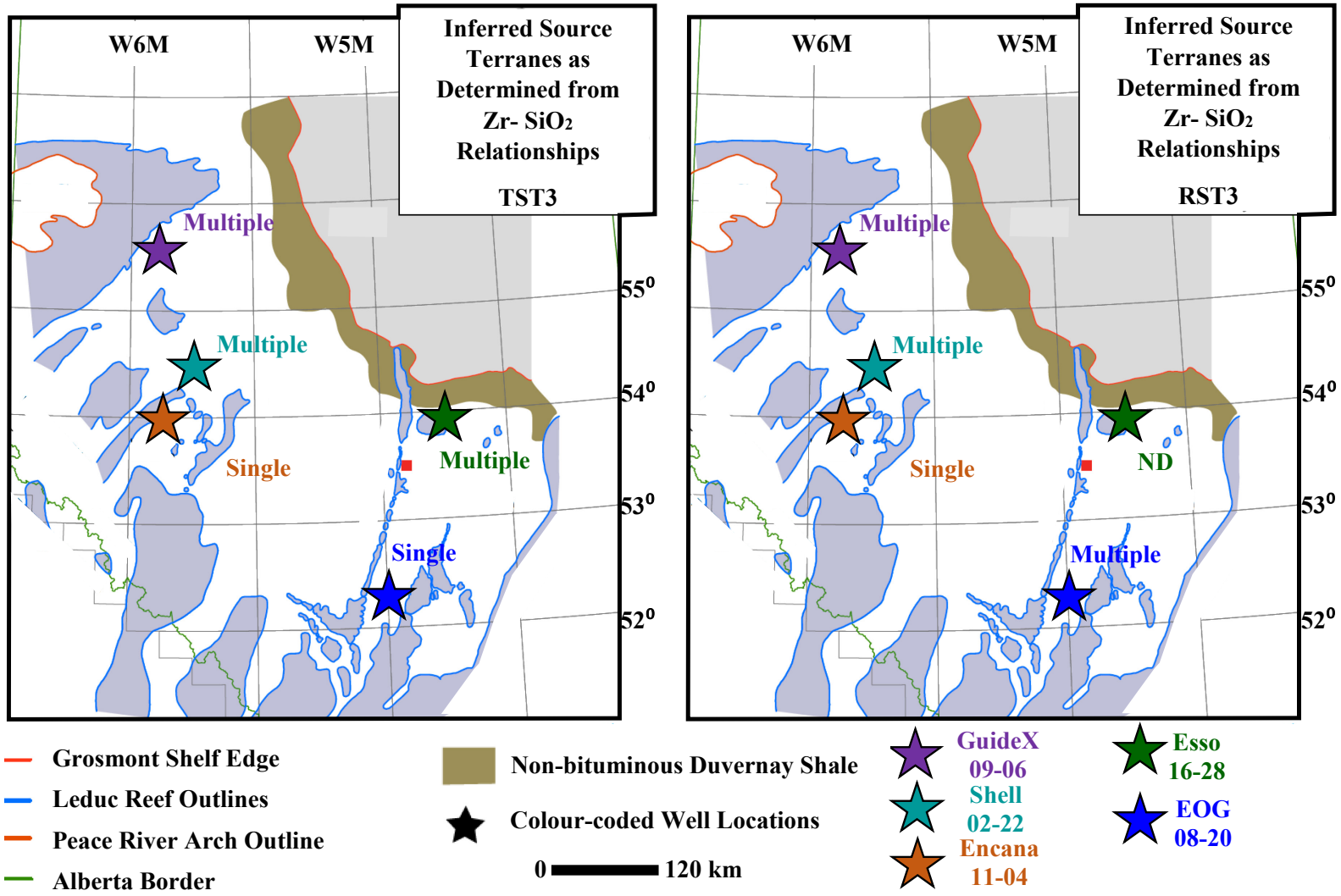


Figure 78. Summary of geographic and stratigraphic variation in inferred source terranes for TST3-RST3 (single or multiple) as determined from Zr-TiO_2 relationships. Stratigraphic interval indicated in upper right of each map.

5.6 Inferences from Redox Proxies

Redox conditions play a significant role in organic matter preservation and accumulations. Two methods for the interpretation of redox conditions were explored: C-Fe-S plots and aluminum-normalized trace element ratios.

5.6.1 Carbon-Iron-Sulfur Systematics

Redox ternary diagrams emphasize ratios independent of dilution effects. C-Fe-S systematics provide independent corroboration of redox conditions when used in conjunction with aluminum-normalized proxies as discussed in section 5.3. However, the iron-sulfur-carbon relationship on a ternary diagram can be affected by carbon loss during diagenesis at increased maturation levels (Dean and Arthur 1989, Raiswell and Berner 1987, Tuttle and Goldhaber 1993, Hay and Honjo 1989) and postdepositional sulfidation (Leventhal 1995, Middleburg 1991). Caution should be exercised when applying estimates of carbon loss to carbonate rich and biogenic silica rich rocks which could affect the position on a ternary diagram and therefore where points lie relative to a line with a given Fe/S intercept (Raiswell and Berner 1987, Lyons and Berner 1992, Hofmann et al. 2000). Redox conditions interpreted from C-Fe-S data are shown for each stratigraphic interval in Figures 79-81. Both the WSB and ESB show a range of redox conditions depending on stratigraphic interval and geographic location.

Within the TST1-RST1 cycle (Figure 79), there is no clear distinction between WSB and ESB. Redox conditions during sediment deposition at three wells in locations with relatively less physical restriction (Guidex 09-06, Shell 02-22 in the WSB and EOG 08-20 in the ESB) range from oxic to dysoxic. This is interpreted to be the result of better circulation in these les

physically restricted locations as compared to locations with more physical restriction. Encana 11-04 samples display an anoxic signature which is attributed to its very restricted location in the Wild River sub-basin. Esso 16-28 in the ESB, located in the northwest corner of the ESB on the edge of a patch reef very close to the edge of the Grosmont Platform, also displays a strong anoxic signal; this location may have been sheltered from circulating currents.

During deposition of the TST2-RST2 cycle (Figure 80), the overall range of redox conditions was similar to the underlying cycle. In general, the water column at the time of deposition becomes less oxic when compared to the previous cycle (i. e. conditions at Shell 02-22 move from marginally oxic-dysoxic to dysoxic), except for Encana 11-04 which becomes slightly more oxic. The bottom water at this location appears to have become more oxygen-rich in cycle 2 than in cycle 1, possibly due to enhanced communication between the Wild-River sub-basin and the WSB.

In the TST3-RST3 cycle (Figure 81), the range of redox conditions within the water column was similar to the previous cycle, including the persistence of relatively oxic conditions at Encana 11-04. Conditions at Esso 16-28 are generally interpreted to have been less oxic relative to all of the other wells, with some intervals deposited in euxinic conditions.

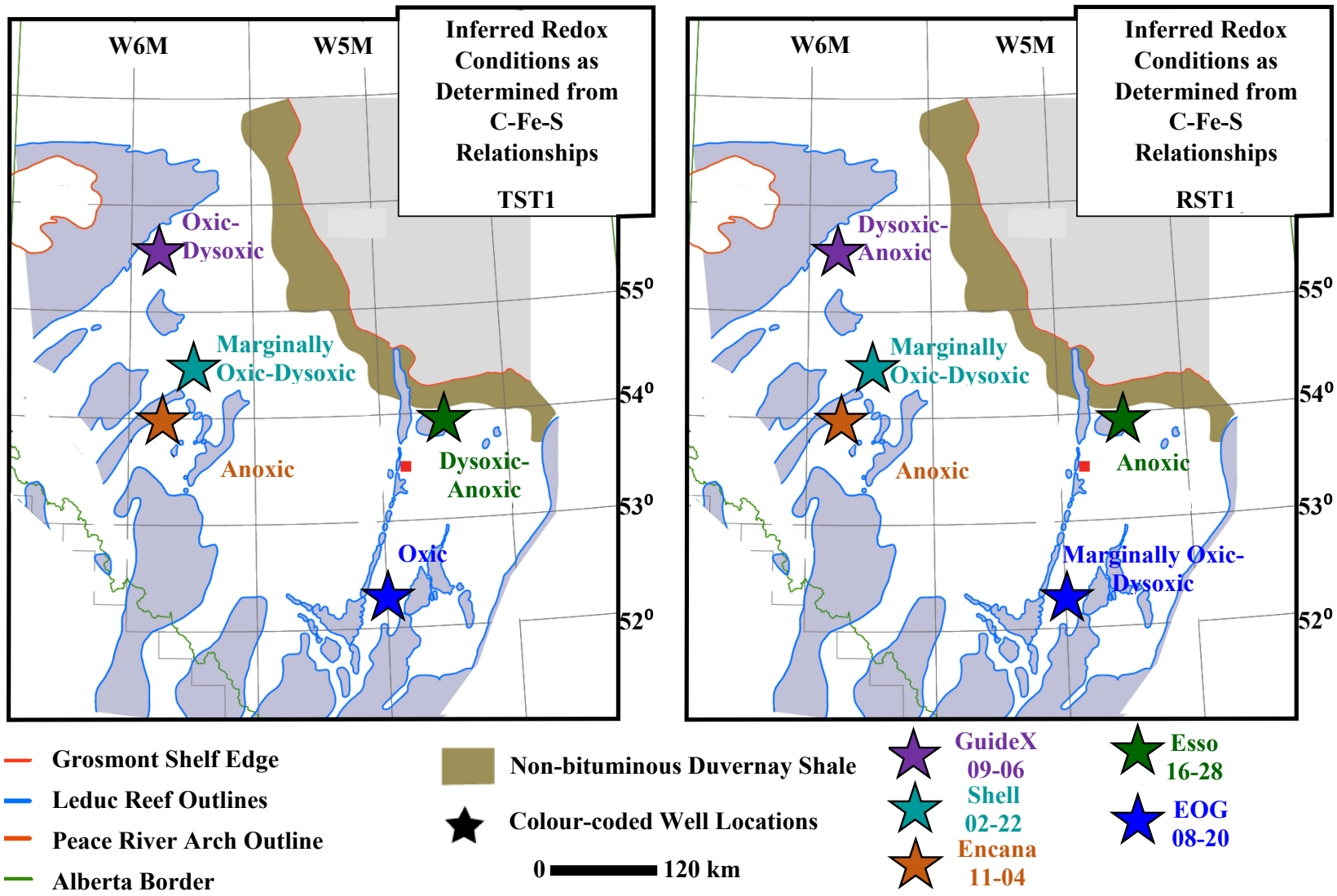


Figure 79. Summary of geographic and stratigraphic variation in inferred redox conditions for TST1-RST1 (oxic, marginally oxic, dysoxic, anoxic, euxinic) as determined from C-Fe-S ternary diagrams. Stratigraphic interval indicated in the upper right of each map.

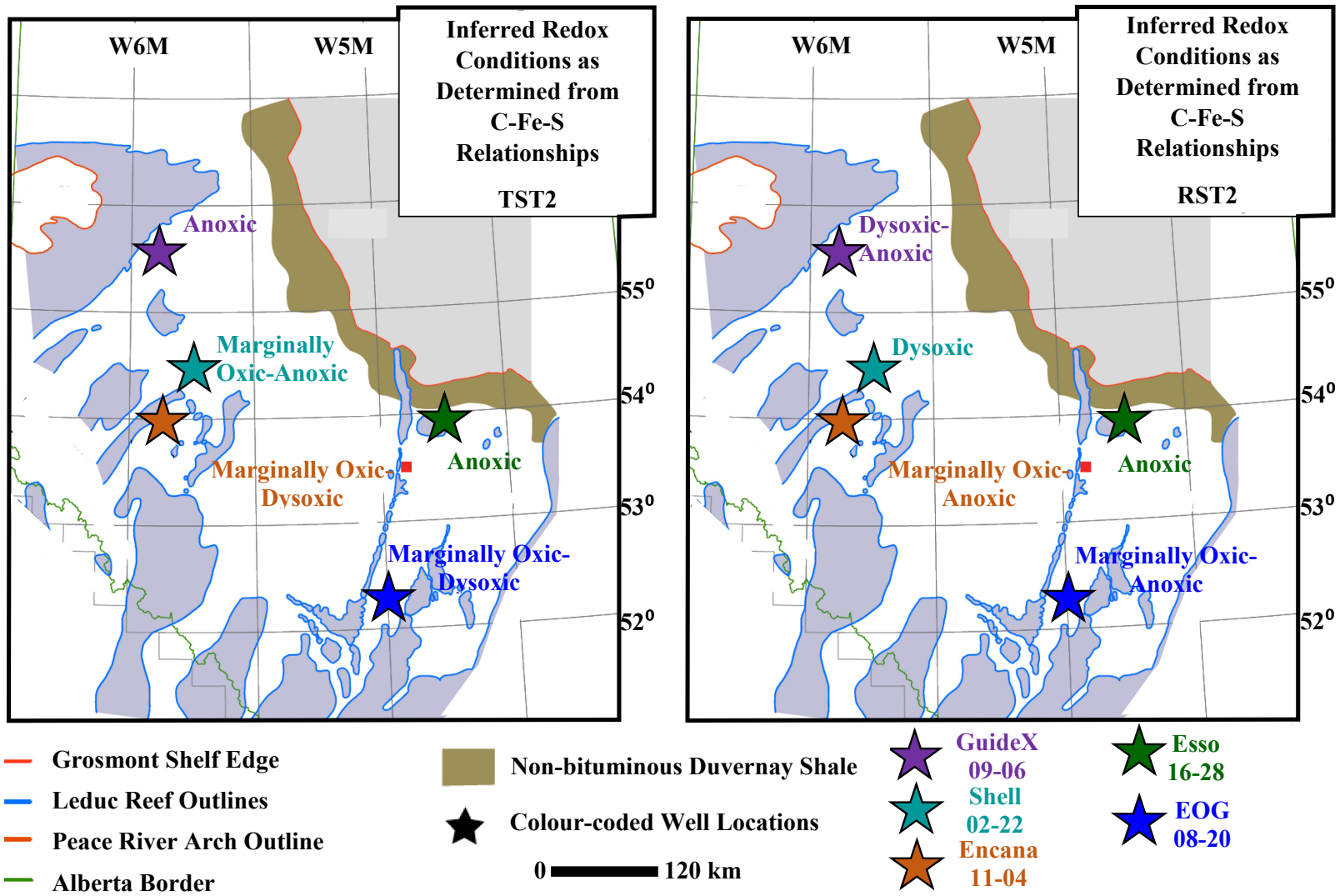


Figure 80. Summary of geographic and stratigraphic variation in inferred redox conditions for TST2-RST2 (oxic, marginally oxic, dysoxic, anoxic, euxinic) as determined from C-Fe-S ternary diagrams. Stratigraphic interval indicated in the upper right of each map.

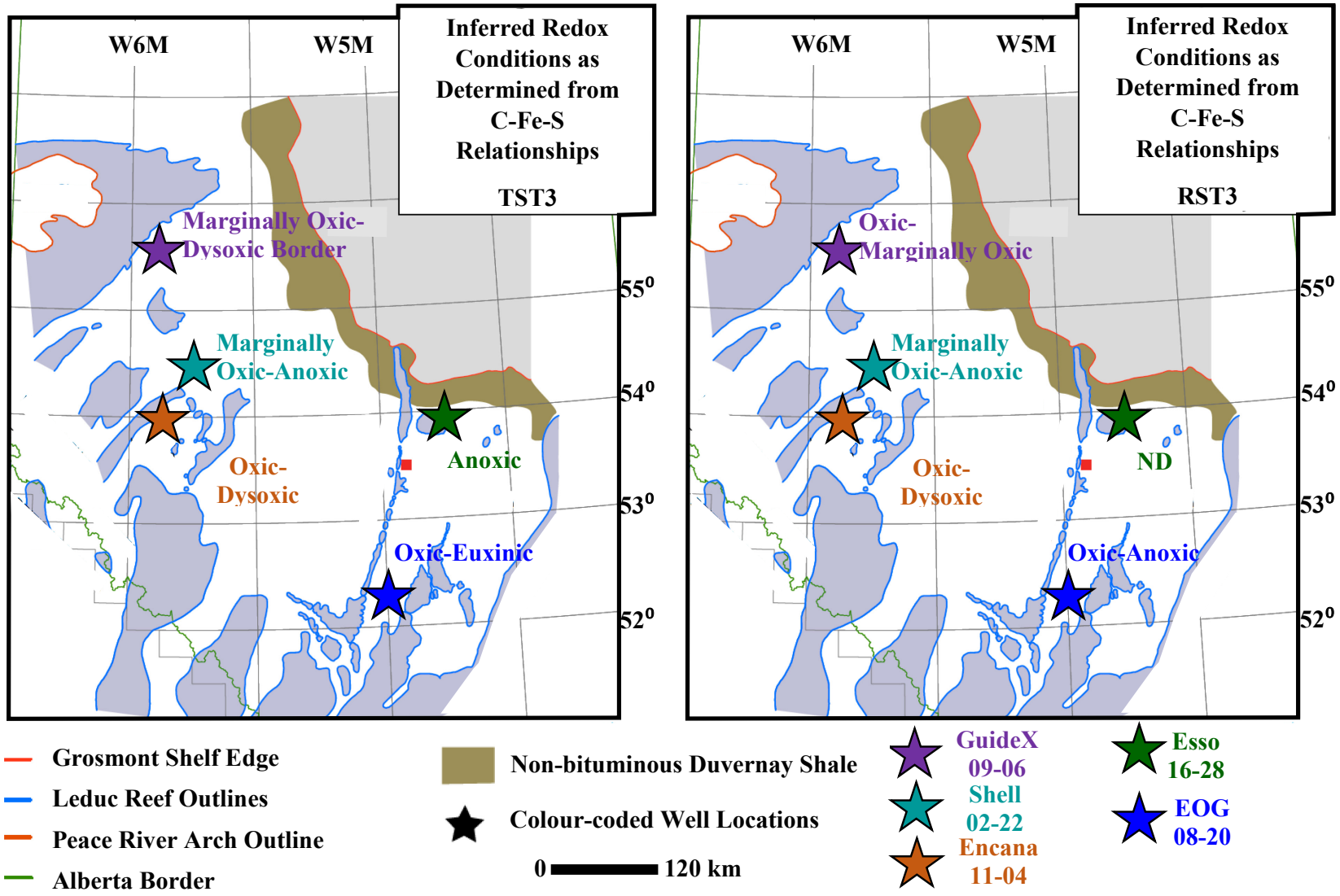


Figure 81. Summary of geographic and stratigraphic variation in inferred redox conditions for TST3-RST3 (oxic, marginally oxic, dysoxic, anoxic, euxinic) as determined from C-Fe-S ternary diagrams. Stratigraphic interval indicated in the upper right of each map.

5.6.2 Redox-Sensitive Trace Elements

Molybdenum has been used extensively as an indicator of redox conditions in both ancient and modern environments (Emerson and Huested 1991, Calvert and Pedersen 1993, Meyers et al. 2005, Meyer et al. 2008, Pi et al. 2013, Lyons et al. 2003, Crusius et al. 1996, Morford and Emerson 1999, Algeo and Maynard 2003, Tribovillard et al. 2006, Algeo and Lyons 2006, Gordon et al. 2009, Dahl et al. 2010, Dale et al. 2012, Mnich 2009, Harris et al. 2013, Colodner et al. 2005, Algeo and Rowe 2012). Uranium (U) and vanadium (V), two other redox sensitive elements have also been the subject of several studies as they become enriched under anoxic conditions (Leventhal 1981, Lüning et al. 2003, 2004, Smith 2011, Algeo and Maynard 2004, Morford and Emerson 1999, Arthur and Sageman 1994, Rimmer et al. 2004, Tribovillard et al. 2006, Algeo and Maynard 2008).

The practice of normalizing marine geochemical values to detrital species is not universally accepted (Eldrett 2009). In order to explore the applicability of aluminum normalized trace element ratios, Mo/Al, U/Al and V/Al values were compared to redox states interpreted from C-Fe-S ternary diagrams.

Redox states indicated by C-Fe-S systematics and interval-averaged trace element ratios are consistent with each other for all wells with a few exceptions (Table 17 and 18). Instances where trace element ratios are lower or higher than expected given a redox assignment via C-Fe-S systematics are: all three trace element ratios are lower in RST2 than in TST2 at Encana 11-04 despite RST2 being classified as anoxic based on C-Fe-S diagrams compared to TST2 which is marginally oxic to dysoxic; Mo/Al ratios at Esso 16-18 fluctuate from 2.19 to 0.45 ppm/% despite being consistently classified as anoxic based on Fe/S ratios; Mo/Al ratios at EOG 08-20 are in some case lower where Fe/S ratios indicate less oxic conditions (for example RST1 is

assigned dysoxic and has Mo/Al ratio of 1.21 ppm/% whereas RST2 is identified as anoxic but has a Mo/Al ratio of 0.59 ppm/%). Average trace element ratios at Encana for these two intervals coincide with stratigraphic intervals that include values that are maxima or minima by virtue of where the sampling points lie within the independently formulated stratigraphic interpretation. For the location of sampling points within the stratigraphic context see Appendix G. Therefore, the occurrence of higher trace element ratios in TST2 which has a less oxic signature than RST2 is interpreted to be the result of the averaging technique. The fluctuation of Mo/Al ratios despite a consistently anoxic signature identified by C-Fe-S diagrams at Esso 16-28 and lower ratios despite an anoxic assignment at EOG 08-20 implies that the Basin Reservoir Effect (BRE) may be influencing the system. The BRE results from the isolation of basins when connection to the open ocean is restricted and is generally tracked by Mo/TOC ratios (Algeo and Lyons 2006, Harris et al. 2013). Although Esso 16-28 is classified as anoxic by Fe/S ratios for almost the entire section, average Mo/Al values fluctuate between 0.45 to 2.19 ppm/%. This suggests that either a) the ESB is more isolated from the open ocean than the WSB and the BRE influenced Mo/Al values or b) the fluctuation in Mo/Al was due to precipitation pathways and is unrelated to basin restriction. These findings imply that, at least in the Duvernay, aluminum-normalized trace element ratios can be used as redox proxies in conjunction with C-Fe-S diagrams and may provide information about degree of restriction.

The Duvernay displays low trace element concentrations with Mo/Al, U/Al and V/Al ratios in the sub-100 ppm range. The low trace metal concentrations suggest that dysoxic conditions persisted during Duvernay deposition, not the anoxic conditions that are commonly considered to be typical of black shale deposition and responsible for elevated TOC accumulations (Tribovillard et al. 2006, Arthur and Sageman 1994, Calvert and Pedersen 1993).

The fact that relatively high TOC contents are not necessarily associated with anoxia in the Duvernay suggesting that preservation under anoxic conditions is not always the dominant factor leading to TOC accumulation. For example, at EOG 08-20 in TST1, TOC content averaged 4.06 wt% despite redox conditions characterized as oxic by relatively low Fe/S ratios and with low trace element ratios (Tables 17 and 18). At the Encana 11-04 location in RST1, average TOC content is 1.64 wt% and the redox conditions are indicated to be anoxic whereas in RST3, conditions are indicated to be oxic to dysoxic and have a TOC content of 1.54 wt % which is only slightly lower than in RST1. Relatively high TOC contents are also found at locations in intervals deposited in redox conditions characterized as oxic to marginally oxic to dysoxic (Tables 17 and 18): in RST1 at EOG 08-20 (in addition to TST1 example above); at Encana 11-04 in TST2 (higher TOC than RST2 which has an anoxic assignment); at Guidex 09-06 in TST1 and TST3). These results suggest that while deposition under anoxic conditions enhances organic matter accumulation, redox conditions may not be the dominant control in all cases (see section 5.8.2 for further discussion).

RST3	2.06 Biogenic Multiple Oxic-Marginally Oxic	49-13-13 0.14 : 185 1.47 : 1.07 24	2.58 Biogenic Multiple Marginally Oxic-Anoxic	56-06-15 0.06 : 268 4.63 : 1.95 54	1.54 Mixed Single Oxic-Dysoxic	41-11-19 0.10 : 171 0.81 : 0.67 18	ND	ND	1.27 Detrital Multiple Oxic-Anoxic	11-03-45 0.14 : 213 1.37 : 2.76 30
TST3	2.30 Biogenic Multiple Marginally Oxic-Dys Brdr	42-09-21 0.11 : 232 3.84 : 2.87 32	2.83 Mixed Multiple Marginally Oxic-Anoxic	49-09-17 0.09 : 205 2.09 : 1.27 38	2.08 Mixed Single Oxic-Dysoxic	44-12-16 0.14 : 175 0.74 : 0.65 19	0.33 Detrital Multiple Anoxic	03-0.6-53 0.11 : 248 1.57 : 3.78 50	1.72 Mixed Single Oxic-Euxinic	15-04-40 0.15 : 208 1.54 : 2.59 28
RST2	3.32 Biogenic Multiple Dysoxic-Anoxic	41-11-18 0.12 : 224 4.90 : 4.61 47	2.87 Biogenic Multiple Dysoxic	53-08-17 0.08 : 197 2.38 : 1.47 30	3.09 Biogenic Single Marginally Oxic-Anoxic	46-10-17 0.11 : 176 2.48 : 1.37 27	1.19 Detrital Multiple Anoxic	09-02-48 0.11 : 360 1.37 : 3.35 28	1.17 Mixed Single Oxic-Marginally Oxic, Anoxic	19-06-37 0.17 : 165 0.59 : 1.24 17
TST2	3.83 Biogenic Single Anoxic	40-08-22 0.11 : 178 4.62 : 2.54 43	2.76 Mixed Multiple Marginally Oxic-Anoxic	49-09-16 0.10 : 223 3.45 : 1.71 28	3.48 Mixed Single Marginally Oxic-Dysoxic	52-06-17 0.07 : 212 3.87 : 1.94 47	1.73 Detrital Multiple Anoxic	17-04-41 0.12 : 330 0.45 : 1.79 21	1.52 Mixed Single Marginally Oxic/ Dysoxic	16-04-38 0.14 : 178 0.87 : 1.75 22
RST1	4.10 Mixed Multiple Dysoxic-Anoxic	43-10-17 0.12 : 212 3.66 : 2.48 31	1.01 Mixed Single Marginally Oxic-Dysoxic	29-08-31 0.13 : 158 0.57 : 0.67 17	1.64 Mixed Single Anoxic	32-06-31 0.10 : 175 1.00 : 1.11 23	3.56 Detrital Multiple Anoxic	20-05-37 0.13 : 296 0.89 : 1.41 20	2.58 Mixed Single Marginally Oxic-Dysoxic	26-08-30 0.16 : 187 1.21 : 1.22 18
TST1	2.90 Mixed Single Oxic-Dysoxic	43-12-16 0.15 : 177 0.69 : 0.62 14	2.40 Mixed Single Marginally Oxic-Dysoxic	43-10-18 0.12 : 156 1.13 : 1.02 21	2.85 Mixed Single Anoxic	32-05-31 0.08 : 179 2.53 : 1.62 37	5.43 Mixed Multiple Dysoxic-Anoxic	33-06-26 0.10 : 271 2.19 : 1.38 19	4.06 Detrital Single Oxic	10-03-44 0.10 : 271 0.39 : 1.16 12

Table 17. Summary of interpreted silica source, source terranes and redox conditions juxtaposed with values of key geochemical indicators. Wells are colour coded: GuideX 09-06 (purple), Shell 02-22 (teal), EnCana 11-04 (orange), Esso 16-28 (green) and EOG 08-20 (blue).

Organic Matter	**TOC (wt%)**
Major Oxides	**SiO_2-$Al2O_3$-Ca+MgO (%)**
Index Ratios	**Al/SiO_2 : Zr/Ti**
Trace Elements	**Mo/Al : U/Al**
	V/Al (ppm/%)

RST3	Mo/Al 1.47 U/Al 1.07 V/Al: 24 Oxic-Marginally Oxic	4.63 : 1.95 54 Marginally Oxic-Anoxic	0.81 : 0.67 18 Oxic-Dysoxic	ND	1.37 : 2.76 30 Oxic-Anoxic
TST3	3.84 : 2.87 32 Marginally Oxic-Dys Border	2.09 : 1.27 38 Marginally Oxic-Anoxic	0.74 : 0.65 19 Oxic-Dysoxic	1.57 : 3.78 50 Anoxic	1.54 : 2.59 28 Oxic-Euxinic
RST2	4.90 : 4.61 47 Dysoxic-Anoxic	2.38 : 1.47 30 Dysoxic	2.48 : 1.37 27 Marginally Oxic-Anoxic	1.37 : 3.35 28 Anoxic	0.59 : 1.24 17 Oxic-Marginally Oxic, Anoxic
TST2	4.62 : 2.54 43 Anoxic	3.45 : 1.71 28 Marginally Oxic-Anoxic	3.87 : 1.94 47 Marginally Oxic-Dysoxic	0.45 : 1.79 21 Anoxic	0.87 : 1.75 22 Marginally Oxic/Dysoxic
RST1	3.66 : 2.48 31 Dysoxic-Anoxic	0.57 : 0.67 17 Marginally Oxic-Dysoxic	1.00 : 1.11 23 Anoxic	0.89 : 1.41 20 Anoxic	1.21 : 1.22 18 Marginally Oxic-Dysoxic
TST1	0.69 : 0.62 14 Oxic-Dysoxic	1.13 : 1.02 21 Marginally Oxic- Dysoxic	2.53 : 1.62 37 Anoxic	2.19 : 1.38 19 Dysoxic-Anoxic	0.39 : 1.16 12 Oxic

Table 18. Summary of the comparison between trace element values and redox assignments based on C-Fe-S ternary diagrams.

Trace Elements	Mo/Al : U/Al V/Al (ppm/%)

5.7 Variation of Geochemical Proxies within the Context of Basin Evolution

This study explored controls on redox conditions, clay enhanced organic matter preservation and sediment sources during evolution of the basin. Two variables that drive the system are mixing of the water column and sea level. Low sea level leads to: 1) shallower water, which allows oxygen to be mixed from surface water to the sea bed over larger areas of the basin, 2) isolation of parts of the basin that are prone to restriction, possibly with less circulation of oxygenated water or nutrient-rich water and 3) increased flux of non-biogenic clastics and potentially carbonate sediments (in the event of reef shedding during highstands or undercutting during lowstands). Higher sea level causes: 1) deeper water columns, which may, in addition to water column stratification, lead to low oxygen conditions at the sea bed over larger areas of the basin, 2) more open communication to parts of the basin that might otherwise be restricted and enhanced circulation of oxygenated water or nutrient-rich water, and 3) sediment trapping in the nearshore during transgressions and forces sources of sediments to back step. Figures 82 and 83 overlay the sedimentological and stratigraphic model with the interpreted geochemical indicators and Tables 16 and 19 summarize sediment sources in each interval respectively and the inferences from the geochemical and sedimentological models respectively. In the following paragraphs, Cycles 1, 2 and 3 are considered in succession.

The TST1-RST1 cycle (Figure 82, Tables 16 and 19) is characterized by platform building, westward thinning of strata, and evidence from sedimentology for a strong eastern source and contourites transported from the north (Knapp 2016). The significance of biogenic silica in the WSB and detrital silica in the ESB (with minor biogenic influence) is interpreted to be the result of isolation of the ESB. This suggests that contour currents, entering the WSB from the north (Knapp, 2016), brought nutrients in addition to clastic sediments, providing a driver for

biogenic productivity in the WSB. Because the ESB is isolated from the WSB by the mostly continuous Rimbey Meadowbrook Trend, these nutrient-rich currents affect the ESB less. Instead, the ESB is influenced almost exclusively by detrital silica from the NE (craton). WSB wells and ESB wells generally have similar relatively dysoxic redox conditions. The exception is Encana 11-04 in the WSB, which an anoxic signature interpreted to be the result of its location, isolated by reefs surrounding the Wild River sub-basin, and consequent lack of circulation.

The TST2-RST2 cycle (Figure 82, center and Tables 16 and 19) is characterized by the strongest transgression during Duvernay deposition, development of a flooded Grosmont platform, and backstepping of the clinoforms, the development of a potential pathway for sediment bypass across the Grosmont Platform, the buildup of sediments from the north along the RMT, and a reduction in craton input (Knapp 2016). The WSB shows significant influence of biogenic silica in TST2-RST2, whereas the ESB continued to be dominated by detrital silica with minor biogenic influence. Sources of sediment were similar to the previous cycle (northern source or PRA in the WSB and craton source with minor influence of northern source in the ESB), except in Shell 02-22. Shell 02-22 shows the influence of multiple sources. Guidex 09-06 and Esso 16-28 also show multiple source signatures in this interval, which is interpreted to be the result of minor input of contourites (northern source) to these parts of the basin in addition to increased input from the PRA. Esso 16-28 may have received increased input from the northern source in addition to the craton source, as there is potential for sediment bypass over the edge of the Grosmont Platform aided by a backstepping of the contourite clinoforms.

The TST3-RST3 cycle (Figures 83, Tables 16 and 19) is characterized by the thickening of sediments originating from the north along the RMT, continued buildup of the RMT itself and

a westward thickening wedge due to material from the PRA (Knapp, 2016). The WSB remained largely influenced by biogenic silica and the ESB by detrital silica. Sources of sediment were generally similar to the TST2-RST2 cycle indicating inputs remained static from cycle 1 to cycle 2. Redox conditions TST3-RST3 cycle were also relatively consistent with cycle 2, with the exceptions that Encana 11-04 became slightly more oxic, apparently because the basin shallowed significantly in this location, and EOG 08-20 has the notable euxinic signal in the TST. The latter is interpreted to be the result of water column stratification and enhanced organic matter degradation via sulphate reduction (where organic matter supply does not exhaust sulphate supplies) during the highstand resulting in lower oxygen conditions at the sediment-water interface. The EOG 08-20 is located in a narrow embayment that tapers southwards, suggesting that currents would not circulate well in this location.

Inferences from silica source indicators	Inferences from source terrane indicators	Inferences from redox indicators	Sedimentological/Stratigraphic Context for Basin Evolution
-WSB and ESB differentiated. - WSB is dominated by mixed silica sources strong biogenic influence -ESB wells display a mixed signal with a strong detrital influence.	-All but one well (EnCana 11-04) shows at least some influence of multiple sources in this cycle although it is very minor in EOG 08-20 and no data were available from Esso 16-28	-WSB and ESB redox conditions dominantly Oxic-dysoxic with no clear distinction between sub-basins - notable occurrence of some potential euxinia in the EOG 08-20 well, all from the TST	TST3-RST3 -Highstand -Contourites continue to build along the -Rimbey Meadowbrook trend, this barrier continues to build up -Westward thickening (W source more active)
-the strong biogenic influence in WSB, only a hint in the ESB -ESB strong detrital silica influence	-no WSB ESB distinction but northernmost wells in each sub-basin and Shell 02-22 in WSB show multiple source terrane influence (stronger in Esso 16-28 than GuideX 09-06)	-WSB and ESB redox conditions dominantly Oxic-dysoxic with no clear distinction between sub-basins -Each wells extreme became less oxic overall except for 11-04 which be-came slightly more oxic	TST2-RST2 -Flood Platform Phse in WSB, Backstepping in ESB -Strongest transgression in this interval -Contourites build up along the Rimbey Meadowbrook Trend, -RMT itself builds up
-the strong biogenic influence in WSB, only a hint in the ESB -ESB strong detrital silica influence	-no WSB ESB distinction but northernmost wells in each sub-basin show multiple source terrane influence (stronger in Esso 16-28 than GuideX 09-06)	-Despite Esso being very bioturbated redox indicators suggest low oxygen levels -WSB and ESB redox conditions dominantly Oxic-dysoxic with no clear distinction between sub-basins -Isolated well location shows a less oxic signature	TST1-RST1 -Platform Building Phase -Westward Thinning (E source more active) -End of interval is top of the Duvernay carbonate -Silica rich interval -Evidence for strong Eastern source GuideX and EnCana relatively shallower than Shell

Table 19. Summary of inferences from geochemical proxies (columns 1-3) and sedimentology and stratigraphy (column 4)

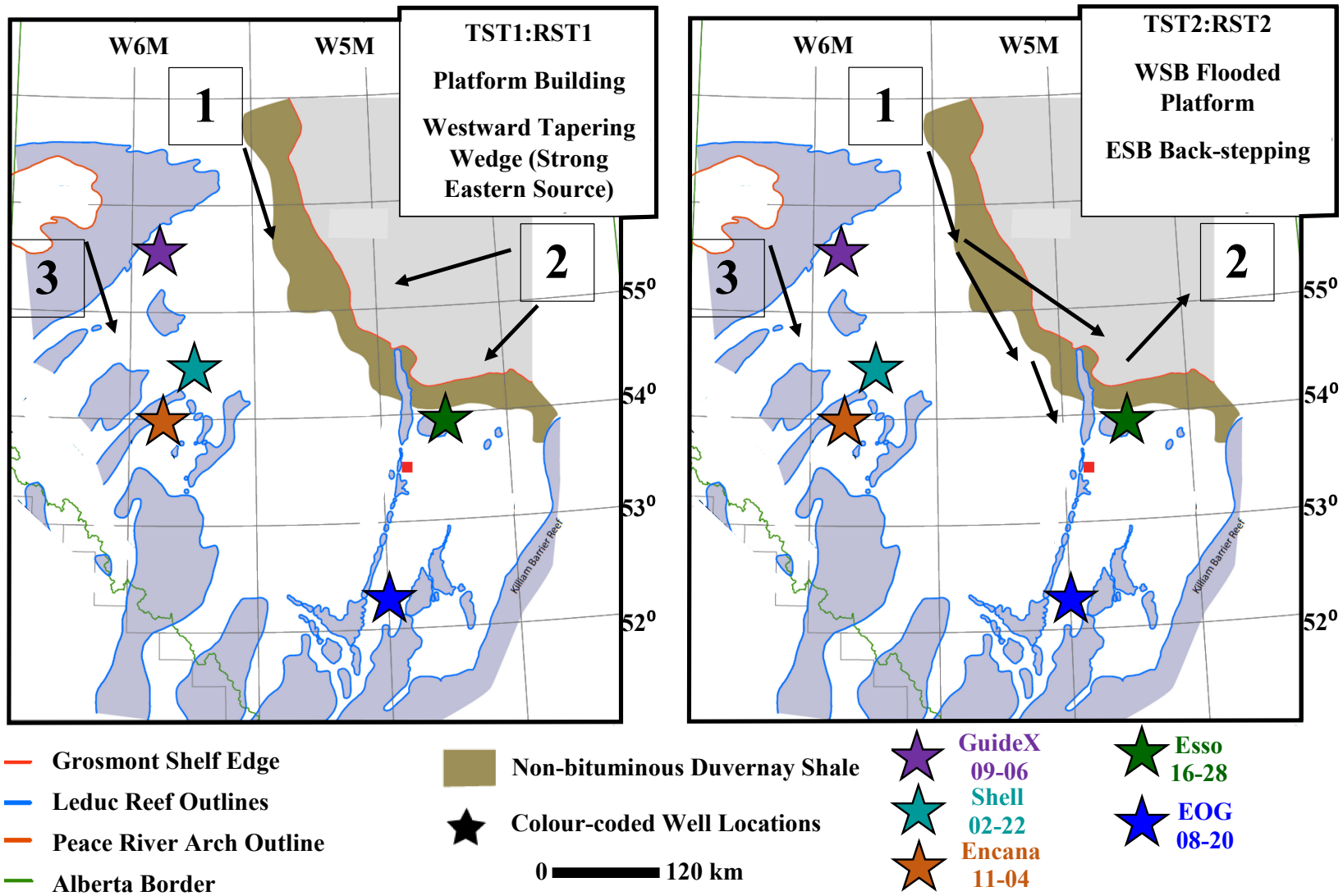


Figure 82. Summary of basin evolution stages overlain on base map with well locations for TST1-RST1 and TST2-RST2.

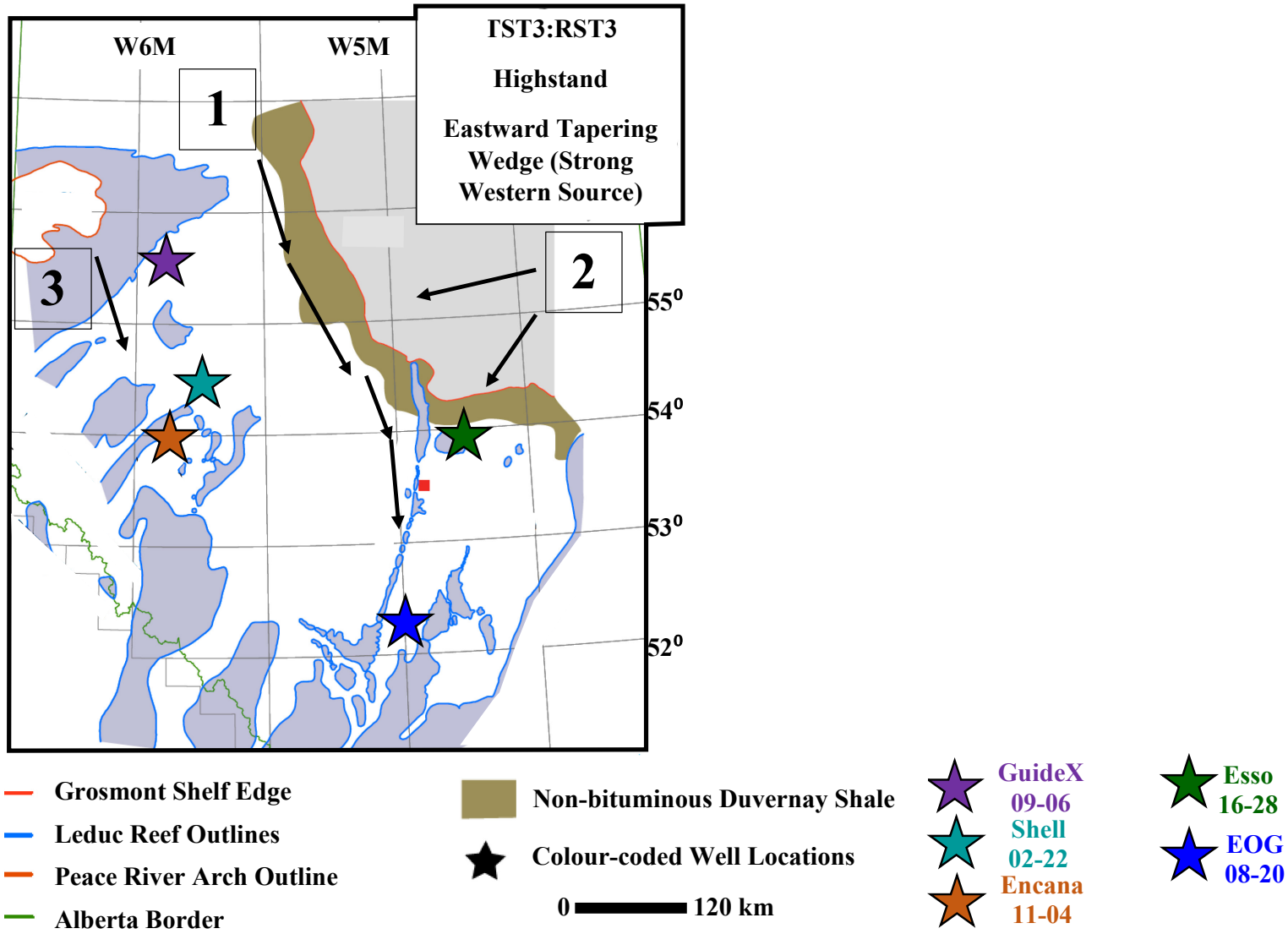


Figure 83. Summary of basin evolution stages overlain on base map with well locations for TST3-RST3.

5.8 Controls on TOC Accumulation

Numerous case studies of source rocks identify specific key processes involved in organic matter accumulation, including studies of formations of the same age as the Duvernay Formation. TOC accumulations in the Duvernay are governed by the interplay between a combination of productivity, preservation, and dilution controls. The majority of the examples from Section 5.8.1 focus on productivity and preservation, whereas this study also includes a focus on dilution. Some models invoke upwelling events as a means of disrupting an otherwise stratified water column leading to higher productivity (Suzuki et al. 1998, Prauss 2015). Most studies agree that productivity and therefore organic flux has a dominant control on TOC accumulations (Algeo et al. 2011, Suzuki et al. 1998, Bertrand et al. 1993, Kennedy et al. 2014, Betts and Holland 1991, Tyson 2001, Xu et al. 2015) and also dictates redox conditions, as degradation of organic matter removes oxygen from the water column. Preservation of TOC is interpreted to be controlled by varying intensity of sulphate reduction or methanogenesis (Bertrand et al. 1993), although oxygen content in the water column is not always considered to be a primary control on organic matter accumulations (Bertrand et al. 1994, Betts and Holland 1991, Tyson 2001). Clastic dilution is often considered a lesser control (Algeo et al. 2011, Chen et al. 2015) although autodilution may have a significant impact on TOC accumulations (Tyson 2001, Bohacs et al. 2005). However, the presence of clays, previously thought to have an exclusively diluting effect, may in fact enhance organic matter preservation (Tyson 2001). While many studies provide information on productivity and preservation controls on TOC accumulations and or exclude a focus on dilution, this study includes a focus on dilution and explores how the dominance of all three controls vary in concert geographically and stratigraphically.

The Duvernay data set in this study allows the exploration of the permutations and combinations of these three variables and how they interacted to produce organic matter accumulations. This study shows that TOC accumulations were controlled by redox enhanced preservation, dilution and possibly clay enhanced preservation. However, the correlation between TOC and Al could be due two three possibilities: 1) carbonate is the diluting agent; 2) a slightly increased sedimentation rate isolates the organic matter from the water column (see Tyson 2005); 3) clay-armoring (Kennedy et al. 2014). Redox proxy results suggest that while preservation under anoxic conditions enhances organic matter accumulation, it may not be the dominant control in all cases (Section 5.6.2). This and previous studies agree that the controls on organic matter accumulations vary geographically and stratigraphically in response to changes in paleodepositional environment.

5.8.1 Insights from Ancient and Modern Organic Rich Mudstones from Around the World

Many studies have focused on determining the controls on organic matter accumulations (Klemme and Ulmishek 1991, Creaney and Passey1995, Arthur and Sageman 1994, Demaison and Moore 1980, Pedersen and Calvert 1990, Chow and Stasiuk 1995, Ingall et al. 1993). Redox controls are one factor affecting organic matter accumulation (Demaison and Moore 1980, Ingall et al. 1993). However, productivity can also control the accumulation of organic matter in addition to preservation (Pedersen and Calvert 1990, Chow and Stasiuk 1995, Arthur and Sageman 1994). A third factor, dilution, must also be considered, as source rocks can result from any combination of these three variables (production, destruction, dilution) (Bohacs et al. 2005). Sea level also plays a role in determining which variables interact in order to produce

TOC accumulations within the context of stratigraphy (Klemme and Ulmishek 1980, Arthur and Sageman 2005, Creaney and Passey 1993). Various studies of ancient and modern systems have attempted to determine the controls on TOC accumulations in specific formations in order to create depositional models. The following is an exploration of several examples in order to assess if the same or similar conditions lead to organic matter accumulations in the Duvernay Formation.

The Late Permian to Early Triassic Ubara and Gujo-Hachiman sections of central Japan both show a shift from organic-poor to organic-rich cherts and siliceous mudstones coincident with increased primary productivity and increased euxinia in the OMZ (Algeo et al. 2011). However, the relative importance of productivity, dilution and redox conditions to the resultant TOC accumulation varied slightly between these two sections: the Ubara section was characterized by more dilution (proximal to clastic source), high productivity resulting in anoxic to euxinic conditions in an oxygen minimum zone (OMZ) and suboxic to weakly anoxic conditions at the seafloor; the Gujo-Hachiman section was characterized by less dilution (relatively distal with respect to clastic source), moderate levels of productivity (insufficient to result in euxinia) resulting in suboxic bottom waters (Algeo et al. 2011). In this example productivity appeared to be the main driver of redox conditions and dilution was a secondary control on TOC accumulations.

Organic matter accumulations in the Permian to Triassic Tanba and Chichibu Belts in Southwest Japan were found to shift from organic-poor in the Permian to organic-rich in the Triassic (Suzuki et al. 1998). The Permian was characterized by a stratified ocean with a well-developed OMZ rich in nutrients, whereas the Triassic was affected by periodic upwelling events

that resulted in high productivity (organic matter of planktonic and bacterial origin) and transport of dissolved oxygen creating oxic to suboxic bottom water conditions (Suzuki et al. 1998).

The Upper Turonian to Coniacian to Lower Santonian in Morocco is characterized by increasing TOC contents upwards coincident with dinoflagelate cyst assemblages associated with upwelling events (Prauss 2015). Across the Turonian-Santonian transition, the dominant control on TOC accumulation shifts from preservation under a stratified water column to production during upwelling events (Prauss 2015).

TOC accumulations in the Kimmeridge Clay Formation of the United Kingdom were dominantly controlled by organic matter supply (linked to primary productivity) and secondarily controlled by preservation (itself controlled by sulphate reduction) (Bertrand et al. 1993). Organic matter rich samples were found to have been deposited under an oxygenated water column although the redox boundary fluctuated in response to primary productivity, moving above and below the sediment-water interface in response to organic matter flux (Bertrand et al. 1993). The preservation of organic matter had slightly different controls depending on TOC content: a TOC content of 10% was found to be a threshold, at which the flux of organic matter and intensity of sulphate reduction equally controlled the burial of organic matter; TOC contents between 2-10% were associated with sulphate reduction controlled preservation (sulphate reduction under dysaerobic conditions); TOC contents above 10% were associated with a decrease in sulphate reduction due to lack of sulphate and a shift to methanogenesis (Bertrand et al. 1993). By modeling the Kimmeridge Clay as a short-term, productivity-controlled, cyclic organic-rich interval deposited during persistently anoxic bottom waters, it was found that increased organic matter accumulation was not necessarily related to enhanced preservation of

organic matter flux if increased degradation was coincident, even in the absence of dilution effects (Bertrand et al. 1994).

A new study of the Woodford Shale suggests that in addition to productivity and bottom-water oxygenation, interaction between high surface area clay particle and organic matter lead to enhanced organic matter preservation (Kennedy et al. 2014). In this model, continental weathering (controlled by climate) and provenance dictate the preservation potential of clays. The findings of this study suggest that TOC accumulations in the Woodford Shale, previously considered to be the result of high productivity and anoxic conditions (Kennedy et al. 2014), are also controlled by clay-mediated preservation (Kennedy et al. 2014). An important insight is that clays may not always act to dilute organic matter and may in fact enhance preservation.

The Devonian Marcellus Shale of the Appalachian Basin exhibited differences in the conditions of deposition at two well locations: a) a more distal location with more marine organic matter and dominantly anoxic conditions and b) a more proximal location with higher clastic input, higher terrestrial organic matter input and higher dissolved oxygen content (Chen et al. 2015). Variation in the organic matter type in liquids-prone versus gas-prone locations in the Marcellus was previously attributed to burial depth and maturity, however, depositional environment and sedimentary facies appear to have played a significant role as well (Chen et al. 2015).

The Pliensbachian (Early Jurassic) Lustianian Basin was characterized by black shale deposition coincident with suboxic to anoxic conditions and periodic euxinia in the lower water column as a result depositional conditions affected by sustained restriction (Silva and Duarte 2015). Organic-rich intervals were associated with periodic warming events coincident with

epieric seas that promoted short-lived, basin-wide development of algal blooms and microbial mats due to mixing of the water column and enhanced preservation of organic matter in anoxic sediments (Silva and Duarte 2015).

Betts and Holland (1991) explored the controls on TOC accumulation at 69 modern locations and found that sedimentation rate (SR) exerted a dominant control on burial efficiency (BE). After the effect of SR was removed, there was a weak correlation with large scatter between TOC accumulation and oxygen content suggesting the effect of oxygen content had a negligible or minor control on the BE of organic matter (Betts and Holland 1991). Tyson (2001) carried out a modeling exercise on the same dataset used by Betts and Holland (1991) in order to evaluate the positive (preservational) and negative (dilution) effects of SR on TOC accumulations. The findings indicated that the role of dissolved oxygen likely depended on SR regime: in high SR regimes, (i. e. Pedersen and Calvert 1990) TOC appears to be independent of oxygen content; in low SR regimes (i. e. "condensed sections"), TOC was critically dependent on BE and somewhat dependent on oxygen content (a function of circulation and bottom water volume) (Tyson 2001). Autodilution was observed to have an effect where high plankton productivity results in a biogenic opal "dilution penalty" limiting TOC to less than 8% generally: the very high TOC values seen in some ancient black shales, even when productivity is relatively low, could be the result of bottom water anoxia under a stratified water column accompanied by low SR and low autodilution (Tyson 2001). The dominance of preservation as a control on TOC accumulation varied with respect to SR: when SR<= 5cm/Ka, preservation effects of SR only enhanced TOC in oxic regimes, after which dilution occurs if carbon supply is held constant; when SR>35 cm/Ka there was no difference in TOC regardless of the oxygen regime at the sea floor; however, once nonlinear effects were taken into account, predicted TOC contents were 2-4

times higher in anoxic facies versus oxic facies indicating redox conditions may be a significant variable (Tyson 2001).

The Duvernay Formation seems to be most similar to the Devonian Woodford Shale of the Permian Basin in that they are both marginal basins. Being located on the coast of a passive margin may be an important factor controlling TOC accumulations in epeiric seas. The Duvernay Formation also shows similarities when compared to the Permian to Triassic Tanba, and Chichibu Belts in Southwest Japan all of which may experience periodic upwelling events suggesting that periodic upwelling events may also play a role in TOC accumulation.

5.8.2 Insights into Controls on TOC Accumulation in the Duvernay Formation

With respect to SiO_2- Zr relationships, instances of high TOC lack a predictable pattern when compared to Al, suggesting dilution is not always the dominant controlling factor (Figure 54). The relationship between TOC and key geochemical indicators was further clarified by examining relationships between TOC, Al, Mo/Al, Fe/S, and Zr/TiO_2, through a series of cross plots, excluding intervals that did not have sufficient data to be statistically significant. R^2 values for these bivariate relationships vary by well and by interval (Tables 11, 13 and 15), suggesting that TOC accumulation in the Duvernay was governed to varying degrees by each control (Figures 57-71 and Tables 10-15). Strength of agreement (Tables 11, 13 and 15) was used in order to determine the dominance of each control on TOC accumulation (Table 20). The dominant control was taken to be the variable that had the highest R^2 value. Secondary controls were taken to be the variables with the next highest R^2 value and so on (Table 20).

A redox -enhanced preservation control on TOC accumulation was interpreted where TOC exhibited a strong agreement with Fe/S or Mo/Al. In general, instances of higher TOC were associated with lower Fe/S ratios and higher Mo/Al ratios and (Figures 57-71, Tables 11, 13 and 15). A possible nutrient delivery or productivity control was interpreted when TOC showed strong agreement with Zr/TiO_2 ratios. In this study, the effectiveness of using the Zr/TiO_2 ratio was used to identify differences in source terrane. These elements are both products of clastic input, so the ratio of these two elements is not a measure of clastic flux. Assuming, Zr/TiO_2 does provide significant information about provenance, sediment sourced from one provenance may be associated with a higher rate of nutrient delivery than sediment sourced from another provenance. However, lacking strong evidence for a nutrient or productivity control on TOC, this is speculation.

Instances of good agreement between TOC and Zr/TiO_2 were generally characterized by a strong negative relationship between TOC and Zr/TiO_2 (Figures 57-71, Tables 11, 13 and 15). Where the slope was not negative there was a lack of correlation (Figures 57-71, Tables 11, 13 and 15). This is interpreted to indicate that TOC is possibly controlled by a nutrient delivery or productivity control. A possible clay-enhanced preservation control was interpreted where TOC showed a good agreement with Al. However, the correlation between TOC and Al suggests three possibilities: 1) carbonate is the diluting agent; 2) a slightly increased sedimentation rate isolates the organic matter from the water column (Tyson 2005); 3) clay-armoring (Kennedy et al. 2014). Instances of good agreement between TOC and Al are characterized by positive slopes indicating that the Al (proxy for clay) may be enhancing TOC preservation rather the diluting the organic matter (Figures 57-71, Tables 11, 13 and 15). This interpretation agrees with observations made in the Woodford Shale by Kennedy et al. (2014) although dilution by

carbonate material and sedimentation rate cannot be excluded as possible causes of the positive correlation. A summary of the assigned ranking of controls for each well and interval is shown in Table 20.

In TST1 (Table 20), the dominant control varies by well and there is no obvious distinction between the WSB and ESB. At the Guidex 09-06 well location, TOC accumulation is controlled by redox-enhanced preservation. At the Encana 11-04 well location, TOC accumulation is possibly controlled by nutrient delivery or productivity. At the Esso 16-28 well location, TOC accumulation may be primarily controlled by clay-enhanced preservation (although increased sedimentation rate or dilution by carbonate material cannot be ruled out), secondarily controlled by redox enhanced preservation and thirdly controlled by nutrient delivery or productivity. In RST1, the dominant control varies by well, and there is no obvious distinction between the WSB and ESB. In this interval, TOC accumulations were possibly controlled by: nutrient delivery or productivity at the Guidex 09-06, Encana 11-04 and EOG 08-20 well locations. At the Shell 02-22 well location TOC accumulations were controlled by redox enhanced preservation. At the Esso 16-28 well location, TOC accumulations were possibly controlled by clay-enhanced preservation.

In TST2 (Tables 20), data were only statistically significant for Shell 02-22 and Encana 11-04. The dominant control varied between wells. TOC accumulations at Shell 02-22 were driven by redox enhanced preservation. TOC accumulations at Encana 11-04 were primarily driven by redox-enhanced preservation, secondarily by possible nutrient delivery or productivity controls and thirdly by possible clay-enhanced preservation. In RST2, the dominant control varies by well, and there is no obvious distinction between the WSB and ESB. TOC accumulations at Guidex 09-06 were primarily driven by a possible nutrient delivery or

productivity control, secondarily by a possible clay-enhanced preservation and thirdly by redox-enhanced preservation. TOC accumulations at Esso 16-28 were possibly driven by clay-enhanced preservation. TOC accumulations at EOG 08-20 were driven by redox-enhanced preservation.

In TST3 (Table 20), data was only statistically significant for Encana 11-04, where TOC accumulations were controlled by redox-enhanced preservation. In RST3, data was only statistically significant for the three WSB wells. Redox-enhanced preservation was the dominant control on TOC accumulations at Guidex 09-06 and Encana 11-04. At Shell 02-22, the dominant control on TOC accumulations was controlled by a possible nutrient delivery or productivity control.

A summary of scatter plot matrices used in addition to the above cross plots can be found in Appendix I. A summary table of insights from various black shale examples can be found in Appendix J. Examples of additional data collection can be found in Appendices A, K-P.

	GuideX 09-06	Shell 02-22	Encana 11-04	Esso 16-28	EOG 08-20
RST3	Redox Enhanced Preservation	Possible Nutrient Delivery/Productivity	Redox Enhanced Preservation		
TST3			Redox Enhanced Preservation		
RST2	Possible Nutrient Delivery/Productivity Possible Clay Preservation Redox Enhanced Preservation			Possible Clay Enhanced Preservation	Redox Enhanced Preservation
TST2		Redox Enhanced Preservation	Redox Enhanced Preservation Possible Nutrient Delivery/Productivity Possible Clay Preservation		
RST1	Possible Nutrient Delivery/Productivity	Redox Enhanced Preservation	Possible Nutrient Delivery/Productivity	Possible Clay Enhanced Preservation	Possible Nutrient Delivery/Productivity
TST1	Redox Enhanced Preservation		Possible Nutrient Delivery/Productivity	Possible Clay Preservation Redox Enhanced Preservation Possible Nutrient Delivery/Productivity	

Table 20. Summary of possible dominant controls on TOC accumulations at each well in each cycle. Dominance of controls indicated as listed order from top down

6. Conclusions

1. In the Duvernay Formation, average TOC contents are higher in TSTs than in RSTs. This result is consistent with other black shales around the world and confirms that the link between high TOC and transgressive seas applies in the Duvernay Formation as well.

2. TOC accumulation in the Duvernay Formation was observed to vary in response to preservation and dilution controls. Dominant controls on TOC accumulation varied by well and by interval. This result implies that geochemical heterogeneity in organic rich mudstones at the small scale is a contributing factor to geographic and stratigraphic variability. Due to the geochemical variability noted in the Duvernay Formation, caution should be exercised when predicting TOC content away from well control on the basis of any one geochemical proxy alone.

3. Controls on TOC accumulations in the Duvernay Formation varied stratigraphically and geographically. Controls on TOC accumulation included redox-enhanced preservation, clay-enhanced preservation and dilution. Redox enhanced preservation frequently played a role in the WSB.

4. In the Duvernay Formation, mudstone composition is influenced by silica and carbonate inputs: bulk mineralogy proxies indicate that the WSB is a silica-dominated system and the ESB

is a carbonate-dominated system. However, locations proximal to reefs in the WSB show increased influence of carbonate material.

5. In the Duvernay Formation, silica is derived from both biogenic and detrital sources in both sub-basins. The WSB has a higher biogenic silica content than the ESB. This implies that productivity may play a role in TOC accumulations in the Duvernay and that SiO_2-Zr cross plots may be applicable for determining silica source in other black shales.

6. In the Duvernay Formation, the existence of multiple source terranes is inferred from Zr/TiO_2 ratios. The influence of the sources varies geographically: wells in locations proximal to land show multiple source terrane influences and wells in physically restricted or distal locations exhibit a single source terrane signal. Sources identified were: PRA, craton and northern. Possible variation in composition within one source terrane cannot be excluded as a factor affecting the signal. This result implies that sediment sources may be traceable using this method in other black shales as well.

7. In the Duvernay Formation, C-Fe-S redox indicators suggest that conditions were generally marginally oxic to dysoxic with common anoxia, only reaching oxic and euxinic conditions occasionally. Relatively high TOC contents were not exclusive to anoxic conditions and instead were often associated with marginally oxic to dysoxic conditions. This result implies that

moderate TOC accumulations may occur in this and other black shales, even when redox conditions are not exclusively anoxic.

8. In the Duvernay Formation, geographic position was observed to affect the redox state of bottom waters; restricted locations were characterized by less oxic conditions. Locations such as in inlets, embayments or reef-circled tend to be restricted. Relatively open locations with better connection to the open ocean were less restricted. This result implies that redox conditions can be predicted away from well control on the basis of geographic position in this and other black shales.

References

Acme Analytical Laboratories, 2013. http://acmelab.com/pdfs/Acme_Proce_Brochure.pdf (downloaded July 18 2013).

Algeo, T. J., Rowe, H., "Elemental Proxies for Hydrographic Conditions in Restricted Marine Systems." Abstracts with Programs - Geological Society of America 38.7 (2006): 478.

Algeo, T. J., Lyons, T. W., Blakey, R. C., Over, D. J., "Hydrographic Conditions of the Devono-Carboniferous North American Seaway Inferred from Sedimentary Mo-TOC Relationships." Palaeogeography, Palaeoclimatology, Palaeoecology 256.3-4 (2007): 204–230.

Algeo, T. J., Ingall, E., "Sedimentary Corg: P Ratios, Paleocean Ventilation, and Phanerozoic Atmospheric pO2." Palaeogeography, Palaeoclimatology, Palaeoecology 256.3–4 (2007): 130–155.

Algeo, T. J., Lyons, T. W., "Mo-total Organic Carbon Covariation in Modern Anoxic Marine Environments; Implications for Analysis of Paleoredox and Paleohydrographic Conditions." Paleoceanography 21.1 (2006): 23.

Algeo, T. J., Maynard, J. B., "Trace-element Behavior and Redox Facies in Core Shales of Upper Pennsylvanian Kansas-type Cyclothems." Ed. Richard B. Schultz. Chemical Geology 206.3-4 (2004): 289–318.

Algeo, T. J., Maynard, J. B. "Trace-metal Covariation as a Guide to Water-mass Conditions in Ancient Anoxic Marine Environments." Geosphere 4.5 (2008): 872–887.

Algeo, T. J., Rowe, H., "Paleoceanographic Applications of Trace-metal Concentration Data." Chemical Geology 324–325 (2012): 6–18.

Algeo, T. J., Kuwahara, K., Sano, H., Bates, S., Lyons, T., Elswick, E., Hinnov, L., Ellwood, B., Moser, J., Maynard, J. B., "Spatial variation in sediment fluxes, redox conditions and productivity in the Permian-Triassic Panthalassic Ocean." Palaeogeography, Palaeoclimatology, Palaeoecology (2011): 65-83.

Alpin, A. C., Macquaker, J. H. S., "Mudstone Diversity; Origin and Implications for Source, Seal, an Reservoir Properties in Petroleum Systems." AAPG Bulletin 95.12 (2011): 2031–2059.

Aplin, A. C., Macquaker, J. H. S., "C-S-Fe Geochemistry of Some Modern and Ancient Anoxic Marine Muds and Mudstones." Ed. M. L. Coleman. Philosophical Transactions - Royal Society of London, Physical Sciences and Engineering 344.1670 (1993): 89–100.

Arthur, M. A., Sageman, B. B., "Marine Black Shales; Depositional Mechanisms and Environments of Ancient Deposits." Annual Review of Earth and Planetary Sciences 22 (1994): 499–551.

Arthur, M. A., Sageman, B.B., “Sea-level Control on Source-rock Development; Perspectives from the Holocene Black Sea, the Mid-Cretaceous Western Interior Basin of North America, and the Late Devonian Appalachian Basin.” Ed. Nicholas B. Harris. Special Publication - Society for Sedimentary Geology 82 (2005): 35–59.

Atlas of the Western Canadian Sedimentary Basin (AWCB). Accessed 2015. http://www.ags.gov.ab.ca/publications/wcsb_atlas/atlas.html

Barbera, G., Giudice, A. L., Mazzoleni, P., Pappalardo, A., “Combined Statistical and Petrological Analysis of Provenance and Diagenetic History of Mudrocks: Application to Alpine Tethydes Shales (Sicily, Italy).” Sedimentary Geology 213.1–2 (2009): 27–40.

Barbera, G., Critelli, S., Mazzoleni, P., “Petrology and Geochemistry of Cretaceous Sedimentary Rocks of the Monte Soro Unit (Sicily, Italy); Constraints on Weathering, Diagenesis, and Provenance.” Journal of Geology 119.1 (2011): 51–68.

Bertrand, P., Lallier-Vergès, E., Huc , A. Y., Bückel, D., Tremblay, P., “Control of the preservation of organic matter by productivity and sulphate reduction in Kimmeridgian shales from Dorset (UK).” Marine Petroleum Geology V 10 (1993): 600-605.

Bertrand, P., Lallier-Verges, E., Boussafir, M., “Enhancement of accumulation and anoxic degradation of organic matter controlled by cyclic productivity: a model.” Organic Geochemistry V. 22, No. 3-5 (1994): 511-520)

Betts, J. N., Holland, H. D. “The oxygen content of ocean bottom waters, the burial efficiency of organic carbon, and the regulation of atmospheric oxygen.” Palaeogeography, Lalaeoclimatology, Palaeoecology (Global and Planetary Change Section) V. 97 (1991): 15-18.

Bhatia, M. R., Crook, K. A.W., "Trace element characteristics of graywackes and tectonic setting discrimination of sedimentary basins."Contributions to mineralogy and petrology 92, no. 2 (1986): 181-193.

Bohacs, K. M., Grabowski Jr., G. J., Carroll, A. R., Mankiewicz, P. J., Miskell-Gerhardt, K. J., Schwalback, J. R., Wegner, M. B., Simo, J. A., “Production, Destruction, and Dilution; the Many Paths to Source-rock Development.” Ed. Nicholas B. Harris. Special Publication - Society for Sedimentary Geology 82 (2005): 61–101.

Bohacs, K. M., Passey, Q. R., Rudnicki, M., Esch, W. L., Lazar, O. R. The Specturm of Fine-Grained reservoirs from ‘Shale Gas’ to ‘Shale Oil’/ Tight Liquids: Essential Attributes, Key Controls, Practical Characterization. International Petroleum Technology Conference (2013).

Brezinski, D. K. , Cecil, C. B., Skema, V. W., Stamm, R., “Late Devonian glacial deposits from the eastern United States signal an end of the mid-Paleozoic warm period.” Paleogeography, Paleoclimatology, Paleoecology 268 (2008): 143-151.

Calvert, S. E, and Pedersen, T. F., “Geochemistry of Recent Oxic and Anoxic Marine Sediments: Implications for the Geological Record.” Marine Geology 113.1–2 (1993): 67–88.

Cardott, B. J. “Determining the Thermal Maturity Level at Which Oil Can be Economically Produced in the Woodford Shale.” Woodford Oil Congress. Modified from AAPG Search and Discovery Article #40928 (2014).

Chalmers, G. R., R., Bustin, R. M. and Power, I. M., “Characterization of Gas Shale Pore Systems by Porosimetry, Pycnometry, Surface Area, and Field Emission Scanning Electron Microscopy/transmission Electron Microscopy Image Analyses; Examples from the Barnett, Woodford, Haynesville, Marcellus.” AAPG Bulletin 96.6 (2012): 1099–1119.

Chalmers, G. R., Daniel, L., Ross, J. K., and Bustin, R. M., “Geological Controls on Matrix Permeability of Devonian Gas Shales in the Horn River and Liard Basins, Northeastern British Columbia, Canada.” International Journal of Coal Geology 103 (2012): 120–131.

Chen, R., Sharma, S., Bank, T., Soeder, D., Eastman, H., “Comparison of isotopic and geochemical characteristics of sediments from a gas- and liquids-prone wells in Marcellus Shale from Appalachian Basin, West Virginia.” Applied Geochemistry V. 60 (2015): 59-71.

Cardott, B. J., “Introduction to Vitrinite Reflectance as a Thermal Maturity Indicator.” Search and Discovery Article #40928, 73 p (2012).

Chow, N., Wendte, J. and Stasiuk, V., “Productivity versus Preservation Controls on Potential Carbonate Source Rocks in the Devonian of the Alberta Basin.” CSPG Reservoir 22.9 (1995): 2–3. Print.

Colodner, D., Edmond, J. and Boyle, E., . “Rhenium in the Black Sea: Comparison with Molybdenum and Uranium.” Earth and Planetary Science Letters 131.1–2 (1995): 1–15.

Colorado Plateau Geosystems Inc., 2013. http://www2.nau.edu/rcb7/namD360.jpg (downloaded Aug 15, 2013).

Creaney, S., and Passey, Q. R., “Recurring Patterns of Total Organic Carbon and Source Rock Quality Within a Sequence Stratigraphic Framework.” AAPG Bulletin 77.3 (1993): 386–401. EBSCOhost. Web.

Crusius, J., Calvert, S., Pedersen, T., Sage, D., “Rhenium and Molybdenum Enrichments in Sediments as Indicators of Oxic, Suboxic and Sulfidic Conditions of Deposition.” Earth and Planetary Science Letters 145.1–4 (1996): 65–78. ScienceDirect.

Cullers, R. L., Basu, A., Suttner, L. J., "Geochemical signature of provenance in sand-size material in soils and stream sediments near the Tobacco Root batholith, Montana, USA." Chemical Geology 70, no. 4 (1988): 335-348.

Dahl, T. W., Anbar, A. D., Gordon, G. W., Minik G., Rosing, T., Frei, R., Canfield, D. E., "The Behavior of Molybdenum and Its Isotopes Across the Chemocline and in the Sediments of Sulfidic Lake Cadagno, Switzerland." Geochimica et Cosmochimica Acta 74.1 (2010): 144–163. EBSCOhost. Web.

Dale, A. W. , Meyers, S. R., Aguilera, D. R., Arndt, S., Wallmann, K., "Controls on Organic Carbon and Molybdenum Accumulation in Cretaceous Marine Sediments from the Cenomanian-Turonian Interval Including Oceanic Anoxic Event 2." Chemical Geology 324-325 (2012): 28–45. EBSCOhost. Web.

Demaison, G. J., Moore, G. T., "Anoxic Environments and Oil Source Bed Genesis." AAPG Bulletin 64.8 (1980): 1179–1209. ProQuest. Web. 17 June 2013.

Droxler, A. W., and Schlager, W., 1985. Glacial versus interglacial sedimentation rates and turbidite frequency in the Bahamas: Geology 13, pp. 799–802.

Eldrett, J. S., Greenwood, D. R., Harding I. C., Huber, M., "Increased seasonality through the Eocene to Oligocene transition in the northern high latitudes." Letters to Nature. 459. (2009)

Emerson, S. R., Huested, S.S., "Ocean Anoxia and the Concentrations of Molybdenum and Vanadium in Seawater." Marine Chemistry 34.3–4 (1991): 177–196. ScienceDirect. Web. 24 Aug. 2013.

Flynn, J. and Cheadle, B. "Integration of Allostratigraphy with Organic Geochemistry: Implications for Stratigraphic and Spatial Distribution of Organic Matter in Foreland Basins." Canadian Society of Petroleum Geologists GeoConvention Abs (2012).

Geological Atlas of the Western Canada Sedimentary Basin. "Devonian Woodbend-Winterburn Strata of the Western Canada Sedimentary Basin." Chapter 12.

Gibson, D.L. "Pyrite-organic Matter Relationships: Currant Bush Limestone, Georgina Basin, Australia." Geochimica et Cosmochimica Acta 49.4 (1985): 989–992. ScienceDirect. Web. 24 Aug. 2013.

Glaser, K. S., Droxler, A. W., 1993. Controls and development of late Quaternary periplatform carbonate stratigraphy in Walton Basin (northeastern Nicaragua Rise, Caribbean Sea). Paleoceanography 8, pp. 243–274.

Gordon, G. W., Lyons, T. W., Arnold, G. L., Roe, J., Sageman, B. B., Anbar, A. D., "When Do Black Shales Tell Molybdenum Isotope Tales?" Geology (Boulder) 37.6 (2009): 535–538. ProQuest. Web. 17 June 2013.

Harris, N.B., Mnich, C. A., Selby, D., Korn, D., Minor and Trace Element and Re-Os Chemistry of the Upper Devonian Woodford Shale, Permina Basin, west Texas: Insights into Metal Abundance and Basin Processes, Chemical Geology (2013).

Hemmesch, N.T., Harris, N.B., Mnich, C.A., and Selby, D., 2014. A sequence-stratigraphic framework for the Upper Devonian Woodford Shale, Permian Basin, west Texas. AAPG Bulletin 98, pp. 23-47.

Holmden, C. , Creaser, R. A., Muehlenbachs, K., Leslie, S. A., Bergström, S. M., "Isotopic Evidence for Geochemical Decoupling Between Ancient Epeiric Seas and Bordering Oceans: Implications for Secular Curves." Geology 26.6 (1998): 567–570.

Imperial Oil, Limited. "Devonian Nomenclature in Edmonton Area, Alberta, Canada." Bulletin of the American Association of Petroleum Geologists 34.9 (1950): 1807–1825.

Isaacson, P.E., Díaz-Martínez, E., Grader, G. W., Kalvoda, J., Babek, O., Devuyst, F. X., "Late Devonian-earliest Mississippian glaciation in Gondwanaland and its biogeographic consequences." Paleogeography, Paleoclimatology, Paleoecology V. 268 (2008): 126-142

Katz, B. J. "Controlling Factors on Source Rock Development; a Review of Productivity, Preservation, and Sedimentation Rate." Special Publication - Society for Sedimentary Geology 82 (2005): 7–16.

Kennedy, M. J., Löhr, S. C., Fraser, S. A., Baruch, E. T., "Direct evidence for organic carbon preservation as clay-organic nanocomposites in a Devonian black shale; from deposition to diagenesis." Earth and Planetary Science Letters. V. 388 (2014): 59-70.

Klemme, H. D., and Ulmishek, G. F., "Effective Petroleum Source Rocks of the World; Stratigraphic Distribution and Controlling Depositional Factors." AAPG Bulletin 75.12 (1991): 1809–1851. Print.

Knapp, L. J. "Sea level and basin morphology control on distribution and character of organic-rich mudstones: A sequence stratigraphic model for the Duvernay Formation, Alberta, Canada." M. Sc. Thesis, Chapter 2 (201-206).

Leventhal, J. S. "Pyrolysis Gas Chromatography-mass Spectrometry to Characterize Organic Matter and Its Relationship to Uranium Content of Appalachian Devonian Black Shales." Geochimica et Cosmochimica Acta 45.6 (1981): 883–889. ScienceDirect. Web. 23 Aug. 2013.

Leventhal, J. S. "Carbon-sulfur plots show diagenetic and epigenetic sulfidation in sediments." Geochemica et Cosmochimica 59.6 (1995): 1207-1211

Lopez, B., Aguilera, R., Evaluation of Quintuple Porosity in Shale Petroleum Reservoirs. Society of Petroleum Engineers (2013).

Lüning, S., Wendt, J., Belka, Z., Kaufmann, B. "Temporal–spatial Reconstruction of the Early Frasnian (Late Devonian) Anoxia in NW Africa: New Field Data from the Ahnet Basin (Algeria)." Sedimentary Geology 163.3 (2004): 237–264. Print.

Lüning, S., Adamson, K. and Craig, J., "Frasnian Organic-rich Shales in North Africa; Regional Distribution and Depositional Model." Geological Society Special Publications 207 (2003): 165–184. Print.

Lyons, T. W. , Werne, J. P., Hollander, D. J., Murray, R. W., "Contrasting Sulfur Geochemistry and Fe/Al and Mo/Al Ratios across the Last Oxic-to-anoxic Transition in the Cariaco Basin, Venezuela." Chemical Geology 195.1-4 (2003): 131–157.

Macquaker, J. H. S., Keller, M. A. and Davies, S. J., "Algal Blooms and 'Marine Snow'; Mechanisms That Enhance Preservation of Organic Carbon in Ancient Fine-grained Sediments." Journal of Sedimentary Research 80.11 (2010): 934–942. EBSCOhost. Web.

Mallamo, M. P., Paleoceanography of the Upper Devonian Fairholme Carbonate Complex, Kananaskis-Banff Area, Alberta." Doctoral Thesis, Department of Earth and Planetary Sciences, McGill University, Montreal (1995): 470 pages.

McLennan, S. M., Hemming, S., McDaniel, D. K. and Hanson, G. N., "Geochemical approaches to sedimentation, provenance, and tectonics. "Geological Society of America Special Papers 284 (1993): 21-40.

Meyer, K. M., Kump, L. R., "Oceanic Euxinia in Earth History: Causes and Consequences." Annual Review of Earth and Planetary Sciences 36 (2008): 251-288.

Meyer, E. E., Burgreen, B. N., Lackey, H., Landis, J. D., Quicksall, A. N., Bostick, B. C., "Evidence for Basin Restriction During Syn-collisional Basin Formation in the Silurian Arisaig Group, Nova Scotia." Chemical Geology 256.1-2 (2008): 1–11.

Meyers, S. R., Sageman, B. B. and Lyons, T. W., "Organic Carbon Burial Rate and the Molybdenum Proxy; Theoretical Framework and Application to Cenomanian-Turonian Oceanic Anoxic Event 2." Paleoceanography 20.2 (2005): n. pag. EBSCOhost. Web.

Mnich , C. A., Geochemical Signatures of Stratigraphic Sequences and Sea Level Change in the Woodford Shale, Permian Basin. (M. Sc Thesis) Colorado School of Mines (2009, 89 pp).

Morford, J. L., and Emerson, S., "The Geochemistry of Redox Sensitive Trace Metals in Sediments." Geochimica et Cosmochimica Acta 63.11-12 (1999): 1735–1750. ProQuest. Web. 17 June 2013.

Passey, Q. R., Bohacs, K., Esch, W. L., Klimentidis, R., Sinha, S., "From Oil-prone Source Rock to Gas-producing Shale Reservoir-geologic and Petrophysical Characterization of Unconventional Shale Gas Reservoirs." International Oil and Gas Conference and Exhibition in China. 2010.

Pedersen, T. F., and Calvert, S. E., "Anoxia Vs Productivity; What Controls the Formation of Organic-carbon-rich Sediments and Sedimentary Rocks?" AAPG Bulletin 74.4 (1990): 454–466. Print.

Peters, K. E., Guidelines for Evaluating Petroleum Source Rocks Using Programmed Pyrolysis. "AAPG Bulletin." (1986).

Peters, K. E. and Cassa, M. R. "Applied Source Rock Geochemistry." AAPG Memoir 60. (1994)

Pi, D. H., Liu, C. Q., Shields-Zhou, G. A., Jiang, S. Y., "Trace and Rare Earth Element Geochemistry of Black Shale and Kerogen in the Early Cambrian Niutitang Formation in Guizhou Province, South China: Constraints for Redox Environments and Origin of Metal Enrichments." Precambrian Research 225 (2013): 218–229. ScienceDirect. Web. 23 Aug. 2013.

Potma, K., Weissenberger, J. A. W., Wong, P. K., Gilhooly, M. G., "Toward a sequence stratigraphic framework for the Frasnian of the Western Canada Basin." Bulletin of Canadian Petroleum Geology V. 49 (2001): 37-85.

Prauss, M. L., "Marine palynology of the Oceanic Anoxic Event 3 (OAE3, Coniacian - Santonian), Morocco, NW Africa-transition from preservation to production controlled accumulation of marine organic carbon." Cretaceous Research V. 53 (2015): 19-37.

Ragueneau, O., Tréguer, P., Leynaert, A., Anderson, R. F., Brzezinski, M. A., DeMaster, D. J., Dugdale, R. C., Dymond, J., Fischer, G., François, R., Heinze, C., Maier-Reimer, E., Martin-Jézéquel, V., Nelson, D. M., Quéguiner, B., "A Review of the Si Cycle in the Modern Ocean; Recent Progress and Missing Gaps in the Application of Biogenic Opal as a Paleoproductivity Proxy." *Global and Planetary Change* 26.4 (2000): 317–365.

Raphael, A. J. W., Nassichuk, B. R., Ron Brezovski, R., Hackley, P. C., Willment, N., "Vitrinite Reflectance Versus Pyrolysis Tmax data: Assessing Thermal Maturity in Shale Plays with Special Reference to the Duvernay Shale Play of the Western Canadian Sedimentary Basin, Alberta, Canada." Society of Petroleum Engineers (2013).

Rimmer, S. M., "Geochemical Paleoredox Indicators in Devonian-Mississippian Black Shales, Central Appalachian Basin; USA." Chemical Geology 206.3-4 (2004): 373–391. EBSCOhost. Web.

Rimmer, S. M., Thompson, J. A., Goodnight, S. A, Robl, T. L. "Multiple Controls on the Preservation of Organic Matter in Devonian-Mississippian Marine Black Shales; Geochemical and Petrographic Evidence." Palaeogeography, Palaeoclimatology, Palaeoecology 215.1-2 (2004): 125–154. ProQuest. Web. 8 Apr. 2013.

Rokosh, D. D., Anderson, S. D. A, Beaton, A. P., Berhane, M., Pawlowicz, J., "Geochemical and Geological Characterization of the Duvernay and Muskwa Formations in Alberta." Society of Petroleum Engineers. (2010)

Ross, D. J. K., and Bustin, R. M., "Characterizing the Shale Gas Resource Potential of Devonian–Mississippian Strata in the Western Canada Sedimentary Basin: Application of an Integrated Formation Evaluation." AAPG Bulletin 92.1 (2008): 87–125.

Ross, D. J. K., and Bustin, R. M., "The Importance of Shale Composition and Pore Structure Upon Gas Storage Potential of Shale Gas Reservoirs." Marine and Petroleum Geology 26.6 (2009): 916–927. ScienceDirect.

Schieber, J., "Simple Gifts and Buried Treasures; Implications of Finding Bioturbation and Erosion Surfaces in Black Shales." Sedimentary Record 1.2 (2003): 4–8.

Schieber, J., and Riciputi, L., "Pyrite Ooids in Devonian Black Shales Record Intermittent Sea-level Drop and Shallow-water Conditions." Geology 32.4 (2004): 305–308.

Schieber, J., "Common Themes in the Formation and Preservation of Intrinsic Porosity in Shales and Mudstones - Illustrated With Examples Across the Phanerozoic." Society of Petroleum Engineers, 2010.

Schlager, W., Reijmer, J. J. G., and Droxler, A., 1994. Highstand Shedding of Carbonate Platforms: Journal of Sedimentary Research 64, pp. 270-281

Silva, R. L., "Organic matter production and preservation in the Lusitanian Basin (Portugal) and Pliensbachian climatic hot snaps." Global and Planetary Change V. 131 (2015): 24-34.

Slatt, R. M., and Rodriguez, N. D., "Comparative Sequence Stratigraphy and Organic Geochemistry of Gas Shales: Commonality or Coincidence?" Journal of Natural Gas Science and Engineering 8 (2012): 68–84. ScienceDirect. Web. 23 Aug. 2013.

Stoakes, F. A., 1980. Nature and control of shale basin fill and its effect on reef growth and termination: Upper Devonian Duvernay and Ireton formations of Alberta, Canada. Bulletin of Canadian Petroleum Geology 28, pp. 345-410.

Suzuki, N., Ishida, K., Shinomiya, Y., Ishiga, H., "High productivity in the earliest Triassic ocean: black shales, Southwest Japan." Paleogeography, Paleoclimatology, Paleoecology V. 141 (1998): 53-65.

Tribovillard, N., Bout-Roumazeilles, V., Algeo, T. J., Lyons, T.W., Sionneau, T., Montero-Serrano, J. C., Riboulleau, A., Baudin, F., "Paleodepositional Conditions in the Orca Basin as Inferred from Organic Matter and Trace Metal Contents." Marine Geology 254.1–2 (2008): 62–72. ScienceDirect.

Tribovillard, N., Algeo, T. J., Lyons , T. W., Riboulleau, A., “Trace Metals as Paleoredox and Paleoproductivity Proxies; an Update.” Chemical Geology 232.1-2 (2006): 12–32. ProQuest.

Tyson, R. V., “The ‘Productivity versus Preservation’ Controversy; Cause, Flaws, and Resolution.” Special Publication - Society for Sedimentary Geology 82 (2005): 17–33. Print.

Tyson, R. V. , “Sedimentation rate, dilution, preservation and total organic carbon: some results of a modelling study.” Organic Geochemistry V. 32 (2001): 333-339.

Uffmann, A. K., Littke, R., Rippen, D., “Mineralogy and Geochemistry of Mississippian and Lower Pennsylvanian Black Shales at the Northern Margin of the Variscan Mountain Belt (Germany and Belgium).” International Journal of Coal Geology 103 (2012): 92–108. EBSCOhost. Web.

Ver Straeten, C. A., Brett, C. E. , Sageman, B. B.., “Mudrock Sequence Stratigraphy: A Multi-proxy (sedimentological, Paleobiological and Geochemical) Approach, Devonian Appalachian Basin.” Palaeogeography, Palaeoclimatology, Palaeoecology 304.1–2 (2011): 54–73. ScienceDirect. Web. 18 Aug. 2013.

Vecsei, A., Sanders, D. G. K, 1997. Sea-level highstand and lowstand shedding related to shelf margin aggradation and emersion, Upper Eocene-Oligocene of Maiella carbonate platform, Italy: Sedimentary Geology 112, pp. 219-234Stoakes, F.A., 1980. Nature and control of shale basin fill and its effect on reef growth and termination: Upper Devonian Duvernay and Ireton formations of Alberta, Canada. Bulletin of Canadian Petroleum Geology 28, pp. 345-410.

Vecsei, A,, Sanders, D. G. K, 1997. Sea-level highstand and lowstand shedding related to shelf margin aggradation and emersion, Upper Eocene-Oligocene of Maiella carbonate platform, Italy: Sedimentary Geology 112, pp. 219-234

Wang, G., Carr, T. R., “Methodology of organic-rich shale lithofacies identification and prediction: A case study from Marcellus Shale in the Appalachian Basin.” Computers & Geosciences 49 (2012): 151-163.

Wedepohl, K. H., “The composition of the continental crust.” Geochemica et Cosmochimica Acta. 59.7 (1995): 1217-1232

Weissenberger, J. A. W. “Frasnian Reef and Basinal Strata of West Central Alberta; a Combined Sedimentological and Biostratigraphic Analysis.” Bulletin of Canadian Petroleum Geology 42.1 (1994): 1–25. Print.

Weissenberger, J. A. W., Potma, K. “The Devonian of western Canada-aspects of a petroleum system: Introduction.” Bulletin of Canadian Petroleum Geology V. 49 (2001): 1-6.

Wignall, P. B. “Model for Transgressive Black Shales?” Geology 19.2 (1991): 167–170.

Wilkin, R. T., Arthur, M. A., "Variations in Pyrite Texture, Sulfur Isotope Composition, and Iron Systematics in the Black Sea; Evidence for Late Pleistocene to Holocene Excursions of the O (sub 2) -H (sub 2) s Redox Transition." Geochimica et Cosmochimica Acta 65.9 (2001): 1399–1416.

Wright, A.M., Spain, D., Ratcliffe, K. T., "Application of inorganic whole rock geochemistry to shale resource plays" SPE Paper 137946, Canadian Unconventional Resources & International Petroleum Conference, Calgary, (2010) 18p.

Xu, J., Liu, Z., Bechtel, A., Meng, Q., Sun, P., Jia, J., Cheng, L., Song, Y., "Basin evolution and oil shale deposition during the Upper Cretaceous in the Songlio Basin (NE China): Implications from sequence stratigraphy and geochemistry." International Journal of Coal Geology V. 149 (2015): 9-23

Appendix A: Supplementary Information Regarding Methodology and Datasets

A.1 Sampling Intervals for Each Well

Well Name and ID	Number Samples: Interval	Processing Location
Shell Kaybob 100-02-22-63-20W5	**94: 3068.1m to 3141.1m**	**TerraTek, Calgary**
EOG Cygnet 100-08-20-38-28W4	92: 2564.5m to 2627.5m	UofA, Edmonton
Guidex Gville 100-09-06-76-23W5	31: 2546.0m to 2572.86m	UofA, Edmonton
Esso Redwater 102-16-28-57-21W4	70: 1107.46m to 1171.5m	UofA, Edmonton
Encana Cecilia 100-11-04-58-23W5	**73: 3935.5m to 3982.573m**	**UofA, Edmonton**

Table 21. Sampling Intervals for Each Well

A.2 Complete Methodology Schematic

Figure 84. Complete Methodology Schematic

A.3 Additional Core Based Petrophysical Sampling Methodology

The author was responsible for designing and implementing a geochemical and petrophysical sampling strategy. Samples were collected approximately every meter in order to create a high resolution dataset that targeted black shale facies. The sample set also included an appropriate range of Duvernay Formation lithofacies as well as a full stratigraphic profile by sampling into the overlying Ireton Formation and underlying Majeau Lake Formation. A total of 266 hand samples and 961 splits were cut by the author.

Hand samples were collected by: laying out sampling locations, measuring and marking sample size, taping each sample location for cutting, slabbing hand samples from whole cores, washing hand samples, photographing hand sample in order to document the cut face. 266 hand samples were slabbed from four whole cores by the author using the saw room facilities at the University of Alberta (training provided by Mark Labbe). The remaining 94 hand samples from one well were cut by TerraTek in Calgary, Alberta.

801 splits were cut by the author and sent for geochemical analysis. Responsibilities included cutting splits from each hand sample, washing each split, milling each split (for XRD samples), packaging and labelling each split and shipping to analytical labs. 360 splits were cut and sent to Weatherford Labs in Shenandoah, Texas for Leco TOC and Rockeval analysis; 360 splits were cut and sent to Acme Analytical Laboratory in Vancouver, British Columbia for total whole rock analysis (major, minor and trace element characterization). 60 splits were cut and sent to Dr. John Humphrey at Colorado school of Mines for carbonate isotope analysis. 21 splits were cut and milled by the author for XRD analysis at the University of Alberta carried out by XRD technician Diane Caird.

An additional 140 splits were cut and prepared by the author before being sent for core based petrophysical analyses. 100 splits were cut, packaged and sent to Trican Geological Solutions (account managed by Cory Twemlow and Brent Nassichuk). for solvent treatment and Helium Porosimetry analysis. 20 splits were cut for mercury injection analysis and 20 more were cut and milled for nitrogen adsorption. These 40 samples were treated with solvent using the group's Dean Stark lab (originally set up by Noga Vaisblat with methodology subsequently tailored by the author to suit the Duvernay Formation samples). Samples were dried using ovens in a lab managed by David Chesterman. Mercury injection experiments were carried out by technician Nam Ong. Nitrogen adsorption was experiments were carried out by the author at the National Institute Nano Techonology at the University of Alberta (training provided by Nancy Zhang).

An additional 20 cubes were cut, polished and ion milled in preparation for SEM imaging. Early samples were hand ground and polished by the author. Subsequent SEM cubes were prepared by Martin Von Dollen (thin section technician) at the University of Alberta. Ion milling was carried out by the author (training provided by Casey Litchfield and Rocco Cerchiara of Fichione Instruments Inc.). Early SEM photos were taken with the assistance of SEM technicians Nathan Gerein and George Braybrook at the Scanning Electron Microscope facilities at the University of Alberta. Subsequent SEM images were taken by the author at the University of Alberta's nanoFAB Fabrication and Characterization Facility following (training provided by Peng Li).

