The SEDIMENTARY Record

Volume 2, No. 1
March 2004

A publication of SEPM Society for Sedimentary Geology

INSIDE: DINOSAUR MUMMIES

PLUS: HAND LENS ARTICLE ON "INTELLIGENT DESIGN"
PRESIDENT'S OBSERVATIONS • ANNUAL MEETING SCHEDULE
FIELD NOTES • ON DEEPWATER EXPLORATION

1926 SEPM
Society for Sedimentary Geology

EMBRACE THE FUTURE

Dallas 2004

CELEBRATE THE PAST

AAPG/SEPM Annual Meeting

April 18-21, 2004
Dallas, Texas
Dallas Convention Center

SEPM BUSINESS MEETING AND LUNCHEON
Tuesday, April 20, 2004
The Fairmont Hotel, 11:30am-1:30pm

This year's SEPM luncheon speaker is Dr. John C. Van Wagoner, Senior Research Advisor at ExxonMobil's Upstream Research Company. Dr. Van Wagoner specializes in stratigraphy and sedimentology. The title of Dr. Van Wagoner's talk is "Energy Dissipation: Origin of Structure and Organization in Siliciclastic Sedimentary Systems."

SEPM President's Reception and Awards Ceremony

DATE: TUESDAY, APRIL 20
TIME: 7:00-9:30 P.M.
LOCATION: THE FAIRMONT HOTEL REGENCY BALLROOM

SEPM President John B. Anderson and his wife Doris invite you to an evening of celebration to honor the 2004 awardees of the Society for Sedimentary Geology (SEPM).

THE AWARDEES ARE:

Twenhofel Medal
Emiliano Mutti
Pettijohn Medal
H. Edward Clifton
Moore Medal
Isabella Premova-Silva
Shepard Medal
Richard Sternberg
Wilson Medal
not awarded in 2004
Honorary Membership
John M. Armentrout
Distinguished Service Award
Gerald M. Friedman
Outstanding Paper in JSR, 2002:
Eugene C. Rankey
Outstanding Paper in PALAIOS, 2002:
C. Dupraz, and A. Strasser
Excellence of Oral Presentation, 2003:
R. Meyer
Excellence of Poster Presentation, 2003:
E. du Fornel, P. Joseph, F. Guillocheau, T. Euzen, and D. Granjeon

SEPM will also be recognizing the members of the 2003 Local Organizing Committee, student travel grant recipients and Student Section Grant winners.

The reception will begin at 7:00 p.m., with cocktails available at cash bars. The awards ceremony will start at 7:30 p.m.

Scheduled Activities

RESEARCH GROUPS

Sunday, April 18
2pm-4pm
- Quantitative Stratigraphy
- Clastic Diagenesis

Monday, April 19
7pm-10pm
- Carbonates
- Marine Micropaleontology
- Sequence Stratigraphy
- Turbidite & Deep Water

OTHER ACTIVITIES

Friday, April 16
8am-5pm
- Open Forum: Research in the Upper Crust-Sedimentary Geology

Saturday, April 17
12pm-5pm
- Geosystems Committee

Sunday, April 18
8am-5pm
- SEPM Council Mtg

9am-11am
- Foundation Investment Committee Meeting

11:30am-12:30
- SEPM Investment Lunch

12:30-2:30pm
- SEPM Investment Meeting

3pm-5pm
- NAMS Board Meeting

Monday, April 19
10am-11am
- Foundation Bd or Dir./Members

4pm-5pm
- Research Concepts

6pm-7pm
- SEPM Student Reception

7pm-10pm
- Earth Science Cyber-Infrastructure

Tuesday, April 20
11:30am-1:30pm
- Annual Business Mtg. Luncheon

6pm-7pm
- Foundation Donor Reception

6:30pm-7pm
- Pictures of Awardees/Council

7pm-9:30pm
- President's Rec. & Awards Ceremony

Dallas SEPM Short Courses and Field Trips *(http://www.sepm.org/events/meetings/annmeeting/scandft.htm)*
After AAPG Pre-Registration closes, you can still get into any open SEPM events by contacting Judy Tarpley at 800-865-9765 or jtarpley@sepm.org

SHORT COURSES

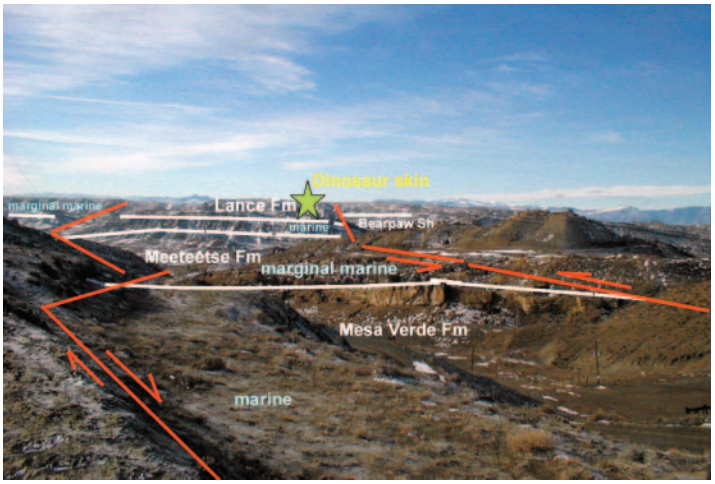
#9. Siltstones, Mudstones and Shales: Depositional Processes and Reservoir Characteristics
#10. Recognizing Continental Trace Fossils in Outcrop and Core
11. Sequence Stratigraphy for Graduate Students

FIELD TRIPS

#8. Fluvial-Deltaic-Submarine Fan Systems: Architecture & Reservoir Characteristics
#9. Imaging and Visualization of Reservoir Analog Outcrops Field Trip and Workshop
#10. Applied Sequence Stratigraphy: Lessons learned from the Triassic Dockum Group, Palo Duro Canyon Area

SEPM Thanks its Sponsors (as of 2/26/04): Anadarko Petroleum Corporation; BP Amoco; Conoco Phillips; Eby Petrography & Consulting, Inc.; Energy & Geoscience Institute; ExxonMobil; Unocal Corporation; Ventex Oil & Gas, Inc.

