CHEMOSTRATIGRAPHY OF THE EAGLE FORD FORMATION

By

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ABSTRACT

CHEMOSTRATIGRPHY OF THE EAGLE FORD FORMATION

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The Late Cretaceous Eagle Ford Formation contains the Cenomanian-Turonian Boundary (CTB). It crops out along the Red River and extends southward through the Dallas-Fort Worth Area of Texas, Waco, Austin and west towards Del Rio and Big Bend. The outcrops were not sampled. Sampling was conducted on cores located at the Bureau of Economic Geology (BEG). The cores were collected from Zavala, La Salle, Frio, Gonzalez, De Witt, and Bee Counties. The Austin Chalk Formation is located above the Eagle Ford Formation and the Buda Formation is located below it.

Deposition of the Eagle Ford Formation occurred in the southern portion of Western Interior Seaway (WIS) of North America during a period of high temperature due to greenhouse warming stemming from enhanced volcanism and associated CO_2 input. Increased CO_2 input ultimately resulted in enhanced continental solubility or weathering and enhanced primary productivity, which resulted in stagnant, oxygen, depleted waters. The effect of the former was to possibly cause the second (OAE-2) of six global ocean anoxic events that occurred during the Cretaceous Period. A combination of enhanced carbonate precipitation from primary productivity and

enhanced preservation caused by ocean anoxia led to the deposition of highly carbonaceous organic-rich mudrock.

All the samples were measured using a Bruker XRF handheld device. Select samples were measured for %TIC, %TOC, %N, %S, δ13C and δ15N.

The data revealed that sampled population included not only the upper and lower portion of the Eagle Ford Formation, but the overlaying Austin Chalk and underlying Buda Formations. This was primarily determined by the Molybdenum concentration. Molybdenum concentration less than or equal to 5 ppm indicate the presence of oxic to suboxic water column conditions. Molybdenum concentration that is greater than or equal to 5 ppm, but less than 20 ppm indicates anoxic water column conditions. Molybdenum concentration that is equal to or greater than 20 ppm indicates euxinic water column conditions. The Eagle Ford Formation was deposited mostly under anoxic to euxinic conditions. The overlying Austin Chalk Formation and underlying Buda Formation were both deposited under dominantly oxic to suboxic conditions.

Analyses of the results indicate upwelling was prevalent during much of the deposition of each core. Upwelling is indicated by the enrichment of Phosphorus and depletion of Manganese. Increased continental weathering and upwelling were the likely primary controlling influences that caused anoxic-euxinc water column conditions. Such conditions facilitated enhanced organic matter preservation during the deposition of the Eagle Ford Formation.

TABLE OF CONTENTS

LIST OF FIGURES

Figure Page

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem

Despite the abundant scientific literature documenting the inferred environmental conditions that led to deposition of the Eagle Ford Formation, an overall understanding of the conditions that led to its deposition is incomplete (Brown and Pierce, 1962; Siemers, 1978; Surles, 1978; Jian, 1989; Liro et al, 1994; Stephenson, 1995; Robison, 1997; Dawson,1997, 2000; Sung-Chi and Nelson, 2002; Dawson and Almon, 2010; Durham, 2010; Edman, 2010; Huntz and Ruppel, 2010; Mullen, 2010; Scott, R.W., 2010). This is especially so in the study area where, during the Late Cretaceous period, the Gulf of Mexico (GOM) and the Arctic Ocean were linked by a warm, shallow and anoxic intercontinental seaway However, periods dominated by anoxia were interrupted by shorten periods in which oxic to suboxic conditions dominated (Kauffman and Erle, 1984; Pratt et al, 1984; Wright, 1987; Dean and Arthur, 1989; Glancy et al, 1993; Gale et al, 1993, Simons, 2001; Flogel, 2002; Luning et al, 2004; Hetzel, 2008; Barclay et al, 2010). To better constrain the environmental conditions and improve upon understanding of the factors that led to the deposition of the Eagle Ford Formation, a drill core-based chemostratigraphic and bulk geochemical study was conducted, with an emphasis on the organic-rich portion of the formation in South Texas.

1.2 Research Tasks

As part of the research, drill cores of the Eagle Ford Formation, stored at the Bureau of Economic Geology in Austin, Texas, were used to develop a chemostratigraphic dataset. The specifics of the all the tasks conducted for the present work are provided below.

- The first task was to conduct a review of the existing literature on the Eagle Ford Formation as to better understand the history of deposition and develop a framework of hypotheses to be tested and improved upon during the study.
- The remaining research tasks focus upon accomplishing the overarching objective of the study: to better constrain the environmental conditions that led to the deposition of the Eagle Ford Formation. The tasks are as follows:
    - Analyses of the drill cores from the study area using x-ray fluorescence (ED-XRF) to determine the major and trace elemental composition in weight percent (wt%) and parts per million (ppm), respectively.
    - Assessment of the total inorganic carbon (%TIC), total organic carbon (%TOC), total nitrogen (%N), and total sulfur (%S) in select drill cores.
    - Isotope data for delta carbon-13 ($\delta^{13}C$) and delta nitrogen-15 ($\delta^{15}N$) were also collected and analyzed.
    - Mineralogical studies utilizing x-ray diffraction (XRD)

1.3 Thesis Organization

Chapter 1 introduces the statement of the problem, which is that the environmental conditions of the Eagle Ford Formation have not been fully appreciated and the model of deposition can be improved upon through chemostratigraphic analysis. The tasks undertaken to accomplish the above objective and the structure of this document is also presented.

Chapter 2 presents a brief review and history of the geologic setting of the Eagle Ford Formation. General background information is also discussed. The potential for regional and global correlation of the organic-rich mudrock is also presented. The potential of the Eagle Ford Formation as a hydrocarbon producer is also considered.

Chapter 3 explores the methods undertaken to determine the chemostratigraphy of the Eagle Ford Formation. Such methods include the quantification of elemental major and trace results utilizing the Energy Dispersive X-Ray Fluorescence (ED-XRF), which includes properly calibrating the device, and the techniques used to determine the total inorganic carbon (%TIC), total organic carbon (%TOC), total Nitrogen (%N), $\delta^{13}C$, $\delta^{15}N$, and total sulfur (%S). The techniques used for determining the mineralogy through x-ray diffraction (XRD) and petrographic analysis are also presented.

Chapter 4 presents the results derived from the analyses conducted in the previous chapter. Chapter 5 consists of analyzing and interpreting the results of the test conducted in Chapter 3 and presented in Chapter 4. Chapter 6 provides a conclusion and a summary resulting from the interpretations of the data interpreted in the previous chapter. Recommendations for further refining the study in order to better constrain the conditions that led to the deposition of the Eagle Ford Formation are also presented in Chapter 6.

CHAPTER 2

BACKGROUND

2.1 Introduction

The main objective of this chapter is to present details of the local geology of the Texas Plains Region and the Oak-Prairie Region. The regions contain the sites from which the research data were collected. The sites are located in Zavala, La Salle, Frio, Gonzalez, Bee, and De Witt counties. The secondary objective is to provide general details of the Eagle Ford Formation within the greater regional context. Supporting maps and figures provide further insight into the local and regional geology of the study area.

In select figures throughout this document the drill core analyzed during this study are referred to as a shorter version of their designation. Their designations are as follows: Geological Research Co. Schauers, FT #1 Drill Core (Schauers), Shell Oil Co. ED Hay, Unit #1 Drill Core (Hay or Hay Shell), Shell Oil Co. Leppard, J.A. #1 Drill Core (Leppard), Quintanna Halff et al # 1 Drill Core (Quintanna), Gose & Shield Hassett #3 Drill Core (Gose S. Shield), Getty Lloyd Hurt #1 Drill Core (Getty Hurt

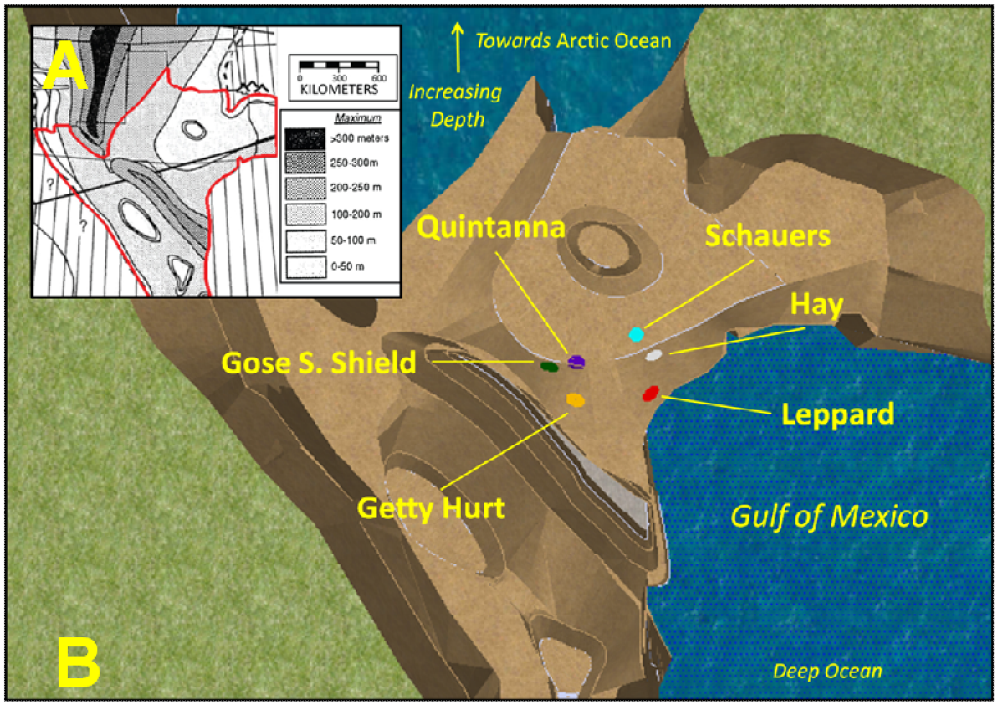

Figure 2.1 Topographic View of Drill Core Locations (CTB) (Sageman and Arthur, 1994. The figure was created using Google Sketchup by the author).

Figure 2.1 (B) displays the drill core locations approximately were they existed during deposition of the CTB. Figure 2.1 (A) Displays the area captured for 3D rendering in Figure 2.1 (B) In Figure 2.1 (A) the area captured in highlighted in red and the maximum contour depths are provided on the right of the figure. The contours range from a maximum of greater than 300 meters (colored filled black) to 0 – 50 meters (colored filled white).

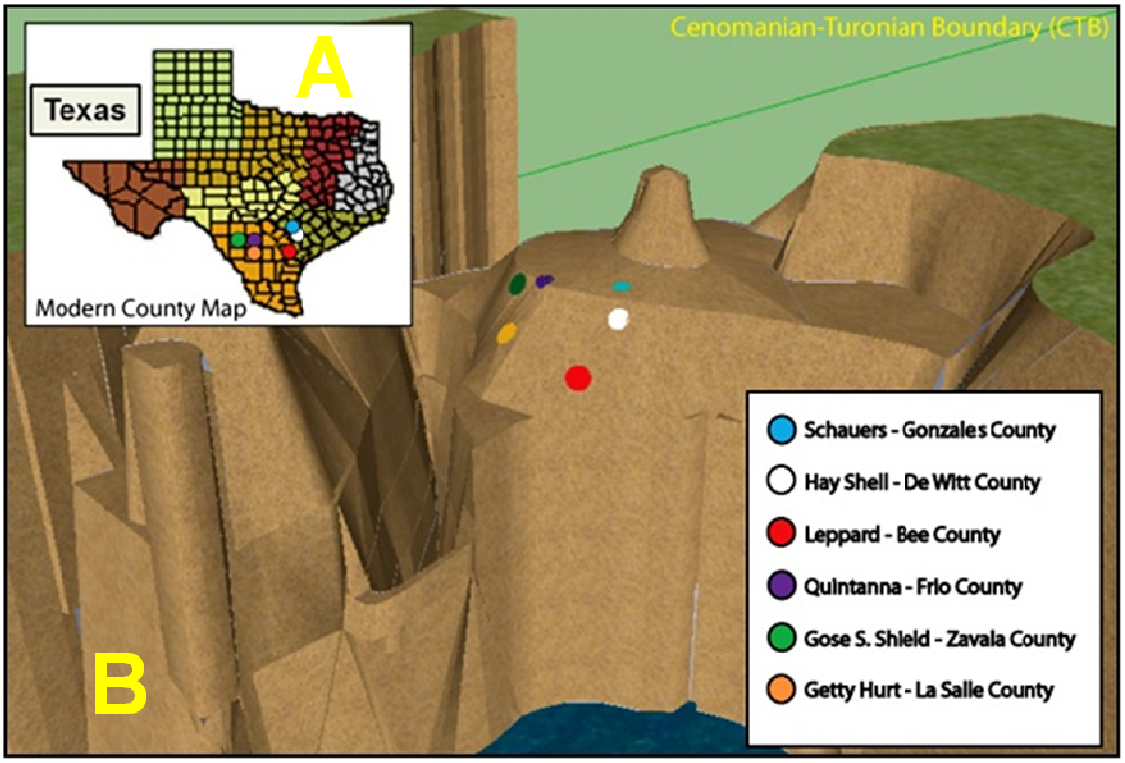

Figure 2.2 3D View of Drill Core Locations (CTB) and Modern County Map (Sageman and Arthur, 1994. The figure was created using Google Sketchup by the author).

Figure 2.2 (A) Contains the approximate locations from where each core was collected. Figure 2.2 (B) displays the approximate locations where the cores existed during the deposition of the CTB. The contour depths utilized to create Figure 2.2 (B) are located in Figure 2.1 (A).

2.2 History

The Eagle Ford Formation is named after the town of Eagle Ford, Texas. The town is located west of Dallas, TX, where the Eagle Ford Formation is typically exposed (Moreman, 1927). The Eagle Ford Group contains the Eagle Ford Formation (Hsu and Nelson, 2002).

The accumulation of the Eagle Ford Formation occurred across the Cenomanian-Turonian boundary (CTB). Figure 2.3 displays the Eagle Ford Formation containing the CTB (Comet et al, 1993; Dawson, 1997; Rowe et al, 2008; Stephenson, 1955; Hancock and Walaszczyk, 2004) during Ocean Anoxic Event #2 (OAE-2) (Schlanger and Jenkyns, 1976; De Graciansky et al, 1986; Farrimond et al, 1990; Jenkyns, 2010). OAEs, in general, are significant because they represent periods of enhanced marine organic carbon accumulation that correlate with transgressions (Berner and Raiswell, 1983; 1984; Berner, 1990; Wignall, 1991; Berner and Kothavala, 2001; Luning et al, 2004).

The contact between the Cenomanian-Turonian, has been radiomatrically dated to approximately 92 Million years ago (Dawson, 2000) (Keller and Pardo, 2004).

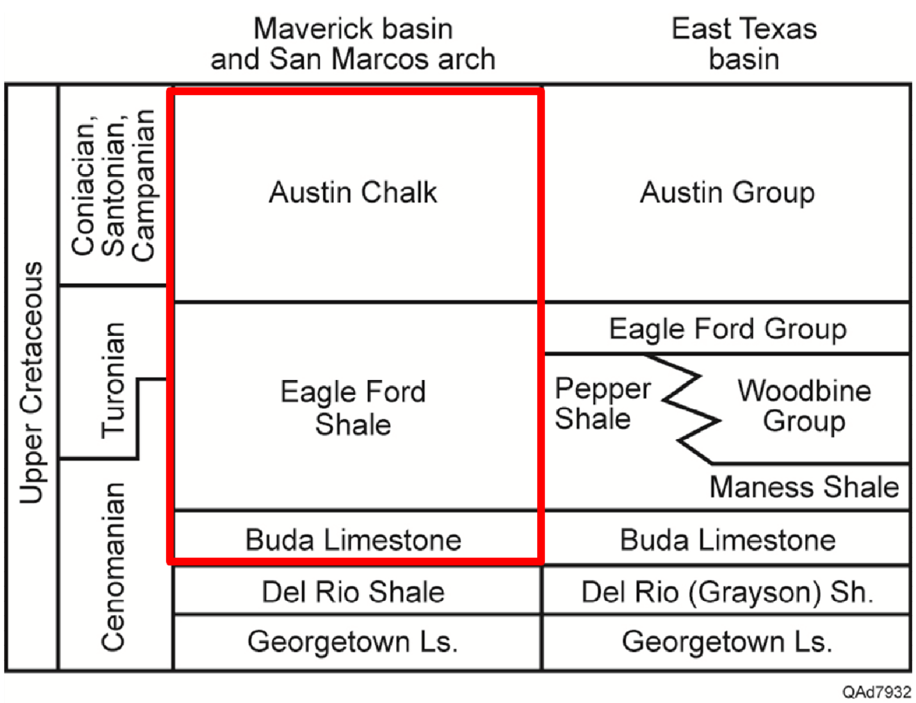

Figure 2.3 Stratigraphic Column (Hentz and Ruppel, 2010). The Cenomanian-Turonian Boundary (CTB) is contained in the Eagle Ford Formation.

The Eagle Ford was deposited on a shallow marine shelf at the southern end of the Western Interior Seaway (WIS) of North America. It represents marine deposition during a relatively brief transgressive period. Overall, it is characterized by mixed siliciclastic-carbonate mud accumulation during an otherwise carbonate-dominated accumulation period (Haq et al, 1987; Mancini et al, 2005). Furthermore, the Eagle Ford Formation records organic carbon-rich accumulation during OAE-2 (Marcel et al, 2001; Meyers et al, 2005).

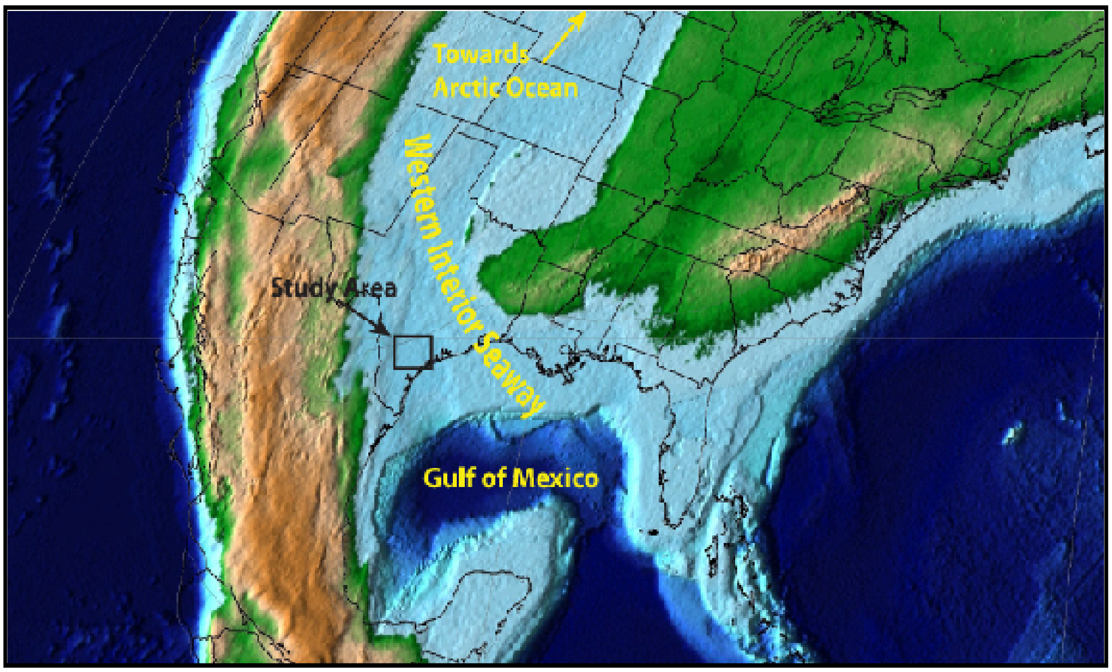

Figure 2.4 Western Interior Seaway (CTB). The figure indicates the approximate location of the study area during the deposition of the CTB (Map Created by Christopher R. Scotese With PALEOMAP Software: Point Tracker).

Figure 2.4 displays the Western Interior Seaway as it existed during the deposition of the Cenomanian-Turonian Boundary. The area within the black square indicates the approximate locations of the cores from the study area during deposition.

Several OAEs occurred during the Cretaceous (Luning et al, 2004; Jenkyns, 2010). Each OAE is significant and is important to understanding the greater context of environmental conditions during marginal marine deposition and its context within the global ocean. OAE-2 was a period characterized by sluggish ocean circulation (Algeo et al 2008; Hetzel et al, 2008; Algeo et al, 2010; Mort, 2010).

During the Late Cretaceous transgression, the WIS linked the Gulf of Mexico to the Arctic Ocean (Kauffman, 1984; Jacobs and Sahagian, 1993; Slingerland et al, 1996). At that time the average sea-surface temperature (SST) in the Arctic Ocean was approximately 15ºC, and the equator-to-pole SST gradient was ~15ºC (Huber et al, 1995; Tarduno et al, 1998; Schouten et al, 2003; Jenkyns et al, 2004). The warm paleo-SSTs are consistent with models of a CO_2-rich atmosphere (Barron, 1983; Ekart et al, 1999).

The Eagle Ford Formation has been referred to as “shale” as in Eagle Ford Shale. This is in accordance with the classification of shale as defined by Underwood, (1967). In a study conducted as early as 2002 to characterize properties of the Eagle Shale the term “shale” was still in use as defined by Underwood, (1967). The results of this study are further elaborated on in the next section of this chapter (Hsu and Nelson, 2002).

However, the overwhelming majority of the interval analyzed in the study area does not possess the required fissility associated with the term “shale” (Folk, 1980). This is a break from earlier classification methods used to define “shale” (Underwood, 1962). However, in much of the current literature organic-rich mudrock deposited across the CTB is, erroneously, defined as shale (Kuypers, 2001; Luning et al, 2004; Kolonic et al, 2005; Hetzel, 2008).

Therefore, for the purposes of the study, abiding by Folk's classification (Folk, 1980), the term "mudrock" will be used to best describe the Eagle Ford Formation as a mix of siliciclastic and carbonate, organic-rich mudrock. However, it should be noted that the Eagle Ford Formation is a mix of siliclastic and carbonate, organic-rich mudrock in *general* as the thickness of cores and sedimentological and geochemical characteristics vary across the study area.

2.3 Geologic Setting

The Eagle Ford Formation crops out along the Red River and southward through the Dallas-Fort Worth Area of Texas. It forms a belt that is broad in the northeast, but in general narrows in a southwesterly direction (Robison, 1997). Figure 2.5 displays the approximate location of the Eagle Ford Outcrop. In the subsurface the Eagle Ford Formation dips to the east-southeast relative to the trend of the outcrop (Harbor, 2011).

Figure 2.5 Approximate Locations of the Eagle Ford Outcrop Belt (Robison, 1997). The outcrop narrows to the southwest and in the subsurface it dips east-southeast (Harbor, 2011).

The Eagle Ford Formation is located in between the Austin Chalk Formation, above it, and the Buda Formation, below it. In descending order, the formations in the study area are: Austin Chalk, Eagle Ford, and Buda (Hall and Houk, 1983). In the following the formations are described briefly in the aforementioned descending order, beginning with the Buda.

The Buda Formation has been described as a poorly bedded to nodular, hard to chalky, mudstone. It is entirely Cenomanian in age (Figure 2.3; Scott and Kidson, 1977); and, its deposition began approximately 99.6 million years ago (Lugowski et al, 2005-2009). The Buda often contains calcite filled veins, is glauconitic, and fossiliferous, with plentiful amounts of shell fragments. It ranges in color from light gray to pale orange. However, it weathers to dark gray to brown. Near the upper contact of the Buda, the formation is more thinly bedded and argillaceous. The lower portion of the Buda consists of soft, chalky limestone. The formation contains burrows filled with chalky marl. Typical fossils include: bountiful amounts of pelecypods, foraminifers, ostracodes, serpulids, echinoid spines, and bryozoans. In some local regions, the Buda formation contains solitary corals and green algae (Blome, 2004). The contact between the Buda and Eagle Ford Formations are often fossiliferous (Blome, 2004).

In 1852 the Eagle Ford was described as black shale with fish remains by Ferdinand Roemer (Harbor, 2011). In 1887 R.T. Hill established the type locality and documented that the Eagle Ford Formation was characteristically bituminous in the Upper Cretaceous section of North Texas enclosing the Red River area (Harbor, 2011). However, it can currently be described in general that the upper part of the Eagle Ford Formation is dark gray and consists of limestone and “shale” (Blome, 2004). In 1932, work by W.L Moreman was introduced that divided the Eagle Ford “”Shale” into three Formation in northern East Texas. The subdivisions were based on lithologic variability (Harbor, 2011). In 1989 outcrop studies would give rise to the Cenomanian-Turonian division of the Eagle Ford Formation (Harbor, 2011). The upper division of the Eagle Ford Formation is the Turonian and the lower division is the Cenomanian.

The lower part can be easily weathered and forms a gently rolling topography. Eagle Ford Formation represents a mix of siliciclastic and carbonate, organic-rich mudrock. Based on collected data and laboratory testing results from the canceled

Superconducting Super Collider (SSC) site in Ellis County, Texas, the Eagle Ford "Shale" contains 38-88% clay minerals, and roughly 50% of the clay minerals are smectitic (Hsu and Nelson, 2002). The Eagle Ford Formation possesses intermittent layers of ash, which can be used for correlation purposes (Robison, 1997).

The Eagle Ford conformably grades upward into the Austin Chalk Formation, which is generally characterized as dense amorphous limestone with vertical fractures (Dees et al, 1990). More specifically, the Austin Chalk is described as having massive to slightly nodular, gray to white, chalky to marly, fossiliferous mudstone.

The Austin Chalk ranges in age from the Lower Coniacian (88.6 Ma) to Upper Santonian (83.5 Ma) (Czerniakowski et al, 1984). Within the immediate study area, the Eagle Ford Formation is distinguished from the other two formations by its dark color. It often consists of calcareous laminations, and is generally described as brown, flaggy and sandy shale, siltstone, and argillaceous limestone. The presence of Gryphaea aucella, Inoceramus prisms, minor foraminifera and ostracoda and echinoid debris are noted (Blome, 2004).

2.3.1 Regional and Global Correlation

The Eagle Ford Formation coincides with the worldwide Cenomanian-Turonian anoxic event, however, precise correlation with the anoxic event remains ambiguous (Dawson and Almon, 2010). This is despite an abundance of geochemical studies in regional and global regions that record the OAE-2 (Arthur, 1987;Farrimond et al, 1990;Gale et al, 1993;Liro, 1994;Dawson, 1997, 2000;Flogel, 2002;Kolonic et al, 2002, 2005;Simons et al, 2003;Luning et al, 2004;Nederbragt et al, 2004;Meyers et al, 2005;

Brumsack,2006; Junium et al, 2007;Hetzel et al, 2008;Sinninghe et al, 1998, 2010;Edman and Pitman, 2010).

2.3.2 Production Potential

Previous studies have already demonstrated that the Eagle Ford Formation is capable of generating commercial quantities of liquid hydrocarbons (Liro, 1994). The formation contains large amounts of oil-prone kerogen. Such kergoen includes both fluorescent amorphinite and exinite (Robison, 1997). The amount of kerogen in the Eagle Ford is significant when compared to that of the overlying Austin Chalk Formation, which is also capable of generating commercial quantities of liquid hydrocarbons (Robison, 1997). However, it is possible that the production results from the underlying Eagle Ford Formation. The difference in these two formations is attributed to the result of different levels of organic preservation. Anoxic conditions cause kerogen to be better preserved than under oxygen rich conditions, which is exhibited in Austin Chalk source rock. It was hypothesized that such anoxic conditions of the Eagle Ford Formation reinforce its potential as a significant play for the production of liquid hydrocarbons (Robinson, 1997). The Eagle Ford Formation has since emerged as a major oil producer.

CHAPTER 3

METHODS

3.1 Introduction

The chemostratigraphy and mineralogy of the Eagle Ford Formation was examined by utilizing energy dispersive x-ray fluorescence (ED-XRF) and x-ray diffraction (XRD). Discrete samples were also collected for geochemical characterization and analyzed for total inorganic carbon (TIC), total organic carbon (TOC), total nitrogen (%N), total sulfur (%S), and δ13C and δ15N or organic matter.

The specifics of how to properly collect, process, and analyze the type of data mentioned above are presented below (Thompson, 1992). The following is a list of drill cores that were examined and analyzed utilizing the Bruker S1 Tracer III/ V ED-XRF.

- A total of 72 samples from the Geological Research Co. Schauers, FT #1 Drill Core (81 ft - 25 meter - long; Gonzalez County, Texas)
- A total of 42 samples from the Shell Oil Co. ED Hay, Unit #1 Drill Core (128 ft - 39 meter - long; De Witt County, Texas)
- A total of 108 samples from the Shell Oil Co. Leppard, J.A. #1 Drill Core (131 ft - 40 meter - long; Bee County, Texas)
- A total of 29 samples from the Quintanna Halff et al # 1 Drill Core (324 ft - 99 meter - long; Frio County, Texas)
- A total of 34 samples from the Gose & Shield Hassett #3 Drill Core (125 ft - 38 meter - long; Zavala County, Texas)
- A total of 173 samples from the Getty Lloyd Hurt #1 Drill Core (225 ft - 69 meter - long; La Salle County, Texas)

Table 3.1 Drill Core Information: Name, Location and API Number

Drill Core Name	Drilled Location	Box #	API Well #
Geological Research Co. Schauers, FT #1 Drill Core	Gonzalez County, TX	1 - ~ 10	421773039400
Shell Oil Co. ED Hay, Unit #1 Drill Core	De Witt County, TX	1 – 5	421233035900
Shell Oil Co. Leppard, J.A. #1 Drill Core	Bee County, TX	1 - ~ 15	420253038900
Quintanna Halff et al # 1 Drill Core	Frio County, TX	1 – 9	421633059100
Gose & Shield Hassett #3 Drill Core	Zavala County, TX	1 – 5	425073040400
Getty Lloyd Hurt #1 Drill Core	La Salle County, TX	29 – 48	422833030500

The cores in the above table are located at the Bureau of Economic Geology, University of Texas at Austin. Facies characterization and stratigraphic architecture of the cores or cuttings (Quintanna Halff et al # 1 Drill Core) has been conducted by Ryan Harbon, 2011.

3.1.1 Energy Dispersive X-Ray Fluorescence (ED-XRF)

ED-XRF is a well a documented method used for measuring major and trace elements in rock samples (Leake, 1969; Harvey, 1973; Schroeder et al, 1980). Measurements collected and calibrated during this study were obtained using a Bruker XRF handheld device (Rowe et al., in press). The major element analysis suite included Mg, Al, S, Si, P, K, Ti, Ca, Mn, and Fe. The trace element suite included Mo, Cr, Co, Ni, Cu, Zn, Th, Rb, U, Sr, Zr, and V.

Each slabbed core was analyzed at approximately one foot intervals. The slabbed face of each sample was placed on top of the ED-XRF during analysis. The ED-XRF remained stationary during analysis, with the XRF beam facing upward.

Analyses of the major and trace element suites were conducted separately, each with a count time of 3 minutes. The ED-XRF was set at 15 kV and 42□A during the major element analysis, and 40 kV and 26□A during the trace element analysis.

3.1.2 Calibration

Calibration for major and trace element analysis for mudrocks was undertaken using a suite of 90 reference materials (Rowe et al., in press). The 90 reference materials encompass five international standards, 7 from the Devonian-Mississippian Ohio Shale, 20 from the Pennsylvanian Smithwick Formation, which is located in Central Texas, 28 from the Devonian-Mississippian Woodford Formation of West Texas, 15 from the Late Cretaceous Eagle Ford Formation of South Texas, 16 from the Mississippian Barnett Formation of North-Central Texas, and 5 internationally accepted standards (SDO-1, SGR-1, SCo-1, GBW-07107, and SARM-40).

Each of the 90 powdered (200 mesh) reference materials was created using a 40 ton Carver pellet press with a boric acid backing, and a 40 millimeter die. Approximately eight grams of powdered reference material was utilized to create the reference materials. Each reference pellet was analyzed for a count time of six minutes for both major and trace elements. The reference pellets were analyzed three times on a different portion of the pellet. Similar to the analysis of the organic rich mudrock samples, the ED-XRF Instrument was set on voltage or 15 Kv and 40 Kv for major and traces respectively.

All x-ray spectra were loaded into the Bruker Cal Process Software (Bruker Elemental, 2010) along with a table of accepted values of elemental concentrations for the references materials. A detailed discussion of calibration, reproducibility, and the limits of detectable measurement for each element are discussed elsewhere (Rowe et al., in press). A total of 458 discrete samples were collected. The samples were marked and analyzed at approximately one-foot intervals along each respective core and the specifics are listed below. The samples ran for majors and traces were analyzed at the same location on the sample.

3.1.3 Collection

Discrete samples selected for additional analyses were collected by drilling the core or by cutting the backs of a drill core and subsequently pulverizing it. All samples were pulverized with a TM Engineering Pulverizer.

Discrete samples were analyzed at the University of Texas at Arlington for Total Inorganic Carbon (TIC). This was accomplished using a UIC, Inc. coulometer (Engleman et al, 1875) equipped with a CM5230 Acidification Module. The average unknown standard deviations were <0.5% and a Baker analyzed calcium carbonate check standard was utilized. To conduct TIC analysis the powdered samples were acidified with 10 percent phosphoric acid (H_3PO_4) at a temperature of 70°C. The coulometer was purchased with support of National Science Foundation Grant No. 0841739.

3.1.4 TOC / Total Nitrogen / $\delta^{13}C$ / $\delta^{15}N$

Total organic carbon (TOC), total nitrogen (TN), and stable isotopic compositions of TOC ($\delta^{13}C_{TOC}$) and ($\delta^{15}N_{TOT}$) were performed on powdered samples that were weighed into silver capsules (Costech Analytical, Inc. #41067) and subsequently acidified repeatedly with 6% sulfurous acid (H_2SO_3) in order to remove carbonate phases (Verardo et al., 1990). Samples were analyzed at the University of

Texas at Arlington using a Costech ECS 4010 elemental analyzer interfaced with a Thermo Finnigan Conflo IV device to a Thermo Finnigan Delta-V isotope-ratio mass spectrometer (IRMS). Isotopic results are reported in per mil (‰) relative to V-PDB for $\delta^{13}C$ and air for $\delta^{15}N$. The average standard deviations were 0.13‰ and 0.08‰ for $\delta^{13}C$ and $\delta^{15}N$ of USGS-40 glutamic acid (IAEA-8573), respectively, and 0.39% and 0.0% for the TOC and TN of USGS-40, respectively. The average standard deviations for unknown samples analyzed in triplicate were <0.2‰ for both $\delta^{13}C_{TOC}$ and $\delta^{15}N_{TOT}$, and 0.1% for both TOC TN.

3.1.5 Total Sulfur

The total sulfur (%S) analysis was conducted using a LECO- S analyzer, with the standard deviation of unknowns averaging <0.01%S.

3.1.6 X-Ray Diffraction (XRD**)**

Subsets of samples were analyzed by the powdered x-ray diffraction method at the Kentucky Geological Survey using a Bruker D8 Advance. The XRD patterns generated were used to evaluate the mineralogy in the discrete zones in a selection of drill core samples. Bulk clay fractions were prepared and analyzed using a suspension and powdered peeled method. Glycolated and unglycolated clay fractions were analyzed across two to 22 degrees and at an angle range to 90 degrees two theta.

Table 3.2 Quantity of Samples Analyzed and Analyses Conducted.

Drill Core Name	ED-XRF	TIC	TOC	% N	δ13C	δ15N	% S
Getty Lloyd Hurt #1 Drill Core	173	173	0	0	0	0	0
Quintanna Halff et al # 1 Drill Core	29	0	0	0	0	0	0
Geological Research Co. Schauers, FT #1 Drill Core	72	30	5	5	5	5	0
Gose & Shield Hassett #3 Drill Core	34	0	0	0	0	0	0
Shell Oil Co. Leppard, J.A. #1 Drill Core	108	26	0	0	0	0	102
Shell Oil Co. ED Hay, Unit #1 Drill Core	42	42	40	40	40	40	42

CHAPTER 4

RESULTS

4.1 Introduction

The main objective of this chapter is to present and analyze the data collected from the drill cores. These data includes the results from all geochemical and mineralogical studies conducted. The first portion of this chapter encompasses the geochemical results used to assess the chemostratigraphy of each drill core. These results include those derived from the analyses of Energy Dispersive X-Ray Fluorescence (ED-XRF), TIC, TOC, Total Nitrogen, $\delta^{13}C$, $\delta^{15}N$, and Total Sulfur.

The next portion of this chapter is comprised of results from mineralogical studies conducted on discrete samples from select drill cores. The results of select discrete samples are derived from X-ray Diffraction (XRD). Other analyses indicate the phases of the elements in the drill cores.

In the latter portion of the chapter, comparisons are drawn between the data derived from the aforementioned drill cores and other similar depositional environments. The depositional environment comparative analyses are done to better constrain the environmental conditions present at the time of deposition. This is accomplished by comparing the relative rate of accumulation to key trace elements to determine water column conditions.

The order of the following data under each subheading is presented from drill cores in northeastern most portion of the study area to the southwestern most portion of the study area.

4.2 Elemental Analyses

4.2.1 Energy Dispersive X-Ray Fluorescence Results

Energy Dispersive X-Ray Fluorescence was utilized to determine the major and trace elements of each discrete sample. Additional data that does not serve to aid in the discussion in the following chapter can be found in the appendix.

To determine the relative elemental enrichment of the drill cores from the study area compared to the average gray shale, as defined by Wedepohl, 1971 and 1991, the enrichment factor is provided for the following elements: P, S, Fe, Mn, V, Ni, Mo, Cu, and U. The enrichment factors of Mo, V, U, Ni and Cu are most relevant to this study because proportional enrichments indicate oxic-sub, anoxic or euxinic water column conditions (Tribovillard, 2006).

The clay concentration of the drill cores is determined indirectly by using Al and Ti as a proxy. Greater clay concentration relative to a given element occurs where Al and Ti values are low and the elemental values are relatively high. Cross plot are of select elements are included to determine relationships with Al. When a linear relationship occurs between the given elements and Al the elements are considered to have occurred with the clay fraction. Aluminum is utilized as a clay proxy. However the Al can be scavenged or the concentration can be authigenically increased. To verify that the Al concentration accurately reflects the clay concentration Ti is plotted against Al. If a linearity occurs the Al concentration is considered accurately reflect clay concentration.

This is explored further in the subsequent results section beginning at 4.2.2. The major elements of interest are Ca, Si, Al, P, Fe, Mn, and Ti. The trace elements of interest are Sr, V, Ni, Mo, Cu, and U. It should be noted that data for major and trace elements were measured for all the following elements: Mg, Al, Si, P, K, Ti, Ca, Mn, Fe, Mo, Cr, Ni, Cu, Zn, Th, Rb, U, Sr, Zr, and V. A complete accounting of these elements is provided in the appendix.

Although not all of the elements are reviewed in the following section the elements most relevant to the interpretation will be examined in discussion section. Calcium and Ti is normalized to Al to separate them from the clay fraction. Due to calcium carbonate and other biogenic diluents comparing trace-elements be misleading, since values are based on weight percent. To be able to compare trace-element proportions the samples it is customary to normalize trace element concentration to aluminum content (Tribovillard, 2006). Molybdenum, V, U, Ni, Cu, P and Mn are considered with particular attention because of their use as geochemical proxies for assessing water column conditions during deposition. Molybdenum, V, U, Ni, Cu are utilized to determine oxic-suboxic, anoxic or euxinic conditions (Zheng, 2000; Tribovillard, 2006). Phosphorus and Mn are utilized to determine if upwelling was or was not an influence during deposition (Brumsack, 2006). Note that in some figures that contain breaks in the data, the topmost point and lowest most point may be obscured.

Not all the elements in each figure or table will be discussed at length. However their concentrations are relevant to the study because in general most support the heterogeneous composition of the Eagle Ford Formation. For example, Figure 4.1 and associated Table 4.1 both indicate that the Eagle Ford Formation was more heterogeneous than the Buda Formation because of large shifts (high standard deviation) in the elemental concentration representative of the Eagle Ford Formation relative to the Buda Formation. I the following, zones that accompany the figures have been selected through pattern recognition and may contain multiple formations.

Subzones of the Shell Oil Co. ED Hay, Unit #1 Drill Core are identified and discussed. This is because of the greater abundance of available data from that drill core relative to the other drill cores collected for this study.

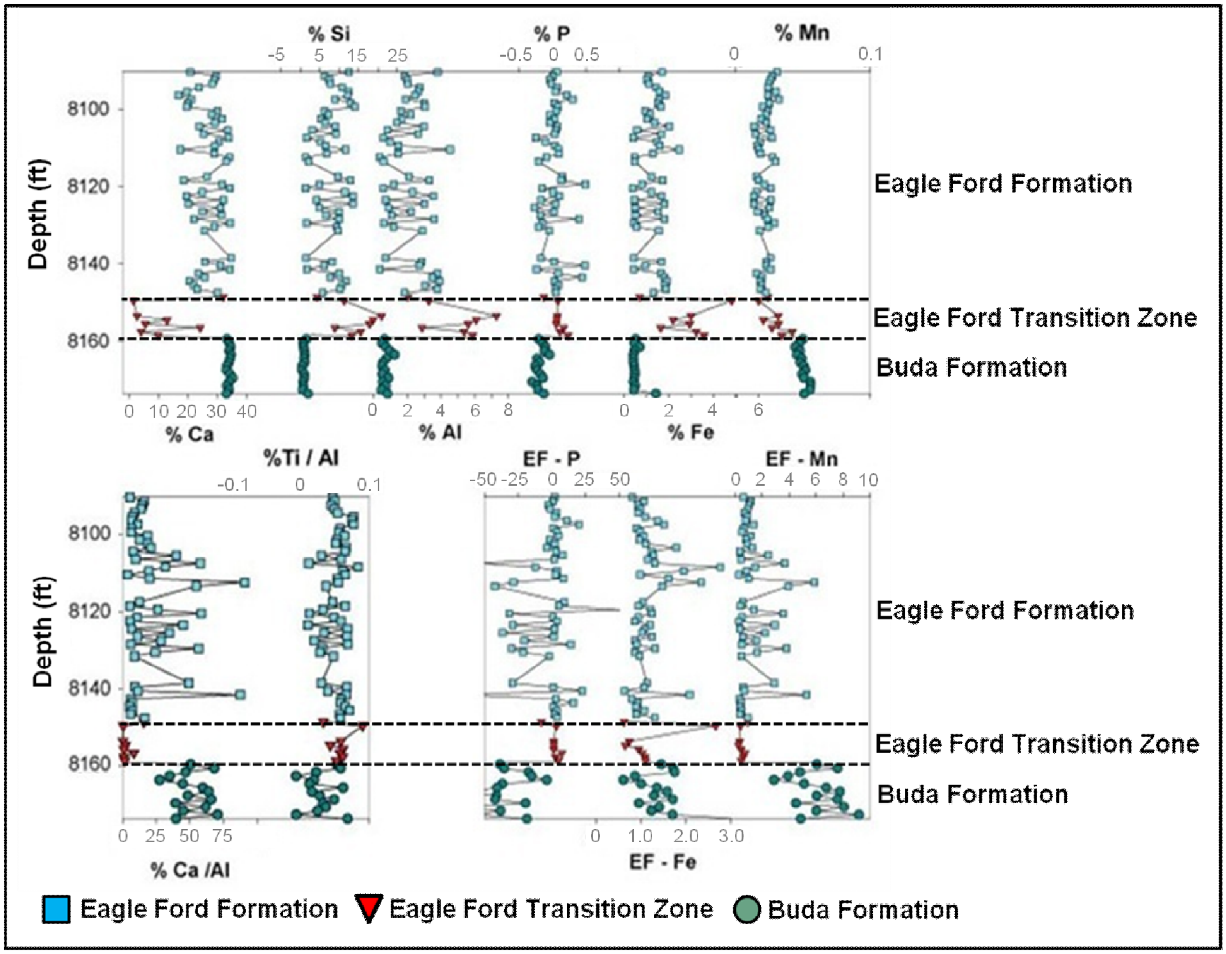

Figure 4.1 Geological Research Co. Schauers, FT #1 Drill Core, Major Element Concentrations, Respective Enrichments and Select Normalized Data. Zone #1 contains the Buda Formation, Zone #2 contains the Eagle Ford Transition Zone and Zone #3 contains the Eagle Ford Formation.

Table 4.1 Geological Research Co. Schauers, FT #1 Drill Core Average, Maximum, Minimum, Range and Standard Deviation for Major Concentrations, Respective Enrichment and Select Normalized Data. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.1. The zones are respective with the Figure 4.1 as follows: Zone #1 consists of the Buda Formation, Zone #2 consists of the Eagle Ford Transition Zone and Zone #3 consists of the Eagle Ford Formation.

Schauers Zone #3	Ca %	Si %	Al %	P %	Fe %	Mn %	Ca/Al %	Ti/Al %	EF-P	EF-Fe	EF-Mn
Average	26.98	7.82	2.14	0.03	1.26	0.02	21.41	0.05	-4.04	1.19	1.38
Max	34.76	13.98	4.54	0.49	2.45	0.03	90.40	0.08	50.76	2.77	5.88
Min	16.86	1.29	0.38	-0.26	0.40	0.01	3.89	0.01	-73.60	0.64	0.31
Range	17.90	12.69	4.16	0.75	2.05	0.02	86.52	0.07	124.36	2.13	5.57
Stnd Dev	5.27	3.75	1.12	0.17	0.54	0.00	20.95	0.02	20.54	0.41	1.33
Schauers Zone #2	**Ca %**	**Si %**	**Al %**	**P %**	**Fe %**	**Mn %**	**Ca/Al %**	**Ti/Al %**	**EF-P**	**EF-Fe**	**EF-Mn**
Average	11.76	13.84	4.81	0.08	2.75	0.03	3.84	0.06	1.82	1.11	0.54
Max	32.22	20.95	7.28	0.23	4.79	0.04	15.75	0.09	7.39	2.67	0.96
Min	1.65	4.24	2.05	-0.13	0.71	0.02	0.39	0.03	-7.80	0.63	0.28
Range	30.57	16.71	5.24	0.36	4.08	0.02	15.36	0.06	15.18	2.03	0.68
Stnd Dev	11.07	5.58	1.83	0.10	1.25	0.01	5.49	0.02	4.42	0.66	0.23
Schauers Zone #1	**Ca %**	**Si %**	**Al %**	**P %**	**Fe %**	**Mn %**	**Ca/Al %**	**Ti/Al %**	**EF-P**	**EF-Fe**	**EF-Mn**
Average	34.10	0.90	0.72	-0.18	0.55	0.05	51.01	0.03	-35.18	1.45	6.09
Max	35.40	1.94	1.27	-0.04	1.43	0.06	70.41	0.07	-3.73	3.11	9.19
Min	33.31	0.38	0.48	-0.30	0.43	0.04	27.45	-0.01	-67.59	0.62	2.90
Range	2.09	1.55	0.78	0.26	1.00	0.01	42.95	0.08	63.86	2.49	6.30
Stnd Dev	0.62	0.41	0.22	0.07	0.25	0.00	13.13	0.02	17.83	0.57	1.75

Figure 4.1 displays the Geological Research Co. Schauers, FT #1 Drill Core Zone one (Buda Formation) ranges from 8,174 feet to 8,160 feet. Zone two (Eagle Ford Transition Zone) ranges from 8,159 feet to 8,149 feet. Zone three (Eagle Ford Formation) ranges from 8,148 feet to 8,091 feet. However, the zones defined through sedimentological analysis (Harbor, 2011) can vary from those defined through chemostratigraphic analysis.

Figure 4.1 displays substantial variability throughout the drill core. In combination with table 4.1 the Geological Research Co. Schauers, FT #1 Drill Core has been subdivided into distinct zones shown above.

Most notable is the near inverse relationship between the percent Ca and percent Al. There loosely-proportional inverse relationship between the percent Ca relative to Si, Al, P, Fe and Mn. This indicates that the influences responsible for the deposition of Ca were separate from those the mechanism responsible for the deposition of the Si and Al.

The descending order of greatest to least relative elemental concentration is as follows: Ca, Al, Si, Fe, P, and Mn. Although the percent Mn is generally several orders of magnitude less than most of the accompanying elements, it is substantially enriched in zone one (Buda Formation), depleted in zone two (Eagle Ford Transition Zone), and dynamically enriched in zone three (Eagle Ford Formation).

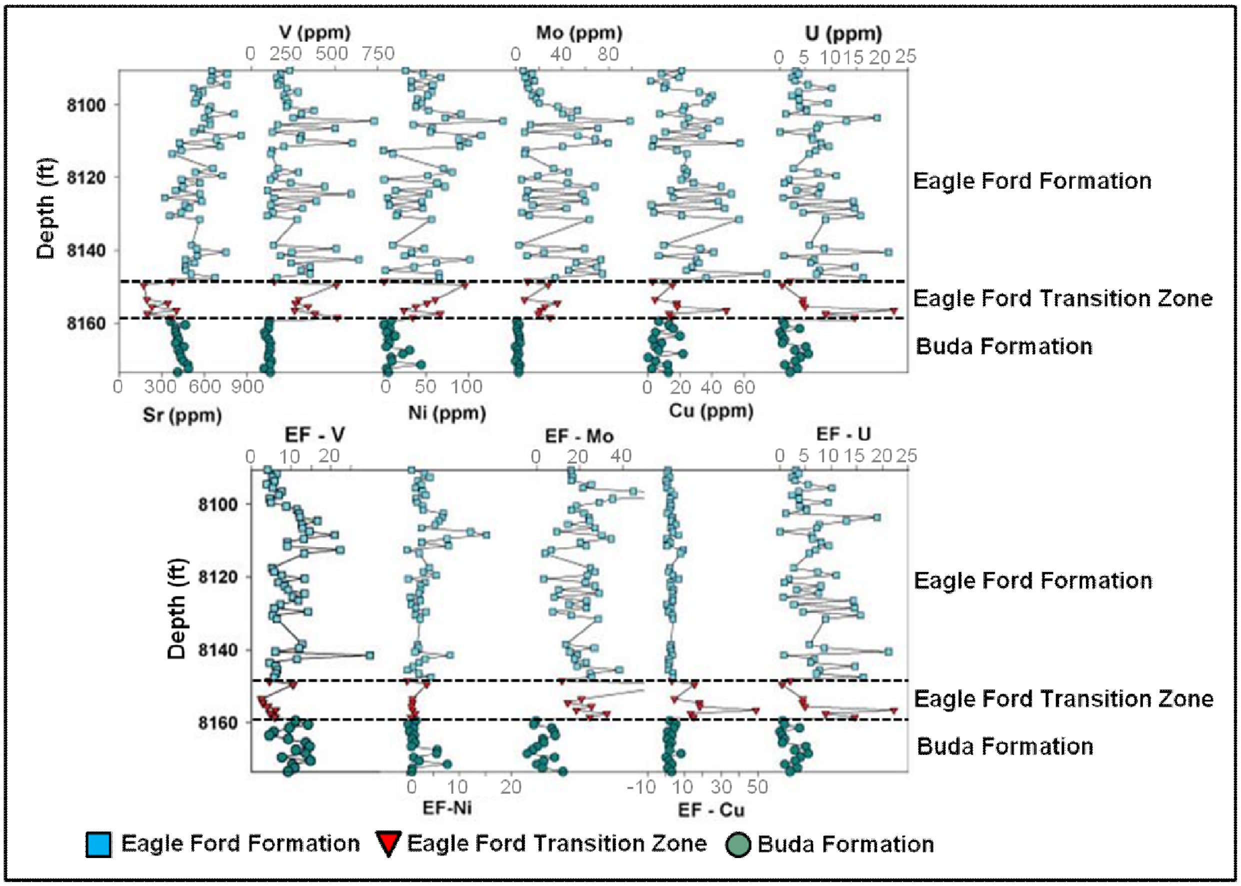

Figure 4.2 Geological Research Co. Schauers, FT #1 Drill Core Trace Element Concentrations and Respective Enrichments. Zone #1 contains the Buda Formation, Zone #2 contains the Eagle Ford Transition Zone and Zone #3 contains the Eagle Ford Formation.

Table 4.2 Geological Research Co. Schauers, FT #1 Drill Core Average, Maximum, Minimum, Range, and Standard Deviation for Trace Element Concentrations and Respective Enrichments. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.2. The zones are respective with the Figure 4.2 as follows: Zone #1 consists of the Buda Formation, Zone #2 consists of the Eagle Ford Transition Zone and Zone #3 consists of the Eagle Ford Formation.

Schauers Zone #3	Sr ppm	V ppm	Ni ppm	Mo ppm	Cu ppm	U ppm	EF-V	EF-Ni	EF-Mo	EF-Cu	EF-U
Average	566.31	262.00	49.89	34.75	26.45	7.07	9.69	3.53	114.42	2.85	9.97
Max	855.22	728.90	139.88	97.79	74.38	21.18	29.60	15.22	371.79	9.35	44.23
Min	322.88	94.71	0.00	3.27	1.82	0.05	3.93	0.00	11.48	0.18	0.22
Range	532.34	634.19	139.88	94.52	72.55	21.13	25.67	15.22	360.31	9.17	44.01
Stnd Dev	119.54	151.53	30.94	25.39	16.26	4.93	5.11	2.92	70.90	1.91	9.16
Schauers Zone #2	**Sr ppm**	**V ppm**	**Ni ppm**	**Mo ppm**	**Cu ppm**	**U ppm**	**EF-V**	**EF-Ni**	**EF-Mo**	**EF-Cu**	**EF-U**
Average	285.58	0.03	46.30	22.29	17.20	7.76	5.19	1.29	35.07	0.87	4.54
Max	403.23	0.05	95.38	35.93	49.11	22.21	10.46	3.77	57.99	3.35	18.43
Min	173.49	0.01	0.80	7.74	3.22	0.46	2.64	0.05	7.22	0.12	0.33
Range	229.74	0.04	94.58	28.20	45.89	21.75	7.82	3.72	50.77	3.23	18.10
Stnd Dev	94.56	0.01	28.83	9.60	14.12	7.29	2.46	1.09	15.59	1.03	5.87
Schauers Zone #1	**Sr ppm**	**V ppm**	**Ni ppm**	**Mo ppm**	**Cu ppm**	**U ppm**	**EF-V**	**EF-Ni**	**EF-Mo**	**EF-Cu**	**EF-U**
Average	427.06	104.09	11.94	2.33	9.39	2.29	10.68	2.24	23.14	2.72	8.87
Max	486.17	120.87	44.35	3.93	22.00	5.56	14.80	7.75	46.66	8.25	25.39
Min	360.10	77.05	1.00	0.00	0.33	0.00	4.58	0.26	0.00	0.07	0.00
Range	126.07	43.82	43.35	3.93	21.67	5.56	10.21	7.49	46.66	8.18	25.39
Stnd Dev	35.28	13.01	11.91	1.25	6.53	1.81	3.16	2.26	14.82	2.05	8.04

Figure 4.2 shows a wide range of trace element concentrations measured in parts per million (ppm). Like the accompanying major elements from the previous figure, these data can also be used to subdivide the drill core into distinct zones. The descending order of greatest to least relative elemental concentration is as follows: Sr, V, Ni, Mo, Cu and U. There is a broad inverse relationship between Sr and the other trace elements.

Although Mo is not the most abundant trace element, it is the most enriched compared to average gray shale. It is only slightly enriched in zone 1one compared to zone two and zone three, where it is substantially enriched. The enrichments of Mo, V, Ni, Cu and U are the most important because their enrichment indicates water column conditions (Tribovillard, 2006).

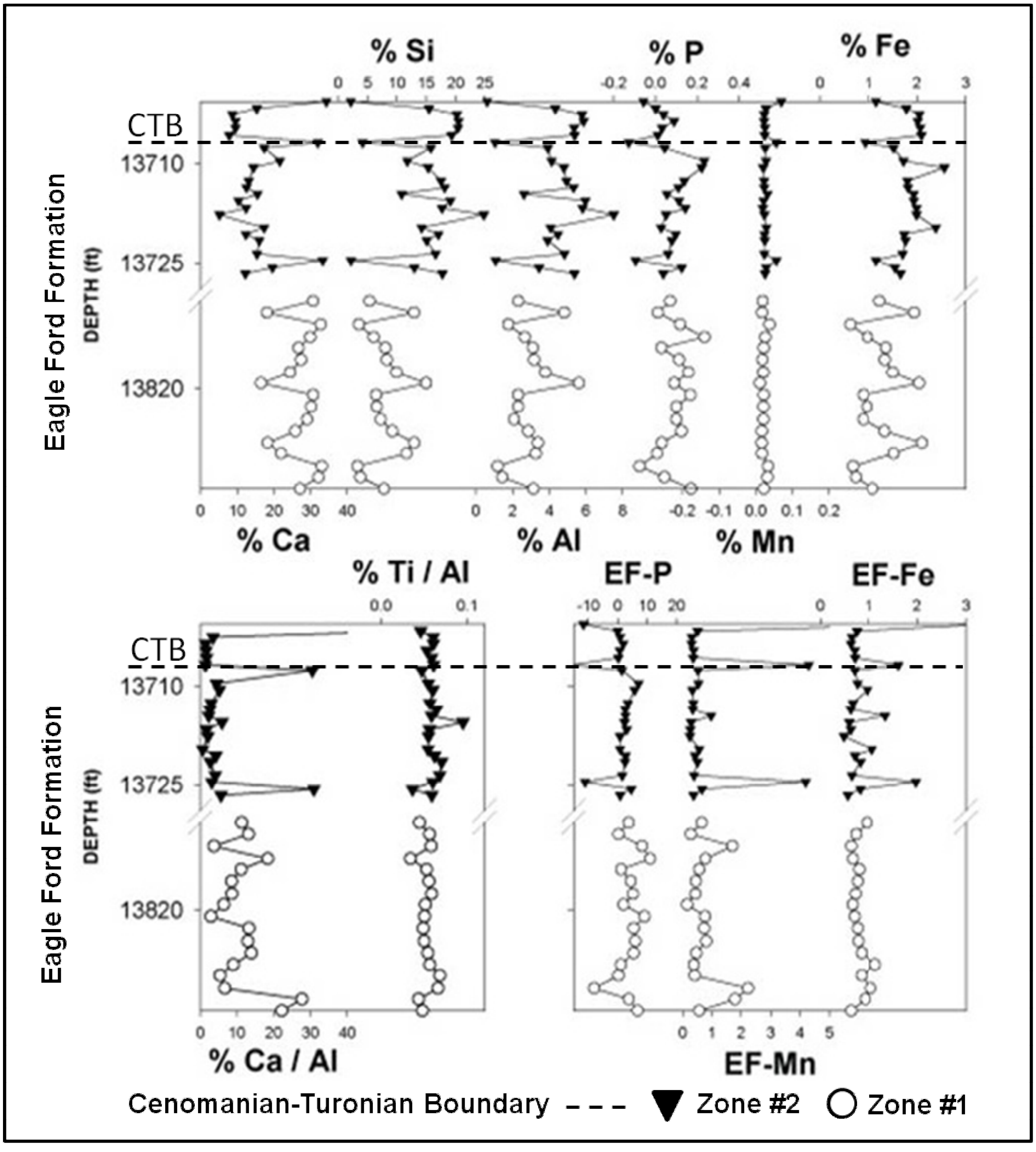

Figure 4.3 Shell Oil Co. ED Hay, Unit #1 Drill Core Major Element Concentrations, Respective Enrichments and Select Normalized Data. Zone one and two consist of the Eagle Ford Formation. However, an increase in the concentration of Ca, Si and Al between an 83ft break in the data define the zones. Zone one contains the Cenomanian-Turonian Boundary.

Table 4.3 Shell Oil Co. ED Hay, Unit #1 Drill Core Average, Maximum, Minimum, Range and Standard Deviation for Major Element Concentrations, Respective Enrichments and Select Normalized Data. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.3. Zone one and two consist of the Eagle Ford Formation. Zone one contains Cenomanian-Turonian Boundary

Hay Zone #2	Ca %	Si %	Al %	P %	Fe %	Mn %	Ca/Al %	Ti/Al %	EF-P	EF-Fe	EF-Mn
Average	15.54	15.54	4.51	0.06	1.83	0.03	7.41	0.06	0.41	0.94	1.10
Max	34.31	24.82	7.68	0.23	2.56	0.07	55.10	0.09	7.11	3.42	8.97
Min	5.18	2.16	0.62	-0.13	0.93	0.02	0.69	0.04	-15.39	0.49	0.24
Range	29.13	22.66	7.05	0.36	1.64	0.05	54.41	0.06	22.50	2.93	8.73
Stnd Dev	7.92	5.91	1.80	0.08	0.40	0.01	12.92	0.01	5.38	0.64	2.00
Hay Zone #1	**Ca %**	**Si %**	**Al %**	**P %**	**Fe %**	**Mn %**	**Ca/Al %**	**Ti/Al %**	**EF-P**	**EF-Fe**	**EF-Mn**
Average	27.03	7.99	2.89	0.09	1.24	0.02	11.37	0.05	3.95	0.80	0.77
Max	33.07	14.99	5.63	0.23	2.11	0.04	27.76	0.07	11.07	1.14	2.23
Min	16.52	3.34	1.19	-0.08	0.62	0.01	2.94	0.03	-8.01	0.63	0.16
Range	16.55	11.65	4.44	0.31	1.49	0.03	24.83	0.03	19.08	0.51	2.07
Stnd Dev	5.22	3.41	1.10	0.07	0.45	0.01	6.38	0.01	4.24	0.14	0.56

Data from Figure 4.3 displays the Shell Oil Co. ED Hay, Unit #1 Drill Core and contains the Eagle Ford Formation. It is divided into two discrete zones defined by an 83 foot break in data, and a distinct change in concentration of accompanying elements. Zone two ranges from 13,729 feet to 13,701 feet. Zone one ranges from 13,829 feet to 13,812 feet. Calcium, Si and Al are three key elements that define the zones. Calcium decreases by nearly half from zone one to zone two, which can indicate a decrease in carbonate deposition. Silicon and Al increase by nearly half from zone one to zone two, which indicates an increase in clay concentration.

The descending order of greatest to least relative elemental concentration is as follows: Ca, Si, Al, Fe, P, and Mn. The percentage of Mn is relatively low compared to the accompanying elements shown, but relatively enriched, displaying very large peaks in zone two compared to zone one. This indicates that although upwelling was prevalent in both zones during deposition there may have short periods where sapropel like conditions dominated (Brumsack, 2006).

There is a near inverse relationship between percent Ca, Si, and Al. Silicon and Al demonstrate a strong inverse relationship with Ca. This indicates that the mechanism responsible for the deposition of clay was separate from the deposition of Ca.

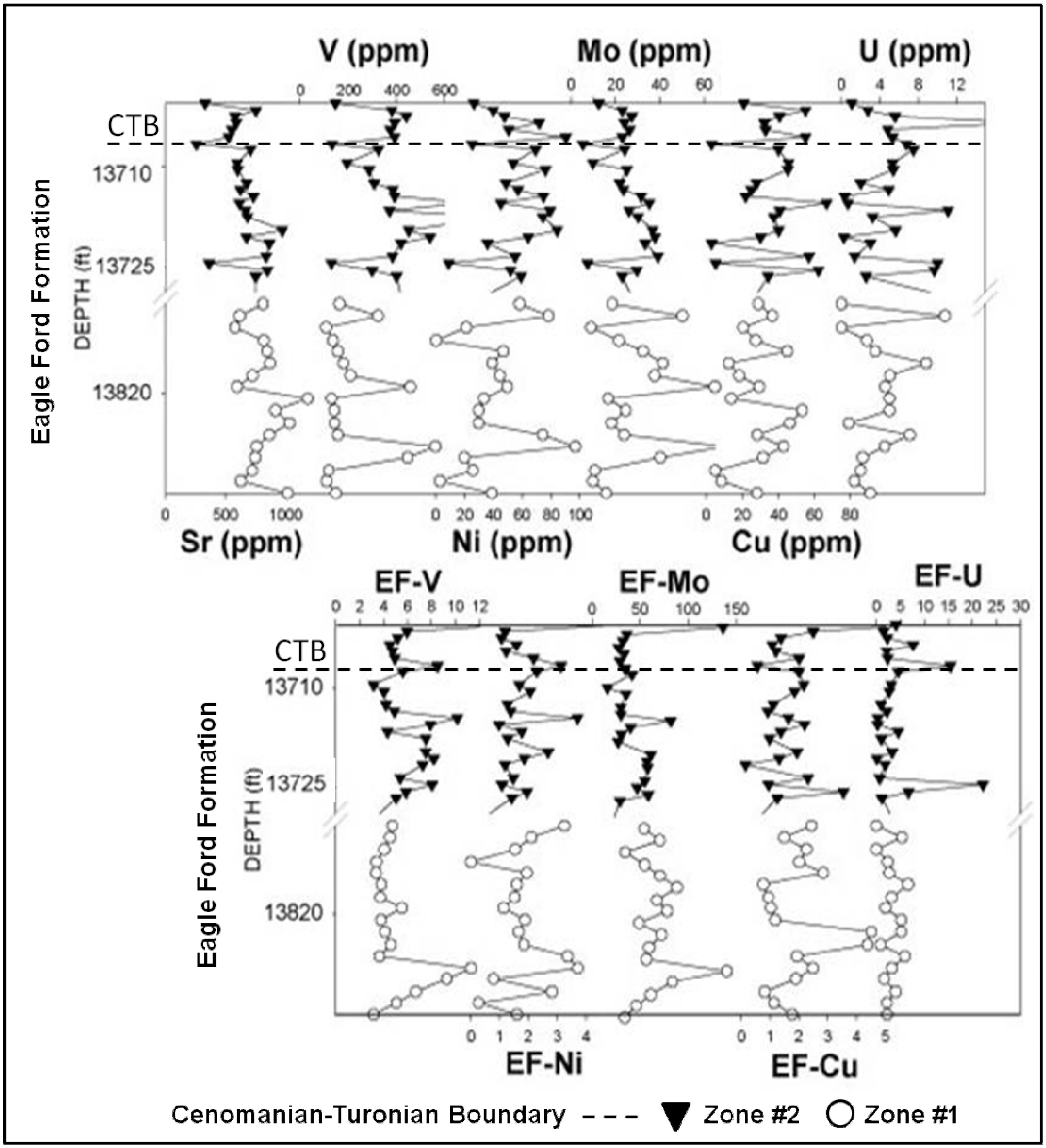

Figure 4.4 Shell Oil Co. ED Hay, Unit #1 Drill Core Trace Element Concentrations and Respective Enrichments. Zone one and two consists of the Eagle Ford Formation. However, an increase in the concentration of Ca, Si and Al between an 83ft break in the data define the zones. Zone one contains the Cenomanian-Turonian Boundary.

Table 4.4 Shell Oil Co. ED Hay, Unit #1 Drill Core Average, Maximum, Minimum, Range and Standard Deviation for Trace Element Concentrations and Respective Enrichments. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.4. Zone one and two consist of the Eagle Ford Formation. Zone one contains Cenomanian-Turonian Boundary.

Hay Zone #2	Sr ppm	V ppm	Ni ppm	Mo ppm	Cu ppm	U ppm	EF-V	EF-Ni	EF-Mo	EF-Cu	EF-U
Average	648.32	377.26	55.30	25.17	35.49	5.30	6.35	1.86	43.97	1.74	3.91
Max	971.95	831.02	90.29	39.17	66.81	18.78	15.82	5.51	136.63	6.56	22.19
Min	257.14	127.33	8.97	5.37	3.00	0.25	3.17	0.66	16.25	0.15	0.14
Range	714.81	703.68	81.32	33.80	63.81	18.53	12.64	4.85	120.38	6.41	22.06
Stnd Dev	167.84	158.69	20.19	9.06	17.34	4.26	2.69	1.05	24.91	1.26	5.06
Hay Zone #1	Sr ppm	V ppm	Ni ppm	Mo ppm	Cu ppm	U ppm	EF-V	EF-Ni	EF-Mo	EF-Cu	EF-U
Average	811.73	211.41	39.62	29.22	28.21	4.01	4.90	1.79	65.19	2.01	3.21
Max	1184.40	561.61	96.82	69.92	53.24	10.77	11.28	3.72	140.45	4.52	6.62
Min	578.26	106.15	0.27	9.06	5.00	0.00	3.16	0.01	34.30	0.77	0.00
Range	606.14	455.46	96.55	60.86	48.24	10.77	8.12	3.71	106.15	3.75	6.62
Stnd Dev	161.98	137.87	25.15	18.16	13.49	2.93	2.17	1.00	24.19	1.08	2.01

Figure 4.4 displays the Shell Oil Co. ED Hay, Unit #1 Drill Core. It contains the Eagle Ford Formation and it is divided into two discrete zones defined by an 83 foot break in data, and a distinct change in concentration of accompanying elements. The Figure displays range of trace element data that are measured in parts per million (ppm). In general the concentrations in both zones increase and decrease contemporaneously, however this is less apparent than that in Figure 4.4. The descending order of greatest to least relative average elemental concentration is as follows: Sr, V, Ni, Mo, Cu, and U. The most enriched element, compared to average gray shale, is Mo. It is substantially more enriched than the other trace elements. The enrichments of Mo, V and U relative to Ni and Cu indicate the water column was anoxic during deposition (Tribovillard, 2006).

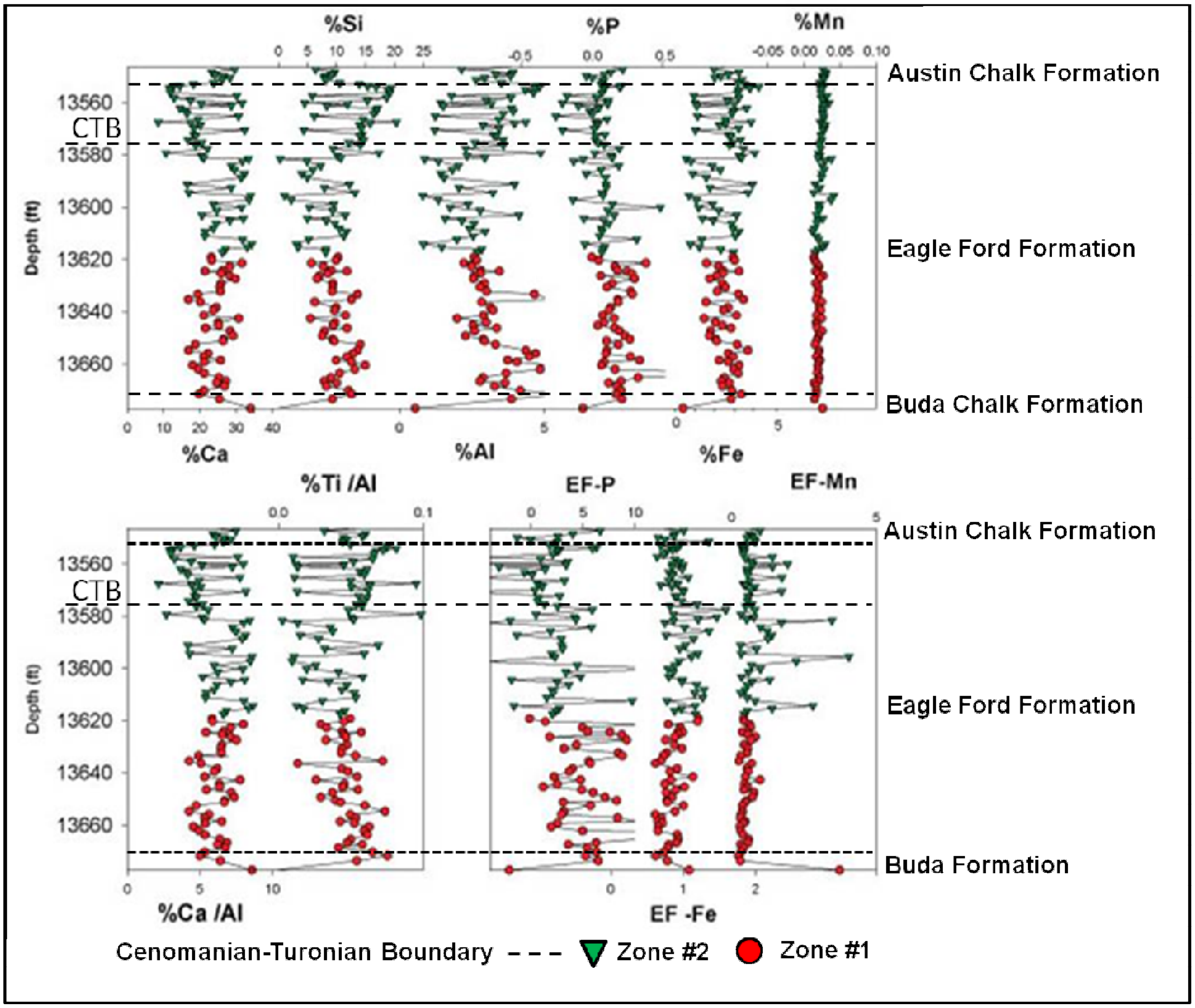

Figure 4.5 Shell Oil Co. Leppard, J.A. #1 Drill Core Major Element Concentrations, Respective Enrichments and Select Normalized Data. The boundary between zones are defined by a general increase in elemental concentrations and standard deviations between zone one and zone two. Zone one contains the Buda and Eagle Ford Formations. Zone two contains the Eagle Ford and Austin Chalk Formations. Zone two also contains the Cenomanian-Turonian Boundary.

Table 4.5 Shell Oil Co. Leppard, J.A. #1 Drill Core Average, Maximum, Minimum, Range and Standard Deviation for Major Element Concentrations, Respective Enrichments and Select Normalized Data. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.5. Zone one contains the Buda and Eagle Ford Formations. Zone two contains the Eagle Ford and Austin Chalk Formations. Zone two also contains the Cenomanian-Turonian Boundary.

Leppard Zone #2	Ca %	Si %	Al %	P %	Fe %	Mn %	Ca/Al %	Ti/Al %	EF-P	EF-Fe	EF-Mn
Average	23.25	10.48	2.87	0.05	1.46	0.02	5.87	0.05	1.71	0.96	0.90
Max	34.34	20.36	5.40	0.47	2.42	0.04	8.68	0.10	14.95	1.59	4.05
Min	8.55	0.31	0.81	-0.25	0.42	0.01	2.16	0.00	-8.06	0.64	0.31
Range	25.78	20.05	4.59	0.72	2.00	0.03	6.51	0.10	23.01	0.95	3.74
Stnd Dev	6.99	4.96	1.15	0.12	0.54	0.01	1.77	0.02	3.68	0.20	0.72
Leppard Zone #1	Ca %	Si %	Al %	P %	Fe %	Mn %	Ca/Al %	Ti/Al %	EF-P	EF-Fe	EF-Mn
Average	24.28	9.84	3.31	0.18	1.48	0.02	6.13	0.05	5.77	0.85	0.57
Max	34.05	15.00	5.72	1.01	2.12	0.03	8.60	0.08	32.31	1.21	3.73
Min	16.89	-0.03	0.56	-0.07	0.33	0.01	4.27	0.00	-2.12	0.62	0.24
Range	17.15	15.04	5.17	1.08	1.79	0.01	4.33	0.08	34.43	0.60	3.49
Stnd Dev	3.99	2.78	1.00	0.16	0.35	0.00	1.01	0.01	5.08	0.15	0.52

Figure 4.5 displays the Shell Oil Co. Leppard, J.A. #1 Drill Core. Zone one ranges from 13,677 feet to 13,619 feet and zone two ranges from 13,617 feet to 13,546 feet. Zone one contains the Buda and Eagle Ford Formation. Zone two contains the Eagle Ford Formation and the Austin Chalk Formation. A possible subzone does exist between zone one and the CTB, however, for the purposes of this study only two zones are defined. Zones are determined by pattern recognition. The standard deviation, or variance in concentration, is on average greater in zone two than zone one.

Silicon and Al demonstrate a strong inverse relationship with Ca. This indicates that the mechanism responsible for the deposition of clay was separate from the deposition of Ca. Other samples do exhibit an inverse relationship with Ca, but are not necessarily linked with clay deposition.

Manganese concentration is relatively low and depleted in zone one relative to average gray shale. However, it is considered nearly enriched in zone two. This indicates that the influence of upwelling decreased in zone two relative to zone one (Brumsack, 2006).

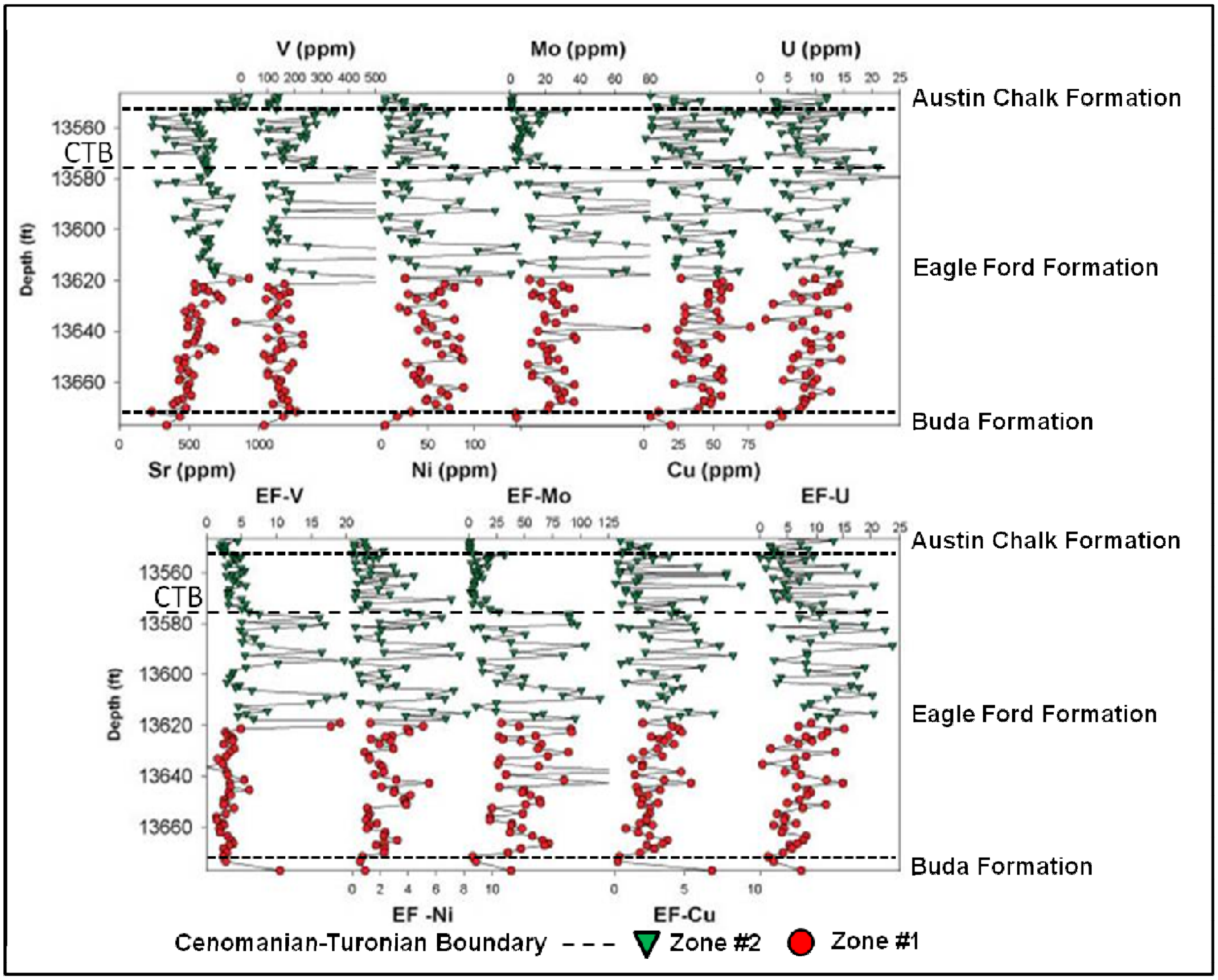

Figure 4.6 Shell Oil Co. Leppard, J.A. #1 Drill Core Trace Element Concentrations and Respective Enrichments. The boundary between zones are defined by a general increase in elemental concentrations and standard deviations between zone one and zone two. Zone one contains the Buda and Eagle Ford Formations. Zone two contains the Eagle Ford and Austin Chalk Formations. Zone two also contains the Cenomanian-Turonian Boundary.

Table 4.6 Shell Oil Co. Leppard, J.A. #1 Drill Core Average, Maximum, Minimum, Range and Standard Deviation for Trace Element Concentrations and Respective Enrichments. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.6. The boundary between zones are defined by a general increase in elemental concentrations between zone one and zone two. Zone one contains the Buda and Eagle Ford Formations. Zone two contains the Eagle Ford and Austin Chalk Formations. Zone two also contains the Cenomanian-Turonian Boundary.

Leppard Zone #2	Sr ppm	V ppm	Ni ppm	Mo ppm	Cu ppm	U ppm	EF-V ppm	EF-Ni ppm	EF-Mo ppm	EF-Cu ppm	EF-U ppm
Average	597.54	243.28	44.23	29.29	37.16	9.46	6.12	2.45	88.18	3.06	9.33
Max	931.73	963.78	151.12	117.35	93.89	26.54	19.71	8.21	455.97	9.10	23.69
Min	237.26	63.92	0.00	0.22	1.50	0.00	1.85	0.00	0.37	0.08	0.00
Range	694.46	899.86	151.12	117.14	92.40	26.54	17.85	8.21	455.59	9.02	23.69
Stnd Dev	148.32	196.75	38.78	32.90	23.44	5.64	4.44	2.30	102.80	2.38	6.19
Leppard Zone #1	**Sr ppm**	**V ppm**	**Ni ppm**	**Mo ppm**	**Cu ppm**	**U ppm**	**EF-V ppm**	**EF-Ni ppm**	**EF-Mo ppm**	**EF-Cu ppm**	**EF-U ppm**
Average	534.30	167.77	54.71	23.59	42.10	8.80	3.87	2.32	52.57	2.79	7.00
Max	930.48	727.61	104.65	78.07	76.52	15.77	19.12	5.51	168.82	6.98	15.10
Min	233.50	-19.55	4.00	3.10	5.14	1.00	-0.47	0.57	3.71	0.26	0.45
Range	696.98	747.15	100.65	74.97	71.37	14.77	19.59	4.94	165.11	6.72	14.65
Stnd Dev	123.87	129.48	22.49	12.54	14.92	3.54	3.62	1.21	30.66	1.34	3.44

Figure 4.6 displays the Shell Oil Co. Leppard, J.A. #1 Drill Core. Zone one ranges from 13,677 feet to 13,619 feet and zone two ranges from 13,617 feet to 13,546 feet. Zone one contains the Buda and Eagle Ford Formation. Zone two contains the Eagle Ford Formation and the Austin Chalk Formation. There is a correlation between much of the data in both zones. The descending order of greatest to least relative average elemental concentration is as follows: Sr, V, Ni, Mo, Cu, and U. However, the most enriched element, compared to average gray shale, is Mo. It is substantially more enriched than the other trace elements. The enrichments of Mo, V and U relative to Ni and Cu indicate the water column was dominantly anoxic during deposition (Tribovillard, 2006).