A.4 Summary of Additional Data Collection and Methodology

- Water based OM and clay separation exploration
- Photos of the cut face of each hand sample (722+)
- prep of SEM 20 stubs, ion milling
- SEM images (500+ primary, secondary and EDX)
- Prep of 21 XRD samples
- Preparation of 60 carbonate isotopes samples
- Preparation of 100 helium porosimetry samples
- Preparation of 20 Mercury injection samples
- Preparation of 2 Nitrogen adsorption samples
- BET analysis of samples at NINT, (08-20-31, 08-20-88, 09-06-18, 09-06-23, 02-22-35, 02-22-02, 02-22-34 + 3)
- Approximately 500 (498) SEM images (08-20-31, 02-22-34, 08-20-11, 09-06-18, 16-28-66, 11-04-22, 09-06-11, 09-06-23, 09-06-16, 08-20-88, 11-04-51)
- Dean Stark solvent treatment of samples for subsequent Hg and BET work (40: 20 BET and 20 Hg), development of appropriate methodology

Appendix B: Published Values for International Shale Standards

Table 22. Published Values for Cody Shale SCo-1

United States Geological Survey
Certificate of Analysis

Cody Shale, SCo-1

Sample used in the preparation of this reference material was collected in Natrona County, Wyoming, near the Naval Petroleum Reserve at Teapot Dome. SCo-1 is typical of the Upper Cretaceous silty marine shales, intermediate between fine-grained offshore shales and coarser nearshore marine siltstones. The rock is a medium dark-gray (Munsel N-4) silty shale having thin lighter colored silty laminations (Flanagan, 1976).

The concentrations were determined by cooperating laboratories using a variety of ana - lytical methods. Values reported are derived from international data compilations (Abbey, 1983, Gladney and Roelandts, 1988, Govindaraju, 1994). Initial USGS reports (Flanagan, 1976) provide background information on sample collection location.

Recommended values

Oxide	Wt %	±	Oxide	Wt %	±
SiO_2	62.8	0.66	CaO	2.62	0.20
Al_2O_3	13.7	0.21	MgO	2.72	0.18
Fe_2O_3	4.19	0.19	Na_2O	0.90	0.06
FeO	0.90	0.16	K_2O	2.77	0.08
Fe_2O_3T	5.13	0.18	P_2O_5	0.21	0.02
			TiO_2	0.63	0.06

Element	µg/g	±	Element	µg/g	±	Element	µg/g	±
As	12	1	F	770	60	S_{tot}	630	90
B	72	6	La	30	1	Sb	2.5	0.1
Ba	570	30	Li	45	3	Sc	11	1
Cs	7.8	0.7	Mn	410	30	Sr	170	16
Be	1.8	0.2	Mo	1.4	0.2	Th	9.7	0.5
Ce	62	6	Nd	26	2	V	130	13
Co	11	0.8	Ni	27	4	Y	26	4
Cr	68	5	Pb	31	3	Zn	100	8
Cu	29	2	Rb	110	4	Zr	160	30

Element	µg/g	Element	µg/g
Bi	0.37	Pr	6.6
Cl	51	S	630
Ga	15	Sn	3.7
Nb	11	W	1.4

Denver, Colorado
revised March 1995

David B. Smith
Branch of Geochemistry

Table 23. Published Values for Brush Creek Shale SBC-1

United States Geological Survey
Certificate of Analysis
Brush Creek Shale, SBC-1

Material used in the preparation of SBC-1 was collected in 1999 under the direction of Roger Hornberger (Pennsylvanian Department Environmental Quality) and Stephen Wilson, USGS. The collection site was a fresh road cut located in Westmoreland County, near Greensburg PA at the intersection of routes 66 and 130. SBC-1 is representative of marine shale of the lower Conemaugh Group, Glenshaw formation. Mineralogical analysis of SBC-1 reveals major concentrations of muscovite, quartz, kaolinite, and chlorite with minor amounts of calcite, siderite, anatase, rutile, and pyrite.

Certificate information is derived from the proficiency testing program called GEOPT which is directed by the International Association of Geoanalysts. A total of 75 laboratory participated in the study. Certificate values are representative of robust study means and are confirmed by USGS analysis.

Oxide	Wt%	s.d.
SiO_2	47.64	0.087
Al_2O_3	21.0	0.04
Fe_2O_3T	9.71	0.02
CaO	2.95	0.01
MgO	2.60	0.01
K_2O	3.45	0.01
Na_2O	<0.15	
MnO	0.15	0.001

Oxide	Wt%	s.d.
P_2O_5	0.37	0.002
TiO_2	0.855	0.003
S_{tot}	0.715	0.008
C_{tot}	2.08	0.02
C_{inorg}	0.85	0.01
C_{org}	1.23	0.02
LOI	10.2	0.08

Element	mg/kg	s.d.
As	25.7	0.7
Ba	788	7.7
Be	3.2	0.08
Bi	0.7	0.02
Cd	0.4	0.02
Ce	108	0.9
Co	22.7	0.3
Cr	109	1
Cs	8.2	0.1
Cu	31	0.6
Dy	7.1	0.09
Er	3.8	0.05
Eu	1.98	0.02
Ga	27	0.3
Gd	8.5	0.1

Element	mg/kg	s.d.
Hf	3.7	0.1
Ho	1.4	0.02
La	52.5	0.6
Li	163	2.5
Lu	0.54	0.01
Mo	2.4	0.07
Nb	15.3	0.2
Nd	49.2	0.5
Ni	82.8	0.8
Pb	35	0.3
Pr	12.6	0.1
Rb	147	1
Sb	1.01	0.03
Sc	20	0.2
Sm	9.6	0.1

Element	mg/kg	s.d.
Sn	3.3	0.1
Sr	178	1.4
Ta	1.1	0.03
Tb	1.2	0.02
Th	15.8	0.2
Tl	0.89	0.01
Tm	0.56	0.01
U	5.76	0.11
V	220	1.4
W	1.6	0.05
Y	36.5	0.3
Yb	3.64	0.04
Zn	186	1.7
Zr	134	1.6

Table 24. Published Values for Carbonaceous Shale SARM 41

Certificate of Analysis

CARBONACEOUS SHALE SARM 41

CERTIFIED REFERENCE MATERIAL

Distributed by
SA BUREAU OF STANDARDS
P/Bag X191, Pretoria 0001
Republic of South Africa

Prepared by
MINTEK
P/Bag X3015, Randburg 2125
Republic of South Africa

11. CERTIFIED PROPERTY VALUES

Constituent	Certified value
	%
SiO_2	56,67
Al_2O_3	13,50
Fe as Fe_2O_3	4,23
MgO	8,10
CaO	1,50
Na_2O	0,93
K_2O	1,39
MnO	0,06
TiO_2	0,55
P_2O_5	0,05
	µg/g
Ba	820
Cr	123
Cu	53
Nb	8
Ni	122
Rb	59
Sr	54
V	139
Y	17
Zn	76
Zr	146

Orders of magnitude for As, Ga, Se, W, Au, Br, Cs, Eu, Hf, La, Lu, Sc, Sm, Ta, Tb, Yb and Sb are available from MINTEK.

Appendix C: Complete Geochemical Results for all Wells Including Acme Analytical Standards

C.1 Complete Geochemical Results for Guidex 09-06

C.1.1 Major, Minor and Trace Element Results Including Acme Internal Standards

Table 25. Major, Minor and Trace Element Results Including Acme Internal Standards for Guidex 09-06

Guidex 09-06	Analyte	Wgt	TOT/C	TOT/S	SiO2	Al2O3	Fe2O3	MgO
	Unit	KG	%	%	%	%	%	%
	MDL	0.01	0.02	0.02	0.01	0.01	0.04	0.01
Sample	Type							
09-06 2546.00	Rock	0.02	4.84	0.95	37.16	12.03	4.57	2.39
09-06 2546.845	Rock	0.01	3.61	1.05	46.75	15.68	5.7	2.7
09-06 2548.94	Rock	0.02	2.71	0.96	51.94	14.18	4.93	2.43
09-06 2549.65	Rock	0.02	2.55	1.31	56.12	16.38	5.65	2.68
09-06 2551.14	Rock	0.02	3.55	1.38	52.2	15.42	5.7	2.99
09-06 2552.93	Rock	0.03	5.23	1.06	44.31	9.67	3.62	2.2
09-06 2553.59	Rock	0.03	6.38	0.93	42	8.63	3.35	2.28
09-06 2555.09	Rock	0.03	6.78	1.3	41.97	8.81	3.56	1.73
09-06 2556.52	Rock	0.03	5.13	2.05	53.31	15.65	5.44	2.37
09-06 2557.13	Rock	0.02	6.85	2.32	43.56	12.4	5.44	2.9
09-06 2558.20	Rock	0.04	10.31	1.17	13.81	0.45	1.37	0.64
09-06 2558.30	Rock	0.03	6.49	2.63	54.36	14.85	5.59	2.21
09-06 2558.71	Rock	0.06	6.61	2.06	59.49	11.59	4.37	1.92
09-06 2559.77	Rock	0.05	10.14	1.16	20.05	4.63	1.98	1.28
09-06 2560.48	Rock	0.04	8.01	3.63	49.6	10.45	5.97	2.17
09-06 2561.06	Rock	0.04	8.37	1.66	31.47	5.16	3.86	5.51
09-06 2562.61	Rock	0.02	5.45	2.29	56.03	14.15	5.35	2.16
09-06 2563.07	Rock	0.03	9.95	1.21	35.85	9.6	3.29	1.8
09-06 2563.49	Rock	0.03	7.54	2.46	49.73	13.12	5.95	2.48
09-06 2564.02	Rock	<0.01	2.47	0.94	52.69	14.54	4.46	2.46
09-06 2565.91	Rock	0.02	6.71	1.41	36.74	10.6	4.76	3.83
09-06 2566.24	Rock	0.02	7.11	1.5	35.86	10.09	5.01	4.26

09-06 2566.40	Rock	0.03	7.69	1.74	36	9.99	5.04	3.59
09-06 2566.69	Rock	0.03	5.27	1.3	46.81	15.09	5.38	2.6
09-06 2568.93	Rock	0.04	6.32	1.23	27.05	9.54	4.25	2.22
09-06 2569.27	Rock	0.04	8.98	1.72	13.56	4.11	3.86	1.51
09-06 2569.85	Rock	0.04	9.87	0.48	10.42	3.5	2.13	1.55
09-06 2571.37	Rock	0.03	9.45	0.29	12.94	4.34	1.63	1.33
09-06 2572.29	Rock	0.05	9.7	0.63	11.05	3.76	2.22	1.82
09-06 2572.86	Rock	0.03	9.99	0.37	10.77	3.59	1.82	1.4
09-06 2574.00	Rock Pulp	<0.01	1.11	0.07	62.96	13.85	5.17	2.79
02-02 3075.85	Rock	0.02	9.97	3.74	10.04	1.32	4.97	1
02-02 3114.50	Rock	0.02	10.66	0.37	8.8	2.13	0.96	0.86
02-02 3115.40	Rock	0.02	10.08	0.65	12.44	2.9	1.52	0.89
02-02 3118.50	Rock	0.01	8.19	0.56	23.64	6.34	2	1.36
Pulp Duplicates								
02-02 3118.50	Rock	0.01	8.19	0.56	23.64	6.34	2	1.36
02-02 3118.50	REP		8.29	0.55				
09-06 2572.86	Rock	0.03	9.99	0.37	10.77	3.59	1.82	1.4
09-06 2572.86	REP		9.81	0.34				
02-02 3115.40	Rock	0.02	10.08	0.65	12.44	2.9	1.52	0.89
02-02 3115.40	REP							
09-06 2562.61	Rock	0.02	5.45	2.29	56.03	14.15	5.35	2.16
09-06 2562.61	REP				56.07	14.11	5.36	2.16
02-02 3118.50	Rock	0.01	8.19	0.56	23.64	6.34	2	1.36
02-02 3118.50	REP							
09-06 2558.71	Rock	0.06	6.61	2.06	59.49	11.59	4.37	1.92
09-06 2558.71	REP							
02-02 3075.85	Rock	0.02	9.97	3.74	10.04	1.32	4.97	1
02-02 3075.85	REP				10.09	1.33	5.05	1.01
Reference Materials								
STD GS311-1	STD		1.01	2.29				
STD GS910-4	STD		2.58	8.17				
STD GS311-1	STD		0.99	2.36				
STD GS910-4	STD		2.54	8.1				
STD DS10	STD							
STD OREAS45EA	STD							
STD SO-18	STD				58.52	14.04	7.51	3.31
STD SO-18	STD				58.23	14.15	7.56	3.37
STD SO-18	STD				58.18	14.09	7.59	3.39
STD SO-18	STD				58.05	14.13	7.6	3.4

STD DS10	STD							
STD OREAS45EA	STD							
STD DS10	STD							
STD OREAS45EA	STD							
STD SO-18	STD				58.12	14.17	7.5	3.36
STD SO-18	STD				58.29	14.06	7.53	3.34
BLK	BLK		<0.02	<0.02				
BLK	BLK		<0.02	<0.02				
BLK	BLK							
BLK	BLK				<0.01	<0.01	<0.04	<0.01
BLK	BLK				<0.01	<0.01	<0.04	<0.01
BLK	BLK							
BLK	BLK							
BLK	BLK				<0.01	<0.01	<0.04	<0.01
Prep Wash								
G1	Prep Blank		<0.02	0.02	66.47	16.41	3.58	1.14
G1	Prep Blank		<0.02	<0.02	67.56	15.67	3.45	1.07

Table 25. Continued

Guidex 09-06	CaO	Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Ni
	%	%	%	%	%	%	%	PPM
MDL	0.01	0.01	0.01	0.01	0.01	0.01	0.002	20
Sample								
09-06 2546.00	19.72	0.47	3.12	0.46	0.1	0.05	0.01	47
09-06 2546.845	9.5	0.65	3.91	0.58	0.07	0.04	0.015	81
09-06 2548.94	9.12	0.54	3.71	0.49	0.06	0.04	0.012	49
09-06 2549.65	2.82	0.68	4.28	0.64	0.08	0.03	0.015	83
09-06 2551.14	5.39	0.69	4.04	0.64	0.09	0.03	0.013	91
09-06 2552.93	17.04	0.48	2.8	0.45	0.15	0.04	0.011	50
09-06 2553.59	18.88	0.43	2.47	0.4	0.08	0.04	0.008	60
09-06 2555.09	18.83	0.42	2.65	0.43	0.13	0.03	0.011	77
09-06 2556.52	3.17	0.67	4.39	0.73	0.15	0.02	0.014	142
09-06 2557.13	11.72	0.58	3.59	0.64	0.18	0.03	0.017	139
09-06 2558.20	47.14	0.06	0.12	0.02	0.12	0.04	<0.002	<20
09-06 2558.30	2.86	0.62	4.21	0.7	0.17	0.02	0.016	229
09-06 2558.71	4.23	0.55	3.37	0.53	0.13	0.02	0.011	140

09-06 2559.77	35.7	0.24	1.51	0.22	0.06	0.03	0.007	42
09-06 2560.48	8.77	0.49	3.27	0.49	0.13	0.03	0.012	174
09-06 2561.06	23.5	0.43	1.74	0.29	0.07	0.08	0.011	25
09-06 2562.61	2.79	0.52	4.31	0.57	0.29	0.02	0.013	96
09-06 2563.07	20.62	0.35	2.97	0.38	0.13	0.04	0.014	75
09-06 2563.49	6.72	0.46	3.68	0.57	0.12	0.03	0.013	78
09-06 2564.02	7.3	0.52	3.93	0.61	0.13	0.03	0.021	54
09-06 2565.91	18.02	0.51	3.17	0.49	0.07	0.07	0.011	40
09-06 2566.24	18.34	0.5	3.01	0.47	0.07	0.07	0.016	46
09-06 2566.40	19.1	0.49	3.03	0.47	0.06	0.08	0.012	42
09-06 2566.69	8.55	0.52	4.23	0.56	0.06	0.05	0.016	67
09-06 2568.93	28.19	0.31	2.71	0.41	0.08	0.08	0.009	29
09-06 2569.27	42.41	0.16	1.26	0.17	0.23	0.14	0.006	24
09-06 2569.85	43.56	0.13	1.05	0.13	0.31	0.18	0.002	<20
09-06 2571.37	41.17	0.16	1.36	0.18	0.09	0.08	0.004	<20
09-06 2572.29	42.72	0.14	1.13	0.14	0.13	0.32	0.003	<20
09-06 2572.86	42.91	0.12	1.08	0.14	0.13	0.1	0.006	<20
09-06 2574.00	2.66	0.91	2.75	0.58	0.19	0.05	0.012	24
02-02 3075.85	43.29	0.09	0.33	0.07	0.05	0.1	<0.002	25
02-02 3114.50	47.18	0.17	0.52	0.09	0.03	0.03	0.005	<20
02-02 3115.40	44.33	0.19	0.87	0.12	0.06	0.04	0.004	<20
02-02 3118.50	33.08	0.2	2.1	0.26	0.09	0.04	0.007	<20
Pulp Duplicates								
02-02 3118.50	33.08	0.2	2.1	0.26	0.09	0.04	0.007	<20
02-02 3118.50								
09-06 2572.86	42.91	0.12	1.08	0.14	0.13	0.1	0.006	<20
09-06 2572.86								
02-02 3115.40	44.33	0.19	0.87	0.12	0.06	0.04	0.004	<20
02-02 3115.40								
09-06 2562.61	2.79	0.52	4.31	0.57	0.29	0.02	0.013	96
09-06 2562.61	2.78	0.52	4.32	0.57	0.29	0.02	0.015	95
02-02 3118.50	33.08	0.2	2.1	0.26	0.09	0.04	0.007	<20
02-02 3118.50								
09-06 2558.71	4.23	0.55	3.37	0.53	0.13	0.02	0.011	140
09-06 2558.71								
02-02 3075.85	43.29	0.09	0.33	0.07	0.05	0.1	<0.002	25
02-02 3075.85	44.11	0.09	0.34	0.07	0.05	0.1	0.002	<20
Reference Materials								
STD GS311-1								
STD GS910-4								

STD GS311-1								
STD GS910-4								
STD DS10								
STD OREAS45EA								
STD SO-18	6.28	3.63	2.13	0.69	0.8	0.4	0.531	46
STD SO-18	6.33	3.62	2.12	0.69	0.82	0.4	0.545	32
STD SO-18	6.33	3.68	2.16	0.68	0.79	0.4	0.546	40
STD SO-18	6.39	3.7	2.16	0.68	0.78	0.39	0.546	42
STD DS10								
STD OREAS45EA								
STD DS10								
STD OREAS45EA								
STD SO-18	6.39	3.63	2.26	0.69	0.77	0.4	0.542	46
STD SO-18	6.34	3.65	2.25	0.68	0.76	0.39	0.539	43
BLK								
BLK								
BLK								
BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
BLK								
BLK								
BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
Prep Wash								
G1	4.05	3.58	3.14	0.39	0.17	0.1	<0.002	<20
G1	3.51	3.7	3.29	0.39	0.17	0.1	0.009	<20

Table 25. Continued

Guidex 09-06	Sc	LOI	Sum	Ba	Be	Co	Cs	Ga
	PPM	%	%	PPM	PPM	PPM	PPM	PPM
MDL	1	-5.1	0.01	1	1	0.2	0.1	0.5
Sample								
09-06 2546.00	11	19.7	99.83	250	3	15.3	6.3	13.9
09-06 2546.845	15	14.2	99.83	330	2	18.7	7.6	17
09-06 2548.94	13	12.4	99.83	468	6	13.6	6.4	15.6
09-06 2549.65	14	10.4	99.75	724	3	15.7	8.3	17.7
09-06 2551.14	13	12.6	99.77	708	7	16.8	7.7	16.4
09-06 2552.93	9	19	99.82	272	<1	9.7	4.2	10.3
09-06 2553.59	8	21.3	99.84	195	4	10.6	4.1	9.2
09-06 2555.09	8	21	99.62	2001	<1	7.6	4.2	9.1

09-06 2556.52	12	13.5	99.41	3554	4	15.6	7.1	17.9
09-06 2557.13	11	18.5	99.55	1957	2	13	6.2	12.6
09-06 2558.20	1	35.2	98.95	7490	2	0.6	0.2	<0.5
09-06 2558.30	12	14.2	99.8	369	4	18.4	8	16.5
09-06 2558.71	10	13.6	99.84	325	4	13.8	6.6	12.9
09-06 2559.77	4	33.4	99.11	6968	<1	4.6	2.4	4.4
09-06 2560.48	9	16.6	98	16012	<1	21.6	5.5	11.8
09-06 2561.06	5	26.6	98.72	9670	<1	6.7	1.9	4.5
09-06 2562.61	13	13.6	99.77	936	3	11.5	8.2	14.7
09-06 2563.07	9	24.8	99.84	226	3	7	5	9.5
09-06 2563.49	12	17	99.84	317	5	16.3	7.7	14.7
09-06 2564.02	14	12.6	99.33	4831	4	14.3	8.3	14.7
09-06 2565.91	10	21.6	99.83	216	<1	11.9	4.2	10.6
09-06 2566.24	9	22.1	99.82	234	<1	13.8	3.9	10.7
09-06 2566.40	10	21.7	99.51	229	<1	14.9	4	10.8
09-06 2566.69	14	16	99.84	308	4	17.2	7.6	17.3
09-06 2568.93	9	25	99.87	197	<1	12.1	4.4	9.6
09-06 2569.27	4	32.5	99.89	110	2	11.3	1.5	2.9
09-06 2569.85	3	36.9	99.88	293	<1	10.3	1.5	2.9
09-06 2571.37	4	36.6	99.92	86	<1	3.6	2	4
09-06 2572.29	3	36.5	99.9	85	<1	7.4	1.7	3.9
09-06 2572.86	3	37.7	99.72	100	<1	5.5	1.5	3.2
09-06 2574.00	11	N.A.	91.94	580	2	10.5	7	14.2
02-02 3075.85	2	32.6	93.84	481	2	2.6	0.7	0.8
02-02 3114.50	2	38.7	99.49	2634	<1	2.3	0.8	1.5
02-02 3115.40	2	36.6	99.92	112	<1	4.5	1	2.2
02-02 3118.50	6	30.8	99.9	155	2	7.3	3.9	7.3
Pulp Duplicates								
02-02 3118.50	6	30.8	99.9	155	2	7.3	3.9	7.3
02-02 3118.50								
09-06 2572.86	3	37.7	99.72	100	<1	5.5	1.5	3.2
09-06 2572.86								
02-02 3115.40	2	36.6	99.92	112	<1	4.5	1	2.2
02-02 3115.40								
09-06 2562.61	13	13.6	99.77	936	3	11.5	8.2	14.7
09-06 2562.61	13	13.6	99.76	957	3	12.7	7.6	15.3
02-02 3118.50	6	30.8	99.9	155	2	7.3	3.9	7.3
02-02 3118.50								
09-06 2558.71	10	13.6	99.84	325	4	13.8	6.6	12.9
09-06 2558.71								
02-02 3075.85	2	32.6	93.84	481	2	2.6	0.7	0.8

02-02 3075.85	2	32.6	94.81	512	<1	2.6	0.6	1.9
Reference Materials								
STD GS311-1								
STD GS910-4								
STD GS311-1								
STD GS910-4								
STD DS10								
STD OREAS45EA								
STD SO-18	24	1.9	99.74	502	<1	24.4	6.6	16
STD SO-18	24	1.9	99.74	520	<1	27.3	6.9	16.3
STD SO-18	24	1.9	99.75	496	<1	24.3	6.8	15.3
STD SO-18	24	1.9	99.75	491	6	23.6	6.5	15.7
STD DS10								
STD OREAS45EA								
STD DS10								
STD OREAS45EA								
STD SO-18	24	1.9	99.73	524	<1	26	7.1	18.6
STD SO-18	24	1.9	99.74	518	<1	25.8	7.4	18.6
BLK								
BLK								
BLK								
BLK	<1	0	<0.01	<1	<1	<0.2	0.1	<0.5
BLK	<1	0	<0.01	<1	2	<0.2	<0.1	<0.5
BLK								
BLK								
BLK	<1	0	<0.01	<1	<1	<0.2	<0.1	<0.5
Prep Wash								
G1	5	0.7	99.76	869	2	4.1	4.8	17.9
G1	5	0.8	99.74	948	2	3.9	5.8	17.8

Table 25. Continued

Guidex 09-06	Hf	Nb	Rb	Sn	Sr	Ta	Th	U
	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
MDL	0.1	0.1	0.1	1	0.5	0.1	0.2	0.1
Sample								
09-06 2546.00	2.1	14.7	113.6	2	370.9	0.8	7.8	4.3
09-06 2546.845	2.5	19.2	146.6	2	191.2	1	10.1	5.7
09-06 2548.94	2.2	16	133.4	2	157.8	1	8	3.9

09-06 2549.65	2.8	28.2	156.2	2	125.8	1.7	12.4	6.5
09-06 2551.14	2.8	32	149.1	2	139.1	1.9	12.9	7.6
09-06 2552.93	2.2	26.4	97.9	1	277.3	1.6	10	7.6
09-06 2553.59	2.2	24	89.2	1	222.4	1.6	8.5	7.7
09-06 2555.09	2.5	29	94.8	1	309.2	1.5	10.2	13.4
09-06 2556.52	3.7	47.4	164.9	2	269	2.7	16.7	15.1
09-06 2557.13	3.5	35.8	121.7	2	255.8	2.1	13.5	13
09-06 2558.20	<0.1	0.9	3.4	<1	1274.7	<0.1	0.6	2.9
09-06 2558.30	2.8	29.9	149.7	2	129.4	1.7	11.2	19.3
09-06 2558.71	2.3	16.7	118.4	1	110.3	1	8.1	17.7
09-06 2559.77	1	7.3	46.5	<1	432.8	0.5	3.5	5.4
09-06 2560.48	3	10.6	108.8	1	743.6	0.8	7.3	21.6
09-06 2561.06	2.8	4.7	45.1	<1	664.4	0.3	3.9	5.9
09-06 2562.61	2.4	12.7	143.7	1	122.5	0.7	10.5	14.2
09-06 2563.07	1.5	8.8	95.3	1	320.8	0.6	6.6	10
09-06 2563.49	2.7	9.3	132.2	2	116.8	0.6	8.4	11.5
09-06 2564.02	2.8	9.1	150.4	2	247	0.6	9.1	3.2
09-06 2565.91	2.4	9.8	100.6	2	277.1	0.6	8.1	2.2
09-06 2566.24	2.5	9	93.1	1	256.4	0.7	7.4	2.4
09-06 2566.40	2.8	9.3	90.9	1	330.5	0.5	7.9	2.7
09-06 2566.69	2.3	11.6	144.6	2	193.9	0.7	10.6	2.5
09-06 2568.93	1.8	7.6	91.7	2	247.8	0.3	7.1	1.5
09-06 2569.27	0.7	2.7	37.1	<1	310.7	0.2	2.6	0.8
09-06 2569.85	0.5	2.4	31	<1	330.6	0.1	2.4	0.8
09-06 2571.37	0.7	3.8	41.6	<1	261.2	0.2	2.9	0.8
09-06 2572.29	0.8	2.5	32.1	<1	361.7	0.2	2.4	0.6
09-06 2572.86	0.5	2.1	33.9	<1	283.1	0.1	2.4	0.6
09-06 2574.00	4.4	10.2	106	3	177.2	0.6	9.8	3.2
02-02 3075.85	0.3	1.7	15.4	<1	356.1	0.1	1.3	1.7
02-02 3114.50	0.4	1.2	17.1	<1	1552.1	0.1	1	0.6
02-02 3115.40	0.7	1.9	25.1	<1	366.1	0.2	1.9	1.6
02-02 3118.50	1.1	4.7	69	<1	290.4	0.2	3.9	1.5
Pulp Duplicates								
02-02 3118.50	1.1	4.7	69	<1	290.4	0.2	3.9	1.5
02-02 3118.50								
09-06 2572.86	0.5	2.1	33.9	<1	283.1	0.1	2.4	0.6
09-06 2572.86								
02-02 3115.40	0.7	1.9	25.1	<1	366.1	0.2	1.9	1.6
02-02 3115.40								
09-06 2562.61	2.4	12.7	143.7	1	122.5	0.7	10.5	14.2
09-06 2562.61	2.2	12.2	145.4	2	130.7	0.7	10.2	14.3

02-02 3118.50	1.1	4.7	69	<1	290.4	0.2	3.9	1.5
02-02 3118.50								
09-06 2558.71	2.3	16.7	118.4	1	110.3	1	8.1	17.7
09-06 2558.71								
02-02 3075.85	0.3	1.7	15.4	<1	356.1	0.1	1.3	1.7
02-02 3075.85	0.4	1.5	15.4	<1	353.4	0.1	1.3	1.6
Reference Materials								
STD GS311-1								
STD GS910-4								
STD GS311-1								
STD GS910-4								
STD DS10								
STD OREAS45EA								
STD SO-18	8.9	18.5	26.4	13	408.2	6.5	9	15.1
STD SO-18	9.4	18.3	27	14	416.9	6.7	9.7	15.8
STD SO-18	9	17.8	27.3	14	396.1	6.6	9.1	14.9
STD SO-18	8.9	18.3	27.1	13	397.1	6.6	8.9	15.5
STD DS10								
STD OREAS45EA								
STD DS10								
STD OREAS45EA								
STD SO-18	9.7	20.7	29.7	14	433.9	6.3	10	16.3
STD SO-18	9.5	20.2	29.3	15	422.5	7.1	9.5	15.8
BLK								
BLK								
BLK								
BLK	<0.1	<0.1	0.4	<1	<0.5	<0.1	<0.2	<0.1
BLK	<0.1	<0.1	<0.1	<1	<0.5	<0.1	<0.2	<0.1
BLK								
BLK								
BLK	<0.1	<0.1	<0.1	<1	<0.5	<0.1	<0.2	<0.1
Prep Wash								
G1	3.8	21.1	117	1	742.3	1.2	8.1	2.9
G1	4.7	23	128.1	1	788.7	1.3	10.1	2.9

Table 25. Continued

Guidex 09-06	V	W	Zr	Y	La	Ce	Pr	Nd
	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
MDL	8	0.5	0.1	0.1	0.1	0.1	0.02	0.3
Sample								
09-06 2546.00	112	0.6	74.8	26	35.9	63.4	7.44	28.1
09-06 2546.845	156	0.9	97	20.5	38.7	65.6	7.47	27
09-06 2548.94	122	0.8	77.3	20	40.3	68.1	7.66	27.4
09-06 2549.65	156	1.3	103.8	19.2	43.6	71.1	8.18	28.5
09-06 2551.14	158	1	117.8	22.9	46.3	80.1	9.18	33.4
09-06 2552.93	154	1	94.5	32.1	44.6	77	9.03	34.9
09-06 2553.59	158	<0.5	84.8	31.8	46.3	76.5	9	33.5
09-06 2555.09	151	1	99.6	32.9	53.5	91.5	10.55	37.1
09-06 2556.52	232	1.9	157.5	22.9	56.9	85.7	9.66	33.9
09-06 2557.13	426	1.3	141.5	28.9	57.2	87.7	9.98	36.9
09-06 2558.20	14	<0.5	5.8	24.8	16.7	31	4.58	19
09-06 2558.30	289	1.6	119.3	22.1	49.7	70.3	7.9	28.5
09-06 2558.71	260	0.9	94.7	19.4	34.4	53.2	6.19	22.4
09-06 2559.77	105	<0.5	39	18.8	23.6	35.4	4.58	18.4
09-06 2560.48	239	7.7	111.6	24.4	31.3	50.6	6.11	23.9
09-06 2561.06	40	<0.5	93.7	26.4	22.7	43.5	5.38	20.3
09-06 2562.61	226	1	83.4	24	42.6	67.1	8.52	32.1
09-06 2563.07	189	0.7	56.8	34.4	41.1	60.6	8.06	30.2
09-06 2563.49	154	0.9	96	23.7	32.8	58.4	6.68	24.9
09-06 2564.02	121	0.9	98.2	23.2	37	65.4	7.42	27.9
09-06 2565.91	59	0.9	90.8	17.8	28.4	54.5	5.96	20.8
09-06 2566.24	64	0.6	91.2	19.6	27	53.7	5.88	22.2
09-06 2566.40	76	0.7	97.8	19.6	28.4	58.2	6.27	23.6
09-06 2566.69	88	1.1	82.2	15	33.4	58.5	6.09	21.8
09-06 2568.93	56	0.7	60.6	15.4	26	51.2	5.58	20.7
09-06 2569.27	39	<0.5	27.1	15.6	17.8	33.3	4.43	19.3
09-06 2569.85	24	<0.5	21.5	13.9	13.7	27.7	3.8	16
09-06 2571.37	28	<0.5	24	13.8	16.7	28.7	3.42	12.4
09-06 2572.29	23	<0.5	22.2	10	12.6	23.5	2.76	11.4
09-06 2572.86	26	<0.5	22	9.7	12.5	21.9	2.56	10
09-06 2574.00	126	1.2	161.9	22.7	30.5	58.9	6.75	23.6
02-02 3075.85	52	<0.5	16.3	8.9	9.6	14.9	1.82	6.8
02-02 3114.50	14	<0.5	13.7	8.2	6.8	14.7	1.82	7.1
02-02 3115.40	23	<0.5	26	9	10.4	19.2	2.4	9
02-02 3118.50	50	<0.5	40	13.5	19.1	31.8	3.81	14.4
Pulp Duplicates								

02-02 3118.50	50	<0.5	40	13.5	19.1	31.8	3.81	14.4
02-02 3118.50								
09-06 2572.86	26	<0.5	22	9.7	12.5	21.9	2.56	10
09-06 2572.86								
02-02 3115.40	23	<0.5	26	9	10.4	19.2	2.4	9
02-02 3115.40								
09-06 2562.61	226	1	83.4	24	42.6	67.1	8.52	32.1
09-06 2562.61	226	1.3	83.2	24.7	42.7	67.6	8.55	31.4
02-02 3118.50	50	<0.5	40	13.5	19.1	31.8	3.81	14.4
02-02 3118.50								
09-06 2558.71	260	0.9	94.7	19.4	34.4	53.2	6.19	22.4
09-06 2558.71								
02-02 3075.85	52	<0.5	16.3	8.9	9.6	14.9	1.82	6.8
02-02 3075.85	53	<0.5	16.7	9.5	9.4	15.6	1.88	6.8
Reference Materials								
STD GS311-1								
STD GS910-4								
STD GS311-1								
STD GS910-4								
STD DS10								
STD OREAS45EA								
STD SO-18	178	12.6	275.6	28.8	12.9	27.1	3.1	12.6
STD SO-18	182	18.9	286.7	28.9	13.4	28.8	3.32	14
STD SO-18	187	13.5	278	28.6	13.6	28	3.15	12.4
STD SO-18	181	13.7	270.9	28.1	12.6	25.5	3.32	12.7
STD DS10								
STD OREAS45EA								
STD DS10								
STD OREAS45EA								
STD SO-18	178	14.5	308.2	30.3	12.7	27.5	3.35	13
STD SO-18	180	16.2	302.1	30.7	13	28.3	3.26	13.5
BLK								
BLK								
BLK								
BLK	<8	<0.5	<0.1	<0.1	<0.1	<0.1	<0.02	<0.3
BLK	<8	<0.5	<0.1	<0.1	<0.1	<0.1	<0.02	<0.3
BLK								
BLK								
BLK	<8	<0.5	<0.1	<0.1	0.1	<0.1	<0.02	<0.3
Prep Wash								

G1	52	<0.5	135.8	15.5	30.1	58.6	6.3	23.1
G1	52	<0.5	159.5	15.8	35.5	68.2	7.15	24.6

Table 25. Continued

Guidex 09-06	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
	0.05	0.02	0.05	0.01	0.05	0.02	0.03	0.01
Sample								
09-06 2546.00	5.27	1.15	5.08	0.72	3.92	0.75	2.18	0.34
09-06 2546.845	4.8	0.99	4.13	0.61	3.58	0.75	2.15	0.32
09-06 2548.94	4.5	0.93	3.88	0.58	3.22	0.68	1.94	0.29
09-06 2549.65	4.52	0.96	4.06	0.6	3.42	0.7	1.99	0.3
09-06 2551.14	5.47	1.1	4.83	0.69	4.04	0.83	2.24	0.33
09-06 2552.93	6.12	1.35	6.06	0.85	4.94	0.97	2.67	0.37
09-06 2553.59	5.77	1.21	5.43	0.77	4.49	0.86	2.46	0.38
09-06 2555.09	6.35	1.34	5.95	0.83	4.79	0.97	2.61	0.44
09-06 2556.52	5.19	1.04	4.19	0.61	3.36	0.69	2.16	0.31
09-06 2557.13	5.69	1.19	5.14	0.72	3.85	0.85	2.24	0.34
09-06 2558.20	3.44	0.76	3.69	0.51	2.73	0.52	1.41	0.21
09-06 2558.30	4.47	0.95	3.96	0.55	3.06	0.72	1.87	0.26
09-06 2558.71	3.69	0.87	3.32	0.5	2.72	0.61	1.82	0.26
09-06 2559.77	2.74	0.58	2.82	0.4	2.39	0.49	1.23	0.18
09-06 2560.48	4.22	0.93	4.09	0.58	3.38	0.72	2.03	0.29
09-06 2561.06	3.57	0.66	3.73	0.61	3.56	0.76	2.02	0.31
09-06 2562.61	5.47	1.07	5.03	0.67	3.95	0.75	2.03	0.28
09-06 2563.07	5.44	1.13	4.91	0.74	4.05	0.87	2.52	0.34
09-06 2563.49	4.47	0.89	4.19	0.59	3.42	0.7	2	0.3
09-06 2564.02	5.07	0.97	4.27	0.61	3.52	0.7	2.23	0.31
09-06 2565.91	3.87	0.88	3.33	0.52	3.14	0.62	1.8	0.26
09-06 2566.24	3.81	0.78	3.45	0.52	3.03	0.64	1.75	0.23
09-06 2566.40	4.18	0.86	3.74	0.6	3.32	0.65	1.83	0.29
09-06 2566.69	3.26	0.62	2.72	0.42	2.48	0.52	1.49	0.22
09-06 2568.93	3.7	0.71	3	0.48	2.71	0.52	1.52	0.21
09-06 2569.27	3.8	0.84	3.78	0.52	2.89	0.51	1.31	0.18
09-06 2569.85	3.01	0.72	2.88	0.44	2.34	0.44	1	0.14
09-06 2571.37	2.24	0.45	2.2	0.33	1.75	0.4	1.04	0.13
09-06 2572.29	1.96	0.39	1.75	0.27	1.33	0.29	0.71	0.11
09-06 2572.86	1.7	0.36	1.75	0.25	1.33	0.29	0.8	0.1
09-06 2574.00	4.75	1.01	4.43	0.68	3.98	0.77	2.17	0.35
02-02 3075.85	1.31	0.3	1.24	0.22	1.17	0.25	0.84	0.1

02-02 3114.50	1.24	0.24	1.34	0.19	1.05	0.21	0.63	0.07
02-02 3115.40	1.74	0.4	1.71	0.24	1.48	0.25	0.71	0.09
02-02 3118.50	2.38	0.53	2.29	0.32	1.79	0.37	1.17	0.16
Pulp Duplicates								
02-02 3118.50	2.38	0.53	2.29	0.32	1.79	0.37	1.17	0.16
02-02 3118.50								
09-06 2572.86	1.7	0.36	1.75	0.25	1.33	0.29	0.8	0.1
09-06 2572.86								
02-02 3115.40	1.74	0.4	1.71	0.24	1.48	0.25	0.71	0.09
02-02 3115.40								
09-06 2562.61	5.47	1.07	5.03	0.67	3.95	0.75	2.03	0.28
09-06 2562.61	5.68	1.1	4.93	0.7	3.58	0.73	1.98	0.3
02-02 3118.50	2.38	0.53	2.29	0.32	1.79	0.37	1.17	0.16
02-02 3118.50								
09-06 2558.71	3.69	0.87	3.32	0.5	2.72	0.61	1.82	0.26
09-06 2558.71								
02-02 3075.85	1.31	0.3	1.24	0.22	1.17	0.25	0.84	0.1
02-02 3075.85	1.39	0.32	1.38	0.21	1.11	0.27	0.73	0.12
Reference Materials								
STD GS311-1								
STD GS910-4								
STD GS311-1								
STD GS910-4								
STD DS10								
STD OREAS45EA								
STD SO-18	2.64	0.77	2.95	0.47	2.72	0.58	1.68	0.27
STD SO-18	2.84	0.85	3.18	0.45	3.11	0.69	1.94	0.29
STD SO-18	2.85	0.8	2.83	0.46	2.99	0.62	1.61	0.26
STD SO-18	2.73	0.85	2.97	0.48	2.73	0.56	1.68	0.26
STD DS10								
STD OREAS45EA								
STD DS10								
STD OREAS45EA								
STD SO-18	2.81	0.83	2.95	0.49	3.2	0.63	1.81	0.27
STD SO-18	2.83	0.94	3.06	0.51	2.92	0.66	1.92	0.29
BLK								
BLK								
BLK								
BLK	<0.05	<0.02	<0.05	<0.01	<0.05	<0.02	<0.03	<0.01
BLK	<0.05	<0.02	<0.05	<0.01	<0.05	<0.02	<0.03	<0.01

BLK								
BLK								
BLK	<0.05	<0.02	<0.05	<0.01	<0.05	<0.02	<0.03	<0.01
Prep Wash								
G1	3.77	1.02	3.35	0.46	2.65	0.55	1.62	0.26
G1	4.32	1.05	3.27	0.48	2.5	0.57	1.67	0.27

Table 25. Continued

Guidex 09-06	Yb	Lu	Mo	Cu	Pb	Zn	Ni	As
	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
MDL	0.05	0.01	0.1	0.1	0.1	1	0.1	0.5
Sample								
09-06 2546.00	1.98	0.31	1.4	33.6	13.3	55	40.6	9.4
09-06 2546.845	1.99	0.3	11.7	43.2	23.4	61	69.2	13.1
09-06 2548.94	1.81	0.28	6.4	35.3	22.4	32	45.8	9.9
09-06 2549.65	1.85	0.3	16	68.5	34.5	332	71.2	13.1
09-06 2551.14	2.21	0.33	13.1	63.7	32.1	65	72.4	13.6
09-06 2552.93	2.32	0.35	4.5	34.4	17	78	40.3	11.2
09-06 2553.59	2.31	0.33	9.8	37.3	21	96	47	10.5
09-06 2555.09	2.46	0.38	17.9	28	22.8	115	56.4	14.1
09-06 2556.52	2	0.31	32.9	52.4	45.5	96	112.6	23
09-06 2557.13	2.26	0.33	32.2	37.9	39.1	104	103.1	25.6
09-06 2558.20	1.18	0.17	1.4	3.7	2.3	135	3	1.2
09-06 2558.30	1.81	0.25	38.2	70.6	57.9	27	159.9	24.5
09-06 2558.71	1.58	0.25	39.2	49.6	39.3	15	102.2	17.9
09-06 2559.77	1.1	0.16	7	16.8	12.6	12	25.4	5.3
09-06 2560.48	1.87	0.28	44.4	54.7	69.3	23	134.4	24.3
09-06 2561.06	1.86	0.28	4.2	15.4	28	9	21.6	7.8
09-06 2562.61	1.88	0.26	23.2	76.5	51.6	26	81.5	14.6
09-06 2563.07	2.2	0.31	10.1	49	27.9	25	52.6	8.6
09-06 2563.49	1.86	0.28	16.9	74.5	52.4	29	64.7	12.3
09-06 2564.02	2.23	0.31	1.4	50.3	15	38	50.7	5.3
09-06 2565.91	1.78	0.28	1.9	37.3	33.1	25	35.3	5.1
09-06 2566.24	1.67	0.25	2.1	40.5	38.7	23	35.2	6
09-06 2566.40	1.79	0.27	3.5	63.4	50.8	25	34.9	7
09-06 2566.69	1.49	0.22	1.2	62.2	33	44	53.6	5.3
09-06 2568.93	1.54	0.21	0.2	14	9.3	25	23.2	5.5
09-06 2569.27	1.05	0.15	0.3	16.8	9.7	14	14.2	9.3
09-06 2569.85	0.78	0.12	0.1	15.1	6.6	11	9.6	8.3
09-06 2571.37	0.94	0.13	0.1	5.9	2.3	13	8.8	1.6

09-06 2572.29	0.66	0.09	0.3	5.5	8.5	11	10.9	4.9
09-06 2572.86	0.66	0.1	0.2	5.9	6.1	13	11.1	8.8
09-06 2574.00	2.24	0.35	0.7	25.9	29.8	86	22.4	10.4
02-02 3075.85	0.66	0.09	5.3	25.7	29.1	6	14.9	13.3
02-02 3114.50	0.39	0.07	0.3	7.1	2.9	4	5.8	<0.5
02-02 3115.40	0.61	0.09	0.6	7.7	4.4	5	8.3	5.5
02-02 3118.50	0.98	0.15	0.6	18.2	5.6	12	17.5	2.4
Pulp Duplicates								
02-02 3118.50	0.98	0.15	0.6	18.2	5.6	12	17.5	2.4
02-02 3118.50								
09-06 2572.86	0.66	0.1	0.2	5.9	6.1	13	11.1	8.8
09-06 2572.86								
02-02 3115.40	0.61	0.09	0.6	7.7	4.4	5	8.3	5.5
02-02 3115.40			0.7	7.6	4	5	8.3	5.3
09-06 2562.61	1.88	0.26	23.2	76.5	51.6	26	81.5	14.6
09-06 2562.61	1.74	0.28						
02-02 3118.50	0.98	0.15	0.6	18.2	5.6	12	17.5	2.4
02-02 3118.50			0.5	17	5.3	12	18.5	2.2
09-06 2558.71	1.58	0.25	39.2	49.6	39.3	15	102.2	17.9
09-06 2558.71			38.7	49.6	40.9	15	102	17
02-02 3075.85	0.66	0.09	5.3	25.7	29.1	6	14.9	13.3
02-02 3075.85	0.6	0.1						
Reference Materials								
STD GS311-1								
STD GS910-4								
STD GS311-1								
STD GS910-4								
STD DS10			14.5	150.7	144.4	346	73.5	45
STD OREAS45EA			1.7	705.5	15.1	32	390.4	11.5
STD SO-18	1.78	0.28						
STD SO-18	1.9	0.27						
STD SO-18	1.7	0.28						
STD SO-18	1.77	0.25						
STD DS10			15.1	157.9	164	349	74.6	44.1
STD OREAS45EA			1.8	709.6	15.6	33	391	12
STD DS10			13.3	152.3	154.2	365	74	45.9
STD OREAS45EA			1.4	644.7	14.9	30	351.8	8.8
STD SO-18	1.75	0.26						
STD SO-18	1.76	0.26						
BLK								

BLK								
BLK			<0.1	<0.1	<0.1	<1	<0.1	<0.5
BLK	<0.05	<0.01						
BLK	<0.05	<0.01						
BLK			<0.1	<0.1	<0.1	<1	<0.1	<0.5
BLK			<0.1	<0.1	<0.1	<1	<0.1	<0.5
BLK	<0.05	<0.01						
Prep Wash								
G1	1.77	0.29	0.8	4.1	2.8	44	3.2	<0.5
G1	1.73	0.28	0.6	3	2.8	45	4.2	<0.5

Table 25. Continued

Guidex 09-06	Cd	Sb	Bi	Ag	Au	Hg	Tl	Se
	PPM	PPM	PPM	PPM	PPB	PPM	PPM	PPM
	0.1	0.1	0.1	0.1	0.5	0.01	0.1	0.5
Sample								
09-06 2546.00	0.1	0.2	0.2	<0.1	<0.5	0.04	0.2	1.2
09-06 2546.845	0.1	0.3	0.3	<0.1	0.5	0.07	0.5	1.5
09-06 2548.94	<0.1	0.3	0.2	<0.1	<0.5	0.06	0.4	0.5
09-06 2549.65	1.1	0.5	0.3	<0.1	1.1	0.09	0.5	1.9
09-06 2551.14	0.2	0.6	0.3	0.1	<0.5	0.08	0.4	2.2
09-06 2552.93	0.6	0.6	0.2	<0.1	<0.5	0.07	0.2	2.3
09-06 2553.59	0.8	0.7	0.2	0.1	0.9	0.09	0.4	1.5
09-06 2555.09	1.3	0.7	0.1	0.1	0.8	0.09	0.5	2.7
09-06 2556.52	1	0.9	0.2	0.3	<0.5	0.18	0.7	4.3
09-06 2557.13	1.3	1.2	0.2	0.2	<0.5	0.16	1	7
09-06 2558.20	1.4	0.3	<0.1	<0.1	<0.5	0.04	0.3	0.9
09-06 2558.30	0.1	1.8	0.3	0.3	<0.5	0.27	0.7	7.7
09-06 2558.71	<0.1	1.6	0.2	0.2	0.6	0.18	0.6	5.9
09-06 2559.77	<0.1	0.4	<0.1	<0.1	<0.5	0.06	0.1	1.3
09-06 2560.48	0.1	2.2	0.3	0.3	0.7	0.27	1.4	6.8
09-06 2561.06	<0.1	0.9	0.1	<0.1	<0.5	0.09	<0.1	<0.5
09-06 2562.61	<0.1	0.9	0.2	0.2	<0.5	0.15	0.2	5.3
09-06 2563.07	<0.1	0.8	0.2	0.2	<0.5	0.09	<0.1	2.9
09-06 2563.49	<0.1	0.7	0.3	0.1	<0.5	0.18	0.2	3.9
09-06 2564.02	<0.1	<0.1	0.2	<0.1	<0.5	0.05	0.1	0.6
09-06 2565.91	<0.1	0.1	0.2	<0.1	<0.5	0.06	<0.1	<0.5
09-06 2566.24	<0.1	0.2	0.2	<0.1	<0.5	0.07	<0.1	<0.5
09-06 2566.40	0.2	0.4	0.2	<0.1	<0.5	0.09	<0.1	0.6

09-06 2566.69	<0.1	0.2	0.3	0.1	<0.5	0.08	<0.1	<0.5
09-06 2568.93	<0.1	<0.1	0.2	<0.1	0.8	0.02	<0.1	<0.5
09-06 2569.27	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
09-06 2569.85	<0.1	<0.1	<0.1	<0.1	0.7	0.02	<0.1	<0.5
09-06 2571.37	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
09-06 2572.29	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
09-06 2572.86	<0.1	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
09-06 2574.00	<0.1	0.8	0.4	<0.1	1.1	0.07	0.2	0.6
02-02 3075.85	<0.1	1	<0.1	<0.1	<0.5	0.03	0.2	3.8
02-02 3114.50	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
02-02 3115.40	<0.1	0.1	<0.1	<0.1	<0.5	0.01	0.1	<0.5
02-02 3118.50	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
Pulp Duplicates								
02-02 3118.50	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
02-02 3118.50								
09-06 2572.86	<0.1	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
09-06 2572.86								
02-02 3115.40	<0.1	0.1	<0.1	<0.1	<0.5	0.01	0.1	<0.5
02-02 3115.40	<0.1	0.1	<0.1	<0.1	<0.5	0.02	0.1	<0.5
09-06 2562.61	<0.1	0.9	0.2	0.2	<0.5	0.15	0.2	5.3
09-06 2562.61								
02-02 3118.50	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
02-02 3118.50	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
09-06 2558.71	<0.1	1.6	0.2	0.2	0.6	0.18	0.6	5.9
09-06 2558.71	0.2	1.4	0.2	0.2	0.5	0.17	0.7	5.8
02-02 3075.85	<0.1	1	<0.1	<0.1	<0.5	0.03	0.2	3.8
02-02 3075.85								
Reference Materials								
STD GS311-1								
STD GS910-4								
STD GS311-1								
STD GS910-4								
STD DS10	2.4	9.3	12.4	2	98.6	0.26	4.6	2.5
STD OREAS45EA	<0.1	0.4	0.3	0.3	51	0.01	<0.1	1.6
STD SO-18								
STD SO-18								
STD SO-18								
STD SO-18								
STD DS10	2.6	7.6	13.9	2.1	95.5	0.32	5.2	2.4
STD OREAS45EA	<0.1	0.3	0.3	0.3	51.2	<0.01	0.1	1

STD DS10	2.8	7.6	12.7	2.3	53.1	0.32	4.8	1.9
STD OREAS45EA	<0.1	0.3	0.2	0.2	51.7	<0.01	<0.1	0.7
STD SO-18								
STD SO-18								
BLK								
BLK								
BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
BLK								
BLK								
BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
BLK								
Prep Wash								
G1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	0.3	<0.5
G1	<0.1	<0.1	<0.1	<0.1	1.4	<0.01	0.3	<0.5

C.1.2 Leco TOC and Rockeval Results

Table 26. Leco TOC and Rockeval Results for Guidex 09-06

Well Name	Depth (ft)	Sample Type	Sample Prep	Leco	SRA
	Top			TOC	S1
Guidex 09-06	2546	Core	NOPR	0.74	1.05
Guidex 09-06	2546.845	Core	NOPR	1.65	1.17
Guidex 09-06	2548.94	Core	NOPR	0.81	0.58
Guidex 09-06	2549.65	Core	NOPR	2.11	1.17
Guidex 09-06	2551.14	Core	NOPR	2.37	1.43
Guidex 09-06	2552.93	Core	NOPR	2.02	1.25
Guidex 09-06	2553.59	Core	NOPR	3.02	2.08
Guidex 09-06	2555.09	Core	NOPR	2.30	1.51
Guidex 09-06	2556.52	Core	NOPR	4.12	2.85
Guidex 09-06	2557.13	Core	NOPR	3.59	2.42
Guidex 09-06	2558.2	Core	NOPR	0.56	0.51
Guidex 09-06	2558.3	Core	NOPR	5.02	3.14
Guidex 09-06	2558.71	Core	NOPR	5.54	3.99
Guidex 09-06	2559.77	Core	NOPR	2.11	1.13
Guidex 09-06	2560.48	Core	NOPR	5.10	3.78
Guidex 09-06	2561.06	Core	NOPR	1.36	1.18

Guidex 09-06	2562.61	Core	NOPR	4.50	2.77
Guidex 09-06	2563.07	Core	NOPR	5.46	3.24
Guidex 09-06	2563.49	Core	NOPR	5.26	3.63
Guidex 09-06	2564.02	Core	NOPR	1.02	0.60
Guidex 09-06	2565.91	Core	NOPR	2.42	1.43
Guidex 09-06	2566.24	Core	NOPR	2.65	1.72
Guidex 09-06	2566.4	Core	NOPR	2.65	2.00
Guidex 09-06	2566.69	Core	NOPR	3.41	1.95
Guidex 09-06	2568.93	Core	NOPR	0.24	0.10
Guidex 09-06	2569.27	Core	NOPR	0.12	0.07
Guidex 09-06	2569.85	Core	NOPR	0.16	0.06
Guidex 09-06	2571.37	Core	NOPR	0.21	0.05
Guidex 09-06	2572.29	Core	NOPR	0.13	0.07
Guidex 09-06	2572.86	Core	NOPR	0.14	0.04

Table 26. Continued

Well Name	Depth (ft)			Tmax	HI	OI
	Top	S2	S3	(°C)		
Guidex 09-06	2546	1.75	0.38	443	238	52
Guidex 09-06	2546.845	3.89	0.29	445	236	18
Guidex 09-06	2548.94	1.63	0.28	445	202	35
Guidex 09-06	2549.65	5.15	0.25	445	245	12
Guidex 09-06	2551.14	6.09	0.31	445	257	13
Guidex 09-06	2552.93	5.38	0.44	448	267	22
Guidex 09-06	2553.59	8.88	0.43	445	294	14
Guidex 09-06	2555.09	6.49	0.40	444	283	17
Guidex 09-06	2556.52	15.82	0.30	444	384	7
Guidex 09-06	2557.13	13.64	0.37	444	380	10
Guidex 09-06	2558.2	1.12	0.33	432	201	59
Guidex 09-06	2558.3	21.09	0.48	444	420	10
Guidex 09-06	2558.71	23.42	0.30	442	423	5
Guidex 09-06	2559.77	5.91	0.34	445	280	16
Guidex 09-06	2560.48	22.48	0.29	442	441	6
Guidex 09-06	2561.06	3.53	0.26	440	259	19
Guidex 09-06	2562.61	16.33	0.37	445	363	8
Guidex 09-06	2563.07	24.86	0.28	444	456	5
Guidex 09-06	2563.49	23.82	0.27	443	453	5
Guidex 09-06	2564.02	1.92	0.36	445	188	35
Guidex 09-06	2565.91	6.65	0.31	444	275	13

Guidex 09-06	2566.24	7.61	0.35	443	287	13
Guidex 09-06	2566.4	9.80	0.28	443	370	11
Guidex 09-06	2566.69	10.83	0.25	445	318	7
Guidex 09-06	2568.93	0.23	0.33	439	95	136
Guidex 09-06	2569.27	0.09	0.34	436	75	283
Guidex 09-06	2569.85	0.10	0.34	435	63	213
Guidex 09-06	2571.37	0.06	0.26	442	28	122
Guidex 09-06	2572.29	0.07	0.26	440	53	195
Guidex 09-06	2572.86	0.03	0.25	428	21	175

Table 26. Continued

Well Name	Depth (ft)	S2/S3	S1/TOC*100	PI
	Top			
Guidex 09-06	2546	4.61	143	0.38
Guidex 09-06	2546.845	13.41	71	0.23
Guidex 09-06	2548.94	5.82	72	0.26
Guidex 09-06	2549.65	20.60	56	0.19
Guidex 09-06	2551.14	19.65	60	0.19
Guidex 09-06	2552.93	12.23	62	0.19
Guidex 09-06	2553.59	20.65	69	0.19
Guidex 09-06	2555.09	16.23	66	0.19
Guidex 09-06	2556.52	52.73	69	0.15
Guidex 09-06	2557.13	36.86	67	0.15
Guidex 09-06	2558.2	3.39	92	0.31
Guidex 09-06	2558.3	43.94	63	0.13
Guidex 09-06	2558.71	78.07	72	0.15
Guidex 09-06	2559.77	17.38	53	0.16
Guidex 09-06	2560.48	77.52	74	0.14
Guidex 09-06	2561.06	13.58	87	0.25
Guidex 09-06	2562.61	44.14	62	0.15
Guidex 09-06	2563.07	88.79	59	0.12
Guidex 09-06	2563.49	88.22	69	0.13
Guidex 09-06	2564.02	5.33	59	0.24
Guidex 09-06	2565.91	21.45	59	0.18
Guidex 09-06	2566.24	21.74	65	0.18
Guidex 09-06	2566.4	35.00	75	0.17
Guidex 09-06	2566.69	43.32	57	0.15
Guidex 09-06	2568.93	0.70	41	0.30
Guidex 09-06	2569.27	0.26	58	0.44

Guidex 09-06	2569.85	0.29	37	0.38
Guidex 09-06	2571.37	0.23	23	0.45
Guidex 09-06	2572.29	0.27	53	0.50
Guidex 09-06	2572.86	0.12	28	0.57

C.2 Complete Geochemical Results for Shell 02-22

C.2.1 Major, Minor and Trace Element Results Including Acme Internal Standards

Table 27. Major, Minor and Trace Element Results Including Acme Internal Standards for Shell 02-22

		Analyte	Wgt	SiO2	Al2O3	Fe2O3	MgO	CaO
		Unit	KG	%	%	%	%	%
		MDL	0.01	0.01	0.01	0.04	0.01	0.01
Well ID	Sample	Type						
Shell 02_22	3068.1	Drill Core	0.02	45.95	15.36	5.51	2.66	10.7
Shell 02_22	3068.5	Drill Core	0.02	45.78	15.13	5.31	2.66	11.06
Shell 02_22	3069.7	Drill Core	0.02	47.61	15.98	5.32	2.7	9.3
Shell 02_22	3070.5	Drill Core	0.03	46.48	15.26	5.2	2.59	10.54
Shell 02_22	3071.5	Drill Core	0.02	52.36	17.36	6.41	2.79	4.14
Shell 02_22	3072.5	Drill Core	0.02	63.08	7.96	3.12	1.47	8.26
Shell 02_22	3073.5	Drill Core	0.03	61.91	7.6	3.33	2.14	8.58
Shell 02_22	3074.5	Drill Core	0.03	57.13	8.17	4.15	3.14	9.26
Shell 02_22	3075.5	Drill Core	0.02	60.91	7.49	3.14	1.88	9.62
Shell 02_22	3076.5	Drill Core	0.02	66.39	7.27	3.31	1.47	6.94
Shell 02_22	3077.22	Drill Core	0.02	62.98	3.7	2.02	1.29	13.89
Shell 02_22	3077.5	Drill Core	0.03	67.06	5.73	2.79	1.21	8.77
Shell 02_22	3078.1	Drill Core	0.02	47.21	7.11	3.36	1.47	18.85
Shell 02_22	3078.8	Drill Core	0.03	42.89	9.72	3.87	2.13	16.88
Shell 02_22	3079.6	Drill Core	0.02	33.06	6.93	3.68	2.37	25.31
Shell 02_22	3080.4	Drill Core	0.03	54.1	8.61	3.77	1.46	12.75
Shell 02_22	3081.5	Drill Core	0.02	55.98	9.56	4.26	1.51	10.28
Shell 02_22	3082.5	Drill Core	0.03	49.96	7.29	3.18	1.49	16.75
Shell 02_22	3083.5	Drill Core	0.04	47.19	7.56	4.48	1.78	16.08
Shell 02_22	3084.5	Drill Core	0.04	64.24	10.62	3.17	1.68	4.9

Shell 02_22	3085.2	Drill Core	0.02	59.51	11.4	3.34	1.91	6.55
Shell 02_22	3085.5	Drill Core	0.03	51.42	10.3	3.09	2.35	12.87
Shell 02_22	3086.24	Drill Core	0.02	43	7.81	2.63	2.24	19.5
Shell 02_22	3086.75	Drill Core	0.03	44.24	8.04	2.58	2.11	18.63
Shell 02_22	3087.68	Drill Core	0.03	45.25	8.04	2.65	2.01	18.11
Shell 02_22	3088.5	Drill Core	0.03	43.73	7.97	2.77	2.02	18.84
Shell 02_22	3089.5	Drill Core	0.03	41.94	7.58	4.15	2.03	19.92
Shell 02_22	3090.45	Drill Core	0.02	60.64	4.86	2.06	1.44	13.13
Shell 02_22	3091.4	Drill Core	0.02	62.49	4.67	2.28	1.58	12.23
Shell 02_22	3092.5	Drill Core	0.03	62.51	6.03	2.76	1.34	10.75
Shell 02_22	3093.5	Drill Core	0.03	63.33	6.02	2.53	1.23	11.84
Shell 02_22	3094.75	Drill Core	0.02	62.97	6.71	2.65	1.31	9.32
Shell 02_22	3095.5	Drill Core	0.03	52.47	9.06	4.17	1.63	12.32
Shell 02_22	3095.9	Drill Core	0.04	51.18	7.53	2.05	1.59	16.52
Shell 02_22	3096.5	Drill Core	0.04	48.51	7.74	2.42	1.7	17.14
Shell 02_22	3097.5	Drill Core	0.03	60.28	7.46	2.67	1.35	10.34
Shell 02_22	3098.5	Drill Core	0.03	63.12	8.65	3.2	1.36	7.19
Shell 02_22	3099.5	Drill Core	0.04	58.22	8.45	3.22	1.42	10.09
Shell 02_22	3100.5	Drill Core	0.04	63.77	7.88	2.94	1.3	7.79
Shell 02_22	3101.5	Drill Core	0.04	55.7	10.02	4.79	1.48	9.21
Shell 02_22	3102.5	Drill Core	0.03	59.52	8.63	4	1.34	8.98
Shell 02_22	3103.5	Drill Core	0.02	56.73	10.11	4.33	1.53	8.21
Shell 02_22	3104	Drill Core	0.03	51.59	7.48	3.43	1.32	15.56
Shell 02_22	3105.5	Drill Core	0.04	56.11	12.67	3.84	1.71	6.25
Shell 02_22	3106.39	Drill Core	0.02	27.15	4.17	6.09	1.46	28.65
Shell 02_22	3106.5	Drill Core	0.04	30.26	5.07	3.11	1.56	30.67
Shell 02_22	3107.5	Drill Core	0.04	50.84	10.71	3.45	1.88	11.53
Shell 02_22	3108.5	Drill Core	0.03	54.6	11	5.79	1.69	5.51
Shell 02_22	3109.05	Drill Core	0.02	39.71	6.56	4.18	4.63	18.7
Shell 02_22	3109.5	Drill Core	0.02	41.65	8.18	4.21	4.1	16.16
Shell 02_22	3109.6	Drill Core	0.02	25.39	4.35	2.58	2.79	32.32
Shell 02_22	3110.5	Drill Core	0.03	56.39	12.64	3.64	1.66	7.58
Shell 02_22	3111.37	Drill Core	0.02	42.74	7.7	3.55	2.08	18.84
Shell 02_22	3111.5	Drill Core	0.02	57.25	10.29	3.3	1.3	8.6
Shell 02_22	3112.5	Drill Core	0.02	60.36	8.5	3.03	1.14	8.94
Shell 02_22	3112.95	Drill Core	0.02	59.83	11.89	4.05	1.57	5.17
Shell 02_22	3113.3	Drill Core	0.02	45.05	12.19	3.86	1.83	13.88
Shell 02_22	3116.5	Drill Core	0.01	40.63	13.09	3.75	2	17
Shell 02_22	3116.85	Drill Core	0.02	35.59	11.14	3.37	1.85	22.05
Shell 02_22	3119.5	Drill Core	0.03	16.79	2.99	1.14	0.91	39.91
Shell 02_22	3120.5	Drill Core	0.02	47.16	9.77	3.7	2.19	15.21

Shell 02_22	3121.5	Drill Core	0.03	45.64	13.09	4.03	2.01	13.01
Shell 02_22	3121.6	Drill Core	0.02	43.37	12.26	4.3	1.99	14.86
Shell 02_22	3122.5	Drill Core	0.02	24.44	4.77	2.31	1.48	34.2
Shell 02_22	3122.74	Drill Core	0.02	46.43	11.72	3.48	1.8	13.1
Shell 02_22	3123.5	Drill Core	0.03	52.05	11.47	3.61	1.79	10.37
Shell 02_22	3124.5	Drill Core	0.03	47.11	8.55	3.23	1.49	15.48
Shell 02_22	3124.9	Drill Core	0.02	34.9	6.39	4.44	1.34	24.58
Shell 02_22	3125.5	Drill Core	0.02	53.48	12.64	4.32	2.03	7.89
Shell 02_22	3126.5	Drill Core	0.03	52.52	15.75	4.25	2.27	7.22
Shell 02_22	3127.5	Drill Core	0.03	54.43	16.56	4.6	2.21	4.3
Shell 02_22	3128.5	Drill Core	0.02	51.44	15.83	4.57	2.27	6.83
Shell 02_22	3129.5	Drill Core	0.03	45.04	14.07	6.11	2.32	11.31
Shell 02_22	3130.5	Drill Core	0.03	48.15	14.42	4.21	2.34	10.33
Shell 02_22	3131.5	Drill Core	0.03	52.61	15.89	4.62	2.4	6.4
Shell 02_22	3132.5	Drill Core	0.03	47.83	14.84	4.34	2.37	10.16
Shell 02_22	3133.5	Drill Core	0.02	42.26	13.46	4.12	2.16	14.88
Shell 02_22	3134.5	Drill Core	0.03	49.5	15.73	4.78	2.52	8.63
Shell 02_22	3135.5	Drill Core	0.03	49.69	16.32	4.94	2.52	7.81
Shell 02_22	3136.5	Drill Core	0.02	48.15	16	4.73	2.47	9.26
Shell 02_22	3137.5	Drill Core	0.03	45.35	15.77	4.47	2.36	11.42
Shell 02_22	3137.66	Drill Core	0.02	37.73	12.73	4.26	2.08	19.16
Shell 02_22	3139.5	Drill Core	0.03	19.53	5.88	2.41	2.03	34.68
Shell 02_22	3141.1	Drill Core	0.03	58.16	11.49	3.99	1.64	5.62
	Pulp Duplicates							
	3071.5	Drill Core	0.02	52.36	17.36	6.41	2.79	4.14
	3071.5	REP						
	3101.5	Drill Core	0.04	55.7	10.02	4.79	1.48	9.21
	3101.5	REP						
	3132.5	Drill Core	0.03	47.83	14.84	4.34	2.37	10.16
	3132.5	REP						
	3141.1	Drill Core	0.03	58.16	11.49	3.99	1.64	5.62
	3141.1	REP						
	3079.6	Drill Core	0.02	33.06	6.93	3.68	2.37	25.31
	3079.6	REP						
	3109.5	Drill Core	0.02	41.65	8.18	4.21	4.1	16.16
	3109.5	REP						
	3073.5	Drill Core	0.03	61.91	7.6	3.33	2.14	8.58
	3073.5	REP		62.02	7.62	3.28	2.11	8.56
	3103.5	Drill Core	0.02	56.73	10.11	4.33	1.53	8.21
	3103.5	REP		56.69	10.12	4.32	1.53	8.21

	3128.5	Drill Core	0.02	51.44	15.83	4.57	2.27	6.83
	3128.5	REP		51.27	15.96	4.51	2.25	6.83
	3126.5	Drill Core	0.03	52.52	15.75	4.25	2.27	7.22
	3126.5	REP		52.59	15.72	4.2	2.26	7.22
	Preparation Duplicates							
	3070.5	Drill Core	0.03	46.48	15.26	5.2	2.59	10.54
	3070.5	DUP		46.55	15.22	5.08	2.55	10.67
	3099.5	Drill Core	0.04	58.22	8.45	3.22	1.42	10.09
	3099.5	DUP		58.05	8.5	3.21	1.43	10.16
	3128.5	Drill Core	0.02	51.44	15.83	4.57	2.27	6.83
	3128.5	DUP		51.48	15.84	4.52	2.25	6.81
	Reference Materials							
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD DS9	STD						
	STD OREAS45EA	STD						
	STD DS9	STD						
	STD OREAS45EA	STD						
	STD DS9	STD						
	STD OREAS45EA	STD						
	STD SO-18	STD		58.14	14.18	7.57	3.33	6.36
	STD SO-18	STD		58	14.18	7.67	3.36	6.37
	STD SO-18	STD		58.52	14.07	7.51	3.32	6.3

	STD SO-18	STD		58.45	14.08	7.59	3.31	6.3
	STD SO-18	STD		58.23	14.19	7.51	3.35	6.39
	STD SO-18	STD		58.11	14.12	7.49	3.33	6.39
	STD SO-18	STD		58.19	14.02	7.7	3.37	6.36
	STD SO-18	STD		57.66	14.34	7.71	3.4	6.45
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	<0.01
	BLK	BLK		<0.01	<0.01	0.04	<0.01	0.03
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	0.01
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	<0.01
	Prep Wash							
	G1	Prep Blank		66.19	16.52	3.53	1.02	3.7
	G1	Prep Blank		66.47	16.22	3.5	1.16	3.45

Table 27. Continued

		Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Ni
		%	%	%	%	%	%	PPM
	MDL	0.01	0.01	0.01	0.01	0.01	0.002	20
Well ID	Sample							
Shell 02_22	3068.1	0.42	4.19	0.59	0.08	0.06	0.013	62
Shell 02_22	3068.5	0.42	4.09	0.58	0.08	0.06	0.014	46
Shell 02_22	3069.7	0.45	4.43	0.6	0.07	0.05	0.013	53
Shell 02_22	3070.5	0.37	4.18	0.59	0.08	0.05	0.014	47
Shell 02_22	3071.5	0.49	4.83	0.66	0.09	0.03	0.014	89
Shell 02_22	3072.5	0.31	2.31	0.39	0.13	0.02	0.012	90
Shell 02_22	3073.5	0.32	2.25	0.41	0.1	0.03	0.009	80
Shell 02_22	3074.5	0.4	2.44	0.46	0.11	0.04	0.014	84
Shell 02_22	3075.5	0.38	2.19	0.4	0.13	0.03	0.009	81
Shell 02_22	3076.5	0.42	2.09	0.39	0.16	0.02	0.014	92
Shell 02_22	3077.22	0.42	0.96	0.22	0.22	0.03	0.005	40
Shell 02_22	3077.5	0.36	1.61	0.33	0.13	0.02	0.014	68
Shell 02_22	3078.1	0.35	2.03	0.35	0.09	0.03	0.008	73
Shell 02_22	3078.8	0.42	2.8	0.46	0.11	0.04	0.014	72
Shell 02_22	3079.6	0.39	2.11	0.36	0.06	0.05	0.007	40
Shell 02_22	3080.4	0.36	2.52	0.42	0.11	0.03	0.013	94

Shell 02_22	3081.5	0.38	2.73	0.44	0.15	0.02	0.01	106
Shell 02_22	3082.5	0.33	2.11	0.33	0.1	0.03	0.01	71
Shell 02_22	3083.5	0.37	2.21	0.33	0.11	0.03	0.009	72
Shell 02_22	3084.5	0.4	3.2	0.47	0.1	0.02	0.013	75
Shell 02_22	3085.2	0.41	3.42	0.49	0.12	0.02	0.012	72
Shell 02_22	3085.5	0.51	3.01	0.42	0.18	0.03	0.014	53
Shell 02_22	3086.24	0.41	2.33	0.41	0.16	0.03	0.009	57
Shell 02_22	3086.75	0.39	2.38	0.41	0.15	0.03	0.013	55
Shell 02_22	3087.68	0.36	2.42	0.41	0.15	0.03	0.009	52
Shell 02_22	3088.5	0.35	2.4	0.4	0.15	0.03	0.013	58
Shell 02_22	3089.5	0.34	2.3	0.39	0.17	0.03	0.01	67
Shell 02_22	3090.45	0.34	1.49	0.25	0.15	0.02	0.014	50
Shell 02_22	3091.4	0.41	1.4	0.25	0.14	0.02	0.007	41
Shell 02_22	3092.5	0.36	1.91	0.3	0.13	0.02	0.012	43
Shell 02_22	3093.5	0.37	1.96	0.3	0.11	0.02	0.008	62
Shell 02_22	3094.75	0.34	2.2	0.32	0.1	0.02	0.013	71
Shell 02_22	3095.5	0.41	2.95	0.43	0.11	0.02	0.01	113
Shell 02_22	3095.9	0.38	2.38	0.37	0.16	0.03	0.012	42
Shell 02_22	3096.5	0.36	2.46	0.39	0.19	0.03	0.009	58
Shell 02_22	3097.5	0.37	2.53	0.37	0.18	0.02	0.012	82
Shell 02_22	3098.5	0.34	2.88	0.41	0.16	0.02	0.013	89
Shell 02_22	3099.5	0.35	2.84	0.41	0.18	0.02	0.009	99
Shell 02_22	3100.5	0.31	2.7	0.38	0.16	0.02	0.011	76
Shell 02_22	3101.5	0.33	3.31	0.46	0.16	0.02	0.01	97
Shell 02_22	3102.5	0.34	2.92	0.42	0.14	0.02	0.011	96
Shell 02_22	3103.5	0.34	3.41	0.47	0.16	0.02	0.01	113
Shell 02_22	3104	0.32	2.46	0.35	0.14	0.02	0.011	71
Shell 02_22	3105.5	0.36	4.34	0.57	0.17	0.02	0.012	102
Shell 02_22	3106.39	0.17	1.35	0.17	0.13	0.04	0.011	30
Shell 02_22	3106.5	0.23	1.58	0.21	0.12	0.05	0.005	28
Shell 02_22	3107.5	0.31	3.69	0.42	0.11	0.03	0.011	71
Shell 02_22	3108.5	0.35	3.94	0.52	0.22	0.02	0.013	226
Shell 02_22	3109.05	0.47	2.14	0.39	0.08	0.05	0.017	36
Shell 02_22	3109.5	0.44	2.91	0.47	0.11	0.05	0.011	52
Shell 02_22	3109.6	0.48	1.34	0.27	0.1	0.1	0.012	33
Shell 02_22	3110.5	0.32	4.59	0.49	0.1	0.02	0.01	56
Shell 02_22	3111.37	0.31	2.79	0.35	0.16	0.03	0.01	60
Shell 02_22	3111.5	0.31	3.81	0.5	0.13	0.02	0.01	112
Shell 02_22	3112.5	0.32	3.27	0.41	0.13	0.02	0.014	90
Shell 02_22	3112.95	0.28	4.29	0.54	0.13	0.02	0.011	117
Shell 02_22	3113.3	0.26	4.09	0.52	0.15	0.03	0.014	98

Shell 02_22	3116.5	0.26	4.49	0.48	0.1	0.03	0.011	45
Shell 02_22	3116.85	0.26	3.71	0.42	0.09	0.03	0.011	40
Shell 02_22	3119.5	0.17	0.98	0.12	0.07	0.06	0.003	<20
Shell 02_22	3120.5	0.22	3.47	0.38	0.09	0.03	0.014	48
Shell 02_22	3121.5	0.29	4.42	0.48	0.13	0.03	0.012	67
Shell 02_22	3121.6	0.27	4.19	0.45	0.34	0.03	0.014	58
Shell 02_22	3122.5	0.21	1.61	0.2	0.08	0.05	0.004	28
Shell 02_22	3122.74	0.28	4.09	0.47	0.15	0.02	0.013	60
Shell 02_22	3123.5	0.27	4.14	0.43	0.12	0.03	0.011	46
Shell 02_22	3124.5	0.29	3.11	0.37	0.14	0.03	0.012	64
Shell 02_22	3124.9	0.27	2.26	0.29	0.07	0.05	0.007	35
Shell 02_22	3125.5	0.25	4.68	0.52	0.13	0.03	0.015	70
Shell 02_22	3126.5	0.27	5.53	0.6	0.1	0.03	0.013	46
Shell 02_22	3127.5	0.31	5.96	0.63	0.12	0.02	0.016	69
Shell 02_22	3128.5	0.3	5.62	0.62	0.1	0.03	0.016	67
Shell 02_22	3129.5	0.25	4.8	0.54	0.08	0.03	0.014	78
Shell 02_22	3130.5	0.26	5.11	0.57	0.09	0.03	0.013	51
Shell 02_22	3131.5	0.28	5.44	0.63	0.1	0.03	0.015	52
Shell 02_22	3132.5	0.27	5.13	0.56	0.09	0.03	0.014	43
Shell 02_22	3133.5	0.26	4.58	0.49	0.09	0.04	0.014	50
Shell 02_22	3134.5	0.27	5.15	0.57	0.07	0.04	0.014	53
Shell 02_22	3135.5	0.27	5.3	0.58	0.07	0.03	0.016	45
Shell 02_22	3136.5	0.3	5.18	0.56	0.1	0.04	0.015	62
Shell 02_22	3137.5	0.29	5.14	0.53	0.07	0.04	0.015	30
Shell 02_22	3137.66	0.25	4.12	0.43	0.13	0.08	0.011	48
Shell 02_22	3139.5	0.13	1.87	0.22	0.05	0.1	0.007	22
Shell 02_22	3141.1	0.34	4.11	0.53	0.14	0.02	0.012	108
	Pulp Duplicates							
	3071.5	0.49	4.83	0.66	0.09	0.03	0.014	89
	3071.5							
	3101.5	0.33	3.31	0.46	0.16	0.02	0.01	97
	3101.5							
	3132.5	0.27	5.13	0.56	0.09	0.03	0.014	43
	3132.5							
	3141.1	0.34	4.11	0.53	0.14	0.02	0.012	108
	3141.1							
	3079.6	0.39	2.11	0.36	0.06	0.05	0.007	40
	3079.6							
	3109.5	0.44	2.91	0.47	0.11	0.05	0.011	52
	3109.5							

	3073.5	0.32	2.25	0.41	0.1	0.03	0.009	80
	3073.5	0.31	2.22	0.41	0.11	0.03	0.008	67
	3103.5	0.34	3.41	0.47	0.16	0.02	0.01	113
	3103.5	0.34	3.44	0.47	0.17	0.02	0.01	117
	3128.5	0.3	5.62	0.62	0.1	0.03	0.016	67
	3128.5	0.3	5.75	0.63	0.09	0.03	0.015	70
	3126.5	0.27	5.53	0.6	0.1	0.03	0.013	46
	3126.5	0.27	5.54	0.6	0.11	0.03	0.014	49
	Preparation Duplicates							
	3070.5	0.37	4.18	0.59	0.08	0.05	0.014	47
	3070.5	0.36	4.19	0.59	0.07	0.05	0.014	50
	3099.5	0.35	2.84	0.41	0.18	0.02	0.009	99
	3099.5	0.36	2.87	0.41	0.19	0.02	0.01	100
	3128.5	0.3	5.62	0.62	0.1	0.03	0.016	67
	3128.5	0.29	5.64	0.63	0.11	0.03	0.015	82
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD SO-18	3.66	2.15	0.7	0.79	0.4	0.546	46
	STD SO-18	3.67	2.15	0.7	0.8	0.4	0.554	41
	STD SO-18	3.61	2.1	0.69	0.79	0.4	0.543	54
	STD SO-18	3.62	2.11	0.69	0.77	0.4	0.548	38
	STD SO-18	3.67	2.09	0.68	0.78	0.4	0.543	35
	STD SO-18	3.76	2.21	0.69	0.78	0.41	0.548	30
	STD SO-18	3.65	2.1	0.69	0.81	0.4	0.533	44
	STD SO-18	3.68	2.11	0.69	0.82	0.41	0.542	50
	BLK							

	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
	Prep Wash							
	G1	3.67	3.78	0.37	0.12	0.1	<0.002	<20
	G1	3.71	3.78	0.41	0.18	0.1	0.008	<20

Table 27. Continued

		Sc	LOI	Sum	Ba	Be	Co	Cs
		PPM	%	%	PPM	PPM	PPM	PPM
	MDL	1	-5.1	0.01	1	1	0.2	0.1
Well ID	Sample							
Shell 02_22	3068.1	15	14.3	99.83	375	3	20.8	7.5
Shell 02_22	3068.5	15	14.6	99.83	379	3	18.7	7.8
Shell 02_22	3069.7	16	13.3	99.82	368	4	17.4	8.3
Shell 02_22	3070.5	15	14.5	99.84	338	2	18.3	7.8
Shell 02_22	3071.5	17	10.6	99.82	408	4	24.1	9.8
Shell 02_22	3072.5	8	12.7	99.78	181	3	11	3.9
Shell 02_22	3073.5	8	13.1	99.82	323	2	8.3	4.4
Shell 02_22	3074.5	8	14.5	99.81	403	1	10.3	4.1
Shell 02_22	3075.5	7	13.6	99.84	258	1	8.9	3.9
Shell 02_22	3076.5	7	11.3	99.81	356	2	10.7	3.3
Shell 02_22	3077.22	4	14.1	99.83	460	<1	4.2	1.8
Shell 02_22	3077.5	6	11.8	99.84	318	2	8	3.1
Shell 02_22	3078.1	7	19	99.88	162	<1	9.2	3.7
Shell 02_22	3078.8	10	20.5	99.84	209	2	12.4	5
Shell 02_22	3079.6	7	25.5	99.86	187	1	7.5	2.9
Shell 02_22	3080.4	9	15.7	99.81	191	2	11.2	4.7
Shell 02_22	3081.5	9	14.5	99.81	220	2	13.1	4.6
Shell 02_22	3082.5	7	18.3	99.85	159	3	10.5	4.5
Shell 02_22	3083.5	8	19.7	99.85	159	1	14.2	4.1
Shell 02_22	3084.5	10	11	99.77	290	2	11.7	6
Shell 02_22	3085.2	10	12.7	99.83	227	2	11	6

Shell 02_22	3085.5	10	15.6	99.84	316	1	9.7	5.2
Shell 02_22	3086.24	7	21.3	99.83	205	<1	9.3	4
Shell 02_22	3086.75	8	20.9	99.83	198	1	9.1	4
Shell 02_22	3087.68	8	20.4	99.85	189	<1	9.9	4.2
Shell 02_22	3088.5	8	21.2	99.85	194	3	9.8	4.5
Shell 02_22	3089.5	7	21	99.85	199	<1	12.3	3.3
Shell 02_22	3090.45	5	15.5	99.88	206	<1	5.7	2.5
Shell 02_22	3091.4	4	14.4	99.86	380	<1	5.6	2.1
Shell 02_22	3092.5	5	13.8	99.87	194	2	8.1	2.9
Shell 02_22	3093.5	6	12.2	99.88	154	3	8.2	2.4
Shell 02_22	3094.75	6	13.9	99.84	252	1	9.5	3.3
Shell 02_22	3095.5	8	16.2	99.82	186	1	14.9	4
Shell 02_22	3095.9	7	17.7	99.88	185	1	7.5	3
Shell 02_22	3096.5	7	18.9	99.86	184	<1	10.7	3.9
Shell 02_22	3097.5	7	14.3	99.86	158	2	9.7	2.8
Shell 02_22	3098.5	8	12.5	99.86	176	1	12.2	3.7
Shell 02_22	3099.5	8	14.6	99.86	168	2	11.9	4.2
Shell 02_22	3100.5	7	12.6	99.86	169	<1	10.6	3.7
Shell 02_22	3101.5	9	14.4	99.86	219	3	13	5
Shell 02_22	3102.5	8	13.5	99.86	171	2	12.7	4.4
Shell 02_22	3103.5	9	14.5	99.86	214	3	14.3	5.1
Shell 02_22	3104	7	17.2	99.87	178	2	9.6	3.6
Shell 02_22	3105.5	11	13.8	99.84	278	3	16.1	7.1
Shell 02_22	3106.39	4	23.3	92.65	122	2	16.7	1.3
Shell 02_22	3106.5	5	27	99.88	133	1	9.5	2.2
Shell 02_22	3107.5	10	16.9	99.86	219	2	14	5.6
Shell 02_22	3108.5	10	16.1	99.79	275	<1	24	5.3
Shell 02_22	3109.05	6	22.9	99.87	302	<1	7.8	2.2
Shell 02_22	3109.5	8	21.6	99.85	278	3	10.4	2.8
Shell 02_22	3109.6	4	30.2	99.89	204	2	4.7	1.1
Shell 02_22	3110.5	10	12.4	99.86	255	2	14.3	5.6
Shell 02_22	3111.37	7	21.3	99.87	160	3	11.7	3.9
Shell 02_22	3111.5	9	14.3	99.86	206	<1	12.8	4.8
Shell 02_22	3112.5	8	13.7	99.87	166	2	9.6	3.9
Shell 02_22	3112.95	11	12.1	99.85	238	<1	13.6	7
Shell 02_22	3113.3	11	18	99.84	312	3	16.7	6.5
Shell 02_22	3116.5	11	18	99.85	254	2	15.9	7.4
Shell 02_22	3116.85	9	21.4	99.88	201	1	13.3	5.3
Shell 02_22	3119.5	3	36.8	99.94	89	<1	2.5	1.1
Shell 02_22	3120.5	9	17.6	99.85	195	2	18.6	5.6
Shell 02_22	3121.5	12	16.7	99.86	254	3	12.5	7.2

Shell 02_22	3121.6	11	17.8	99.87	225	2	13	6.8
Shell 02_22	3122.5	5	30.5	99.9	119	1	7.3	2.2
Shell 02_22	3122.74	11	18.3	99.86	225	1	11	6.6
Shell 02_22	3123.5	11	15.6	99.86	232	3	10.7	6
Shell 02_22	3124.5	8	20	99.86	167	3	7.2	4.5
Shell 02_22	3124.9	6	25.3	99.87	173	<1	9.9	3.1
Shell 02_22	3125.5	12	13.8	99.84	291	<1	14.6	6.6
Shell 02_22	3126.5	14	11.3	99.82	351	2	15.1	8.2
Shell 02_22	3127.5	15	10.7	99.83	346	2	16.5	8.5
Shell 02_22	3128.5	14	12.2	99.84	330	1	16.3	8.8
Shell 02_22	3129.5	13	15.3	99.86	300	<1	19.6	7.4
Shell 02_22	3130.5	13	14.3	99.84	316	1	15.4	8.3
Shell 02_22	3131.5	14	11.4	99.84	378	4	15.9	9.3
Shell 02_22	3132.5	13	14.2	99.85	343	2	14.7	8.5
Shell 02_22	3133.5	12	17.5	99.84	301	2	14.7	8.1
Shell 02_22	3134.5	14	12.6	99.85	367	2	16.4	9.1
Shell 02_22	3135.5	14	12.3	99.83	398	2	16.4	10.1
Shell 02_22	3136.5	14	13.1	99.85	371	2	17.1	9.6
Shell 02_22	3137.5	14	14.4	99.85	353	2	15.1	9.2
Shell 02_22	3137.66	12	18.8	99.83	323	<1	22	7.4
Shell 02_22	3139.5	5	33	99.9	201	2	6.4	2.9
Shell 02_22	3141.1	10	13.7	99.78	313	<1	14.7	6.8
	Pulp Duplicates							
	3071.5	17	10.6	99.82	408	4	24.1	9.8
	3071.5							
	3101.5	9	14.4	99.86	219	3	13	5
	3101.5							
	3132.5	13	14.2	99.85	343	2	14.7	8.5
	3132.5							
	3141.1	10	13.7	99.78	313	<1	14.7	6.8
	3141.1							
	3079.6	7	25.5	99.86	187	1	7.5	2.9
	3079.6							
	3109.5	8	21.6	99.85	278	3	10.4	2.8
	3109.5							
	3073.5	8	13.1	99.82	323	2	8.3	4.4
	3073.5	8	13.1	99.81	321	1	8.8	4.5
	3103.5	9	14.5	99.86	214	3	14.3	5.1
	3103.5	9	14.5	99.86	214	1	14.8	5.4
	3128.5	14	12.2	99.84	330	1	16.3	8.8

	3128.5	14	12.2	99.85	332	3	16.1	8.6
	3126.5	14	11.3	99.82	351	2	15.1	8.2
	3126.5	14	11.3	99.82	339	2	14.8	8.7
	Preparation Duplicates							
	3070.5	15	14.5	99.84	338	2	18.3	7.8
	3070.5	15	14.5	99.84	358	4	17.6	8.1
	3099.5	8	14.6	99.86	168	2	11.9	4.2
	3099.5	8	14.6	99.86	181	3	11.1	3.8
	3128.5	14	12.2	99.84	330	1	16.3	8.8
	3128.5	14	12.2	99.84	330	3	17.4	8.3
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD SO-18	24	1.9	99.73	534	<1	27.3	7
	STD SO-18	24	1.9	99.75	485	2	26.5	6.1
	STD SO-18	23	1.9	99.76	517	<1	26.9	7.6
	STD SO-18	24	1.9	99.77	464	1	25.5	6.3

	STD SO-18	23	1.9	99.73	556	2	25.2	7.8
	STD SO-18	23	1.9	99.74	523	1	26.8	7.5
	STD SO-18	23	1.9	99.73	497	4	26	7.3
	STD SO-18	23	1.9	99.74	507	2	28.6	7.7
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<1	0	0.03	<1	<1	<0.2	<0.1
	BLK	<1	0	0.09	<1	<1	<0.2	<0.1
	BLK	<1	0	<0.01	<1	<1	<0.2	<0.1
	BLK	<1	0	<0.01	<1	2	0.3	<0.1
	Prep Wash							
	G1	6	0.7	99.69	1096	3	4.9	4.9
	G1	6	0.7	99.69	1126	2	4.7	4.7

Table 27. Continued

		Ga	Hf	Nb	Rb	Sn	Sr	Ta
		PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.5	0.1	0.1	0.1	1	0.5	0.1
Well ID	Sample							
Shell 02_22	3068.1	19.6	2.2	9.7	153.8	2	227.9	0.6
Shell 02_22	3068.5	19.6	2	10.4	153.1	2	238	0.8
Shell 02_22	3069.7	19.9	2.5	9.7	156.1	3	198.7	0.8
Shell 02_22	3070.5	18.4	2.8	9.7	154.2	2	201.4	0.6
Shell 02_22	3071.5	22	2.3	10.6	172.5	3	142.3	0.7
Shell 02_22	3072.5	9.4	1.9	9.2	82.8	1	150.1	0.6
Shell 02_22	3073.5	9.5	2.5	7.7	82.7	1	186.5	0.5
Shell 02_22	3074.5	10.3	3.6	9.1	82.9	1	202.9	0.6
Shell 02_22	3075.5	9.9	2.9	9.2	76.4	1	176.1	0.7
Shell 02_22	3076.5	9.2	2.6	8.5	72.9	<1	193.4	0.5
Shell 02_22	3077.22	3.9	1.7	4.1	32.1	<1	318.3	0.4
Shell 02_22	3077.5	6.7	1.7	6.4	54	<1	227.8	0.4
Shell 02_22	3078.1	8.8	1.6	7.7	68.2	<1	217.2	0.5
Shell 02_22	3078.8	11.4	2.4	12.5	95.4	2	316	0.8
Shell 02_22	3079.6	8.4	1.9	7.3	69.6	<1	380.6	0.3

