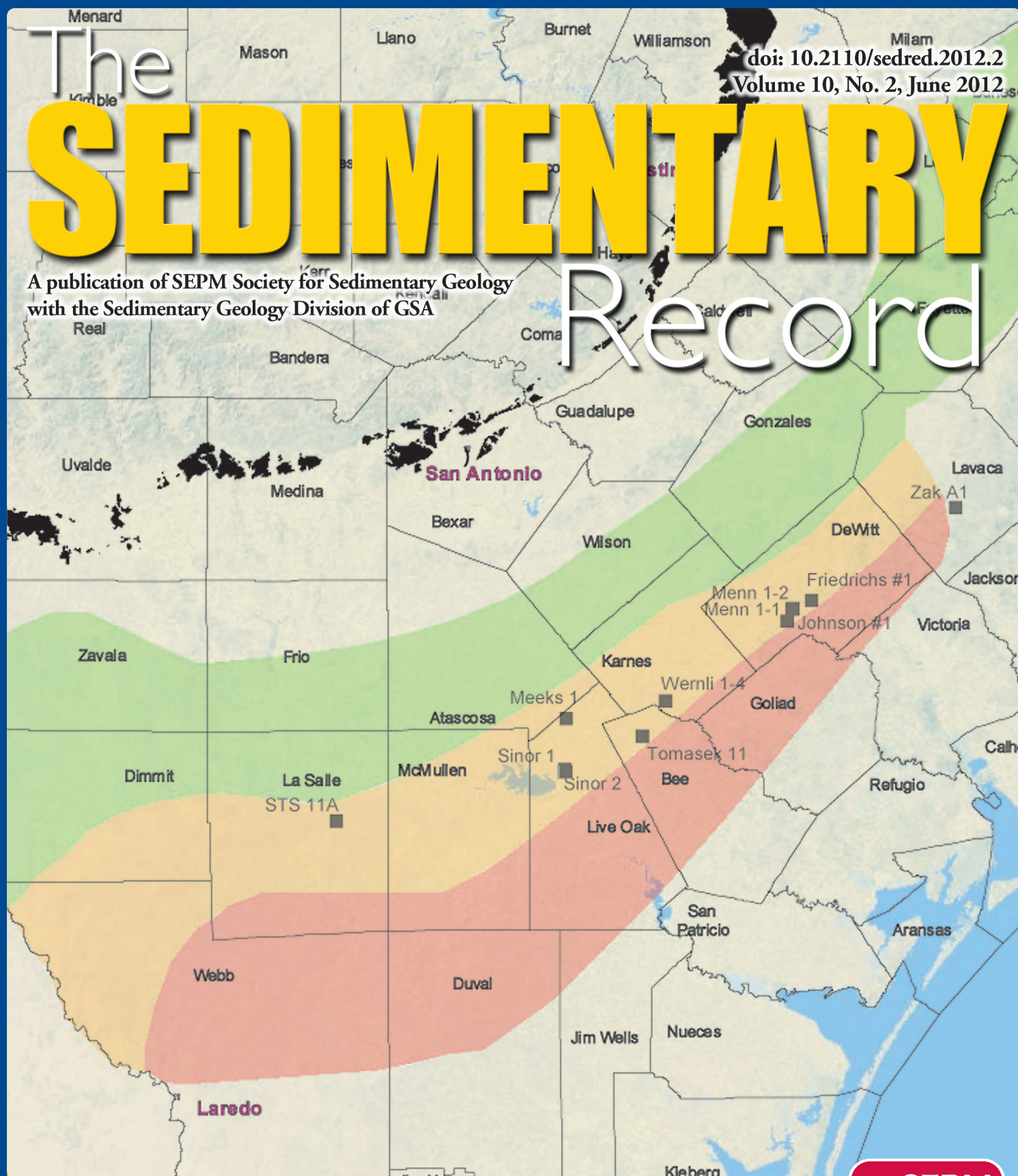


The SEDIMENTARY Record

A publication of SEPM Society for Sedimentary Geology
with the Sedimentary Geology Division of GSA

doi: 10.2110/sedred.2012.2
Volume 10, No. 2, June 2012



INSIDE: APPLICATION OF INORGANIC WHOLE-ROCK
GEOCHEMISTRY TO SHALE RESOURCE PLAYS: AN EXAMPLE
FROM THE EAGLE FORD SHALE FORMATION, TEXAS
PLUS:
PRESIDENT'S COMMENTS, NEW COUNCILOR POSITIONS



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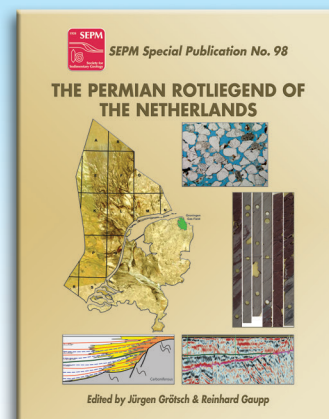
The Permian Rotliegend of the Netherlands

Edited by: Jürgen Grötsch and Reinhard Gaupp

More than 50 years ago, the discovery of the giant Groningen Gas Field in the subsurface of the Netherlands by NAM B.V. marked a turning point in the Dutch and European energy market initiating the replacement of coal by gas. Despite the fact that the Rotliegend dryland deposits in the Southern Permian Basin are one of Europe's most important georesources, no sedimentological overview is available to date for the subsurface of the Netherlands. This SEPM Special Publication presents for the first time such a summary of the present-day knowledge, including a comprehensive core atlas from on- and offshore wells. The latter is closely linked to the series of papers in the volume itself, essentially providing a reference handbook for "The Permian Rotliegend of the Netherlands". Progress as a result of many scientific and consultancy studies in the Rotliegend reservoirs is summarized in this volume, with contributions covering paleogeography, depositional environment, stratigraphy, diagenesis, structural geology as well as pressure and fluid distribution in the subsurface.

The title page illustrates a typical subsurface workflow to arrive at a conceptual geological model for hydrocarbon reservoirs. As a backdrop to the map of the Netherlands, a satellite image from Lake Eyre Basin in Australia is used, one of the closest present day analogues to the Southern Permian Basin depositional environments, albeit, much smaller in size (satellite image courtesy of Google Earth). Seismic cross section, depositional model, core photo, and thin section microphotograph of a good quality reservoir sandstone in the Rotliegend depict essential sources of information to develop reliable conceptual reservoir models for the subsurface. Supporting this is one of the objectives of SEPM SP 98.

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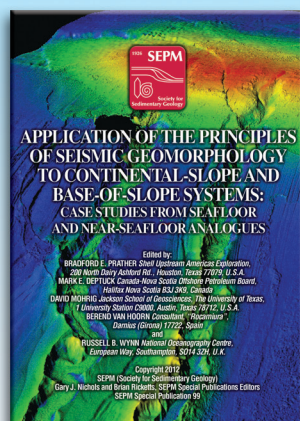
Application of the Principles of Seismic Geomorphology to Continental Slope and Base-of-slope Systems: Case Studies from Seafloor and Near-Seafloor Analogues

Edited by: Bradford E. Prather, Mark E. Deptuck, David Mohrig, Berend van Hoorn and Russell B. Wynn

SEPM's newest publication is now available both on line and on high-resolution CD. Thanks to sponsorship from Shell this publication is free access and available for viewing at the SEPM online web site. The free access online version contains down-sample PDF files to allow for ease of download. The CD version contains the high-resolution files and is available for purchase at reduced pricing at the SEPM Bookstore.