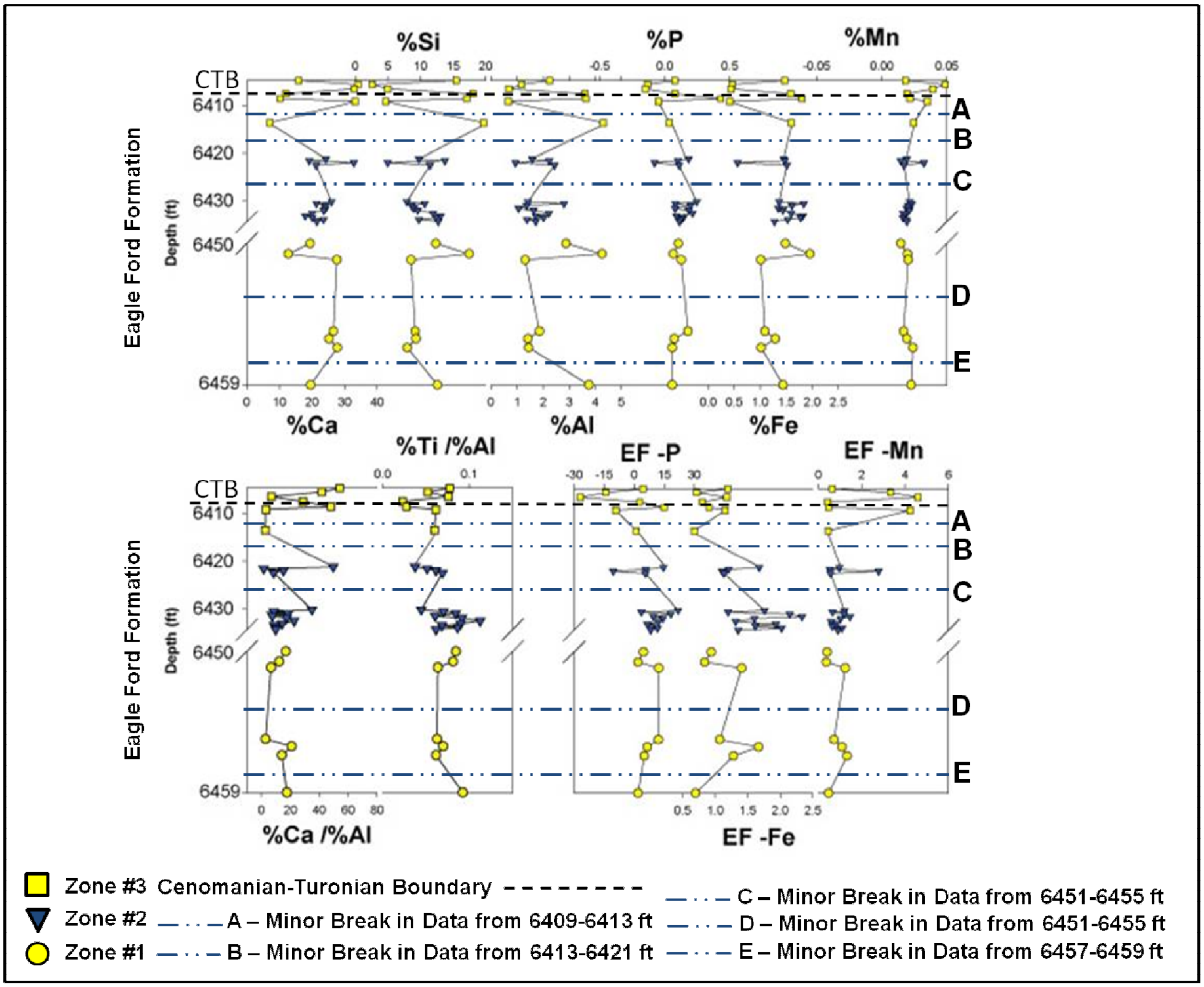

Figure 4.7 Quintanna Halff et al # 1 Drill Core, Major Elemental Concentrations, Respective Enrichments and Selected Normalized Data. Zone #1, Zone #2 and Zone #3 contains the Eagle Ford Formation. Zone #3 also contains the Cenomanian-Turonian Boundary. There is a major break between Zone #1 and Zone #2 of 15.5 feet. Minor breaks occur throughout (A) 6409-6413 ft (B) 6413-6421 (C) 6451-6455 ft (D) 6451-6455 ft (E) 6457-6459.

Table 4.7 Quintanna Halff et al # 1 Drill Core, Maximum, Minimum, Range and Standard Deviation for Concentration, Respective Enrichment and Select Normalized Data. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.7. Zone #1, Zone #2 and Zone #3 contains the Eagle Ford Formation. Zone #3 also contains the Cenomanian-Turonian Boundary.

Quintanna Zone #3	Ca %	Si %	Al %	P %	Fe %	Mn %	Ca/Al %	Ti/Al %	EF-P	EF-Fe	EF-Mn
Average	23.99	9.58	1.98	0.03	1.02	0.04	26.41	0.05	-3.26	1.13	3.11
Max	35.20	19.70	4.32	0.43	1.80	0.07	54.26	0.08	15.00	1.90	8.36
Min	7.13	1.69	0.65	-0.15	0.42	0.02	1.65	0.02	-26.80	0.68	0.44
Range	28.07	18.01	3.67	0.58	1.38	0.05	52.61	0.05	41.80	1.23	7.92
Stnd Dev	12.26	7.74	1.50	0.17	0.58	0.02	22.66	0.02	12.29	0.41	2.82
Quintanna Zone #2	**Ca %**	**Si %**	**Al %**	**P %**	**Fe %**	**Mn %**	**Ca/Al %**	**Ti/Al %**	**EF-P**	**EF-Fe**	**EF-Mn**
Average	22.87	10.41	1.75	0.13	1.47	0.02	14.81	0.08	9.39	1.60	1.04
Max	32.89	13.76	2.80	0.25	1.84	0.03	35.04	0.11	21.98	2.34	2.78
Min	17.97	4.98	0.94	-0.08	0.57	0.01	7.63	0.04	-10.40	1.11	0.53
Range	14.93	8.78	1.87	0.32	1.27	0.02	27.41	0.07	32.39	1.23	2.25
Stnd Dev	3.68	2.38	0.53	0.08	0.31	0.00	7.37	0.02	7.67	0.40	0.58
Quintanna Zone #1	**Ca %**	**Si %**	**Al %**	**P %**	**Fe %**	**Mn %**	**Ca/Al %**	**Ti/Al %**	**EF-P**	**EF-Fe**	**EF-Mn**
Average	22.75	11.08	2.42	0.10	1.33	0.02	12.47	0.07	6.41	1.13	0.81
Max	27.83	17.50	4.27	0.18	1.96	0.02	21.05	0.09	12.33	1.67	1.33
Min	12.77	7.98	1.31	0.06	1.01	0.01	2.99	0.06	1.97	0.70	0.37
Range	15.05	9.52	2.95	0.12	0.95	0.01	18.06	0.03	10.36	0.97	0.96
Stnd Dev	5.65	3.36	1.22	0.05	0.34	0.00	7.37	0.01	4.33	0.34	0.41

Figure 4.7 displays the Quintanna Halff et al # 1 Drill Core. It is subdivided into the three distinct zones shown above. These zones are defined by large gaps and breaks in the data after which the values appear to change considerably. Zone one ranges from 6,459 feet to 6,449 feet. Zone two ranges from 6,434 feet to 6,421 feet. Zone three ranges from 6,413 feet to 6,404 feet. Zone two data exhibit the smallest range while zone one shows slightly more variability. Zone three shows the largest range. Silicon and Al demonstrate a strong inverse relationship with Ca. Where Si and Al demonstrate an inverse relationship with Ca it indicates that the mechanism responsible for the deposition of clay was separate from the deposition of Ca.

The descending order of greatest to least relative elemental concentration is as follows: Ca, Si, Al, Fe, P, and Mn. Phosphorus and Mn have low concentrations relative to the other elements. However, P is particularly enriched relative to average gray shale in zone one and zone two, but become less enriched in zone three. This indicates that upwelling was more prevalent during the deposition in zone one and zone two relative to zone three. Manganese is not particularly enriched in zone one and zone two, but is dynamically enriched in zone three. This indicates that sapropel conditions were prevalent during deposition (Brumsack, 2006).

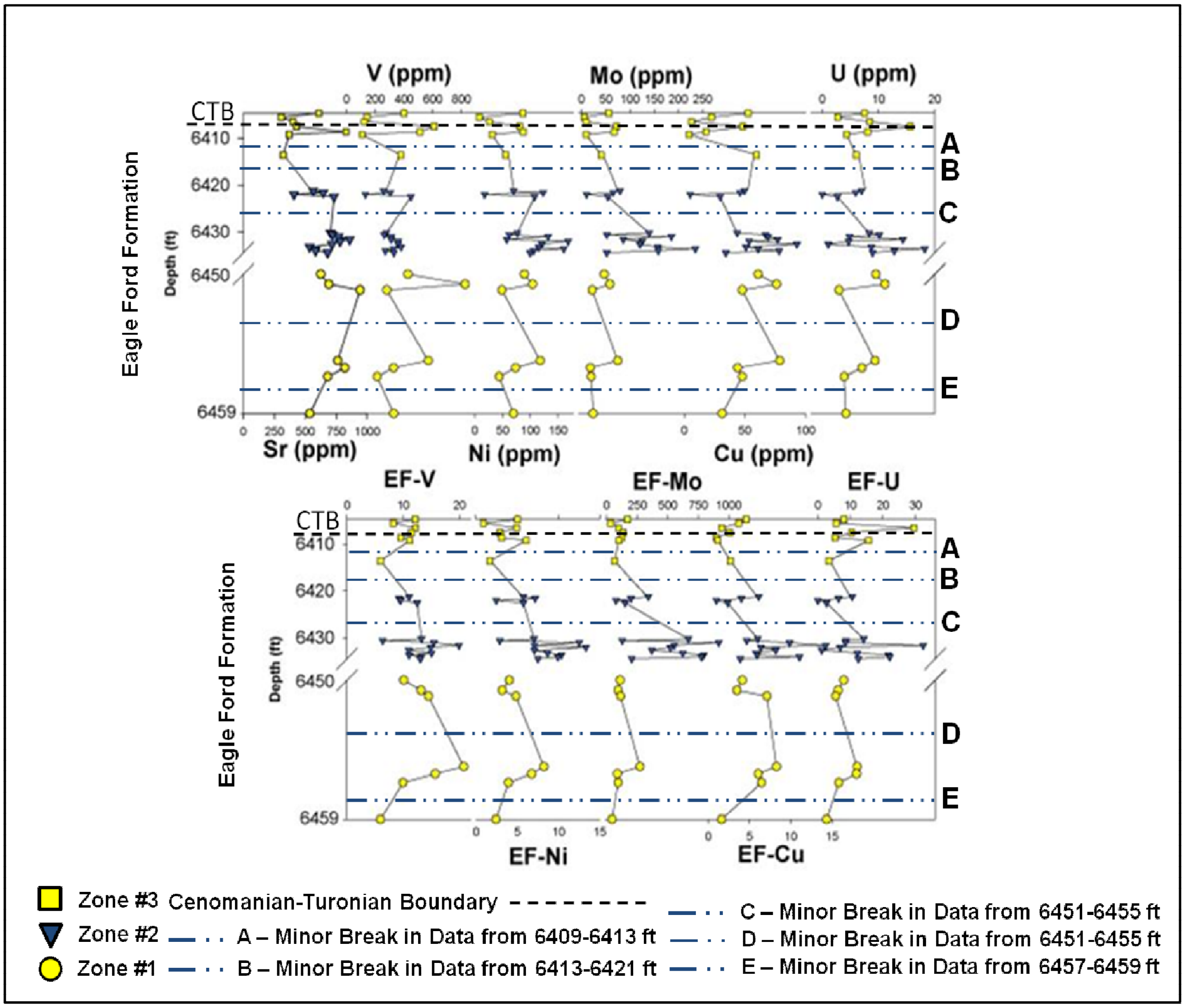

Figure 4.8 Quintanna Halff et al # 1 Drill Core, Trace Element Concentrations and Respective Enrichments. Zone #1, Zone #2 and Zone #3 contains the Eagle Ford Formation. Zone #3 also contains the Cenomanian-Turonian Boundary. There is a major break between Zone #1 and Zone #2 of 15.5 feet. Minor breaks occur throughout (A) 6409-6413 ft (B) 6413-6421 (C) 6451-6455 ft (D) 6451-6455 ft (E) 6457-6459.

Table 4.8 Quintanna Halff et al # 1 Drill Core Average, Maximum, Minimum, Range and Standard Deviation for Trace Element Concentrations and Respective Enrichments. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.8. Zone #1, Zone #2 and Zone #3 contains the Eagle Ford Formation. Zone #3 also contains the Cenomanian-Turonian Boundary.

Quintanna Zone #3	Sr ppm	V ppm	Ni ppm	Mo ppm	Cu ppm	U ppm	EF-V ppm	EF-Ni ppm	EF-Mo ppm	EF-Cu ppm	EF-U ppm
Average	607.40	278.93	49.82	29.31	26.59	6.76	10.28	4.24	84.48	2.86	11.53
Max	1122.95	609.16	87.63	71.65	59.49	15.63	12.20	10.29	170.17	6.26	29.47
Min	306.56	109.68	8.18	0.59	4.00	2.76	5.94	0.90	4.80	0.96	3.36
Range	816.39	499.48	79.46	71.06	55.49	12.87	6.26	9.39	165.37	5.30	26.12
Stnd Dev	324.00	197.26	30.22	29.29	21.26	3.90	2.13	2.80	54.58	1.73	7.94
Quintanna Zone #2	**Sr ppm**	**V ppm**	**Ni ppm**	**Mo ppm**	**Cu ppm**	**U ppm**	**EF-V ppm**	**EF-Ni ppm**	**EF-Mo ppm**	**EF-Cu ppm**	**EF-U ppm**
Average	662.48	308.85	101.22	108.67	53.99	7.71	12.52	7.68	451.38	6.40	11.39
Max	857.80	447.96	168.18	235.10	92.70	18.23	19.90	13.33	918.54	14.24	32.35
Min	408.15	131.10	17.78	10.31	4.76	0.00	6.35	2.46	74.68	1.00	0.00
Range	449.65	316.86	150.40	224.79	87.94	18.23	13.55	10.87	843.86	13.24	32.35
Stnd Dev	117.47	72.93	41.16	62.30	22.63	5.10	3.29	3.13	279.47	3.50	8.94
Quintanna Zone #1	**Sr ppm**	**V ppm**	**Ni ppm**	**Mo ppm**	**Cu ppm**	**U ppm**	**EF-V ppm**	**EF-Ni ppm**	**EF-Mo ppm**	**EF-Cu ppm**	**EF-U ppm**
Average	721.72	424.02	78.22	37.51	55.08	6.89	12.86	4.77	115.67	5.32	7.52
Max	941.89	825.08	117.91	74.43	78.57	11.16	20.74	8.23	271.65	8.28	12.03
Min	535.98	212.35	43.88	18.09	31.16	3.00	5.95	2.41	42.81	1.63	2.68
Range	405.90	612.74	74.03	56.35	47.41	8.16	14.79	5.81	228.84	6.66	9.35
Stnd Dev	132.96	210.45	27.36	22.37	17.44	3.23	4.77	2.05	72.53	2.32	3.41

In Figure 4.8 there is some correlation between much of the data in all three zones. The descending order of greatest to least relative average elemental concentration is as follows: Sr, V, Mo, Ni, Cu, and U. However, the most enriched element compared to average gray shale, is Mo. It is substantially more enriched than the other trace elements. It is particularly enriched in zone two. Since the average Mo value is above 20 ppm in all the zones euxinic conditions likely dominated during deposition (Zheng, 2000).

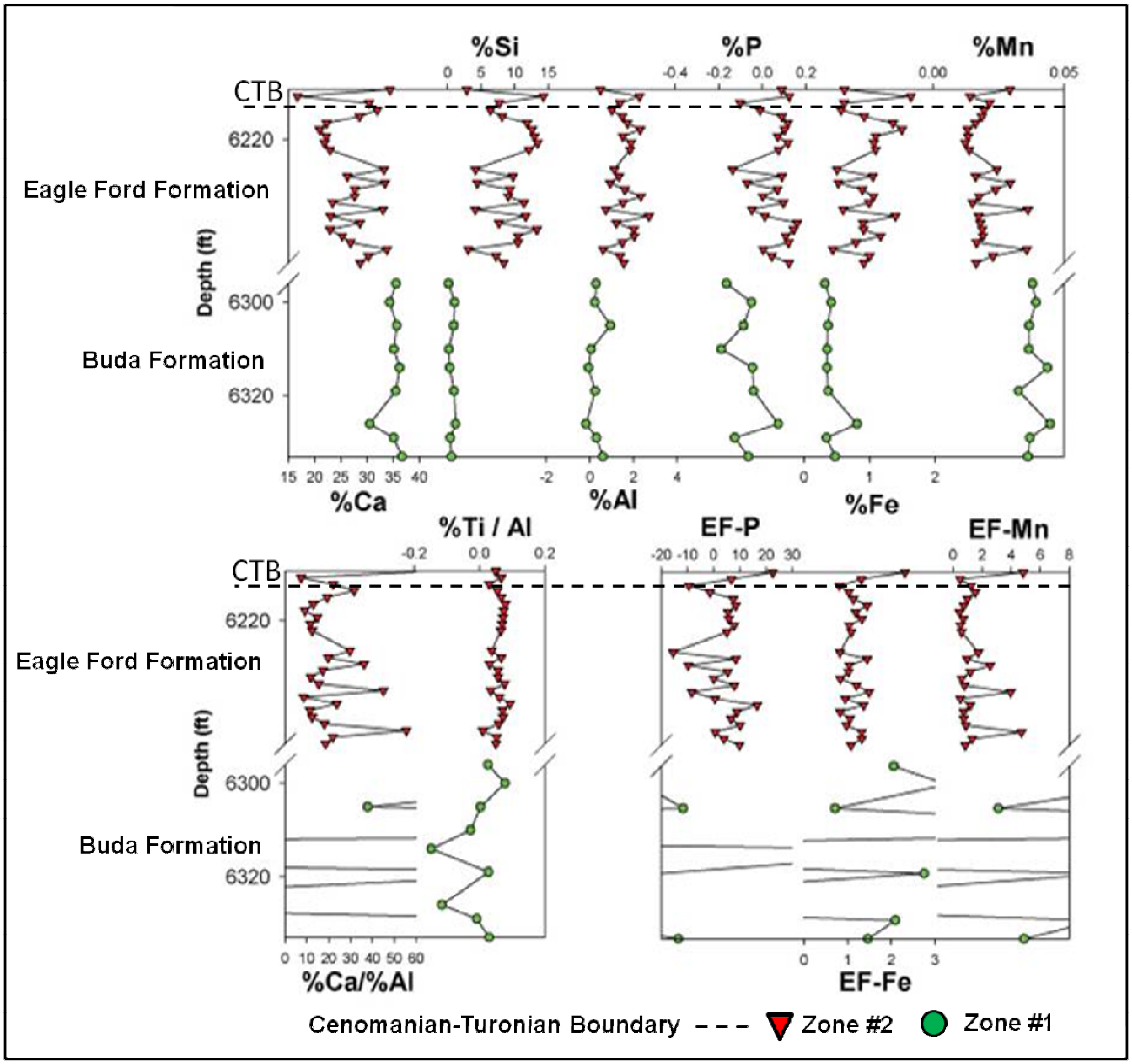

Figure 4.9 Gose & Shield Hassett #3 Drill Core, Major Concentrations, Respective Enrichments and Select Normalized Data. Zone #1 contains of the Buda Formation and Zone #2 contains of the Eagle Ford Formation. There is a break in the data of 57.5 feet from Zone #1 to Zone #2. Zone #2 contains the Cenomanian-Turonian Boundary.

Table 4.9 Gose & Shield Hassett #3 Drill Core Average, Maximum, Minimum, Range and Standard Deviation for Major Element Concentrations, Respective Enrichments and Select Normalized Data. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.9. Zone #1 contains the Buda Formation and Zone #2 contains the Eagle Ford Formation. There is a break in the data of 57.5 feet from Zone #1 to Zone #2. Zone #2 contains the Cenomanian-Turonian Boundary.

Gose S. Shield Zone #2	Ca %	Si %	Al %	P %	Fe %	Mn %	Ca / Al %	Ti / Al %	EF-P	EF-Fe	EF-Mn
Average	27.065	9.0649	1.5382	0.0549	0.9441	0.0201	22.25778	0.05809	4.1995	1.1764	1.4067
Max	34.379	14.267	2.7033	0.1594	1.6315	0.0363	70.19389	0.09293	22.584	2.3103	4.8281
Min	16.713	2.8763	0.4898	-0.136	0.44	0.0124	7.348666	0.00993	-15.36	0.8117	0.4641
Range	17.667	11.391	2.2135	0.2957	1.1915	0.0239	62.84522	0.083	37.949	1.4986	4.364
Stnd Dev	4.8	3.443	0.5585	0.079	0.3179	0.0066	15.32963	0.01851	8.334	0.3137	1.2662
Gose S. Shield Zone #1	**Ca %**	**Si %**	**Al %**	**P %**	**Fe %**	**Mn %**	**Ca / Al %**	**Ti / Al %**	**EF-P**	**EF-Fe**	**EF-Mn**
Average	34.976	0.657	0.2706	-0.077	0.4243	0.0384	45.71054	-0.0146	-61.01	0.3745	2.2086
Max	36.682	1.2131	0.9429	0.0727	0.8102	0.0447	589.153	0.07791	100.27	10.921	49.34
Min	30.52	0.1509	-0.173	-0.188	0.3212	0.0327	-632.76	-0.1469	-397.9	-11.31	-61.5
Range	6.1619	1.0622	1.1155	0.2605	0.489	0.0119	1221.913	0.22477	498.2	22.231	110.84
Stnd Dev	1.7992	0.4028	0.3373	0.0776	0.1519	0.0038	323.4057	0.07245	135.69	6.6077	29.894

Figure 4.9 displays the Gose & Shield Hassett #3 Core. The core is subdivided into two zones. Zone one ascends from 6,333 feet to 6,296 feet before a break in the data. Zone two ascends from 6,239 feet to 6,213 feet. Silicon and Al demonstrate a strong inverse relationship with Ca. This indicates that the mechanism responsible for the deposition of clay was separate from the deposition of Ca.

The descending order of greatest to least relative elemental concentration is as follows: Ca, Si, Al, Fe, P, and Mn. Zone two exhibits a greater range in the data than zone one. Among elements enriched relative to average gray shale Mn, in zone one is more enriched than zone two. This indicates sapropel type conditions may have dominated more so during the deposition of zone one than zone two (Brumsack, 2006).

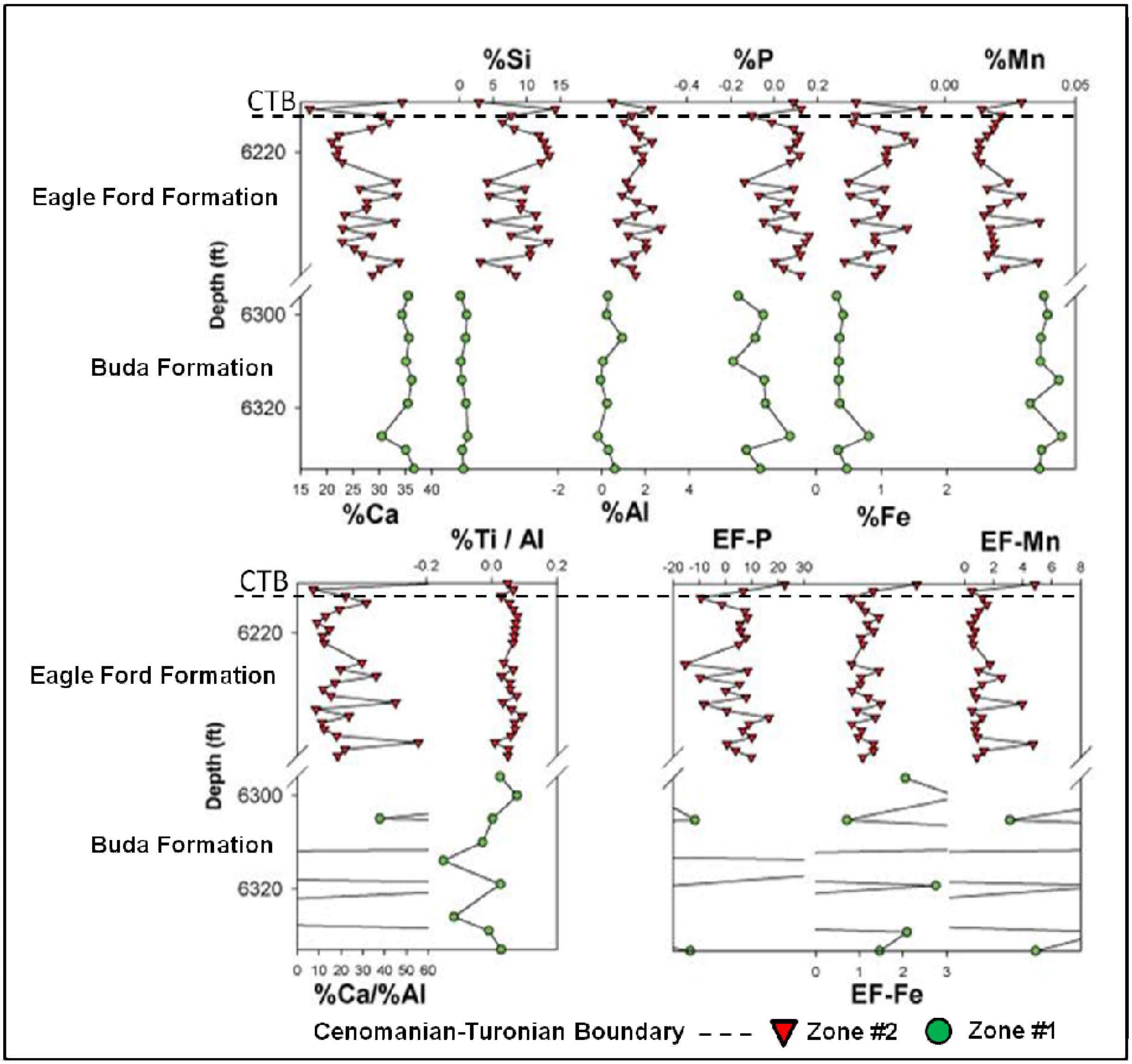

Figure 4.10 Gose & Shield Hassett #3 Drill Core, Major Concentrations, Respective Enrichments and Select Normalized Data. Zone #1 contains of the Buda Formation and Zone #2 contains of the Eagle Ford Formation. There is a break in the data of 57.5 feet from Zone #1 to Zone #2. Zone #2 contains the Cenomanian-Turonian Boundary.

Table 4.10 Gose & Shield Hassett #3 Drill Core Average, Maximum, Minimum, Range, and Standard Deviation for Trace Element Concentrations and Respective Enrichments. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.10. Zone #1 contains the Buda Formation and Zone #2 contains the Eagle Ford Formation. There is a break in the data of 57.5 feet from Zone #1 to Zone #2. Zone #2 contains the Cenomanian-Turonian Boundary.

Gose S. Shield Zone #2	Sr ppm	V ppm	Ni ppm	Mo ppm	Cu ppm	U ppm	EF-V	EF-Ni	EF-Mo	EF-Cu	EF-U
Average	1075.1	496.54	78.474	57.095	40.117	7.3386	21.97448	6.2588	240.4	4.9391	10.838
Max	1610.8	1092.3	338.99	226.09	67.459	18.38	35.73621	19.3773	675.99	8.6178	26.695
Min	831.31	152.36	-1.008	4.1039	3.3036	-2.105	7.485439	-0.0947	20.163	1.065	-5.173
Range	779.5	939.94	340	221.98	64.156	20.485	28.25077	19.472	655.83	7.5528	31.868
Stnd Dev	197.61	250.94	68.991	46.643	21.306	5.6171	7.619869	4.35768	148.91	2.1729	8.4466
Gose S. Shield Zone #1	**Sr ppm**	**V ppm**	**Ni ppm**	**Mo ppm**	**Cu ppm**	**U ppm**	**EF-V**	**EF-Ni**	**EF-Mo**	**EF-Cu**	**EF-U**
Average	837.84	112.27	8.578	1.8076	0.3717	-0.825	10.08663	-11.242	-17.18	-6.597	-53.7
Max	913.69	131.59	31.531	3.492	31.91	5.901	123.9886	7.24576	88.747	11.063	30.028
Min	755.07	85.009	-12.18	0.5793	-31.65	-6.599	-123.936	-71.584	-383.5	-18.4	-246.2
Range	158.62	46.586	43.707	2.9128	63.557	12.5	247.9249	78.8294	472.29	29.464	276.24
Stnd Dev	50.808	14.522	14.572	1.2032	19.745	4.2289	66.91221	25.5222	145.56	10.35	98.609

Figure 4.10 shows some correlation between much of the data in both zones. The descending order of greatest to least relative average elemental concentration is as follows: Sr, V, Ni, Cu, and U. Trace elements are significantly enriched on average in zone two compared to zone one.

The most enriched element, compared to average gray shale, is Mo. The average value in zone one is 1.8 ppm, which indicates deposition under oxic-suboxic conditions (Zheng, 2000). The average value in zone two is 57.1 ppm, which indicates deposition under euxinic conditions (Zheng, 2000).

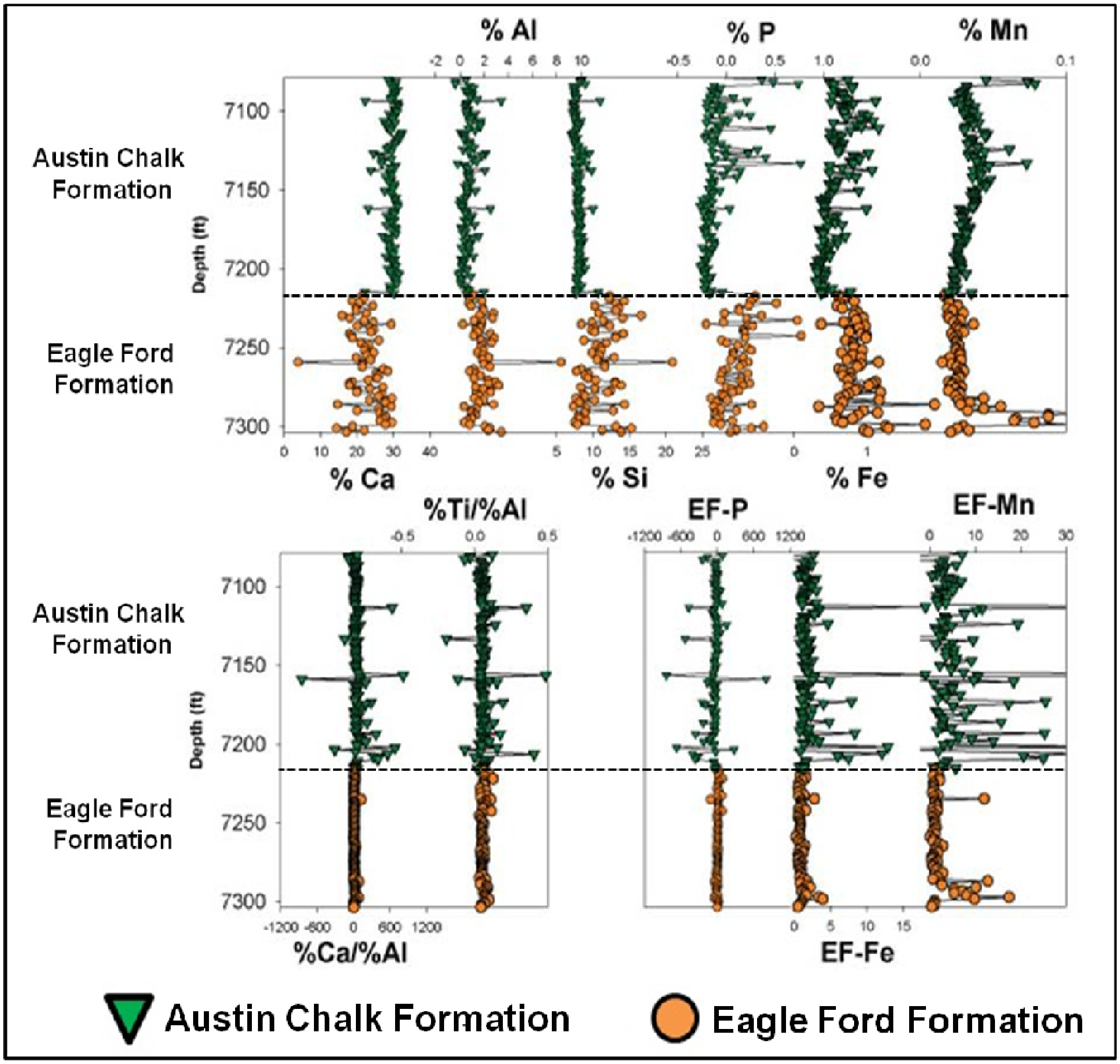

Figure 4.11 Getty Lloyd Hurt #1 Drill Core, Major Concentrations, Respective Enrichments and Select Normalized Data. Zone #1 contains the Eagle Ford Formation and Zone #2 contains the Austin Chalk Formation.

Table 4.11 Getty Lloyd Hurt #1 Drill Core, Average Maximum, Minimum, Range and Standard Deviation for Major Concentrations, Respective Enrichment and Select Normalized Data. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.11. Zone #1 contains the Eagle Ford Formation and Zone #2 contains of the Austin Chalk Formation.

Getty Hurt Zone #2	Ca %	Si %	Al %	P %	Fe %	Mn %	Ca/Al %	Ti/Al %	EF-P	EF-Fe	EF-Mn
Average	29.47	8.01	0.71	-0.09	0.60	0.03	72.52	0.07	-59.41	2.05	5.75
Max	32.40	10.98	3.43	0.76	1.16	0.08	818.41	0.49	809.78	18.06	83.27
Min	22.23	7.02	-0.39	-0.27	0.29	0.02	-853.77	-0.20	-837.74	-19.31	-84.15
Range	10.17	3.96	3.82	1.04	0.87	0.06	1672.18	0.68	1647.52	37.37	167.41
Stnd Dev	1.86	0.64	0.59	0.19	0.20	0.01	170.66	0.08	168.76	3.92	15.71
Getty Hurt Zone #1	**Ca %**	**Si %**	**Al %**	**P %**	**Fe %**	**Mn %**	**Ca/Al %**	**Ti/Al %**	**EF-P**	**EF-Fe**	**EF-Mn**
Average	22.76	11.02	1.79	0.11	0.85	0.03	19.71	0.06	6.08	1.09	2.50
Max	30.27	20.93	8.36	0.77	1.93	0.12	121.20	0.13	89.24	3.94	17.49
Min	3.89	7.29	0.24	-0.21	0.34	0.01	0.47	0.02	-108.89	0.25	0.14
Range	26.38	13.64	8.11	0.98	1.59	0.11	120.73	0.11	198.13	3.69	17.34
Stnd Dev	4.59	2.58	1.10	0.19	0.27	0.02	19.95	0.02	27.32	0.63	3.34

Figure 4.11 displays the Getty Lloyd Hurt #1 Drill Core. It is subdivided into two zones. Zone one ascends from 7,304 feet to 7,217 feet. Zone two ascends from 7,215 feet to 7,078 feet. Silicon and Al demonstrate a strong inverse relationship with Ca. Silicon and Al demonstrate a strong inverse relationship with Ca. This indicates that the influence mechanism responsible for the deposition of clay was separate from the deposition of Ca. However, there is much less Al than either Ca or Si. Both zones are considered in descending order of greatest to least relative elemental concentration is as follows: Ca, Si, Al, Fe, P, and Mn.

Data from zone one exhibits a greater overall range in concentration than in zone two**.** Among elements enriched relative to average gray shale, Mn is more enriched in zone two than in zone one. This indicates that sapropel like condition were more prevalent during the deposition of zone one than during the deposition of zone two (Brumsack, 2006).

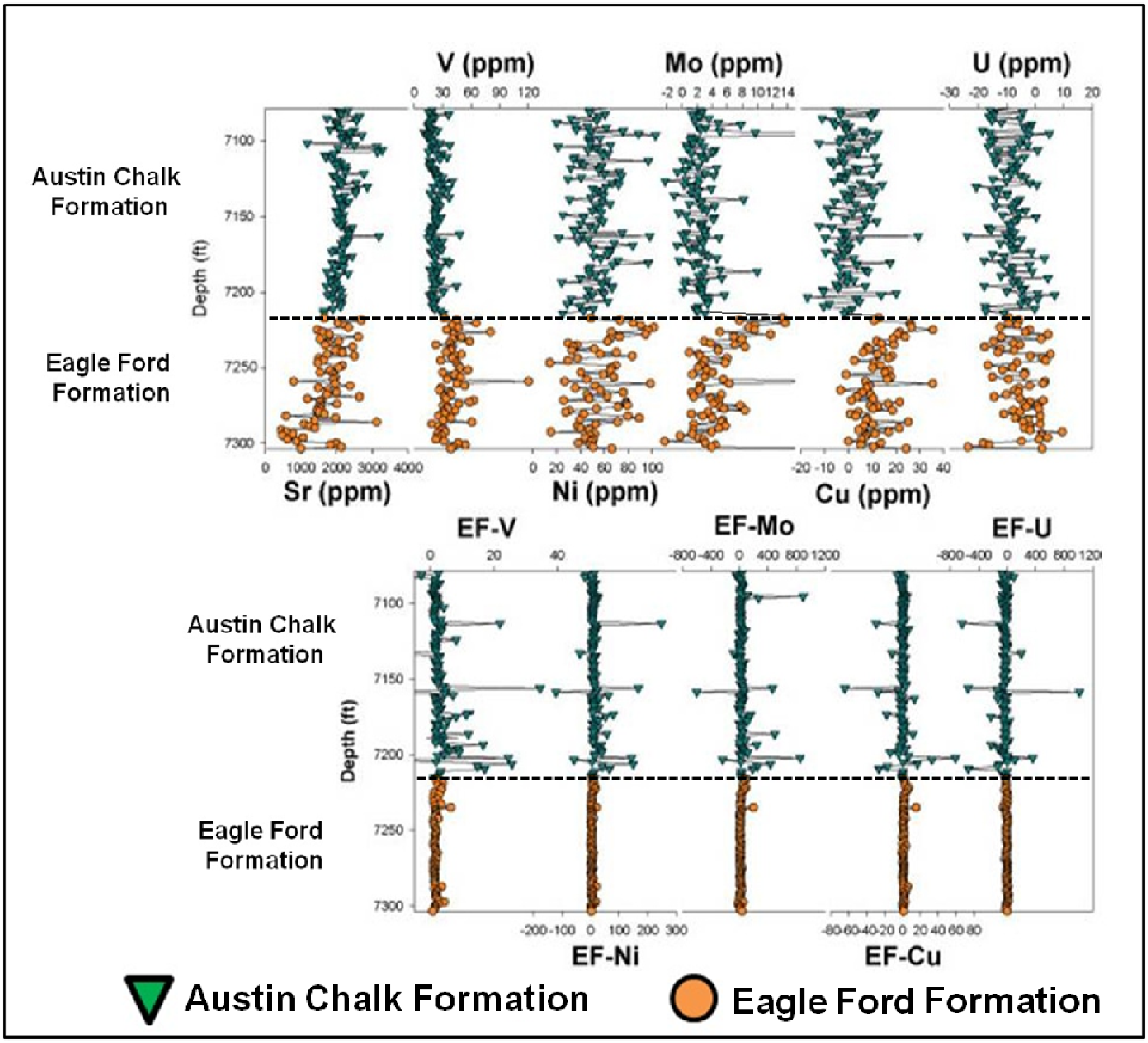

Figure 4.12 Getty Lloyd Hurt #1 Drill Core Average, Maximum, Minimum, Range, and Standard Deviation for Trace Element Concentrations and Respective Enrichments. Zone #1 contains the Eagle Ford Formation and Zone #2 contains the Austin Chalk Formation.

Table 4.12 Getty Lloyd Hurt #1 Drill Core Average, Maximum, Minimum, Range, and Standard Deviation for Trace Element Concentrations and Respective Enrichments. Each zone represents a chemostratigraphically distinct portion of the core that is consistent with the respective Figure 4.12. Zone #1 contains of the Eagle Ford Formation and Zone #2 contains the Austin Chalk Formation.

Getty Hurt Zone #2	Sr ppm	V ppm	Ni ppm	Mo ppm	Cu ppm	U ppm	EF-V ppm	EF-Ni ppm	EF-Mo ppm	EF-Cu ppm	EF-U ppm
Average	2146.44	23.26	53.02	3.25	0.83	-8.30	3.36	17.63	53.82	-0.59	-34.62
Max	3273.86	48.06	102.86	65.04	29.41	6.80	34.59	247.89	892.22	59.40	1011.23
Min	1182.57	10.71	19.81	-2.25	-17.25	-23.82	-32.57	-121.02	-598.78	-64.61	-631.54
Range	2091.28	37.34	83.05	67.29	46.66	30.62	67.15	368.91	1491.00	124.00	1642.76
Stnd Dev	335.02	6.78	16.49	6.59	7.60	5.95	6.97	38.81	158.57	11.11	150.60
Getty Hurt Zone #1	**Sr ppm**	**V ppm**	**Ni ppm**	**Mo ppm**	**Cu ppm**	**U ppm**	**EF-V ppm**	**EF-Ni ppm**	**EF-Mo ppm**	**EF-Cu ppm**	**EF-U ppm**
Average	1671.32	40.65	56.07	5.16	12.44	-5.03	1.87	5.66	24.69	1.80	-8.48
Max	3122.57	120.57	101.52	25.11	35.63	9.47	6.47	19.78	196.51	15.40	17.14
Min	452.48	16.23	14.29	-2.30	-3.27	-23.53	0.77	0.41	-18.67	-0.82	-51.99
Range	2670.10	104.34	87.23	27.41	38.90	33.00	5.70	19.37	215.18	16.22	69.13
Stnd Dev	564.53	15.52	20.88	4.36	8.40	6.74	0.96	4.33	29.14	2.21	12.35

In Figure 4.12 there is correlation between much of the data in both zones. The descending order of greatest to least relative average elemental concentration is as follows: Sr, Ni, V, Mo, Cu, and U. In general, zone two demonstrates greater elemental concentration and enrichment than that of zone one. An average Mo value of greater 5 ppm is only exhibited in zone one, which indicates that anoxic conditions occurred during the deposition of zone one, but not during the deposition of zone two (Zheng, 2000).

4.2.2 Clay Enrichment Results

The following cross plots are created from the assortment of data presented in the former portion of this chapter. They reveal a relationship, linearity, or no relation in key sets of data that indicate the origin of select elements. For example, in the following figure the concentration of Ti is plotted against the concentration of Al. Since linearity occurs it indicates that Ti was deposited with clay because Al is utilized as a proxy for clay (Tribovillard, 2006). In the following section clay enrichment refers to the concentration of Al measured in weight percent.

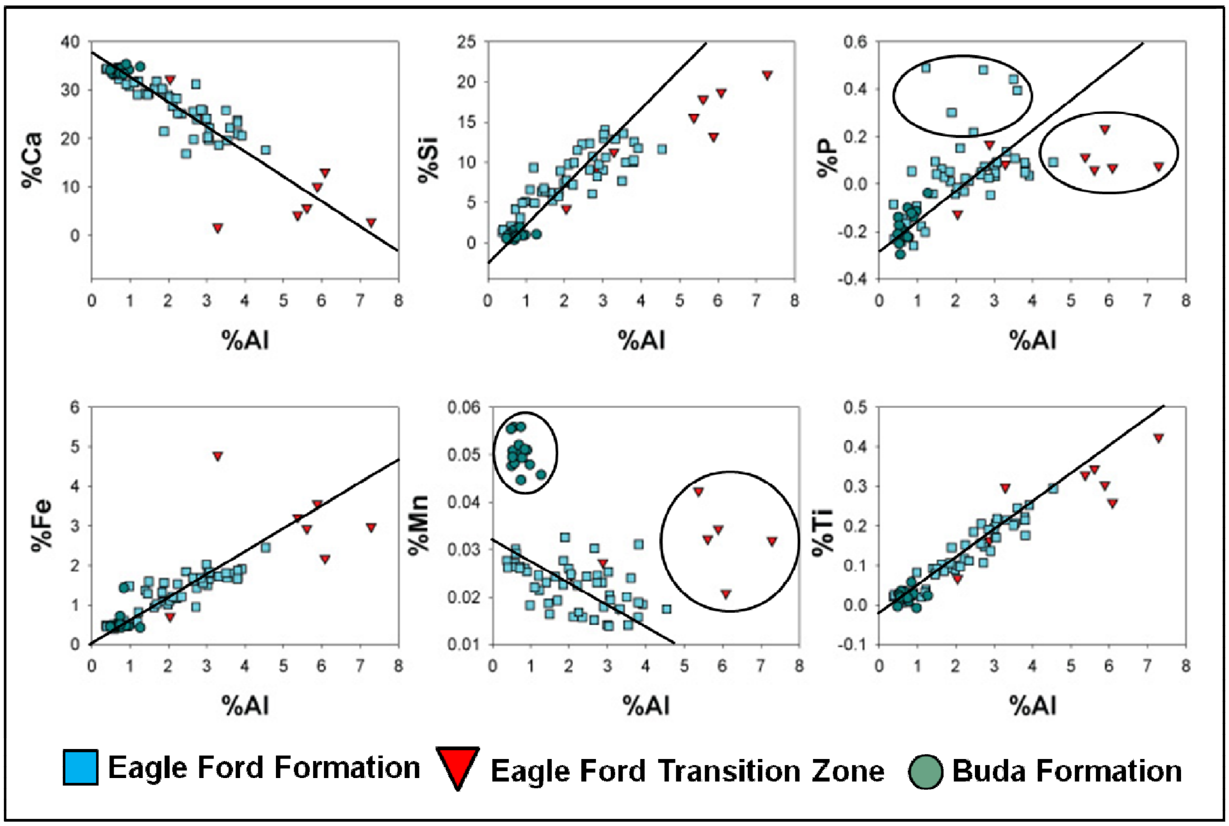

Figure 4.13 Geological Research Co. Schauers, FT #1 Drill Core Major Elements VS Clay Enrichment.

Geological Research Co. Schauers, FT #1 Drill Core contains the Buda Formation, Zone #1 (Figures 4.1 & 4.1), an Eagle Ford Transition Zone, Zone#2 (Figure 4.1 & 4.1) and the Eagle Ford Formation, Zone #3 (Figure 4.1 & 4.1).

Calcium VS Al demonstrates inverse linear relationship. This indicates that clay concentration was diluted by Ca deposition. Silicon VS Al, Fe VS Al and Ti VS Al demonstrate linearity. Those elements occurred with clay deposition. Phosphorus VS Al demonstrates a possible relationship, but not linearity throughout the deposition the Buda and Eagle Ford Formations. This indicates that some P may have occurred with clay deposition. Manganese VS Al demonstrates a negative relationship during the deposition of the Eagle Ford Formation. This indicates that Manganese may have diluted clay concentration during deposition of the Eagle Ford Formation.

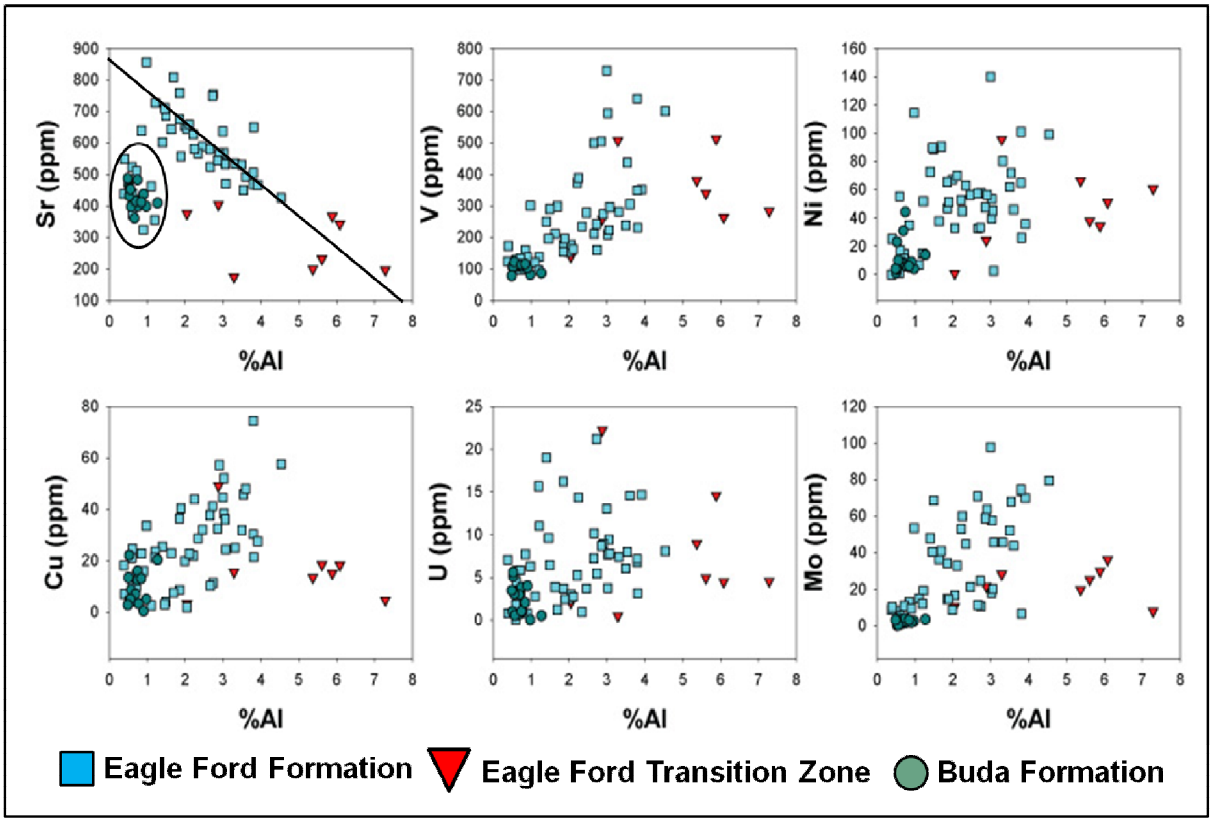

Figure 4.14 Geological Research Co. Schauers, FT #1 Drill Core Trace Elements VS Clay Enrichment.

Geological Research Co. Schauers, FT #1 Drill Core contains the Buda Formation (Zone #1), an Eagle Ford Transition (Zone #2) and the Eagle Ford Formation (Zone #3). Strontium VS Al demonstrates a possible inverse linear relationship during the deposition of the Eagle Ford Formation, which indicates that the clay fraction was diluted by Sr deposition. There is no relationship between V, Ni, Cu, U and Mo with Al. This indicates that the aforementioned elements did not occur with the clay fraction.

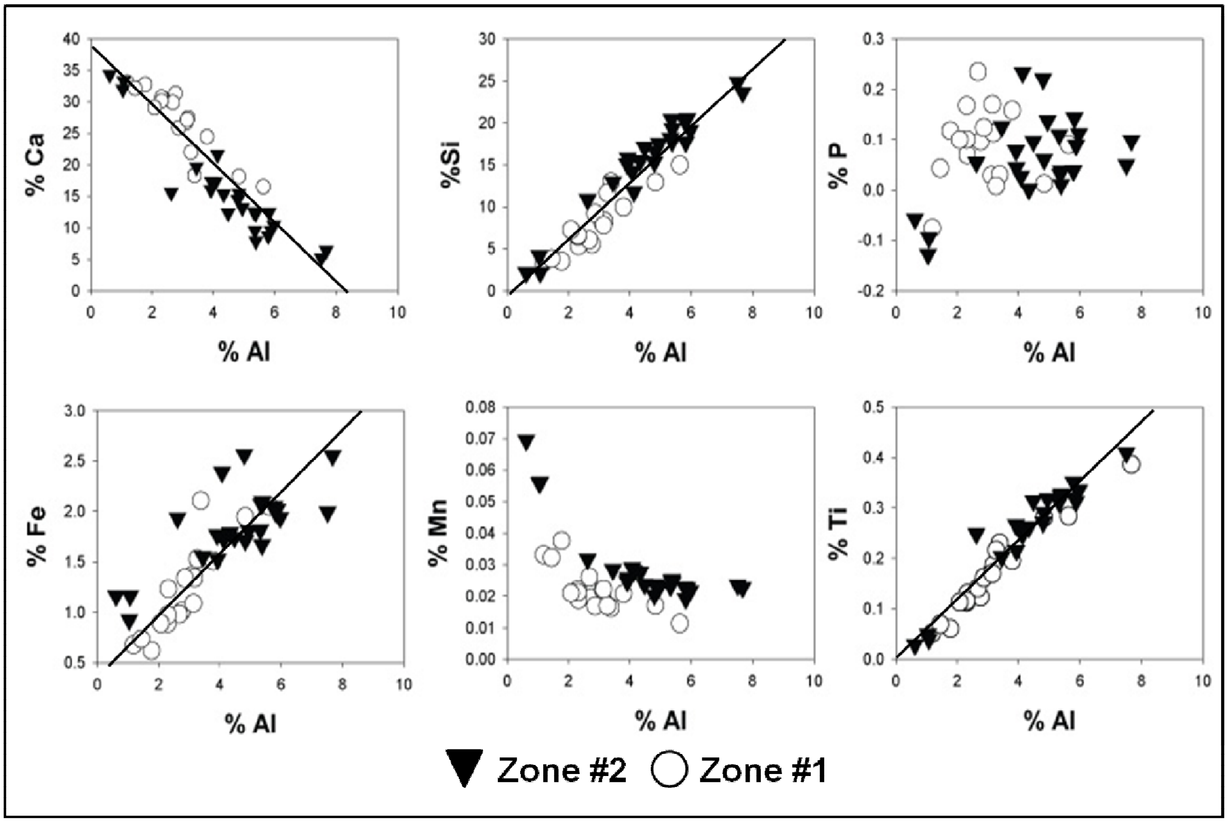

Figure 4.15 Shell Oil Co. ED Hay, Unit #1 Drill Core Major Elements VS Clay Enrichment.

The Shell Oil Co. ED Hay, Unit #1 Drill Core contains the Eagle Ford Formation. Zones one and two are part of the Eagle Ford Formation. Calcium VS Al demonstrates an inverse relationship. This indicates that clay concentration was diluted by Ca deposition. Silicon VS Al, Ti VS Al demonstrates linearity. Those elements occurred with clay deposition. Iron VS Al demonstrates a relationship that indicates that a fraction of Fe occurred with clay deposition. The elements in the remaining plots did not occur with clay deposition.

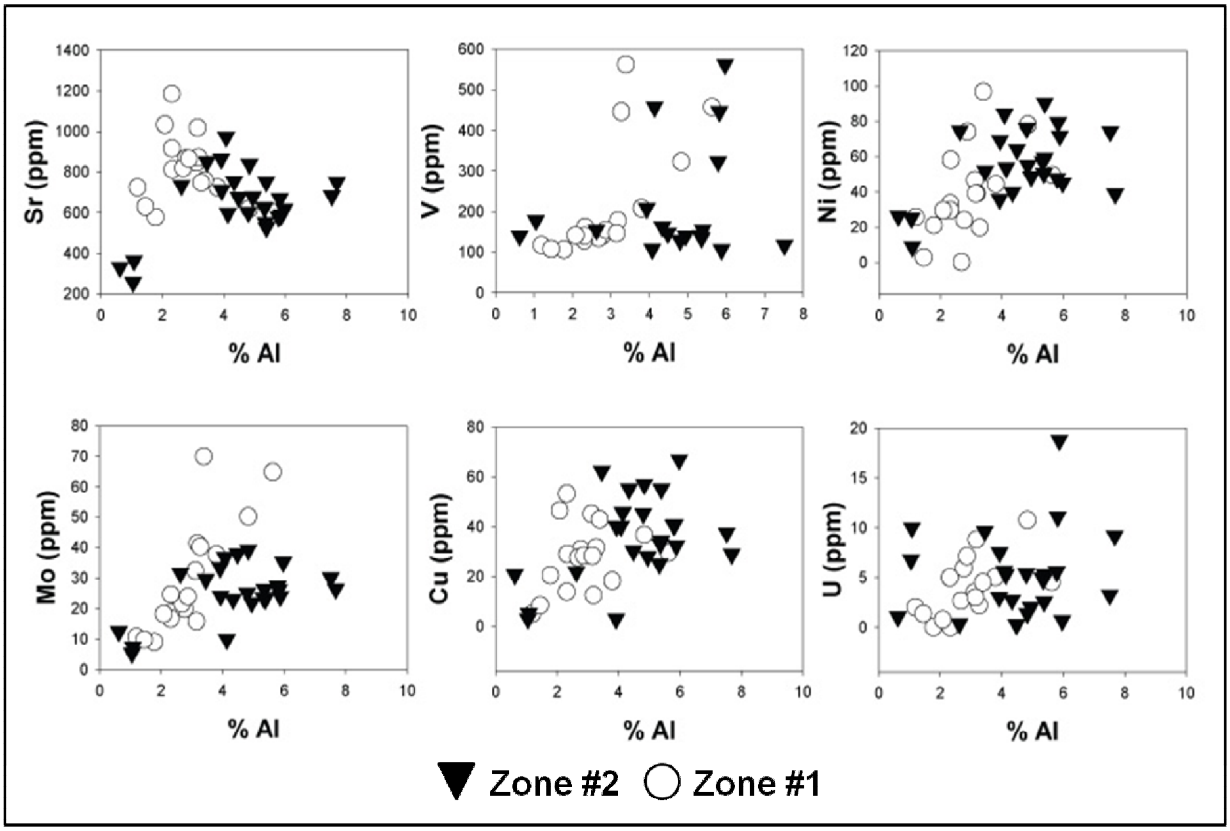

Figure 4.16 Shell Oil Co. ED Hay, Unit #1Core Trace Elements VS Clay Enrichment.

The Shell Oil Co. ED Hay, Unit #1 Drill Core contains the Eagle Ford Formation. Zones one and two are part of the Eagle Ford Formation. There is no relationship between Sr, V, Ni, Cu, U and Mo with Al. This indicates that the aforementioned elements did not occur with the clay deposition.

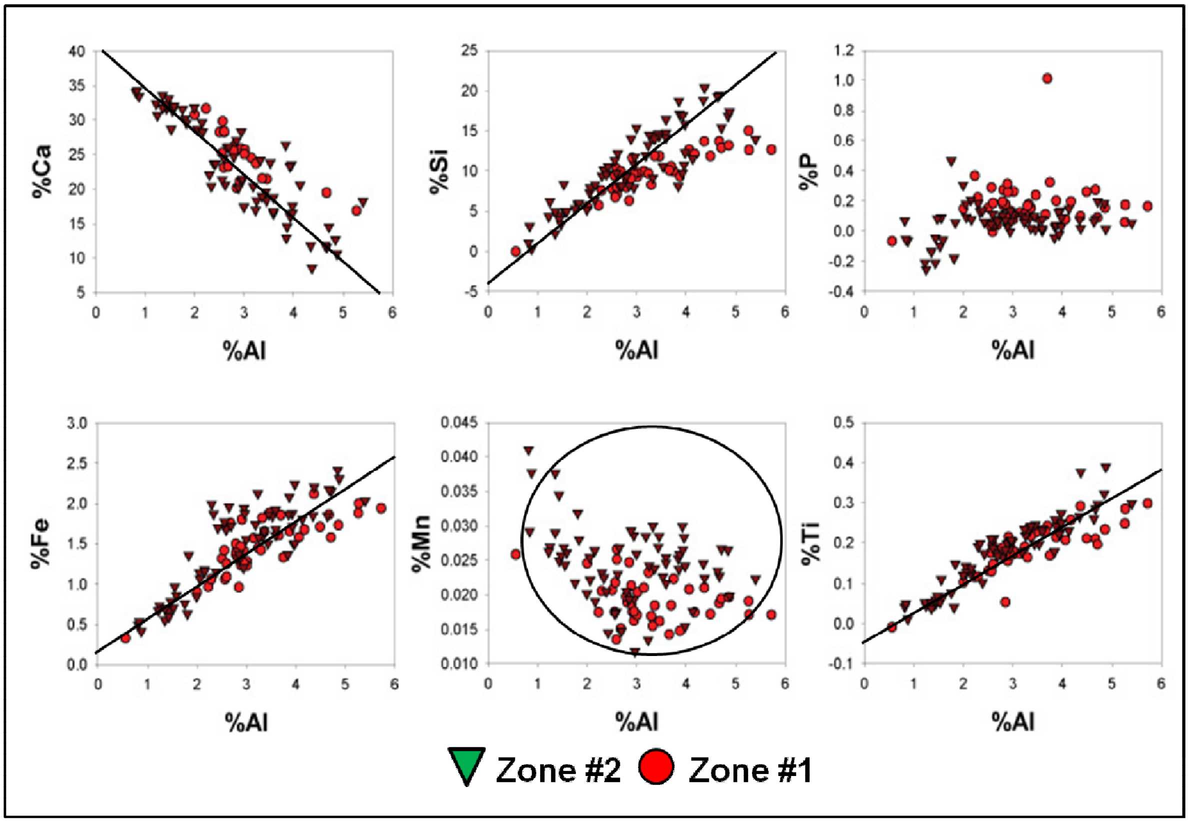

Figure 4.17 Shell Oil Co. Leppard, J.A. #1 Drill Core Major Elements VS Clay Enrichment.

Shell Oil Co. Leppard, J.A. #1 Drill Core contains the Buda, Eagle Ford and Austin Chalk Formations. Zone one contains the Buda and Eagle Ford Formations. Zone two contains the Eagle Ford and Austin Chalk Formations.

Calcium VS Al demonstrates an inverse relationship that approaches, but is not linear. This indicates that clay concentration was diluted by Ca deposition. Silicon VS Al, Fe VS Al and Ti VS Al also demonstrate a relationship that approaches, but does not reach linearity. Those elements occurred with clay deposition. Manganese and P did not occur with clay deposition. This is indicated by the absence of a relationship.

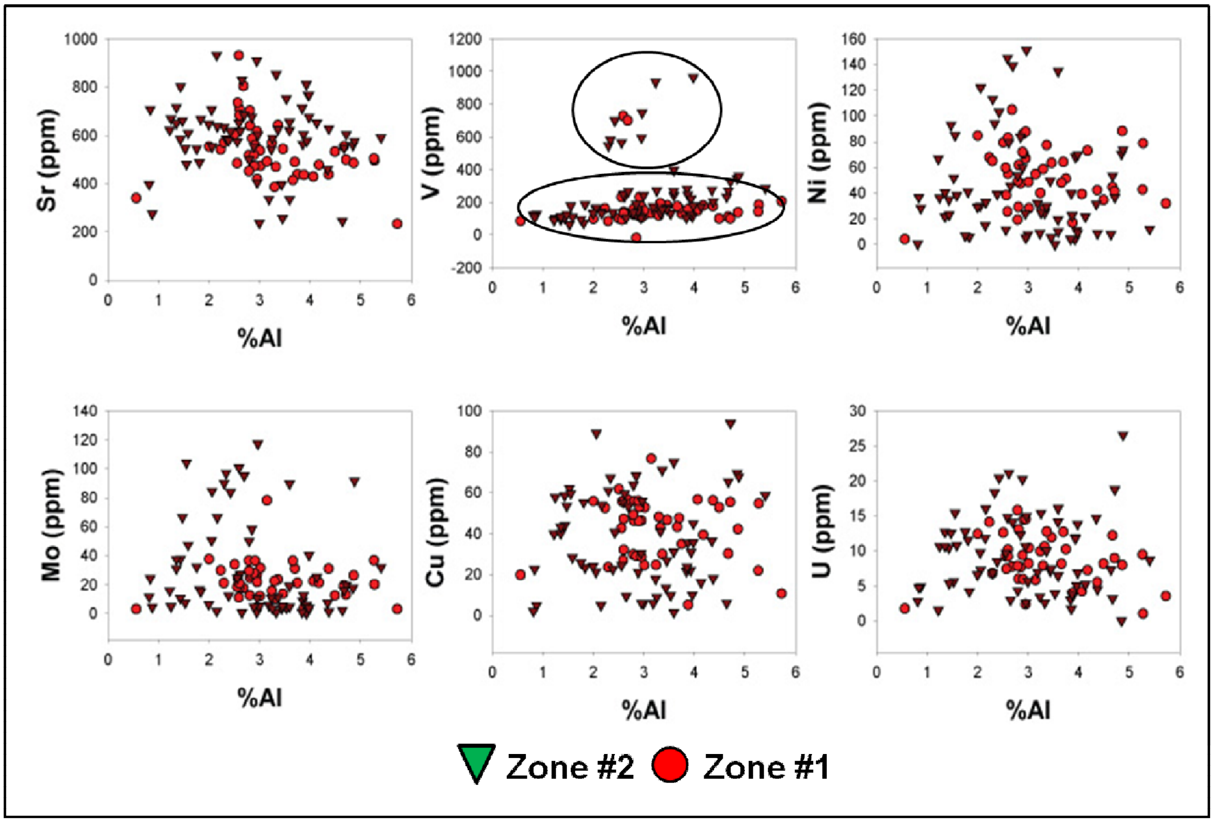

Figure 4.18 Shell Oil Co. Leppard, J.A. #1 Drill Core Trace Elements VS Clay Enrichment.

Shell Oil Co. Leppard, J.A. #1 Drill Core contains the Buda, Eagle Ford and Austin Chalk Formations. Zone one contains the Buda and Eagle Ford Formations. Zone two contains the Eagle Ford and Austin Chalk Formations.

There is no relationship between Sr, Ni, Cu, U and Mo with Al. This indicates that the aforementioned elements did not occur with the clay fraction. Vanadium VS Al demonstrates a relationship that indicates that V could have partially occurred with the deposition of the clay fraction.

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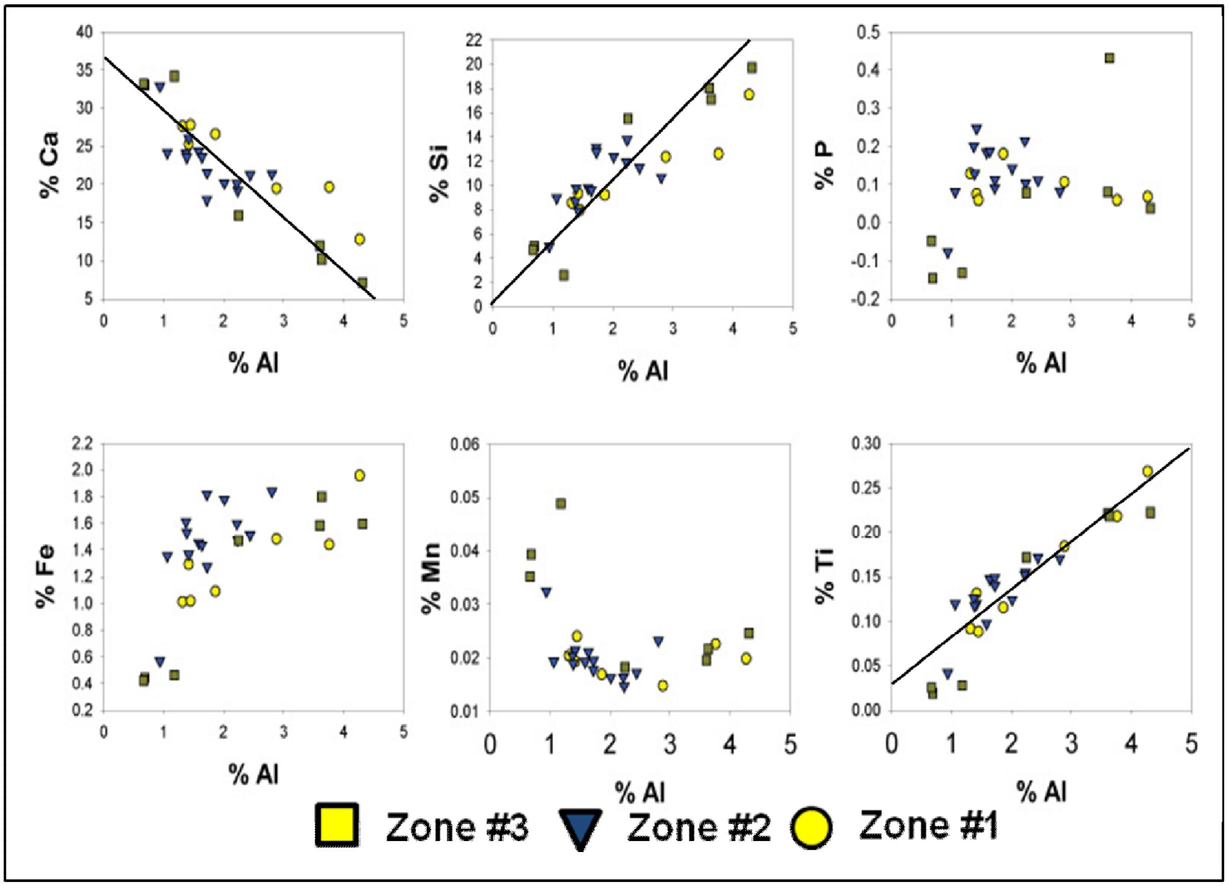


Figure 4.19 Quintanna Halff et al # 1 Drill Core Trace Elements VS Clay Enrichment.

The Quintanna Halff et al # 1 Drill Core contains the Eagle Ford Formation. Zone one, two and three consists of the Eagle Form Formation. Calcium VS Al demonstrates an inverse linear relationship. This indicates that clay concentration was diluted by Ca deposition. Silicon VS Al and Ti VS Al demonstrate a relationship that approaches, but does not reach linearity. Those elements occurred with clay deposition. A relationship does not exist in the remaining plots.

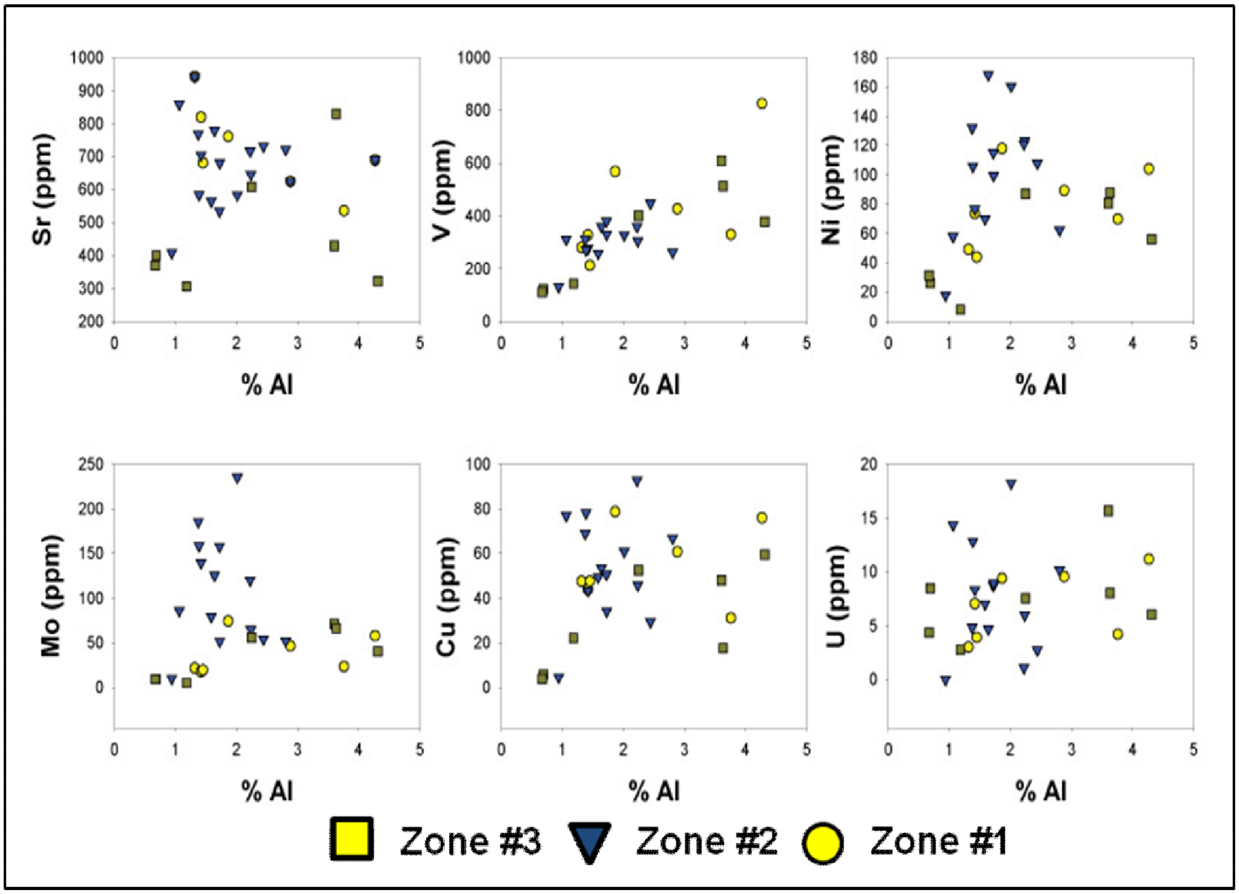


Figure 4.20 Quintanna Halff et al # 1 Drill Core Trace Elements VS Clay Enrichment.

The Quintanna Halff et al # 1 Drill Core contains the Eagle Ford Formation. Zone one, two and three consists of the Eagle Form Formation. There is no relationship between Sr, V, Ni, Cu, U and Mo with Al. This indicates that the aforementioned elements did not occur with clay deposition.

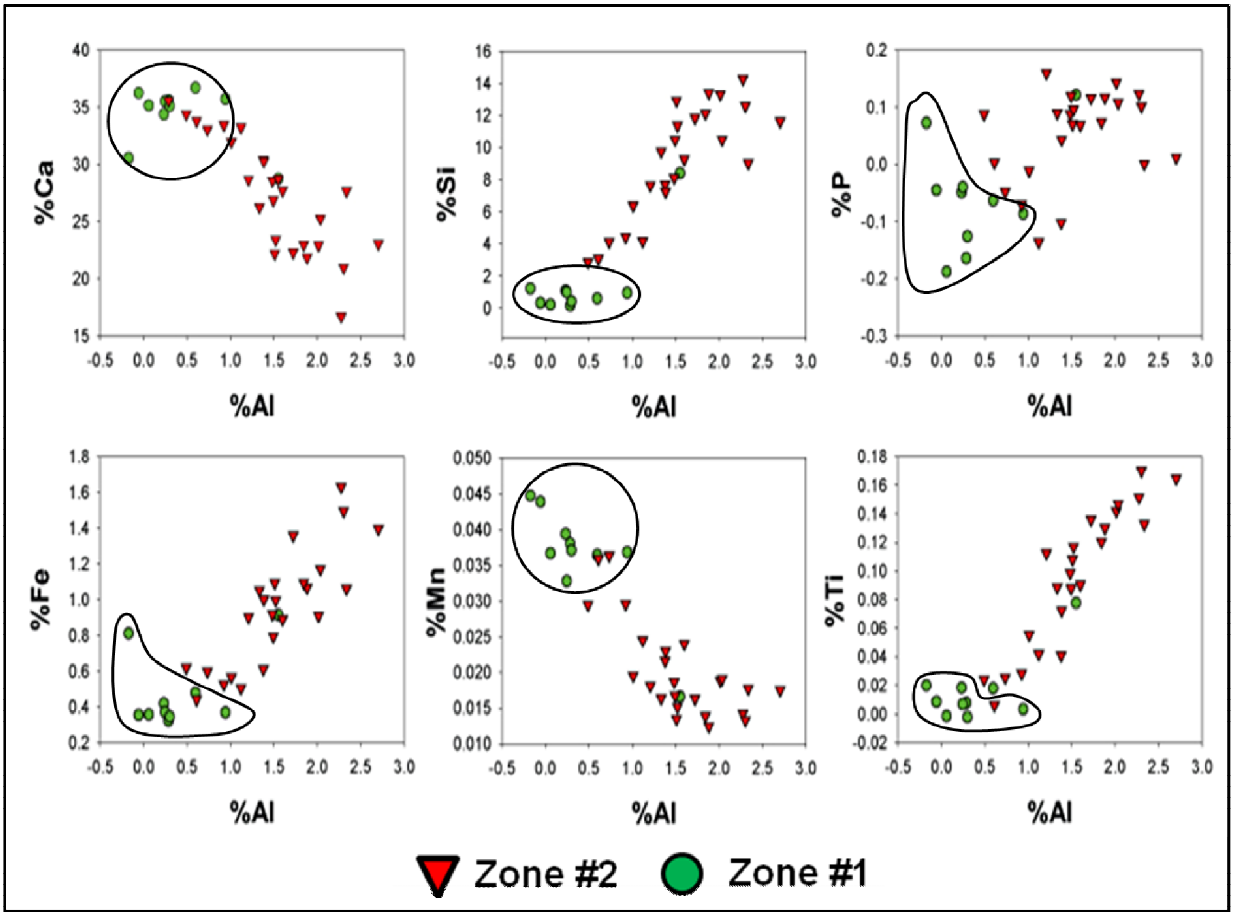


Figure 4.21 Gose & Shield Hassett #3 Drill Core Major Elements VS Clay Enrichment.

Gose & Shield Hassett #3 Drill Core contains the Buda and Eagle Ford Formations. Zone one consist of the Buda Formation. Zone two consists of the Eagle Ford Formation. Calcium VS Al demonstrates an inverse relationship in zone two. This indicates that clay concentration was diluted by Ca deposition. There is no relationship between Ca and Al in zone one. Silicon VS Al, Fe VS Al and Ti VS Al demonstrate a positive relationship in zone two. This indicates that Si, Fe and Ti occurred, at least partially, with clay deposition. There is no relationship in zone one between the aforementioned elements and Al. Manganese VS Al demonstrates a negative relationship in both zones. This indicates that clay concentration was diluted by Mn deposition.

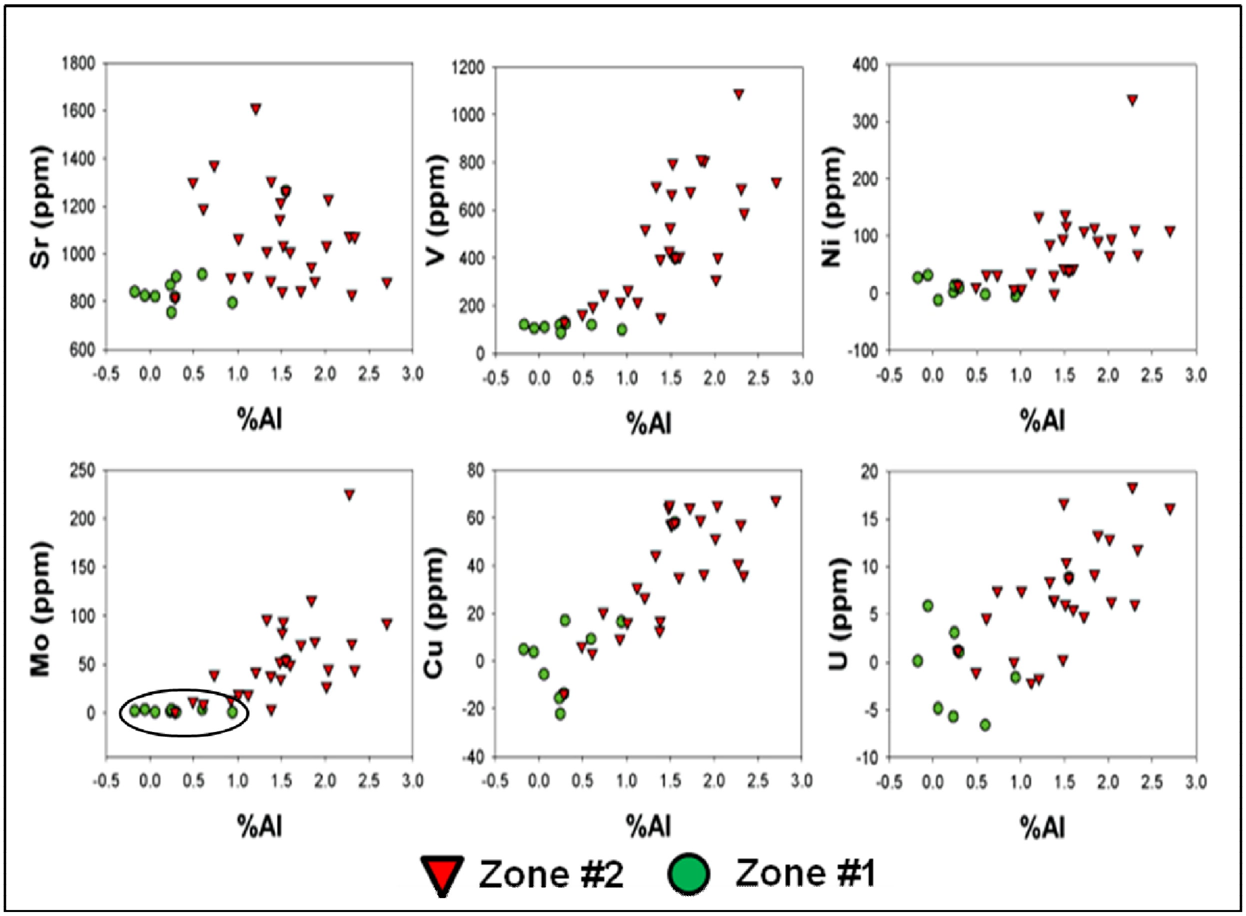


Figure 4.22 Gose & Shield Hassett #3 Drill Core Trace Elements VS Clay Enrichment.

Gose & Shield Hassett #3 Drill Core contains the Buda and Eagle Ford Formations. Zone one consist of the Buda Formation. Zone two consists of the Eagle Ford Formation. There is no relationship between Sr, V, Ni, Cu, U and Mo with Al. This indicates that the aforementioned elements did not occur with the clay fraction. However, in zone one of the plot Molybdenum VS Al Mo values remain relatively constant as the Al concentration increases and is not scattered, which is largely observed the other aforementioned plots. This also indicates that the Mo did not occur with clay deposition.

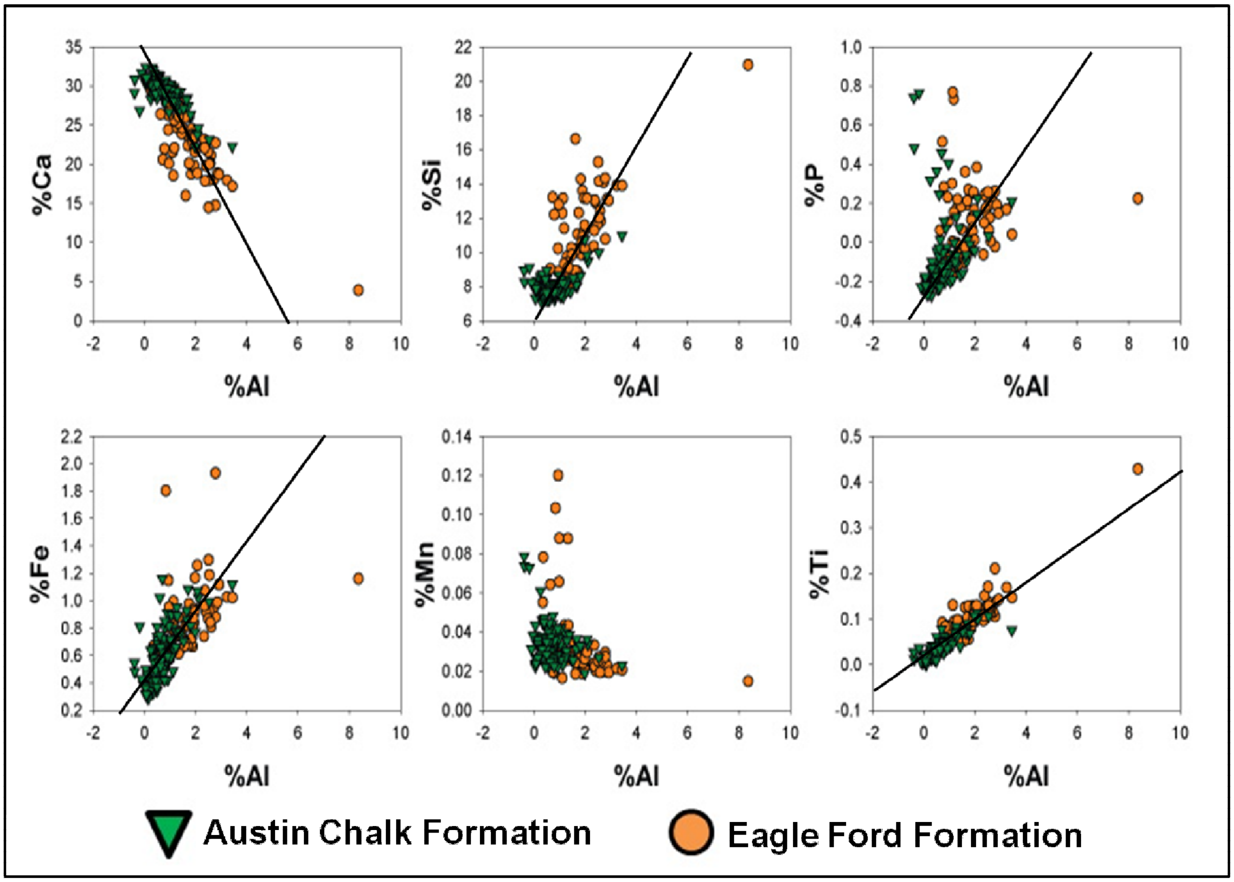


Figure 4.23 Getty Lloyd Hurt #1 Drill Core Major Elements VS Clay Enrichment.