Shell 02_22	3080.4	10.2	1.8	10.9	85.9	1	193.1	0.7
Shell 02_22	3081.5	10.7	2.8	14	97.5	2	183.5	0.8
Shell 02_22	3082.5	8.8	1.9	11.7	71.5	<1	232.4	0.7
Shell 02_22	3083.5	9.4	1.1	11.1	73	<1	293.1	0.7
Shell 02_22	3084.5	11.9	1.8	13.7	110.2	1	161.9	0.9
Shell 02_22	3085.2	12.8	2.6	14.7	117.2	2	155	1.2
Shell 02_22	3085.5	11.8	2.6	9.8	102.3	1	233.3	0.8
Shell 02_22	3086.24	8.9	2.6	10.9	76.5	<1	326.5	0.6
Shell 02_22	3086.75	9.5	1.6	12	79.7	1	334.1	0.7
Shell 02_22	3087.68	9.6	1.9	11.9	82.5	<1	330.9	0.9
Shell 02_22	3088.5	9.5	2.1	11.2	81.5	1	342.4	0.7
Shell 02_22	3089.5	8.6	2.2	10.8	73.1	1	346	0.7
Shell 02_22	3090.45	5.6	1.9	7	43.7	<1	184.3	0.3
Shell 02_22	3091.4	5.3	1.6	7.3	44.6	<1	211.2	0.5
Shell 02_22	3092.5	7.1	2	10.6	57.4	<1	182.2	0.6
Shell 02_22	3093.5	6.8	1.6	10.3	54.7	<1	168.4	0.5
Shell 02_22	3094.75	8.2	2	10.2	65.6	1	156.5	0.8
Shell 02_22	3095.5	10.7	1.4	18.1	87.5	2	209.6	0.9
Shell 02_22	3095.9	9.8	1.8	11.2	71.6	2	239.8	0.7
Shell 02_22	3096.5	10.1	2	12.6	76	1	261.2	0.7
Shell 02_22	3097.5	8.8	1.6	14.1	68.6	1	154.7	0.8
Shell 02_22	3098.5	9.6	2.1	13.2	79.3	<1	114.1	0.8
Shell 02_22	3099.5	10.1	2.2	16.5	79.4	2	154.8	0.7
Shell 02_22	3100.5	9	1.7	13.4	75.1	1	138.1	0.7
Shell 02_22	3101.5	11.4	1.5	14.6	99.4	2	155.3	0.8
Shell 02_22	3102.5	9.4	2.2	13.8	84.8	1	147.4	0.9
Shell 02_22	3103.5	11.5	2.2	15.7	101.7	1	134.9	0.9
Shell 02_22	3104	8.5	1.6	10.5	73	<1	178	0.6
Shell 02_22	3105.5	14.4	3.4	21.8	138.1	2	135	1.5
Shell 02_22	3106.39	3.9	1.3	5	45.4	<1	490.9	0.2
Shell 02_22	3106.5	5.7	1.1	5.5	48.6	<1	413.1	0.4
Shell 02_22	3107.5	12.1	1.9	13.6	107.9	2	186.1	0.7
Shell 02_22	3108.5	13	2.8	19.4	110.3	2	133.9	1
Shell 02_22	3109.05	7.2	3.3	6.4	56.6	1	197.7	0.4
Shell 02_22	3109.5	9.3	3.8	8.5	73.4	<1	208	0.6
Shell 02_22	3109.6	4.6	2.2	4.3	34.8	<1	243.3	0.4
Shell 02_22	3110.5	13.3	1.6	26.1	116.2	1	148.3	1.3
Shell 02_22	3111.37	8.5	2.1	13.4	74.1	<1	257.1	0.7
Shell 02_22	3111.5	11.2	2.3	19.8	105.1	1	155.6	1
Shell 02_22	3112.5	9.1	1.9	13.6	79.8	<1	134	1
Shell 02_22	3112.95	12.9	1.7	18.7	124.3	2	131.5	1

Shell 02_22	3113.3	13.9	1.9	13.5	120.3	2	207.1	0.9
Shell 02_22	3116.5	14.9	2.1	8.6	134.3	2	273.5	0.6
Shell 02_22	3116.85	12.4	1.7	6.9	110.8	<1	244.9	0.4
Shell 02_22	3119.5	3.1	0.7	2.6	29.8	<1	243.8	<0.1
Shell 02_22	3120.5	10.5	1.7	8.8	100.9	1	328.1	0.5
Shell 02_22	3121.5	13.5	2	8.9	139.1	<1	265.7	0.4
Shell 02_22	3121.6	14	1.7	8	133.3	2	311.6	0.6
Shell 02_22	3122.5	4.9	0.8	3.3	46.6	<1	372.3	0.2
Shell 02_22	3122.74	12.3	2	8.6	121.8	1	215.6	0.5
Shell 02_22	3123.5	13.3	1.4	9.9	113.3	<1	182.7	0.6
Shell 02_22	3124.5	9.9	1.9	8.7	84	1	275	0.5
Shell 02_22	3124.9	8	1.1	5.2	61.8	<1	230.2	0.2
Shell 02_22	3125.5	15.8	2.4	9.6	136.4	2	127.3	0.7
Shell 02_22	3126.5	16.5	2.2	10	166.2	3	146.6	0.8
Shell 02_22	3127.5	20.3	2.9	11.3	181.4	2	107.4	0.8
Shell 02_22	3128.5	19.1	2.3	10.7	174.3	2	134.7	0.8
Shell 02_22	3129.5	18.1	2.5	8.9	154.2	2	193.7	0.7
Shell 02_22	3130.5	18.3	2.5	9.9	165.7	2	192.7	0.7
Shell 02_22	3131.5	20.8	3	11.1	179.8	2	146	0.8
Shell 02_22	3132.5	19.9	2.7	9.2	167.2	2	200.1	0.7
Shell 02_22	3133.5	17.4	2.6	8.3	156.1	2	238.9	0.6
Shell 02_22	3134.5	21.7	2.5	9.5	178	2	187	0.7
Shell 02_22	3135.5	21.8	3.1	9.7	185.8	2	180.7	0.6
Shell 02_22	3136.5	20.3	2.6	8.8	182.6	2	180.9	0.8
Shell 02_22	3137.5	19.8	2.6	8.2	175	2	165.5	0.6
Shell 02_22	3137.66	17.7	2.5	7.3	150.4	2	252.4	0.6
Shell 02_22	3139.5	8.4	1.3	3.6	63.5	<1	294.7	0.2
Shell 02_22	3141.1	15	2.9	24.2	130.3	2	136.4	1.5
	Pulp Duplicates							
	3071.5	22	2.3	10.6	172.5	3	142.3	0.7
	3071.5							
	3101.5	11.4	1.5	14.6	99.4	2	155.3	0.8
	3101.5							
	3132.5	19.9	2.7	9.2	167.2	2	200.1	0.7
	3132.5							
	3141.1	15	2.9	24.2	130.3	2	136.4	1.5
	3141.1							
	3079.6	8.4	1.9	7.3	69.6	<1	380.6	0.3
	3079.6							
	3109.5	9.3	3.8	8.5	73.4	<1	208	0.6

	3109.5							
	3073.5	9.5	2.5	7.7	82.7	1	186.5	0.5
	3073.5	9.6	2.9	8.1	78.5	<1	192.2	0.6
	3103.5	11.5	2.2	15.7	101.7	1	134.9	0.9
	3103.5	11.8	1.8	15.7	100.5	2	136.9	0.8
	3128.5	19.1	2.3	10.7	174.3	2	134.7	0.8
	3128.5	19.5	2.8	11.1	170.3	2	135.1	0.7
	3126.5	16.5	2.2	10	166.2	3	146.6	0.8
	3126.5	19.6	1.9	10	166.7	3	154.5	0.7
	Preparation Duplicates							
	3070.5	18.4	2.8	9.7	154.2	2	201.4	0.6
	3070.5	19.1	2.5	10.4	157.6	2	209.9	0.5
	3099.5	10.1	2.2	16.5	79.4	2	154.8	0.7
	3099.5	9.9	2.4	16.1	80.5	2	158.5	1
	3128.5	19.1	2.3	10.7	174.3	2	134.7	0.8
	3128.5	19	2.5	10.7	176.6	2	136.8	0.6
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD DS9							

	STD OREAS45EA							
	STD SO-18	16.5	9.6	18.9	27.6	17	384.2	6.1
	STD SO-18	15.5	8.4	18.4	25.5	14	369.4	6.4
	STD SO-18	16.5	8.8	19.8	27.7	15	390.7	6.5
	STD SO-18	15.5	9.3	18.9	27.4	14	382.2	6.5
	STD SO-18	19.7	10.5	21.8	30.6	16	447.2	7.5
	STD SO-18	17.8	10.3	20.2	28.9	16	405.8	7.1
	STD SO-18	17.1	9.2	19.3	26.9	13	398.2	7.2
	STD SO-18	17.1	9.9	19.2	26.9	15	403.5	6.6
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<0.5	<0.1	<0.1	<0.1	<1	<0.5	<0.1
	BLK	<0.5	<0.1	0.3	0.4	<1	0.5	<0.1
	BLK	<0.5	<0.1	<0.1	<0.1	<1	<0.5	<0.1
	BLK	<0.5	<0.1	0.3	<0.1	<1	<0.5	<0.1
	Prep Wash							
	G1	19.6	3.7	20.7	130.8	1	777.9	1.3
	G1	19.4	3.9	24.2	137.5	2	777.8	1.4

Table 27. Continued

		Th	U	V	W	Zr	Y	La
		PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.2	0.1	8	0.5	0.1	0.1	0.1
Well ID	Sample							
Shell 02_22	3068.1	8.8	2.4	133	1	87.7	19	30.1
Shell 02_22	3068.5	9.5	2.5	136	1.8	90.8	21.3	32.6
Shell 02_22	3069.7	9.2	2.5	139	1	90.6	20.1	32
Shell 02_22	3070.5	8.9	2.7	130	0.9	90.4	20.4	32.1
Shell 02_22	3071.5	10.8	4.5	165	1.3	110.4	19.9	34.2
Shell 02_22	3072.5	6.1	6.4	155	0.8	76.9	20.4	22.3
Shell 02_22	3073.5	6	6.3	320	0.5	109.3	20.6	24.7
Shell 02_22	3074.5	6.8	7	255	0.5	140.7	23.1	27.3

Shell 02_22	3075.5	6.7	7.4	208	<0.5	106.5	22.6	26.1
Shell 02_22	3076.5	6.4	8.6	198	0.7	97.7	21.6	25.6
Shell 02_22	3077.22	3.8	4.8	73	0.5	80.6	25.7	20.5
Shell 02_22	3077.5	4.8	5.9	128	0.7	85.4	21.2	22.2
Shell 02_22	3078.1	5.4	6.7	121	<0.5	65.6	24.2	29.8
Shell 02_22	3078.8	6.9	7.4	166	0.7	93.7	24.5	34.1
Shell 02_22	3079.6	5.1	4.6	69	0.6	89.6	21.5	26.5
Shell 02_22	3080.4	6.5	7.1	312	1	76.7	24.4	30.4
Shell 02_22	3081.5	8	6.6	270	0.9	84.6	24.4	34
Shell 02_22	3082.5	5.7	5	203	0.5	64	22.5	30.6
Shell 02_22	3083.5	5.7	5.4	155	<0.5	61.4	22.2	29.8
Shell 02_22	3084.5	7.7	4.6	257	0.9	81.6	18.1	30.6
Shell 02_22	3085.2	7.9	4.8	184	0.6	88.1	21	33
Shell 02_22	3085.5	7.8	5.1	114	1	106.4	29.3	33
Shell 02_22	3086.24	7	5.7	118	0.6	93.6	29.8	33
Shell 02_22	3086.75	7	5.7	137	0.6	92.7	27.7	32.6
Shell 02_22	3087.68	6.7	4.9	135	0.7	87.2	29	35
Shell 02_22	3088.5	6.8	4.1	133	0.8	85.3	27.7	32.4
Shell 02_22	3089.5	6.3	3.8	123	0.7	84	27.7	33.6
Shell 02_22	3090.45	4.2	4	81	<0.5	61.4	19.5	22.5
Shell 02_22	3091.4	4.3	3.5	77	<0.5	76.3	21.6	22.7
Shell 02_22	3092.5	5.7	4.3	90	<0.5	77.8	20.8	26.9
Shell 02_22	3093.5	5.2	4.8	103	0.6	66.2	19.4	24.7
Shell 02_22	3094.75	5.1	5.4	186	0.6	65.6	18.1	23.5
Shell 02_22	3095.5	6.9	9.7	260	1	84.2	23.7	34.8
Shell 02_22	3095.9	10	4.7	83	0.6	74.4	26.8	32.5
Shell 02_22	3096.5	8.1	3.9	91	<0.5	79.3	27.9	31.6
Shell 02_22	3097.5	6.7	5.5	126	0.5	72.6	23	29.3
Shell 02_22	3098.5	6.5	7.4	133	1	68.1	20	29.3
Shell 02_22	3099.5	6.7	11	158	<0.5	74.2	24.5	36.6
Shell 02_22	3100.5	6.3	7.3	131	1.2	66.9	21.6	31
Shell 02_22	3101.5	7.3	8.1	133	1	70.7	24.8	35.1
Shell 02_22	3102.5	6.6	6.7	108	1	71.2	20.6	33.5
Shell 02_22	3103.5	7.3	10.7	163	1	75.5	24	33.9
Shell 02_22	3104	5.6	7.3	112	0.7	59.6	26.3	30.4
Shell 02_22	3105.5	9.5	11.1	174	0.6	93.1	25.6	41.4
Shell 02_22	3106.39	2.4	3.1	23	0.8	33.2	29.3	24.5
Shell 02_22	3106.5	3.3	3	50	<0.5	32.4	32	32.2
Shell 02_22	3107.5	6.9	5.5	133	1.2	66	23.7	34.1
Shell 02_22	3108.5	10	27.5	308	1.3	105.2	21.3	33.7
Shell 02_22	3109.05	5.2	3.2	54	0.8	134.4	26.8	22.7

Shell 02_22	3109.5	6.3	5.1	83	1.3	142.8	22.3	25
Shell 02_22	3109.6	3.2	1.9	34	<0.5	89	18.6	18.6
Shell 02_22	3110.5	9.6	2.9	90	0.8	87.5	18.4	33.4
Shell 02_22	3111.37	6	7.5	96	0.7	59.1	26.7	34.3
Shell 02_22	3111.5	8.8	11	177	0.7	85.3	22.7	35.9
Shell 02_22	3112.5	6.8	9.2	194	0.6	62.6	18.5	27.1
Shell 02_22	3112.95	8.7	9	224	0.9	83.8	16.4	33.9
Shell 02_22	3113.3	8.1	6.2	202	0.9	77	18.9	31.7
Shell 02_22	3116.5	7.5	3.1	103	1.9	67.4	15.1	28.7
Shell 02_22	3116.85	6.7	2.3	90	0.6	59.3	14.6	24
Shell 02_22	3119.5	1.8	1	32	<0.5	18	14.2	14.4
Shell 02_22	3120.5	5.6	4.5	58	1.1	62	19.3	26.8
Shell 02_22	3121.5	7	3.6	110	0.5	69	18.2	28.3
Shell 02_22	3121.6	7.4	3.2	108	0.6	67.6	22.3	29.8
Shell 02_22	3122.5	3.4	1.7	42	<0.5	29.5	21.8	23.7
Shell 02_22	3122.74	6.8	4.9	130	0.9	71.8	18.5	27.5
Shell 02_22	3123.5	7.2	3.8	120	0.6	69	19.3	29.1
Shell 02_22	3124.5	5.8	3.2	120	<0.5	62	23.6	28.8
Shell 02_22	3124.9	4.3	11.8	99	0.5	49.8	29.1	32.1
Shell 02_22	3125.5	8.1	5.6	175	1.3	80.9	21.3	31.1
Shell 02_22	3126.5	8.4	3.2	122	2	93	21.6	35.4
Shell 02_22	3127.5	10	4.5	224	1	92.9	21.4	37.4
Shell 02_22	3128.5	10.1	3.9	203	1.3	92	22.3	37.1
Shell 02_22	3129.5	8.3	2.7	132	1.1	79	21.3	33.1
Shell 02_22	3130.5	8.9	3.4	150	1.3	91.1	22.5	35.1
Shell 02_22	3131.5	10.9	3.8	174	2.4	104.2	21.9	37.6
Shell 02_22	3132.5	9.4	3.1	144	1.2	87.2	19.9	33.7
Shell 02_22	3133.5	8	3.6	146	1.3	80.4	23.5	35.1
Shell 02_22	3134.5	9.1	3	151	1	93.2	19.6	33.2
Shell 02_22	3135.5	10.1	2.7	152	1.1	96.4	18.6	34.7
Shell 02_22	3136.5	9.5	2.4	143	1.1	90.2	18.7	32.3
Shell 02_22	3137.5	8	2.1	143	0.9	83.7	15.5	29.6
Shell 02_22	3137.66	7.7	2.4	123	1.1	75.2	18.7	29.3
Shell 02_22	3139.5	3.8	1	47	0.6	44.6	10.2	14.7
Shell 02_22	3141.1	9.9	14.3	233	1	96.4	23.2	39.9
	Pulp Duplicates							
	3071.5	10.8	4.5	165	1.3	110.4	19.9	34.2
	3071.5							
	3101.5	7.3	8.1	133	1	70.7	24.8	35.1
	3101.5							

	3132.5	9.4	3.1	144	1.2	87.2	19.9	33.7
	3132.5							
	3141.1	9.9	14.3	233	1	96.4	23.2	39.9
	3141.1							
	3079.6	5.1	4.6	69	0.6	89.6	21.5	26.5
	3079.6							
	3109.5	6.3	5.1	83	1.3	142.8	22.3	25
	3109.5							
	3073.5	6	6.3	320	0.5	109.3	20.6	24.7
	3073.5	6.1	6.6	327	0.8	113.7	21.9	24
	3103.5	7.3	10.7	163	1	75.5	24	33.9
	3103.5	7.7	10.9	156	1.1	73.3	24.5	33.6
	3128.5	10.1	3.9	203	1.3	92	22.3	37.1
	3128.5	10.1	4.3	206	1.3	92	22.3	37.1
	3126.5	8.4	3.2	122	2	93	21.6	35.4
	3126.5	8.6	3.6	122	2.2	92.8	22	39.3
	Preparation Duplicates							
	3070.5	8.9	2.7	130	0.9	90.4	20.4	32.1
	3070.5	9.5	2.6	135	0.9	95.1	22.7	33.3
	3099.5	6.7	11	158	<0.5	74.2	24.5	36.6
	3099.5	6.9	10.4	158	0.8	76.5	25.5	38.1
	3128.5	10.1	3.9	203	1.3	92	22.3	37.1
	3128.5	10.2	4.2	208	1.2	93.3	22.1	37.8
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD DS9							

	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD SO-18	9.7	14.8	217	12.4	280.2	29	12.7
	STD SO-18	8.8	14.9	204	14.1	269.6	28.6	11.9
	STD SO-18	9.8	14.5	208	13.1	281.1	29.9	13.1
	STD SO-18	9.4	14.9	196	13.9	279.1	28.8	12.3
	STD SO-18	11.4	18.5	227	16.6	317.2	34	14.3
	STD SO-18	10.9	16.9	217	14.6	295	32.1	13.3
	STD SO-18	9.9	14.9	166	16.4	289.7	30.4	12.6
	STD SO-18	10.1	15.6	177	16.2	296.1	31	12.7
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<0.2	<0.1	<8	<0.5	<0.1	<0.1	<0.1
	BLK	<0.2	<0.1	<8	<0.5	0.2	<0.1	<0.1
	BLK	<0.2	<0.1	<8	<0.5	<0.1	<0.1	<0.1
	BLK	<0.2	<0.1	<8	<0.5	<0.1	<0.1	<0.1
	Prep Wash							
	G1	7.3	3.2	67	<0.5	146	14.5	25.6
	G1	8.4	3.2	65	5.2	141.2	16.9	31.5

Table 27. Continued

		Ce	Pr	Nd	Sm	Eu	Gd	Tb
		PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.1	0.02	0.3	0.05	0.02	0.05	0.01
Well ID	Sample							
Shell 02_22	3068.1	57.2	6.65	24.5	4.87	1.01	3.65	0.6
Shell 02_22	3068.5	59.8	7.21	25.4	4.87	1	4.17	0.67

Shell 02_22	3069.7	60.1	6.9	25	4.89	0.92	3.98	0.61
Shell 02_22	3070.5	63.8	7.14	26.6	5.08	1.08	4.25	0.62
Shell 02_22	3071.5	67.1	7.57	28.6	4.21	0.94	3.86	0.57
Shell 02_22	3072.5	44.6	5.54	25	3.81	0.86	3.96	0.53
Shell 02_22	3073.5	44.4	5.39	19.7	3.62	0.84	3.89	0.53
Shell 02_22	3074.5	48.6	5.93	20.5	3.83	0.84	3.97	0.6
Shell 02_22	3075.5	46.3	5.83	22.1	4.27	0.92	3.93	0.56
Shell 02_22	3076.5	47	5.92	25.3	4.58	0.89	4.07	0.59
Shell 02_22	3077.22	41.4	5.84	24.1	4.99	1.08	4.57	0.66
Shell 02_22	3077.5	40	5.03	21.8	3.59	0.65	3.81	0.55
Shell 02_22	3078.1	45.9	5.79	23.8	3.87	0.78	3.77	0.54
Shell 02_22	3078.8	57.7	6.71	25	4.54	0.9	4.34	0.59
Shell 02_22	3079.6	44.3	5.47	19.1	3.85	0.78	3.9	0.55
Shell 02_22	3080.4	52.4	5.9	23.2	4.12	0.89	3.65	0.56
Shell 02_22	3081.5	54.8	6.63	27.6	4.31	1	4.41	0.61
Shell 02_22	3082.5	48.7	5.79	23.5	3.84	0.77	3.66	0.52
Shell 02_22	3083.5	53.7	6.06	21.9	3.59	0.94	3.91	0.53
Shell 02_22	3084.5	50.3	5.58	15.7	3.78	0.76	3.18	0.48
Shell 02_22	3085.2	53.4	6.03	22.5	3.83	0.62	3.04	0.49
Shell 02_22	3085.5	61.3	7.74	28.5	5.33	1.12	5.05	0.74
Shell 02_22	3086.24	57.3	6.99	28.7	4.97	1	4.64	0.71
Shell 02_22	3086.75	57.9	6.92	29	5.17	1.01	4.98	0.61
Shell 02_22	3087.68	56	7.06	28.8	4.51	0.92	4.64	0.64
Shell 02_22	3088.5	54.1	6.79	26.3	4.3	0.99	4.16	0.61
Shell 02_22	3089.5	53	6.52	27.6	4.63	0.94	4.24	0.57
Shell 02_22	3090.45	36.2	4.42	18.6	3.17	0.7	3.1	0.46
Shell 02_22	3091.4	40.6	5.05	17.3	3.77	0.71	3.31	0.49
Shell 02_22	3092.5	43.8	5.25	22.2	3.44	0.76	3.56	0.49
Shell 02_22	3093.5	39.5	4.9	17.1	3.1	0.74	3.09	0.44
Shell 02_22	3094.75	40.1	4.94	18.1	3.19	0.71	2.9	0.44
Shell 02_22	3095.5	57.3	6.91	29.3	4.01	0.93	3.58	0.57
Shell 02_22	3095.9	54.7	6.31	22	4.15	0.92	4.01	0.56
Shell 02_22	3096.5	56.1	6.82	27.7	4.34	1	4.78	0.66
Shell 02_22	3097.5	48.8	5.57	18.7	4	0.87	4.07	0.54
Shell 02_22	3098.5	48.2	5.21	19.7	3.64	0.84	3.32	0.48
Shell 02_22	3099.5	57.6	6.4	23	4.64	0.94	4.18	0.6
Shell 02_22	3100.5	53.6	5.8	22.4	3.67	0.91	3.22	0.52
Shell 02_22	3101.5	59.6	6.92	27	4.99	1.09	4.27	0.57
Shell 02_22	3102.5	52.6	6.33	24.1	4.22	0.9	4	0.5
Shell 02_22	3103.5	55	6.79	26	4.5	0.89	4.14	0.55
Shell 02_22	3104	51.4	6.78	25.8	4.69	1	4.23	0.64

Shell 02_22	3105.5	69.5	8.24	30.8	5.17	1.04	4.41	0.64
Shell 02_22	3106.39	42.3	5.96	23.5	4.35	1.18	4.07	0.67
Shell 02_22	3106.5	50.8	6.01	25.8	4.75	1.07	4.57	0.64
Shell 02_22	3107.5	53.7	6.98	24.8	4.48	0.97	4.3	0.56
Shell 02_22	3108.5	57.4	7.46	27	4.76	1.19	4.34	0.65
Shell 02_22	3109.05	45.3	5.34	21.1	4.14	0.84	4.3	0.65
Shell 02_22	3109.5	48.4	5.51	23.5	4.29	0.81	4.14	0.61
Shell 02_22	3109.6	34.5	4.04	17.8	3.22	0.75	2.69	0.45
Shell 02_22	3110.5	61.7	6.89	23.1	4.09	0.85	3.82	0.49
Shell 02_22	3111.37	54	7.24	28.8	5.17	1.15	4.66	0.64
Shell 02_22	3111.5	58.5	7.08	23.4	4.45	0.87	3.59	0.6
Shell 02_22	3112.5	43.8	5.6	16.7	4.1	0.74	3.44	0.5
Shell 02_22	3112.95	53.6	6.39	23.2	4.06	0.77	3.14	0.45
Shell 02_22	3113.3	52.1	5.96	23.7	4.2	0.84	3.28	0.45
Shell 02_22	3116.5	49.3	5.53	18.7	3.34	0.65	2.81	0.41
Shell 02_22	3116.85	43.1	4.66	18.7	3.35	0.64	2.65	0.37
Shell 02_22	3119.5	22.9	3.2	10.3	2.32	0.53	2.35	0.3
Shell 02_22	3120.5	47.4	5.63	23.6	3.18	0.7	2.56	0.51
Shell 02_22	3121.5	48.3	5.84	22.3	3.59	0.69	3.36	0.47
Shell 02_22	3121.6	51.6	6.65	28.8	5.03	0.95	4.46	0.58
Shell 02_22	3122.5	39.1	5.08	18.7	3.94	0.85	3.17	0.51
Shell 02_22	3122.74	47.1	5.78	21.9	3.86	0.65	2.63	0.45
Shell 02_22	3123.5	52.1	6.39	27	3.92	0.8	3.2	0.47
Shell 02_22	3124.5	49.5	6.53	24.6	4.34	0.88	3.77	0.54
Shell 02_22	3124.9	51.3	6.2	24.8	4.25	0.95	4.29	0.57
Shell 02_22	3125.5	54.5	6.48	23.5	4.42	0.88	3.73	0.54
Shell 02_22	3126.5	60	7.27	26.4	4.41	0.8	3.04	0.57
Shell 02_22	3127.5	63.7	7.53	28.6	4.65	0.86	3.77	0.54
Shell 02_22	3128.5	63.8	7.61	27.9	4.69	0.92	4	0.55
Shell 02_22	3129.5	54.8	7.12	25	4.7	0.86	3.78	0.55
Shell 02_22	3130.5	58.7	7.47	29	4.65	0.93	4.13	0.57
Shell 02_22	3131.5	60.9	7.75	27	4.8	0.93	4.1	0.57
Shell 02_22	3132.5	56.5	7.19	25.6	4.47	0.9	3.85	0.55
Shell 02_22	3133.5	55.3	7.29	26.5	4.9	1	4.25	0.62
Shell 02_22	3134.5	54.7	6.91	23.6	4.52	0.82	3.81	0.54
Shell 02_22	3135.5	53.7	6.99	22.6	4.26	0.85	3.68	0.53
Shell 02_22	3136.5	52.6	6.67	24.3	4.27	0.8	3.5	0.49
Shell 02_22	3137.5	48.8	5.85	20.8	3.58	0.69	2.86	0.4
Shell 02_22	3137.66	41.1	6.22	24.4	4.3	0.9	3.8	0.52
Shell 02_22	3139.5	24.6	3.43	13.5	2.25	0.47	2.1	0.28
Shell 02_22	3141.1	60.4	7.72	26.1	4.65	0.96	3.93	0.58

	Pulp Duplicates							
	3071.5	67.1	7.57	28.6	4.21	0.94	3.86	0.57
	3071.5							
	3101.5	59.6	6.92	27	4.99	1.09	4.27	0.57
	3101.5							
	3132.5	56.5	7.19	25.6	4.47	0.9	3.85	0.55
	3132.5							
	3141.1	60.4	7.72	26.1	4.65	0.96	3.93	0.58
	3141.1							
	3079.6	44.3	5.47	19.1	3.85	0.78	3.9	0.55
	3079.6							
	3109.5	48.4	5.51	23.5	4.29	0.81	4.14	0.61
	3109.5							
	3073.5	44.4	5.39	19.7	3.62	0.84	3.89	0.53
	3073.5	46.4	5.46	21.5	3.58	0.81	3.92	0.53
	3103.5	55	6.79	26	4.5	0.89	4.14	0.55
	3103.5	55.4	6.7	26.1	4.53	0.96	3.84	0.59
	3128.5	63.8	7.61	27.9	4.69	0.92	4	0.55
	3128.5	63	7.8	27.5	4.78	0.92	3.97	0.56
	3126.5	60	7.27	26.4	4.41	0.8	3.04	0.57
	3126.5	63.4	7.5	30.4	4.65	0.98	3.85	0.58
	Preparation Duplicates							
	3070.5	63.8	7.14	26.6	5.08	1.08	4.25	0.62
	3070.5	62.3	7.29	26.3	5.21	0.96	4.25	0.65
	3099.5	57.6	6.4	23	4.64	0.94	4.18	0.6
	3099.5	56.9	6.88	27.1	4.63	1.02	4.12	0.6
	3128.5	63.8	7.61	27.9	4.69	0.92	4	0.55
	3128.5	65.4	7.73	27.8	4.62	0.92	3.96	0.56
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							

	STD GS311-1							
	STD GS910-4							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD SO-18	26.3	3.32	11.7	2.77	0.77	3.3	0.48
	STD SO-18	25.1	3.15	12.8	2.66	0.81	2.86	0.45
	STD SO-18	28	3.34	14	3.06	0.88	3.24	0.48
	STD SO-18	25.3	3.33	15.1	2.92	0.91	3	0.49
	STD SO-18	24.8	3.78	15.6	3.21	0.98	3.29	0.54
	STD SO-18	27.6	3.49	14.7	2.84	0.88	3.05	0.49
	STD SO-18	26.6	3.26	10.4	3.28	0.82	2.54	0.47
	STD SO-18	26.8	3.45	13.2	2.83	0.9	2.98	0.49
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	0.03
	Prep Wash							
	G1	49.7	5.68	21	3.63	0.96	3.28	0.44
	G1	60.8	6.79	24.6	4.67	1.06	3.87	0.52

Table 27. Continued

		Dy	Ho	Er	Tm	Yb	Lu	TOT/C
		PPM	PPM	PPM	PPM	PPM	PPM	%
	MDL	0.05	0.02	0.03	0.01	0.05	0.01	0.02
Well ID	Sample							
Shell 02_22	3068.1	3.86	0.8	2.1	0.33	2.02	0.3	3.19
Shell 02_22	3068.5	3.88	0.7	2.25	0.33	2.2	0.29	3.24
Shell 02_22	3069.7	3.82	0.7	1.9	0.33	1.97	0.3	2.98
Shell 02_22	3070.5	3.94	0.78	1.99	0.32	1.91	0.28	3.41
Shell 02_22	3071.5	3.61	0.73	2.13	0.33	1.97	0.31	2.2
Shell 02_22	3072.5	2.91	0.57	1.71	0.27	1.66	0.22	5.26
Shell 02_22	3073.5	3.06	0.68	1.69	0.25	1.75	0.3	5.08
Shell 02_22	3074.5	3.4	0.84	2.24	0.28	2.14	0.33	5.42
Shell 02_22	3075.5	3.32	0.77	2.15	0.24	1.39	0.23	5.25
Shell 02_22	3076.5	3.28	0.6	1.85	0.27	2	0.28	4.73
Shell 02_22	3077.22	4.48	0.84	2.05	0.27	1.37	0.21	5.34
Shell 02_22	3077.5	2.58	0.62	1.6	0.24	1.15	0.2	4.9
Shell 02_22	3078.1	3.52	0.7	2.16	0.27	1.94	0.26	7.41
Shell 02_22	3078.8	3.82	0.78	2.03	0.3	1.61	0.31	8.25
Shell 02_22	3079.6	3.61	0.69	2.05	0.27	1.58	0.24	9
Shell 02_22	3080.4	3.41	0.69	2.25	0.3	1.73	0.23	6.28
Shell 02_22	3081.5	3.32	0.76	2.03	0.29	1.56	0.3	5.79
Shell 02_22	3082.5	3.01	0.64	1.82	0.25	1.86	0.2	7.25
Shell 02_22	3083.5	3.11	0.7	1.52	0.28	1.55	0.23	7.83
Shell 02_22	3084.5	2.47	0.55	1.73	0.21	1.62	0.2	4.55
Shell 02_22	3085.2	3.38	0.6	1.8	0.26	1.69	0.23	5.02
Shell 02_22	3085.5	4.12	0.8	2.33	0.34	2.39	0.31	5.5
Shell 02_22	3086.24	4.08	0.81	2.16	0.35	1.99	0.28	8
Shell 02_22	3086.75	3.57	0.82	2.1	0.28	1.92	0.3	7.85
Shell 02_22	3087.68	4.06	0.62	1.92	0.31	2.19	0.31	7.76
Shell 02_22	3088.5	3.44	0.66	2.19	0.29	1.72	0.27	7.78
Shell 02_22	3089.5	3.69	0.75	1.89	0.33	1.82	0.26	8.01
Shell 02_22	3090.45	2.74	0.51	1.66	0.22	1.41	0.2	6.49
Shell 02_22	3091.4	2.49	0.59	1.62	0.22	1.11	0.2	5.76
Shell 02_22	3092.5	2.59	0.63	1.71	0.24	1.56	0.22	6.09
Shell 02_22	3093.5	2.18	0.56	1.38	0.24	1.34	0.2	6.54
Shell 02_22	3094.75	3.08	0.6	1.59	0.2	1.33	0.18	6.37
Shell 02_22	3095.5	3.59	0.71	2.06	0.3	2.3	0.28	7.17
Shell 02_22	3095.9	3.24	0.72	1.83	0.26	1.82	0.22	6.53
Shell 02_22	3096.5	3.74	0.65	2.02	0.3	1.83	0.26	6.68
Shell 02_22	3097.5	2.97	0.57	1.82	0.23	1.74	0.24	6.1

Shell 02_22	3098.5	2.48	0.62	1.54	0.22	1.27	0.21	5.58
Shell 02_22	3099.5	3.59	0.61	1.94	0.27	1.87	0.26	6.33
Shell 02_22	3100.5	3.02	0.65	1.7	0.24	1.54	0.21	5.75
Shell 02_22	3101.5	3.69	0.67	2.2	0.32	1.62	0.26	5.58
Shell 02_22	3102.5	3.14	0.64	1.61	0.28	1.84	0.21	5.7
Shell 02_22	3103.5	3.24	0.73	2	0.29	2.24	0.24	6.21
Shell 02_22	3104	3.38	0.81	2.2	0.29	1.56	0.3	6.95
Shell 02_22	3105.5	3.99	0.71	2.08	0.32	2.11	0.27	5.73
Shell 02_22	3106.39	4.08	0.68	2.13	0.3	1.91	0.28	7.92
Shell 02_22	3106.5	3.77	0.74	2.64	0.25	1.63	0.22	8.5
Shell 02_22	3107.5	3.68	0.77	2.05	0.29	1.84	0.26	6.18
Shell 02_22	3108.5	3.11	0.55	1.72	0.26	1.9	0.26	8.61
Shell 02_22	3109.05	4.1	0.83	2.23	0.36	1.98	0.34	7.53
Shell 02_22	3109.5	2.99	0.65	2.14	0.27	1.96	0.25	7.82
Shell 02_22	3109.6	2.84	0.51	1.74	0.23	1.17	0.22	9.57
Shell 02_22	3110.5	2.96	0.58	1.66	0.24	1.85	0.27	3.96
Shell 02_22	3111.37	3.52	0.71	2.05	0.26	1.76	0.27	7.87
Shell 02_22	3111.5	3.31	0.65	1.9	0.26	2.05	0.25	5.77
Shell 02_22	3112.5	2.86	0.48	1.71	0.25	1.46	0.22	5.63
Shell 02_22	3112.95	2.32	0.43	1.47	0.26	1.25	0.23	4.69
Shell 02_22	3113.3	2.61	0.63	1.83	0.24	1.28	0.21	6.05
Shell 02_22	3116.5	2.2	0.51	1.23	0.21	1.26	0.2	4.96
Shell 02_22	3116.85	2.64	0.38	1.48	0.23	1.11	0.19	6.18
Shell 02_22	3119.5	1.81	0.44	0.78	0.12	0.8	0.11	10.56
Shell 02_22	3120.5	3.14	0.54	1.63	0.22	1.61	0.32	5.32
Shell 02_22	3121.5	2.62	0.56	1.47	0.21	1.52	0.24	5.46
Shell 02_22	3121.6	4.43	0.65	1.78	0.24	1.72	0.27	5.33
Shell 02_22	3122.5	2.9	0.48	1.31	0.19	1.05	0.15	9.39
Shell 02_22	3122.74	2.2	0.47	1.43	0.2	1.57	0.2	6.84
Shell 02_22	3123.5	2.55	0.68	1.74	0.25	2.05	0.26	5.83
Shell 02_22	3124.5	3.31	0.66	1.53	0.25	1.92	0.2	8.27
Shell 02_22	3124.9	3.02	0.71	2.21	0.29	1.62	0.27	10.49
Shell 02_22	3125.5	3.14	0.64	1.78	0.28	1.7	0.26	5.64
Shell 02_22	3126.5	3.87	0.58	1.65	0.35	2.47	0.32	2.75
Shell 02_22	3127.5	3.52	0.68	1.78	0.28	1.89	0.29	2.87
Shell 02_22	3128.5	3.36	0.68	1.8	0.3	1.75	0.29	3.38
Shell 02_22	3129.5	2.94	0.62	1.75	0.28	1.64	0.26	3.64
Shell 02_22	3130.5	3.65	0.7	1.98	0.29	1.94	0.28	3.55
Shell 02_22	3131.5	3.43	0.7	2.03	0.3	2.02	0.31	2.78
Shell 02_22	3132.5	3	0.58	1.89	0.3	2.04	0.29	3.22
Shell 02_22	3133.5	3.62	0.73	2.02	0.31	1.91	0.28	4.63

Shell 02_22	3134.5	3.19	0.58	1.97	0.28	2.06	0.27	2.75
Shell 02_22	3135.5	3.51	0.67	1.81	0.29	1.92	0.29	2.41
Shell 02_22	3136.5	3.07	0.6	1.74	0.28	1.75	0.29	2.71
Shell 02_22	3137.5	2.34	0.53	1.72	0.25	1.51	0.24	3.14
Shell 02_22	3137.66	3.06	0.56	1.87	0.26	1.95	0.26	4.87
Shell 02_22	3139.5	1.96	0.32	0.97	0.13	1.01	0.13	9.42
Shell 02_22	3141.1	3.38	0.63	1.95	0.27	1.67	0.25	6.06
	Pulp Duplicates							
	3071.5	3.61	0.73	2.13	0.33	1.97	0.31	2.2
	3071.5							2.22
	3101.5	3.69	0.67	2.2	0.32	1.62	0.26	5.58
	3101.5							5.54
	3132.5	3	0.58	1.89	0.3	2.04	0.29	3.22
	3132.5							3.23
	3141.1	3.38	0.63	1.95	0.27	1.67	0.25	6.06
	3141.1							
	3079.6	3.61	0.69	2.05	0.27	1.58	0.24	9
	3079.6							
	3109.5	2.99	0.65	2.14	0.27	1.96	0.25	7.82
	3109.5							
	3073.5	3.06	0.68	1.69	0.25	1.75	0.3	5.08
	3073.5	3.69	0.65	1.82	0.28	1.9	0.27	
	3103.5	3.24	0.73	2	0.29	2.24	0.24	6.21
	3103.5	3.39	0.67	1.59	0.26	1.79	0.26	
	3128.5	3.36	0.68	1.8	0.3	1.75	0.29	3.38
	3128.5	3.51	0.67	2.08	0.29	2.11	0.29	
	3126.5	3.87	0.58	1.65	0.35	2.47	0.32	2.75
	3126.5	3.09	0.79	1.78	0.33	2.22	0.35	
	Preparation Duplicates							
	3070.5	3.94	0.78	1.99	0.32	1.91	0.28	3.41
	3070.5	4	0.71	2.52	0.34	2.08	0.31	3.35
	3099.5	3.59	0.61	1.94	0.27	1.87	0.26	6.33
	3099.5	2.99	0.7	1.75	0.24	1.84	0.24	6.26
	3128.5	3.36	0.68	1.8	0.3	1.75	0.29	3.38
	3128.5	3.19	0.66	1.95	0.28	1.94	0.29	3.35
	Reference Materials							
	STD GS311-1							1.05

	STD GS910-4							2.86
	STD GS311-1							0.98
	STD GS910-4							2.78
	STD GS311-1							1.04
	STD GS910-4							2.84
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD DS9							
	STD OREAS45EA							
	STD SO-18	2.73	0.61	1.86	0.26	1.46	0.26	
	STD SO-18	2.61	0.53	1.54	0.27	1.93	0.24	
	STD SO-18	2.59	0.58	1.87	0.24	2.1	0.25	
	STD SO-18	2.84	0.58	1.69	0.28	1.71	0.27	
	STD SO-18	3.28	0.71	1.88	0.32	1.91	0.29	
	STD SO-18	2.93	0.59	1.83	0.29	1.73	0.27	
	STD SO-18	2.68	0.64	1.79	0.28	1.77	0.29	
	STD SO-18	2.86	0.55	1.75	0.28	1.72	0.3	
	BLK							<0.02
	BLK							<0.02
	BLK							<0.02
	BLK							
	BLK							
	BLK							
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	0.05	<0.02	0.06	<0.01	<0.05	0.02	
	Prep Wash							
	G1	2.45	0.44	1.55	0.25	1.53	0.27	<0.02

	G1	2.83	0.64	1.85	0.27	1.76	0.31	<0.02

Table 27. Continued

		TOT/S	Mo	Cu	Pb	Zn	Ni	As
		%	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.02	0.1	0.1	0.1	1	0.1	0.5
Well ID	Sample							
Shell 02_22	3068.1	0.72	1.4	38.8	17.7	43	50.4	6.6
Shell 02_22	3068.5	0.5	1.2	35.9	15.3	42	42	4.7
Shell 02_22	3069.7	0.53	1.8	32.2	13	37	46.3	4.6
Shell 02_22	3070.5	0.75	2.1	33	13.1	35	42.1	5
Shell 02_22	3071.5	1.51	7.8	47	46.7	37	73.5	20
Shell 02_22	3072.5	0.94	12.9	41.7	37.7	735	73.5	13
Shell 02_22	3073.5	0.85	19.9	23.9	28.2	41	50.4	8.3
Shell 02_22	3074.5	1.11	17.8	37.5	32.3	13	65.9	12.4
Shell 02_22	3075.5	1.06	14	34.5	30.9	88	66.5	11.8
Shell 02_22	3076.5	1.22	23.7	41.5	42.1	189	74	14.3
Shell 02_22	3077.22	0.72	5	18.3	15.7	6	31	6
Shell 02_22	3077.5	1.15	15.3	29	32.3	12	58.1	11.7
Shell 02_22	3078.1	1.43	15.2	29.5	35.9	14	55.5	11.7
Shell 02_22	3078.8	1.41	12.1	34.5	37	15	56.5	10.9
Shell 02_22	3079.6	1.58	4.6	20.5	29.3	8	28.5	6.5
Shell 02_22	3080.4	1.68	21.8	51.9	25.4	175	73	15.9
Shell 02_22	3081.5	1.99	17.2	66.4	35.1	122	88.8	17.9

Shell 02_22	3082.5	1.25	11.3	44.6	19.9	28	56.2	10.4
Shell 02_22	3083.5	2.41	9.1	61	35.9	19	65.3	18.1
Shell 02_22	3084.5	1.13	11.2	57.4	17.1	392	52.3	6.6
Shell 02_22	3085.2	1.1	5.9	57.5	17.3	109	54.5	6.6
Shell 02_22	3085.5	0.91	2.1	47	15.2	12	38	4.1
Shell 02_22	3086.24	0.67	1.6	61.5	10.1	99	38.1	3.2
Shell 02_22	3086.75	0.73	1.5	62.4	9.3	52	39	3.2
Shell 02_22	3087.68	0.87	1.6	54.2	8.6	9	40.3	5
Shell 02_22	3088.5	0.9	1.7	55.1	10.3	9	39.9	7.4
Shell 02_22	3089.5	2.07	3.1	63.2	19.8	8	57.7	12.3
Shell 02_22	3090.45	0.6	5	23.7	9.6	7	35.6	4.8
Shell 02_22	3091.4	0.69	3.7	25.4	12.1	5	30.5	7
Shell 02_22	3092.5	1.33	7.2	39.9	16.4	9	40.7	10.5
Shell 02_22	3093.5	1.08	9.1	30.8	14.1	22	43.6	8.9
Shell 02_22	3094.75	1.06	13.2	27.4	12.8	134	52.2	10.6
Shell 02_22	3095.5	2.11	19.3	52	31.4	15	80.3	19.1
Shell 02_22	3095.9	0.56	1.4	45	4.8	13	30.2	3.1
Shell 02_22	3096.5	0.66	2.2	57.8	8.9	12	42.9	3.8
Shell 02_22	3097.5	0.96	10.5	37.6	12.8	73	56.7	8
Shell 02_22	3098.5	1.31	19.5	49.3	18.3	77	69.7	11.9
Shell 02_22	3099.5	1.36	21	41.6	17.4	76	69.1	12

Shell 02_22	3100.5	1.2	14.9	39.5	15.2	160	61.1	10
Shell 02_22	3101.5	2.42	14.5	65.2	30.1	24	75.6	23.3
Shell 02_22	3102.5	1.95	13.4	51.8	23.5	33	65.6	20.4
Shell 02_22	3103.5	1.83	21.8	56.6	26.4	50	90.7	22.5
Shell 02_22	3104	1.43	13.5	32.3	15.8	12	53.5	13.1
Shell 02_22	3105.5	1.22	21	54.5	16	125	73	11
Shell 02_22	3106.39	3.95	3.8	50.6	18.1	7	22.9	42.4
Shell 02_22	3106.5	1.42	2.7	29.6	9.8	10	22.6	13.4
Shell 02_22	3107.5	1.1	9.7	54.9	14.4	16	54.5	11.9
Shell 02_22	3108.5	3.14	64.3	78.8	36.8	24	162	36.6
Shell 02_22	3109.05	0.79	6.1	18.6	11	8	32.8	5.8
Shell 02_22	3109.5	1.28	7.6	29.1	15.8	13	42.9	8.1
Shell 02_22	3109.6	0.54	2.2	13.1	7.5	36	18.1	3.7
Shell 02_22	3110.5	1.2	2.3	55.9	20.1	15	44.5	7.4
Shell 02_22	3111.37	1.16	12.2	52.3	16.7	15	52.7	11.2
Shell 02_22	3111.5	1.34	22.2	57.2	22.6	12	96.3	14.2
Shell 02_22	3112.5	1.07	19.1	40.5	20.9	10	74.5	11.2
Shell 02_22	3112.95	1.51	24.3	60.3	29.2	14	101.6	17.9
Shell 02_22	3113.3	1.3	16.2	51.4	20.5	15	86.4	16.5
Shell 02_22	3116.5	1.21	1.7	35.4	15.6	13	41.6	7.5
Shell 02_22	3116.85	1.08	1.1	29.3	12.3	11	35.4	6.7

Shell 02_22	3119.5	0.3	0.8	13	1.7	8	6.6	<0.5
Shell 02_22	3120.5	1.34	1.4	50.3	14.9	11	39.4	13.4
Shell 02_22	3121.5	1.32	2.7	47.3	15.8	12	49.9	10.6
Shell 02_22	3121.6	1.65	2.2	51	16.1	13	54.5	13.3
Shell 02_22	3122.5	0.62	0.5	27.2	5	23	15.2	6.2
Shell 02_22	3122.74	1	6.4	49.3	11.2	14	49.4	8.1
Shell 02_22	3123.5	0.85	4.7	54.7	11.6	24	45.1	5.4
Shell 02_22	3124.5	1.13	7.7	46.1	11.9	17	50.4	6.3
Shell 02_22	3124.9	1.98	11.5	58.7	24.1	22	37.5	12.8
Shell 02_22	3125.5	1.15	8.3	53.6	17.2	19	53.2	9.2
Shell 02_22	3126.5	0.7	2.3	41.8	12.8	34	45.5	5.9
Shell 02_22	3127.5	0.86	3.9	52.5	16	25	64.5	7.3
Shell 02_22	3128.5	0.77	4.2	73.6	15.7	30	61.3	7
Shell 02_22	3129.5	2.12	1.1	44	12.4	25	65.9	4.7
Shell 02_22	3130.5	0.58	1.3	48.5	12.3	27	45.9	4.9
Shell 02_22	3131.5	0.72	1.2	44	6.3	31	47.2	3.8
Shell 02_22	3132.5	0.55	0.6	52.4	11.7	37	46.1	5.2
Shell 02_22	3133.5	0.65	1.4	57.1	15.6	29	48.1	5.4
Shell 02_22	3134.5	0.76	0.6	44.6	11.4	35	51.5	4.8
Shell 02_22	3135.5	0.81	0.3	45.8	9.4	53	51	3.3
Shell 02_22	3136.5	0.69	0.2	38.4	9	37	49.3	3.7

Shell 02_22	3137.5	0.57	<0.1	39.8	2.9	34	35.2	2.2
Shell 02_22	3137.66	0.82	<0.1	29.5	5.9	30	38	8.9
Shell 02_22	3139.5	0.3	0.1	15.3	6.4	14	17.7	0.5
Shell 02_22	3141.1	1.54	30.3	47.3	18.1	368	71.2	15.3
	Pulp Duplicates							
	3071.5	1.51	7.8	47	46.7	37	73.5	20
	3071.5	1.54						
	3101.5	2.42	14.5	65.2	30.1	24	75.6	23.3
	3101.5	2.38						
	3132.5	0.55	0.6	52.4	11.7	37	46.1	5.2
	3132.5	0.54						
	3141.1	1.54	30.3	47.3	18.1	368	71.2	15.3
	3141.1		29.7	46	18.1	357	68.8	16.7
	3079.6	1.58	4.6	20.5	29.3	8	28.5	6.5
	3079.6		4.7	20.8	29	8	29.3	6.7
	3109.5	1.28	7.6	29.1	15.8	13	42.9	8.1
	3109.5		7.6	27.9	14.6	14	40.7	7.8
	3073.5	0.85	19.9	23.9	28.2	41	50.4	8.3
	3073.5							
	3103.5	1.83	21.8	56.6	26.4	50	90.7	22.5
	3103.5							
	3128.5	0.77	4.2	73.6	15.7	30	61.3	7
	3128.5							
	3126.5	0.7	2.3	41.8	12.8	34	45.5	5.9
	3126.5							
	Preparation Duplicates							
	3070.5	0.75	2.1	33	13.1	35	42.1	5
	3070.5	0.76	1.9	32.5	13.2	35	43.2	4.5
	3099.5	1.36	21	41.6	17.4	76	69.1	12
	3099.5	1.26	20	40	17.1	71	66.3	10.8
	3128.5	0.77	4.2	73.6	15.7	30	61.3	7
	3128.5	0.82	3.8	75	15.3	29	62.5	6.5
	Reference Materials							
	STD GS311-1	2.37						

	STD GS910-4	8.35						
	STD GS311-1	2.32						
	STD GS910-4	8.28						
	STD GS311-1	2.51						
	STD GS910-4	8.27						
	STD DS9		11.4	102.9	127.7	306	36.6	25.6
	STD OREAS45EA		1.6	678.8	13.9	29	369.5	10.3
	STD DS9		13.9	107.6	140.7	331	39.9	26.2
	STD OREAS45EA		1.3	702.2	15.7	32	385.2	10.2
	STD DS9		13.1	109.4	145.2	320	41.4	24.4
	STD OREAS45EA		1.5	695.9	15.6	31	381.8	9
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	BLK	<0.02						
	BLK	<0.02						
	BLK	<0.02						
	BLK		<0.1	0.2	<0.1	<1	<0.1	<0.5
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5
	BLK							
	BLK							
	BLK							
	BLK							
	Prep Wash							
	G1	<0.02	0.7	4	3.7	56	3	<0.5
	G1	<0.02	0.7	5.9	3.8	50	3.6	<0.5

Table 27. Continued

		Cd	Sb	Bi	Ag	Au	Hg	Tl	Se
		PPM	PPM	PPM	PPM	PPB	PPM	PPM	PPM
	MDL	0.1	0.1	0.1	0.1	0.5	0.01	0.1	0.5
Well ID	Sample								
Shell 02_22	3068.1	<0.1	0.1	0.1	<0.1	0.9	0.05	0.1	<0.5
Shell 02_22	3068.5	<0.1	0.1	0.2	<0.1	<0.5	0.04	0.3	0.8
Shell 02_22	3069.7	<0.1	<0.1	0.2	<0.1	2.2	0.05	0.2	0.8
Shell 02_22	3070.5	<0.1	0.1	0.1	<0.1	<0.5	0.04	0.2	0.5
Shell 02_22	3071.5	<0.1	0.3	0.1	<0.1	<0.5	0.11	0.4	1.1
Shell 02_22	3072.5	4.5	0.6	<0.1	0.1	1.4	0.18	0.1	3.9
Shell 02_22	3073.5	0.3	0.5	<0.1	<0.1	0.5	0.1	0.2	2.9
Shell 02_22	3074.5	<0.1	1	<0.1	0.1	<0.5	0.14	0.2	3.9
Shell 02_22	3075.5	0.7	0.7	<0.1	0.1	<0.5	0.15	0.2	2.6
Shell 02_22	3076.5	1.6	0.9	<0.1	0.1	<0.5	0.18	0.3	4.9
Shell 02_22	3077.22	<0.1	0.3	<0.1	<0.1	<0.5	0.09	0.2	1
Shell 02_22	3077.5	0.1	0.6	<0.1	0.1	<0.5	0.14	0.4	3.1
Shell 02_22	3078.1	0.1	0.8	<0.1	<0.1	0.6	0.15	0.2	3.2
Shell 02_22	3078.8	<0.1	0.8	<0.1	0.1	<0.5	0.15	<0.1	2.8
Shell 02_22	3079.6	0.2	0.5	<0.1	<0.1	0.9	0.09	<0.1	1.6
Shell 02_22	3080.4	1.6	1.4	<0.1	0.2	<0.5	0.14	0.2	5.7
Shell 02_22	3081.5	1.6	1.2	<0.1	0.2	<0.5	0.19	0.2	7
Shell 02_22	3082.5	0.2	0.6	<0.1	0.1	0.9	0.13	0.1	4.5

Shell 02_22	3083.5	0.2	1.8	<0.1	0.2	<0.5	0.19	<0.1	4.4
Shell 02_22	3084.5	2.4	0.4	<0.1	0.1	2.1	0.14	0.2	3.6
Shell 02_22	3085.2	0.7	0.3	<0.1	0.1	<0.5	0.13	0.1	4
Shell 02_22	3085.5	<0.1	0.2	<0.1	0.1	1	0.1	<0.1	1.7
Shell 02_22	3086.24	0.4	0.3	<0.1	<0.1	<0.5	0.11	<0.1	2
Shell 02_22	3086.75	0.3	0.2	<0.1	<0.1	<0.5	0.12	<0.1	1.7
Shell 02_22	3087.68	<0.1	0.2	<0.1	<0.1	<0.5	0.1	<0.1	2.3
Shell 02_22	3088.5	<0.1	0.2	<0.1	<0.1	<0.5	0.12	<0.1	2.2
Shell 02_22	3089.5	<0.1	0.5	<0.1	<0.1	<0.5	0.17	<0.1	3.3
Shell 02_22	3090.45	<0.1	0.3	<0.1	<0.1	<0.5	0.07	<0.1	1.9
Shell 02_22	3091.4	<0.1	0.5	<0.1	0.1	2	0.09	<0.1	2
Shell 02_22	3092.5	<0.1	0.7	<0.1	<0.1	0.9	0.12	<0.1	3
Shell 02_22	3093.5	0.1	0.8	<0.1	<0.1	<0.5	0.13	0.1	2
Shell 02_22	3094.75	1.3	0.8	<0.1	0.1	<0.5	0.15	0.2	3.8
Shell 02_22	3095.5	0.1	2	<0.1	0.2	<0.5	0.23	0.2	5.7
Shell 02_22	3095.9	<0.1	0.3	<0.1	<0.1	3.2	0.07	<0.1	1.5
Shell 02_22	3096.5	<0.1	0.4	<0.1	<0.1	2.7	0.08	<0.1	1.3
Shell 02_22	3097.5	0.4	0.5	0.1	<0.1	1.2	0.13	<0.1	2.9
Shell 02_22	3098.5	0.8	0.7	<0.1	0.2	4	0.17	0.2	3.9
Shell 02_22	3099.5	0.5	0.9	<0.1	0.1	2.2	0.17	0.2	4.3
Shell 02_22	3100.5	1.6	0.7	<0.1	0.1	1.9	0.18	0.2	3.4

Shell 02_22	3101.5	0.2	1.4	<0.1	0.2	2.5	0.18	0.1	3.6
Shell 02_22	3102.5	0.2	1	<0.1	0.2	1.7	0.16	0.1	2.1
Shell 02_22	3103.5	0.5	1.1	<0.1	0.2	2.9	0.19	<0.1	5.3
Shell 02_22	3104	<0.1	0.7	<0.1	<0.1	4	0.13	<0.1	2.8
Shell 02_22	3105.5	1.1	0.6	<0.1	0.1	3.1	0.16	0.1	2.9
Shell 02_22	3106.39	<0.1	0.4	<0.1	<0.1	3	0.09	<0.1	1.2
Shell 02_22	3106.5	<0.1	0.4	<0.1	<0.1	2.3	0.08	<0.1	<0.5
Shell 02_22	3107.5	<0.1	0.6	<0.1	<0.1	0.9	0.13	<0.1	2.3
Shell 02_22	3108.5	0.2	2.5	0.1	0.3	1.8	0.39	0.4	11.5
Shell 02_22	3109.05	<0.1	0.4	<0.1	<0.1	1.4	0.08	<0.1	0.6
Shell 02_22	3109.5	<0.1	0.6	<0.1	<0.1	2.6	0.13	<0.1	1.3
Shell 02_22	3109.6	0.3	0.3	<0.1	<0.1	2.6	0.06	<0.1	<0.5
Shell 02_22	3110.5	<0.1	0.2	<0.1	<0.1	0.8	0.12	<0.1	1.1
Shell 02_22	3111.37	<0.1	0.4	<0.1	<0.1	1	0.16	<0.1	1.3
Shell 02_22	3111.5	<0.1	0.7	<0.1	0.1	1.2	0.17	<0.1	3.8
Shell 02_22	3112.5	<0.1	1	<0.1	0.1	3.3	0.16	0.1	2.7
Shell 02_22	3112.95	<0.1	0.8	<0.1	0.2	4.9	0.18	0.2	5
Shell 02_22	3113.3	<0.1	0.5	<0.1	0.2	1.4	0.14	<0.1	2.7
Shell 02_22	3116.5	<0.1	<0.1	<0.1	<0.1	4	0.07	<0.1	<0.5
Shell 02_22	3116.85	<0.1	<0.1	<0.1	<0.1	<0.5	0.06	<0.1	<0.5
Shell 02_22	3119.5	<0.1	<0.1	<0.1	<0.1	1.4	0.03	<0.1	<0.5

Shell 02_22	3120.5	<0.1	0.2	<0.1	<0.1	1.4	0.09	<0.1	0.8
Shell 02_22	3121.5	<0.1	0.2	<0.1	0.1	2.8	0.14	0.1	1.7
Shell 02_22	3121.6	<0.1	0.2	0.1	<0.1	1.7	0.13	<0.1	1.3
Shell 02_22	3122.5	<0.1	0.1	<0.1	<0.1	1.9	0.06	<0.1	0.5
Shell 02_22	3122.74	<0.1	0.2	<0.1	<0.1	1.6	0.14	<0.1	2
Shell 02_22	3123.5	<0.1	0.2	<0.1	<0.1	0.7	0.11	<0.1	1.9
Shell 02_22	3124.5	<0.1	0.5	<0.1	0.1	1.7	0.11	<0.1	2.7
Shell 02_22	3124.9	0.1	0.9	<0.1	0.1	2.4	0.22	<0.1	2.3
Shell 02_22	3125.5	<0.1	0.4	<0.1	0.1	2	0.11	<0.1	2
Shell 02_22	3126.5	<0.1	0.2	<0.1	<0.1	4	0.06	0.1	0.9
Shell 02_22	3127.5	<0.1	0.3	<0.1	0.1	<0.5	0.09	0.2	1.3
Shell 02_22	3128.5	<0.1	0.3	<0.1	<0.1	0.5	0.07	0.2	2.2
Shell 02_22	3129.5	<0.1	0.1	<0.1	<0.1	<0.5	0.03	0.1	1.5
Shell 02_22	3130.5	<0.1	0.2	<0.1	<0.1	<0.5	0.07	<0.1	0.6
Shell 02_22	3131.5	<0.1	<0.1	<0.1	<0.1	0.6	0.04	<0.1	0.6
Shell 02_22	3132.5	<0.1	0.1	<0.1	<0.1	<0.5	0.06	<0.1	0.8
Shell 02_22	3133.5	<0.1	0.2	<0.1	<0.1	0.6	0.04	<0.1	1.1
Shell 02_22	3134.5	<0.1	0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
Shell 02_22	3135.5	<0.1	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	0.5
Shell 02_22	3136.5	<0.1	<0.1	<0.1	<0.1	0.5	0.05	<0.1	<0.5
Shell 02_22	3137.5	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	0.8

Shell 02_22	3137.66	<0.1	<0.1	<0.1	<0.1	0.5	0.03	<0.1	<0.5
Shell 02_22	3139.5	<0.1	<0.1	<0.1	<0.1	1.8	0.01	<0.1	<0.5
Shell 02_22	3141.1	3.6	1.1	<0.1	0.1	<0.5	0.19	0.4	4
	Pulp Duplicates								
	3071.5	<0.1	0.3	0.1	<0.1	<0.5	0.11	0.4	1.1
	3071.5								
	3101.5	0.2	1.4	<0.1	0.2	2.5	0.18	0.1	3.6
	3101.5								
	3132.5	<0.1	0.1	<0.1	<0.1	<0.5	0.06	<0.1	0.8
	3132.5								
	3141.1	3.6	1.1	<0.1	0.1	<0.5	0.19	0.4	4
	3141.1	3.3	1.2	<0.1	0.2	<0.5	0.16	0.3	5.2
	3079.6	0.2	0.5	<0.1	<0.1	0.9	0.09	<0.1	1.6
	3079.6	0.1	0.5	<0.1	<0.1	<0.5	0.11	<0.1	1.8
	3109.5	<0.1	0.6	<0.1	<0.1	2.6	0.13	<0.1	1.3
	3109.5	0.1	0.7	<0.1	0.1	1.5	0.12	<0.1	1.3
	3073.5	0.3	0.5	<0.1	<0.1	0.5	0.1	0.2	2.9
	3073.5								
	3103.5	0.5	1.1	<0.1	0.2	2.9	0.19	<0.1	5.3
	3103.5								
	3128.5	<0.1	0.3	<0.1	<0.1	0.5	0.07	0.2	2.2
	3128.5								
	3126.5	<0.1	0.2	<0.1	<0.1	4	0.06	0.1	0.9
	3126.5								
	Preparation Duplicates								
	3070.5	<0.1	0.1	0.1	<0.1	<0.5	0.04	0.2	0.5
	3070.5	<0.1	0.1	<0.1	<0.1	<0.5	0.04	0.2	0.7
	3099.5	0.5	0.9	<0.1	0.1	2.2	0.17	0.2	4.3
	3099.5	0.6	0.7	<0.1	0.2	3	0.18	0.1	3.7
	3128.5	<0.1	0.3	<0.1	<0.1	0.5	0.07	0.2	2.2
	3128.5	<0.1	0.4	<0.1	<0.1	1.2	0.07	0.2	1.5
	Reference Materials								
	STD GS311-1								
	STD GS910-4								

	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD DS9	2.5	5.8	5.5	1.6	101.7	0.21	4.9	6.7
	STD OREAS45EA	<0.1	0.3	0.5	0.3	43.1	<0.01	<0.1	0.5
	STD DS9	2.5	4.6	6	1.7	113.9	0.22	5.7	5.7
	STD OREAS45EA	<0.1	0.2	<0.1	0.3	52.2	0.02	<0.1	1.1
	STD DS9	2.4	5.3	5.9	1.9	102.8	0.21	5.6	5.5
	STD OREAS45EA	<0.1	0.2	<0.1	0.3	58.6	0.02	<0.1	0.5
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	BLK								
	BLK								
	BLK								
	BLK	<0.1	<0.1	<0.1	0.2	<0.5	0.05	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
	BLK								
	BLK								
	BLK								
	BLK								
	Prep Wash								
	G1	<0.1	0.5	<0.1	<0.1	1	0.01	0.3	<0.5
	G1	<0.1	<0.1	<0.1	<0.1	0.6	<0.01	0.4	<0.5

C.2.2 Leco TOC and Rockeval Results

Table 28. Leco TOC and Rockeval Results for Shell 02-22

	Depth ()	Sample Type	Sample Prep	Leco	SRA			Tmax
Well Name	Top			TOC	S1	S2	S3	(°C)
Shell 02_22	3068.1	Core	NOPR	0.48	0.16	0.21	0.39	458
Shell 02_22	3068.5	Core	NOPR	0.43	0.12	0.17	0.33	464
Shell 02_22	3069.7	Core	NOPR	0.53	0.26	0.24	0.38	456
Shell 02_22	3070.5	Core	NOPR	0.52	0.39	0.35	0.26	461
Shell 02_22	3071.5	Core	NOPR	0.93	0.55	0.46	0.42	451
Shell 02_22	3072.5	Core	NOPR	2.94	1.78	1.99	0.58	473
Shell 02_22	3073.5	Core	NOPR	2.42	1.58	1.59	0.38	471
Shell 02_22	3074.5	Core	NOPR	2.54	1.50	1.47	0.38	470
Shell 02_22	3075.5	Core	NOPR	2.64	1.61	1.52	0.58	471
Shell 02_22	3076.5	Core	NOPR	2.73	2.03	1.86	0.37	477
Shell 02_22	3077.22	Core	NOPR	1.79	2.52	1.27	0.61	472
Shell 02_22	3077.5	Core	NOPR	2.42	2.08	1.63	0.30	478
Shell 02_22	3078.1	Core	NOPR	2.61	1.61	1.58	0.35	469
Shell 02_22	3078.8	Core	NOPR	3.83	1.66	2.39	0.35	476
Shell 02_22	3079.6	Core	NOPR	2.09	1.08	1.18	0.42	464
Shell 02_22	3080.4	Core	NOPR	2.84	2.14	2.63	0.42	483
Shell 02_22	3081.5	Core	NOPR	2.98	1.75	1.55	0.23	473
Shell 02_22	3082.5	Core	NOPR	2.83	1.53	1.54	0.22	470
Shell 02_22	3083.5	Core	NOPR	3.65	1.65	1.91	0.32	481
Shell 02_22	3084.5	Core	NOPR	2.90	1.62	1.96	0.30	472
Shell 02_22	3085.2	Core	NOPR	3.13	1.99	2.05	0.34	477
Shell 02_22	3085.5	Core	NOPR	2.46	1.44	1.53	0.32	475
Shell 02_22	3086.24	Core	NOPR	1.91	1.43	1.09	0.27	470
Shell 02_22	3086.75	Core	NOPR	2.68	2.36	2.08	0.42	476
Shell 02_22	3087.68	Core	NOPR	2.53	1.43	1.74	0.27	473
Shell 02_22	3088.5	Core	NOPR	2.91	2.84	3.57	0.58	474
Shell 02_22	3089.5	Core	NOPR	2.68	1.54	1.48	0.30	473
Shell 02_22	3090.45	Core	NOPR	2.56	4.16	1.91	0.52	472
Shell 02_22	3091.4	Core	NOPR	2.25	4.45	2.08	0.29	469
Shell 02_22	3092.5	Core	NOPR	3.18	2.44	2.28	0.37	473
Shell 02_22	3093.5	Core	NOPR	3.17	2.83	2.30	0.38	472
Shell 02_22	3094.75	Core	NOPR	3.61	2.14	2.74	0.37	471
Shell 02_22	3095.5	Core	NOPR	4.43	2.22	2.80	0.25	472

Shell 02_22	3095.9	Core	NOPR	2.35	1.44	1.53	0.34	478
Shell 02_22	3096.5	Core	NOPR	2.56	1.50	1.66	0.29	477
Shell 02_22	3097.5	Core	NOPR	3.45	2.19	2.50	0.27	473
Shell 02_22	3098.5	Core	NOPR	2.24	2.56	2.96	0.22	472
Shell 02_22	3099.5	Core	NOPR	2.87	2.26	2.89	0.24	470
Shell 02_22	3100.5	Core	NOPR	3.89	2.62	3.17	0.18	471
Shell 02_22	3101.5	Core	NOPR	3.53	1.95	2.29	0.24	479
Shell 02_22	3102.5	Core	NOPR	2.69	2.07	2.22	0.23	482
Shell 02_22	3103.5	Core	NOPR	3.21	2.20	2.81	0.20	473
Shell 02_22	3104	Core	NOPR	2.91	1.77	1.83	0.22	477
Shell 02_22	3105.5	Core	NOPR	3.43	2.50	3.39	0.31	471
Shell 02_22	3106.39	Core	NOPR	0.90	0.73	0.43	0.25	452
Shell 02_22	3106.5	Core	NOPR	1.25	0.97	0.68	0.25	461
Shell 02_22	3107.5	Core	NOPR	3.46	1.98	2.50	0.28	480
Shell 02_22	3108.5	Core	NOPR	5.62	2.92	4.90	0.17	475
Shell 02_22	3109.05	Core	NOPR	1.65	1.43	1.19	0.21	464
Shell 02_22	3109.5	Core	NOPR	3.06	1.88	2.35	0.19	477
Shell 02_22	3109.6	Core	NOPR	1.23	0.84	0.55	0.23	456
Shell 02_22	3110.5	Core	NOPR	2.30	1.61	1.51	0.18	468
Shell 02_22	3111.37	Core	NOPR	2.55	1.51	2.05	0.19	478
Shell 02_22	3111.5	Core	NOPR	3.71	2.49	3.40	0.22	471
Shell 02_22	3112.5	Core	NOPR	2.01	1.21	1.41	0.25	466
Shell 02_22	3112.95	Core	NOPR	2.75	1.93	2.44	0.24	472
Shell 02_22	3113.3	Core	NOPR	2.58	2.23	2.54	0.21	481
Shell 02_22	3116.5	Core	NOPR	0.53	0.41	0.26	0.30	459
Shell 02_22	3116.85	Core	NOPR	0.92	0.51	0.42	0.44	444
Shell 02_22	3119.5	Core	NOPR	0.83	0.33	0.37	0.36	468
Shell 02_22	3120.5	Core	NOPR	1.69	1.18	1.01	0.56	454
Shell 02_22	3121.5	Core	NOPR	2.26	1.29	1.24	0.32	461
Shell 02_22	3121.6	Core	NOPR	1.92	1.35	1.09	0.26	468
Shell 02_22	3122.5	Core	NOPR	2.73	2.53	2.76	0.19	476
Shell 02_22	3122.74	Core	NOPR	3.07	2.48	3.17	0.16	474
Shell 02_22	3123.5	Core	NOPR	0.99	0.81	0.61	0.40	464
Shell 02_22	3124.5	Core	NOPR	3.46	2.73	3.73	0.31	474
Shell 02_22	3124.9	Core	NOPR	2.15	1.71	1.30	0.30	459
Shell 02_22	3125.5	Core	NOPR	2.59	2.09	1.92	0.35	470
Shell 02_22	3126.5	Core	NOPR	1.24	0.75	0.63	0.21	456
Shell 02_22	3127.5	Core	NOPR	1.84	1.18	1.19	0.19	459
Shell 02_22	3128.5	Core	NOPR	1.16	0.61	0.51	0.23	462
Shell 02_22	3129.5	Core	NOPR	1.00	0.41	0.34	0.24	465
Shell 02_22	3130.5	Core	NOPR	1.07	0.45	0.38	0.33	464

Shell 02_22	3131.5	Core	NOPR	1.33	0.53	0.56	0.42	463
Shell 02_22	3132.5	Core	NOPR	0.93	0.31	0.31	0.32	471
Shell 02_22	3133.5	Core	NOPR	1.18	0.46	0.46	0.21	465
Shell 02_22	3134.5	Core	NOPR	0.72	0.25	0.24	0.46	461
Shell 02_22	3135.5	Core	NOPR	0.61	0.17	0.22	0.19	475
Shell 02_22	3136.5	Core	NOPR	0.63	0.21	0.20	0.47	470
Shell 02_22	3137.5	Core	NOPR	0.55	0.15	0.16	0.43	466
Shell 02_22	3137.66	Core	NOPR	0.51	0.12	0.13	0.27	457
Shell 02_22	3139.5	Core	NOPR	0.44	0.19	0.13	0.29	466
Shell 02_22	3141.1	Core	NOPR	3.70	2.84	3.29	0.26	474
Shell 02_22	3075.85	Core	NOPR	3.18	2.08	2.15	0.32	475
Shell 02_22	3114.5	Core	NOPR	0.25	0.19	0.08	0.31	448
Shell 02_22	3115.4	Core	NOPR	0.38	0.30	0.17	0.30	437
Shell 02_22	3118.5	Core	NOPR	0.90	0.61	0.64	0.37	443

Table 28. Continued

	Depth ()	HI	OI	S2/S3	S1/TOC*100	PI
Well Name	Top					
Shell 02_22	3068.1	44	81	1	33	0.43
Shell 02_22	3068.5	40	77	1	28	0.41
Shell 02_22	3069.7	45	71	1	49	0.52
Shell 02_22	3070.5	67	50	1	75	0.53
Shell 02_22	3071.5	50	45	1	59	0.54
Shell 02_22	3072.5	68	20	3	61	0.47
Shell 02_22	3073.5	66	16	4	65	0.50
Shell 02_22	3074.5	58	15	4	59	0.51
Shell 02_22	3075.5	58	22	3	61	0.51
Shell 02_22	3076.5	68	14	5	74	0.52
Shell 02_22	3077.22	71	34	2	141	0.66
Shell 02_22	3077.5	67	12	5	86	0.56
Shell 02_22	3078.1	60	13	5	62	0.50
Shell 02_22	3078.8	62	9	7	43	0.41
Shell 02_22	3079.6	56	20	3	52	0.48
Shell 02_22	3080.4	93	15	6	75	0.45
Shell 02_22	3081.5	52	8	7	59	0.53
Shell 02_22	3082.5	54	8	7	54	0.50
Shell 02_22	3083.5	52	9	6	45	0.46

Shell 02_22	3084.5	68	10	7	56	0.45
Shell 02_22	3085.2	65	11	6	64	0.49
Shell 02_22	3085.5	62	13	5	58	0.48
Shell 02_22	3086.24	57	14	4	75	0.57
Shell 02_22	3086.75	77	16	5	88	0.53
Shell 02_22	3087.68	69	11	6	56	0.45
Shell 02_22	3088.5	123	20	6	98	0.44
Shell 02_22	3089.5	55	11	5	57	0.51
Shell 02_22	3090.45	75	20	4	163	0.69
Shell 02_22	3091.4	93	13	7	198	0.68
Shell 02_22	3092.5	72	12	6	77	0.52
Shell 02_22	3093.5	73	12	6	89	0.55
Shell 02_22	3094.75	76	10	7	59	0.44
Shell 02_22	3095.5	63	6	11	50	0.44
Shell 02_22	3095.9	65	14	5	61	0.48
Shell 02_22	3096.5	65	11	6	59	0.47
Shell 02_22	3097.5	72	8	9	63	0.47
Shell 02_22	3098.5	132	10	13	114	0.46
Shell 02_22	3099.5	101	8	12	79	0.44
Shell 02_22	3100.5	82	5	18	67	0.45
Shell 02_22	3101.5	65	7	10	55	0.46
Shell 02_22	3102.5	82	9	10	77	0.48
Shell 02_22	3103.5	87	6	14	68	0.44
Shell 02_22	3104	63	8	8	61	0.49
Shell 02_22	3105.5	99	9	11	73	0.42
Shell 02_22	3106.39	48	28	2	81	0.63
Shell 02_22	3106.5	54	20	3	78	0.59
Shell 02_22	3107.5	72	8	9	57	0.44
Shell 02_22	3108.5	87	3	29	52	0.37
Shell 02_22	3109.05	72	13	6	87	0.55
Shell 02_22	3109.5	77	6	12	61	0.44
Shell 02_22	3109.6	45	19	2	68	0.60
Shell 02_22	3110.5	66	8	8	70	0.52
Shell 02_22	3111.37	81	7	11	59	0.42
Shell 02_22	3111.5	92	6	15	67	0.42
Shell 02_22	3112.5	70	12	6	60	0.46
Shell 02_22	3112.95	89	9	10	70	0.44
Shell 02_22	3113.3	98	8	12	86	0.47
Shell 02_22	3116.5	49	57	1	77	0.61
Shell 02_22	3116.85	46	48	1	55	0.55
Shell 02_22	3119.5	45	43	1	40	0.47

Shell 02_22	3120.5	60	33	2	70	0.54
Shell 02_22	3121.5	55	14	4	57	0.51
Shell 02_22	3121.6	57	14	4	70	0.55
Shell 02_22	3122.5	101	7	15	93	0.48
Shell 02_22	3122.74	103	5	20	81	0.44
Shell 02_22	3123.5	61	40	2	82	0.57
Shell 02_22	3124.5	108	9	12	79	0.42
Shell 02_22	3124.9	60	14	4	79	0.57
Shell 02_22	3125.5	74	14	5	81	0.52
Shell 02_22	3126.5	51	17	3	60	0.54
Shell 02_22	3127.5	65	10	6	64	0.50
Shell 02_22	3128.5	44	20	2	52	0.54
Shell 02_22	3129.5	34	24	1	41	0.55
Shell 02_22	3130.5	36	31	1	42	0.54
Shell 02_22	3131.5	42	32	1	40	0.49
Shell 02_22	3132.5	33	34	1	33	0.50
Shell 02_22	3133.5	39	18	2	39	0.50
Shell 02_22	3134.5	33	64	1	35	0.51
Shell 02_22	3135.5	36	31	1	28	0.44
Shell 02_22	3136.5	32	75	0	33	0.51
Shell 02_22	3137.5	29	78	0	27	0.48
Shell 02_22	3137.66	25	53	0	23	0.48
Shell 02_22	3139.5	29	66	0	43	0.59
Shell 02_22	3141.1	89	7	13	77	0.46
Shell 02_22	3075.85	68	10	6.72	65	0.49
Shell 02_22	3114.5	32	123	0.26	75	0.70
Shell 02_22	3115.4	45	79	0.57	79	0.64
Shell 02_22	3118.5	71	41	1.73	68	0.49

C.3 Complete Geochemical Results for Encana 11-04 and Esso 16-28 (Analyzed Together)

C.3.1 Major, Minor and Trace Element Results Including Acme Internal Standards

Table 29. Major, Minor and Trace Element Results Including Acme Internal Standards for Encana 11-04 and Esso 16-28

		Analyte	Wgt	SiO2	Al2O3	Fe2O3	MgO	CaO
		Unit	KG	%	%	%	%	%
	MDL	MDL	0.01	0.01	0.01	0.04	0.01	0.01
Well ID	Sample	Type						
Esso 16-28	1107.46	Drill Core	0.02	0.84	0.23	0.39	0.62	54.54
Esso 16-28	1108.54	Drill Core	0.02	1.49	0.32	0.53	0.91	54.14
Esso 16-28	1109.51	Drill Core	0.02	0.75	0.11	0.21	0.65	54.57
Esso 16-28	1110.4	Drill Core	0.02	0.67	0.1	0.2	0.64	54.7
Esso 16-28	1111.48	Drill Core	0.01	1.55	0.29	0.85	1.57	53.19
Esso 16-28	1112.31	Drill Core	0.02	3.98	0.89	0.64	1.99	50.05
Esso 16-28	1113.46	Drill Core	0.02	6.24	1.73	0.9	1.3	47.99
Esso 16-28	1114.57	Drill Core	0.02	2.87	0.6	0.62	1.42	51.5
Esso 16-28	1115.33	Drill Core	0.02	0.95	0.18	0.64	1.08	53.97
Esso 16-28	1116.63	Drill Core	0.02	10.42	0.82	1.42	3.3	45.39
Esso 16-28	1117.51	Drill Core	0.02	4	0.76	0.96	1.35	51.07
Esso 16-28	1118.4	Drill Core	0.02	5.66	1.26	1.1	1.37	49.17
Esso 16-28	1119.64	Drill Core	0.02	1.57	0.32	0.54	0.87	53.89
Esso 16-28	1120.46	Drill Core	0.02	12.98	3.09	2.03	1.68	42.3
Esso 16-28	1121.48	Drill Core	0.02	17.06	4.27	2.44	1.6	37.85
Esso 16-28	1122.55	Drill Core	0.02	10.84	2.38	2.52	1.52	44.76
Esso 16-28	1124.38	Drill Core	0.02	3.97	0.77	0.89	1.04	51.95
Esso 16-28	1125.48	Drill Core	0.02	17.54	2.66	1.89	1.64	40.57
Esso 16-28	1126.53	Drill Core	0.02	10.78	2.17	1.65	1.4	44.83
Esso 16-28	1127.56	Drill Core	0.02	12.92	2.87	1.37	1.91	42.66
Esso 16-28	1128.42	Drill Core	0.02	0.66	0.21	0.2	0.66	54.42
Esso 16-28	1129.74	Drill Core	0.02	3.16	0.37	0.27	0.91	52.35
Esso 16-28	1130.31	Drill Core	0.02	20.47	3.95	1.36	2.96	35.47
Esso 16-28	1131.53	Drill Core	0.02	21.17	4.68	1.85	2.19	34.52
Esso 16-28	1132.54	Drill Core	0.02	17.43	3.79	1.42	2.46	38.5
Esso 16-28	1133.54	Drill Core	0.02	20.42	5.34	2.62	2.01	35.01
Esso 16-28	1134.64	Drill Core	0.02	2.85	0.56	1.92	1.02	53.64
Esso 16-28	1135.68	Drill Core	0.02	22.53	5.97	2.73	2	32.82
Esso 16-28	1136.7	Drill Core	0.02	19.68	5.24	2.13	2.19	35.76
Esso 16-28	1137.44	Drill Core	0.02	3.59	0.71	1.67	0.88	53.17
Esso 16-28	1138.62	Drill Core	0.02	24.43	5.89	4.43	1.81	31.25

Esso 16-28	1139.59	Drill Core	0.02	7.43	1.67	1.39	1.02	48.83
Esso 16-28	1140.52	Drill Core	0.02	21.12	5.29	2.35	1.68	32.97
Esso 16-28	1141.15	Drill Core	0.01	19.91	5.13	2.58	1.52	34.17
Esso 16-28	1142.52	Drill Core	0.02	19.26	4.67	2.8	1.46	37.35
Esso 16-28	1143.4	Drill Core	0.02	21.55	5.6	2.43	1.49	33.33
Esso 16-28	1144.48	Drill Core	0.02	6.35	1.95	1.47	0.83	49.31
Esso 16-28	1145.57	Drill Core	0.02	22.13	6.15	4.47	1.36	31.47
Esso 16-28	1146.4	Drill Core	0.02	19.03	4.93	5.77	1.36	35.71
Esso 16-28	1147.4	Drill Core	0.02	16.97	4.41	2.15	1.31	38.71
Esso 16-28	1148.55	Drill Core	0.03	20.78	4.77	2.63	1.53	33.8
Esso 16-28	1149.53	Drill Core	0.02	23.89	5.3	3.17	1.72	30.83
Esso 16-28	1150.5	Drill Core	0.02	22.38	5.06	3.02	1.7	32.29
Esso 16-28	1151.4	Drill Core	0.02	19.76	4.47	2.8	1.62	34.54
Esso 16-28	1152.51	Drill Core	0.02	19.93	4.73	2.53	1.58	36.58
Esso 16-28	1153.63	Drill Core	0.02	21.42	5.63	2.45	1.7	33.38
Esso 16-28	1154.62	Drill Core	0.02	23.3	5.55	4.11	1.83	30.33
Esso 16-28	1155.48	Drill Core	0.02	23.88	6.13	3.12	1.79	29.41
Esso 16-28	1156.47	Drill Core	0.02	25.86	6.57	3.29	1.8	26.41
Esso 16-28	1157.49	Drill Core	0.02	28.36	7.21	3.32	1.93	24.17
Esso 16-28	1158.39	Drill Core	0.02	20.07	3.36	1.73	1.79	38.24
Esso 16-28	1159.4	Drill Core	0.02	30.09	6.25	3.19	2	23.68
Esso 16-28	1160.57	Drill Core	0.02	30.26	7.29	3.66	2.03	21.58
Esso 16-28	1161.52	Drill Core	0.03	32.05	4.16	1.63	3	29.78
Esso 16-28	1162.5	Drill Core	0.02	35.36	6.11	2.97	3.06	21.09
Esso 16-28	1163.55	Drill Core	0.02	35.76	6.28	3.17	2.52	20.36
Esso 16-28	1164.5	Drill Core	0.02	29.42	6.61	2.77	3.43	25.23
Esso 16-28	1165.42	Drill Core	0.02	30.53	5.63	1.94	5.15	25.58
Esso 16-28	1166.5	Drill Core	0.02	30.67	5.22	1.95	4.98	27.27
Esso 16-28	1168.62	Drill Core	0.02	29.14	8.21	3.23	1.92	24.21
Esso 16-28	1169.32	Drill Core	0.02	5.49	1.22	0.58	0.67	50.41
Esso 16-28	1170.5	Drill Core	0.02	2.31	0.63	0.52	0.6	53.23
Esso 16-28	1171.5	Drill Core	0.04	2.4	0.58	1.2	0.65	53.82
Esso 16-28	1144.3	Drill Core	0.01	15.5	3.71	2.14	1.31	41.54
Esso 16-28	1168.09	Drill Core	<0.01	18.76	4.46	2.36	2.42	36.04
Esso 16-28	1161.07	Drill Core	0.02	22.78	4.62	1.77	1.93	34.97
Esso 16-28	1154.27	Drill Core	0.02	21.23	4.96	2.53	1.7	32.69
Esso 16-28	1145.745	Drill Core	0.02	6.41	1.7	1.78	0.92	49.58
Standard	1180	Rock Pulp	<0.01	46.77	21.3	9.86	2.65	3.06
Encana 11-04	1190	Rock Pulp	<0.01	54.65	13.26	4.19	8.24	1.5

Encana 11-04	3935.5	Drill Core	0.01	42.94	12.68	5.22	2.83	14.69
Encana 11-04	3936.515	Drill Core	0.01	47.63	13.72	4.92	2.79	10.39
Encana 11-04	3937.51	Drill Core	0.02	49.84	14.29	4.97	2.73	8.8
Encana 11-04	3938.5	Drill Core	0.01	50.99	13.59	4.84	2.67	9.17
Encana 11-04	3939.42	Drill Core	0.02	49.69	13.61	4.86	2.69	9.45
Encana 11-04	3940.515	Drill Core	0.02	34.54	8.62	6.11	2.92	22.12
Encana 11-04	3941.595	Drill Core	0.01	19.05	4.39	3.95	1.77	37.57
Encana 11-04	3942.425	Drill Core	0.02	45.03	9.13	3.89	1.8	15.87
Encana 11-04	3943.535	Drill Core	0.01	46.91	9.74	3.87	1.67	14.76
Encana 11-04	3944.48	Drill Core	0.02	48.42	9.78	4.48	1.59	13.49
Encana 11-04	3945.37	Drill Core	0.01	48.57	9.39	3.89	1.6	14.08
Encana 11-04	3946.475	Drill Core	0.02	48.05	10.38	4.41	1.71	12.82
Encana 11-04	3947.46	Drill Core	0.01	47.23	10.91	4.43	1.79	13.26
Encana 11-04	3948.45	Drill Core	0.01	37.69	9.29	3.64	1.96	21.11
Encana 11-04	3949.52	Drill Core	0.01	37	10.49	6.81	2.52	19.16
Encana 11-04	3950.64	Drill Core	0.01	41.21	12.84	5.41	2.84	14.63
Encana 11-04	3951.53	Drill Core	0.01	44.45	13.65	5.04	2.68	11.91
Encana 11-04	3952.515	Drill Core	0.02	40.72	12.29	5.34	2.74	15.6
Encana 11-04	3953.38	Drill Core	0.01	40.89	11.73	5.96	3.57	15.04
Encana 11-04	3954.54	Drill Core	0.01	42.65	12.83	5.61	2.75	13.56
Encana 11-04	3955.49	Drill Core	0.02	41.26	12.05	6.34	2.65	15.23

Encana 11-04	3956.475	Drill Core	0.02	51.16	13.45	4.26	2.07	9
Encana 11-04	3957.515	Drill Core	0.02	44.98	12.74	7.62	2.32	11.99
Encana 11-04	3958.49	Drill Core	0.02	48.96	13.75	4.2	2.32	9.61
Encana 11-04	3959.5	Drill Core	0.02	53.59	15.9	5.54	2.24	4.96
Encana 11-04	3960.5	Drill Core	0.02	46.34	13.67	4.96	2.38	11.1
Encana 11-04	3962.43	Drill Core	0.02	52.46	5.78	2.81	1.61	15.55
Encana 11-04	3963.49	Drill Core	0.02	49.53	10.56	5.19	1.61	12.2
Encana 11-04	3964.465	Drill Core	0.01	56.11	7.22	2.93	1.48	12.04
Encana 11-04	3965.41	Drill Core	0.01	44.57	8.8	3.8	1.69	16.22
Encana 11-04	3966.5	Drill Core	0.02	43.37	11.54	3.48	1.86	15.33
Encana 11-04	3967.5	Drill Core	0.02	43.64	10.67	3.29	1.89	16.17
Encana 11-04	3968.46	Drill Core	0.01	43.69	11.02	2.99	1.76	15.79
Encana 11-04	3969.43	Drill Core	0.03	46.56	9.61	3.64	1.57	14.59
Encana 11-04	3970.44	Drill Core	0.02	43.97	6.99	2.95	1.56	19.49
Encana 11-04	3971.47	Drill Core	<0.01	52.89	10.64	4.55	1.54	10.44
Encana 11-04	3972.5	Drill Core	0.01	54.63	10.34	3.47	1.54	9.37
Encana 11-04	3973.54	Drill Core	0.01	49.7	12.5	3.17	1.65	11.01
Encana 11-04	3974.54	Drill Core	0.01	24.29	5.19	4.6	2.75	31.48
Encana 11-04	3975.5	Drill Core	0.01	51.28	8.73	2.94	1.35	12.54
Encana 11-04	3976.49	Drill Core	0.01	56.71	6.58	2.43	1.08	12.42
Encana 11-04	3977.47	Drill Core	0.01	51.3	8.58	2.98	1.42	12.54

Encana 11-04	3978.415	Drill Core	0.02	24.81	3.24	4.5	8.27	26.06
Encana 11-04	3979.5	Drill Core	0.01	63.34	7.29	2.03	0.94	9.26
Encana 11-04	3980.455	Drill Core	0.01	61.79	6.51	1.98	0.86	10.41
Encana 11-04	3981.53	Drill Core	0.01	19.77	3.13	2.75	1.35	39.34
Encana 11-04	3982.465	Drill Core	0.01	28.6	6.72	2.78	2.01	29.88
Encana 11-04	3983.51	Drill Core	0.01	45.12	5.68	2.14	1.71	20.7
Encana 11-04	3984.5	Drill Core	0.01	37.14	4.49	1.97	0.96	27.08
Encana 11-04	3985.465	Drill Core	0.01	26.41	3.3	2.24	1.99	33.65
Encana 11-04	3986.48	Drill Core	0.02	32.47	4.8	2.61	1.72	28.72
Encana 11-04	3987.48	Drill Core	0.02	32.35	5.21	2.74	2.06	28.06
Encana 11-04	3988.42	Drill Core	0.02	29.36	6.59	3.1	2.48	27.93
Encana 11-04	3989.54	Drill Core	0.01	4.3	0.86	1.37	0.83	52.11
Encana 11-04	3990.435	Drill Core	0.01	19.37	5.27	1.69	2.79	35.75
Encana 11-04	3991.4	Drill Core	0.01	9.83	1.98	1.39	1.46	46.78
Encana 11-04	3992.4	Drill Core	0.01	11.38	2.94	1.23	1.1	45.36
Encana 11-04	3993.43	Drill Core	0.01	21.13	6.26	2.33	1.56	35.74
Encana 11-04	3994.455	Drill Core	0.02	15.11	4.28	1.35	1.18	41.26
Encana 11-04	3995.45	Drill Core	0.02	19.61	6.12	2.24	1.35	36.23
Encana 11-04	3996.47	Drill Core	0.02	6.74	1.98	0.88	0.94	49.19
Encana 11-04	3997.42	Drill Core	0.02	8.37	2.31	1.04	0.97	47.77
Encana 11-04	3998.5	Drill Core	0.01	19.78	6.57	2.13	1.38	35.16