We look forward to seeing you in Dallas!



Cover art: *Outcrop photo from the Elk Basin, Wyoming, showing the Lance Formation and related Cretaceous strata (see Wegweiser et al., this issue).*

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The Sedimentary Record (ISSN 1543-8740) is published quarterly by the Society for Sedimentary Geology with offices at 6128 East 38th Street, Suite 308, Tulsa, OK 74135-5814, USA.

The Sedimentary Record is provided as part of membership dues to the Society for Sedimentary Geology.

Open Forum:

Research in the Upper Crust – Sedimentary Geology

Friday, April 16, 2004
8:30 am – 6:00 pm
Parisian Room, Fairmont Hotel
Dallas, Texas

Who should attend?
Anyone with a stake in the future of sedimentary geology: Academic, Industry and Government Researchers, Technology Consultants, and Students at all levels

Presentations

- Introduction and Charge
  The current perception of "Sedimentary Geology" as a science and how the sedimentary geology community needs to communicate its own perception.
- Grand Challenge Problems in Sedimentary Geology
- Infrastructure Status and Needs
  Current projects in infrastructure and an overview of data (existing, available, new)
- Overview of Current Complementary Programs
  Existing programs and projects within the upper crust arena.
- Break Out Group Discussions
  Small groups meet and discuss the information and ideas shown to determine practical next steps in determining and communicating this community's perception of its science
- Presentation of Group Ideas
  Whole group discussion of breakout group presentations
- Next Steps
  Discussion and selection of "best" next steps and selection of a synthesis committee for production of a summary report from the workshop.

For more information: hharper@sepm.org or www.nced.umn.edu/Sedimentology_Stratigraphy_Initiative.html

Quo Vadis?

Paleoenvironmental and Diagenetic Constraints on Late Cretaceous Dinosaur Skin from Western North America

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ABSTRACT

Upper Cretaceous sandstone deposits of the Western Interior Seaway include fossil skin (integument) associated with the skeletal remains of some dinosaurs. Skin preserves as thin pyrolusite (manganese oxide) coatings on sandstone molds and casts. Pyrolusite is an authigenic marine mineral used to map paleoshorelines, thus the dinosaur fossil is inferred to have been deposited in a nearshore marine environment. Rapid burial of the dinosaur remains in marginal-marine settings in the presence of seawater resulted in the inhibition of scavenging activity by other creatures. Seawater mixed with freshwater promoted the natural embalming of the corpse. Thus, it effected changes in the microbial consortia responsible for decay leading to an increase in pH allowing for preferential precipitation of pyrolusite as a replacement for dinosaur integument.

INTRODUCTION

Fossilization of non-biomineralized anatomy of terrestrial animals and the circumstances under which it occurred are of great importance to our understanding of the processes that have led to exceptional preservation. Fossilization processes provide proxy evidence in the interpretation of paleoenvironments. Evidence is provided of environmental toxins, salts, cold, or dry conditions and other principal factors aside from burial rate and early diagenesis that lead to soft tissue preservation in vertebrate animals (e.g., Briggs et al., 1997; Babcock, 1998; Babcock et al., 2000; Chamberlain and Pearson, 2001).

Paleoenvironmental and diagenetic processes combined during the Late Maastrichtian in Wyoming's Lance Formation resulting in exceptional preservation of dinosaur skin. Instances of fossilized dinosaur skin impressions are usually explained by desiccation and subsequent burial in sediment (e.g., Cope, 1885; Osborn, 1912; Brown, 1916; Sternberg, 1925; Czerkas, 1997; Anderson et al., 1999; Murphy et al., 2002). This explanation requires rapid onset of desiccation because it assumes fossilization in an arid setting and presumes desiccation occurs mere hours to days after death to effectively restrict scavengers and microbes responsible for decay prior to burial. Whereas this argument could be compelling for corpses of relatively small mass, it is less convincing for corpses of large mass. New laboratory and field evidence associated with a corpse of large mass, namely a hadrosaur dinosaur found in the Lance Formation of Wyoming, suggests that paleoenvironmental settings combined with diagenetic processes to play key roles in the fossilization of soft tissues (Wegweiser et. al., 2003). Soft-part preservation occurred preferentially after the dinosaur was buried rapidly in sediments saturated with seawater in nearshore marine settings. Integument was replaced by beta-manganese dioxide (pyrolusite) mediated by activity of some marine-adapted microbial consortia occurring relatively soon after burial, and prior to extensive compaction and dewatering of the host sediment.