The Getty Lloyd Hurt #1 Drill Core contains the Eagle Ford Formation and Austin Chalk Formations. Zone one consist the Eagle Ford Formation and zone two consist of the Austin Chalk Formation. Calcium VS Al demonstrates a near linear inverse relationship. This indicates that clay concentration was diluted by Ca deposition. Silicon VS Al, P VS Al and Fe VS Al demonstrate a relationship that approaches linearity. This indicates that they aforementioned elements occurred partially with clay deposition. Titanium VS Al demonstrates linearity. This indicates that Ti occurred with clay deposition. There is no relationship between Mn and Al. This indicates that Mn did not occur with clay deposition.

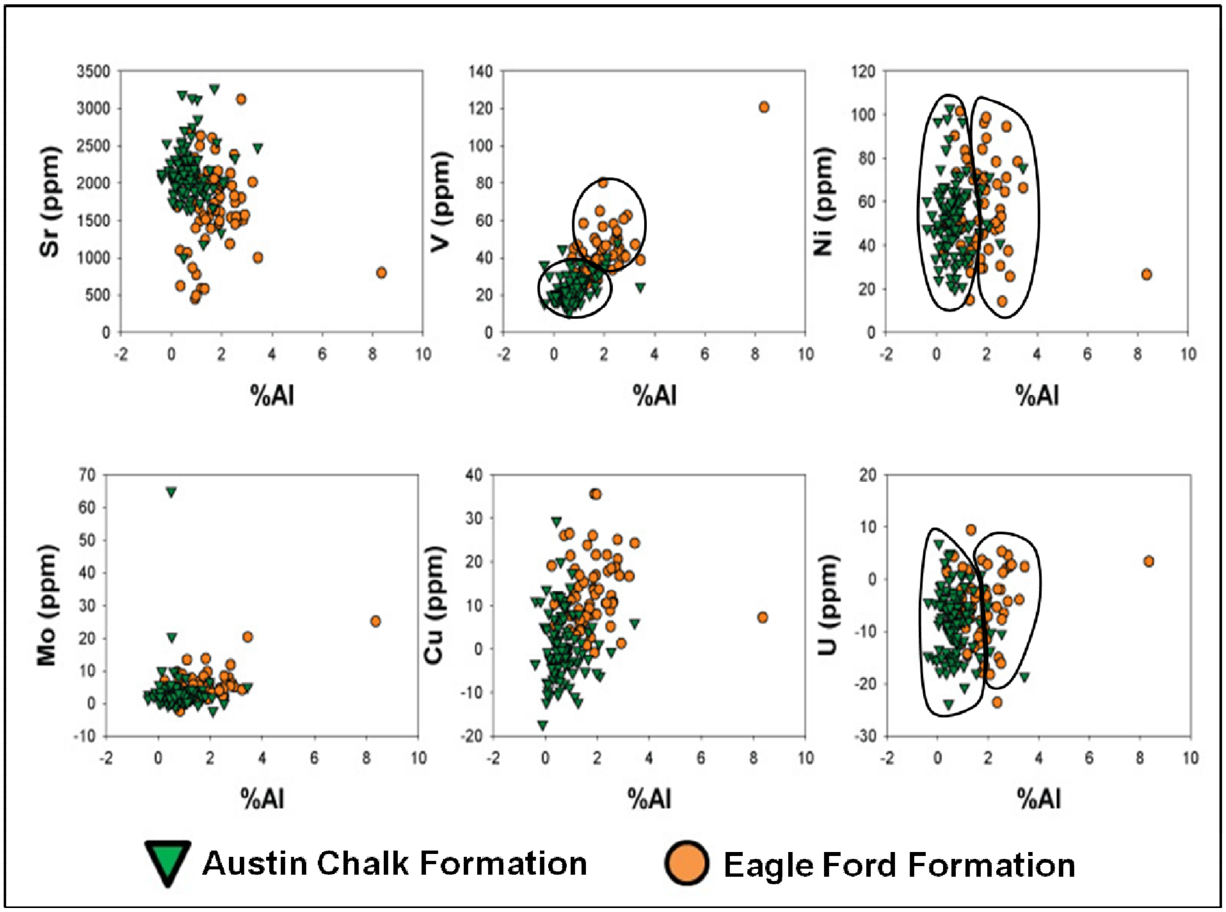


Figure 4.24 Getty Lloyd Hurt #1 Drill Core Trace Elements VS Clay Enrichment.

The Getty Lloyd Hurt #1 Drill Core contains the Eagle Ford Formation and Austin Chalk Formations. Zone one consist the Eagle Ford Formation and zone two consist of the Austin Chalk Formation. There is no relationship between Sr, V, Ni, Cu, U and Mo with Al. This indicates that the aforementioned elements did not occur with the clay fraction. It should be noted that clay deposition decreased during the deposition of the Austin Chalk Formation relative to the Eagle Ford Formation. This is particularly observable in the plots V VS Al, Ni VS Al and U VS Al.

4.2.3 %TOC, %N, δ13C, δ15N Results

The following data were collected through the use of a variety of techniques. The methods are discussed in chapter three.

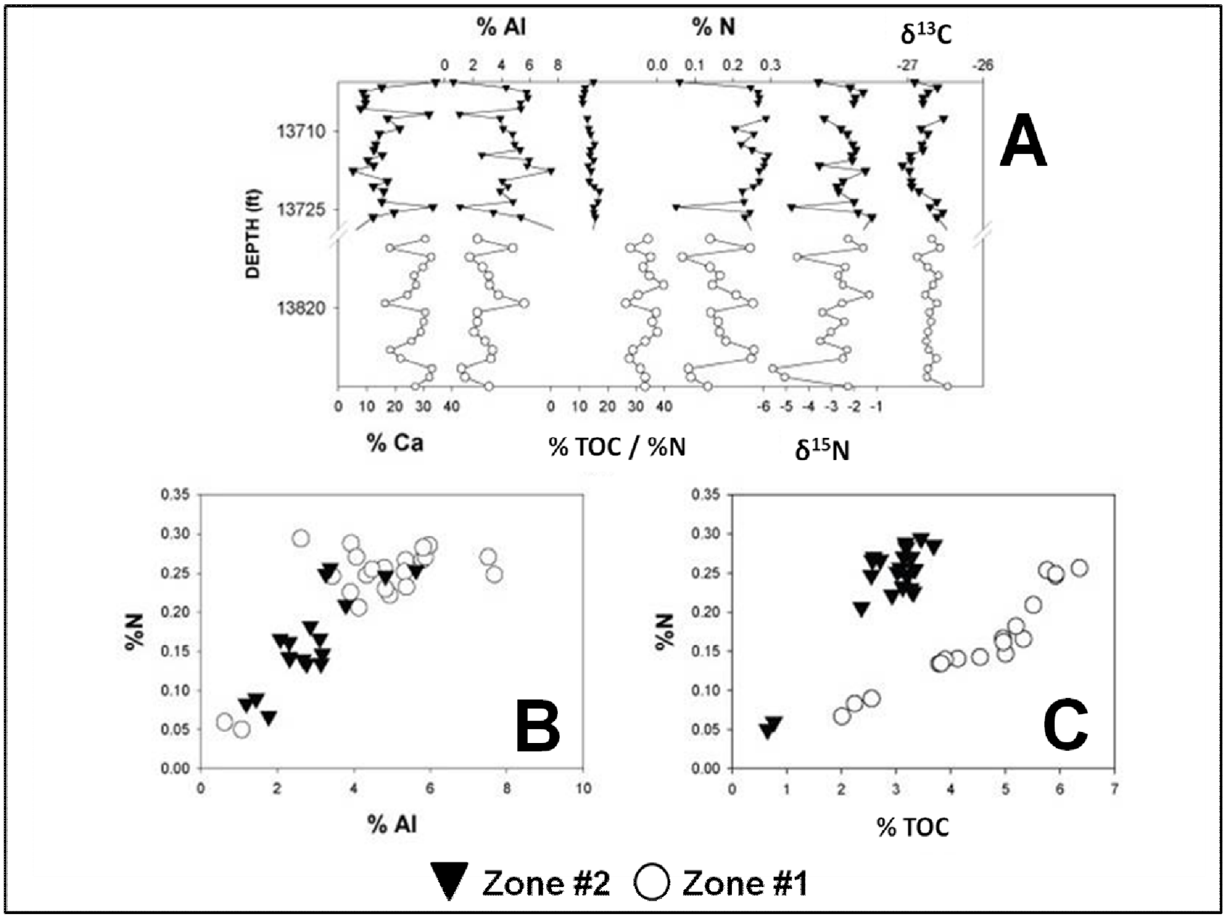


Figure 4.25 Shell Oil Co. ED Hay, Unit #1 Concentrations for Ca %, Al %, TOC %, N % and Isotopic Data for $\delta^{13}C$, $\delta^{15}N$.

Table 4.13 Shell Oil Co. ED Hay, Unit #1 Average, Maximum, Minimum, Range and Standard Deviation for C/N, N %, $\delta^{15}N$, $\delta^{13}C$ and TOC%.

Hay Zone #2	C/N	N %	d15N	d13C	TOC %
Average	14.11	0.24	-2.37	-26.78	2.84
Max	17.16	0.29	-1.22	-26.48	3.69
Min	11.17	0.05	-4.76	-27.07	0.65
Range	5.99	0.24	3.55	0.59	3.04
Stnd Dev	1.63	0.06	0.82	0.17	0.76
Hay Zone #1	**C/N**	**N %**	**d15N**	**d13C**	**TOC %**
Average	32.97	0.16	-2.89	-26.69	4.55
Max	39.78	0.26	-1.33	-26.47	6.36
Min	26.50	0.07	-5.60	-26.87	2.01
Range	13.28	0.19	4.27	0.40	4.35
Stnd Dev	3.60	0.06	1.14	0.09	1.29

In the Shell Oil Co. ED Hay, Unit #1 Drill Core Figure 4.25 (A) percent TOC is normalized by percent N. Zone one generally demonstrates greater average values and range than zone two. Nitrogen demonstrates a greater average and range in zone two relative to zone one. However, the N concentration is more dynamic in zone one relative to zone two. C/N ratios of 25 to 50 are typical of average black shale deposited during the CT anoxic event (Junium and Arthur, 2007). The values indicate that zone one was deposited during the CT anoxic event and the zone two was not deposited during that period.

The plots Depth VS $\delta^{15}N$ demonstrates a greater average and range and standard deviation in zone one relative to zone two. The average values of zone one and zone two both, -2.89 $^{o}/_{oo}$ and -2.37 $^{o}/_{oo}$ respectively, both as could have been deposited during the during the CT anoxic event. This is because the typical black shale deposited during the period ranged from 1.2 $^{o}/_{oo}$ to -3.9 $^{o}/_{oo}$ (Junium and Arthur, 2007). The decrease in average carbon in zone two relative to zone one indicates that conditions were less favorable for the preservation of organic matter. Organic matter is better preserved in the absence of oxygen in the water column.

In the Shell Oil Co. ED Hay, Unit #1 Drill Core Figure 4.25 (B) the plots N VS Al demonstrates a positive correlation. Zone two demonstrates a greater enrichment of N and Al relative to zone two. This indicates that the deposition of N is linked to the deposition of clay.

In the Shell Oil Co. ED Hay, Unit #1 Drill Core Figure 4.25 (C) the plots N VS TOC demonstrates a positive linearity in zone one. The data from zone two are mostly constrained in a cluster between 0.20 to 0.30 percent N and 2 to 4 percent TOC. This indicates that in the zone one the deposition of N occurred with the deposition of TOC. However, there is no apparent relation in zone two. This indicates that the deposition of N did not occur with TOC during the deposition of zone two.

4.3 Mineralogical Analyses

4.3.1 Mineral Phase Results

Cross plots are utilized to determine the mineral phase of those elements that exist throughout the drill cores. Plots that fall along or close to the phase line represent samples existing in that phase. This is based on the formula for calcium carbonate, $CaCO_3$. Total inorganic carbon is utilized as a proxy from CO_3.

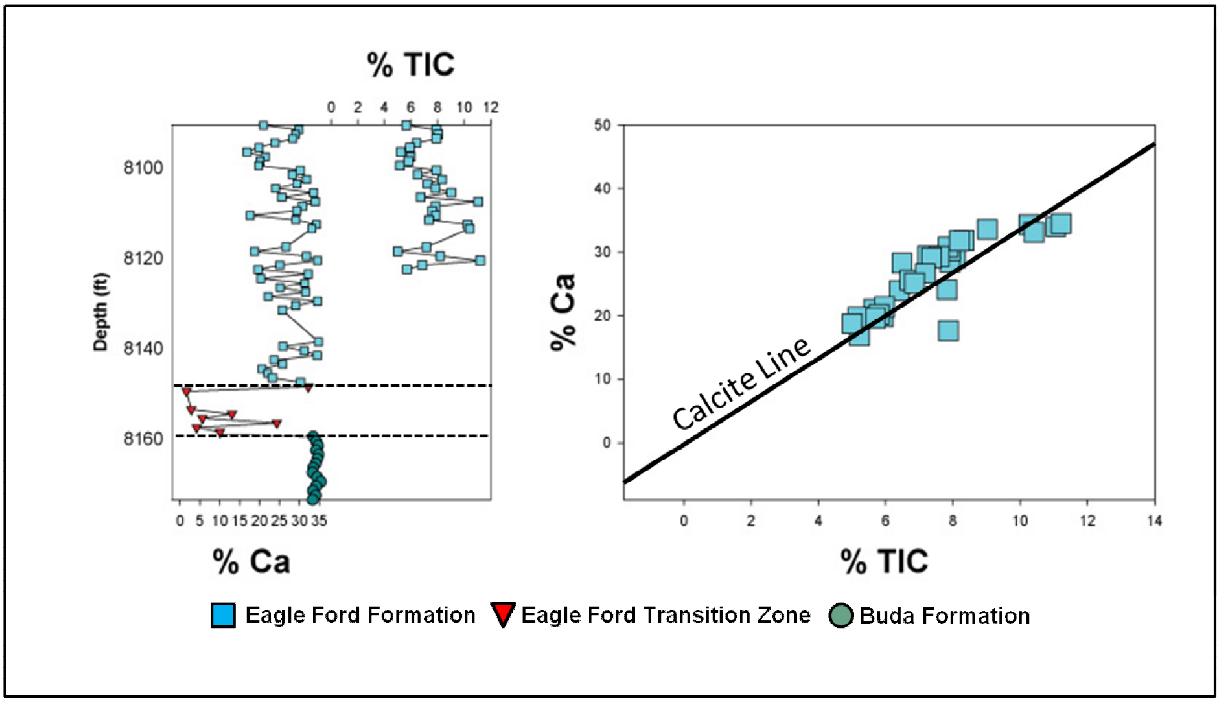


Figure 4.26 Geological Research Co. Schauers, FT #1 Drill Core Calcite Phase. When the concentration of calcium and the concentration of total inorganic carbon intersect on the calcite line the calcium is considered to exist in the calcite phase.

In Figure 4.26 the plots of Ca VS TIC demonstrate that most points form a positive linear relationship along the line that defines the calcite mineral phase. This data is from zone three, the Eagle Ford Formation. This indicates that Ca exist in the calcite phase.

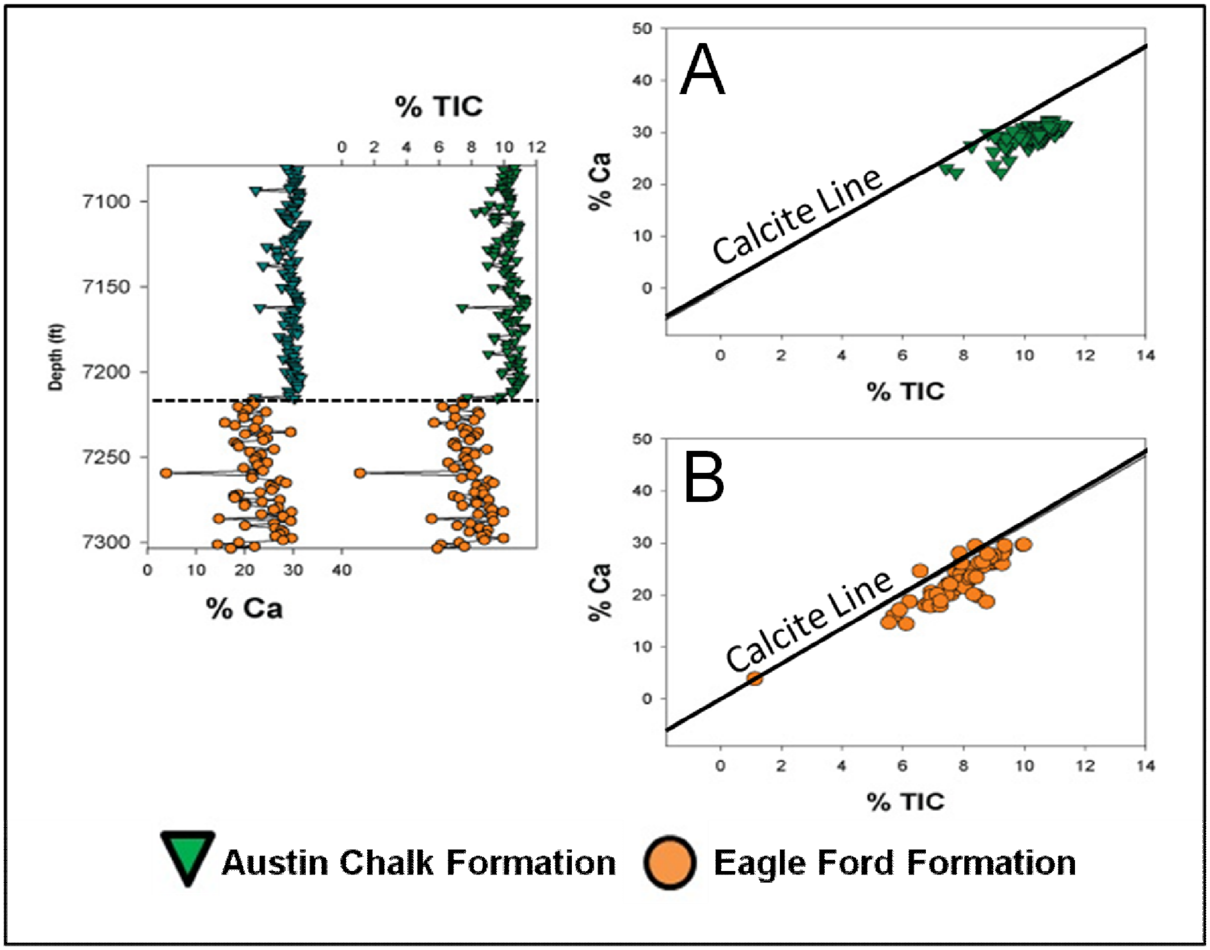


Figure 4.27 Getty Lloyd Hurt #1 Drill Core Calcite Phase. When the concentration of calcium and the concentration of total inorganic carbon intersect on the calcite line the calcium is considered to exist in the calcite phase.

In the Getty Lloyd Hurt #1 Drill Core Figure 4.27 (A) and (B) the plots Ca VS TIC demonstrate that most points form a positive linear relationship. However in Getty Lloyd Hurt #1 Drill Core Figure 4.27 (A) most points plot slightly below the line that defines the calcite phase in both zones. It is possible that the Ca in both zones exists in the calcite phase, but because most points plot below the line it is possible that it exist as ankerite. Ankerite is part of the dolomite series, which is primarily found in sedimentary strata that is typically the result of the replacement of Ca with Mg (Klein and Dutrow, 2002).

4.3.2 Ternary Diagrams

There are two primary types of ternary diagrams in this section. The first type contains sulfur on the x-axis, TOC on the y-axis and iron on the z-axis. This type of diagram can indicate sulfur concentration, iron concentration, or TOC concentration of samples relative to each other. This relative concentration can indicate the degree to which pyrite enrichment has occurred. The diagram can also indicate the conditions under which the samples in the diagram were deposited relative to normal marine conditions (Rimmer, 2003).

The other type of diagram contains calcium oxide on the x-axis, aluminum oxide on the y-axis, and silicon dioxide on the z-axis. This type diagram can demonstrate calcium oxide concentration, aluminum oxide concentration, or silicon dioxide concentration relative to each other. It can also indicate if a sample has a greater abundance of quartz or clay relative to average shale (Rimmer, 2003).

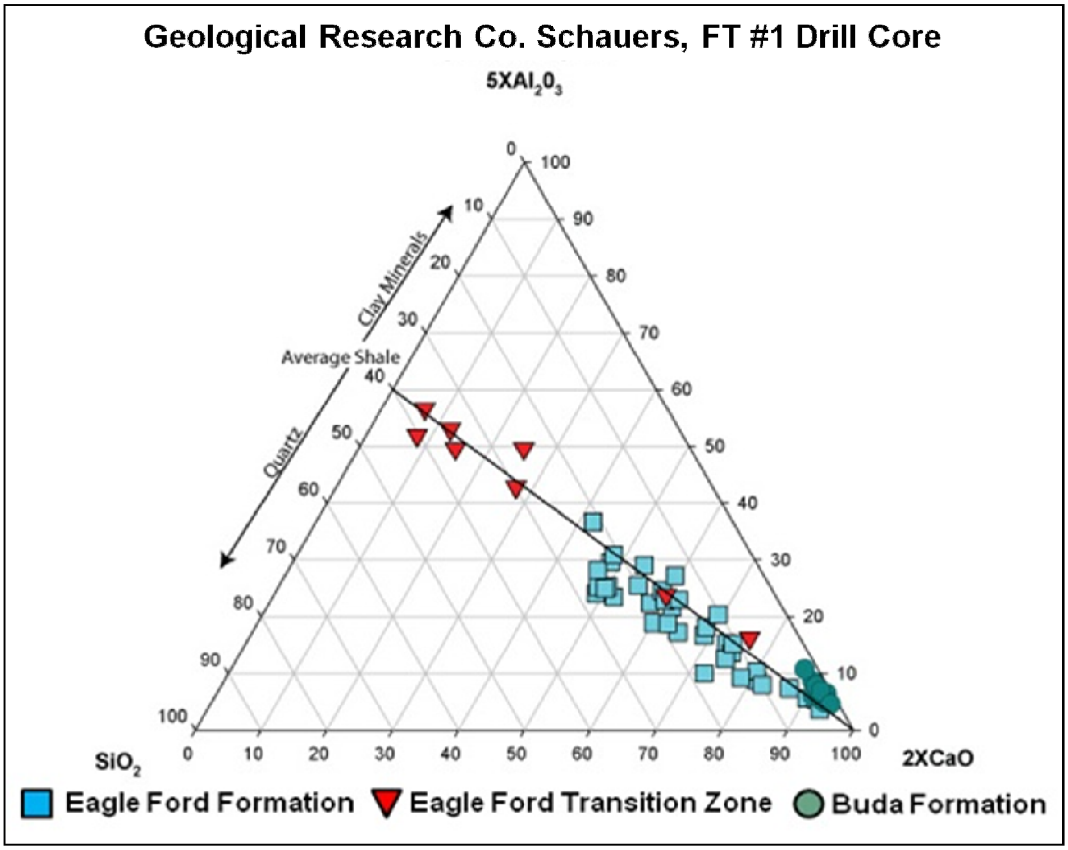


Figure 4.28 Geological Research Co. Schauers, FT #1 Drill Core: CaO VS Al_2O_3 VS SiO_2 Ternary Diagram.

The Research Co. Schauers, FT #1 Drill Core contains the Buda and Eagle Ford Formations. Zone one consist of the Buda Formation. Zone two consists of the Eagle Ford Transition Zone. Zone three consists of the Eagle Ford Formation. Figure 4.28 demonstrates that most points fall along or close to the average shale line (Rimmer, 2003). Points from zone one tends towards a greater concentration of calcium oxide than zone two and zone three. Zone two demonstrates the least concentration of calcium oxide relative to zone one. This indicates that as calcium carbonate deposition decreased in zone two relative to zone one and then increased in zone three. The deposition of quartz, SiO_2, also increased during the deposition of zone two and three relative to zone one.

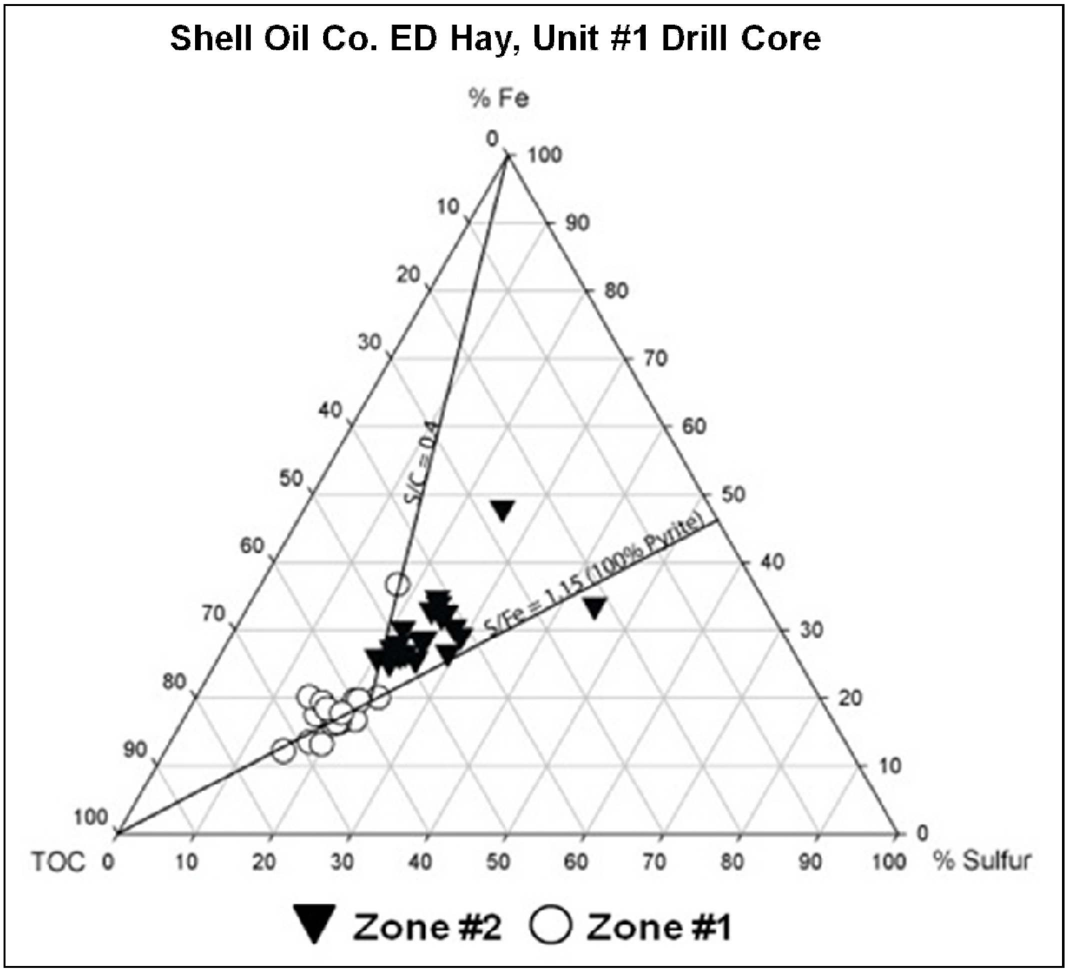


Figure 4.29 Shell Oil Co. ED Hay, Unit #1 Drill Core: S VS TOC VS Fe Ternary Diagram.

The Shell Oil Co. ED Hay, Unit #1 Drill Core contains the Eagle Ford Formation. Zone one and zone two consists of the Eagle Ford Formation. Figure 4.29 demonstrates that most points in zone one plot along the line that defines the pyrite mineral phase (Rimmer, 2003). However, most points in zone two demonstrate an excess of Fe that put the data points above the pyrite line. Most points in zone one plot below the line defined by the modern normal marine ratio of Sulfur to TOC (Rimmer, 2003). Most points in zone two plot above the normal marine line. The aforementioned results indicate that ocean conditions were not "normal" or predominantly oxic during deposition. Rather conditions were predominantly anoxic, which facilitated for the deposition of pyrite (Tribovillard, 2006).

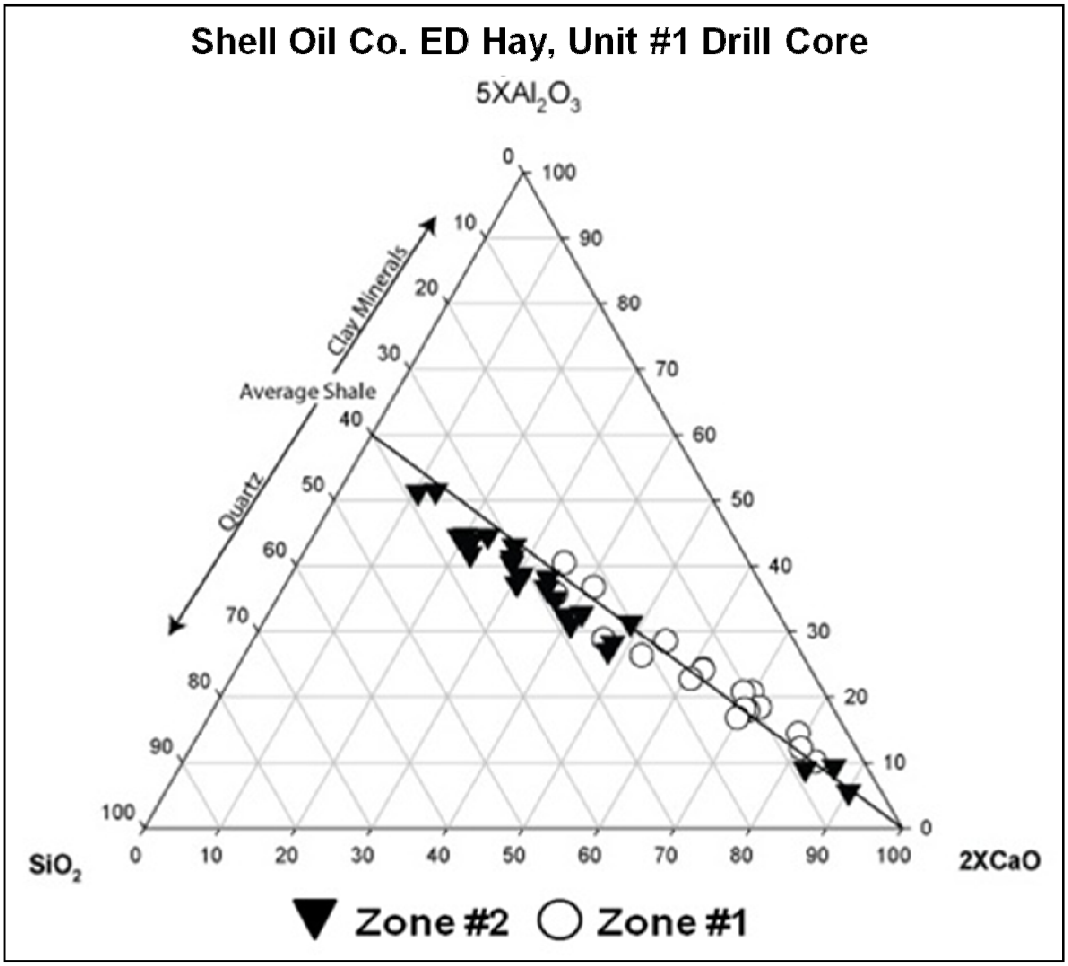


Figure 4.30 Shell Oil Co. ED Hay, Unit #1 Drill Core: S VS TOC VS Fe: CaO VS Al_2O_3 VS SiO_2 Ternary Diagram.

The Shell Oil Co. ED Hay, Unit #1 Drill Core contains the Eagle Ford Formation. Zone one and zone two consists of the Eagle Ford Formation. Figure 4.30 demonstrates that most points in both zones plot along the average shale line (Rimmer, 2003). However, most points in zone two have a slightly greater abundance of silicon oxide rather than aluminum oxide. Points in zone one contain a greater concentration of calcium oxide than zone two. This indicates that carbonate deposition was greater in zone one than in zone two and the quartz deposition was greater in zone two than in zone one.

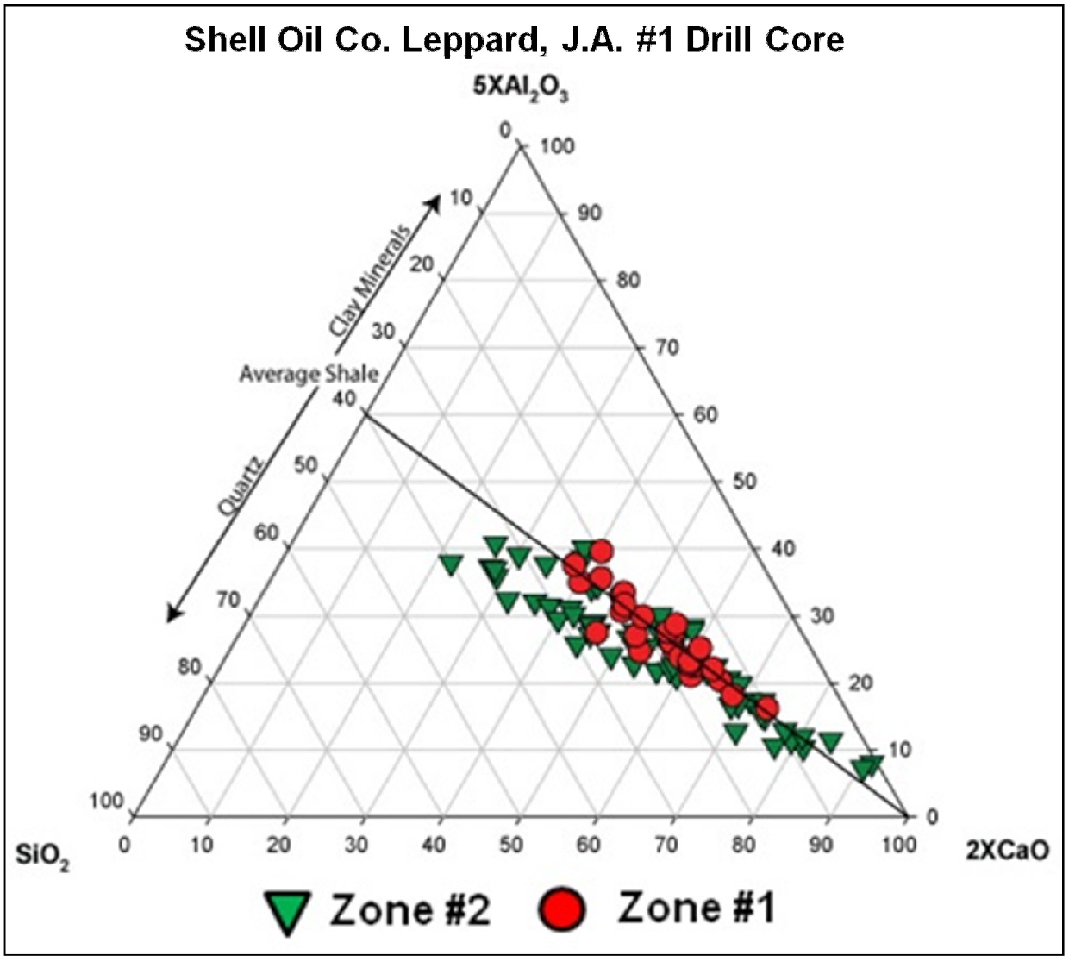


Figure 4.31 Shell Oil Co. Leppard, J.A. #1 Drill Core: CaO VS Al_2O_3 VS SiO_2 Ternary Diagram.

Shell Oil Co. Leppard, J.A. #1 Drill Core contains the Buda, Eagle Ford and Austin Chalk Formations. Zone one contains the Buda and Eagle Ford Formations. Zone two contains the Eagle Ford and Austin Chalk Formations. Figure 4.31 demonstrates that most points plot on or close to the average shale line (Rimmer, 2003). Points from both zone one and zone two contains a greater concentration of calcium oxide relative to aluminum oxide and or silicon dioxide. However, points from zone two have a slightly greater concentration of silicon dioxide than aluminum oxide relative to zone one. This indicates that silicon dioxide increased during the deposition of zone two relative to zone one.

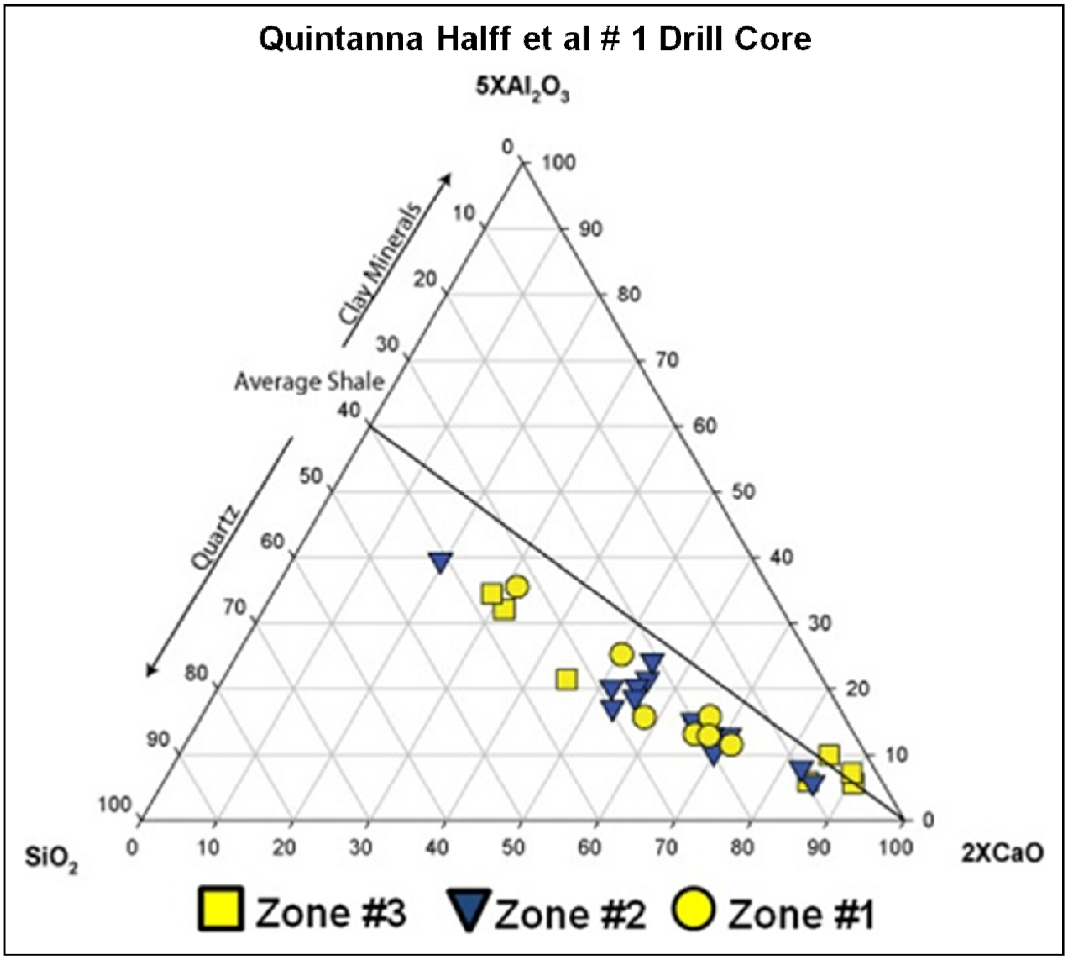


Figure 4.32 Quintanna Halff et al # 1 Drill Core: CaO VS Al_2O_3 VS SiO_2 Ternary Diagram.

The Quintanna Halff et al # 1 Drill Core contains the Eagle Ford Formation. Zone one, two and three consists of the Eagle Form Formation. Figure 4.32 demonstrates that most points plot below the line that defines average shale (Rimmer, 2003). Points from all three generally have a greater concentration of calcium oxide relative to aluminum oxide and silicon dioxide. On average the data plots closer towards silicon dioxide relative to aluminum oxide. This indicates that throughout the deposition of all three zones that greater a concentration of quartz was deposited relative to clay.

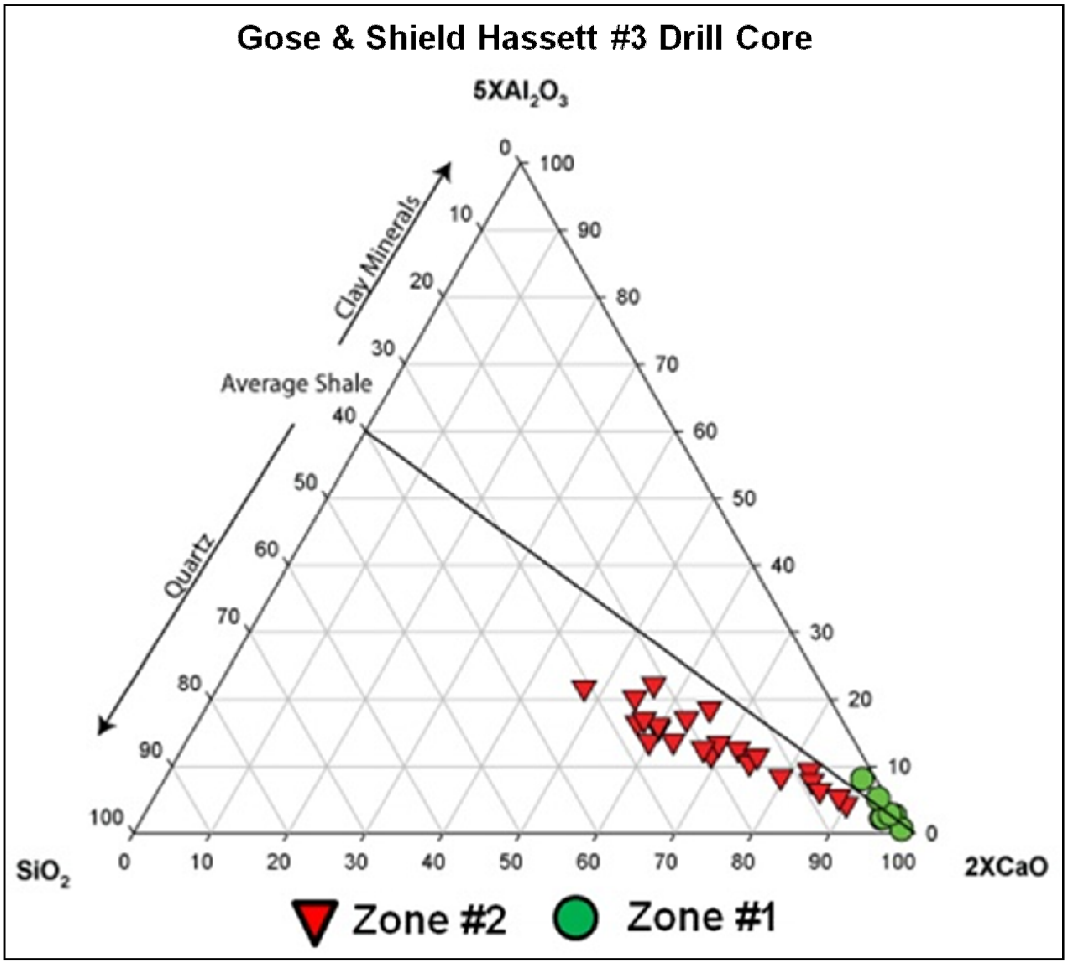


Figure 4.33 Gose & Shield Hassett #3 Drill Core: CaO VS Al_2O_3 VS SiO_2Ternary Diagram.

Gose & Shield Hassett #3 Drill Core contains the Buda and Eagle Ford Formations. Zone one consist of the Buda Formation. Zone two consists of the Eagle Ford Formation. Figure 4.33 demonstrates that most points plot below the line that defines average shale (Rimmer, 2003). Data from both zones indicates a greater concentration of calcium oxide relative to aluminum oxide and silicon dioxide. However, points from zone one tends towards greater concentration in calcium oxide than zone two. Both zones generally have a greater concentration in silicon dioxide than aluminum oxide. This indicates that carbonate deposition decreased in zone two relative to zone one. The former also indicates that a greater concentration of quartz was deposited during the deposition of zone two relative to zone one.

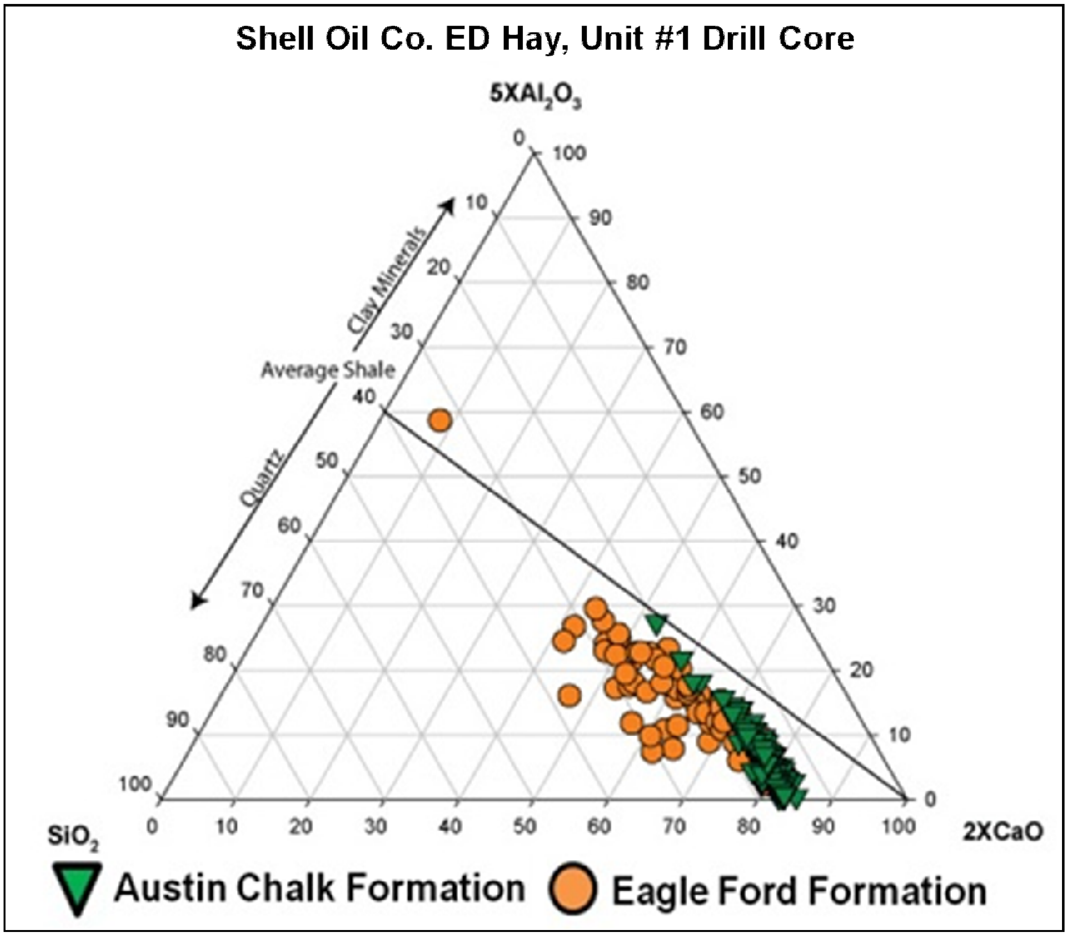


Figure 4.34 Getty Lloyd Hurt #1 Drill Core: CaO VS Al_2O_3 VS SiO_2 Ternary Diagram.

The Getty Lloyd Hurt #1 Drill Core contains the Eagle Ford Formation and Austin Chalk Formations. Zone one consist the Eagle Ford Formation and zone two consist of the Austin Chalk Formation. Figure 4.34 demonstrates that most points plot below the line that defines the average shale line (Rimmer, 2003). Data from both zones generally have a greater concentration of calcium oxide relative to aluminum oxide and silicon dioxide. However, points from zone two generally have a greater concentration of calcium oxide relative to zone one. Points from both zones tend towards greater concentration of silicon dioxide rather than aluminum oxide. The former indicates that quartz concentration decreased and carbonate concentration increased in zone two relative to zone one.

4.3.3 X-Ray Diffraction (XRD) Results

X-ray diffraction (XRD) is utilized to determine the mineralogy of a selection of samples. The mineralogy supports the accuracy of the chemostratigraphic data interpreted from the drill cores using Energy Dispersive X-Ray Fluorescence (ED-XRF) in combination with other techniques discussed in the methods section.

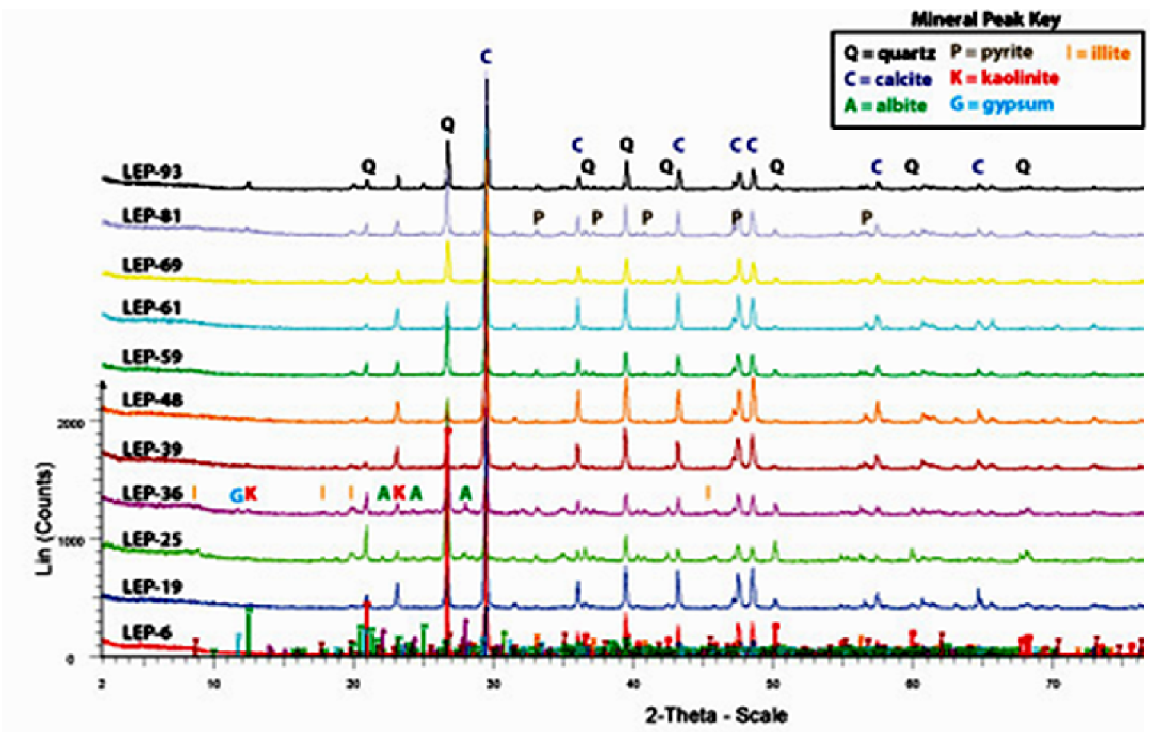


Figure 4.35 XRD Mineral Results from the Shell Oil Co. Leppard, J.A. #1 Drill Core.

XRD results indicate that the Shell Oil Co. Leppard, J.A. #1 Drill Core contains the minerals quartz, calcite, albite, pyrite, kaolinite, gypsum, and illite in select samples. Samples LEP-93, LEP-81, and LEP-69 are from zone one (Figure 4.5 and Figure 4.6). Samples LEP-61, LEP-59, LEP-48, LEP-39, LEP-36, LEP-25, LEP-19, and LEP-6 are from zone two (Figure 4.5

and Figure 4.6). The results reinforce and confirm the presence of quartz, calcite (calcium likely exist as calcium carbonate) and clay (kaolinite and illite are a clays) as calculated in Figure 4.29. The presence of pyrite also indicates that the water column was anoxic during deposition (Tribovillard, 2006; Harbor, 2011).

4.4 Depositional Environment Comparative Analyses

4.4.1 Mo VS TOC Results

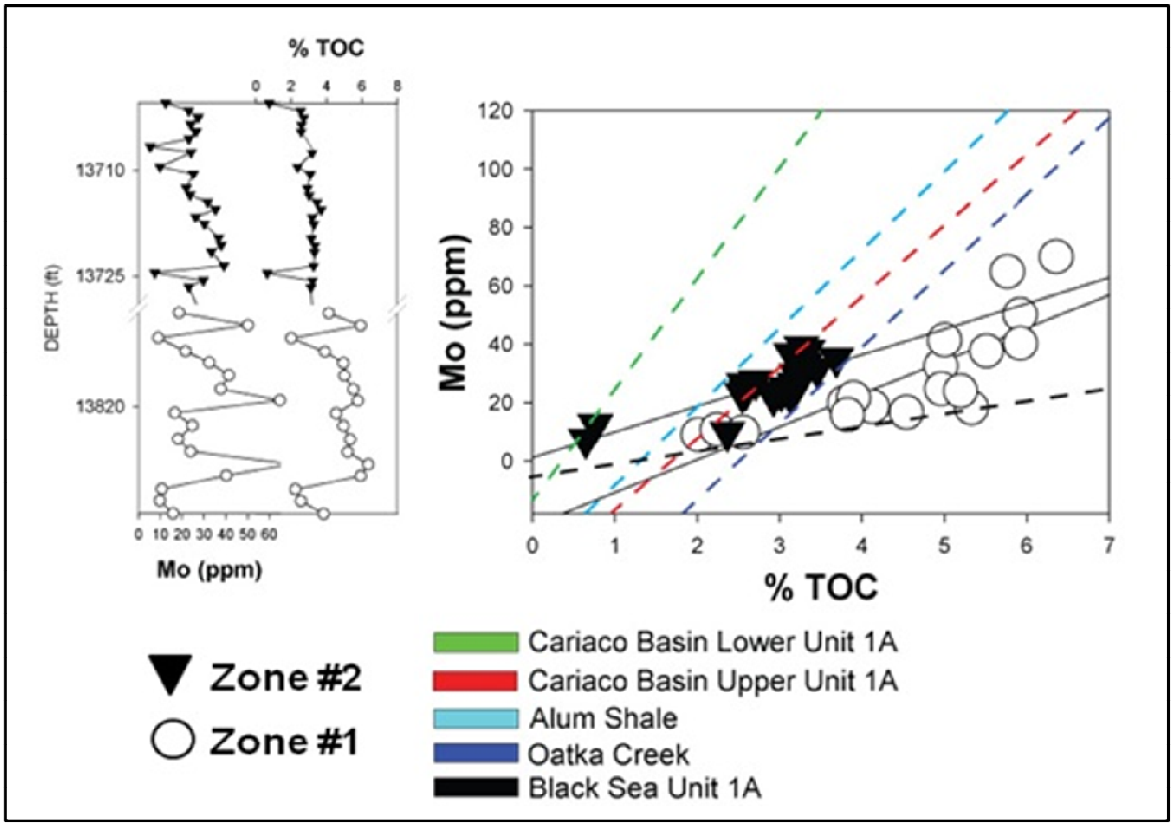


Figure 4.36 Shell Oil Co. ED Hay, Unit #1 Drill Core Mo VS TOC.

Shell Oil Co. ED Hay, Unit #1 Drill Core, Figure 4.36 compares the plots of Mo VS TOC from the Hay ED. Unit 1 Shell Oil Drill Core to the Cariaco Basin Lower Unit 1A, Cariaco Basin Upper Unit 1A, Alum Shale, Oatka Creek, and Black Sea Unit 1A as defined by Lyons et al, 2009. The plots demonstrate that most points from zone one occurs between the dashed lines that defines the Black Sea Unit 1A and Oatka Creek. It also demonstrates that most points from zone two plot between the dashed lines that define Oatka Creek and Alum Shale. The dashed line that defines Cariaco Basin Unit 1A goes through the approximate focus of the points from zone two. The results indicate that on average zone two was more restricted that of zone one.

4.4.2 Trace metal Enrichment in Organic Carbon Rich Sediments Results

Trace metal enrichment, also known as enrichment factor, of select elements is utilized to compare paleoenvironmental settings to the average enrichment factor of each zone of each core analyzed. These cores include the Geological Research Co. Schauers, FT #1 Drill Core, Shell Oil Co. ED Hay, Unit #1 Drill Core, Shell Oil Co. Leppard, J.A. #1 Drill Core, Quintanna Halff et al # 1 Drill Core, Gose & Shield Hassett #3 Drill Core and the Getty Lloyd Hurt #1 Drill Core. In the following figure and respective tables the cores are referred to as the Schauers, Hay, Leppard, Quintanna, Shield and Hurt, which are respective of the core designations in the previous sentence. The range of values, as determined by Brumsack, 2006, which defines sapropel and upwelling paleoenvironmental settings are compared to the aforementioned cores in the following figure. The ranges of values that define average C/T Black Shale, as determined by Brumsack 2006, are also included.

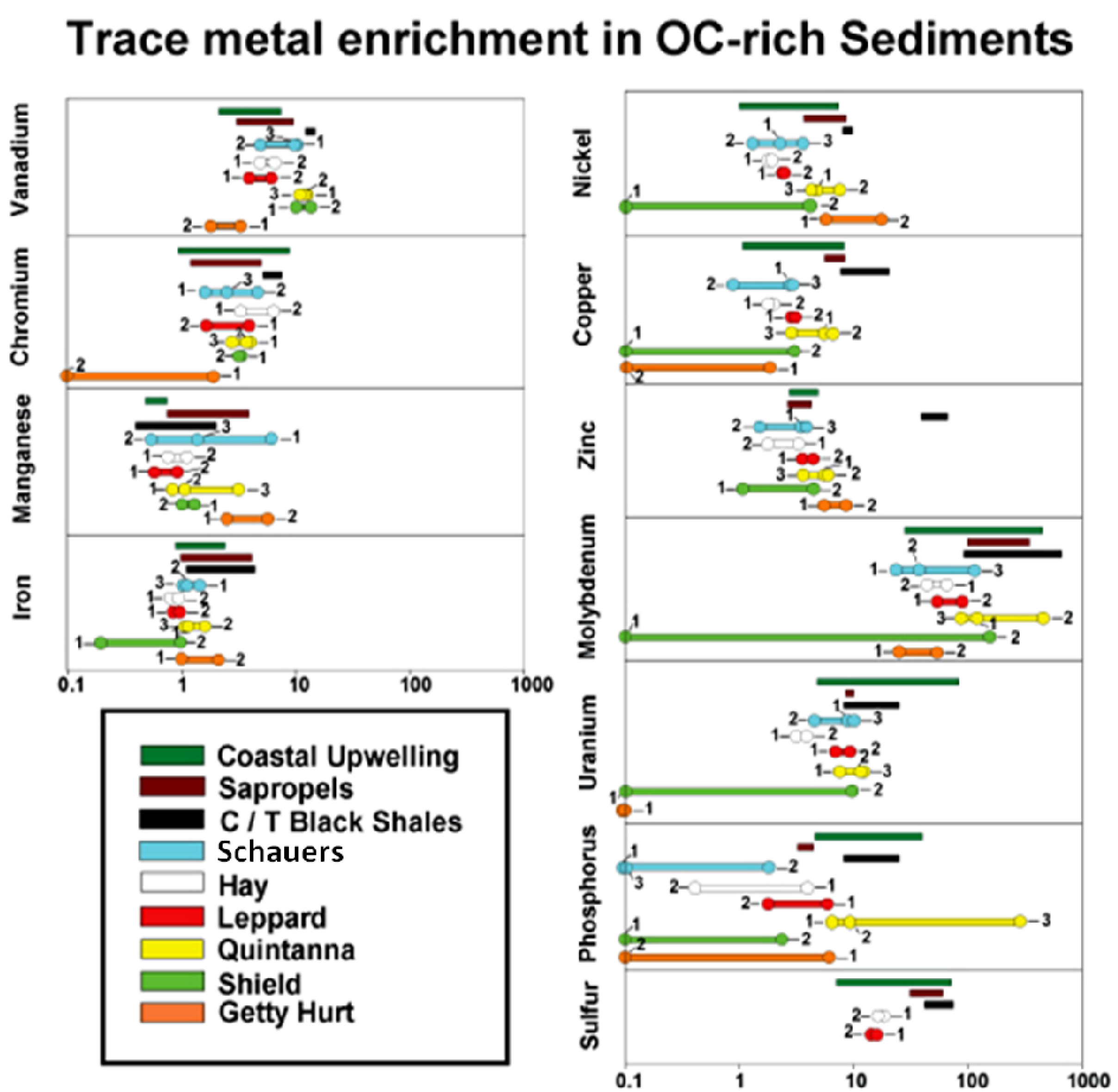


Figure 4.37 Trace Metals and Major Element Enrichment in OC-Rich Sediment (Brumsack, 2006).

Figure 4.37 demonstrates the average trace metal or major element enrichments of each zone (designated by the number: 1, 2 or 3) from the Geological Research Co. Schauers, FT #1 Drill Core, Shell Oil Co. ED Hay, Unit #1 Drill Core, Shell Oil Co. Leppard, J.A. #1 Drill Core, Quintanna Halff et al # 1 Drill Core, Gose & Shield Hassett #3 Drill Core, and the Getty Lloyd Hurt #1 Drill Core. The averages of select elements from the zones of each core are compared against the range of values in organic carbon rich (OC-Rich) sediment, as defined by Brumsack, 2006, that could indicate an upwelling or sapropel depositional environment. The ranges that define average Cenomanian-Turonian black shale are also provided for comparative purposes.

Averages of each zone that plot within both ranges of enrichments that define an upwelling or sapropel depositional environment are considered inconclusive. Averages of each zone that plot outside the ranges of enrichment that define an upwelling or sapropel depositional environment are considered to approach the environment that exhibits a range of enrichment that is most similar in value. In Tables 4.14, 4.15, 4.16, and 4.17 the averages that approach a specific depositional environment are considered under the environment they approach. The black boxes in Tables 4.14, 4.15, 4.16, and 4.17 indicate which environment each zone of each core occurred under given the associated element considered. For example, in the following table, the average enrichment of V in zone three of the Geological Research Co. Schauers, FT #1 Drill Core (designated Schauers #3) is most consistent with a sapropel type environment as determined by Brumsack, 2006. All zones relate to associated formations as indicated in Figures 4.1 – 4.12.

It should be noted that S samples were only available for comparison and analysis in the Shell Oil Co. ED Hay, Unit #1 Drill Core and the Shell Oil Co. Leppard, J.A. #1 Drill Core. Also, regardless of the formation contained in each core, all zones are compared. The results either reinforce (consistent with previous results from this study) or undermine the hypothesis that the formations consists of the Buda, Eagle Ford or Austin Chalk Formations. Providing that the zones in question have an average value that within the range those defined by Brumsack, 2006 it would reinforce the aforementioned hypothesis. If the zone in question does not have an average value within the range as those defined by Brumsack, 2006 then it would undermine the aforementioned hypothesis.

Table 4.14 Average Enrichments of Trace Elements V, Cr and Major Element Mn for Each Core Compared by Zone to Depositional Environment Types and C/T Black Shale.

	UPWELLING	SAPROPEL	INCONCLUSIVE	C/T SHALE
VANADIUM				
Schauers #3		■		
Schauers #2			■	
Schauers #1		■		
Hay #2			■	
Hay #1			■	
Leppard #2			■	
Leppard #1			■	
Quintanna #3		■		
Quintanna #2		■		■
Quintanna #1		■		■
Shield #2		■		■
Shield #1		■		
Getty Hurt #2	■			
Getty Hurt #1			■	
CHROMIUM				
Schauers #3		■		■
Schauers #2			■	
Schauers #1			■	
Hay #2	■			■
Hay #1			■	
Leppard #2			■	
Leppard #1			■	
Quintanna #3			■	
Quintanna #2			■	
Quintanna #1			■	
Shield #2			■	
Shield #1			■	
Getty Hurt #2	■			
Getty Hurt #1			■	
MANGANESE				
Schauers #3		■		■
Schauers #2	■			■
Schauers #1		■		
Hay #2		■		■
Hay #1		■		■
Leppard #2		■		■
Leppard #1	■			■
Quintanna #3		■		
Quintanna #2		■		■
Quintanna #1		■		■
Shield #2		■		■
Shield #1		■		■
Getty Hurt #2		■		
Getty Hurt #1		■		

Table 4.15 Average Enrichments of Trace Elements Fe, Ni and Cu for Each Core Compared by Zone to Depositional Environment Types and C/T Black Shale.

	UPWELLING	SAPROPEL	INCONCLUSIVE	C/T SHALE
IRON				
Schauers #3			■	
Schauers #2			■	■
Schauers #1			■	■
Hay #2			■	
Hay #1	■			
Leppard #2			■	
Leppard #1	■			
Quintanna #3			■	■
Quintanna #2			■	■
Quintanna #1			■	■
Shield #2		■		
Shield #1	■			
Getty Hurt #2			■	■
Getty Hurt #1			■	■
NICKEL				
Schauers #3			■	
Schauers #2	■			
Schauers #1	■			
Hay #2	■			
Hay #1	■			
Leppard #2	■			
Leppard #1	■			
Quintanna #3			■	
Quintanna #2		■		■
Quintanna #1			■	
Shield #2		■		
Shield #1	■			
Getty Hurt #2		■		
Getty Hurt #1			■	
COPPER				
Schauers #3	■			
Schauers #2	■			
Schauers #1	■			
Hay #2	■			
Hay #1	■			
Leppard #2	■			
Leppard #1	■			
Quintanna #3	■			
Quintanna #2			■	
Quintanna #1			■	
Shield #2	■			
Shield #1	■			
Getty Hurt #2	■			
Getty Hurt #1	■			

Table 4.16 Average Enrichments of Trace Elements Zn, Mo and U for Each Core Compared by Zone to Depositional Environment Types and C/T Black Shale.

	UPWELLING	SAPROPEL	INCONCLUSIVE	C/T SHALE
ZINC				
Schauers #3			■	
Schauers #2		■		
Schauers #1			■	
Hay #2			■	
Hay #1		■		
Leppard #2			■	
Leppard #1			■	
Quintanna #3			■	
Quintanna #2	■			
Quintanna #1	■			
Shield #2		■		
Shield #1		■		
Getty Hurt #2	■			
Getty Hurt #1	■			
MOLYBDENUM				
Schauers #3			■	■
Schauers #2	■			
Schauers #1	■			
Hay #2	■			
Hay #1	■			
Leppard #2	■			■
Leppard #1	■			
Quintanna #3	■			■
Quintanna #2	■			■
Quintanna #1			■	■
Shield #2		■		■
Shield #1	■			
Getty Hurt #2	■			
Getty Hurt #1	■			
URANIUM				
Schauers #3	■			■
Schauers #2	■			
Schauers #1			■	■
Hay #2	■			
Hay #1	■			
Leppard #2			■	■
Leppard #1	■			
Quintanna #3	■			■
Quintanna #2	■			■
Quintanna #1	■			
Shield #2			■	■
Shield #1	■			
Getty Hurt #2	■			
Getty Hurt #1	■			

Table 4.17 Average Enrichment of Trace Elements P and Available S for Each Core Compared by Zone to Depositional Environment Types and C/T Black Shale.

	UPWELLING	SAPROPEL	INCONCLUSIVE	C/T SHALE
PHOSPHORUS				
Schauers #3		■		
Schauers #2		■		
Schauers #1		■		
Hay #2		■		
Hay #1		■		
Leppard #2		■		
Leppard #1	■			
Quintanna #3	■			
Quintanna #2	■			■
Quintanna #1	■			
Shield #2		■		
Shield #1	■			
Getty Hurt #2		■		
Getty Hurt #1	■			
SULFUR				
Hay #2	■			
Hay #1	■			
Leppard #2	■			
Leppard #1	■			

The results of Tables 4.14 – 4.17 are summarized in the table below.

Table 4.18 Summation of Tables 4.14 – 4.17. A tally mark is placed under each column that indicates an Upwelling or Sapropel Depositional Environment, Inconclusive Results or Cenomanian-Turonian Black Shale. The former is respective of each zone for each drill core analyzed in this study.

	UPWELLING	SAPROPEL	INCONCLUSIVE	C/T SHALE
Schauers #3	II	IIIII	IIII	IIIII
Schauers #2	IIIII	II	III	II
Schauers #1	III	IIIII	IIII	II
Hay #2	IIIIII	III	III	II
Hay #1	IIIIII	III	II	I
Leppard # 2	IIII	II	IIIII	III
Leppard # 1	IIIIIIII		III	I
Quintanna #3	IIIII	I	IIII	III
Quintanna #2	IIIII	II	III	IIIIIII
Quintanna #1	IIII	I	IIIII	IIIII
Shield #2	II	IIIIII	II	IIII
Shield #1	IIIIIII	II	I	I
Getty Hurt #2	IIIIII	III	I	I
Getty Hurt #1	IIIII	I	IIII	I

4.4.3 Trace Metal Relative Enrichment: Relative Rate of Accumulation

The fact that certain trace metals were not significantly affected by the detrital fraction, their relative enrichments can be utilized to determine environmental conditions that persisted during deposition (Tribovillard, 2006). Hence, their relative rate of accumulation can be utilized to determine water column condition during deposition. The term relative in this section refers to the relative enrichment of U, V, Mo, Ni and Cu as their values are high or low relative to each other. For example, the following figure (Figure 4.40 (C)) Mo is enriched 114.4 and U is enriched 10.0 on average. Molybdenum has an average value an order of magnitude greater than U. Therefore Mo accumulated at a relatively greater rate during deposition than U. The former is considered on the Y-axis in the following figures. The technique of utilizing the relative rate of accumulation of V, U, Mo, Ni and Cu to determine water column conditions is modeled after (Tribovillard, 2006).

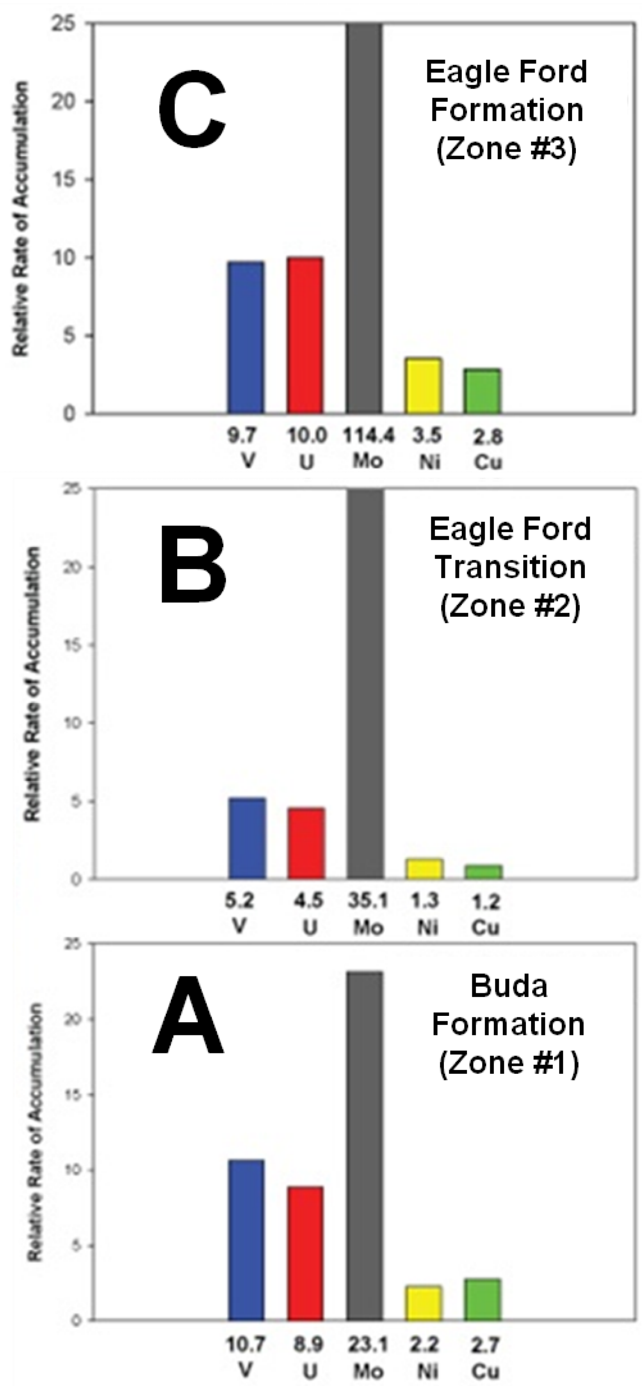


Figure 4.38 Geological Research Co. Schauers, FT #1 Drill Core Relative Rate of Accumulation of Trace Elements: V, U, Mo, Ni and Cu (A) Buda Formation (Zone #1) (B) Eagle Ford Transition Zone (Zone #2) (C) Eagle Ford Formation (Zone #3).

Figure 4.38 displays the Geological Research Co. Schauers, FT #1 Drill Core and zone one, two and three. In zone one (A), V and U exhibit a greater enrichment than Ni and Cu. However, Mo is substantially more enriched in all the zones. However, the average enrichment of U increases throughout zone two and three (B and C, respectively), compared to V. In zone three (C) U becomes more enriched than V. The average Mo enrichment increases substantially throughout each zone compared to all other elemental enrichments.

In summation the relative rate of accumulation indicates that water column conditions were anoxic during deposition. However, it is suspect that outliers with an unusual high trace metal value and correspondingly low Al value in (A) cause the indication during the deposition of the Buda Formation. Water column conditions were not anoxic during the deposition of the Buda Formation.

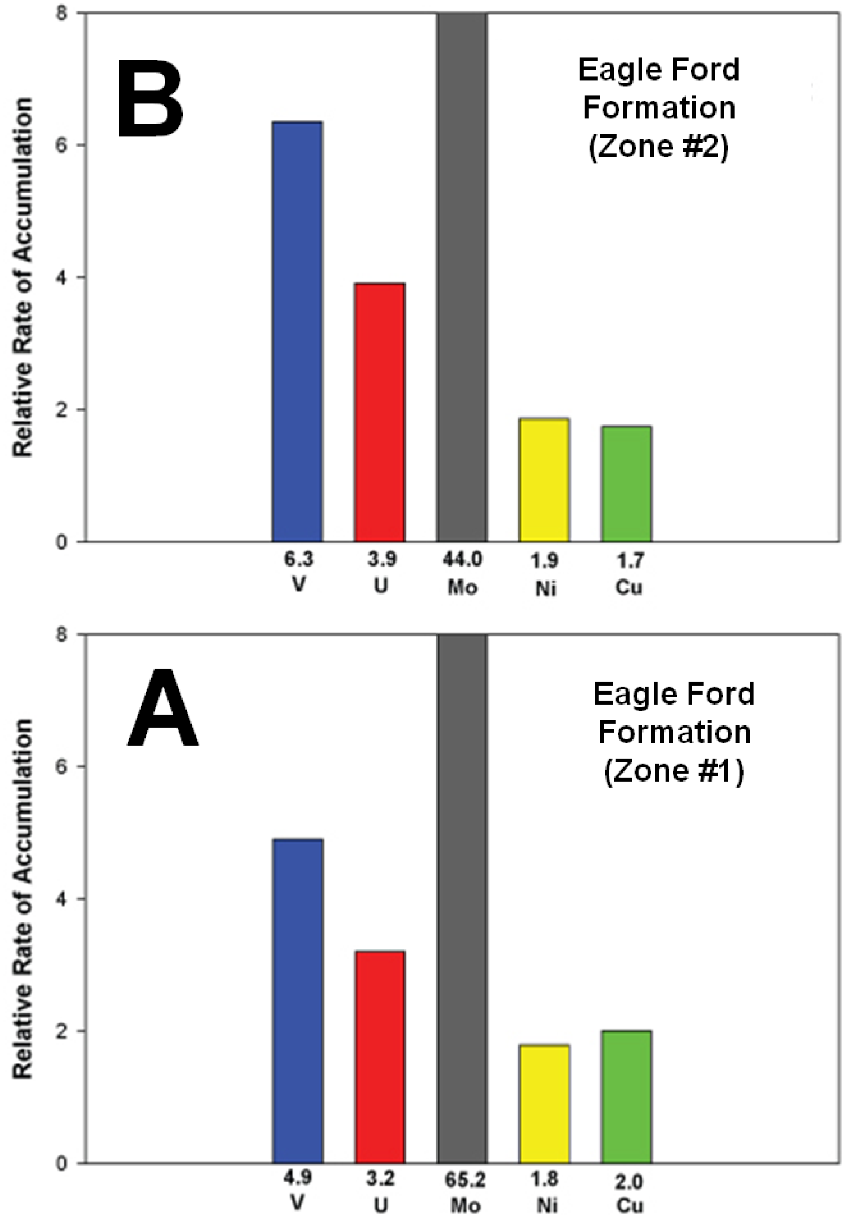


Figure 4.39 Shell Oil Co. ED Hay, Unit #1 Drill Core Relative Rate of Accumulation of Trace Elements: V, U, Mo, Ni and Cu (A) Eagle Ford Formation (Zone #1) (B) Eagle Ford Formation (Zone #2).

Figure 4.39 displays the Shell Oil Co. ED Hay, Unit #1 Drill Core. Figure 4.39 (A) indicates that zone one exhibits that on average V and U are more concurrently enriched than Ni and Cu. However, Mo is exceedingly more enriched than all other elements. This pattern of enrichment continues throughout (B) zone two. However, the average Mo decreases in zone two. The results indicate that the water column was anoxic during the deposition the Eagle Ford Formation during captured in the zone one and zone two.

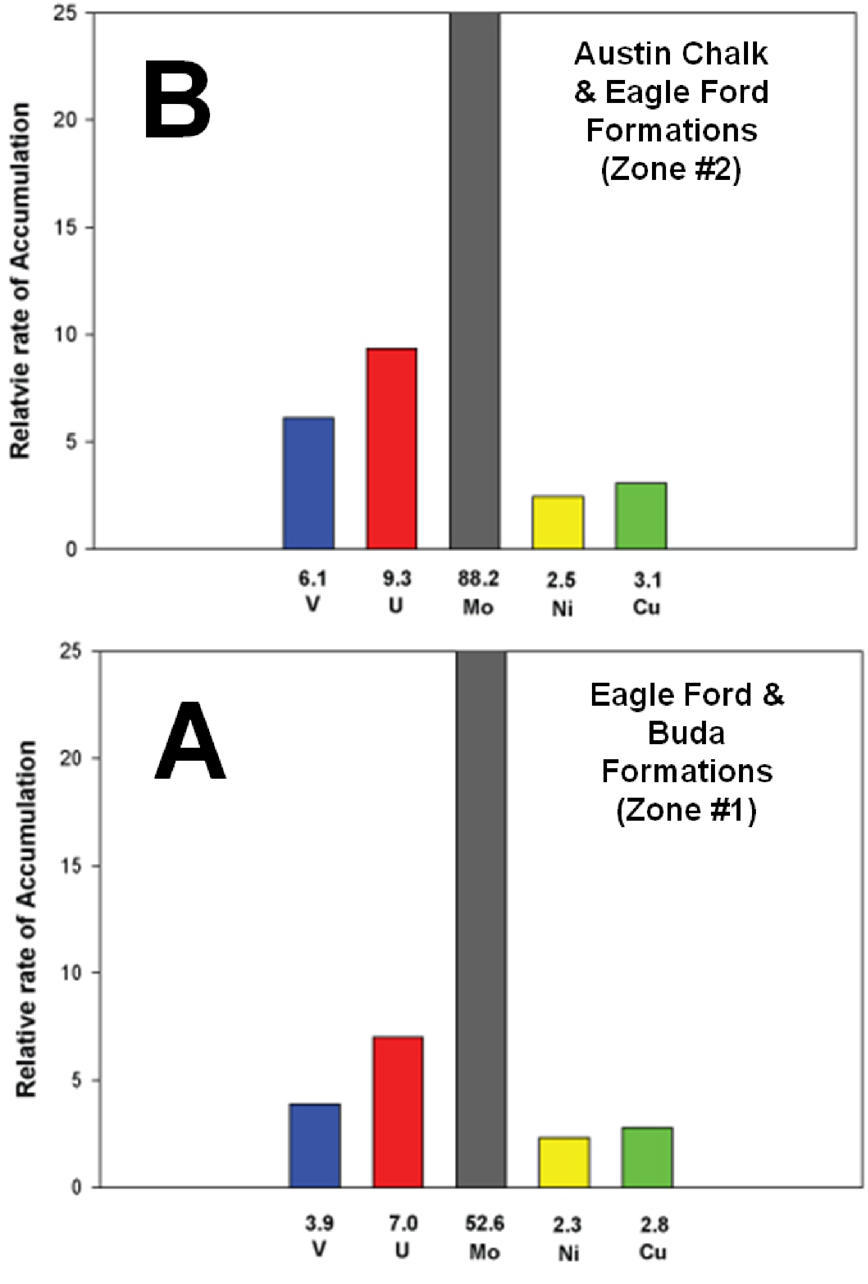


Figure 4.40 Shell Oil Co. Leppard, J.A. #1 Drill Core Relative Rate of Accumulation of Trace Elements: V, U, Mo, Ni and Cu (A) (Eagle Ford and Buda Formations (Zone #1) (B) Eagle Ford and Austin Chalk Formations (Zone #2).

Figure 4.40 displays the Shell Oil Co. Leppard, J.A. #1 Drill Core, which contains the Buda, Eagle Ford and Austin Chalk Formations. Figure 4.40 (A) Zone one exhibits that on average V and U are more concurrently enriched than Ni and Cu. However, unlike the previous two cores U is enriched more than V throughout both zones (A) and (B). However, similar to the previous two cores Mo is substantially more enriched compared to all the other elements. The results indicate that water column was predominately anoxic during deposition. The effect of some data points that include the Buda and Austin Chalk Formations is ignored for the purpose of this study. Although the Buda and Austin Chalk Formations were deposited in a oxic-suboxic water column there are not enough data points to significantly alter the averages of each zone.