Encana 11-04	3999.53	Drill Core	0.01	19.18	6.48	2.29	1.39	35.34
Encana 11-04	3960.84	Drill Core	0.01	48.35	14.21	4.47	2.34	9.66
Encana 11-04	3965.67	Drill Core	0.02	42.04	8.63	4.24	1.82	18.37
Encana 11-04	3974.91	Drill Core	0.02	35.17	7.16	2.64	2.22	25.19
Encana 11-04	3931.53	Drill Core	0.01	44.34	13.93	5.33	3.17	12.23
Encana 11-04	3932.475	Drill Core	0.01	33.03	10.06	4.79	3.91	21.73
Encana 11-04	3933.47	Drill Core	0.01	28.63	8.68	4.93	3.88	25.57
Encana 11-04	3933.515	Drill Core	0.02	41.37	13.06	5.04	3.55	14.74
Encana 11-04	1123.58	Drill Core	0.02	3.85	0.93	0.56	1.02	51.98
Encana 11-04	1167.42	Drill Core	0.02	26.82	5.18	2.14	4.13	29.49
Encana 11-04	3961.53	Drill Core	0.02	41.6	8.34	6.76	2.01	17.11
Encana 11-04	3982.57	Drill Core	0.02	33.18	8.34	2.95	1.88	25.22
	Pulp Duplicates							
	1129.74	Drill Core	0.02	3.16	0.37	0.27	0.91	52.35
	1129.74	REP						
	1165.42	Drill Core	0.02	30.53	5.63	1.94	5.15	25.58
	1165.42	REP						
	3982.57	Drill Core	0.02	33.18	8.34	2.95	1.88	25.22
	3982.57	REP						
	3958.49	Drill Core	0.02	48.96	13.75	4.2	2.32	9.61
	3958.49	REP						
	3995.45	Drill Core	0.02	19.61	6.12	2.24	1.35	36.23
	3995.45	REP						
	3987.48	Drill Core	0.02	32.35	5.21	2.74	2.06	28.06
	3987.48	REP						
	3950.64	Drill Core	0.01	41.21	12.84	5.41	2.84	14.63
	3950.64	REP						
	1120.46	Drill Core	0.02	12.98	3.09	2.03	1.68	42.3
	1120.46	REP						

	3982.57	Drill Core	0.02	33.18	8.34	2.95	1.88	25.22
	3982.57	REP						
	1157.49	Drill Core	0.02	28.36	7.21	3.32	1.93	24.17
	1157.49	REP						
	1168.62	Drill Core	0.02	29.14	8.21	3.23	1.92	24.21
	1168.62	REP		28.87	8.29	3.21	1.91	24.36
	3982.57	Drill Core	0.02	33.18	8.34	2.95	1.88	25.22
	3982.57	REP		33.13	8.42	2.97	1.9	25.1
	1131.53	Drill Core	0.02	21.17	4.68	1.85	2.19	34.52
	1131.53	REP		21.04	4.7	1.87	2.2	34.58
	3960.5	Drill Core	0.02	46.34	13.67	4.96	2.38	11.1
	3960.5	REP		46.18	13.73	4.98	2.38	11.23
	3997.42	Drill Core	0.02	8.37	2.31	1.04	0.97	47.77
	3997.42	REP		8.29	2.27	1.03	0.96	47.92
	Reference Materials							
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD GS311-1	STD						
	STD GS910-4	STD						
	STD DS10	STD						
	STD OREAS45EA	STD						
	STD DS10	STD						
	STD OREAS45EA	STD						

	STD DS10	STD						
	STD OREAS45EA	STD						
	STD DS10	STD						
	STD OREAS45EA	STD						
	STD DS10	STD						
	STD OREAS45EA	STD						
	STD SO-18	STD		58.1	14.11	7.62	3.36	6.37
	STD SO-18	STD		57.89	14.23	7.67	3.4	6.33
	STD SO-18	STD		58.06	14.21	7.59	3.37	6.33
	STD SO-18	STD		57.98	14.2	7.58	3.4	6.35
	STD SO-18	STD		58.16	14.15	7.57	3.37	6.39
	STD SO-18	STD		58.13	14.18	7.57	3.38	6.35
	STD SO-18	STD		58.16	14.19	7.55	3.38	6.35
	STD SO-18	STD		58.18	14.13	7.57	3.36	6.43
	STD SO-18	STD		57.76	14.27	7.64	3.39	6.4
	STD SO-18	STD		58.06	14.14	7.58	3.35	6.39
	STD SO-18	STD		58.18	13.99	7.64	3.35	6.35
	STD SO-18	STD		58.19	14.13	7.67	3.35	6.41
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK						
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	<0.01
	BLK	BLK		0.01	<0.01	<0.04	<0.01	0.02
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	0.01
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	<0.01
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	<0.01
	BLK	BLK		<0.01	<0.01	<0.04	<0.01	0.01
	Prep Wash							
	ROCK-VAN	Prep Blank		70.28	14.32	3.57	0.92	2.78
	ROCK-VAN	Prep Blank		71.03	14.11	3.08	0.8	2.35

Table 29. Continued

		Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Ni
		%	%	%	%	%	%	PPM
	MDL	0.01	0.01	0.01	0.01	0.01	0.002	20
Well ID	Sample							
Esso 16-28	1107.46	0.05	0.07	0.01	0.02	<0.01	<0.002	<20
Esso 16-28	1108.54	0.07	0.11	0.02	0.05	<0.01	<0.002	<20
Esso 16-28	1109.51	0.03	0.04	<0.01	<0.01	<0.01	0.003	<20
Esso 16-28	1110.4	0.03	0.03	<0.01	0.01	<0.01	0.003	<20
Esso 16-28	1111.48	0.06	0.13	0.02	0.04	0.01	0.003	<20
Esso 16-28	1112.31	0.04	0.38	0.05	0.12	0.01	0.007	<20
Esso 16-28	1113.46	0.08	0.66	0.11	0.18	0.01	0.038	21
Esso 16-28	1114.57	0.05	0.25	0.05	0.08	0.01	0.028	<20
Esso 16-28	1115.33	0.04	0.08	0.02	0.02	0.02	0.014	<20
Esso 16-28	1116.63	0.06	0.33	0.04	0.05	0.02	0.004	<20
Esso 16-28	1117.51	0.05	0.31	0.04	0.08	0.01	<0.002	<20
Esso 16-28	1118.4	0.06	0.47	0.07	0.14	0.01	<0.002	<20
Esso 16-28	1119.64	0.03	0.1	0.02	0.03	0.02	0.002	<20
Esso 16-28	1120.46	0.13	1.12	0.17	0.19	0.02	0.01	41
Esso 16-28	1121.48	0.15	1.52	0.23	0.31	0.02	0.007	48
Esso 16-28	1122.55	0.12	1.02	0.15	0.25	0.02	0.005	43
Esso 16-28	1124.38	0.05	0.29	0.05	0.06	0.01	0.004	<20
Esso 16-28	1125.48	0.1	1.15	0.2	0.23	0.02	0.006	27
Esso 16-28	1126.53	0.09	0.93	0.13	0.18	0.02	0.004	28
Esso 16-28	1127.56	0.12	1.21	0.18	0.23	0.02	0.108	31
Esso 16-28	1128.42	0.03	0.08	0.01	<0.01	<0.01	0.002	<20
Esso 16-28	1129.74	0.03	0.18	0.03	0.06	0.03	0.02	<20
Esso 16-28	1130.31	0.15	2.02	0.23	0.24	0.02	0.008	40
Esso 16-28	1131.53	0.18	2.3	0.27	0.27	0.02	0.007	55
Esso 16-28	1132.54	0.14	1.82	0.22	0.24	0.03	0.01	31
Esso 16-28	1133.54	0.18	2.26	0.27	0.36	0.02	0.007	55
Esso 16-28	1134.64	0.03	0.22	0.03	0.1	0.02	<0.002	<20
Esso 16-28	1135.68	0.19	2.51	0.3	0.4	0.02	0.013	56
Esso 16-28	1136.7	0.16	2.13	0.26	0.35	0.02	0.006	44
Esso 16-28	1137.44	0.05	0.4	0.04	0.11	0.04	<0.002	<20
Esso 16-28	1138.62	0.17	2.52	0.32	0.42	0.03	0.01	48
Esso 16-28	1139.59	0.06	0.65	0.1	0.14	0.03	<0.002	<20
Esso 16-28	1140.52	0.18	2.28	0.27	0.22	0.03	0.012	53
Esso 16-28	1141.15	0.18	2.2	0.26	0.22	0.02	0.011	52

Esso 16-28	1142.52	0.19	2.08	0.25	0.33	0.02	0.007	41
Esso 16-28	1143.4	0.21	2.3	0.29	0.35	0.02	0.007	38
Esso 16-28	1144.48	0.09	0.69	0.09	0.11	0.06	<0.002	<20
Esso 16-28	1145.57	0.24	2.46	0.3	0.33	0.02	0.007	49
Esso 16-28	1146.4	0.19	1.86	0.26	0.31	0.03	0.007	39
Esso 16-28	1147.4	0.18	1.64	0.23	0.2	0.03	0.005	26
Esso 16-28	1148.55	0.19	1.93	0.27	0.25	0.02	0.007	44
Esso 16-28	1149.53	0.22	2.18	0.31	0.26	0.02	0.009	46
Esso 16-28	1150.5	0.23	2.08	0.3	0.35	0.02	0.008	47
Esso 16-28	1151.4	0.22	1.84	0.26	0.32	0.02	0.007	43
Esso 16-28	1152.51	0.23	1.95	0.27	0.33	0.02	0.008	47
Esso 16-28	1153.63	0.24	2.27	0.31	0.37	0.02	0.009	51
Esso 16-28	1154.62	0.23	2.33	0.31	0.35	0.02	0.009	62
Esso 16-28	1155.48	0.24	2.5	0.33	0.37	0.02	0.009	59
Esso 16-28	1156.47	0.26	2.74	0.36	0.3	0.02	0.01	80
Esso 16-28	1157.49	0.25	3.15	0.39	0.27	0.02	0.011	77
Esso 16-28	1158.39	0.16	1.8	0.23	0.11	0.03	0.005	26
Esso 16-28	1159.4	0.25	3	0.36	0.15	0.02	0.01	70
Esso 16-28	1160.57	0.27	3.34	0.4	0.2	0.02	0.012	79
Esso 16-28	1161.52	0.17	2.39	0.3	0.07	0.03	0.007	<20
Esso 16-28	1162.5	0.23	2.94	0.35	0.14	0.03	0.009	64
Esso 16-28	1163.55	0.26	2.98	0.35	0.18	0.03	0.008	78
Esso 16-28	1164.5	0.22	3.13	0.37	0.12	0.03	0.009	42
Esso 16-28	1165.42	0.2	2.79	0.34	0.08	0.04	0.007	<20
Esso 16-28	1166.5	0.2	2.66	0.35	0.08	0.04	0.007	<20
Esso 16-28	1168.62	0.26	3.43	0.43	0.11	0.03	0.009	59
Esso 16-28	1169.32	0.06	0.58	0.06	0.05	0.05	<0.002	<20
Esso 16-28	1170.5	0.06	0.24	0.03	0.04	0.02	<0.002	<20
Esso 16-28	1171.5	0.04	0.22	0.03	0.09	0.02	<0.002	<20
Esso 16-28	1144.3	0.17	1.64	0.2	0.25	0.03	0.005	30
Esso 16-28	1168.09	0.17	2.04	0.25	0.07	0.03	0.006	21
Esso 16-28	1161.07	0.21	2.25	0.28	0.08	0.03	0.007	27
Esso 16-28	1154.27	0.21	2.06	0.28	0.2	0.02	0.009	59
Esso 16-28	1145.745	0.1	0.65	0.09	0.26	0.03	<0.002	<20
Standard	1180	0.22	3.5	0.83	0.38	0.15	0.015	73
Encana 11-04	1190	1.03	1.36	0.55	0.05	0.06	0.017	110
Encana 11-04	3935.5	0.42	4.17	0.52	0.11	0.06	0.011	71
Encana 11-04	3936.515	0.44	4.57	0.55	0.13	0.05	0.012	57
Encana 11-04	3937.51	0.45	4.8	0.58	0.11	0.04	0.013	71
Encana 11-04	3938.5	0.43	4.53	0.55	0.1	0.04	0.011	60
Encana 11-04	3939.42	0.45	4.58	0.57	0.1	0.04	0.012	58

Encana 11-04	3940.515	0.36	3.2	0.4	0.31	0.06	0.008	62
Encana 11-04	3941.595	0.31	1.54	0.2	0.39	0.07	0.005	36
Encana 11-04	3942.425	0.49	3.22	0.42	0.2	0.04	0.01	80
Encana 11-04	3943.535	0.51	3.38	0.44	0.22	0.03	0.01	72
Encana 11-04	3944.48	0.5	3.41	0.43	0.2	0.03	0.01	89
Encana 11-04	3945.37	0.5	3.22	0.42	0.16	0.03	0.01	90
Encana 11-04	3946.475	0.51	3.56	0.47	0.17	0.03	0.011	92
Encana 11-04	3947.46	0.51	3.7	0.49	0.19	0.03	0.012	81
Encana 11-04	3948.45	0.5	3.17	0.39	0.21	0.05	0.009	51
Encana 11-04	3949.52	0.55	3.53	0.45	0.41	0.05	0.011	69
Encana 11-04	3950.64	0.48	4.27	0.51	0.24	0.06	0.013	64
Encana 11-04	3951.53	0.54	4.53	0.6	0.17	0.04	0.013	68
Encana 11-04	3952.515	0.49	4.16	0.54	0.2	0.05	0.011	62
Encana 11-04	3953.38	0.58	3.93	0.55	0.18	0.06	0.011	60
Encana 11-04	3954.54	0.56	4.28	0.56	0.29	0.04	0.013	76
Encana 11-04	3955.49	0.48	4.13	0.51	0.19	0.05	0.012	71
Encana 11-04	3956.475	0.47	4.73	0.53	0.19	0.03	0.013	64
Encana 11-04	3957.515	0.48	4.5	0.52	0.19	0.04	0.011	69
Encana 11-04	3958.49	0.5	4.84	0.54	0.17	0.03	0.013	67
Encana 11-04	3959.5	0.54	5.44	0.58	0.14	0.03	0.013	65
Encana 11-04	3960.5	0.47	4.85	0.53	0.19	0.03	0.013	68
Encana 11-04	3962.43	0.35	2.5	0.26	0.15	0.04	0.007	60
Encana 11-04	3963.49	0.46	4.42	0.46	0.23	0.03	0.01	71
Encana 11-04	3964.465	0.36	3.22	0.31	0.16	0.03	0.008	58
Encana 11-04	3965.41	0.46	3.74	0.41	0.16	0.03	0.01	84
Encana 11-04	3966.5	0.45	4.62	0.52	0.2	0.03	0.012	86
Encana 11-04	3967.5	0.41	4.3	0.48	0.22	0.03	0.01	77
Encana 11-04	3968.46	0.43	4.58	0.5	0.18	0.03	0.01	75
Encana 11-04	3969.43	0.37	4.21	0.43	0.17	0.03	0.01	93
Encana 11-04	3970.44	0.33	3.08	0.31	0.13	0.03	0.008	83
Encana 11-04	3971.47	0.35	4.6	0.45	0.17	0.02	0.011	82
Encana 11-04	3972.5	0.36	4.5	0.44	0.17	0.02	0.011	107
Encana 11-04	3973.54	0.41	4.99	0.5	0.17	0.02	0.013	74
Encana 11-04	3974.54	0.35	2.24	0.24	0.12	0.06	0.006	57
Encana 11-04	3975.5	0.22	4.19	0.38	0.17	0.02	0.01	117
Encana 11-04	3976.49	0.2	3.17	0.29	0.14	0.02	0.009	99
Encana 11-04	3977.47	0.21	4.12	0.38	0.18	0.02	0.01	117
Encana 11-04	3978.415	0.32	1.43	0.21	0.05	0.11	0.004	<20
Encana 11-04	3979.5	0.21	3.46	0.33	0.13	0.02	0.008	89
Encana 11-04	3980.455	0.19	3.1	0.32	0.18	0.02	0.009	106
Encana 11-04	3981.53	0.16	1.56	0.15	0.19	0.05	0.004	35

Encana 11-04	3982.465	0.21	3.06	0.28	0.14	0.05	0.008	39
Encana 11-04	3983.51	0.21	2.56	0.25	0.16	0.04	0.007	54
Encana 11-04	3984.5	0.18	2.08	0.2	0.2	0.05	0.006	63
Encana 11-04	3985.465	0.18	1.48	0.17	0.13	0.1	0.005	34
Encana 11-04	3986.48	0.19	2.1	0.22	0.11	0.09	0.006	36
Encana 11-04	3987.48	0.2	2.26	0.24	0.12	0.1	0.006	41
Encana 11-04	3988.42	0.22	2.83	0.3	0.14	0.11	0.008	54
Encana 11-04	3989.54	0.09	0.34	0.05	1	0.19	<0.002	<20
Encana 11-04	3990.435	0.15	2.19	0.23	0.11	0.07	0.006	53
Encana 11-04	3991.4	0.15	0.9	0.12	0.08	0.05	0.003	36
Encana 11-04	3992.4	0.11	1.14	0.14	0.09	0.04	0.004	31
Encana 11-04	3993.43	0.16	2.29	0.29	0.16	0.04	0.007	42
Encana 11-04	3994.455	0.15	1.67	0.2	0.15	0.04	0.004	46
Encana 11-04	3995.45	0.15	2.26	0.28	0.2	0.04	0.007	72
Encana 11-04	3996.47	0.08	0.72	0.1	0.16	0.04	0.002	<20
Encana 11-04	3997.42	0.1	0.91	0.12	0.1	0.04	0.003	33
Encana 11-04	3998.5	0.14	2.46	0.28	0.2	0.05	0.007	89
Encana 11-04	3999.53	0.14	2.43	0.27	0.28	0.05	0.007	90
Encana 11-04	3960.84	0.5	5.01	0.55	0.22	0.03	0.013	65
Encana 11-04	3965.67	0.45	3.71	0.42	0.28	0.04	0.01	79
Encana 11-04	3974.91	0.24	3.1	0.27	0.15	0.05	0.008	44
Encana 11-04	3931.53	0.43	4.42	0.56	0.13	0.06	0.012	68
Encana 11-04	3932.475	0.32	3.14	0.43	0.08	0.15	0.009	38
Encana 11-04	3933.47	0.36	2.7	0.37	0.09	0.19	0.007	29
Encana 11-04	3933.515	0.42	4.08	0.53	0.13	0.1	0.01	43
Encana 11-04	1123.58	0.05	0.32	0.05	0.06	0.02	<0.002	<20
Encana 11-04	1167.42	0.18	2.55	0.31	0.08	0.03	0.008	32
Encana 11-04	3961.53	0.53	3.3	0.36	0.38	0.04	0.009	117
Encana 11-04	3982.57	0.26	3.62	0.37	0.31	0.04	0.009	71
	Pulp Duplicates							
	1129.74	0.03	0.18	0.03	0.06	0.03	0.02	<20
	1129.74							
	1165.42	0.2	2.79	0.34	0.08	0.04	0.007	<20
	1165.42							
	3982.57	0.26	3.62	0.37	0.31	0.04	0.009	71
	3982.57							
	3958.49	0.5	4.84	0.54	0.17	0.03	0.013	67
	3958.49							
	3995.45	0.15	2.26	0.28	0.2	0.04	0.007	72
	3995.45							

	3987.48	0.2	2.26	0.24	0.12	0.1	0.006	41
	3987.48							
	3950.64	0.48	4.27	0.51	0.24	0.06	0.013	64
	3950.64							
	1120.46	0.13	1.12	0.17	0.19	0.02	0.01	41
	1120.46							
	3982.57	0.26	3.62	0.37	0.31	0.04	0.009	71
	3982.57							
	1157.49	0.25	3.15	0.39	0.27	0.02	0.011	77
	1157.49							
	1168.62	0.26	3.43	0.43	0.11	0.03	0.009	59
	1168.62	0.26	3.49	0.43	0.11	0.03	0.009	61
	3982.57	0.26	3.62	0.37	0.31	0.04	0.009	71
	3982.57	0.26	3.66	0.37	0.3	0.04	0.01	63
	1131.53	0.18	2.3	0.27	0.27	0.02	0.007	55
	1131.53	0.18	2.33	0.27	0.27	0.02	0.009	50
	3960.5	0.47	4.85	0.53	0.19	0.03	0.013	68
	3960.5	0.47	4.81	0.53	0.19	0.03	0.012	73
	3997.42	0.1	0.91	0.12	0.1	0.04	0.003	33
	3997.42	0.1	0.9	0.12	0.1	0.04	0.003	28
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							

	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD SO-18	3.69	2.15	0.69	0.81	0.39	0.546	38
	STD SO-18	3.68	2.16	0.7	0.82	0.4	0.555	34
	STD SO-18	3.66	2.17	0.69	0.79	0.39	0.553	50
	STD SO-18	3.69	2.19	0.69	0.79	0.4	0.553	47
	STD SO-18	3.63	2.12	0.69	0.8	0.39	0.549	44
	STD SO-18	3.66	2.13	0.69	0.8	0.39	0.555	42
	STD SO-18	3.64	2.13	0.68	0.79	0.39	0.554	45
	STD SO-18	3.61	2.16	0.68	0.78	0.39	0.542	41
	STD SO-18	3.73	2.18	0.7	0.83	0.4	0.552	37
	STD SO-18	3.7	2.16	0.69	0.81	0.4	0.548	45
	STD SO-18	3.65	2.21	0.69	0.8	0.39	0.547	46
	STD SO-18	3.58	2.07	0.69	0.78	0.39	0.55	38
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
	BLK	<0.01	0.01	<0.01	<0.01	<0.01	<0.002	<20
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	0.003	<20
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20

	BLK	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<20
	Prep Wash							
	ROCK-VAN	4.39	2.18	0.38	0.11	0.09	<0.002	<20
	ROCK-VAN	4.46	2.26	0.35	0.09	0.08	<0.002	<20

Table 29. Continued

		Sc	LOI	Sum	Ba	Be	Co	Cs
		PPM	%	%	PPM	PPM	PPM	PPM
	MDL	1	-5.1	0.01	1	1	0.2	0.1
Well ID	Sample							
Esso 16-28	1107.46	<1	43.1	99.92	13	<1	<0.2	<0.1
Esso 16-28	1108.54	<1	42.3	99.92	18	2	0.2	<0.1
Esso 16-28	1109.51	<1	43.5	99.94	5	<1	<0.2	<0.1
Esso 16-28	1110.4	<1	43.5	99.93	8	2	<0.2	<0.1
Esso 16-28	1111.48	<1	42.2	99.89	15	2	<0.2	0.2
Esso 16-28	1112.31	1	41.7	99.86	27	2	0.9	0.4
Esso 16-28	1113.46	2	40.6	99.84	43	<1	1.6	1.3
Esso 16-28	1114.57	1	42.3	99.83	19	<1	0.9	0.4
Esso 16-28	1115.33	<1	42.9	99.95	7	<1	<0.2	<0.1
Esso 16-28	1116.63	1	38	99.88	21	<1	1.1	0.5
Esso 16-28	1117.51	<1	41.2	99.83	27	<1	<0.2	0.4
Esso 16-28	1118.4	<1	40.5	99.83	32	5	1	0.4
Esso 16-28	1119.64	<1	42.4	99.83	11	<1	0.4	0.2
Esso 16-28	1120.46	2	36.1	99.83	84	<1	3	1.9
Esso 16-28	1121.48	4	34.4	99.84	127	2	2.9	2.3
Esso 16-28	1122.55	2	36.3	99.82	69	<1	1.8	1.4
Esso 16-28	1124.38	<1	40.7	99.79	26	<1	0.4	0.4
Esso 16-28	1125.48	2	33.8	99.82	92	<1	2.6	1.2
Esso 16-28	1126.53	1	37.6	99.82	68	2	2	1
Esso 16-28	1127.56	3	36.2	99.81	71	4	4	1.7
Esso 16-28	1128.42	<1	43.7	99.93	6	<1	<0.2	0.2
Esso 16-28	1129.74	<1	42.5	99.87	17	<1	0.6	0.2
Esso 16-28	1130.31	4	33	99.87	102	3	3.3	1.9
Esso 16-28	1131.53	5	32.4	99.85	118	2	4	2.7
Esso 16-28	1132.54	4	33.8	99.86	95	<1	3	1.7
Esso 16-28	1133.54	5	31.3	99.83	128	<1	5.3	3.2
Esso 16-28	1134.64	<1	39.5	99.88	36	<1	0.9	0.4
Esso 16-28	1135.68	6	30.3	99.84	146	<1	5.6	3.4
Esso 16-28	1136.7	4	31.9	99.84	129	2	5.6	3.3
Esso 16-28	1137.44	<1	39.3	99.9	23	4	1.7	<0.1

Esso 16-28	1138.62	6	28.6	99.85	158	2	6.3	4
Esso 16-28	1139.59	2	38.5	99.86	43	6	1.8	0.9
Esso 16-28	1140.52	5	33.4	99.86	130	<1	4.9	3.3
Esso 16-28	1141.15	5	33.7	99.86	125	<1	4.9	3.2
Esso 16-28	1142.52	5	31.5	99.87	106	2	4.3	2.5
Esso 16-28	1143.4	6	32.3	99.88	116	<1	4.4	3.3
Esso 16-28	1144.48	2	39	99.89	43	<1	3.9	1
Esso 16-28	1145.57	7	30.9	99.86	139	2	5.4	3.6
Esso 16-28	1146.4	6	30.4	99.88	116	<1	5.7	2.6
Esso 16-28	1147.4	5	34.1	99.88	156	<1	3.6	2.5
Esso 16-28	1148.55	5	33.7	99.88	148	4	4.2	1.9
Esso 16-28	1149.53	6	32	99.87	211	<1	3.8	2.5
Esso 16-28	1150.5	6	32.4	99.87	175	<1	4.2	2.5
Esso 16-28	1151.4	5	34	99.88	124	<1	4.4	2.1
Esso 16-28	1152.51	5	31.7	99.87	113	2	3.8	2.4
Esso 16-28	1153.63	6	32.1	99.88	134	2	4.8	3.1
Esso 16-28	1154.62	7	31.5	99.87	185	<1	5.3	2.4
Esso 16-28	1155.48	7	32.1	99.88	154	2	4.7	2.9
Esso 16-28	1156.47	7	32.2	99.87	141	<1	5.3	3
Esso 16-28	1157.49	8	30.8	99.87	157	2	4.9	3.6
Esso 16-28	1158.39	4	32.4	99.9	132	<1	3.3	1.5
Esso 16-28	1159.4	7	30.8	99.87	165	6	6.4	2.4
Esso 16-28	1160.57	8	30.8	99.88	147	<1	6.6	2.9
Esso 16-28	1161.52	4	26.3	99.87	267	<1	3.1	1.2
Esso 16-28	1162.5	7	27.6	99.88	151	2	6.4	2.2
Esso 16-28	1163.55	7	28	99.88	143	4	8.2	2.6
Esso 16-28	1164.5	7	28.5	99.89	149	2	7.8	2.8
Esso 16-28	1165.42	6	27.6	99.9	168	<1	4.6	2
Esso 16-28	1166.5	5	26.5	99.89	182	2	4.8	1.7
Esso 16-28	1168.62	9	28.9	99.87	169	<1	10.8	3.8
Esso 16-28	1169.32	2	40.8	99.94	30	2	3.4	0.7
Esso 16-28	1170.5	<1	42.3	99.95	17	<1	0.9	0.3
Esso 16-28	1171.5	1	40.9	99.93	101	<1	0.9	0.2
Esso 16-28	1144.3	4	33.4	99.88	90	<1	4.2	2
Esso 16-28	1168.09	5	33.3	99.88	99	2	6.3	2
Esso 16-28	1161.07	5	31	99.89	113	2	4.6	1.8
Esso 16-28	1154.27	6	34	99.88	128	2	4.1	2.5
Esso 16-28	1145.745	2	38.4	99.9	39	<1	2.3	0.7
Standard	1180	22	11	99.74	721	4	20.1	7.1
Encana 11-04	1190	14	14.9	99.81	615	6	10.8	2.6
Encana 11-04	3935.5	12	16.2	99.82	294	<1	20	8.2

Encana 11-04	3936.515	13	14.6	99.8	510	2	18	7.7
Encana 11-04	3937.51	14	13.2	99.82	405	2	16.7	8.2
Encana 11-04	3938.5	13	12.9	99.83	326	<1	16.4	8.1
Encana 11-04	3939.42	13	13.8	99.83	352	<1	16	7.9
Encana 11-04	3940.515	8	21.2	99.82	251	4	12	5
Encana 11-04	3941.595	4	30.6	99.83	188	9	5.7	2.1
Encana 11-04	3942.425	9	19.7	99.84	285	3	8.4	4.9
Encana 11-04	3943.535	9	18.3	99.85	272	<1	7.4	5.2
Encana 11-04	3944.48	9	17.4	99.77	277	2	10.1	5.3
Encana 11-04	3945.37	9	17.9	99.78	582	3	9.4	5.2
Encana 11-04	3946.475	10	17.7	99.8	387	<1	10	5.6
Encana 11-04	3947.46	10	17.2	99.76	340	<1	9.3	5.7
Encana 11-04	3948.45	9	21.8	99.84	286	2	8.6	4.7
Encana 11-04	3949.52	10	18.8	99.81	321	2	16.3	6
Encana 11-04	3950.64	12	17.3	99.81	349	<1	16	8.5
Encana 11-04	3951.53	13	16.2	99.81	399	3	17.4	8
Encana 11-04	3952.515	11	17.7	99.81	315	3	17.5	6.7
Encana 11-04	3953.38	11	17.3	99.8	307	3	15.5	6.4
Encana 11-04	3954.54	12	16.7	99.81	352	4	15.4	6.9
Encana 11-04	3955.49	11	16.9	99.82	318	2	18.8	7.2
Encana 11-04	3956.475	12	13.9	99.8	419	<1	12.9	7.6
Encana 11-04	3957.515	11	14.4	99.81	487	<1	19.3	7.9
Encana 11-04	3958.49	12	14.9	99.83	362	<1	12.7	8.5
Encana 11-04	3959.5	14	10.9	99.83	500	<1	18.8	8.7
Encana 11-04	3960.5	12	15.3	99.82	453	2	16.2	7.6
Encana 11-04	3962.43	5	18.3	99.85	353	3	6.2	2.4
Encana 11-04	3963.49	9	15.1	99.85	365	3	14.8	5.7
Encana 11-04	3964.465	6	16	99.86	457	<1	8.1	3.4
Encana 11-04	3965.41	8	19.9	99.84	243	3	13	4.3
Encana 11-04	3966.5	10	18.4	99.83	451	2	13	6.3
Encana 11-04	3967.5	9	18.7	99.84	345	<1	10.6	5.3
Encana 11-04	3968.46	10	18.8	99.83	352	<1	11.2	5.5
Encana 11-04	3969.43	9	18.7	99.84	245	<1	11.5	5
Encana 11-04	3970.44	6	21	99.85	264	4	9.3	2.8
Encana 11-04	3971.47	9	14.2	99.86	366	<1	12.5	5.5
Encana 11-04	3972.5	11	14.9	99.82	270	2	13.1	4.9
Encana 11-04	3973.54	12	15.7	99.84	387	2	12.8	7.2
Encana 11-04	3974.54	7	28.5	99.84	246	<1	7.8	2.2
Encana 11-04	3975.5	9	18	99.84	221	2	10.5	3.9
Encana 11-04	3976.49	7	16.8	99.82	294	2	7.4	2.4
Encana 11-04	3977.47	9	18.1	99.84	261	<1	11.6	4

Encana 11-04	3978.415	4	30.9	99.9	173	2	3.9	0.9
Encana 11-04	3979.5	7	12.8	99.86	287	<1	9.3	2.5
Encana 11-04	3980.455	7	14.5	99.84	285	<1	8.5	2.7
Encana 11-04	3981.53	4	31.4	99.87	183	2	7.8	1.5
Encana 11-04	3982.465	8	26.1	99.86	240	2	11.6	3.3
Encana 11-04	3983.51	6	21.3	99.86	315	3	6.4	3.3
Encana 11-04	3984.5	5	25.5	99.86	204	<1	7.5	2.1
Encana 11-04	3985.465	4	30.2	99.88	147	<1	5.1	1.3
Encana 11-04	3986.48	6	26.8	99.87	150	<1	8.4	1.8
Encana 11-04	3987.48	6	26.5	99.86	200	1	8.4	2.2
Encana 11-04	3988.42	8	26.8	99.85	247	<1	10.3	3.1
Encana 11-04	3989.54	1	38.7	99.87	172	<1	10.3	0.3
Encana 11-04	3990.435	6	32.2	99.86	168	<1	5.2	2.6
Encana 11-04	3991.4	3	37.1	99.87	117	<1	3.5	0.8
Encana 11-04	3992.4	4	36.3	99.82	467	2	4.3	1.4
Encana 11-04	3993.43	7	29.9	99.84	323	2	7.7	3.3
Encana 11-04	3994.455	5	34.5	99.86	142	<1	4.4	1.8
Encana 11-04	3995.45	7	31.3	99.84	264	<1	7.4	3.5
Encana 11-04	3996.47	2	39	99.8	663	<1	1.5	0.9
Encana 11-04	3997.42	3	38.1	99.87	119	1	2.7	1.1
Encana 11-04	3998.5	7	31.7	99.85	211	<1	9	3.1
Encana 11-04	3999.53	7	32	99.85	178	3	8.5	3.5
Encana 11-04	3960.84	14	14.5	99.83	350	4	14.7	8.3
Encana 11-04	3965.67	9	19.8	99.83	295	2	9.4	4.2
Encana 11-04	3974.91	8	23.7	99.86	253	1	9.1	3.2
Encana 11-04	3931.53	15	15.2	99.83	331	3	24.8	8.3
Encana 11-04	3932.475	11	22.2	99.86	247	2	17.1	5.8
Encana 11-04	3933.47	9	24.4	99.84	244	<1	16.1	4.8
Encana 11-04	3933.515	14	16.8	99.83	331	3	15.1	7.1
Encana 11-04	1123.58	1	41	99.83	25	<1	1.1	0.7
Encana 11-04	1167.42	5	28.9	99.84	152	<1	6	1.7
Encana 11-04	3961.53	8	19.4	99.82	343	<1	17	3.7
Encana 11-04	3982.57	9	23.1	99.26	2753	<1	10.2	4.2
	Pulp Duplicates							
	1129.74	<1	42.5	99.87	17	<1	0.6	0.2
	1129.74							
	1165.42	6	27.6	99.9	168	<1	4.6	2
	1165.42							
	3982.57	9	23.1	99.26	2753	<1	10.2	4.2
	3982.57							

	3958.49	12	14.9	99.83	362	<1	12.7	8.5
	3958.49							
	3995.45	7	31.3	99.84	264	<1	7.4	3.5
	3995.45							
	3987.48	6	26.5	99.86	200	1	8.4	2.2
	3987.48							
	3950.64	12	17.3	99.81	349	<1	16	8.5
	3950.64							
	1120.46	2	36.1	99.83	84	<1	3	1.9
	1120.46							
	3982.57	9	23.1	99.26	2753	<1	10.2	4.2
	3982.57							
	1157.49	8	30.8	99.87	157	2	4.9	3.6
	1157.49							
	1168.62	9	28.9	99.87	169	<1	10.8	3.8
	1168.62	9	28.9	99.86	162	4	11.3	4.3
	3982.57	9	23.1	99.26	2753	<1	10.2	4.2
	3982.57	9	23.1	99.27	2795	2	9.7	4.2
	1131.53	5	32.4	99.85	118	2	4	2.7
	1131.53	5	32.4	99.86	115	<1	3.8	2.8
	3960.5	12	15.3	99.82	453	2	16.2	7.6
	3960.5	12	15.3	99.82	445	3	15.8	7.7
	3997.42	3	38.1	99.87	119	1	2.7	1.1
	3997.42	3	38.1	99.86	120	<1	2.5	1.3
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							

	STD GS311-1							
	STD GS910-4							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD SO-18	26	1.9	99.76	448	<1	24.5	6.9
	STD SO-18	27	1.9	99.75	447	<1	24.8	6.1
	STD SO-18	24	1.9	99.73	509	<1	25.2	6.7
	STD SO-18	24	1.9	99.73	491	<1	25.3	6.9
	STD SO-18	26	1.9	99.72	555	3	29.2	7.1
	STD SO-18	26	1.9	99.73	534	<1	26.3	6.8
	STD SO-18	24	1.9	99.74	525	<1	26.6	6.9
	STD SO-18	24	1.9	99.74	501	<1	24.9	6.9
	STD SO-18	27	1.9	99.74	513	1	25.6	6.6
	STD SO-18	26	1.9	99.74	494	<1	23.8	7.1
	STD SO-18	23	1.9	99.71	536	3	29	6.8
	STD SO-18	24	1.9	99.73	533	<1	28.4	7.1
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<1	0	0.01	<1	4	<0.2	<0.1

	BLK	<1	0	0.03	<1	<1	<0.2	<0.1
	BLK	<1	0	<0.01	<1	<1	<0.2	<0.1
	BLK	<1	0	<0.01	<1	<1	<0.2	<0.1
	BLK	<1	0	<0.01	<1	2	<0.2	<0.1
	BLK	<1	0	<0.01	<1	1	<0.2	<0.1
	Prep Wash							
	ROCK-VAN	9	0.8	99.78	931	<1	5.4	0.3
	ROCK-VAN	7	1.2	99.79	889	2	3.9	0.4

Table 29. Continued

		Ga	Hf	Nb	Rb	Sn	Sr	Ta
		PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.5	0.1	0.1	0.1	1	0.5	0.1
Well ID	Sample							
Esso 16-28	1107.46	<0.5	<0.1	0.3	1.9	<1	517.7	<0.1
Esso 16-28	1108.54	<0.5	0.1	0.6	2.9	<1	554.4	<0.1
Esso 16-28	1109.51	<0.5	<0.1	0.1	1.4	<1	418.5	<0.1
Esso 16-28	1110.4	<0.5	<0.1	0.2	1.1	<1	487.4	<0.1
Esso 16-28	1111.48	<0.5	0.1	0.2	3.1	<1	741.8	<0.1
Esso 16-28	1112.31	<0.5	0.4	1.1	9.2	<1	921.4	0.1
Esso 16-28	1113.46	0.8	0.6	2.3	18.1	<1	989.3	0.1
Esso 16-28	1114.57	<0.5	0.3	0.8	6.6	<1	1217.8	<0.1
Esso 16-28	1115.33	<0.5	<0.1	0.1	2.1	<1	273.7	<0.1
Esso 16-28	1116.63	<0.5	0.3	1	8.2	<1	749.8	<0.1
Esso 16-28	1117.51	0.6	0.5	1	8.1	<1	1180.6	<0.1
Esso 16-28	1118.4	1.4	0.7	1.6	12.8	<1	1055.5	<0.1
Esso 16-28	1119.64	<0.5	0.2	0.3	3.3	<1	1270.4	<0.1
Esso 16-28	1120.46	3.8	1.3	4.2	33.2	<1	829.3	0.5
Esso 16-28	1121.48	4.7	1.9	5.4	45.3	<1	587.1	0.1
Esso 16-28	1122.55	3.2	1.4	3.5	25.3	<1	931.8	0.2
Esso 16-28	1124.38	<0.5	0.4	0.9	7.4	<1	1359.5	<0.1
Esso 16-28	1125.48	2.7	2.7	4.3	29.5	<1	889.3	0.3
Esso 16-28	1126.53	2.2	1.4	2.9	25.4	<1	1048.4	0.2
Esso 16-28	1127.56	1.9	1.6	3.9	30.5	<1	833.2	0.3
Esso 16-28	1128.42	<0.5	<0.1	0.1	2.5	<1	447.9	<0.1
Esso 16-28	1129.74	<0.5	0.4	0.4	4	<1	884.1	<0.1
Esso 16-28	1130.31	2.9	1.9	5	42.5	<1	516.1	0.4
Esso 16-28	1131.53	4.6	2.1	5.6	50.5	<1	531.4	0.3
Esso 16-28	1132.54	2.6	2	4.8	37.6	<1	630.8	0.4
Esso 16-28	1133.54	6.7	2	6.6	60.3	<1	557.2	0.6

Esso 16-28	1134.64	<0.5	0.4	0.6	6.1	<1	636.7	<0.1
Esso 16-28	1135.68	5.5	2.3	5.7	61.6	1	487.3	0.4
Esso 16-28	1136.7	6.7	1.5	5.8	59.5	<1	552.1	0.2
Esso 16-28	1137.44	<0.5	0.3	1.3	7.6	<1	434.9	<0.1
Esso 16-28	1138.62	7.2	3.1	6.9	66.1	1	449.7	0.6
Esso 16-28	1139.59	1.3	1	2.1	18	<1	837.7	0.3
Esso 16-28	1140.52	4.5	2.1	5.6	55.5	<1	475.6	0.3
Esso 16-28	1141.15	4.3	1.7	5.1	53.9	<1	465.9	0.3
Esso 16-28	1142.52	4.5	2	4.9	46.9	<1	428.5	0.2
Esso 16-28	1143.4	6.7	2	6.5	58.9	<1	350.7	0.4
Esso 16-28	1144.48	1.8	0.5	1.9	20.9	<1	577.1	0.2
Esso 16-28	1145.57	6.8	1.8	6	62.1	1	356.4	0.5
Esso 16-28	1146.4	5.5	1.9	5.5	47.4	<1	405.4	0.3
Esso 16-28	1147.4	4.8	1.6	4.5	45	<1	418.6	0.5
Esso 16-28	1148.55	5	2.1	5.3	44.5	<1	347.1	0.4
Esso 16-28	1149.53	5.8	2.7	5.8	49.1	<1	349.6	0.4
Esso 16-28	1150.5	5.2	2.6	5.8	46.6	<1	356	0.3
Esso 16-28	1151.4	4.3	2.4	4.7	42.4	<1	375.8	0.3
Esso 16-28	1152.51	5.1	2	5	44	<1	387.5	0.2
Esso 16-28	1153.63	5.3	1.9	7.3	51.7	<1	375.7	0.5
Esso 16-28	1154.62	4.9	2	5.8	49.5	<1	376.5	0.4
Esso 16-28	1155.48	6.2	2.1	5.8	57.6	<1	337.5	0.4
Esso 16-28	1156.47	7.2	2.4	6.1	61	<1	321.7	0.4
Esso 16-28	1157.49	6.6	2.3	7.8	63.2	<1	293.9	0.5
Esso 16-28	1158.39	3.4	2.3	3.9	32.2	<1	340.1	0.3
Esso 16-28	1159.4	6	2.6	6.7	59.2	<1	309.6	0.5
Esso 16-28	1160.57	7.9	2.3	7.6	67.6	<1	262.4	0.5
Esso 16-28	1161.52	3.2	3	5.3	37.5	<1	321.7	0.4
Esso 16-28	1162.5	6.2	2.2	5.8	54.8	<1	252.3	0.4
Esso 16-28	1163.55	6.2	2	5.6	55.2	<1	229.8	0.3
Esso 16-28	1164.5	7.4	2.1	5.8	59.5	<1	233.5	0.4
Esso 16-28	1165.42	5.3	2.6	6.1	51.2	<1	207	0.3
Esso 16-28	1166.5	4.3	3.2	6.8	47.5	<1	217.1	0.5
Esso 16-28	1168.62	9.4	2.2	6.8	76.4	1	289.1	0.5
Esso 16-28	1169.32	0.9	0.3	1.4	10.8	<1	270.2	<0.1
Esso 16-28	1170.5	<0.5	0.1	0.9	6.2	<1	318.6	<0.1
Esso 16-28	1171.5	0.8	0.2	0.9	5.1	<1	327.6	<0.1
Esso 16-28	1144.3	4	1.5	3.9	37.1	<1	465	0.4
Esso 16-28	1168.09	4.9	1.8	3.9	42.6	<1	504.3	0.2
Esso 16-28	1161.07	4.3	1.7	4.8	43.3	<1	327.1	0.3
Esso 16-28	1154.27	5.2	2.2	6.3	45.9	<1	353.6	0.3

Esso 16-28	1145.745	1.5	0.6	2.2	16.9	<1	585.1	0.2
Standard	1180	23	3.7	13.7	126.8	3	184.1	1
Encana 11-04	1190	15.7	3.7	6.5	46.7	1	49.4	0.6
Encana 11-04	3935.5	15.9	2.2	10.2	135.7	2	321.8	0.6
Encana 11-04	3936.515	17.5	2.4	10.9	149.9	2	257.8	0.6
Encana 11-04	3937.51	17.5	2.8	11.6	157.9	2	216.5	0.7
Encana 11-04	3938.5	16.1	2.4	10.2	144.4	2	209.1	0.7
Encana 11-04	3939.42	16.3	2.6	10.3	146.4	2	218.1	0.7
Encana 11-04	3940.515	9.6	2.2	9.1	91.2	2	439.8	0.6
Encana 11-04	3941.595	4.8	1.2	4.8	45.6	<1	706.2	0.1
Encana 11-04	3942.425	10	2.1	10.9	92.3	2	283.1	0.8
Encana 11-04	3943.535	10.4	2	10.9	98.1	2	297.3	0.7
Encana 11-04	3944.48	10.7	2.1	11.1	98.7	2	264.7	0.7
Encana 11-04	3945.37	9.8	1.9	10.3	93.6	2	270.5	0.6
Encana 11-04	3946.475	12.3	2.1	11.7	105.1	2	248	0.7
Encana 11-04	3947.46	12.5	2.3	12.2	110.6	2	271.3	0.9
Encana 11-04	3948.45	10.4	1.9	9.2	95.2	2	441.9	0.7
Encana 11-04	3949.52	11.1	2.1	10.6	105.7	2	409.1	0.7
Encana 11-04	3950.64	13.6	2.3	13.2	141.3	3	355.1	0.8
Encana 11-04	3951.53	15.4	2.7	13.2	142.5	2	293	0.8
Encana 11-04	3952.515	14	2.6	14.8	127.9	2	362.4	0.8
Encana 11-04	3953.38	13.4	2.9	14.7	118.9	2	304.3	1.1
Encana 11-04	3954.54	13.6	2.5	15.5	128.6	2	305.7	1
Encana 11-04	3955.49	13.4	2.5	13.9	126.6	2	335.9	0.9
Encana 11-04	3956.475	15.3	2.3	14.9	142.3	2	215.8	1.1
Encana 11-04	3957.515	14.1	2.4	14.4	132.9	2	264.3	0.8
Encana 11-04	3958.49	15.2	2.5	15.5	145.7	2	221.8	1.1
Encana 11-04	3959.5	17.4	2.8	13.9	164.7	3	145.9	0.7
Encana 11-04	3960.5	14.9	2.2	15	142.3	2	244.6	1
Encana 11-04	3962.43	5.2	1.4	7.4	54.3	1	246.2	0.4
Encana 11-04	3963.49	9.9	2.1	15.5	101.9	1	262	0.9
Encana 11-04	3964.465	6.5	1.6	9.9	67.9	1	236.7	0.6
Encana 11-04	3965.41	9.7	2.2	13.5	84.7	2	245.5	1
Encana 11-04	3966.5	12.8	2.4	15	115.5	2	278.8	1
Encana 11-04	3967.5	11.1	2.2	12.7	106.1	2	295.1	0.8
Encana 11-04	3968.46	11.6	2.4	14.9	108.5	2	305.6	0.9
Encana 11-04	3969.43	11.4	1.8	13.4	96.1	1	232.3	0.9
Encana 11-04	3970.44	6.7	1.5	8.4	67.7	1	271.5	0.5
Encana 11-04	3971.47	10.7	2	12.5	104.3	2	190.9	0.7
Encana 11-04	3972.5	12.3	1.7	11.7	107.5	2	160.9	0.6
Encana 11-04	3973.54	13.8	2.1	13.2	132.5	2	205.7	0.8

Encana 11-04	3974.54	5.1	1.4	5.1	50	<1	457.2	0.3
Encana 11-04	3975.5	9.7	1.6	10.3	87.7	2	196.9	0.6
Encana 11-04	3976.49	7.6	1.2	6.9	64	1	184.4	0.3
Encana 11-04	3977.47	9.4	1.7	8.7	85.7	1	199.2	0.4
Encana 11-04	3978.415	3.2	2	3.3	28.9	<1	237	0.2
Encana 11-04	3979.5	7.4	1.5	10.4	69	1	130.7	0.7
Encana 11-04	3980.455	6.9	1.3	8.2	61.6	1	159.7	0.5
Encana 11-04	3981.53	3	0.6	2.7	29.9	<1	554.4	0.1
Encana 11-04	3982.465	6.5	1.1	4.5	63	<1	421.2	0.3
Encana 11-04	3983.51	6	1.3	4.8	56.9	<1	278.8	0.3
Encana 11-04	3984.5	5.2	0.8	3.6	45	<1	326.3	0.2
Encana 11-04	3985.465	3.5	0.8	2.5	30.7	<1	431.2	<0.1
Encana 11-04	3986.48	5	0.9	3.5	45.8	<1	395.9	0.2
Encana 11-04	3987.48	5.5	1.1	3.4	49.8	<1	372.2	0.2
Encana 11-04	3988.42	7	1.4	4.7	62.9	<1	382.8	0.4
Encana 11-04	3989.54	<0.5	0.3	0.4	7.6	<1	747	<0.1
Encana 11-04	3990.435	5.4	0.8	3.2	52.7	<1	592.4	0.3
Encana 11-04	3991.4	1.5	0.6	1.7	19	<1	689.4	0.1
Encana 11-04	3992.4	2.1	0.6	2	31	<1	750.9	0.2
Encana 11-04	3993.43	6.4	1.2	4.3	62.2	<1	634.1	0.2
Encana 11-04	3994.455	4.1	0.9	2.9	42.4	<1	694	0.3
Encana 11-04	3995.45	6.3	1.2	3.9	60.5	1	633.9	0.4
Encana 11-04	3996.47	1.2	0.5	1.2	18.9	<1	824.1	<0.1
Encana 11-04	3997.42	1.5	0.6	1.5	24.7	<1	719.4	<0.1
Encana 11-04	3998.5	7	1.2	4.2	63.6	1	552.7	0.4
Encana 11-04	3999.53	7.7	1.2	4	65.9	1	562.4	0.3
Encana 11-04	3960.84	17.5	2.4	14.8	157.5	2	237.1	0.8
Encana 11-04	3965.67	8.2	2.1	14.3	83.2	1	342.7	0.9
Encana 11-04	3974.91	6.7	1.1	5.9	72.9	1	423.7	0.4
Encana 11-04	3931.53	15	2.5	9.6	151.5	2	310.3	0.6
Encana 11-04	3932.475	11.2	1.9	7.2	108.5	2	406.3	0.5
Encana 11-04	3933.47	9.9	1.7	6	89.1	2	535.9	0.4
Encana 11-04	3933.515	14.1	2.5	9.3	137.5	2	353.1	0.7
Encana 11-04	1123.58	<0.5	0.4	0.9	8.5	<1	1168.7	0.1
Encana 11-04	1167.42	6.2	2.8	4.2	49.3	<1	309.1	0.2
Encana 11-04	3961.53	9.9	1.7	9.7	78.7	1	304.9	0.7
Encana 11-04	3982.57	9.6	1.8	6.5	84.4	1	2879.4	0.3
	Pulp Duplicates							
	1129.74	<0.5	0.4	0.4	4	<1	884.1	<0.1
	1129.74							

	1165.42	5.3	2.6	6.1	51.2	<1	207	0.3
	1165.42							
	3982.57	9.6	1.8	6.5	84.4	1	2879.4	0.3
	3982.57							
	3958.49	15.2	2.5	15.5	145.7	2	221.8	1.1
	3958.49							
	3995.45	6.3	1.2	3.9	60.5	1	633.9	0.4
	3995.45							
	3987.48	5.5	1.1	3.4	49.8	<1	372.2	0.2
	3987.48							
	3950.64	13.6	2.3	13.2	141.3	3	355.1	0.8
	3950.64							
	1120.46	3.8	1.3	4.2	33.2	<1	829.3	0.5
	1120.46							
	3982.57	9.6	1.8	6.5	84.4	1	2879.4	0.3
	3982.57							
	1157.49	6.6	2.3	7.8	63.2	<1	293.9	0.5
	1157.49							
	1168.62	9.4	2.2	6.8	76.4	1	289.1	0.5
	1168.62	9.8	2.2	6.3	74	1	293.1	0.3
	3982.57	9.6	1.8	6.5	84.4	1	2879.4	0.3
	3982.57	9	1.7	6	82.9	1	2829.6	0.3
	1131.53	4.6	2.1	5.6	50.5	<1	531.4	0.3
	1131.53	3.6	2.3	5.8	49	<1	523	0.3
	3960.5	14.9	2.2	15	142.3	2	244.6	1
	3960.5	15.2	2.4	15.4	146.1	2	257.8	0.9
	3997.42	1.5	0.6	1.5	24.7	<1	719.4	<0.1
	3997.42	2	0.6	1.5	25	<1	731.1	0.1
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							

	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD SO-18	15.6	8.9	18	26.1	13	369.8	6.5
	STD SO-18	16.1	8.8	18.5	26	13	388.3	6.3
	STD SO-18	16.3	8.9	19.8	26.5	14	410.5	6.5
	STD SO-18	16.4	9.3	19.1	27.5	15	399.4	6.6
	STD SO-18	16.4	9.8	21.2	28.6	16	442.9	7.1
	STD SO-18	17	9.5	21	28.4	15	442.3	7.1
	STD SO-18	16	9.7	19.9	27.9	15	420.1	7
	STD SO-18	16.1	9	18.9	27.7	14	421	6.4
	STD SO-18	16.8	9.2	19.4	27.3	15	401.7	6.9
	STD SO-18	15.8	8.8	19.7	27.9	14	400.5	6.7
	STD SO-18	17.7	9.6	20.4	29.7	14	429.8	7
	STD SO-18	17	10	19.8	28.9	15	430.2	7.1
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							

	BLK							
	BLK							
	BLK							
	BLK	<0.5	<0.1	0.3	<0.1	<1	<0.5	<0.1
	BLK	<0.5	<0.1	<0.1	<0.1	<1	0.8	<0.1
	BLK	<0.5	<0.1	<0.1	<0.1	<1	<0.5	<0.1
	BLK	<0.5	<0.1	<0.1	<0.1	<1	<0.5	<0.1
	BLK	<0.5	<0.1	<0.1	<0.1	<1	<0.5	<0.1
	BLK	<0.5	<0.1	<0.1	<0.1	<1	<0.5	<0.1
	Prep Wash							
	ROCK-VAN	13.8	3.3	6.2	39.2	1	243.1	0.4
	ROCK-VAN	13.4	3.3	5.9	40.7	<1	217.2	0.4

Table 29. Continued

		Th	U	V	W	Zr	Y	La
		PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.2	0.1	8	0.5	0.1	0.1	0.1
Well ID	Sample							
Esso 16-28	1107.46	<0.2	0.7	<8	<0.5	3.1	5.3	4.5
Esso 16-28	1108.54	0.3	1.1	<8	<0.5	5.4	6.9	5.1
Esso 16-28	1109.51	<0.2	0.7	<8	<0.5	2	4.6	3.5
Esso 16-28	1110.4	<0.2	1	<8	<0.5	2.1	3.8	3
Esso 16-28	1111.48	0.3	1	<8	<0.5	5.4	8.1	6.7
Esso 16-28	1112.31	0.7	1.2	13	<0.5	16.7	14.4	11.6
Esso 16-28	1113.46	1.5	2	31	<0.5	24.1	20.2	18.2
Esso 16-28	1114.57	0.7	1.2	16	<0.5	12.4	11	9.2
Esso 16-28	1115.33	0.2	1.2	11	<0.5	3.1	6	5.8
Esso 16-28	1116.63	0.8	1	13	<0.5	13.5	7.5	7.9
Esso 16-28	1117.51	0.9	0.9	11	0.5	18.8	12.3	10.8
Esso 16-28	1118.4	1.2	1.8	20	<0.5	27.2	16.4	16.3
Esso 16-28	1119.64	0.5	0.8	<8	<0.5	7.4	10.3	9.2
Esso 16-28	1120.46	2.8	4.1	43	0.9	55.4	31.1	27.9
Esso 16-28	1121.48	4.2	4.9	49	0.8	69.6	44.6	35.7
Esso 16-28	1122.55	2.5	2.9	28	0.5	50	31	27
Esso 16-28	1124.38	0.9	1.1	10	<0.5	21.1	10.3	10.8
Esso 16-28	1125.48	3.4	2.4	27	0.8	92.5	28.7	26.1
Esso 16-28	1126.53	2.1	2.9	23	<0.5	45.6	28.1	23.2
Esso 16-28	1127.56	2.8	2.2	28	<0.5	62	29.5	27
Esso 16-28	1128.42	<0.2	0.9	<8	<0.5	3.4	4.5	3.2
Esso 16-28	1129.74	0.6	0.6	<8	<0.5	15.7	7.5	8.5

Esso 16-28	1130.31	3.3	4.4	41	0.6	81.1	32.9	28.4
Esso 16-28	1131.53	4.2	5.9	53	<0.5	86.9	32.9	30.6
Esso 16-28	1132.54	3.3	3.6	43	<0.5	72.6	28.3	25.1
Esso 16-28	1133.54	4.4	5.1	61	0.7	82.5	39.3	35.5
Esso 16-28	1134.64	0.5	1.1	17	<0.5	17.4	11.8	11.2
Esso 16-28	1135.68	5.7	4.8	59	0.9	88	36.5	33
Esso 16-28	1136.7	4	3.9	53	<0.5	72.2	37.7	35.4
Esso 16-28	1137.44	0.6	0.5	24	<0.5	15.5	9.6	11
Esso 16-28	1138.62	6.1	6.6	72	0.7	109.4	40	37.8
Esso 16-28	1139.59	1.4	1.2	28	0.5	35	17.3	18.2
Esso 16-28	1140.52	4.4	4.3	48	<0.5	76.2	28.4	27.5
Esso 16-28	1141.15	3.6	4.9	49	0.5	67.9	30.1	29.4
Esso 16-28	1142.52	3.7	5.2	44	0.6	67.5	33.5	29
Esso 16-28	1143.4	4.5	3.6	50	0.7	79	31.9	31.1
Esso 16-28	1144.48	1.2	0.9	16	<0.5	18.9	11.7	11.9
Esso 16-28	1145.57	4.9	3.4	51	0.8	69.6	31.1	30.8
Esso 16-28	1146.4	4.2	3.3	39	1	69.9	26.2	24.8
Esso 16-28	1147.4	3.7	3	36	<0.5	66	20.6	21.1
Esso 16-28	1148.55	4.2	3.4	37	<0.5	83.9	24.9	25.6
Esso 16-28	1149.53	4.2	3.3	43	0.7	106.2	27.7	26.1
Esso 16-28	1150.5	3.8	3.4	40	<0.5	92.2	31.5	27.8
Esso 16-28	1151.4	3.3	2.6	36	0.7	80.1	33.1	31.5
Esso 16-28	1152.51	3.7	2.7	38	<0.5	71.8	35.1	33
Esso 16-28	1153.63	4.2	3.5	46	0.8	71.8	35.1	30.2
Esso 16-28	1154.62	4.3	3.4	45	0.6	84.9	32	28.7
Esso 16-28	1155.48	4	3.5	48	0.7	79.2	35.3	32.1
Esso 16-28	1156.47	4.8	3.8	50	0.7	88.1	35.7	31.5
Esso 16-28	1157.49	4.8	4	54	1	89.8	30.6	31
Esso 16-28	1158.39	3.2	1.6	24	<0.5	76.9	19.7	20.3
Esso 16-28	1159.4	3.8	4.1	51	0.7	97.1	22.3	24.5
Esso 16-28	1160.57	4.6	3.6	56	1	84.6	25	23.3
Esso 16-28	1161.52	3	1.5	26	<0.5	120.4	15.5	15.3
Esso 16-28	1162.5	4.4	4.3	78	0.6	86.1	18.9	18.1
Esso 16-28	1163.55	3.9	8.5	87	<0.5	79	21.3	19.7
Esso 16-28	1164.5	4.8	2.7	50	0.7	84.9	16.4	18
Esso 16-28	1165.42	3.7	1.2	35	0.5	105.2	13.8	15.2
Esso 16-28	1166.5	3.7	1.3	36	0.9	111.4	13.5	15.6
Esso 16-28	1168.62	5.3	6.7	81	0.7	76.6	15.7	21.5
Esso 16-28	1169.32	1	0.8	12	<0.5	12.6	8.1	7.9
Esso 16-28	1170.5	0.4	1.2	<8	<0.5	6.8	7.9	6.1
Esso 16-28	1171.5	0.3	0.9	<8	<0.5	7.1	8.9	6.1

Esso 16-28	1144.3	2.8	2.3	33	1	56.8	24.5	21.5
Esso 16-28	1168.09	3.3	3.4	39	0.6	65	12.2	15.4
Esso 16-28	1161.07	3.5	2.5	32	<0.5	68.2	17.2	18.7
Esso 16-28	1154.27	3.6	3	41	0.7	81.1	29.3	26.6
Esso 16-28	1145.745	1.6	1.6	15	2.3	22	14.6	15.2
Standard	1180	14.5	5.4	223	1.5	126.2	34.8	50.2
Encana 11-04	1190	11.3	1.8	141	0.5	121.8	13	30.6
Encana 11-04	3935.5	7.4	2.6	103	0.8	84.6	22.3	32.9
Encana 11-04	3936.515	7.9	2.9	115	1.4	90.7	21.3	30.2
Encana 11-04	3937.51	8.6	3.2	116	1.1	98.3	23.3	30.6
Encana 11-04	3938.5	7.8	3	107	0.9	91.6	21.5	30.1
Encana 11-04	3939.42	7.8	2.9	110	1.1	96.9	22	31.4
Encana 11-04	3940.515	6	4.5	84	0.7	80.4	28.5	33.1
Encana 11-04	3941.595	3	3.3	46	0.7	39.9	36.1	36.6
Encana 11-04	3942.425	6.4	5.3	113	0.8	74.7	29.2	31.7
Encana 11-04	3943.535	6.8	4.6	105	1	75	29.5	34.1
Encana 11-04	3944.48	6.4	6.2	122	0.8	74.1	27.3	34.8
Encana 11-04	3945.37	6.2	6	155	1.2	75.3	24.8	31.6
Encana 11-04	3946.475	7	5.7	163	1.3	83.9	26.5	32.8
Encana 11-04	3947.46	7.7	5.2	142	1.1	87.6	27.7	35.1
Encana 11-04	3948.45	5.9	2.5	74	1.3	67.7	27.6	34.2
Encana 11-04	3949.52	6.8	4	94	1	81.8	35.4	40.6
Encana 11-04	3950.64	7.8	3.4	113	1	84.8	29.2	39.8
Encana 11-04	3951.53	8.9	3.5	124	1.3	100.7	28.1	39.3

Encana 11-04	3952.515	8.9	3.6	111	1	94.8	29.9	40.1
Encana 11-04	3953.38	8.7	3.3	111	0.6	104.3	28.8	39.2
Encana 11-04	3954.54	9.2	4.3	111	1.4	100.2	33.6	45.8
Encana 11-04	3955.49	8.3	3.4	107	0.9	89.1	29.2	42.7
Encana 11-04	3956.475	8.6	3.4	115	1.5	88.1	26.6	39.3
Encana 11-04	3957.515	8.5	3.2	107	2.4	92	28.6	38.9
Encana 11-04	3958.49	9.2	3.5	113	0.9	91.1	26.9	39.3
Encana 11-04	3959.5	9.1	3.3	119	1	96.4	22.1	36.2
Encana 11-04	3960.5	7.6	3.3	115	1.6	85.5	26.3	39.1
Encana 11-04	3962.43	4.4	4.4	100	0.8	54.5	21.7	25
Encana 11-04	3963.49	7.1	4.9	98	1.2	84.1	27.4	36
Encana 11-04	3964.465	5.1	3	64	0.6	58.6	20.7	26.4
Encana 11-04	3965.41	7.1	16.2	137	0.9	82.3	25.5	33.9
Encana 11-04	3966.5	8.2	5.5	105	1.2	88.3	30.3	43.5
Encana 11-04	3967.5	7.5	4.5	90	0.9	84.5	30.8	38.4
Encana 11-04	3968.46	8	5.9	94	1	85.1	26.8	39.8
Encana 11-04	3969.43	6.5	9.3	207	1.3	74.4	29	36.2
Encana 11-04	3970.44	4.6	8.6	193	0.7	54.9	26.8	30.1
Encana 11-04	3971.47	6.9	4.8	101	1.8	74.3	22.5	32.5
Encana 11-04	3972.5	6.4	9.1	247	1.1	66.1	23.2	29.8
Encana 11-04	3973.54	7.6	4.8	108	1.5	73.6	25.1	37.5

Encana 11-04	3974.54	3.3	6.1	91	0.6	49.6	28.2	28.8
Encana 11-04	3975.5	5.3	11.4	249	0.8	60.7	22.2	28.1
Encana 11-04	3976.49	4.1	6.8	184	0.6	47.1	18.1	20.8
Encana 11-04	3977.47	5.1	10.8	227	1	66.1	22.9	26.2
Encana 11-04	3978.415	2.6	2.4	26	0.5	78.8	16.5	18
Encana 11-04	3979.5	5.5	7.2	173	0.8	59.9	17.4	24.2
Encana 11-04	3980.455	4.2	7.2	240	0.5	52.7	20.3	22.4
Encana 11-04	3981.53	2.2	2.7	30	0.8	26.1	17.3	17.8
Encana 11-04	3982.465	3.9	3.1	56	<0.5	45.9	23.3	26.6
Encana 11-04	3983.51	3.8	3.2	103	<0.5	45.5	22.6	24.9
Encana 11-04	3984.5	2.8	7.8	106	<0.5	33.7	24.6	26.8
Encana 11-04	3985.465	2.2	2	61	<0.5	32.5	12.4	16.7
Encana 11-04	3986.48	2.7	2.9	91	1.1	41	12.7	17.1
Encana 11-04	3987.48	3.2	3	96	0.9	42.3	14.1	18.1
Encana 11-04	3988.42	4.1	5.1	127	1.4	51.6	15.3	22.8
Encana 11-04	3989.54	0.6	2.9	11	<0.5	9.2	15.8	10.1
Encana 11-04	3990.435	3.3	3.8	66	0.5	36.9	22.1	21.5
Encana 11-04	3991.4	1.6	1.8	22	<0.5	23.3	19.1	15.3
Encana 11-04	3992.4	2	1.1	26	<0.5	21.9	17.7	16.3
Encana 11-04	3993.43	3.9	1.7	49	<0.5	44.9	21.6	22.7
Encana 11-04	3994.455	2.5	2.6	41	<0.5	33	21.2	19.5

Encana 11-04	3995.45	3.9	4.1	63	0.6	44.3	23.4	23
Encana 11-04	3996.47	1.4	1.8	17	<0.5	17.6	11.5	9.6
Encana 11-04	3997.42	1.7	1.4	22	<0.5	20.8	17.1	13.6
Encana 11-04	3998.5	4.1	4.5	72	0.6	45.9	25.7	25.4
Encana 11-04	3999.53	4.1	3.6	71	<0.5	44.3	24.2	24.1
Encana 11-04	3960.84	9	3.2	113	1.3	89.7	26.6	38.9
Encana 11-04	3965.67	6.2	8	131	0.9	76.5	31.5	39.6
Encana 11-04	3974.91	3.9	3.9	79	0.6	44.5	28	30.5
Encana 11-04	3931.53	8.5	2.6	109	1.1	90.3	18.1	28.7
Encana 11-04	3932.475	6	1.9	76	0.7	65	16.6	24.8
Encana 11-04	3933.47	5.1	1.6	75	0.6	59.1	17.6	23.5
Encana 11-04	3933.515	7	2.2	107	1.1	84.2	20.9	30.9
Encana 11-04	1123.58	0.8	0.7	<8	<0.5	15.9	10.6	11.5
Encana 11-04	1167.42	3.8	2	48	0.7	112.7	12.8	16.9
Encana 11-04	3961.53	5.5	9	144	0.9	71.9	31.3	35.8
Encana 11-04	3982.57	5.8	3.9	113	1.2	66.6	32.8	36.6
	Pulp Duplicates							
	1129.74	0.6	0.6	<8	<0.5	15.7	7.5	8.5
	1129.74							
	1165.42	3.7	1.2	35	0.5	105.2	13.8	15.2
	1165.42							
	3982.57	5.8	3.9	113	1.2	66.6	32.8	36.6
	3982.57							
	3958.49	9.2	3.5	113	0.9	91.1	26.9	39.3
	3958.49							
	3995.45	3.9	4.1	63	0.6	44.3	23.4	23

	3995.45							
	3987.48	3.2	3	96	0.9	42.3	14.1	18.1
	3987.48							
	3950.64	7.8	3.4	113	1	84.8	29.2	39.8
	3950.64							
	1120.46	2.8	4.1	43	0.9	55.4	31.1	27.9
	1120.46							
	3982.57	5.8	3.9	113	1.2	66.6	32.8	36.6
	3982.57							
	1157.49	4.8	4	54	1	89.8	30.6	31
	1157.49							
	1168.62	5.3	6.7	81	0.7	76.6	15.7	21.5
	1168.62	5.7	7	80	0.8	74.2	15.6	19.4
	3982.57	5.8	3.9	113	1.2	66.6	32.8	36.6
	3982.57	6	3.7	96	1.3	65.7	32.4	35
	1131.53	4.2	5.9	53	<0.5	86.9	32.9	30.6
	1131.53	4	6.1	54	0.6	85.3	32.5	30.4
	3960.5	7.6	3.3	115	1.6	85.5	26.3	39.1
	3960.5	8.4	3.5	112	1.4	87.7	26.3	39.4
	3997.42	1.7	1.4	22	<0.5	20.8	17.1	13.6
	3997.42	1.6	1.6	22	<0.5	20.3	16.7	14.4
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							

	STD GS910-4							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD SO-18	8.6	15.6	199	13.7	270.5	27.7	12.1
	STD SO-18	9.8	15.3	201	13.2	275.5	29.1	12.1
	STD SO-18	9.9	16.1	203	14.7	288.7	28.7	13
	STD SO-18	9.1	15.6	196	14.6	289.9	28	13.1
	STD SO-18	10.5	16.1	197	15.4	313.9	31.9	13
	STD SO-18	9.5	16.3	201	14.7	304.7	30.6	12.8
	STD SO-18	10.3	16	191	14.1	306.1	30	13.2
	STD SO-18	9.3	14.9	189	14.9	288.1	28.2	12.7
	STD SO-18	9.5	15.6	197	13.4	287	28.7	13
	STD SO-18	9.3	15.5	193	13.1	284.6	28.8	12.3
	STD SO-18	9.5	17	204	14.5	301.7	31.5	13.3
	STD SO-18	9.9	17.7	202	15.5	301.9	29.3	14.4
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<0.2	<0.1	<8	<0.5	0.4	<0.1	<0.1
	BLK	<0.2	<0.1	<8	<0.5	0.7	<0.1	0.2
	BLK	<0.2	<0.1	<8	<0.5	0.2	<0.1	0.1

	BLK	<0.2	<0.1	<8	<0.5	<0.1	<0.1	<0.1
	BLK	<0.2	<0.1	<8	<0.5	0.1	<0.1	<0.1
	BLK	<0.2	<0.1	<8	<0.5	<0.1	<0.1	<0.1
	Prep Wash							
	ROCK-VAN	3	1.5	43	<0.5	126.2	19.8	14.6
	ROCK-VAN	2.7	1.4	34	<0.5	130.4	16.8	12.7

Table 29. Continued

		Ce	Pr	Nd	Sm	Eu	Gd	Tb
		PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.1	0.02	0.3	0.05	0.02	0.05	0.01
Well ID	Sample							
Esso 16-28	1107.46	4.2	0.54	2.2	0.39	0.08	0.45	0.07
Esso 16-28	1108.54	4.4	0.61	2.4	0.43	0.1	0.49	0.07
Esso 16-28	1109.51	2.6	0.4	1.7	0.26	0.07	0.37	0.05
Esso 16-28	1110.4	3	0.41	1.5	0.25	0.06	0.36	0.05
Esso 16-28	1111.48	5.6	0.79	3.1	0.56	0.12	0.7	0.09
Esso 16-28	1112.31	11.2	1.63	6.2	1.12	0.27	1.31	0.2
Esso 16-28	1113.46	18.8	2.64	10	1.81	0.42	2.04	0.29
Esso 16-28	1114.57	9.6	1.31	5.1	0.94	0.19	1.19	0.15
Esso 16-28	1115.33	4.7	0.68	2.6	0.46	0.14	0.57	0.09
Esso 16-28	1116.63	8.6	1.1	4.6	0.78	0.16	0.83	0.13
Esso 16-28	1117.51	11.5	1.59	7.8	0.92	0.26	1.4	0.21
Esso 16-28	1118.4	17.4	2.48	9.9	1.79	0.48	1.93	0.3
Esso 16-28	1119.64	9.1	1.17	4	0.74	0.18	0.9	0.13
Esso 16-28	1120.46	30.6	4.26	16.2	2.83	0.61	3.35	0.48
Esso 16-28	1121.48	38.7	5.82	23.7	3.73	0.89	4.52	0.65
Esso 16-28	1122.55	29.9	4.06	17.7	2.89	0.65	3.54	0.48
Esso 16-28	1124.38	12.8	1.61	7	0.97	0.24	1.13	0.17
Esso 16-28	1125.48	33.6	4.31	17.8	3.08	0.67	3.32	0.48
Esso 16-28	1126.53	25.6	3.66	14.5	2.58	0.62	2.78	0.42
Esso 16-28	1127.56	29.7	4.12	16.1	2.93	0.66	3.15	0.44
Esso 16-28	1128.42	2.7	0.44	1.7	0.32	0.07	0.43	0.07
Esso 16-28	1129.74	11.2	1.35	4.9	0.93	0.22	0.97	0.14
Esso 16-28	1130.31	35.6	4.81	18.8	3.39	0.69	3.68	0.52
Esso 16-28	1131.53	40.2	5.29	21	3.45	0.81	4.07	0.56
Esso 16-28	1132.54	32.5	4.29	16.7	3.15	0.69	3.36	0.49
Esso 16-28	1133.54	45.9	5.84	23	4.19	1.08	4.57	0.67
Esso 16-28	1134.64	11.3	1.39	5.8	0.72	0.2	1.31	0.16
Esso 16-28	1135.68	45.5	5.76	21.9	4.06	0.84	4.25	0.61

Esso 16-28	1136.7	43.4	5.55	20.4	3.74	0.9	4.51	0.63
Esso 16-28	1137.44	12.5	1.29	5.5	1.08	0.21	1.06	0.16
Esso 16-28	1138.62	49	6.39	27.3	4.84	0.98	5.1	0.74
Esso 16-28	1139.59	21.8	2.56	10	1.91	0.44	1.97	0.33
Esso 16-28	1140.52	36.1	4.82	17.9	3.42	0.74	3.48	0.5
Esso 16-28	1141.15	39.1	4.94	19.3	3.35	0.81	3.62	0.51
Esso 16-28	1142.52	38.3	5.11	20.6	3.3	0.73	3.91	0.57
Esso 16-28	1143.4	43.9	5.23	22.3	3.77	0.85	3.95	0.57
Esso 16-28	1144.48	16.5	1.91	7.8	1.57	0.32	1.49	0.22
Esso 16-28	1145.57	45.3	5.32	22.2	4.04	0.87	3.97	0.58
Esso 16-28	1146.4	36.5	4.63	18.4	3.31	0.67	3.43	0.49
Esso 16-28	1147.4	29.4	3.84	13.7	2.53	0.6	2.67	0.42
Esso 16-28	1148.55	35.4	4.41	18.4	3.19	0.69	3.21	0.48
Esso 16-28	1149.53	35.2	4.59	18.7	3.21	0.77	3.78	0.52
Esso 16-28	1150.5	41.6	4.82	20.4	3.38	0.74	3.91	0.58
Esso 16-28	1151.4	40.5	5.07	19.8	3.78	0.79	4	0.55
Esso 16-28	1152.51	40.9	5.14	19.8	3.6	0.81	4.11	0.58
Esso 16-28	1153.63	38.5	5.14	21.6	3.78	0.82	4.31	0.6
Esso 16-28	1154.62	38.7	5.28	20.4	3.86	0.87	4.08	0.6
Esso 16-28	1155.48	44.9	5.65	23.8	3.58	0.91	4	0.62
Esso 16-28	1156.47	44.4	5.73	22.7	3.88	0.85	4.15	0.61
Esso 16-28	1157.49	44.5	5.47	23.2	3.88	0.82	3.83	0.61
Esso 16-28	1158.39	31.8	3.73	14.9	2.84	0.51	2.79	0.38
Esso 16-28	1159.4	38.9	4.78	18.6	3.28	0.77	3.43	0.51
Esso 16-28	1160.57	39.5	4.89	18.4	3.66	0.75	3.66	0.54
Esso 16-28	1161.52	26.9	3.39	13.7	2.57	0.54	2.38	0.37
Esso 16-28	1162.5	31.4	3.9	15.8	2.81	0.66	3.01	0.44
Esso 16-28	1163.55	35.6	4.31	16.8	3.28	0.78	3.25	0.5
Esso 16-28	1164.5	35.2	4.13	15.9	3.25	0.65	3.16	0.45
Esso 16-28	1165.42	30.3	3.52	13.4	2.58	0.57	2.39	0.37
Esso 16-28	1166.5	28.9	3.43	13.4	2.74	0.59	2.63	0.4
Esso 16-28	1168.62	35.9	3.97	15.5	2.84	0.6	2.93	0.39
Esso 16-28	1169.32	10.9	1.39	5.7	1	0.23	1.07	0.17
Esso 16-28	1170.5	6.6	0.92	4.1	0.6	0.17	0.69	0.11
Esso 16-28	1171.5	7.5	0.96	4	0.92	0.17	0.92	0.12
Esso 16-28	1144.3	31.7	3.83	14.8	2.34	0.59	2.73	0.42
Esso 16-28	1168.09	30	3.22	13.1	2.41	0.47	2.29	0.34
Esso 16-28	1161.07	29.9	3.65	13.8	2.48	0.6	2.59	0.35
Esso 16-28	1154.27	33.9	4.6	15.5	3.21	0.72	3.23	0.5
Esso 16-28	1145.745	19.6	2.5	9.5	2	0.44	2.13	0.29
Standard	1180	109.2	12.45	49	9.19	1.81	8.49	1.25

Encana 11-04	1190	62.7	6.18	21.9	3.83	0.64	3.45	0.48
Encana 11-04	3935.5	58.9	6.86	25.7	4.99	1.01	4.63	0.67
Encana 11-04	3936.515	55.5	6.49	24.7	4.35	0.86	3.95	0.6
Encana 11-04	3937.51	56.3	6.63	24.5	4.22	0.92	4.29	0.66
Encana 11-04	3938.5	52.4	6.37	23.7	4.34	0.91	4.07	0.62
Encana 11-04	3939.42	58	6.38	24.3	4.66	0.88	3.94	0.57
Encana 11-04	3940.515	55.2	6.9	26.9	5.18	1.06	4.8	0.73
Encana 11-04	3941.595	53.3	7.27	29.1	5.06	1.22	4.86	0.75
Encana 11-04	3942.425	46.9	5.99	22.5	3.88	0.93	3.99	0.57
Encana 11-04	3943.535	50.7	6.58	24.2	4.41	0.95	4.33	0.64
Encana 11-04	3944.48	52.5	6.59	24.6	4.32	0.91	4.15	0.61
Encana 11-04	3945.37	47.7	6.02	22.7	3.98	0.88	3.91	0.58
Encana 11-04	3946.475	52.1	6.31	25	4.14	0.92	4.02	0.59
Encana 11-04	3947.46	52.9	6.84	26.5	4.52	0.99	4.28	0.66
Encana 11-04	3948.45	53.8	6.54	24.5	4.31	0.98	4.25	0.61
Encana 11-04	3949.52	68.8	8.6	35	6.36	1.49	6.22	0.89
Encana 11-04	3950.64	63.8	7.39	27.8	4.85	1.05	4.83	0.7
Encana 11-04	3951.53	69.1	7.94	30.6	5.24	1.09	5.08	0.72
Encana 11-04	3952.515	64.5	7.83	29.1	5.27	1.1	4.61	0.72
Encana 11-04	3953.38	65.1	7.68	28.9	4.91	1.07	4.64	0.69
Encana 11-04	3954.54	76.5	9.27	34.7	6.36	1.43	6.08	0.88
Encana 11-04	3955.49	65.3	8.1	30.2	5.36	1.14	5.05	0.73
Encana 11-04	3956.475	64.1	7.78	27.9	4.67	1.06	4.52	0.65
Encana 11-04	3957.515	66.3	7.93	30.2	5.14	1.07	4.79	0.67
Encana 11-04	3958.49	64	7.56	27.7	4.97	1.02	4.44	0.66
Encana 11-04	3959.5	60.4	7.06	25.4	4.1	0.81	3.82	0.55
Encana 11-04	3960.5	63.8	7.52	26.6	4.2	1.06	4.24	0.63
Encana 11-04	3962.43	37.9	4.83	18.4	3.02	0.66	3.15	0.46
Encana 11-04	3963.49	53.2	6.72	25.5	4.51	0.91	4.23	0.62
Encana 11-04	3964.465	41	5.09	20	3.26	0.79	3.36	0.48
Encana 11-04	3965.41	54.3	6.32	24.2	4.13	0.87	3.91	0.57
Encana 11-04	3966.5	66.9	8.08	30	4.99	1.14	4.88	0.71
Encana 11-04	3967.5	62.3	7.68	28.1	5.06	1.05	4.66	0.69
Encana 11-04	3968.46	61.9	7.53	28.1	4.8	1.04	4.41	0.66
Encana 11-04	3969.43	54.3	6.77	26.3	4.34	0.88	4.17	0.62
Encana 11-04	3970.44	44.6	5.73	22.1	3.75	0.81	3.64	0.54
Encana 11-04	3971.47	54.3	6.49	24	4.1	0.85	3.76	0.57
Encana 11-04	3972.5	46.5	5.85	21.3	3.66	0.77	3.76	0.52
Encana 11-04	3973.54	60.1	7.14	25.5	4.6	1.02	4.1	0.61
Encana 11-04	3974.54	44.6	5.8	21.8	3.63	0.87	4.1	0.59
Encana 11-04	3975.5	39.1	5.05	19.4	3.33	0.69	3.36	0.47

Encana 11-04	3976.49	32.2	4.04	15.9	3.01	0.65	2.89	0.38
Encana 11-04	3977.47	39.6	5.23	19.9	3.46	0.8	3.39	0.52
Encana 11-04	3978.415	28.5	3.29	11.2	2.12	0.53	2.41	0.39
Encana 11-04	3979.5	36.4	4.31	15	2.75	0.6	2.59	0.41
Encana 11-04	3980.455	34.4	4.41	15.8	2.94	0.71	2.98	0.43
Encana 11-04	3981.53	26.7	3.27	12	2.2	0.48	2.42	0.35
Encana 11-04	3982.465	37.1	4.52	17.3	3.2	0.69	3.03	0.45
Encana 11-04	3983.51	32.8	4.3	16.4	2.78	0.63	2.8	0.43
Encana 11-04	3984.5	34.6	4.52	17.6	2.85	0.67	3.2	0.45
Encana 11-04	3985.465	26.1	2.86	9.9	2.05	0.41	1.89	0.3
Encana 11-04	3986.48	30.2	3.13	12	1.96	0.48	2.16	0.34
Encana 11-04	3987.48	32.1	3.38	12.8	2.09	0.48	2.29	0.35
Encana 11-04	3988.42	39.2	4.25	15.8	2.8	0.6	2.76	0.4
Encana 11-04	3989.54	16.5	2.35	10.1	2.12	0.53	2.57	0.34
Encana 11-04	3990.435	27.4	3.5	13.7	2.59	0.54	2.62	0.38
Encana 11-04	3991.4	19.2	2.58	10.4	2.04	0.45	2.32	0.34
Encana 11-04	3992.4	20.1	2.65	9.6	1.88	0.49	2.12	0.32
Encana 11-04	3993.43	32.5	3.91	14.3	2.45	0.57	2.81	0.41
Encana 11-04	3994.455	24.8	3	12.3	2.25	0.52	2.57	0.36
Encana 11-04	3995.45	29.6	3.72	15.4	2.51	0.52	2.87	0.41
Encana 11-04	3996.47	12.2	1.65	6	1.23	0.25	1.34	0.19
Encana 11-04	3997.42	16.3	2.26	8.6	1.42	0.39	1.83	0.28
Encana 11-04	3998.5	31.2	4.18	16.8	3.1	0.62	3.22	0.49
Encana 11-04	3999.53	32	4.06	15.8	3.1	0.64	3.31	0.45
Encana 11-04	3960.84	60.8	7.29	26.9	4.44	0.95	4.39	0.64
Encana 11-04	3965.67	59.2	7.43	27.1	4.95	1.13	4.75	0.71
Encana 11-04	3974.91	47	5.73	20.9	3.43	0.89	3.87	0.56
Encana 11-04	3931.53	54	5.96	21.9	4.01	0.77	3.63	0.54
Encana 11-04	3932.475	44.1	5.15	19.6	3.38	0.79	3.28	0.47
Encana 11-04	3933.47	41.4	4.86	17.4	3.27	0.71	3.27	0.49
Encana 11-04	3933.515	56.6	6.45	23.8	4.11	0.92	4.06	0.61
Encana 11-04	1123.58	12.6	1.6	6.2	1.08	0.27	1.15	0.17
Encana 11-04	1167.42	29.9	3.48	12.9	2.34	0.56	2.64	0.39
Encana 11-04	3961.53	55.4	7.19	28.2	5.07	1.2	5.5	0.77
Encana 11-04	3982.57	49.1	6.34	25.5	4.45	0.92	4.67	0.69
	Pulp Duplicates							
	1129.74	11.2	1.35	4.9	0.93	0.22	0.97	0.14
	1129.74							
	1165.42	30.3	3.52	13.4	2.58	0.57	2.39	0.37
	1165.42							

	3982.57	49.1	6.34	25.5	4.45	0.92	4.67	0.69
	3982.57							
	3958.49	64	7.56	27.7	4.97	1.02	4.44	0.66
	3958.49							
	3995.45	29.6	3.72	15.4	2.51	0.52	2.87	0.41
	3995.45							
	3987.48	32.1	3.38	12.8	2.09	0.48	2.29	0.35
	3987.48							
	3950.64	63.8	7.39	27.8	4.85	1.05	4.83	0.7
	3950.64							
	1120.46	30.6	4.26	16.2	2.83	0.61	3.35	0.48
	1120.46							
	3982.57	49.1	6.34	25.5	4.45	0.92	4.67	0.69
	3982.57							
	1157.49	44.5	5.47	23.2	3.88	0.82	3.83	0.61
	1157.49							
	1168.62	35.9	3.97	15.5	2.84	0.6	2.93	0.39
	1168.62	35	3.95	15	2.78	0.58	2.68	0.41
	3982.57	49.1	6.34	25.5	4.45	0.92	4.67	0.69
	3982.57	48.5	6.17	23.9	4.28	1.02	4.89	0.68
	1131.53	40.2	5.29	21	3.45	0.81	4.07	0.56
	1131.53	38.6	5.26	21	3.51	0.91	3.9	0.58
	3960.5	63.8	7.52	26.6	4.2	1.06	4.24	0.63
	3960.5	62.9	7.62	29	4.82	0.95	4.22	0.61
	3997.42	16.3	2.26	8.6	1.42	0.39	1.83	0.28
	3997.42	16.1	2.19	8.3	1.42	0.4	2	0.27
	Reference Materials							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							

	STD GS910-4							
	STD GS311-1							
	STD GS910-4							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD SO-18	26.8	3.29	13.1	2.79	0.79	3.01	0.46
	STD SO-18	27.7	3.23	12.6	2.81	0.84	2.99	0.47
	STD SO-18	26.5	3.23	12.8	2.79	0.92	2.86	0.46
	STD SO-18	27.1	3.25	12.5	2.75	0.8	2.82	0.48
	STD SO-18	26.8	3.42	14.4	3.08	0.87	3.04	0.49
	STD SO-18	27.7	3.3	13.1	2.88	0.77	2.98	0.49
	STD SO-18	27	3.42	13.6	2.8	0.84	2.81	0.5
	STD SO-18	26.5	3.14	12.2	2.79	0.83	3.07	0.49
	STD SO-18	26.2	3.18	12.8	2.7	0.86	2.92	0.48
	STD SO-18	25.4	3.26	12.3	2.91	0.82	2.69	0.48
	STD SO-18	28.2	3.35	13	2.66	0.83	3.04	0.52
	STD SO-18	28.5	3.48	14.1	3.37	0.93	3.03	0.51
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							

	BLK							
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	BLK	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05	<0.01
	Prep Wash							
	ROCK-VAN	27.8	3.21	13.1	3	0.78	2.97	0.52
	ROCK-VAN	23.8	2.86	11.4	2.25	0.68	2.42	0.42

Table 29. Continued

		Dy	Ho	Er	Tm	Yb	Lu	TOT/C
		PPM	PPM	PPM	PPM	PPM	PPM	%
	MDL	0.05	0.02	0.03	0.01	0.05	0.01	0.02
Well ID	Sample							
Esso 16-28	1107.46	0.5	0.07	0.27	0.02	0.18	0.03	12.08
Esso 16-28	1108.54	0.46	0.13	0.29	0.03	0.26	0.03	11.94
Esso 16-28	1109.51	0.31	0.09	0.22	0.02	0.11	0.02	12.17
Esso 16-28	1110.4	0.37	0.07	0.16	0.02	0.14	0.02	12.11
Esso 16-28	1111.48	0.57	0.13	0.41	0.04	0.23	0.04	12.11
Esso 16-28	1112.31	1.12	0.27	0.65	0.08	0.53	0.07	11.92
Esso 16-28	1113.46	1.78	0.4	1.17	0.14	0.8	0.12	11.79
Esso 16-28	1114.57	0.95	0.2	0.56	0.07	0.45	0.06	12.04
Esso 16-28	1115.33	0.47	0.11	0.37	0.04	0.27	0.03	12.09
Esso 16-28	1116.63	0.74	0.16	0.46	0.07	0.39	0.05	10.92
Esso 16-28	1117.51	1.09	0.25	0.7	0.07	0.37	0.05	11.98
Esso 16-28	1118.4	1.54	0.35	0.86	0.1	0.66	0.1	12.15
Esso 16-28	1119.64	0.69	0.15	0.52	0.06	0.34	0.06	12.05
Esso 16-28	1120.46	2.81	0.56	1.54	0.22	1.25	0.17	12.25
Esso 16-28	1121.48	3.59	0.79	2.29	0.26	1.87	0.28	12.41
Esso 16-28	1122.55	2.56	0.57	1.75	0.18	1.12	0.17	11.57
Esso 16-28	1124.38	0.97	0.21	0.65	0.08	0.5	0.07	11.9
Esso 16-28	1125.48	2.98	0.6	2	0.21	1.47	0.22	10.44
Esso 16-28	1126.53	2.15	0.5	1.54	0.19	1.09	0.15	11.73
Esso 16-28	1127.56	2.66	0.62	1.68	0.24	1.15	0.19	11.36
Esso 16-28	1128.42	0.32	0.06	0.21	0.02	0.16	0.03	12.39
Esso 16-28	1129.74	0.86	0.18	0.44	0.05	0.34	0.05	11.89
Esso 16-28	1130.31	3.28	0.64	1.93	0.23	1.59	0.22	10.92
Esso 16-28	1131.53	3.34	0.8	2.08	0.25	1.65	0.23	11.17

Esso 16-28	1132.54	2.88	0.59	1.71	0.23	1.32	0.21	10.71
Esso 16-28	1133.54	3.79	0.82	2.15	0.29	1.65	0.23	10.8
Esso 16-28	1134.64	0.88	0.22	0.62	0.06	0.42	0.06	11.71
Esso 16-28	1135.68	3.43	0.79	2.2	0.28	1.73	0.27	10.41
Esso 16-28	1136.7	3.7	0.7	2.15	0.25	1.54	0.22	10.64
Esso 16-28	1137.44	0.86	0.18	0.57	0.06	0.47	0.06	11.42
Esso 16-28	1138.62	4.29	0.85	2.39	0.29	1.93	0.28	10.01
Esso 16-28	1139.59	1.74	0.35	1.1	0.13	0.88	0.11	11.47
Esso 16-28	1140.52	2.84	0.66	1.89	0.25	1.5	0.22	11.58
Esso 16-28	1141.15	2.92	0.67	1.84	0.24	1.49	0.21	11.65
Esso 16-28	1142.52	3.08	0.69	1.85	0.25	1.31	0.25	11.11
Esso 16-28	1143.4	3.2	0.78	1.93	0.28	1.52	0.25	10.78
Esso 16-28	1144.48	1.31	0.28	0.75	0.13	0.71	0.1	10.98
Esso 16-28	1145.57	3.23	0.74	1.97	0.26	1.62	0.22	10.86
Esso 16-28	1146.4	2.68	0.64	1.66	0.21	1.44	0.2	9.93
Esso 16-28	1147.4	2.35	0.49	1.41	0.2	1.3	0.19	10.38
Esso 16-28	1148.55	2.73	0.6	1.48	0.23	1.4	0.21	12.05
Esso 16-28	1149.53	3.04	0.6	1.78	0.27	1.78	0.23	11.96
Esso 16-28	1150.5	3.07	0.65	1.8	0.26	1.63	0.23	11.29
Esso 16-28	1151.4	3.57	0.71	1.91	0.28	1.71	0.23	11.59
Esso 16-28	1152.51	3.29	0.72	1.95	0.25	1.64	0.25	11.55
Esso 16-28	1153.63	3.61	0.73	1.88	0.28	1.58	0.26	12.12
Esso 16-28	1154.62	3.26	0.76	2.04	0.27	1.65	0.24	11.94
Esso 16-28	1155.48	3.66	0.78	2.26	0.28	1.67	0.24	12.57
Esso 16-28	1156.47	3.74	0.78	2.17	0.31	1.95	0.27	14.12
Esso 16-28	1157.49	3.39	0.71	2	0.27	1.73	0.25	14.36
Esso 16-28	1158.39	2.55	0.49	1.45	0.2	1.31	0.19	10.76
Esso 16-28	1159.4	3.26	0.63	1.9	0.26	1.71	0.19	14.19
Esso 16-28	1160.57	3.26	0.64	1.8	0.25	1.61	0.24	14.77
Esso 16-28	1161.52	2.25	0.53	1.51	0.21	1.28	0.21	7.95
Esso 16-28	1162.5	2.42	0.56	1.37	0.23	1.36	0.23	11.07
Esso 16-28	1163.55	2.91	0.57	1.52	0.24	1.47	0.23	12.48
Esso 16-28	1164.5	2.68	0.54	1.43	0.21	1.33	0.22	10.02
Esso 16-28	1165.42	2.13	0.45	1.35	0.2	1.31	0.19	7.34
Esso 16-28	1166.5	2.59	0.46	1.51	0.19	1.42	0.2	7.58
Esso 16-28	1168.62	2.27	0.48	1.39	0.21	1.28	0.22	12.11
Esso 16-28	1169.32	1.07	0.22	0.6	0.06	0.41	0.06	11.28
Esso 16-28	1170.5	0.75	0.14	0.46	0.05	0.35	0.05	11.93
Esso 16-28	1171.5	0.83	0.16	0.49	0.05	0.36	0.06	12.01
Esso 16-28	1144.3	2.35	0.51	1.48	0.21	1.26	0.19	11.02
Esso 16-28	1168.09	1.64	0.4	1.08	0.15	1.02	0.14	11.89