The study of near-seafloor deepwater landscapes and the processes that form them are as important to the understanding of deeply buried marine depositional systems as the study of modern fluvial environments is to our understanding of ancient terrestrial depositional systems. In fact, these near-seafloor studies follow in the great tradition established by earlier clastic sedimentologists in the use of modern systems to understand ancient environments. The acquisition and mapping of exploration 3D seismic surveys over the last few decades allows for the study of seafloor geomorphology with a spatial resolution comparable to most deepwater multibeam bathymetric tools, and represents a significant advancement that can be used to push forward general understanding of slope and base-of-slope depositional systems through the application of the emerging science of seismic geomorphology. The papers assembled for this volume demonstrate the utility of seafloor-to-shallow subsurface data sets in studying the development of submarine landscapes and their affiliated sedimentary deposits. These contributions highlight the controls of slope morphology on patterns of both sedimentation and erosion. Many of the papers also highlight the influence of pre-existing seafloor relief on confining sediment-gravity flows specific transport pathways, thereby affecting subsequent evolution of the seafloor. The understanding of depositional processes that comes from studying deepwater analogue systems remains the best way take to knowledge from one basin or system and apply confidently to another for prediction and characterization of reservoirs for exploration and production of hydrocarbons.

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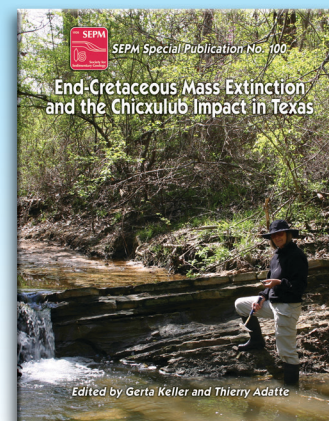
Special Publication #100

The End-Cretaceous Mass Extinction and the Chicxulub Impact in Texas

Edited by: Gerta Keller and Thierry Adatte

One of the liveliest, contentious, and long-running scientific debates began over three decades ago with the discovery of an iridium anomaly in a thin clay layer at Gubbio, Italy, that led to the hypothesis that a large impact caused the end-Cretaceous mass extinction. For many scientists the discovery of an impact crater near Chicxulub on Yucatán in 1991 all but sealed the impact-kill hypothesis as proven with the impact as sole cause for the mass extinction. Ever since that time evidence to the contrary has generally been interpreted as an impact-tsunami disturbance. A multi-disciplinary team of researchers has tested this assertion in new cores and a dozen outcrops along the Brazos River, Texas. In this area undisturbed sediments reveal a complete time stratigraphic sequence containing the primary impact spherule ejecta layer in late Maastrichtian claystones deposited about 200–300 thousand years before the mass extinction. About 60 cm above this level is a submarine channel with lithified spherule-rich clasts at the base followed by two to three reworked impact spherule layers and topped by sandstones. Above this channel deposit late Maastrichtian claystone deposition resumed followed by the KT boundary mass extinction. Brazos River sections thus show three events separated by time—the Chicxulub impact, the reworked spherule layers in a submarine channel, and the KTB mass extinction. In this volume a multi-disciplinary team of researchers from the USA, Switzerland, Germany, and Israel carefully documents this evidence based on paleontology, sedimentology, sequence stratigraphy, mineralogy, isotope geochemistry, trace and platinum group element geochemistry. The results are presented in a series of twelve articles with data tables and supplementary material.

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Application of inorganic whole-rock geochemistry to shale resource plays: an example from the Eagle Ford Shale Formation, Texas.

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doi: 10.2110/sedred.2012.2.4

ABSTRACT

Shale resource plays continue to be the most actively explored and developed hydrocarbon plays in North America. However, despite the intense activity surrounding the shale plays, understanding the controls on reservoir quality and successfully exploiting shale formations remains challenging. Using examples primarily from the Eagle Ford Formation, this paper demonstrates how inorganic whole-rock geochemical data can be used to help with the development of shale plays. Elemental data are used to provide regional stratigraphic correlations and provide sufficiently high resolution characterization to enable horizontal well-bores to be related back to pilot holes. The same elemental data used for chemostratigraphy can also be used to model mineralogy and total organic carbon, determine paleoredox facies and provide information on the formation brittleness, all valuable information in the exploitation of shale resource plays. The methodologies demonstrated here in the Eagle Ford Shale Formation have been used extensively in other North American shale plays and are readily applicable to any of the newly emerging shale gas resource play around the World.

INTRODUCTION

Over the past few years shale resource plays have become increasingly important hydrocarbon targets. In the USA, formations such as the Marcellus Formation, the Haynesville Formation and the Eagle Ford Formation have become major hydrocarbon exploration targets, with over 270 rigs active in the Eagle Ford Formation in April 2012. However, the fine grained, macro-scale homogeneity of many shale plays currently being exploited has negated some of the more traditional approaches to reservoir characterization and stratigraphic correlation, resulting in the search for new methodologies that enable better understanding of shale reservoirs. Here, the application and potential of one approach is demonstrated, namely the application of inorganic whole-rock geochemical data to shale resource plays. Inorganic whole-rock data from the Eagle Ford Formation are used to create a regional chemostratigraphic correlation framework, model bulk mineralogy, model total organic carbon (TOC) data, better understand paleoredox conditions and provide information on relative rock brittleness, which are all aspects that are key to understanding shale reservoirs.

Inorganic whole-rock geochemical data have been used to define stratigraphic correlations in the petroleum industry for over a decade

(Ratcliffe et al. 2010 and references cited therein). The stratigraphic technique of chemostratigraphy relies upon recognizing changes in element concentrations through time and using those to model changes with respect to geological events, such as paleoclimate (Pearce et al. 2005, Ratcliffe et al. 2010) and provenance (Ratcliffe et al. 2007, Wright et al. 2010). Published accounts using this approach are largely on fluvial successions, where stratigraphic correlation using traditional techniques are often problematic (e.g. Pearce et al. 2005, Ratcliffe et al. 2006, Ratcliffe et al. 2010, Wright et al. 2010, Hildred et al. 2010). Over the same decade, inorganic whole-rock geochemical datasets have routinely been acquired from organic-rich mudrocks, the data typically being used to help elucidate paleoredox conditions during oceanic anoxic events (e.g. Tribouillard et al. 2006, Turgen and Brumsack 2006, Tribouillard et al. 2008, Negri et al. 2009, Jenkyns 2010). Here, approaches of the chemostratigraphic workers and the oceanic anoxic event workers are combined and pragmatically applied to shale gas plays.

METHODOLOGY AND DATASET

The Eagle Ford Formation is a dark grey, calcareous, locally organic-rich mudstone of Cenomanian – Turonian age between the Cenomanian-age Buda Formation and the Coniacian-Santonian-age Austin Chalk Formation (Figure 1). The study area, in south Texas, forms a narrow strip that extends from La Salle County in the SW to Lavaca County in the NE, a distance of >150 miles (241 km) (Figure 2). Over this distance, the Eagle Ford Shale Formation varies in thickness from approximately 75ft to 300ft (23 to 91 m).

For this paper, over 500 samples from 11 wells have been analysed using inductively coupled plasma optical emission (ICP-OES) and mass spectrometry (ICP-MS), following a Li-metaborate fusion procedure (Jarvis and Jarvis 1995). These preparation and analytical methods provide data for 10 major elements, 25 trace elements and 14 rare-earth elements. Precision error for the major-element data is generally better than 2%, and is around 3% for the high abundance trace-element data derived by ICP-OES (Ba, Cr, Sc, Sr, Zn and Zr). The remaining trace elements are determined from the ICP-MS and data are generally less precise, with precision error in the order of 5%.