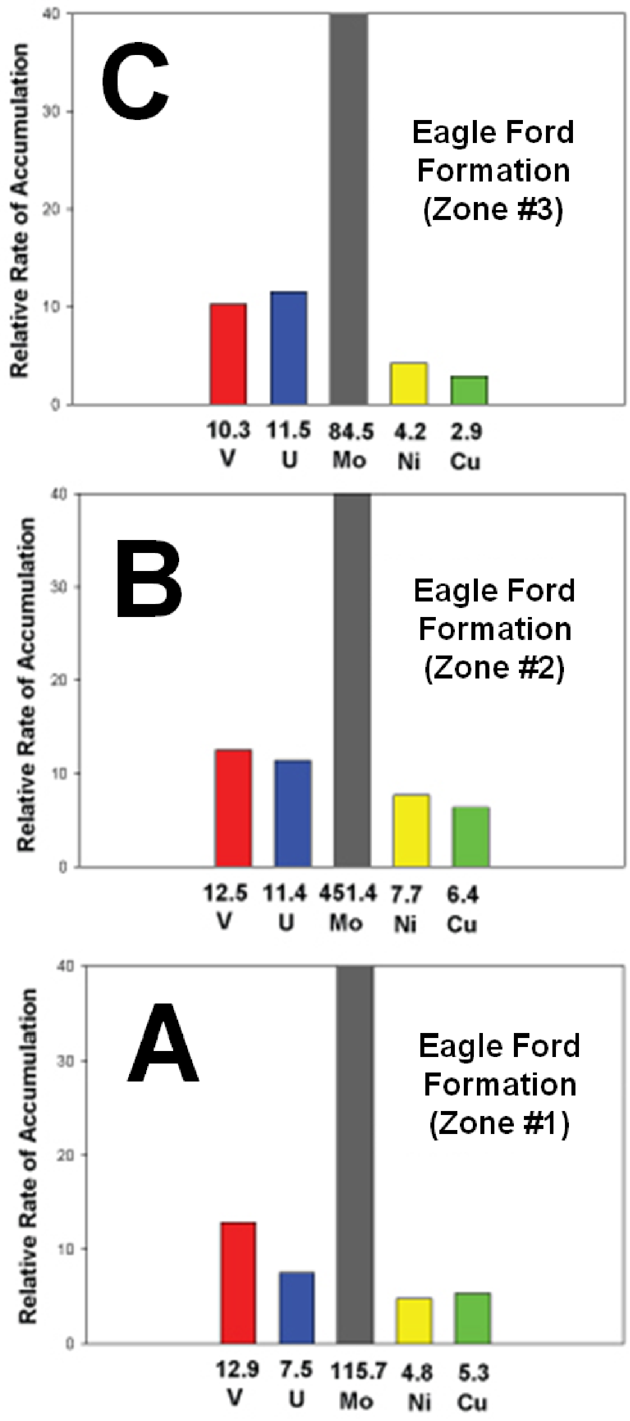


Figure 4.41 Quintanna Halff et al # 1 Drill Core Relative Rate of Accumulation of Trace Elements: V, U, Mo, Ni and Cu (A) Eagle Ford Formation (Zone #1) (B) Eagle Ford Formation (Zone #2) (C) Eagle Ford Formation (Zone #3).

Figure 4.41 displays the Quintanna Halff et al # 1 Drill Core. The figure indicates V and U are generally more enriched compared to Ni and Cu throughout each zone (A), (B) and (C). However, U is more enriched compared to V in zone three (C). Mo is an order of magnitude more enriched in both zone one (A) and zone two (B) and is nearly so in zone three (C). However, zone three (C) exhibits the greatest average enrichment in Mo in all of the study cores. The results indicate that water column conditions were anoxic during deposition of the all the zones of the Eagle Ford Formation contained in the Quintanna Halff et al # 1 Drill Core.

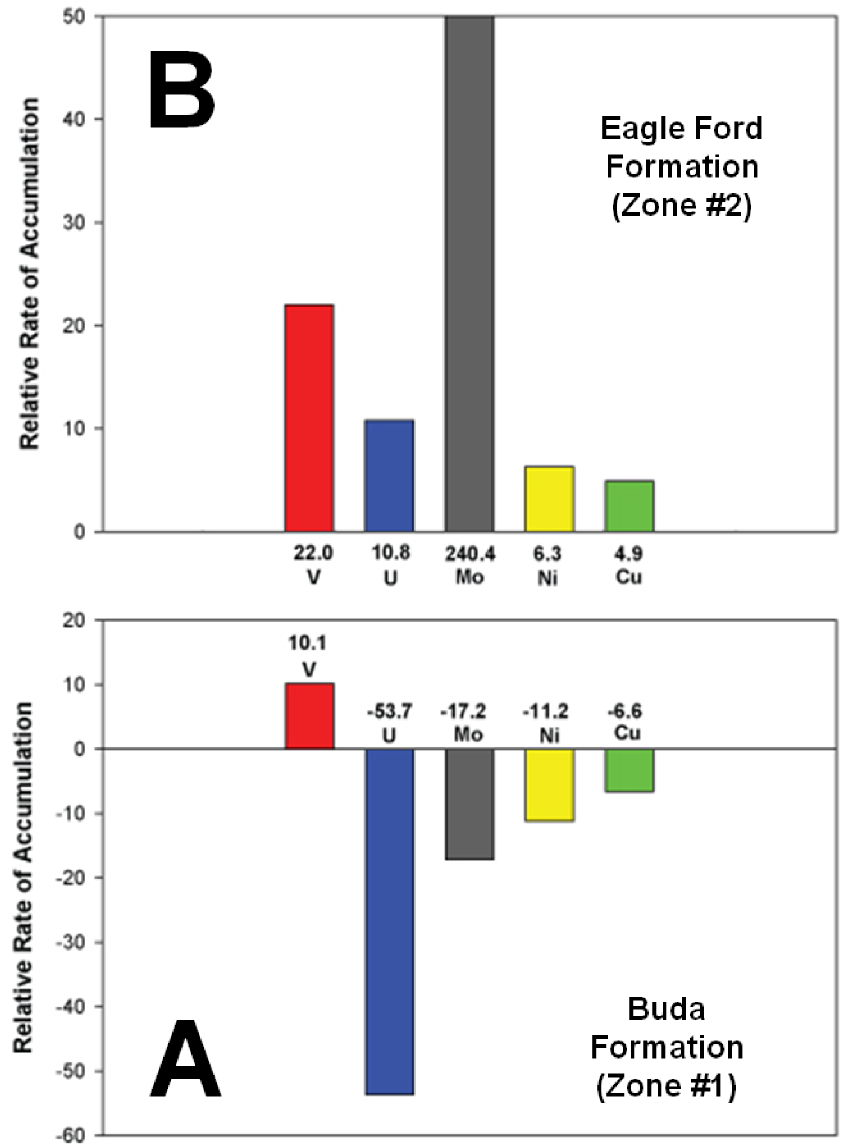


Figure 4.42 Gose & Shield Hassett #3 Drill Core Relative Rate of Accumulation of Trace Elements: V, U, Mo, Ni and Cu (A) Buda Formation (Zone #1) (B) Eagle Ford Formation (Zone #2).

Figure 4.42 displays the Gose & Shield Hassett #3 Core. In figure (A) indicates there is no correlation between the average enrichments of V, U, Mo, Ni, and Cu in zone one. However, V is particularly enriched compared to the other elements. In zone two (B) Mo is enriched by an order of magnitude compared to V, U, Ni and Cu. Vanadium, U and Mo are concurrently more enriched than Ni and Cu. The results suggest that in zone one (A) oxic to suboxic conditions dominated during the deposition of the Buda Formation. Water column conditions were anoxic during the deposition of zone two (B).

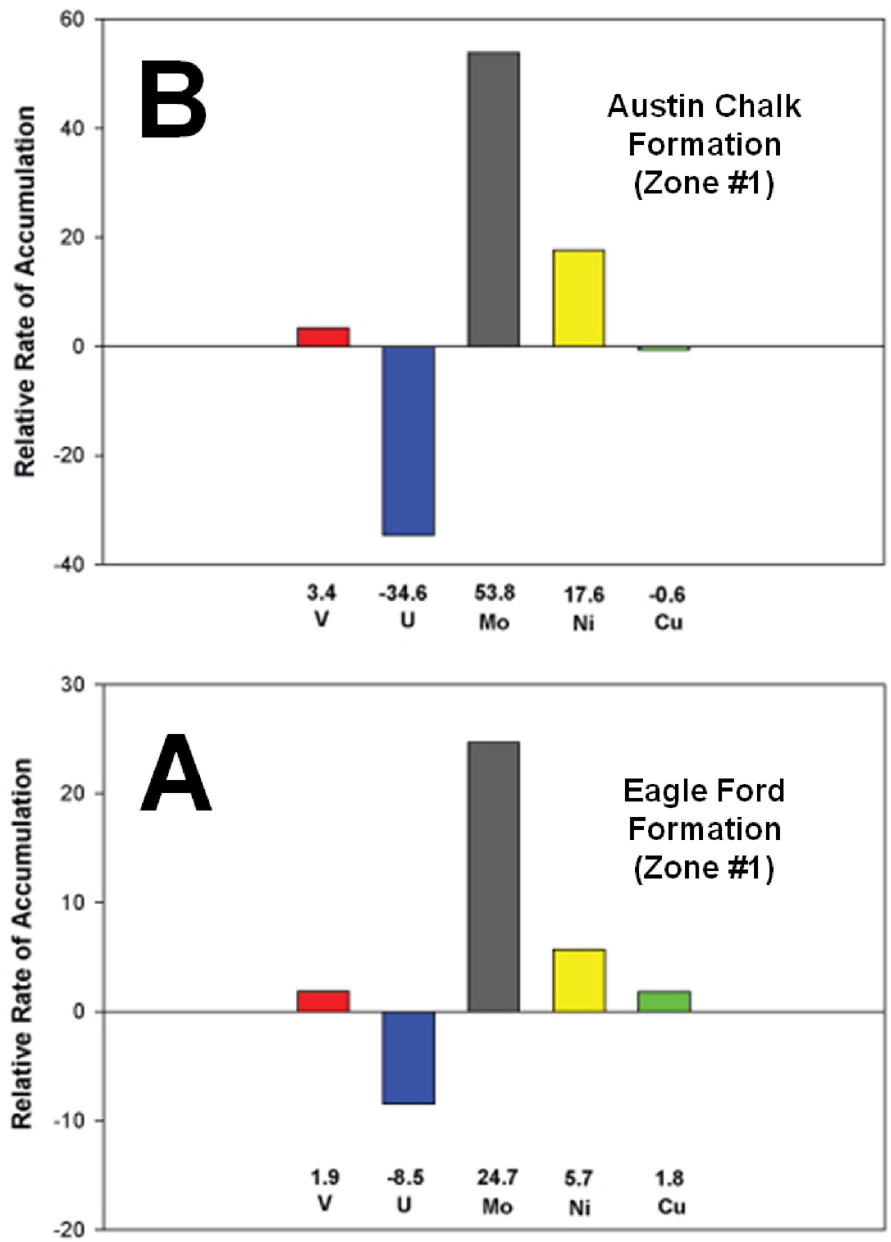


Figure 4.43 Getty Lloyd Hurt #1 Drill Core Relative Rate of Accumulation of Trace Elements: V, U, Mo, Ni and Cu (A) Eagle Ford Formation (Zone #1) (B) Austin Chalk Formation (Zone #2).

Figure 4.45 displays the Getty Lloyd Hurt #1 Drill Core. In Figure 4.43 (A) and (B) there is no correlation between the average enrichments of V, U, Mo, Ni, and Cu in any of the zones. Molybdenum exhibits a greater enrichment in both zones compared to V, U, Ni and Cu. Uranium is substantially less enriched in both zones compared to the other elemental enrichments.

This indicates that in (A) conditions were oxic-suboxic during the deposition of the Eagle Ford Formation. However, other studies indicate that the Eagle Ford Formation was deposited under anoxic conditions Schlanger and Jenkyns, 1976; De Graciansky et al, 1986; Farrimond et al, 1990; Jenkyns, 2010). It is possible that a weakness in calibration utilized for determining weight percent of the elements of interest in responsible for the indication. In (B) the lack of correlation between elements indicates the conditions were oxic-suboxic during the deposition of the Austin Chalk Formation.

4.5. Shell Oil Co. ED Hay, Unit #1 Drill Core Sub-Zonal Analysis

In an attempt to further constrain the environmental conditions that led to the deposition of the Eagle Ford Formation, the two primary zones (Zone #1 and Zone #2) of Shell Oil Co. ED Hay, Unit #1 Drill Core are divided into subzones (A,B,C,D,E,F,G,H, I and J) for further analyses.

4.5.1 Sub-Zones: Mn Peaks

Subzones of zone one and zone two are subdivided in to subzones (A, B and C) and (D, E, F, G, H, I and J), respectively. The subzones are primary defined by the presence or absence of Mn peaks.

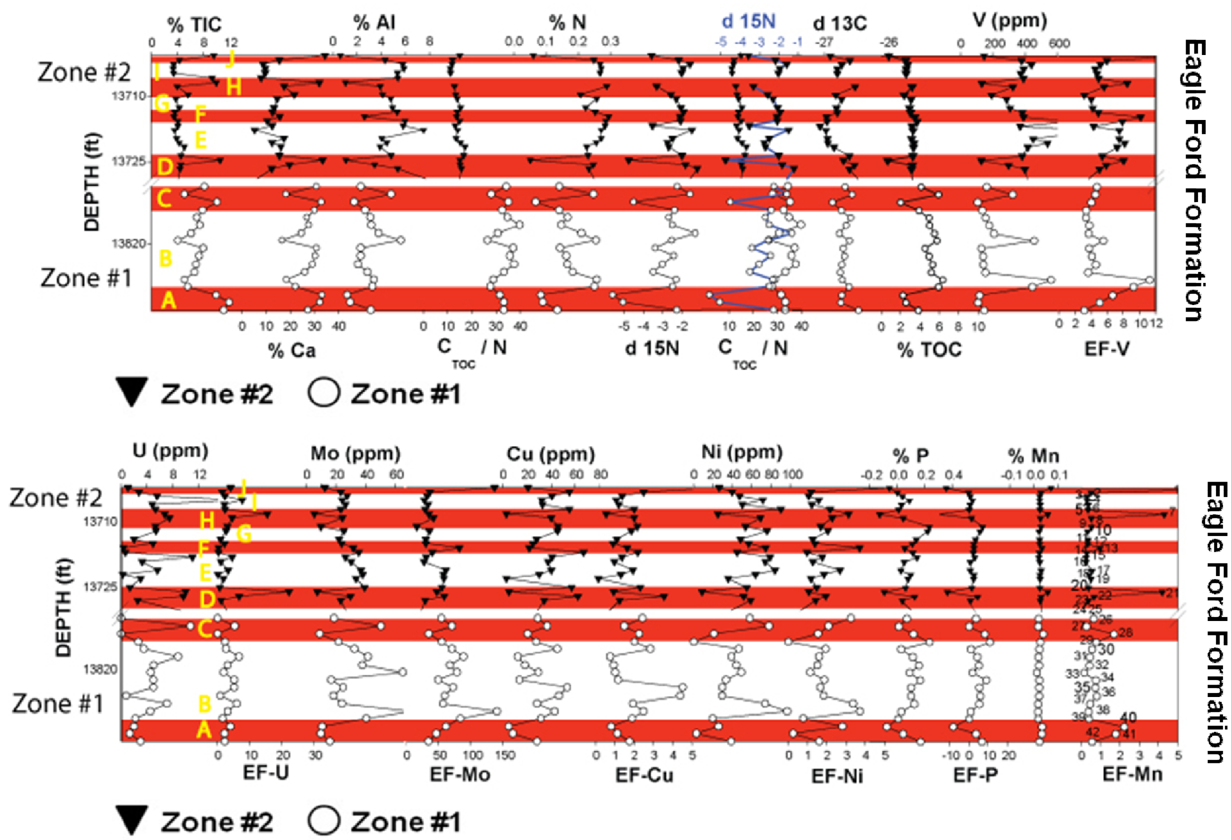


Figure 4.44 Shell Oil Co. ED Hay, Unit #1 Drill Core Major and Trace Concentrations, Respective Enrichments and Isotopic Values.

4.5.2 Subzone Trace Element Enrichment and Mineralogy

In order to better understand the water column conditions, at the time of deposition, the averages of key trace elements for each of the subzones are compared. The former is considered on the Y-axis in the following figures. The key trace elements are V, U, Mo, Ni and Cu and their relative rates of enrichments are utilized determine water column conditions. When the enrichments of V, U and Mo are more enriched relative to Ni and Cu it indicates that anoxia was prevalent in the water column. The mineralogy is also analyzed. The primary purpose the latter is to determine carbonate concentration during deposition.

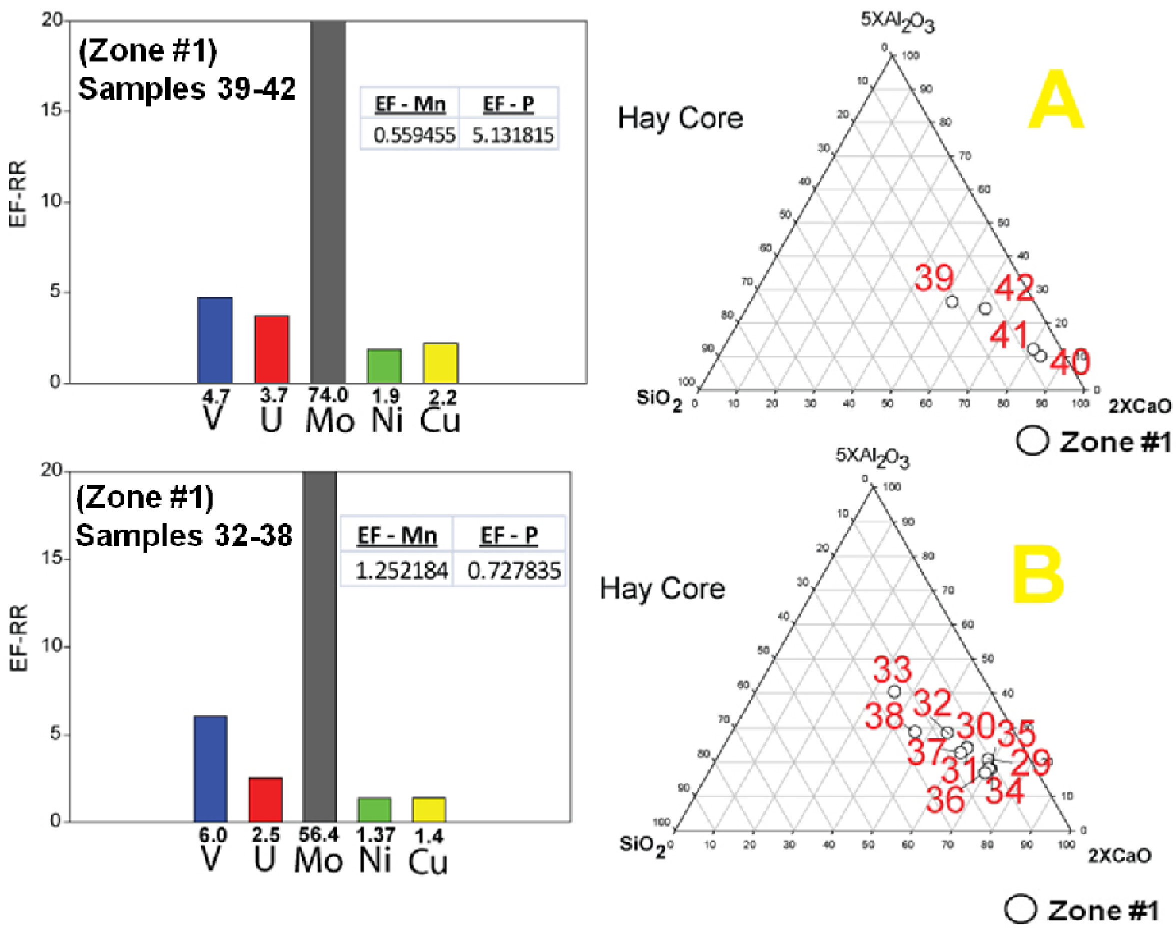


Figure 4.45 Shell Oil Co. ED Hay, Unit #1 Drill Core Zone #1 (Sub-Zone A and B) Rate of Accumulation and Mineralogy.

Both sub-zones A and B demonstrate high concurrent enrichment of V, U, and Mo relative to Ni and Cu. However, in subzone B, U enrichment decreases noticeably compared to zone A. Uranium was likely lost to post depositional reoxygenation. Both zones demonstrate high carbonate concentration.

The results indicate that both zones were dominantly anoxic during deposition. This is indicated by the concurrent enrichment of V, U and Mo relative to Ni and Cu (Tribovillard, 2006). The decrease in the enrichment of P and increase in the enrichment of Mn from subzone A to subzone B indicates that upwelling conditions dominated during the deposition of subzone A and sapropel conditions dominated during the deposition of subzone B (Brumsack, 2006).

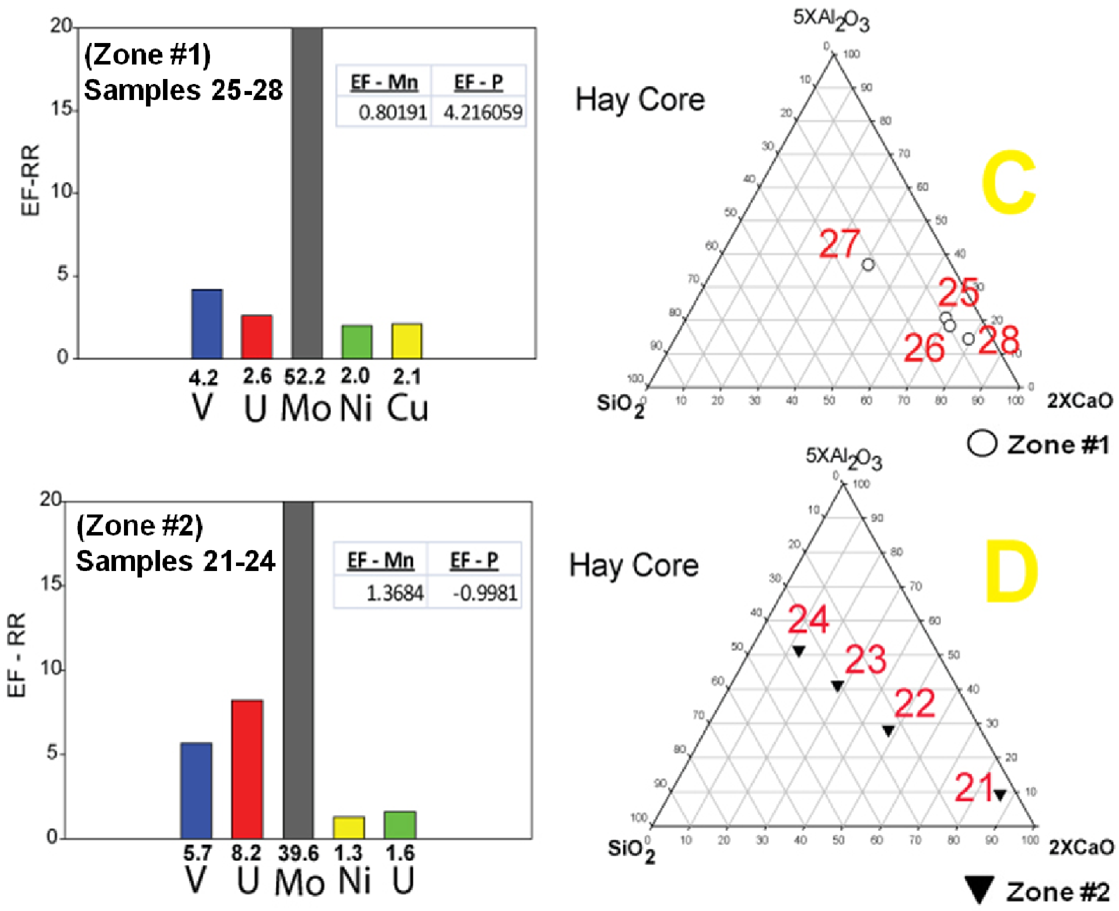


Figure 4.46 Shell Oil Co. ED Hay, Unit #1 Drill Core Zone #1 (Sub Zone C) and Zone #2 (Sub Zone) D Rate of Accumulation and Mineralogy.

Both subzones C and D demonstrate high concurrent enrichment of V, U, and Mo relative to Ni and Cu. In subzone D, U enrichment increases significantly in subzone D relative to subzone C. Subzone C demonstrates high carbonate concentration, but subzone D demonstrates variable carbonate enrichment.

The results indicate that both zones were dominantly anoxic during deposition. This is indicated by the concurrent enrichment of V, U and Mo relative to Ni and Cu (Tribovillard, 2006). The decrease in the enrichment of P and increase in the enrichment of Mn from subzone C to subzone D indicates that upwelling conditions dominated during the deposition of subzone C and sapropel conditions dominated during the deposition of subzone D (Brumsack, 2006).

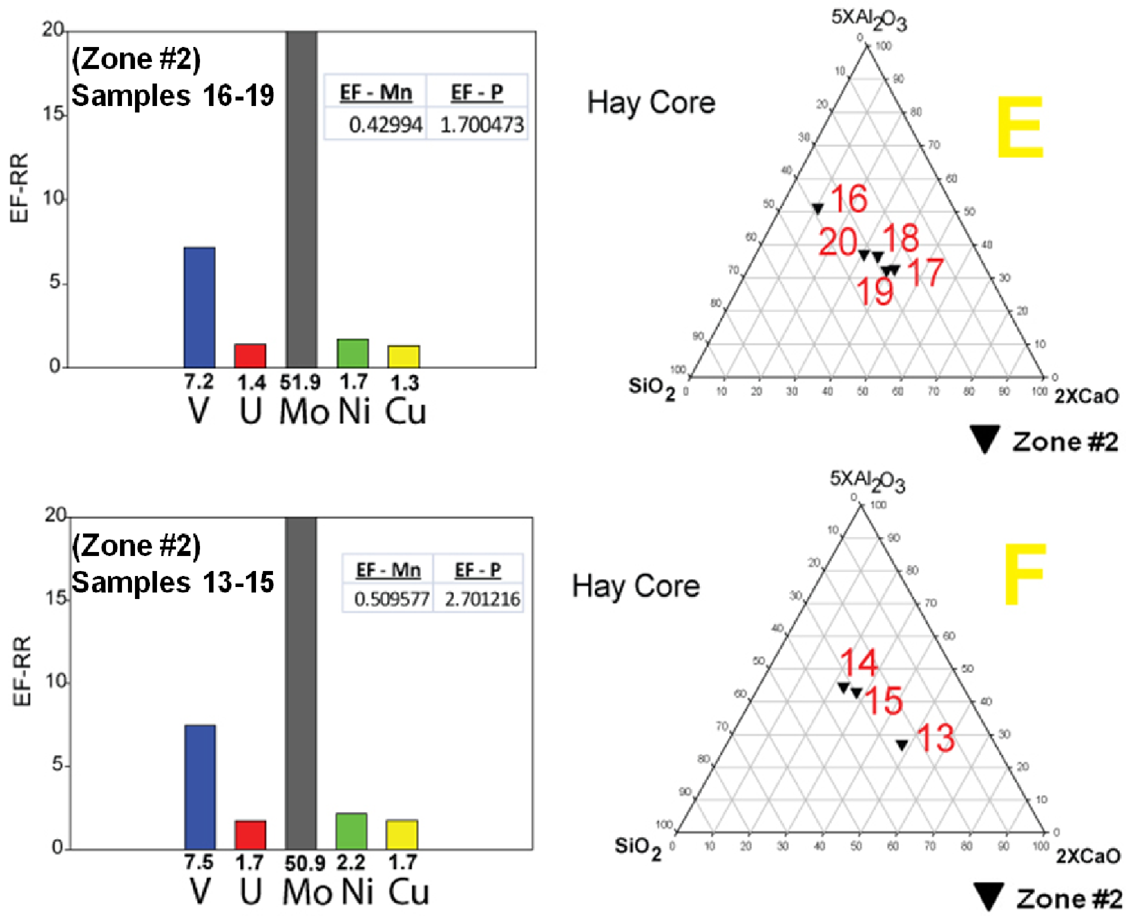


Figure 4.47 Shell Oil Co. ED Hay, Unit #1 Drill Core Zone #2 (Sub Zone E and F) Rate of Accumulation and Mineralogy.

Subzones E and F both demonstrate a concurrent enrichment of V and Mo relative to Ni and Cu. Uranium is comparably enriched relative to Ni and Cu. The mineral concentration demonstrates that carbonate, aluminum oxide and silicon dioxide occur in approximately equal proportions.

The results indicate that both zones were dominantly anoxic during deposition. This is indicated by the concurrent enrichment of V, U and Mo relative to Ni and Cu (Tribovillard, 2006).

It is possible that U was lost due to post depositional reoxygenation. The enrichment of P and depletion of Mn in subzones E and F indicates that upwelling conditions dominated during the deposition of both zones (Brumsack, 2006).

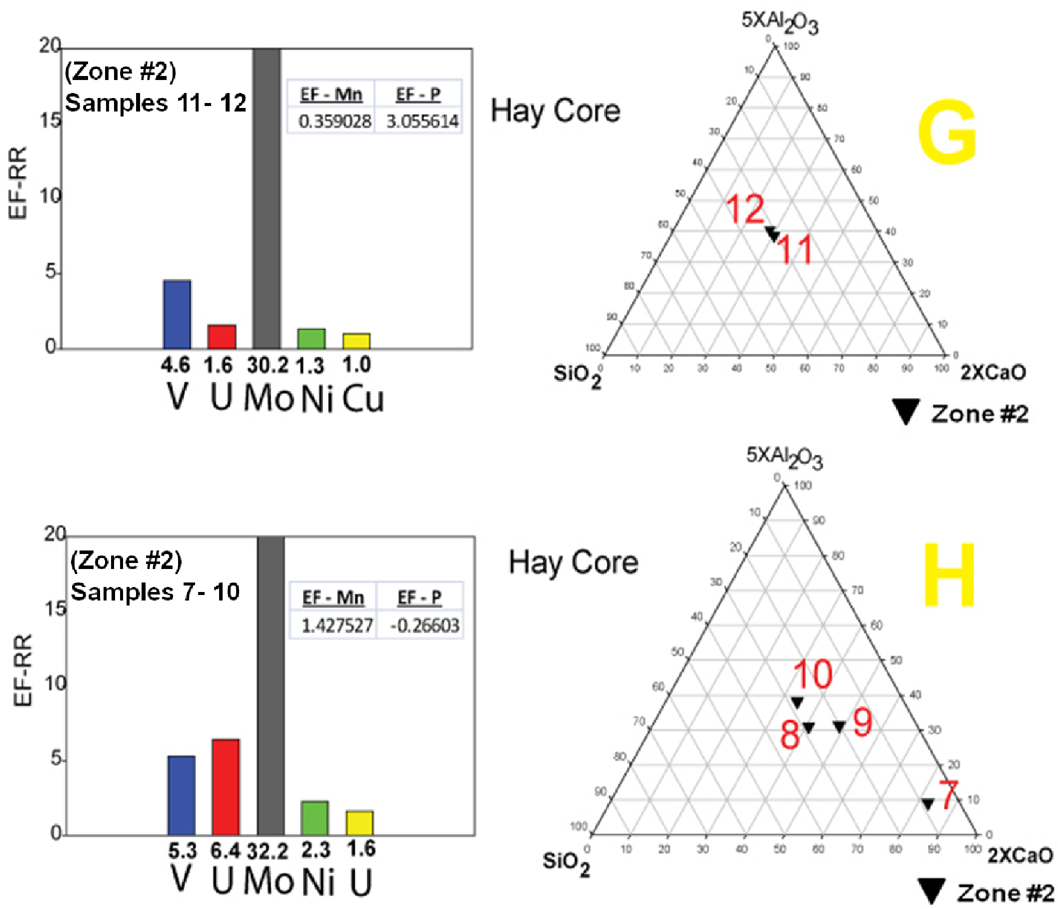


Figure 4.48 Shell Oil Co. ED Hay, Unit #1 Drill Core Zone #2 (Sub Zone G and H) Rate of Accumulation and Mineralogy.

Subzone G demonstrates a concurrent enrichment of V and Mo relative to Ni and Cu. Uranium is enriched relative to Ni and Cu. Subzone H demonstrates concurrent enrichment of V, U and Mo compared to Ni and U. The mineral concentration demonstrates that carbonate, aluminum oxide and silicon dioxide occur in approximately equal proportions in both subzones

G and H. However, H does exhibit an increase in carbonate concentration compared to the other subzones.

The results indicate that both zones were dominantly anoxic during deposition due to the aforementioned concurrent enrichment of V, U and Mo compared to Ni and U (Tribovillard, 2006). It is possible that U was lost due to post depositional reoxygenation. Upwelling type conditions dominated during the deposition of subzone G. This is indicated by the enrichment of P (Brumsack, 2006). Upwelling type conditions decreases during the deposition of subzone H and sapropel type conditions dominate (Brumsack, 2006). .

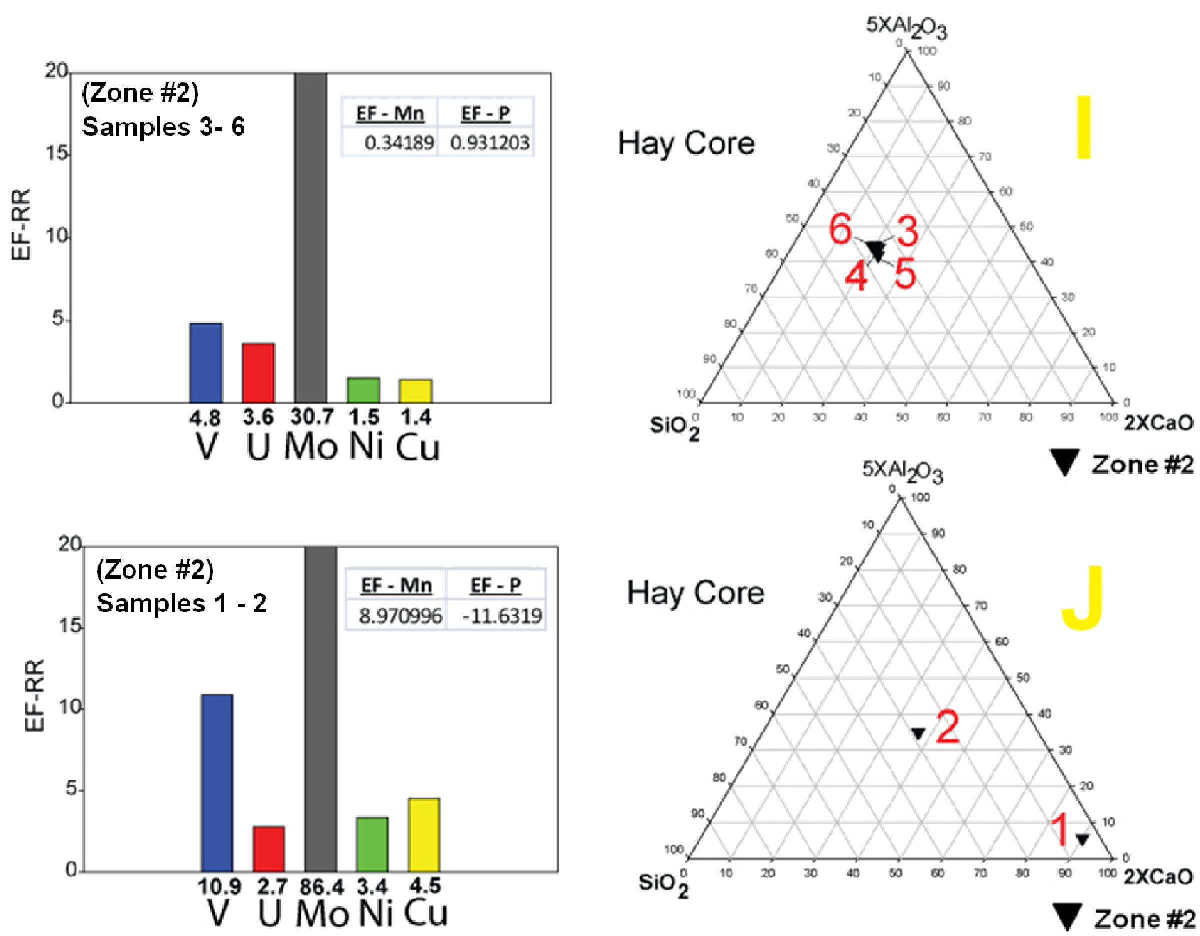


Figure 4.49 Shell Oil Co. ED Hay, Unit #1 Drill Core Zone #2 (Sub Zone I and J) Rate of Accumulation and Mineralogy.

Subzone I demonstrates a concurrent enrichment of V, U and Mo relative to Ni and Cu. However, in subzone J there is concurrent enrichment of V and Mo compared to U, Ni, and Cu. Uranium is comparably enriched to Ni and U. The ternary diagram of Subzone I demonstrates that carbonate concentration is relatively low. In subzone J, data point two exhibits approximately equal concentrations of carbonate, aluminum oxide and silicon dioxide. However, data point one exhibits a high carbonate concentration.

The results indicate that both zones were dominantly anoxic during deposition due to the aforementioned concurrent enrichment of V, U and Mo compared to Ni and U (Tribovillard, 2006). It is possible that U was lost due to post depositional reoxygenation. The influence of upwelling decreased from subzone I to subzone J and sapropel type conditions dominated during the deposition of subzone J. This is indicated by the decrease of P and increase in the enrichment of Mn (Brumsack, 2006).

4.6 Regional Correlation

The following contains the regional correlation of the cores from this study. The correlation includes the Austin Chalk, Eagle Ford (Cenomanian-Turonian Boundary) and Buda Formations, where present. The gamma ray signature utilized to mark the approximate Cenomanian-Turonian Boundary is derived from Mancini and Puckett, 2005 and Donovan and Staerker, 2010 and it is utilized for correlation purposes in industry. A large peak followed by a large trough in the gamma ray signature that defines the Cenomanian-Turonian Boundary. This peak is recognizable, as it occurs after the deposition of the Austin Chalk Formation. Determining the gamma ray signature that defines the Cenomanian-Turonian Boundary is subjective, hence errors can occur. Harbor, 2011, identifies different depths as the Cenomanian-Turonian Boundary. The gamma ray presented in the correlation is the calculated total gamma ray. It is calculated utilizing the formula: (K % X 16)+(U ppm X 8)+(Th ppm X 4) (Doveton and Merrian, 2003).

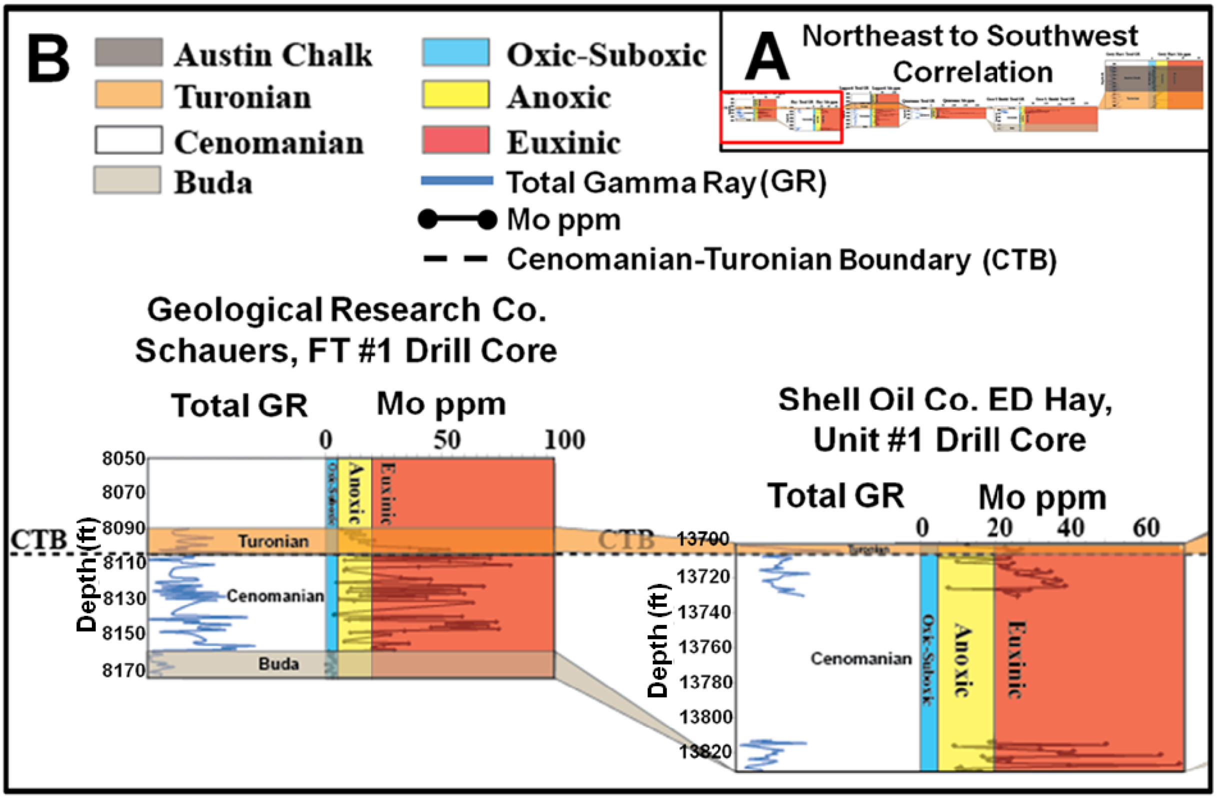


Figure 4.50 Study Area Correlation Part 1 (A) Locations of the Cores in B relative to all the cores in the study area (B) Correlation of the Geological Research Co. Schauers, FT #1 Drill Core to the Shell Oil Co. ED Hay Unit #1 Drill Core.

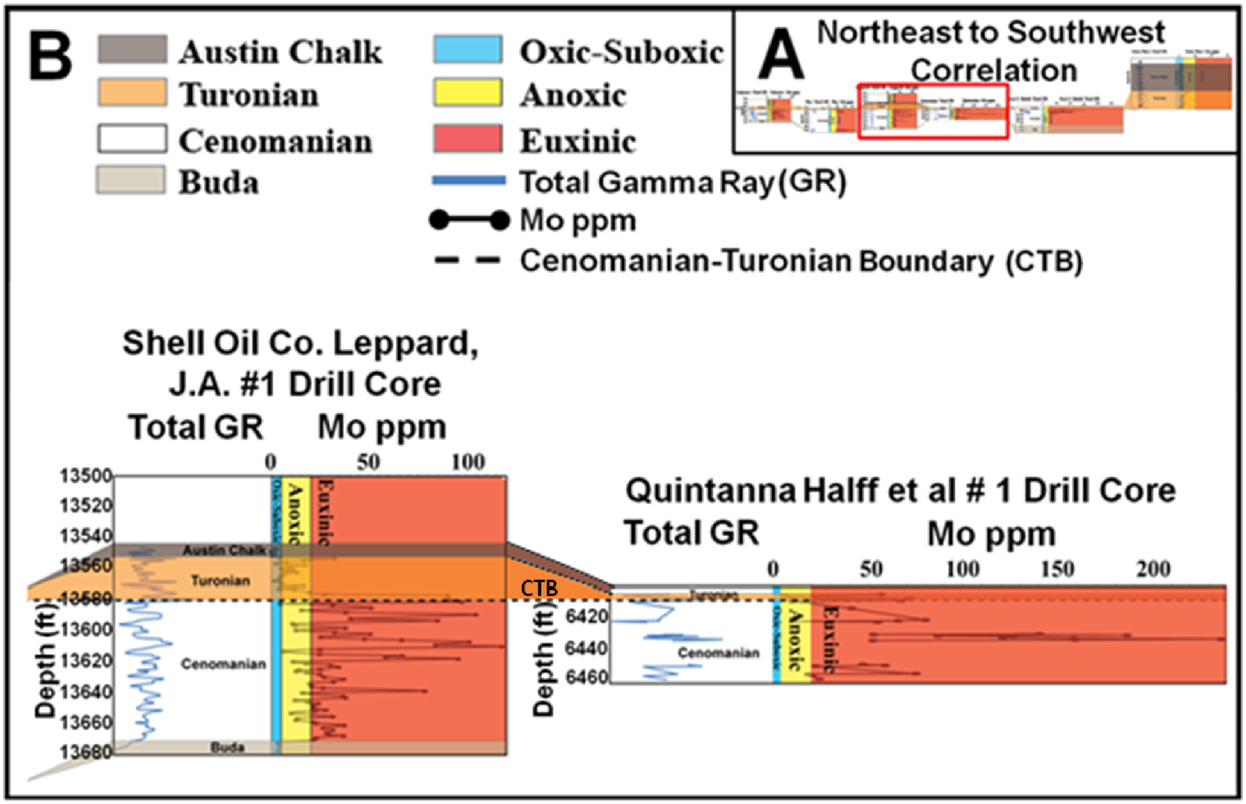


Figure 4.51 Study Area Correlation Part 2 (A) Locations of the Cores in B relative to all the cores in the study area (B) Correlation from the Shell Oil Co. Leppard J.A. #1 Drill Core to the Quintanna Halff et al #1 Drill Core.

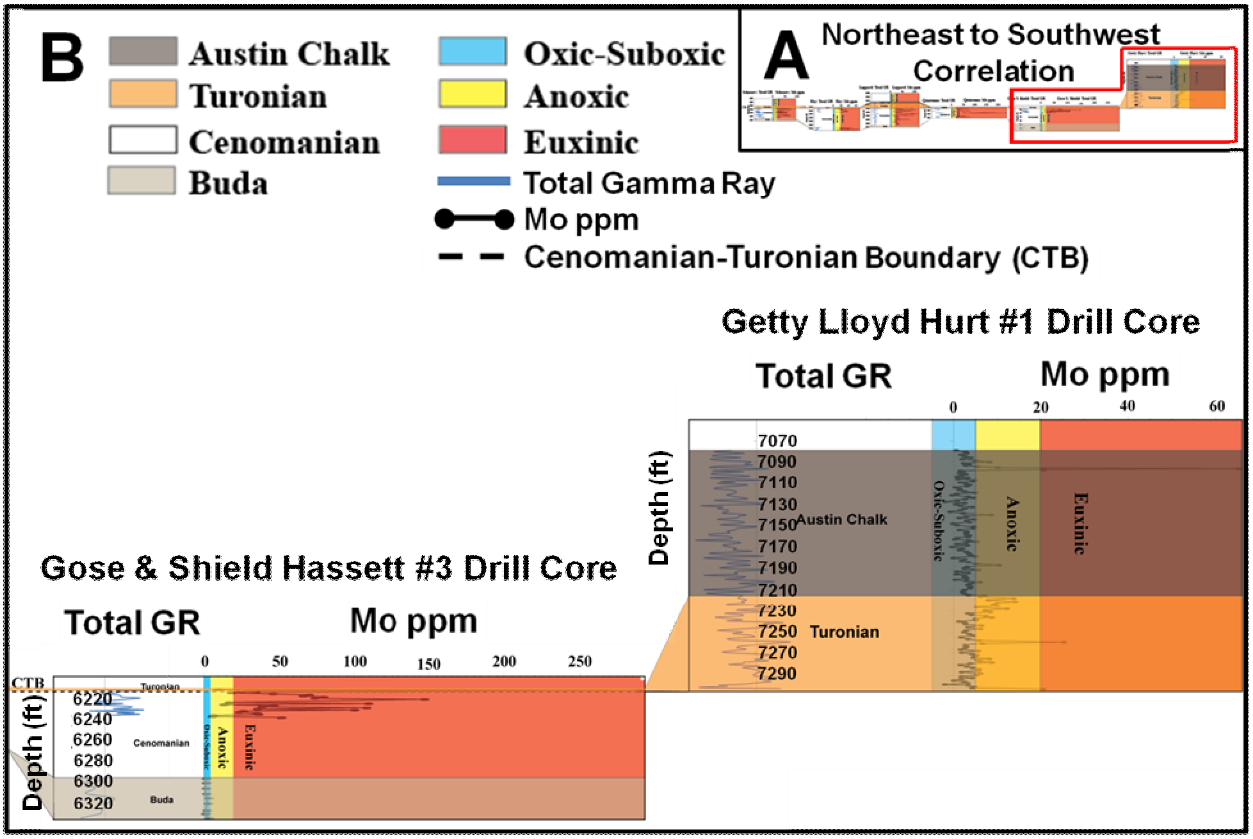


Figure 4.52 Study Area Correlation Part 3 (A) Locations of the Cores in B relative to all the cores in the study area (B) Correlation from the Gose & Shield Hassett #3 Drill Core to the Getty Lloyd Hurt #1 Drill Core.

CHAPTER 5

DISCUSSION

5.1 Introduction

The Eagle Ford Formation was deposited approximately 93 million years ago during a period of enhanced volcanism, which resulted in an abrupt rise in temperature due to an influx of CO_2 into the atmosphere (Jenkyns, 2010). The rise in temperature in addition to tectonic plate movements likely contributed to sluggish ocean circulation (Brumsack, 2006). In restricted basins, such as the Western Interior Seaway, (Sageman and Arthur, 1994) an increased carbon sinking flux likely contributed to the depletion of oxygen in the water column.

In the shallow intercontinental seaway, the demand for oxygen in a low oxygen water column exceeded the supply (Jenkyns, 2010). In combination with enhanced productivity and anoxic conditions, CO_2 was sequestered and preserved as organic- rich mudrock (C/T Black Shale). Once the excess CO_2 was converted into organic-rich mud rock (through primary production, carbon sinking flux and subsequent diagenesis) the ocean atmosphere system returned to "normal" (Brumsack, 2006). The basic model for this process is as follows:

Enhanced Volcanism → Increased CO_2 influx → Global Warming → Concurrent Sluggish Ocean Circulation and Enhanced Productivity → Ocean Anoxia → C/T Organic-Rich Mud Rock Deposition → CO_2 Sequestration → Temperature Decrease.

The study area encompasses a region where deposition occurred on a proximal extended shelfal marine slope prone to the coastal effects of Ekman transport (Brumsack, 2006) and associated upwelling. This is of key importance, as the results from the previous section (See Ternary Diagrams) suggest that the study area was dominated by biogenic carbonate deposition. This reinforces and confirms the results from numerous other studies. In addition to possible water column renewal, nutrient influx, and increased primary productivity (not necessarily accompanied by preservation), the solubility of carbonate increases with a reduction in temperature. The effect on carbonate preservation and associated productivity is discussed below.

The above model does not compensate for *all* local variables that may influence deposition. Such influences, considered in the sections below, include depositional environments absent an oxygen minimum zone (OMZ) above the sediment-water interface, a sporadically euxinic OMZ, or the varying influences of the detrital fraction.

Furthermore it is assumed that upwelling was an influence throughout the duration of deposition, but the extent of the influence likely varied over time. This can result in depositional environments that are typical of an idealized upwelling type environment or idealized anoxic basin type depositional environment (Brumsack, 2006). However, when the cores from this study are analyzed from zone to zone (see results), they rarely meet the criterion of being deposited in an ideal anoxic basin or an upwelling type depositional environment. Depositional environments can exhibit characteristics one or the other as a function of upwelling strength. A depositional environment with weak upwelling can be more similar to an anoxic basin and a strong upwelling depositional environment can be more similar to the ideal upwelling depositional type environment as defined by Brumsack, 2006.

In the following sections, the results from the previous section (4.2 – 4.6) of this study are considered and interpreted for each zone and subzones, if present, for each core. These analyses imply that deposition occurred within the framework of an overarching model (Brumsack, 2006; Jenkyns 2010) that accounts for the major conditions that led to deposition.

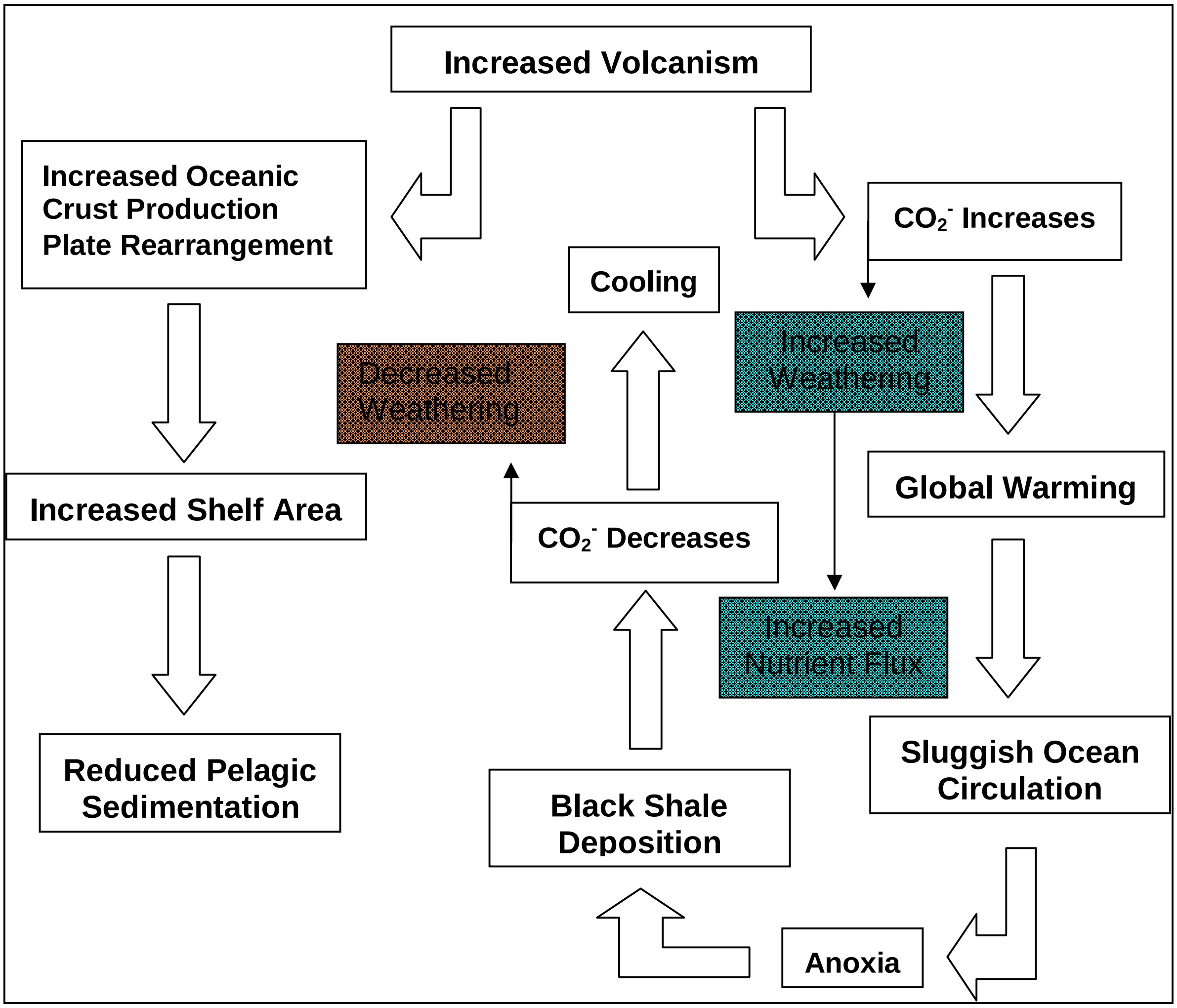


Fig 5.1 Simple Model of Environmental Influences on the Deposition of Black Shale (Brumsack, 2006; Jenkyns 2010).

Figure 5.1 displays the environmental influences on the deposition of black shale as indicated by Brumsack, 2006, and Jenkyns, 2010. The figure indicates that volcanism was the driver of ocean anoxia because of an increase in CO_2^- and other greenhouse gases that lead to global warming sluggish ocean circulation and ocean anoxia (Brumsack, 2006; Jenkyns 2010).

The ocean became anoxic because the demand for oxygen exceeded supply. This occurred because global warming resulted in increased weathering and associated leeching that provided primary productivity with the means to increase to the extent that the demand for oxygen exceeded the supply (Brumsack, 2006; Jenkyns 2010). Primary productivity was then more preserved, in general as carbon, when anoxic conditions were in place, as black shale. Primary productivity is better preserved in an anoxic environment because microbes that break down long-chained organic molecules require oxygen for the process (Brumsack, 2006; Jenkyns 2010).

As free oxygen in the water column diminishes, microbes cleave away oxygen that is bonded with other elements to break down organic matter. The process occurs as follows: $O_2 \rightarrow NO_3^- \rightarrow MnO_2 \rightarrow Fe(OH)_3 \rightarrow SO_4^{-2} \rightarrow CO_2$ (Burdige, 2006). The rate that microbes break down organic matter decreases as function of the strength of the bond formed between the oxygen and associated element. Microbes break down organic matter more quickly when cleaving oxygen from NO_3^- and more slowly when cleaving it from CO_2 (Burdige, 2006).

As volcanism decreased, CO_2^- and other greenhouse gas input decreased, weathering decreased and nutrients for primary productivity decreased. This occurred as temperatures decreased and ocean oxygen levels returned to normal (Brumsack, 2006; Jenkyns 2010).

The former occurred contemporaneously with tectonic plate rearrangement, which is linked to the same processes responsible for increased volcanism. Increased shelf area that resulted allowed for warm shallow ocean conditions that provide for an increase in primary productivity (Brumsack, 2006; Jenkyns 2010). The drill cores sampled in this study were deposited in such an environment.

It is important to note that individual interpretations suggested for each set of results may or may not be indicative of all of the local influences and factors that contributed to the deposition as “Black shale comprise a vast array of sediment types produced by a variety of processes (Ruppel, 2011).

The interpretation of the conditions leading to the deposition of each zone and sub-zone is considered tentative and is evaluated against all the data and presented in the overarching interpretation at the end of each section. In short, incongruities that deviate from the overarching model (see above) are considered and further investigated.

Trace element analysis is the primary means of determining the environmental conditions present during deposition and is the most useful method of interpreting depositional environments for this study

All interpretations are considered under the understanding that, as explained by Brumsack, 2006, "*trace metal enrichments seen in upwelling environments and anoxic-euxinic basins are broadly rather similar*". In short, the use of trace metals for distinguishing upwelling environments from anoxic-euxinic basins as presented in Figure 4.37 and Tables 4.14 – 4.17 is not weighed as heavily to support the interpretation as other results in this document.

The depositional environments and dominating environmental conditions that led to the deposition of the Eagle Ford Formation within the study area are discussed in the following sections. To provide perspective concerning the bathymetry of the depositional environment discussed the approximate location of the drill cores is provided at the beginning of each section. The interpretations of the results are summarized presented in the following figure. It is referenced throughout the discussion.

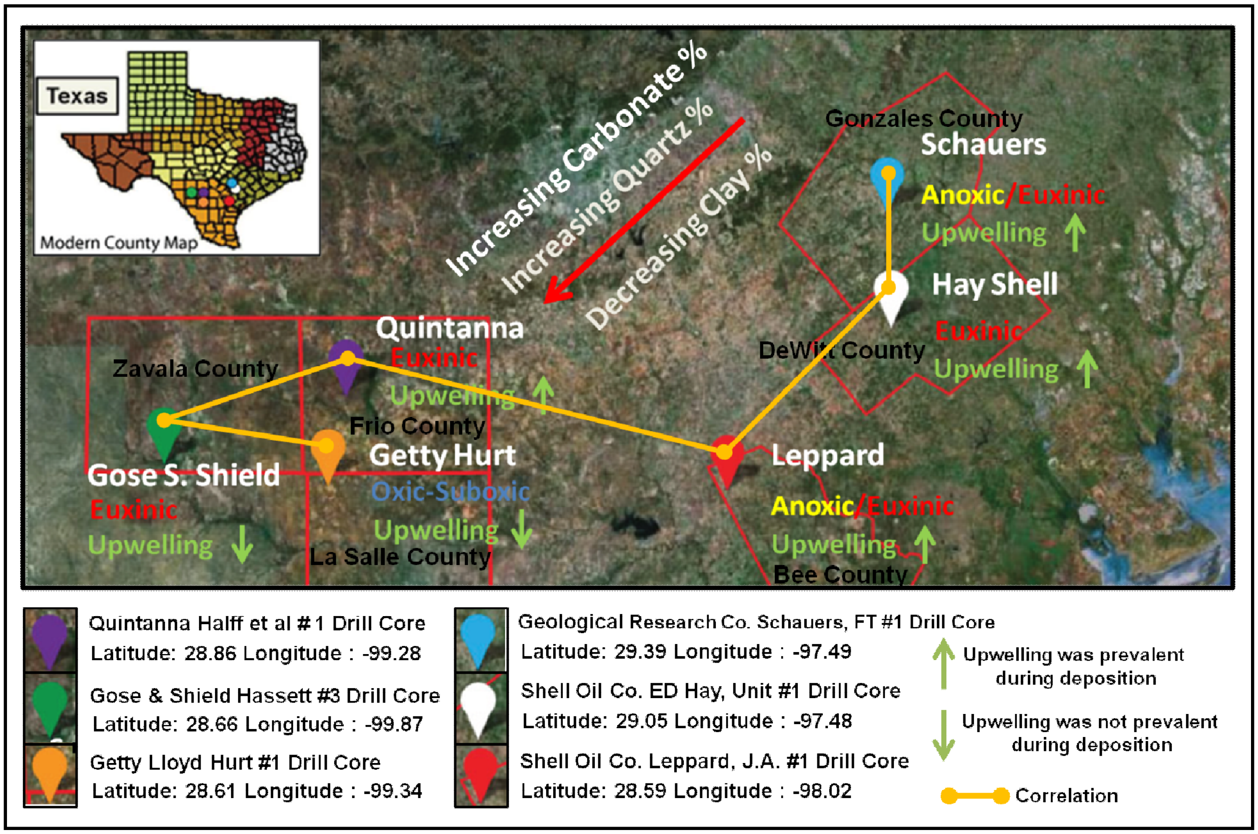


Figure 5.2 Summary of the Study Results. Includes the location of each drill core (Geocentre Consulting et al, 2011), water column conditions during deposition, influence of upwelling, correlation scheme (See Figures 4.50 – 4.52), carbonate, quartz and clay trends.

There is a trend of increasing quartz and carbonate concentration from the northeast to the southwest as the clay content decreases (Figures 4.28 - 4.34). There is also a decreased upwelling trend from the northeast to the southwest (Figures 5.3 – 5.8).

Samples from the Geological Research Co. Schauers, FT #1 Drill Core were deposited in a dominantly anoxic-euxinic environment. Most of the samples deposited in an anoxic-euxinic environment are from the Eagle Ford Formation. However the drill core contains samples, deposited in the Buda and the Austin Chalk Formations, which were dominantly oxic-suboxic during deposition. Samples from the Shell Oil Co. ED Hay, Unit #1 Drill Core are from the Eagle Ford Formation and deposited in a dominantly euxinic environment. Samples from the Shell Oil Co. Leppard, J.A. #1 Drill Core were deposited in a dominantly anoxic-euxinic environment. Most of the samples deposited in an anoxic-euxinic environment are from the Eagle Ford Formation. However the drill core contains samples, deposited in the Buda and the Austin Chalk Formations, which were dominantly oxic-suboxic during deposition. Samples from the Quintanna Halff et al # 1 Drill Core are from the Eagle Ford Formation and were deposited in a dominantly euxinic environment. Samples from the Gose & Shield Hassett #3 Drill Core that contain the Eagle Ford Formation were deposited in a dominantly euxinic environment. The drill core also contains the Buda Formation. Samples from the Buda Formation were deposited in dominantly oxic-suboxic environment. Samples from the Getty Lloyd Hurt #1 Drill Core were deposited in a dominantly oxic-suboxic environment. The drill core contains samples from the Eagle Ford and Austin Chalk Formations.

5.2 Geological Research Co. Schauers, FT #1 Drill Core

The deposition of this core is believed to have occurred on a proximal extended shelfal marine slope. It was deposited approximately 100 kilometers northwest of the Hay ED. Unit 1 Shell Oil Core (Figure 2.1).

5.2.1 Water Column Conditions

5.2.1.1 Molybdenum Concentration

In Table 4.2 zone one exhibits a value of 2 ppm Mo, indicating that zone one was likely oxic-suboxic (Zheng, 2000). This zone captures the Buda Formation. This is consistent with a previous study, which indicates the Buda Formation was deposited in a shallow, well-oxygenated water column (GCAGS, 1995). Zone two and three are dominantly euxinic and exhibit an average enrichment of 22 and 35 ppm Mo, respectively (Table 4.1) (Zheng, 2000).

5.2.1.2 Multi-Proxy Trace Elements: U, V, Mo, Ni, Cu

To further justify the results of the previous section the enrichment of other trace metals are considered. Figure 4.14 demonstrates that the select elements utilized (U, V, Mo, Ni, and Cu) show no correlation with Al, which is a proxy for clay concentration and therefore the detrital fraction. Uranium, V, Mo, Ni and Cu did not occur with clay and therefore are trace elements that can be utilized to determine water column conditions (Tribovillard, 2006).

The average enrichments in Figure 4.38 indicate that each zone in the Geological Research Co. Schauers, FT #1 was anoxic during deposition. However, in zone one the average trace elements indicate that anoxic conditions were prevalent during deposition. It is suspect that outliers with an unusual high trace metal values and correspondingly low Al value are responsible for the indication of anoxia.

5.2.2 Anoxic-Euxinic Basins and Upwelling Environments

5.2.2.1 P Enrichment and Mn Depletion

Zone one exhibits relatively high Mn (6 ppm)(Table 4.1) average values and unrealistically low P (-35 ppm) (Table 4.1) values. The unrealistically low values are likely due to the carbonate enrichment that accompanies elements in this zone, which weakens the calibration for the instrument, a Bruker XRF handheld device, utilized for measuring concentration. When values less than 2 ppm are measured with the instrument utilized in this study a negative value occurs. Negative numbers indicate very low values below 2 ppm and hence can be utilized for this study. The enrichment of Mn may be due to the downward diffusion of Mn^{2+} can lead to the $MnCO_3$ (Manganese (II) carbonate) when a well developed pycnocline forces trapping, as carbonate is the only available sink for Mn.

However, Mn may also have been fixed as diagenetic carbonate in pore waters where anoxic conditions dominated the water column and euxinia was limited to pore waters. However, conditions may have been sporadically euxinic at the water-sediment interface.

In zone two, Mn is depleted (0.54 ppm) (Table 4.1) and P (1.8 ppm) (Table 4.1) is enriched, which indicates an upwelling type of depositional environment (Brumsack, 2006). Figure 4.28 demonstrates that carbonate enrichment decreased substantially, leading to the conclusion that the depositional environment was dominated by upwelling because upwelling brings up cool waters that dissolve carbonate (Brumsack, 2006; Jenkyns, 2010).

Similar to zone one, zone three exhibits relatively high Mn values (1.4 ppm) (Table 4.1) and low P values (-4.0 ppm) (Table 4.1) leading to the conclusion that upwelling conditions were not likely as prevalent during deposition. However, the average values are misleading because significant outliers bring down the average value of Mn. These values can be observed in Figure 4.1, which demonstrates that upwelling was prevalent during deposition. Manganese may have been fixed as diagenetic carbonate or forced into carbonate during periods of a well pronounced pycnocline (Brumsack, 2006; Tribovillard, 2006; Jenkyns, 2010).

5.2.3 Mineralogy and Implications

Figure 4.28 demonstrates that carbonate comprises most of the core throughout zones one and three. Figure 4.27 demonstrates that calcium carbonate (calcite phase) may be the sink for most of the calcium throughout zone three. It is reasonable to suspect that the carbonate was in the calcite phase in zone one as well, but may also be present as $MnCO_3$ (Manganese (II) Carbonate). This is supported by the high enrichments of Mn and carbonate concentration observed in Figure 4.2 and figure 4.28, respectively.

5.2.4 Conclusions

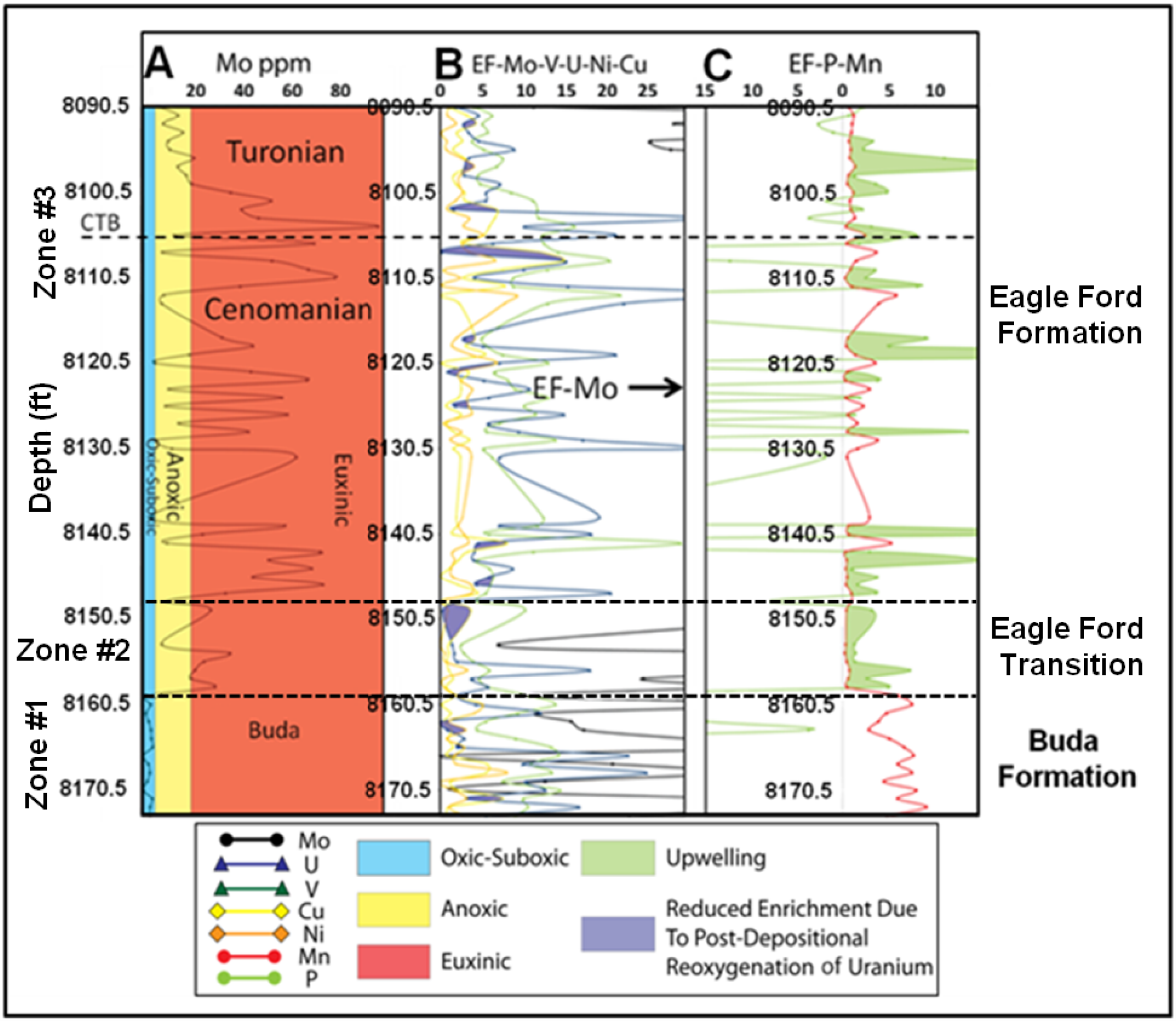


Figure 5.3 Geological Research Co. Schauers, FT #1 Drill Core Depositional Environment (A) Molybdenum Concentration (B) Enrichments of Molybdenum, Vanadium, Uranium, Nickel and Copper (C) Enrichments of Phosphorus and Manganese. The Figure is Constructed from the Results Section (Figures 4.1 and 4.2).

The portion of the Geological Research Co. Schauers, FT #1 Drill Core that comprises the Eagle Ford Formation was deposited during anoxic-euxinic water column conditions. Oxic-suboxic conditions dominated during the deposition of the Buda Formation. The former is supported by the Mo values (Zheng, 2000) (Figure 5.3 (A) and concurrent enrichment of Mo, V and U relative to Ni and Cu (Figure 4.38)(Figure 5.3 (B)(Tribovillard, 2006).

Upwelling (Figure 5.3 (C)) was likely the influence that contributed to anoxic-euxinic water column conditions at some depths, sapropel conditions, indicated by the substantial enrichment of Mn could be contemporaneous with anoxic-euxinic water column conditions at other depths (Brumsack, 2006). It is possible that during the deposition of the Buda Formation that Mn-carbonate formed during oxic-suboxic water column conditions.

During the deposition of zone two and three, the hydrologic cycle likely increased in intensity relative to zone one. This is indicated by the increase in upwelling and ocean anoxia (Jenkyns, 2010). Upon organic matter decay, P likely escaped back into the water column (Jenkyns, 2010), which may resulted in P depletion in some intervals of zone three and some P may have been taken up by nitrogen-fixing bacteria (Jenkyns, 2010). Populations of green sulfur bacteria also likely increased due to the free H_2S in the water column (Jenkyns, 2010). In intervals of high Mn enrichment, Mn was likely incorporated into carbonate (Brumsack, 2006; Tribovillard, 2006; Jenkyns, 2010).

5.3 Shell Oil Co. ED Hay, Unit #1 Drill Core

The deposition of the Shell Oil Co. ED Hay, Unit #1 Drill Core occurred on a proximal extended shelfal marine slope. It was deposited approximately 400 kilometers southwest of the nearest coastline of the intercontinental seaway (Sageman and Arthur, 1994).

5.3.1 Water Column Conditions

5.3.1.1 Molybdenum Concentration (*Zone #1 and Zone #2*)

Molybdenum concentrations are commonly used as a proxy for redox potential (Zheng, 2000). It typically occurs as molybdate (MoO_4^{2-}) and is not concentrated by primary productivity or absorbed by most particles. However, it does show propensity for adhering to Mnoxyhydroxids at the sediment surface (sediment-water interface). Reduction of the aforementioned phase liberates the Mo into pore waters. Hence, a persistent H_2S column or HS^- is typically required to convert Mo from a conservative element to a particle reactive species (Tribovillard, 2006).

In short, concentrations less than ~5 ppm Mo indicates oxic depositional environments, while concentrations of >5-20 ppm Mo indicate an anoxic environment transitioning to an euxinic environment at and above values greater than 20 ppm Mo (Zheng, 2000). This cursory analysis reveals that the lower and upper Eagle Ford, from Table 4.4, exhibits an enrichment of 29 and 25 ppm Mo, respectively, were dominated by euxinia.

However, due to the dynamic nature of the depositional environment and possible strong local influences further examination is required to confirm environmental conditions during deposition.

5.3.1.2 Molybdenum Concentration (*Zone #1: Sub-Zones*)

Although the lower Eagle Ford Formation is dominated by an Mo concentration that indicates euxinia, the values change dynamically throughout the zone. *Sub-Zone A* exhibits an Mo concentration of 24 ppm Mo, indicating a euxinic water column. *Sub-Zone B* exhibits an Mo concentration of 5 ppm Mo, which may indicate an anoxic water column. Sub-Zone C exhibits an Mo concentration of 19 ppm, which his indicates an anoxic water column that may be in transition into an euxinic water column.

5.3.1.3 Molybdenum Concentration (*Zone #2: Sub-Zones*)

Similar to zone one, the Mo concentration of the upper Eagle Ford Formation in the core indicates that euxinic conditions were dominant during deposition. However, the concentration varies throughout deposition of the sub-zones throughout zone two. Sub-Zone D exhibits an Mo concentration of 22 ppm. Sub-Zone E exhibits an Mo concentration of 3 ppm. Sub-Zone F exhibits an Mo concentration of 31 ppm Mo. In Sub-Zone G, the Mo concentration again drops to 3 ppm. In Sub-Zone H the Mo concentration increases to 16 Mo ppm. In Sub-Zone I the Mo concentration increases to 25 ppm. In Sub-Zone J the Mo concentration drops to 17 ppm. This ultimately suggest that water column conditions may have been euxinic (D), oxic-anoxic (E), euxinic (F), oxic-anoxic (G), anoxic (H), euxinic (I), and anoxic (J). However, it is important to note the aforementioned condition could have been restricted to pore waters.

5.3.1.4. Multi-Proxy Trace Elements: U, V, Mo, Ni, Cu (*Zone #1 and Zone #2*)

The use of Mo as a paleoredox proxy can be justified through the comparison of the enrichment of other trace metals that are not significantly affected by detrital influences (Tribovillard, 2006). Figure 4.16 demonstrates that U, V, Mo, Ni, and Cu show no correlation with Al, Al being a proxy for clay concentration.

The lack of correlation in the previous or linearity when U, V, Mo, Ni and Cu are plotted against Al suggests the aforementioned elements are acceptable for comparison (Tribovillard, 2006). The proportional enrichment, relative to average gray shale, of U, V, Mo, Ni, and Cu can be reduced to a function of the redox status. Under anoxic or denitrifying conditions, uranium and V are reduced and accumulate more quickly than Mo, Ni, and Cu. In a euxinic, sulfate reducing, depositional environment, V, U and Mo is concurrently more enriched than Ni and Cu (Tribovillard, 2006).

Figure 4.39 demonstrates that an enrichment of V and U corresponds with an enrichment of Ni and Cu. However, Mo is significantly enriched in comparison to all the other elements. The enrichments indicate that euxinic conditions were in place during deposition. The Mo enrichment in Figure 4.39 possibly occurred because Mo will not precipitate until sulfide concentration reaches about 0.1 uM (Zheng, 2000). In pore water, the conversion can be catalyzed, which can cause greater enrichment in Mo than in the overlaying anoxic waters (Brumsack, 2006, 2003).

This reaffirms that, at the very least,, anoxic conditions existed during deposition. However, even if anoxic conditions persisted euxinic conditions may have been limited to pore waters. It should be noted that in Figure 4.39, U may be lost due to post-depositional reoxygenation (Tribovillard, 2006).

In summation, subzones in both zone one and zone two exhibits a correlation of enrichment that is indicative of a euxinic depositional environment. The significant loss of U in subzones F, G, H, and J is likely due to post-depositional reoxygenation.

5.3.2 Basin Restriction

5.3.2.1 Mo VS TOC

Previous studies have demonstrated that basin restriction can be indicated in anoxic to euxinic settings where primary productivity and the associated carbon sinking flux are relatively high (Rowe et al, 2008). Figure 4.36 reveals no correlation between Mo and Al, which indicates that Mo occurs independently of Al enrichment. This indicates that Mo deposition was not occur as part of the detrital fraction. Molybdenum exists within the water column and is not concentrated through primary productivity or absorbed by most natural particles (Tribovillard, 2006).

As Mo becomes more limited, the ratio of Mo to TOC becomes increasingly small, as the basin becomes more restricted. This corresponds to a decrease in slope steepness of the line in Figure 4.36. As the slope because more steep in the figure the rocks become more concentration with TOC relative to Mo. Figure 4.36 indicates results imply that zone two is more restricted than zone one during the deposition of the Eagle Ford Formation contained in the Shell Oil Co. ED Hay, Unit #1 Drill Core.

Figure 4.36 also demonstrates the degree of restriction, meaning whether it was more or less restricted as a function sea level rise or fall, of zone one and zone two in comparison to the restriction of Cariaco Basin Lower Unit 1A, Cariaco Basin Upper Unit 1A, Alum Shale, Oatka Creek, and the Black Sea Unit 1A (Lyons, 2009). Zone one of the Eagle Ford Formation contained in the Shell Oil Co. ED Hay, Unit #1 Drill Core is less restricted than Black Sea Unit #1 and more constricted than Oatka Creek. Zone two of the Eagle Ford Formation contained in the Shell Oil Co. ED Hay, Unit #1 Drill Core is comparable to the Cariaco Basin Upper Unit 1A. In short, the zone was more restricted than zone two.

5.3.3 Anoxic-Euxinic Basins and Upwelling Environments

5.3.3.1 Nitrogen Cycling and Isotopic Implications

Low values of $\delta^{15}N$ that range from 1.2 $^{o}/_{oo}$ to -3.9 $^{o}/_{oo}$ and C/N ratios of 25 to 50 are typical of average black shale deposited during the CT anoxic event (Junium and Arthur, 2007). Figure 4.25 demonstrates that the average $\delta^{15}N$ values of zone one and two fall within that range, -2.9 $^{o}/_{oo}$ and -2.4 $^{o}/_{oo}$, respectively. This data quantified in Table 4.13. However, in figure 4.25 a negative shift (shift a shift to the left in the associated figure) in the average C/N ratio of 33 in zone one to 14 in zone two indicates a change in depositional environment conditions from one not defined by low oxygen and high productivity in upwelling environments to one that is defined by low oxygen and high productivity in upwelling environments as provided by Junium and Arthur, 2007. Carbon to nitrogen ratios between 10 and 15 indicate low oxygen and high productivity in upwelling environments similar to those that dominate offshore Peru and Namibia and some euxinic environments (Junium and Arthur, 2007).

The antithetic relationship between C/N ratios and $\delta^{15}N$ in (Figure 4.25: Zone one) indicates that the processes that elevated the C/N ratios relates to the $\delta^{15}N$ decrease. The antithetic relationship between C/N ratios and $\delta^{15}N$ does not occur in zone two. It is possible that the $\delta^{15}N$ values in zone two are the result of changes in the nitrogen cycle, such as the rate of nitrogen being taken up by microbes as the demand for oxygen exceeds supply and water column anoxia increases (Burdige, 2006). Increasing water column anoxia could be the result of a transition from an anoxic to upwelling environment.

In figure 4.25, the above interpretation is reinforced by the negative shifts of TOC percent and $\delta^{13}C$ in zone two relative to zone one. Previous studies demonstrate that in some instances, upwelling can reduce organic matter preservation (Bartolini et al, 2003). This explains why TOC preservation may have been reduced in an upwelling environment, which as explained by Brumsack, 2006, normally provides nutrients for primary productivity, drives anoxia and increases TOC preservation.

5.3.3.2 P Enrichment and Mn Depletion

While P and Mn have little use when considered separately, they can yield information regarding the depositional environment when considered together as enrichment values relative to average gray shale. Mn serves as a redox proxy while P serves as a redox and productivity proxy. When sediments are enriched in P and depleted in Mn it implies upwelling (Table 4.3)(Tribovillard, 2006).

However, Mn enrichment and associated P depletion are merely suggestive and not definitive. Manganese to P enrichments should only be used as a cursory means of evaluating types of depositional environments. In short, the depletion of Mn (0.8) in zone one and enrichment of P (4.0) does indicate that upwelling conditions occurred during deposition. The enrichment of Mn (1.1) and depletion of P (0.4) in zone two of the Eagle Ford Formation contained in the Shell Oil Co. ED Hay, Unit #1 Drill Core indicates that upwelling was not the a significant influence during deposition. However, Mn exhibits such little enrichment that upwelling conditions may have occurred to some extent.

5.3.3.3 Trace Metal Enrichment in Organic Carbon Rich Sediments

Brumsack 2006, demonstrated that distinguishing depositional environments based on their trace metal enrichments proved difficult, as trace metal enrichment is similar in an upwelling or sapropel, organic carbon sediment rich anoxic to euxinic, type depositional environment.

However, by tallying the numbers of zones that fall under the range of depositional environments that define an upwelling or sapropel anoxic basin through trace metal analyses, it may be plausible to suggest that an individual zone is characteristic of one type of environment or another. Trace metal enrichment in Tables 4.14, 4.15, 4.16 and 4.17 indicates that both zone one and zone two were predominately influenced by an upwelling depositional environment.

5.3.4 Mineralogy and Implications

5.3.4.1 Degree of Pyritization: Fe, C & S Limitations: Carbonate Dilution

Pyrite formation, or the degree of pyritization (DOP), has been used in previous studies to indicate bottom water conditions (Raiswell et al, 1988)(Dean and Arthur, 1989)(Rimmer, 2004) Rowe et al, 2008). These conditions range from oxic, sub-oxic, to euxinic. The ternary diagram presented in Figure 4.29 illustrates these conditions and functions as a means of determining iron, carbon, and sulfur limitation on pyrite formation. However, this method is only applicable to zone two because the method does not apply to samples that are mostly limestone (Berner and Raiswell, 1984), or as in the case of zone one mostly comprised of calcium carbonate (Figure 4.30).

This indicates the zone one was diluted with calcium to the extent that pyrite concentrations in zone one cannot be determined utilizing Figure 4.29. Figure 4.29 also demonstrates that in zone two, approximately 85 percent of the Fe exists in the pyrite phase (Rowe et al, 2008). In zone one, most points plot above the DOP_T line that designates the maximum degree of pyritization. These results are invalid because of the carbonate dilution present in these samples.