In this paper, we summarize results of field studies and laboratory analyses concerning the taphonomic history of dinosaur integument from a new occurrence in the Lance Formation from This Side of Hell Quarry located northwest of Pitchfork and Hell's Half Acre, Wyoming. Questions addressed in this paper are: 1) How was dinosaur integument preserved? 2) What was the depositional environment in the Lance Formation that preserved dinosaur integument? 3) How rapidly did fossilization of dinosaur integument occur? Preservation of hadrosaur integument in the Lance Formation in northwestern Wyoming by pyrolusite provides new and intriguing paleoenvironmental evidence for the exceptional preservation of non-biomineralized tissue.

MATERIAL AND LOCATION

Material described here is from the Lance Formation (Upper Cretaceous, Maastrichtian)

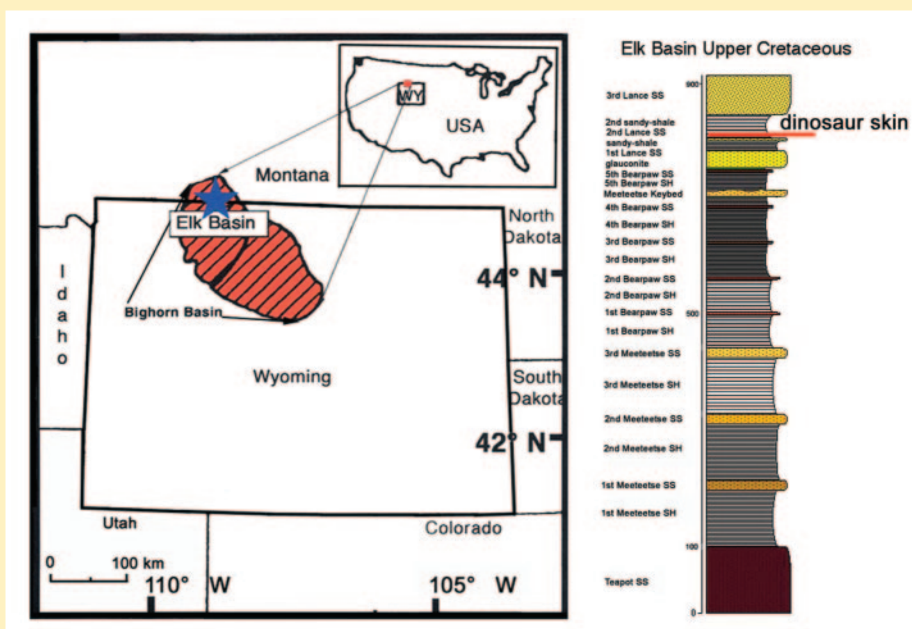

Figure 1: *Location of This Side of Hell Quarry in Elk Basin Anticline, Wyoming and Upper Cretaceous stratigraphy within Elk Basin.*

Figure 2: An example of lambeosaurine (hadrosaur) bones in the process of excavation, located in the This Side of Hell Quarry, Wyoming.

and is found in This Side of Hell Quarry, located in the Elk Basin Anticline in the northwestern Bighorn Basin in Park County, Wyoming (Figure 1). Dinosaur skin and skin impressions associated with lambeosaurine dinosaur bone (Figure 2) described herein occur in the second sandstone interval of the Lance Formation in Park County, Wyoming (Wegweiser, 2002). Specimens of dinosaur skin casts and molds (Figures 3) are reposited in the collections of the University of Wyoming.

SEM-EDX ANALYSIS

Samples of dinosaur skin, dinosaur skin impressions, associated bone, and associated matrix were examined using the JEOL JSM-820 scanning electron microscope with Oxford eXL energy dispersive X-ray analyzer of the Microscopic and Chemical Analysis Research Center (MARC) of The Ohio State University (Figure 4). The samples were left uncoated and subjected to an acceleration voltage of 10 keV. SEM-EDX analysis shows significant evidence of Mn on the dark portions of the skin impression, but effectively none on portions that lack this material. Bone material lacks any evidence of Mn, while the surrounding matrix contains only an isolated, small trace.

STRATIGRAPHY AND SEDIMENTOLOGY

The Lance Formation in Elk Basin Anticline, Wyoming, consists of coastal dune deposits and fluvial to marginal-marine deposits (Wegweiser, 2002). Fine-grained overbank deposits are interbedded with delta lobe deposits that were at times subaerially exposed. The Lance Formation in Elk Basin is dominated by pale orange, bentonitic, silty arenaceous sandstone interbedded with silty sandstone, sandstone, silty shale, and occasional beds of siderite containing trace fossils (such as inferred arthropod dwelling traces) and nodules exhibiting desiccation cracks. Lenticular and vertically stacked sandstone, shale, and siltstone bodies are interbedded with sheet-flood sandstones.

Bedding plane exposures of sheet sandstones, back-barrier deposits, coastal dune deposits, and lagoonal deposits, some with organic lags containing charcoal, iron-carbonate beds, and thin lenses of conglomerate are present near the This Side of Hell Quarry. In the quarry, strata range through beds of mudrock, silty mudrock, bentonitic muddy siltstone, and bentonitic silty fine-grained sandstone. Flaser bedding and very fine-grained clay drapes occur in the quarry. Flaser bedding is an indicator of fluctuating hydraulic conditions with transport and traction followed by periods of quiescence. Flasers are thus commonly considered to be indicators of tidal flat settings. Sandstone containing dinosaur skin impressions is fine-grained bentonitic litharenite containing abundant mica and volcanic fragments punctuated by micaceous flasers and almost white clay drapes. Micro-ripple marks occur in the quarry in the finer grained intervals. In general, the region contains stratigraphic units that imply deposition in a low topographic area, such as on a delta lobe consisting of sandy braidplain fluvial deposits interspersed with shallow intertidal bays that were occasionally subjected to volcanic ash-falls, channel abandonment, and regular marine incursions.