Esso 16-28	1161.07	2.17	0.42	1.36	0.19	1.29	0.17	10.4
Esso 16-28	1154.27	3.01	0.61	1.58	0.23	1.6	0.21	13.18
Esso 16-28	1145.745	1.69	0.34	0.9	0.12	0.72	0.11	11.49
Standard	1180	6.62	1.26	3.83	0.52	3.57	0.55	2.34
Encana 11-04	1190	2.52	0.47	1.3	0.2	1.37	0.22	6.81
Encana 11-04	3935.5	3.81	0.76	2.19	0.33	1.98	0.29	4.73
Encana 11-04	3936.515	3.52	0.66	2.08	0.31	2.07	0.29	3.84
Encana 11-04	3937.51	3.82	0.74	2.06	0.3	1.92	0.29	3.79
Encana 11-04	3938.5	3.42	0.7	2.06	0.3	1.88	0.3	3.62
Encana 11-04	3939.42	3.48	0.72	2.21	0.3	1.99	0.32	3.62
Encana 11-04	3940.515	3.93	0.84	2.35	0.31	1.87	0.26	7.23
Encana 11-04	3941.595	4.31	0.89	2.29	0.3	1.58	0.26	10
Encana 11-04	3942.425	3.65	0.72	2.04	0.28	1.92	0.29	7.76
Encana 11-04	3943.535	3.96	0.78	2.23	0.3	1.99	0.31	7.56
Encana 11-04	3944.48	3.7	0.76	2.02	0.29	1.87	0.29	7.46
Encana 11-04	3945.37	3.53	0.73	2.07	0.29	1.8	0.27	7.26
Encana 11-04	3946.475	3.67	0.78	2.14	0.31	1.97	0.29	7.34
Encana 11-04	3947.46	3.65	0.74	2.27	0.32	2.03	0.28	7.24
Encana 11-04	3948.45	3.64	0.75	2.12	0.29	1.84	0.25	7.29
Encana 11-04	3949.52	4.73	0.87	2.48	0.33	2.15	0.31	6.5
Encana 11-04	3950.64	4.03	0.81	2.2	0.32	2.06	0.32	5.48
Encana 11-04	3951.53	4.35	0.87	2.41	0.35	2.2	0.33	4.94
Encana 11-04	3952.515	4.15	0.86	2.31	0.36	2.17	0.34	5.39

Encana 11-04	3953.38	4.18	0.82	2.36	0.34	2.25	0.34	5.78
Encana 11-04	3954.54	5.04	1.03	2.68	0.35	2.37	0.36	5.87
Encana 11-04	3955.49	4.38	0.91	2.5	0.33	2.16	0.31	5.56
Encana 11-04	3956.475	3.9	0.82	2.26	0.31	2.06	0.3	4.79
Encana 11-04	3957.515	4	0.88	2.45	0.33	2.09	0.29	4.63
Encana 11-04	3958.49	3.74	0.74	2.19	0.33	2.03	0.3	5.18
Encana 11-04	3959.5	3.47	0.64	2.01	0.32	1.94	0.31	3.27
Encana 11-04	3960.5	3.51	0.73	2.1	0.28	1.82	0.29	5.15
Encana 11-04	3962.43	2.68	0.58	1.49	0.22	1.32	0.19	7.75
Encana 11-04	3963.49	3.82	0.7	1.95	0.29	1.82	0.27	6.54
Encana 11-04	3964.465	2.78	0.54	1.6	0.23	1.21	0.22	6.87
Encana 11-04	3965.41	3.45	0.68	1.89	0.27	1.81	0.25	9.36
Encana 11-04	3966.5	4.14	0.85	2.32	0.33	2.1	0.29	7.65
Encana 11-04	3967.5	4.01	0.82	2.26	0.3	1.82	0.3	7.15
Encana 11-04	3968.46	3.64	0.79	2.11	0.31	1.96	0.28	7.08
Encana 11-04	3969.43	3.69	0.75	2.14	0.28	1.88	0.27	8.13
Encana 11-04	3970.44	3.08	0.66	1.83	0.25	1.54	0.24	8.61
Encana 11-04	3971.47	3.39	0.66	1.8	0.27	1.87	0.26	6.33
Encana 11-04	3972.5	2.91	0.6	1.89	0.25	1.47	0.23	6.95
Encana 11-04	3973.54	3.28	0.7	1.97	0.33	1.86	0.28	6.44
Encana 11-04	3974.54	3.37	0.69	1.92	0.27	1.54	0.25	10.15

Encana 11-04	3975.5	2.62	0.53	1.71	0.21	1.41	0.21	8.61
Encana 11-04	3976.49	2.18	0.44	1.27	0.21	1.2	0.19	8.16
Encana 11-04	3977.47	2.98	0.56	1.62	0.23	1.44	0.2	8.75
Encana 11-04	3978.415	2.03	0.46	1.29	0.19	1.14	0.18	10.72
Encana 11-04	3979.5	2.3	0.46	1.22	0.19	1.35	0.18	6.06
Encana 11-04	3980.455	2.26	0.49	1.3	0.2	1.15	0.17	7.27
Encana 11-04	3981.53	1.88	0.41	1.18	0.14	0.85	0.11	10.03
Encana 11-04	3982.465	2.58	0.54	1.55	0.23	1.25	0.21	8.58
Encana 11-04	3983.51	2.42	0.47	1.47	0.21	1.26	0.18	8.22
Encana 11-04	3984.5	2.51	0.5	1.48	0.21	1.26	0.17	10.44
Encana 11-04	3985.465	1.6	0.32	0.95	0.13	0.79	0.11	10.97
Encana 11-04	3986.48	1.9	0.39	1.06	0.14	0.88	0.15	10.58
Encana 11-04	3987.48	1.89	0.4	1.02	0.15	0.9	0.15	10.22
Encana 11-04	3988.42	2.36	0.5	1.23	0.19	1.18	0.19	10.35
Encana 11-04	3989.54	1.83	0.34	0.72	0.09	0.55	0.07	11.69
Encana 11-04	3990.435	2.3	0.47	1.35	0.16	1.15	0.16	10.4
Encana 11-04	3991.4	1.76	0.4	1.12	0.15	0.86	0.12	11.45
Encana 11-04	3992.4	1.71	0.37	1.03	0.14	0.82	0.12	11.27
Encana 11-04	3993.43	2.33	0.48	1.42	0.19	1.21	0.17	9.32
Encana 11-04	3994.455	1.97	0.44	1.2	0.18	1.01	0.16	11.08
Encana 11-04	3995.45	2.36	0.51	1.56	0.21	1.24	0.18	10.82

Encana 11-04	3996.47	1.17	0.26	0.77	0.09	0.57	0.08	11.85
Encana 11-04	3997.42	1.6	0.35	0.98	0.14	0.8	0.12	11.66
Encana 11-04	3998.5	2.84	0.6	1.8	0.22	1.31	0.19	11.62
Encana 11-04	3999.53	2.63	0.55	1.56	0.2	1.29	0.17	11.95
Encana 11-04	3960.84	3.62	0.74	2.14	0.3	1.94	0.28	5.1
Encana 11-04	3965.67	3.86	0.8	2.16	0.29	1.73	0.27	8.45
Encana 11-04	3974.91	3.07	0.71	2.01	0.26	1.66	0.23	7.92
Encana 11-04	3931.53	3.08	0.64	1.91	0.28	1.82	0.27	4.13
Encana 11-04	3932.475	2.78	0.58	1.62	0.23	1.57	0.23	6.26
Encana 11-04	3933.47	2.66	0.54	1.53	0.23	1.46	0.21	7.19
Encana 11-04	3933.515	3.48	0.72	2.02	0.27	1.83	0.3	4.54
Encana 11-04	1123.58	1.06	0.21	0.53	0.08	0.53	0.06	12.3
Encana 11-04	1167.42	2.23	0.42	1.34	0.19	1.23	0.18	9.07
Encana 11-04	3961.53	4.1	0.75	2	0.28	1.84	0.28	7.96
Encana 11-04	3982.57	3.73	0.77	2.15	0.31	1.8	0.27	7.89
	Pulp Duplicates							
	1129.74	0.86	0.18	0.44	0.05	0.34	0.05	11.89
	1129.74							11.89
	1165.42	2.13	0.45	1.35	0.2	1.31	0.19	7.34
	1165.42							7.33
	3982.57	3.73	0.77	2.15	0.31	1.8	0.27	7.89
	3982.57							7.85
	3958.49	3.74	0.74	2.19	0.33	2.03	0.3	5.18
	3958.49							5.23
	3995.45	2.36	0.51	1.56	0.21	1.24	0.18	10.82
	3995.45							10.73
	3987.48	1.89	0.4	1.02	0.15	0.9	0.15	10.22

	3987.48							
	3950.64	4.03	0.81	2.2	0.32	2.06	0.32	5.48
	3950.64							
	1120.46	2.81	0.56	1.54	0.22	1.25	0.17	12.25
	1120.46							
	3982.57	3.73	0.77	2.15	0.31	1.8	0.27	7.89
	3982.57							
	1157.49	3.39	0.71	2	0.27	1.73	0.25	14.36
	1157.49							
	1168.62	2.27	0.48	1.39	0.21	1.28	0.22	12.11
	1168.62	2.68	0.5	1.33	0.21	1.36	0.22	
	3982.57	3.73	0.77	2.15	0.31	1.8	0.27	7.89
	3982.57	3.74	0.76	2.05	0.28	1.82	0.27	
	1131.53	3.34	0.8	2.08	0.25	1.65	0.23	11.17
	1131.53	3.44	0.76	2.01	0.28	1.72	0.22	
	3960.5	3.51	0.73	2.1	0.28	1.82	0.29	5.15
	3960.5	3.5	0.75	2.05	0.3	1.95	0.3	
	3997.42	1.6	0.35	0.98	0.14	0.8	0.12	11.66
	3997.42	1.64	0.33	1.01	0.14	0.79	0.11	
	Reference Materials							
	STD GS311-1							1.03
	STD GS910-4							2.68
	STD GS311-1							1.01
	STD GS910-4							2.68
	STD GS311-1							1.01
	STD GS910-4							2.67
	STD GS311-1							1.05
	STD GS910-4							2.73
	STD GS311-1							1.05
	STD GS910-4							2.81
	STD DS10							

	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD DS10							
	STD OREAS45EA							
	STD SO-18	2.72	0.56	1.8	0.28	1.75	0.27	
	STD SO-18	2.97	0.62	1.71	0.27	1.83	0.3	
	STD SO-18	2.96	0.57	1.65	0.26	1.83	0.26	
	STD SO-18	2.88	0.63	1.7	0.27	1.75	0.25	
	STD SO-18	3.04	0.71	1.86	0.27	1.86	0.3	
	STD SO-18	2.91	0.61	1.8	0.27	1.88	0.28	
	STD SO-18	2.83	0.68	1.78	0.27	1.79	0.28	
	STD SO-18	2.63	0.59	1.76	0.25	1.7	0.26	
	STD SO-18	2.69	0.62	1.88	0.26	1.63	0.26	
	STD SO-18	2.67	0.6	1.72	0.25	1.75	0.25	
	STD SO-18	3.05	0.63	1.78	0.27	1.79	0.28	
	STD SO-18	2.99	0.68	2.01	0.27	1.87	0.24	
	BLK							<0.02
	BLK							<0.02
	BLK							<0.02
	BLK							<0.02
	BLK							<0.02
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	

	Prep Wash							
	ROCK-VAN	3.01	0.7	2.14	0.34	2.44	0.41	0.03
	ROCK-VAN	2.68	0.62	1.82	0.29	2.06	0.35	0.03

Table 29. Continued

		TOT/S	Mo	Cu	Pb	Zn	Ni	As
		%	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.02	0.1	0.1	0.1	1	0.1	0.5
Well ID	Sample							
Esso 16-28	1107.46	0.2	0.3	1.2	1.3	3	<0.1	1
Esso 16-28	1108.54	0.33	0.9	1.7	1.6	2	1.3	3.2
Esso 16-28	1109.51	0.1	0.2	1	1.1	1	<0.1	0.9
Esso 16-28	1110.4	0.09	0.6	2.2	1.1	2	<0.1	<0.5
Esso 16-28	1111.48	0.61	0.9	1.8	3.8	2	2.9	4.2
Esso 16-28	1112.31	0.39	0.5	4.5	2.2	2	5.8	1.8
Esso 16-28	1113.46	0.51	0.4	8.8	2.4	4	12.7	2.6
Esso 16-28	1114.57	0.39	0.5	3.4	1.6	3	4.2	2.2
Esso 16-28	1115.33	0.43	0.5	1.3	1.9	3	0.7	1.4
Esso 16-28	1116.63	1.02	0.6	3.4	6.6	6	3.5	3.8
Esso 16-28	1117.51	0.7	0.6	3.9	2.1	2	4.8	3.4
Esso 16-28	1118.4	0.79	0.6	6.5	2.3	3	7.7	3.7
Esso 16-28	1119.64	0.34	0.5	1.7	1.6	2	1.4	3.7
Esso 16-28	1120.46	1.44	1.2	15.6	4.1	7	33.4	8.2
Esso 16-28	1121.48	1.86	1.5	20.5	5.5	8	43.5	11
Esso 16-28	1122.55	1.88	1.1	11.4	4.2	5	24.1	11.8
Esso 16-28	1124.38	0.64	0.7	3.6	1.6	3	4.1	5
Esso 16-28	1125.48	1.29	0.8	8.4	3.2	7	22.3	8.2
Esso 16-28	1126.53	1.28	0.8	9.5	3.3	8	23.3	8
Esso 16-28	1127.56	0.8	0.4	10.6	2.8	5	21.1	3.3
Esso 16-28	1128.42	0.13	0.3	2.4	1.5	9	1.9	0.9
Esso 16-28	1129.74	0.15	0.3	2.5	0.7	1	1.7	0.8
Esso 16-28	1130.31	0.77	0.9	28.2	3.1	5	31.3	2.8
Esso 16-28	1131.53	1.15	1.3	33.5	4.3	11	38.5	7.2
Esso 16-28	1132.54	0.78	0.9	23.7	3.2	5	24	5
Esso 16-28	1133.54	1.68	2.3	29.3	5.2	8	44.8	10.8
Esso 16-28	1134.64	1.38	0.4	3.8	3.7	2	5.4	1.7
Esso 16-28	1135.68	1.61	1.1	23.2	5.1	27	43.3	8.1
Esso 16-28	1136.7	1.26	1.1	20.9	4.8	19	40.1	6.5
Esso 16-28	1137.44	1.22	0.9	2.7	3.2	2	2.4	10.4
Esso 16-28	1138.62	3.06	3.3	29.4	5.6	30	43.6	23

Esso 16-28	1139.59	0.93	0.6	7.9	3.7	8	10.8	5.3
Esso 16-28	1140.52	1.4	1.8	21.4	4.1	10	40.2	8.5
Esso 16-28	1141.15	1.61	2	22.8	4.5	12	39.8	11.1
Esso 16-28	1142.52	1.84	1.9	24.2	5	10	38.3	14.2
Esso 16-28	1143.4	1.41	1.1	27.6	5.1	8	39.3	9.2
Esso 16-28	1144.48	0.93	0.5	7.1	4.9	3	6.7	12
Esso 16-28	1145.57	3.06	3.6	31.5	7.3	49	50.7	19.9
Esso 16-28	1146.4	4.03	6.8	39.5	6.2	27	39.2	26
Esso 16-28	1147.4	1.21	1.1	19.3	3.8	11	25.9	10.3
Esso 16-28	1148.55	1.66	1.6	24.1	4.4	28	41.7	12.2
Esso 16-28	1149.53	1.95	2.6	27.1	5.6	11	46.8	15.2
Esso 16-28	1150.5	1.89	1.6	24.7	5.8	11	46.8	15
Esso 16-28	1151.4	1.81	1.7	25.7	5	14	46.3	13.3
Esso 16-28	1152.51	1.47	1.4	25.6	5.9	46	48.5	10.5
Esso 16-28	1153.63	1.32	1	25.9	4.2	24	49.2	7.6
Esso 16-28	1154.62	2.68	2.7	32.8	10.5	12	61.1	19.2
Esso 16-28	1155.48	1.81	1.8	29.4	6.3	12	58	12.1
Esso 16-28	1156.47	1.96	2.8	36	7	21	72.1	10.1
Esso 16-28	1157.49	1.97	3.9	36.5	6.6	23	64.1	8.9
Esso 16-28	1158.39	1.02	1	15.4	3.4	7	22.8	5.6
Esso 16-28	1159.4	1.84	7.4	34.2	9	18	62.4	7.5
Esso 16-28	1160.57	2.23	7.2	40.5	10.8	42	64.3	9
Esso 16-28	1161.52	0.65	1.3	8.2	3.1	7	13.6	1.8
Esso 16-28	1162.5	1.55	10	28.6	8.3	20	58.9	8.8
Esso 16-28	1163.55	1.9	10.7	32.5	10.8	21	68.8	7.8
Esso 16-28	1164.5	1.4	3.8	20.1	7.7	11	37.8	5
Esso 16-28	1165.42	0.56	0.6	9	3	8	19	1.2
Esso 16-28	1166.5	0.52	0.6	8.7	2.5	7	17	1.1
Esso 16-28	1168.62	1.72	6.4	80.9	15.7	12	56	7.4
Esso 16-28	1169.32	0.24	0.4	8.1	3.5	3	3.2	1.8
Esso 16-28	1170.5	0.33	0.4	5	2.3	2	5	1.1
Esso 16-28	1171.5	0.87	0.6	5.6	3	5	9.2	0.5
Esso 16-28	1144.3	1.27	0.9	17.5	3.8	6	29.4	5.8
Esso 16-28	1168.09	1.42	1.6	15.8	8.7	7	21.9	4.9
Esso 16-28	1161.07	0.83	1.2	17.7	3.9	12	23.5	3
Esso 16-28	1154.27	1.52	2	25.8	4.2	12	48.2	6.4
Esso 16-28	1145.745	1.16	1.4	8.8	3.3	6	12.2	7.8
Standard	1180	0.73	1.6	29.7	28.6	165	68.2	25.3
Encana 11-04	1190	0.17	0.9	48.3	8.5	70	102.8	20.6

Encana 11-04	3935.5	1.15	1.4	46	28.5	68	52.3	12.2
Encana 11-04	3936.515	0.89	1.2	105.8	20.3	52	46.6	8.1
Encana 11-04	3937.51	0.93	1.8	58.4	24.5	30	50	7.1
Encana 11-04	3938.5	0.91	1.6	51	17.9	40	42.4	6.5
Encana 11-04	3939.42	0.9	1.4	48.3	22.1	41	44.8	7.8
Encana 11-04	3940.515	2.64	5.2	32.9	20.2	26	42.8	31.6
Encana 11-04	3941.595	1.85	4.8	20.9	19.9	13	27.3	17.8
Encana 11-04	3942.425	1.45	10.3	28.1	24.9	91	49.8	7.6
Encana 11-04	3943.535	1.51	6	24.6	18.9	72	40.7	9.4
Encana 11-04	3944.48	2	14.5	36.9	28.4	601	56.4	17.5
Encana 11-04	3945.37	1.53	12.3	27.2	23.5	278	57.9	8.6
Encana 11-04	3946.475	1.67	12.9	30.9	24.3	257	63.3	12.1
Encana 11-04	3947.46	1.68	9.9	33	20.7	606	58	11.4
Encana 11-04	3948.45	1.06	1.7	20.8	11.8	24	32.9	5.5
Encana 11-04	3949.52	3.2	3.6	69.3	27.2	36	57.7	25.4
Encana 11-04	3950.64	1.79	1.3	52.2	20.3	13	46.8	16.7
Encana 11-04	3951.53	1.22	1.1	60.6	14.6	24	49.7	12.3
Encana 11-04	3952.515	1.71	2.1	56.5	19.2	17	48.9	19.4
Encana 11-04	3953.38	1.65	1.3	49	17.7	22	49.1	17.2
Encana 11-04	3954.54	1.75	2.3	60.2	19.5	28	61.1	16
Encana 11-04	3955.49	2.5	2.6	52.2	21.7	17	62	31.2

Encana 11-04	3956.475	1.16	1.7	56.7	10.4	272	45.4	6.6
Encana 11-04	3957.515	3.71	4.9	53.4	25.2	20	57.2	38
Encana 11-04	3958.49	1.04	2	67	8.6	71	46.3	7.6
Encana 11-04	3959.5	1.94	2.2	51.3	20.3	19	50.4	28.1
Encana 11-04	3960.5	1.67	2.2	61.6	15.2	25	51.1	14
Encana 11-04	3962.43	1.03	12.7	21.7	9.1	144	39.1	6.7
Encana 11-04	3963.49	2.75	4.7	50.4	23.1	10	54.8	24.3
Encana 11-04	3964.465	1.14	2.7	29	10.8	8	40.4	7.8
Encana 11-04	3965.41	1.7	27.2	59.3	22.4	27	59.3	14.9
Encana 11-04	3966.5	1.16	3.5	47	15.7	16	64.7	7.4
Encana 11-04	3967.5	1.09	2.3	43.4	13.2	25	56.3	7
Encana 11-04	3968.46	0.85	1.8	70.7	12.8	35	57.5	6.1
Encana 11-04	3969.43	1.53	20.7	47.5	13.8	63	65.9	9.5
Encana 11-04	3970.44	1.18	27.9	35.8	10.8	52	54.3	10.4
Encana 11-04	3971.47	2.31	5.9	52.7	21.8	10	61.3	15.3
Encana 11-04	3972.5	1.36	20.6	40.5	13.3	181	65	11.2
Encana 11-04	3973.54	0.88	4.3	48.2	8.2	14	44.7	6.9
Encana 11-04	3974.54	1.9	11.8	34.1	18.5	9	40.2	11.3
Encana 11-04	3975.5	1.36	28.4	39.2	11.6	14	67.8	11.2
Encana 11-04	3976.49	1.24	16.9	39.5	9.6	305	57.3	11.3
Encana 11-04	3977.47	1.48	23.4	34.7	11.7	12	69.3	12.4

Encana 11-04	3978.415	1.29	1.3	10.4	8.1	4	14.1	4.8
Encana 11-04	3979.5	0.88	12.2	57.5	11.6	6	55.7	9.7
Encana 11-04	3980.455	0.99	18.6	38.7	8.7	39	62.9	7.9
Encana 11-04	3981.53	1.64	2.2	34.9	8	6	23.3	18.6
Encana 11-04	3982.465	1.34	1.7	46.6	12.2	8	33.6	11.2
Encana 11-04	3983.51	1.04	4.6	76.4	9.4	5	42.1	5.8
Encana 11-04	3984.5	1.18	10.2	69.2	9.8	14	42.6	8.6
Encana 11-04	3985.465	1.35	4.2	40.6	9.1	6	20.4	9.5
Encana 11-04	3986.48	1.71	5	55.9	11.7	6	29.1	13.1
Encana 11-04	3987.48	1.66	5.2	60.2	11.8	6	29.9	14
Encana 11-04	3988.42	1.8	7.3	73.6	13.8	5	38.9	14.6
Encana 11-04	3989.54	0.85	0.7	12.7	5.4	3	13.1	13.9
Encana 11-04	3990.435	0.66	1.5	54.9	5.9	4	35.5	3
Encana 11-04	3991.4	0.66	1	19.5	3.9	8	25.5	1.8
Encana 11-04	3992.4	0.53	0.7	19.6	3.5	6	21.2	2.6
Encana 11-04	3993.43	1.02	0.8	35	7.7	8	37.7	6.1
Encana 11-04	3994.455	0.46	1	33.5	3.6	8	30.3	3.2
Encana 11-04	3995.45	1.04	2.5	42.5	6.2	4	40.2	7
Encana 11-04	3996.47	0.38	0.8	16.3	2.5	7	14.3	4.1
Encana 11-04	3997.42	0.41	0.7	20.6	3.6	4	18.1	3.5
Encana 11-04	3998.5	0.87	3.1	81.2	9.9	12	60.3	5.1

Encana 11-04	3999.53	0.97	3.4	74.3	12.2	9	59.1	5.5
Encana 11-04	3960.84	1.39	1.2	65.6	11.4	21	47.1	13
Encana 11-04	3965.67	2.07	11.3	49.3	18.8	13	57.4	26.7
Encana 11-04	3974.91	1.04	3.2	42.2	12.3	13	36.7	12
Encana 11-04	3931.53	1	0.9	41.3	19.8	29	53.1	10.3
Encana 11-04	3932.475	0.6	0.4	25.4	11.1	20	33.6	3
Encana 11-04	3933.47	0.83	0.5	23.5	5	20	23.9	4.4
Encana 11-04	3933.515	0.59	0.3	49.1	4.7	30	31.1	8.8
Encana 11-04	1123.58	0.27	0.3	4.4	1.4	3	3.1	1.7
Encana 11-04	1167.42	1.01	1.3	12.7	7.8	8	20.6	3.6
Encana 11-04	3961.53	3.88	22.9	64.5	35.9	29	84.7	41.7
Encana 11-04	3982.57	1.91	3	65.4	9.6	11	43.2	10.6
	Pulp Duplicates							
	1129.74	0.15	0.3	2.5	0.7	1	1.7	0.8
	1129.74	0.14						
	1165.42	0.56	0.6	9	3	8	19	1.2
	1165.42	0.53						
	3982.57	1.91	3	65.4	9.6	11	43.2	10.6
	3982.57	1.92						
	3958.49	1.04	2	67	8.6	71	46.3	7.6
	3958.49	1.04						
	3995.45	1.04	2.5	42.5	6.2	4	40.2	7
	3995.45	1.03						
	3987.48	1.66	5.2	60.2	11.8	6	29.9	14
	3987.48		5	60.9	12.2	7	29.7	14.4
	3950.64	1.79	1.3	52.2	20.3	13	46.8	16.7
	3950.64		1.4	54.7	21.2	14	46.9	17.9
	1120.46	1.44	1.2	15.6	4.1	7	33.4	8.2
	1120.46		1.1	14.9	4.1	8	34.1	8.1

	3982.57	1.91	3	65.4	9.6	11	43.2	10.6
	3982.57		2.7	65.9	9.7	10	44.4	10.7
	1157.49	1.97	3.9	36.5	6.6	23	64.1	8.9
	1157.49		3.5	39.8	7	24	67.8	9.6
	1168.62	1.72	6.4	80.9	15.7	12	56	7.4
	1168.62							
	3982.57	1.91	3	65.4	9.6	11	43.2	10.6
	3982.57							
	1131.53	1.15	1.3	33.5	4.3	11	38.5	7.2
	1131.53							
	3960.5	1.67	2.2	61.6	15.2	25	51.1	14
	3960.5							
	3997.42	0.41	0.7	20.6	3.6	4	18.1	3.5
	3997.42							
	Reference Materials							
	STD GS311-1	2.43						
	STD GS910-4	8.25						
	STD GS311-1	2.29						
	STD GS910-4	8.22						
	STD GS311-1	2.33						
	STD GS910-4	8.02						
	STD GS311-1	2.39						
	STD GS910-4	8.49						
	STD GS311-1	2.26						
	STD GS910-4	8.55						
	STD DS10		14	155.4	153.5	366	76.5	44.4
	STD OREAS45EA		1.7	756.4	15.3	34	414.4	10.9
	STD DS10		15	166.8	159	400	78.7	48.8
	STD OREAS45EA		1.6	727.6	15.7	32	393.9	10.3

	STD DS10		14.2	159	155.3	380	74.5	48.8
	STD OREAS45EA		1.7	699.7	14.8	32	382	11.7
	STD DS10		13.1	154.1	155.4	365	74.1	45.4
	STD OREAS45EA		1.6	729.1	16.4	32	384.8	11.2
	STD DS10		13.5	155	155.8	379	77.4	46.1
	STD OREAS45EA		1.5	709.9	14.9	32	385.1	9.9
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	BLK	<0.02						
	BLK	<0.02						
	BLK	<0.02						
	BLK	<0.02						
	BLK	<0.02						
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	Prep Wash							
	ROCK-VAN	<0.02	1.7	9	1	28	2.7	0.7
	ROCK-VAN	<0.02	2	11	1.1	30	0.9	0.8

Table 29. Continued

		Cd	Sb	Bi	Ag	Au	Hg	Tl	Se
		PPM	PPM	PPM	PPM	PPB	PPM	PPM	PPM
	MDL	0.1	0.1	0.1	0.1	0.5	0.01	0.1	0.5
Well ID	Sample								
Esso 16-28	1107.46	<0.1	<0.1	<0.1	<0.1	0.6	0.02	<0.1	<0.5
Esso 16-28	1108.54	<0.1	<0.1	<0.1	<0.1	1.3	0.04	<0.1	0.5
Esso 16-28	1109.51	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
Esso 16-28	1110.4	<0.1	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	0.6
Esso 16-28	1111.48	<0.1	0.1	<0.1	<0.1	1	0.04	<0.1	<0.5
Esso 16-28	1112.31	<0.1	<0.1	<0.1	<0.1	0.5	0.05	<0.1	<0.5
Esso 16-28	1113.46	<0.1	<0.1	<0.1	<0.1	<0.5	0.08	<0.1	<0.5
Esso 16-28	1114.57	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Esso 16-28	1115.33	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Esso 16-28	1116.63	<0.1	<0.1	<0.1	<0.1	<0.5	0.07	<0.1	<0.5
Esso 16-28	1117.51	<0.1	<0.1	<0.1	<0.1	<0.5	0.09	<0.1	<0.5
Esso 16-28	1118.4	<0.1	<0.1	<0.1	<0.1	<0.5	0.09	<0.1	<0.5
Esso 16-28	1119.64	<0.1	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
Esso 16-28	1120.46	<0.1	0.1	<0.1	<0.1	1.6	0.3	<0.1	1.4
Esso 16-28	1121.48	<0.1	0.2	<0.1	<0.1	1.7	0.37	0.1	2.6
Esso 16-28	1122.55	<0.1	0.2	<0.1	<0.1	<0.5	0.26	<0.1	1.1
Esso 16-28	1124.38	<0.1	<0.1	<0.1	<0.1	<0.5	0.06	<0.1	<0.5
Esso 16-28	1125.48	<0.1	0.2	<0.1	<0.1	0.8	0.16	<0.1	0.8
Esso 16-28	1126.53	<0.1	0.2	<0.1	<0.1	0.8	0.18	0.1	1.9
Esso 16-28	1127.56	<0.1	<0.1	<0.1	<0.1	0.8	0.15	<0.1	0.6
Esso 16-28	1128.42	<0.1	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
Esso 16-28	1129.74	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Esso 16-28	1130.31	<0.1	0.2	<0.1	<0.1	<0.5	0.13	0.1	1.3
Esso 16-28	1131.53	<0.1	0.3	<0.1	<0.1	2	0.24	0.2	2.2
Esso 16-28	1132.54	<0.1	0.2	<0.1	<0.1	<0.5	0.13	0.2	0.8
Esso 16-28	1133.54	<0.1	0.2	<0.1	<0.1	<0.5	0.22	0.1	1.7
Esso 16-28	1134.64	<0.1	<0.1	<0.1	<0.1	<0.5	0.05	0.1	<0.5
Esso 16-28	1135.68	0.1	0.2	0.1	<0.1	<0.5	0.23	0.1	0.9
Esso 16-28	1136.7	<0.1	0.1	<0.1	<0.1	0.6	0.19	0.1	0.9
Esso 16-28	1137.44	<0.1	<0.1	<0.1	<0.1	0.8	0.03	<0.1	<0.5
Esso 16-28	1138.62	0.1	0.2	0.1	<0.1	<0.5	0.26	0.2	1.5
Esso 16-28	1139.59	<0.1	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
Esso 16-28	1140.52	<0.1	0.2	<0.1	<0.1	<0.5	0.25	0.1	1.3
Esso 16-28	1141.15	<0.1	0.2	<0.1	<0.1	<0.5	0.3	0.1	2.1
Esso 16-28	1142.52	<0.1	0.2	0.1	<0.1	1.7	0.23	0.1	0.7
Esso 16-28	1143.4	<0.1	<0.1	0.1	<0.1	<0.5	0.2	<0.1	1

Esso 16-28	1144.48	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Esso 16-28	1145.57	0.1	0.1	0.2	<0.1	1	0.31	<0.1	1.7
Esso 16-28	1146.4	<0.1	0.2	0.1	<0.1	<0.5	0.23	0.2	1.1
Esso 16-28	1147.4	<0.1	0.1	0.1	<0.1	1	0.12	<0.1	1.3
Esso 16-28	1148.55	<0.1	0.1	<0.1	<0.1	<0.5	0.25	0.1	1.4
Esso 16-28	1149.53	<0.1	0.2	0.1	<0.1	<0.5	0.31	<0.1	1.7
Esso 16-28	1150.5	<0.1	0.1	<0.1	<0.1	<0.5	0.27	<0.1	1.3
Esso 16-28	1151.4	<0.1	0.1	<0.1	<0.1	<0.5	0.29	<0.1	0.6
Esso 16-28	1152.51	<0.1	0.1	<0.1	<0.1	<0.5	0.2	<0.1	0.7
Esso 16-28	1153.63	<0.1	0.1	0.1	<0.1	<0.5	0.23	<0.1	1.9
Esso 16-28	1154.62	<0.1	0.2	<0.1	<0.1	<0.5	0.37	<0.1	2
Esso 16-28	1155.48	<0.1	0.1	0.1	<0.1	<0.5	0.31	<0.1	1.4
Esso 16-28	1156.47	<0.1	0.1	0.1	<0.1	<0.5	0.34	<0.1	2.3
Esso 16-28	1157.49	<0.1	0.1	0.2	<0.1	0.5	0.32	<0.1	2.5
Esso 16-28	1158.39	<0.1	0.1	<0.1	<0.1	<0.5	0.13	<0.1	<0.5
Esso 16-28	1159.4	<0.1	0.2	0.1	<0.1	<0.5	0.33	0.2	5.2
Esso 16-28	1160.57	0.1	0.2	0.2	<0.1	<0.5	0.34	0.1	4.3
Esso 16-28	1161.52	<0.1	<0.1	<0.1	<0.1	<0.5	0.08	<0.1	<0.5
Esso 16-28	1162.5	<0.1	0.4	<0.1	<0.1	<0.5	0.27	0.5	3.9
Esso 16-28	1163.55	0.1	0.4	0.1	<0.1	<0.5	0.26	0.6	3.4
Esso 16-28	1164.5	<0.1	0.1	0.1	<0.1	<0.5	0.15	0.3	1
Esso 16-28	1165.42	<0.1	<0.1	<0.1	<0.1	0.7	0.03	<0.1	<0.5
Esso 16-28	1166.5	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Esso 16-28	1168.62	0.2	0.3	0.1	0.2	1.6	0.17	0.3	1.3
Esso 16-28	1169.32	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
Esso 16-28	1170.5	<0.1	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
Esso 16-28	1171.5	<0.1	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
Esso 16-28	1144.3	<0.1	<0.1	<0.1	<0.1	<0.5	0.12	<0.1	<0.5
Esso 16-28	1168.09	<0.1	0.2	<0.1	<0.1	<0.5	0.1	<0.1	<0.5
Esso 16-28	1161.07	<0.1	0.1	<0.1	<0.1	0.5	0.12	<0.1	0.8
Esso 16-28	1154.27	<0.1	0.1	<0.1	<0.1	<0.5	0.21	<0.1	1.7
Esso 16-28	1145.745	<0.1	<0.1	<0.1	<0.1	<0.5	0.06	<0.1	0.5
Standard	1180	0.4	0.3	0.7	<0.1	1.1	0.07	0.1	1.3
Encana 11-04	1190	0.1	0.3	0.3	<0.1	1.4	<0.01	0.8	2.8
Encana 11-04	3935.5	0.1	0.3	0.3	<0.1	<0.5	0.08	<0.1	<0.5
Encana 11-04	3936.515	<0.1	0.2	0.3	<0.1	<0.5	0.08	<0.1	0.5
Encana 11-04	3937.51	<0.1	0.2	0.3	<0.1	<0.5	0.09	<0.1	0.6
Encana 11-04	3938.5	<0.1	0.2	0.2	<0.1	<0.5	0.06	<0.1	<0.5
Encana 11-04	3939.42	<0.1	0.2	0.3	<0.1	0.5	0.07	<0.1	<0.5
Encana 11-04	3940.515	<0.1	0.2	0.1	<0.1	<0.5	0.13	0.1	0.7
Encana 11-04	3941.595	<0.1	0.2	<0.1	<0.1	<0.5	0.1	<0.1	1.2

Encana 11-04	3942.425	0.4	0.2	0.2	<0.1	<0.5	0.12	0.1	4.7
Encana 11-04	3943.535	0.4	0.2	0.1	<0.1	<0.5	0.12	<0.1	3.4
Encana 11-04	3944.48	4.8	0.4	0.2	0.1	<0.5	0.22	0.2	6.3
Encana 11-04	3945.37	2	0.4	0.2	<0.1	<0.5	0.14	0.3	3.8
Encana 11-04	3946.475	1.8	0.5	0.2	<0.1	<0.5	0.14	0.3	5.7
Encana 11-04	3947.46	2.5	0.4	0.2	<0.1	<0.5	0.21	0.2	4.8
Encana 11-04	3948.45	<0.1	0.2	0.1	<0.1	<0.5	0.09	<0.1	<0.5
Encana 11-04	3949.52	<0.1	0.2	0.2	<0.1	0.8	0.16	0.1	1.1
Encana 11-04	3950.64	<0.1	0.2	0.2	<0.1	1.1	0.12	<0.1	0.8
Encana 11-04	3951.53	<0.1	0.1	0.3	<0.1	<0.5	0.1	<0.1	<0.5
Encana 11-04	3952.515	<0.1	0.1	0.3	<0.1	<0.5	0.12	<0.1	0.6
Encana 11-04	3953.38	<0.1	0.1	0.3	<0.1	<0.5	0.09	<0.1	<0.5
Encana 11-04	3954.54	<0.1	0.2	0.3	<0.1	<0.5	0.14	<0.1	0.9
Encana 11-04	3955.49	<0.1	0.2	0.3	<0.1	<0.5	0.14	<0.1	0.5
Encana 11-04	3956.475	0.4	0.1	0.2	<0.1	<0.5	0.11	<0.1	1.9
Encana 11-04	3957.515	<0.1	0.2	0.2	<0.1	<0.5	0.15	<0.1	1.1
Encana 11-04	3958.49	<0.1	0.1	0.2	<0.1	<0.5	0.1	<0.1	1.6
Encana 11-04	3959.5	<0.1	0.2	0.3	<0.1	<0.5	0.13	<0.1	0.6
Encana 11-04	3960.5	<0.1	0.2	0.2	<0.1	<0.5	0.13	<0.1	1
Encana 11-04	3962.43	1.1	0.4	0.1	<0.1	<0.5	0.1	0.1	3.1
Encana 11-04	3963.49	<0.1	0.4	0.2	0.1	<0.5	0.26	0.1	1.5
Encana 11-04	3964.465	<0.1	0.2	0.1	<0.1	0.6	0.13	<0.1	2.1
Encana 11-04	3965.41	0.1	0.6	0.2	0.2	1.2	0.27	0.2	3.5
Encana 11-04	3966.5	<0.1	0.3	0.2	<0.1	<0.5	0.15	<0.1	2.2
Encana 11-04	3967.5	<0.1	0.2	0.2	<0.1	<0.5	0.14	<0.1	1.5
Encana 11-04	3968.46	<0.1	0.3	0.2	<0.1	<0.5	0.14	<0.1	0.9
Encana 11-04	3969.43	0.2	0.5	0.2	0.2	<0.5	0.16	0.2	3.6
Encana 11-04	3970.44	0.3	0.5	0.1	<0.1	<0.5	0.12	0.2	2.9
Encana 11-04	3971.47	<0.1	0.7	0.2	0.1	0.6	0.14	0.1	3.1
Encana 11-04	3972.5	1.4	0.7	0.2	0.1	<0.5	0.15	0.4	3.6
Encana 11-04	3973.54	<0.1	0.3	0.2	<0.1	1.7	0.06	<0.1	1
Encana 11-04	3974.54	<0.1	0.8	<0.1	0.1	0.7	0.1	0.2	1.3
Encana 11-04	3975.5	<0.1	0.7	0.1	0.2	0.9	0.15	0.2	5.3
Encana 11-04	3976.49	3.5	0.7	0.1	0.1	<0.5	0.14	0.1	5.5
Encana 11-04	3977.47	<0.1	0.8	0.2	0.2	<0.5	0.15	0.2	6.1
Encana 11-04	3978.415	<0.1	0.4	<0.1	<0.1	<0.5	0.05	<0.1	<0.5
Encana 11-04	3979.5	<0.1	0.9	0.1	0.2	<0.5	0.13	0.2	2.5
Encana 11-04	3980.455	0.3	0.8	0.1	0.1	0.6	0.12	0.1	4.2
Encana 11-04	3981.53	<0.1	0.4	0.1	<0.1	<0.5	0.08	<0.1	<0.5
Encana 11-04	3982.465	<0.1	0.2	0.2	<0.1	<0.5	0.11	<0.1	0.5
Encana 11-04	3983.51	<0.1	0.3	0.2	0.1	<0.5	0.11	<0.1	1.3

Encana 11-04	3984.5	<0.1	0.7	0.1	0.2	<0.5	0.15	0.1	2.9
Encana 11-04	3985.465	<0.1	0.5	<0.1	0.1	<0.5	0.12	<0.1	<0.5
Encana 11-04	3986.48	<0.1	0.5	0.1	0.1	<0.5	0.14	<0.1	<0.5
Encana 11-04	3987.48	<0.1	0.5	0.1	0.1	<0.5	0.14	<0.1	0.7
Encana 11-04	3988.42	<0.1	0.5	0.2	0.1	<0.5	0.17	<0.1	0.8
Encana 11-04	3989.54	<0.1	0.1	<0.1	<0.1	<0.5	0.05	<0.1	<0.5
Encana 11-04	3990.435	<0.1	0.2	<0.1	<0.1	<0.5	0.06	<0.1	0.6
Encana 11-04	3991.4	<0.1	0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
Encana 11-04	3992.4	<0.1	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
Encana 11-04	3993.43	<0.1	0.1	0.1	<0.1	<0.5	0.08	<0.1	<0.5
Encana 11-04	3994.455	<0.1	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
Encana 11-04	3995.45	<0.1	0.2	<0.1	<0.1	<0.5	0.08	<0.1	0.8
Encana 11-04	3996.47	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Encana 11-04	3997.42	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Encana 11-04	3998.5	<0.1	0.2	0.1	<0.1	<0.5	0.07	<0.1	1.3
Encana 11-04	3999.53	<0.1	0.2	0.1	<0.1	1	0.1	<0.1	1.4
Encana 11-04	3960.84	<0.1	0.2	0.2	<0.1	<0.5	0.13	<0.1	1.7
Encana 11-04	3965.67	<0.1	0.5	0.2	0.1	<0.5	0.2	0.2	3.4
Encana 11-04	3974.91	<0.1	0.5	0.1	<0.1	<0.5	0.09	<0.1	1.6
Encana 11-04	3931.53	<0.1	0.3	0.3	<0.1	<0.5	0.06	<0.1	<0.5
Encana 11-04	3932.475	<0.1	0.1	0.2	<0.1	<0.5	0.03	<0.1	<0.5
Encana 11-04	3933.47	<0.1	0.1	0.2	<0.1	<0.5	0.03	<0.1	<0.5
Encana 11-04	3933.515	<0.1	0.1	0.3	<0.1	<0.5	0.03	<0.1	<0.5
Encana 11-04	1123.58	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
Encana 11-04	1167.42	<0.1	0.2	<0.1	<0.1	<0.5	0.09	0.2	<0.5
Encana 11-04	3961.53	0.1	1.1	0.2	0.2	<0.5	0.26	0.5	5.6
Encana 11-04	3982.57	<0.1	0.3	0.2	<0.1	<0.5	0.14	0.1	0.7
	Pulp Duplicates								
	1129.74	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
	1129.74								
	1165.42	<0.1	<0.1	<0.1	<0.1	0.7	0.03	<0.1	<0.5
	1165.42								
	3982.57	<0.1	0.3	0.2	<0.1	<0.5	0.14	0.1	0.7
	3982.57								
	3958.49	<0.1	0.1	0.2	<0.1	<0.5	0.1	<0.1	1.6
	3958.49								
	3995.45	<0.1	0.2	<0.1	<0.1	<0.5	0.08	<0.1	0.8
	3995.45								
	3987.48	<0.1	0.5	0.1	0.1	<0.5	0.14	<0.1	0.7
	3987.48	<0.1	0.5	0.2	0.1	<0.5	0.16	<0.1	1

	3950.64	<0.1	0.2	0.2	<0.1	1.1	0.12	<0.1	0.8
	3950.64	<0.1	0.2	0.3	<0.1	0.6	0.1	<0.1	1
	1120.46	<0.1	0.1	<0.1	<0.1	1.6	0.3	<0.1	1.4
	1120.46	<0.1	0.1	<0.1	<0.1	1.5	0.3	<0.1	1.5
	3982.57	<0.1	0.3	0.2	<0.1	<0.5	0.14	0.1	0.7
	3982.57	<0.1	0.3	0.2	<0.1	<0.5	0.13	0.1	1.7
	1157.49	<0.1	0.1	0.2	<0.1	0.5	0.32	<0.1	2.5
	1157.49	<0.1	0.1	0.2	<0.1	<0.5	0.37	<0.1	2.6
	1168.62	0.2	0.3	0.1	0.2	1.6	0.17	0.3	1.3
	1168.62								
	3982.57	<0.1	0.3	0.2	<0.1	<0.5	0.14	0.1	0.7
	3982.57								
	1131.53	<0.1	0.3	<0.1	<0.1	2	0.24	0.2	2.2
	1131.53								
	3960.5	<0.1	0.2	0.2	<0.1	<0.5	0.13	<0.1	1
	3960.5								
	3997.42	<0.1	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
	3997.42								
	Reference Materials								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD DS10	2.7	8.3	12.4	2.1	86.6	0.29	5.3	1.6

	STD OREAS45EA	<0.1	0.4	0.3	0.3	55.6	<0.01	<0.1	<0.5
	STD DS10	2.8	8.9	13.6	2.3	54.5	0.32	5.5	2.2
	STD OREAS45EA	<0.1	0.4	0.3	0.3	54.2	<0.01	<0.1	0.5
	STD DS10	2.8	8	13	2.1	122.4	0.29	5.2	2.4
	STD OREAS45EA	<0.1	0.4	0.2	0.3	61.4	<0.01	<0.1	0.8
	STD DS10	2.4	9.2	12.5	1.9	57.5	0.28	5	2
	STD OREAS45EA	<0.1	0.4	0.3	0.3	63.2	0.02	0.1	0.8
	STD DS10	2.4	8.2	13.1	2.1	57.1	0.28	5.2	2
	STD OREAS45EA	<0.1	0.3	0.2	0.2	51.8	0.02	<0.1	1.2
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	BLK								
	BLK								
	BLK								
	BLK								
	BLK								
	BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK								
	BLK								
	BLK								
	BLK								
	BLK								
	BLK								

	Prep Wash								
	ROCK-VAN	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	ROCK-VAN	<0.1	<0.1	<0.1	<0.1	4.5	<0.01	<0.1	<0.5

C.3.2 Leco TOC and Rockeval Results

Table 30. Leco TOC and Rockeval Results for Encana 11-04 and Esso 16-28

Well ID	Depth ()	Sample Type	Sample Prep	Leco	RE			Tmax
	Top			TOC	S1	S2	S3	(°C)
Encana 11-04	3931.53	Core	NOPR	0.91	0.12	0.06	0.22	358
Encana 11-04	3932.475	Core	NOPR	0.33	0.03	0.03	0.22	-1
Encana 11-04	3933.47	Core	NOPR	0.37	0.05	0.03	0.23	-1
Encana 11-04	3933.515	Core	NOPR	0.48	0.10	0.05	0.33	422
Encana 11-04	3935.5	Core	NOPR	1.10	0.19	0.12	0.36	424
Encana 11-04	3936.515	Core	NOPR	0.97	0.15	0.05	0.24	342
Encana 11-04	3937.51	Core	NOPR	1.20	0.23	0.10	0.25	362
Encana 11-04	3938.5	Core	NOPR	1.16	0.16	0.09	0.18	-1
Encana 11-04	3939.42	Core	NOPR	1.01	0.19	0.07	0.20	308
Encana 11-04	3940.515	Core	NOPR	1.61	0.60	0.22	0.29	-1
Encana 11-04	3941.595	Core	NOPR	1.23	1.72	0.23	0.50	376
Encana 11-04	3942.425	Core	NOPR	3.45	2.39	0.77	0.58	380
Encana 11-04	3943.535	Core	NOPR	3.43	2.03	0.74	0.53	388
Encana 11-04	3944.48	Core	NOPR	3.73	2.48	0.76	0.53	371
Encana 11-04	3945.37	Core	NOPR	3.19	1.75	0.62	0.54	425
Encana 11-04	3946.475	Core	NOPR	3.56	2.24	0.94	0.57	376
Encana 11-04	3947.46	Core	NOPR	3.30	1.08	0.61	0.51	391
Encana 11-04	3948.45	Core	NOPR	1.93	0.82	0.37	0.43	349
Encana 11-04	3949.52	Core	NOPR	1.63	0.88	0.28	0.39	347
Encana 11-04	3950.64	Core	NOPR	1.55	0.22	0.15	0.27	-1
Encana 11-04	3951.53	Core	NOPR	1.59	0.33	0.21	0.27	-1
Encana 11-04	3952.515	Core	NOPR	1.29	0.14	0.12	0.20	305
Encana 11-04	3953.38	Core	NOPR	1.41	0.18	0.14	0.34	423
Encana 11-04	3954.54	Core	NOPR	2.06	0.56	0.31	0.39	338

Encana 11-04	3955.49	Core	NOPR	1.53	0.16	0.10	0.25	301
Encana 11-04	3956.475	Core	NOPR	2.25	0.18	0.19	0.25	430
Encana 11-04	3957.515	Core	NOPR	1.45	0.23	0.19	0.26	344
Encana 11-04	3958.49	Core	NOPR	2.36	0.30	0.26	0.23	449
Encana 11-04	3959.5	Core	NOPR	1.70	0.14	0.16	0.31	436
Encana 11-04	3960.5	Core	NOPR	1.98	0.30	0.26	0.31	366
Encana 11-04	3960.84	Core	NOPR	2.19	0.27	0.26	0.26	429
Encana 11-04	3961.51	Core	NOPR	3.90	4.48	0.88	0.62	364
Encana 11-04	3962.43	Core	NOPR	3.29	4.06	0.80	0.54	377
Encana 11-04	3963.49	Core	NOPR	3.16	1.17	0.43	0.37	432
Encana 11-04	3964.465	Core	NOPR	3.36	3.41	0.74	0.58	431
Encana 11-04	3965.41	Core	NOPR	4.88	0.84	0.63	0.49	514
Encana 11-04	3965.67	Core	NOPR	3.15	0.51	0.33	0.37	507
Encana 11-04	3966.5	Core	NOPR	3.41	2.59	0.87	0.58	387
Encana 11-04	3967.5	Core	NOPR	2.76	1.14	0.47	0.44	424
Encana 11-04	3968.46	Core	NOPR	2.86	0.46	0.31	0.30	517
Encana 11-04	3969.43	Core	NOPR	3.69	0.75	0.39	0.36	520
Encana 11-04	3970.44	Core	NOPR	3.49	1.43	0.43	0.37	511
Encana 11-04	3971.47	Core	NOPR	3.36	3.43	0.97	0.63	368
Encana 11-04	3972.5	Core	NOPR	3.78	2.36	0.71	0.58	424
Encana 11-04	3973.54	Core	NOPR	2.96	0.59	0.38	0.33	503
Encana 11-04	3974.54	Core	NOPR	2.02	0.77	0.22	0.38	351
Encana 11-04	3974.91	Core	NOPR	1.60	0.39	0.25	0.33	424
Encana 11-04	3975.5	Core	NOPR	4.31	0.27	0.43	0.48	536
Encana 11-04	3976.49	Core	NOPR	4.35	4.63	1.16	0.66	377
Encana 11-04	3977.47	Core	NOPR	4.78	0.60	0.45	0.40	534
Encana 11-04	3978.415	Core	NOPR	1.18	2.69	0.26	0.53	339
Encana 11-04	3979.5	Core	NOPR	3.16	8.28	1.05	0.46	364
Encana 11-04	3980.455	Core	NOPR	3.94	7.43	1.32	0.53	367
Encana 11-04	3981.53	Core	NOPR	0.84	0.82	0.05	0.47	423
Encana 11-04	3982.465	Core	NOPR	1.02	0.43	0.05	0.33	360
Encana 11-04	3982.573	Core	NOPR	2.06	0.25	0.24	0.28	479
Encana 11-04	3983.51	Core	NOPR	2.66	0.32	0.26	0.31	517
Encana 11-04	3984.5	Core	NOPR	3.07	0.50	0.32	0.34	523
Encana 11-04	3985.465	Core	NOPR	2.52	0.16	0.12	0.25	516
Encana 11-04	3986.48	Core	NOPR	2.88	0.16	0.15	0.20	520
Encana 11-04	3987.48	Core	NOPR	2.91	0.20	0.15	0.21	516
Encana 11-04	3988.42	Core	NOPR	2.85	0.31	0.24	0.24	525
Encana 11-04	3989.54	Core	NOPR	0.28	0.08	0.01	0.26	-1
Encana 11-04	3990.435	Core	NOPR	1.42	0.13	0.06	0.23	501
Encana 11-04	3991.4	Core	NOPR	0.71	0.25	0.04	0.22	366

Encana 11-04	3992.4	Core	NOPR	0.72	0.08	0.02	0.35	332
Encana 11-04	3993.43	Core	NOPR	0.84	0.03	0.01	0.16	325
Encana 11-04	3994.455	Core	NOPR	1.34	0.07	0.07	0.18	416
Encana 11-04	3995.45	Core	NOPR	2.49	0.16	0.26	0.23	523
Encana 11-04	3996.47	Core	NOPR	0.77	0.15	0.04	0.22	389
Encana 11-04	3997.42	Core	NOPR	0.70	0.09	0.03	0.18	372
Encana 11-04	3998.5	Core	NOPR	3.06	0.16	0.30	0.26	532
Encana 11-04	3999.53	Core	NOPR	2.89	0.31	0.35	0.28	525
Esso 16-28	1107.46	Core	NOPR	0.27	0.17	0.21	0.22	429
Esso 16-28	1108.54	Core	NOPR	0.35	0.08	0.41	0.34	430
Esso 16-28	1109.51	Core	NOPR	0.21	0.06	0.17	0.15	427
Esso 16-28	1110.4	Core	NOPR	0.19	0.06	0.11	0.14	427
Esso 16-28	1111.48	Core	NOPR	0.28	0.12	0.29	0.16	429
Esso 16-28	1112.31	Core	NOPR	1.06	0.22	4.15	0.57	423
Esso 16-28	1113.46	Core	NOPR	0.99	0.18	4.33	0.59	424
Esso 16-28	1114.57	Core	NOPR	0.33	0.08	0.44	0.25	433
Esso 16-28	1115.33	Core	NOPR	0.19	0.04	0.05	0.19	427
Esso 16-28	1116.63	Core	NOPR	0.23	0.09	0.26	0.33	430
Esso 16-28	1117.51	Core	NOPR	0.77	0.16	2.69	0.46	422
Esso 16-28	1118.4	Core	NOPR	0.69	0.22	2.53	0.43	425
Esso 16-28	1119.64	Core	NOPR	0.22	0.02	0.18	0.24	430
Esso 16-28	1120.46	Core	NOPR	2.66	0.57	13.15	1.01	420
Esso 16-28	1121.48	Core	NOPR	3.78	0.99	20.35	1.23	419
Esso 16-28	1122.55	Core	NOPR	1.53	0.47	7.13	0.79	418
Esso 16-28	1123.6	Core	NOPR	0.61	0.20	2.16	0.50	430
Esso 16-28	1124.38	Core	NOPR	0.40	0.10	0.82	0.33	429
Esso 16-28	1125.48	Core	NOPR	1.68	0.36	9.19	0.85	421
Esso 16-28	1126.53	Core	NOPR	1.46	0.32	7.46	0.84	419
Esso 16-28	1127.56	Core	NOPR	0.99	0.18	4.13	0.62	424
Esso 16-28	1128.42	Core	NOPR	0.31	0.04	0.20	0.32	431
Esso 16-28	1129.74	Core	NOPR	0.23	0.02	0.17	0.21	431
Esso 16-28	1130.31	Core	NOPR	1.60	0.30	7.28	0.72	422
Esso 16-28	1131.53	Core	NOPR	2.91	0.58	15.39	1.21	419
Esso 16-28	1132.54	Core	NOPR	1.73	0.37	8.41	0.85	420
Esso 16-28	1133.54	Core	NOPR	2.67	0.48	14.32	1.04	422
Esso 16-28	1134.64	Core	NOPR	0.22	0.03	0.18	0.33	429
Esso 16-28	1135.68	Core	NOPR	2.66	0.48	12.64	0.93	424
Esso 16-28	1136.7	Core	NOPR	1.87	0.38	9.65	0.85	421
Esso 16-28	1137.44	Core	NOPR	0.27	0.07	0.22	0.35	430
Esso 16-28	1138.62	Core	NOPR	2.98	0.47	13.90	1.06	422
Esso 16-28	1139.59	Core	NOPR	0.92	0.17	2.96	0.53	427

Esso 16-28	1140.52	Core	NOPR	3.40	0.63	17.84	1.41	423
Esso 16-28	1141.15	Core	NOPR	3.54	0.64	17.87	1.29	419
Esso 16-28	1142.52	Core	NOPR	3.05	0.54	14.22	1.21	419
Esso 16-28	1143.4	Core	NOPR	3.29	0.54	15.12	1.13	420
Esso 16-28	1144.3	Core	NOPR	2.36	0.53	12.24	1.14	421
Esso 16-28	1144.48	Core	NOPR	0.34	0.08	0.54	0.55	432
Esso 16-28	1145.57	Core	NOPR	3.81	0.67	17.71	1.39	421
Esso 16-28	1145.745	Core	NOPR	1.58	1.36	6.52	0.90	424
Esso 16-28	1146.4	Core	NOPR	2.63	0.50	11.56	1.06	422
Esso 16-28	1147.4	Core	NOPR	2.00	0.39	9.20	0.98	423
Esso 16-28	1148.55	Core	NOPR	4.40	0.68	22.37	1.35	421
Esso 16-28	1149.53	Core	NOPR	4.75	0.87	23.36	1.36	418
Esso 16-28	1150.5	Core	NOPR	3.94	0.83	19.49	1.18	418
Esso 16-28	1151.4	Core	NOPR	3.77	0.57	18.92	1.17	423
Esso 16-28	1152.51	Core	NOPR	3.21	0.47	15.34	1.09	422
Esso 16-28	1153.63	Core	NOPR	4.59	0.80	24.75	1.48	422
Esso 16-28	1154.27	Core	NOPR	5.57	1.59	29.81	1.62	420
Esso 16-28	1154.62	Core	NOPR	4.73	1.01	26.04	1.50	418
Esso 16-28	1155.48	Core	NOPR	5.48	1.06	30.31	1.60	418
Esso 16-28	1156.47	Core	NOPR	8.15	1.68	40.50	1.92	419
Esso 16-28	1157.49	Core	NOPR	8.26	1.88	40.92	1.93	421
Esso 16-28	1158.39	Core	NOPR	2.41	0.44	12.20	0.93	424
Esso 16-28	1159.4	Core	NOPR	8.82	2.33	41.02	2.13	418
Esso 16-28	1160.57	Core	NOPR	9.00	2.39	47.06	2.08	415
Esso 16-28	1161.07	Core	NOPR	2.61	0.75	14.68	1.13	421
Esso 16-28	1161.52	Core	NOPR	0.92	0.25	4.08	0.76	424
Esso 16-28	1162.5	Core	NOPR	5.00	1.41	28.41	1.59	417
Esso 16-28	1163.55	Core	NOPR	6.79	1.91	35.25	1.69	416
Esso 16-28	1164.5	Core	NOPR	3.31	0.80	17.80	1.19	418
Esso 16-28	1165.42	Core	NOPR	0.34	0.14	0.69	0.71	430
Esso 16-28	1166.5	Core	NOPR	0.37	0.12	0.80	0.72	430
Esso 16-28	1167.46	Core	NOPR	1.56	0.30	7.56	1.00	423
Esso 16-28	1168.09	Core	NOPR	4.13	1.33	26.27	1.38	412
Esso 16-28	1168.62	Core	NOPR	7.77	1.80	41.20	2.08	416
Esso 16-28	1169.32	Core	NOPR	0.32	0.10	0.71	0.54	427
Esso 16-28	1170.5	Core	NOPR	0.31	0.08	0.44	0.30	433
Esso 16-28	1171.5	Core	NOPR	0.11	0.01	0.07	0.20	432

Table 30. Continued

Well ID	Depth ()	HI	OI	S2/S3	S1/TOC*100	PI
	Top					
Encana 11-04	3931.53	7	24	0.3	13	0.67
Encana 11-04	3932.475	9	67	0.1	9	0.50
Encana 11-04	3933.47	8	63	0.1	14	0.63
Encana 11-04	3933.515	10	68	0.2	21	0.67
Encana 11-04	3935.5	11	33	0.3	17	0.62
Encana 11-04	3936.515	5	25	0.2	15	0.75
Encana 11-04	3937.51	8	21	0.4	19	0.69
Encana 11-04	3938.5	8	16	0.5	14	0.64
Encana 11-04	3939.42	7	20	0.3	19	0.73
Encana 11-04	3940.515	14	18	0.8	37	0.73
Encana 11-04	3941.595	19	41	0.5	140	0.88
Encana 11-04	3942.425	22	17	1.3	69	0.76
Encana 11-04	3943.535	22	15	1.4	59	0.73
Encana 11-04	3944.48	20	14	1.4	66	0.77
Encana 11-04	3945.37	19	17	1.1	55	0.74
Encana 11-04	3946.475	26	16	1.6	63	0.70
Encana 11-04	3947.46	18	15	1.2	33	0.64
Encana 11-04	3948.45	19	22	0.9	43	0.69
Encana 11-04	3949.52	17	24	0.7	54	0.76
Encana 11-04	3950.64	10	17	0.6	15	0.60
Encana 11-04	3951.53	13	17	0.8	21	0.61
Encana 11-04	3952.515	9	16	0.6	11	0.53
Encana 11-04	3953.38	10	24	0.4	12	0.56
Encana 11-04	3954.54	15	19	0.8	27	0.64
Encana 11-04	3955.49	7	16	0.4	10	0.61
Encana 11-04	3956.475	8	11	0.8	8	0.49
Encana 11-04	3957.515	13	18	0.7	16	0.55
Encana 11-04	3958.49	11	10	1.1	13	0.54
Encana 11-04	3959.5	9	18	0.5	8	0.46
Encana 11-04	3960.5	13	16	0.8	15	0.54
Encana 11-04	3960.84	12	12	1.0	12	0.51
Encana 11-04	3961.51	23	16	1.4	115	0.84
Encana 11-04	3962.43	24	16	1.5	124	0.84
Encana 11-04	3963.49	14	12	1.2	37	0.73
Encana 11-04	3964.465	22	17	1.3	102	0.82
Encana 11-04	3965.41	13	10	1.3	17	0.57
Encana 11-04	3965.67	10	12	0.9	16	0.61
Encana 11-04	3966.5	26	17	1.5	76	0.75

Encana 11-04	3967.5	17	16	1.1	41	0.71
Encana 11-04	3968.46	11	10	1.0	16	0.60
Encana 11-04	3969.43	11	10	1.1	20	0.66
Encana 11-04	3970.44	12	11	1.2	41	0.77
Encana 11-04	3971.47	29	19	1.5	102	0.78
Encana 11-04	3972.5	19	15	1.2	62	0.77
Encana 11-04	3973.54	13	11	1.2	20	0.61
Encana 11-04	3974.54	11	19	0.6	38	0.78
Encana 11-04	3974.91	16	21	0.8	24	0.61
Encana 11-04	3975.5	10	11	0.9	6	0.39
Encana 11-04	3976.49	27	15	1.8	106	0.80
Encana 11-04	3977.47	9	8	1.1	13	0.57
Encana 11-04	3978.415	22	45	0.5	228	0.91
Encana 11-04	3979.5	33	15	2.3	262	0.89
Encana 11-04	3980.455	33	13	2.5	188	0.85
Encana 11-04	3981.53	6	56	0.1	98	0.94
Encana 11-04	3982.465	5	33	0.2	42	0.90
Encana 11-04	3982.573	12	14	0.9	12	0.51
Encana 11-04	3983.51	10	12	0.8	12	0.55
Encana 11-04	3984.5	10	11	0.9	16	0.61
Encana 11-04	3985.465	5	10	0.5	6	0.57
Encana 11-04	3986.48	5	7	0.8	6	0.52
Encana 11-04	3987.48	5	7	0.7	7	0.57
Encana 11-04	3988.42	8	8	1.0	11	0.56
Encana 11-04	3989.54	4	92	0.0	28	0.89
Encana 11-04	3990.435	4	16	0.3	9	0.68
Encana 11-04	3991.4	6	31	0.2	35	0.86
Encana 11-04	3992.4	3	49	0.1	11	0.80
Encana 11-04	3993.43	1	19	0.1	4	0.75
Encana 11-04	3994.455	5	13	0.4	5	0.50
Encana 11-04	3995.45	10	9	1.1	6	0.38
Encana 11-04	3996.47	5	29	0.2	20	0.79
Encana 11-04	3997.42	4	26	0.2	13	0.75
Encana 11-04	3998.5	10	8	1.2	5	0.35
Encana 11-04	3999.53	12	10	1.3	11	0.47
Esso 16-28	1107.46	77	81	1.0	62	0.45
Esso 16-28	1108.54	118	98	1.2	23	0.16
Esso 16-28	1109.51	79	70	1.1	28	0.26
Esso 16-28	1110.4	58	73	0.8	31	0.35
Esso 16-28	1111.48	103	57	1.8	43	0.29
Esso 16-28	1112.31	392	54	7.3	21	0.05

Esso 16-28	1113.46	436	59	7.3	18	0.04
Esso 16-28	1114.57	133	75	1.8	24	0.15
Esso 16-28	1115.33	27	102	0.3	22	0.44
Esso 16-28	1116.63	111	141	0.8	39	0.26
Esso 16-28	1117.51	351	60	5.8	21	0.06
Esso 16-28	1118.4	366	62	5.9	32	0.08
Esso 16-28	1119.64	84	112	0.8	10	0.10
Esso 16-28	1120.46	494	38	13.0	21	0.04
Esso 16-28	1121.48	538	33	16.5	26	0.05
Esso 16-28	1122.55	467	52	9.0	30	0.06
Esso 16-28	1123.6	354	82	4.3	33	0.09
Esso 16-28	1124.38	204	82	2.5	25	0.11
Esso 16-28	1125.48	547	51	10.8	22	0.04
Esso 16-28	1126.53	511	58	8.9	22	0.04
Esso 16-28	1127.56	417	63	6.7	18	0.04
Esso 16-28	1128.42	65	104	0.6	13	0.16
Esso 16-28	1129.74	73	90	0.8	8	0.10
Esso 16-28	1130.31	454	45	10.1	18	0.04
Esso 16-28	1131.53	529	42	12.7	20	0.04
Esso 16-28	1132.54	485	49	9.9	21	0.04
Esso 16-28	1133.54	536	39	13.8	18	0.03
Esso 16-28	1134.64	82	151	0.5	13	0.14
Esso 16-28	1135.68	476	35	13.6	18	0.04
Esso 16-28	1136.7	516	45	11.4	20	0.04
Esso 16-28	1137.44	83	132	0.6	27	0.24
Esso 16-28	1138.62	467	36	13.1	16	0.03
Esso 16-28	1139.59	321	57	5.6	19	0.06
Esso 16-28	1140.52	524	41	12.7	19	0.03
Esso 16-28	1141.15	505	36	13.9	18	0.03
Esso 16-28	1142.52	466	40	11.8	18	0.04
Esso 16-28	1143.4	460	34	13.4	16	0.03
Esso 16-28	1144.3	520	48	10.7	22	0.04
Esso 16-28	1144.48	159	162	1.0	24	0.13
Esso 16-28	1145.57	465	37	12.7	18	0.04
Esso 16-28	1145.745	412	57	7.2	86	0.17
Esso 16-28	1146.4	440	40	10.9	19	0.04
Esso 16-28	1147.4	459	49	9.4	19	0.04
Esso 16-28	1148.55	508	31	16.6	15	0.03
Esso 16-28	1149.53	492	29	17.2	18	0.04
Esso 16-28	1150.5	495	30	16.5	21	0.04
Esso 16-28	1151.4	502	31	16.2	15	0.03

Esso 16-28	1152.51	478	34	14.1	15	0.03
Esso 16-28	1153.63	539	32	16.7	17	0.03
Esso 16-28	1154.27	535	29	18.4	29	0.05
Esso 16-28	1154.62	550	32	17.4	21	0.04
Esso 16-28	1155.48	553	29	18.9	19	0.03
Esso 16-28	1156.47	497	24	21.1	21	0.04
Esso 16-28	1157.49	495	23	21.2	23	0.04
Esso 16-28	1158.39	507	39	13.1	18	0.03
Esso 16-28	1159.4	465	24	19.3	26	0.05
Esso 16-28	1160.57	523	23	22.6	27	0.05
Esso 16-28	1161.07	562	43	13.0	29	0.05
Esso 16-28	1161.52	442	82	5.4	28	0.06
Esso 16-28	1162.5	568	32	17.9	28	0.05
Esso 16-28	1163.55	519	25	20.9	28	0.05
Esso 16-28	1164.5	539	36	15.0	24	0.04
Esso 16-28	1165.42	206	212	1.0	42	0.17
Esso 16-28	1166.5	214	193	1.1	32	0.13
Esso 16-28	1167.46	486	64	7.6	20	0.04
Esso 16-28	1168.09	636	33	19.0	32	0.05
Esso 16-28	1168.62	530	27	19.8	23	0.04
Esso 16-28	1169.32	223	169	1.3	31	0.12
Esso 16-28	1170.5	142	97	1.5	26	0.16
Esso 16-28	1171.5	61	175	0.3	9	0.12

C.4 Complete Geochemical Results for EOG 08-20

C.4.1 Major, Minor and Trace Element Results Including Acme Internal Standards

Table 31. Major, Minor and Trace Element Results Including Acme Internal Standards for EOG 08-20

		Analyte	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O
		Unit	%	%	%	%	%	%	%
		MDL	0.01	0.01	0.04	0.01	0.01	0.01	0.01
Well ID	Sample	Type							
EOG 08_20	2564.5	Rock	38.07	13.24	5.11	4.8	14.71	0.29	4.27
EOG 08_20	2565.5	Rock	38.67	13.31	5.28	5.07	14.1	0.28	4.28

EOG 08_20	2566.5	Rock	39	13.97	5.38	5.08	13.34	0.28	4.52
EOG 08_20	2567.5	Rock	38.32	13.15	5.25	5.23	13.69	0.28	4.29
EOG 08_20	2568.535	Rock	39.23	13.68	5.3	5.12	13.22	0.29	4.45
EOG 08_20	2569.475	Rock	18.86	5.55	2.42	2.47	35.31	0.13	2.23
EOG 08_20	2570.44	Rock	19.28	4.03	2.48	2.8	36.66	0.11	2
EOG 08_20	2571.55	Rock	11.21	3.02	1.2	1.49	43.25	0.1	1.28
EOG 08_20	2572.4	Rock	9.74	2.79	1.06	1.27	44.81	0.09	0.99
EOG 08_20	2573.54	Rock	10.73	2.46	1.32	2.02	44.04	0.09	0.92
EOG 08_20	2574.515	Rock	7.33	2.07	0.91	1.09	47.16	0.07	0.75
EOG 08_20	2575.445	Rock	6.15	1.76	0.75	0.9	46.44	0.07	0.67
EOG 08_20	2576.545	Rock	6.29	1.8	1.71	0.99	48.22	0.08	0.67
EOG 08_20	2577.5	Rock	10.66	3.13	1.59	1.21	43.13	0.12	1.46
EOG 08_20	2578.61	Rock	7.5	2.06	0.8	1.1	46.73	0.08	0.81
EOG 08_20	2579.425	Rock	11.2	3.31	2.01	1.26	42.21	0.12	1.57
EOG 08_20	2582.535	Rock	10.54	2.76	1.03	1.27	43.16	0.11	1.35
EOG 08_20	2583.51	Rock	9.43	2.54	1.06	1.2	45.03	0.09	1.06
EOG 08_20	2584.5	Rock	9.3	2.5	1.02	1.18	45.37	0.1	1.28
EOG 08_20	2585.465	Rock	4.75	1.15	0.77	0.88	50.26	0.05	0.5
EOG 08_20	2586.5	Rock	10.91	2.81	0.93	1.17	43.89	0.08	1.49
EOG 08_20	2587.5	Rock	14.37	3.31	2.64	1.2	39.4	0.12	1.9
EOG 08_20	2588.5	Rock	9.92	1.87	0.87	1.12	45.38	0.09	0.96

EOG 08_20	2589.6	Rock	11.52	2.04	0.79	1.11	44.68	0.08	0.91
EOG 08_20	2590.51	Rock	12.77	2.61	1.03	1.19	41.83	0.11	1.34
EOG 08_20	2591.36	Rock	13.56	3.31	1.3	1.17	40.07	0.11	1.78
EOG 08_20	2591.455	Rock	11.22	2.46	0.87	1.15	43.2	0.1	1.21
EOG 08_20	2591.61	Rock	14.17	3.33	1.18	1.27	39.7	0.12	1.65
EOG 08_20	2591.87	Rock	10.73	2.57	1.09	1.17	44.23	0.1	1.17
EOG 08_20	2592.03	Rock	27.23	7.32	4.96	1.72	26.71	0.19	3.51
EOG 08_20	2592.525	Rock	23.56	6.34	3.26	1.54	30.41	0.18	3.16
EOG 08_20	2593.555	Rock	7.74	1.9	0.87	1.12	46.64	0.09	0.97
EOG 08_20	2594.5	Rock	3.35	0.87	0.73	0.94	51.7	0.06	0.38
EOG 08_20	2595.4	Rock	6.92	2.01	1.21	1.16	48.15	0.07	0.84
EOG 08_20	2596.52	Rock	11.79	3.35	1.07	1.06	43.02	0.1	1.82
EOG 08_20	2597.455	Rock	2.82	0.39	0.84	0.76	53.41	0.03	0.13
EOG 08_20	2598.455	Rock	0.66	0.15	0.3	0.74	54.39	0.03	0.06
EOG 08_20	2599	Rock	4.34	1.14	0.62	0.84	49.93	0.05	0.48
EOG 08_20	2599.25	Rock	15.49	4.53	1.71	1.95	37.91	0.12	2.04
EOG 08_20	2599.39	Rock	10.7	3.09	2.46	1.32	41.66	0.09	1.39
EOG 08_20	2599.5	Rock	25.12	7.79	5.62	2.93	20.54	0.15	3.26
EOG 08_20	2599.6	Rock	32.2	9.87	5.58	3.83	17.02	0.19	3.95
EOG 08_20	2599.765	Rock	11.93	3.75	1.37	1.21	42.43	0.11	1.47
EOG 08_20	2599.86	Rock	6.34	2.02	0.86	0.84	48.47	0.07	0.76

EOG 08_20	2599.96	Rock	10.89	3.28	1.43	1.14	43.23	0.09	1.35
EOG 08_20	2600.07	Rock	19.89	6.42	2.29	1.7	33.13	0.15	2.54
EOG 08_20	2600.15	Rock	26.5	8.81	2.89	2.07	27.73	0.19	3.53
EOG 08_20	2600.25	Rock	23.24	7.62	2.49	1.91	30.36	0.17	3.01
EOG 08_20	2600.4	Rock	10.48	3.28	1.15	1.08	43.91	0.1	1.25
EOG 08_20	2600.5	Rock	21.8	7.13	2.66	1.71	32.15	0.17	2.71
EOG 08_20	2600.62	Rock	23.98	7.99	2.58	1.73	30.21	0.18	3.09
EOG 08_20	2600.725	Rock	16.66	5.27	1.83	1.42	36.55	0.13	2.13
EOG 08_20	2600.9	Rock	11.78	3.58	1.48	1.23	42.36	0.11	1.46
EOG 08_20	2601.04	Rock	19.42	6.22	2.22	1.71	33.62	0.16	2.46
EOG 08_20	2601.14	Rock	24.3	8.04	3.19	1.86	30.23	0.19	3.3
EOG 08_20	2601.24	Rock	29.72	10.09	3.25	1.92	24.41	0.2	3.87
EOG 08_20	2601.51	Rock	20.13	6.62	2.27	1.65	32.58	0.16	2.69
EOG 08_20	2602.515	Rock	24.31	7.88	2.8	2.2	29.92	0.18	3.04
EOG 08_20	2602.75	Rock	17.17	5.68	1.95	1.49	36.21	0.15	2.13
EOG 08_20	2602.85	Rock	29.48	10.05	3.15	1.93	24.6	0.2	3.76
EOG 08_20	2603	Rock	16.68	5.61	1.83	1.39	36.8	0.13	2.08
EOG 08_20	2603.2	Rock	13.35	4.37	1.45	1.21	40.49	0.11	1.68
EOG 08_20	2603.3	Rock	9.22	2.88	1.08	0.95	45.32	0.08	1.09
EOG 08_20	2603.4	Rock	24.36	8.3	2.8	1.79	29.82	0.18	3.06
EOG 08_20	2603.5	Rock	33.01	11.54	3.23	2.1	21.71	0.22	4.15

EOG 08_20	2603.62	Rock	5.5	1.71	0.68	0.81	49.43	0.06	0.64
EOG 08_20	2604.405	Rock	16.41	5.3	1.61	1.53	36.42	0.12	1.92
EOG 08_20	2605.565	Rock	12.45	3.52	1.09	1.02	41.88	0.08	1.63
EOG 08_20	2606.5	Rock	18.59	6.17	2.18	1.74	35.27	0.12	2.36
EOG 08_20	2607.545	Rock	20.06	5.64	2.93	1.42	32.25	0.13	2.96
EOG 08_20	2608.5	Rock	17.44	4.39	2.43	1.26	34.84	0.1	2.28
EOG 08_20	2609.865	Rock	15.99	4.21	1.33	1.27	37.63	0.1	2.14
EOG 08_20	2610.51	Rock	16.85	4.65	1.63	1.24	36.73	0.1	2.36
EOG 08_20	2611.54	Rock	32.26	9.98	4.07	1.82	20.04	0.16	4.45
EOG 08_20	2612.5	Rock	27.72	8.9	2.7	1.74	26.05	0.16	3.65
EOG 08_20	2613.455	Rock	9.68	2.66	0.86	0.86	45.33	0.06	1.08
EOG 08_20	2614.28	Rock	30.59	10.97	3.95	3	22.59	0.21	4.09
EOG 08_20	2615.585	Rock	27.53	7.5	4.91	3.6	23	0.17	3.38
EOG 08_20	2616.415	Rock	10.41	2.94	1.25	2.26	42.15	0.07	1.32
EOG 08_20	2617.38	Rock	7.15	2.05	0.83	0.88	47.93	0.06	0.88
EOG 08_20	2618.5	Rock	8.63	2.57	0.92	0.99	45.74	0.07	1.06
EOG 08_20	2619.06	Rock	32.98	11.2	3.5	1.96	20.57	0.22	4.2
EOG 08_20	2620.475	Rock	7.64	2.27	0.77	0.86	47.59	0.06	0.88
EOG 08_20	2621.5	Rock	4.52	1.24	0.59	0.64	50.19	0.04	0.56
EOG 08_20	2622.37	Rock	20.99	6.21	3.43	1.19	30.79	0.12	3.22
EOG 08_20	2623.62	Rock	28.91	8.87	7.09	1.36	14.97	0.13	4.2

EOG 08_20	2624.5	Rock	16.92	5.03	6.34	0.99	26.85	0.08	2.57
EOG 08_20	2625.525	Rock	8.06	2.36	0.94	0.97	47.35	0.05	0.89
EOG 08_20	2626.5	Rock	10.06	2.81	0.9	1	44.82	0.06	1.26
EOG 08_20	2627.5	Rock	24.5	8.14	2.45	1.45	28.84	0.15	3.56
EOG 08_20	2593.12	Rock	11.53	2.6	2.06	1.25	41.38	0.08	1.11
EOG 08_20	2560	Rock Pulp	62.69	13.39	5.07	2.66	2.57	0.87	2.71
EOG 08_20	Pulp Duplicates								
EOG 08_20	2621.5	Rock	4.52	1.24	0.59	0.64	50.19	0.04	0.56
EOG 08_20	2621.5	REP	4.3	1.12	0.55	0.59	46.77	0.04	0.56
EOG 08_20	2603.4	Rock	24.36	8.3	2.8	1.79	29.82	0.18	3.06
EOG 08_20	2603.4	REP	24.31	8.35	2.79	1.79	29.82	0.18	3.1
EOG 08_20	2607.545	Rock	20.06	5.64	2.93	1.42	32.25	0.13	2.96
EOG 08_20	2607.545	REP							
EOG 08_20	2584.5	Rock	9.3	2.5	1.02	1.18	45.37	0.1	1.28
EOG 08_20	2584.5	REP							
EOG 08_20	2601.04	Rock	19.42	6.22	2.22	1.71	33.62	0.16	2.46
EOG 08_20	2601.04	REP							
EOG 08_20	2627.5	Rock	24.5	8.14	2.45	1.45	28.84	0.15	3.56
EOG 08_20	2627.5	REP							
EOG 08_20	2601.14	Rock	24.3	8.04	3.19	1.86	30.23	0.19	3.3
EOG 08_20	2601.14	REP	24.23	8.04	3.23	1.85	30.28	0.19	3.29

EOG 08_20	2584.5	Rock	9.3	2.5	1.02	1.18	45.37	0.1	1.28
EOG 08_20	2584.5	REP	9.13	2.46	0.98	1.18	45.91	0.09	1.02
EOG 08_20	2588.5	Rock	9.92	1.87	0.87	1.12	45.38	0.09	0.96
EOG 08_20	2588.5	REP							
EOG 08_20	2602.515	Rock	24.31	7.88	2.8	2.2	29.92	0.18	3.04
EOG 08_20	2602.515	REP							
Standard	2560	Rock Pulp	62.69	13.39	5.07	2.66	2.57	0.87	2.71
Standard	2560	REP							
	Preparation Duplicates								
	2600.5	Rock	21.8	7.13	2.66	1.71	32.15	0.17	2.71
	2600.5	DUP	21.77	7.18	2.63	1.7	32.13	0.17	2.75
	Reference Materials								
	STD SO-18	STD	58.33	13.94	7.71	3.37	6.3	3.65	2.13
	STD SO-18	STD	57.98	14.13	7.68	3.38	6.39	3.71	2.14
	STD SO-18	STD	58.45	13.92	7.64	3.33	6.31	3.62	2.15
	STD SO-18	STD	58.02	14.12	7.75	3.35	6.33	3.65	2.16
	STD SO-18	STD	57.92	14.13	7.71	3.42	6.41	3.67	2.13
	STD SO-18	STD	58.08	14.05	7.66	3.39	6.38	3.71	2.13
	STD DS10	STD							
	STD OREAS45EA	STD							
	STD DS10	STD							
	STD OREAS45EA	STD							
	STD DS10	STD							
	STD OREAS45EA	STD							
	STD DS10	STD							
	STD OREAS45EA	STD							
	STD SO-18	STD	57.74	14.07	7.68	3.38	6.46	3.65	2.36

	STD SO-18	STD	58.1	13.88	7.73	3.38	6.36	3.6	2.31
	STD SO-18	STD	58.12	14	7.56	3.37	6.34	3.66	2.31
	STD SO-18	STD	58.26	13.9	7.61	3.35	6.34	3.63	2.29
	STD GS311-1	STD							
	STD GS910-4	STD							
	STD GS311-1	STD							
	STD GS910-4	STD							
	STD GS311-1	STD							
	STD GS910-4	STD							
	STD GGC-02	STD							
	BLK	BLK	<0.01	<0.01	<0.04	<0.01	0.05	<0.01	<0.01
	BLK	BLK	<0.01	<0.01	<0.04	<0.01	0.02	<0.01	<0.01
	BLK	BLK	<0.01	<0.01	<0.04	<0.01	0.07	<0.01	<0.01
	BLK	BLK							
	BLK	BLK							
	BLK	BLK							
	BLK	BLK							
	BLK	BLK	<0.01	<0.01	<0.04	<0.01	<0.01	<0.01	<0.01
	BLK	BLK	<0.01	<0.01	<0.04	<0.01	0.03	<0.01	<0.01
	BLK	BLK							
	BLK	BLK							
	BLK	BLK							
	Prep Wash								
	G1	Prep Blank	68.06	15.4	3.42	1.07	3.39	3.56	3.5
	G1	Prep Blank	67	15.81	3.61	1.18	3.45	3.57	3.82

Table 31. Continued

		TiO2	P2O5	MnO	Cr2O3	Ni	Sc	LOI	Sum
		%	%	%	%	PPM	PPM	%	%
	MDL	0.01	0.01	0.01	0.002	20	1	-5.1	0.01
Well ID	Sample								
EOG 08_20	2564.5	0.55	0.06	0.09	0.012	34	13	18.6	99.8
EOG 08_20	2565.5	0.56	0.06	0.1	0.011	33	13	18.1	99.8
EOG 08_20	2566.5	0.56	0.08	0.09	0.012	37	14	17.5	99.81
EOG 08_20	2567.5	0.55	0.07	0.09	0.011	39	13	18.9	99.8
EOG 08_20	2568.535	0.56	0.04	0.09	0.013	39	13	17.8	99.81
EOG 08_20	2569.475	0.29	0.1	0.1	0.007	42	5	32.4	99.87
EOG 08_20	2570.44	0.22	0.35	0.06	0.003	59	5	31	98.99
EOG 08_20	2571.55	0.17	0.12	0.04	0.004	<20	4	38	99.86
EOG 08_20	2572.4	0.14	0.16	0.03	0.005	<20	3	38.7	99.82
EOG 08_20	2573.54	0.14	0.17	0.04	0.004	29	2	37.7	99.65
EOG 08_20	2574.515	0.11	0.15	0.04	<0.002	23	2	40.2	99.85
EOG 08_20	2575.445	0.09	0.13	0.04	<0.002	24	2	35.2	92.16
EOG 08_20	2576.545	0.09	0.1	0.05	0.003	33	2	39.1	99.09
EOG 08_20	2577.5	0.15	0.26	0.05	<0.002	53	3	37.9	99.69
EOG 08_20	2578.61	0.1	0.11	0.05	<0.002	34	2	40.5	99.84
EOG 08_20	2579.425	0.16	0.2	0.05	0.004	59	4	37.6	99.68
EOG 08_20	2582.535	0.14	0.27	0.06	0.003	39	3	39.2	99.86
EOG 08_20	2583.51	0.12	0.2	0.06	0.004	38	2	39	99.84
EOG 08_20	2584.5	0.12	0.16	0.06	0.004	41	3	38.8	99.88
EOG 08_20	2585.465	0.05	0.12	0.06	0.002	32	<1	41.3	99.88
EOG 08_20	2586.5	0.15	0.16	0.05	0.002	39	3	38.2	99.87
EOG 08_20	2587.5	0.15	0.3	0.04	0.004	118	4	36.1	99.56
EOG 08_20	2588.5	0.09	0.12	0.06	0.003	29	2	39.4	99.89
EOG 08_20	2589.6	0.1	0.12	0.05	0.002	<20	2	38.5	99.88
EOG 08_20	2590.51	0.13	0.17	0.05	0.004	35	3	38.7	99.88
EOG 08_20	2591.36	0.15	0.18	0.04	0.003	47	4	38.2	99.82
EOG 08_20	2591.455	0.12	0.14	0.04	0.002	32	3	39.4	99.88
EOG 08_20	2591.61	0.16	0.13	0.04	0.008	40	4	38.1	99.88
EOG 08_20	2591.87	0.11	0.14	0.05	0.003	36	2	38.5	99.87

EOG 08_20	2592.03	0.31	0.32	0.03	0.009	208	7	27.3	99.58
EOG 08_20	2592.525	0.27	0.27	0.04	0.007	134	6	30.7	99.79
EOG 08_20	2593.555	0.09	0.11	0.05	0.003	26	2	40.3	99.89
EOG 08_20	2594.5	0.04	0.09	0.04	<0.002	<20	<1	41.7	99.88
EOG 08_20	2595.4	0.09	0.19	0.05	<0.002	31	2	39.2	99.88
EOG 08_20	2596.52	0.15	0.1	0.04	0.007	21	4	37.4	99.88
EOG 08_20	2597.455	0.02	0.07	0.03	<0.002	<20	<1	40.5	98.97
EOG 08_20	2598.455	<0.01	0.05	0.05	<0.002	<20	<1	43.5	99.91
EOG 08_20	2599	0.06	0.1	0.09	0.003	<20	1	42.2	99.81
EOG 08_20	2599.25	0.21	0.16	0.05	0.003	33	5	35.7	99.86
EOG 08_20	2599.39	0.13	0.16	0.04	0.006	79	3	38.7	99.81
EOG 08_20	2599.5	0.35	0.13	0.04	0.008	101	8	26.5	92.4
EOG 08_20	2599.6	0.45	0.16	0.05	0.013	133	10	26.3	99.6
EOG 08_20	2599.765	0.16	0.1	0.05	0.005	<20	4	37.3	99.89
EOG 08_20	2599.86	0.08	0.07	0.08	0.002	<20	2	40.3	99.91
EOG 08_20	2599.96	0.14	0.1	0.06	0.004	23	3	38.2	99.9
EOG 08_20	2600.07	0.26	0.14	0.05	0.007	43	6	33.3	99.87
EOG 08_20	2600.15	0.36	0.26	0.04	0.009	64	9	27.5	99.85
EOG 08_20	2600.25	0.31	0.26	0.04	0.007	56	8	30.4	99.85
EOG 08_20	2600.4	0.14	0.17	0.05	0.004	22	3	38.3	99.89
EOG 08_20	2600.5	0.29	0.37	0.05	0.007	58	7	30.8	99.86
EOG 08_20	2600.62	0.32	0.33	0.04	0.007	54	8	29.4	99.86
EOG 08_20	2600.725	0.22	0.2	0.04	0.006	37	6	35.4	99.88
EOG 08_20	2600.9	0.16	0.13	0.05	0.004	25	4	37.6	99.9
EOG 08_20	2601.04	0.26	0.17	0.05	0.006	37	6	33.6	99.87
EOG 08_20	2601.14	0.35	0.39	0.04	0.011	76	8	27.9	99.79
EOG 08_20	2601.24	0.38	0.36	0.04	0.01	109	10	25.6	99.84
EOG 08_20	2601.51	0.27	0.22	0.05	0.007	45	7	33.2	99.86
EOG 08_20	2602.515	0.35	0.22	0.05	0.008	47	8	28.9	99.85
EOG 08_20	2602.75	0.25	0.19	0.04	0.007	35	6	34.6	99.87
EOG 08_20	2602.85	0.37	0.37	0.04	0.01	107	10	25.9	99.85
EOG 08_20	2603	0.24	0.16	0.05	0.006	41	6	34.9	99.89
EOG 08_20	2603.2	0.19	0.11	0.04	0.005	21	4	36.9	99.9
EOG 08_20	2603.3	0.13	0.11	0.04	0.004	<20	3	39	99.91
EOG 08_20	2603.4	0.32	0.22	0.04	0.009	47	8	28.9	99.85
EOG 08_20	2603.5	0.42	0.3	0.04	0.01	91	11	23.1	99.87
EOG 08_20	2603.62	0.07	0.13	0.04	<0.002	<20	2	40.9	99.91