During the deposition of zone one, upwelling conditions were not as prevalent, which may have attributed to a greater concentration of carbonate. This likely occurs because greater concentration of calcium carbonate accumulates in warm water in cold water.

In short, cold water (upwelling) environments can contribute to reduced carbonate accumulation and preservation. However, it should also be noted that a general increase in acidification of the ocean can also contribute the calcium carbonate dissolution. Nitrates such as nitrous oxide (N_2O) (Lueker, 2004) and nitrates that typically accompany upwelling can drive primary production (Eppley, 1979). However, an increase in these concentrations does not necessarily increase preservation.

Also, when acidification in the water column is prevalent carbonate can still be preserved in bottom waters due to Mn diagenetic fixation (Jenkyns 2010). Under some anoxic conditions calcite can also be precipitated chemogenically and can be trapped in the sediment (Anderson, 1987). To summarize, a greater concentration of carbonate is likely to be preserved when upwelling is less prevalent. However, in zone one of the Shell Oil Co. ED Hay, Unit #1 Drill Core it is possible that primary productivity and deposition occurred so quickly due to increased nutrient flux that rate of deposition and subsequent preservation outpaced the rate carbonate is dissolved. It is supported by the average increase TOC concentration from zone two to zone one (Table 4.13).

5.3.5 Conclusions

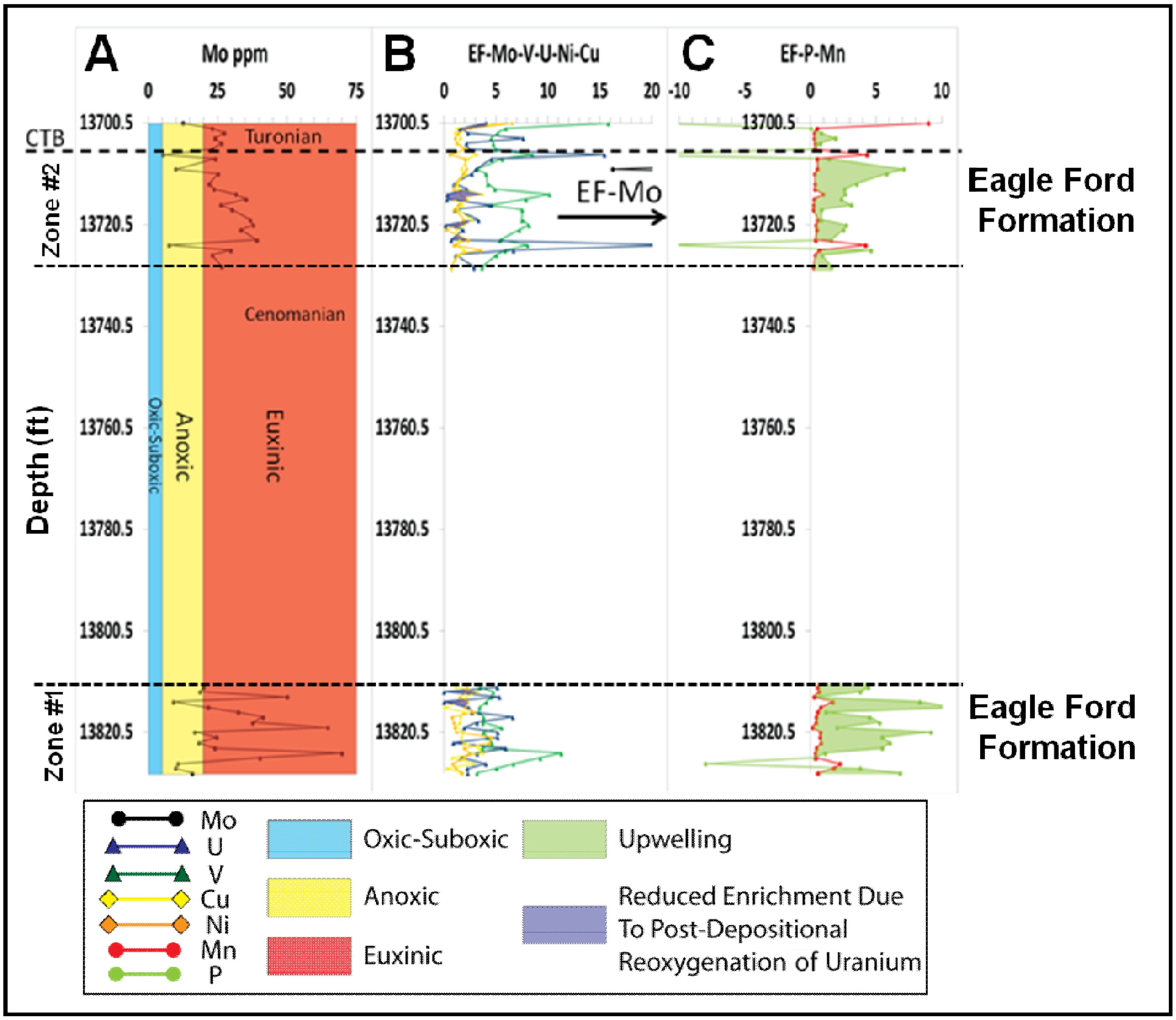


Figure 5.4 Shell Oil Co. ED Hay, Unit #1 Drill Core Depositional Environment (A) Molybdenum Concentration (B) Enrichments of Molybdenum, Vanadium, Uranium, Nickel and Copper (C) Enrichments of Phosphorus and Manganese. The Figure is Constructed from the Results Section (Figures 4.3 and 4.4).

The Shell Oil Co. ED Hay, Unit #1 Drill Core was deposited in a dynamic environment on a proximal extended shelfal marine slope. Both zones of this core mostly represent the Lower Eagle Ford Unit (Cenomanian) and are dominated by dark organic rich mud rock. Both zones were deposited under anoxic conditions, but euxinia dominated during the deposition. This is supported by the observation that all the data points have a Mo value of or above 5 ppm, which indicates at least anoxic conditions (Figure 5.4(A)(Zheng, 2000).

Among those points most have a Mo value of or above 20 ppm, which indicates euxinia (Figure 5.4(A))(Zheng, 2000). The former is supported by the concurrent enrichment of Mo, V and U relative to Ni and Cu (Figure 4.39 A and B)(Figure 5.4 (B))(Tribovillard, 2006). It is possible that some vanadium is not concurrently enriched due to post-depositional reoxygenation. Upwelling is also indicated during the deposition of most of the core (Figure 5.4 (C)), especially where euxinia is observed. This is because when sediments are enriched in phosphorus and depleted in manganese it implies that upwelling occurred in that environment (Tribovillard, 2006). It is possible that upwelling contributed substantially to water column conditions (Brumsack, 2006).

5.3.5.1 Zone #1 : Sub-Zones A, B and C

Sub-zone A was deposited under stagnant water column conditions (Figure 4.45 and Figure 4.46) that resulted in free hydrogen sulfide (H_2S), weak water column acidification, and upwelling conditions. Increase in carbonate precipitation was possibly due to an increase in primary productivity, such as Coccolithophores (Riebesell et al, 2000).

Sub-zone B was likely deposited concomitant with a change in the nitrogen cycle in which more nitrogen was taken up and preserved in this zone compared to sub-zone A (Figure 4.44 and 4.45). An increase of nitrogen fixing bacteria, primary productivity and subsequent increase of carbon sinking possibly contributed to persistent euxinic conditions (Jenkyns, 2010). This is possibly the result of an intensified hydrologic cycle in which phosphate was released from deposited organic matter and facilitated in the increase of nitrogen fixing bacteria (Jenkyns, 2010). As a result of the former, anoxic-euxinic water column conditions and the increased preservation of primary productivity occurred (Increased concentration of TOC (Table 4.13). In short, the level of preservation is greater in sub-zone A than in sub-zone B (Figure 4.44 and 4.45).

Sub-Zone C was deposited under conditions in which the hydrologic cycle was less intense compared to sub-zone B. This is indicated by the decrease concentration of TOC (Figure 4.44)(Jenkyns, 2010). The level of anoxia was less prevalent than in which is supported by decreased average Mo values (Zheng, 2000) and enrichments of V, U, Mo, Ni and Cu (Figure 4.46).

It is likely that a change in hydrologic cycle, as in it decreased, during the deposition of subzone C relative to subzone B, which resulted in less primary productivity and associated carbon sinking flux. This occurs because of the reduced availability of nutrients from weathering and weakening of upwelling, which transports nutrients, associated with a less intense hydrologic cycle (Jenkyns, 2010). The environmental conditions present during the deposition of sub-zone C were possibly similar to those of subzone A.

5.3.5.2 Conclusion: Zone #1: Sub-Zones A, B, and C

The concentrations of greenhouse gasses, such as CO_2, are the driving forces behind changes in the hydrologic cycle (Jenkyns, 2010; Brumsack, 2006). Through continental weathering and nutrient rich upwelling, CO_2 input indirectly controls productivity and therefore the amount carbon sinking and resulting water column conditions. Due to an increase in CO_2 input into the system during the deposition *Sub-Zone B,* the hydrologic cycle may have intensified and facilitated an increase in primary productivity. This would have resulted in subsequent anoxic-euxinic water column conditions, and subsequent organic matter preservation not present in Sub-Zone A. The hydrologic cycle became less intense during the deposition of Sub-Zone C. This is evidenced by the increase of δ^{15} N and reduced organic matter preservation (Jenkyns, 2010).

5.3.5.3 Zone #2 : Sub-Zones D, E, F, G, H, I, J

Sub-Zone D was deposited under significantly reduced carbonate preservation compared sub-zones A, B, and C of zone one. This is possibly the result of reduced primary productivity associated with a less intense hydrologic cycle than that exhibited in all of zone one.

The intensity of the hydrologic cycle decreases in sub-zones E, G, and J. This is supported by decreased TOC concentration (Figure 4.44)(Jenkyns, 2010) and the processes associated with a reduced hydrologic cycle, as explained above and the reasoning applied throughout the deposition of the sub-zones zone two. Conversely, subzones F, H, I, in which the hydrologic cycle was intensified, resulted in increased productivity and preservation as indicated by increased TOC concentration (Figure 4.44).

5.3.5.4 Summary

The deposition of zone one and zone two both occurred under water column conditions that were anoxic-euxinic. However, it is possible that during various intervals of deposition euxinic conditions occurred sporadically near the water-sediment interface or was constrained within the pore water. If so then organic matter would not be as well preserved relative a euxinic water column. Increases in volcanic activity and subsequent increases in CO_2 input into the atmosphere was likely the driving force of intensified hydrologic cycles, subsequent continental weathering, leaching of nutrients, enhanced primary production, and anoxia-euxinic conditions.

Zone one was deposited under the influence of a more intensified hydrologic cycle relative to zone two. However, both zones experienced varying degrees of hydrologic cycle intensity throughout deposition. Zone one was deposited during a period of enhanced productivity upwelling. Nutrients were leached from the continent and it is possible that phosphates were released from deposited organic matter for the utilization of nitrogen fixing bacteria (Jenkyns, 2010). An increase in the populations of nitrogen fixing bacteria could have facilitated the relatively high $\delta^{15}N$ values in Sub-Zone B. Zone two was deposited under reduced hydrologic cycle. The reduced hydrologic cycle likely led to decrease in upwelling and subsequent reduction in carbonate preservation (Jenkyns, 2010).

5.4 Shell Oil Co. Leppard, J.A. #1 Drill Core

The Shell Oil Co. Leppard, J.A. #1 Drill Core was deposited at the approximate edge of a distal shelfal marine slope. The site of deposition was approximately 100 kilometers south of the Hay ED. Unit 1 Shell Oil Core (Figure 2.1).

5.4.1 Water Column Conditions

5.4.1.1 Molybdenum Concentration

Both zone one and zone two exhibit Mo concentrations that indicate euxinic environments. The average enrichments are 24 ppm and 29 ppm Mo, respectively (Table 4.3).

5.4.1.2 Multi-Proxy Trace Elements: U, V, Mo, Ni, Cu

Trace elements U, V, Mo, Ni, and Cu are acceptable because they show no correlation with Al (Figure 4.18). To say they acceptable because if they show no correlation with Al means that U, V, Mo, Ni and Cu were enriched not as a result of the detrital fraction. That is to say that they did into occur with clay (Tribovillard, 2006). Prevailing anoxic-euxinic conditions indicated by the Mo concentrations in the immediate former section are supported by the relative enrichments of U, V, Mo, Ni, and Cu (Figure 4.40).

5.4.2 Anoxic-Euxinic Basins and Upwelling Environments

5.4.2.1 P Enrichment and Mn Depletion

Zone one is enriched in P (5.8 ppm) and depleted in Mn (0.6 ppm). Zone two is enriched in P (1.7 ppm) and depleted in Mn (0.9 ppm) (Table 4.5). This is an indication that upwelling was an influence during the deposition of both zones (Brumsack, 2006). However, the concentrations relative from zone one to zone two indicate that upwelling conditions may have weakened during the deposition of zone two.

It is possible that as upwelling conditions were reduced and free H_2S became more prevalent in the water column, primary production decreased and P was taken up by nitrogen-fixing bacteria. Manganese would have been incorporated into carbonate, as it would have been the only available sink as carbonate preservation increased due to decreasingly acidic ocean (Brumsack, 2006; Tribovillard, 2006; Jenkyns, 2010).

5.4.2.2 Trace Metal Enrichment in OC-Rich Sediments

Trace metal enrichment in Tables 4.14, 4.15, 4.16 and 4.17 indicate that zone one and zone two were influenced by upwelling type depositional conditions.

5.4.3. Mineralogy and Implications

Figure 4.35 demonstrates that quartz, calcite, albite, pyrite, kaolinite, gypsum, and illite all occur in the Shell Oil Co. Leppard, J.A. #1 Drill Core. Pyrite readily occurs in a euxinic environment. Gypsum likely formed during the few oxic-anoxic periods during deposition. This mineralogy suggests that euxinic conditions were at least in place in the pore waters or at the sediment-water interface during much of the deposition.

5.5.4 Conclusions

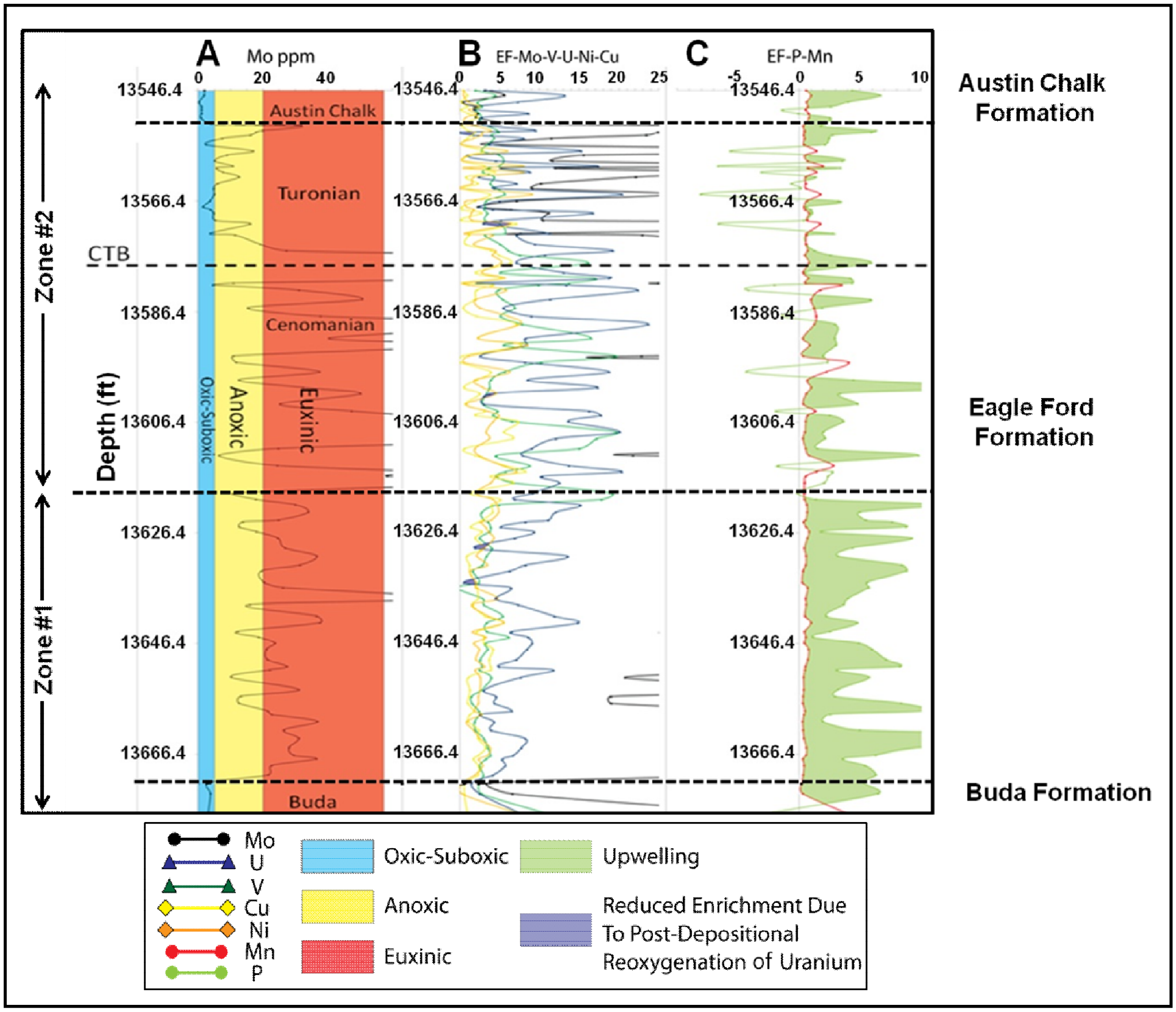


Figure 5.5 Shell Oil Co. Leppard, J.A. #1 Drill Core Depositional Environment (A) Molybdenum Concentration (B) Enrichments of Molybdenum, Vanadium, Uranium, Nickel and Copper (C) Enrichments of Phosphorus and Manganese. The Figure is Constructed from the Results Section (Figures 4.5 and 4.6).

The Shell Oil Co. Leppard, J.A. #1 Drill Core includes the Austin Chalk, Eagle Ford and Buda Formations. Molybdenum (Figure 5.5 (A)) values and the concurrent enrichment of Mo, V and U relative to Ni and Cu (Figure 5.5 (B))(Tribovillard, 2006) supports that is was deposited during anoxic-euxinic water column conditions. Upwelling (Figure 5.5 (C)) may have influenced water column conditions to be anoxic-euxinic at some depths (Brumsack, 2006). A high enrichment of Mn at some depths may also indicate the presence of Mn-carbonate. As ocean circulation decreased, Mn may have been trapped in the sediment and phosphorus could have been taken up from decaying organic matter by nitrogen- fixing bacteria. During the deposition of zone two, more carbonate likely existed in non-calcite phases (Jenkyns, 2010).

5.6 Quintanna Halff et al # 1 Drill Core

The Quintanna Halff et al # 1 Drill Core was deposited on the slope of a proximal shallow shelf type depositional environment. The core was recovered site of deposition was approximately 200 kilometers west of the Shell Oil Co. ED Hay, Unit #1 Drill Core Data (Figure 2.1).

5.5.1 Water Column Conditions

5.5.1.1 Molybdenum Concentration

In Table 4.2, in zone one the average Mo concentration is 38 ppm, which lies above the threshold for euxinia (Zheng, 2000). The Mo concentration of zone two is nearly three times that of zone one, at 109 ppm, well above the euxinia threshold. In zone three the Mo concentration decreases substantially to 29 ppm, but the depositional environment could still be euxinic. Water column conditions were dominantly anoxic-euxinic during deposition.

5.5.1.2 Multi-Proxy Trace Elements: U, V, Mo, Ni, Cu

To further corroborate the depositional environment with the interpretation from the previous section the enrichments of U, V, Mo, Ni, and Cu are compared. Figure 4.20 demonstrates that the select elements utilized (U, V, Mo, Ni, and Cu) show no correlation with Al. Figure 4.41 demonstrates that in each zone U, V and Mo are concurrently more enriched relative to Ni and Cu. This supports that water column conditions were anoxic-euxinic. Zone one and two both demonstrate some loss of U that could be the result post-depositional reoxygenation (Tribovillard, 2006).

5.5.2 Anoxic-Euxinic Basins and Upwelling Environments

5.5.2.1 P Enrichment and Mn Depletion

In Table 4.7 P (6.4 ppm) enrichment and Mn (0.8 ppm) depletion in zone one indicates that upwelling was occurring during deposition. Although Mn (1.0 ppm) is not depleted in zone two it is nearly so and P (9.4 ppm) is enriched. It is likely that upwelling was occurring during deposition. Phosphorus (-3.2 ppm) is substantially depleted and Mn (3.1 ppm) is enriched in zone three.

5.5.2.2 Trace Metal Enrichment in OC-Rich Sediments

Tables 4.14, 4.15, 4.16 and 4.17 demonstrate that each zone was dominated by upwelling-type conditions. This supports the immediate former section.

5.5.3 Mineralogy and Implications

Figure 4.32 indicates that all three zones are enriched in carbonate, but have a slightly higher concentration of quartz than clay. Due to the enrichment of Fe in zones one and two, it is possible the carbonate exist in the siderite ($FeCO_3$) phase. Manganese enrichment increases substantially in zone three while Fe decreases, indicating that carbonate may exist as $MnCO_3$. However, it is also possible that ankerite was a sink in each of the zones given that Fe, Mg, and Mn can all form bonds with CO_3 as ankerite.

5.5.4 Conclusions

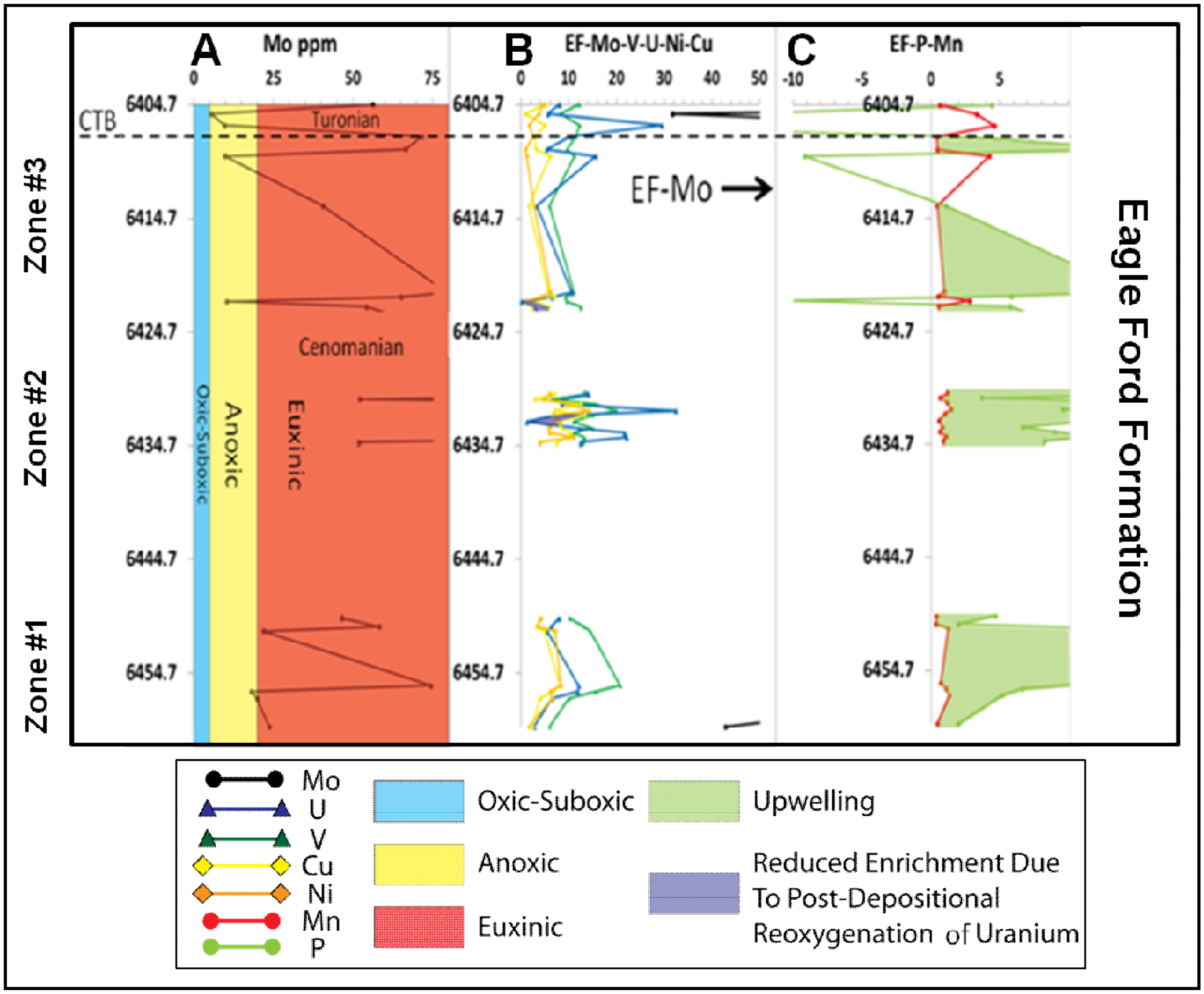


Figure 5.6 Quintanna Halff et al # 1 Drill Core Depositional Environment (A) Molybdenum Concentration (B) Enrichments of Molybdenum, Vanadium, Uranium, Nickel and Copper (C) Enrichments of Phosphorus and Manganese. The Figure is Constructed from the Results Section (Figures 4.7 and 4.8).

The Quintanna Halff et al # 1 Drill Core was deposited on a proximal shallow shelf type depositional environment (Figure 2.1) and it is subdivided into three sections due to changes in the geochemical signature and significant breaks in the data.

The all three zones Quintanna Halff et al # 1 Drill Core were deposited under dominantly anoxic-euxinic water column conditions. This is supported by Mo values (Figure 5.6 (A))(Zheng,

2000) and the concurrent enrichment of Mo, V and U relative to Ni and Cu (Figure 5.6 (B))(Tribovillard, 2006). Upwelling largely accompanies euxinia in this core, which is supported by enriched P and depleted Mn. Evidence of upwelling is reinforced by trace metal enrichment in organic carbon rich sediment (Tables 4.14, 4.15, 4.16 and 4.17)(Figure 5.6 C).

5.6 Gose & Shield Hassett #3 Drill Core

The Gose & Shield Hassett #3 Drill Core was deposited on a proximal shallow shelf type depositional environment. The site of deposition was located approximately 300 kilometers west of the Shell Oil Co. ED Hay, Unit #1 Drill Core (Figure 2.1).

5.6.1 Water Column Conditions

5.6.1.1 Molybdenum Concentration

In Table 4.10 the average Mo concentration for zone one is 2 ppm, which is within the oxic range (Zheng, 2000). In zone two, the average Mo concentration increases substantially to 59 ppm, indicating that euxinia occurred during the deposition of the zone two (Zheng, 2000). This indicates that zone one consist of the Buda Formation and zone two consist of the Eagle Ford Formation.

5.6.1.2. Multi-Proxy Trace Elements: U, V, Mo, Ni, Cu

Trace elements of U, V, Mo, Ni, and Cu they are compared with Al in Figure 4.22. There is some correlation with Al, which indicates that the detrital fraction may have contributed to some of the enrichment of U, V, Mo, Ni and Cu. However, it is not to the extent that they cannot be utilized to determine water column conditions, since linearity is not demonstrated.

The absence of correlation between U, V, Mo relative Ni Cu indicates that zone one was dominantly oxic-suboxic during the deposition (Figure 4.41). The enrichment of U, V and Mo relative Ni and Cu indicate that zone two was dominantly anoxic-euxinic during the deposition of zone two (Figure 4.41). This supports the immediate former interpretation based on Mo concentration (Zheng, 2000).

5.6.2 Anoxic-Euxinic Basins and Upwelling Environments

5.6.2.1 P Enrichment and Mn Depletion

Zone one exhibits substantially depleted P (-61.0 ppm) and enriched Mn (2.2 ppm) (Table 4.9). This is an indication that upwelling was not the dominant influence throughout deposition of this zone (Brumsack, 2006). The enrichment of P (4.2 ppm) and Mn (1.7 ppm) in zone two suggests that upwelling was an influence during deposition (Brumsack, 2006).

5.6.2.2 Trace Metal Enrichment in OC-Rich Sediments

Table 4.18 indicates that zone one was deposited under the influence of upwelling type depositional conditions. Zone two was dominated by more sapropel, anoxic basin, type depositional conditions.

5.6.3 Mineralogy and Implications

Figure 4.32 indicates that zone one was more enriched in carbonate than in zone two. Accompanying the enrichment in zone one is a high concentration of Ca and low concentration of Fe and Mn. The high concentration of carbonate may indicate that upwelling was weak during deposition since cool upwelling waters dissolve carbonate.

In zone two, the carbonate enrichment is reduced and the respective calcium concentration is reduced accordingly. In hand sample, this core appears as finely laminated carbonaceous mudstone. The reduction in Mn and increase in Fe indicates the carbonate may exist in the siderite phase ($FeCO_3$) and calcite phase ($CaCO_3$) because siderite commonly forms at shallow depths, the site of deposition reinforces this possibility (Klein and Dutrow, 2002).

5.6.4 Conclusions

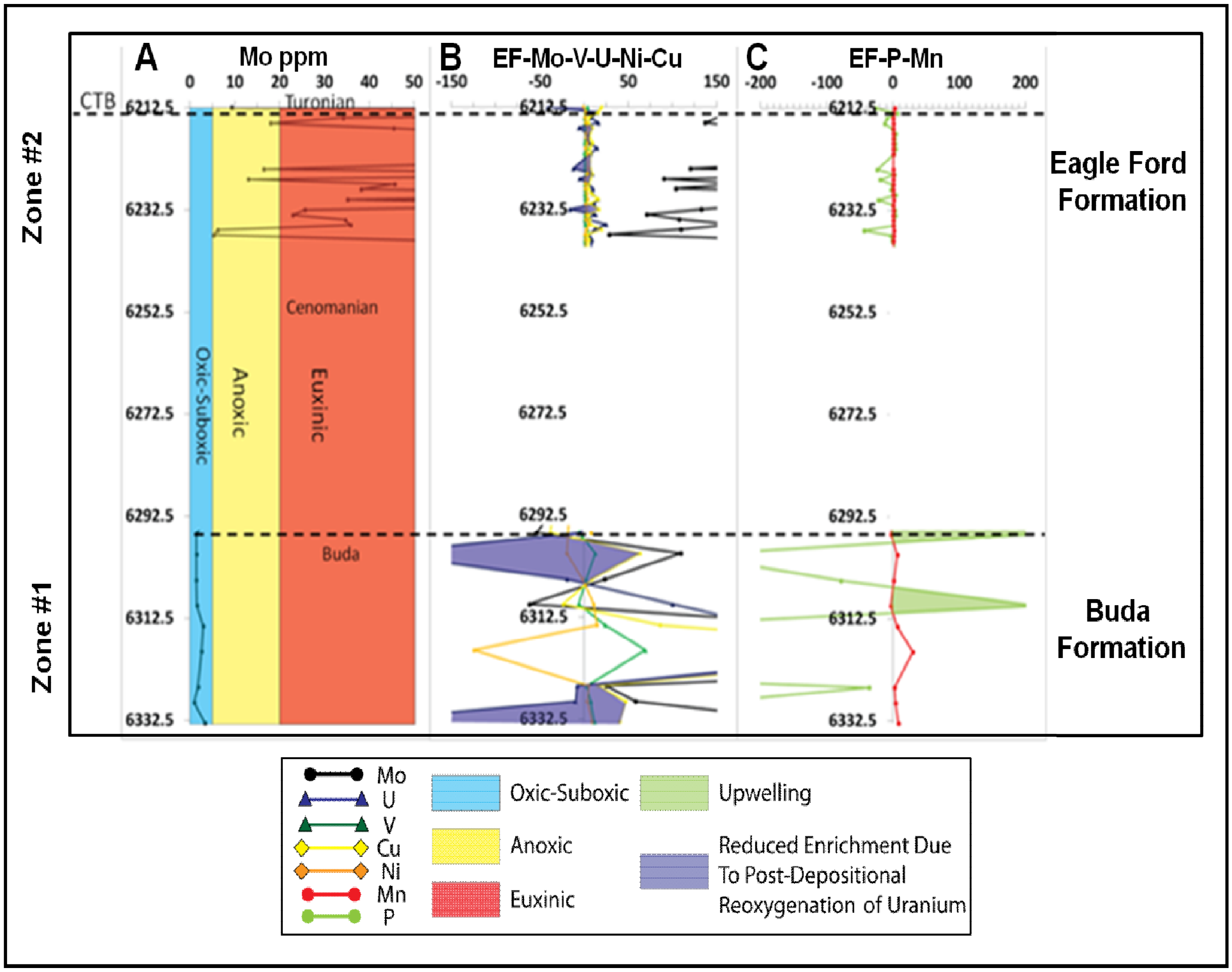


Figure 5.7 Gose & Shield Hassett #3 Drill Core Depositional Environment (A) Molybdenum Concentration (B) Enrichments of Molybdenum, Vanadium, Uranium, Nickel and Copper (C) Enrichments of Phosphorus and Manganese. The Figure is Constructed from the Results Section from (Figures 4.7 and 4.8).

The Gose & Shield Hassett #3 Drill Core includes both the Eagle Ford and Buda Formations. Deposition of the Eagle Ford Formation was dominated by euxinia, which is supported by the Mo values (Figure 5.7 (A))(Zheng, 2000) and concurrent enrichment of Mo, V and U relative to Ni and Cu (Figure 5.7 (B))(Tribovillard, 2006). Deposition of the Buda Formation was deposited when water column conditions were oxic-suboxic. This is supported by Mo values and lack of correlation between Mo, V, U, Ni and Cu.

Unlike most of the other cores from this study, substantial upwelling does not seem to accompany anoxic-euxinic water column conditions (Figure 5.7 (C))(Brumsack, 2006). During the deposition of zone two sapropel, anoxic basin-type conditions, likely dominated during deposition. It is possible that nutrients were of terrestrial provenance and not transported by upwelling, as is indicated all other cores analyzed in this study. Providing that sufficient nutrients are available primary productivity could increase, stagnation of the water column would ensue and anoxia would occur.

5.7 Getty Lloyd Hurt #1 Drill Core

Sediment of the Getty Lloyd Hurt #1 Drill Core was deposited on an extended shallow marine slope. It was located approximately 300 kilometers southwest of the Hay Shell Oil Co. ED Hay, Unit #1 Drill Core (Figure 2.1). Intervals of the core are composed interlaminated silty shale (organic-rich mudrock) and argrillaceous quartzose siltstone typical of the Eagle Ford Formation. This is consistent a study in the proximity of this study area conducted by (Dawson and Almon, 2010). However, a more recent study conducted by Harbor, 2011 differs from the description in this study. Nonetheless, for the purposes of this study the former description is utilized.

However, the upper end member of the core seems more analogous to a laminated white chalky limestone more typical of the overlaying Austin Chalk Formation. Furthermore, the radical shifts in the data (Figure 4.11 and 4.12) between zone one and zone two, the Eagle Ford and Austin Chalk, respectively, that will be discussed indicate that possibility.

5.7.1 Water Column Conditions

Molybdenum Concentration

Note on Molybdenum Enrichment:

Molybdenum concentration is useful as a proxy for determining deposition redox conditions (Zheng et al, 2000). Molybdenum concentration is linked to appreciably high hydrogen sulfide and associated organic carbon accumulation. However, there is some question as to whether "Mo enrichment speaks directly to the presence or absence of sulfide in the water column (Mackenzie, 2005)." In oxic waters, Mo can diffuse into sulfide-rich pore waters. Sediments deposited in these conditions can become more enriched in Mo than what is normally delivered to the sediment as the detrital fraction. High Mo concentrations are observed in the Getty Lloyd Hurt #1 Drill Core, suggesting this method of Mo enrichment. In short, it is "hypothesized that a euxinic setting is not required for Mo enrichment (Mackenzie, 2005)." Hence, oxic depositional environments may result in an enrichment of Mo. Some such conditions are indicated in following sections.

Zone one and zones two are concentrated with an average of 5 and 3 ppm Mo (Table 4.12), respectively. This indicates that oxic-suboxic conditions may have been prevalent during the deposition of each zone. The presence of burrows also supports an oxic-suboxic water column (Harbor, 2011).

5.7.1.1 Multi-Proxy Trace Elements: U, V, Mo, Ni, Cu

Uranium, V, Mo, Ni, and Cu concentrations are compared to Al concentrations in Figure 4.24. Uranium, Mo, and Ni show no apparent correlation or linearity with Al. This implies that the detrital fraction does not significantly contribute to their enrichment or that they were deposited with clay. Figure 4.45 demonstrates that there is no correlation between any of the trace elements in either zone one or zone two, which is indicative of an oxic-suboxic depositional environment.

5.7.2 Anoxic-Euxinic Basins and Upwelling Environments

5.7.2.1 P Enrichment and Mn Depletion

Zone one is enriched in P (6.1 ppm) and depleted in Mn (2.5 ppm) (Table 4.11). Phosphorus may be enriched due to a reduced hydrologic cycle. The subsequent reduction in productivity could be the result in the reduction of P released from organic matter after deposition. Manganese is relatively enriched in surface waters compared to deeper waters. At the oxic-anoxic interface Mn, may diffuse upward or downward within the sediment. The downward diffusion of Mn^{2+} can lead to the precipitation of $MnCO_3$, or rhodochrosite (Tribovillard, 2006). This is plausible given the relatively high abundance of carbonate (Figure 4.34). However, it is also possible that Mn^{2+} it went into calcium carbonate.

Approximately only one percent of P escapes cycling and is preserved in the sediment. In zone two P is depleted (-59.4 ppm) and Mn is enriched (5.8 ppm). The enrichment could indicate greater organic matter burial (absent anoxia-euxinic conditions in the water column) and greater preservation in zone one than in zone two. However, P cycling is dynamic (Tribovillard, 2006) and the enrichment is considered with caution. In this scheme, P and Mn values do not support a depositional environment influenced by upwelling.

5.7.3 Mineralogy and Implications

Zone two has a higher carbonate concentration than zone one (Figure 4.36). This is consistent with an increase of Mn enrichment in zone two compared to zone one, due to the fact that Mn^{2+} readily goes into calcium carbonate and can even lead to the precipitation of $MnCO_3$. Figure 4.27 also indicates that some carbonate precipitated as calcite. An increase in zone two in Fe concentration indicates the possibility of siderite precipitation as well.

Given that Mn and Fe both exhibit an increase in concentration throughout zone two, it is also possible that the carbonate exists in some intervals in the ankerite phase Ca(Fe, Mg, Mn)$(CO_3)_2$. Since ankerite typically consists of alternating layers of carbonate and metal cations, this could explain the lamination throughout much of the core. Ankerite is part of the dolomite series, which is primarily found in sedimentary strata that is typically the result of the replacement of Ca with Mg (Klein and Dutrow, 2002).

5.7.4 Conclusions

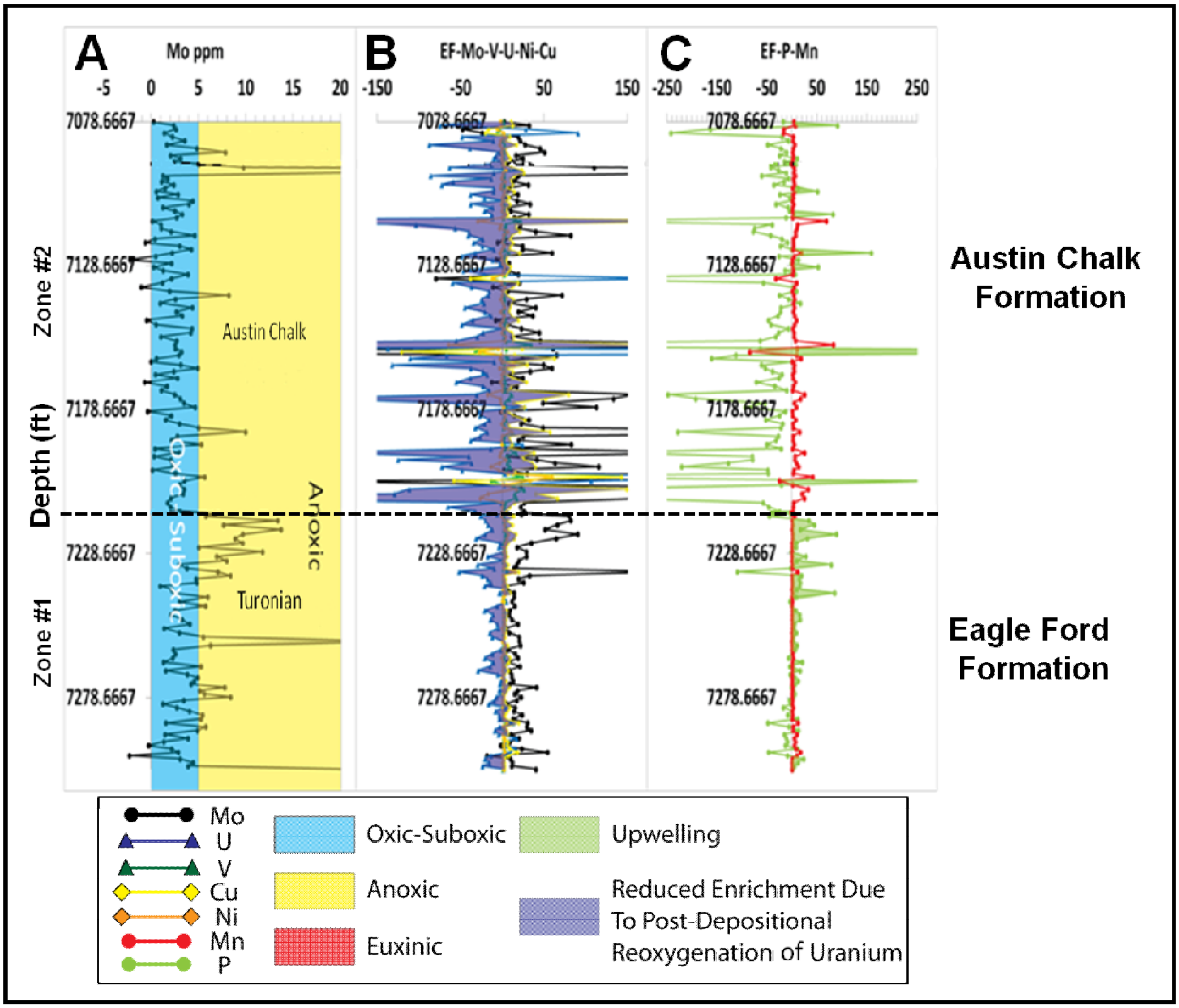


Figure 5.8 Getty Lloyd Hurt #1 Drill Core Depositional Environment (A) Molybdenum Concentration (B) Enrichments of Molybdenum, Vanadium, Uranium, Nickel and Copper (C) Enrichments of Phosphorus and Manganese. The Figure is Constructed from the Results Section (Figures 4.11 and 4.12).

The Getty Lloyd Hurt #1 Drill Core was deposited on a proximal extended shelfal marine slope. The Mo concentration (Figure 5.8 (A))((Zheng, 2000) and multi-proxy trace elements (Figure 5.8 (B)) (Tribovillard, 2006) used to evaluate the environment type indicate that both zones were deposited under suboxic-oxic conditions. Upwelling did not significantly influence environmental conditions (Figure 5.8 (C)).

Providing that the depositional environment is similar to that of the modern normal (oxic) marine environments, carbonate is readily mediated and preserved on continental shelves. Although $MnCO_3$ could have been precipitated in both zones, it is possible that during some intervals Mn went into calcite or was preserved as ankerite. Dawson and Almon, 2010 found that parts of the Eagle Ford were preserved under oxic conditions and that a portion from La Salle County (the same county from where this core was sampled) in particular was preserved under oxic conditions. Their findings are consistent with this study.

In summation, due to the dynamic shift in chemical signature that occurs at approximately 7,214 feet, it is possible that the controlling factors that lead to the deposition and preservation of detritus from primary productivity changed from zone one to zone two. The results and analyses indicate that suboxic-oxic conditions were in place. Previous studies are consistent with results from this study and indicate that the Eagle Ford consists of a lower and upper portion deposited during an oxygen deficit and suboxic-oxic water column conditions, respectfully. The Austin Chalk, the formation deposited above the Eagle Ford, was deposited while oxic-suboxic conditions were in place. Also, U is only enriched in sediment by diffusion directly from the water column during oxygen depleted conditions. As is expected, under increasingly oxic conditions U becomes more depleted from zone one to zone two.

The above observations lead to the conclusion that zone one represents the upper portion (Turonian) of the Eagle Ford Formation and that zone two represents the lower portion of the Austin Chalk Formation.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

In this section an abridged interpretation of the discussion in the previous section is provided in a brief conclusion. Providing this conclusion serves its purpose, a reading of it alone and removed from all previous sections will explain the majority of the results of the study through a broad interpretation of the environmental conditions that led to deposition of the Eagle Ford Formation.

Following the conclusion a series of brief recommendations are provided that will address areas of future research in order to further the understanding of the environmental conditions that led to the deposition of the Eagle Ford Formation. Though not comprehensive, the results of this study should provide the most plausible means of developing a comprehensive model for the influences of depositional conditions.

6.2 Conclusion

The results of this study suggest that the Eagle Ford Formation was deposited under range of local dynamic conditions, such as upwelling strength. However, such conditions occurred in tandem with tectonic plate rearrangement, abrupt rise in temperature due to an influx of CO_2 into the atmosphere as a result of enhanced volcanism, and ultimately sluggish or stagnant ocean circulation. Once the excess CO_2 was sequestered in sediment, water column conditions returned to "normal."

As indicated in the previous section, each core and each zone captures a unique period of time in which deposition occurred under the influence of one of the aforementioned conditions or in transition from one dominant condition to another. In short, deposition mostly occurred under the influence of:

- an oxic-suboxic water column before or after the onset of an OAE
- an anoxic and possibly sporadically euxinic water column during the onset of an OAE
- a euxinic water column with available H_2S during the late phase of an OAE

6.2.1 Summary

In conclusion the intent of this study was to determine the environmental conditions that led to the deposition of the Eagle Ford Formation. However, in doing so it was determined not only was the Eagle Ford Formation contained within the cores analyzed, but also present were the Buda and Austin Chalk Formations in select cores. Through an understanding of OAEs, environmental conditions and effects some assumptions concerning the deposition of each core can be made when considering the chemostratigraphy. However, all such factors it is still difficult to correlate within the Upper or Lower Eagle Ford Formation. The results of this study *ultimately* reveal that the analysis of the geochemistry can be used to correlate different formations (Figure 4.50 – 4.52), but not reliably within the formation itself due to its heterogeneous character.

6.3 Recommendations

Analyses of the chemostratigraphy provide a thorough account of the constituent elements that comprise the Eagle Ford Formation. However, it is limited in the sense that the results only *imply* water column conditions during deposition, although the implications are compelling.

In this study the chemostratigraphy also yielded little use in resolving the time of deposition through the application of orbital forcing. Although some patterns in the data did emerge that were suggestive, they were not definitive enough to warrant further investigation in this study.

A means of confirming or reinforcing the chemostratigraphic results is necessary for a complete and comprehensive interpretation of the environmental conditions that led to the deposition of the Eagle Ford Formation. Proposed further analyses include:

- Integrating the results of this study with the one conducted by (Harbor, 2011) would aid in confirming if free H_2S existed in the water column.
- Radiometric dating of the ash beds would aid in better resolving the time of deposition for each drill core.
- Higher resolution sampling may also reveal more pronounced Milankovitch cycles to better determine the timing of deposition for each drill core.

The procurement of complete cores that capture large sections of the Buda, Eagle Ford, and Austin Chalk Formations would be invaluable in determining the paleoenvironmental conditions. A supreme weakness of this study was that few “good” cores were available for analysis. At times, interpretations had to be pieced together using assumptions in environmental conditions that prevailed during the deposition of missing sections of core.

The various techniques utilized in this study to determine water column conditions in place during depositions were at times more successful than others. Some techniques resulted in interpretations that were contradictory to results derived from other techniques. Other techniques complimented and reinforced the results.

The most useful technique for determining water column conditions was by evaluating the concentration of Mo as indicated by Zheng, 2000. By utilizing the technique indicated by

Tribovillard, 2006, it is possible to determine water column conditions by considering the relative rate of accumulation of U, V, Mo, Ni and Cu. However, considering the relative rate of accumulation by averaging the enrichments in zones defined by pattern recognition could be and were at time misleading. Misleading results can be reduced by eliminating outliers that cause a misleading large or small average. This was considered in the interpretation provided in the discussion.

Evaluating the enrichments and depletions of P and Mn, as indicated by Brumsack, 2006, the presence of upwelling or sapropel type environments can be determined. This technique was the primary means to determine the influence of upwelling in this study. However, the technique of utilizing trace metals in organic carbon rich sediments that typify upwelling or sapropel environments and comparing them with the average enrichment of trace metals in each zone of each drill core often provided for contradictory results when compared to those returned by evaluating the enrichments and depletions of P and Mn. This is considered in the discussion and the results are not weighted as heavily as the enrichments and depletions of P and Mn when interpreting whether upwelling or sapropel type conditions were an influence during deposition.

An unsuccessful technique was utilized in which linkages were made between various depositional environments with the drill cores analyzed in this study. This was accomplished by comparing elemental abundances, oxides and elemental abundances normalized to Al from the cores utilized in this study with those from known depositional environments determined by Brumsack, 2006. However, the attempt was unsuccessful as the returned results were often contradictory to all the other results in this study or anomalous and therefore disregarded. All the data compared and the associated results concerning this technique are located in Appendix B.

In summation, for the purpose of determining water column conditions, evaluating the Mo concentration proved to be the most reliable for this study. The Buda and Austin Chalk Formations were dominantly oxic-suboxic during deposition and the Eagle Ford Formation was dominantly anoxic-euxinic during deposition, except in some regional locations where the upper portion was dominated by oxic-suboxic conditions (Figure 5.8). Nonetheless, Mo concentrations in those formations most reliably support the former and can be observed in Figures 5.3 – 5.8.

APPENDIX A

DRILL CORE DATA

Geological Research Co. Schauers, FT #1 Drill Core Data

Geological Research Co. Schauers, FT #1		Depth (ft)	N %	TOC %	C/N	δ15N	δ13C	TIC %
Zone #3	**Sample X1**	8090.50						5.639
Zone #3	**Sample X2**	8091.50						7.929
Zone #3	**Sample X3**	8092.50						8.069
Zone #3	**Sample X4**	8093.50						7.915
Zone #3	**Sample X5**	8094.50						6.412
Zone #3	**Sample X6**	8095.50	0.101	2.827	32.518	-2.804	-24.782	5.929
Zone #3	**Sample X7**	8096.50	0.113	2.871	29.611	-2.773	-26.023	5.221
Zone #3	**Sample X8**	8097.50	0.101	3.056	35.406	-1.666	-24.094	5.966
Zone #3	**Sample X9**	8098.50	0.104	2.768	31.059	-2.067	-25.213	5.803
Zone #3	**Sample X10**	8099.50	0.108	2.985	32.237	-1.833	-24.988	5.176
Zone #3	**Sample X11**	8100.50						7.923
Zone #3	**Sample X12**	8101.50						6.490
Zone #3	**Sample X13**	8102.50						8.334
Zone #3	**Sample X14**	8103.50						7.252
Zone #3	**Sample X15**	8104.50						7.825
Zone #3	**Sample X16**	8105.50						9.023
Zone #3	**Sample X17**	8106.50						6.717
Zone #3	**Sample X18**	8107.50						11.059
Zone #3	**Sample X19**	8108.50						7.856
Zone #3	**Sample X20**	8109.50						7.589
Zone #3	**Sample X21**	8110.50						7.870
Zone #3	**Sample X22**	8111.50						7.358
Zone #3	**Sample X23**	8112.50						10.255
Zone #3	**Sample X24**	8113.50						10.409
Zone #3	**Sample X25**	8117.50						7.179
Zone #3	**Sample X26**	8118.50						5.004
Zone #3	**Sample X27**	8119.50						8.188
Zone #3	**Sample X28**	8120.50						11.211
Zone #3	**Sample X29**	8121.50						6.853
Zone #3	**Sample X30**	8122.50						5.694
Zone #3	**Sample X31**	8123.50						
Zone #3	**Sample X32**	8124.50						
Zone #3	**Sample X33**	8125.50						
Zone #3	**Sample X34**	8126.50						
Zone #3	**Sample X35**	8127.50						

Zone #3	**Sample X36**	8128.50						
Zone #3	**Sample X37**	8129.50						
Zone #3	**Sample X38**	8130.50						
Zone #3	**Sample X39**	8131.50						
Zone #3	**Sample X40**	8138.50						
Zone #3	**Sample X41**	8139.50						
Zone #3	**Sample X42**	8140.50						
Zone #3	**Sample X43**	8141.50						
Zone #3	**Sample X44**	8142.50						
Zone #3	**Sample X45**	8143.50						
Zone #3	**Sample X46**	8144.50						
Zone #3	**Sample X47**	8145.50						
Zone #3	**Sample X48**	8146.50						
Zone #3	**Sample X49**	8147.50						
Zone #2	**Sample X50**	8148.50						
Zone #2	**Sample X51**	8149.50						
Zone #2	**Sample X52**	8153.50						
Zone #2	**Sample X53**	8154.50						
Zone #2	**Sample X54**	8155.50						
Zone #2	**Sample X55**	8156.50						
Zone #2	**Sample X56**	8157.50						
Zone #2	**Sample X57**	8158.50						
Zone #1	**Sample X58**	8159.50						
Zone #1	**Sample X59**	8160.50						
Zone #1	**Sample X60**	8161.50						
Zone #1	**Sample X61**	8162.50						
Zone #1	**Sample X62**	8163.50						
Zone #1	**Sample X63**	8164.50						
Zone #1	**Sample X64**	8165.50						
Zone #1	**Sample X65**	8166.50						
Zone #1	**Sample X66**	8167.50						
Zone #1	**Sample X67**	8168.50						
Zone #1	**Sample X68**	8169.50						
Zone #1	**Sample X69**	8170.50						
Zone #1	**Sample X70**	8171.50						
Zone #1	**Sample X71**	8172.50						
Zone #1	**Sample X72**	8173.50						

Geological Research Co. Schauers, FT #1		Depth (ft)	Mg %	Al %	Si %	P %	K %
Zone #3	Sample X1	8090.50	0.856	3.810	12.551	0.070	2.050
Zone #3	Sample X2	8091.50	0.673	1.853	6.236	0.010	0.897
Zone #3	Sample X3	8092.50	0.922	1.989	7.475	-0.042	0.962
Zone #3	Sample X4	8093.50	0.694	2.046	7.744	-0.017	1.009
Zone #3	Sample X5	8094.50	0.698	2.740	10.686	0.072	1.327
Zone #3	Sample X6	8095.50	0.835	2.661	12.366	0.049	1.810
Zone #3	Sample X7	8096.50	1.165	2.462	12.233	0.218	1.512
Zone #3	Sample X8	8097.50	0.635	1.891	8.908	0.301	1.070
Zone #3	Sample X9	8098.50	0.652	3.023	12.988	0.032	1.718
Zone #3	Sample X10	8099.50	0.831	3.054	13.979	0.088	1.484
Zone #3	Sample X11	8100.50	0.843	1.632	6.236	0.062	0.766
Zone #3	Sample X12	8101.50	0.759	2.216	7.199	-0.031	1.043
Zone #3	Sample X13	8102.50	0.635	1.692	5.245	0.029	0.450
Zone #3	Sample X14	8103.50	0.634	1.400	6.359	-0.041	0.460
Zone #3	Sample X15	8104.50	0.833	2.995	9.033	0.075	1.304
Zone #3	Sample X16	8105.50	0.769	0.847	3.064	0.054	-0.072
Zone #3	Sample X17	8106.50	0.602	2.651	9.090	0.039	1.239
Zone #3	Sample X18	8107.50	0.701	0.591	1.470	-0.242	-0.458
Zone #3	Sample X19	8108.50	0.592	0.977	5.130	-0.096	0.247
Zone #3	Sample X20	8109.50	0.841	1.491	6.419	0.042	0.343
Zone #3	Sample X21	8110.50	0.836	4.537	11.616	0.092	1.989
Zone #3	Sample X22	8111.50	0.868	1.461	6.761	0.095	0.290
Zone #3	Sample X23	8112.50	0.482	0.379	1.345	-0.085	-0.423
Zone #3	Sample X24	8113.50	0.799	0.609	2.068	-0.203	-0.374
Zone #3	Sample X25	8117.50	0.884	2.111	9.721	0.152	0.503
Zone #3	Sample X26	8118.50	1.008	3.317	12.898	0.135	1.229
Zone #3	Sample X27	8119.50	1.073	1.217	4.949	0.489	-0.052
Zone #3	Sample X28	8120.50	0.356	0.591	1.285	-0.147	-0.371
Zone #3	Sample X29	8121.50	0.695	2.343	11.483	0.015	0.572
Zone #3	Sample X30	8122.50	0.656	3.539	13.563	0.107	1.429
Zone #3	Sample X31	8123.50	0.819	0.718	4.136	-0.164	-0.280
Zone #3	Sample X32	8124.50	0.619	3.029	13.501	0.046	1.227
Zone #3	Sample X33	8125.50	0.861	0.901	4.942	-0.260	-0.257
Zone #3	Sample X34	8126.50	0.590	2.247	9.939	0.023	0.591
Zone #3	Sample X35	8127.50	0.521	1.103	6.597	-0.178	-0.204
Zone #3	Sample X36	8128.50	0.573	3.600	9.977	0.394	0.649
Zone #3	Sample X37	8129.50	0.636	0.613	1.484	-0.144	-0.388

Zone #3	**Sample X38**	8130.50	0.838	1.196	9.295	-0.202	-0.100
Zone #3	**Sample X39**	8131.50	0.608	2.905	9.677	-0.045	0.750
Zone #3	**Sample X40**	8138.50	0.603	0.710	1.406	-0.164	-0.371
Zone #3	**Sample X41**	8139.50	0.662	2.854	8.236	0.026	1.060
Zone #3	**Sample X42**	8140.50	0.407	2.722	6.116	0.481	0.436
Zone #3	**Sample X43**	8141.50	0.752	0.395	1.627	-0.230	-0.340
Zone #3	**Sample X44**	8142.50	0.558	3.798	9.981	0.089	1.450
Zone #3	**Sample X45**	8143.50	0.918	3.502	7.717	0.441	0.987
Zone #3	**Sample X46**	8144.50	0.951	3.914	11.761	0.034	1.523
Zone #3	**Sample X47**	8145.50	0.672	3.071	10.604	0.092	1.308
Zone #3	**Sample X48**	8146.50	0.536	3.803	10.248	0.049	1.342
Zone #3	**Sample X49**	8147.50	0.570	1.846	5.743	0.053	0.541
Zone #2	**Sample X50**	8148.50	0.731	2.045	4.236	-0.126	0.200
Zone #2	**Sample X51**	8149.50	0.183	3.289	11.288	0.084	2.326
Zone #2	**Sample X52**	8153.50	-0.105	7.285	20.949	0.076	2.280
Zone #2	**Sample X53**	8154.50	0.285	6.083	18.741	0.068	1.710
Zone #2	**Sample X54**	8155.50	0.680	5.612	17.855	0.060	1.858
Zone #2	**Sample X55**	8156.50	0.810	2.878	8.848	0.168	0.808
Zone #2	**Sample X56**	8157.50	0.443	5.372	15.572	0.113	1.975
Zone #2	**Sample X57**	8158.50	0.094	5.883	13.266	0.233	1.679
Zone #1	**Sample X58**	8159.50	0.874	0.663	1.516	-0.201	-0.026
Zone #1	**Sample X59**	8160.50	0.601	0.504	0.655	-0.140	-0.319
Zone #1	**Sample X60**	8161.50	0.576	0.743	0.783	-0.101	-0.324
Zone #1	**Sample X61**	8162.50	0.846	0.976	0.975	-0.115	-0.231
Zone #1	**Sample X62**	8163.50	0.553	1.269	1.078	-0.037	-0.194
Zone #1	**Sample X63**	8164.50	0.521	0.772	0.964	-0.224	-0.259
Zone #1	**Sample X64**	8165.50	0.861	0.573	1.081	-0.184	-0.184
Zone #1	**Sample X65**	8166.50	0.768	0.525	0.424	-0.251	-0.458
Zone #1	**Sample X66**	8167.50	0.743	0.690	0.384	-0.224	-0.430
Zone #1	**Sample X67**	8168.50	0.427	0.524	0.929	-0.174	-0.210
Zone #1	**Sample X68**	8169.50	0.317	0.903	0.921	-0.138	-0.248
Zone #1	**Sample X69**	8170.50	0.591	0.556	0.630	-0.297	-0.362
Zone #1	**Sample X70**	8171.50	0.865	0.744	0.728	-0.223	-0.298
Zone #1	**Sample X71**	8172.50	0.687	0.484	0.568	-0.210	-0.394
Zone #1	**Sample X72**	8173.50	0.832	0.843	1.938	-0.123	0.045

Geological Research Co. Schauers, FT #1		Depth (ft)	Ca %	Ti %	Mn %	Fe %	V ppm
Zone #3	**Sample X1**	8090.50	20.979	0.176	0.031	1.696	229.947
Zone #3	**Sample X2**	8091.50	29.855	0.092	0.028	1.081	173.813
Zone #3	**Sample X3**	8092.50	29.026	0.088	0.026	1.013	152.465
Zone #3	**Sample X4**	8093.50	28.419	0.101	0.025	1.113	176.000
Zone #3	**Sample X5**	8094.50	23.908	0.147	0.025	1.430	158.495
Zone #3	**Sample X6**	8095.50	19.850	0.205	0.030	1.600	209.966
Zone #3	**Sample X7**	8096.50	16.859	0.185	0.024	1.842	277.938
Zone #3	**Sample X8**	8097.50	21.424	0.145	0.033	1.567	194.053
Zone #3	**Sample X9**	8098.50	20.178	0.172	0.025	1.508	208.076
Zone #3	**Sample X10**	8099.50	19.785	0.170	0.020	1.652	221.834
Zone #3	**Sample X11**	8100.50	30.243	0.104	0.024	0.943	209.423
Zone #3	**Sample X12**	8101.50	28.246	0.117	0.023	1.174	372.835
Zone #3	**Sample X13**	8102.50	31.814	0.085	0.019	1.031	297.546
Zone #3	**Sample X14**	8103.50	29.379	0.092	0.023	1.367	249.710
Zone #3	**Sample X15**	8104.50	24.074	0.193	0.014	2.024	728.900
Zone #3	**Sample X16**	8105.50	33.596	0.025	0.026	0.596	156.809
Zone #3	**Sample X17**	8106.50	25.562	0.156	0.015	1.679	498.098
Zone #3	**Sample X18**	8107.50	33.987	0.006	0.027	0.423	126.088
Zone #3	**Sample X19**	8108.50	30.770	0.082	0.018	1.478	299.494
Zone #3	**Sample X20**	8109.50	29.306	0.091	0.016	1.590	289.040
Zone #3	**Sample X21**	8110.50	17.631	0.295	0.017	2.450	600.037
Zone #3	**Sample X22**	8111.50	29.112	0.078	0.019	1.291	193.868
Zone #3	**Sample X23**	8112.50	34.275	0.021	0.028	0.485	123.503
Zone #3	**Sample X24**	8113.50	33.112	0.022	0.030	0.491	118.508
Zone #3	**Sample X25**	8117.50	26.664	0.097	0.016	1.215	160.869
Zone #3	**Sample X26**	8118.50	18.712	0.215	0.017	1.724	280.832
Zone #3	**Sample X27**	8119.50	31.785	0.039	0.021	0.817	137.615
Zone #3	**Sample X28**	8120.50	34.458	0.007	0.026	0.404	115.390
Zone #3	**Sample X29**	8121.50	25.094	0.111	0.016	1.216	233.325
Zone #3	**Sample X30**	8122.50	19.635	0.207	0.014	1.681	436.382
Zone #3	**Sample X31**	8123.50	32.202	0.007	0.026	0.473	97.433
Zone #3	**Sample X32**	8124.50	20.337	0.206	0.014	1.803	593.265
Zone #3	**Sample X33**	8125.50	31.308	0.030	0.025	0.506	136.526
Zone #3	**Sample X34**	8126.50	25.152	0.152	0.017	1.536	387.463
Zone #3	**Sample X35**	8127.50	31.550	0.021	0.022	0.527	118.715
Zone #3	**Sample X36**	8128.50	22.183	0.246	0.024	1.800	304.160
Zone #3	**Sample X37**	8129.50	34.473	0.019	0.029	0.441	127.869

Zone #3	**Sample X38**	8130.50	29.089	0.033	0.025	0.566	94.715
Zone #3	**Sample X39**	8131.50	25.759	0.137	0.018	1.551	273.762
Zone #3	**Sample X40**	8138.50	34.764	0.021	0.026	0.441	132.423
Zone #3	**Sample X41**	8139.50	25.903	0.191	0.023	1.676	503.549
Zone #3	**Sample X42**	8140.50	31.224	0.107	0.023	0.952	241.192
Zone #3	**Sample X43**	8141.50	34.447	0.026	0.026	0.451	172.100
Zone #3	**Sample X44**	8142.50	23.684	0.223	0.016	1.658	639.519
Zone #3	**Sample X45**	8143.50	25.800	0.201	0.020	1.805	236.719
Zone #3	**Sample X46**	8144.50	20.606	0.253	0.019	1.906	351.188
Zone #3	**Sample X47**	8145.50	22.129	0.219	0.019	1.825	294.953
Zone #3	**Sample X48**	8146.50	23.252	0.214	0.019	1.868	348.210
Zone #3	**Sample X49**	8147.50	30.285	0.106	0.023	1.322	153.251
Zone #2	**Sample X50**	8148.50	32.223	0.066	0.024	0.708	137.410
Zone #2	**Sample X51**	8149.50	1.655	0.298	0.017	4.789	506.037
Zone #2	**Sample X52**	8153.50	2.867	0.424	0.032	2.978	282.680
Zone #2	**Sample X53**	8154.50	13.085	0.259	0.021	2.180	263.057
Zone #2	**Sample X54**	8155.50	5.630	0.344	0.032	2.932	338.525
Zone #2	**Sample X55**	8156.50	24.328	0.163	0.027	1.636	257.157
Zone #2	**Sample X56**	8157.50	4.188	0.329	0.042	3.218	379.797
Zone #2	**Sample X57**	8158.50	10.065	0.303	0.034	3.562	511.535
Zone #1	**Sample X58**	8159.50	33.449	0.035	0.050	0.528	107.910
Zone #1	**Sample X59**	8160.50	34.213	0.029	0.048	0.473	104.994
Zone #1	**Sample X60**	8161.50	34.690	0.016	0.045	0.712	104.131
Zone #1	**Sample X61**	8162.50	34.186	-0.008	0.048	0.466	80.761
Zone #1	**Sample X62**	8163.50	34.826	0.024	0.046	0.427	85.517
Zone #1	**Sample X63**	8164.50	34.486	0.009	0.049	0.427	105.508
Zone #1	**Sample X64**	8165.50	34.094	0.035	0.048	0.426	114.900
Zone #1	**Sample X65**	8166.50	33.464	0.008	0.051	0.455	112.338
Zone #1	**Sample X66**	8167.50	33.316	0.019	0.052	0.486	113.245
Zone #1	**Sample X67**	8168.50	34.428	0.025	0.050	0.491	105.628
Zone #1	**Sample X68**	8169.50	35.397	0.029	0.051	0.474	101.878
Zone #1	**Sample X69**	8170.50	34.205	0.020	0.056	0.429	120.871
Zone #1	**Sample X70**	8171.50	33.387	0.018	0.056	0.503	112.057
Zone #1	**Sample X71**	8172.50	34.103	-0.004	0.055	0.452	77.047
Zone #1	**Sample X72**	8173.50	33.308	0.058	0.051	1.430	114.549

Geological Research Co. Schauers, FT #1		Depth (ft)	Cr ppm	Ni ppm	Cu ppm	Zn ppm	Th ppm
Zone #3	**Sample X1**	8090.50	80.662	25.961	21.235	81.686	5.782
Zone #3	**Sample X2**	8091.50	62.930	46.910	8.725	76.723	1.924
Zone #3	**Sample X3**	8092.50	92.070	67.180	19.790	81.935	3.344
Zone #3	**Sample X4**	8093.50	76.000	32.787	1.824	71.732	3.034
Zone #3	**Sample X5**	8094.50	59.085	57.774	11.421	70.556	4.111
Zone #3	**Sample X6**	8095.50	43.114	32.618	10.260	61.478	4.697
Zone #3	**Sample X7**	8096.50	31.702	56.334	32.103	104.796	3.928
Zone #3	**Sample X8**	8097.50	12.017	51.373	40.273	73.695	5.213
Zone #3	**Sample X9**	8098.50	50.681	39.670	38.294	87.152	6.122
Zone #3	**Sample X10**	8099.50	71.513	45.243	36.082	71.917	4.575
Zone #3	**Sample X11**	8100.50	89.849	37.870	22.890	67.387	3.320
Zone #3	**Sample X12**	8101.50	66.747	52.732	21.828	100.476	4.958
Zone #3	**Sample X13**	8102.50	104.536	90.378	7.581	134.862	2.324
Zone #3	**Sample X14**	8103.50	46.657	72.622	25.443	69.167	3.438
Zone #3	**Sample X15**	8104.50	96.157	139.881	44.575	218.504	3.110
Zone #3	**Sample X16**	8105.50	71.892	34.978	22.778	35.118	3.100
Zone #3	**Sample X17**	8106.50	71.109	57.349	37.643	143.442	3.152
Zone #3	**Sample X18**	8107.50	48.008	55.150	10.866	34.137	1.107
Zone #3	**Sample X19**	8108.50	62.155	114.367	33.645	156.195	2.601
Zone #3	**Sample X20**	8109.50	68.964	88.504	4.000	85.617	2.852
Zone #3	**Sample X21**	8110.50	54.173	99.043	57.546	113.358	8.750
Zone #3	**Sample X22**	8111.50	71.108	89.526	3.000	73.504	3.498
Zone #3	**Sample X23**	8112.50	54.210	0.000	18.044	26.083	2.018
Zone #3	**Sample X24**	8113.50	46.312	11.165	24.596	40.186	2.260
Zone #3	**Sample X25**	8117.50	93.205	69.925	22.644	70.590	4.183
Zone #3	**Sample X26**	8118.50	75.066	80.234	25.015	103.789	4.843
Zone #3	**Sample X27**	8119.50	81.865	51.893	23.518	56.305	3.107
Zone #3	**Sample X28**	8120.50	39.973	1.168	21.000	22.909	2.220
Zone #3	**Sample X29**	8121.50	106.318	62.866	28.741	111.091	4.052
Zone #3	**Sample X30**	8122.50	110.488	71.752	45.750	155.186	5.120
Zone #3	**Sample X31**	8123.50	83.113	14.514	14.470	16.215	1.624
Zone #3	**Sample X32**	8124.50	98.501	53.354	52.018	87.025	3.786
Zone #3	**Sample X33**	8125.50	88.888	5.000	16.000	26.470	2.366
Zone #3	**Sample X34**	8126.50	97.047	44.998	43.886	77.089	3.622
Zone #3	**Sample X35**	8127.50	122.537	6.960	2.458	35.075	1.552
Zone #3	**Sample X36**	8128.50	54.078	45.897	48.017	74.470	6.513
Zone #3	**Sample X37**	8129.50	38.903	17.000	4.000	5.902	1.589

Zone #3	**Sample X38**	8130.50	120.522	15.000	21.104	35.659	2.673
Zone #3	**Sample X39**	8131.50	84.806	56.259	57.145	87.881	3.915
Zone #3	**Sample X40**	8138.50	52.965	11.000	10.000	25.706	1.826
Zone #3	**Sample X41**	8139.50	76.956	47.531	32.613	111.261	3.223
Zone #3	**Sample X42**	8140.50	117.792	33.137	41.099	144.416	4.226
Zone #3	**Sample X43**	8141.50	36.540	25.092	7.000	26.515	0.579
Zone #3	**Sample X44**	8142.50	109.393	100.957	30.369	140.595	5.759
Zone #3	**Sample X45**	8143.50	98.867	61.837	31.917	85.711	2.158
Zone #3	**Sample X46**	8144.50	97.183	35.822	27.510	100.070	5.450
Zone #3	**Sample X47**	8145.50	85.524	2.575	24.290	62.438	4.520
Zone #3	**Sample X48**	8146.50	108.567	64.900	74.376	112.113	4.978
Zone #3	**Sample X49**	8147.50	79.856	65.485	36.435	69.706	3.172
Zone #2	**Sample X50**	8148.50	102.363	0.799	3.225	36.286	1.740
Zone #2	**Sample X51**	8149.50	53.361	95.378	15.541	54.625	10.390
Zone #2	**Sample X52**	8153.50	41.700	60.628	4.593	74.719	10.626
Zone #2	**Sample X53**	8154.50	92.791	50.992	18.201	128.003	6.695
Zone #2	**Sample X54**	8155.50	26.544	37.883	18.409	91.878	8.077
Zone #2	**Sample X55**	8156.50	63.503	24.039	49.111	71.295	4.855
Zone #2	**Sample X56**	8157.50	36.422	66.356	13.460	47.961	10.791
Zone #2	**Sample X57**	8158.50	57.675	34.307	15.068	69.066	6.773
Zone #1	**Sample X58**	8159.50	13.100	9.000	7.000	23.818	1.457
Zone #1	**Sample X59**	8160.50	-1.837	1.000	13.389	34.387	1.814
Zone #1	**Sample X60**	8161.50	26.754	7.555	16.000	15.119	1.050
Zone #1	**Sample X61**	8162.50	21.043	4.000	5.000	22.959	0.456
Zone #1	**Sample X62**	8163.50	54.771	14.000	20.273	16.744	1.520
Zone #1	**Sample X63**	8164.50	22.841	5.842	3.219	17.805	0.842
Zone #1	**Sample X64**	8165.50	10.512	7.000	8.712	33.788	1.611
Zone #1	**Sample X65**	8166.50	25.732	3.617	4.741	24.639	1.150
Zone #1	**Sample X66**	8167.50	12.741	30.851	7.000	23.466	0.682
Zone #1	**Sample X67**	8168.50	27.160	22.941	22.000	21.990	2.778
Zone #1	**Sample X68**	8169.50	18.964	9.000	0.329	20.886	0.939
Zone #1	**Sample X69**	8170.50	7.998	10.000	5.000	12.054	0.716
Zone #1	**Sample X70**	8171.50	11.432	44.352	12.457	24.117	0.545
Zone #1	**Sample X71**	8172.50	14.051	4.000	2.694	30.820	1.595
Zone #1	**Sample X72**	8173.50	6.781	6.000	13.000	33.425	2.169

Geological Research Co. Schauers, FT #1		**Depth (ft)**	**Rb ppm**	**U ppm**	**Sr ppm**	**Zr ppm**	**Mo ppm**
Zone #3	**Sample X1**	8090.50	94.295	3.115	650.330	70.434	6.434

Zone #3	**Sample X2**	8091.50	46.034	3.682	758.389	38.030	14.496
Zone #3	**Sample X3**	8092.50	39.976	2.412	654.012	34.645	8.394
Zone #3	**Sample X4**	8093.50	40.872	3.000	644.084	48.144	16.492
Zone #3	**Sample X5**	8094.50	42.430	5.431	755.441	47.064	10.446
Zone #3	**Sample X6**	8095.50	68.345	10.156	523.601	71.491	11.095
Zone #3	**Sample X7**	8096.50	70.710	3.682	587.824	86.835	21.142
Zone #3	**Sample X8**	8097.50	51.433	2.426	556.577	58.086	14.423
Zone #3	**Sample X9**	8098.50	60.431	3.752	542.204	88.070	17.890
Zone #3	**Sample X10**	8099.50	52.701	9.406	531.671	73.315	20.112
Zone #3	**Sample X11**	8100.50	31.683	3.857	643.353	40.937	36.290
Zone #3	**Sample X12**	8101.50	42.656	5.221	626.417	64.573	53.053
Zone #3	**Sample X13**	8102.50	29.698	1.181	807.923	27.366	40.724
Zone #3	**Sample X14**	8103.50	33.679	18.963	600.498	52.047	47.827
Zone #3	**Sample X15**	8104.50	45.547	13.011	636.238	59.570	97.793
Zone #3	**Sample X16**	8105.50	2.957	7.668	639.021	6.079	12.822
Zone #3	**Sample X17**	8106.50	63.596	7.198	578.933	75.129	70.836
Zone #3	**Sample X18**	8107.50	8.935	0.053	523.396	8.230	7.931
Zone #3	**Sample X19**	8108.50	32.015	6.250	855.218	32.634	53.413
Zone #3	**Sample X20**	8109.50	36.237	6.415	685.257	35.042	68.443
Zone #3	**Sample X21**	8110.50	60.039	8.034	424.409	123.546	79.398
Zone #3	**Sample X22**	8111.50	30.326	9.603	708.760	42.516	40.218
Zone #3	**Sample X23**	8112.50	8.651	7.018	436.347	3.505	8.627
Zone #3	**Sample X24**	8113.50	5.180	5.755	372.655	3.151	7.713
Zone #3	**Sample X25**	8117.50	27.160	2.716	657.735	46.407	32.669
Zone #3	**Sample X26**	8118.50	47.094	7.355	533.307	97.639	45.440
Zone #3	**Sample X27**	8119.50	18.496	11.007	726.092	28.886	19.119
Zone #3	**Sample X28**	8120.50	0.194	1.800	438.581	4.820	4.987
Zone #3	**Sample X29**	8121.50	30.159	0.911	565.418	59.814	44.655
Zone #3	**Sample X30**	8122.50	52.212	7.976	448.785	110.232	67.822
Zone #3	**Sample X31**	8123.50	1.000	3.306	398.214	8.364	10.601
Zone #3	**Sample X32**	8124.50	31.510	7.602	567.303	60.470	57.448
Zone #3	**Sample X33**	8125.50	4.000	0.706	322.877	4.854	9.268
Zone #3	**Sample X34**	8126.50	40.228	14.332	580.239	70.883	59.750
Zone #3	**Sample X35**	8127.50	6.000	2.766	460.813	6.833	14.735
Zone #3	**Sample X36**	8128.50	30.090	14.560	491.750	146.758	43.607
Zone #3	**Sample X37**	8129.50	1.000	4.503	436.521	9.479	5.523
Zone #3	**Sample X38**	8130.50	3.000	15.650	354.961	33.717	11.896
Zone #3	**Sample X39**	8131.50	37.401	8.921	564.970	59.106	63.440
Zone #3	**Sample X40**	8138.50	4.645	5.820	510.298	8.371	3.271

Zone #3	**Sample X41**	8139.50	63.132	8.653	542.939	99.472	58.782
Zone #3	**Sample X42**	8140.50	31.403	21.182	748.227	47.783	24.615
Zone #3	**Sample X43**	8141.50	7.583	0.783	548.196	4.754	9.893
Zone #3	**Sample X44**	8142.50	80.044	6.735	467.366	91.489	73.402
Zone #3	**Sample X45**	8143.50	67.506	6.027	529.605	59.921	52.055
Zone #3	**Sample X46**	8144.50	88.931	14.672	464.548	83.927	69.872
Zone #3	**Sample X47**	8145.50	62.122	7.733	469.369	53.724	45.460
Zone #3	**Sample X48**	8146.50	74.025	7.128	504.083	82.733	74.520
Zone #3	**Sample X49**	8147.50	51.976	16.222	674.451	48.398	34.113
Zone #2	**Sample X50**	8148.50	28.858	2.000	374.312	16.081	10.329
Zone #2	**Sample X51**	8149.50	169.365	0.456	173.489	129.823	28.045
Zone #2	**Sample X52**	8153.50	172.879	4.544	195.663	138.556	7.736
Zone #2	**Sample X53**	8154.50	119.779	4.469	341.902	82.723	35.931
Zone #2	**Sample X54**	8155.50	138.312	4.928	231.155	114.402	25.237
Zone #2	**Sample X55**	8156.50	68.469	22.208	403.227	75.334	21.546
Zone #2	**Sample X56**	8157.50	135.923	8.931	198.577	131.298	19.739
Zone #2	**Sample X57**	8158.50	77.899	14.581	366.346	84.093	29.755
Zone #1	**Sample X58**	8159.50	11.584	0.592	360.100	0.850	1.026
Zone #1	**Sample X59**	8160.50	14.297	0.934	464.944	5.004	3.133
Zone #1	**Sample X60**	8161.50	7.281	3.842	397.402	0.559	1.311
Zone #1	**Sample X61**	8162.50	15.786	0.000	397.296	1.000	2.312
Zone #1	**Sample X62**	8163.50	11.150	0.488	407.997	5.037	3.296
Zone #1	**Sample X63**	8164.50	11.013	0.961	416.808	3.534	3.463
Zone #1	**Sample X64**	8165.50	10.234	0.516	396.397	8.289	3.930
Zone #1	**Sample X65**	8166.50	5.554	5.078	454.867	6.000	0.000
Zone #1	**Sample X66**	8167.50	2.495	2.928	414.762	3.444	2.152
Zone #1	**Sample X67**	8168.50	15.524	5.565	430.214	9.270	2.777
Zone #1	**Sample X68**	8169.50	13.630	4.000	435.016	1.336	1.715
Zone #1	**Sample X69**	8170.50	4.254	3.000	451.463	1.000	0.144
Zone #1	**Sample X70**	8171.50	14.761	1.000	481.683	2.231	3.798
Zone #1	**Sample X71**	8172.50	17.497	3.467	486.171	2.131	2.951
Zone #1	**Sample X72**	8173.50	24.892	2.000	410.749	18.992	2.883

Shell Oil Co. ED Hay, Unit #1 Drill Core Data

Shell Oil Co. ED Hay, Unit #1 Drill Core		**Total Depth (ft)**	**N %**	**TOC %**	**C/N**	**δ15N**	**δ13C**
Zone #2	**Sample X1**	13700.50	0.059	0.763	15.018	-3.576	-26.908