Fluvial deposits in the Lance Formation in Elk Basin consist of large-scale, wedge-shaped cross-trough bedded sands exhibiting intermittent very thin narrow conglomerate lenses and large-scale soft sediment deformation structures. These deposits interfinger with marginal-marine deposits characterized by thin, laminar fine-grained bentonitic sandstone beds exhibiting reactivation surfaces, mud drapes, and flaser bedding. Fine-grained overbank units are interbedded with these delta lobe braid-plain deposits.

Thin (1 to 2 mm) clay drapes and truncated lenses of light gray shale occur in direct associ-

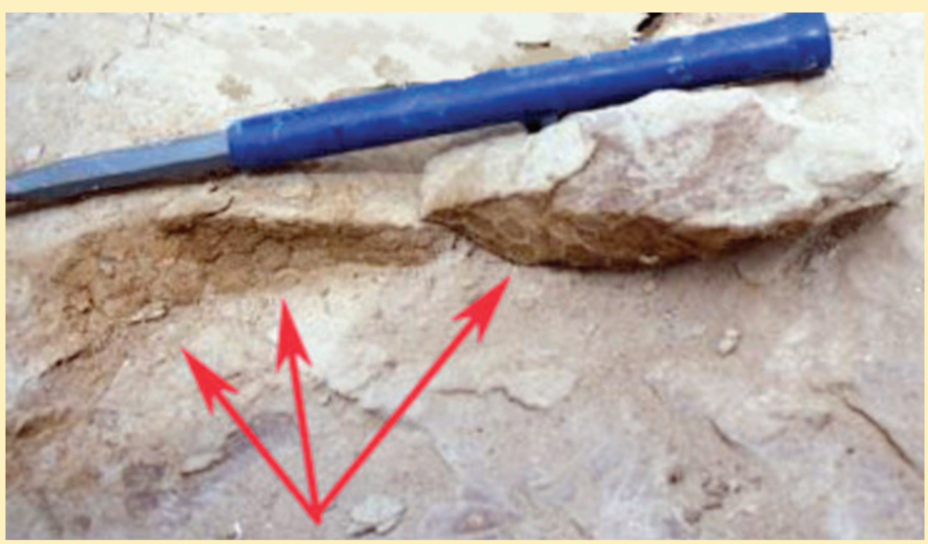

Figure 3: Section of pyrolusite (ß-MnO2) preserved dinosaur skin in situ, in the Lance Formation. The location of the skin is from the scapular area of a lambeosaurine (hadrosaur) dinosaur whose ribs are shown in Figure 2.

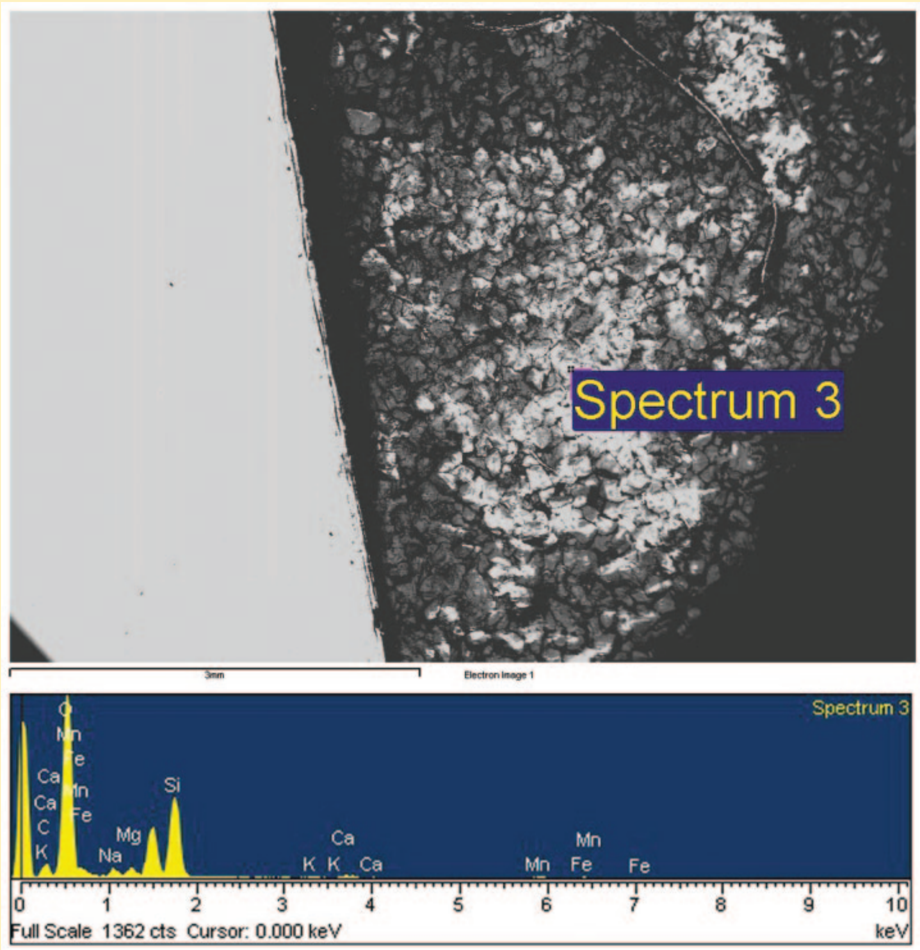

Figure 4: *Backscattered electron image of dinosaur skin with EDX analysis. The brighter regions of the image represent pyrolusite.*