EOG 08_20	2604.405	0.21	0.06	0.04	0.005	22	5	36.3	99.89
EOG 08_20	2605.565	0.15	0.13	0.05	0.004	26	4	37.9	99.9
EOG 08_20	2606.5	0.25	0.08	0.05	0.005	25	6	33.1	99.86
EOG 08_20	2607.545	0.24	0.34	0.04	0.008	86	6	33.8	99.87
EOG 08_20	2608.5	0.19	0.15	0.03	0.005	80	5	36.7	99.87
EOG 08_20	2609.865	0.2	0.23	0.04	0.005	39	5	36.8	99.9
EOG 08_20	2610.51	0.21	0.19	0.04	0.003	59	5	35.9	99.88
EOG 08_20	2611.54	0.42	0.33	0.03	0.014	165	10	26.3	99.84
EOG 08_20	2612.5	0.38	0.25	0.04	0.009	92	9	28.2	99.85
EOG 08_20	2613.455	0.11	0.04	0.08	<0.002	<20	3	39.2	99.93
EOG 08_20	2614.28	0.4	0.13	0.05	0.01	46	10	23.9	99.87
EOG 08_20	2615.585	0.41	0.1	0.04	0.012	74	8	28.7	99.35
EOG 08_20	2616.415	0.13	0.05	0.04	0.003	28	4	39.3	99.92
EOG 08_20	2617.38	0.11	0.04	0.05	<0.002	<20	2	40	99.93
EOG 08_20	2618.5	0.12	0.06	0.05	0.002	20	3	39.7	99.92
EOG 08_20	2619.06	0.45	0.2	0.03	0.01	124	10	24.5	99.85
EOG 08_20	2620.475	0.09	0.09	0.03	0.003	<20	3	39.6	99.93
EOG 08_20	2621.5	0.06	0.11	0.02	0.003	38	1	41.9	99.92
EOG 08_20	2622.37	0.29	0.25	0.03	0.007	97	6	33.3	99.84
EOG 08_20	2623.62	0.39	0.13	0.04	0.009	100	8	29.7	95.75
EOG 08_20	2624.5	0.23	0.15	0.05	0.01	73	5	36.3	95.55
EOG 08_20	2625.525	0.09	0.08	0.04	<0.002	24	3	39.1	99.9
EOG 08_20	2626.5	0.12	0.13	0.03	0.003	20	3	38.7	99.91
EOG 08_20	2627.5	0.39	0.22	0.02	0.01	99	8	30.1	99.86
EOG 08_20	2593.12	0.1	0.18	0.03	0.004	71	3	35.5	95.83
EOG 08_20	2560	0.57	0.21	0.05	0.012	<20	11	9	99.79
EOG 08_20	Pulp Duplicates								
EOG 08_20	2621.5	0.06	0.11	0.02	0.003	38	1	41.9	99.92
EOG 08_20	2621.5	0.05	0.11	0.02	0.003	25	1	41.9	96.07
EOG 08_20	2603.4	0.32	0.22	0.04	0.009	47	8	28.9	99.85
EOG 08_20	2603.4	0.32	0.2	0.04	0.007	50	8	28.9	99.86
EOG 08_20	2607.545	0.24	0.34	0.04	0.008	86	6	33.8	99.87
EOG 08_20	2607.545								
EOG 08_20	2584.5	0.12	0.16	0.06	0.004	41	3	38.8	99.88
EOG 08_20	2584.5								
EOG 08_20	2601.04	0.26	0.17	0.05	0.006	37	6	33.6	99.87
EOG 08_20	2601.04								
EOG 08_20	2627.5	0.39	0.22	0.02	0.01	99	8	30.1	99.86

EOG 08_20	2627.5								
EOG 08_20	2601.14	0.35	0.39	0.04	0.011	76	8	27.9	99.79
EOG 08_20	2601.14	0.34	0.41	0.04	0.01	71	8	27.9	99.82
EOG 08_20	2584.5	0.12	0.16	0.06	0.004	41	3	38.8	99.88
EOG 08_20	2584.5	0.12	0.15	0.06	0.003	34	3	38.8	99.87
EOG 08_20	2588.5	0.09	0.12	0.06	0.003	29	2	39.4	99.89
EOG 08_20	2588.5								
EOG 08_20	2602.515	0.35	0.22	0.05	0.008	47	8	28.9	99.85
EOG 08_20	2602.515								
Standard	2560	0.57	0.21	0.05	0.012	<20	11	9	99.79
Standard	2560								
	Preparation Duplicates								
	2600.5	0.29	0.37	0.05	0.007	58	7	30.8	99.86
	2600.5	0.29	0.36	0.05	0.008	54	7	30.8	99.84
	Reference Materials								
	STD SO-18	0.69	0.79	0.4	0.552	39	24	1.9	99.75
	STD SO-18	0.69	0.8	0.4	0.555	45	24	1.9	99.75
	STD SO-18	0.68	0.8	0.4	0.546	37	24	1.9	99.75
	STD SO-18	0.69	0.82	0.4	0.549	38	24	1.9	99.74
	STD SO-18	0.69	0.8	0.4	0.549	45	24	1.9	99.75
	STD SO-18	0.68	0.8	0.4	0.557	46	24	1.9	99.74
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD SO-18	0.7	0.82	0.41	0.561	46	24	1.9	99.73
	STD SO-18	0.69	0.82	0.4	0.557	45	24	1.9	99.73

	STD SO-18	0.69	0.81	0.4	0.552	51	24	1.9	99.72
	STD SO-18	0.68	0.79	0.39	0.553	55	24	1.9	99.73
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GGC-02								
	BLK	<0.01	<0.01	<0.01	<0.002	<20	<1	0	0.1
	BLK	<0.01	<0.01	<0.01	<0.002	<20	<1	0	0.04
	BLK	<0.01	<0.01	<0.01	<0.002	<20	<1	0	0.06
	BLK								
	BLK								
	BLK								
	BLK								
	BLK	<0.01	<0.01	<0.01	<0.002	<20	<1	0	0.05
	BLK	<0.01	<0.01	<0.01	<0.002	<20	<1	0	0.03
	BLK								
	BLK								
	BLK								
	Prep Wash								
	G1	0.38	0.14	0.09	<0.002	<20	5	0.8	99.77
	G1	0.39	0.18	0.1	<0.002	<20	6	0.6	99.73

Table 31. Continued

		Ba	Be	Co	Cs	Ga	Hf	Nb	Rb
		PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	1	1	0.2	0.1	0.5	0.1	0.1	0.1
Well ID	Sample								
EOG 08_20	2564.5	342	4	15.9	7.5	16.3	2.6	9.3	135.1
EOG 08_20	2565.5	343	2	18.5	7.9	17.5	2.6	10	146.1
EOG 08_20	2566.5	343	1	15.3	8.3	16	2.6	10.2	151.3
EOG 08_20	2567.5	323	3	15.3	7.2	15.7	2.5	9.3	143
EOG 08_20	2568.535	319	2	15.1	7.6	15.2	2.4	9	136.8
EOG 08_20	2569.475	146	3	9.8	3.5	12	1.1	6.8	62
EOG 08_20	2570.44	877	<1	6.9	2.8	9.9	2	6.3	42.8
EOG 08_20	2571.55	102	2	3.7	1.5	2.9	1	2.9	33.2
EOG 08_20	2572.4	153	5	3	1.6	7.4	0.9	5.1	30.1
EOG 08_20	2573.54	438	<1	3.3	1.3	7.3	1.2	4.6	27
EOG 08_20	2574.515	71	<1	3.2	1	6.9	0.6	3.2	22.8
EOG 08_20	2575.445	396	3	2.4	0.7	4.7	0.4	2.9	20.2
EOG 08_20	2576.545	1525	<1	4.3	1	5.8	0.5	3.2	19.5
EOG 08_20	2577.5	310	5	5.6	1.9	6.9	0.7	4.7	33.3
EOG 08_20	2578.61	96	<1	2.5	1.2	5.2	0.5	3.3	22.6
EOG 08_20	2579.425	281	<1	6.5	2	6.6	0.6	4.6	37.1
EOG 08_20	2582.535	93	<1	3.7	1.5	2.1	0.8	2.7	29.5
EOG 08_20	2583.51	124	5	4.3	1.7	5.7	0.6	3.9	26.1
EOG 08_20	2584.5	73	<1	3.9	1.1	6.1	0.6	3.2	26.7
EOG 08_20	2585.465	50	<1	2.4	0.6	4	0.3	2	12.7
EOG 08_20	2586.5	128	3	4.9	1.6	6.1	0.6	3.4	28.6
EOG 08_20	2587.5	531	3	7.8	1.7	8.2	0.7	3.9	38
EOG 08_20	2588.5	80	<1	3.3	0.9	0.8	0.5	2.3	19.1
EOG 08_20	2589.6	68	<1	2.8	1	4.5	0.5	2.3	20.4
EOG 08_20	2590.51	75	1	3.9	1.3	1.5	0.7	2.7	28.4
EOG 08_20	2591.36	119	3	5.3	2	6.6	0.7	4	38.7
EOG 08_20	2591.455	67	<1	3.1	1.3	1.2	0.7	2.1	26.4
EOG 08_20	2591.61	95	<1	4.8	1.5	2.7	0.9	3.9	37.9
EOG 08_20	2591.87	69	5	3.3	1.4	5.3	0.5	2.8	27.7
EOG 08_20	2592.03	470	3	16.5	4.1	13.4	1.2	7.5	80.1
EOG 08_20	2592.525	165	<1	13.2	3.9	10.2	1.3	6.5	68.9
EOG 08_20	2593.555	60	<1	3.4	0.9	1	0.5	1.8	20.8
EOG 08_20	2594.5	40	5	1.4	0.4	3.5	0.2	1.1	9.5
EOG 08_20	2595.4	61	<1	3.6	1	4.6	0.5	2.5	21.8
EOG 08_20	2596.52	90	<1	4.4	1.5	2.9	0.7	2.9	33.5
EOG 08_20	2597.455	4537	<1	0.9	0.3	<0.5	0.2	0.4	3.9

EOG 08_20	2598.455	27	<1	0.5	<0.1	<0.5	0.1	0.3	1.6
EOG 08_20	2599	697	<1	3.7	0.5	<0.5	0.3	1.2	11.7
EOG 08_20	2599.25	128	1	6.8	2.1	4	1	4.2	45.2
EOG 08_20	2599.39	90	1	14.3	1.4	4.2	0.7	3	32.5
EOG 08_20	2599.5	423	2	21	3.9	10.6	1.7	6.6	80.4
EOG 08_20	2599.6	1970	1	28.2	5.2	13.8	2.4	8.7	99.5
EOG 08_20	2599.765	120	2	7.4	2	2.9	0.7	2.7	40.4
EOG 08_20	2599.86	67	<1	5.3	1.1	1.3	0.4	1.3	20.6
EOG 08_20	2599.96	106	1	10.5	1.8	2.5	0.7	2.7	37
EOG 08_20	2600.07	154	<1	13.5	3.4	6.3	1.2	4.8	69.3
EOG 08_20	2600.15	229	<1	16.5	4.4	9.1	1.6	6.3	88.6
EOG 08_20	2600.25	194	<1	14.4	3.9	8	1.4	5.4	77.2
EOG 08_20	2600.4	112	<1	5.5	1.8	2.9	0.7	2.3	36
EOG 08_20	2600.5	172	<1	15.8	4	7.4	1.3	5.3	73
EOG 08_20	2600.62	203	1	12.7	4.1	7.3	1.4	5.8	80.2
EOG 08_20	2600.725	146	<1	8.1	2.9	4.3	1.1	4	56.2
EOG 08_20	2600.9	90	<1	6.9	1.8	2.2	0.8	2.7	36.6
EOG 08_20	2601.04	138	<1	9.9	3.4	5.5	1.2	4.7	64.4
EOG 08_20	2601.14	195	3	19.2	5.1	9.8	1.6	7.7	90.9
EOG 08_20	2601.24	216	<1	21.5	6.1	10.7	1.7	7.1	104
EOG 08_20	2601.51	153	2	11.6	3.6	5.9	1.2	5.4	66.9
EOG 08_20	2602.515	187	<1	11.9	4	7.4	1.6	5.9	76.6
EOG 08_20	2602.75	131	3	8	3.4	5.5	1.1	4.6	58.3
EOG 08_20	2602.85	231	<1	20.2	6.1	10.8	1.7	7.8	102.7
EOG 08_20	2603	128	<1	9.3	3.3	4.2	1.1	4.5	56.7
EOG 08_20	2603.2	102	<1	6.9	2.4	3	0.8	3.3	45.5
EOG 08_20	2603.3	88	<1	5.7	1.8	1.9	0.6	2.1	31.5
EOG 08_20	2603.4	186	3	16.5	4.8	8.2	1.5	6.2	86.2
EOG 08_20	2603.5	235	3	19.5	6.5	11.2	1.6	8	113.5
EOG 08_20	2603.62	61	<1	3.2	1	<0.5	0.3	0.7	18.5
EOG 08_20	2604.405	205	2	5.8	2.9	4.4	0.9	3.3	54.2
EOG 08_20	2605.565	124	<1	6.9	1.9	2.3	0.7	3.1	35.7
EOG 08_20	2606.5	268	1	11.2	3.3	5.9	1	4	67.1
EOG 08_20	2607.545	145	3	13.9	3.5	9.4	1	6.7	59.6
EOG 08_20	2608.5	123	<1	9.5	2.3	6.5	1.1	5.4	50.1
EOG 08_20	2609.865	121	2	4.5	2.3	5.2	1	4.6	43.3
EOG 08_20	2610.51	116	2	6.3	2.4	5.7	1.1	4.7	50.9
EOG 08_20	2611.54	240	2	19.6	5.7	14.9	2.1	10	104.8
EOG 08_20	2612.5	223	3	13.7	5.2	11.8	1.9	8.1	99.9
EOG 08_20	2613.455	99	<1	6.3	1.3	2.7	0.5	1.9	28.6
EOG 08_20	2614.28	259	2	17.9	5.9	13	1.7	7	116.2

EOG 08_20	2615.585	4139	5	15.1	3.4	12.3	2.9	7.3	75.6
EOG 08_20	2616.415	116	<1	3.7	1.1	2.7	0.7	2.5	28.7
EOG 08_20	2617.38	78	<1	5.9	0.8	1.4	0.6	1.6	19.3
EOG 08_20	2618.5	68	<1	6.8	1.1	2	0.7	1.9	26.7
EOG 08_20	2619.06	231	4	23.6	7.6	14.2	2.1	6.9	122.5
EOG 08_20	2620.475	64	<1	4.7	1.4	1.6	0.4	1	25.1
EOG 08_20	2621.5	56	<1	2.3	0.8	4.2	0.2	1.1	13.1
EOG 08_20	2622.37	157	5	16.1	3.7	11.3	1.4	5.5	63.2
EOG 08_20	2623.62	223	8	28.9	5.1	15.9	2.3	9.5	93.7
EOG 08_20	2624.5	122	<1	14.8	2.5	9.8	1.2	5.1	52.9
EOG 08_20	2625.525	74	<1	3	1.4	4.6	0.5	1.9	26.2
EOG 08_20	2626.5	71	2	2.3	1.4	2.1	0.6	1.7	28.6
EOG 08_20	2627.5	185	2	9.4	3.9	10.3	2	5.8	76.5
EOG 08_20	2593.12	488	<1	6.7	1.4	6.5	0.7	2.3	29.7
EOG 08_20	2560	577	2	10.7	7.7	14.9	4.8	10.7	110.7
EOG 08_20	Pulp Duplicates								
EOG 08_20	2621.5	56	<1	2.3	0.8	4.2	0.2	1.1	13.1
EOG 08_20	2621.5	47	<1	2.4	0.5	<0.5	0.2	0.7	12.1
EOG 08_20	2603.4	186	3	16.5	4.8	8.2	1.5	6.2	86.2
EOG 08_20	2603.4	184	1	17.2	4.8	8.2	1.4	6.1	86.9
EOG 08_20	2607.545	145	3	13.9	3.5	9.4	1	6.7	59.6
EOG 08_20	2607.545								
EOG 08_20	2584.5	73	<1	3.9	1.1	6.1	0.6	3.2	26.7
EOG 08_20	2584.5								
EOG 08_20	2601.04	138	<1	9.9	3.4	5.5	1.2	4.7	64.4
EOG 08_20	2601.04								
EOG 08_20	2627.5	185	2	9.4	3.9	10.3	2	5.8	76.5
EOG 08_20	2627.5								
EOG 08_20	2601.14	195	3	19.2	5.1	9.8	1.6	7.7	90.9
EOG 08_20	2601.14	186	<1	19.7	5.1	9.2	1.9	7.3	90.8
EOG 08_20	2584.5	73	<1	3.9	1.1	6.1	0.6	3.2	26.7
EOG 08_20	2584.5	77	<1	3.3	1.3	6	0.6	3.4	25.8
EOG 08_20	2588.5	80	<1	3.3	0.9	0.8	0.5	2.3	19.1
EOG 08_20	2588.5								
EOG 08_20	2602.515	187	<1	11.9	4	7.4	1.6	5.9	76.6
EOG 08_20	2602.515								
Standard	2560	577	2	10.7	7.7	14.9	4.8	10.7	110.7
Standard	2560								
	Preparation Duplicates								

	2600.5	172	<1	15.8	4	7.4	1.3	5.3	73
	2600.5	186	1	16.1	4	7.4	1.3	5.5	75.7
	Reference Materials								
	STD SO-18	509	1	27.5	7	17.2	9.6	20.6	27.5
	STD SO-18	520	<1	24.5	7	15	10.1	21	26.5
	STD SO-18	488	<1	27.1	6.7	17.6	9.1	18.7	28.5
	STD SO-18	513	2	25.8	6.9	17.1	9.5	19.8	28.1
	STD SO-18	516	2	26.6	7.3	15.7	9.9	19.9	27.1
	STD SO-18	506	1	27.3	7.5	16.9	9.8	20.4	28.6
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD SO-18	519	<1	30.4	7.4	17.1	9.4	20.7	29.4
	STD SO-18	518	<1	29.9	7.3	17.2	9.2	20.8	29.4
	STD SO-18	485	7	26.9	7.8	15.9	9.6	18.4	30.8
	STD SO-18	475	5	27.8	7.2	18.8	8.9	19.5	29.3
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GGC-02								
	BLK	<1	<1	0.3	<0.1	<0.5	<0.1	<0.1	<0.1
	BLK	<1	<1	<0.2	<0.1	<0.5	<0.1	<0.1	<0.1

	BLK	<1	<1	<0.2	<0.1	<0.5	<0.1	<0.1	0.2
	BLK								
	BLK								
	BLK								
	BLK								
	BLK	<1	<1	<0.2	<0.1	<0.5	<0.1	<0.1	0.1
	BLK	<1	<1	0.3	<0.1	0.7	<0.1	<0.1	0.4
	BLK								
	BLK								
	BLK								
	Prep Wash								
	G1	912	3	4.7	4.2	18.6	4.1	25.2	114
	G1	1159	4	5.2	3.9	20.6	4	27.8	127.7

Table 31. Continued

		Sn	Sr	Ta	Th	U	V	W	Zr
		PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	1	0.5	0.1	0.2	0.1	8	0.5	0.1
Well ID	Sample								
EOG 08_20	2564.5	2	251.8	0.8	8.3	2.1	96	1.4	86.4
EOG 08_20	2565.5	2	244.5	0.7	8.1	2	101	1.2	92.9
EOG 08_20	2566.5	2	217.7	0.8	8.5	2.1	106	1.1	91.2
EOG 08_20	2567.5	2	211.7	0.8	8.2	1.8	101	1.4	87.5
EOG 08_20	2568.535	2	202.6	0.7	8.4	2.2	102	1.2	83.5
EOG 08_20	2569.475	2	409.7	0.3	4.6	2.4	60	0.7	60.2
EOG 08_20	2570.44	2	5808.7	0.3	4	5.7	43	1.1	62.3
EOG 08_20	2571.55	<1	709.1	0.2	2.4	4	30	<0.5	39.8
EOG 08_20	2572.4	2	951.9	0.2	2.6	5.5	42	<0.5	30.2
EOG 08_20	2573.54	2	1961	0.3	2.8	4.7	40	<0.5	44.1
EOG 08_20	2574.515	2	711.5	0.2	1.9	2.5	23	0.7	22.2
EOG 08_20	2575.445	2	2022.7	0.2	1.3	2.2	49	<0.5	19.1
EOG 08_20	2576.545	1	5936.3	0.2	1.5	2.6	40	<0.5	17.2
EOG 08_20	2577.5	2	1608.4	0.2	2.2	5.2	53	0.6	25.9
EOG 08_20	2578.61	1	809.6	0.2	1.6	3.8	31	1	19.3
EOG 08_20	2579.425	1	1787.5	0.3	2.4	5	42	0.7	30.6
EOG 08_20	2582.535	<1	568.3	0.2	2.1	4.4	39	<0.5	29.4
EOG 08_20	2583.51	2	787	0.1	2	3.2	29	<0.5	23.3
EOG 08_20	2584.5	2	599.5	0.3	1.8	2.6	35	<0.5	23.3
EOG 08_20	2585.465	1	609.7	<0.1	1	1.9	11	<0.5	11.3
EOG 08_20	2586.5	2	612.9	0.3	2.3	3.2	46	0.6	27

EOG 08_20	2587.5	1	2623.5	0.2	2.8	7.1	108	0.9	29
EOG 08_20	2588.5	<1	500.5	<0.1	1.4	2.5	28	<0.5	18.4
EOG 08_20	2589.6	2	547.9	0.3	1.6	3.1	31	<0.5	19.7
EOG 08_20	2590.51	<1	573.1	0.1	1.9	4	34	<0.5	26.3
EOG 08_20	2591.36	2	767.4	0.2	2.6	7.1	61	<0.5	29.2
EOG 08_20	2591.455	<1	536	0.2	2	5	37	<0.5	24.1
EOG 08_20	2591.61	<1	561.7	0.3	2.3	5.5	45	<0.5	31
EOG 08_20	2591.87	2	543.3	0.2	1.8	4.6	42	<0.5	20.8
EOG 08_20	2592.03	3	2091.1	0.7	5.3	14.3	255	1.1	58
EOG 08_20	2592.525	2	537.5	0.3	4.4	10	143	0.7	47
EOG 08_20	2593.555	<1	538.3	0.2	1.3	3.5	35	<0.5	18.6
EOG 08_20	2594.5	<1	600.6	<0.1	0.6	1.8	41	<0.5	7
EOG 08_20	2595.4	2	588.8	0.2	1.6	3.1	23	<0.5	17.5
EOG 08_20	2596.52	<1	479	<0.1	2.5	6	34	<0.5	29.7
EOG 08_20	2597.455	<1	3833.8	0.1	0.3	1	14	<0.5	5.6
EOG 08_20	2598.455	<1	427	<0.1	0.2	0.9	<8	<0.5	4.5
EOG 08_20	2599	<1	534.8	<0.1	0.9	0.8	12	<0.5	12.2
EOG 08_20	2599.25	<1	456.2	0.3	3.3	3.4	42	0.5	38.5
EOG 08_20	2599.39	<1	506.9	0.2	2.2	4.7	72	0.8	28.5
EOG 08_20	2599.5	1	301	0.4	5.4	8	96	0.7	67.1
EOG 08_20	2599.6	2	410.8	0.6	6	10.4	129	1.1	84
EOG 08_20	2599.765	<1	389.2	0.3	2.6	2.6	38	<0.5	27.1
EOG 08_20	2599.86	<1	345.9	0.1	1.3	1.5	21	<0.5	15.3
EOG 08_20	2599.96	<1	398.1	0.2	2.1	2.3	31	<0.5	25.8
EOG 08_20	2600.07	<1	418.7	0.4	4.1	3.8	56	0.6	45.2
EOG 08_20	2600.15	1	379.2	0.4	5.4	5.6	66	0.8	60.7
EOG 08_20	2600.25	1	396.1	0.3	5	5.8	59	<0.5	51.8
EOG 08_20	2600.4	<1	349.7	0.1	2.1	2.8	32	<0.5	23.5
EOG 08_20	2600.5	1	416.3	0.3	4.5	4.8	72	0.7	47.5
EOG 08_20	2600.62	2	385	0.3	4.9	4.4	65	0.5	52
EOG 08_20	2600.725	<1	374.3	0.3	3.2	3.3	41	0.5	38.1
EOG 08_20	2600.9	<1	373	0.2	2.3	2.6	30	<0.5	27.5
EOG 08_20	2601.04	<1	424.2	0.3	3.9	3.8	46	0.6	45
EOG 08_20	2601.14	1	489.7	0.5	5.5	7.2	81	<0.5	61.7
EOG 08_20	2601.24	1	322.7	0.4	6.1	6.8	101	0.8	58
EOG 08_20	2601.51	<1	402.8	0.3	4.2	5.4	54	0.6	43.8
EOG 08_20	2602.515	1	343.1	0.3	5.1	4.3	60	0.6	57.2
EOG 08_20	2602.75	<1	341.2	0.2	3.6	3.5	50	<0.5	39.4
EOG 08_20	2602.85	2	311.8	0.5	5.8	4.9	86	0.8	60.5
EOG 08_20	2603	<1	330.8	0.3	3.4	2.6	43	0.6	38.1
EOG 08_20	2603.2	<1	354.3	0.3	2.9	2.5	30	<0.5	32.1

EOG 08_20	2603.3	<1	326.6	0.2	1.7	1.8	24	<0.5	21.6
EOG 08_20	2603.4	1	366.8	0.3	4.8	3.9	66	0.6	52.3
EOG 08_20	2603.5	1	267.7	0.5	6.1	4.9	89	0.9	63.9
EOG 08_20	2603.62	<1	396.3	<0.1	1	1.6	13	<0.5	11.2
EOG 08_20	2604.405	<1	426.1	0.2	3.4	2.2	36	<0.5	32.3
EOG 08_20	2605.565	<1	353.8	0.1	2.1	1.5	26	<0.5	26.6
EOG 08_20	2606.5	1	278	0.3	3.8	1.6	47	1.4	41
EOG 08_20	2607.545	2	410	0.4	4.1	7.9	87	1.1	40.9
EOG 08_20	2608.5	<1	399.4	0.3	3.2	6.1	83	<0.5	37
EOG 08_20	2609.865	<1	342.7	0.3	3.1	4	55	<0.5	35.3
EOG 08_20	2610.51	<1	390.6	0.3	3	4.2	49	0.5	37.7
EOG 08_20	2611.54	2	297.4	0.8	6.5	9.7	157	0.9	71.8
EOG 08_20	2612.5	2	335	0.5	6.5	3.7	70	1	64.3
EOG 08_20	2613.455	<1	269.8	<0.1	1.8	1.1	22	<0.5	17.9
EOG 08_20	2614.28	2	239.9	0.4	6.4	2.2	83	1	66.1
EOG 08_20	2615.585	2	592.4	0.5	5.5	9.2	66	0.6	109.2
EOG 08_20	2616.415	<1	285.5	0.1	1.9	1.8	19	<0.5	25.9
EOG 08_20	2617.38	<1	309.7	0.1	1.6	1.4	20	<0.5	20.3
EOG 08_20	2618.5	<1	340.7	0.1	1.8	1.1	21	<0.5	26.7
EOG 08_20	2619.06	1	237.8	0.5	7.3	3.7	93	0.8	75.6
EOG 08_20	2620.475	<1	279.4	<0.1	1.3	1	19	<0.5	15.8
EOG 08_20	2621.5	1	388.4	0.2	0.8	1.1	18	0.8	10.2
EOG 08_20	2622.37	2	370.7	0.4	3.9	6.5	81	<0.5	53.2
EOG 08_20	2623.62	2	186.7	0.6	6.3	14.6	114	1	71.3
EOG 08_20	2624.5	2	329.3	0.3	3.4	13.9	70	0.8	45.7
EOG 08_20	2625.525	1	290.3	0.2	1.7	1.5	27	<0.5	16.8
EOG 08_20	2626.5	<1	352.3	0.1	1.9	1	25	<0.5	23
EOG 08_20	2627.5	1	323.9	0.3	6.2	3	74	0.8	67.6
EOG 08_20	2593.12	1	3544.7	0.1	1.5	4.8	49	0.5	19
EOG 08_20	2560	3	180.1	0.8	9.2	2.8	130	1.5	169.4
EOG 08_20	Pulp Duplicates								
EOG 08_20	2621.5	1	388.4	0.2	0.8	1.1	18	0.8	10.2
EOG 08_20	2621.5	<1	345.4	<0.1	0.7	0.9	15	<0.5	9.7
EOG 08_20	2603.4	1	366.8	0.3	4.8	3.9	66	0.6	52.3
EOG 08_20	2603.4	1	363.4	0.3	4.8	3.8	69	<0.5	51.4
EOG 08_20	2607.545	2	410	0.4	4.1	7.9	87	1.1	40.9
EOG 08_20	2607.545								
EOG 08_20	2584.5	2	599.5	0.3	1.8	2.6	35	<0.5	23.3
EOG 08_20	2584.5								
EOG 08_20	2601.04	<1	424.2	0.3	3.9	3.8	46	0.6	45

EOG 08_20	2601.04								
EOG 08_20	2627.5	1	323.9	0.3	6.2	3	74	0.8	67.6
EOG 08_20	2627.5								
EOG 08_20	2601.14	1	489.7	0.5	5.5	7.2	81	<0.5	61.7
EOG 08_20	2601.14	2	471.1	0.4	5.5	6.6	79	0.6	61.7
EOG 08_20	2584.5	2	599.5	0.3	1.8	2.6	35	<0.5	23.3
EOG 08_20	2584.5	2	581.4	0.2	1.7	2.7	47	<0.5	22.6
EOG 08_20	2588.5	<1	500.5	<0.1	1.4	2.5	28	<0.5	18.4
EOG 08_20	2588.5								
EOG 08_20	2602.515	1	343.1	0.3	5.1	4.3	60	0.6	57.2
EOG 08_20	2602.515								
Standard	2560	3	180.1	0.8	9.2	2.8	130	1.5	169.4
Standard	2560								
	Preparation Duplicates								
	2600.5	1	416.3	0.3	4.5	4.8	72	0.7	47.5
	2600.5	<1	425.8	0.3	4.8	5	62	0.7	47.7
	Reference Materials								
	STD SO-18	14	367.9	6.6	9.5	16.1	189	15.5	283
	STD SO-18	15	375.9	7	9.9	16.6	185	15	301.6
	STD SO-18	14	406.3	6.7	9.6	15.1	187	13.9	293.9
	STD SO-18	15	418.9	6.7	10	15.2	185	14.6	302
	STD SO-18	15	394.4	7.4	9.8	15.6	188	14.4	297.3
	STD SO-18	15	411.5	7.3	9.7	15.1	189	15	306.3
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD SO-18	15	451.3	6.1	9.7	16.6	194	14.6	316.4
	STD SO-18	15	436.7	6.6	9.9	16.6	197	14	300.5
	STD SO-18	16	405.4	6.5	9.5	16.6	191	14.8	297.1
	STD SO-18	15	398.4	6.1	9.5	16.8	217	14	297

	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GGC-02								
	BLK	<1	1.3	<0.1	<0.2	<0.1	<8	<0.5	<0.1
	BLK	<1	<0.5	<0.1	<0.2	<0.1	<8	<0.5	0.7
	BLK	<1	0.6	<0.1	<0.2	<0.1	<8	<0.5	<0.1
	BLK								
	BLK								
	BLK								
	BLK								
	BLK	<1	<0.5	<0.1	<0.2	<0.1	<8	<0.5	<0.1
	BLK	<1	0.6	<0.1	<0.2	<0.1	<8	<0.5	<0.1
	BLK								
	BLK								
	BLK								
	Prep Wash								
	G1	2	683.9	1.6	8.5	3.7	45	<0.5	134.2
	G1	2	716.6	1.7	7	3	54	<0.5	141.8

Table 31. Continued

		Y	La	Ce	Pr	Nd	Sm	Eu	Gd
		PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.1	0.1	0.1	0.02	0.3	0.05	0.02	0.05
Well ID	Sample								
EOG 08_20	2564.5	19.3	26.8	51	6.32	23.8	4.49	0.9	3.68
EOG 08_20	2565.5	20.6	27.3	52	6.35	24.8	4.44	0.97	4.35
EOG 08_20	2566.5	19.1	27.7	51.4	6.4	23	4.33	0.87	4.16

EOG 08_20	2567.5	19.5	26.5	50.5	5.88	22.3	4.23	0.9	4.28
EOG 08_20	2568.535	17.9	26.2	48.7	6	23.1	4.25	0.86	3.49
EOG 08_20	2569.475	20.2	22.9	38	4.54	16.2	2.87	0.64	2.71
EOG 08_20	2570.44	30.8	29.5	43.4	5.5	21.2	3.81	0.83	4.03
EOG 08_20	2571.55	23	18.7	26.8	3.55	14.8	2.81	0.64	3.18
EOG 08_20	2572.4	22.5	20.9	29	3.53	13.5	2.68	0.57	2.63
EOG 08_20	2573.54	20.3	20.2	26.6	3.29	12.6	2.39	0.57	2.76
EOG 08_20	2574.515	21.7	18.1	19.4	2.74	10	2.05	0.5	2.13
EOG 08_20	2575.445	18.6	17	17.7	2.32	9.2	1.72	0.44	2.33
EOG 08_20	2576.545	17.6	16.6	19.1	2.55	9.6	2.12	0.47	2.21
EOG 08_20	2577.5	28.4	25.2	30.7	4.03	16.5	2.75	0.65	3.2
EOG 08_20	2578.61	19.1	19.1	20.3	2.64	10	1.78	0.45	2.22
EOG 08_20	2579.425	27.3	24.8	31.6	3.84	15.2	2.79	0.54	3.32
EOG 08_20	2582.535	32	26.2	27.6	4.03	16.7	2.92	0.7	3.56
EOG 08_20	2583.51	22.2	22.8	27.6	3.48	14.3	2.52	0.57	2.42
EOG 08_20	2584.5	24.6	23.2	25.8	3.38	12.4	2.31	0.49	2.81
EOG 08_20	2585.465	19.2	17.5	17.8	2.31	9.2	1.37	0.41	2.13
EOG 08_20	2586.5	22.1	18.9	23.7	3.09	12.5	2.11	0.54	2.6
EOG 08_20	2587.5	37.5	31.9	32	4.39	18.6	3.2	0.78	4.16
EOG 08_20	2588.5	21.2	20.3	20	2.8	10.6	1.85	0.44	2.29
EOG 08_20	2589.6	23.9	21.8	25.2	3.2	12	2.46	0.54	2.52

EOG 08_20	2590.51	27.1	22.5	24.8	3.56	13.5	2.4	0.61	3.07
EOG 08_20	2591.36	33	28.2	33	4.05	15.8	2.62	0.64	3.67
EOG 08_20	2591.455	25.4	22.2	25.6	3.42	14	2.41	0.56	2.76
EOG 08_20	2591.61	26.7	23.2	27.4	3.65	14.3	2.52	0.6	3.03
EOG 08_20	2591.87	25.7	26.5	30.6	3.83	14.9	2.3	0.61	2.81
EOG 08_20	2592.03	36.6	32	43.1	5.67	23.3	4.17	0.87	4.9
EOG 08_20	2592.525	28.5	30.1	40.2	5.17	20.3	3.67	0.77	3.45
EOG 08_20	2593.555	20.9	19.9	21.4	2.95	11.5	2.04	0.46	2.2
EOG 08_20	2594.5	18	16.3	16.6	2.2	8.9	1.58	0.31	1.74
EOG 08_20	2595.4	23.2	22.5	25	3.05	11.6	2.01	0.51	2.54
EOG 08_20	2596.52	24.4	25.2	37.7	4.73	18.7	3.35	0.82	3.6
EOG 08_20	2597.455	6.9	6.6	7.8	0.88	3.7	0.63	0.18	0.81
EOG 08_20	2598.455	8	7.6	7.6	0.91	3.5	0.64	0.17	0.78
EOG 08_20	2599	10.8	9.9	11.4	1.51	6	1.08	0.28	1.2
EOG 08_20	2599.25	20.7	20.3	30.9	4.05	16	2.98	0.68	2.96
EOG 08_20	2599.39	22.6	28	40.8	4.23	16.3	2.82	0.68	2.82
EOG 08_20	2599.5	17.4	21.7	37.1	4.63	17.8	3.29	0.68	2.8
EOG 08_20	2599.6	17.6	24.6	42.3	4.67	17.6	3.08	0.67	3.04
EOG 08_20	2599.765	17.5	19.1	30.4	3.77	13.9	2.92	0.6	2.6
EOG 08_20	2599.86	10	10	15.9	1.94	7.7	1.47	0.35	1.39
EOG 08_20	2599.96	16.4	16.1	25.4	3.04	11.5	2.11	0.49	2.31

EOG 08_20	2600.07	20.8	22.6	36.4	4.4	17.1	3.06	0.72	3.18
EOG 08_20	2600.15	24.2	24.5	40.4	5.19	20.2	4.1	0.85	3.9
EOG 08_20	2600.25	24.6	24.4	40.7	5.25	20.6	4.03	0.89	3.9
EOG 08_20	2600.4	18	17.8	26.6	3.4	13.2	2.48	0.58	2.51
EOG 08_20	2600.5	27.4	27.9	42.2	5.42	22.9	3.97	0.9	3.87
EOG 08_20	2600.62	26	27.2	42.2	5.18	19.8	3.59	0.81	3.9
EOG 08_20	2600.725	22.6	22.1	33	4.21	16.3	2.96	0.66	3.12
EOG 08_20	2600.9	19.2	18.5	26.9	3.38	13	2.39	0.54	2.64
EOG 08_20	2601.04	23.5	23.1	35.4	4.4	16.7	3.03	0.69	3.29
EOG 08_20	2601.14	37.5	37.5	55.2	6.68	26.2	4.79	1.11	5.32
EOG 08_20	2601.24	31.1	29.9	45.4	5.99	23.5	4.54	0.96	4.36
EOG 08_20	2601.51	23.7	24	35.6	4.54	17.5	3.43	0.73	3.26
EOG 08_20	2602.515	23.1	25.5	39.2	4.96	19.5	3.69	0.71	3.3
EOG 08_20	2602.75	23	23.6	35.1	4.37	16.9	3.22	0.66	2.85
EOG 08_20	2602.85	30.4	30.8	48.1	5.99	23	4.51	0.88	4.14
EOG 08_20	2603	21.2	22.4	33.1	4.11	16.1	2.85	0.66	2.89
EOG 08_20	2603.2	17.1	17.3	26.1	3.16	12.6	2.21	0.51	2.28
EOG 08_20	2603.3	16.6	15.5	22	2.75	10.5	1.99	0.47	2.07
EOG 08_20	2603.4	25.2	25.8	39.8	4.7	18.5	3.32	0.73	3.42
EOG 08_20	2603.5	25.2	26.8	41.2	5.23	20.9	3.93	0.79	3.54
EOG 08_20	2603.62	11.3	10.5	16	2.11	8.4	1.55	0.38	1.51

EOG 08_20	2604.405	12.4	15.3	25.5	3.06	11.1	2.05	0.45	1.75
EOG 08_20	2605.565	16.2	16.1	21.8	2.77	10.9	1.91	0.43	1.95
EOG 08_20	2606.5	12.1	15.5	25	3.06	11	1.99	0.34	1.77
EOG 08_20	2607.545	38.3	34.5	43.9	5.51	20.4	3.55	0.85	4.18
EOG 08_20	2608.5	33.2	34	43.9	5.24	19.6	3.3	0.75	3.56
EOG 08_20	2609.865	21.8	22.3	34	4.12	15.3	2.54	0.57	2.53
EOG 08_20	2610.51	24.5	24.2	32.8	3.99	15.7	2.6	0.61	2.91
EOG 08_20	2611.54	33.5	34.5	50.7	5.86	21.5	3.83	0.87	4.02
EOG 08_20	2612.5	27.6	30.2	45.2	5.56	21.2	3.65	0.8	3.86
EOG 08_20	2613.455	8.7	9.6	16	1.97	7.1	1.51	0.29	1.18
EOG 08_20	2614.28	16.7	23.4	38.4	4.46	16	2.7	0.51	2.42
EOG 08_20	2615.585	18.9	22.1	41.2	4.56	17.5	3.54	0.85	3.39
EOG 08_20	2616.415	11.9	11.1	17.6	2.32	8.7	1.67	0.37	1.73
EOG 08_20	2617.38	6.9	7.9	12.2	1.53	5.7	1.05	0.24	1
EOG 08_20	2618.5	11.3	10.9	15.7	2.07	8.1	1.63	0.35	1.55
EOG 08_20	2619.06	19	26.8	43.8	5.33	19.4	3.43	0.71	2.91
EOG 08_20	2620.475	9.5	10.3	15.3	1.96	7.6	1.35	0.34	1.42
EOG 08_20	2621.5	17.2	14.2	11.4	1.58	6.3	1.16	0.27	1.42
EOG 08_20	2622.37	23.4	24.7	32.9	3.92	16.4	2.88	0.7	3.02
EOG 08_20	2623.62	23.7	28.3	41.7	4.62	16.2	3.2	0.6	2.89
EOG 08_20	2624.5	23.1	25.7	38.5	3.94	15.8	2.88	0.67	3.37

EOG 08_20	2625.525	7.3	8.1	12.2	1.5	5.6	1.04	0.29	1.02
EOG 08_20	2626.5	13.5	11.1	16.4	2.25	8.8	1.73	0.41	1.81
EOG 08_20	2627.5	19.5	20.4	34.4	4.52	17.1	3.25	0.63	2.92
EOG 08_20	2593.12	22.9	20	21.1	2.67	10.6	1.96	0.45	2.58
EOG 08_20	2560	23.3	28.9	54.3	6.9	25.3	4.9	1.04	4.61
EOG 08_20	Pulp Duplicates								
EOG 08_20	2621.5	17.2	14.2	11.4	1.58	6.3	1.16	0.27	1.42
EOG 08_20	2621.5	14.7	11.5	10.7	1.51	5.7	0.92	0.22	1.33
EOG 08_20	2603.4	25.2	25.8	39.8	4.7	18.5	3.32	0.73	3.42
EOG 08_20	2603.4	24.2	25.5	38.1	4.82	19.8	3.48	0.74	3.41
EOG 08_20	2607.545	38.3	34.5	43.9	5.51	20.4	3.55	0.85	4.18
EOG 08_20	2607.545								
EOG 08_20	2584.5	24.6	23.2	25.8	3.38	12.4	2.31	0.49	2.81
EOG 08_20	2584.5								
EOG 08_20	2601.04	23.5	23.1	35.4	4.4	16.7	3.03	0.69	3.29
EOG 08_20	2601.04								
EOG 08_20	2627.5	19.5	20.4	34.4	4.52	17.1	3.25	0.63	2.92
EOG 08_20	2627.5								
EOG 08_20	2601.14	37.5	37.5	55.2	6.68	26.2	4.79	1.11	5.32
EOG 08_20	2601.14	36.7	36.6	53.1	6.51	25.7	4.81	1.16	5.46
EOG 08_20	2584.5	24.6	23.2	25.8	3.38	12.4	2.31	0.49	2.81

EOG 08_20	2584.5	24.1	25.5	29.6	3.65	14.6	2.56	0.56	3.02
EOG 08_20	2588.5	21.2	20.3	20	2.8	10.6	1.85	0.44	2.29
EOG 08_20	2588.5								
EOG 08_20	2602.515	23.1	25.5	39.2	4.96	19.5	3.69	0.71	3.3
EOG 08_20	2602.515								
Standard	2560	23.3	28.9	54.3	6.9	25.3	4.9	1.04	4.61
Standard	2560								
	Preparation Duplicates								
	2600.5	27.4	27.9	42.2	5.42	22.9	3.97	0.9	3.87
	2600.5	29.5	28.3	43.3	5.68	22.2	4.07	0.91	3.82
	Reference Materials								
	STD SO-18	30.6	12.5	25.5	3.29	14	2.94	0.87	3.13
	STD SO-18	29.9	12.7	26.5	3.2	13.3	2.69	0.82	2.95
	STD SO-18	29	11.8	25	3.29	13.7	2.96	0.93	3.07
	STD SO-18	30.2	12	25.5	3.29	13.3	2.73	0.91	3.17
	STD SO-18	29.7	12.8	26.1	3.3	13	2.63	0.84	2.86
	STD SO-18	31.1	12.4	26.7	3.39	13.7	2.87	0.87	2.95
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD SO-18	32.1	14	27.8	3.37	13.6	2.88	0.93	3.13
	STD SO-18	31.4	14.1	27.7	3.44	14.1	2.71	0.95	3.1
	STD SO-18	29.3	13	26	3.3	13.1	2.94	0.88	3.29
	STD SO-18	31.1	12.8	26.6	3.13	14	2.77	0.89	3.17
	STD GS311-1								

	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GS311-1								
	STD GS910-4								
	STD GGC-02								
	BLK	<0.1	<0.1	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05
	BLK	<0.1	<0.1	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05
	BLK	<0.1	<0.1	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05
	BLK								
	BLK								
	BLK								
	BLK								
	BLK	<0.1	<0.1	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05
	BLK	0.1	<0.1	<0.1	<0.02	<0.3	<0.05	<0.02	<0.05
	BLK								
	BLK								
	BLK								
	Prep Wash								
	G1	17.8	24.7	48.7	5.86	22.3	3.96	1.04	3.58
	G1	18.4	21.9	43.3	5.07	20.4	3.84	1.06	3.67

Table 31. Continued

		Tb	Dy	Ho	Er	Tm	Yb	Lu	TOT/C
		PPM	PPM	PPM	PPM	PPM	PPM	PPM	%
	MDL	0.01	0.05	0.02	0.03	0.01	0.05	0.01	0.02
Well ID	Sample								
EOG 08_20	2564.5	0.58	3.25	0.66	1.88	0.27	1.73	0.27	4.22
EOG 08_20	2565.5	0.59	3.38	0.67	1.85	0.3	2.11	0.31	4.19
EOG 08_20	2566.5	0.6	3.15	0.61	1.71	0.26	1.91	0.29	3.94
EOG 08_20	2567.5	0.57	3.2	0.63	1.72	0.27	1.96	0.3	4.19

EOG 08_20	2568.535	0.52	3.2	0.64	1.8	0.26	1.73	0.26	3.92
EOG 08_20	2569.475	0.51	3.03	0.57	1.74	0.26	1.42	0.21	8.62
EOG 08_20	2570.44	0.7	3.78	0.79	1.83	0.31	1.54	0.23	9.5
EOG 08_20	2571.55	0.41	2.53	0.48	1.4	0.19	1.26	0.17	10.79
EOG 08_20	2572.4	0.45	2.37	0.47	1.41	0.21	1.13	0.15	10.95
EOG 08_20	2573.54	0.4	2.47	0.44	1.32	0.2	1.11	0.17	11.07
EOG 08_20	2574.515	0.38	2.01	0.41	1.14	0.17	0.88	0.15	11.46
EOG 08_20	2575.445	0.35	1.92	0.39	1.05	0.26	0.75	0.13	10.24
EOG 08_20	2576.545	0.31	1.69	0.35	1.16	0.16	0.8	0.12	11.41
EOG 08_20	2577.5	0.51	2.9	0.59	1.57	0.2	1.24	0.17	12
EOG 08_20	2578.61	0.36	1.91	0.4	1.09	0.13	0.84	0.15	11.97
EOG 08_20	2579.425	0.48	2.59	0.56	1.54	0.23	1.39	0.19	11.75
EOG 08_20	2582.535	0.47	3.07	0.59	1.63	0.2	1.21	0.17	12.24
EOG 08_20	2583.51	0.41	2.29	0.51	1.43	0.17	1.18	0.13	11.9
EOG 08_20	2584.5	0.42	2.57	0.42	1.19	0.18	0.99	0.14	11.7
EOG 08_20	2585.465	0.32	1.51	0.34	1	0.13	0.87	0.1	12.4
EOG 08_20	2586.5	0.4	2.64	0.48	1.41	0.2	1.09	0.13	11.36
EOG 08_20	2587.5	0.56	3.38	0.71	1.97	0.22	1.48	0.21	13.85
EOG 08_20	2588.5	0.33	2.1	0.39	1.05	0.14	0.84	0.13	12
EOG 08_20	2589.6	0.36	2.31	0.49	1.32	0.18	1.05	0.14	11.52
EOG 08_20	2590.51	0.4	2.32	0.48	1.22	0.17	1.13	0.16	11.66

EOG 08_20	2591.36	0.51	3.17	0.59	1.76	0.24	1.44	0.21	12.22
EOG 08_20	2591.455	0.39	2.45	0.52	1.44	0.18	1.11	0.15	11.75
EOG 08_20	2591.61	0.41	2.33	0.48	1.32	0.17	1.23	0.17	11.77
EOG 08_20	2591.87	0.44	2.89	0.58	1.62	0.2	1.14	0.18	11.94
EOG 08_20	2592.03	0.7	3.82	0.8	2.12	0.28	1.88	0.26	12.73
EOG 08_20	2592.525	0.61	3.17	0.69	1.73	0.22	1.47	0.21	12.04
EOG 08_20	2593.555	0.31	1.97	0.41	1.1	0.14	0.84	0.12	12.41
EOG 08_20	2594.5	0.26	1.61	0.35	0.95	0.14	0.83	0.1	12.62
EOG 08_20	2595.4	0.39	2.09	0.42	1.09	0.17	0.85	0.14	12.28
EOG 08_20	2596.52	0.52	3.22	0.63	1.72	0.24	1.5	0.2	11.05
EOG 08_20	2597.455	0.12	0.69	0.15	0.42	0.04	0.28	0.05	11.51
EOG 08_20	2598.455	0.12	0.71	0.15	0.42	0.06	0.35	0.05	12.43
EOG 08_20	2599	0.18	1.01	0.2	0.58	0.09	0.48	0.08	11.66
EOG 08_20	2599.25	0.42	2.59	0.55	1.45	0.21	1.21	0.17	11.16
EOG 08_20	2599.39	0.45	2.6	0.55	1.38	0.21	1.18	0.17	14.39
EOG 08_20	2599.5	0.44	2.76	0.55	1.46	0.21	1.32	0.2	13.44
EOG 08_20	2599.6	0.48	2.87	0.58	1.56	0.24	1.46	0.22	13.11
EOG 08_20	2599.765	0.43	2.41	0.46	1.26	0.18	1.13	0.16	10.39
EOG 08_20	2599.86	0.22	1.29	0.26	0.72	0.09	0.57	0.09	11.33
EOG 08_20	2599.96	0.36	2.11	0.39	1.06	0.15	0.98	0.14	10.52
EOG 08_20	2600.07	0.5	2.8	0.53	1.41	0.2	1.42	0.21	8.78

EOG 08_20	2600.15	0.59	3.15	0.66	1.86	0.27	1.68	0.24	7.96
EOG 08_20	2600.25	0.57	3.44	0.66	1.86	0.27	1.66	0.24	8.5
EOG 08_20	2600.4	0.37	2.22	0.45	1.16	0.17	0.99	0.15	10.71
EOG 08_20	2600.5	0.59	3.58	0.72	1.91	0.26	1.52	0.22	8.72
EOG 08_20	2600.62	0.59	3.41	0.63	1.69	0.24	1.5	0.21	8.21
EOG 08_20	2600.725	0.49	2.72	0.57	1.49	0.2	1.2	0.19	9.51
EOG 08_20	2600.9	0.41	2.3	0.48	1.18	0.17	1.06	0.15	10.05
EOG 08_20	2601.04	0.5	2.93	0.57	1.55	0.22	1.41	0.21	9.04
EOG 08_20	2601.14	0.75	4.18	0.78	2.36	0.34	1.86	0.29	8.84
EOG 08_20	2601.24	0.62	3.76	0.77	2.07	0.31	1.72	0.24	8.93
EOG 08_20	2601.51	0.5	3.04	0.63	1.71	0.24	1.39	0.19	9
EOG 08_20	2602.515	0.53	2.93	0.69	1.77	0.25	1.47	0.21	8.07
EOG 08_20	2602.75	0.47	2.93	0.59	1.57	0.2	1.34	0.18	9.28
EOG 08_20	2602.85	0.67	3.82	0.74	1.92	0.27	1.59	0.24	8.79
EOG 08_20	2603	0.47	2.71	0.51	1.54	0.19	1.18	0.16	9.53
EOG 08_20	2603.2	0.37	2.07	0.41	1.15	0.16	0.97	0.16	10.03
EOG 08_20	2603.3	0.32	1.83	0.36	1.1	0.14	0.87	0.13	10.76
EOG 08_20	2603.4	0.5	2.91	0.56	1.66	0.23	1.46	0.22	7.98
EOG 08_20	2603.5	0.53	3.22	0.64	1.85	0.26	1.57	0.24	7.32
EOG 08_20	2603.62	0.25	1.4	0.28	0.8	0.1	0.58	0.09	11.37
EOG 08_20	2604.405	0.29	1.79	0.36	1.03	0.14	0.85	0.12	9.49

EOG 08_20	2605.565	0.32	1.8	0.36	0.97	0.13	0.81	0.12	10.24
EOG 08_20	2606.5	0.27	1.51	0.33	0.97	0.13	0.89	0.15	8.65
EOG 08_20	2607.545	0.61	3.56	0.69	1.8	0.26	1.57	0.21	11.93
EOG 08_20	2608.5	0.53	3.02	0.63	1.85	0.25	1.58	0.23	13.17
EOG 08_20	2609.865	0.41	2.44	0.5	1.28	0.18	1.07	0.14	10.63
EOG 08_20	2610.51	0.44	2.47	0.51	1.46	0.19	1.13	0.18	10.94
EOG 08_20	2611.54	0.66	3.38	0.68	1.84	0.25	1.65	0.23	11.87
EOG 08_20	2612.5	0.57	3.02	0.68	1.81	0.27	1.65	0.23	9.8
EOG 08_20	2613.455	0.2	1.13	0.25	0.71	0.1	0.6	0.09	11.09
EOG 08_20	2614.28	0.39	2.18	0.48	1.37	0.21	1.38	0.22	6.51
EOG 08_20	2615.585	0.5	2.98	0.68	1.66	0.26	1.64	0.23	12.06
EOG 08_20	2616.415	0.26	1.37	0.28	0.82	0.12	0.77	0.11	10.97
EOG 08_20	2617.38	0.16	1.03	0.2	0.56	0.08	0.44	0.07	11.25
EOG 08_20	2618.5	0.23	1.3	0.27	0.79	0.12	0.64	0.11	10.87
EOG 08_20	2619.06	0.44	2.61	0.53	1.56	0.23	1.46	0.21	9.18
EOG 08_20	2620.475	0.21	1.16	0.24	0.66	0.1	0.63	0.08	11.13
EOG 08_20	2621.5	0.23	1.23	0.27	0.66	0.11	0.64	0.09	12.79
EOG 08_20	2622.37	0.43	2.35	0.53	1.44	0.2	1.19	0.17	14.09
EOG 08_20	2623.62	0.48	2.59	0.55	1.58	0.19	1.06	0.21	17.9
EOG 08_20	2624.5	0.4	2.18	0.46	1.24	0.21	1.33	0.17	21.35
EOG 08_20	2625.525	0.18	1.05	0.21	0.57	0.08	0.41	0.08	11.17

EOG 08_20	2626.5	0.27	1.61	0.31	0.84	0.14	0.86	0.11	10.89
EOG 08_20	2627.5	0.46	2.68	0.55	1.57	0.22	1.33	0.21	10.63
EOG 08_20	2593.12	0.35	1.96	0.4	1.09	0.16	1.11	0.15	12.1
EOG 08_20	2560	0.7	3.99	0.7	2.25	0.35	2.31	0.36	1.07
EOG 08_20	Pulp Duplicates								
EOG 08_20	2621.5	0.23	1.23	0.27	0.66	0.11	0.64	0.09	12.79
EOG 08_20	2621.5	0.19	1.13	0.25	0.74	0.09	0.55	0.08	
EOG 08_20	2603.4	0.5	2.91	0.56	1.66	0.23	1.46	0.22	7.98
EOG 08_20	2603.4	0.5	2.77	0.59	1.71	0.23	1.52	0.22	
EOG 08_20	2607.545	0.61	3.56	0.69	1.8	0.26	1.57	0.21	11.93
EOG 08_20	2607.545								
EOG 08_20	2584.5	0.42	2.57	0.42	1.19	0.18	0.99	0.14	11.7
EOG 08_20	2584.5								
EOG 08_20	2601.04	0.5	2.93	0.57	1.55	0.22	1.41	0.21	9.04
EOG 08_20	2601.04								
EOG 08_20	2627.5	0.46	2.68	0.55	1.57	0.22	1.33	0.21	10.63
EOG 08_20	2627.5								
EOG 08_20	2601.14	0.75	4.18	0.78	2.36	0.34	1.86	0.29	8.84
EOG 08_20	2601.14	0.74	4	0.83	2.25	0.32	1.9	0.3	
EOG 08_20	2584.5	0.42	2.57	0.42	1.19	0.18	0.99	0.14	11.7
EOG 08_20	2584.5	0.45	2.68	0.5	1.43	0.19	1.08	0.15	

EOG 08_20	2588.5	0.33	2.1	0.39	1.05	0.14	0.84	0.13	12
EOG 08_20	2588.5								12.04
EOG 08_20	2602.515	0.53	2.93	0.69	1.77	0.25	1.47	0.21	8.07
EOG 08_20	2602.515								8.09
Standard	2560	0.7	3.99	0.7	2.25	0.35	2.31	0.36	1.07
Standard	2560								1.06
	Preparation Duplicates								
	2600.5	0.59	3.58	0.72	1.91	0.26	1.52	0.22	8.72
	2600.5	0.63	3.79	0.7	1.94	0.25	1.46	0.21	8.58
	Reference Materials								
	STD SO-18	0.47	2.84	0.61	1.71	0.27	1.74	0.27	
	STD SO-18	0.49	2.84	0.57	1.66	0.25	1.62	0.25	
	STD SO-18	0.47	2.85	0.58	1.71	0.27	1.83	0.27	
	STD SO-18	0.5	2.99	0.58	1.75	0.26	1.86	0.28	
	STD SO-18	0.5	3.02	0.6	1.69	0.25	1.67	0.26	
	STD SO-18	0.5	2.96	0.56	1.69	0.27	1.75	0.27	
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD DS10								
	STD OREAS45EA								
	STD SO-18	0.47	2.99	0.61	1.88	0.3	1.89	0.27	
	STD SO-18	0.5	3.11	0.59	1.86	0.3	1.89	0.27	
	STD SO-18	0.52	2.79	0.6	2.06	0.29	1.76	0.26	
	STD SO-18	0.49	3.05	0.61	2.01	0.27	2.03	0.29	
	STD GS311-1								1.03
	STD GS910-4								2.62

	STD GS311-1								0.99
	STD GS910-4								2.59
	STD GS311-1								1.02
	STD GS910-4								2.65
	STD GGC-02								28.55
	BLK	<0.01	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.01	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.01	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK								
	BLK								
	BLK								
	BLK								
	BLK	<0.01	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK	<0.01	<0.05	<0.02	<0.03	<0.01	<0.05	<0.01	
	BLK								<0.02
	BLK								<0.02
	BLK								<0.02
	Prep Wash								
	G1	0.54	2.92	0.55	1.63	0.26	1.91	0.31	<0.02
	G1	0.49	2.62	0.55	1.59	0.28	2.04	0.34	<0.02

Table 31. Continued

		TOT/S	Mo	Cu	Pb	Zn	Ni	As	Cd
		%	PPM	PPM	PPM	PPM	PPM	PPM	PPM
	MDL	0.02	0.1	0.1	0.1	1	0.1	0.5	0.1
Well ID	Sample								
EOG 08_20	2564.5	0.32	0.1	16.2	3.2	43	34.4	4.8	<0.1
EOG 08_20	2565.5	0.31	<0.1	13.7	2.9	40	32.3	5	<0.1
EOG 08_20	2566.5	0.3	<0.1	18.2	2.9	46	36.4	5.5	<0.1
EOG 08_20	2567.5	0.33	<0.1	13.8	2.9	40	34.5	4.3	<0.1
EOG 08_20	2568.535	0.32	<0.1	17.1	3.2	43	36.6	5.3	<0.1

EOG 08_20	2569.475	0.42	0.7	19.9	4.1	20	20.1	2.7	<0.1
EOG 08_20	2570.44	1.83	2.9	22	14.3	743	36.4	10.7	2.5
EOG 08_20	2571.55	0.23	0.4	10.5	2.8	17	9.8	1.9	<0.1
EOG 08_20	2572.4	0.29	0.5	21.9	4.4	18	17.2	1.7	<0.1
EOG 08_20	2573.54	0.66	2	10.9	6.8	13	16.1	5.2	<0.1
EOG 08_20	2574.515	0.31	0.9	12.9	4.8	9	15.4	2.7	<0.1
EOG 08_20	2575.445	3.22	0.5	16.3	3.7	41	11.7	1.2	<0.1
EOG 08_20	2576.545	1.28	2.9	16.2	11	8	17.5	1.9	<0.1
EOG 08_20	2577.5	1.01	1.9	20.2	9.8	19	31.2	3	<0.1
EOG 08_20	2578.61	0.24	1	11.7	4.9	6	14.6	2.1	<0.1
EOG 08_20	2579.425	1.24	1.6	26.8	10.1	114	34.5	5.1	0.6
EOG 08_20	2582.535	0.48	1.4	16.7	5.9	6	25.8	2.7	<0.1
EOG 08_20	2583.51	0.47	1.3	15.5	7.2	10	23.9	2.3	<0.1
EOG 08_20	2584.5	0.43	0.7	14.9	5.3	12	21.9	2.1	<0.1
EOG 08_20	2585.465	0.43	0.4	7.4	3.4	6	9.7	1.1	<0.1
EOG 08_20	2586.5	0.43	0.8	17.7	6.3	3	23.8	1.6	<0.1
EOG 08_20	2587.5	1.8	15	31.9	19.2	22	87.1	10.2	<0.1
EOG 08_20	2588.5	0.38	1	10	6	7	17.7	2.1	<0.1
EOG 08_20	2589.6	0.34	0.9	13.2	4.7	16	18.2	2.2	<0.1
EOG 08_20	2590.51	0.43	1.5	19.7	6.6	15	29.5	3.9	<0.1
EOG 08_20	2591.36	0.65	4.7	20.9	9.3	7	41	4.8	<0.1

EOG 08_20	2591.455	0.29	0.8	11.9	4.2	10	19	2.9	<0.1
EOG 08_20	2591.61	0.48	1.8	17.8	7.7	10	31.3	3.4	<0.1
EOG 08_20	2591.87	0.49	2	13.2	7.3	6	23.4	4.5	<0.1
EOG 08_20	2592.03	3.28	31.5	57.3	44.5	40	188.5	21.2	<0.1
EOG 08_20	2592.525	1.98	14.8	45.3	24.9	217	97.4	12.5	1.1
EOG 08_20	2593.555	0.37	1.6	11.9	5.1	7	18.2	3.4	<0.1
EOG 08_20	2594.5	0.48	1.2	6.1	4	6	10.1	2.3	<0.1
EOG 08_20	2595.4	1.05	1.5	10	5.9	5	18.9	4	<0.1
EOG 08_20	2596.52	0.34	0.8	25.2	5.7	15	15.3	1	<0.1
EOG 08_20	2597.455	1.36	0.7	4.7	4.1	2	5.8	1.7	<0.1
EOG 08_20	2598.455	0.28	0.4	2.3	1.4	2	3.8	0.8	<0.1
EOG 08_20	2599	0.25	0.5	6.5	4.5	55	6.4	2.7	<0.1
EOG 08_20	2599.25	0.45	0.9	22.6	4.7	7	24.4	3.2	<0.1
EOG 08_20	2599.39	1.28	6.1	57.2	22.5	31	51.2	8.4	0.3
EOG 08_20	2599.5	3.11	8.5	121	53.3	24	77.1	20.2	<0.1
EOG 08_20	2599.6	2.09	12.8	147.8	38.4	18	81.9	12.4	0.1
EOG 08_20	2599.765	0.38	0.5	17.9	5.8	11	15.7	3.1	<0.1
EOG 08_20	2599.86	0.33	0.3	13.9	5.1	6	13.6	3.9	<0.1
EOG 08_20	2599.96	0.52	0.4	19.6	6.9	7	18.8	4.7	<0.1
EOG 08_20	2600.07	0.72	0.6	31.6	9.3	9	35	5.6	<0.1
EOG 08_20	2600.15	0.8	1.1	51	11.7	10	49.2	7.5	<0.1

EOG 08_20	2600.25	0.65	0.9	50.9	9	12	44.4	4.6	<0.1
EOG 08_20	2600.4	0.3	0.4	20.9	4.2	20	15.1	1.9	<0.1
EOG 08_20	2600.5	0.9	1.2	41.2	9.7	13	46.1	6.9	0.1
EOG 08_20	2600.62	0.79	1.2	42.2	8.9	12	45.3	6.6	<0.1
EOG 08_20	2600.725	0.54	0.6	32.7	7.1	30	31.7	3.7	<0.1
EOG 08_20	2600.9	0.44	0.6	22.5	6.8	16	20.2	3.4	<0.1
EOG 08_20	2601.04	0.65	1.1	38.2	8.6	26	34.1	6.1	<0.1
EOG 08_20	2601.14	1.12	1.7	62.2	12.7	26	61	10.4	<0.1
EOG 08_20	2601.24	1.01	2.5	115.1	13.6	59	76.7	9.4	0.1
EOG 08_20	2601.51	0.69	0.7	47.8	8.7	22	33.3	6.2	<0.1
EOG 08_20	2602.515	0.72	0.9	45.9	9.2	29	38	6.6	<0.1
EOG 08_20	2602.75	0.54	0.9	30.6	7.8	17	28.5	4.2	<0.1
EOG 08_20	2602.85	0.96	2.1	91.3	12.6	24	83	9.3	<0.1
EOG 08_20	2603	0.55	0.7	24.2	6.6	12	26.3	4.1	<0.1
EOG 08_20	2603.2	0.41	0.5	21.1	6.7	8	19.4	2.1	<0.1
EOG 08_20	2603.3	0.33	0.4	16.7	5.5	15	17.6	4.9	<0.1
EOG 08_20	2603.4	0.94	1.2	45.2	12.2	19	43.1	9.9	<0.1
EOG 08_20	2603.5	0.88	1.5	55.9	10.6	15	66.1	7	<0.1
EOG 08_20	2603.62	0.19	0.2	10	2.5	18	6.7	0.7	<0.1
EOG 08_20	2604.405	0.35	0.3	14.8	5.5	7	15.1	1.6	<0.1
EOG 08_20	2605.565	0.36	0.2	18.9	6.1	5	14.5	2.2	<0.1

EOG 08_20	2606.5	0.82	0.5	21.5	9.4	9	21.3	6.4	<0.1
EOG 08_20	2607.545	1.71	6.2	34	19.3	13	54.6	12.5	<0.1
EOG 08_20	2608.5	1.42	8.9	30	14.5	17	49.4	9.2	<0.1
EOG 08_20	2609.865	0.49	1.6	22.1	5.6	3	25.8	3.5	<0.1
EOG 08_20	2610.51	0.6	2.5	22.1	6.7	5	27.6	4.5	<0.1
EOG 08_20	2611.54	1.94	17.4	62.3	25.2	15	112.6	14.6	<0.1
EOG 08_20	2612.5	0.91	2.8	41.1	9	8	46.4	5.3	<0.1
EOG 08_20	2613.455	0.26	0.3	7.1	3.4	4	7	1.1	<0.1
EOG 08_20	2614.28	1.4	0.7	32.1	9.9	9	34.4	9.6	<0.1
EOG 08_20	2615.585	2.77	7.3	40.9	32	11	44.5	10.6	0.2
EOG 08_20	2616.415	0.2	0.6	18.1	2.4	3	9.5	1.6	<0.1
EOG 08_20	2617.38	0.36	0.3	10.7	3.3	4	6.9	1.7	<0.1
EOG 08_20	2618.5	0.25	0.2	10.1	2.3	3	7.2	1.2	<0.1
EOG 08_20	2619.06	1.11	3.3	87.1	10.8	15	70.9	6.9	<0.1
EOG 08_20	2620.475	0.29	0.3	10.7	2	5	4.8	2.8	<0.1
EOG 08_20	2621.5	0.26	0.6	13	2.6	6	11.1	1.9	<0.1
EOG 08_20	2622.37	2.19	4.8	91.5	28.3	7	57.7	12.6	<0.1
EOG 08_20	2623.62	5.28	10.6	116	69.6	20	69.3	24.5	0.2
EOG 08_20	2624.5	4.8	8.2	56.9	53.4	14	40	18.9	<0.1
EOG 08_20	2625.525	0.37	0.4	18.1	2.9	3	8.1	3.4	<0.1
EOG 08_20	2626.5	0.31	0.9	14.6	3.4	8	9.6	2.1	<0.1

EOG 08_20	2627.5	0.83	2.1	91.2	6.1	10	49.1	5.4	<0.1
EOG 08_20	2593.12	2.27	6.4	17.8	11.9	12	41.2	7.1	<0.1
EOG 08_20	2560	0.1	0.6	24.3	25.2	78	20.3	8.7	0.1
EOG 08_20	Pulp Duplicates								
EOG 08_20	2621.5	0.26	0.6	13	2.6	6	11.1	1.9	<0.1
EOG 08_20	2621.5								
EOG 08_20	2603.4	0.94	1.2	45.2	12.2	19	43.1	9.9	<0.1
EOG 08_20	2603.4								
EOG 08_20	2607.545	1.71	6.2	34	19.3	13	54.6	12.5	<0.1
EOG 08_20	2607.545		6.4	32.1	18.3	13	51.7	11.9	<0.1
EOG 08_20	2584.5	0.43	0.7	14.9	5.3	12	21.9	2.1	<0.1
EOG 08_20	2584.5		0.9	15.6	5.6	13	21.5	2.5	<0.1
EOG 08_20	2601.04	0.65	1.1	38.2	8.6	26	34.1	6.1	<0.1
EOG 08_20	2601.04		0.8	41.1	8.8	27	31	5.4	0.1
EOG 08_20	2627.5	0.83	2.1	91.2	6.1	10	49.1	5.4	<0.1
EOG 08_20	2627.5		2.3	89.1	5.7	9	48.1	5.7	<0.1
EOG 08_20	2601.14	1.12	1.7	62.2	12.7	26	61	10.4	<0.1
EOG 08_20	2601.14								
EOG 08_20	2584.5	0.43	0.7	14.9	5.3	12	21.9	2.1	<0.1
EOG 08_20	2584.5								
EOG 08_20	2588.5	0.38	1	10	6	7	17.7	2.1	<0.1

EOG 08_20	2588.5	0.39							
EOG 08_20	2602.515	0.72	0.9	45.9	9.2	29	38	6.6	<0.1
EOG 08_20	2602.515	0.71							
Standard	2560	0.1	0.6	24.3	25.2	78	20.3	8.7	0.1
Standard	2560	0.07							
	Preparation Duplicates								
	2600.5	0.9	1.2	41.2	9.7	13	46.1	6.9	0.1
	2600.5	0.9	0.9	44.5	10.9	14	52.7	7.9	<0.1
	Reference Materials								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD DS10		11	141.6	142.7	333	67.8	39.8	2.2
	STD OREAS45EA		1.6	612.7	13.2	26	328	8.9	<0.1
	STD DS10		15.1	157.6	152.8	361	77.1	46.7	2.5
	STD OREAS45EA		1.4	690.8	14.4	30	376.9	10.2	<0.1
	STD DS10		13.8	154.8	156.8	380	78.4	46.8	2.4
	STD OREAS45EA		0.9	673.1	14.4	30	368.8	9.5	<0.1
	STD DS10		13.7	147	141.7	333	72.6	43.1	2.6
	STD OREAS45EA		1.3	659.5	13.7	31	367.5	9.7	<0.1
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD SO-18								
	STD GS311-1	2.28							
	STD GS910-4	8.51							
	STD GS311-1	2.27							

	STD GS910-4	8.12							
	STD GS311-1	2.32							
	STD GS910-4	8.09							
	STD GGC-02	0.03							
	BLK								
	BLK								
	BLK								
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5	<0.1
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5	<0.1
	BLK		<0.1	<0.1	<0.1	<1	<0.1	0.7	<0.1
	BLK		<0.1	<0.1	<0.1	<1	<0.1	<0.5	<0.1
	BLK								
	BLK								
	BLK	<0.02							
	BLK	<0.02							
	BLK	<0.02							
	Prep Wash								
	G1	0.03	1.1	2.8	3.4	44	5.1	<0.5	<0.1
	G1	0.03	0.9	2.6	3.3	51	4.6	<0.5	<0.1

Table 31. Continued

		Sb	Bi	Ag	Au	Hg	Tl	Se
		PPM	PPM	PPM	PPB	PPM	PPM	PPM
	MDL	0.1	0.1	0.1	0.5	0.01	0.1	0.5
Well ID	Sample							
EOG 08_20	2564.5	<0.1	0.2	<0.1	<0.5	0.01	<0.1	<0.5
EOG 08_20	2565.5	<0.1	0.2	<0.1	<0.5	<0.01	<0.1	0.8
EOG 08_20	2566.5	<0.1	0.2	<0.1	<0.5	<0.01	<0.1	0.5
EOG 08_20	2567.5	<0.1	0.2	<0.1	1.3	0.02	<0.1	<0.5
EOG 08_20	2568.535	<0.1	0.2	<0.1	<0.5	<0.01	<0.1	0.5
EOG 08_20	2569.475	0.1	<0.1	<0.1	0.7	0.02	<0.1	<0.5

EOG 08_20	2570.44	0.4	<0.1	<0.1	<0.5	0.09	<0.1	1.2
EOG 08_20	2571.55	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	1.1
EOG 08_20	2572.4	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	0.6
EOG 08_20	2573.54	0.2	<0.1	<0.1	<0.5	0.04	<0.1	0.8
EOG 08_20	2574.515	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
EOG 08_20	2575.445	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2576.545	<0.1	<0.1	<0.1	<0.5	0.05	<0.1	1
EOG 08_20	2577.5	0.2	<0.1	<0.1	<0.5	0.06	<0.1	2.3
EOG 08_20	2578.61	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
EOG 08_20	2579.425	0.2	<0.1	<0.1	1.7	0.08	<0.1	1.2
EOG 08_20	2582.535	0.1	<0.1	<0.1	0.7	0.05	<0.1	1.5
EOG 08_20	2583.51	<0.1	<0.1	<0.1	<0.5	0.06	<0.1	0.7
EOG 08_20	2584.5	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2585.465	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2586.5	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2587.5	0.4	<0.1	<0.1	<0.5	0.18	<0.1	6.4
EOG 08_20	2588.5	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2589.6	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	0.5
EOG 08_20	2590.51	0.1	<0.1	<0.1	0.5	0.06	<0.1	1
EOG 08_20	2591.36	0.2	<0.1	<0.1	0.6	0.08	<0.1	1.3
EOG 08_20	2591.455	0.1	<0.1	<0.1	<0.5	0.04	<0.1	0.9

EOG 08_20	2591.61	0.2	<0.1	<0.1	<0.5	0.05	<0.1	1
EOG 08_20	2591.87	0.2	<0.1	<0.1	<0.5	0.04	<0.1	0.7
EOG 08_20	2592.03	1	0.1	0.2	<0.5	0.32	0.4	12
EOG 08_20	2592.525	0.6	0.1	<0.1	<0.5	0.19	0.3	4.8
EOG 08_20	2593.555	0.1	<0.1	<0.1	<0.5	0.03	<0.1	0.7
EOG 08_20	2594.5	<0.1	<0.1	<0.1	0.5	0.02	<0.1	0.7
EOG 08_20	2595.4	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2596.52	0.1	<0.1	<0.1	1.2	0.05	<0.1	<0.5
EOG 08_20	2597.455	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2598.455	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
EOG 08_20	2599	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
EOG 08_20	2599.25	0.1	<0.1	<0.1	<0.5	0.06	<0.1	1.5
EOG 08_20	2599.39	0.3	<0.1	<0.1	0.8	0.1	<0.1	1.7
EOG 08_20	2599.5	0.8	0.2	0.2	<0.5	0.3	<0.1	2.2
EOG 08_20	2599.6	0.4	0.2	0.2	1.7	0.19	<0.1	4.1
EOG 08_20	2599.765	<0.1	0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2599.86	0.1	<0.1	<0.1	<0.5	0.05	<0.1	<0.5
EOG 08_20	2599.96	<0.1	<0.1	<0.1	3.9	0.03	<0.1	1.3
EOG 08_20	2600.07	0.1	0.1	<0.1	2.9	0.06	<0.1	0.6
EOG 08_20	2600.15	0.1	0.2	<0.1	<0.5	0.06	<0.1	0.6
EOG 08_20	2600.25	0.2	0.1	<0.1	2.8	0.08	<0.1	<0.5

EOG 08_20	2600.4	<0.1	<0.1	<0.1	2.5	0.02	<0.1	<0.5
EOG 08_20	2600.5	0.2	0.1	<0.1	1.4	0.07	<0.1	<0.5
EOG 08_20	2600.62	<0.1	0.2	<0.1	<0.5	0.09	<0.1	0.6
EOG 08_20	2600.725	<0.1	<0.1	<0.1	<0.5	0.06	<0.1	<0.5
EOG 08_20	2600.9	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	0.6
EOG 08_20	2601.04	0.1	<0.1	<0.1	2	0.06	<0.1	0.6
EOG 08_20	2601.14	0.1	0.1	<0.1	<0.5	0.11	<0.1	1.6
EOG 08_20	2601.24	0.2	0.2	<0.1	<0.5	0.09	<0.1	1.4
EOG 08_20	2601.51	0.2	<0.1	<0.1	<0.5	0.05	<0.1	<0.5
EOG 08_20	2602.515	0.1	0.1	<0.1	<0.5	0.05	<0.1	<0.5
EOG 08_20	2602.75	0.1	<0.1	<0.1	<0.5	0.06	<0.1	0.6
EOG 08_20	2602.85	0.3	0.2	<0.1	0.7	0.1	<0.1	1.3
EOG 08_20	2603	0.1	<0.1	<0.1	<0.5	0.05	<0.1	<0.5
EOG 08_20	2603.2	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
EOG 08_20	2603.3	0.1	<0.1	<0.1	0.9	<0.01	<0.1	0.6
EOG 08_20	2603.4	0.1	0.2	<0.1	0.7	0.08	<0.1	1.4
EOG 08_20	2603.5	0.2	0.1	<0.1	<0.5	0.07	<0.1	2.8
EOG 08_20	2603.62	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	0.9
EOG 08_20	2604.405	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2605.565	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2606.5	<0.1	<0.1	<0.1	<0.5	0.06	<0.1	1.1

EOG 08_20	2607.545	0.4	0.1	<0.1	<0.5	0.16	<0.1	3.3
EOG 08_20	2608.5	0.5	<0.1	<0.1	0.9	0.14	<0.1	4.1
EOG 08_20	2609.865	0.2	<0.1	<0.1	<0.5	0.06	<0.1	<0.5
EOG 08_20	2610.51	0.2	<0.1	<0.1	0.9	0.06	<0.1	<0.5
EOG 08_20	2611.54	0.5	0.2	0.2	0.5	0.16	<0.1	4.5
EOG 08_20	2612.5	0.2	<0.1	<0.1	<0.5	0.09	<0.1	1.1
EOG 08_20	2613.455	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
EOG 08_20	2614.28	0.1	0.2	<0.1	<0.5	0.06	<0.1	<0.5
EOG 08_20	2615.585	0.4	0.2	<0.1	<0.5	0.22	<0.1	1.2
EOG 08_20	2616.415	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2617.38	<0.1	<0.1	<0.1	<0.5	0.01	<0.1	<0.5
EOG 08_20	2618.5	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2619.06	0.2	0.2	<0.1	<0.5	0.13	<0.1	<0.5
EOG 08_20	2620.475	<0.1	<0.1	<0.1	<0.5	0.02	<0.1	<0.5
EOG 08_20	2621.5	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
EOG 08_20	2622.37	0.4	0.2	0.4	<0.5	0.29	<0.1	2.4
EOG 08_20	2623.62	0.6	0.3	0.3	<0.5	0.48	<0.1	3.2
EOG 08_20	2624.5	0.5	0.2	0.2	<0.5	0.5	<0.1	2.1
EOG 08_20	2625.525	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
EOG 08_20	2626.5	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
EOG 08_20	2627.5	0.2	0.1	<0.1	<0.5	0.07	<0.1	0.9

EOG 08_20	2593.12	0.3	<0.1	<0.1	<0.5	0.1	<0.1	1.8
EOG 08_20	2560	0.4	0.3	<0.1	<0.5	0.06	0.1	0.6
EOG 08_20	Pulp Duplicates							
EOG 08_20	2621.5	<0.1	<0.1	<0.1	<0.5	0.03	<0.1	<0.5
EOG 08_20	2621.5							
EOG 08_20	2603.4	0.1	0.2	<0.1	0.7	0.08	<0.1	1.4
EOG 08_20	2603.4							
EOG 08_20	2607.545	0.4	0.1	<0.1	<0.5	0.16	<0.1	3.3
EOG 08_20	2607.545	0.4	0.1	<0.1	<0.5	0.16	<0.1	3.5
EOG 08_20	2584.5	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2584.5	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2601.04	0.1	<0.1	<0.1	2	0.06	<0.1	0.6
EOG 08_20	2601.04	0.2	<0.1	<0.1	<0.5	0.03	<0.1	0.9
EOG 08_20	2627.5	0.2	0.1	<0.1	<0.5	0.07	<0.1	0.9
EOG 08_20	2627.5	0.1	0.1	<0.1	<0.5	0.07	<0.1	0.8
EOG 08_20	2601.14	0.1	0.1	<0.1	<0.5	0.11	<0.1	1.6
EOG 08_20	2601.14							
EOG 08_20	2584.5	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2584.5							
EOG 08_20	2588.5	<0.1	<0.1	<0.1	<0.5	0.04	<0.1	<0.5
EOG 08_20	2588.5							

EOG 08_20	2602.515	0.1	0.1	<0.1	<0.5	0.05	<0.1	<0.5
EOG 08_20	2602.515							
Standard	2560	0.4	0.3	<0.1	<0.5	0.06	0.1	0.6
Standard	2560							
	Preparation Duplicates							
	2600.5	0.2	0.1	<0.1	1.4	0.07	<0.1	<0.5
	2600.5	0.2	0.2	<0.1	2.2	0.09	<0.1	<0.5
	Reference Materials							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD DS10	7.8	10.2	1.6	64.8	0.28	4.5	2.6
	STD OREAS45EA	0.4	0.3	0.3	42.9	<0.01	<0.1	<0.5
	STD DS10	6.7	10.4	2.2	76.4	0.25	4.9	3.5
	STD OREAS45EA	0.2	0.2	0.2	41.9	0.01	<0.1	1.8
	STD DS10	6.1	10.7	2.2	73.5	0.29	4.8	3.1
	STD OREAS45EA	0.2	0.2	0.2	56.7	0.01	<0.1	1.2
	STD DS10	7.7	9.8	1.9	60.8	0.27	4.5	1.5
	STD OREAS45EA	0.2	0.2	0.2	45.9	0.01	<0.1	<0.5
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD SO-18							
	STD GS311-1							
	STD GS910-4							
	STD GS311-1							
	STD GS910-4							

	STD GS311-1							
	STD GS910-4							
	STD GGC-02							
	BLK							
	BLK							
	BLK							
	BLK	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
	BLK							
	BLK							
	BLK							
	BLK							
	BLK							
	Prep Wash							
	G1	<0.1	<0.1	<0.1	0.6	<0.01	0.3	<0.5
	G1	<0.1	<0.1	<0.1	<0.5	<0.01	0.3	<0.5

C.4.2 Leco TOC and Rockeval Results

Table 32. Leco TOC and Rockeval Results for EOG 08-20

Well ID	Depth ()	Sample Type	Sample Prep	Leco	SRA			Tmax
	Top			TOC	S1	S2	S3	(°C)
EOG 08_20	2564.5	Rock	NOPR	0.18	0.09	0.25	0.27	447
EOG 08_20	2565.5	Rock	NOPR	0.28	0.05	0.14	0.31	450
EOG 08_20	2566.5	Rock	NOPR	0.17	0.08	0.15	0.25	445
EOG 08_20	2567.5	Rock	NOPR	0.07	0.11	0.21	0.39	443
EOG 08_20	2568.535	Rock	NOPR	0.24	0.06	0.14	0.31	446
EOG 08_20	2569.475	Rock	NOPR	0.08	0.06	0.12	0.29	449
EOG 08_20	2570.44	Rock	NOPR		0.99	2.87	0.19	446
EOG 08_20	2571.55	Rock	NOPR	0.61	0.62	1.48	0.16	448
EOG 08_20	2572.4	Rock	NOPR	0.54	0.53	1.35	0.21	446
EOG 08_20	2573.54	Rock	NOPR	0.56				
EOG 08_20	2574.515	Rock	EXT	0.60	0.09	0.82	0.29	448

EOG 08_20	2574.515	Rock	NOPR	3.54	2.88	7.70	0.31	454
EOG 08_20	2575.445	Rock	NOPR	0.56	0.89	1.62	0.22	450
EOG 08_20	2576.545	Rock	NOPR	0.64	0.83	1.37	0.23	442
EOG 08_20	2577.5	Rock	NOPR	1.84	1.73	4.88	0.22	451
EOG 08_20	2578.61	Rock	NOPR	0.90	0.95	2.40	0.21	447
EOG 08_20	2579.425	Rock	NOPR	1.93	1.79	5.30	0.20	452
EOG 08_20	2582.535	Rock	NOPR	2.42	2.48	6.11	0.31	454
EOG 08_20	2583.51	Rock	NOPR	0.92	1.37	2.57	0.22	441
EOG 08_20	2584.5	Rock	NOPR	0.80	1.03	2.02	0.11	445
EOG 08_20	2585.465	Rock	NOPR	0.52	1.18	1.51	0.12	444
EOG 08_20	2586.5	Rock	NOPR	0.93	1.39	2.84	0.19	446
EOG 08_20	2587.5	Rock	EXT	3.59	0.15	6.97	0.35	450
EOG 08_20	2587.5	Rock	NOPR	3.56	2.42	7.17	0.26	453
EOG 08_20	2588.5	Rock	NOPR	1.29	1.79	3.44	0.17	447
EOG 08_20	2589.6	Rock	NOPR		1.12	2.05	0.17	441
EOG 08_20	2590.51	Rock	NOPR	1.42	1.54	3.85	0.21	450
EOG 08_20	2591.03	Rock	NOPR	5.75				
EOG 08_20	2591.36	Rock	NOPR	2.64	1.85	6.26	0.21	452
EOG 08_20	2591.455	Rock	NOPR	0.93	0.98	2.29	0.14	446
EOG 08_20	2591.61	Rock	NOPR	1.15	1.39	3.55	0.17	449
EOG 08_20	2591.87	Rock	NOPR	1.19	1.30	3.21	0.24	449
EOG 08_20	2598.455	Rock	NOPR	0.20	0.23	0.20	0.10	444
EOG 08_20	2592.525	Rock	NOPR	6.06	2.80	9.09	0.21	451
EOG 08_20	2593.12	Rock	EXT	1.83	0.09	2.71	0.29	450
EOG 08_20	2593.12	Rock	NOPR	3.71	2.84	7.81	0.39	453
EOG 08_20	2593.555	Rock	NOPR		1.67	3.45	0.13	447
EOG 08_20	2594.5	Rock	NOPR		0.91	1.14	0.16	446
EOG 08_20	2595.4	Rock	NOPR	1.17	1.31	2.51	0.16	450
EOG 08_20	2596.52	Rock	NOPR	0.79	0.82	1.89	0.14	449
EOG 08_20	2597.455	Rock	NOPR	0.17	0.38	0.50	0.07	449
EOG 08_20	2599.25	Rock	NOPR	1.60	1.70	4.00	0.21	449
EOG 08_20	2599.39	Rock	NOPR	2.83	2.24	7.04	0.22	451
EOG 08_20	2599.5	Rock	NOPR	8.38	5.21	21.21	0.29	452
EOG 08_20	2599.6	Rock	NOPR	4.45	3.61	10.97	0.24	451
EOG 08_20	2599.765	Rock	NOPR	0.45	1.23	1.59	0.24	438
EOG 08_20	2599.86	Rock	EXT	0.18	0.05	0.09	0.24	440
EOG 08_20	2599.86	Rock	NOPR	0.30	0.34	0.41	0.18	436
EOG 08_20	2599.9	Rock	NOPR	0.34	0.44	0.41	0.25	440
EOG 08_20	2599.96	Rock	NOPR	0.25	0.86	0.89	0.20	436
EOG 08_20	2600.07	Rock	NOPR	0.70	1.16	1.88	0.22	443
EOG 08_20	2600.15	Rock	NOPR	1.28	1.75	3.19	0.33	448

EOG 08_20	2600.25	Rock	NOPR	0.96	1.34	2.29	0.35	448
EOG 08_20	2600.4	Rock	NOPR	0.28	0.85	0.94	0.18	441
EOG 08_20	2600.5	Rock	NOPR	0.81	1.45	2.36	0.32	445
EOG 08_20	2600.62	Rock	NOPR	1.08	1.64	3.08	0.43	449
EOG 08_20	2600.725	Rock	NOPR	0.44	0.73	1.05	0.27	438
EOG 08_20	2600.9	Rock	NOPR	0.27	0.59	0.82	0.23	438
EOG 08_20	2601.04	Rock	EXT	0.81	0.07	0.92	0.33	449
EOG 08_20	2601.04	Rock	NOPR	1.09	1.30	2.11	0.26	446
EOG 08_20	2601.14	Rock	NOPR	1.27	1.89	3.98	0.31	450
EOG 08_20	2601.24	Rock	NOPR		3.42	8.24	0.45	452
EOG 08_20	2601.51	Rock	NOPR	1.08	1.58	3.11	0.21	449
EOG 08_20	2602.515	Rock	NOPR	0.70	1.26	2.13	0.27	445
EOG 08_20	2602.75	Rock	NOPR	0.81	1.63	2.59	0.26	448
EOG 08_20	2602.85	Rock	NOPR		3.08	7.71	0.25	451
EOG 08_20	2603	Rock	NOPR	0.90	1.38	2.35	0.27	444
EOG 08_20	2603.2	Rock	NOPR	0.54	1.10	1.58	0.30	443
EOG 08_20	2603.3	Rock	NOPR	0.19	0.58	0.56	0.17	437
EOG 08_20	2603.4	Rock	NOPR					
EOG 08_20	2603.5	Rock	EXT	1.82	0.10	2.65	0.25	452
EOG 08_20	2603.5	Rock	NOPR	2.17	2.17	4.74	0.21	452
EOG 08_20	2603.62	Rock	NOPR	0.04	0.46	0.45	0.14	436
EOG 08_20	2604.405	Rock	NOPR	0.61	1.47	1.97	0.29	442
EOG 08_20	2605.565	Rock	NOPR	0.17	0.74	0.79	0.21	440
EOG 08_20	2606.5	Rock	NOPR	0.53	1.08	1.44	0.23	444
EOG 08_20	2607.545	Rock	NOPR	3.03	2.80	7.73	0.24	454
EOG 08_20	2608.5	Rock	NOPR	4.51	3.11	9.72	0.20	453
EOG 08_20	2609.865	Rock	NOPR	0.24	0.47	0.83	0.17	444
EOG 08_20	2610.51	Rock	NOPR	2.81	2.68	7.69	0.22	452
EOG 08_20	2611.54	Rock	NOPR	3.74	3.42	9.90	0.20	454
EOG 08_20	2612.5	Rock	NOPR	5.75	4.67	13.76	0.24	453
EOG 08_20	2613.455	Rock	EXT	0.25	0.05	0.15	0.24	446
EOG 08_20	2613.455	Rock	NOPR	0.30	0.61	0.46	0.13	428
EOG 08_20	2614.28	Rock	NOPR	0.53	1.14	1.89	0.28	443
EOG 08_20	2615.585	Rock	NOPR		3.09	7.27	0.19	453
EOG 08_20	2616.415	Rock	NOPR	4.06	2.39	5.09	0.19	453
EOG 08_20	2617.38	Rock	NOPR	2.14	0.55	0.45	0.11	442
EOG 08_20	2618.5	Rock	NOPR	1.80	0.77	0.76	0.16	431
EOG 08_20	2619.06	Rock	NOPR	1.62	2.73	7.28	0.30	455
EOG 08_20	2620.475	Rock	NOPR	2.09				
EOG 08_20	2621.5	Rock	NOPR	1.08	1.16	2.17	0.22	449
EOG 08_20	2622.37	Rock	NOPR	2.53	3.38	12.09	0.19	457

EOG 08_20	2623.62	Rock	NOPR	2.00				
EOG 08_20	2624.5	Rock	EXT	12.80	0.19	25.77	0.51	453
EOG 08_20	2624.5	Rock	NOPR	11.25	5.27	24.49	0.33	455
EOG 08_20	2625.525	Rock	NOPR	3.73	0.54	0.67	0.16	443
EOG 08_20	2626.5	Rock	NOPR	0.51	0.81	1.52	0.17	446
EOG 08_20	2627.5	Rock	NOPR	4.14	3.26	8.65	0.41	454