Zone #2	**Sample X2**	13701.58	0.247	2.546	12.010	-2.174	-26.605
Zone #2	**Sample X3**	13702.50	0.267	2.710	11.845	-1.599	-26.728
Zone #2	**Sample X4**	13703.50	0.270	2.591	11.175	-1.954	-26.796
Zone #2	**Sample X5**	13704.50	0.267	2.566	11.226	-2.026	-26.797
Zone #2	**Sample X6**	13705.58					
Zone #2	**Sample X7**	13706.67					
Zone #2	**Sample X8**	13707.50	0.288	3.175	12.865	-3.320	-26.524
Zone #2	**Sample X9**	13709.50	0.206	2.364	13.390	-2.580	-26.822
Zone #2	**Sample X10**	13710.50	0.256	3.074	13.984	-2.301	-26.732
Zone #2	**Sample X11**	13712.50	0.222	2.926	15.374	-2.061	-26.810
Zone #2	**Sample X12**	13713.50	0.252	3.019	13.996	-1.933	-26.797
Zone #2	**Sample X13**	13714.50	0.294	3.454	13.707	-2.103	-26.965
Zone #2	**Sample X14**	13715.50	0.285	3.687	15.083	-2.083	-26.955
Zone #2	**Sample X15**	13716.58	0.283	3.186	13.150	-3.533	-27.069
Zone #2	**Sample X16**	13717.58	0.270	3.279	14.147	-1.499	-26.975
Zone #2	**Sample X17**	13719.58	0.270	3.140	13.538	-2.490	-26.950
Zone #2	**Sample X18**	13720.58	0.255	3.340	15.292	-2.755	-26.945
Zone #2	**Sample X19**	13721.50	0.225	3.314	17.164	-2.693	-26.849
Zone #2	**Sample X20**	13723.50	0.229	3.264	16.591	-2.007	-26.614
Zone #2	**Sample X21**	13724.50	0.050	0.646	15.077	-4.764	-26.704
Zone #2	**Sample X22**	13725.58	0.246	3.203	15.196	-1.827	-26.534
Zone #2	**Sample X23**	13726.50	0.232	3.120	15.680	-1.217	-26.610
Zone #2	**Sample X24**	13728.83	0.248	3.184	14.977	-1.568	-26.481
Zone #1	**Sample X25**	13811.58	0.134	3.785	32.959	-2.186	-26.712
Zone #1	**Sample X26**	13812.50	0.140	4.126	34.294	-2.261	-26.678
Zone #1	**Sample X27**	13813.50	0.246	5.918	28.034	-1.592	-26.571
Zone #1	**Sample X28**	13814.50	0.067	2.010	35.206	-4.517	-26.872
Zone #1	**Sample X29**	13815.58	0.140	3.898	32.538	-2.385	-26.735
Zone #1	**Sample X30**	13816.50	0.166	4.956	34.805	-2.695	-26.592
Zone #1	**Sample X31**	13817.50	0.147	5.002	39.782	-2.498	-26.662
Zone #1	**Sample X32**	13818.58	0.209	5.511	30.734	-1.328	-26.765
Zone #1	**Sample X33**	13819.50	0.254	5.763	26.500	-2.533	-26.609
Zone #1	**Sample X34**	13820.50	0.142	4.538	37.166	-3.392	-26.707
Zone #1	**Sample X35**	13821.50	0.162	4.962	35.822	-2.428	-26.688
Zone #1	**Sample X36**	13822.58	0.165	5.329	37.565	-3.023	-26.728
Zone #1	**Sample X37**	13823.58	0.182	5.194	33.317	-3.496	-26.752
Zone #1	**Sample X38**	13824.58	0.256	6.356	28.929	-2.304	-26.720
Zone #1	**Sample X39**	13825.50	0.249	5.921	27.746	-2.495	-26.617
Zone #1	**Sample X40**	13826.58	0.083	2.243	31.574	-5.595	-26.729

Zone #1	**Sample X41**	13827.50	0.089	2.553	33.311	-5.061	-26.742
Zone #1	**Sample X42**	13828.50	0.134	3.823	33.218	-2.273	-26.470

Shell Oil Co. ED Hay, Unit #1 Drill Core		**Total Depth (ft)**	**TIC %**	**S %**	**Mg %**	**Al %**	**Si %**
Zone #2	**Sample X1**	13700.50	9.547	1.531	0.480	0.623	2.164
Zone #2	**Sample X2**	13701.58	4.306	1.802	0.834	4.336	15.490
Zone #2	**Sample X3**	13702.50	3.422	1.624	0.423	5.787	20.238
Zone #2	**Sample X4**	13703.50	3.357	1.601	0.697	5.874	20.506
Zone #2	**Sample X5**	13704.50	3.434	1.486	0.685	5.358	20.410
Zone #2	**Sample X6**	13705.58	9.304	1.290	0.556	5.385	19.325
Zone #2	**Sample X7**	13706.67	9.950	0.709	0.739	1.047	4.184
Zone #2	**Sample X8**	13707.50	3.952	1.341	0.576	3.929	15.807
Zone #2	**Sample X9**	13709.50	5.655	1.583	0.487	4.133	11.791
Zone #2	**Sample X10**	13710.50	3.760	1.744	1.559	4.798	15.346
Zone #2	**Sample X11**	13712.50	4.271	1.577	0.787	4.944	17.539
Zone #2	**Sample X12**	13713.50	3.604	1.972	0.841	5.324	18.149
Zone #2	**Sample X13**	13714.50	3.481	1.518	0.369	2.621	10.827
Zone #2	**Sample X14**	13715.50	4.074	1.902	0.593	5.967	19.131
Zone #2	**Sample X15**	13716.58	4.059	1.414	0.787	5.819	17.706
Zone #2	**Sample X16**	13717.58	3.564	1.724	0.589	7.514	24.824
Zone #2	**Sample X17**	13719.58	3.885	1.720	1.091	4.074	14.221
Zone #2	**Sample X18**	13720.58	4.263	1.519	0.248	4.479	17.084
Zone #2	**Sample X19**	13721.50	5.042	1.566	0.344	3.916	15.092
Zone #2	**Sample X20**	13723.50	4.522	1.443	0.835	4.830	16.596
Zone #2	**Sample X21**	13724.50	10.554	0.612	0.733	1.077	2.188
Zone #2	**Sample X22**	13725.58	4.497	1.206	0.386	3.447	12.986
Zone #2	**Sample X23**	13726.50	4.393	1.314	0.894	5.377	17.766
Zone #2	**Sample X24**	13728.83	4.116	1.217	0.864	7.676	23.611
Zone #1	**Sample X25**	13811.58	8.434	0.959	0.405	2.766	5.547
Zone #1	**Sample X26**	13812.50	8.118	1.382	0.607	2.326	5.353
Zone #1	**Sample X27**	13813.50	5.083	2.042	0.608	4.830	12.942
Zone #1	**Sample X28**	13814.50	10.067	0.445	0.735	1.777	3.526
Zone #1	**Sample X29**	13815.58	7.841	1.187	0.997	2.677	6.052
Zone #1	**Sample X30**	13816.50	6.966	1.619	0.453	3.114	8.049
Zone #1	**Sample X31**	13817.50	7.443	1.491	0.116	3.178	8.286
Zone #1	**Sample X32**	13818.58	6.130	1.983	0.431	3.792	9.960

Zone #1	**Sample X33**	13819.50	4.070	2.386	0.548	5.627	14.992
Zone #1	**Sample X34**	13820.50	7.940	1.177	0.093	2.308	6.484
Zone #1	**Sample X35**	13821.50	7.321	1.443	0.523	2.313	6.609
Zone #1	**Sample X36**	13822.58	6.879	1.112	0.588	2.080	7.267
Zone #1	**Sample X37**	13823.58	6.645	1.655	0.431	2.866	9.224
Zone #1	**Sample X38**	13824.58	5.058	2.261	0.785	3.385	12.967
Zone #1	**Sample X39**	13825.50	5.565	1.845	0.517	3.269	11.641
Zone #1	**Sample X40**	13826.58	9.920	0.579	0.536	1.191	3.344
Zone #1	**Sample X41**	13827.50	11.917	0.701	1.000	1.446	3.818
Zone #1	**Sample X42**	13828.50	11.083	1.215	0.547	3.144	7.823

Shell Oil Co. ED Hay, Unit #1 Drill Core		**Total Depth (ft)**	**P %**	**K %**	**Ca %**	**Ti %**	**Mn %**
Zone #2	**Sample X1**	13700.50	-0.057	-0.302	34.312	0.029	0.070
Zone #2	**Sample X2**	13701.58	0.001	1.646	15.358	0.262	0.028
Zone #2	**Sample X3**	13702.50	0.038	2.241	8.712	0.351	0.023
Zone #2	**Sample X4**	13703.50	0.088	2.159	9.568	0.312	0.023
Zone #2	**Sample X5**	13704.50	0.031	2.088	9.536	0.315	0.025
Zone #2	**Sample X6**	13705.58	0.011	2.173	7.863	0.328	0.024
Zone #2	**Sample X7**	13706.67	-0.128	-0.156	32.002	0.049	0.056
Zone #2	**Sample X8**	13707.50	0.044	1.518	17.396	0.216	0.026
Zone #2	**Sample X9**	13709.50	0.233	1.197	21.614	0.248	0.028
Zone #2	**Sample X10**	13710.50	0.220	1.355	14.481	0.272	0.020
Zone #2	**Sample X11**	13712.50	0.137	1.880	13.168	0.318	0.023
Zone #2	**Sample X12**	13713.50	0.110	1.834	12.539	0.312	0.023
Zone #2	**Sample X13**	13714.50	0.055	1.275	15.572	0.249	0.032
Zone #2	**Sample X14**	13715.50	0.112	2.311	10.379	0.335	0.022
Zone #2	**Sample X15**	13716.58	0.143	1.991	12.444	0.320	0.019
Zone #2	**Sample X16**	13717.58	0.050	2.575	5.179	0.409	0.024
Zone #2	**Sample X17**	13719.58	0.027	1.273	17.352	0.253	0.029
Zone #2	**Sample X18**	13720.58	0.097	1.907	12.351	0.314	0.024
Zone #2	**Sample X19**	13721.50	0.078	1.614	16.028	0.266	0.025
Zone #2	**Sample X20**	13723.50	0.061	1.741	15.393	0.290	0.024
Zone #2	**Sample X21**	13724.50	-0.095	-0.179	33.341	0.039	0.056
Zone #2	**Sample X22**	13725.58	0.126	1.340	19.640	0.203	0.028
Zone #2	**Sample X23**	13726.50	0.038	1.970	12.263	0.324	0.025
Zone #2	**Sample X24**	13728.83	0.098	2.277	6.384	0.386	0.023
Zone #1	**Sample X25**	13811.58	0.097	0.605	31.366	0.123	0.020

Zone #1	**Sample X26**	13812.50	0.070	0.608	30.702	0.131	0.019
Zone #1	**Sample X27**	13813.50	0.013	1.735	18.142	0.281	0.017
Zone #1	**Sample X28**	13814.50	0.117	-0.051	32.783	0.061	0.038
Zone #1	**Sample X29**	13815.58	0.235	0.727	29.912	0.141	0.026
Zone #1	**Sample X30**	13816.50	0.029	0.968	26.727	0.173	0.022
Zone #1	**Sample X31**	13817.50	0.113	0.943	27.448	0.187	0.018
Zone #1	**Sample X32**	13818.58	0.158	1.168	24.464	0.196	0.021
Zone #1	**Sample X33**	13819.50	0.090	1.543	16.518	0.284	0.011
Zone #1	**Sample X34**	13820.50	0.168	0.558	30.730	0.113	0.022
Zone #1	**Sample X35**	13821.50	0.100	0.589	30.147	0.116	0.021
Zone #1	**Sample X36**	13822.58	0.100	0.600	29.085	0.113	0.021
Zone #1	**Sample X37**	13823.58	0.124	0.811	25.866	0.162	0.017
Zone #1	**Sample X38**	13824.58	0.030	1.199	18.317	0.230	0.016
Zone #1	**Sample X39**	13825.50	0.008	1.224	21.999	0.216	0.017
Zone #1	**Sample X40**	13826.58	-0.076	-0.061	33.066	0.052	0.033
Zone #1	**Sample X41**	13827.50	0.043	0.044	32.182	0.069	0.032
Zone #1	**Sample X42**	13828.50	0.170	0.848	27.148	0.170	0.022

Shell Oil Co. ED Hay, Unit #1 Drill Core		**Total Depth (ft)**	**Fe %**	**V ppm**	**Cr ppm**	**Ni ppm**
Zone #2	**Sample X1**	13700.50	1.163	144.835	-8.512	26.390
Zone #2	**Sample X2**	13701.58	1.786	378.985	53.578	39.833
Zone #2	**Sample X3**	13702.50	2.050	440.115	48.365	47.635
Zone #2	**Sample X4**	13703.50	2.019	391.697	61.688	71.708
Zone #2	**Sample X5**	13704.50	2.070	373.509	53.092	50.480
Zone #2	**Sample X6**	13705.58	2.096	391.150	44.650	90.292
Zone #2	**Sample X7**	13706.67	0.926	130.680	34.143	25.225
Zone #2	**Sample X8**	13707.50	1.525	323.671	73.438	69.176
Zone #2	**Sample X9**	13709.50	1.725	192.895	82.253	53.681
Zone #2	**Sample X10**	13710.50	2.563	284.996	77.891	76.109
Zone #2	**Sample X11**	13712.50	1.808	305.645	74.745	48.674
Zone #2	**Sample X12**	13713.50	1.818	383.641	81.262	57.013
Zone #2	**Sample X13**	13714.50	1.934	390.637	31.949	74.704
Zone #2	**Sample X14**	13715.50	1.938	692.656	67.062	45.130
Zone #2	**Sample X15**	13716.58	1.995	370.137	81.730	79.321
Zone #2	**Sample X16**	13717.58	1.994	831.016	73.878	74.203
Zone #2	**Sample X17**	13719.58	2.389	450.160	58.881	84.164

Zone #2	**Sample X18**	13720.58	1.740	539.135	32.672	64.008
Zone #2	**Sample X19**	13721.50	1.768	417.622	56.656	35.807
Zone #2	**Sample X20**	13723.50	1.710	382.291	65.368	55.065
Zone #2	**Sample X21**	13724.50	1.163	127.334	25.186	8.971
Zone #2	**Sample X22**	13725.58	1.551	297.652	47.633	51.827
Zone #2	**Sample X23**	13726.50	1.668	399.230	53.528	59.047
Zone #2	**Sample X24**	13728.83	2.553	414.552	95.411	38.833
Zone #1	**Sample X25**	13811.58	1.008	139.547	96.219	24.134
Zone #1	**Sample X26**	13812.50	1.234	161.967	69.360	58.181
Zone #1	**Sample X27**	13813.50	1.947	322.659	88.355	78.166
Zone #1	**Sample X28**	13814.50	0.619	106.154	76.835	21.155
Zone #1	**Sample X29**	13815.58	0.980	134.358	85.058	0.268
Zone #1	**Sample X30**	13816.50	1.366	154.883	82.091	46.717
Zone #1	**Sample X31**	13817.50	1.343	178.025	104.299	39.143
Zone #1	**Sample X32**	13818.58	1.508	208.081	103.248	44.459
Zone #1	**Sample X33**	13819.50	2.048	456.932	134.372	49.584
Zone #1	**Sample X34**	13820.50	0.893	128.610	95.881	33.450
Zone #1	**Sample X35**	13821.50	0.972	140.078	98.793	29.698
Zone #1	**Sample X36**	13822.58	0.891	141.116	97.266	29.609
Zone #1	**Sample X37**	13823.58	1.339	154.547	112.847	74.158
Zone #1	**Sample X38**	13824.58	2.106	561.611	55.824	96.820
Zone #1	**Sample X39**	13825.50	1.528	445.710	81.375	19.878
Zone #1	**Sample X40**	13826.58	0.677	117.111	54.821	25.798
Zone #1	**Sample X41**	13827.50	0.735	107.706	67.484	3.000
Zone #1	**Sample X42**	13828.50	1.089	146.268	68.708	39.023

Shell Oil Co. ED Hay, Unit #1 Drill Core		**Total Depth (ft)**	**Cu ppm**	**Zn ppm**	**Th ppm**	**Rb ppm**
Zone #2	**Sample X1**	13700.50	20.791	19.571	1.270	14.568
Zone #2	**Sample X2**	13701.58	55.096	71.354	7.764	90.098
Zone #2	**Sample X3**	13702.50	40.639	94.841	8.220	108.391
Zone #2	**Sample X4**	13703.50	32.311	77.602	7.841	103.996
Zone #2	**Sample X5**	13704.50	32.918	98.571	5.831	124.176
Zone #2	**Sample X6**	13705.58	55.139	101.249	9.578	107.200
Zone #2	**Sample X7**	13706.67	3.000	21.358	0.950	5.900
Zone #2	**Sample X8**	13707.50	40.137	65.715	7.694	97.932
Zone #2	**Sample X9**	13709.50	45.634	68.771	7.278	91.255
Zone #2	**Sample X10**	13710.50	45.264	82.777	7.312	100.496

Zone #2	**Sample X11**	13712.50	27.984	75.800	8.180	84.662
Zone #2	**Sample X12**	13713.50	24.952	73.654	7.066	100.891
Zone #2	**Sample X13**	13714.50	21.854	62.398	6.539	103.256
Zone #2	**Sample X14**	13715.50	66.814	125.514	7.830	117.657
Zone #2	**Sample X15**	13716.58	40.757	72.551	7.845	98.850
Zone #2	**Sample X16**	13717.58	37.502	85.840	7.415	113.741
Zone #2	**Sample X17**	13719.58	40.190	114.197	5.707	93.773
Zone #2	**Sample X18**	13720.58	30.148	84.918	5.711	101.605
Zone #2	**Sample X19**	13721.50	3.000	66.718	6.546	86.114
Zone #2	**Sample X20**	13723.50	57.013	94.622	8.995	100.621
Zone #2	**Sample X21**	13724.50	5.201	19.209	1.741	7.392
Zone #2	**Sample X22**	13725.58	62.227	108.886	5.842	98.907
Zone #2	**Sample X23**	13726.50	34.299	60.494	8.929	104.744
Zone #2	**Sample X24**	13728.83	28.869	205.410	7.322	78.598
Zone #1	**Sample X25**	13811.58	30.812	67.405	4.148	29.807
Zone #1	**Sample X26**	13812.50	28.922	90.308	4.877	53.350
Zone #1	**Sample X27**	13813.50	36.710	193.590	7.930	83.118
Zone #1	**Sample X28**	13814.50	20.506	44.234	2.325	9.260
Zone #1	**Sample X29**	13815.58	27.518	68.354	2.628	39.251
Zone #1	**Sample X30**	13816.50	45.094	92.922	5.523	39.432
Zone #1	**Sample X31**	13817.50	12.522	82.003	3.200	39.687
Zone #1	**Sample X32**	13818.58	18.312	119.568	3.779	65.635
Zone #1	**Sample X33**	13819.50	29.491	125.653	6.153	53.655
Zone #1	**Sample X34**	13820.50	13.848	96.250	3.187	37.529
Zone #1	**Sample X35**	13821.50	53.238	77.848	4.430	45.566
Zone #1	**Sample X36**	13822.58	46.439	113.871	2.709	52.712
Zone #1	**Sample X37**	13823.58	28.311	91.743	3.912	49.609
Zone #1	**Sample X38**	13824.58	42.879	256.530	4.882	69.609
Zone #1	**Sample X39**	13825.50	31.581	108.247	3.794	63.858
Zone #1	**Sample X40**	13826.58	5.000	44.374	2.072	12.352
Zone #1	**Sample X41**	13827.50	8.421	42.926	1.940	22.640
Zone #1	**Sample X42**	13828.50	28.232	82.894	3.995	46.632

Shell Oil Co. ED Hay, Unit #1 Drill Core		**Total Depth (ft)**	**U ppm**	**Sr ppm**	**Zr ppm**	**Mo ppm**
Zone #2	**Sample X1**	13700.50	1.057	330.654	16.945	12.512
Zone #2	**Sample X2**	13701.58	2.745	753.878	88.178	23.079
Zone #2	**Sample X3**	13702.50	5.575	579.384	105.489	27.389

Zone #2	**Sample X4**	13703.50	18.783	589.026	110.676	24.036
Zone #2	**Sample X5**	13704.50	4.818	552.086	116.547	26.423
Zone #2	**Sample X6**	13705.58	5.321	526.106	128.286	23.139
Zone #2	**Sample X7**	13706.67	6.764	257.140	31.480	5.371
Zone #2	**Sample X8**	13707.50	7.492	708.912	97.774	24.175
Zone #2	**Sample X9**	13709.50	5.310	596.717	107.002	9.876
Zone #2	**Sample X10**	13710.50	5.390	601.510	111.339	25.152
Zone #2	**Sample X11**	13712.50	2.000	676.796	92.643	21.963
Zone #2	**Sample X12**	13713.50	4.937	624.244	105.750	23.658
Zone #2	**Sample X13**	13714.50	0.347	733.623	105.095	31.632
Zone #2	**Sample X14**	13715.50	0.673	616.832	121.047	35.268
Zone #2	**Sample X15**	13716.58	11.085	667.972	97.252	26.190
Zone #2	**Sample X16**	13717.58	3.249	683.023	98.690	30.191
Zone #2	**Sample X17**	13719.58	5.637	971.948	92.586	36.730
Zone #2	**Sample X18**	13720.58	0.253	674.500	95.366	37.923
Zone #2	**Sample X19**	13721.50	3.022	864.814	80.850	33.426
Zone #2	**Sample X20**	13723.50	1.373	837.669	106.470	39.169
Zone #2	**Sample X21**	13724.50	10.000	363.283	9.691	7.463
Zone #2	**Sample X22**	13725.58	9.643	849.762	81.310	29.697
Zone #2	**Sample X23**	13726.50	2.555	751.153	106.194	23.096
Zone #2	**Sample X24**	13728.83	9.193	748.654	97.972	26.514
Zone #1	**Sample X25**	13811.58	5.937	866.411	38.435	19.918
Zone #1	**Sample X26**	13812.50	0.000	812.605	41.071	18.618
Zone #1	**Sample X27**	13813.50	10.771	618.804	99.542	50.194
Zone #1	**Sample X28**	13814.50	0.000	578.262	26.229	9.055
Zone #1	**Sample X29**	13815.58	2.659	819.393	53.053	21.643
Zone #1	**Sample X30**	13816.50	3.504	847.405	56.297	32.449
Zone #1	**Sample X31**	13817.50	8.809	871.052	62.533	41.401
Zone #1	**Sample X32**	13818.58	5.041	724.002	69.387	37.692
Zone #1	**Sample X33**	13819.50	4.568	596.968	76.704	64.863
Zone #1	**Sample X34**	13820.50	5.000	1184.401	28.811	16.708
Zone #1	**Sample X35**	13821.50	5.006	915.695	50.016	24.694
Zone #1	**Sample X36**	13822.58	0.773	1033.556	48.867	18.211
Zone #1	**Sample X37**	13823.58	7.118	865.098	55.535	23.974
Zone #1	**Sample X38**	13824.58	4.515	758.990	80.374	69.916
Zone #1	**Sample X39**	13825.50	2.210	747.225	67.977	40.265
Zone #1	**Sample X40**	13826.58	2.000	723.536	29.002	10.756
Zone #1	**Sample X41**	13827.50	1.344	629.047	37.635	9.823
Zone #1	**Sample X42**	13828.50	3.000	1018.691	68.080	15.861

Shell Oil Co. Leppard, J.A. #1 Drill Core

Shell Oil Co. Leppard, J.A. #1 Drill Core		Total Depth (ft)	TIC %	S %	Mg %	Al %	Si %
Zone #2	Sample X1	13546.42	6.619	1.850	0.903	3.957	10.734
Zone #2	Sample X2	13547.33		1.060	0.597	2.150	6.415
Zone #2	Sample X3	13548.50	6.707	1.851	0.837	3.924	9.740
Zone #2	Sample X4	13549.33		1.646	1.142	3.326	9.161
Zone #2	Sample X5	13549.88		1.843	1.241	3.840	8.109
Zone #2	Sample X6	13550.58		1.361	0.412	2.943	7.907
Zone #2	Sample X7	13551.33			0.626	2.649	8.175
Zone #2	Sample X8	13552.50		1.639	0.679	3.529	10.582
Zone #2	Sample X9	13552.92		2.340	0.595	5.403	13.958
Zone #2	Sample X10	13553.67	3.727	2.780	0.522	4.712	15.396
Zone #2	Sample X11	13554.00	4.050	2.483	0.380	4.845	16.837
Zone #2	Sample X12	13554.50		2.341	0.368	4.670	19.465
Zone #2	Sample X13	13555.08	3.641	2.038	0.318	4.345	18.811
Zone #2	Sample X14	13556.21			0.367	4.636	19.232
Zone #2	Sample X15	13557.33		1.883	0.819	1.807	5.871
Zone #2	Sample X16	13558.08		1.676	0.372	3.853	18.672
Zone #2	Sample X17	13559.17		0.886	0.613	2.994	15.362
Zone #2	Sample X18	13560.13	4.822	5.741	0.695	1.431	4.527
Zone #2	Sample X19	13560.46	8.351	0.840	0.242	3.183	11.934
Zone #2	Sample X20	13561.17		2.047	0.722	1.527	8.342
Zone #2	Sample X21	13562.08		2.022	-0.118	3.868	17.072
Zone #2	Sample X22	13563.25	5.061	1.747	0.241	3.933	16.903
Zone #2	Sample X23	13564.13		0.924	0.818	3.592	16.405
Zone #2	Sample X24	13565.17		1.453	0.533	1.246	6.205
Zone #2	Sample X25	13566.42		3.390	0.455	3.435	14.626
Zone #2	Sample X26	13567.50		1.698	0.716	4.369	20.362
Zone #2	Sample X27	13568.00		1.314	0.596	3.976	15.821
Zone #2	Sample X28	13568.58		1.888	0.601	2.887	13.988
Zone #2	Sample X29	13569.92		1.625	0.536	3.452	14.370
Zone #2	Sample X30	13570.50	5.692	1.557	0.464	1.222	4.359
Zone #2	Sample X31	13572.25	5.905	1.302	0.611	3.253	14.508
Zone #2	Sample X32	13572.54	5.260	1.834	0.547	3.361	13.978
Zone #2	Sample X33	13574.21		2.087	0.272	3.591	14.731
Zone #2	Sample X34	13575.42		2.090	0.246	2.616	12.165
Zone #2	Sample X35	13576.21		2.522	0.548	3.592	14.151

Zone #2	**Sample X36**	13577.58		3.018	0.697	2.296	9.431
Zone #2	**Sample X37**	13579.33		2.162	0.054	4.876	17.341
Zone #2	**Sample X38**	13580.33		2.335	1.596	2.336	10.158
Zone #2	**Sample X39**	13581.25		0.651	0.814	2.950	10.785
Zone #2	**Sample X40**	13581.58	9.131	0.333	0.069	0.875	0.310
Zone #2	**Sample X41**	13582.50		1.603	0.752	1.353	4.944
Zone #2	**Sample X42**	13584.21		1.513	0.343	2.049	7.299
Zone #2	**Sample X43**	13585.71	9.708	0.486	0.349	1.833	5.968
Zone #2	**Sample X44**	13587.21		1.476	0.828	1.434	4.026
Zone #2	**Sample X45**	13588.63		2.283	0.777	1.552	4.996
Zone #2	**Sample X46**	13591.21		1.168	0.353	3.976	12.264
Zone #2	**Sample X47**	13592.46	4.964	2.277	0.374	2.059	7.947
Zone #2	**Sample X48**	13594.42		0.376	0.200	3.232	13.221
Zone #2	**Sample X49**	13595.54		0.479	0.683	0.815	1.082
Zone #2	**Sample X50**	13597.25		1.363	0.313	1.352	2.214
Zone #2	**Sample X51**	13598.75		0.572	3.089	2.387	9.582
Zone #2	**Sample X52**	13600.13		1.229	0.506	1.755	5.315
Zone #2	**Sample X53**	13601.25	5.465	1.805	0.372	2.793	9.354
Zone #2	**Sample X54**	13603.13	9.143	0.630	0.401	4.130	11.534
Zone #2	**Sample X55**	13604.33		1.197	0.659	1.585	4.989
Zone #2	**Sample X56**	13605.13		1.557	0.281	2.160	8.289
Zone #2	**Sample X57**	13606.25		2.231	0.703	2.591	9.756
Zone #2	**Sample X58**	13608.13	6.055	1.958	0.375	2.424	10.560
Zone #2	**Sample X59**	13609.33		1.942	0.234	2.963	11.744
Zone #2	**Sample X60**	13611.13	8.943	0.776	0.530	2.558	11.291
Zone #2	**Sample X61**	13612.38	9.854	0.595	0.508	1.992	5.226
Zone #2	**Sample X62**	13614.25	9.522	0.758	0.218	0.836	3.125
Zone #2	**Sample X63**	13615.33		1.494	0.486	1.471	3.390
Zone #2	**Sample X64**	13616.17	7.052	1.844	0.332	2.848	8.179
Zone #2	**Sample X65**	13617.33		2.008	0.462	2.694	8.161
Zone #1	**Sample X66**	13619.17		0.783	0.627	2.588	10.300
Zone #1	**Sample X67**	13620.33		1.117	0.418	2.679	9.941
Zone #1	**Sample X68**	13621.33		1.270	-0.010	2.230	5.715
Zone #1	**Sample X69**	13622.67	6.057	1.782	0.495	2.505	7.747
Zone #1	**Sample X70**	13624.08		1.418	0.012	2.809	9.163
Zone #1	**Sample X71**	13624.42		1.753	0.577	3.462	11.839
Zone #1	**Sample X72**	13625.33	7.951	0.984	0.496	2.806	8.545
Zone #1	**Sample X73**	13626.17		1.475	0.074	2.598	7.088
Zone #1	**Sample X74**	13627.33			0.632	2.566	6.707

Zone #1	**Sample X75**	13629.17	6.575	1.457	0.161	2.944	9.391
Zone #1	**Sample X76**	13630.58	6.193	1.775	0.380	2.788	9.338
Zone #1	**Sample X77**	13632.21		1.898	0.457	3.014	9.288
Zone #1	**Sample X78**	13633.29	7.594	1.237	0.857	4.667	13.691
Zone #1	**Sample X79**	13635.33		1.647	0.040	5.271	12.591
Zone #1	**Sample X80**	13636.25		1.558	8.843	2.848	6.309
Zone #1	**Sample X81**	13638.29		1.394	0.259	3.144	9.959
Zone #1	**Sample X82**	13639.38		0.712	1.862	3.241	9.681
Zone #1	**Sample X83**	13641.42		1.719	0.716	2.909	11.615
Zone #1	**Sample X84**	13642.63		1.649	0.674	2.000	5.530
Zone #1	**Sample X85**	13644.21		2.014	0.798	3.004	9.801
Zone #1	**Sample X86**	13645.25		1.221	0.413	2.553	9.407
Zone #1	**Sample X87**	13646.33		0.848	0.496	3.363	11.874
Zone #1	**Sample X88**	13647.42		1.405	0.157	2.600	7.968
Zone #1	**Sample X89**	13649.25		1.462	0.383	2.291	7.588
Zone #1	**Sample X90**	13650.54		1.873	0.469	2.897	9.320
Zone #1	**Sample X91**	13651.13		2.267	0.654	2.949	9.655
Zone #1	**Sample X92**	13652.50	6.421	1.687	0.247	3.321	14.137
Zone #1	**Sample X93**	13654.75		1.807	0.305	4.365	13.675
Zone #1	**Sample X94**	13655.96	6.561	1.481	0.221	4.708	12.879
Zone #1	**Sample X95**	13657.17		1.577	0.147	4.490	11.847
Zone #1	**Sample X96**	13658.54	5.875	1.682	0.265	3.746	9.978
Zone #1	**Sample X97**	13659.21	5.406	1.720	0.662	4.062	12.613
Zone #1	**Sample X98**	13660.50	5.574	1.839	0.331	5.261	15.005
Zone #1	**Sample X99**	13662.04		1.347	-0.148	4.860	13.178
Zone #1	**Sample X100**	13663.54		1.256	0.595	3.696	10.566
Zone #1	**Sample X101**	13665.21		1.579	0.250	2.888	9.075
Zone #1	**Sample X102**	13666.58		1.509	0.335	2.791	7.936
Zone #1	**Sample X103**	13667.25	5.955	1.703	0.369	3.658	10.093
Zone #1	**Sample X104**	13668.50		1.826	0.462	3.294	8.273
Zone #1	**Sample X105**	13670.17	6.747	1.756	0.261	4.172	12.108
Zone #1	**Sample X106**	13671.58			0.029	5.722	12.627
Zone #1	**Sample X107**	13673.50			0.098	3.875	9.314
Zone #1	**Sample X108**	13677.00			0.505	0.557	-0.032

Shell Oil Co. Leppard, J.A. #1 Drill Core		**Total Depth (ft)**	**P %**	**K %**	**Ca %**	**Ti %**	**Mn %**
Zone #2	**Sample X1**	13546.42	0.136	1.131	23.579	0.227	0.028

Zone #2	**Sample X2**	13547.33	0.208	0.204	29.658	0.125	0.026
Zone #2	**Sample X3**	13548.50	0.126	1.239	23.347	0.238	0.030
Zone #2	**Sample X4**	13549.33	0.081	1.117	24.205	0.229	0.030
Zone #2	**Sample X5**	13549.88	-0.042	0.767	26.406	0.178	0.025
Zone #2	**Sample X6**	13550.58	-0.002	0.969	28.336	0.186	0.029
Zone #2	**Sample X7**	13551.33	0.079	0.728	26.120	0.176	0.027
Zone #2	**Sample X8**	13552.50	0.073	1.067	23.821	0.197	0.023
Zone #2	**Sample X9**	13552.92	0.056	1.885	18.240	0.298	0.022
Zone #2	**Sample X10**	13553.67	0.197	1.857	14.527	0.296	0.027
Zone #2	**Sample X11**	13554.00	0.185	1.727	12.680	0.322	0.026
Zone #2	**Sample X12**	13554.50	0.085	1.764	11.600	0.285	0.023
Zone #2	**Sample X13**	13555.08	0.077	1.736	11.802	0.266	0.024
Zone #2	**Sample X14**	13556.21	0.066	1.754	11.881	0.261	0.023
Zone #2	**Sample X15**	13557.33	-0.176	-0.117	30.200	0.040	0.032
Zone #2	**Sample X16**	13558.08	0.028	1.621	12.911	0.258	0.024
Zone #2	**Sample X17**	13559.17	0.110	1.231	17.431	0.205	0.026
Zone #2	**Sample X18**	13560.13	-0.208	-0.246	31.688	0.048	0.034
Zone #2	**Sample X19**	13560.46	0.106	1.284	20.382	0.178	0.028
Zone #2	**Sample X20**	13561.17	-0.097	0.039	28.720	0.053	0.027
Zone #2	**Sample X21**	13562.08	0.042	1.572	14.545	0.242	0.026
Zone #2	**Sample X22**	13563.25	-0.020	1.583	16.049	0.223	0.026
Zone #2	**Sample X23**	13564.13	0.003	1.441	16.499	0.235	0.025
Zone #2	**Sample X24**	13565.17	-0.252	-0.129	30.711	0.044	0.027
Zone #2	**Sample X25**	13566.42	0.101	1.270	19.561	0.197	0.027
Zone #2	**Sample X26**	13567.50	0.019	1.800	8.555	0.376	0.022
Zone #2	**Sample X27**	13568.00	0.030	1.608	17.579	0.250	0.024
Zone #2	**Sample X28**	13568.58	0.034	1.389	20.181	0.199	0.029
Zone #2	**Sample X29**	13569.92	0.012	1.423	18.354	0.245	0.028
Zone #2	**Sample X30**	13570.50	-0.207	-0.154	32.370	0.052	0.026
Zone #2	**Sample X31**	13572.25	0.086	1.385	18.322	0.219	0.024
Zone #2	**Sample X32**	13572.54	0.020	1.332	18.932	0.243	0.024
Zone #2	**Sample X33**	13574.21	0.019	1.531	16.740	0.235	0.025
Zone #2	**Sample X34**	13575.42	0.040	1.075	20.627	0.212	0.023
Zone #2	**Sample X35**	13576.21	0.080	1.367	18.805	0.229	0.022
Zone #2	**Sample X36**	13577.58	0.185	0.994	22.122	0.191	0.023
Zone #2	**Sample X37**	13579.33	0.014	2.111	10.640	0.389	0.020
Zone #2	**Sample X38**	13580.33	0.131	1.123	20.413	0.199	0.022
Zone #2	**Sample X39**	13581.25	0.136	1.075	21.102	0.205	0.019
Zone #2	**Sample X40**	13581.58	-0.064	-0.663	33.455	0.011	0.038

Zone #2	**Sample X41**	13582.50	-0.131	-0.271	31.777	0.053	0.029
Zone #2	**Sample X42**	13584.21	0.182	0.434	28.706	0.142	0.025
Zone #2	**Sample X43**	13585.71	0.059	0.351	29.625	0.148	0.028
Zone #2	**Sample X44**	13587.21	-0.044	-0.159	32.311	0.059	0.025
Zone #2	**Sample X45**	13588.63	0.092	0.183	31.375	0.110	0.024
Zone #2	**Sample X46**	13591.21	0.092	1.541	16.544	0.273	0.015
Zone #2	**Sample X47**	13592.46	0.095	0.447	28.669	0.127	0.022
Zone #2	**Sample X48**	13594.42	0.062	1.430	16.984	0.235	0.013
Zone #2	**Sample X49**	13595.54	0.072	-0.482	34.039	0.042	0.041
Zone #2	**Sample X50**	13597.25	-0.135	-0.364	33.585	0.038	0.038
Zone #2	**Sample X51**	13598.75	0.139	0.544	23.695	0.103	0.020
Zone #2	**Sample X52**	13600.13	0.469	0.033	31.537	0.077	0.022
Zone #2	**Sample X53**	13601.25	0.105	0.785	24.684	0.164	0.021
Zone #2	**Sample X54**	13603.13	0.150	0.966	20.603	0.231	0.018
Zone #2	**Sample X55**	13604.33	-0.059	0.074	32.006	0.066	0.026
Zone #2	**Sample X56**	13605.13	0.079	0.640	28.317	0.138	0.019
Zone #2	**Sample X57**	13606.25	0.114	0.862	24.490	0.187	0.017
Zone #2	**Sample X58**	13608.13	0.062	0.878	23.710	0.173	0.015
Zone #2	**Sample X59**	13609.33	0.067	1.071	21.508	0.208	0.012
Zone #2	**Sample X60**	13611.13	0.047	1.045	21.367	0.211	0.017
Zone #2	**Sample X61**	13612.38	0.306	0.458	31.805	0.120	0.020
Zone #2	**Sample X62**	13614.25	-0.053	-0.178	34.335	0.050	0.029
Zone #2	**Sample X63**	13615.33	0.085	0.173	33.099	0.068	0.026
Zone #2	**Sample X64**	13616.17	0.074	1.031	27.071	0.182	0.019
Zone #2	**Sample X65**	13617.33	0.064	0.925	26.172	0.168	0.015
Zone #1	**Sample X66**	13619.17	-0.004	1.092	23.167	0.196	0.014
Zone #1	**Sample X67**	13620.33	0.043	1.098	23.283	0.179	0.015
Zone #1	**Sample X68**	13621.33	0.369	0.401	31.661	0.116	0.017
Zone #1	**Sample X69**	13622.67	0.155	0.798	28.270	0.132	0.021
Zone #1	**Sample X70**	13624.08	0.171	1.124	26.309	0.175	0.019
Zone #1	**Sample X71**	13624.42	0.238	1.257	21.469	0.227	0.016
Zone #1	**Sample X72**	13625.33	0.274	1.055	25.879	0.179	0.020
Zone #1	**Sample X73**	13626.17	0.056	0.874	28.264	0.185	0.027
Zone #1	**Sample X74**	13627.33	0.289	0.792	29.835	0.130	0.022
Zone #1	**Sample X75**	13629.17	0.137	1.027	25.854	0.187	0.016
Zone #1	**Sample X76**	13630.58	0.099	0.988	25.531	0.174	0.020
Zone #1	**Sample X77**	13632.21	0.263	0.985	25.675	0.172	0.020
Zone #1	**Sample X78**	13633.29	0.275	1.398	19.487	0.211	0.019
Zone #1	**Sample X79**	13635.33	0.174	1.664	16.891	0.285	0.017

Zone #1	**Sample X80**	13636.25	0.179	0.873	20.136	0.053	0.025
Zone #1	**Sample X81**	13638.29	0.125	1.211	24.538	0.174	0.021
Zone #1	**Sample X82**	13639.38	0.115	1.149	23.714	0.190	0.023
Zone #1	**Sample X83**	13641.42	0.070	1.105	21.147	0.215	0.018
Zone #1	**Sample X84**	13642.63	0.150	0.368	30.797	0.103	0.025
Zone #1	**Sample X85**	13644.21	0.079	0.912	25.065	0.181	0.017
Zone #1	**Sample X86**	13645.25	0.036	1.001	25.203	0.176	0.018
Zone #1	**Sample X87**	13646.33	0.153	1.180	21.576	0.218	0.018
Zone #1	**Sample X88**	13647.42	0.187	0.735	28.374	0.147	0.025
Zone #1	**Sample X89**	13649.25	0.223	0.588	29.174	0.116	0.021
Zone #1	**Sample X90**	13650.54	0.259	0.711	26.557	0.156	0.019
Zone #1	**Sample X91**	13651.13	0.097	0.670	26.460	0.170	0.018
Zone #1	**Sample X92**	13652.50	0.180	1.002	18.794	0.237	0.016
Zone #1	**Sample X93**	13654.75	0.099	1.180	16.904	0.291	0.021
Zone #1	**Sample X94**	13655.96	0.092	0.994	22.324	0.196	0.019
Zone #1	**Sample X95**	13657.17	0.262	1.053	21.123	0.212	0.017
Zone #1	**Sample X96**	13658.54	0.325	0.671	25.756	0.169	0.022
Zone #1	**Sample X97**	13659.21	0.080	0.951	21.282	0.207	0.021
Zone #1	**Sample X98**	13660.50	0.061	1.107	18.023	0.248	0.019
Zone #1	**Sample X99**	13662.04	0.156	1.153	19.611	0.234	0.020
Zone #1	**Sample X100**	13663.54	1.013	1.097	21.245	0.243	0.018
Zone #1	**Sample X101**	13665.21	0.315	0.869	25.259	0.198	0.021
Zone #1	**Sample X102**	13666.58	0.196	0.773	27.257	0.188	0.020
Zone #1	**Sample X103**	13667.25	0.112	1.025	24.646	0.230	0.014
Zone #1	**Sample X104**	13668.50	0.170	0.782	26.835	0.164	0.017
Zone #1	**Sample X105**	13670.17	0.197	1.273	21.188	0.257	0.017
Zone #1	**Sample X106**	13671.58	0.165	1.287	19.814	0.298	0.017
Zone #1	**Sample X107**	13673.50	0.203	0.957	25.404	0.215	0.015
Zone #1	**Sample X108**	13677.00	-0.066	-0.680	34.046	-0.009	0.026

Shell Oil Co. Leppard, J.A. #1 Drill Core		**Total Depth (ft)**	**Fe %**	**V ppm**	**Cr ppm**	**Ni ppm**
Zone #2	**Sample X1**	13546.42	1.498	111.785	51.069	11.092
Zone #2	**Sample X2**	13547.33	1.183	140.804	66.240	15.000
Zone #2	**Sample X3**	13548.50	1.875	125.669	35.282	4.000
Zone #2	**Sample X4**	13549.33	1.589	135.535	39.781	24.781
Zone #2	**Sample X5**	13549.88	1.367	104.710	70.018	4.133
Zone #2	**Sample X6**	13550.58	1.205	105.887	43.564	24.021

Zone #2	**Sample X7**	13551.33	1.961	105.102	36.472	45.678
Zone #2	**Sample X8**	13552.50	1.845	131.772	61.211	0.000
Zone #2	**Sample X9**	13552.92	2.038	284.733	41.910	11.957
Zone #2	**Sample X10**	13553.67	2.157	326.735	23.144	36.667
Zone #2	**Sample X11**	13554.00	2.418	347.082	16.315	70.294
Zone #2	**Sample X12**	13554.50	2.179	269.152	37.257	53.383
Zone #2	**Sample X13**	13555.08	1.851	273.941	19.009	31.433
Zone #2	**Sample X14**	13556.21	1.850	232.793	32.318	7.840
Zone #2	**Sample X15**	13557.33	0.633	73.171	90.857	40.896
Zone #2	**Sample X16**	13558.08	1.870	280.982	30.750	39.531
Zone #2	**Sample X17**	13559.17	1.558	242.097	33.859	7.649
Zone #2	**Sample X18**	13560.13	0.668	104.270	58.214	34.824
Zone #2	**Sample X19**	13560.46	1.743	172.430	10.953	32.000
Zone #2	**Sample X20**	13561.17	0.708	63.916	95.442	51.855
Zone #2	**Sample X21**	13562.08	2.085	244.394	22.229	22.574
Zone #2	**Sample X22**	13563.25	1.721	220.984	7.975	68.117
Zone #2	**Sample X23**	13564.13	1.682	241.349	33.632	10.000
Zone #2	**Sample X24**	13565.17	0.730	102.969	58.911	36.392
Zone #2	**Sample X25**	13566.42	1.504	166.293	27.555	49.405
Zone #2	**Sample X26**	13567.50	2.208	202.201	-4.198	8.498
Zone #2	**Sample X27**	13568.00	1.502	177.347	21.409	8.809
Zone #2	**Sample X28**	13568.58	1.334	146.435	16.538	59.769
Zone #2	**Sample X29**	13569.92	1.868	159.295	41.068	5.237
Zone #2	**Sample X30**	13570.50	0.673	90.357	42.652	66.668
Zone #2	**Sample X31**	13572.25	1.580	270.736	28.581	24.891
Zone #2	**Sample X32**	13572.54	1.661	155.108	36.332	29.703
Zone #2	**Sample X33**	13574.21	1.923	266.382	21.594	19.525
Zone #2	**Sample X34**	13575.42	1.708	234.478	28.600	79.221
Zone #2	**Sample X35**	13576.21	1.611	397.807	50.644	134.893
Zone #2	**Sample X36**	13577.58	1.994	545.002	45.272	113.094
Zone #2	**Sample X37**	13579.33	2.310	360.792	28.599	73.351
Zone #2	**Sample X38**	13580.33	1.873	580.995	31.447	94.207
Zone #2	**Sample X39**	13581.25	1.944	594.540	60.449	5.000
Zone #2	**Sample X40**	13581.58	0.416	127.202	18.178	28.352
Zone #2	**Sample X41**	13582.50	0.553	95.748	45.939	21.714
Zone #2	**Sample X42**	13584.21	1.140	161.337	55.197	29.814
Zone #2	**Sample X43**	13585.71	1.358	186.027	33.784	5.828
Zone #2	**Sample X44**	13587.21	0.597	107.365	71.314	23.174
Zone #2	**Sample X45**	13588.63	0.972	178.073	58.474	85.003

Zone #2	**Sample X46**	13591.21	2.244	963.776	51.042	69.713
Zone #2	**Sample X47**	13592.46	1.068	166.386	71.955	122.090
Zone #2	**Sample X48**	13594.42	2.128	936.621	74.385	8.613
Zone #2	**Sample X49**	13595.54	0.497	122.113	-11.705	0.355
Zone #2	**Sample X50**	13597.25	0.698	111.836	26.136	40.287
Zone #2	**Sample X51**	13598.75	1.150	136.214	68.150	38.990
Zone #2	**Sample X52**	13600.13	0.759	96.264	73.381	6.670
Zone #2	**Sample X53**	13601.25	1.323	137.611	35.227	53.526
Zone #2	**Sample X54**	13603.13	1.810	173.513	59.059	21.695
Zone #2	**Sample X55**	13604.33	0.861	110.206	56.965	38.209
Zone #2	**Sample X56**	13605.13	1.161	132.857	59.233	32.812
Zone #2	**Sample X57**	13606.25	1.680	248.344	61.114	144.779
Zone #2	**Sample X58**	13608.13	1.704	699.759	63.926	102.964
Zone #2	**Sample X59**	13609.33	1.877	748.306	66.237	151.122
Zone #2	**Sample X60**	13611.13	1.773	564.080	57.630	11.322
Zone #2	**Sample X61**	13612.38	0.846	133.383	49.956	29.332
Zone #2	**Sample X62**	13614.25	0.533	107.664	-5.628	36.702
Zone #2	**Sample X63**	13615.33	0.784	123.579	38.815	92.974
Zone #2	**Sample X64**	13616.17	1.372	188.692	68.143	83.795
Zone #2	**Sample X65**	13617.33	1.726	266.219	69.786	138.988
Zone #1	**Sample X66**	13619.17	1.712	727.608	68.212	25.750
Zone #1	**Sample X67**	13620.33	1.757	700.191	54.677	104.650
Zone #1	**Sample X68**	13621.33	0.970	161.209	75.865	67.753
Zone #1	**Sample X69**	13622.67	1.316	100.552	83.274	79.102
Zone #1	**Sample X70**	13624.08	1.433	123.521	65.142	61.800
Zone #1	**Sample X71**	13624.42	1.881	180.759	78.983	63.514
Zone #1	**Sample X72**	13625.33	1.428	159.003	49.777	29.102
Zone #1	**Sample X73**	13626.17	1.254	142.610	20.086	55.133
Zone #1	**Sample X74**	13627.33	1.064	93.555	61.331	38.201
Zone #1	**Sample X75**	13629.17	1.414	173.069	68.337	66.910
Zone #1	**Sample X76**	13630.58	1.501	137.403	58.738	19.302
Zone #1	**Sample X77**	13632.21	1.280	125.454	65.793	28.238
Zone #1	**Sample X78**	13633.29	1.862	112.000	84.669	44.485
Zone #1	**Sample X79**	13635.33	2.001	184.153	48.979	78.638
Zone #1	**Sample X80**	13636.25	0.962	-19.546	51.357	47.473
Zone #1	**Sample X81**	13638.29	1.575	134.205	59.512	54.755
Zone #1	**Sample X82**	13639.38	1.452	142.592	61.091	39.989
Zone #1	**Sample X83**	13641.42	1.804	230.289	57.290	70.622
Zone #1	**Sample X84**	13642.63	0.910	98.551	54.070	84.713

Zone #1	**Sample X85**	13644.21	1.228	150.337	81.023	48.666
Zone #1	**Sample X86**	13645.25	1.418	230.521	63.885	59.730
Zone #1	**Sample X87**	13646.33	1.655	158.126	56.685	77.249
Zone #1	**Sample X88**	13647.42	1.092	132.727	53.852	83.265
Zone #1	**Sample X89**	13649.25	1.063	85.468	63.212	65.018
Zone #1	**Sample X90**	13650.54	1.231	117.447	83.182	86.081
Zone #1	**Sample X91**	13651.13	1.260	106.696	92.176	87.794
Zone #1	**Sample X92**	13652.50	1.824	192.435	62.115	27.442
Zone #1	**Sample X93**	13654.75	2.121	175.445	38.755	42.183
Zone #1	**Sample X94**	13655.96	1.582	100.350	85.376	41.360
Zone #1	**Sample X95**	13657.17	1.714	100.456	84.797	34.631
Zone #1	**Sample X96**	13658.54	1.332	131.641	59.754	51.298
Zone #1	**Sample X97**	13659.21	1.584	149.336	71.132	39.070
Zone #1	**Sample X98**	13660.50	1.881	143.235	78.574	42.652
Zone #1	**Sample X99**	13662.04	1.733	139.372	74.308	88.321
Zone #1	**Sample X100**	13663.54	1.857	163.858	71.654	64.197
Zone #1	**Sample X101**	13665.21	1.469	148.781	52.901	71.727
Zone #1	**Sample X102**	13666.58	1.385	157.700	68.692	49.123
Zone #1	**Sample X103**	13667.25	1.609	174.882	107.258	48.046
Zone #1	**Sample X104**	13668.50	1.423	118.859	85.217	58.672
Zone #1	**Sample X105**	13670.17	1.679	179.900	79.803	72.882
Zone #1	**Sample X106**	13671.58	1.942	206.098	79.827	32.000
Zone #1	**Sample X107**	13673.50	1.659	157.149	86.875	17.000
Zone #1	**Sample X108**	13677.00	0.330	86.069	-45.673	4.000

Shell Oil Co. Leppard, J.A. #1 Drill Core		**Total Depth (ft)**	**Zn ppm**	**Th ppm**	**Rb ppm**	**U ppm**
Zone #2	**Sample X1**	13546.42	66.749	7.254	61.642	5.049
Zone #2	**Sample X2**	13547.33	34.382	2.647	13.116	11.837
Zone #2	**Sample X3**	13548.50	45.133	4.928	58.122	11.918
Zone #2	**Sample X4**	13549.33	52.568	3.802	74.420	2.569
Zone #2	**Sample X5**	13549.88	42.703	2.899	37.918	3.000
Zone #2	**Sample X6**	13550.58	51.750	5.921	49.424	10.621
Zone #2	**Sample X7**	13551.33	74.954	5.430	48.413	2.962
Zone #2	**Sample X8**	13552.50	50.587	4.896	51.060	3.897
Zone #2	**Sample X9**	13552.92	97.133	7.235	82.082	8.659
Zone #2	**Sample X10**	13553.67	167.494	5.859	89.699	18.775
Zone #2	**Sample X11**	13554.00	145.129	6.783	70.925	0.000

Zone #2	**Sample X12**	13554.50	148.166	7.019	81.377	3.141
Zone #2	**Sample X13**	13555.08	185.343	5.578	78.800	14.636
Zone #2	**Sample X14**	13556.21	42.203	1.802	7.240	7.309
Zone #2	**Sample X15**	13557.33	97.602	5.814	63.335	11.534
Zone #2	**Sample X16**	13558.08	84.912	5.500	58.843	1.680
Zone #2	**Sample X17**	13559.17	28.012	0.401	5.982	5.647
Zone #2	**Sample X18**	13560.13	95.036	4.855	65.360	10.402
Zone #2	**Sample X19**	13560.46	38.013	1.207	5.691	6.936
Zone #2	**Sample X20**	13561.17	101.888	5.259	66.930	5.629
Zone #2	**Sample X21**	13562.08	102.573	6.018	61.296	3.791
Zone #2	**Sample X22**	13563.25	106.601	3.992	76.420	11.742
Zone #2	**Sample X23**	13564.13	57.536	1.422	12.388	6.444
Zone #2	**Sample X24**	13565.17	105.114	6.668	62.606	10.640
Zone #2	**Sample X25**	13566.42	86.773	9.090	81.505	7.138
Zone #2	**Sample X26**	13567.50	73.149	4.801	53.955	4.490
Zone #2	**Sample X27**	13568.00	81.919	4.639	58.494	6.854
Zone #2	**Sample X28**	13568.58	120.853	5.693	85.878	20.216
Zone #2	**Sample X29**	13569.92	31.335	2.466	6.309	7.416
Zone #2	**Sample X30**	13570.50	118.660	4.564	58.850	1.509
Zone #2	**Sample X31**	13572.25	93.930	4.046	68.168	15.357
Zone #2	**Sample X32**	13572.54	117.970	4.658	61.630	9.992
Zone #2	**Sample X33**	13574.21	150.255	5.976	53.454	14.147
Zone #2	**Sample X34**	13575.42	151.121	5.656	71.383	21.072
Zone #2	**Sample X35**	13576.21	186.602	4.856	60.974	16.044
Zone #2	**Sample X36**	13577.58	182.028	5.806	77.231	6.823
Zone #2	**Sample X37**	13579.33	162.955	4.753	63.184	26.538
Zone #2	**Sample X38**	13580.33	184.808	5.390	53.487	18.325
Zone #2	**Sample X39**	13581.25	29.364	0.175	3.000	2.546
Zone #2	**Sample X40**	13581.58	34.798	1.863	0.265	4.890
Zone #2	**Sample X41**	13582.50	66.979	3.371	29.789	12.661
Zone #2	**Sample X42**	13584.21	123.926	4.636	21.365	9.713
Zone #2	**Sample X43**	13585.71	52.129	1.699	6.871	4.189
Zone #2	**Sample X44**	13587.21	111.160	5.452	39.562	5.376
Zone #2	**Sample X45**	13588.63	214.429	6.603	65.200	15.390
Zone #2	**Sample X46**	13591.21	110.714	5.002	30.692	13.792
Zone #2	**Sample X47**	13592.46	419.470	7.132	75.804	7.277
Zone #2	**Sample X48**	13594.42	46.354	2.560	1.325	3.425
Zone #2	**Sample X49**	13595.54	35.534	0.887	1.292	2.785
Zone #2	**Sample X50**	13597.25	123.783	3.572	26.178	10.624

Zone #2	**Sample X51**	13598.75	83.375	3.106	15.268	8.460
Zone #2	**Sample X52**	13600.13	94.096	3.086	32.869	12.712
Zone #2	**Sample X53**	13601.25	150.327	4.549	59.885	4.323
Zone #2	**Sample X54**	13603.13	100.865	2.956	17.375	5.194
Zone #2	**Sample X55**	13604.33	105.055	2.823	40.208	10.773
Zone #2	**Sample X56**	13605.13	130.202	4.618	50.521	16.011
Zone #2	**Sample X57**	13606.25	280.222	5.970	52.463	14.746
Zone #2	**Sample X58**	13608.13	181.752	4.179	59.574	20.407
Zone #2	**Sample X59**	13609.33	251.566	2.793	58.110	14.952
Zone #2	**Sample X60**	13611.13	86.647	3.087	22.099	9.666
Zone #2	**Sample X61**	13612.38	37.923	0.812	5.670	6.576
Zone #2	**Sample X62**	13614.25	78.282	1.726	27.147	4.784
Zone #2	**Sample X63**	13615.33	156.521	6.183	59.223	12.529
Zone #2	**Sample X64**	13616.17	95.327	3.693	43.532	12.304
Zone #2	**Sample X65**	13617.33	238.675	6.190	57.922	14.098
Zone #1	**Sample X66**	13619.17	85.094	3.919	22.993	9.903
Zone #1	**Sample X67**	13620.33	110.313	3.465	42.322	7.714
Zone #1	**Sample X68**	13621.33	107.991	5.455	42.509	14.097
Zone #1	**Sample X69**	13622.67	140.016	4.882	55.382	12.594
Zone #1	**Sample X70**	13624.08	119.366	5.518	52.318	13.040
Zone #1	**Sample X71**	13624.42	91.483	4.194	38.587	11.920
Zone #1	**Sample X72**	13625.33	104.916	3.449	38.276	6.000
Zone #1	**Sample X73**	13626.17	122.122	5.016	48.559	10.153
Zone #1	**Sample X74**	13627.33	116.591	6.154	54.140	7.401
Zone #1	**Sample X75**	13629.17	79.905	3.152	55.470	2.351
Zone #1	**Sample X76**	13630.58	111.417	5.170	45.793	15.769
Zone #1	**Sample X77**	13632.21	171.401	7.433	58.644	10.389
Zone #1	**Sample X78**	13633.29	85.718	2.801	32.642	12.198
Zone #1	**Sample X79**	13635.33	104.156	5.271	48.602	1.000
Zone #1	**Sample X80**	13636.25	102.825	4.111	42.598	7.634
Zone #1	**Sample X81**	13638.29	120.416	5.089	36.619	5.852
Zone #1	**Sample X82**	13639.38	139.361	3.490	28.252	9.898
Zone #1	**Sample X83**	13641.42	108.618	5.184	42.496	14.450
Zone #1	**Sample X84**	13642.63	193.130	5.354	55.446	12.405
Zone #1	**Sample X85**	13644.21	113.997	5.484	45.611	8.170
Zone #1	**Sample X86**	13645.25	74.022	4.341	36.912	9.184
Zone #1	**Sample X87**	13646.33	89.010	2.982	43.354	12.757
Zone #1	**Sample X88**	13647.42	98.829	3.505	51.357	9.173
Zone #1	**Sample X89**	13649.25	96.006	3.793	32.664	6.797

Zone #1	**Sample X90**	13650.54	113.561	5.160	46.556	5.924
Zone #1	**Sample X91**	13651.13	157.426	8.096	49.256	14.518
Zone #1	**Sample X92**	13652.50	109.126	5.455	38.213	10.607
Zone #1	**Sample X93**	13654.75	125.569	8.222	45.926	5.544
Zone #1	**Sample X94**	13655.96	96.263	4.627	31.106	8.924
Zone #1	**Sample X95**	13657.17	109.130	6.022	43.146	8.136
Zone #1	**Sample X96**	13658.54	108.024	5.393	43.487	10.190
Zone #1	**Sample X97**	13659.21	117.591	5.922	47.518	4.212
Zone #1	**Sample X98**	13660.50	104.508	4.842	57.761	9.431
Zone #1	**Sample X99**	13662.04	122.630	6.401	43.987	7.939
Zone #1	**Sample X100**	13663.54	127.571	4.009	45.150	12.701
Zone #1	**Sample X101**	13665.21	130.059	6.885	55.732	9.327
Zone #1	**Sample X102**	13666.58	134.876	4.832	51.016	7.808
Zone #1	**Sample X103**	13667.25	154.504	5.949	45.112	8.127
Zone #1	**Sample X104**	13668.50	146.764	7.490	47.221	7.850
Zone #1	**Sample X105**	13670.17	136.501	2.552	63.204	7.223
Zone #1	**Sample X106**	13671.58	39.626	1.647	5.000	3.516
Zone #1	**Sample X107**	13673.50	26.448	0.938	1.945	4.000
Zone #1	**Sample X108**	13677.00	27.730	0.221	6.000	1.720

Shell Oil Co. Leppard, J.A. #1 Drill Core		**Total Depth (ft)**	**Sr ppm**	**Zr ppm**	**Mo ppm**
Zone #2	**Sample X1**	13546.42	767.374	72.523	1.864
Zone #2	**Sample X2**	13547.33	931.726	13.600	1.756
Zone #2	**Sample X3**	13548.50	811.152	71.141	0.215
Zone #2	**Sample X4**	13549.33	852.485	77.561	1.000
Zone #2	**Sample X5**	13549.88	712.771	49.370	1.000
Zone #2	**Sample X6**	13550.58	909.250	54.246	1.000
Zone #2	**Sample X7**	13551.33	830.131	63.393	0.801
Zone #2	**Sample X8**	13552.50	751.647	65.748	4.013
Zone #2	**Sample X9**	13552.92	590.729	104.967	31.926
Zone #2	**Sample X10**	13553.67	604.335	106.456	19.874
Zone #2	**Sample X11**	13554.00	558.499	106.494	17.737
Zone #2	**Sample X12**	13554.50	548.275	109.432	16.079
Zone #2	**Sample X13**	13555.08	459.262	93.988	7.329
Zone #2	**Sample X14**	13556.21	244.800	16.226	2.381
Zone #2	**Sample X15**	13557.33	487.272	96.187	16.916
Zone #2	**Sample X16**	13558.08	563.482	80.471	8.798

Zone #2	**Sample X17**	13559.17	237.261	7.267	5.114
Zone #2	**Sample X18**	13560.13	583.766	95.684	10.654
Zone #2	**Sample X19**	13560.46	335.047	30.220	5.629
Zone #2	**Sample X20**	13561.17	544.398	94.908	7.583
Zone #2	**Sample X21**	13562.08	604.422	99.279	12.571
Zone #2	**Sample X22**	13563.25	575.822	91.941	5.885
Zone #2	**Sample X23**	13564.13	334.706	34.151	4.797
Zone #2	**Sample X24**	13565.17	669.405	79.221	4.934
Zone #2	**Sample X25**	13566.42	396.109	207.583	3.593
Zone #2	**Sample X26**	13567.50	627.922	77.046	1.429
Zone #2	**Sample X27**	13568.00	675.594	75.412	3.737
Zone #2	**Sample X28**	13568.58	552.180	127.887	4.738
Zone #2	**Sample X29**	13569.92	256.886	40.092	5.298
Zone #2	**Sample X30**	13570.50	622.879	72.417	16.044
Zone #2	**Sample X31**	13572.25	587.616	87.412	3.637
Zone #2	**Sample X32**	13572.54	625.356	68.436	11.330
Zone #2	**Sample X33**	13574.21	621.223	74.684	19.094
Zone #2	**Sample X34**	13575.42	618.389	86.195	27.200
Zone #2	**Sample X35**	13576.21	654.859	77.514	89.697
Zone #2	**Sample X36**	13577.58	633.797	82.380	90.009
Zone #2	**Sample X37**	13579.33	575.216	70.868	91.627
Zone #2	**Sample X38**	13580.33	586.290	77.774	96.929
Zone #2	**Sample X39**	13581.25	404.406	4.717	10.817
Zone #2	**Sample X40**	13581.58	275.081	15.408	4.502
Zone #2	**Sample X41**	13582.50	649.732	58.658	31.041
Zone #2	**Sample X42**	13584.21	706.408	50.764	50.521
Zone #2	**Sample X43**	13585.71	666.795	18.467	15.324
Zone #2	**Sample X44**	13587.21	802.320	41.588	37.683
Zone #2	**Sample X45**	13588.63	480.960	109.131	104.085
Zone #2	**Sample X46**	13591.21	767.243	51.316	40.301
Zone #2	**Sample X47**	13592.46	552.732	103.109	84.556
Zone #2	**Sample X48**	13594.42	542.238	58.617	10.843
Zone #2	**Sample X49**	13595.54	396.275	41.843	11.683
Zone #2	**Sample X50**	13597.25	715.367	41.012	37.438
Zone #2	**Sample X51**	13598.75	578.218	38.856	12.480
Zone #2	**Sample X52**	13600.13	544.214	60.818	32.243
Zone #2	**Sample X53**	13601.25	499.179	111.024	50.051
Zone #2	**Sample X54**	13603.13	651.564	23.835	25.186
Zone #2	**Sample X55**	13604.33	609.355	57.170	47.331

Zone #2	**Sample X56**	13605.13	637.893	61.287	66.336
Zone #2	**Sample X57**	13606.25	651.117	57.652	100.659
Zone #2	**Sample X58**	13608.13	617.351	63.221	83.861
Zone #2	**Sample X59**	13609.33	602.074	74.531	117.354
Zone #2	**Sample X60**	13611.13	573.600	33.188	24.667
Zone #2	**Sample X61**	13612.38	646.699	21.223	6.366
Zone #2	**Sample X62**	13614.25	706.544	27.473	24.358
Zone #2	**Sample X63**	13615.33	660.866	79.163	66.504
Zone #2	**Sample X64**	13616.17	675.433	60.103	58.338
Zone #2	**Sample X65**	13617.33	683.988	70.250	95.139
Zone #1	**Sample X66**	13619.17	930.477	20.549	11.108
Zone #1	**Sample X67**	13620.33	804.716	39.395	17.747
Zone #1	**Sample X68**	13621.33	540.807	69.296	29.947
Zone #1	**Sample X69**	13622.67	604.022	67.574	33.918
Zone #1	**Sample X70**	13624.08	640.128	72.241	24.721
Zone #1	**Sample X71**	13624.42	543.273	64.856	13.764
Zone #1	**Sample X72**	13625.33	701.941	47.013	12.635
Zone #1	**Sample X73**	13626.17	709.054	55.071	17.952
Zone #1	**Sample X74**	13627.33	735.112	72.284	24.525
Zone #1	**Sample X75**	13629.17	616.010	66.552	26.817
Zone #1	**Sample X76**	13630.58	516.902	72.278	36.553
Zone #1	**Sample X77**	13632.21	473.318	119.796	31.375
Zone #1	**Sample X78**	13633.29	554.086	45.164	19.527
Zone #1	**Sample X79**	13635.33	496.345	85.629	20.338
Zone #1	**Sample X80**	13636.25	587.412	73.264	26.153
Zone #1	**Sample X81**	13638.29	491.431	69.660	78.065
Zone #1	**Sample X82**	13639.38	568.919	35.596	15.906
Zone #1	**Sample X83**	13641.42	559.315	56.323	36.461
Zone #1	**Sample X84**	13642.63	553.276	67.844	37.538
Zone #1	**Sample X85**	13644.21	535.832	74.898	12.130
Zone #1	**Sample X86**	13645.25	484.521	43.463	18.619
Zone #1	**Sample X87**	13646.33	642.909	54.275	23.655
Zone #1	**Sample X88**	13647.42	682.804	58.851	21.078
Zone #1	**Sample X89**	13649.25	569.668	53.226	21.320
Zone #1	**Sample X90**	13650.54	472.687	78.875	27.385
Zone #1	**Sample X91**	13651.13	418.822	123.373	22.050
Zone #1	**Sample X92**	13652.50	469.509	82.453	10.135
Zone #1	**Sample X93**	13654.75	438.366	91.421	31.051
Zone #1	**Sample X94**	13655.96	498.729	61.259	13.126

Zone #1	Sample X95	13657.17	531.982	80.014	12.546
Zone #1	Sample X96	13658.54	438.539	88.018	21.373
Zone #1	Sample X97	13659.21	428.886	95.733	22.675
Zone #1	Sample X98	13660.50	503.733	90.967	36.792
Zone #1	Sample X99	13662.04	485.084	66.665	26.392
Zone #1	Sample X100	13663.54	489.583	61.761	31.054
Zone #1	Sample X101	13665.21	517.495	74.232	28.017
Zone #1	Sample X102	13666.58	452.309	76.029	29.455
Zone #1	Sample X103	13667.25	414.710	85.387	36.474
Zone #1	Sample X104	13668.50	385.313	108.693	22.631
Zone #1	Sample X105	13670.17	477.940	64.185	21.561
Zone #1	Sample X106	13671.58	233.501	7.000	3.122
Zone #1	Sample X107	13673.50	436.450	6.000	3.749
Zone #1	Sample X108	13677.00	339.185	8.000	3.099

Quintanna Halff et al # 1 Drill Core

Quintanna Halff et al # 1 Drill Core		Total Depth (ft)	Mg %	Al %	Si %	P %	K %
Zone #3	Sample X1	6404.70	0.518	2.247	15.494	0.078	0.667
Zone #3	Sample X2	6405.50	0.625	1.182	2.612	-0.132	-0.169
Zone #3	Sample X3	6406.50	0.350	0.686	4.988	-0.146	-0.360
Zone #3	Sample X4	6407.50	0.081	3.604	18.046	0.080	1.180
Zone #3	Sample X5	6408.60	0.247	3.633	17.098	0.431	1.311
Zone #3	Sample X6	6409.20	0.829	0.668	4.670	-0.048	-0.368
Zone #3	Sample X7	6413.60	-0.115	4.316	19.705	0.037	1.352
Zone #2	Sample X8	6421.20	0.322	1.585	9.790	0.184	0.328
Zone #2	Sample X9	6421.60	0.411	2.235	13.761	0.103	0.771
Zone #2	Sample X10	6422.00	0.672	0.939	4.981	-0.077	-0.170
Zone #2	Sample X11	6422.50	0.333	2.441	11.481	0.111	1.040
Zone #2	Sample X12	6430.20	0.034	1.418	7.925	0.247	0.254
Zone #2	Sample X13	6430.60	0.163	2.804	10.675	0.082	0.602
Zone #2	Sample X14	6431.00	0.861	1.373	8.653	0.200	0.557
Zone #2	Sample X15	6431.60	0.321	1.061	8.968	0.080	0.502
Zone #2	Sample X16	6432.00	0.402	1.640	9.589	0.187	0.607
Zone #2	Sample X17	6432.60	0.480	2.222	11.939	0.214	0.896
Zone #2	Sample X18	6433.20	0.229	1.720	13.113	0.091	0.707
Zone #2	Sample X19	6433.60	0.464	2.013	12.375	0.143	0.570
Zone #2	Sample X20	6434.00	0.571	1.386	9.770	0.128	0.445
Zone #2	Sample X21	6434.40	0.120	1.724	12.745	0.113	0.615

Zone #1	**Sample X22**	6449.90	0.532	2.881	12.358	0.107	1.303
Zone #1	**Sample X23**	6450.60	0.710	4.268	17.498	0.067	1.563
Zone #1	**Sample X24**	6451.00	0.347	1.315	8.566	0.128	0.433
Zone #1	**Sample X25**	6455.80	0.658	1.863	9.207	0.180	0.622
Zone #1	**Sample X26**	6456.30	0.480	1.419	9.329	0.074	0.856
Zone #1	**Sample X27**	6456.90	0.503	1.449	7.981	0.059	0.481
Zone #1	**Sample X28**	6459.40	0.304	3.759	12.607	0.059	1.452

Quintanna Halff et al # 1 Drill Core		**Total Depth (ft)**	**Ca %**	**Ti %**	**Mn %**	**Fe %**	**V ppm**
Zone #3	**Sample X1**	6404.70	15.939	0.171	0.018	1.471	400.502
Zone #3	**Sample X2**	6405.50	34.183	0.028	0.049	0.464	142.917
Zone #3	**Sample X3**	6406.50	33.047	0.019	0.039	0.443	123.185
Zone #3	**Sample X4**	6407.50	11.959	0.221	0.020	1.584	609.155
Zone #3	**Sample X5**	6408.60	10.195	0.218	0.022	1.800	512.189
Zone #3	**Sample X6**	6409.20	33.216	0.025	0.035	0.422	109.680
Zone #3	**Sample X7**	6413.60	7.130	0.222	0.025	1.597	377.239
Zone #2	**Sample X8**	6421.20	24.326	0.098	0.019	1.452	257.493
Zone #2	**Sample X9**	6421.60	19.185	0.155	0.015	1.474	304.075
Zone #2	**Sample X10**	6422.00	32.892	0.042	0.032	0.568	131.102
Zone #2	**Sample X11**	6422.50	21.271	0.172	0.017	1.514	447.964
Zone #2	**Sample X12**	6430.20	26.018	0.120	0.021	1.365	276.120
Zone #2	**Sample X13**	6430.60	21.390	0.170	0.023	1.839	261.993
Zone #2	**Sample X14**	6431.00	24.098	0.126	0.020	1.611	311.452
Zone #2	**Sample X15**	6431.60	24.138	0.119	0.019	1.354	310.438
Zone #2	**Sample X16**	6432.00	23.608	0.148	0.021	1.436	358.540
Zone #2	**Sample X17**	6432.60	20.095	0.152	0.016	1.598	358.343
Zone #2	**Sample X18**	6433.20	17.966	0.149	0.018	1.817	380.179
Zone #2	**Sample X19**	6433.60	20.164	0.124	0.016	1.778	326.621
Zone #2	**Sample X20**	6434.00	23.548	0.117	0.019	1.531	270.013
Zone #2	**Sample X21**	6434.40	21.546	0.140	0.019	1.275	329.634
Zone #1	**Sample X22**	6449.90	19.465	0.184	0.015	1.485	426.730
Zone #1	**Sample X23**	6450.60	12.772	0.268	0.020	1.958	825.084
Zone #1	**Sample X24**	6451.00	27.671	0.092	0.020	1.013	279.825
Zone #1	**Sample X25**	6455.80	26.611	0.115	0.017	1.092	568.295
Zone #1	**Sample X26**	6456.30	25.259	0.131	0.019	1.293	327.140
Zone #1	**Sample X27**	6456.90	27.826	0.088	0.024	1.018	212.345
Zone #1	**Sample X28**	6459.40	19.621	0.218	0.023	1.440	328.705

Quintanna Halff et al # 1 Drill Core		Total Depth (ft)	Cr ppm	Ni ppm	Cu ppm	Zn ppm
Zone #3	Sample X1	6404.70	77.716	86.956	52.589	119.165
Zone #3	Sample X2	6405.50	33.881	8.177	22.275	34.369
Zone #3	Sample X3	6406.50	55.245	26.000	5.807	17.131
Zone #3	Sample X4	6407.50	36.210	80.670	48.090	142.610
Zone #3	Sample X5	6408.60	21.722	87.635	17.697	118.428
Zone #3	Sample X6	6409.20	67.787	31.265	4.000	21.302
Zone #3	Sample X7	6413.60	11.111	56.040	59.492	151.186
Zone #2	Sample X8	6421.20	78.849	69.872	49.456	106.037
Zone #2	Sample X9	6421.60	86.412	123.252	45.897	109.425
Zone #2	Sample X10	6422.00	63.703	17.777	4.759	34.090
Zone #2	Sample X11	6422.50	100.009	107.846	29.547	141.319
Zone #2	Sample X12	6430.20	47.567	76.690	43.484	59.844
Zone #2	Sample X13	6430.60	54.568	62.164	66.850	114.584
Zone #2	Sample X14	6431.00	43.278	132.113	68.979	99.118
Zone #2	Sample X15	6431.60	52.797	57.746	76.897	126.794
Zone #2	Sample X16	6432.00	62.478	168.180	53.415	130.298
Zone #2	Sample X17	6432.60	85.049	120.892	92.701	142.713
Zone #2	Sample X18	6433.20	60.689	114.916	50.720	139.100
Zone #2	Sample X19	6433.60	73.946	160.387	60.830	100.490
Zone #2	Sample X20	6434.00	58.464	105.760	78.080	62.965
Zone #2	Sample X21	6434.40	67.890	99.521	34.209	81.120
Zone #1	Sample X22	6449.90	108.927	89.243	60.693	107.548
Zone #1	Sample X23	6450.60	59.966	104.125	75.912	144.010
Zone #1	Sample X24	6451.00	95.701	49.015	47.673	135.919
Zone #1	Sample X25	6455.80	100.081	117.912	78.573	153.872
Zone #1	Sample X26	6456.30	72.500	73.578	43.833	105.860
Zone #1	Sample X27	6456.90	54.240	43.885	47.721	68.358
Zone #1	Sample X28	6459.40	73.387	69.806	31.160	77.435

Quintanna Halff et al # 1 Drill Core		Total Depth (ft)	Th ppm	Rb ppm	U ppm	Sr ppm
Zone #3	Sample X1	6404.70	5.091	12.235	7.525	608.483
Zone #3	Sample X2	6405.50	0.000	6.000	2.760	306.561
Zone #3	Sample X3	6406.50	2.033	9.000	8.467	400.279
Zone #3	Sample X4	6407.50	5.134	25.638	15.633	429.753
Zone #3	Sample X5	6408.60	8.550	49.173	8.052	829.058
Zone #3	Sample X6	6409.20	0.430	2.000	4.359	369.811

Zone #3	**Sample X7**	6413.60	7.248	34.817	6.064	321.459
Zone #2	**Sample X8**	6421.20	3.026	29.283	7.002	564.322
Zone #2	**Sample X9**	6421.60	4.096	26.296	5.973	645.701
Zone #2	**Sample X10**	6422.00	1.555	2.665	0.000	408.147
Zone #2	**Sample X11**	6422.50	4.327	44.662	2.734	730.878
Zone #2	**Sample X12**	6430.20	3.446	16.682	8.345	703.404
Zone #2	**Sample X13**	6430.60	5.469	28.493	10.165	720.634
Zone #2	**Sample X14**	6431.00	2.406	30.169	4.862	767.946
Zone #2	**Sample X15**	6431.60	3.438	29.294	14.362	857.796
Zone #2	**Sample X16**	6432.00	5.090	29.616	4.696	779.201
Zone #2	**Sample X17**	6432.60	7.264	51.827	1.093	715.783
Zone #2	**Sample X18**	6433.20	4.181	40.572	8.727	534.556
Zone #2	**Sample X19**	6433.60	4.458	30.448	18.230	582.714
Zone #2	**Sample X20**	6434.00	3.914	23.211	12.809	583.258
Zone #2	**Sample X21**	6434.40	3.694	54.944	8.973	680.348
Zone #1	**Sample X22**	6449.90	5.961	59.831	9.545	624.533
Zone #1	**Sample X23**	6450.60	6.759	73.119	11.163	689.646
Zone #1	**Sample X24**	6451.00	5.199	31.603	3.000	941.887
Zone #1	**Sample X25**	6455.80	4.809	56.601	9.383	760.663
Zone #1	**Sample X26**	6456.30	2.555	39.457	7.045	818.750
Zone #1	**Sample X27**	6456.90	3.244	59.100	3.909	680.549
Zone #1	**Sample X28**	6459.40	7.739	55.680	4.216	535.984

Quintanna Halff et al # 1 Drill Core		**Total Depth (ft)**	**Sr ppm**	**Zr ppm**	**Mo ppm**
Zone #3	**Sample X1**	6404.70	608.483	76.903	56.221
Zone #3	**Sample X2**	6405.50	306.561	5.978	5.510
Zone #3	**Sample X3**	6406.50	400.279	8.205	9.607
Zone #3	**Sample X4**	6407.50	429.753	118.303	71.654
Zone #3	**Sample X5**	6408.60	829.058	153.342	66.553
Zone #3	**Sample X6**	6409.20	369.811	9.859	9.770
Zone #3	**Sample X7**	6413.60	321.459	120.731	40.552
Zone #2	**Sample X8**	6421.20	564.322	57.608	79.413
Zone #2	**Sample X9**	6421.60	645.701	59.750	65.142
Zone #2	**Sample X10**	6422.00	408.147	14.570	10.309
Zone #2	**Sample X11**	6422.50	730.878	63.161	54.247
Zone #2	**Sample X12**	6430.20	703.404	52.779	139.557
Zone #2	**Sample X13**	6430.60	720.634	78.220	52.178

Zone #2	**Sample X14**	6431.00	767.946	62.347	185.504
Zone #2	**Sample X15**	6431.60	857.796	46.587	86.128
Zone #2	**Sample X16**	6432.00	779.201	56.959	125.576
Zone #2	**Sample X17**	6432.60	715.783	67.880	120.337
Zone #2	**Sample X18**	6433.20	534.556	49.324	157.706
Zone #2	**Sample X19**	6433.60	582.714	53.692	235.104
Zone #2	**Sample X20**	6434.00	583.258	46.587	158.362
Zone #2	**Sample X21**	6434.40	680.348	59.349	51.886
Zone #1	**Sample X22**	6449.90	624.533	79.011	46.513
Zone #1	**Sample X23**	6450.60	689.646	121.160	58.229
Zone #1	**Sample X24**	6451.00	941.887	48.127	21.881
Zone #1	**Sample X25**	6455.80	760.663	75.175	74.434
Zone #1	**Sample X26**	6456.30	818.750	54.438	18.087
Zone #1	**Sample X27**	6456.90	680.549	60.833	19.777
Zone #1	**Sample X28**	6459.40	535.984	99.329	23.661

Gose & Shield Hassett #3 Drill Core

Gose & Shield Hassett #3 Drill Core		**Total Depth (ft)**	**Mg %**	**Al %**	**Si %**	**P %**	**K %**
Zone #2	**Sample X1**	6212.50	0.897	0.330	7.537	-0.068	-0.169
Zone #2	**Sample X2**	6213.50	0.614	2.859	14.932	0.147	0.650
Zone #2	**Sample X3**	6214.50	0.414	1.541	9.100	-0.110	0.101
Zone #2	**Sample X4**	6215.50	0.739	0.891	8.363	-0.087	0.011
Zone #2	**Sample X5**	6216.50	0.641	1.693	10.361	-0.008	0.273
Zone #2	**Sample X6**	6217.50	0.592	2.239	13.310	0.077	0.485
Zone #2	**Sample X7**	6218.50	0.937	2.749	13.920	0.059	0.505
Zone #2	**Sample X8**	6219.50	0.635	1.917	13.625	0.054	0.428
Zone #2	**Sample X9**	6220.50	0.620	2.185	13.519	0.070	0.507
Zone #2	**Sample X10**	6221.50	0.742	2.277	13.098	0.029	0.494
Zone #2	**Sample XA**	6224.50	0.987	0.927	7.392	-0.175	-0.123
Zone #2	**Sample X11**	6225.50	0.597	1.642	11.504	0.028	0.335
Zone #2	**Sample X12**	6226.50	0.709	0.976	7.826	-0.149	-0.084
Zone #2	**Sample X13**	6227.50	0.616	1.746	10.822	-0.009	0.286
Zone #2	**Sample X14**	6228.50	0.593	2.492	10.823	-0.055	0.365
Zone #2	**Sample X15**	6229.50	0.624	2.024	12.746	0.068	0.477
Zone #2	**Sample X16**	6230.50	1.035	0.653	6.975	-0.113	-0.134
Zone #2	**Sample X17**	6231.50	0.584	3.189	12.744	0.005	0.524
Zone #2	**Sample X18**	6232.50	1.137	1.310	9.463	0.032	0.192
Zone #2	**Sample X19**	6233.50	0.412	2.184	13.892	0.068	0.380

Zone #2	**Sample X20**	6234.50	0.869	2.186	11.919	0.022	0.406
Zone #2	**Sample X21**	6235.50	0.881	1.442	11.347	0.014	0.254
Zone #2	**Sample X22**	6236.50	1.299	0.382	7.288	-0.131	-0.185
Zone #2	**Sample X23**	6237.50	0.687	1.255	8.993	-0.031	0.098
Zone #2	**Sample X24**	6238.50	0.607	1.593	10.708	-0.011	0.267
Zone #1	**Sample X25**	6296.00	0.819	-0.176	8.253	-0.297	-0.574
Zone #1	**Sample X26**	6300.00	1.638	0.089	7.886	-0.218	-0.346
Zone #1	**Sample X27**	6305.00	0.919	0.395	7.730	-0.246	-0.416
Zone #1	**Sample X28**	6310.00	1.073	-0.173	8.175	-0.300	-0.565
Zone #1	**Sample X29**	6314.00	1.088	0.071	8.844	-0.239	-0.381
Zone #1	**Sample X30**	6319.00	0.925	0.017	7.607	-0.203	-0.403
Zone #1	**Sample X31**	6326.00	5.041	0.491	9.519	-0.140	-0.098
Zone #1	**Sample X32**	6329.00	0.966	0.113	8.024	-0.262	-0.486
Zone #1	**Sample X33**	6333.00	0.691	0.085	7.959	-0.239	-0.480