APPLICATIONS

Regional stratigraphic characterization and correlation

Developing stratigraphic frameworks is the key to the exploration for and exploitation of any hydrocarbon-bearing basin. In shale plays, the more traditional methods to stratigraphic correlations used by the petroleum industry are often limited. Commonly, the restricted basin

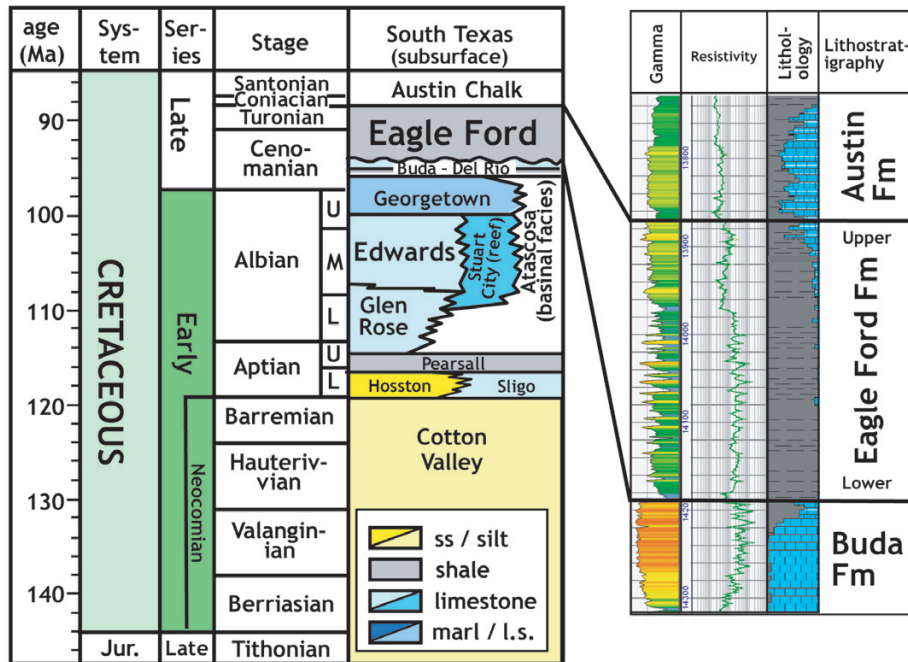


Figure 1: Stratigraphic column and type log for Eagle Ford Formation.

nature of their accumulation can limit the use of biostratigraphy and palynomorphs are often thermally degraded. Log correlations are hampered by high, but erratic U values that reflect a mixture of detrital input and authigenic enrichment from sea water. Furthermore, the apparent macro-scale homogeneity of the mudrocks precludes the recognition of sedimentary facies that can be used for stratigraphic correlations, particularly when the only samples available are cuttings.

Figure 3 displays the geochemical characterization of the Del Rio, Buda, Eagle Ford and Austin formations in Friedrichs #1 well and Figure 4 the extension of that characterization into 4 of the 11 wells in the study. The Eagle Ford Formation is divisible into a chemically defined upper and lower Eagle Ford, which is primarily based on an upward decrease in U values at the lower/upper Eagle Ford boundary (Figure 3). Furthermore, both the Lower and Upper Eagle Ford can be subdivided into 3 geochemical units, based on changing values of P_2O_5 , Th/U , Na_2O/Al_2O_3 and U. The formation top is readily geochemically defined by a decrease in the values of U and an increase in TiO_2/Nb , Na_2O/Al_2O_3 and CaO/Al_2O_3 values. It is also noted that in many wells in this study the boundary between the Eagle Ford and Austin formations is not expressed as a sharp change in chemical composition, but more as a gradational change, which is shown as a chemical “transition” on Figures 3 and 4.

When dealing with basin-wide chemostratigraphic correlations, it is imperative to understand the mineralogical and therefore geological controls on the elements and element ratios used to define the zonation (e.g., Wright et al. 2010). It is essential to do so in order to ascertain

whether the chemostratigraphic correlations produced can be viewed as chronostratigraphic, lithostratigraphic or sequence stratigraphic. For example a correlation based upon modeling the kaolinite/illite ratio in a fluvial setting as described by Ratcliffe et al. (2010), and shown by those authors to be climate-related, can be considered to be broadly chronostratigraphic, whereas Hildred et al. (2010) demonstrated the homotaxial nature of two valley systems using changes in provenance-related elements and element ratios. The elemental composition of individual minerals is relatively well understood, however, it is being able to disentangle the bulk and trace mineral controls on the elemental geochemistry acquired from a bulk sample that is the challenge to the chemostratigrapher. One pragmatic approach is the use of direct comparison between elemental data and mineralogical data (e.g. Pearce et al. 2005) or when mineralogical data are not available by using multivariate statistical analysis (e.g. Ratcliffe et al. 2010, Wright et al. 2010). Using both of these approaches on numerous sections through the Eagle Ford Formation, it can be demonstrated that changes in the key element and element ratios displayed on Figure 3, and their interpretation are:

CaO/Al_2O_3 = changes in relative proportion of carbonate and clay mineral content

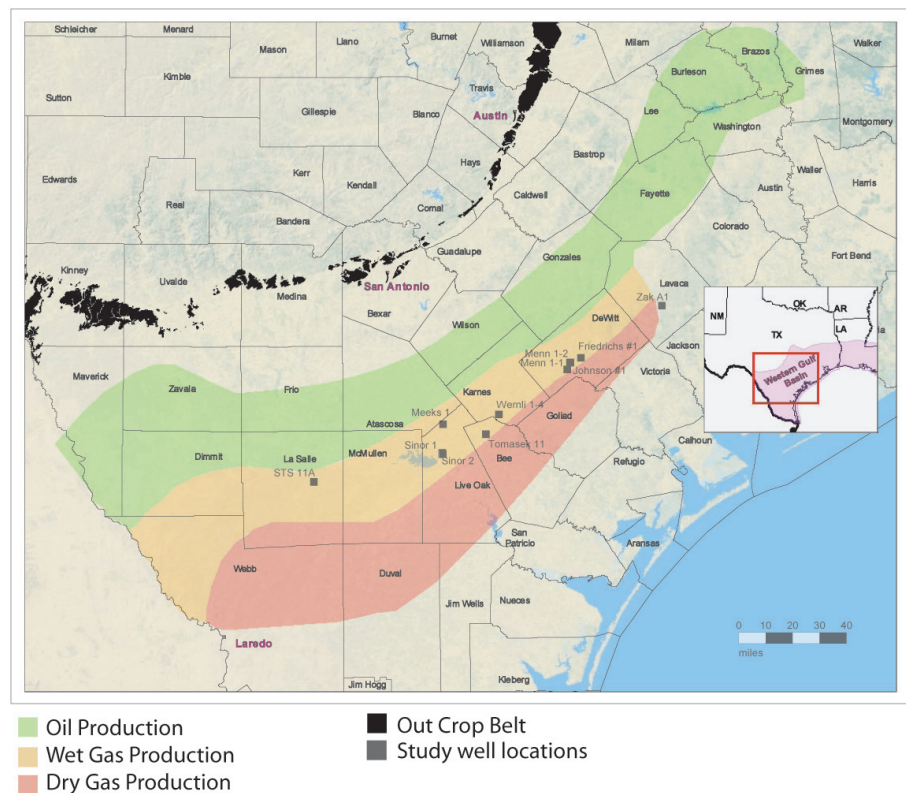


Figure 2: Location map for the Eagle Ford wells in the study.