ation with the dinosaur remains. Sheet-flood sandstone deposits underlying the quarry represent episodic deposition and proximal crevasse splay and interfluvial channel paleoenvironments, as well as coastal dune deposits in which organisms were deposited during recession of floodwaters. Finer grained deposits, with higher percentages of organic material, represent lagoons and back barrier bar environments, and contain fossils of vertebrate and invertebrate organisms. Sheet-flood sandstone deposits make up approximately 60 percent of the outcrop. Another 20 percent are composed of thinner, friable siltstone, silty sandstone, and fine-grained sandstone, some with desiccation features. Another 5 percent of the outcrop are composed of strata containing siderite and manganese nodules, and fossils replaced by siderite and manganese. Approximately 15 percent are finer grained interfluve deposits.

Elongate log-like and ribbon-like lenticular structures cemented by iron minerals are common in the sheet-flood sandstone units of the Lance Formation (Connor, 1992). Elongate log-like concretions with distorted bedding and ribbon-like lenticular structures are indicators of paleochannel and paleoshoreline positions (Connor, 1992), and are here interpreted as the upper parts of transverse bars found in non-braided, low sinuosity streams of lower delta plains.

The Lance Formation contains one of the best known and diverse Late Cretaceous vertebrate faunas from North America (Cope, 1872; Clemens, 1964, 1966, 1973; Estes, 1964; Breithaupt, 1982, 1985, 1997, 2001; Whitmore, 1985; Whitmore and Martin, 1985; Derstler, 1994; Archibald, 1996; Webb, 1998). Remains of cartilaginous and bony fishes, amphibians, champsosaurs, turtles, lizards, snakes, crocodilians, pterosaurs, dinosaurs, birds, and mammals are known from this unit. In addition, the Lance Formation is the source of the some of the best-known Cretaceous dinosaurs from North America (e.g., Triceratops, Thescelosaurus, Ankylosaurus, Edmontonia, Edmontosaurus, Pachycephalosaurus, Ornithomimus, Troodon, and Tyrannosaurus). Most vertebrate fossils from the Lance Formation are biomineralized bones and teeth. Reported instances of exceptional preservation of skin surrounding skeletal material are rare. These occurrences have been primarily reported as coming from hadrosaur dinosaurs (e.g., Sternberg, 1909; Osborn, 1912; Lull and Wright, 1942; Derstler, 1994; Czerkas, 1997).

TIMING AND STYLE OF INTEGUMENT PRESERVATION

Dinosaur integument (Figure 3) in the Lance Formation has been preserved through a combination of molds and casts in sandstone and thin (1 to 2 mm) voids filled by pyrolusite (MnO2). Skin impressions consist of small (1 to 2 mm) to large (5 to 10 mm) diameter polygonal, primarily hexagonal, non-overlapping scales. Grooves between the scales range in depth from 1 to 4 mm. Skin relief ranges from 2-5 mm in thickness. Skin fossils and impressions come from the area of the quarry surrounding the scapula of a lambeosaurine (hadrosaur) dinosaur. Pyrolusite preferentially covers moldic integument, and has not been observed to coat either adjacent bones or adjoining sediment. This indicates that the mineral is an early replacement product that affected only the integument.

Precipitation of pyrolusite occurs in environments that became more strongly alkaline through a combination of microbial decay (Kothny, 1983) and mixing of slightly acidic fresh water with more alkaline marine water. Fresh and marine water would be expected to mix in marginal-marine environments where streams enter the ocean. In order for manganese oxides to precipitate, Fe and Al ions must first be preferentially removed from the sediment, pH must be at least 8.0, and Eh must be at least 0.75 (Figure 5). Once formed, pyrolusite is virtually insoluble (Krauskopf, 1957). Manganese commonly precipitates in nearshore and marine paleoenvironments, recording such events as periods of transgression, delta-lobe abandonment, or storm breaching (Curtis and Coleman, 1986; Guilbert and Park, 1986; Blatt et al., 1991; Connor, 1992). Even small amounts of foreign ions (e.g., Fe, Al) present in soils from the weathering of minerals prevent the formation of pyrolusite (McKenzie, 1976).

Ion exchange of MnO2 is strongly controlled by Eh and pH (Guilbert and Park, 1986). Anions of manganese are commonly released and precipitate when river waters reach oxic marine conditions with higher pH values (generally exceeding 8.0). The isoelectric point for common colloidal particles of manganese is 4.0 to 4.5. As groundwater interacts with seawater within the phreatic zone, pyrolusite precipitates (Curtis and Coleman, 1986). Burial of organic remains under these conditions results in deposition of

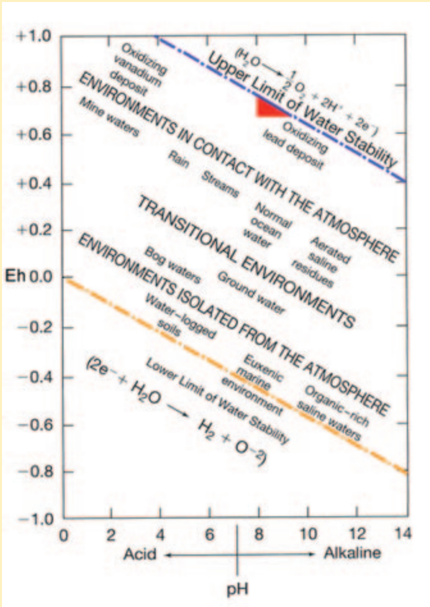

Figure 5: Phase equilibria diagram for depositional environments of iron oxide minerals. The red triangle indicates the window of environmental parameters necessary for the precipitation of pyrolusite to occur.

manganese into voids left by the biological material within the paleo-phreatic zone (Curtis and Coleman, 1986). Fe and Al are removed first by the movement of groundwater in different Eh and pH conditions (Figure 5), leaving Mn that will precipitate given the appropriate oxidizing conditions.