Gose & Shield Hassett #3 Drill Core		**Total Depth (ft)**	**Ca %**	**Ti %**	**Mn %**	**Fe %**	**V ppm**
Zone #2	**Sample X1**	6212.50	29.707	0.024	0.031	0.517	18.659
Zone #2	**Sample X2**	6213.50	13.266	0.166	0.015	1.465	85.939
Zone #2	**Sample X3**	6214.50	25.654	0.044	0.023	0.496	18.571
Zone #2	**Sample X4**	6215.50	27.338	0.054	0.022	0.465	19.557
Zone #2	**Sample X5**	6216.50	23.476	0.092	0.021	0.798	45.300
Zone #2	**Sample X6**	6217.50	18.614	0.135	0.018	1.207	84.617
Zone #2	**Sample X7**	6218.50	17.380	0.169	0.016	1.369	93.492
Zone #2	**Sample X8**	6219.50	18.137	0.113	0.015	0.953	26.951
Zone #2	**Sample X9**	6220.50	18.090	0.136	0.016	0.952	108.775
Zone #2	**Sample X10**	6221.50	18.691	0.126	0.016	0.970	19.351
Zone #2	**Sample XA**	6224.50	29.128	0.039	0.027	0.401	13.970
Zone #2	**Sample X11**	6225.50	21.758	0.090	0.019	0.906	67.050
Zone #2	**Sample X12**	6226.50	28.349	0.030	0.031	0.425	12.000
Zone #2	**Sample X13**	6227.50	23.015	0.086	0.025	0.775	26.618
Zone #2	**Sample X14**	6228.50	22.419	0.121	0.022	0.942	54.929
Zone #2	**Sample X15**	6229.50	18.761	0.120	0.017	0.858	36.900
Zone #2	**Sample X16**	6230.50	29.494	0.028	0.042	0.512	15.460
Zone #2	**Sample X17**	6231.50	19.408	0.156	0.020	1.252	79.758
Zone #2	**Sample X18**	6232.50	24.325	0.103	0.020	0.780	46.900
Zone #2	**Sample X19**	6233.50	19.008	0.132	0.017	0.779	47.600
Zone #2	**Sample X20**	6234.50	20.971	0.134	0.020	1.054	33.103
Zone #2	**Sample X21**	6235.50	22.143	0.087	0.019	0.679	33.563

Zone #2	**Sample X22**	6236.50	29.861	0.011	0.038	0.350	21.884
Zone #2	**Sample X23**	6237.50	26.070	0.067	0.026	0.907	29.677
Zone #2	**Sample X24**	6238.50	22.782	0.073	0.018	0.793	28.375
Zone #1	**Sample X25**	6296.00	32.275	0.009	0.040	0.237	15.916
Zone #1	**Sample X26**	6300.00	30.706	0.018	0.040	0.325	16.517
Zone #1	**Sample X27**	6305.00	31.409	0.004	0.040	0.284	14.881
Zone #1	**Sample X28**	6310.00	32.272	0.000	0.040	0.269	15.622
Zone #1	**Sample X29**	6314.00	30.427	0.010	0.043	0.266	25.044
Zone #1	**Sample X30**	6319.00	31.483	0.003	0.034	0.279	17.267
Zone #1	**Sample X31**	6326.00	25.845	0.026	0.047	0.697	24.173
Zone #1	**Sample X32**	6329.00	31.821	0.002	0.038	0.254	12.679
Zone #1	**Sample X33**	6333.00	31.795	0.017	0.041	0.397	14.927

Gose & Shield Hassett #3 Drill Core		Total Depth (ft)	**Cr ppm**	**Ni ppm**	**Cu ppm**	**Zn ppm**	**Th ppm**
Zone #2	**Sample X1**	6212.50	-31.878	50.370	-0.933	38.276	0.702
Zone #2	**Sample X2**	6213.50	59.348	355.173	31.030	166.839	5.159
Zone #2	**Sample X3**	6214.50	45.268	63.833	10.799	60.872	1.129
Zone #2	**Sample X4**	6215.50	30.995	31.985	9.825	20.472	0.097
Zone #2	**Sample X5**	6216.50	66.080	121.503	33.340	130.251	3.558
Zone #2	**Sample X6**	6217.50	90.263	115.725	34.812	160.964	4.239
Zone #2	**Sample X7**	6218.50	93.811	134.109	37.998	151.940	4.772
Zone #2	**Sample X8**	6219.50	99.241	141.633	33.784	125.259	5.341
Zone #2	**Sample X9**	6220.50	101.264	113.451	21.945	88.740	5.659
Zone #2	**Sample X10**	6221.50	82.780	128.475	40.994	173.801	4.921
Zone #2	**Sample XA**	6224.50	-5.463	49.029	18.686	39.933	-0.195
Zone #2	**Sample X11**	6225.50	89.097	113.461	32.748	154.681	3.294
Zone #2	**Sample X12**	6226.50	-11.791	51.170	9.005	35.393	-0.372
Zone #2	**Sample X13**	6227.50	52.912	74.748	17.256	121.660	2.565
Zone #2	**Sample X14**	6228.50	75.241	99.311	22.223	131.358	3.653
Zone #2	**Sample X15**	6229.50	92.710	137.345	34.510	165.751	4.136
Zone #2	**Sample X16**	6230.50	-13.647	79.874	13.242	68.121	0.773
Zone #2	**Sample X17**	6231.50	86.213	151.661	41.127	222.664	3.849
Zone #2	**Sample X18**	6232.50	36.318	167.901	19.483	161.754	2.115
Zone #2	**Sample X19**	6233.50	86.322	85.674	32.286	140.666	2.924
Zone #2	**Sample X20**	6234.50	53.582	107.451	26.494	83.116	4.819
Zone #2	**Sample X21**	6235.50	71.297	79.930	36.606	222.915	2.625
Zone #2	**Sample X22**	6236.50	-42.590	57.990	5.731	38.600	0.085
Zone #2	**Sample X23**	6237.50	34.851	40.669	8.800	49.825	1.893

Zone #2	**Sample X24**	6238.50	54.898	72.061	18.131	86.071	3.142
Zone #1	**Sample X25**	6296.00	-128.203	51.543	-7.190	9.280	-2.457
Zone #1	**Sample X26**	6300.00	-96.385	43.385	-8.766	2.206	-1.275
Zone #1	**Sample X27**	6305.00	-87.129	26.952	-3.105	-6.778	-1.552
Zone #1	**Sample X28**	6310.00	-121.665	31.537	-9.601	6.379	-1.734
Zone #1	**Sample X29**	6314.00	-107.944	47.027	5.220	6.720	-1.890
Zone #1	**Sample X30**	6319.00	-86.291	59.128	-10.696	-1.477	-1.205
Zone #1	**Sample X31**	6326.00	-59.491	59.725	13.634	19.201	0.639
Zone #1	**Sample X32**	6329.00	-112.878	41.014	2.061	4.713	-1.515
Zone #1	**Sample X33**	6333.00	-102.350	26.404	3.922	12.271	-1.514

Gose & Shield Hassett #3 Drill Core		Total Depth (ft)	**Rb ppm**	**U ppm**	**Sr ppm**	**Zr ppm**	**Mo ppm**
Zone #2	**Sample X1**	6212.50	12.355	-5.623	1574.291	53.901	9.272
Zone #2	**Sample X2**	6213.50	55.162	17.888	1433.342	119.572	288.086
Zone #2	**Sample X3**	6214.50	14.043	5.504	1055.503	38.813	34.183
Zone #2	**Sample X4**	6215.50	13.007	6.044	1198.439	34.064	17.975
Zone #2	**Sample X5**	6216.50	41.649	-4.087	1447.362	61.735	45.444
Zone #2	**Sample X6**	6217.50	39.265	2.766	981.671	59.859	69.145
Zone #2	**Sample X7**	6218.50	32.786	4.546	1018.955	83.483	65.478
Zone #2	**Sample X8**	6219.50	42.093	4.424	1000.186	77.762	78.774
Zone #2	**Sample X9**	6220.50	33.318	13.373	1106.108	65.648	73.128
Zone #2	**Sample X10**	6221.50	39.497	7.545	1094.718	81.477	146.375
Zone #2	**Sample XA**	6224.50	6.997	-4.701	923.024	45.702	16.447
Zone #2	**Sample X11**	6225.50	40.405	6.399	1249.407	55.999	108.455
Zone #2	**Sample X12**	6226.50	11.512	-2.055	1039.196	44.468	13.003
Zone #2	**Sample X13**	6227.50	28.409	3.254	1233.445	45.482	45.703
Zone #2	**Sample X14**	6228.50	25.853	10.554	1343.782	53.867	38.169
Zone #2	**Sample X15**	6229.50	52.953	8.503	1266.506	77.125	107.186
Zone #2	**Sample X16**	6230.50	12.031	4.185	1803.733	50.706	35.147
Zone #2	**Sample X17**	6231.50	61.173	15.755	1126.379	119.404	99.272
Zone #2	**Sample X18**	6232.50	22.610	-8.857	2200.197	66.271	25.622
Zone #2	**Sample X19**	6233.50	26.063	11.844	1248.374	48.231	22.916
Zone #2	**Sample X20**	6234.50	41.070	2.925	1556.945	57.151	34.665
Zone #2	**Sample X21**	6235.50	27.210	15.148	1496.143	37.299	35.823
Zone #2	**Sample X22**	6236.50	6.782	1.958	1366.403	47.663	6.170
Zone #2	**Sample X23**	6237.50	26.407	3.195	1703.509	35.864	5.297
Zone #2	**Sample X24**	6238.50	36.890	5.943	1649.890	49.210	51.036
Zone #1	**Sample X25**	6296.00	5.550	0.218	854.474	46.304	1.396

Zone #1	**Sample X26**	6300.00	5.550	-8.722	959.440	45.020	1.433
Zone #1	**Sample X27**	6305.00	12.064	-3.166	813.588	39.169	1.373
Zone #1	**Sample X28**	6310.00	6.163	-7.260	862.570	39.893	1.569
Zone #1	**Sample X29**	6314.00	3.972	6.010	782.721	47.571	2.939
Zone #1	**Sample X30**	6319.00	7.477	2.847	832.670	55.931	2.575
Zone #1	**Sample X31**	6326.00	4.530	-1.582	926.413	32.770	1.826
Zone #1	**Sample X32**	6329.00	6.278	-0.468	933.082	33.725	0.967
Zone #1	**Sample X33**	6333.00	12.965	-9.766	917.701	32.940	3.314

Getty Lloyd Hurt #1 Drill Core

Getty Lloyd Hurt #1 Drill Core		**Total Depth (ft)**	**TIC %**	**Mg %**	**Al %**	**Si %**	**P %**
Zone #2	**Sample X1**	7078.67	10.505	1.090	0.756	7.470	-0.102
Zone #2	**Sample X2**	7080.00	10.647	1.119	0.504	8.477	0.365
Zone #2	**Sample X3**	7081.33	9.969	1.146	-0.374	8.260	0.483
Zone #2	**Sample X4**	7082.67	10.716	1.512	-0.387	8.940	0.741
Zone #2	**Sample X5**	7084.00	10.280	0.991	0.798	7.263	-0.125
Zone #2	**Sample X6**	7085.33	9.895	1.038	1.139	7.403	-0.060
Zone #2	**Sample X7**	7086.67	10.513	1.089	0.413	7.356	-0.158
Zone #2	**Sample X8**	7088.00	10.220	1.139	0.725	7.470	-0.125
Zone #2	**Sample X9**	7089.33	9.890	0.909	1.052	7.511	-0.088
Zone #2	**Sample X10**	7090.50	10.252	0.814	0.853	7.492	-0.165
Zone #2	**Sample X11**	7091.50	9.863	1.139	0.861	7.820	0.072
Zone #2	**Sample X12**	7092.50	9.911	0.956	1.422	7.677	-0.166
Zone #2	**Sample X13**	7093.50	9.231	1.322	3.431	10.982	0.210
Zone #2	**Sample X14**	7094.50	10.289	1.350	0.602	7.225	-0.200
Zone #2	**Sample X15**	7095.50	10.150	1.070	0.496	7.389	-0.105
Zone #2	**Sample X16**	7096.50	10.158	0.837	0.522	7.247	-0.046
Zone #2	**Sample X17**	7097.50	10.434	1.157	0.430	7.420	-0.206
Zone #2	**Sample X18**	7098.50	10.285	1.374	0.750	7.546	-0.039
Zone #2	**Sample X19**	7099.56	10.381	1.184	0.586	7.420	-0.072
Zone #2	**Sample X20**	7100.67	10.382	1.263	0.519	7.198	-0.147
Zone #2	**Sample X21**	7101.78	9.127	0.969	1.268	7.747	0.131
Zone #2	**Sample X22**	7102.89	9.716	1.165	0.605	7.449	0.246
Zone #2	**Sample X23**	7104.00	10.258	1.309	1.030	7.433	-0.194
Zone #2	**Sample X24**	7105.11	8.809	0.897	0.894	7.542	-0.027
Zone #2	**Sample X25**	7106.22	8.262	1.158	1.708	8.314	0.013
Zone #2	**Sample X26**	7107.33	10.610	0.972	0.820	7.617	-0.205
Zone #2	**Sample X27**	7108.44	9.547	1.122	1.670	8.004	-0.097

Zone #2	**Sample X28**	7109.61	9.402	0.990	1.652	8.075	-0.065
Zone #2	**Sample X29**	7110.83	9.621	1.390	0.701	7.836	0.457
Zone #2	**Sample X30**	7112.06	9.394	0.692	1.268	7.700	-0.116
Zone #2	**Sample X31**	7113.28	10.821	1.115	0.051	7.313	-0.188
Zone #2	**Sample X32**	7114.50	10.944	0.807	0.321	7.024	-0.099
Zone #2	**Sample X33**	7115.72	10.807	0.930	0.350	7.332	-0.206
Zone #2	**Sample X34**	7116.94	10.522	1.124	0.359	7.866	-0.220
Zone #2	**Sample X35**	7118.17	10.793	0.996	0.381	7.326	-0.128
Zone #2	**Sample X36**	7119.39	10.466	0.971	0.827	7.503	-0.131
Zone #2	**Sample X37**	7120.61	10.232	0.688	0.760	7.498	-0.052
Zone #2	**Sample X38**	7121.83	10.180	1.212	0.843	8.007	-0.151
Zone #2	**Sample X39**	7123.06	9.604	1.033	1.189	7.932	-0.001
Zone #2	**Sample X40**	7124.28	10.585	1.232	0.253	8.572	0.319
Zone #2	**Sample X41**	7125.50	10.275	0.782	0.723	7.735	-0.147
Zone #2	**Sample X42**	7126.72	9.505	1.192	2.102	9.468	0.225
Zone #2	**Sample X43**	7127.94	8.992	0.804	1.807	8.611	-0.010
Zone #2	**Sample X44**	7129.17	9.449	1.162	0.965	8.669	0.404
Zone #2	**Sample X45**	7130.39	10.398	1.505	1.058	7.490	-0.114
Zone #2	**Sample X46**	7131.72	9.392	1.244	1.380	8.440	0.075
Zone #2	**Sample X47**	7133.17	10.142	1.541	-0.183	9.111	0.764
Zone #2	**Sample X48**	7134.61	10.789	1.184	0.396	7.537	-0.177
Zone #2	**Sample X49**	7136.06	10.042	1.122	0.644	7.747	0.012
Zone #2	**Sample X50**	7137.50	9.002	0.934	2.067	9.813	0.146
Zone #2	**Sample X51**	7138.94	10.356	1.023	0.778	8.011	-0.152
Zone #2	**Sample X52**	7140.39	10.134	1.333	0.602	7.707	-0.030
Zone #2	**Sample X53**	7141.83	10.000	1.431	0.799	8.207	0.109
Zone #2	**Sample X54**	7143.28	10.444	0.967	0.739	7.659	-0.127
Zone #2	**Sample X55**	7144.72	10.358	0.933	0.935	7.953	-0.166
Zone #2	**Sample X56**	7146.17	10.676	1.267	0.611	7.680	-0.134
Zone #2	**Sample X57**	7147.61	10.893	1.189	0.393	7.878	-0.145
Zone #2	**Sample X58**	7149.06	10.428	1.035	0.562	8.033	-0.186
Zone #2	**Sample X59**	7150.50	9.347	0.917	1.288	8.319	-0.068
Zone #2	**Sample X60**	7151.94	10.294	1.357	0.643	7.818	-0.136
Zone #2	**Sample X61**	7153.39	10.343	0.775	0.589	7.922	-0.150
Zone #2	**Sample X62**	7154.83	10.616	1.241	0.404	7.814	-0.203
Zone #2	**Sample X63**	7156.28	11.151	1.061	0.037	8.199	-0.247
Zone #2	**Sample X64**	7157.56	11.227	1.078	0.286	7.785	-0.143
Zone #2	**Sample X65**	7158.67	11.334	0.681	-0.037	8.048	-0.235
Zone #2	**Sample X66**	7159.78	10.962	0.748	0.306	7.820	-0.272

Zone #2	**Sample X67**	7160.89	11.325	0.854	0.156	7.929	-0.199
Zone #2	**Sample X68**	7162.00	7.424	1.471	2.528	9.984	0.033
Zone #2	**Sample X69**	7163.11	10.937	0.779	0.430	8.047	-0.208
Zone #2	**Sample X70**	7164.22	10.327	1.016	0.566	8.174	-0.238
Zone #2	**Sample X71**	7165.33	10.284	0.812	0.488	7.626	-0.148
Zone #2	**Sample X72**	7166.44	9.702	1.047	1.047	8.427	-0.163
Zone #2	**Sample X73**	7167.72	10.111	0.786	0.768	8.068	-0.157
Zone #2	**Sample X74**	7169.17	10.847	0.878	0.379	7.967	-0.213
Zone #2	**Sample X75**	7170.61	10.514	0.944	0.659	8.065	-0.179
Zone #2	**Sample X76**	7172.06	10.191	1.213	1.229	8.121	-0.100
Zone #2	**Sample X77**	7173.50	11.259	0.692	0.106	8.338	-0.208
Zone #2	**Sample X78**	7174.94	11.275	0.999	0.156	8.087	-0.238
Zone #2	**Sample X79**	7176.39	10.509	0.925	0.487	8.022	-0.206
Zone #2	**Sample X80**	7177.83	10.893	0.874	0.280	7.830	-0.207
Zone #2	**Sample X81**	7179.28	9.381	1.005	1.531	8.494	-0.155
Zone #2	**Sample X82**	7180.72	9.418	0.914	1.034	7.924	-0.201
Zone #2	**Sample X83**	7182.17	10.645	1.159	0.322	8.692	-0.132
Zone #2	**Sample X84**	7183.61	10.229	0.960	0.911	8.120	-0.131
Zone #2	**Sample X85**	7185.06	10.158	0.726	0.703	8.194	-0.121
Zone #2	**Sample X86**	7186.50	10.978	0.738	0.137	8.167	-0.248
Zone #2	**Sample X87**	7187.94	10.210	1.220	0.748	8.074	-0.159
Zone #2	**Sample X88**	7189.39	9.034	0.846	0.754	7.987	-0.190
Zone #2	**Sample X89**	7190.83	10.818	0.665	0.435	8.100	-0.172
Zone #2	**Sample X90**	7192.28	10.457	1.403	1.121	8.177	-0.189
Zone #2	**Sample X91**	7193.61	11.050	1.039	0.083	7.946	-0.234
Zone #2	**Sample X92**	7194.83	11.010	1.109	0.332	8.708	-0.208
Zone #2	**Sample X93**	7196.06	10.359	1.127	0.342	8.118	-0.212
Zone #2	**Sample X94**	7197.28	10.830	1.303	0.242	8.049	-0.244
Zone #2	**Sample X95**	7198.50	11.022	1.291	0.153	7.982	-0.267
Zone #2	**Sample X96**	7199.72	9.979	1.190	0.495	8.926	-0.188
Zone #2	**Sample X97**	7200.94	9.867	0.925	0.588	7.899	-0.219
Zone #2	**Sample X98**	7202.17	10.898	0.492	0.045	8.024	-0.240
Zone #2	**Sample X99**	7203.39	11.202	1.247	-0.103	8.230	-0.227
Zone #2	**Sample X100**	7204.78	10.510	0.874	0.918	7.756	-0.151
Zone #2	**Sample X101**	7206.33	10.975	0.800	0.055	7.816	-0.176
Zone #2	**Sample X102**	7207.89	10.925	0.850	0.093	7.721	-0.232
Zone #2	**Sample X103**	7209.44	10.818	1.127	0.077	7.873	-0.221
Zone #2	**Sample X104**	7211.00	10.480	0.970	0.450	8.422	-0.204
Zone #2	**Sample X105**	7212.56	10.502	0.819	0.631	7.798	-0.230

Zone #2	**Sample X106**	7214.11	9.839	0.959	0.787	7.676	-0.152
Zone #2	**Getty Hurt-XA**	7214.89	7.751	0.903	1.980	10.716	-0.043
Zone #1	**Sample X107**	7215.67	9.616	0.978	0.490	7.619	-0.174
Zone #1	**Sample X108**	7217.22	7.417	0.623	1.106	12.282	0.300
Zone #1	**Sample X109**	7218.78	7.486	0.834	0.787	12.198	0.283
Zone #1	**Sample X110**	7220.33	6.218	0.578	1.824	14.282	0.247
Zone #1	**Sample X111**	7221.89	6.929	0.517	0.728	13.207	0.514
Zone #1	**Sample X112**	7223.44	8.394	0.762	0.934	10.217	0.231
Zone #1	**Sample X113**	7225.00	8.470	0.415	1.891	13.582	0.131
Zone #1	**Sample X114**	7226.56	7.007	1.029	1.948	13.164	0.132
Zone #1	**Sample X115**	7228.11	8.165	1.078	2.781	10.757	-0.020
Zone #1	**Sample X116**	7229.67	5.697	0.709	1.619	16.627	0.362
Zone #1	**Sample X117**	7231.22	6.745	0.824	2.717	14.073	0.204
Zone #1	**Sample X118**	7232.61	7.487	1.229	1.172	11.388	0.732
Zone #1	**Sample X119**	7233.83	7.748	0.890	1.846	9.872	-0.030
Zone #1	**Sample X120**	7235.06	8.386	0.704	0.243	8.399	-0.210
Zone #1	**Sample X121**	7236.28	7.594	1.086	1.746	12.310	0.270
Zone #1	**Sample X122**	7237.50	8.224	1.294	1.661	10.180	0.193
Zone #1	**Sample X123**	7238.72	7.956	1.023	1.287	9.754	0.173
Zone #1	**Sample X124**	7239.94	7.903	0.949	1.458	10.243	0.184
Zone #1	**Sample X125**	7241.17	6.974	0.828	2.535	14.155	0.191
Zone #1	**Sample X126**	7242.39	6.867	1.035	1.137	13.140	0.769
Zone #1	**Sample X127**	7243.78	7.073	0.975	2.851	13.111	0.191
Zone #1	**Sample X128**	7245.33	8.951	1.050	1.748	8.738	-0.050
Zone #1	**Sample X129**	7246.89	7.719	0.938	2.612	11.824	0.006
Zone #1	**Sample X130**	7248.44	8.210	0.834	1.855	10.447	0.117
Zone #1	**Sample X131**	7250.00	7.540	1.018	1.701	11.051	0.213
Zone #1	**Sample X132**	7251.56	7.724	1.226	1.942	11.174	0.257
Zone #1	**Sample X133**	7253.11	6.570	1.209	1.480	9.840	0.066
Zone #1	**Sample X134**	7254.67	7.883	0.720	1.890	10.880	0.072
Zone #1	**Sample X135**	7256.22	6.939	0.890	2.407	12.902	0.174
Zone #1	**Sample X136**	7257.72	8.272	0.930	1.854	10.574	0.045
Zone #1	**Sample X137**	7259.17	1.128	0.253	8.357	20.930	0.224
Zone #1	**Sample X138**	7260.61	8.022	0.860	1.972	11.578	0.167
Zone #1	**Sample X139**	7262.06	7.404	1.346	2.493	11.632	0.136
Zone #1	**Sample X140**	7263.50	9.062	0.724	1.122	8.352	0.002
Zone #1	**Sample X141**	7264.94	9.354	0.894	0.819	7.730	-0.042
Zone #1	**Sample X142**	7266.39	8.335	1.042	1.318	9.387	0.220

Zone #1	**Sample X143**	7267.83	8.814	0.713	1.692	8.886	-0.055
Zone #1	**Sample X144**	7269.28	8.664	0.946	1.170	9.314	0.154
Zone #1	**Sample X145**	7270.56	8.190	1.098	2.331	10.353	-0.062
Zone #1	**Sample X146**	7271.67	8.761	1.086	2.922	13.038	0.150
Zone #1	**Sample X147**	7272.78	6.904	1.029	2.369	13.037	0.242
Zone #1	**Sample X148**	7273.89	7.236	1.240	3.227	13.893	0.169
Zone #1	**Sample X149**	7275.00	9.063	0.707	1.289	8.319	-0.005
Zone #1	**Sample X150**	7276.11	8.261	1.403	1.916	10.237	0.056
Zone #1	**Sample X151**	7277.22	8.333	1.112	2.579	12.424	0.125
Zone #1	**Sample X152**	7278.33	7.444	2.171	2.537	12.021	0.065
Zone #1	**Sample X153**	7279.44	9.081	0.980	1.355	8.636	-0.053
Zone #1	**Sample X154**	7280.67	9.272	1.075	1.608	8.927	-0.025
Zone #1	**Sample X155**	7282.00	9.961	1.235	1.190	7.643	-0.159
Zone #1	**Sample X156**	7283.33	8.420	0.922	1.980	10.200	0.011
Zone #1	**Sample X157**	7284.67	9.275	1.108	1.567	8.104	-0.102
Zone #1	**Sample X158**	7286.00	5.549	1.241	2.775	14.328	0.261
Zone #1	**Sample X159**	7287.33	9.355	1.037	0.346	7.290	-0.131
Zone #1	**Sample X160**	7288.67	7.935	1.039	1.343	9.111	-0.061
Zone #1	**Sample X161**	7290.00	7.134	0.610	0.966	12.781	0.103
Zone #1	**Sample X162**	7291.33	8.513	0.569	0.944	8.874	-0.111
Zone #1	**Sample X163**	7292.61	9.002	0.710	1.320	8.044	-0.115
Zone #1	**Sample X164**	7293.83	7.867	0.876	0.987	7.938	-0.066
Zone #1	**Sample X165**	7295.06	8.882	0.907	0.981	8.131	-0.101
Zone #1	**Sample X166**	7296.28	8.636	0.743	0.635	9.046	0.062
Zone #1	**Sample X167**	7297.50	9.983	0.978	0.359	7.453	-0.132
Zone #1	**Sample X168**	7298.72	8.793	1.353	0.838	7.879	-0.058
Zone #1	**Sample X169**	7299.94	7.245	1.490	2.067	13.145	0.385
Zone #1	**Sample X170**	7301.17	6.116	1.316	2.509	15.269	0.257
Zone #1	**Sample X171**	7302.39	7.561	1.005	2.352	11.258	0.101
Zone #1	**Sample X172**	7303.50	5.892	1.083	3.442	13.885	0.040

Getty Lloyd Hurt #1 Drill Core		**Total Depth (ft)**	**K %**	**Ca %**	**Ti %**	**Mn %**	**Fe %**
Zone #2	**Sample X1**	7078.67	-0.261	30.570	0.040	0.042	0.625
Zone #2	**Sample X2**	7080.00	0.053	28.584	0.061	0.045	0.740
Zone #2	**Sample X3**	7081.33	-0.218	30.874	0.012	0.074	0.484
Zone #2	**Sample X4**	7082.67	-0.077	29.147	0.027	0.079	0.547
Zone #2	**Sample X5**	7084.00	-0.277	30.647	0.035	0.032	0.804
Zone #2	**Sample X6**	7085.33	-0.135	29.836	0.054	0.032	0.800

Zone #2	**Sample X7**	7086.67	-0.370	31.223	0.030	0.030	0.550
Zone #2	**Sample X8**	7088.00	-0.223	30.256	0.047	0.028	0.642
Zone #2	**Sample X9**	7089.33	-0.158	29.934	0.043	0.027	0.674
Zone #2	**Sample X10**	7090.50	-0.251	30.367	0.032	0.033	0.524
Zone #2	**Sample X11**	7091.50	-0.053	29.537	0.051	0.029	0.688
Zone #2	**Sample X12**	7092.50	-0.092	29.279	0.040	0.027	0.746
Zone #2	**Sample X13**	7093.50	1.029	22.269	0.076	0.023	1.120
Zone #2	**Sample X14**	7094.50	-0.372	31.294	0.029	0.033	0.508
Zone #2	**Sample X15**	7095.50	-0.324	30.933	0.037	0.033	0.810
Zone #2	**Sample X16**	7096.50	-0.349	31.387	0.033	0.028	0.711
Zone #2	**Sample X17**	7097.50	-0.396	31.333	0.012	0.037	0.659
Zone #2	**Sample X18**	7098.50	-0.170	30.141	0.048	0.032	0.725
Zone #2	**Sample X19**	7099.56	-0.255	30.633	0.033	0.033	0.658
Zone #2	**Sample X20**	7100.67	-0.351	31.128	0.039	0.037	0.686
Zone #2	**Sample X21**	7101.78	0.104	28.851	0.083	0.030	0.951
Zone #2	**Sample X22**	7102.89	-0.054	30.029	0.044	0.039	1.023
Zone #2	**Sample X23**	7104.00	-0.233	30.216	0.039	0.034	0.715
Zone #2	**Sample X24**	7105.11	-0.130	29.806	0.047	0.035	0.909
Zone #2	**Sample X25**	7106.22	0.241	27.431	0.090	0.034	1.087
Zone #2	**Sample X26**	7107.33	-0.301	30.599	0.040	0.040	0.539
Zone #2	**Sample X27**	7108.44	0.059	28.437	0.075	0.036	0.860
Zone #2	**Sample X28**	7109.61	0.100	28.227	0.071	0.031	0.926
Zone #2	**Sample X29**	7110.83	0.172	28.780	0.078	0.031	1.163
Zone #2	**Sample X30**	7112.06	-0.083	29.325	0.063	0.030	0.776
Zone #2	**Sample X31**	7113.28	-0.521	32.397	0.018	0.043	0.501
Zone #2	**Sample X32**	7114.50	-0.465	32.347	0.043	0.046	0.576
Zone #2	**Sample X33**	7115.72	-0.483	31.962	0.037	0.045	0.652
Zone #2	**Sample X34**	7116.94	-0.380	30.866	0.032	0.034	0.492
Zone #2	**Sample X35**	7118.17	-0.393	31.558	0.025	0.036	0.583
Zone #2	**Sample X36**	7119.39	-0.288	30.741	0.033	0.035	0.547
Zone #2	**Sample X37**	7120.61	-0.208	30.349	0.049	0.032	0.674
Zone #2	**Sample X38**	7121.83	-0.158	29.112	0.045	0.039	0.579
Zone #2	**Sample X39**	7123.06	0.050	28.452	0.052	0.040	0.635
Zone #2	**Sample X40**	7124.28	-0.012	28.307	0.036	0.061	0.639
Zone #2	**Sample X41**	7125.50	-0.182	29.560	0.045	0.044	0.608
Zone #2	**Sample X42**	7126.72	0.645	24.588	0.100	0.034	1.023
Zone #2	**Sample X43**	7127.94	0.344	26.350	0.069	0.033	0.816
Zone #2	**Sample X44**	7129.17	0.397	26.638	0.060	0.037	0.818
Zone #2	**Sample X45**	7130.39	-0.141	29.513	0.051	0.042	0.898

Zone #2	**Sample X46**	7131.72	0.278	26.972	0.072	0.039	0.772
Zone #2	**Sample X47**	7133.17	0.113	26.841	0.036	0.073	0.814
Zone #2	**Sample X48**	7134.61	-0.328	30.706	0.022	0.047	0.488
Zone #2	**Sample X49**	7136.06	-0.081	29.347	0.043	0.040	0.657
Zone #2	**Sample X50**	7137.50	0.708	23.803	0.114	0.036	1.071
Zone #2	**Sample X51**	7138.94	-0.132	29.066	0.026	0.041	0.483
Zone #2	**Sample X52**	7140.39	-0.131	29.484	0.048	0.041	0.751
Zone #2	**Sample X53**	7141.83	0.093	27.972	0.062	0.036	0.851
Zone #2	**Sample X54**	7143.28	-0.170	29.571	0.040	0.048	0.614
Zone #2	**Sample X55**	7144.72	-0.110	28.892	0.055	0.042	0.568
Zone #2	**Sample X56**	7146.17	-0.248	30.211	0.041	0.045	0.480
Zone #2	**Sample X57**	7147.61	-0.299	30.399	0.024	0.045	0.542
Zone #2	**Sample X58**	7149.06	-0.274	29.908	0.022	0.040	0.557
Zone #2	**Sample X59**	7150.50	0.074	27.666	0.061	0.036	0.890
Zone #2	**Sample X60**	7151.94	-0.153	29.379	0.035	0.037	0.511
Zone #2	**Sample X61**	7153.39	-0.223	29.764	0.023	0.035	0.494
Zone #2	**Sample X62**	7154.83	-0.383	30.919	0.015	0.038	0.424
Zone #2	**Sample X63**	7156.28	-0.361	30.437	0.018	0.039	0.367
Zone #2	**Sample X64**	7157.56	-0.324	30.652	0.012	0.038	0.438
Zone #2	**Sample X65**	7158.67	-0.443	31.230	0.004	0.038	0.386
Zone #2	**Sample X66**	7159.78	-0.417	30.952	0.031	0.037	0.427
Zone #2	**Sample X67**	7160.89	-0.425	31.288	0.024	0.036	0.414
Zone #2	**Sample X68**	7162.00	0.762	23.139	0.107	0.027	0.994
Zone #2	**Sample X69**	7163.11	-0.304	30.132	0.026	0.028	0.444
Zone #2	**Sample X70**	7164.22	-0.272	29.689	0.020	0.031	0.402
Zone #2	**Sample X71**	7165.33	-0.273	30.366	0.023	0.030	0.407
Zone #2	**Sample X72**	7166.44	-0.054	28.210	0.044	0.027	0.583
Zone #2	**Sample X73**	7167.72	-0.177	29.329	0.044	0.028	0.529
Zone #2	**Sample X74**	7169.17	-0.328	30.346	0.023	0.032	0.474
Zone #2	**Sample X75**	7170.61	-0.182	29.230	0.035	0.030	0.566
Zone #2	**Sample X76**	7172.06	0.031	28.067	0.069	0.027	0.661
Zone #2	**Sample X77**	7173.50	-0.377	30.613	0.021	0.034	0.457
Zone #2	**Sample X78**	7174.94	-0.402	30.874	0.017	0.034	0.345
Zone #2	**Sample X79**	7176.39	-0.261	29.823	0.015	0.031	0.371
Zone #2	**Sample X80**	7177.83	-0.379	30.856	0.018	0.032	0.399
Zone #2	**Sample X81**	7179.28	0.116	27.110	0.072	0.025	0.704
Zone #2	**Sample X82**	7180.72	-0.120	28.767	0.041	0.026	0.588
Zone #2	**Sample X83**	7182.17	-0.201	28.923	0.023	0.031	0.402
Zone #2	**Sample X84**	7183.61	-0.085	28.705	0.039	0.028	0.596

Zone #2	**Sample X85**	7185.06	-0.127	28.923	0.051	0.027	0.499
Zone #2	**Sample X86**	7186.50	-0.381	30.543	0.018	0.027	0.362
Zone #2	**Sample X87**	7187.94	-0.127	28.965	0.040	0.026	0.470
Zone #2	**Sample X88**	7189.39	-0.156	29.131	0.040	0.025	0.429
Zone #2	**Sample X89**	7190.83	-0.294	30.111	0.039	0.026	0.494
Zone #2	**Sample X90**	7192.28	-0.007	27.993	0.044	0.023	0.487
Zone #2	**Sample X91**	7193.61	-0.354	30.625	0.015	0.026	0.377
Zone #2	**Sample X92**	7194.83	-0.277	29.461	0.015	0.027	0.324
Zone #2	**Sample X93**	7196.06	-0.299	30.022	0.016	0.027	0.377
Zone #2	**Sample X94**	7197.28	-0.335	30.357	0.018	0.028	0.343
Zone #2	**Sample X95**	7198.50	-0.395	30.854	0.015	0.027	0.288
Zone #2	**Sample X96**	7199.72	-0.180	28.416	0.014	0.028	0.344
Zone #2	**Sample X97**	7200.94	-0.249	29.724	0.026	0.023	0.426
Zone #2	**Sample X98**	7202.17	-0.395	30.992	0.007	0.024	0.318
Zone #2	**Sample X99**	7203.39	-0.481	31.614	0.007	0.031	0.429
Zone #2	**Sample X100**	7204.78	-0.200	29.697	0.036	0.022	0.426
Zone #2	**Sample X101**	7206.33	-0.341	30.787	0.022	0.022	0.362
Zone #2	**Sample X102**	7207.89	-0.359	30.893	0.000	0.024	0.305
Zone #2	**Sample X103**	7209.44	-0.384	31.038	0.008	0.024	0.316
Zone #2	**Sample X104**	7211.00	-0.204	28.978	0.030	0.022	0.418
Zone #2	**Sample X105**	7212.56	-0.206	29.410	0.034	0.025	0.521
Zone #2	**Sample X106**	7214.11	-0.113	29.172	0.049	0.023	0.420
Zone #2	**Sample-XA**	7214.89	0.504	22.231	0.107	0.019	0.773
Zone #1	**Sample X107**	7215.67	-0.266	30.269	0.009	0.035	0.371
Zone #1	**Sample X108**	7217.22	0.395	21.515	0.072	0.017	0.618
Zone #1	**Sample X109**	7218.78	0.390	21.972	0.078	0.019	0.664
Zone #1	**Sample X110**	7220.33	0.715	18.742	0.121	0.020	0.827
Zone #1	**Sample X111**	7221.89	0.465	20.611	0.092	0.020	0.624
Zone #1	**Sample X112**	7223.44	0.308	24.411	0.058	0.026	0.590
Zone #1	**Sample X113**	7225.00	0.639	19.742	0.109	0.019	0.665
Zone #1	**Sample X114**	7226.56	0.675	19.816	0.129	0.022	0.839
Zone #1	**Sample X115**	7228.11	0.577	22.698	0.106	0.029	0.880
Zone #1	**Sample X116**	7229.67	0.782	15.950	0.125	0.019	0.819
Zone #1	**Sample X117**	7231.22	0.964	18.047	0.115	0.020	0.953
Zone #1	**Sample X118**	7232.61	0.700	22.067	0.094	0.027	0.854
Zone #1	**Sample X119**	7233.83	0.384	24.524	0.079	0.023	0.683
Zone #1	**Sample X120**	7235.06	-0.256	29.468	0.027	0.036	0.373
Zone #1	**Sample X121**	7236.28	0.749	20.113	0.128	0.025	0.978
Zone #1	**Sample X122**	7237.50	0.504	23.727	0.093	0.025	0.893

Zone #1	**Sample X123**	7238.72	0.405	24.650	0.091	0.027	0.761
Zone #1	**Sample X124**	7239.94	0.488	23.903	0.081	0.030	0.760
Zone #1	**Sample X125**	7241.17	1.048	17.949	0.136	0.021	0.926
Zone #1	**Sample X126**	7242.39	0.858	18.537	0.130	0.025	0.995
Zone #1	**Sample X127**	7243.78	0.999	18.853	0.139	0.023	0.987
Zone #1	**Sample X128**	7245.33	0.275	26.064	0.056	0.025	0.710
Zone #1	**Sample X129**	7246.89	0.748	21.115	0.113	0.025	0.812
Zone #1	**Sample X130**	7248.44	0.569	23.364	0.093	0.027	0.828
Zone #1	**Sample X131**	7250.00	0.636	22.364	0.103	0.024	0.819
Zone #1	**Sample X132**	7251.56	0.686	22.087	0.113	0.025	0.938
Zone #1	**Sample X133**	7253.11	0.365	24.654	0.070	0.027	0.656
Zone #1	**Sample X134**	7254.67	0.548	22.701	0.089	0.027	0.806
Zone #1	**Sample X135**	7256.22	0.819	19.807	0.125	0.020	0.917
Zone #1	**Sample X136**	7257.72	0.445	23.781	0.085	0.028	0.729
Zone #1	**Sample X137**	7259.17	1.704	3.892	0.428	0.015	1.161
Zone #1	**Sample X138**	7260.61	0.626	21.549	0.125	0.021	0.919
Zone #1	**Sample X139**	7262.06	0.690	21.545	0.128	0.025	0.867
Zone #1	**Sample X140**	7263.50	0.127	27.335	0.052	0.029	0.618
Zone #1	**Sample X141**	7264.94	-0.011	28.519	0.043	0.030	0.671
Zone #1	**Sample X142**	7266.39	0.331	25.276	0.081	0.026	0.775
Zone #1	**Sample X143**	7267.83	0.230	26.018	0.065	0.027	0.671
Zone #1	**Sample X144**	7269.28	0.317	25.601	0.073	0.027	0.777
Zone #1	**Sample X145**	7270.56	0.564	23.180	0.097	0.024	0.742
Zone #1	**Sample X146**	7271.67	0.964	18.691	0.143	0.019	1.120
Zone #1	**Sample X147**	7272.78	0.968	17.861	0.151	0.022	1.075
Zone #1	**Sample X148**	7273.89	1.146	17.956	0.169	0.021	1.027
Zone #1	**Sample X149**	7275.00	0.111	27.233	0.058	0.028	0.743
Zone #1	**Sample X150**	7276.11	0.468	23.613	0.096	0.024	0.873
Zone #1	**Sample X151**	7277.22	0.808	20.099	0.125	0.019	0.843
Zone #1	**Sample X152**	7278.33	0.569	19.989	0.129	0.027	1.188
Zone #1	**Sample X153**	7279.44	0.123	26.961	0.069	0.027	0.750
Zone #1	**Sample X154**	7280.67	0.214	26.018	0.074	0.024	0.698
Zone #1	**Sample X155**	7282.00	-0.176	29.642	0.058	0.043	0.627
Zone #1	**Sample X156**	7283.33	0.357	23.469	0.113	0.026	1.168
Zone #1	**Sample X157**	7284.67	0.045	27.919	0.051	0.034	0.670
Zone #1	**Sample X158**	7286.00	0.855	14.726	0.210	0.027	1.932
Zone #1	**Sample X159**	7287.33	-0.134	29.518	0.016	0.055	0.339
Zone #1	**Sample X160**	7288.67	0.192	26.084	0.051	0.043	0.614
Zone #1	**Sample X161**	7290.00	0.302	20.093	0.080	0.032	0.952

Zone #1	**Sample X162**	7291.33	0.054	26.244	0.084	0.120	1.149
Zone #1	**Sample X163**	7292.61	0.022	27.616	0.098	0.088	0.881
Zone #1	**Sample X164**	7293.83	0.016	28.012	0.057	0.088	0.575
Zone #1	**Sample X165**	7295.06	0.024	27.278	0.072	0.066	0.800
Zone #1	**Sample X166**	7296.28	0.095	26.393	0.045	0.064	0.591
Zone #1	**Sample X167**	7297.50	-0.176	29.681	0.029	0.078	0.671
Zone #1	**Sample X168**	7298.72	-0.050	27.909	0.083	0.103	1.804
Zone #1	**Sample X169**	7299.94	0.841	18.846	0.130	0.030	1.258
Zone #1	**Sample X170**	7301.17	1.063	14.462	0.171	0.025	1.298
Zone #1	**Sample X171**	7302.39	0.681	22.059	0.107	0.033	0.964
Zone #1	**Sample X172**	7303.50	1.104	17.147	0.147	0.021	1.023

Getty Lloyd Hurt #1 Drill Core		**Total Depth (ft)**	**V ppm**	**Cr ppm**	**Ni ppm**	**Cu ppm**
Zone #2	**Sample X1**	7078.67	20.166	-61.214	62.162	-7.886
Zone #2	**Sample X2**	7080.00	19.158	-30.175	47.411	-3.704
Zone #2	**Sample X3**	7081.33	15.576	-77.587	47.569	11.037
Zone #2	**Sample X4**	7082.67	36.370	-63.107	60.409	-3.381
Zone #2	**Sample X5**	7084.00	19.682	-60.395	55.166	9.585
Zone #2	**Sample X6**	7085.33	21.626	-44.660	31.926	-10.977
Zone #2	**Sample X7**	7086.67	18.045	-65.978	53.543	-6.645
Zone #2	**Sample X8**	7088.00	16.562	-60.366	19.808	-1.362
Zone #2	**Sample X9**	7089.33	15.579	-43.362	35.351	-5.486
Zone #2	**Sample X10**	7090.50	14.778	-72.912	45.906	0.443
Zone #2	**Sample X11**	7091.50	17.061	-20.413	61.696	-1.585
Zone #2	**Sample X12**	7092.50	20.061	-25.195	36.304	-0.969
Zone #2	**Sample X13**	7093.50	24.669	29.055	75.758	6.033
Zone #2	**Sample X14**	7094.50	10.715	-77.981	48.667	7.727
Zone #2	**Sample X15**	7095.50	15.689	-83.878	88.704	12.471
Zone #2	**Sample X16**	7096.50	13.906	-82.669	102.856	2.225
Zone #2	**Sample X17**	7097.50	14.120	-81.614	47.268	0.652
Zone #2	**Sample X18**	7098.50	18.127	-44.108	56.201	-2.837
Zone #2	**Sample X19**	7099.56	17.663	-61.609	46.536	11.046
Zone #2	**Sample X20**	7100.67	20.676	-66.970	47.411	-3.704
Zone #2	**Sample X21**	7101.78	27.574	-5.859	48.082	-12.249
Zone #2	**Sample X22**	7102.89	37.582	-30.383	65.177	7.694
Zone #2	**Sample X23**	7104.00	19.805	-56.647	21.162	8.037
Zone #2	**Sample X24**	7105.11	18.688	-48.543	53.460	0.409
Zone #2	**Sample X25**	7106.22	22.031	-4.880	46.113	4.339

Zone #2	**Sample X26**	7107.33	15.278	-76.262	57.095	-3.302
Zone #2	**Sample X27**	7108.44	29.627	-17.106	63.126	3.938
Zone #2	**Sample X28**	7109.61	25.201	-24.831	58.612	-2.239
Zone #2	**Sample X29**	7110.83	34.940	5.913	35.207	11.135
Zone #2	**Sample X30**	7112.06	27.130	-34.098	34.085	-3.005
Zone #2	**Sample X31**	7113.28	16.396	-92.753	96.845	-7.631
Zone #2	**Sample X32**	7114.50	18.482	-104.139	39.539	-1.868
Zone #2	**Sample X33**	7115.72	17.242	-88.144	42.839	-6.060
Zone #2	**Sample X34**	7116.94	16.225	-90.351	57.707	12.219
Zone #2	**Sample X35**	7118.17	19.896	-87.212	31.762	3.188
Zone #2	**Sample X36**	7119.39	22.353	-74.027	55.314	4.240
Zone #2	**Sample X37**	7120.61	20.735	-61.539	72.549	-0.360
Zone #2	**Sample X38**	7121.83	22.881	-69.497	59.929	10.140
Zone #2	**Sample X39**	7123.06	25.698	-20.144	74.510	-2.783
Zone #2	**Sample X40**	7124.28	30.352	-43.632	40.392	-3.547
Zone #2	**Sample X41**	7125.50	24.044	-52.804	29.370	-1.434
Zone #2	**Sample X42**	7126.72	40.305	27.002	71.707	-6.130
Zone #2	**Sample X43**	7127.94	31.168	-12.180	66.315	5.217
Zone #2	**Sample X44**	7129.17	26.581	-2.647	72.055	14.186
Zone #2	**Sample X45**	7130.39	20.303	-39.694	61.142	8.067
Zone #2	**Sample X46**	7131.72	36.312	3.888	50.048	1.537
Zone #2	**Sample X47**	7133.17	30.457	-25.934	53.936	10.962
Zone #2	**Sample X48**	7134.61	17.024	-74.728	57.032	-1.804
Zone #2	**Sample X49**	7136.06	26.312	-38.185	59.454	10.250
Zone #2	**Sample X50**	7137.50	36.887	33.782	48.503	1.211
Zone #2	**Sample X51**	7138.94	20.521	-52.188	30.721	-0.454
Zone #2	**Sample X52**	7140.39	24.097	-38.920	58.228	-5.860
Zone #2	**Sample X53**	7141.83	24.833	-15.312	64.825	3.156
Zone #2	**Sample X54**	7143.28	27.322	-52.148	52.329	9.860
Zone #2	**Sample X55**	7144.72	22.061	-57.356	55.639	-8.777
Zone #2	**Sample X56**	7146.17	24.105	-63.663	49.657	6.467
Zone #2	**Sample X57**	7147.61	21.678	-75.040	57.250	1.876
Zone #2	**Sample X58**	7149.06	21.756	-71.478	25.187	-7.360
Zone #2	**Sample X59**	7150.50	28.670	-25.953	42.527	7.964
Zone #2	**Sample X60**	7151.94	22.972	-60.355	55.773	-1.430
Zone #2	**Sample X61**	7153.39	22.488	-59.260	58.859	11.938
Zone #2	**Sample X62**	7154.83	24.968	-90.510	39.893	7.038
Zone #2	**Sample X63**	7156.28	18.915	-95.482	47.696	-12.231
Zone #2	**Sample X64**	7157.56	20.627	-71.128	52.238	-6.861

Zone #2	**Sample X65**	7158.67	17.518	-100.250	34.052	5.115
Zone #2	**Sample X66**	7159.78	20.355	-78.383	34.804	-2.328
Zone #2	**Sample X67**	7160.89	16.443	-91.437	75.097	-2.338
Zone #2	**Sample X68**	7162.00	48.058	35.217	41.007	-0.602
Zone #2	**Sample X69**	7163.11	17.426	-82.629	98.190	29.410
Zone #2	**Sample X70**	7164.22	14.812	-76.844	21.761	-9.615
Zone #2	**Sample X71**	7165.33	22.534	-55.125	46.315	4.919
Zone #2	**Sample X72**	7166.44	30.189	-39.451	37.862	-2.743
Zone #2	**Sample X73**	7167.72	23.991	-43.922	68.369	0.048
Zone #2	**Sample X74**	7169.17	19.744	-73.129	83.855	-3.932
Zone #2	**Sample X75**	7170.61	26.077	-52.297	50.295	0.641
Zone #2	**Sample X76**	7172.06	29.046	-10.066	64.294	-0.334
Zone #2	**Sample X77**	7173.50	17.661	-95.078	64.849	-9.507
Zone #2	**Sample X78**	7174.94	18.557	-95.012	62.758	-2.003
Zone #2	**Sample X79**	7176.39	21.631	-77.290	50.822	-4.199
Zone #2	**Sample X80**	7177.83	22.330	-80.408	56.877	2.296
Zone #2	**Sample X81**	7179.28	33.889	-6.368	71.334	-5.179
Zone #2	**Sample X82**	7180.72	37.289	-51.855	96.801	17.454
Zone #2	**Sample X83**	7182.17	21.275	-77.901	66.949	3.557
Zone #2	**Sample X84**	7183.61	27.146	-50.376	47.927	-3.458
Zone #2	**Sample X85**	7185.06	16.810	-57.797	46.646	7.022
Zone #2	**Sample X86**	7186.50	24.265	-93.912	60.423	8.247
Zone #2	**Sample X87**	7187.94	24.150	-49.557	47.305	-0.410
Zone #2	**Sample X88**	7189.39	21.297	-61.202	52.531	-3.632
Zone #2	**Sample X89**	7190.83	19.538	-84.649	39.479	-0.384
Zone #2	**Sample X90**	7192.28	28.049	-31.791	62.308	2.403
Zone #2	**Sample X91**	7193.61	20.241	-103.083	24.106	-0.669
Zone #2	**Sample X92**	7194.83	22.150	-97.940	57.957	-5.327
Zone #2	**Sample X93**	7196.06	44.643	-84.474	66.731	7.053
Zone #2	**Sample X94**	7197.28	21.225	-90.072	66.528	-4.263
Zone #2	**Sample X95**	7198.50	20.422	-86.893	46.370	-10.766
Zone #2	**Sample X96**	7199.72	31.086	-63.126	57.828	-10.416
Zone #2	**Sample X97**	7200.94	19.683	-68.643	59.955	20.055
Zone #2	**Sample X98**	7202.17	16.380	-84.730	49.751	13.679
Zone #2	**Sample X99**	7203.39	19.940	-109.013	45.781	-17.251
Zone #2	**Sample X100**	7204.78	24.360	-51.046	32.047	3.309
Zone #2	**Sample X101**	7206.33	20.776	-81.922	62.942	4.654
Zone #2	**Sample X102**	7207.89	20.297	-79.689	28.631	-8.004
Zone #2	**Sample X103**	7209.44	19.460	-75.301	39.213	-10.384

Zone #2	**Sample X104**	7211.00	22.063	-64.483	50.447	1.505
Zone #2	**Sample X105**	7212.56	27.783	-69.203	42.585	-0.360
Zone #2	**Sample X106**	7214.11	30.759	-36.033	24.955	-1.782
Zone #2	**Getty Hurt-XA**	7214.89	34.463	58.319	50.289	-5.454
Zone #1	**Sample X107**	7215.67	16.228	-67.482	50.618	-2.036
Zone #1	**Sample X108**	7217.22	32.221	81.900	48.529	12.743
Zone #1	**Sample X109**	7218.78	44.835	93.493	73.278	10.761
Zone #1	**Sample X110**	7220.33	65.112	112.618	84.117	26.041
Zone #1	**Sample X111**	7221.89	40.023	107.738	90.450	26.056
Zone #1	**Sample X112**	7223.44	46.835	57.739	101.522	26.502
Zone #1	**Sample X113**	7225.00	34.326	109.351	96.232	35.627
Zone #1	**Sample X114**	7226.56	80.360	110.252	65.934	21.538
Zone #1	**Sample X115**	7228.11	41.505	50.660	94.639	20.613
Zone #1	**Sample X116**	7229.67	50.120	96.984	72.600	23.801
Zone #1	**Sample X117**	7231.22	40.656	92.954	64.599	18.694
Zone #1	**Sample X118**	7232.61	58.447	70.452	62.720	11.873
Zone #1	**Sample X119**	7233.83	37.867	52.117	29.581	13.909
Zone #1	**Sample X120**	7235.06	23.135	-88.632	36.757	19.065
Zone #1	**Sample X121**	7236.28	40.404	70.384	33.820	7.771
Zone #1	**Sample X122**	7237.50	39.541	48.766	51.319	8.722
Zone #1	**Sample X123**	7238.72	38.532	33.685	32.548	14.319
Zone #1	**Sample X124**	7239.94	33.809	29.583	70.115	6.151
Zone #1	**Sample X125**	7241.17	49.877	75.335	56.477	12.296
Zone #1	**Sample X126**	7242.39	43.037	57.705	83.494	18.343
Zone #1	**Sample X127**	7243.78	40.755	59.341	37.385	16.846
Zone #1	**Sample X128**	7245.33	28.161	14.220	29.463	2.563
Zone #1	**Sample X129**	7246.89	44.768	51.394	14.293	10.802
Zone #1	**Sample X130**	7248.44	46.377	54.105	69.905	13.491
Zone #1	**Sample X131**	7250.00	48.388	56.665	65.827	10.212
Zone #1	**Sample X132**	7251.56	56.696	74.784	65.210	16.917
Zone #1	**Sample X133**	7253.11	30.353	47.091	40.230	15.374
Zone #1	**Sample X134**	7254.67	42.891	59.354	59.206	-0.906
Zone #1	**Sample X135**	7256.22	49.192	74.093	68.049	17.891
Zone #1	**Sample X136**	7257.72	34.893	36.465	45.167	16.418
Zone #1	**Sample X137**	7259.17	120.572	-0.470	26.627	7.229
Zone #1	**Sample X138**	7260.61	45.241	67.135	98.776	35.538
Zone #1	**Sample X139**	7262.06	53.330	61.970	52.027	8.841
Zone #1	**Sample X140**	7263.50	28.720	2.094	35.477	7.689
Zone #1	**Sample X141**	7264.94	26.763	-20.981	56.508	-3.273

Zone #1	**Sample X142**	7266.39	37.980	19.921	75.988	5.835
Zone #1	**Sample X143**	7267.83	39.073	6.022	45.363	9.307
Zone #1	**Sample X144**	7269.28	32.065	14.544	62.680	3.640
Zone #1	**Sample X145**	7270.56	33.527	16.634	47.042	10.488
Zone #1	**Sample X146**	7271.67	62.680	70.641	25.748	1.269
Zone #1	**Sample X147**	7272.78	58.210	60.812	78.358	21.518
Zone #1	**Sample X148**	7273.89	47.099	69.948	78.387	16.725
Zone #1	**Sample X149**	7275.00	30.849	-0.434	79.565	9.061
Zone #1	**Sample X150**	7276.11	34.921	41.004	71.519	12.533
Zone #1	**Sample X151**	7277.22	35.802	58.362	53.223	10.479
Zone #1	**Sample X152**	7278.33	43.585	37.184	30.664	18.515
Zone #1	**Sample X153**	7279.44	30.502	1.669	27.494	4.174
Zone #1	**Sample X154**	7280.67	31.805	11.216	42.678	0.817
Zone #1	**Sample X155**	7282.00	25.862	-42.162	79.968	3.160
Zone #1	**Sample X156**	7283.33	39.192	29.211	89.227	7.946
Zone #1	**Sample X157**	7284.67	30.957	-19.202	39.150	7.423
Zone #1	**Sample X158**	7286.00	60.870	50.739	71.206	25.102
Zone #1	**Sample X159**	7287.33	18.805	-14.421	52.649	10.259
Zone #1	**Sample X160**	7288.67	26.081	26.348	37.396	6.632
Zone #1	**Sample X161**	7290.00	30.654	45.762	39.994	21.350
Zone #1	**Sample X162**	7291.33	29.619	27.700	47.244	4.348
Zone #1	**Sample X163**	7292.61	32.934	23.875	15.010	16.925
Zone #1	**Sample X164**	7293.83	24.649	16.366	51.924	11.203
Zone #1	**Sample X165**	7295.06	29.399	18.260	47.965	7.644
Zone #1	**Sample X166**	7296.28	25.703	40.779	43.832	6.690
Zone #1	**Sample X167**	7297.50	23.241	-34.631	50.625	5.569
Zone #1	**Sample X168**	7298.72	31.767	10.790	49.017	0.059
Zone #1	**Sample X169**	7299.94	46.487	58.314	38.097	13.701
Zone #1	**Sample X170**	7301.17	54.111	48.535	47.960	5.214
Zone #1	**Sample X171**	7302.39	41.353	44.512	50.476	10.507
Zone #1	**Sample X172**	7303.50	38.828	60.486	66.401	24.285

Getty Lloyd Hurt #1 Drill Core		**Total Depth (ft)**	**Zn ppm**	**Th ppm**	**Rb ppm**	**U ppm**
Zone #2	**Sample X1**	7078.67	19.208	-0.438	30.740	-8.681
Zone #2	**Sample X2**	7080.00	11.466	-0.014	29.391	-15.778
Zone #2	**Sample X3**	7081.33	63.618	0.356	39.198	-4.372
Zone #2	**Sample X4**	7082.67	27.829	0.910	39.452	-14.657
Zone #2	**Sample X5**	7084.00	13.861	1.261	43.672	-16.212

Zone #2	**Sample X6**	7085.33	42.518	-0.885	35.789	-5.163
Zone #2	**Sample X7**	7086.67	4.068	-1.943	19.550	-15.166
Zone #2	**Sample X8**	7088.00	36.431	-1.837	27.503	-11.870
Zone #2	**Sample X9**	7089.33	31.532	-1.039	26.578	-1.307
Zone #2	**Sample X10**	7090.50	67.373	-0.722	31.880	-2.733
Zone #2	**Sample X11**	7091.50	33.639	-0.523	30.889	-3.826
Zone #2	**Sample X12**	7092.50	24.637	1.076	35.937	-2.045
Zone #2	**Sample X13**	7093.50	32.862	3.510	36.753	-18.509
Zone #2	**Sample X14**	7094.50	32.889	-0.792	26.224	-15.972
Zone #2	**Sample X15**	7095.50	116.607	-0.240	34.869	4.911
Zone #2	**Sample X16**	7096.50	35.752	-0.080	37.385	-2.261
Zone #2	**Sample X17**	7097.50	6.691	-0.016	34.017	-15.484
Zone #2	**Sample X18**	7098.50	30.122	-0.674	38.117	-4.205
Zone #2	**Sample X19**	7099.56	15.118	-0.688	32.909	-14.503
Zone #2	**Sample X20**	7100.67	11.466	-0.014	29.391	-15.778
Zone #2	**Sample X21**	7101.78	14.364	-1.747	12.700	-5.476
Zone #2	**Sample X22**	7102.89	74.251	-0.179	47.804	-2.681
Zone #2	**Sample X23**	7104.00	50.405	0.088	37.712	-16.560
Zone #2	**Sample X24**	7105.11	79.548	-0.331	27.002	-8.027
Zone #2	**Sample X25**	7106.22	43.351	0.852	47.553	0.847
Zone #2	**Sample X26**	7107.33	28.853	1.151	42.205	-13.087
Zone #2	**Sample X27**	7108.44	27.649	-0.123	27.224	-8.175
Zone #2	**Sample X28**	7109.61	44.284	0.499	49.026	-14.792
Zone #2	**Sample X29**	7110.83	14.225	-0.446	37.278	-3.775
Zone #2	**Sample X30**	7112.06	17.296	-0.657	19.006	-6.361
Zone #2	**Sample X31**	7113.28	66.314	1.720	53.973	-13.425
Zone #2	**Sample X32**	7114.50	19.436	-1.517	25.708	-13.957
Zone #2	**Sample X33**	7115.72	19.548	-1.484	17.908	-8.295
Zone #2	**Sample X34**	7116.94	96.550	-1.861	28.002	-6.003
Zone #2	**Sample X35**	7118.17	18.866	-0.686	32.846	-6.505
Zone #2	**Sample X36**	7119.39	44.437	-0.389	33.001	-8.213
Zone #2	**Sample X37**	7120.61	46.384	0.769	32.986	-11.020
Zone #2	**Sample X38**	7121.83	70.833	0.718	42.444	-8.505
Zone #2	**Sample X39**	7123.06	34.420	-0.462	35.253	-5.015
Zone #2	**Sample X40**	7124.28	20.080	-0.165	20.360	-3.457
Zone #2	**Sample X41**	7125.50	12.895	-0.347	31.067	-14.867
Zone #2	**Sample X42**	7126.72	9.539	-0.197	31.389	-10.160
Zone #2	**Sample X43**	7127.94	30.853	1.268	46.110	-1.810
Zone #2	**Sample X44**	7129.17	42.782	1.001	47.865	0.654

Zone #2	**Sample X45**	7130.39	48.278	1.824	55.566	-20.700
Zone #2	**Sample X46**	7131.72	36.014	-0.860	35.632	-12.748
Zone #2	**Sample X47**	7133.17	73.902	0.773	56.462	-15.083
Zone #2	**Sample X48**	7134.61	61.403	-0.017	28.668	-9.906
Zone #2	**Sample X49**	7136.06	33.477	-0.899	34.280	-9.937
Zone #2	**Sample X50**	7137.50	22.594	-0.419	31.911	-13.712
Zone #2	**Sample X51**	7138.94	69.343	3.280	54.205	-5.413
Zone #2	**Sample X52**	7140.39	56.952	0.385	43.062	-6.295
Zone #2	**Sample X53**	7141.83	37.847	0.265	40.545	-7.382
Zone #2	**Sample X54**	7143.28	38.936	-0.369	43.661	-13.963
Zone #2	**Sample X55**	7144.72	21.118	0.100	29.413	-8.232
Zone #2	**Sample X56**	7146.17	39.568	-0.924	34.632	-3.455
Zone #2	**Sample X57**	7147.61	41.716	-0.537	33.195	-5.807
Zone #2	**Sample X58**	7149.06	5.784	-2.196	18.473	-11.491
Zone #2	**Sample X59**	7150.50	23.125	-0.934	25.793	0.362
Zone #2	**Sample X60**	7151.94	15.140	-0.212	34.908	-6.239
Zone #2	**Sample X61**	7153.39	45.813	0.250	42.117	-7.441
Zone #2	**Sample X62**	7154.83	50.374	-1.389	32.547	-9.379
Zone #2	**Sample X63**	7156.28	38.338	-1.344	26.865	-8.561
Zone #2	**Sample X64**	7157.56	43.302	-0.783	29.200	-16.492
Zone #2	**Sample X65**	7158.67	54.345	-1.580	22.664	-15.482
Zone #2	**Sample X66**	7159.78	10.889	-1.844	11.501	-8.556
Zone #2	**Sample X67**	7160.89	62.835	-1.672	24.697	-7.260
Zone #2	**Sample X68**	7162.00	38.276	-1.685	23.927	-10.369
Zone #2	**Sample X69**	7163.11	264.511	4.026	70.468	-23.823
Zone #2	**Sample X70**	7164.22	11.772	-0.657	28.428	-9.030
Zone #2	**Sample X71**	7165.33	16.874	-1.188	36.176	-4.740
Zone #2	**Sample X72**	7166.44	36.848	-0.174	30.397	-8.050
Zone #2	**Sample X73**	7167.72	60.024	0.665	40.241	-12.363
Zone #2	**Sample X74**	7169.17	28.600	-1.452	39.054	-8.784
Zone #2	**Sample X75**	7170.61	11.007	-1.331	24.573	-6.431
Zone #2	**Sample X76**	7172.06	25.919	-1.303	43.927	-7.962
Zone #2	**Sample X77**	7173.50	11.661	0.615	38.541	-1.367
Zone #2	**Sample X78**	7174.94	17.994	-2.699	16.954	-15.012
Zone #2	**Sample X79**	7176.39	31.714	-2.303	27.232	-10.925
Zone #2	**Sample X80**	7177.83	9.080	0.009	43.175	3.205
Zone #2	**Sample X81**	7179.28	26.701	-2.414	23.076	-17.948
Zone #2	**Sample X82**	7180.72	131.552	-0.242	60.846	-11.654
Zone #2	**Sample X83**	7182.17	104.149	0.282	44.738	-2.065

Zone #2	**Sample X84**	7183.61	1.317	-0.493	18.789	-8.009
Zone #2	**Sample X85**	7185.06	56.779	-1.738	30.662	-9.571
Zone #2	**Sample X86**	7186.50	26.817	-1.145	32.332	-1.056
Zone #2	**Sample X87**	7187.94	41.022	-1.479	21.877	-8.313
Zone #2	**Sample X88**	7189.39	51.508	-1.381	22.022	-12.037
Zone #2	**Sample X89**	7190.83	18.762	0.005	36.445	4.419
Zone #2	**Sample X90**	7192.28	30.954	-0.620	37.784	-6.561
Zone #2	**Sample X91**	7193.61	31.050	0.918	31.522	-7.810
Zone #2	**Sample X92**	7194.83	1.009	-1.858	15.805	-5.576
Zone #2	**Sample X93**	7196.06	46.850	-1.710	17.739	-17.913
Zone #2	**Sample X94**	7197.28	50.504	0.247	19.742	-3.734
Zone #2	**Sample X95**	7198.50	18.744	-0.801	22.192	-4.653
Zone #2	**Sample X96**	7199.72	23.854	-2.149	16.202	-10.021
Zone #2	**Sample X97**	7200.94	76.148	0.359	27.149	0.824
Zone #2	**Sample X98**	7202.17	72.422	0.691	32.613	6.799
Zone #2	**Sample X99**	7203.39	57.319	-1.438	16.197	-4.571
Zone #2	**Sample X100**	7204.78	38.120	-0.805	25.550	0.846
Zone #2	**Sample X101**	7206.33	41.713	-0.527	31.925	-2.564
Zone #2	**Sample X102**	7207.89	15.025	-2.358	17.236	-5.039
Zone #2	**Sample X103**	7209.44	35.999	-1.901	16.976	-17.592
Zone #2	**Sample X104**	7211.00	41.476	-1.065	19.078	-0.177
Zone #2	**Sample X105**	7212.56	50.268	-0.732	25.007	-17.334
Zone #2	**Sample X106**	7214.11	33.982	-0.681	20.000	-10.951
Zone #2	**Sample-XA**	7214.89	-10.041	-2.019	2.617	-5.131
Zone #1	**Sample X107**	7215.67	59.455	0.232	6.711	-5.397
Zone #1	**Sample X108**	7217.22	103.550	3.380	22.233	-9.302
Zone #1	**Sample X109**	7218.78	197.626	2.405	20.241	-5.685
Zone #1	**Sample X110**	7220.33	181.331	4.569	41.690	-9.436
Zone #1	**Sample X111**	7221.89	261.069	1.785	29.163	-6.290
Zone #1	**Sample X112**	7223.44	193.589	1.455	20.806	-12.364
Zone #1	**Sample X113**	7225.00	378.115	4.053	32.482	-2.007
Zone #1	**Sample X114**	7226.56	153.788	2.757	33.680	-3.477
Zone #1	**Sample X115**	7228.11	182.305	2.886	24.136	4.497
Zone #1	**Sample X116**	7229.67	96.093	5.852	40.865	-11.912
Zone #1	**Sample X117**	7231.22	175.679	4.230	42.098	2.111
Zone #1	**Sample X118**	7232.61	39.518	3.794	41.444	-14.643
Zone #1	**Sample X119**	7233.83	41.736	2.861	36.611	-7.558
Zone #1	**Sample X120**	7235.06	36.828	1.647	56.307	-5.291
Zone #1	**Sample X121**	7236.28	74.702	2.409	46.625	-17.784

Zone #1	**Sample X122**	7237.50	30.168	1.672	38.544	-12.319
Zone #1	**Sample X123**	7238.72	71.005	2.953	43.291	-7.416
Zone #1	**Sample X124**	7239.94	25.499	3.126	43.971	-13.033
Zone #1	**Sample X125**	7241.17	109.486	4.039	48.463	5.315
Zone #1	**Sample X126**	7242.39	59.886	5.023	57.563	-1.731
Zone #1	**Sample X127**	7243.78	49.236	2.827	51.526	2.431
Zone #1	**Sample X128**	7245.33	36.269	1.633	38.423	3.687
Zone #1	**Sample X129**	7246.89	61.611	3.477	46.152	-6.488
Zone #1	**Sample X130**	7248.44	113.417	1.985	42.459	-16.539
Zone #1	**Sample X131**	7250.00	127.390	3.017	46.247	-7.970
Zone #1	**Sample X132**	7251.56	80.761	2.818	45.968	-11.491
Zone #1	**Sample X133**	7253.11	48.377	1.124	39.833	-3.643
Zone #1	**Sample X134**	7254.67	66.001	3.695	39.652	-3.832
Zone #1	**Sample X135**	7256.22	125.458	5.053	43.306	-15.016
Zone #1	**Sample X136**	7257.72	42.968	2.232	35.794	-9.409
Zone #1	**Sample X137**	7259.17	119.950	10.262	17.097	3.409
Zone #1	**Sample X138**	7260.61	362.457	3.574	45.368	2.815
Zone #1	**Sample X139**	7262.06	65.964	2.543	47.304	-1.977
Zone #1	**Sample X140**	7263.50	85.016	-0.629	30.095	-5.587
Zone #1	**Sample X141**	7264.94	23.813	-0.056	22.305	-7.250
Zone #1	**Sample X142**	7266.39	95.064	2.876	34.809	-5.886
Zone #1	**Sample X143**	7267.83	41.592	2.104	34.283	-10.194
Zone #1	**Sample X144**	7269.28	41.443	2.296	40.985	-14.339
Zone #1	**Sample X145**	7270.56	32.660	3.103	56.482	-5.326
Zone #1	**Sample X146**	7271.67	60.939	1.431	29.272	2.758
Zone #1	**Sample X147**	7272.78	84.043	3.755	61.072	-1.888
Zone #1	**Sample X148**	7273.89	37.646	5.809	55.616	-3.908
Zone #1	**Sample X149**	7275.00	39.016	2.011	34.873	0.912
Zone #1	**Sample X150**	7276.11	97.582	2.784	43.542	-3.061
Zone #1	**Sample X151**	7277.22	42.167	2.890	46.669	1.310
Zone #1	**Sample X152**	7278.33	74.398	4.222	26.610	-7.708
Zone #1	**Sample X153**	7279.44	33.849	0.417	24.224	-5.367
Zone #1	**Sample X154**	7280.67	19.984	0.982	28.386	-10.959
Zone #1	**Sample X155**	7282.00	209.751	-0.319	7.155	1.797
Zone #1	**Sample X156**	7283.33	38.306	2.603	33.307	-7.026
Zone #1	**Sample X157**	7284.67	21.348	0.968	21.204	-2.473
Zone #1	**Sample X158**	7286.00	74.835	5.352	55.627	-4.251
Zone #1	**Sample X159**	7287.33	15.471	-0.155	11.643	1.820
Zone #1	**Sample X160**	7288.67	33.909	2.875	24.039	-1.841

Zone #1	**Sample X161**	7290.00	37.483	3.747	20.906	-3.701
Zone #1	**Sample X162**	7291.33	36.888	1.873	4.512	-1.767
Zone #1	**Sample X163**	7292.61	23.746	0.690	4.543	9.465
Zone #1	**Sample X164**	7293.83	28.821	2.085	9.854	2.266
Zone #1	**Sample X165**	7295.06	20.511	0.370	4.625	2.258
Zone #1	**Sample X166**	7296.28	20.583	1.650	11.321	4.337
Zone #1	**Sample X167**	7297.50	13.121	-0.806	2.079	1.399
Zone #1	**Sample X168**	7298.72	22.157	0.587	16.910	-4.793
Zone #1	**Sample X169**	7299.94	39.670	5.091	50.221	-18.188
Zone #1	**Sample X170**	7301.17	47.389	6.299	56.027	-16.085
Zone #1	**Sample X171**	7302.39	24.544	3.201	49.785	-23.531
Zone #1	**Sample X172**	7303.50	224.917	8.429	92.950	2.387

Getty Lloyd Hurt #1 Drill Core		**Total Depth (ft)**	**Sr ppm**	**Zr ppm**	**Mo ppm**
Zone #2	**Sample X1**	7078.67	1772.895	39.195	0.252
Zone #2	**Sample X2**	7080.00	2319.480	5.312	2.390
Zone #2	**Sample X3**	7081.33	2072.755	20.414	2.625
Zone #2	**Sample X4**	7082.67	2128.473	25.642	1.381
Zone #2	**Sample X5**	7084.00	2633.984	29.051	2.246
Zone #2	**Sample X6**	7085.33	1731.768	24.339	3.559
Zone #2	**Sample X7**	7086.67	2558.839	35.555	1.648
Zone #2	**Sample X8**	7088.00	2002.604	31.952	4.824
Zone #2	**Sample X9**	7089.33	1997.370	37.841	7.838
Zone #2	**Sample X10**	7090.50	2021.483	16.132	2.038
Zone #2	**Sample X11**	7091.50	2091.270	13.857	3.118
Zone #2	**Sample X12**	7092.50	1814.375	37.013	2.425
Zone #2	**Sample X13**	7093.50	2480.890	-19.289	5.049
Zone #2	**Sample X14**	7094.50	2378.900	30.967	9.742
Zone #2	**Sample X15**	7095.50	2141.333	44.564	65.040
Zone #2	**Sample X16**	7096.50	2707.118	50.005	20.490
Zone #2	**Sample X17**	7097.50	2217.689	32.824	1.231
Zone #2	**Sample X18**	7098.50	2141.781	30.382	1.749
Zone #2	**Sample X19**	7099.56	2311.416	18.693	1.090
Zone #2	**Sample X20**	7100.67	2319.480	5.312	2.390
Zone #2	**Sample X21**	7101.78	1182.574	58.428	1.470
Zone #2	**Sample X22**	7102.89	2500.909	6.876	0.537
Zone #2	**Sample X23**	7104.00	3123.765	-21.212	2.830
Zone #2	**Sample X24**	7105.11	2040.454	38.170	0.692

Zone #2	**Sample X25**	7106.22	3273.859	-0.445	4.403
Zone #2	**Sample X26**	7107.33	3139.977	5.179	4.005
Zone #2	**Sample X27**	7108.44	1932.511	25.223	1.229
Zone #2	**Sample X28**	7109.61	1671.723	44.199	2.502
Zone #2	**Sample X29**	7110.83	1706.773	11.034	3.280
Zone #2	**Sample X30**	7112.06	1862.384	19.665	2.687
Zone #2	**Sample X31**	7113.28	2035.108	48.017	0.120
Zone #2	**Sample X32**	7114.50	2116.488	45.702	1.023
Zone #2	**Sample X33**	7115.72	1994.165	42.774	1.052
Zone #2	**Sample X34**	7116.94	2254.105	34.681	2.108
Zone #2	**Sample X35**	7118.17	2026.550	39.649	4.596
Zone #2	**Sample X36**	7119.39	2269.108	44.898	0.402
Zone #2	**Sample X37**	7120.61	2245.283	33.239	-0.623
Zone #2	**Sample X38**	7121.83	2760.175	19.609	3.002
Zone #2	**Sample X39**	7123.06	1900.285	46.487	4.248
Zone #2	**Sample X40**	7124.28	1984.341	14.722	2.214
Zone #2	**Sample X41**	7125.50	2159.687	0.607	0.474
Zone #2	**Sample X42**	7126.72	2042.256	27.846	-2.248
Zone #2	**Sample X43**	7127.94	2553.452	0.433	2.161
Zone #2	**Sample X44**	7129.17	2123.672	14.493	0.252
Zone #2	**Sample X45**	7130.39	2856.706	1.053	1.265
Zone #2	**Sample X46**	7131.72	1943.478	47.269	3.900
Zone #2	**Sample X47**	7133.17	2536.562	6.995	2.148
Zone #2	**Sample X48**	7134.61	2529.911	7.230	1.194
Zone #2	**Sample X49**	7136.06	2228.866	33.922	-1.062
Zone #2	**Sample X50**	7137.50	2004.530	28.264	1.939
Zone #2	**Sample X51**	7138.94	2089.017	40.130	8.203
Zone #2	**Sample X52**	7140.39	2330.388	36.863	2.559
Zone #2	**Sample X53**	7141.83	2105.337	26.846	0.948
Zone #2	**Sample X54**	7143.28	2147.191	39.002	4.359
Zone #2	**Sample X55**	7144.72	2157.470	25.221	2.652
Zone #2	**Sample X56**	7146.17	1984.781	18.384	3.283
Zone #2	**Sample X57**	7147.61	2026.348	29.673	-0.468
Zone #2	**Sample X58**	7149.06	2199.860	11.073	0.500
Zone #2	**Sample X59**	7150.50	2047.996	39.409	4.318
Zone #2	**Sample X60**	7151.94	2155.778	32.287	4.185
Zone #2	**Sample X61**	7153.39	2001.296	26.735	1.011
Zone #2	**Sample X62**	7154.83	2184.605	24.993	2.696
Zone #2	**Sample X63**	7156.28	2117.855	38.689	2.526

Zone #2	**Sample X64**	7157.56	2436.650	45.379	2.556
Zone #2	**Sample X65**	7158.67	2273.538	28.085	3.221
Zone #2	**Sample X66**	7159.78	2288.876	36.166	2.928
Zone #2	**Sample X67**	7160.89	2318.799	43.875	0.557
Zone #2	**Sample X68**	7162.00	2340.349	31.253	-0.006
Zone #2	**Sample X69**	7163.11	3188.663	-26.514	3.125
Zone #2	**Sample X70**	7164.22	2315.267	30.809	4.949
Zone #2	**Sample X71**	7165.33	2208.752	30.580	2.391
Zone #2	**Sample X72**	7166.44	2316.753	43.115	0.449
Zone #2	**Sample X73**	7167.72	2134.443	43.653	2.772
Zone #2	**Sample X74**	7169.17	2191.151	35.375	-0.705
Zone #2	**Sample X75**	7170.61	2185.119	41.901	1.686
Zone #2	**Sample X76**	7172.06	1971.785	27.555	1.058
Zone #2	**Sample X77**	7173.50	1863.834	38.229	2.482
Zone #2	**Sample X78**	7174.94	2124.721	42.158	3.074
Zone #2	**Sample X79**	7176.39	2438.309	24.729	3.469
Zone #2	**Sample X80**	7177.83	2268.556	35.002	4.645
Zone #2	**Sample X81**	7179.28	2181.270	37.213	-0.379
Zone #2	**Sample X82**	7180.72	1879.275	40.964	2.139
Zone #2	**Sample X83**	7182.17	2070.521	32.092	1.520
Zone #2	**Sample X84**	7183.61	2196.083	29.225	2.988
Zone #2	**Sample X85**	7185.06	1946.224	45.452	5.029
Zone #2	**Sample X86**	7186.50	1728.286	25.527	9.982
Zone #2	**Sample X87**	7187.94	2322.790	36.607	2.761
Zone #2	**Sample X88**	7189.39	2048.283	24.334	2.142
Zone #2	**Sample X89**	7190.83	1819.425	47.293	5.301
Zone #2	**Sample X90**	7192.28	1936.705	27.101	0.406
Zone #2	**Sample X91**	7193.61	1843.081	32.417	2.947
Zone #2	**Sample X92**	7194.83	2011.587	25.320	0.308
Zone #2	**Sample X93**	7196.06	1710.730	34.608	2.078
Zone #2	**Sample X94**	7197.28	2078.871	53.441	2.249
Zone #2	**Sample X95**	7198.50	1956.468	49.009	2.603
Zone #2	**Sample X96**	7199.72	2130.392	49.506	0.130
Zone #2	**Sample X97**	7200.94	1867.835	38.587	2.565
Zone #2	**Sample X98**	7202.17	1748.561	48.933	5.648
Zone #2	**Sample X99**	7203.39	2170.693	35.782	3.517
Zone #2	**Sample X100**	7204.78	1893.130	28.950	3.018
Zone #2	**Sample X101**	7206.33	2082.561	50.133	3.504
Zone #2	**Sample X102**	7207.89	2141.186	22.411	3.397

Zone #2	**Sample X103**	7209.44	2110.213	26.172	2.087
Zone #2	**Sample X104**	7211.00	1894.378	30.744	1.737
Zone #2	**Sample X105**	7212.56	1652.572	21.363	2.038
Zone #2	**Sample X106**	7214.11	1652.627	26.603	3.035
Zone #2	**Sample-XA**	7214.89	1338.799	41.277	6.688
Zone #1	**Sample X107**	7215.67	1010.609	40.436	5.786
Zone #1	**Sample X108**	7217.22	1661.091	12.219	13.367
Zone #1	**Sample X109**	7218.78	2689.193	-33.712	7.646
Zone #1	**Sample X110**	7220.33	2039.399	-2.089	13.721
Zone #1	**Sample X111**	7221.89	2240.903	-20.400	9.670
Zone #1	**Sample X112**	7223.44	2338.925	14.146	8.852
Zone #1	**Sample X113**	7225.00	1461.952	38.601	9.664
Zone #1	**Sample X114**	7226.56	1612.277	15.011	5.047
Zone #1	**Sample X115**	7228.11	1800.756	17.029	11.774
Zone #1	**Sample X116**	7229.67	2608.214	-30.914	6.904
Zone #1	**Sample X117**	7231.22	1539.557	18.036	7.973
Zone #1	**Sample X118**	7232.61	2062.852	2.158	2.950
Zone #1	**Sample X119**	7233.83	1770.554	11.376	3.771
Zone #1	**Sample X120**	7235.06	1681.570	48.909	7.026
Zone #1	**Sample X121**	7236.28	2457.577	-9.312	8.395
Zone #1	**Sample X122**	7237.50	2016.364	5.508	4.728
Zone #1	**Sample X123**	7238.72	1968.364	24.768	4.830
Zone #1	**Sample X124**	7239.94	2165.057	13.625	0.943
Zone #1	**Sample X125**	7241.17	1741.428	10.293	2.173
Zone #1	**Sample X126**	7242.39	2497.671	3.435	2.393
Zone #1	**Sample X127**	7243.78	1507.563	20.688	5.980
Zone #1	**Sample X128**	7245.33	1635.866	26.825	3.001
Zone #1	**Sample X129**	7246.89	1475.580	17.645	5.759
Zone #1	**Sample X130**	7248.44	2163.126	9.987	2.500
Zone #1	**Sample X131**	7250.00	2061.040	0.034	2.084
Zone #1	**Sample X132**	7251.56	1815.704	16.131	3.252
Zone #1	**Sample X133**	7253.11	1545.712	19.610	4.087
Zone #1	**Sample X134**	7254.67	1924.241	18.075	1.369
Zone #1	**Sample X135**	7256.22	1963.405	3.502	2.971
Zone #1	**Sample X136**	7257.72	1919.058	10.209	5.507
Zone #1	**Sample X137**	7259.17	797.786	274.764	25.106
Zone #1	**Sample X138**	7260.61	1964.146	10.789	6.281
Zone #1	**Sample X139**	7262.06	2379.491	-3.298	2.337
Zone #1	**Sample X140**	7263.50	1490.897	28.818	2.563

Zone #1	**Sample X141**	7264.94	1760.423	16.716	2.287
Zone #1	**Sample X142**	7266.39	2002.668	15.395	1.299
Zone #1	**Sample X143**	7267.83	1726.631	42.597	5.262
Zone #1	**Sample X144**	7269.28	2638.457	10.659	1.529
Zone #1	**Sample X145**	7270.56	1185.837	50.478	3.818
Zone #1	**Sample X146**	7271.67	1573.313	34.240	4.956
Zone #1	**Sample X147**	7272.78	1540.167	37.949	4.552
Zone #1	**Sample X148**	7273.89	2014.993	15.774	4.211
Zone #1	**Sample X149**	7275.00	1559.263	53.312	7.777
Zone #1	**Sample X150**	7276.11	1495.112	33.958	5.140
Zone #1	**Sample X151**	7277.22	1548.263	32.147	5.604
Zone #1	**Sample X152**	7278.33	1454.405	34.763	8.383
Zone #1	**Sample X153**	7279.44	1515.057	33.837	3.446
Zone #1	**Sample X154**	7280.67	1660.684	26.718	1.225
Zone #1	**Sample X155**	7282.00	585.620	60.954	2.702
Zone #1	**Sample X156**	7283.33	1973.689	31.156	4.051
Zone #1	**Sample X157**	7284.67	1390.389	45.988	5.435
Zone #1	**Sample X158**	7286.00	3122.573	-21.544	5.253
Zone #1	**Sample X159**	7287.33	1095.373	25.163	1.544
Zone #1	**Sample X160**	7288.67	1240.374	27.753	5.783
Zone #1	**Sample X161**	7290.00	1394.192	33.472	4.904
Zone #1	**Sample X162**	7291.33	452.477	33.650	1.459
Zone #1	**Sample X163**	7292.61	584.151	26.571	3.906
Zone #1	**Sample X164**	7293.83	778.233	26.823	1.344
Zone #1	**Sample X165**	7295.06	491.455	35.249	-0.275
Zone #1	**Sample X166**	7296.28	1066.580	24.535	2.172
Zone #1	**Sample X167**	7297.50	623.258	32.234	2.857
Zone #1	**Sample X168**	7298.72	869.544	18.989	-2.301
Zone #1	**Sample X169**	7299.94	1995.456	15.994	3.049
Zone #1	**Sample X170**	7301.17	1827.193	32.901	4.437
Zone #1	**Sample X171**	7302.39	2130.022	1.457	3.906
Zone #1	**Sample X172**	7303.50	1003.160	68.389	20.367

APPENDIX B

DEPOSITIONAL ENVIRONMENT ASSESSMENT DATA STANDARDS

DISCLAIMER: In the following section linkages are made between various depositional environments with the drill cores analyzed in this study. This was accomplished by comparing elemental abundances, oxides and elemental abundances normalized to Al from the cores utilized in this study with those from known depositional environments (Brumsack, 2006). The purpose of the comparison was ultimately to better determine environmental conditions in place during the deposition of the drill cores analyzed in this study. However, the attempt was unsuccessful and the results in this section are not included in the discussion portion of this document.