P_2O_5 = changes in biogenic apatite, which relate to surface productivity

V Enrichment factor (EFV) = changes in oxygenation of bottom waters

U = changes in total organic carbon contents (TOC)

Th/U = amount of clastic input vs. organic content

Na_2O/Al_2O_3 = amount of plagioclase feldspar present

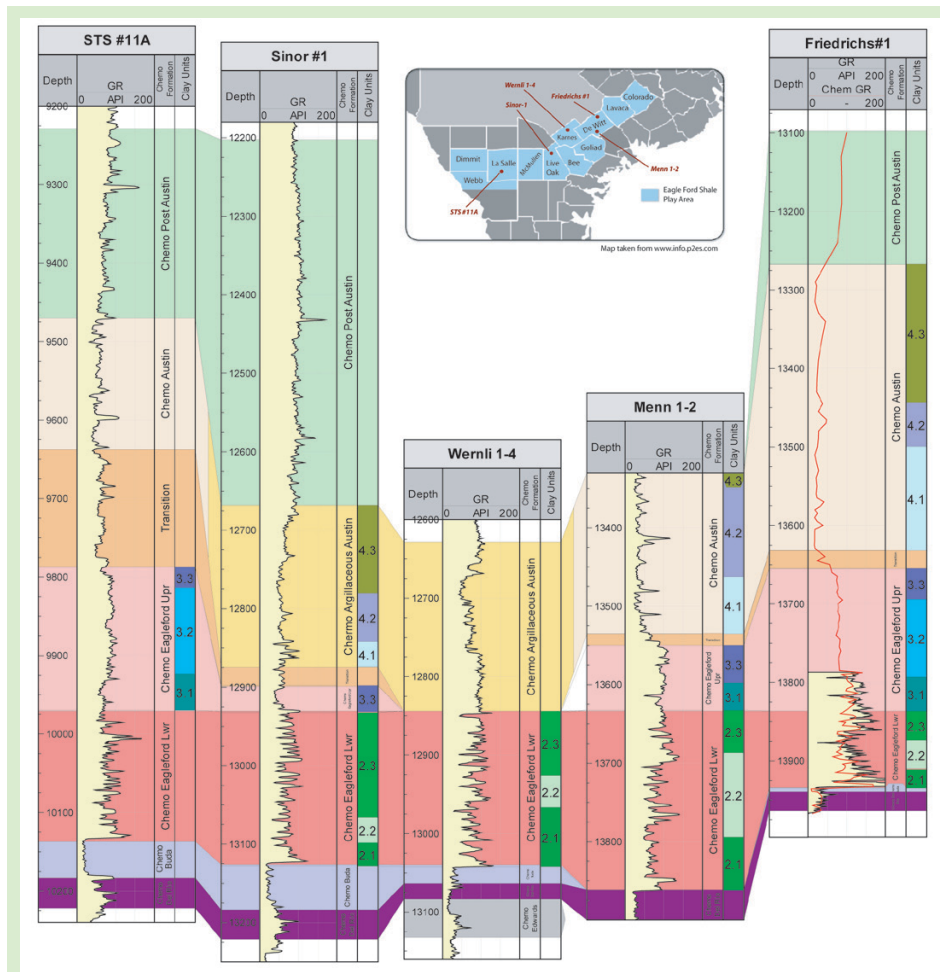
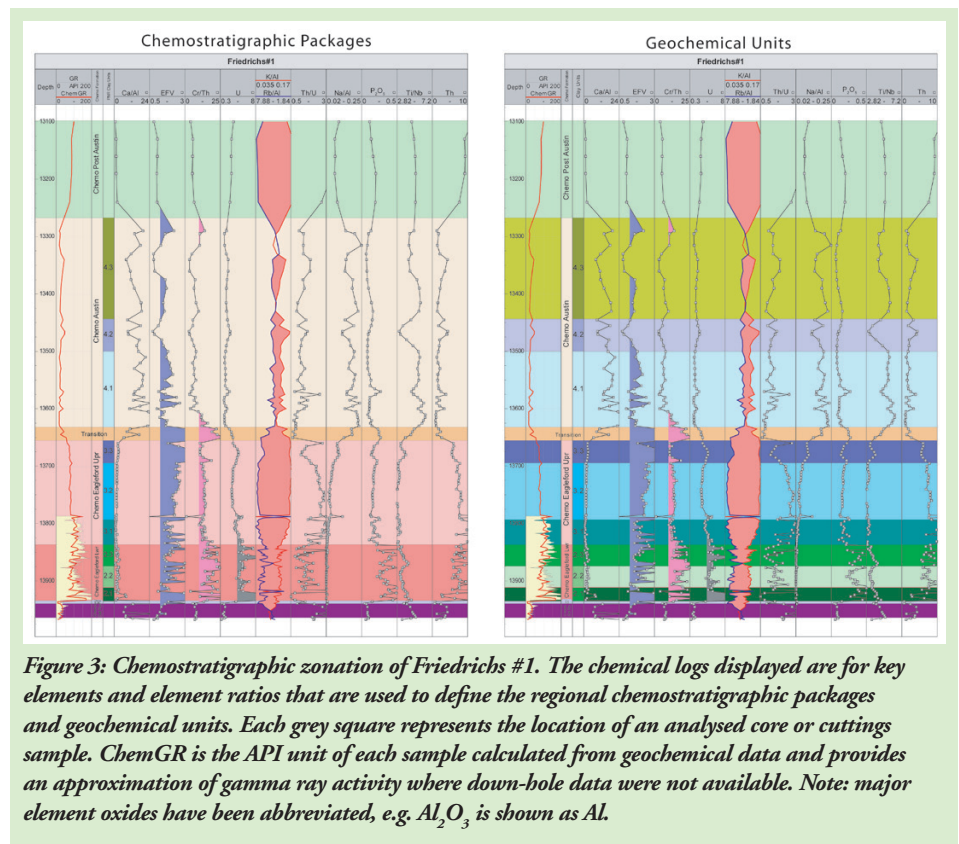
TiO_2/Nb = changes in composition of clastic material entering the basin

K_2O/Al_2O_3 (and Rb/Al_2O_3) = changes in the percentage of clay mineral species

Cr/Th = changes in oxygenation of bottom waters vs. clastic material entering the basin

Th = amount of clastic input. Where values exceed 20 ppm, Th can be related to volcanogenic material

Many of the geochemical patterns show distinct stratigraphic variations. For example, P_2O_5 and Cr/Th are higher in the lower Eagle Ford chemo unit relative to the upper



Eagle Ford chemo unit, illustrating greater surface productivity and lower bottom water oxygenation during lower Eagle Ford deposition. Differences in clastic influx and organic accumulation between the Eagle Ford and Austin chalk are also indicated by temporal CaO/Al_2O_3 and TiO_2/Nb ratios.

HIGH-RESOLUTION STRATIGRAPHIC CHARACTERIZATION FOR AID WITH GEOSTEERING

The need for high-resolution stratigraphic frameworks is exacerbated in shale plays by the increased use of horizontal drilling in their exploitation. Typically, the horizontal leg of a well will be several thousand feet in length, with the aim of remaining in a thin stratigraphic horizon over as much of that distance as possible.

Key to working in lateral wells is identifying element and element ratios that change at the top and base of the target zone. The ideal target zone for lateral wells through the Eagle Ford Formation in the Friedrichs area is shown in Figure 5A and it is broadly coincident with unit 2.3. Regionally, the top of the Eagle Ford lithostratigraphic unit is coincident with the top of chemo unit 3.3, and the top of the Lower Eagle Ford lithostratigraphic unit is the top of chemo unit 2.3 (upper portion of the

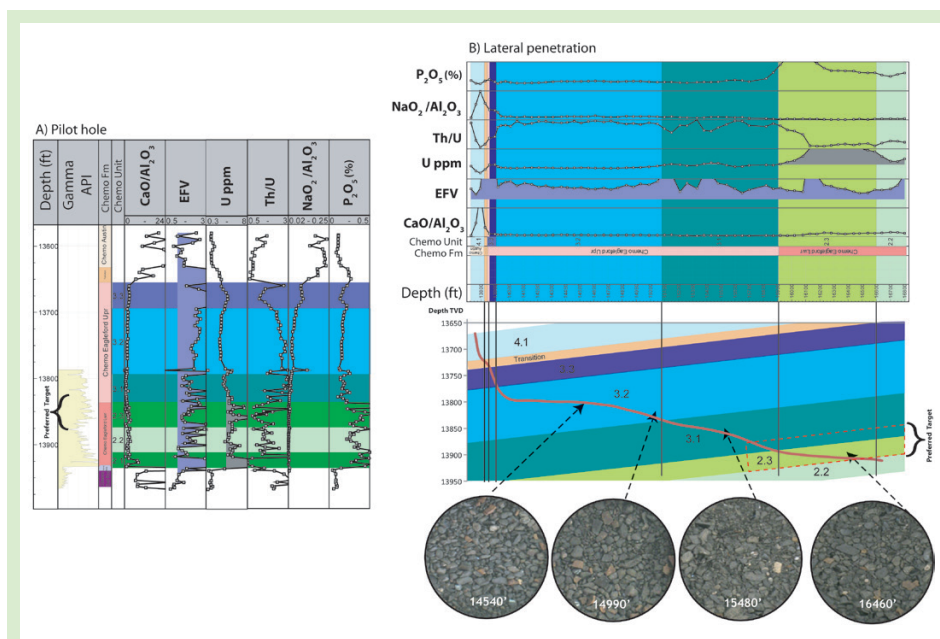


Figure 5: Relating a lateral well back to the pilot hole using selected chemical logs. 5A) High resolution zonation of Friedrichs #1 pilot hole, with the target zone for the lateral well indicated. 5B) Data obtained from cuttings samples in the Friedrichs lateral well, with an interpretation of the geochemical units through which the lateral travelled.