Table 32. Continued

Well ID	Depth ()	HI	OI	S2/S3	S1/TOC*100	PI
	Top					
EOG 08_20	2564.5	140	151	1	50	0.26
EOG 08_20	2565.5	50	111	0	18	0.26
EOG 08_20	2566.5	87	145	1	46	0.35
EOG 08_20	2567.5	300	557	1	157	0.34
EOG 08_20	2568.535	58	129	0	25	0.30
EOG 08_20	2569.475	148	358	0	74	0.33
EOG 08_20	2570.44	0	0	15	0	0.26
EOG 08_20	2571.55	242	26	9	101	0.30
EOG 08_20	2572.4	248	39	6	97	0.28
EOG 08_20	2573.54					
EOG 08_20	2574.515	136	48	3	15	0.10
EOG 08_20	2574.515	218	9	25	81	0.27
EOG 08_20	2575.445	288	39	7	158	0.35
EOG 08_20	2576.545	216	36	6	131	0.38
EOG 08_20	2577.5	265	12	22	94	0.26
EOG 08_20	2578.61	268	23	11	106	0.28
EOG 08_20	2579.425	274	10	27	93	0.25
EOG 08_20	2582.535	252	13	20	102	0.29
EOG 08_20	2583.51	278	24	12	148	0.35
EOG 08_20	2584.5	252	14	18	129	0.34
EOG 08_20	2585.465	292	23	13	228	0.44
EOG 08_20	2586.5	307	21	15	150	0.33
EOG 08_20	2587.5	194	10	20	4	0.02
EOG 08_20	2587.5	201	7	28	68	0.25
EOG 08_20	2588.5	267	13	20	139	0.34
EOG 08_20	2589.6	0	0	12	0	0.35
EOG 08_20	2590.51	271	15	18	108	0.29
EOG 08_20	2591.03					
EOG 08_20	2591.36	237	8	30	70	0.23
EOG 08_20	2591.455	248	15	16	106	0.30

EOG 08_20	2591.61	310	15	21	121	0.28
EOG 08_20	2591.87	271	20	13	110	0.29
EOG 08_20	2598.455	99	49	2	113	0.53
EOG 08_20	2592.525	150	3	43	46	0.24
EOG 08_20	2593.12	148	16	9	5	0.03
EOG 08_20	2593.12	211	11	20	77	0.27
EOG 08_20	2593.555	0	0	27	0	0.33
EOG 08_20	2594.5	0	0	7	0	0.44
EOG 08_20	2595.4	215	14	16	112	0.34
EOG 08_20	2596.52	238	18	14	103	0.30
EOG 08_20	2597.455	289	40	7	220	0.43
EOG 08_20	2599.25	250	13	19	106	0.30
EOG 08_20	2599.39	248	8	32	79	0.24
EOG 08_20	2599.5	253	3	73	62	0.20
EOG 08_20	2599.6	246	5	46	81	0.25
EOG 08_20	2599.765	352	53	7	273	0.44
EOG 08_20	2599.86	49	130	0	27	0.36
EOG 08_20	2599.86	136	60	2	113	0.45
EOG 08_20	2599.9	122	74	2	131	0.52
EOG 08_20	2599.96	358	80	4	345	0.49
EOG 08_20	2600.07	267	31	9	165	0.38
EOG 08_20	2600.15	248	26	10	136	0.35
EOG 08_20	2600.25	238	36	7	139	0.37
EOG 08_20	2600.4	334	64	5	301	0.47
EOG 08_20	2600.5	291	39	7	179	0.38
EOG 08_20	2600.62	287	40	7	153	0.35
EOG 08_20	2600.725	237	61	4	165	0.41
EOG 08_20	2600.9	307	86	4	221	0.42
EOG 08_20	2601.04	113	41	3	9	0.07
EOG 08_20	2601.04	194	24	8	120	0.38
EOG 08_20	2601.14	313	24	13	149	0.32
EOG 08_20	2601.24	0	0	18	0	0.29
EOG 08_20	2601.51	288	19	15	146	0.34
EOG 08_20	2602.515	303	38	8	179	0.37
EOG 08_20	2602.75	318	32	10	200	0.39
EOG 08_20	2602.85	0	0	31	0	0.29
EOG 08_20	2603	262	30	9	154	0.37
EOG 08_20	2603.2	293	56	5	204	0.41
EOG 08_20	2603.3	295	89	3	305	0.51
EOG 08_20	2603.4					
EOG 08_20	2603.5	146	14	11	5	0.04

EOG 08_20	2603.5	218	10	23	100	0.31
EOG 08_20	2603.62	1184	368	3	1211	0.51
EOG 08_20	2604.405	325	48	7	243	0.43
EOG 08_20	2605.565	479	127	4	448	0.48
EOG 08_20	2606.5	272	43	6	204	0.43
EOG 08_20	2607.545	256	8	32	93	0.27
EOG 08_20	2608.5	216	4	49	69	0.24
EOG 08_20	2609.865	353	72	5	200	0.36
EOG 08_20	2610.51	273	8	35	95	0.26
EOG 08_20	2611.54	265	5	50	91	0.26
EOG 08_20	2612.5	239	4	57	81	0.25
EOG 08_20	2613.455	60	96	1	20	0.25
EOG 08_20	2613.455	154	43	4	204	0.57
EOG 08_20	2614.28	355	53	7	214	0.38
EOG 08_20	2615.585			38		0.30
EOG 08_20	2616.415	125	5	27	59	0.32
EOG 08_20	2617.38	21	5	4	26	0.55
EOG 08_20	2618.5	42	9	5	43	0.50
EOG 08_20	2619.06	451	19	24	169	0.27
EOG 08_20	2620.475					
EOG 08_20	2621.5	200	20	10	107	0.35
EOG 08_20	2622.37	479	8	64	134	0.22
EOG 08_20	2623.62					
EOG 08_20	2624.5	201	4	51	1	0.01
EOG 08_20	2624.5	218	3	74	47	0.18
EOG 08_20	2625.525	18	4	4	14	0.45
EOG 08_20	2626.5	300	34	9	160	0.35
EOG 08_20	2627.5	209	10	21	79	0.27

Appendix D: Complete Comparison of Published and Analyzed Results for International Shale Standards

Table 33. Complete Comparison of Published and Analyzed Results for International Shale Standards

	Cody Sh Analy.	**Cody Sh Analy.**	**Cody Sh Stand. Values**	**Brush Creek Analy.**	**Brush Ck Sh Stand. Values**	**Carb. Sh Analy.**	**Carb. Sh Stand. Values**
Well ID	08_20	09_06		11_04 &16_28		11_04 &16_29	
SiO_2	62.69	62.96	**62.8±0.66**	46.77	**47.64±.09**	54.65	**56.67**
Al2O3	13.39	13.85	**13.7±0.21**	21.3	**21.0±0.04**	13.26	**13.5**
$Fe2O_3$	5.07	5.17	**4.19±0.19**	9.86	**9.71±0.02**	4.19	**4.23**
MgO	2.66	2.79	**2.72±0.18**	2.65	**2.60±0.01**	8.24	**8.10**
CaO	2.57	2.66	**2.62±0.20**	3.06	**2.95±0.01**	1.5	**1.50**
Na2O	0.87	0.91	**0.90±0.06**	0.22	**<0.15**	1.03	**0.93**
K2O	2.71	2.75	**2.77±0.08**	3.5	**3.45±0.01**	1.36	**1.39**
TiO_2	0.57	0.58	**0.63±0.06**	0.83	**0.86±.003**	0.55	**0.55**
P2O5	0.21	0.19	**0.21±0.02**	0.38	**0.37±.002**	0.05	**0.05**
MnO	0.05	0.05		0.15	**0.15±.001**	0.06	**0.08**
Cr2O3	0.012	0.012		0.015		0.017	
Ni	<20	24		73	**82.8±0.8**	110	**122**
Sc	11	11		22	**20±0.2**	14	
LOI	9	N.A.		11		14.9	
Sum	99.79	91.94		99.74		99.81	
Ba	577	580	**570±30**	721	**788±7.7**	615	**820**
Be	2	2	**1.8 ±0.2**	4	**3.2±0.08**	6	
Co	10.7	10.5	**11 ±0.8**	20.1	**22.7±0.03**	10.8	
Cs	7.7	7	**7.8 ±0.7**	7.1	**8.2±0.1**	2.6	
Ga	14.9	14.2		23	**27±0.3**	15.7	
Hf	4.8	4.4		3.7	**3.7±0.1**	3.7	
Nb	10.7	10.2		13.7	**15.3±0.2**	6.5	
Rb	110.7	106		126.8	**147±1**	46.7	
Sn	3	3		3	**3.3±0.1**	1	
Sr	180.1	177.2	**170±16**	184.1	**178±1.4**	49.4	
Ta	0.8	0.6		1	**1.1±0.03**	0.6	

Th	9.2	9.8	**9.7 ± 0.5**	14.5	**15.8±0.2**	11.3	
U	2.8	3.2		5.4	**5.76±0.11**	1.8	
V	130	126	**130 ± 13**	223	**220±1.4**	141	**139**
W	1.5	1.2	**1.4**	1.5	**1.6±0.05**	0.5	
Zr	169.4	161.9	**160±30**	126.2	**134±1.6**	121.8	**1466**
Y	23.3	22.7	**26±4**	34.8	**36.5±0.3**	13	**17**
La	28.9	30.5		50.2	**52.5±0.6**	30.6	
Ce	54.3	58.9	**62 ±6**	109.2	**108±0.9**	62.7	
Pr	6.9	6.75		12.45	**12.6±0.1**	6.18	
Nd	25.3	23.6	**26±2**	49	**49.2±0.5**	21.9	
Sm	4.9	4.75		9.19	**9.6±0.1**	3.83	
Eu	1.04	1.01		1.81	**1.98±0.02**	0.64	
Gd	4.61	4.43		8.49	**8.5±0.1**	3.45	
Tb	0.7	0.68		1.25	**1.2±0.02**	0.48	
Dy	3.99	3.98		6.62	**7.1±0.09**	2.52	
Ho	0.7	0.77		1.26	**1.4±0.02**	0.47	
Er	2.25	2.17		3.83	**3.8±0.05**	1.3	
Tm	0.35	0.35		0.52	**0.56±0.01**	0.2	
Yb	2.31	2.24		3.57	**3.64±0.3**	1.37	
Lu	0.36	0.35		0.55	**0.54±0.01**	0.22	
TOT/C	1.07	1.11		2.34		6.81	
TOT/S	0.1	0.07		0.73		0.17	
Mo	0.6	0.7	**1.4±0.2**	1.6	**2.4±0.07**	0.9	
Cu	24.3	25.9	**29±2**	29.7	**31±0.6**	48.3	**53**
Pb	25.2	29.8	**29 ±2**	28.6	**35±0.3**	8.5	
Zn	78	86	**100 ±8**	165	**186±1.7**	70	
Ni	20.3	22.4		68.2	**82.8±0.8**	102.8	**122**
As	8.7	10.4	**12±1**	25.3	**25.7 ±0.7**	20.6	
Cd	0.1	<0.1		0.4	**0.4±0.02**	0.1	
Sb	0.4	0.8	**2.5±0.1**	0.3	**1.01±0.03**	0.3	
Bi	0.3	0.4		0.7	**0.7±0.02**	0.3	
Ag	<0.1	<0.1		<0.1		<0.1	
Au	<0.5	1.1		1.1		1.4	
Hg	0.06	0.07		0.07		<0.01	
Tl	0.1	0.2		0.1	**0.89±0.01**	0.8	
Se	0.6	0.6		1.3		2.8	

Appendix E: Select Average Values for Each Well and Interval

Table 34. Select Average Values for Guidex 09-06

Well ID	Interval	TOC (wt %)	Tmax (^{0}C)	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)	TiO_2 (%)	Zr (ppm)	TOT/C (%)
Guidex 09-06	RST3	2.06	446	49.3	12.9	13.2	0.52	95.6	4.1
	TST3	2.30	444	42.0	8.8	20.6	0.43	99.6	6.8
	RST2	3.32	441	41.3	10.8	18.3	0.52	106.0	7.2
	TST2	3.83	444	39.8	8.1	21.6	0.38	66.9	8.4
	RST1	4.10	443	43.2	9.8	16.8	0.43	86.4	7.9
	TST1	2.90	444	43.0	12.2	16.2	0.53	92.7	6.1
Well ID	**Interval**	**TOT/S (%)**	**Fe (%)**	**Mo/Al (ppm/%)**	**U/Al (ppm/%)**	**V/Al (ppm/%)**	**Zr/TiO_2 (ppm/%)**	**Al (%)**	**Fe/S**
Guidex 09-06	RST3	1.13	3.25	1.47	1.07	23.7	185	6.80	2.88
	TST3	1.30	2.49	3.84	2.87	32.4	232	4.66	1.92
	RST2	2.04	3.12	4.90	4.61	47.1	224	5.74	1.45
	TST2	1.61	2.22	4.62	2.54	42.6	178	4.29	1.34
	RST1	2.20	3.23	3.66	2.48	31.3	212	5.21	1.58
	TST1	1.56	3.57	0.69	0.62	14.3	177	6.48	2.44

Table 35. Select Average Values for Shell 02-22

Well ID	Interval	TOC (wt %)	Tmax (^{0}C)	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)	TiO_2 (%)	Zr (ppm)	TOT/C (%)
Shell 02-22	RST3	2.58	473	56.2	6.2	15.3	0.33	89.2	5.7
	TST3	2.83	474	49.4	8.7	16.8	0.41	83.2	6.9
	RST2	2.87	472	53.4	7.7	15.2	0.37	70.7	6.6
	TST2	2.76	470	48.7	9.0	15.9	0.44	94.4	6.8
	RST1	1.01	454	28.8	7.6	30.6	0.30	45.4	7.8
	TST1	2.40	468	43.4	10.1	18.4	0.40	62.5	7.2
Well ID	**Interval**	**TOT/S (%)**	**Fe (%)**	**Mo/Al (ppm/%)**	**U/Al (ppm/%)**	**V/Al (ppm/%)**	**Zr/TiO_2 (ppm/%)**	**Al (%)**	**Fe/S**
Shell 02-22	RST3	1.35	2.35	4.63	1.95	54.2	268	3.26	2.03
	TST3	1.36	2.41	2.09	1.27	37.9	205	4.63	1.92
	RST2	1.39	2.30	2.38	1.47	29.6	197	4.08	1.82
	TST2	1.34	2.67	3.45	1.71	27.9	223	4.77	2.27
	RST1	0.85	1.77	0.57	0.67	16.9	158	4.01	2.12
	TST1	1.21	2.60	1.13	1.02	21.5	156	5.35	2.27

Table 36. Select Average Values for Encana 11-04

Well ID	Interval	TOC (wt %)	Tmax (^{0}C)	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)	TiO_2 (%)	Zr (ppm)	TOT/C (%)
Encana 11-04	RST3	1.54	259	41.4	10.9	19.5	0.46	78.0	6.0
	TST3	2.08	320	43.9	11.8	16.5	0.51	88.7	5.9
	RST2	3.09	441	46.2	9.9	16.8	0.42	72.8	7.3
	TST2	3.48	396	51.6	6.4	16.7	0.31	60.9	8.2
	RST1	1.64	445	31.7	6.0	30.5	0.26	46.0	8.7
	TST1	2.85	520	31.5	4.9	30.9	0.23	40.2	10.5
Well ID	**Interval**	**TOT/S (%)**	**Fe (%)**	**Mo/Al (ppm/%)**	**U/Al (ppm/%)**	**V/Al (ppm/%)**	**Zr/TiO_2 (ppm/%)**	**Al (%)**	**Fe/S**
Encana 11-04	RST3	1.25	3.33	0.81	0.67	17.6	171	5.75	3.26
	TST3	1.83	3.64	0.74	0.65	19.1	175	6.27	2.14
	RST2	1.61	2.74	2.48	1.37	26.6	176	5.23	1.82
	TST2	1.18	1.95	3.87	1.94	46.5	212	3.41	1.65
	RST1	1.48	1.86	1.00	1.11	23.4	175	3.16	1.29
	TST1	1.54	1.77	2.53	1.62	37.3	179	2.58	1.15

Table 37. Select Average Values for Esso 16-28

Well ID	Interval	TOC (wt %)	Tmax (^{0}C)	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)	TiO_2 (%)	Zr (ppm)	TOT/C (%)
Esso 16-28	RST3	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	TST3	0.33	433	2.9	0.6	52.9	0.05	12.4	12.0
	RST2	1.19	425	9.3	1.9	47.9	0.11	39.4	11.7
	TST2	1.73	420	17.4	3.8	41.0	0.22	72.6	10.7
	RST1	3.56	422	19.5	4.8	37.0	0.26	72.5	11.6
	TST1	5.43	418	33.4	6.0	25.9	0.35	92.5	11.6
Well ID	**Interval**	**TOT/S (%)**	**Fe (%)**	**Mo/Al (ppm/%)**	**U/Al (ppm/%)**	**V/Al (ppm/%)**	**Zr/TiO_2 (ppm/%)**	**Al (%)**	**Fe/S**
Esso 16-28	RST3	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	TST3	0.39	0.43	1.57	3.78	50.39	248	0.32	1.11
	RST2	0.88	0.89	1.37	3.35	28.49	360	0.99	1.07
	TST2	0.78	0.99	0.45	1.79	21.44	330	2.01	1.27
	RST1	1.78	1.98	0.89	1.41	20.19	296	2.52	1.12
	TST1	1.58	2.00	2.19	1.38	19.16	271	3.15	1.35

Table 38. Select Average Values for EOG 08-20

Well ID	Interval	TOC (wt %)	Tmax (^{0}C)	SiO_2 (%)	Al_2O_3 (%)	CaO+MgO (%)	TiO_2 (%)	Zr (ppm)	TOT/C (%)
EOG 08-20	RST3	1.27	448	10.5	2.8	45.2	0.14	30.2	11.4
	TST3	1.72	446	15.0	4.4	40.3	0.19	33.9	11.1
	RST2	1.17	446	18.5	6.0	36.7	0.24	39.9	9.7
	TST2	1.52	448	16.4	4.4	38.4	0.21	36.5	10.8
	RST1	2.58	446	25.6	8.0	29.6	0.34	65.9	10.3
	TST1	4.06	453	10.4	2.9	44.4	0.13	25.9	11.0
Well ID	**Interval**	**TOT/S (%)**	**Fe (%)**	**Mo/Al (ppm/%)**	**U/Al (ppm/%)**	**V/Al (ppm/%)**	**Zr/TiO_2 (ppm/%)**	**Al (%)**	**Fe/S**
EOG 08-20	RST3	0.87	0.98	1.37	2.76	29.6	213	1.46	1.70
	TST3	0.88	1.36	1.54	2.59	28.4	208	2.31	1.78
	RST2	0.72	1.47	0.59	1.24	17.1	165	3.16	2.24
	TST2	0.55	1.04	0.87	1.75	22.3	178	2.34	1.90
	RST1	1.46	2.31	1.21	1.22	18.2	187	4.23	1.81
	TST1	0.20	0.87	0.39	1.16	12.2	199	1.56	4.37

Appendix F: Leco TOC and RockEval Data

Table 39. Leco TOC and Rockeval Data (S2>1): Guidex 09-06 (purple) and Encana 11-04 (orange)

Well ID	Depth Shifted	UofA ID	TOC (%)	S1	S2	S3	Tmax	HI	OI	Well Avg
09_06	2548.94	3	0.81	0.58	1.63	0.28	445	202	35	444
09_06	2549.65	4	2.11	1.17	5.15	0.25	445	245	12	
09_06	2551.14	5	2.37	1.43	6.09	0.31	445	257	13	
09_06	2552.93	6	2.02	1.25	5.38	0.44	448	267	22	
09_06	2553.59	7	3.02	2.08	8.88	0.43	445	294	14	
09_06	2555.09	8	2.30	1.51	6.49	0.40	444	283	17	
09_06	2556.52	9	4.12	2.85	15.82	0.30	444	384	7	
09_06	2557.13	10	3.59	2.42	13.64	0.37	444	380	10	
09_06	2558.2	11	0.56	0.51	1.12	0.33	432	201	59	
09_06	2558.3	12	5.02	3.14	21.09	0.48	444	420	10	
09_06	2558.71	13	5.54	3.99	23.42	0.30	442	423	5	
09_06	2559.77	14	2.11	1.13	5.91	0.34	445	280	16	
09_06	2560.48	15	5.10	3.78	22.48	0.29	442	441	6	
09_06	2561.06	16	1.36	1.18	3.53	0.26	440	259	19	
09_06	2562.61	17	4.50	2.77	16.33	0.37	445	363	8	
09_06	2563.07	18	5.46	3.24	24.86	0.28	444	456	5	
09_06	2563.49	19	5.26	3.63	23.82	0.27	443	453	5	
09_06	2564.02	20	1.02	0.60	1.92	0.36	445	188	35	
09_06	2565.91	21	2.42	1.43	6.65	0.31	444	275	13	
09_06	2566.24	22	2.65	1.72	7.61	0.35	443	287	13	
09_06	2566.4	23	2.65	2.00	9.80	0.28	443	370	11	
09_06	2566.69	24	3.41	1.95	10.83	0.25	445	318	7	
11_04	3982.29	42	4.35	4.63	1.16	0.66	377	27	15	369
11_04	3985	45	3.16	8.28	1.05	0.46	364	33	15	
11_04	3985.955	46	3.94	7.43	1.32	0.53	367	33	13	

Table 40. Leco TOC and RockEval Data (S2 > 1): Shell 02-22 (teal)

Well ID	Depth Shifted	UofA ID	TOC (%)	S1	S2	S3	Tmax	HI	OI	Well Avg
02_22	3085.09	6	2.94	1.78	1.99	0.58	473	68	20	473
02_22	3086.09	7	2.42	1.58	1.59	0.38	471	66	16	
02_22	3087.09	8	2.54	1.50	1.47	0.38	470	58	15	
02_22	3088.09	9	2.64	1.61	1.52	0.58	471	58	22	
02_22	3088.44	10	3.18	2.08	2.15	0.32	475	68	10	
02_22	3089.09	11	2.73	2.03	1.86	0.37	477	68	14	
02_22	3089.81	12	1.79	2.52	1.27	0.61	472	71	34	
02_22	3090.09	13	2.42	2.08	1.63	0.30	478	67	12	
02_22	3090.69	14	2.61	1.61	1.58	0.35	469	60	13	
02_22	3091.39	15	3.83	1.66	2.39	0.35	476	62	9	
02_22	3092.19	16	2.09	1.08	1.18	0.42	464	56	20	
02_22	3092.99	17	2.84	2.14	2.63	0.42	483	93	15	
02_22	3094.09	18	2.98	1.75	1.55	0.23	473	52	8	
02_22	3095.09	19	2.83	1.53	1.54	0.22	470	54	8	
02_22	3096.09	20	3.65	1.65	1.91	0.32	481	52	9	
02_22	3097.09	21	2.90	1.62	1.96	0.30	472	68	10	
02_22	3097.79	22	3.13	1.99	2.05	0.34	477	65	11	
02_22	3098.09	23	2.46	1.44	1.53	0.32	475	62	13	
02_22	3098.83	24	1.91	1.43	1.09	0.27	470	57	14	
02_22	3099.34	25	2.68	2.36	2.08	0.42	476	77	16	
02_22	3100.27	26	2.53	1.43	1.74	0.27	473	69	11	
02_22	3101.09	27	2.91	2.84	3.57	0.58	474	123	20	
02_22	3102.09	28	2.68	1.54	1.48	0.30	473	55	11	
02_22	3103.04	29	2.56	4.16	1.91	0.52	472	75	20	
02_22	3103.99	30	2.25	4.45	2.08	0.29	469	93	13	
02_22	3105.09	31	3.18	2.44	2.28	0.37	473	72	12	
02_22	3106.09	32	3.17	2.83	2.30	0.38	472	73	12	
02_22	3107.34	33	3.61	2.14	2.74	0.37	471	76	10	
02_22	3108.09	34	4.43	2.22	2.80	0.25	472	63	6	
02_22	3108.49	35	2.35	1.44	1.53	0.34	478	65	14	
02_22	3109.09	36	2.56	1.50	1.66	0.29	477	65	11	
02_22	3110.09	37	3.45	2.19	2.50	0.27	473	72	8	
02_22	3111.09	38	2.24	2.56	2.96	0.22	472	132	10	
02_22	3112.09	39	2.87	2.26	2.89	0.24	470	101	8	
02_22	3113.09	40	3.89	2.62	3.17	0.18	471	82	5	
02_22	3114.09	41	3.53	1.95	2.29	0.24	479	65	7	
02_22	3115.09	42	2.69	2.07	2.22	0.23	482	82	9	
02_22	3116.09	43	3.21	2.20	2.81	0.20	473	87	6	
02_22	3116.59	44	2.91	1.77	1.83	0.22	477	63	8	
02_22	3118.09	45	3.43	2.50	3.39	0.31	471	99	9	
02_22	3120.09	48	3.46	1.98	2.50	0.28	480	72	8	
02_22	3121.09	49	5.62	2.92	4.90	0.17	475	87	3	
02_22	3121.64	50	1.65	1.43	1.19	0.21	464	72	13	
02_22	3122.09	51	3.06	1.88	2.35	0.19	477	77	6	
02_22	3123.09	53	2.30	1.61	1.51	0.18	468	66	8	
02_22	3123.96	54	2.55	1.51	2.05	0.19	478	81	7	
02_22	3124.09	55	3.71	2.49	3.40	0.22	471	92	6	
02_22	3125.09	56	2.01	1.21	1.41	0.25	466	70	12	
02_22	3125.54	57	2.75	1.93	2.44	0.24	472	89	9	
02_22	3125.89	58	2.58	2.23	2.54	0.21	481	98	8	
02_22	3133.09	67	1.69	1.18	1.01	0.56	454	60	33	
02_22	3134.09	68	2.26	1.29	1.24	0.32	461	55	14	
02_22	3134.19	69	1.92	1.35	1.09	0.26	468	57	14	
02_22	3135.09	70	2.73	2.53	2.76	0.19	476	101	7	
02_22	3135.33	71	3.07	2.48	3.17	0.16	474	103	5	
02_22	3137.09	74	3.46	2.73	3.73	0.31	474	108	9	
02_22	3137.49	75	2.15	1.71	1.30	0.30	459	60	14	
02_22	3138.09	76	2.59	2.09	1.92	0.35	470	74	14	

Table 41. Leco TOC and Rockeval Data (S2>1) for Esso 16-28 (green)

Well ID	Depth Shifted	UofA ID	TOC (%)	S1	S2	S3	Tmax	HI	OI	Well Avg
16_28	1117.51	11	0.77	0.16	2.69	0.46	422	351	60	421
16_28	1118.4	12	0.69	0.22	2.53	0.43	425	366	62	
16_28	1120.46	14	2.66	0.57	13.15	1.01	420	494	38	
16_28	1121.48	15	3.78	0.99	20.35	1.23	419	538	33	
16_28	1122.55	16	1.53	0.47	7.13	0.79	418	467	52	
16_28	1123.6	17	0.61	0.20	2.16	0.50	430	354	82	
16_28	1125.48	19	1.68	0.36	9.19	0.85	421	547	51	
16_28	1126.53	20	1.46	0.32	7.46	0.84	419	511	58	
16_28	1130.31	24	1.60	0.30	7.28	0.72	422	454	45	
16_28	1131.53	25	2.91	0.58	15.39	1.21	419	529	42	
16_28	1132.54	26	1.73	0.37	8.41	0.85	420	485	49	
16_28	1133.54	27	2.67	0.48	14.32	1.04	422	536	39	
16_28	1135.68	29	2.66	0.48	12.64	0.93	424	476	35	
16_28	1136.7	30	1.87	0.38	9.65	0.85	421	516	45	
16_28	1138.62	32	2.98	0.47	13.90	1.06	422	467	36	
16_28	1140.52	34	3.40	0.63	17.84	1.41	423	524	41	
16_28	1141.15	35	3.54	0.64	17.87	1.29	419	505	36	
16_28	1142.52	36	3.05	0.54	14.22	1.21	419	466	40	
16_28	1143.4	37	3.29	0.54	15.12	1.13	420	460	34	
16_28	1145.57	39	3.81	0.67	17.71	1.39	421	465	37	
16_28	1146.4	40	2.63	0.50	11.56	1.06	422	440	40	
16_28	1147.4	41	2.00	0.39	9.20	0.98	423	459	49	
16_28	1148.55	42	4.40	0.68	22.37	1.35	421	508	31	
16_28	1149.53	43	4.75	0.87	23.36	1.36	418	492	29	
16_28	1150.5	44	3.94	0.83	19.49	1.18	418	495	30	
16_28	1151.4	45	3.77	0.57	18.92	1.17	423	502	31	
16_28	1152.51	46	3.21	0.47	15.34	1.09	422	478	34	
16_28	1153.63	47	4.59	0.80	24.75	1.48	422	539	32	
16_28	1154.62	48	4.73	1.01	26.04	1.50	418	550	32	
16_28	1155.48	49	5.48	1.06	30.31	1.60	418	553	29	
16_28	1156.47	50	8.15	1.68	40.50	1.92	419	497	24	
16_28	1157.49	51	8.26	1.88	40.92	1.93	421	495	23	
16_28	1158.39	52	2.41	0.44	12.20	0.93	424	507	39	
16_28	1159.4	53	8.82	2.33	41.02	2.13	418	465	24	
16_28	1160.57	54	9.00	2.39	47.06	2.08	415	523	23	
16_28	1161.52	55	0.92	0.25	4.08	0.76	424	442	82	
16_28	1162.5	56	5.00	1.41	28.41	1.59	417	568	32	
16_28	1163.55	57	6.79	1.91	35.25	1.69	416	519	25	

Table 42. Leco TOC and Rockeval Data (S2>1) for EOG 08-20 (blue)

Well ID	Depth Shifted	UofA ID	TOC (%)	S1	S2	S3	Tmax	HI	OI	Well Avg
08_20	2570.44	7		0.99	2.87	0.19	446	0	0	448
08_20	2571.55	8	0.61	0.62	1.48	0.16	448	242	26	
08_20	2572.4	9	0.54	0.53	1.35	0.21	446	248	39	
08_20	2574.515	11	3.54	2.88	7.70	0.31	454	218	9	
08_20	2575.445	12	0.56	0.89	1.62	0.22	450	288	39	
08_20	2576.545	13	0.64	0.83	1.37	0.23	442	216	36	
08_20	2577.5	14	1.84	1.73	4.88	0.22	451	265	12	
08_20	2578.61	15	0.90	0.95	2.40	0.21	447	268	23	
08_20	2579.425	16	1.93	1.79	5.30	0.20	452	274	10	
08_20	2582.535	17	2.42	2.48	6.11	0.31	454	252	13	
08_20	2583.51	18	0.92	1.37	2.57	0.22	441	278	24	
08_20	2584.5	19	0.80	1.03	2.02	0.11	445	252	14	
08_20	2585.465	20	0.52	1.18	1.51	0.12	444	292	23	
08_20	2586.5	21	0.93	1.39	2.84	0.19	446	307	21	
08_20	2587.5	22	3.56	2.42	7.17	0.26	453	201	7	
08_20	2588.5	23	1.29	1.79	3.44	0.17	447	267	13	
08_20	2589.6	24		1.12	2.05	0.17	441	0	0	
08_20	2590.51	25	1.42	1.54	3.85	0.21	450	271	15	
08_20	2591.36	26	2.64	1.85	6.26	0.21	452	237	8	
08_20	2591.455	27	0.93	0.98	2.29	0.14	446	248	15	
08_20	2591.61	28	1.15	1.39	3.55	0.17	449	310	15	
08_20	2591.87	29	1.19	1.30	3.21	0.24	449	271	20	
08_20	2592.525	31	6.06	2.80	9.09	0.21	451	150	3	
08_20	2593.12	92	3.71	2.84	7.81	0.39	453	211	11	
08_20	2593.555	32		1.67	3.45	0.13	447	0	0	
08_20	2594.5	33		0.91	1.14	0.16	446	0	0	
08_20	2595.4	34	1.17	1.31	2.51	0.16	450	215	14	
08_20	2596.52	35	0.79	0.82	1.89	0.14	449	238	18	
08_20	2599.25	40	1.60	1.70	4.00	0.21	449	250	13	
08_20	2599.39	41	2.83	2.24	7.04	0.22	451	248	8	
08_20	2599.5	42	8.38	5.21	21.21	0.29	452	253	3	
08_20	2599.6	43	4.45	3.61	10.97	0.24	451	246	5	
08_20	2599.765	44	0.45	1.23	1.59	0.24	438	352	53	
08_20	2600.07	47	0.70	1.16	1.88	0.22	443	267	31	
08_20	2600.15	48	1.28	1.75	3.19	0.33	448	248	26	
08_20	2600.25	49	0.96	1.34	2.29	0.35	448	238	36	
08_20	2600.5	51	0.81	1.45	2.36	0.32	445	291	39	
08_20	2600.62	52	1.08	1.64	3.08	0.43	449	287	40	
08_20	2600.725	53	0.44	0.73	1.05	0.27	438	237	61	
08_20	2601.04	55	1.09	1.30	2.11	0.26	446	194	24	
08_20	2601.14	56	1.27	1.89	3.98	0.31	450	313	24	
08_20	2601.24	57		3.42	8.24	0.45	452	0	0	
08_20	2601.51	58	1.08	1.58	3.11	0.21	449	288	19	
08_20	2602.515	59	0.70	1.26	2.13	0.27	445	303	38	
08_20	2602.75	60	0.81	1.63	2.59	0.26	448	318	32	
08_20	2602.85	61		3.08	7.71	0.25	451	0	0	
08_20	2603	62	0.90	1.38	2.35	0.27	444	262	30	
08_20	2603.2	63	0.54	1.10	1.58	0.30	443	293	56	
08_20	2603.5	66	2.17	2.17	4.74	0.21	452	218	10	
08_20	2604.405	68	0.61	1.47	1.97	0.29	442	325	48	
08_20	2606.5	70	0.53	1.08	1.44	0.23	444	272	43	
08_20	2607.545	71	3.03	2.80	7.73	0.24	454	256	8	
08_20	2608.5	72	4.51	3.11	9.72	0.20	453	216	4	
08_20	2610.51	74	2.81	2.68	7.69	0.22	452	273	8	
08_20	2611.54	75	3.74	3.42	9.90	0.20	454	265	5	
08_20	2612.5	76	5.75	4.67	13.76	0.24	453	239	4	
08_20	2614.28	78	0.53	1.14	1.89	0.28	443	355	53	
08_20	2615.585	79		3.09	7.27	0.19	453			
08_20	2616.415	80	4.06	2.39	5.09	0.19	453	125	5	

Table 43. Values Excluded with S2<1: Guidex 09-06 (purple), Shell 02-22 (teal), Encana 11-04 (orange), Esso 16-28 (green) and EOG 08-20 (blue)

Formation	Well ID	Depth	Depth Shifted	UofA ID	TOC (%)	S1	S2	S3	Tmax	HI	OI	S2/S3	S1/TOC	PI
IRE	11_04	3932.475	3936.475	71	0.33	0.03	0.03	0.22	-1	9	67	0.1	9	0.50
IRE	11_04	3933.47	3937.47	72	0.37	0.05	0.03	0.23	-1	8	63	0.1	14	0.63
DUV	16_28	1115.33	1115.33	**9**	0.19	0.04	0.05	0.19	427	27	102	0.3	22	0.44
IRE	11_04	3933.515	3937.515	73	0.48	0.10	0.05	0.33	422	10	68	0.2	21	0.67
DUV	11_04	3936.515	3940.515	2	0.97	0.15	0.05	0.24	342	5	25	0.2	15	0.75
DUV	11_04	3981.53	3987.03	47	0.84	0.82	0.05	0.47	423	6	56	0.1	98	0.94
DUV	11_04	3982.465	3988.165	48	1.02	0.43	0.05	0.33	360	5	33	0.2	42	0.90
DUV	11_04	3939.42	3943.42	5	1.01	0.19	0.07	0.20	308	7	20	0.3	19	0.73
DUV	02_22	**3114.5**	3127.09	60	**0.25**	**0.19**	**0.08**	**0.31**	**448**	**32**	**123**	**0.26**	**75**	**0.70**
DUV	11_04	3938.5	3942.5	4	1.16	0.16	0.09	0.18	-1	8	16	0.5	14	0.64
DUV	11_04	3937.51	3941.51	3	1.20	0.23	0.10	0.25	362	8	21	0.4	19	0.69
DUV	11_04	3955.49	3959.49	21	1.53	0.16	0.10	0.25	301	7	16	0.4	10	0.61
DUV	08_20	2569.475	2569.475	**6**	0.08	0.06	0.12	0.29	449	148	358	0	74	0.33
DUV	11_04	3935.5	3939.5	1	1.10	0.19	0.12	0.36	424	11	33	0.3	17	0.62
DUV	11_04	3952.515	3956.515	18	1.29	0.14	0.12	0.20	305	9	16	0.6	11	0.53
DUV	11_04	3985.465	3990.665	51	2.52	0.16	0.12	0.25	516	5	10	0.5	6	0.57
DUV	11_04	3953.38	3957.38	19	1.41	0.18	0.14	0.34	423	10	24	0.4	12	0.56
DUV	11_04	3950.64	3954.64	16	1.55	0.22	0.15	0.27	-1	10	17	0.6	15	0.60
DUV	11_04	3986.48	3991.68	52	2.88	0.16	0.15	0.20	520	5	7	0.8	6	0.52
DUV	11_04	3987.48	3992.68	53	2.91	0.20	0.15	0.21	516	5	7	0.7	7	0.57
DUV	11_04	3959.5	3963.5	25	1.70	0.14	0.16	0.31	436	9	18	0.5	8	0.46
DUV	02_22	**3115.4**	3127.99	61	**0.38**	**0.30**	**0.17**	**0.30**	**437**	**45**	**79**	**0.57**	**79**	**0.64**
DUV	16_28	1129.74	1129.74	**23**	0.23	0.02	0.17	0.21	431	73	90	0.8	8	0.10
DUV	16_28	1119.64	1119.64	**13**	0.22	0.02	0.18	0.24	430	84	112	0.8	10	0.10
DUV	16_28	1134.64	1134.64	**28**	0.22	0.03	0.18	0.33	429	82	151	0.5	13	0.14
DUV	11_04	3956.475	3960.475	22	2.25	0.18	0.19	0.25	430	8	11	0.8	8	0.49
DUV	11_04	3957.515	3961.515	23	1.45	0.23	0.19	0.26	344	13	18	0.7	16	0.55
DUV	08_20	2598.455	2598.455	**37**	0.20	0.23	0.20	0.10	444	99	49	2	113	0.53
DUV	16_28	1128.42	1128.42	**22**	0.31	0.04	0.20	0.32	431	65	104	0.6	13	0.16
DUV	11_04	3951.53	3955.53	17	1.59	0.33	0.21	0.27	-1	13	17	0.8	21	0.61
DUV	16_28	1137.44	1137.44	**31**	0.27	0.07	0.22	0.35	430	83	132	0.6	27	0.24
DUV	11_04	3940.515	3944.515	6	1.61	0.60	0.22	0.29	-1	14	18	0.8	37	0.73
DUV	11_04	3974.54	3980.34	40	2.02	0.77	0.22	0.38	351	11	19	0.6	38	0.78
DUV	11_04	3941.595	3945.595	7	1.23	1.72	0.23	0.50	376	19	41	0.5	140	0.88
DUV	11_04	3982.573	3988.273	69	2.06	0.25	0.24	0.28	479	12	14	0.9	12	0.51
DUV	11_04	3988.42	3994.42	54	2.85	0.31	0.24	0.24	525	8	8	1.0	11	0.56
DUV	11_04	3974.91	3980.71	68	1.60	0.39	0.25	0.33	424	16	21	0.8	24	0.61
DUV	02_22	3116.5	3129.09	62	0.53	0.41	0.26	0.30	459	49	57	1	77	0.61
DUV	16_28	1116.63	1116.63	**10**	0.23	0.09	0.26	0.33	430	111	141	0.8	39	0.26
DUV	11_04	3958.49	3962.49	24	2.36	0.30	0.26	0.23	449	11	10	1.1	13	0.54
DUV	11_04	3960.5	3964.5	26	1.98	0.30	0.26	0.31	366	13	16	0.8	15	0.54
DUV	11_04	3960.84	3964.84	66	2.19	0.27	0.26	0.26	429	12	12	1.0	12	0.51
DUV	11_04	3978.415	3983.915	44	1.18	2.69	0.26	0.53	339	22	45	0.5	228	0.91
DUV	11_04	3983.51	3989.21	49	2.66	0.32	0.26	0.31	517	10	12	0.8	12	0.55
DUV	11_04	3949.52	3953.52	15	1.63	0.88	0.28	0.39	347	17	24	0.7	54	0.76
DUV	11_04	3954.54	3958.54	20	2.06	0.56	0.31	0.39	338	15	19	0.8	27	0.64
DUV	11_04	3968.46	3972.46	34	2.86	0.46	0.31	0.30	517	11	10	1.0	16	0.60
DUV	11_04	3984.5	3990.2	50	3.07	0.50	0.32	0.34	523	10	11	0.9	16	0.61
DUV	11_04	3965.67	3969.67	67	3.15	0.51	0.33	0.37	507	10	12	0.9	16	0.61
DUV	02_22	3119.5	3132.09	66	0.83	0.33	0.37	0.36	468	45	43	1	40	0.47
DUV	11_04	3948.45	3952.45	14	1.93	0.82	0.37	0.43	349	19	22	0.9	43	0.69
DUV	11_04	3973.54	3979.34	39	2.96	0.59	0.38	0.33	503	13	11	1.2	20	0.61
DUV	11_04	3969.43	3973.43	35	3.69	0.75	0.39	0.36	520	11	10	1.1	20	0.66
DUV	08_20	2599.86	2599.86	**45**	0.30	0.34	0.41	0.18	436	136	60	2	113	0.45
DUV	08_20	2599	2599	**38**	0.34	0.44	0.41	0.25	440	122	74	2	131	0.52

DUV	08_20	2599.86	2599.86	**45**	0.30	0.34	0.41	0.18	436	136	60	2	113	0.45
DUV	08_20	2599	2599	**38**	0.34	0.44	0.41	0.25	440	122	74	2	131	0.52
DUV	02_22	3116.85	3129.44	63	0.92	0.51	0.42	0.44	444	46	48	1	55	0.55
DUV	02_22	3106.39	3118.98	46	0.90	0.73	0.43	0.25	452	48	28	2	81	0.63
DUV	11_04	3963.49	3967.49	29	3.16	1.17	0.43	0.37	432	14	12	1.2	37	0.73
DUV	11_04	3970.44	3976.24	36	3.49	1.43	0.43	0.37	511	12	11	1.2	41	0.77
DUV	11_04	3975.5	3981.3	41	4.31	0.27	0.43	0.48	536	10	11	0.9	6	0.39
DUV	16_28	1114.57	1114.57	**8**	0.33	0.08	0.44	0.25	433	133	75	1.8	24	0.15
DUV	08_20	2603.62	2603.62	**67**	0.04	0.46	0.45	0.14	436	1184	368	3	1211	0.51
DUV	11_04	3977.47	3982.97	43	4.78	0.60	0.45	0.40	534	9	8	1.1	13	0.57
DUV	08_20	2613.455	2613.455	**77**	0.30	0.61	0.46	0.13	428	154	43	4	204	0.57
DUV	11_04	3967.5	3971.5	33	2.76	1.14	0.47	0.44	424	17	16	1.1	41	0.71
DUV	08_20	2597.455	2597.455	**36**	0.17	0.38	0.50	0.07	449	289	40	7	220	0.43
DUV	16_28	1144.48	1144.48	**38**	0.34	0.08	0.54	0.55	432	159	162	1.0	24	0.13
DUV	02_22	3109.6	3122.19	52	1.23	0.84	0.55	0.23	456	45	19	2	68	0.60
DUV	08_20	2603.3	2603.3	**64**	0.19	0.58	0.56	0.17	437	295	89	3	305	0.51
DUV	02_22	3123.5	3136.09	72	0.99	0.81	0.61	0.40	464	61	40	2	82	0.57
DUV	11_04	3947.46	3951.46	13	3.30	1.08	0.61	0.51	391	18	15	1.2	33	0.64
DUV	11_04	3945.37	3949.37	11	3.19	1.75	0.62	0.54	425	19	17	1.1	55	0.74
DUV	11_04	3965.41	3969.41	31	4.88	0.84	0.63	0.49	514	13	10	1.3	17	0.57
DUV	02_22	**3118.5**	3131.09	65	**0.90**	**0.61**	**0.64**	**0.37**	**443**	**71**	**41**	**1.73**	**68**	**0.49**
DUV	02_22	3106.5	3119.09	47	1.25	0.97	0.68	0.25	461	54	20	3	78	0.59
DUV	11_04	3972.5	3978.3	38	3.78	2.36	0.71	0.58	424	19	15	1.2	62	0.77
DUV	11_04	3943.535	3947.535	9	3.43	2.03	0.74	0.53	388	22	15	1.4	59	0.73
DUV	11_04	3964.465	3968.465	30	3.36	3.41	0.74	0.58	431	22	17	1.3	102	0.82
DUV	11_04	3944.48	3948.48	10	3.73	2.48	0.76	0.53	371	20	14	1.4	66	0.77
DUV	11_04	3942.425	3946.425	8	3.45	2.39	0.77	0.58	380	22	17	1.3	69	0.76
DUV	08_20	2605.565	2605.565	**69**	0.17	0.74	0.79	0.21	440	479	127	4	448	0.48
DUV	11_04	3962.43	3966.43	28	3.29	4.06	0.80	0.54	377	24	16	1.5	124	0.84
DUV	08_20	2600.9	2600.9	**54**	0.27	0.59	0.82	0.23	438	307	86	4	221	0.42
DUV	16_28	1124.38	1124.38	**18**	0.40	0.10	0.82	0.33	429	204	82	2.5	25	0.11
DUV	08_20	2609.865	2609.865	**73**	0.24	0.47	0.83	0.17	444	353	72	5	200	0.36
DUV	11_04	3966.5	3970.5	32	3.41	2.59	0.87	0.58	387	26	17	1.5	76	0.75
DUV	11_04	3961.51	3965.51	27	3.90	4.48	0.88	0.62	364	23	16	1.4	115	0.84
DUV	08_20	2599.96	2599.96	**46**	0.25	0.86	0.89	0.20	436	358	80	4	345	0.49
DUV	11_04	3946.475	3950.475	12	3.56	2.24	0.94	0.57	376	26	16	1.6	63	0.70
DUV	08_20	2600.4	2600.4	**50**	0.28	0.85	0.94	0.18	441	334	64	5	301	0.47
DUV	11_04	3971.47	3977.27	37	3.36	3.43	0.97	0.63	368	29	19	1.5	102	0.78
DUV	02_22	3120.5	3133.09	67	1.69	1.18	1.01	0.56	454	60	33	2	70	0.54
DUV	08_20	2600.725	2600.725	**53**	0.44	0.73	1.05	0.27	438	237	61	4	165	0.41
DUV	11_04	3979.5	3985	45	3.16	8.28	1.05	0.46	364	33	15	2.3	262	0.89
DUV	02_22	3086.24	3098.83	24	1.91	1.43	1.09	0.27	470	57	14	4	75	0.57
DUV	02_22	3121.6	3134.19	69	1.92	1.35	1.09	0.26	468	57	14	4	70	0.55
DUV	09_06	2558.2	2558.2	11	0.56	0.51	1.12	0.33	432	201	59	3.39	92	0.31
DUV	08_20	2594.5	2594.5	**33**		0.91	1.14	0.16	446	0	0	7	0	0.44
DUV	11_04	3976.49	3982.29	42	4.35	4.63	1.16	0.66	377	27	15	1.8	106	0.80
DUV	02_22	3079.6	3092.19	16	2.09	1.08	1.18	0.42	464	56	20	3	52	0.48
DUV	02_22	3109.05	3121.64	50	1.65	1.43	1.19	0.21	464	72	13	6	87	0.55
DUV	02_22	3121.5	3134.09	68	2.26	1.29	1.24	0.32	461	55	14	4	57	0.51
DUV	02_22	3077.22	3089.81	12	1.79	2.52	1.27	0.61	472	71	34	2	141	0.66
DUV	02_22	3124.9	3137.49	75	2.15	1.71	1.30	0.30	459	60	14	4	79	0.57
DUV	11_04	3980.455	3985.955	46	3.94	7.43	1.32	0.53	367	33	13	2.5	188	0.85
DUV	08_20	2572.4	2572.4	**9**	0.54	0.53	1.35	0.21	446	248	39	6	97	0.28
DUV	08_20	2576.545	2576.545	**13**	0.64	0.83	1.37	0.23	442	216	36	6	131	0.38

DUV	08_20	2572.4	2572.4	**9**	0.54	0.53	1.35	0.21	446	248	39	6	97	0.28
DUV	08_20	2576.545	2576.545	**13**	0.64	0.83	1.37	0.23	442	216	36	6	131	0.38
DUV	02_22	3112.5	3125.09	56	2.01	1.21	1.41	0.25	466	70	12	6	60	0.46
DUV	08_20	2606.5	2606.5	**70**	0.53	1.08	1.44	0.23	444	272	43	6	204	0.43
DUV	02_22	3074.5	3087.09	8	2.54	1.50	1.47	0.38	470	58	15	4	59	0.51
DUV	02_22	3089.5	3102.09	28	2.68	1.54	1.48	0.30	473	55	11	5	57	0.51
DUV	08_20	2571.55	2571.55	**8**	0.61	0.62	1.48	0.16	448	242	26	9	101	0.30
DUV	02_22	3110.5	3123.09	53	2.30	1.61	1.51	0.18	468	66	8	8	70	0.52
DUV	08_20	2585.465	2585.465	**20**	0.52	1.18	1.51	0.12	444	292	23	13	228	0.44
DUV	02_22	3075.5	3088.09	9	2.64	1.61	1.52	0.58	471	58	22	3	61	0.51
DUV	02_22	3085.5	3098.09	23	2.46	1.44	1.53	0.32	475	62	13	5	58	0.48
DUV	02_22	3095.9	3108.49	35	2.35	1.44	1.53	0.34	478	65	14	5	61	0.48
DUV	02_22	3082.5	3095.09	19	2.83	1.53	1.54	0.22	470	54	8	7	54	0.50
DUV	02_22	3081.5	3094.09	18	2.98	1.75	1.55	0.23	473	52	8	7	59	0.53
DUV	02_22	3078.1	3090.69	14	2.61	1.61	1.58	0.35	469	60	13	5	62	0.50
DUV	08_20	2603.2	2603.2	**63**	0.54	1.10	1.58	0.30	443	293	56	5	204	0.41
DUV	08_20	2599.765	2599.765	**44**	0.45	1.23	1.59	0.24	438	352	53	7	273	0.44
DUV	02_22	3073.5	3086.09	7	2.42	1.58	1.59	0.38	471	66	16	4	65	0.50
DUV	08_20	2575.445	2575.445	**12**	0.56	0.89	1.62	0.22	450	288	39	7	158	0.35
DUV	02_22	3077.5	3090.09	13	2.42	2.08	1.63	0.30	478	67	12	5	86	0.56
DUV	09_06	2548.94	2548.94	3	0.81	0.58	1.63	0.28	445	202	35	5.82	72	0.26
DUV	02_22	3096.5	3109.09	36	2.56	1.50	1.66	0.29	477	65	11	6	59	0.47
DUV	02_22	3087.68	3100.27	26	2.53	1.43	1.74	0.27	473	69	11	6	56	0.45
DUV	02_22	3104	3116.59	44	2.91	1.77	1.83	0.22	477	63	8	8	61	0.49
DUV	02_22	3076.5	3089.09	11	2.73	2.03	1.86	0.37	477	68	14	5	74	0.52
DUV	08_20	2600.07	2600.07	**47**	0.70	1.16	1.88	0.22	443	267	31	9	165	0.38
DUV	08_20	2596.52	2596.52	**35**	0.79	0.82	1.89	0.14	449	238	18	14	103	0.30
DUV	08_20	2614.28	2614.28	**78**	0.53	1.14	1.89	0.28	443	355	53	7	214	0.38
DUV	02_22	3083.5	3096.09	20	3.65	1.65	1.91	0.32	481	52	9	6	45	0.46
DUV	02_22	3090.45	3103.04	29	2.56	4.16	1.91	0.52	472	75	20	4	163	0.69
MILK	02_22	3125.5	3138.09	76	2.59	2.09	1.92	0.35	470	74	14	5	81	0.52
DUV	09_06	2564.02	2564.02	20	1.02	0.60	1.92	0.36	445	188	35	5.33	59	0.24
DUV	02_22	3084.5	3097.09	21	2.90	1.62	1.96	0.30	472	68	10	7	56	0.45
DUV	08_20	2604.405	2604.405	**68**	0.61	1.47	1.97	0.29	442	325	48	7	243	0.43
DUV	02_22	3072.5	3085.09	6	2.94	1.78	1.99	0.58	473	68	20	3	61	0.47
DUV	08_20	2584.5	2584.5	**19**	0.80	1.03	2.02	0.11	445	252	14	18	129	0.34
DUV	02_22	3085.2	3097.79	22	3.13	1.99	2.05	0.34	477	65	11	6	64	0.49
DUV	02_22	3111.37	3123.96	54	2.55	1.51	2.05	0.19	478	81	7	11	59	0.42
DUV	08_20	2589.6	2589.6	**24**		1.12	2.05	0.17	441	0	0	12	0	0.35
DUV	02_22	3086.75	3099.34	25	2.68	2.36	2.08	0.42	476	77	16	5	88	0.53
DUV	02_22	3091.4	3103.99	30	2.25	4.45	2.08	0.29	469	93	13	7	198	0.68
DUV	08_20	2601.04	2601.04	**55**	1.09	1.30	2.11	0.26	446	194	24	8	120	0.38
DUV	08_20	2602.515	2602.515	**59**	0.70	1.26	2.13	0.27	445	303	38	8	179	0.37
DUV	02_22	**3075.85**	3088.44	10	**3.18**	**2.08**	**2.15**	**0.32**	**475**	**68**	**10**	**6.72**	**65**	**0.49**
DUV	16_28	1123.6	1123.6	**17**	0.61	0.20	2.16	0.50	430	354	82	4.3	33	0.09
DUV	02_22	3102.5	3115.09	42	2.69	2.07	2.22	0.23	482	82	9	10	77	0.48
DUV	02_22	3092.5	3105.09	31	3.18	2.44	2.28	0.37	473	72	12	6	77	0.52
DUV	02_22	3101.5	3114.09	41	3.53	1.95	2.29	0.24	479	65	7	10	55	0.46
DUV	08_20	2591.455	2591.455	**27**	0.93	0.98	2.29	0.14	446	248	15	16	106	0.30
DUV	08_20	2600.25	2600.25	**49**	0.96	1.34	2.29	0.35	448	238	36	7	139	0.37
DUV	02_22	3093.5	3106.09	32	3.17	2.83	2.30	0.38	472	73	12	6	89	0.55
DUV	02_22	3109.5	3122.09	51	3.06	1.88	2.35	0.19	477	77	6	12	61	0.44
DUV	08_20	2603	2603	**62**	0.90	1.38	2.35	0.27	444	262	30	9	154	0.37
DUV	08_20	2600.5	2600.5	**51**	0.81	1.45	2.36	0.32	445	291	39	7	179	0.38
DUV	02_22	3078.8	3091.39	15	3.83	1.66	2.39	0.35	476	62	9	7	43	0.41

DUV	08_20	2600.5	2600.5	**51**	0.81	1.45	2.36	0.32	445	291	39	7	179	0.38
DUV	02_22	3078.8	3091.39	15	3.83	1.66	2.39	0.35	476	62	9	7	43	0.41
DUV	08_20	2578.61	2578.61	**15**	0.90	0.95	2.40	0.21	447	268	23	11	106	0.28
DUV	02_22	3112.95	3125.54	57	2.75	1.93	2.44	0.24	472	89	9	10	70	0.44
DUV	02_22	3097.5	3110.09	37	3.45	2.19	2.50	0.27	473	72	8	9	63	0.47
DUV	02_22	3107.5	3120.09	48	3.46	1.98	2.50	0.28	480	72	8	9	57	0.44
DUV	08_20	2595.4	2595.4	**34**	1.17	1.31	2.51	0.16	450	215	14	16	112	0.34
DUV	16_28	1118.4	1118.4	**12**	0.69	0.22	2.53	0.43	425	366	62	5.9	32	0.08
DUV	02_22	3113.3	3125.89	58	2.58	2.23	2.54	0.21	481	98	8	12	86	0.47
DUV	08_20	2583.51	2583.51	**18**	0.92	1.37	2.57	0.22	441	278	24	12	148	0.35
DUV	08_20	2602.75	2602.75	**60**	0.81	1.63	2.59	0.26	448	318	32	10	200	0.39
DUV	02_22	3080.4	3092.99	17	2.84	2.14	2.63	0.42	483	93	15	6	75	0.45
DUV	16_28	1117.51	1117.51	**11**	0.77	0.16	2.69	0.46	422	351	60	5.8	21	0.06
DUV	02_22	3094.75	3107.34	33	3.61	2.14	2.74	0.37	471	76	10	7	59	0.44
DUV	02_22	3122.5	3135.09	70	2.73	2.53	2.76	0.19	476	101	7	15	93	0.48
DUV	02_22	3095.5	3108.09	34	4.43	2.22	2.80	0.25	472	63	6	11	50	0.44
DUV	02_22	3103.5	3116.09	43	3.21	2.20	2.81	0.20	473	87	6	14	68	0.44
DUV	08_20	2586.5	2586.5	**21**	0.93	1.39	2.84	0.19	446	307	21	15	150	0.33
DUV	08_20	2570.44	2570.44	**7**		0.99	2.87	0.19	446	0	0	15	0	0.26
DUV	02_22	3099.5	3112.09	39	2.87	2.26	2.89	0.24	470	101	8	12	79	0.44
DUV	02_22	3098.5	3111.09	38	2.24	2.56	2.96	0.22	472	132	10	13	114	0.46
DUV	16_28	1139.59	1139.59	**33**	0.92	0.17	2.96	0.53	427	321	57	5.6	19	0.06
DUV	08_20	2600.62	2600.62	**52**	1.08	1.64	3.08	0.43	449	287	40	7	153	0.35
DUV	08_20	2601.51	2601.51	**58**	1.08	1.58	3.11	0.21	449	288	19	15	146	0.34
DUV	02_22	3100.5	3113.09	40	3.89	2.62	3.17	0.18	471	82	5	18	67	0.45
DUV	02_22	3122.74	3135.33	71	3.07	2.48	3.17	0.16	474	103	5	20	81	0.44
DUV	08_20	2600.15	2600.15	**48**	1.28	1.75	3.19	0.33	448	248	26	10	136	0.35
DUV	08_20	2591.87	2591.87	**29**	1.19	1.30	3.21	0.24	449	271	20	13	110	0.29
DUV	02_22	3105.5	3118.09	45	3.43	2.50	3.39	0.31	471	99	9	11	73	0.42
DUV	02_22	3111.5	3124.09	55	3.71	2.49	3.40	0.22	471	92	6	15	67	0.42
DUV	08_20	2588.5	2588.5	**23**	1.29	1.79	3.44	0.17	447	267	13	20	139	0.34
DUV	08_20	2593.555	2593.555	**32**		1.67	3.45	0.13	447	0	0	27	0	0.33
DUV	09_06	2561.06	2561.06	16	1.36	1.18	3.53	0.26	440	259	19	13.58	87	0.25
DUV	08_20	2591.61	2591.61	**28**	1.15	1.39	3.55	0.17	449	310	15	21	121	0.28
DUV	02_22	3088.5	3101.09	27	2.91	2.84	3.57	0.58	474	123	20	6	98	0.44
DUV	02_22	3124.5	3137.09	74	3.46	2.73	3.73	0.31	474	108	9	12	79	0.42
DUV	08_20	2590.51	2590.51	**25**	1.42	1.54	3.85	0.21	450	271	15	18	108	0.29
DUV	08_20	2601.14	2601.14	**56**	1.27	1.89	3.98	0.31	450	313	24	13	149	0.32
DUV	08_20	2599.25	2599.25	**40**	1.60	1.70	4.00	0.21	449	250	13	19	106	0.30
DUV	16_28	1161.52	1161.52	**55**	0.92	0.25	4.08	0.76	424	442	82	5.4	28	0.06
DUV	16_28	1127.56	1127.56	**21**	0.99	0.18	4.13	0.62	424	417	63	6.7	18	0.04
DUV	08_20	2603.5	2603.5	**66**	2.17	2.17	4.74	0.21	452	218	10	23	100	0.31
DUV	08_20	2577.5	2577.5	**14**	1.84	1.73	4.88	0.22	451	265	12	22	94	0.26
DUV	02_22	3108.5	3121.09	49	5.62	2.92	4.90	0.17	475	87	3	29	52	0.37
DUV	08_20	2616.415	2616.415	**80**	4.06	2.39	5.09	0.19	453	125	5	27	59	0.32
DUV	09_06	2549.65	2549.65	4	2.11	1.17	5.15	0.25	445	245	12	20.60	56	0.19
DUV	08_20	2579.425	2579.425	**16**	1.93	1.79	5.30	0.20	452	274	10	27	93	0.25
DUV	09_06	2552.93	2552.93	6	2.02	1.25	5.38	0.44	448	267	22	12.23	62	0.19
DUV	09_06	2559.77	2559.77	14	2.11	1.13	5.91	0.34	445	280	16	17.38	53	0.16
DUV	09_06	2551.14	2551.14	5	2.37	1.43	6.09	0.31	445	257	13	19.65	60	0.19
DUV	08_20	2582.535	2582.535	**17**	2.42	2.48	6.11	0.31	454	252	13	20	102	0.29
DUV	08_20	2591.36	2591.36	**26**	2.64	1.85	6.26	0.21	452	237	8	30	70	0.23
DUV	09_06	2555.09	2555.09	8	2.30	1.51	6.49	0.40	444	283	17	16.23	66	0.19
DUV	09_06	2565.91	2565.91	21	2.42	1.43	6.65	0.31	444	275	13	21.45	59	0.18
DUV	08_20	2599.39	2599.39	**41**	2.83	2.24	7.04	0.22	451	248	8	32	79	0.24
DUV	16_28	1122.55	1122.55	**16**	1.53	0.47	7.13	0.79	418	467	52	9.0	30	0.06
DUV	08_20	2587.5	2587.5	**22**	3.56	2.42	7.17	0.26	453	201	7	28	68	0.25
DUV	08_20	2615.585	2615.585	**79**		3.09	7.27	0.19	453			38		0.30

DUV	08_20	2587.5	2587.5	**22**	3.56	2.42	7.17	0.26	453	201	7	28	68	0.25
DUV	08_20	2615.585	2615.585	**79**		3.09	7.27	0.19	453			38		0.30
DUV	16_28	1130.31	1130.31	**24**	1.60	0.30	7.28	0.72	422	454	45	10.1	18	0.04
DUV	16_28	1126.53	1126.53	**20**	1.46	0.32	7.46	0.84	419	511	58	8.9	22	0.04
DUV	09_06	2566.24	2566.24	22	2.65	1.72	7.61	0.35	443	287	13	21.74	65	0.18
DUV	08_20	2610.51	2610.51	**74**	2.81	2.68	7.69	0.22	452	273	8	35	95	0.26
DUV	08_20	2574.515	2574.515	**11**	3.54	2.88	7.70	0.31	454	218	9	25	81	0.27
DUV	08_20	2602.85	2602.85	**61**		3.08	7.71	0.25	451	0	0	31	0	0.29
DUV	08_20	2607.545	2607.545	**71**	3.03	2.80	7.73	0.24	454	256	8	32	93	0.27
DUV	08_20	2593.12	2593.12	**92**	3.71	2.84	7.81	0.39	453	211	11	20	77	0.27
DUV	08_20	2601.24	2601.24	**57**		3.42	8.24	0.45	452	0	0	18	0	0.29
DUV	16_28	1132.54	1132.54	**26**	1.73	0.37	8.41	0.85	420	485	49	9.9	21	0.04
DUV	09_06	2553.59	2553.59	7	3.02	2.08	8.88	0.43	445	294	14	20.65	69	0.19
DUV	08_20	2592.525	2592.525	**31**	6.06	2.80	9.09	0.21	451	150	3	43	46	0.24
DUV	16_28	1125.48	1125.48	**19**	1.68	0.36	9.19	0.85	421	547	51	10.8	22	0.04
DUV	16_28	1147.4	1147.4	**41**	2.00	0.39	9.20	0.98	423	459	49	9.4	19	0.04
DUV	16_28	1136.7	1136.7	**30**	1.87	0.38	9.65	0.85	421	516	45	11.4	20	0.04
DUV	08_20	2608.5	2608.5	**72**	4.51	3.11	9.72	0.20	453	216	4	49	69	0.24
DUV	09_06	2566.4	2566.4	23	2.65	2.00	9.80	0.28	443	370	11	35.00	75	0.17
DUV	08_20	2611.54	2611.54	**75**	3.74	3.42	9.90	0.20	454	265	5	50	91	0.26
DUV	09_06	2566.69	2566.69	24	3.41	1.95	10.83	0.25	445	318	7	43.32	57	0.15
DUV	08_20	2599.6	2599.6	**43**	4.45	3.61	10.97	0.24	451	246	5	46	81	0.25
DUV	16_28	1146.4	1146.4	**40**	2.63	0.50	11.56	1.06	422	440	40	10.9	19	0.04
DUV	16_28	1158.39	1158.39	**52**	2.41	0.44	12.20	0.93	424	507	39	13.1	18	0.03
DUV	16_28	1135.68	1135.68	**29**	2.66	0.48	12.64	0.93	424	476	35	13.6	18	0.04
DUV	16_28	1120.46	1120.46	**14**	2.66	0.57	13.15	1.01	420	494	38	13.0	21	0.04
DUV	09_06	2557.13	2557.13	10	3.59	2.42	13.64	0.37	444	380	10	36.86	67	0.15
DUV	08_20	2612.5	2612.5	**76**	5.75	4.67	13.76	0.24	453	239	4	57	81	0.25
DUV	16_28	1138.62	1138.62	**32**	2.98	0.47	13.90	1.06	422	467	36	13.1	16	0.03
DUV	16_28	1142.52	1142.52	**36**	3.05	0.54	14.22	1.21	419	466	40	11.8	18	0.04
DUV	16_28	1133.54	1133.54	**27**	2.67	0.48	14.32	1.04	422	536	39	13.8	18	0.03
DUV	16_28	1143.4	1143.4	**37**	3.29	0.54	15.12	1.13	420	460	34	13.4	16	0.03
DUV	16_28	1152.51	1152.51	**46**	3.21	0.47	15.34	1.09	422	478	34	14.1	15	0.03
DUV	16_28	1131.53	1131.53	**25**	2.91	0.58	15.39	1.21	419	529	42	12.7	20	0.04
DUV	09_06	2556.52	2556.52	9	4.12	2.85	15.82	0.30	444	384	7	52.73	69	0.15
DUV	09_06	2562.61	2562.61	17	4.50	2.77	16.33	0.37	445	363	8	44.14	62	0.15
DUV	16_28	1145.57	1145.57	**39**	3.81	0.67	17.71	1.39	421	465	37	12.7	18	0.04
DUV	16_28	1140.52	1140.52	**34**	3.40	0.63	17.84	1.41	423	524	41	12.7	19	0.03
DUV	16_28	1141.15	1141.15	**35**	3.54	0.64	17.87	1.29	419	505	36	13.9	18	0.03
DUV	16_28	1151.4	1151.4	**45**	3.77	0.57	18.92	1.17	423	502	31	16.2	15	0.03
DUV	16_28	1150.5	1150.5	**44**	3.94	0.83	19.49	1.18	418	495	30	16.5	21	0.04
DUV	16_28	1121.48	1121.48	**15**	3.78	0.99	20.35	1.23	419	538	33	16.5	26	0.05
DUV	09_06	2558.3	2558.3	12	5.02	3.14	21.09	0.48	444	420	10	43.94	63	0.13
DUV	08_20	2599.5	2599.5	**42**	8.38	5.21	21.21	0.29	452	253	3	73	62	0.20
DUV	16_28	1148.55	1148.55	**42**	4.40	0.68	22.37	1.35	421	508	31	16.6	15	0.03
DUV	09_06	2560.48	2560.48	15	5.10	3.78	22.48	0.29	442	441	6	77.52	74	0.14
DUV	16_28	1149.53	1149.53	**43**	4.75	0.87	23.36	1.36	418	492	29	17.2	18	0.04
DUV	09_06	2558.71	2558.71	13	5.54	3.99	23.42	0.30	442	423	5	78.07	72	0.15
DUV	09_06	2563.49	2563.49	19	5.26	3.63	23.82	0.27	443	453	5	88.22	69	0.13
DUV	16_28	1153.63	1153.63	**47**	4.59	0.80	24.75	1.48	422	539	32	16.7	17	0.03
DUV	09_06	2563.07	2563.07	18	5.46	3.24	24.86	0.28	444	456	5	88.79	59	0.12
DUV	16_28	1154.62	1154.62	**48**	4.73	1.01	26.04	1.50	418	550	32	17.4	21	0.04
DUV	16_28	1162.5	1162.5	**56**	5.00	1.41	28.41	1.59	417	568	32	17.9	28	0.05
DUV	16_28	1155.48	1155.48	**49**	5.48	1.06	30.31	1.60	418	553	29	18.9	19	0.03
DUV	16_28	1163.55	1163.55	**57**	6.79	1.91	35.25	1.69	416	519	25	20.9	28	0.05
DUV	16_28	1156.47	1156.47	**50**	8.15	1.68	40.50	1.92	419	497	24	21.1	21	0.04
DUV	16_28	1157.49	1157.49	**51**	8.26	1.88	40.92	1.93	421	495	23	21.2	23	0.04
DUV	16_28	1159.4	1159.4	**53**	8.82	2.33	41.02	2.13	418	465	24	19.3	26	0.05
DUV	16_28	1160.57	1160.57	**54**	9.00	2.39	47.06	2.08	415	523	23	22.6	27	0.05

Appendix G: Overall stratigraphic patterns in GR, TOC, Tmax, Zr/TiO_2, Al/SiO_2, Mo/Al and U/Al

Figure 85. Summary for **GuideX 09-06** of overall stratigraphic patterns in GR (API), TOC (wt %), Tmax (^{0}C), Zr/TiO_2 (Zr/Ti in ppm/%), Al/SiO_2 (Al/Si), Mo/Al (ppm/%) and U/Al (ppm/%). Depth is indicated down the left hand side of the Figure and stratigraphic intervals are indicated down the right hand side of the Figure.

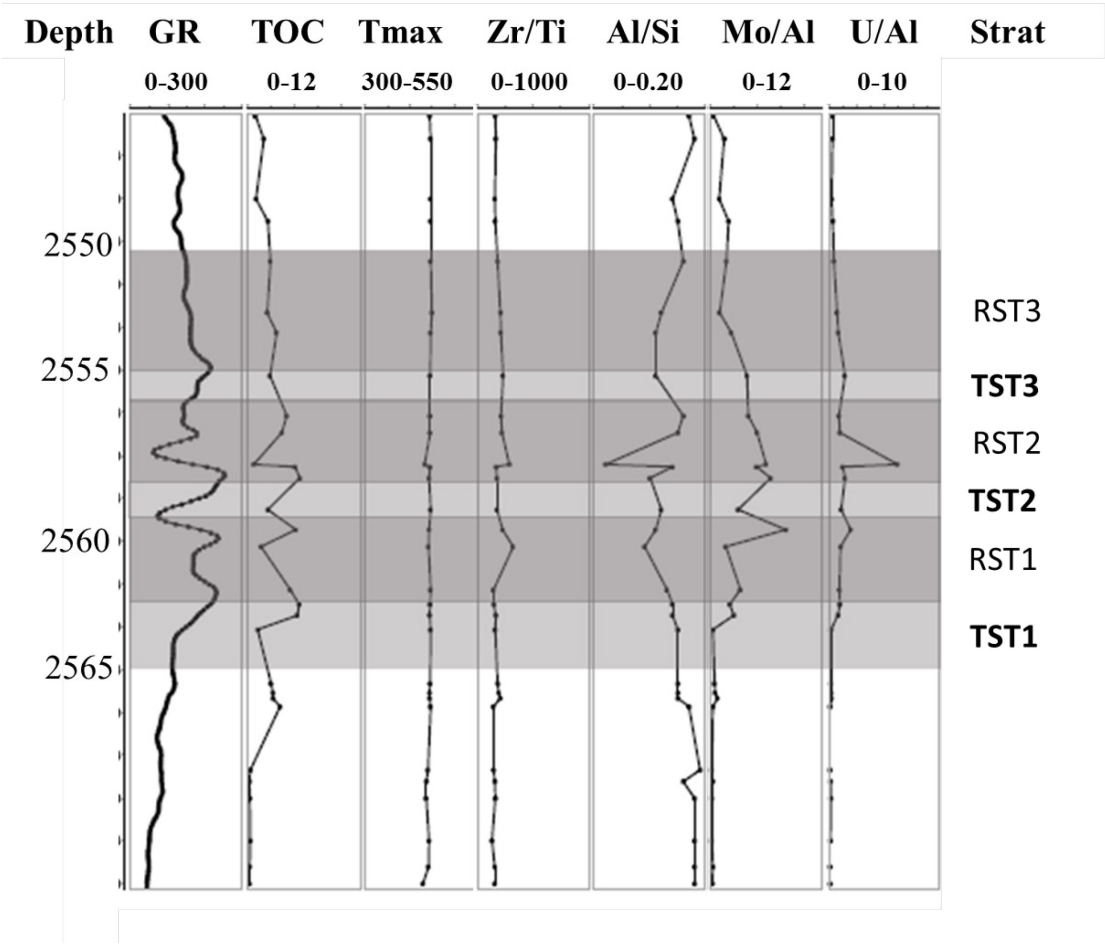


Figure 86. Summary for **Shell 02-22** of overall stratigraphic patterns in GR (API), TOC (wt %), Tmax (^{0}C), Zr/TiO_2 (Zr/Ti in ppm/%), Al/SiO_2 (Al/Si), Mo/Al (ppm/%) and U/Al (ppm/%). Depth is indicated down the left hand side of the Figure and stratigraphic intervals are indicated down the right hand side of the Figure.

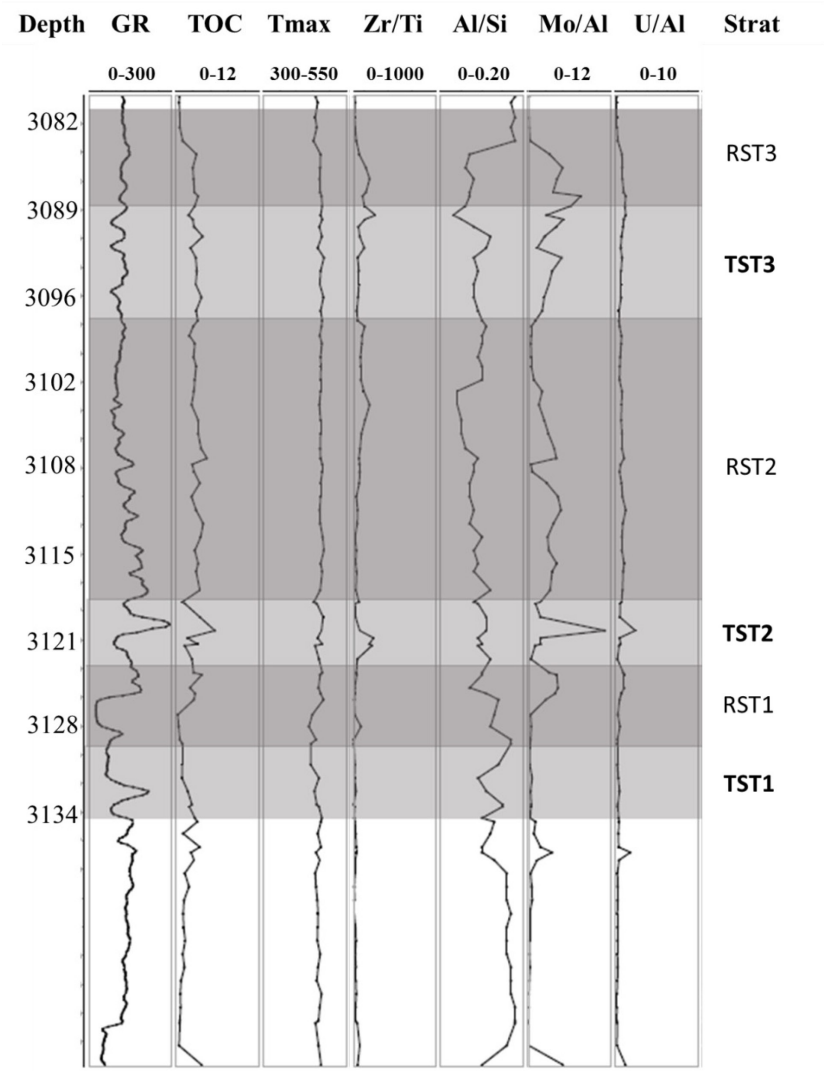


Figure 87. Summary for **Encana 11-04** of overall stratigraphic patterns in GR (API), TOC (wt %), Tmax (^{0}C), Zr/TiO_2 (Zr/Ti in ppm/%), Al/Si_{O2} (Al/Si), Mo/Al (ppm/%) and U/Al (ppm/%). Depth is indicated down the left hand side of the Figure and stratigraphic intervals are indicated down the right hand side of the Figure.

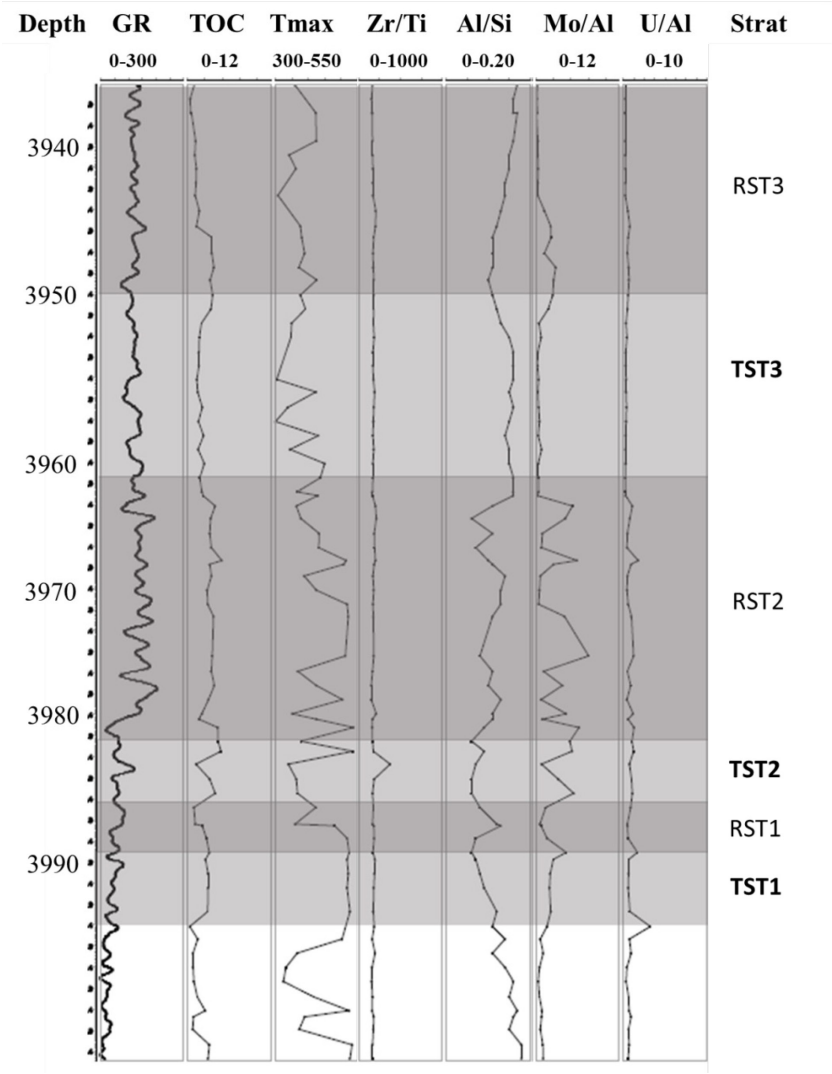


Figure 88. Summary for **Esso 16-28** of overall stratigraphic patterns in GR (API), TOC (wt %), Tmax (^{0}C), Zr/TiO_2 (Zr/Ti in ppm/%), Al/SiO_2 (Al/Si), Mo/Al (ppm/%) and U/Al (ppm/%). Depth is indicated down the left hand side of the Figure and stratigraphic intervals are indicated down the right hand side of the Figure.

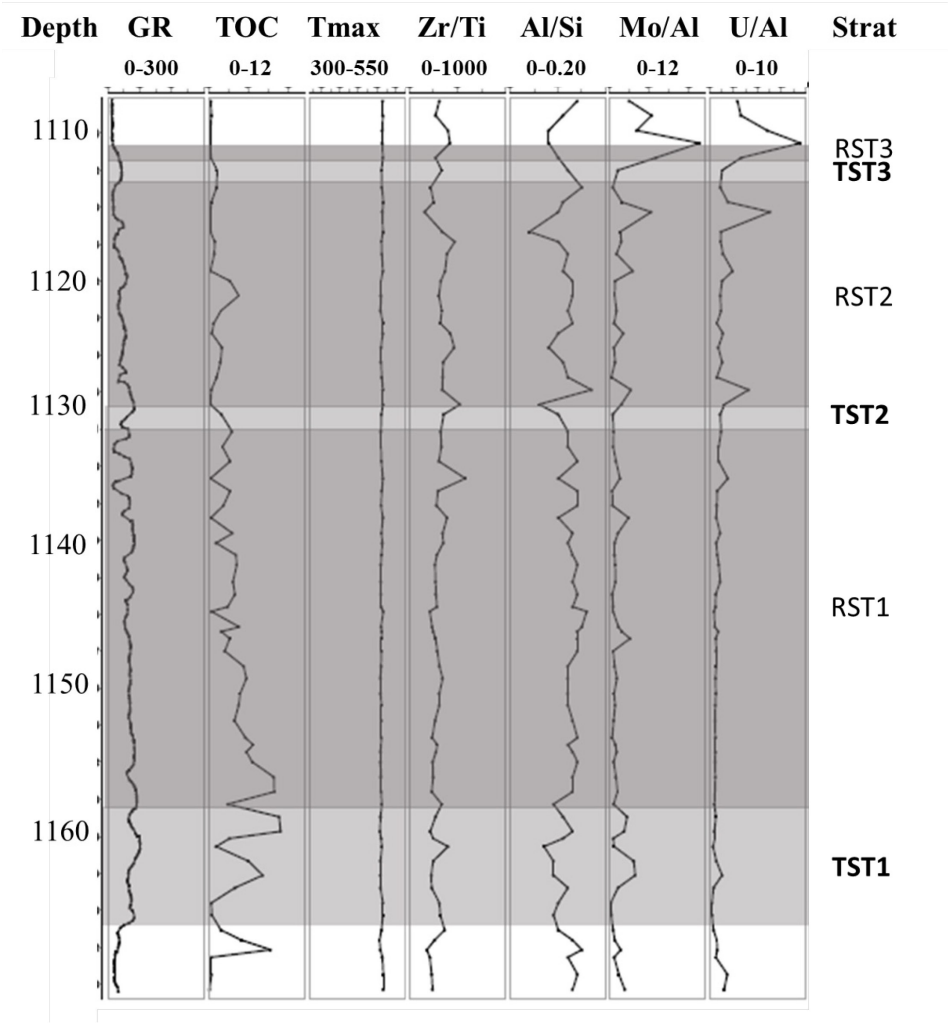
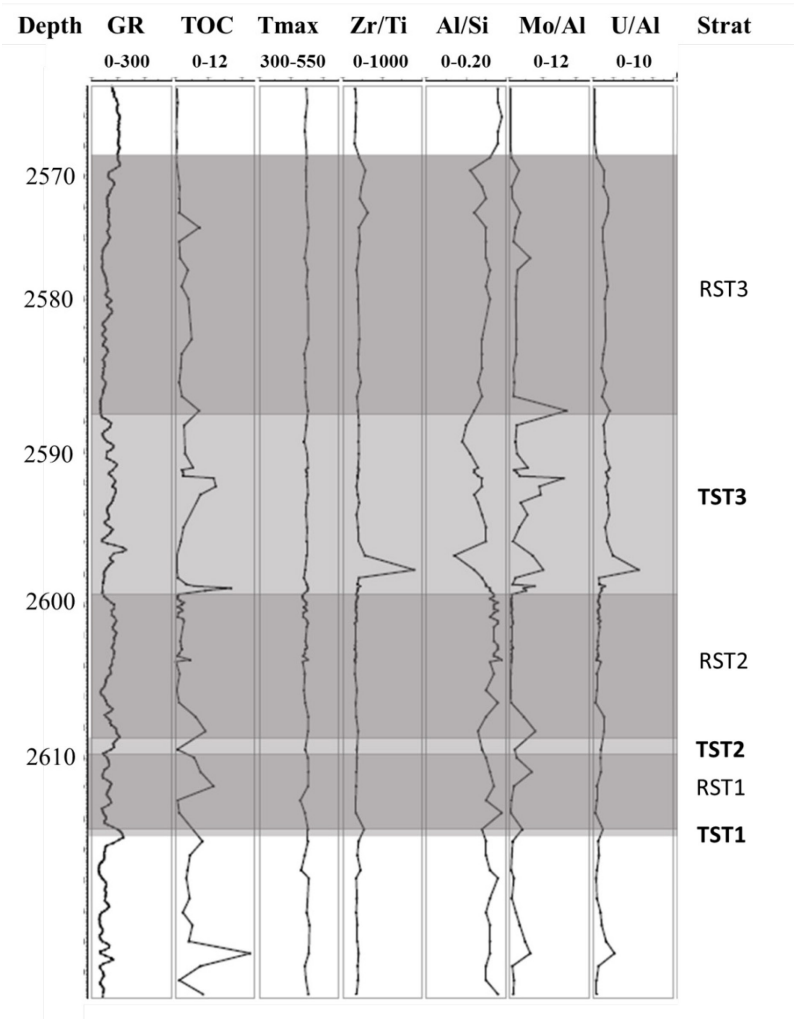


Figure 89. Summary for **EOG 08-20** of overall stratigraphic patterns in GR (API), TOC (wt %), Tmax (^{0}C), Zr/TiO_2 (Zr/Ti in ppm/%), Al/SiO_2 (Al/Si), Mo/Al (ppm/%) and U/Al (ppm/%). Depth is indicated down the left hand side of the Figure and stratigraphic intervals are indicated down the right hand side of the Figure.