Depositional Environment Assessment Data (DEAD) Standards

The purpose of this study is to chemostratigraphically categorize the individual zones of each core in either an upwelling or sapropel, organic carbon sediment rich anoxic to euxinic basin, type depositional environments. This was done by comparing select major and trace elements from this study (normalized to Al) to results from Brumsack, 2006. The results of Brumsack, 2006, comprise the Aluminum Depositional Environmental Data Standards (Al-DEADs). Select elemental concentration and oxides from this study are also compared to the raw elemental abundances and oxides presented by Brumsack, 2006, which comprise the Abundance Depositional Environmental Data Standards (AB-DEADs).

It should be noted that concentrations of the select elements vary considerably and there could be local or regional factors not involving upwelling or sapropel type conditions that can affect the concentration. Therefore, comparisons between the individual zones in this study are not definitive, but merely suggestive of the conditions present during the time of deposition. The extent of this study is the suggestion that the concentrations (based on Al-DEADs and AB-DEADS) are most consistent with the Peru Margin, the Namibian Mud Lens, Mediterranean

Sapropels, Black Sea Unit #1, and Black Sea Unit #2 and that each was deposited in an upwelling or sapropel type environment.

To better constrain the environmental conditions that influenced deposition of the Eagle Ford Formation, the drill cores analyzed during this study are compared to depositional environment assessment data (DEAD). This DEAD is from several locations exhibiting the characteristics of depositional environments of both upwelling and anoxic basins.

The DEAD is provided by Brumsack, 2006, which for the purposes of this study the Peru Margin, Namibian Mud Lens, Mediterranean Sapropels, Black Sea Unit #1, and Black Sea Unit #2 are all considered standards for their respective depositional environments. The Peru Margin and Namibian Mud Lens were deposited in a nutrient upwelling environment. Mediterranean Sapropels (with greater than two percent TOC), Black Sea Unit #1 and Black Sea Unit #2 were deposited in an anoxic basin type environment.

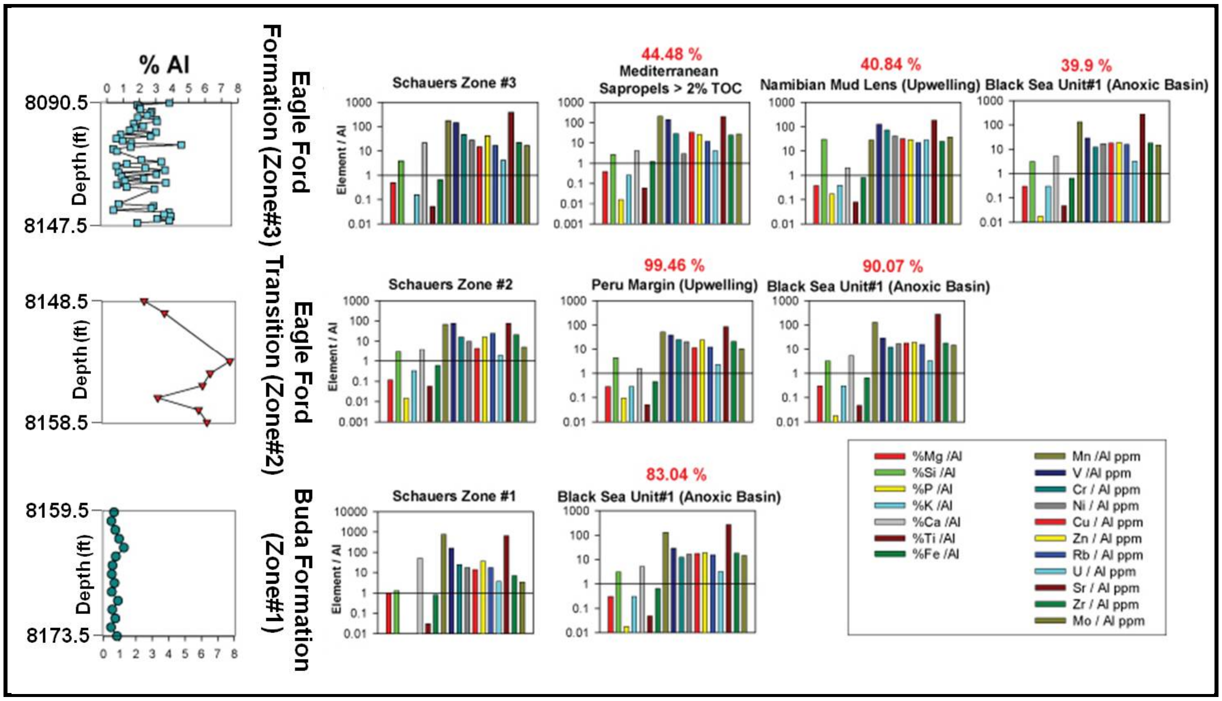
When considering elemental abundances and determining how each environment compares to each drill core the percent of that element is considered the standard and assigned a value of 100 percent. The same element within the core considered is compared with that standard. For example, if a given core has a value for Mg of 4 percent and the Mg within a given standard has a value of 9 % it is calculated as follows: 9/4 = 100 / X → 2.25 X = 100 → X = 44.4 %. Hence Mg % in the given core is 44.4 % consistent with the Mg % from the given standard. The process is repeated for sample in the core. All the values, in percent are then added together and compared with standard as follows: Given Core = 4 % Mg, 22 % Si and 10 % K, Standard = 9 % Mg, 25 % Si, 5 % K; Mg /4 Mg = 100 / X → 2.25 % X = 100 % → 44.4 %, 25 Mg /22 Mg = 100 / X → 2.36 X = 100 → 42.37 %, 5 K /10 K → 100 / X → 0.5 X = 100 → 200 %. The values are then added averaged as follows: Given Core: 44.4 % + 44.37 % + 200 % = 288.77 % / 3 = 96 %. Therefore the given core is 96% consistent with the depositional environmental assessment data (DEAD) standard. The process is utilized for the both abundances and normalized samples.

DEAD provides standards in the form of Aluminum Normalized DEAD Standards, in which major and trace elements are normalized to aluminum, and elemental and Oxide Abundance Standard, in which abundances of certain elements and oxides are compared to one another.

In should be noted that in the following charts that the raw average data for each core analyzed, total and zonal, is provided along with their respective DEAD Standards. The charts included in those sections correspond to their associated figures. In addition to the aforementioned data, the charts also possess average shale and C/T mean data as determined by Brumsack, 2006. However, this data does not directly relate to their respective figures, but relates indirectly and will be referenced throughout.

Also, in the following figures, the aluminum enrichment for each zone of each drill core analyzed during this study accompanies the average drill core data and their respective DEAD Standards. The Al enrichment is provided to display, define, and emphasize the different zones in each core. Note that the key in figure 4.46 applies to all figures in this section.

Geological Research Co. Schauers, FT #1 Drill Core



Aluminum Normalized DEAD Standards against the Geological Research Co. Schauers, FT #1 Drill Core.

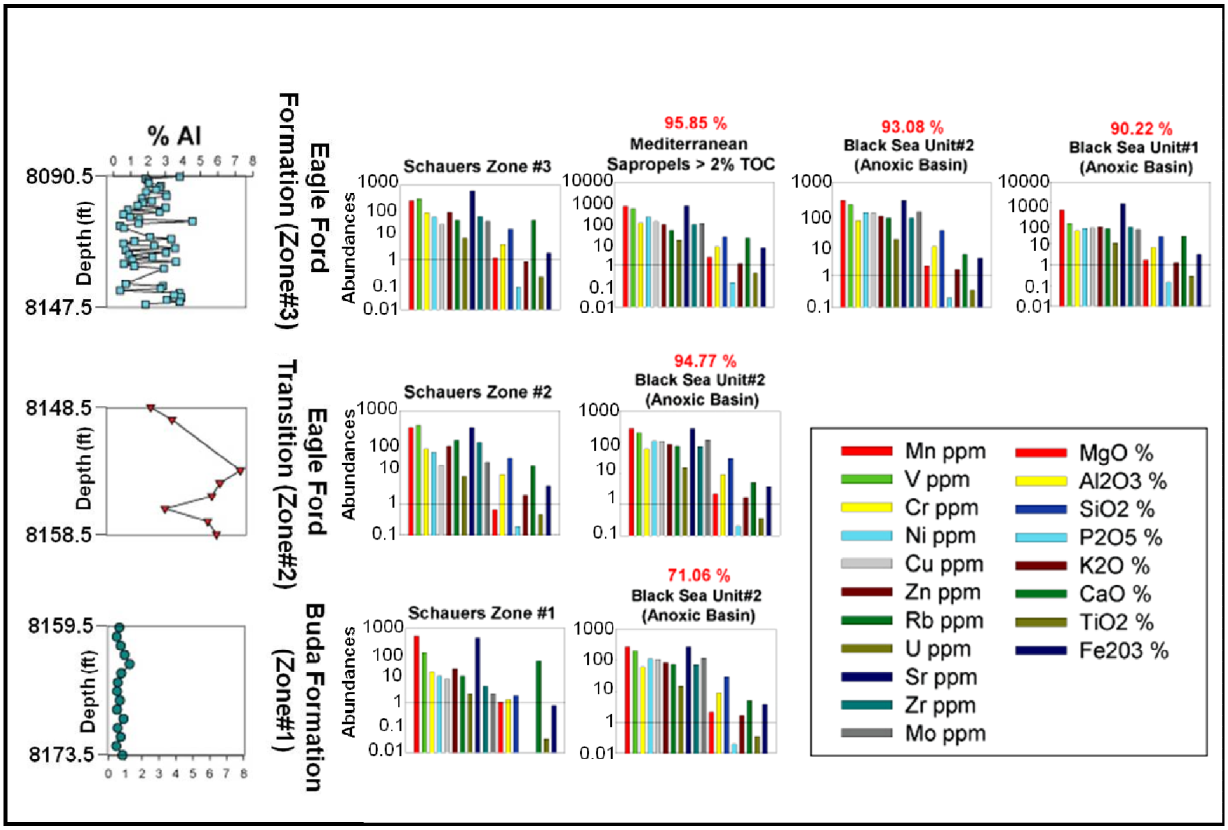
In the above figure comparisons are made with the major and trace elements normalized to aluminum of the individual zones of the Geological Research Co. Schauers, FT #1 Drill Core to their respective DEAD Standards. The DEAD Standards are as follows: Black Sea Unit #1 (Anoxic Basin), Peru Margin (Upwelling), Mediterranean Sapropels (Anoxic Basin) and the Namibian Mud Lens.

The geochemical signature of zone three is most similar to Mediterranean Sapropels, which is 44.48 percent consistent. Zone two possesses a geochemical signature that is 96.46 percent consistent to Peru Margin (Upwelling). Zone one exhibits a geochemical signature 83.04 percent consistent to Black Sea Unit #1 (Anoxic Basin).

Table Aluminum Normalized DEAD Standards and Geological Research Co. Schauers, FT #1 Drill Core Data.

	Schauers Total (AVG)	Schauers Zone#3 (AVG)	Schauers Zone#2 (AVG)	Schauers Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
%Mg/Al	0.56	0.50	0.12	1.01	0.28	0.38	0.39	0.30	0.28	0.18	0.22
%Si/Al	3.18	3.81	2.86	1.29	4.33	30.20	2.65	3.08	2.98	3.11	7.36
%P /Al	-0.08	-0.03	0.01	-0.28	0.10	0.17	0.02	0.02	0.02	0.01	0.05
%K/Al	0.06	0.16	0.33	-0.41	0.28	0.39	0.25	0.30	0.30	0.34	0.28
%Ca/Al	25.63	21.41	3.84	51.01	1.50	2.00	4.07	5.15	0.77	0.18	2.15
%Ti/Al	0.05	0.05	0.06	0.03	0.05	0.08	0.06	0.05	0.04	0.05	0.05
%Fe/Al	0.68	0.65	0.61	0.79	0.45	0.80	1.22	0.65	0.57	0.55	0.77
Mn/Al ppm	282.23	172.00	67.47	758.00	52.00	28.00	202.00	129.00	56.00	96.00	125.00
V / Al ppm	138.16	142.49	76.30	156.99	38.00	126.00	139.00	29.00	44.00	15.00	271.00
Cr / Al ppm	39.44	47.70	16.33	24.80	24.40	72.00	28.30	12.20	28.80	10.20	41.40
Ni / Al ppm	23.20	27.19	9.92	17.27	20.20	41.00	2.90	16.70	24.50	7.70	65.20
Cu / Al ppm	13.24	14.50	4.42	13.83	11.60	32.00	33.10	17.60	23.70	5.10	43.80
Zn / Al ppm	37.69	41.62	15.93	36.46	24.00	29.00	25.00	19.00	18.00	11.00	459.00
Rb / Al ppm	17.65	16.53	24.50	17.66	12.30	22.00	12.10	15.60	15.70	16.00	18.10
U / Al ppm	3.83	4.17	1.90	3.71	2.30	28.60	4.10	3.20	3.30	0.42	6.40
Sr / Al ppm	404.28	384.16	74.92	645.64	86.00	181.00	200.00	271.00	59.00	34.00	106.00
Ar / Al ppm	18.61	21.87	20.66	6.89	21.00	25.20	24.00	18.00	15.00	18.00	18.00
Mo / Al ppm	12.73	16.83	5.16	3.40	10.60	37.00	27.90	14.70	26.20	0.15	61.40

Comparisons between zone one and the Al-DEAD standards reveal zone one is 83.04 percent consistent with the Black Sea Unit #1, an anoxic basin. Zone two is 99.46 percent consistent with the Peru Margin, upwelling. Zone three is most consistent with Mediterranean Sapropels (44.48 %), which represents an upwelling type of depositional environment.



Elemental and Oxide DEAD Standards against Geological Research Co. Schauers, FT #1 Drill Core Data.

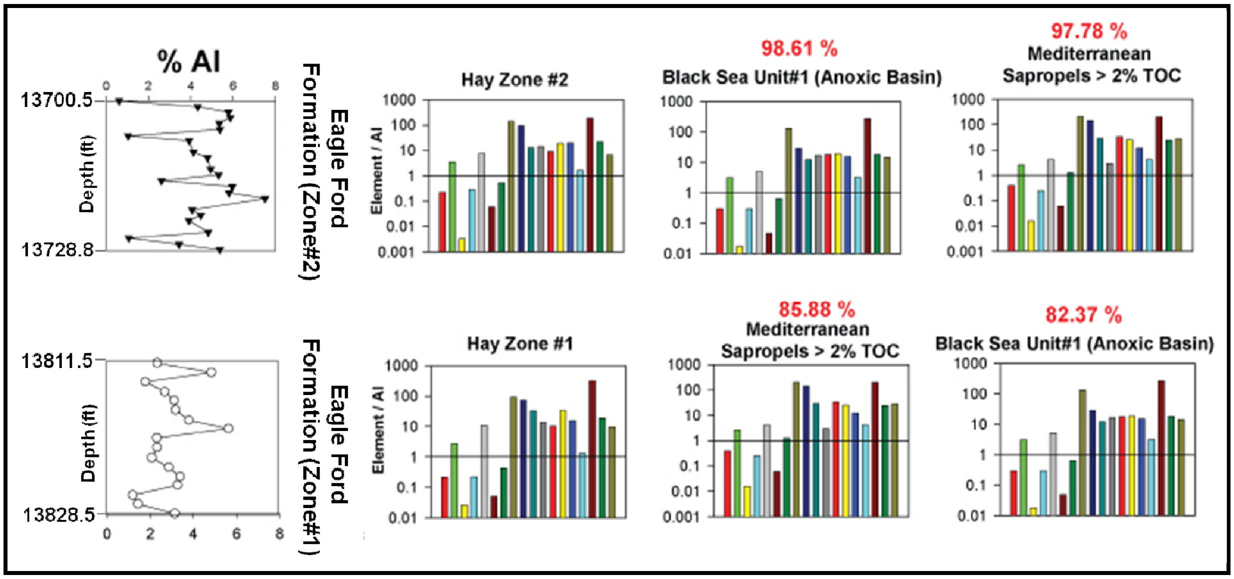
In the above figure comparisons are made between the elemental and oxide abundances of all the zones of the Geological Research Co. Schauers, FT #1 Drill Core to the respective DEAD Standards. The geochemical signature of zone three is 95.85 percent consistent with the Mediterranean Sapropels (Anoxic Basin), 93.08 percent consistent with the Black Sea Unit #2 (Anoxic Basin), and 90.22 percent constant with Black Sea Unit #1 (Anoxic Basin). Zone two is 94.77 percent consistent with Black Sea Unit #2. Zone one is 71.06 percent consistent with the Black Sea Unit #2.

Elemental and Oxide DEAD Standards and Geological Research Co. Schauers, FT #1 Drill Core Data.

	Schauers Total (AVG)	Schauers Zone#3 (AVG)	Schauers Zone#2 (AVG)	Schauers Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
Mn (ppm)	288.54	222.78	288.53	503.38	260.00	45.00	686.00	430.00	270.00	850.00	557.00
V (ppm)	237.16	262.00	334.52	104.09	152.00	138.00	518.00	100.00	196.00	130.00	1016.00
Cr (ppm)	61.63	75.32	59.29	18.14	98.00	93.00	110.00	43.00	60.00	90.00	179.00
Ni (ppm)	41.58	49.89	46.30	11.94	74.00	46.00	208.00	57.00	110.00	68.00	267.00
Cu (ppm)	21.86	26.45	17.20	9.39	49.00	37.00	127.00	59.00	106.00	45.00	194.00
Zn (ppm)	67.41	80.08	71.73	23.73	106.00	35.00	96.00	65.00	83.00	95.00	2056.00
Rb (ppm)	40.98	37.95	113.94	12.00	59.00	28.00	48.00	55.00	73.00	140.00	97.00
U (ppm)	6.15	7.07	7.76	2.29	10.50	30.00	15.50	10.90	14.80	3.70	28.00
Sr (ppm)	506.11	566.31	285.58	427.06	311.00	198.00	693.00	870.00	269.00	300.00	272.00
Zr (ppm)	46.67	51.41	96.54	4.58	100.00	31.00	97.00	62.00	72.00	160.00	88.00
Mo (ppm)	26.61	34.75	22.29	2.33	42.00	40.00	105.00	51.00	117.00	1.00	316.00
%MgO	1.09	1.20	0.65	1.11	1.97	0.76	2.52	1.70	2.16	2.60	1.81
%Al2O3	3.57	4.05	9.08	1.36	8.90	2.38	7.69	6.66	8.86	16.70	4.97
%SiO2	13.32	16.72	29.61	1.94	42.70	68.80	22.90	22.50	29.40	58.90	44.60
%P2O5	-0.02	0.08	0.19	-0.40	0.82	0.49	0.14	0.14	0.20	0.16	0.35
%K2O	0.68	0.83	1.93	-0.31	1.53	0.58	1.18	1.26	1.67	3.60	1.19
%CaO	36.94	37.75	16.45	47.72	6.65	3.09	19.80	23.10	4.97	2.20	6.04
%TiO2	0.18	0.20	0.46	0.03	0.41	0.16	0.42	0.28	0.35	0.78	0.20
%Fe2O3	1.69	1.80	3.93	0.78	3.10	1.43	6.80	3.18	3.80	6.90	4.25

Comparisons between zone one and two and the AB-DEAD standards reveal that they are both most consistent with the Black Sea Unit #2, an anoxic basin. Although the geochemical signatures are similar for zone two, interpretations from the previous sections indicate that it was deposited in an upwelling type environment. Zone three is most consistent with the Mediterranean sapropel-type depositional environment

Shell Oil Co. ED Hay, Unit #1 Drill Core



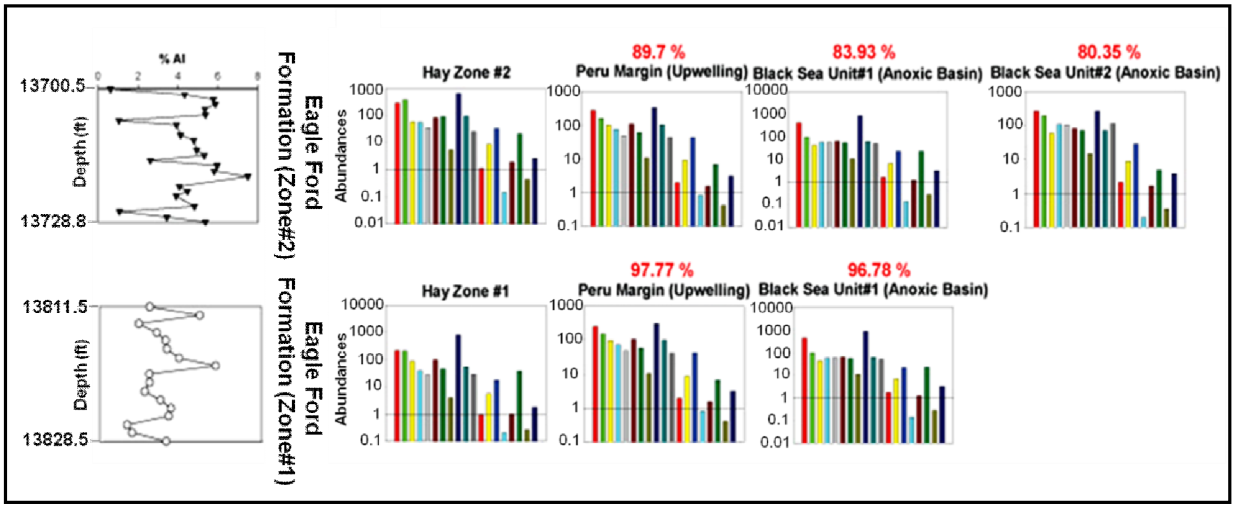
Aluminum Normalized DEAD Standards against the Shell Oil Co. ED Hay, Unit #1 Drill Core.

In the above figure a comparison is made between the major and minor elements normalized to aluminum of both zones of the Shell Oil Co. ED Hay, Unit #1 Drill Core to their respective DEAD Standards. The DEAD Standards are as follows: Black Sea Unit #1 (Anoxic Basin) and Mediterranean Sapropels (Anoxic Basin). Both DEAD Standards experienced deposition during anoxic basin conditions. The geochemical signature of zone two is 98.61 percent consistent with Mediterranean Sapropels (Anoxic Basin). The geochemical signature of zone one is 85.88 percent consistent with the Mediterranean Sapropels.

Aluminum Normalized DEAD Standards and Shell Oil Co. ED Hay, Unit #1 Drill Core Data.

	Hay Zone Total (AVG)	Hay Zone#2 (AVG)	Hay Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
%Mg/Al	0.22	0.23	0.22	0.28	0.38	0.39	0.30	0.28	0.18	0.22
%Si/Al	3.15	3.46	2.71	4.33	30.20	2.65	3.08	2.98	3.11	7.36
%P /Al	0.02	0.00	0.03	0.10	0.17	0.02	0.02	0.02	0.01	0.05
%K/Al	0.27	0.29	0.22	0.28	0.39	0.25	0.30	0.30	0.34	0.28
%Ca/Al	9.11	7.41	10.93	1.50	2.00	4.07	5.15	0.77	0.18	2.15
%Ti/Al	0.06	0.06	0.05	0.05	0.08	0.06	0.05	0.04	0.05	0.05
%Fe/Al	0.48	0.51	0.43	0.45	0.80	1.22	0.65	0.57	0.55	0.77
Mn/Al ppm	119.23	137.00	91.52	52.00	28.00	202.00	129.00	56.00	96.00	125.00
V / Al ppm	84.27	93.38	72.13	38.00	126.00	139.00	29.00	44.00	15.00	271.00
Cr / Al ppm	21.54	12.93	33.03	24.40	72.00	28.30	12.20	28.80	10.20	41.40
Ni / Al ppm	14.09	14.32	13.78	20.20	41.00	2.90	16.70	24.50	7.70	65.20
Cu / Al ppm	9.44	8.86	10.22	11.60	32.00	33.10	17.60	23.70	5.10	43.80
Zn / Al ppm	25.77	18.94	34.86	24.00	29.00	25.00	19.00	18.00	11.00	459.00
Rb / Al ppm	18.11	19.93	15.69	12.30	22.00	12.10	15.60	15.70	16.00	18.10
U / Al ppm	1.51	1.64	1.34	2.30	28.60	4.10	3.20	3.30	0.42	6.40
Sr / Al ppm	239.10	177.07	321.82	86.00	181.00	200.00	271.00	59.00	34.00	106.00
Zr / Al ppm	20.59	21.45	19.44	21.00	25.20	24.00	18.00	15.00	18.00	18.00
Mo / Al ppm	7.80	6.47	9.59	10.60	37.00	27.90	14.70	26.20	0.15	61.40

Comparisons between zone one and the Al-DEAD standards reveal it is most consistent with Mediterranean Sapropels, also an anoxic basin. Zone two is most consistent with the Black Sea Unit #1, an anoxic basin. It is consistent with the previous sections in that the geochemical signature is consistent with an anoxic to euxinic depositional environment.



Elemental and Oxide DEAD Standards against Shell Oil Co. ED Hay, Unit #1 Drill Core Data.

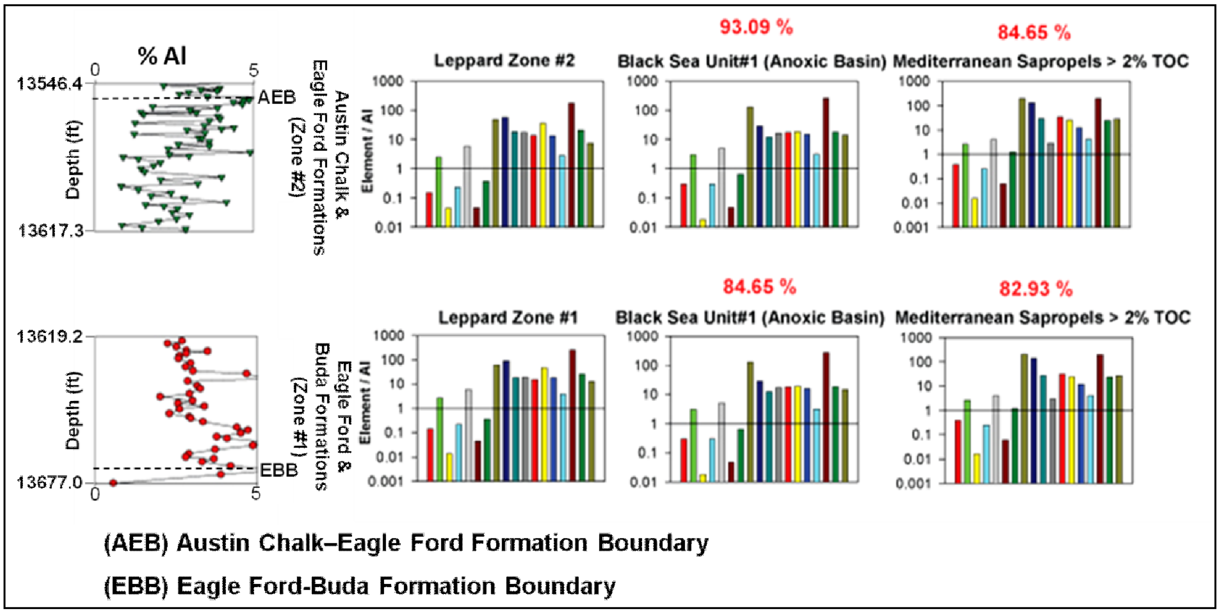
In the above figure comparisons are made between elemental and oxide abundances of both zones of the Hay ED. Unit 1 Shell Oil Core to the respective DEAD Standards. The geochemical signature of zone two is 89.7 percent consistent with the Peru Margin (Upwelling), 83.93 percent consistent with the Black Sea Unit #1 (Anoxic Basin), and 80.35 percent consistent with Black Sea Unit #2 (Anoxic Basin). Zone one is 97.77 percent consistent with Peru Margin (Upwelling) and 96.78 percent consistent with Black Sea Unit #1 (Anoxic Basin).

Elemental and Oxide DEAD Standards and Shell Oil Co. ED Hay, Unit #1 Drill Core Data.

	Hay Zone Total (AVG)	Hay Zone#2 (AVG)	Hay Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
Mn (ppm)	259.91	290.00	220.00	260.00	45.00	686.00	430.00	270.00	850.00	557.00
V (ppm)	306.18	377.26	211.41	152.00	138.00	518.00	100.00	196.00	130.00	1016.00
Cr (ppm)	69.99	56.94	87.38	98.00	93.00	110.00	43.00	60.00	90.00	179.00
Ni (ppm)	48.58	55.30	39.62	74.00	46.00	208.00	57.00	110.00	68.00	267.00
Cu (ppm)	32.37	35.49	28.21	49.00	37.00	127.00	59.00	106.00	45.00	194.00
Zn (ppm)	89.30	81.33	99.93	106.00	35.00	96.00	65.00	83.00	95.00	2056.00
Rb (ppm)	70.20	88.95	45.21	59.00	28.00	48.00	55.00	73.00	140.00	97.00
U (ppm)	4.75	5.30	4.01	10.50	30.00	15.50	10.90	14.80	3.70	28.00
Sr (ppm)	718.35	648.32	811.73	311.00	198.00	693.00	870.00	269.00	300.00	272.00
Zr (ppm)	76.05	91.86	54.97	100.00	31.00	97.00	62.00	72.00	160.00	88.00
Mo (ppm)	26.91	25.17	29.22	42.00	40.00	105.00	51.00	117.00	1.00	316.00
%MgO	1.04	1.13	0.91	1.97	0.76	2.52	1.70	2.16	2.60	1.81
%Al2O3	7.22	8.53	5.47	8.90	2.38	7.69	6.66	8.86	16.70	4.97
%SiO2	26.32	33.24	17.10	42.70	68.80	22.90	22.50	29.40	58.90	44.60
%P2O5	0.17	0.14	0.20	0.82	0.49	0.14	0.14	0.20	0.16	0.35
%K2O	1.49	1.89	0.94	1.53	0.58	1.18	1.26	1.67	3.60	1.19
%CaO	28.63	21.74	37.82	6.65	3.09	19.80	23.10	4.97	2.20	6.04
%TiO2	0.37	0.44	0.26	0.41	0.16	0.42	0.28	0.35	0.78	0.20
%Fe2O3	2.25	2.62	1.77	3.10	1.43	6.80	3.18	3.80	6.90	4.25

Comparisons between zone one and two and the AB-DEAD standards reveal that they are both most consistent with the Peru Margin, an upwelling environment. However, the difference in zone one between the Peru Margin and Black Sea Unit #1 is approximately 0.99 percent. This indicates that the depositional environment could be dominated by either upwelling or anoxic basin type conditions. Zone two is most consistent with the Peru Margin, an upwelling environment. In short, the geochemical signatures indicate that zone one could have been influenced by either an upwelling or anoxic basin type environment. Zone two was likely influenced by upwelling conditions.

Shell Oil Co. Leppard, J.A. #1 Drill Core



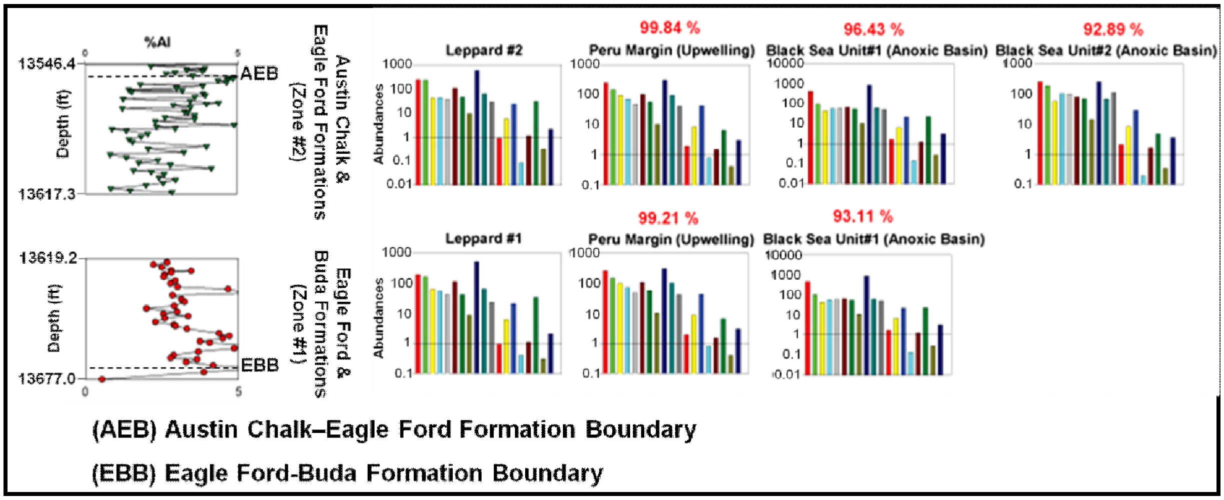
Aluminum Normalized DEAD Standards against the Shell Oil Co. Leppard, J.A. #1 Drill Core Data.

In the above figure comparisons are made between major and trace elements normalized to aluminum of both zones of the Shell Oil Co. Leppard, J.A. #1 Drill Core to the geochemical signature of their respective DEAD Standards. The DEAD Standards are as follows: Black Sea Unit #1 (Anoxic Basin) and Mediterranean Sapropels (Anoxic Basin). The geochemical signature of zone two is 93.09 percent consistent with Black Sea Unit #1 (Anoxic Basin). The geochemical signature of zone one is 84.65 consistent with Black Sea Unit #1 (Anoxic Basin).

Aluminum Normalized DEAD Standards and Shell Oil Co. Leppard, J.A. #1 Drill Core Data.

	Leppard Total (AVG)	Leppard Zone #2 (AVG)	Leppard Zone #1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
%Mg/Al	0.15	0.15	0.14	0.28	0.38	0.39	0.30	0.28	0.18	0.22
%Si/Al	2.58	2.49	2.65	4.33	30.20	2.65	3.08	2.98	3.11	7.36
%P /Al	0.03	0.05	0.01	0.10	0.17	0.02	0.02	0.02	0.01	0.05
%K/Al	0.23	0.24	0.22	0.28	0.39	0.25	0.30	0.30	0.34	0.28
%Ca/Al	5.98	6.13	5.87	1.50	2.00	4.07	5.15	0.77	0.18	2.15
%Ti/Al	0.05	0.05	0.05	0.05	0.08	0.06	0.05	0.04	0.05	0.05
%Fe/Al	0.37	0.37	0.37	0.45	0.80	1.22	0.65	0.57	0.55	0.77
Mn/Al ppm	56.71	48.73	61.99	52.00	28.00	202.00	129.00	56.00	96.00	125.00
V / Al ppm	76.82	56.95	89.96	38.00	126.00	139.00	29.00	44.00	15.00	271.00
Cr / Al ppm	18.47	18.65	18.36	24.40	72.00	28.30	12.20	28.80	10.20	41.40
Ni / Al ppm	18.46	17.82	18.88	20.20	41.00	2.90	16.70	24.50	7.70	65.20
Cu / Al ppm	15.02	14.18	15.58	11.60	32.00	33.10	17.60	23.70	5.10	43.80
Zn / Al ppm	42.58	36.67	46.50	24.00	29.00	25.00	19.00	18.00	11.00	459.00
Rb / Al ppm	16.53	13.77	18.36	12.30	22.00	12.10	15.60	15.70	16.00	18.10
U / Al ppm	3.52	2.93	3.91	2.30	28.60	4.10	3.20	3.30	0.42	6.40
Sr / Al ppm	227.44	184.91	255.58	86.00	181.00	200.00	271.00	59.00	34.00	106.00
Zr / Al ppm	24.66	21.02	27.07	21.00	25.20	24.00	18.00	15.00	18.00	18.00
Mo / Al ppm	10.88	7.73	12.97	10.60	37.00	27.90	14.70	26.20	0.15	61.40

Comparisons between zone one and two and the Al-DEAD standards (Figure 4.48) reveal them to both be most consistent with the Black Sea Unit #1. Zone one and two are 84.65 and 93.09 percent consistent, respectively. This may indicate that conditions were favorable for anoxic basin type environments.



Elemental and Oxide DEAD Standards against the Shell Oil Co. Leppard, J.A. #1 Drill Core Data.

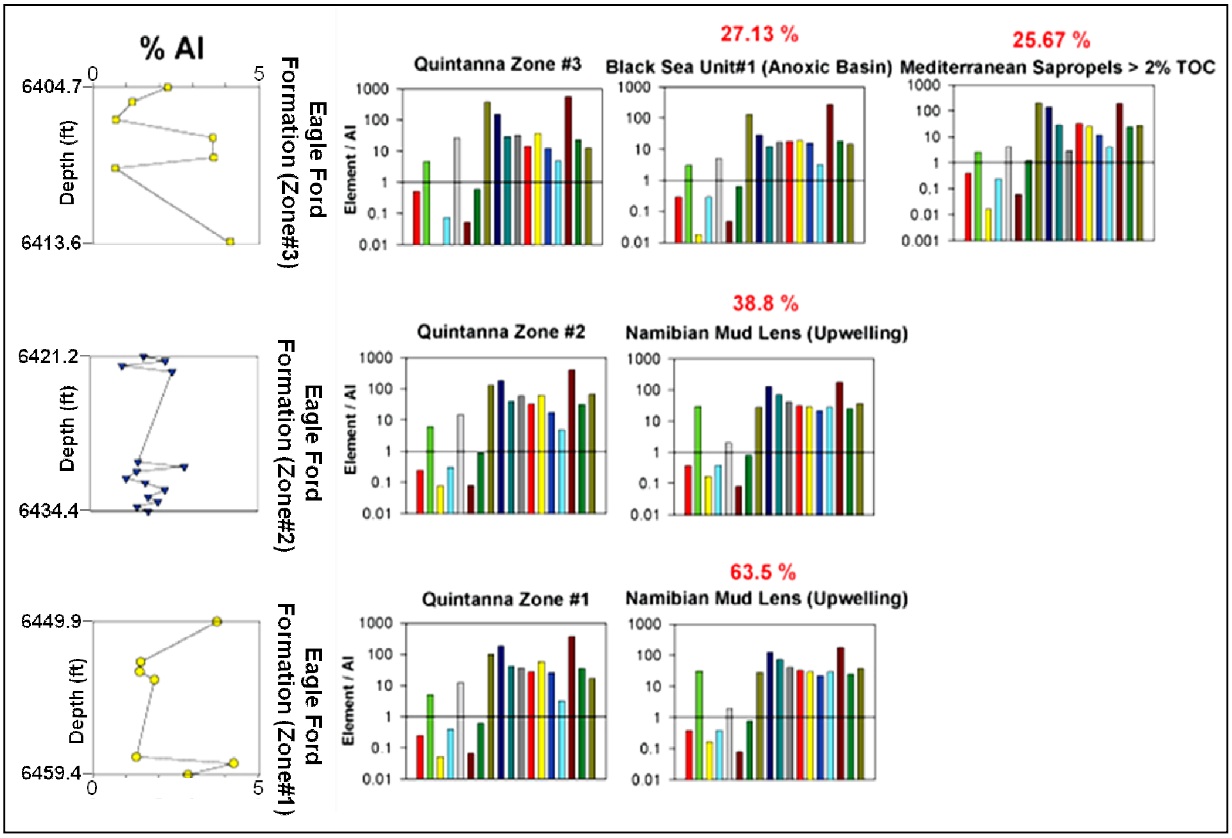
In the above figure comparisons are made between the elemental and oxide abundances of both zones of the Shell Oil Co. Leppard, J.A. #1 Drill Core to the geochemical signature of their respective DEAD Standards. The geochemical signature of zone two is 99.84 percent consistent with the Peru Margin (Upwelling), 96.43 percent consistent with the Black Sea Unit #1 (Anoxic Basin), and 92.89 percent consistent with Black Sea Unit #2 (Anoxic Basin). Zone one is 99.21 percent consistent with Peru Margin (Upwelling) and 93.11 percent consistent with the Black Sea Unit #1 (Anoxic Basin).

Elemental and Oxide DEAD Standards and the Shell Oil Co. Leppard, J.A. #1 Drill Core Data.

	Leppard Total (AVG)	Leppard Zone #2 (AVG)	Leppard Zone #1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels > 2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
Mn (ppm)	224.42	245.30	192.84	260.00	45.00	686.00	430.00	270.00	850.00	557.00
V (ppm)	213.22	243.28	167.77	152.00	138.00	518.00	100.00	196.00	130.00	1016.00
Cr (ppm)	51.96	43.23	65.18	98.00	93.00	110.00	43.00	60.00	90.00	179.00
Ni (ppm)	48.41	44.23	54.71	74.00	46.00	208.00	57.00	110.00	68.00	267.00
Cu (ppm)	39.13	37.16	42.10	49.00	37.00	127.00	59.00	106.00	45.00	194.00
Zn (ppm)	110.91	110.82	111.04	106.00	35.00	96.00	65.00	83.00	95.00	2056.00
Rb (ppm)	45.00	46.78	42.30	59.00	28.00	48.00	55.00	73.00	140.00	97.00
U (ppm)	9.20	9.46	8.80	10.50	30.00	15.50	10.90	14.80	3.70	28.00
Sr (ppm)	572.36	597.54	534.30	311.00	198.00	693.00	870.00	269.00	300.00	272.00
Zr (ppm)	66.76	67.30	65.93	100.00	31.00	97.00	62.00	72.00	160.00	88.00
Mo (ppm)	27.02	29.29	23.59	42.00	40.00	105.00	51.00	117.00	1.00	316.00
%MgO	0.96	0.94	0.84	1.97	0.76	2.52	1.70	2.16	2.60	1.81
%Al2O3	5.75	5.42	1.05	8.90	2.38	7.69	6.66	8.86	16.70	4.97
%SiO2	21.88	22.42	-0.07	42.70	68.80	22.90	22.50	29.40	58.90	44.60
%P2O5	0.24	0.12	-0.15	0.82	0.49	0.14	0.14	0.20	0.16	0.35
%K2O	1.09	1.06	1.14	1.53	0.58	1.18	1.26	1.67	3.60	1.19
%CaO	33.10	32.53	33.97	6.65	3.09	19.80	23.10	4.97	2.20	6.04
%TiO2	0.30	0.30	0.31	0.41	0.16	0.42	0.28	0.35	0.78	0.20
%Fe2O3	2.10	2.09	2.12	3.10	1.43	6.80	3.18	3.80	6.90	4.25

Concentrations of the AB-DEAD standards indicate that both zone one and zone two are most consistent with the Peru Margin, an upwelling-type dispositional environment. This contradicts the interpretation from the previous section, but is consistent with all the previous sections before that section.

Quintanna Halff et al # 1 Drill Core



Aluminum Normalized DEAD Standards against Quintanna Halff et al # 1 Drill Core Data.

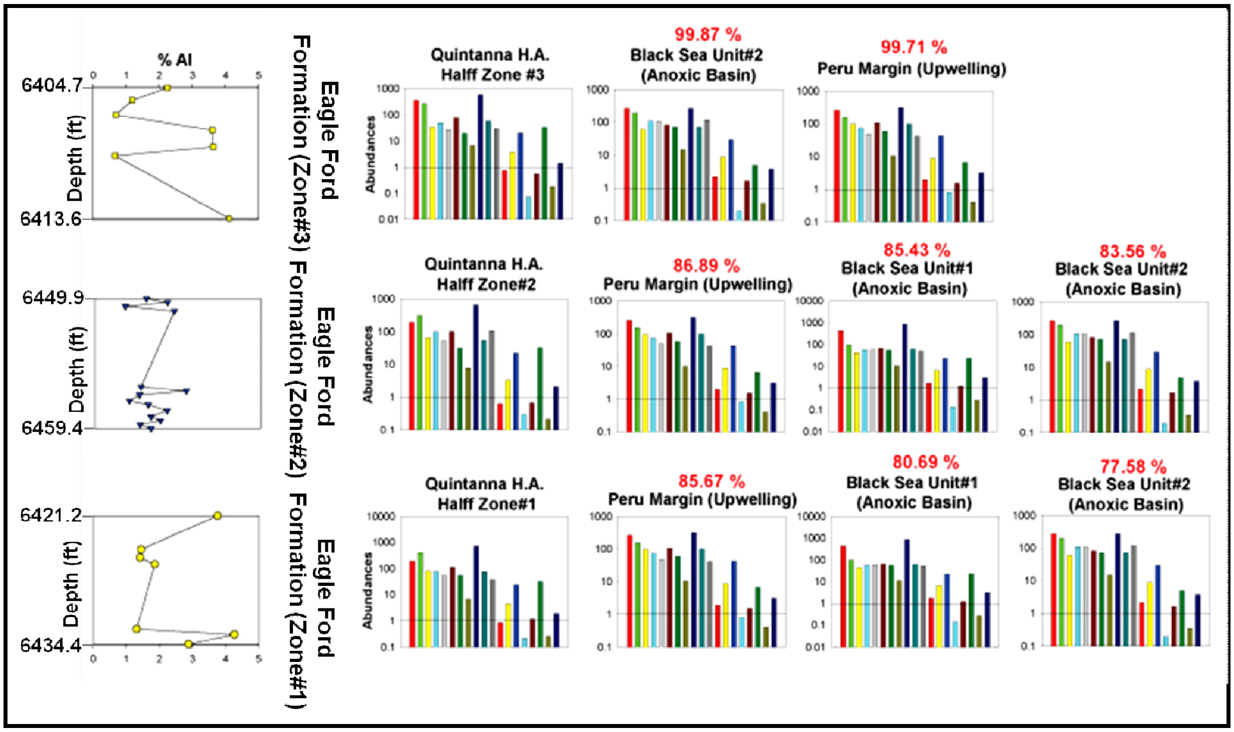
In the above figure comparisons are made between the major and trace elements normalized to aluminum of all the zones of the Quintanna H.A. Halff Core to the DEAD Standards. The geochemical signature of zone three is 27.13 percent consistent with the Black Sea Unit #1 (Anoxic Basin). Zone two is 38.8 percent consistent with the Namibian Mud Lens (Upwelling). Zone one is 63.5 percent consistent with the Namibian Mud Lens.

Aluminum Normalized DEAD Standards and Quintanna Halff et al # 1 Drill Core Data

	Quintanna H.A. Halff Total (AVG)	Quintanna H.A. Halff Zone#3 (AVG)	Quintanna H.A. Halff Zone#2 (AVG)	Quintanna H.A. Halff Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
%Mg/Al	0.33	0.52	0.25	0.25	0.28	0.38	0.39	0.30	0.28	0.18	0.22
%Si/Al	5.46	4.74	6.14	5.04	4.33	30.20	2.65	3.08	2.98	3.11	7.36
%P /Al	0.04	-0.03	0.07	0.05	0.10	0.17	0.02	0.02	0.02	0.01	0.05
%K/Al	0.26	0.07	0.30	0.40	0.28	0.39	0.25	0.30	0.30	0.34	0.28
%Ca/Al	17.74	26.41	14.81	12.47	1.50	2.00	4.07	5.15	0.77	0.18	2.15
%Ti/Al	0.07	0.05	0.08	0.07	0.05	0.08	0.06	0.05	0.04	0.05	0.05
%Fe/Al	0.74	0.62	0.87	0.62	0.45	0.80	1.22	0.65	0.57	0.55	0.77
Mn/Al ppm	199.78	387.00	129.00	101.00	52.00	28.00	202.00	129.00	56.00	96.00	125.00
V / Al ppm	175.45	151.24	184.18	189.12	38.00	126.00	139.00	29.00	44.00	15.00	271.00
Cr / Al ppm	36.99	29.08	40.11	40.92	24.40	72.00	28.30	12.20	28.80	10.20	41.40
Ni / Al ppm	45.89	32.58	59.05	36.66	20.20	41.00	2.90	16.70	24.50	7.70	65.20
Cu / Al ppm	25.89	14.55	32.59	27.06	11.60	32.00	33.10	17.60	23.70	5.10	43.80
Zn / Al ppm	53.11	38.02	60.84	57.06	24.00	29.00	25.00	19.00	18.00	11.00	459.00
Rb / Al ppm	17.93	12.28	17.97	25.10	12.30	22.00	12.10	15.60	15.70	16.00	18.10
U / Al ppm	4.41	4.83	4.77	3.15	2.30	28.60	4.10	3.20	3.30	0.42	6.40
Sr / Al ppm	449.88	565.66	408.07	384.62	86.00	181.00	200.00	271.00	59.00	34.00	106.00
Zr / Al ppm	29.75	22.81	31.97	34.22	21.00	25.20	24.00	18.00	15.00	18.00	18.00
Mo / Al ppm	38.67	12.42	66.38	17.01	10.60	37.00	27.90	14.70	26.20	0.15	61.40

The above figure and table demonstrate that zone one and two of the Leppard Core are most consistent with the Namibian Mud Lens, an upwelling type depositional environment. However, the geochemical signature departs from the Namibian Mud Lens further up the core.

Quintanna Halff et al # 1 Drill Core



Elemental and Oxide Abundance of DEAD Standards against the Quintanna Halff et al # 1 Drill Core.

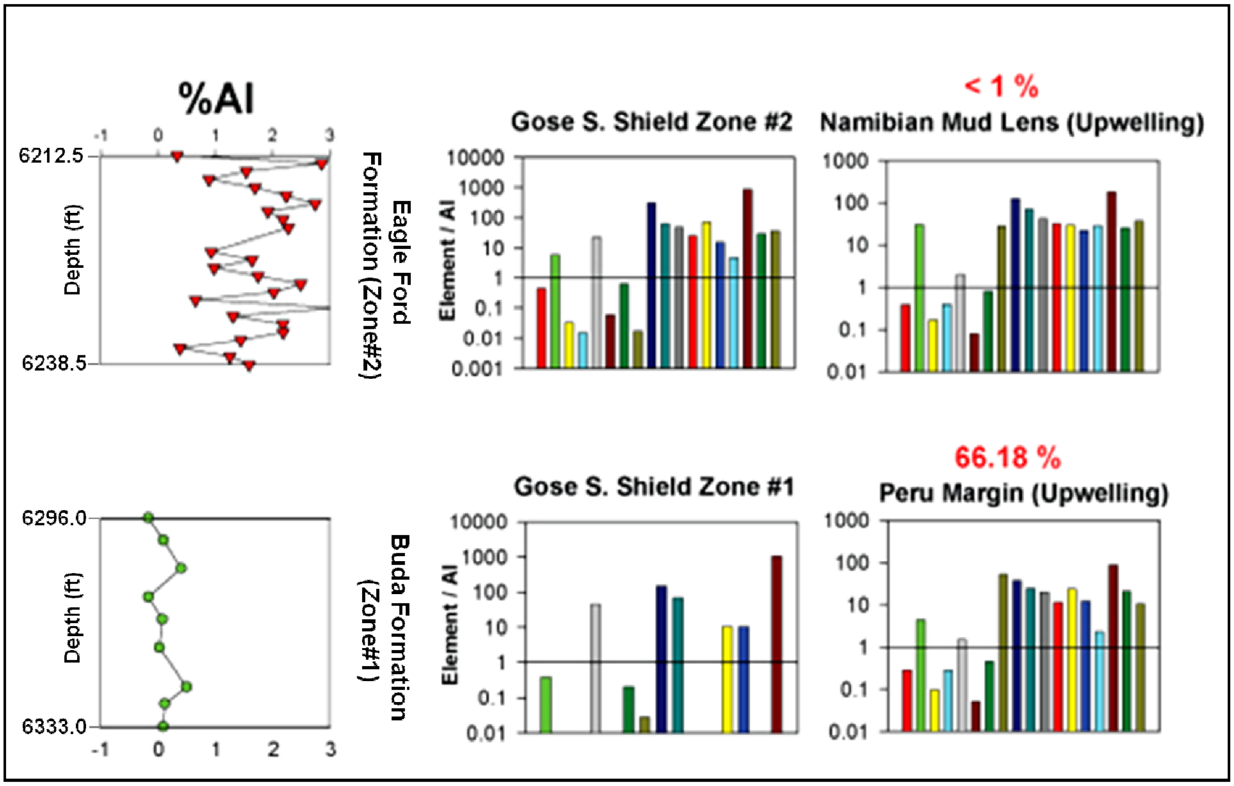
In the above figure comparisons between elemental and oxide abundances for all the zones of the Quintanna Halff et al # 1 Drill Core to their respective DEAD Standards. The geochemical signature of zone three is 99.87 percent consistent with Black Sea Unit #2 (Anoxic Basin) and 99.71 percent consistent with the Peru Margin (Upwelling). Zone two is 86.89 percent consistent with Peru Margin (Upwelling), 85.43 percent consistent with the Black Sea Unit #1 (Anoxic Basin) and 83.56 percent consistent with the Black Sea Unit #2 (Anoxic Basin). Zone one is 85.67 percent consistent with the Peru Margin (Upwelling), 80.69 percent consistent with Black Sea Unit #1, and 77.58 percent consistent with Black Sea Unit #2 (Anoxic Basin).

Elemental and Oxide DEAD Standards and the Quintanna Halff et al # 1 Drill Core.

	Quintanna H.A. Halff Total (AVG)	Quintanna H.A. Halff Zone#3 (AVG)	Quintanna H.A. Halff Zone#2 (AVG)	Quintanna H.A. Halff Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels > 2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
Mn (ppm)	249.15	368.66	198.41	197.00	260.00	45.00	686.00	430.00	270.00	850.00	567.00
V (ppm)	326.75	278.93	308.85	424.02	152.00	138.00	518.00	100.00	196.00	130.00	1016.00
Cr (ppm)	60.17	33.84	66.84	80.69	96.00	93.00	110.00	43.00	60.00	90.00	179.00
Ni (ppm)	80.43	49.82	101.22	78.22	74.00	46.00	208.00	57.00	110.00	68.00	267.00
Cu (ppm)	46.02	26.59	53.99	56.06	49.00	37.00	127.00	59.00	106.00	45.00	194.00
Zn (ppm)	97.19	74.98	103.42	113.29	106.00	35.00	96.00	65.00	83.00	95.00	2056.00
Rb (ppm)	33.08	19.87	31.30	53.63	59.00	28.00	48.00	55.00	73.00	140.00	97.00
U (ppm)	7.24	6.76	7.71	6.89	10.50	30.00	15.50	10.90	14.80	3.70	28.00
Sr (ppm)	659.78	607.40	662.48	721.72	311.00	198.00	693.00	870.00	269.00	300.00	272.00
Zr (ppm)	60.82	57.53	54.92	76.87	100.00	31.00	97.00	62.00	72.00	160.00	88.00
Mo (ppm)	68.26	29.31	108.68	37.51	42.00	40.00	105.00	51.00	117.00	1.00	316.00
%MgO	0.72	0.75	0.64	0.84	1.97	0.76	2.52	1.70	2.16	2.60	1.81
%Al2O3	3.74	3.74	3.31	4.58	8.90	2.38	7.69	6.66	8.96	16.70	4.97
%SiO2	22.07	20.50	22.27	23.70	42.70	68.80	22.90	22.50	29.40	58.90	44.60
%P2O5	0.21	0.07	0.30	0.22	0.82	0.49	0.14	0.14	0.20	0.16	0.35
%K2O	0.74	0.54	0.66	1.15	1.53	0.58	1.18	1.26	1.67	3.60	1.19
%CaO	32.43	33.57	32.01	31.83	6.65	3.09	19.30	23.10	4.97	2.20	6.04
%TiO2	0.22	0.19	0.22	0.26	0.41	0.16	0.42	0.28	0.35	0.78	0.20
%Fe2O3	1.86	1.46	2.11	1.90	3.10	1.43	6.80	3.18	3.00	6.90	4.25

The above figure demonstrates that zone one and two are most consistent with the Peru Margin, an upwelling type depositional environment. Zone three is most consistent with Black Sea Unit #1, an anoxic basin. However, it is nearly as consistent with the Namibian Mud Lens, an upwelling type depositional environment.

Gose & Shield Hassett #3 Drill Core



Aluminum Normalized DEAD Standards against Gose & Shield Hassett #3 Drill Core Data.

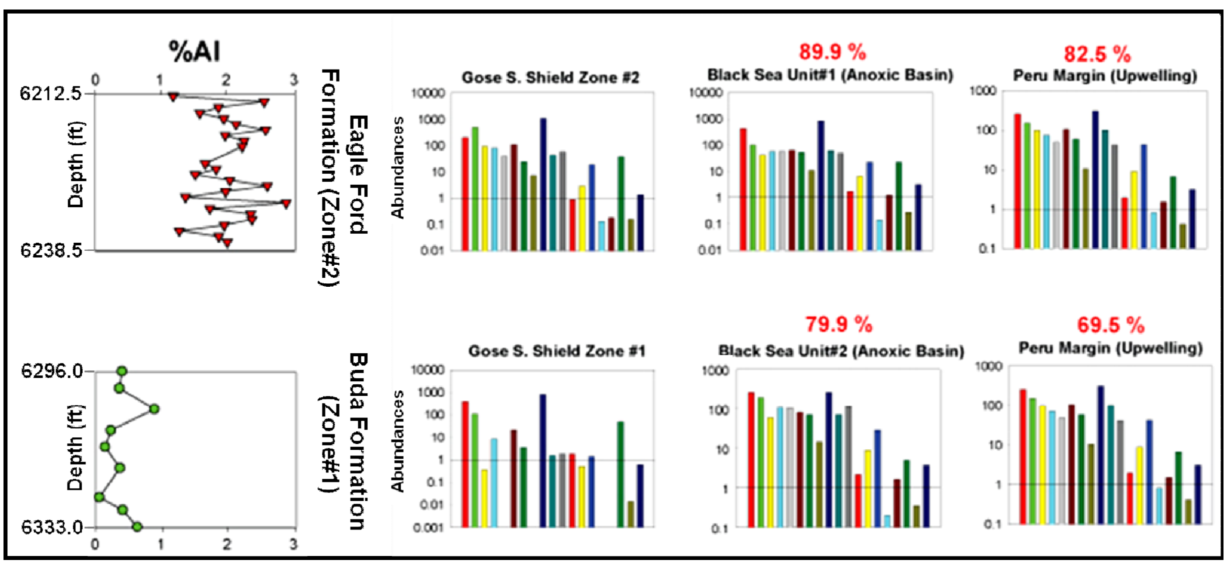
In the above figure and table comparisons are made between the major and minor elements normalized to aluminum of the Gose S. Shield Core to their respective DEAD Standards for Namibian Mud Lens (Upwelling) and the Peru Margin (Upwelling). The geochemical signature of zone two is less than one percent consistent with the Namibian Mud Lens (Upwelling). Zone one is 66.18 percent consistent with the Peru Margin (Upwelling).

Aluminum Normalized DEAD Standards and Gose & Shield Hassett #3 Drill Core Data.

	Gose S. Shield Total (AVG)	Gose S. Shield Zone#2 (AVG)	Gose S. Shield Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
%Mg/Al	-0.10	0.46	-1.65	0.28	0.38	0.39	0.30	0.28	0.18	0.22
%Si/Al	4.45	5.91	0.38	4.33	30.20	2.65	3.08	2.98	3.11	7.36
%P /Al	-0.10	0.03	-0.48	0.10	0.17	0.02	0.02	0.02	0.01	0.05
%K/Al	-0.21	0.02	-0.82	0.28	0.39	0.25	0.30	0.30	0.34	0.28
%Ca/Al	28.47	22.26	45.71	1.50	2.00	4.07	5.15	0.77	0.18	2.15
%Ti/Al	0.04	0.06	-0.01	0.05	0.08	0.06	0.05	0.04	0.05	0.05
%Fe/Al	0.53	0.64	0.20	0.45	0.80	1.22	0.65	0.57	0.55	0.77
Mn/Al ppm	201.46	175.05	274.83	52.00	28.00	202.00	129.00	56.00	96.00	125.00
V / Al ppm	276.88	323.15	148.33	38.00	126.00	139.00	29.00	44.00	15.00	271.00
Cr / Al ppm	64.78	62.80	70.26	24.40	72.00	28.30	12.20	28.80	10.20	41.40
Ni / Al ppm	12.51	48.14	-86.48	20.20	41.00	2.90	16.70	24.50	7.70	65.20
Cu / Al ppm	9.60	25.14	-33.58	11.60	32.00	33.10	17.60	23.70	5.10	43.80
Zn / Al ppm	55.04	71.07	10.52	24.00	29.00	25.00	19.00	18.00	11.00	459.00
Rb / Al ppm	13.85	15.15	10.24	12.30	22.00	12.10	15.60	15.70	16.00	18.10
U / Al ppm	-2.61	4.54	-22.48	2.30	28.60	4.10	3.20	3.30	0.42	6.40
Sr / Al ppm	912.74	859.68	1060.13	86.00	181.00	200.00	271.00	59.00	34.00	106.00
Zr / Al ppm	14.46	29.16	-26.38	21.00	25.20	24.00	18.00	15.00	18.00	18.00
Mo / Al ppm	25.33	35.35	-2.53	10.60	37.00	27.90	14.70	26.20	0.15	61.40

The above figure and table demonstrates that zone one is 66.18 percent consistent with the Peru Margin, an upwelling type depositional environment. Zone two is less than one percent consistent with the Namibian Mud Lens, an upwelling type depositional environment.

Gose & Shield Hassett #3 Drill Core



Elemental and Oxide DEAD Standards against Gose & Shield Hassett #3 Drill Core.

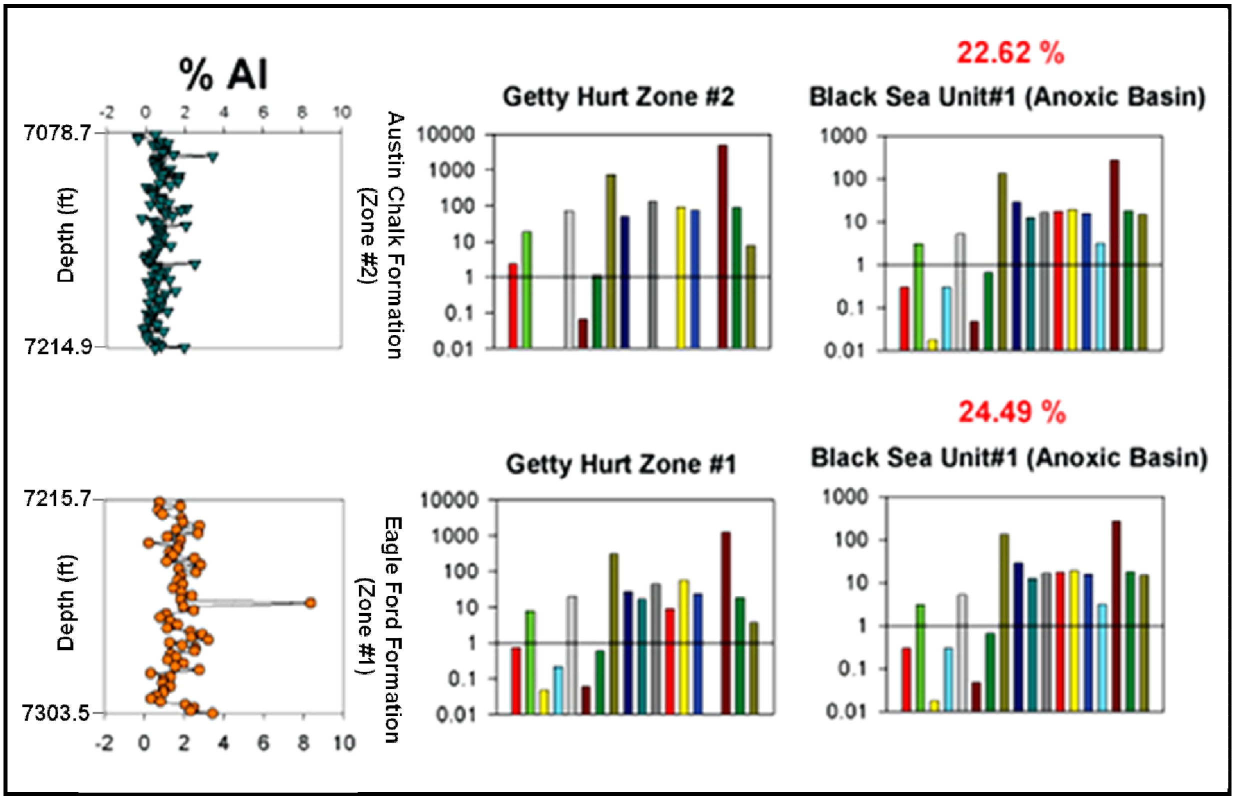
In the above figure comparisons are made between elemental and oxide abundances of both zones of the Gose & Shield Hassett #3 Drill Core to their respective DEAD Standards. The geochemical signature of zone two is 89.9 percent consistent with the Black Sea Unit #1 (Anoxic Basin) and 82.5 percent consistent with the Peru Margin (Upwelling). Zone one is 79.9 percent consistent with Black Sea Unit #2 (Anoxic Basin) and 69.5 percent consistent with the Peru Margin (Upwelling).

Elemental and Oxide DEAD Standards and the Gose & Shield Hassett #3 Drill Core Data.

	Gose S. Shield Total (AVG)	Gose S. Shield Zone#2 (AVG)	Gose S. Shield Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
Mn (ppm)	249.13	200.66	383.75	260.00	45.00	686.00	430.00	270.00	850.00	557.00
V (ppm)	394.82	496.54	112.27	152.00	138.00	518.00	100.00	196.00	130.00	1016.00
Cr (ppm)	66.37	90.13	0.37	98.00	93.00	110.00	43.00	60.00	90.00	179.00
Ni (ppm)	59.97	78.47	8.58	74.00	46.00	208.00	57.00	110.00	68.00	267.00
Cu (ppm)	29.32	40.12	-0.69	49.00	37.00	127.00	59.00	106.00	45.00	194.00
Zn (ppm)	85.08	108.03	21.32	106.00	35.00	96.00	65.00	83.00	95.00	2056.00
Rb (ppm)	18.98	24.49	3.66	59.00	28.00	48.00	55.00	73.00	140.00	97.00
U (ppm)	5.18	7.34	-0.83	10.50	30.00	15.50	10.90	14.80	3.70	28.00
Sr (ppm)	1012.29	1075.10	837.84	311.00	198.00	693.00	870.00	269.00	300.00	272.00
Zr (ppm)	33.01	44.34	1.55	100.00	31.00	97.00	62.00	72.00	160.00	88.00
Mo (ppm)	42.46	57.09	1.81	42.00	40.00	105.00	51.00	117.00	1.00	316.00
%MgO	1.11	0.87	1.79	1.97	0.76	2.52	1.70	2.16	2.60	1.81
%Al2O3	2.27	2.91	0.51	8.90	2.38	7.69	6.66	8.86	16.70	4.97
%SiO2	14.63	19.39	1.41	42.70	68.80	22.90	22.50	29.40	58.90	44.60
%P2O5	0.05	0.13	-0.18	0.82	0.49	0.14	0.14	0.20	0.16	0.35
%K2O	-0.04	0.18	-0.66	1.53	0.58	1.18	1.26	1.67	3.60	1.19
%CaO	40.80	37.87	48.94	6.65	3.09	19.80	23.10	4.97	2.20	6.04
%TiO2	0.12	0.16	0.01	0.41	0.16	0.42	0.28	0.35	0.78	0.20
%Fe2O3	1.15	1.35	0.61	3.10	1.43	6.80	3.18	3.80	6.90	4.25

The above figure and table demonstrates that zone one is most consistent with the Black Sea Unit #2, an anoxic basin. Zone two is most consistent with Black Sea Unit #1, also an anoxic basin.

Getty Lloyd Hurt #1 Drill Core



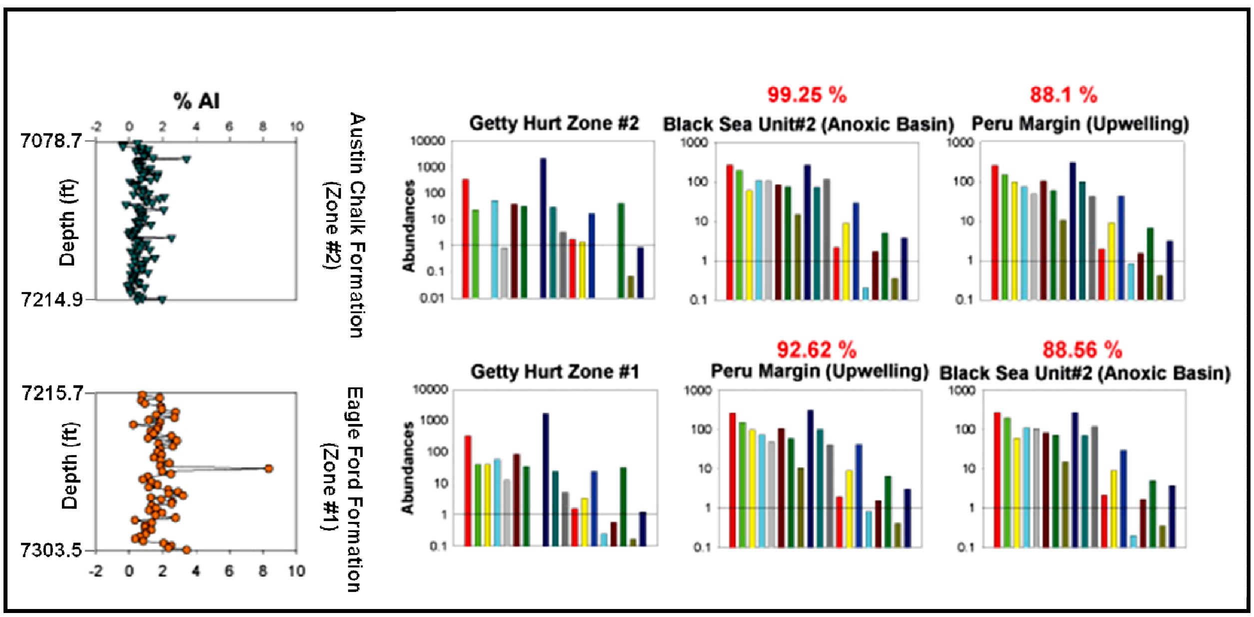
Aluminum Normalized DEAD Standards against Getty Lloyd Hurt #1 Drill Core Data.

In the above figure comparisons are made between major and trace elements normalized to aluminum of both zones of the Getty Hurt Core to their respective DEAD Standards. The geochemical signature of zone two is 22.62 percent consistent with the Black Sea Unit #1 (Anoxic Basin) and zone one is 24.49 percent consistent with the Black Sea Unit #1 (Anoxic Basin).

Aluminum Normalized DEAD Standards and Getty Lloyd Hurt #1 Drill Core Data.

	Getty Hurt Total (AVG)	Getty Hurt Zone#2 (AVG)	Getty Hurt Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
%Mg/Al	1.72	2.33	0.74	0.28	0.38	0.39	0.30	0.28	0.18	0.22
%Si/Al	14.62	18.73	7.96	4.33	30.20	2.65	3.08	2.98	3.11	7.36
%P /Al	-0.27	-0.47	0.05	0.10	0.17	0.02	0.02	0.02	0.01	0.05
%K/Al	-0.35	-0.70	0.22	0.28	0.39	0.25	0.30	0.30	0.34	0.28
%Ca/Al	52.37	72.52	19.71	1.50	2.00	4.07	5.15	0.77	0.18	2.15
%Ti/Al	0.06	0.07	0.06	0.05	0.08	0.06	0.05	0.04	0.05	0.05
%Fe/Al	0.92	1.12	0.59	0.45	0.80	1.22	0.65	0.57	0.55	0.77
Mn/Al ppm	561.23	716.00	311.00	52.00	28.00	202.00	129.00	56.00	96.00	125.00
V / Al ppm	41.03	49.34	27.56	38.00	126.00	139.00	29.00	44.00	15.00	271.00
Cr / Al ppm	-102.17	-175.53	16.77	24.40	72.00	28.30	12.20	28.80	10.20	41.40
Ni / Al ppm	100.48	135.59	43.56	20.20	41.00	2.90	16.70	24.50	7.70	65.20
Cu / Al ppm	1.63	-3.03	9.19	11.60	32.00	33.10	17.60	23.70	5.10	43.80
Zn / Al ppm	78.14	90.94	57.40	24.00	29.00	25.00	19.00	18.00	11.00	459.00
Rb / Al ppm	55.95	75.72	23.90	12.30	22.00	12.10	15.60	15.70	16.00	18.10
U / Al ppm	-10.32	-14.49	-3.55	2.30	28.60	4.10	3.20	3.30	0.42	6.40
Sr / Al ppm	3499.05	4890.42	1243.35	86.00	181.00	200.00	271.00	59.00	34.00	106.00
Zr / Al ppm	61.26	87.73	18.37	21.00	25.20	24.00	18.00	15.00	18.00	18.00
Mo / Al ppm	6.28	7.91	3.63	10.60	37.00	27.90	14.70	26.20	0.15	61.40

Zone one and zone two is both most consistent with the Black Sea Unit #1, an anoxic basin. They are 22.62 and 24.49 percent consistent, respectively.



Elemental and Oxide DEAD Standards against the Getty Lloyd Hurt #1 Drill Core Data.

In the above figure comparisons are made between elemental and oxide abundances of both zones of the Getty Hurt Core to their respective DEAD Standards. The geochemical signature of zone two is 99.25 percent consistent with the Black Sea Unit #2 (Anoxic Basin) and 88.1 percent consistent with the Peru Margin (Upwelling). Zone one is 92.62 percent consistent with the Peru Margin (Upwelling) and 88.56 percent consistent with the Black Sea Unit #2 (Anoxic Basin).

Elemental and Oxide DEAD Standards and the Getty Lloyd Hurt #1 Drill Core Data.

	Getty Hurt Total (AVG)	Getty Hurt Zone#2 (AVG)	Getty Hurt Zone#1 (AVG)	Peru Margin (Upwelling)	Namibian Mud Lens (Upwelling)	Mediterranean Sapropels >2% TOC	Black Sea Unit #1 (Anoxic Basin)	Black Sea Unit #2 (Anoxic Basin)	Average Shale	C/T Mean
Mn (ppm)	335.79	341.86	325.95	260.00	45.00	686.00	430.00	270.00	850.00	557.00
V (ppm)	29.89	23.26	40.65	152.00	138.00	518.00	100.00	196.00	130.00	1016.00
Cr (ppm)	-18.88	-55.13	39.87	98.00	93.00	110.00	43.00	60.00	90.00	179.00
Ni (ppm)	54.18	53.02	56.07	74.00	46.00	208.00	57.00	110.00	68.00	267.00
Cu (ppm)	5.26	0.83	12.44	49.00	37.00	127.00	59.00	106.00	45.00	194.00
Zn (ppm)	56.12	39.20	83.54	106.00	35.00	96.00	65.00	83.00	95.00	2056.00
Rb (ppm)	33.17	32.02	35.03	59.00	28.00	48.00	55.00	73.00	140.00	97.00
U (ppm)	-7.06	-8.30	-5.03	10.50	30.00	15.50	10.90	14.80	3.70	28.00
Sr (ppm)	1965.18	2146.44	1671.32	311.00	198.00	693.00	870.00	269.00	300.00	272.00
Zr (ppm)	27.33	29.31	24.11	100.00	31.00	97.00	62.00	72.00	160.00	88.00
Mo (ppm)	3.98	3.25	5.16	42.00	40.00	105.00	51.00	117.00	1.00	316.00
%MgO	1.68	1.73	1.61	1.97	0.76	2.52	1.70	2.16	2.60	1.81
%Al2O3	2.12	1.34	3.38	8.90	2.38	7.69	6.66	8.86	16.70	4.97
%SiO2	19.59	17.14	23.56	42.70	68.80	22.90	22.50	29.40	58.90	44.60
%P2O5	-0.03	-0.20	0.25	0.82	0.49	0.14	0.14	0.20	0.16	0.35
%K2O	0.11	-0.18	0.58	1.53	0.58	1.18	1.26	1.67	3.60	1.19
%CaO	37.65	41.24	31.84	6.65	3.09	19.80	23.10	4.97	2.20	6.04
%TiO2	0.10	0.07	0.17	0.41	0.16	0.42	0.28	0.35	0.78	0.20
%Fe2O3	0.99	0.86	1.22	3.10	1.43	6.80	3.18	3.80	6.90	4.25

The deposition of zone one is most consistent with the Peru Margin, an upwelling type depositional environment. The deposition of zone two is most consistent the Black Sea Unit #2, an anoxic basin.

APPENDIX C

CALCULATIONS: ENRICHMENT FACTORS AND OXIDE CONCENTRATIONS

$$\frac{\dfrac{\text{Your Trace Element Sample} \quad X}{\text{Your Aluminum Sample} \quad Al}}{\dfrac{\text{Average Trace Element Abundance} \quad X}{\text{Average Aluminum Abundance} \quad Al}}$$

(Tribovillard et al, 2006)

Element	ppm	X/Al
Al	88400	----
V	130	0.001470588
Cr	90	0.0010181
Mn	1100	0.012443439
Fe	48300	0.54638009
S	2400	0.027149321
Ni	68	0.000769231
Cu	45	0.00050905
Zn	95	0.001074661
Mo	1.3	1.47059E-05
U	3.7	4.18552E-05
P	700	0.007918552

(Wedepohl, 1971, 1991)

A sample is Enriched if the result is greater than 1 — EF > 1

A sample is Depleted if the result is less than 1 — EF < 1

How to calculate the enrichment factor of a sample:

(Example)

$$\frac{\dfrac{\text{Your Trace Element Sample} \quad 15\ \text{Mo ppm}}{\text{Your Aluminum Sample} \quad 39570\ \text{Al ppm}}}{\dfrac{\text{Average Trace Element Abundance} \quad 1.3\ \text{Mo ppm}}{\text{Average Aluminum Abundance} \quad 88400\ \text{Al ppm}}} \quad \frac{0.000379}{0.0000147} = 25.78 \text{ Unitless Value}$$

25.78 EF Mo

Elemental Oxide	Elemental Oxide Formula	Corresponding Element	%
Aluminum Oxide	Al_2O_3	Al	0.5292
Calcium Oxide	CaO	Ca	0.7147
Silicon Dioxide	SiO_2	Si	0.4675

Al_2O_3 - Aluminium Oxide = Clay Proxy
CaO - Calcium Oxide = Carbonate Proxy
SiO_2 - Silicon Dioxide = Quartz

How to calculate the elemental oxide of a sample:

Your Element Sample → $\frac{\text{Element \%}}{\text{Element Weight Fraction}} = \text{Oxide \%}$

Example)

$$\frac{\text{Al \%}}{\text{Wt Fraction}} \rightarrow \frac{3.4\ \%}{0.5292\ \%} = 6.4\ \%\ Al_2O_3$$

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BIOGRAPHICAL INFORMATION

Timothy (Jak) J. Kearns was primarily raised in Nacogdoches, Texas, and graduated from Nacogdoches High School in 2001. He attended Stephen F. Austin State University for one year. At the age of 20 he enlisted with the rank of Private First Class to serve in the United States Army Reserve as a Combat Engineer (12B). After Basic Training and Advanced Individual Training (AIT) he was assigned to the 420th Engineering Brigade.

Shortly after being assigned he was activated for Operation Enduring Freedom and was cross leveled to the 489th Engineering Battalion, and served in a line platoon. As the Iraq War approached he was reassigned with the campaign identified as Operation Iraqi Freedom. In the Iraq Theater he was attached to the 130th Engineer Brigade, 3rd of the 3rd Armored Cavalry Regiment, and the 82nd Airborne Division.

During this deployment he developed an interest in strategy, but in particular strategy as it must be formulated according to terrain and environmental conditions. Military activities have been and shall be in the foreseeable future linked to geosciences. As such interest in geology was driven largely as means of conducting warfare. This is particularly relevant in regard to movement and logistical support over geologically unstable terrain.

Jak enrolled at Sam Houston State University in 2004 and received a Bachelors of Science degree in Geology in 2008. He attributes much of his success in that endeavor to the discipline he had incorporated in his life in the military and enhanced during the pursuit of his Certified Black Belt in Hapkido. In 2009 he enrolled in the Earth and Environmental Sciences graduate program at the University of Texas at Arlington.