DISCUSSION

Preservation of soft tissue in the fossil record is a relatively rare occurrence globally, requiring a narrow set of paleoenvironmental and diagenetic conditions. Preservation of soft parts can begin to occur once the decomposing animal is buried below the taphonomically active zone. Occurrence of pyrolusite in the voids where the dinosaur skin decomposed after burial in the Lance Formation is indicative of extraordinary geochemical conditions in the sediment shortly after burial.

Pyrolusite (ß-MnO2) replacement of the Lance Formation dinosaur skin from the This Side of Hell Quarry in Elk Basin, Wyoming resulted in 3-D preservation and suggests that precise oxidizing Eh and pH conditions existed in the sediments around the dinosaur during decomposition. Such conditions had to occur almost immediately after burial and were sustained during diagenesis and the fossilization process. A sustained pH of at least 8.0 and an Eh of at least 0.75 (Figure 5) was reached. These constrained conditions had to be sustained in pore waters surrounding the dinosaur carcass during diagenesis for a few weeks to at least a few months (see Lynn and Bonatti, 1965; Burns and Burns, 1979; Curtis and Coleman, 1986; Guilbert and Park, 1986; Blatt et al., 1991; Connor, 1992).

Replacement of integument by pyrolusite probably began within hours to days of burial and continued over a period of weeks to months (see Mackenzie, 1976). Integument is usually preserved three-dimensionally, meaning that skin diagenesis occurred before the occurrence of significant compaction and dewatering of surrounding sediment. Cobalt and nickel commonly occur in association with other manganese oxides and sometimes with pyrolusite formed in soils, but cobalt and nickel are not associated with material analyzed by SEM-EDX from the Lance Formation. These results suggest that replacement of dinosaur skin by pyrolusite did not likely occur in a soil horizon. Furthermore, the ratio of Mn/Fe is higher when acidic groundwater percolates through soils depositing much of the ferric oxide in the B soil horizon, thereby enriching the B-horizon in manganese (Krauskopf, 1957). A near lack of Fe in the EDX Lance Formation material suggests that replacement of the dinosaur skin took place below the B-paleosoil horizon. Replacement of skin probably occurred after the carcass was buried in a marginal-marine setting, possibly in the marine phreatic zone.

Paleosols in the Lance Formation would have formed regionally during emergent conditions within deltaic complexes, and being naturally rich in Fe, Al, Mn, and CO2, would have become leached as a consequence of net downward movement of acidic water during deposition, provided Eh and Ph conditions combined properly. Thus, the paleosols could have provided a source of Mn and eventual precipitation of pyrolusite.

SUMMARY AND IMPLICATIONS

The dinosaur in This Side of Hell Quarry in the Lance Formation fossilized in tightly constrained paleoenvironmental conditions resulting in replacement of integument by pyrolusite. Sediments provided an environment in which sustained contact between the marine-fluvial interface and dinosaur integument occurred during diagenesis and fossilization. This suggests dinosaur skin replacement occurred near to a source of marine water that mixed with fluvial water. Replacement of integument was relatively rapid, having to occur prior to total dissolution by decay and prior to the invasion of carrion eating meiofauna. The apparent preferential preservation of hadrosaur dinosaur skin and the association and partial articulation of the skeleton (Figure 2), suggests that this dinosaur lived close to the environment in which exceptional preservation of soft tissue could occur (Figure 6). It further suggests rapid and nearly complete burial that occurred in this instance in fine-grained sandstone. The presence of pyrolusite is proxy evidence that the environment in which fossilization and diagenesis occurred was influenced by the marine-fluvial interface.

This Side of Hell Quarry is located relatively far to the west of the generally accepted Maastrichtian paleogeography, which places the ancient shoreline well to the east (Figure 7). Other Maastrichtian dinosaur skin occurrences (Figure 7) should be examined and investigated for the mineralogy of the skin and