target zone), where there is a marked down-hole increase in P_2O_5 and U values and decrease in Th/U values. From the top of chemo unit 2.3 to its base the P_2O_5 and U values remain

high (Figure 5), with a drop in U values and increases in Th/U and EFV ratios marking the boundary between chemo units 2.3/2.2. This chemo unit boundary is coincident with the

base of the preferred zone for horizontal wells. Therefore, from the pilot well, a target zone for lateral wells (chemo unit 2.3) can be defined using chemostratigraphy.

Figure 5B has the same ratios as used in Figure 5A plotted for the Friedrichs #1 lateral. While drilling the horizontal section immediately beyond the heel of the well (c. 14000' measured depth (MD)), field technicians monitoring the data suggested that the well-bore was above chemo unit 3.3 (top Eagle Ford Formation) and therefore needed deepening. Throughout the Upper Eagle Ford Formation P_2O_5 and U values remain low, however as the well deepens toward the target zone an increase in P_2O_5 and U values occurs and subsequent drop in Th/U values clearly defines the top of chemo unit 2.3, indicating that the target zone is penetrated. Furthermore, near the toe of the well a drop in U values is observed suggesting that chemo unit 2.3 has been penetrated and that the last 200 ft of this lateral sits just below the target zone.

MINERAL AND TOC MODELLING

Reservoir quality in shale resource plays is

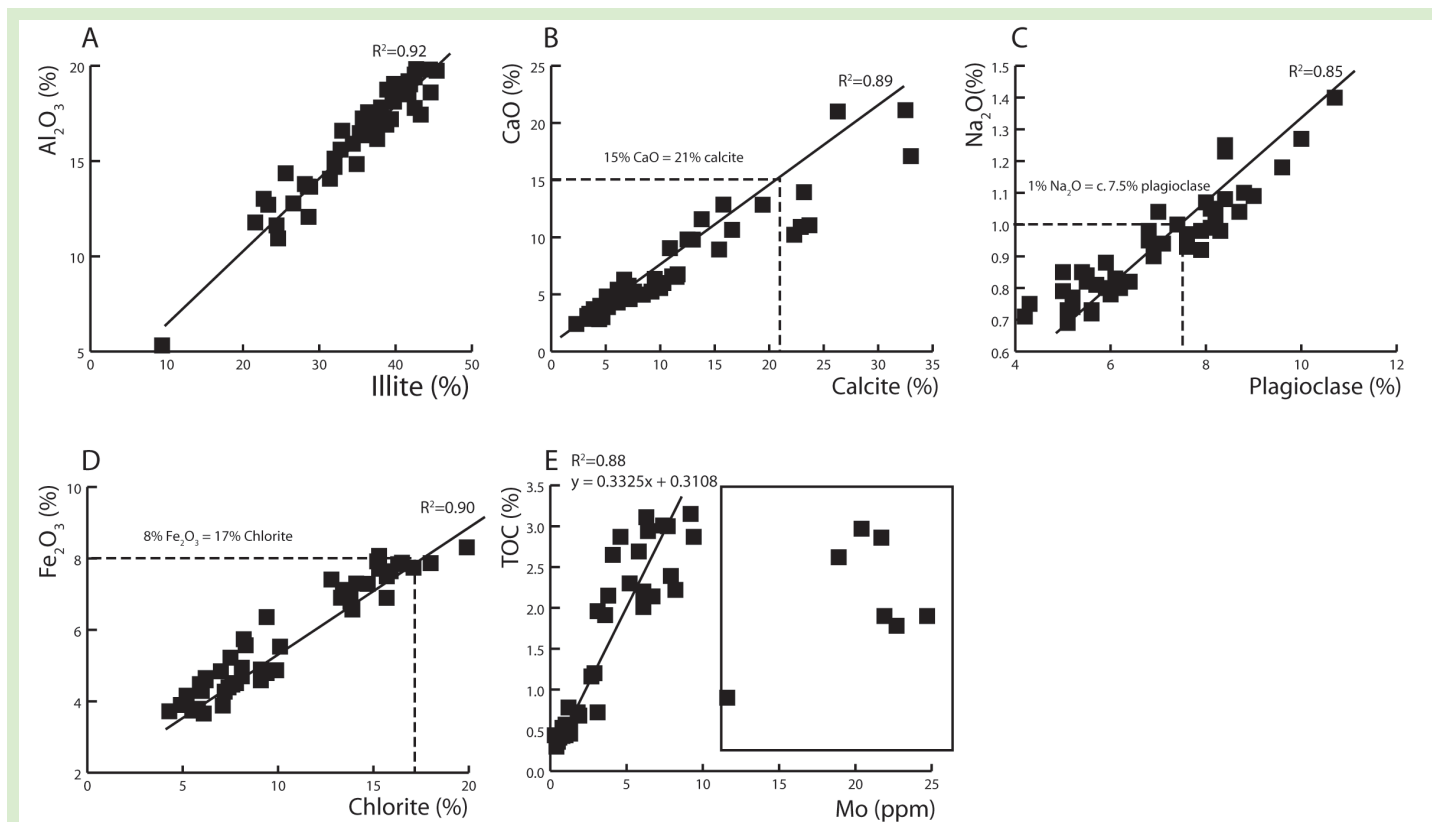


Figure 6: A-D) Comparison of selected element concentration and mineral abundance. E) Comparison of Mo concentration and TOC. Mineral abundances have been determined by XRD measurements. In all cases elemental data, mineralogical data and TOC data are from the same sample, but not the same, homogenised powder, which will result in some scatter. R^2 values and regression equations are displayed.