Appendix H: Geochemical Signatures of Lithofacies

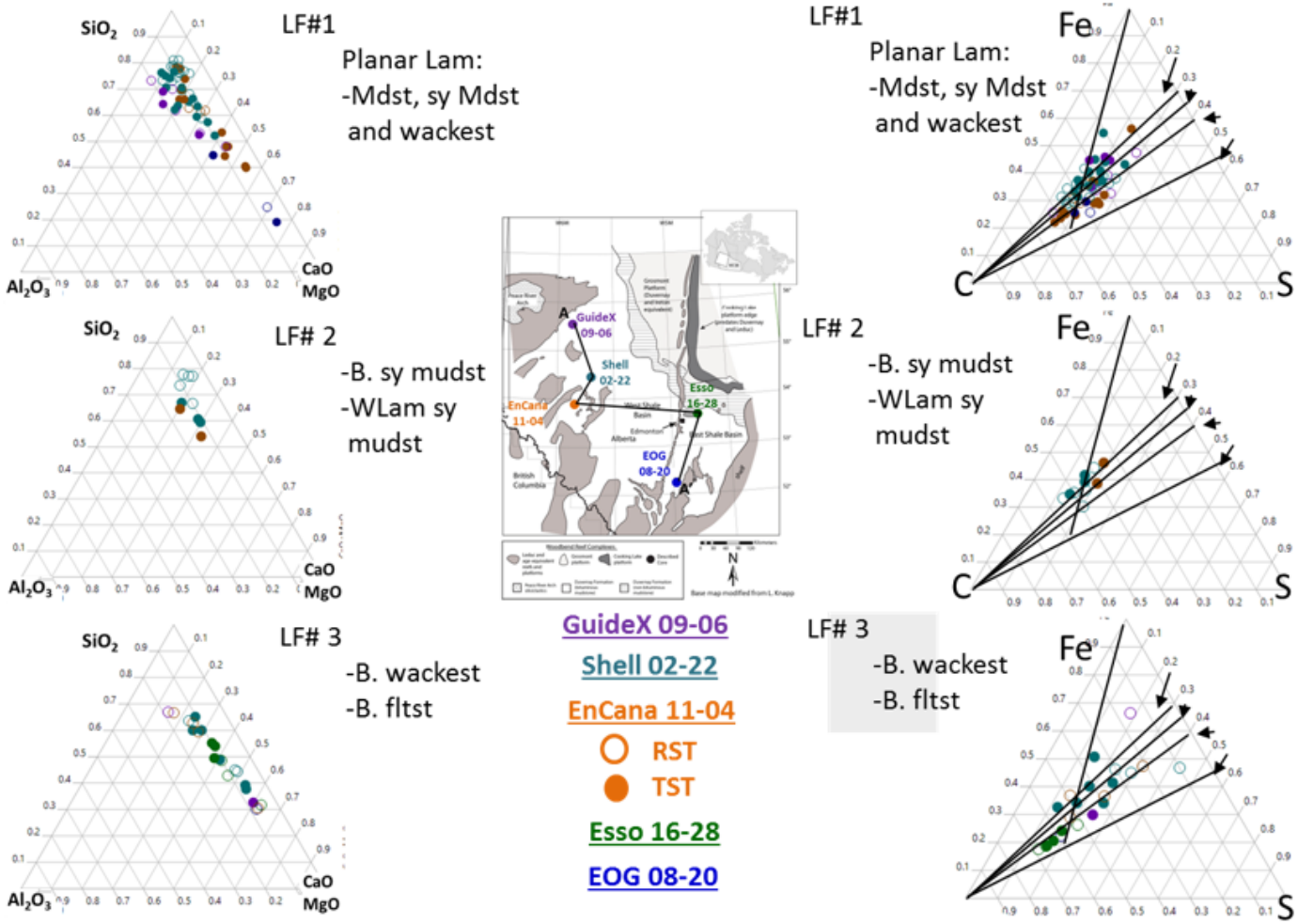


Figure 90. Geochemical Signatures of Lithofacies: 1, 2 and 3

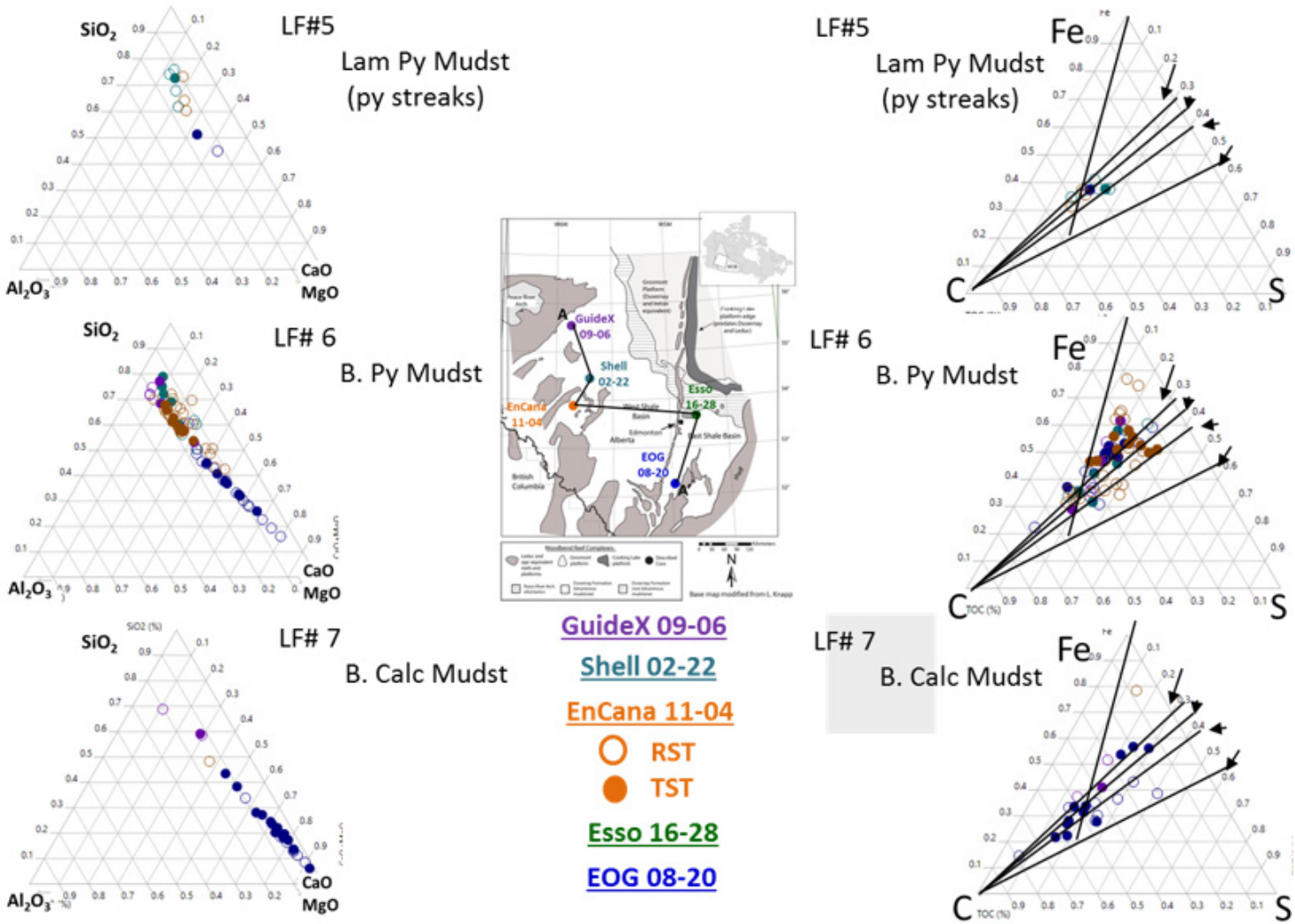


Figure 91. Geochemical Signatures of Lithofacies: 5, 6 and 7

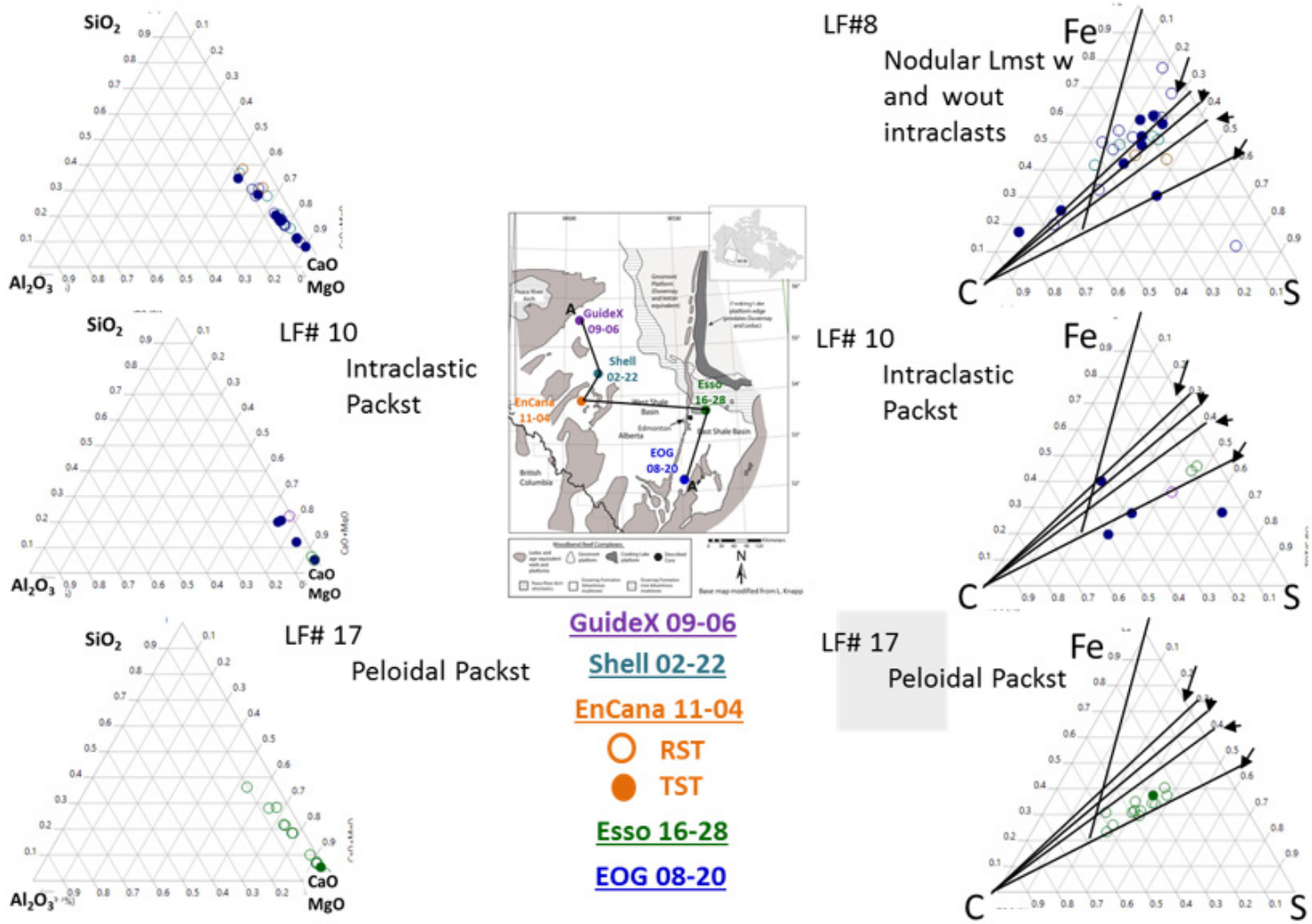


Figure 92. Geochemical Signatures of Lithofacies: 8, 10 and 17

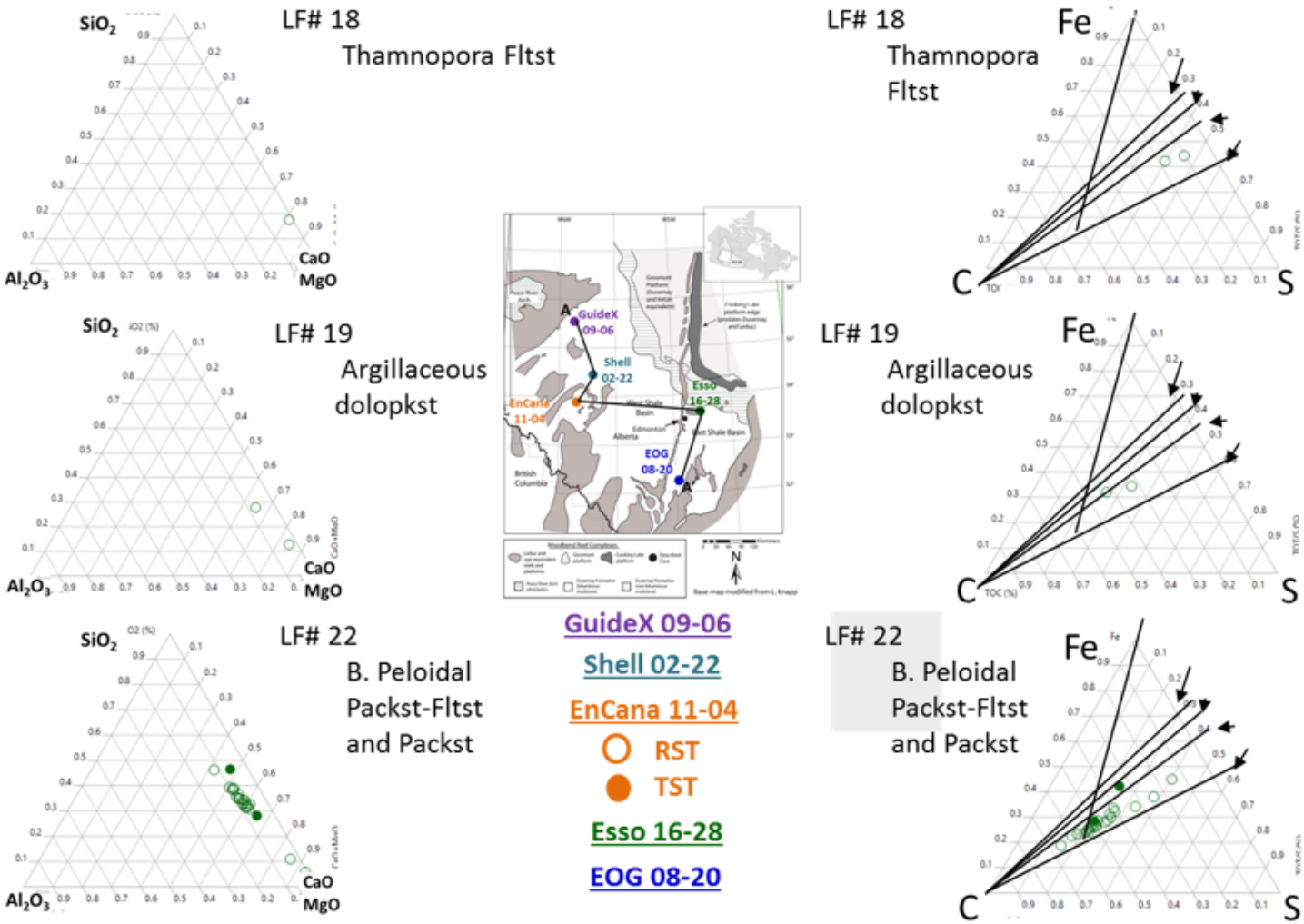


Figure 93. Geochemical Signatures of Lithofacies: 18, 19 and 22

Appendix I: Summary of Scatter Plot Matrices for Each Well

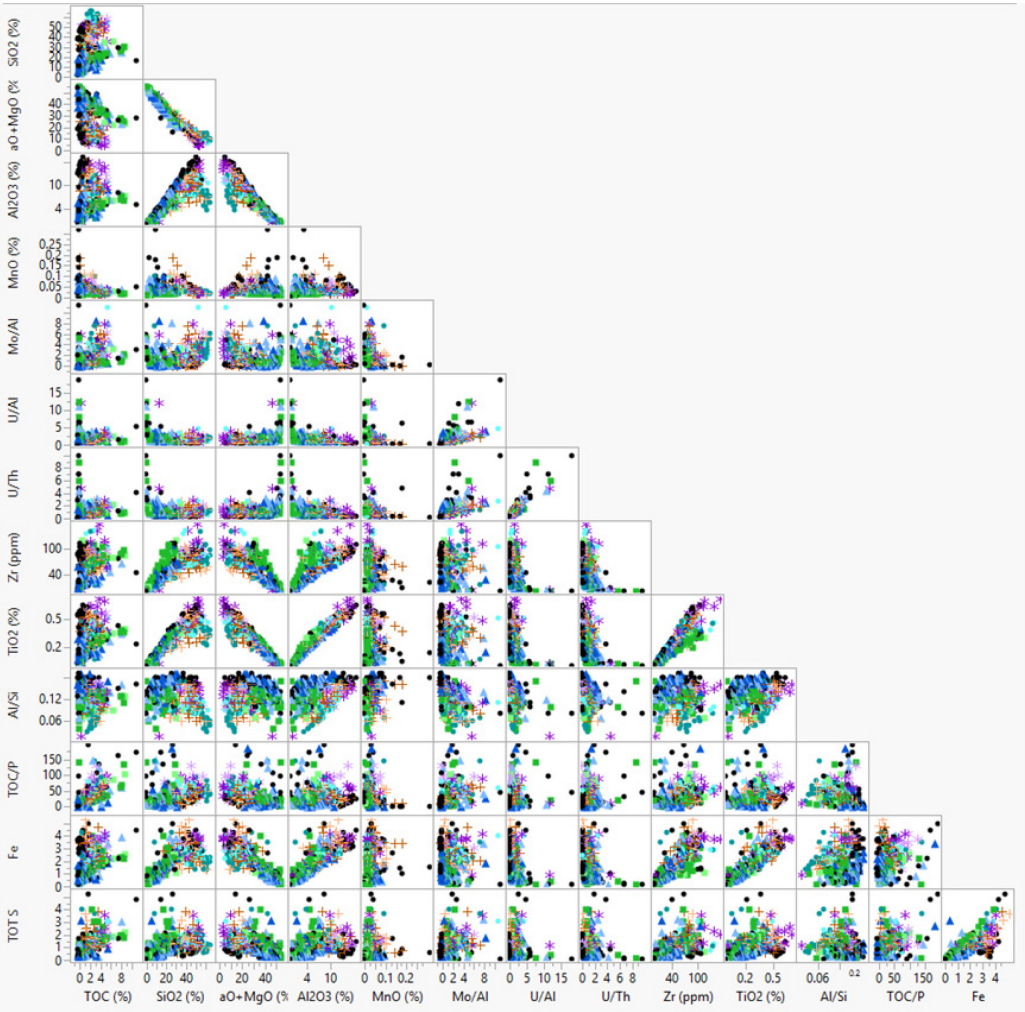


Figure 94. Scatter Plot Matrices for All Wells

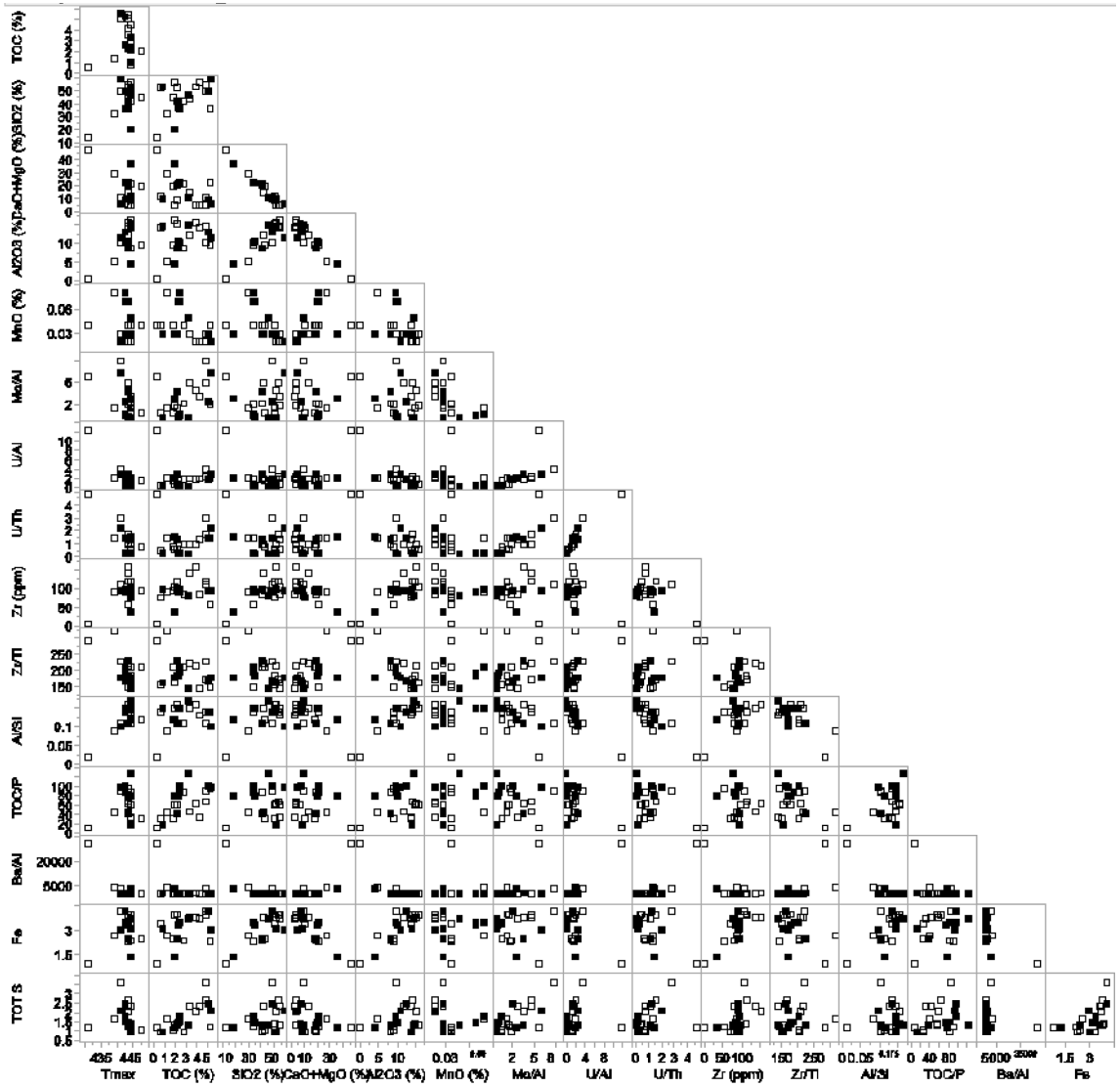


Figure 95. Scatter Plot Matrices for GuideX 09-06

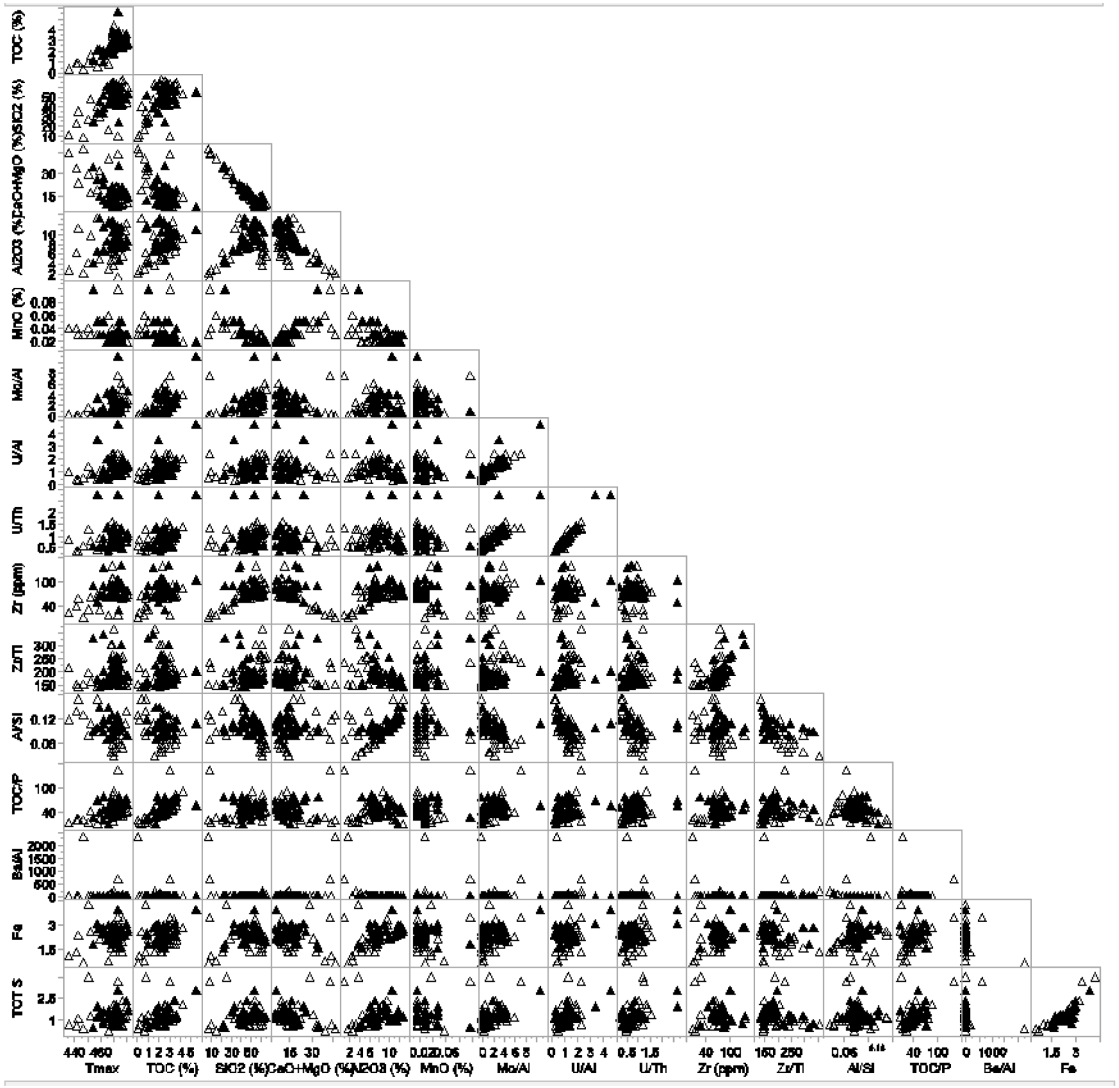


Figure 96. Scatter Plot Matrices for Shell 02-22

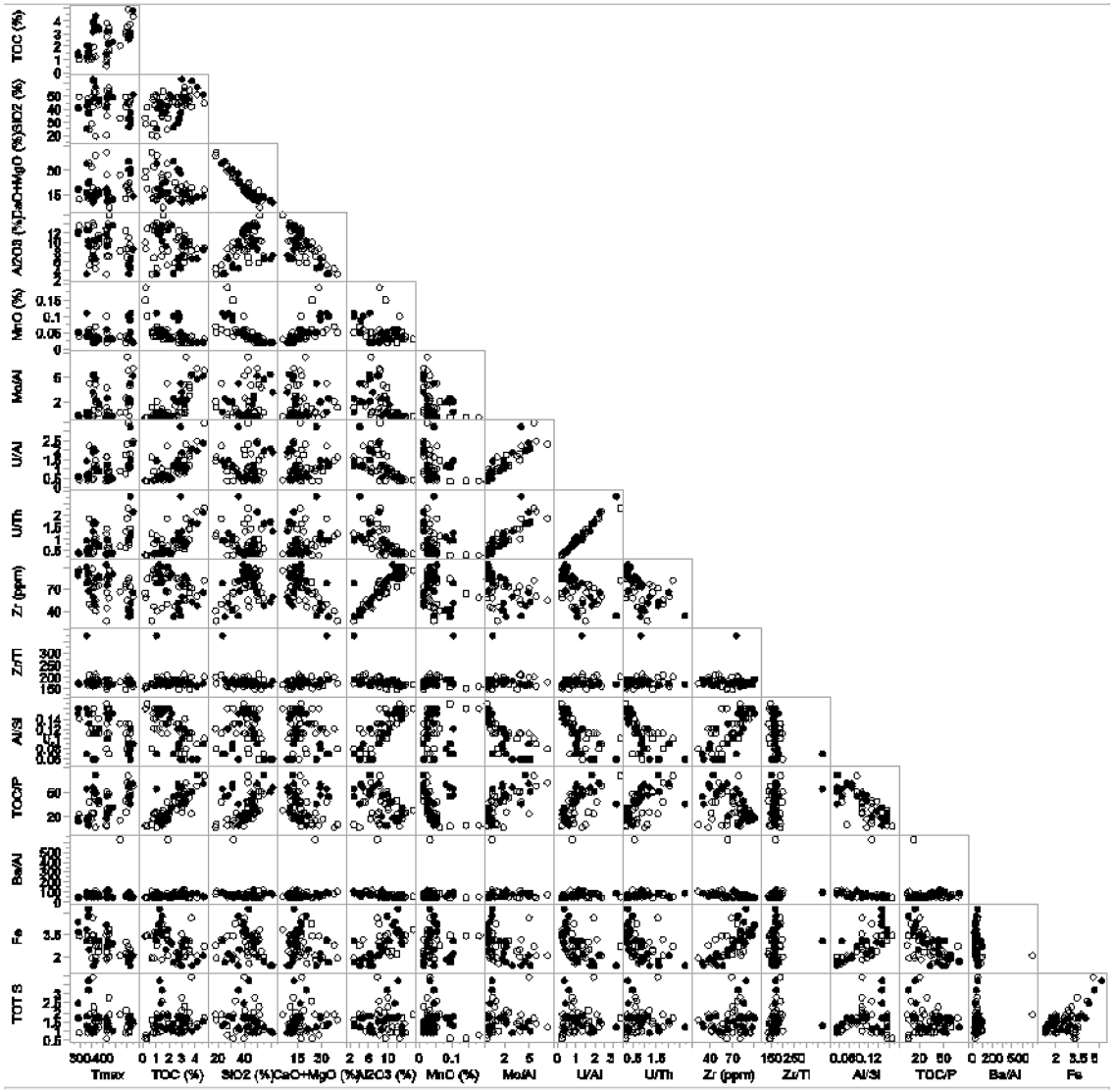


Figure 97. Scatter Plot Matrices for Encana 11-04

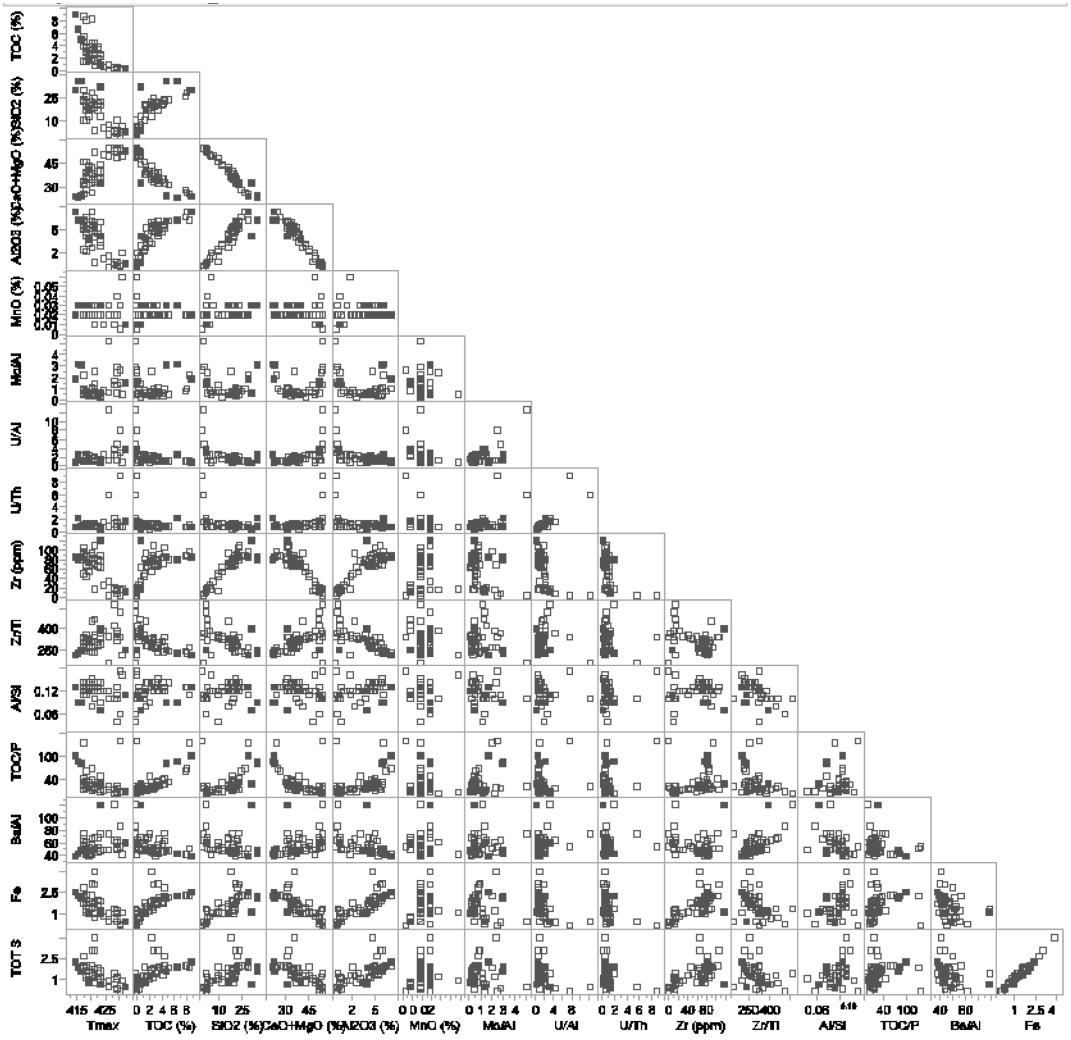


Figure 98. Scatter Plot Matrices for Esso 16-28

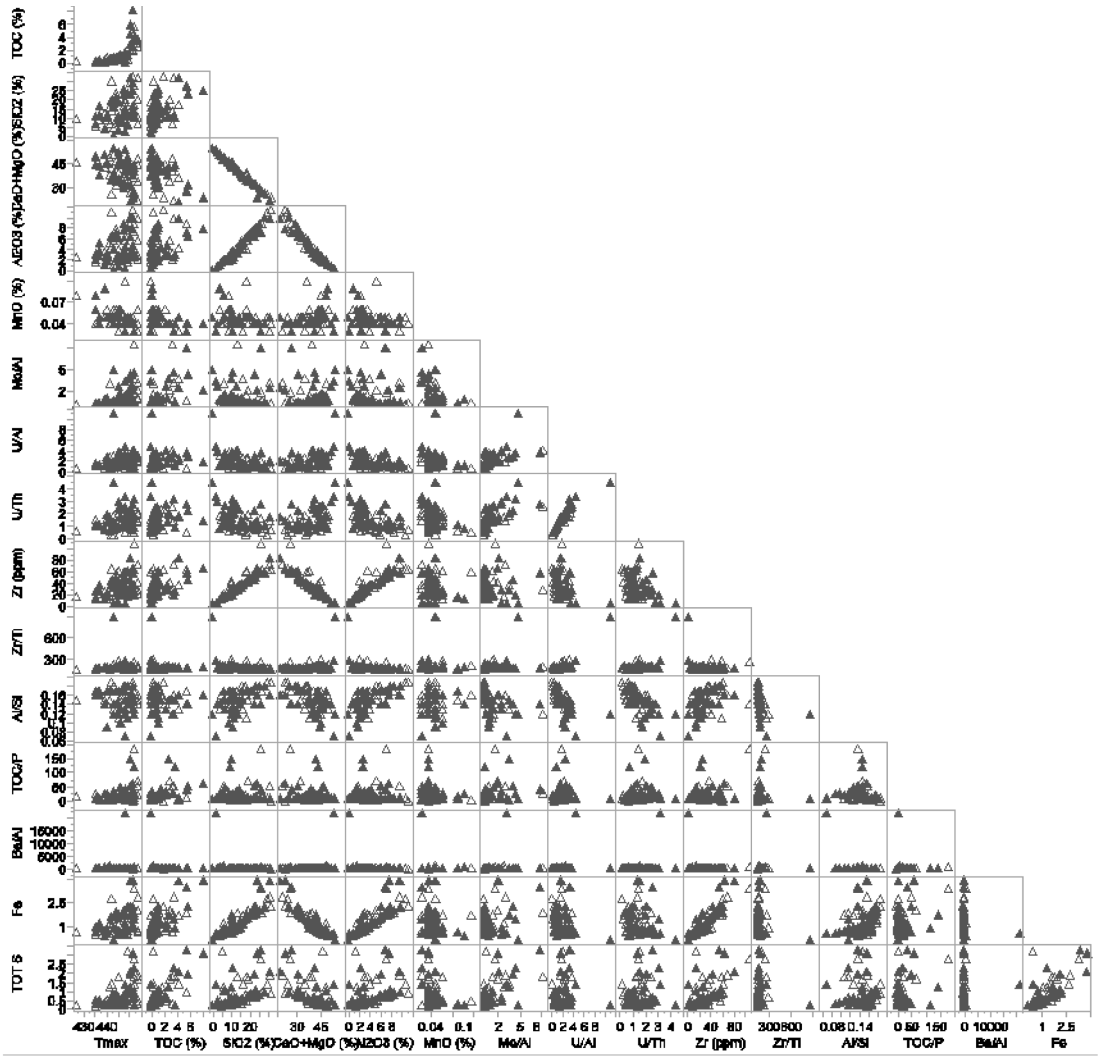


Figure 99. Scatter Plot Matrices for EOG 08-20

Appendix J: Summary of Insights from various Black Shales

Reference	Formation/Section	Age and Location	TOC Model Summary Notes: Reference (Author column)
Algeo et al. 2011	Ubara Section Gujo-Hachiman Section Panthalassic Ocean	Late Permian to Early Triassic Central Japan	Overall at both locations: shift from organic poor to organic rich cherts/siliceous mudstones coincident with increased primary productivity and increased euxinia in the OMZ Ubara: high productivity leading to reducing to euxinic conditions (OMZ) and suboxic to weakly anoxic at the seafloor Gujo-Hachiman: moderate levels of productivity lead to suboxic bottom waters (productivity insufficient to result in euxinia) and more distal relative continental clastics
Suzuki et al 1998	Tanba and Chichibu Belts	Permian/ Triassic (P/T) boundary Southwest Japan	-OM in black shales mainly from phytoplankton +OM derived from bacterial activity indicating high primary productivity was periodic in the early Triassic -Tectonically or climactically driven ocean current systems resulted in upwelling which periodically disrupted an otherwise stratified ocean (well-developed OMZ rich in nutrients) -Upwelling results in very high primary productivity -Overall from Permian (organic poor, stratified column) to Triassic (organic rich, upwelling events) and transport to dissolved oxygen to create suboxic to oxic bottom water conditions
Bertrand et al. 1993	Kimmeridge Clay Formation	Kimmeridgian Dorset, UK	-TOC preservation controlled by organic matter supply (linked to primary productivity) -OM rich samples deposited under an oxygenated water column with a redox boundary that fluctuated between above and below the sediment-water interface in response to organic flux/primary productivity -OM preservation controlled by sulphate reduction replaced by methanogenisis (TOCs above 10%), sulphate reduction under dysaerobic conditions (TOCs between 2-10%), and -10% threshold: 10%~flux of OM and intensity of sulphate reduction are equally important in the burial of OM, above 10%~resistant OM accumulates, sulphate reduction decreases due to lack of sulphate, replaced by methanogenesis, below 10%~OM degraded by sulphate reduction
Bertrand et al. 1994	Kimmeridge Clay Formation		Model: short-term cyclic organic rich series during persistently anoxic bottom waters assuming cyclicity is controlled phytoplanktonic productivity -Even in the absence of dilution effects, increased OM accumulation is not necessarily related to enhanced preservation of OM flux if increased degradation of material is coincident

Kennedy et al. 2014	Woodford Shale	Permian Basin	-In addition to oceanographic regulation of bottom-water oxygenation and biological productivity, the interaction between organic matter and high surface area clay particles leads to enhanced OM preservation -preservative potential of clays depends on continental climate (weathering) and provenance -Woodford considered representative of TOC accumulations resulting from high productivity and anoxic conditions, however, this new info suggests clay nanocomposites play an important role in preservation -more emphasis on processes acting on landward side of the continental margin that affect TOC accumulation
Prauss 2015	Tarfaya	Upper Turonian to Coniacian-lower Santonian Morocco, NW Africa	-Black shale horizons increase in frequency upwards, Increasing TOC upwards, not strictly correlative to black shale intervals -Fluctuating oxygen conditions of bottom waters indicated from -Turonian to Santonian transition, coincident with dinocyst assemblages associated with upwelling and water column stratification: preservation dominant in former, changes to increased production in the latter -Final preservation event at Coniacian-Santonian boundary (maybe related to shutdown of upwelling) -generally high productivity controlled with periodic preservation
Silva and Duarte 2015	Lustianian Basin (between Tethyan and Boreal)	Pliensbachian (Early Jurassic) Portugal	-Black shale deposition coincident with suboxic-anoxic conditions with periodic euxinia in the lower water column and sediment, sustained restricted depositional conditions, -short lived basinwide development of algal blooms and microbial matts due to mixing of the water column and enhanced preservation in anoxic sediments -black shales related to warming events and periodic epeiric seas
Betts and Holland 1991	69 Locations	Modern	-BE (burial efficiency) = Corg buried/Corg reached sed-water interface, -SR (sedimentation rate-exerts dominant control on BE) -log (BE) and log (SR) linearly related -at high SR, BE can exceed 50% and becomes close to independent from SR -residual BE after effect of SR effect removed, weakly correlated to oxygen content but has large scatter: effect of oxygen content on BE of Corg could be negligible or a minor (but significant) part of controls on O2 in atmosphere
Tyson 2001 Based on Data from Betts and	69 Locations (see Betts and Holland 1991)	Modern MRA	Serial Calculation -the perceived role of dissolved oxygen probably depends on SR regime -High SR modern regimes (Pedersen and Calvert 1990) TOC always appears to be independent of oxygen -Low SR (low sedimentation i. e. “condensed sections”) TOC critically dependent on BE and somewhat dependent on oxygen (function of circulation and bottom water volume)

Holland 1991		Modelling exercise evaluating positive (preservational) and negative (dilution) effects and SR on TOC	-enhanced preservation seems to be associated with degradation under anoxic conditions -pore water anoxia could be result of: 1) increased DF (greater productivity or lesser depths), 2) more rapid incorporation of Corg into sediment column (high SR), or reduced water column oxygen levels -SR mechanism associated with dilution penalty and only has significant effect at low SR (5-20 cm/Ka) -Once diatoms became dominant plankton at high productivity, greater autodilution by biogenic opal limits TOCs to less than 8% generally (Tyson 1995) -In shelf waters DF sufficient to create bottom water anoxia under stratified conditions when associated with low SR (ie condensed sections) and low autodilution: should result in potentially very high TOC values as seen in some ancient black shales even when productivity is relatively low -Preservation effects of SR only enhances TOC<=5cm/Ka in oxic regimes after which dilution occurs if carbon supply is held constant -Above 35 cm/Ka no appreciable difference in TOC regardless of whether sea floor is anoxic -Below 10cm/Ka, strong divergence in TOC values in oxic and anoxic conditions -Observed correlation between SR and TOC artifact of including sites at shallower depths and/or higher productivities -re-scaled to allow for non-linear effects, oxygen may be a significant additional variable in determine TOC, predicting 2-4 times higher contents in anoxic facies vs oxic -generally negative correlation between Corg delivery flux and BE producing significant moderating effect on the predicted TOC
Xu et al. 2015	Qingshankou and Nenjiang Formations	Cretaceous Songlio Basin, China	-comparable depositional environment, but differences in accommodation space existed for the two formations, more differences related to paleoenvironment and primary productivity -distinction between 1st member and 2nd member in terms of control on TOC -1st member of both formations in saline brackish lake with anoxic conditions in bottom water -higher productivity is believed to be responsible for TOC accumulation in the Qing 1st member -preservation less favourable in the 2nd member of Nenj Qing better than Nenj because of interplay of these two factors, primary productivity is dominant controlling factor on shale quality and source rock potential between these two formations, but variations in quality within each formation depend on preservation
Chen et al. 2015	Marcellus	Devonian Appalachian Basin	-conditions of deposition different at these two wells -previous studies focus on depth of burial and maturity but study shows that depositional environment and sedimentary facies may have played a significant role as well liquids prone WV-7

		West Virginia	-may contain greater marine Corg -clastic influx proxies suggest more distal location -distal area, low terrestrial sediment supply, om predominantly derived from marine algae, bottom water conditions dominantly anoxic -conditions favourable for accumulation of Type II kerogen that has a greater capacity to generate liquid hydrocarbons gas-prone WV-6 -may contain more terrestrial Corg -higher siliciclastic input consistent with more proximal location to dry land and delivery of greater amounts of terrestrial org matter -low concentration of redox sensitive elements, depleted delta carb values and high variability in N isotopes suggest higher dissolved oxygen concentration and short term shifts in an oxic/anoxic boundary near the sediment water interface -indicates depositional conditions were favourable to accumulation of predominantly gas-prone type III kerogen

Table 44. Summary of Insights from Various Black Shales

Appendix K: Example of Hand Sample Photos

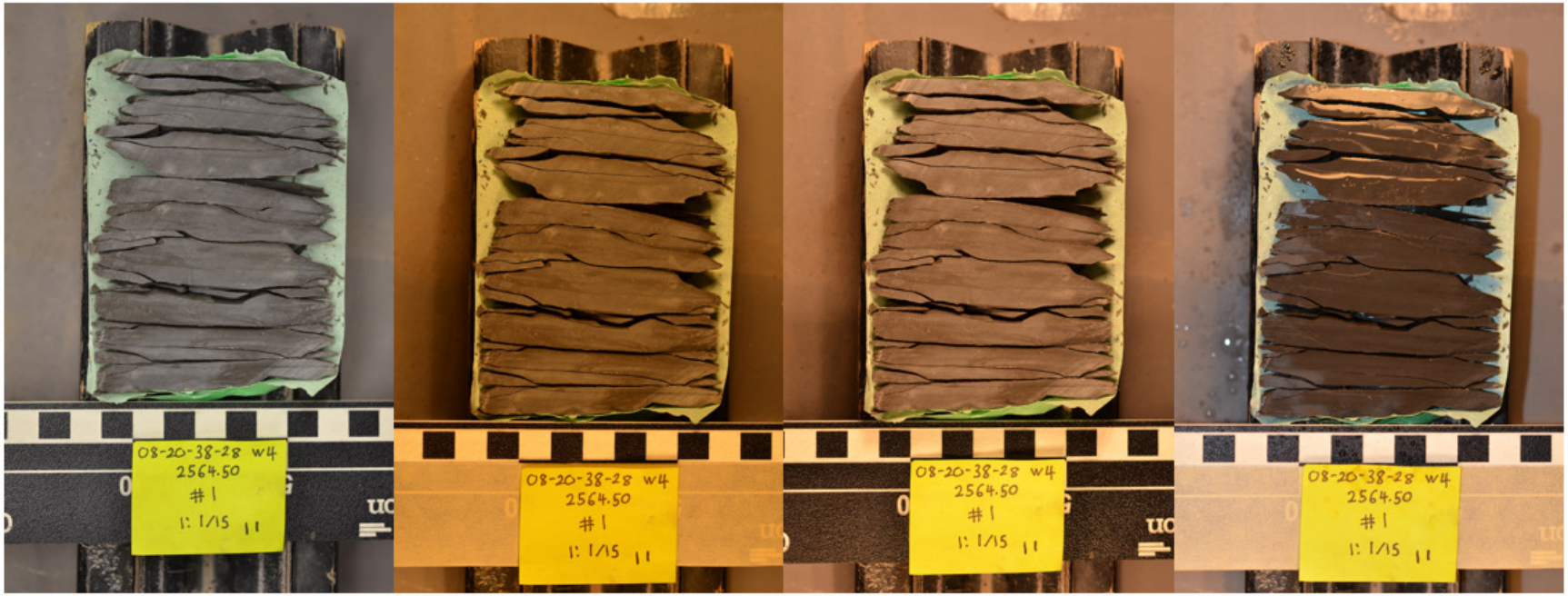


Figure 100. Example of Hand Sample Photos for EOG 08-20 sample #1

Appendix L: Example of SEM Photos from Esso 16-28 Sample 66 (~70 photos)

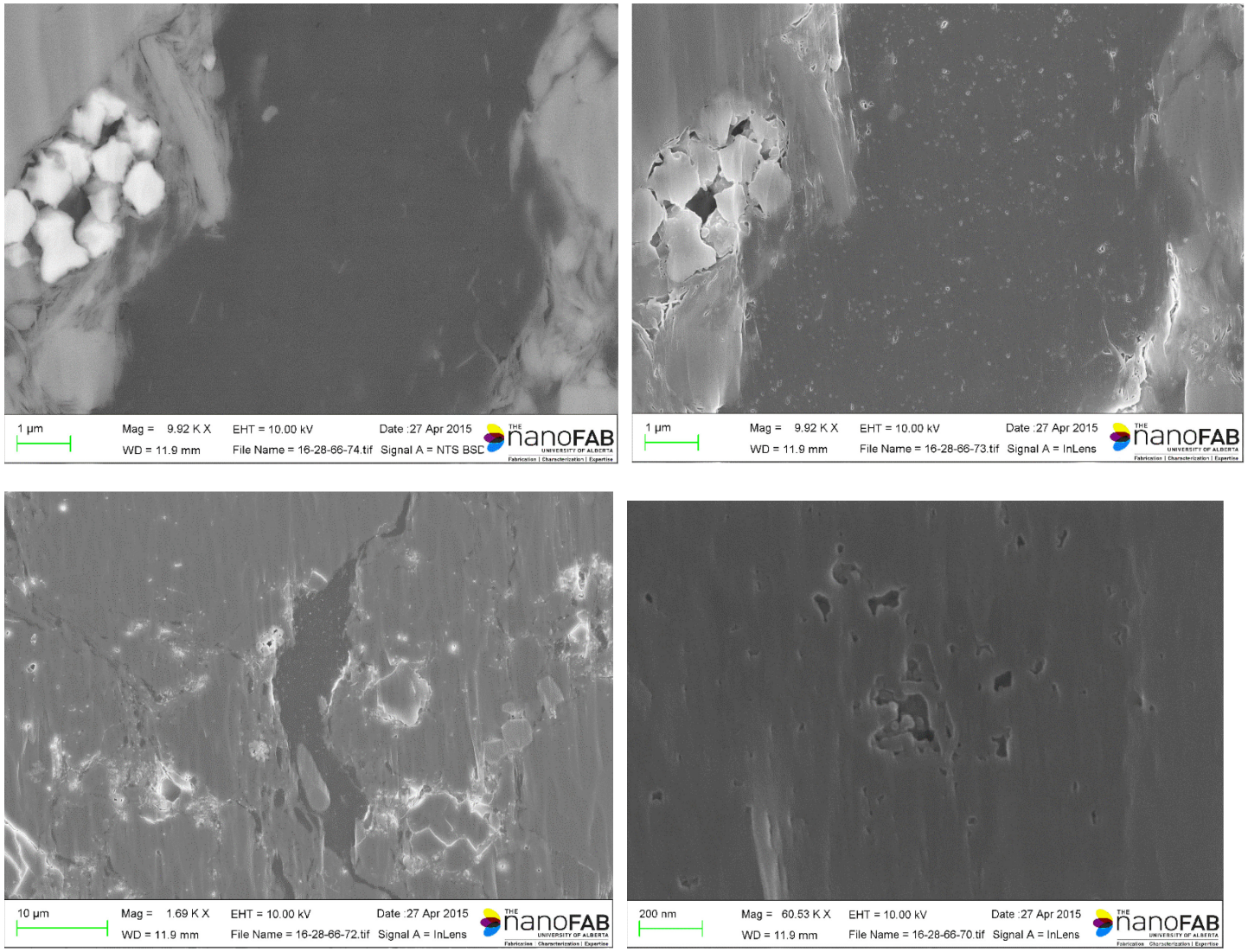


Figure 101. Examples of SEM Photos from Esso 16-28 Sample 66

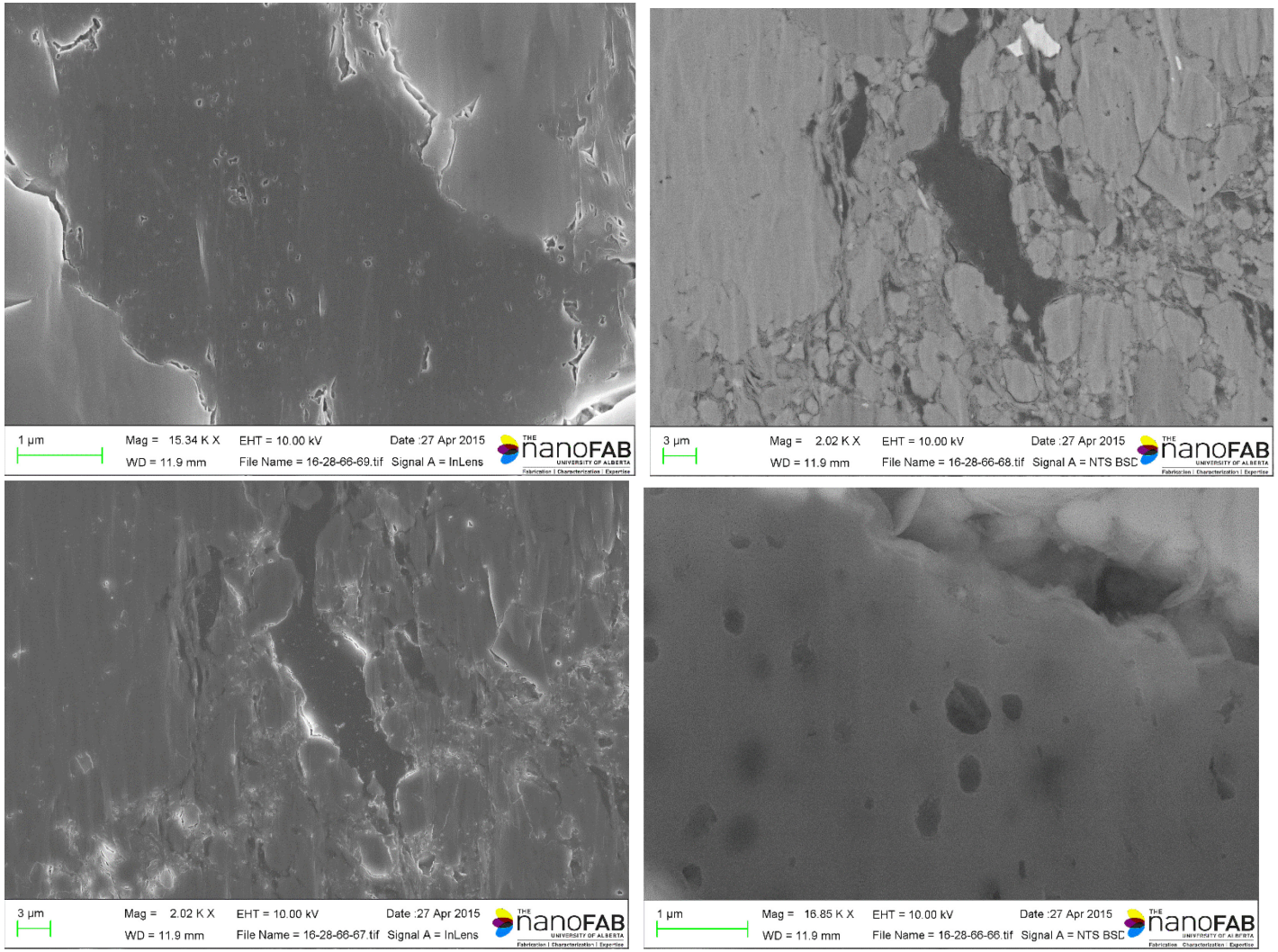


Figure 102. Examples of SEM Photos from Esso 16-28 Sample 66

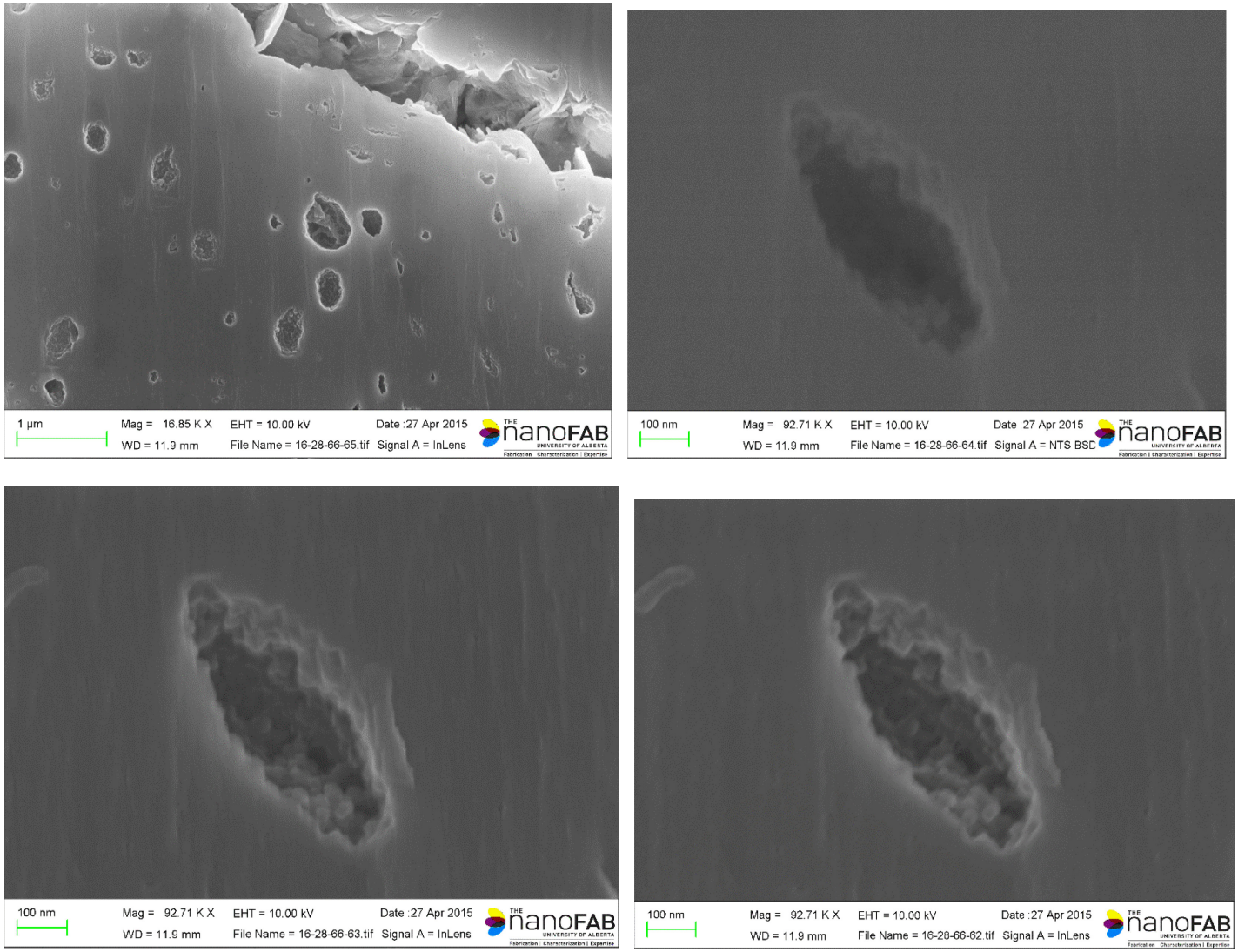


Figure 103. Examples of SEM Photos from Esso 16-28 Sample 66

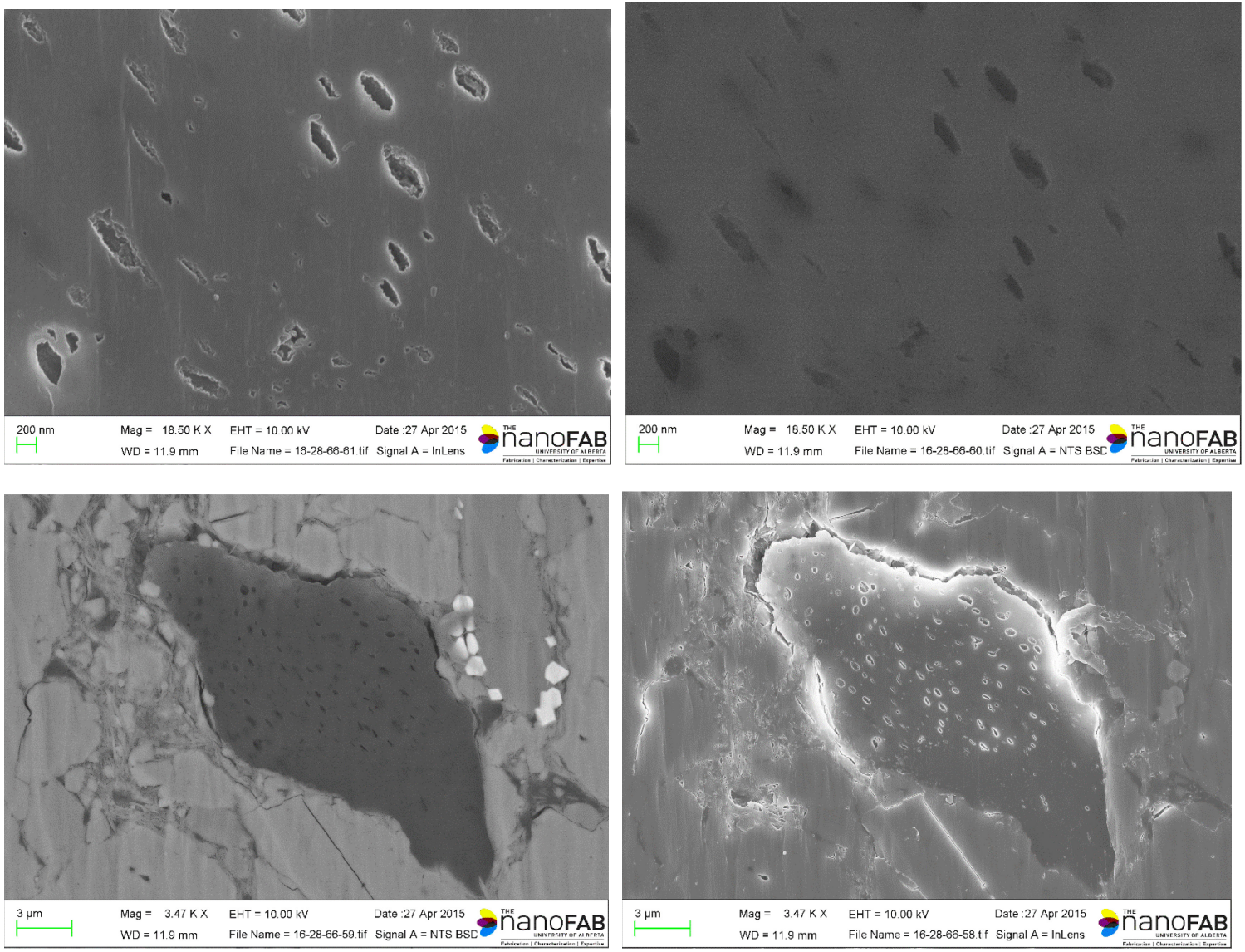


Figure 104. Examples of SEM Photos from Esso 16-28 Sample 66

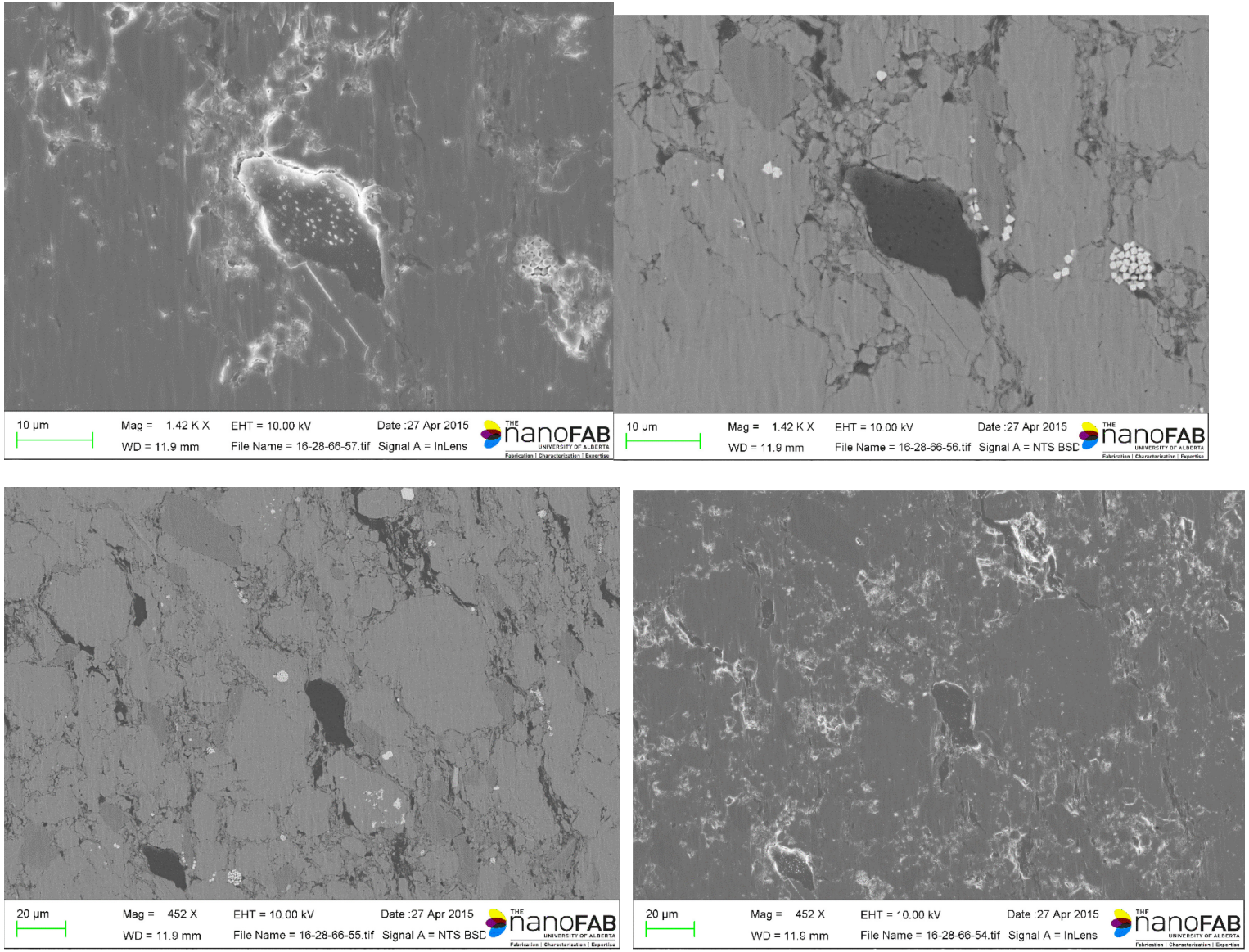


Figure 105. Examples of SEM Photos from Esso 16-28 Sample 66

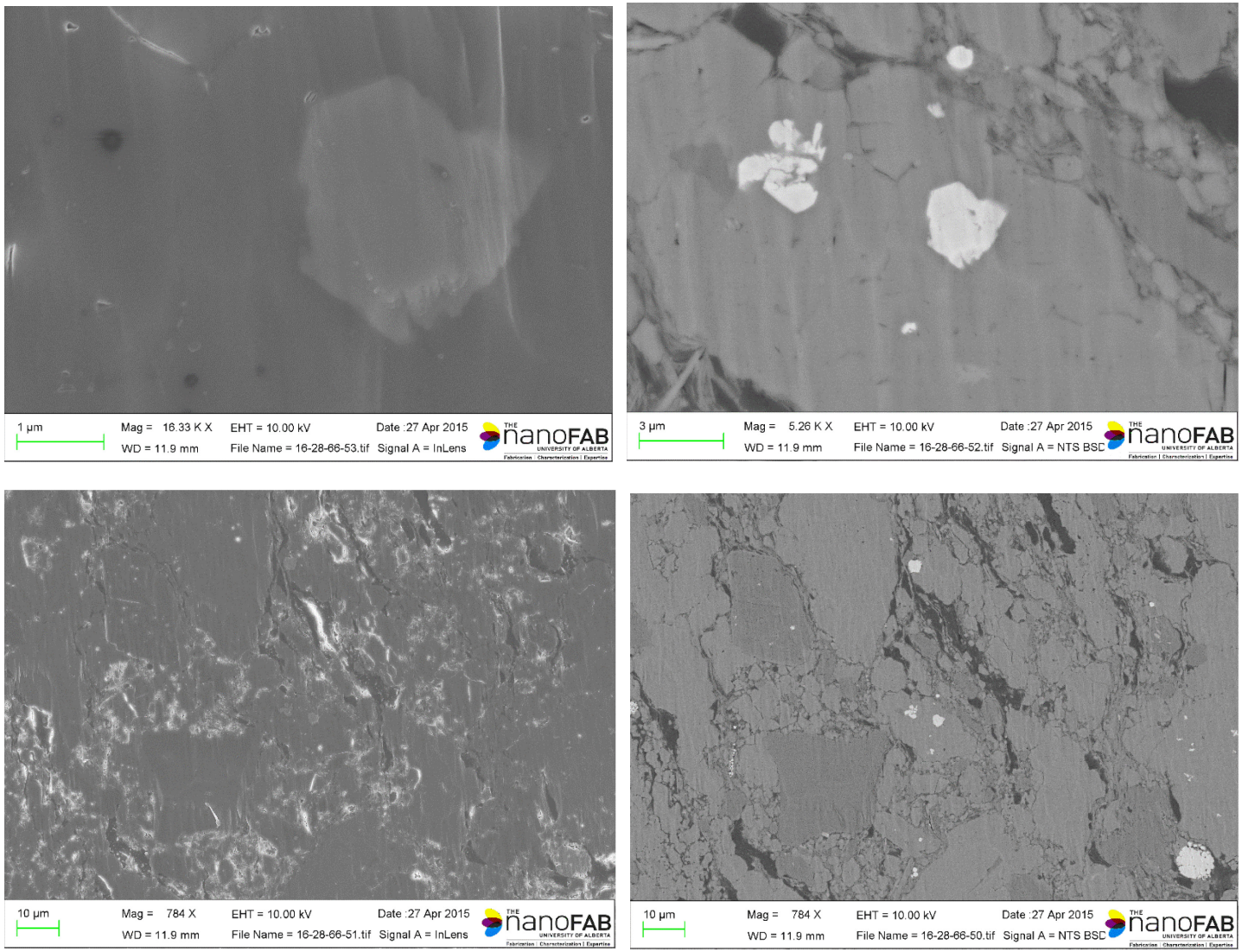


Figure 106. Examples of SEM Photos from Esso 16-28 Sample 66

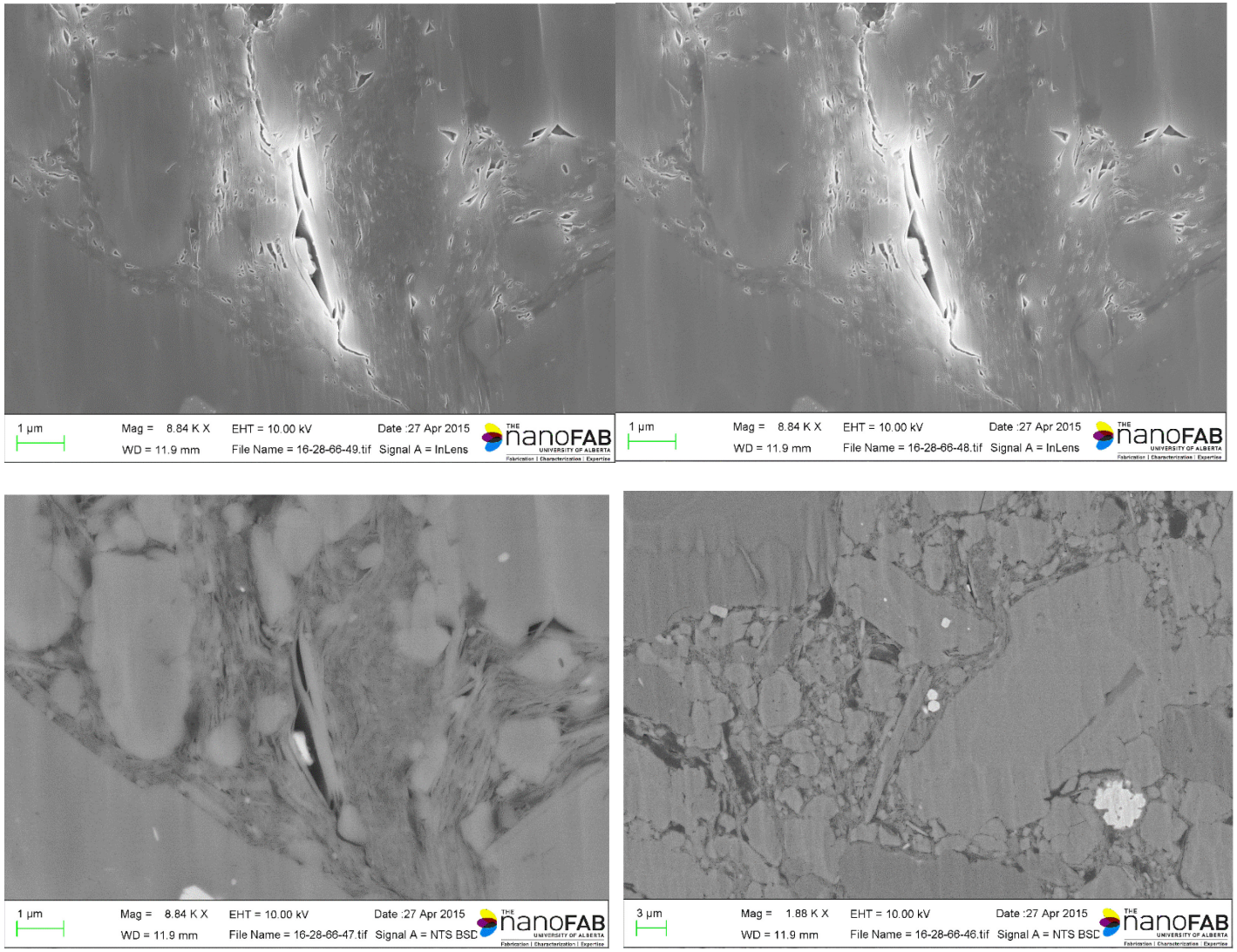


Figure 107. Examples of SEM Photos from Esso 16-28 Sample 66

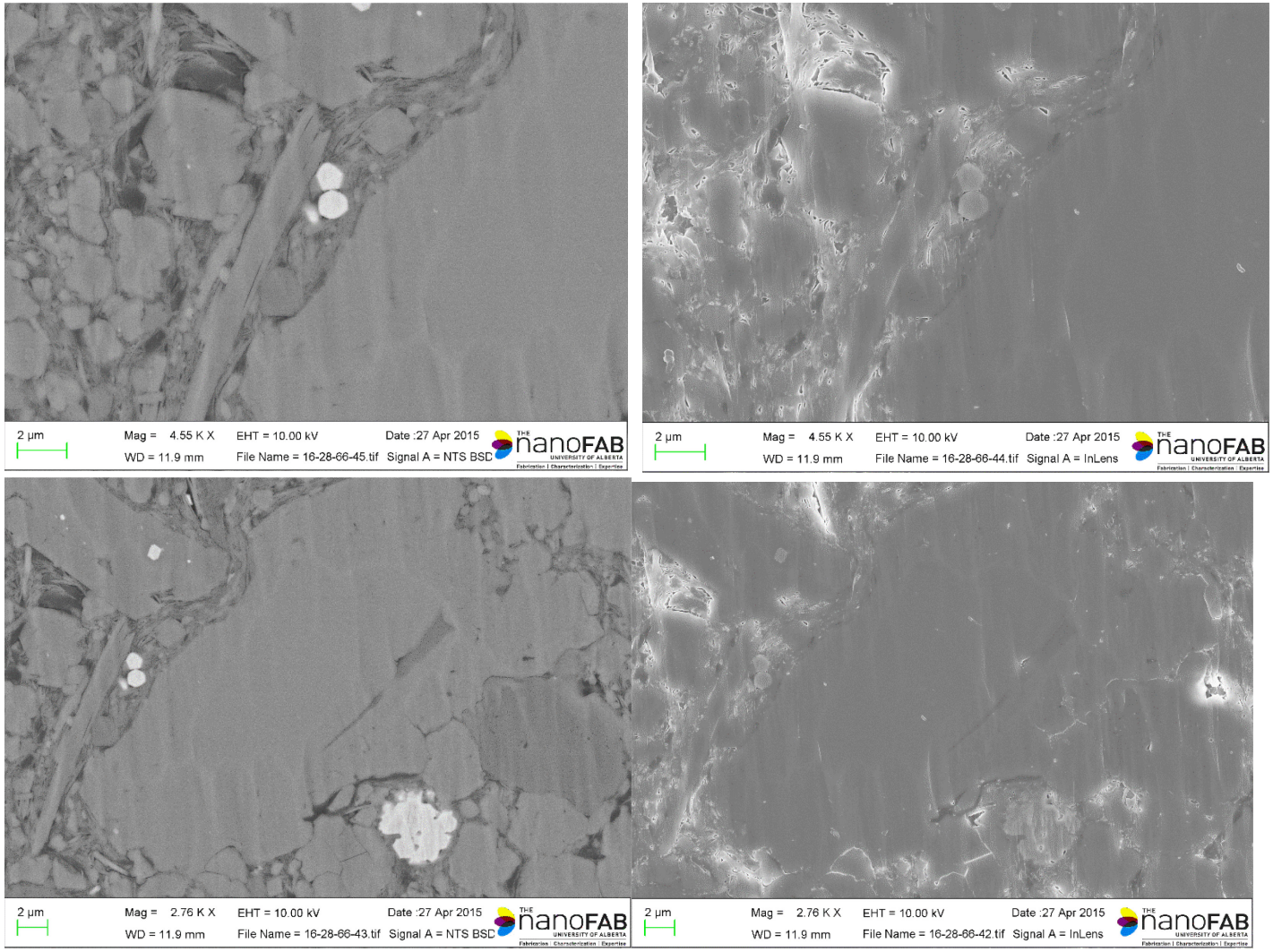


Figure 108. Examples of SEM Photos from Esso 16-28 Sample 66

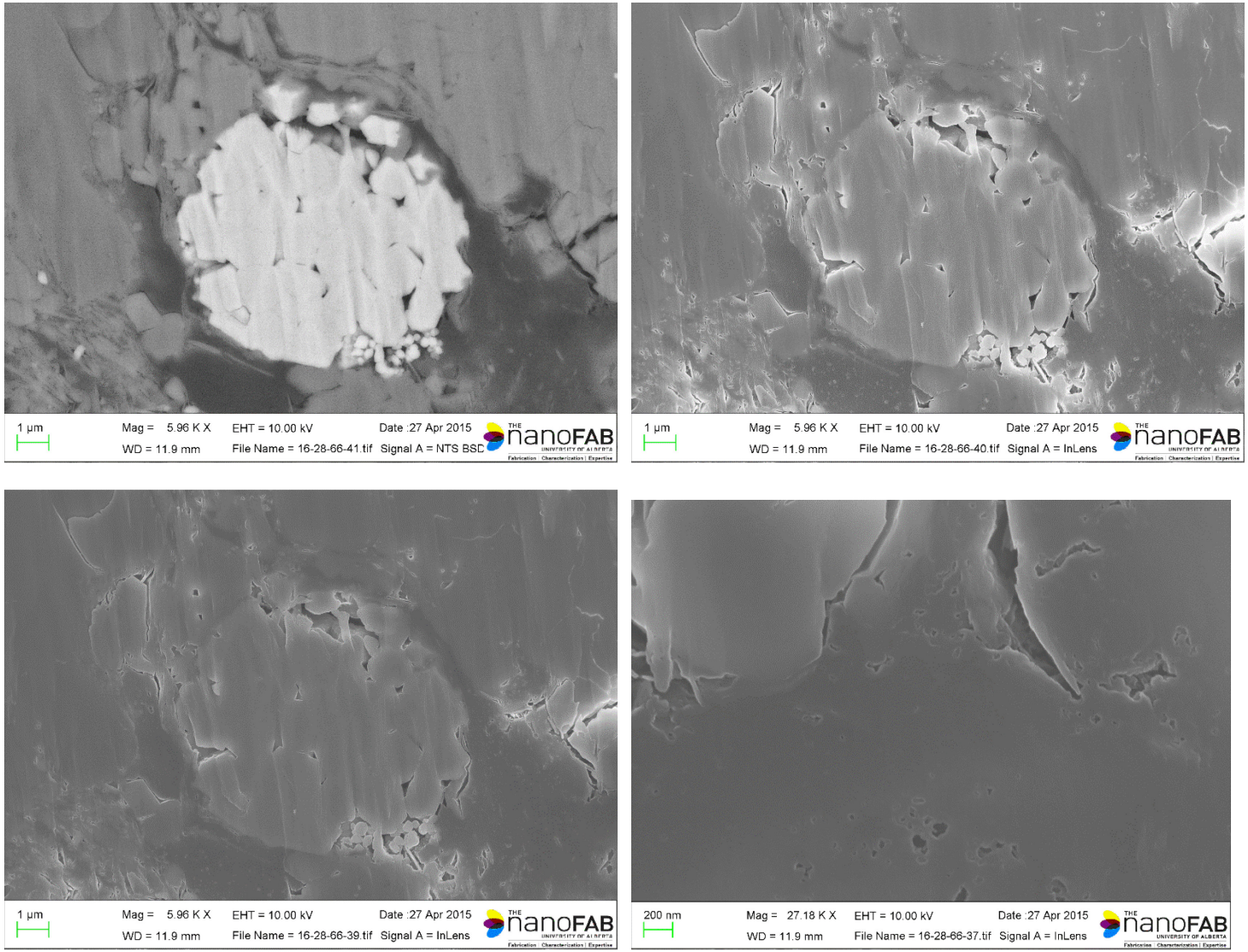


Figure 109. Examples of SEM Photos from Esso 16-28 Sample 66

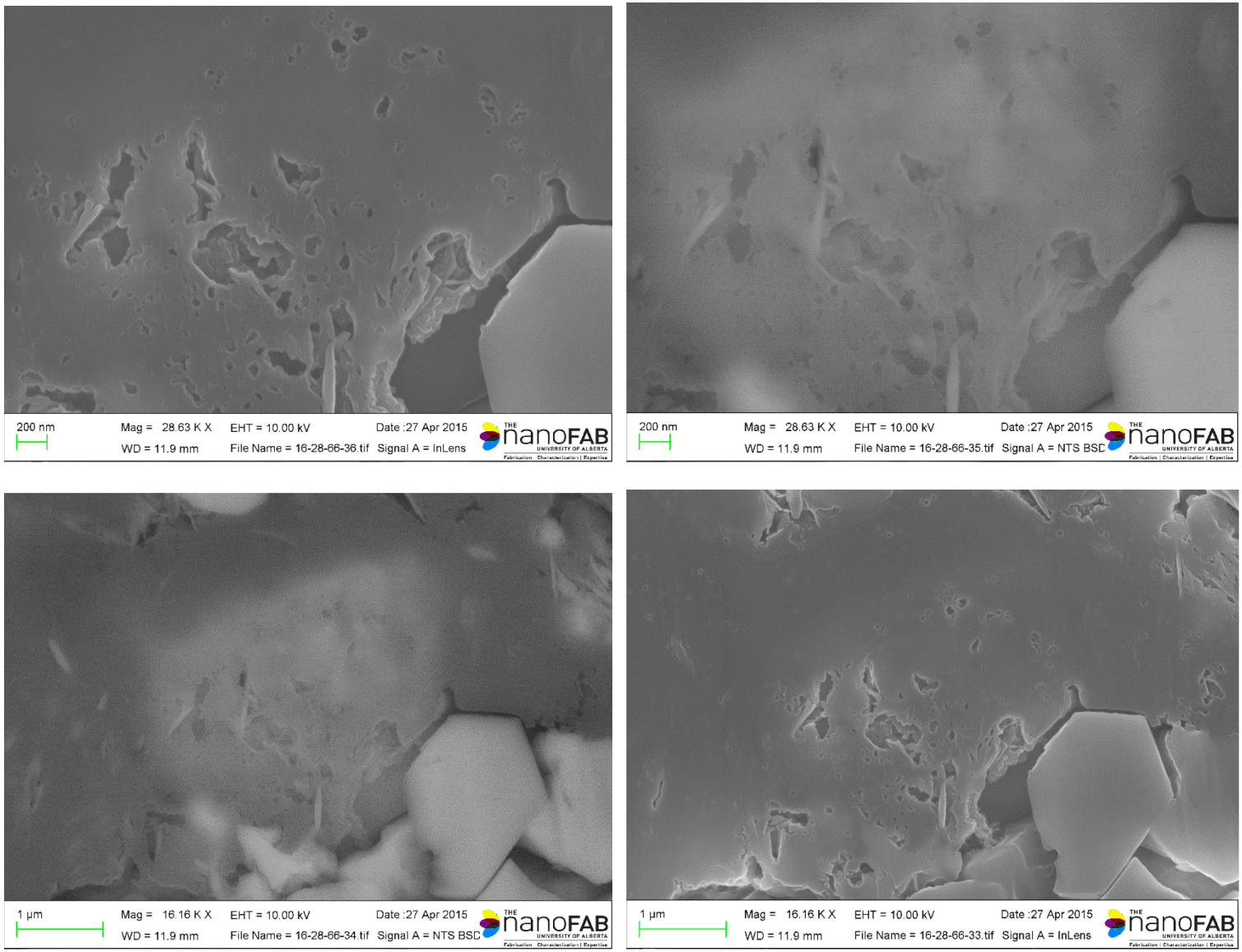


Figure 110. Examples of SEM Photos from Esso 16-28 Sample 66

Appendix M: Example of BET Results Shell 02-22 Sample 34

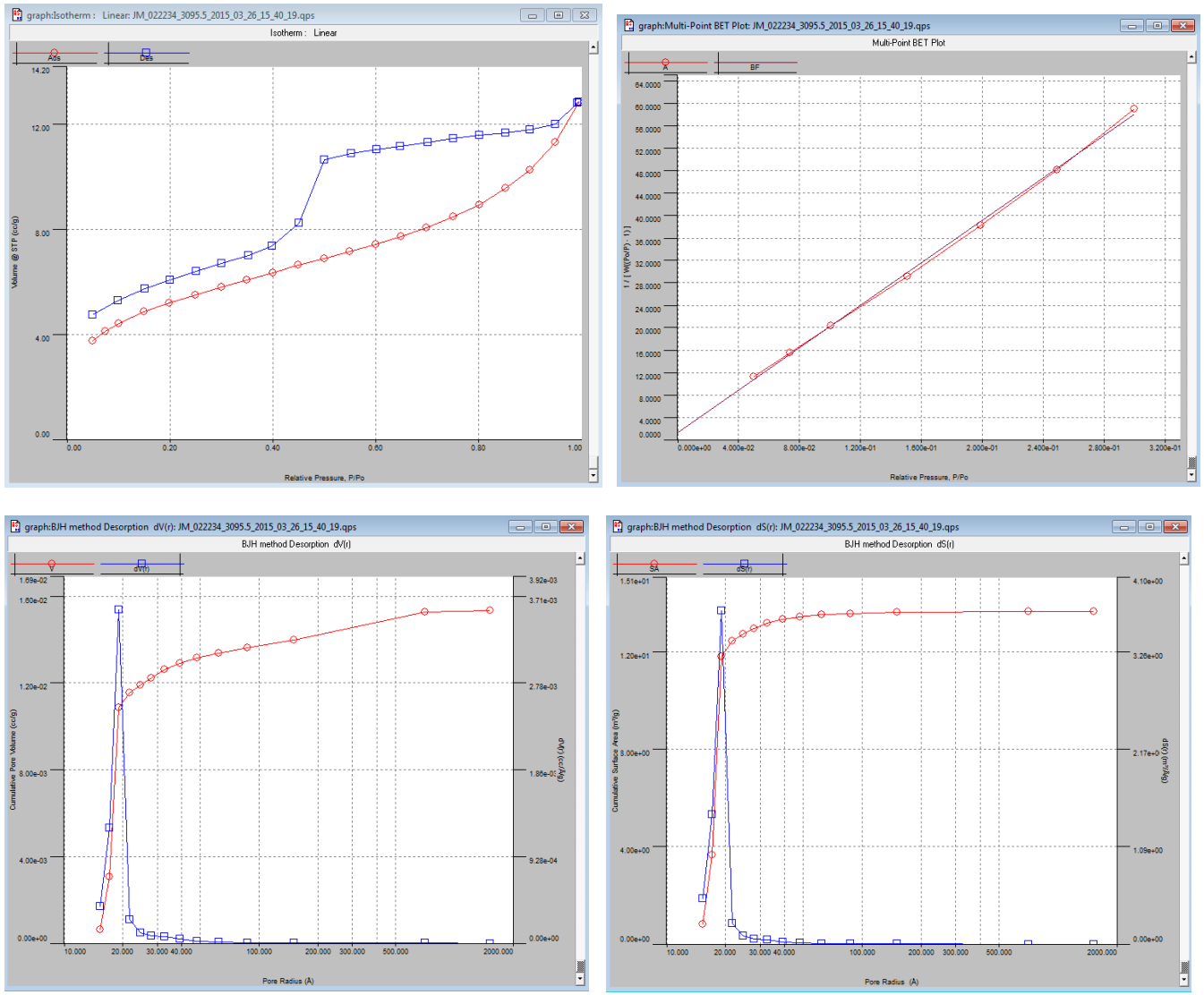


Figure 111. Examples of BET Results

Appendix N: Example of Helium Porosimetry Results

Julia McMillan - University of Alberta Project Unconfined Total Porosity, Fluid Saturations and GRI Matrix Permeability										
Well ID	Sample	Core Depth (m)	Dry Bulk Density (g/cc)	Dry Skeletal Density (g/cc)		Total Porosity %	GRI Matrix Permeability (md)		GRI Matrix Permeability (nd)	
			Avg	Avg	Std Dev		Avg	Std Dev	Avg	Std Dev
02-22	6	3072.50	2.429	2.629	0.001	7.61	3.27E-05	2.67E-06	32.750	2.668
	18	3081.50	2.477	2.660	0.001	6.88	2.32E-05	2.49E-06	23.226	2.487
	20	3083.50	2.529	2.655	0.001	4.72	8.76E-06	1.34E-06	8.764	1.339
	21	3084.50	2.419	2.635	0.001	8.20	1.90E-05	1.81E-06	18.974	1.813
	28	3089.50	2.529	2.710	0.001	6.69	3.58E-06	1.24E-06	3.576	1.240
	30	3091.40	2.412	2.663	0.001	9.43	7.06E-05	4.21E-05	70.610	42.051
	34	3095.50	2.455	2.640	0.002	7.00	1.93E-05	3.78E-06	19.307	3.783
	35	3095.90	2.473	2.642	0.001	6.39	1.09E-05	1.48E-06	10.937	1.481
	38	3098.50	2.408	2.606	0.003	7.56	2.09E-05	5.86E-06	20.916	5.856
	42	3102.50	2.420	2.647	0.002	8.56	3.14E-05	1.88E-06	31.417	1.882
	45	3105.50	2.419	2.608	0.002	7.24	1.06E-05	3.27E-06	10.624	3.269
	46	3106.39	2.646	2.756	0.001	3.99	4.48E-06	1.78E-06	4.483	1.781
	49	3108.50	2.360	2.577	0.003	8.42	2.18E-05	6.47E-06	21.800	6.472
	54	3111.37	2.512	2.672	0.001	5.98	1.16E-05	1.31E-06	11.595	1.314
	56	3112.50	2.424	2.611	0.006	7.18	1.51E-05	1.68E-06	15.054	1.679
	58	3113.30	2.465	2.659	0.002	7.29	1.28E-05	4.57E-06	12.789	4.566
	60	3114.50	2.649	2.727	0.001	2.85	3.05E-06	6.23E-07	3.054	0.623
	62	3116.50	2.556	2.731	0.002	6.39	1.21E-05	3.45E-06	12.053	3.449
	68	3121.50	2.491	2.701	0.001	7.78	1.91E-05	2.14E-06	19.146	2.140
	77	3126.50	2.514	2.724	0.001	7.68	1.58E-05	3.96E-06	15.828	3.958
11-04	1	3935.50	2.607	2.727	0.003	4.41	5.63E-06	1.34E-06	5.635	1.339
	22	3956.48	2.522	2.683	0.002	6.03	8.24E-06	2.64E-06	8.244	2.644
	51	3985.46	2.586	2.670	0.001	3.12	5.18E-06	2.34E-06	5.184	2.341
	61	3995.45	2.418	2.688	0.000	10.06	4.44E-05	5.22E-06	44.441	5.222
Averages			2.513	2.659		5.50	1.79E-05		1.79E+01	

	Anomalously high bulk density values. Resulting from large volume of pyrite in bulk density piece that was not as prevalent in the skeletal density
	Non representative bulk density (density too high) results in a porosity calculation that does not accurately reflect the porosity of the sample.

Note: no bulk density piece for sample 12 from 16-38, no calculations can be made for porosity, saturations or permeability.

Table 45. Examples of Unconfined Total Porosity

Appendix O: Example of Mercury Injection Results Shell 02-22 Sample 35

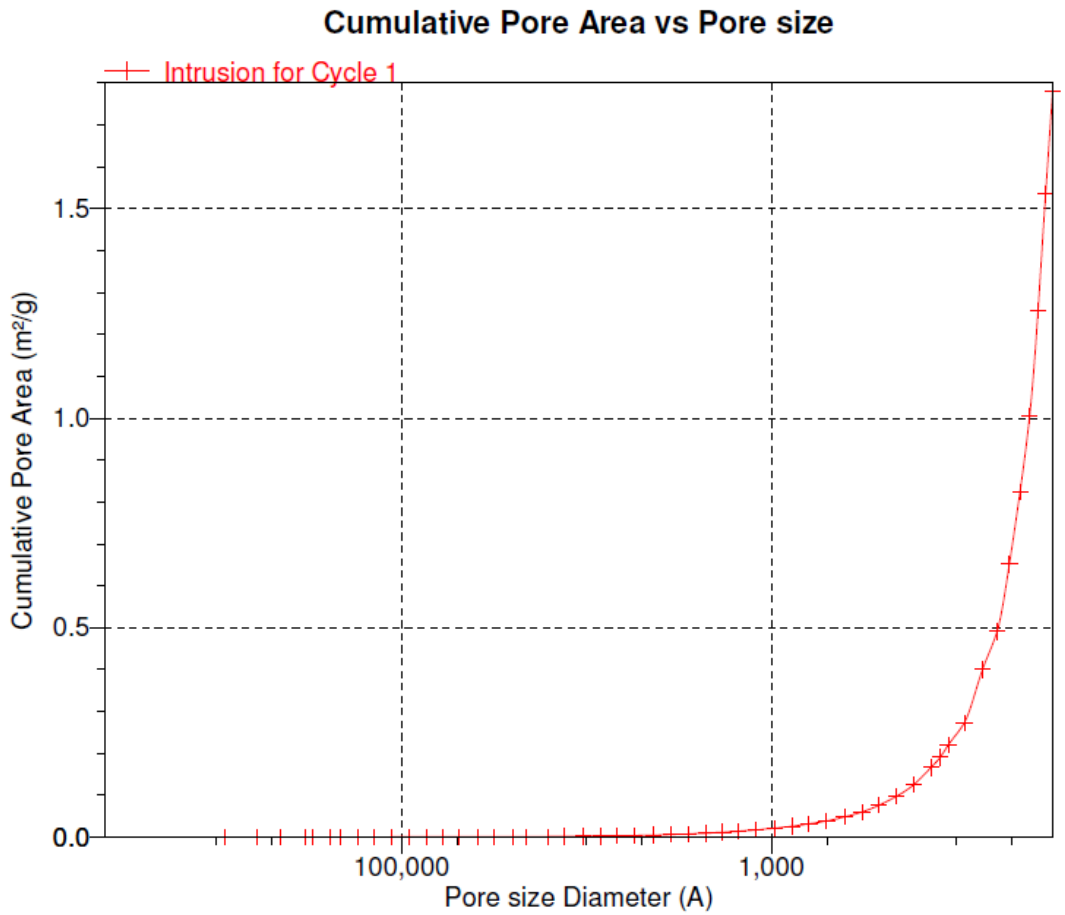


Figure 112. Example of Pore Area vs Pore Size Diameter from Mercury Injection

Appendix P: Example of XRD Results Shell 02-22

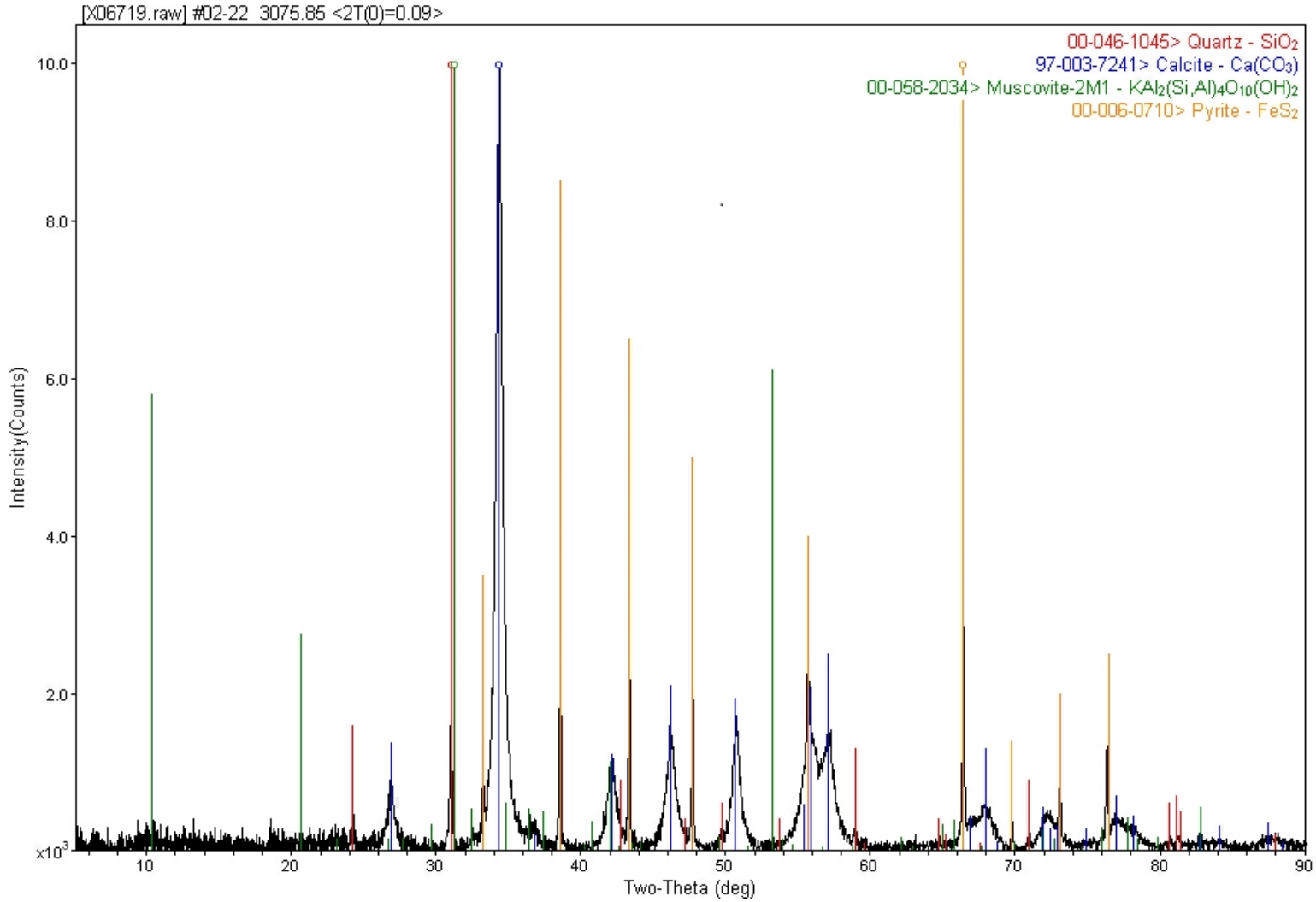


Figure 113. Example of XRD Results