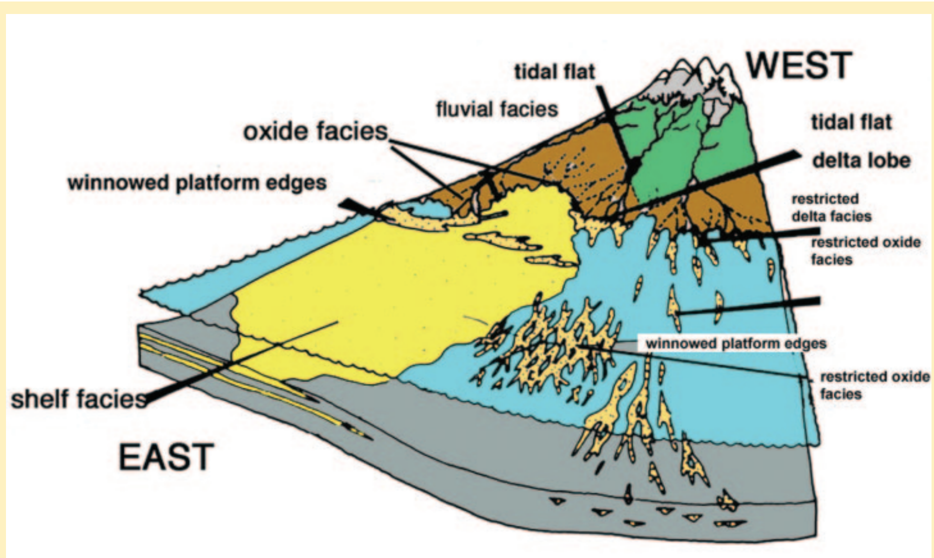

Figure 6: Paleoenvironmental model for the deposition of Lance Formation and related strata in the present-day Elk Basin, Wyoming.

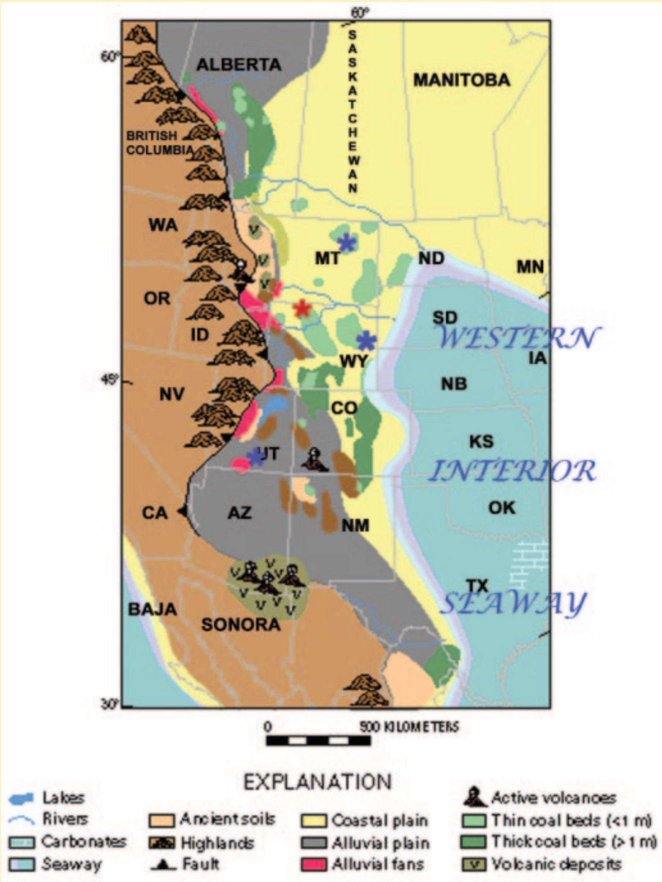

Figure 7: *Generalized partial Late Maastrichtian paleogeography map of North America. The "This Side of Hell, Wyoming Quarry" with pyrolusite replacement of dinosaur skin is shown in a red asterisk. Representative localities of additional Maastrichtian dinosaur skin occurrences are shown in blue asterisks (e.g., Sternberg, 1925; Horner, 1984; Gillette, 2002). Only the "This Side of Hell, Wyoming Quarry" dinosaur skin has undergone SEM-EDX thus far to test for replacement mechanisms. Modified from http://energy.usgs.gov/factsheets/cret.coals/maas.gif.*

thus, the potential geochemistry of the sedimentary environment surrounding the fossils. In the Lance Formation, in the This Side of Hell Quarry, possibilities that could result in this mixing of marine and fluvial waters include the following: 1) Replacement by pyrolusite occurred because marine water could mix with fluvial water, all in sustained contact with the dinosaur carcass during decomposition. 2) The dinosaur was buried in sediments indirectly influenced by marine conditions such as a salt marsh, tidal-flat, or deltaic complex during fossilization processes. 3) Replacement by pyrolusite during decomposition can (and in this case probably did) happen in a matter of weeks to a few months, so preservation took place relatively rapidly during diagenesis as 3-D preservation of hadrosaur dinosaur integument has occurred.

ACKNOWLEDGMENTS

This research is permitted and facilitated by the United States Department of the Interior, Bureau of Land Management, Wyoming permit PA02-WY-069. S. Bhattiprolu and the MARC analytical facility at The Ohio State University provided access and assistance with SEM-EDX analysis. S. Bergström, G. Faure, D. Hanson, S. Huson, V. Meyers, J. Murray, J. Mononi, and G. J. Wasserman provided constructive input and/or physical assistance to the facilitation of the project. Howell Petroleum Elk Basin Field Operations, Earthwatch Institute Volunteer Teams of 2002, and Quarry Volunteers 2003 provided help in excavating the This Side of Hell Quarry. L.E. Babcock, S.A. Leslie, and K. Polak provided editorial assistance in the preparation of this paper. We would like to thank M. E. McMillan for her review of this paper.

REFERENCES

ANDERSON, B.G., BARRICK, R.E., DROSER, M.L., and STADTMAN, K.L., 1999, Hadrosaur skin impressions from the Upper Cretaceous Neslen Formation, Book Cliffs, Utah: Morphology and paleoenvironmental context, in Gillette, D.D., ed., Vertebrate Paleontology of Utah: Utah Geological Survey, Miscellaneous Publication 99-1, p. 295-302.