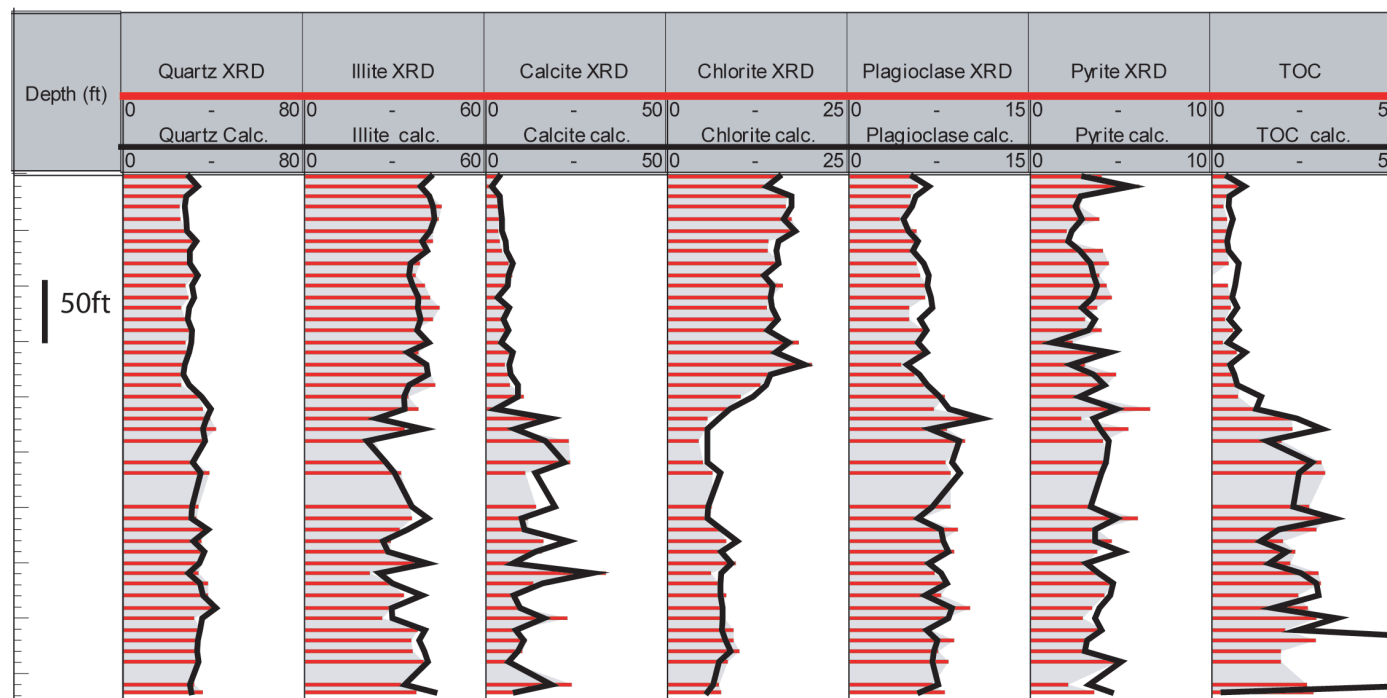


Figure 7: A comparison of mineralogy calculated from elemental data using ChemMin™ and mineralogy obtained by XRD. The right-hand column is a comparison of TOC calculated from a linear regression equation and TOC measured in the sample. Note that this example is from the Haynesville Formation, not the Eagle Ford Formation.

dependent on numerous factors, all of which revolve around mineralogy and TOC values. Mineralogically, the Eagle Ford Formation is relatively simple, comprising quartz (av. 13%), calcite (av. 50%) and clay minerals (av. 27% illite, illite/smectite, kaolinite and chlorite), with lesser amounts of pyrite, apatite and plagioclase feldspar. TOC values are typically between 1% and 7%. Each of these mineral phases and the TOC contents are readily modelled from the same elemental dataset used to define chemostratigraphic correlation framework.

Figure 6 demonstrates the close association of major element concentrations and mineralogy. From those cross-plots it is evident that aspects of mineralogy can be modelled using the regression line equations displayed. Several public domain programs take this simple modeling further and use changes in geochemistry to provide semi quantitative mineralogical data (Paktunc 2001, Rosen et al. 2004). Proprietary software is also used by wireline logging companies to transform elemental data gathered from down-hole geochemical logging tools into mineralogical data. Figure 7 compares the bulk mineralogy calculated from whole rock geochemical data acquired by ICP analysis against mineralogical data acquired from x-ray diffraction (XRD).

In this case, the bulk mineralogical data were calculated using Chemostrat's in-house software program, ChemMin™ and the samples used for this are from the Haynesville Formation, not the Eagle Ford Formation.

Semi quantitative TOC values can be calculated from trace element geochemistry by calculating a linear regression equation between selected trace elements and measured TOC (Figure 6E). Provided the relationship between trace elements and TOC has a regression coefficient of over 0.8, it can be used to model TOC values where TOC measurements have not been made. The results of this approach are displayed in the right hand column of Figure 7.

PALEOREDOX

Understanding paleoredox conditions is of paramount importance to shale gas exploration, since high TOC values are only typically found in sediments deposited where bottom conditions were anoxic or euxinic. Oceanic anoxic events have long been recognized and studied (Schlanger and Jenkyns 1976) and in recent years, much has been written on the use of elemental geochemistry in sediments and water columns as a proxy for depositional redox conditions (e.g., Tribovillard et al. 2006, Turchen and Brumsack 2006, Tribovillard et al. 2008, Negri et al. 2009, Jenkyns, 2010). The

key to using major and trace element changes to understand paleoredox in ancient sequences is understanding the geological controls on each of the elements. Principal components analysis provides a quick and effective way to detangle the influences of terrigenous input, carbonate production and authigenic enrichment from sea water on major and trace elements (Ratcliffe et al. 2012). Typically redox-sensitive elements, such as V, Cr and U provide a means to determine the degree of anoxia during deposition. Vertical and lateral changes in elements associated with authigenic enrichment within the Eagle Ford Formation (Figure 3) provide a means to understand temporal and geographic changes in paleoredox conditions, therefore providing important data regarding likely hydrocarbon productivity. For example, in Figure 3, Cr/Th and EFV values are generally high throughout the Eagle Ford Formation relative to over and underlying sequences; however, it is also clear that within the Eagle Ford Formation there are significant fluctuations of these ratios. This implies that although bottom water conditions tended to be anoxic during deposition, there is considerable high-resolution variability in paleoredox conditions throughout the deposition of the Eagle Ford Formation.

RELATIVE ROCK BRITTLINESS

Another important feature of shale gas production is the “fracability” of the formations being drilled. This is controlled by the inorganic and organic mineralogy of the sediments and the rock fabrics. Since the whole rock geochemical data is directly linked to mineralogy and, as discussed above and demonstrated on Figure 7, the bulk mineralogy can be used to calculate mineralogy and TOC, it is possible to calculate a relative brittleness (RBI) value for each sample analysed for chemostratigraphy. Simplistically, Al_2O_3 is primarily controlled by clay content, which increases ductility; SiO_2 relates to silica, which increases brittleness, particularly if present as biogenic quartz; and CaO is present as calcite, which can potentially increase brittleness. While RBI does not provide a quantitative value of brittleness such as a Young’s Modulus calculation, it does provide a rapid and visual indication of relative brittleness within the formation. This measure can be rapidly determined from core samples, where it can be calibrated against physical data, such as a scratch-test before being calculated from cutting samples, thereby enabling RBI to be calculated in lateral wells. This information can then be used to better understand which sections in a lateral well will be most likely to respond well to fracturing.

CONCLUSIONS

Until relatively recently, the prime purpose of obtaining whole rock inorganic geochemical data for the petroleum industry has been for stratigraphic purposes. However, with increased exploration in shale resource plays, it is rapidly becoming apparent that the same dataset obtained to help refine stratigraphic correlations can be used to;

- Determine bulk mineralogy semi-quantitatively
- Determine TOC semi-quantitatively
- Understand temporal and lateral variation in paleoredox conditions
- Determine relative changes in rock brittleness
- Determine stages in a lateral well that may be unsuitable for frac-ing, thereby reducing the number of frac-jobs carried out.
- Understand how changes in mineralogical composition along a lateral may be used to design better completion treatment programs for a given area.

While the calculations of mineralogy, TOC and rock brittleness are not as accurate as direct measurements of those parameters, the results described here can all be achieved rapidly and at no extra cost from the same ICP-derived data used for chemostratigraphy. Furthermore, the applications for the Eagle Ford Formation can readily be applied to any shale resource play.

REFERENCES

- HILDRED, G.V., RATCLIFFE, K.T., WRIGHT, A.M., ZAITLIN, B.A., AND WRAY, D.S., 2010. Chemostratigraphic applications to low-accommodation fluvial incised-valley settings; an example from the Lower Mannville Formation of Alberta, Canada. *Journal of Sedimentary Research*, v. 80, p. 1032-1045.
- JARVIS, I., AND JARVIS, K.E., 1995. Plasma spectrometry in earth sciences: techniques, applications and future trends. *Chemical Geology*, v. 95, p. 1-33.
- JENKYN, H.C., 2010. Geochemistry of oceanic anoxic events. *Geochemistry Geophysics Geosystems*, v. 11, p.1-30.
- NEGRI, A., FERRETTI, A., WAGNER, T., AND MEYERS, P. A., 2009. Organic-carbon-rich sediments through the Phanerozoic: processes, progress, and perspectives. *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 273, p. 302-328.
- PAKTUNC, A.D., 2001. MODAN – a computer program for estimating mineral quantities based on bulk composition; Windows version. *Computers & Geosciences*, v. 27, p. 883-886.
- PEARCE, T.J., WRAY, D.S., RATCLIFFE, K.T., WRIGHT, D.K. AND MOSCARELLO, A., 2005. Chemostratigraphy of the Upper Carboniferous Schooner Formation, southern North Sea, in Collinson, J.D., Evans, D.J., Holliday, D.W., and Jones N.S., eds., *Carboniferous hydrocarbon geology: the southern North Sea and surrounding onshore areas*. Yorkshire Geological Society, Occasional Publications series, v. 7, p. 147-64.
- RATCLIFFE, K.T., HUGHES, A.D., LAWTON, D.E., WRAY, D.S., BESSA, F., PEARCE, T.J. AND MARTIN, J., 2006. A regional chemostratigraphically-defined correlation frame-work for the late Triassic TAG-I in Blocks 402 and 405a, Algeria. *Petroleum Geoscience*, v. 12, p. 3-12.
- RATCLIFFE, K.T., MORTON, A., RITCEY, D., AND EVENCHICK, C.E., 2007. Whole rock geochemistry and heavy mineral analysis as exploration tools in the Bowser and Sustut Basins, British Columbia, Canada. *Journal of Canadian Petroleum Geology*, v. 55, p. 320-37.
- RATCLIFFE, K.T., WRIGHT, A.M., MONTGOMERY, P., PALFREY, A., VONK, A., VERMEULEN J., AND BARRETT, M., 2010. Application of chemostratigraphy to the Mungaroo Formation, the Gorgon Field, offshore Northwest Australia. *Australian Petroleum Production and Exploration Association Journal*, v. 50, p. 371-385.
- RATCLIFFE, K.T., WRIGHT, A.M., AND SPAIN, D., 2012. Unconventional methods for unconventional plays: Using elemental data to understand shale resource plays. *Petroleum Exploration Society of Australia, News Resources*, March / April 2012, p. 89-93. Accessed May 1, 2012, <http://www.pnronline.com.au/article.php/240/1842>.
- ROSEN, O.M., ABBYASOV, A.A., AND TIPPER, J.C., 2004. MINLITH – an experience-based algorithm for estimating the likely mineralogical compositions of sedimentary rocks from bulk chemical analyses. *Computers & Geosciences*, v. 30, p. 647-661.
- SCHLANGER, S.O., AND JENKYN, H.C., 1976. Cretaceous oceanic anoxic events: causes and consequences. *Geologie Mijnbouw*, v. 55, p. 179-194.
- TRIBOVILLARD, N., ALGEO, T.J., LYONS, T., AND RIBOULLEAU, A., 2006. Trace metals as paleoredox and paleoproductivity proxies: an update. *Chemical Geology*, v. 232, p. 12-32.
- TRIBOVILLARD, N., BOUT-ROUMAZEILLES, V., ALGEO, T., LYONS, T.W., SIONNEAU, T., MONTERO-SERRANO, J.C., RIBOULLEAU, A., AND BAUDIN, F., 2008. Paleodepositional conditions in the Orca Basin as inferred from organic matter and trace metal contents. *Marine Geology*, v. 254, p. 62-72.
- TURGEON, S. AND BRUMSACK, H-J., 2006. Anoxic vs. dysoxic events reflected in sediment geochemistry during the Cenomanian–Turonian Boundary Event (Cretaceous) in the Umbria–Marche Basin of central Italy. *Chemical Geology*, v. 234, p 321-339.
- WRIGHT, A.M., RATCLIFFE, K.T., ZAITLIN, B.A., AND WRAY, D.S., 2010. The application of chemostratigraphic techniques to distinguish compound incised valleys in low-accommodation incised-valley systems in a foreland-basin setting: an example from the Lower Cretaceous Mannville Group and Basal Colorado Sandstone (Colorado Group), Western Canadian Sedimentary Basin, in Ratcliffe, K.T., and Zaitlin, B.A., eds., *Application of Modern Stratigraphic Techniques: Theory and Case Histories*. SEPM Special Publication 94, p. 93-109.

Accepted June 2012

PRESIDENT'S COMMENTS

I believe that the SEPM of the future, and by that I mean the not-too-distant future, will be quite different than the SEPM of today. Our mission will be the same – fostering the dissemination of scientific information on sedimentology, stratigraphy, paleontology, and other related specialties. What will change, is changing, is how that dissemination is done, who facilitates that mission, and how many geoscientists support the effort through their membership. It is not particularly original of me to suggest our publications will all be digital, leadership will be from a generation that is innately functional in a digital world, and there will be far fewer members than today.

Those of us who are over 45 years of age (67% of the membership) probably joined SEPM prior to the digital age. At that time, our journals and special publications were print only and all of the Society's business was done through the mail, over a telephone, or in face-to-face meetings. Now, both *Palaaios* and *JSR* will ONLY be e-journals (as of January 2013), we have a new and improved website, our journal and Society websites will soon be accessible by any mobile device in the world, and we do most Society business by email and web conferencing.

A quick review of the President's columns in past issues of the *Sedimentary Record* indicates that the transition from SEPM's past to the uncertain future has dominated the attention of SEPM's Council for at least the last decade. One aspect of Council's effort has been to try and engage more young members – especially students – in SEPM activities, with the hope that leadership would gain a better understanding of younger members' desires of SEPM. Since 2006, Council has required that all SEPM committees include a student member. Students and young professionals were explicitly invited to an SEPM strategic planning retreat held in early 2009, and ~70 students at the 2009 GSA were surveyed to gain a better understanding of what student were seeking from SEPM and how the

Society could better serve them (see Steve Driese's President's Comments, *Sedimentary Record*, v. 7, no. 3). More recently, former president Mitch Harris convened a focus group of ~12 graduate students in the fall of 2010 to provide a critical assessment of SEPM activities, our website, and our means of communication. These efforts led to specific and positive actions on Council's part. However, in the midst of its deliberations on key issues, Council still has not been able to readily solicit the input of younger members.

Last year's Council recognized that more younger voices were needed in its deliberations. There was a clear desire for different perspective on the future and how the Society will function and meet its mission. Council thus proposed revisions to the SEPM bylaws in order to expand the size of Council with the addition of three new seats for a Student Councilor, an Early Career Councilor, and a Web and Communications Councilor. These bylaw changes were approved by the membership at the recent SEPM Business Meeting held at the Long Beach convention. I think the influx of new ideas and perspectives will be invaluable as Council continues to plot SEPM's course into the future.

The **Student and Early Career councilors** will represent the ~15% of the current membership that are from what is commonly known in the US as the Millennials or Generation Y (and eventually Generation Z). Each will be specifically charged with chairing a committee of student and early career geoscientists, respectively, that will stay abreast of issues and events that are particularly significant to our younger members. Both will represent the needs and views of their respective membership cadre to Council. The Early Career Councilor is defined to be an SEPM member that possesses less than 12 years' experience beyond achieving the competency generally associated with a bachelor's degree in the earth sciences. The Student Councilor must be an associate or full member of SEPM and a student in an Earth Sciences graduate

program at the time of his/her election. The first Student Councilor will appear on the Council ballot this fall as an unopposed candidate. Student members interested in this position will be able to apply for it (see the call for applications on page 11 of this issue of the *Record*), with the SEPM Nominating Committee selecting from among the applicants. So as to stagger the tenure of these two positions on Council, the Early Career Councilor will not appear on the Council ballot until 2014; Council will make an interim appointment this fall.

The **Web and Technology Councilor** is added to bring more expertise to Council with all things "web". The specific charge is to stay abreast of ongoing advances in web-based networking, technologies, and communication systems that may affect SEPM's operations and interactions with and between members. This Councilor will chair a communications committee (which will include the Student and Early Career Councilors as members). The Web and Communications Councilor will report to Council on the strengths and weaknesses of SEPM's web presence and digital communications, and will be expected to recommend improvements and changes as to how SEPM makes use of web-based technologies, networking, and communication. This position will also not appear on the ballot until fall 2013. In the meantime, **Brian Romans** (Assistant Professor at Virginia Tech) has accepted Council's call to serve. Check out his personal geoscience blog – Clastic Detritus – at <http://clasticdetritus.com/>.

With the energetic input from the younger members, and specifically these three new Councilors, I do believe SEPM will not only survive "change" but flourish. I welcome the new young voices to Council – look for their names on page 3 of future issues of the *Sedimentary Record* and contact them with your thoughts and advice. Better yet, contact them to volunteer to help shape **YOUR** Society.

David A. Budd, President



SEPM Society for Sedimentary Geology
"Bringing the Sedimentary Geology Community Together"
www.sepm.org

Announcing New SEPM Council Positions

At the Long Beach annual business meeting, the attending members unanimously approved a change to the By-Laws, which expanded the membership of the SEPM Council to include three new councilors: a Web and Technology Councilor; an Early Career Councilor; and a Student Councilor. In order to get input from these new positions as soon as possible, two of them will be filled by Council appointment until they can be added to the regular Council ballot with staggered terms. The first position to be filled by appointment is the Web Councilor who is Brian Romans (Virginia Tech), who has been acting as an advisor to Council in this area. The Early Career Councilor will be determined later this year.

The Student Councilor will be filled from a pool of applicants. Any student member that fills the requirements is invited to send in an application. Requirements are that the student must be in a graduate geoscience degree program and of course a SEPM member in good standing. The application should include a resume and a short (~300 words) statement about why they are applying to be the SEPM Student Councilor. The general responsibilities of the Student Councilor are to represent to Council the input from SEPM student members and geoscience students in general. He or she will also chair a Student Committee whose main charge is to discuss student issues and make recommendations to SEPM Council. The Student Councilor will receive travel support to attend SEPM Council meetings, usually held at the AAPG ACE in the spring and the GSA Annual Meeting in the fall.

Please send questions or applications to Howard Harper, SEPM Executive Director (hharper@sepm.org).

Latest Book Reviews available Online

Atlas of sedimentary structures in estuarine and tidally-influenced river deposits of the Rhine-Meuse-Scheldt system,
by Allard W. Martinus
& J.H. (Janrik) van den Berg, 2011.

Ice-marginal and periglacial processes and sediments,
edited by I.P. Martini, H.M. French
& A. Perez-Alberti, 2011.

The geological record of Neoproterozoic glaciations, edited
by Emmanuelle Arnaud,
Galen P. Halverson
& Graham Shields-Zhou, 2011.

Principles of tidal sedimentology,
edited by Richard A. Davis Jr.
& Robert W. Dalrymple, 2011.

Gulf Coast Association of Geological Societies and the Gulf Coast Section of SEPM

62nd Annual Convention



“Solving for E3”—addressing the complexities at the intersection of energy, environment, and the economy

A 3-day technical program will focus on areas such as stratigraphically deep opportunities in the Gulf of Mexico, salt tectonics, unconventional plays, balancing water and energy needs, and the environmental future and economic challenges of the Gulf of Mexico region. The third day will feature speakers from the 2011 GCAGS Veracruz technical program.

OCTOBER 21–24, 2012 • AUSTIN, TEXAS
HOSTED BY THE AUSTIN GEOLOGICAL SOCIETY

The conference will host panel discussions that focus on energy, water, and the economy. Join the conference and listen and learn from these industry thought leaders:

- **Dr. Scott W. Tinker**—Panel Chair & Moderator—Director, BEG
- **Amy Jaffe**, Associate Director, James A. Baker III Institute for Public Policy, Rice University
- **Dr. Tadeusz Patzek**, Professor & Chair, Department of Petroleum and Geosystems Engineering, UT
- **Scott Anderson**, Senior Policy Advisor, Air and Climate Program, Environmental Defense Fund
- **Dr. Ken Medlock**, Adjunct Professor of Economics, James A. Baker III Institute for Public Policy, Rice University
- **William (Bill) Maloney**, Executive Vice President, Development and Production North America, Statoil
- **James H. Painter**, Executive Vice President, Exploration and Technology, Cobalt International Energy

Early registration begins June 1. Reserve your space today!

Visit this link for registration information: <http://www.gcags2012.com/>





Microfossils III: Geologic Problem Solving with Microfossils March 10-13, 2013 University of Houston Houston, TX USA

The North American Micropaleontology Section (NAMS) of SEPM announces the *Third Geologic Problem Solving with Microfossils Conference* (Microfossils III) to be held March 10th-13th, 2013 at the University of Houston, Houston, Texas. The mission of Microfossils III is to bring together geoscientists from academia, industry and government to focus on the use of microfossil to solve geologic problems. The conference is open to all microfossil specialties.

Conference activities include: oral and poster technical presentations, a regional pre-meeting field trip, post-meeting short courses, ice breaker, and plenary dinner at the Houston Museum of Natural Science. Session themes are:

- The Microfossil record of Major Oceanic Events
- Microfossils and Unconventional Resources: The New Frontier
- High-resolution Biostratigraphy, Chronostratigraphy, and Geochronology
- Reconstructing Past Environments Using Microfossils
- Paralic and Lacustrine Micropaleontology
- Microfossils and Biofacies Analysis: Applications and Challenges
- Paleoclimate, Paleooceanography, and Relative Sea-level Change
- Taxonomy, Phylogeny, and Evolution
- New Technologies and Techniques in Microfossil Studies

Abstract submittal deadline: November 11, 2012

For information on the meeting and abstract submission, visit
<http://www.sepm.org/nams/meetings.htm#abstracts> or
contact **Dr. Mark Leckie** at MLeckie@geo.umass.edu

Volcanism, Impacts and Mass Extinctions: *Causes & Effects*

International Conference
March 27-29, 2013
The Natural History Museum
LONDON

Visit: massextinction.princeton.edu



This conference brings together researchers across the geological, geophysical, and biological disciplines to assess the state of research into the causes of mass extinction events. The main goal is to evaluate the respective roles of volcanism, bolide impacts, sea level fluctuations and associated climate and environmental changes in major episodes of species extinction.

Over the past 30 years considerable research efforts have been directed toward understanding the context and nature of environmental changes that occurred immediately prior to, at, and after the five major Phanerozoic mass extinctions. Important new data and observations have emerged from the fields of palaeontology, stratigraphy, sedimentology, geochronology, geochemistry, mineralogy, volcanology, geophysics, palaeomagnetism and astrophysics. Consequently, a critical review of these data — and their implications with respect to identification of the cause(s) of these eco-evolutionary events — is warranted. The conference is intended to foster a new, collaborative, interdisciplinary approach to resolving outstanding problems in this field. Access the first circular of this meeting at url:massextinction.princeton.edu

EXPLORATION INSIGHTS: STRAIGHT FROM THE SOURCE



Access to distinctive and specialized scientific research is key to unraveling the secrets of the Earth and helping push your business forward.

Coming this autumn, Elsevier is launching a partnership with the SEPM (Society for Sedimentary Geology) that will provide geoscientists with unrivalled access to geological maps and insights that are at the very heart of commercial success.

Learn more about the partnership at: info.geofacets.com/SEPM



MAKE YOUR DECISIONS WITH CONFIDENCE.