ARCHIBALD, J.D., 1996, Dinosaur extinction and the end of an era: Columbia University Press, New York, 237 p.

BABCOCK, L.E., 1998, Experimental investigation of the processes of fossilization: Journal of Geoscience Education, v. 46, p. 252-260.

BABCOCK, L.E., MERRIAM, D.F., and WEST, R.R., 2000, Paleolimulus, an early limuline (Xiphosurida), from Pennsylvanian-Permian Lagerstätten of Kansas, and taphonomic comparison with modern Limulus: Lethaia, v. 33, p. 129-141.

BLATT, H., BERRY, W.B.N., and BRANDE, S., 1991, Principles of Stratigraphic Analysis: Blackwell Scientific Publications, p. 428-429.

BREITHAUPT, B.H., 1982, Paleontology and paleoecology of the Lance Formation (Maastrichtian), east flank of Rock Springs Uplift, Sweetwater County, Wyoming: Wyoming Geological Survey, Contributions to Geology, v. 21, p. 123-151.

BREITHAUPT, B.H., 1985, Nonmammalian vertebrate faunas from the Late Cretaceous of Wyoming, in Nelson, G.E., ed., Wyoming Geological Association, Thirty-Sixth Annual Field Conference Guidebook, Casper, p. 159-175.

BREITHAUPT, B.H., 1997, Lance Formation, in Currie, P. J., and Padian, K, eds., Encyclopedia of dinosaurs, Academic Press, San Diego, p. 394-395.

BREITHAUPT, B.H., 2001, Passport-In-Time microvertebrate Fossil Project at the University of Wyoming Geological Museum: Late Cretaceous paleontological resources in the public eye, in Santucci V. L., and McClelland L. eds., Proceedings of the 6th Fossil Resources Conference, United States Department of Interior - National Park Services - Geological Resources Division, p. 107-112.

BRIGGS, D.E.G., WILBY, P.R., PEREZ. M., BERNARDINO, P., SANZ, J-L., and FREGENAL MARTINEZ, M., 1997, The mineralization of dinosaur soft tissue in the Lower Cretaceous of Las Hoyas, Spain: Journal of the Geological Society of London, v. 154, p. 587-588.

BROWN, B., 1916, A complete skeleton of the horned dinosaur Monoclonius, and description of a second skeleton showing skin impressions: American Museum of Natural History, Bulletin, No. 37, p. 281-306.

BURNS, R.G., and BURNS, V.M., 1979, Manganese oxides, in Burns, R.G., ed., Marine Minerals: Mineralogical Society of America Short Course Notes, v. 6, p. 1-40.

CHAMBERLAIN, A.T., and PEARSON, M.P., 2001, Earthly remains: Oxford University Press, 207 p.

CLEMENS, W.A., 1964, Fossil mammals of the type Lance Formation, Wyoming. Part I. Introduction and Multituberculata: University of California Publications in Geological Sciences, v. 48, p. 1-105.

CLEMENS, W.A., 1966, Fossil mammals of the type Lance Formation, Wyoming. Part II. Marsupialia: University of California Publications in Geological Sciences, v. 62, p. 1-122.

CLEMENS, W.A., 1973, Fossil mammals of the type Lance Formation, Wyoming. Part III. Eutheria and summary: University of California Publications in Geological Sciences, v. 94, p. 1-102.

CONNOR, C.W., 1992, The Lance Formation – petrography and stratigraphy, Powder River Basin and nearby basins, Wyoming and Montana: U. S. Geological Survey, Bulletin 1917-I, p. 11-19; 110-117.

COPE, E.D., 1872, On the existence of Dinosauria in the Transition Beds of Wyoming: Proceedings of the American Philosophical Society, v. 12, p. 481-483.

COPE, E.D., 1885, The ankle and skin of the dinosaur Diclonius mirabilis: American Naturalist, v. 19, p. 1208.

CURTIS, C.D., and COLEMAN, M.L., 1986, Controls on the precipitation of early diagenetic calcite, dolomite, and siderite concretions in complex depositional sequences, in Gautier, D.L., ed., Roles of organic matter in sediment diagenesis, SEPM Special Publication 38, p. 23-34.

CZERKAS, S., 1997, Skin, in Currie, P. J., and Padian, K, eds., Encyclopedia of dinosaurs, Academic Press, San Diego, p. 669-675.

DERSTLER, K., 1994, Dinosaurs of the Lance Formation in eastern Wyoming, in Nelson, G.E. ed., Wyoming Geological Association, Forty-Fourth Annual Field Conference Guidebook, Casper, p. 127-146.

ESTES, R., 1964, Fossil vertebrates from the Late Cretaceous Lance Formation, eastern Wyoming: University of California Publications in Geological Sciences, v. 49, p. 1-180.

GILLETTE, D.D., 2002, Skin impressions from the tail of a Hadrosaurian dinosaur in the Kaiparowits Formation (Upper Cretaceous), Grand Staircase-Escalante National Monument: Geological Society of America, Abstracts with Programs, v. 34, no. 4, p. 6.

GUILBERT, J.M., and PARK, C.F., 1986, The geology of ore deposits: W.H. Freeman and Company, New York, p. 708-715.

HORNER, J.R., 1984. A 'segmented' epidermal tail frill in a species of hadrosaurian dinosaur: Journal of Paleontology, .v. 58, p. 270-271._

KOTHNY, E.L., 1983, The nature of manganese oxides: California Mining Journal, v. 52, no. 8, p. 5-6.

KRAUSKOPF, K.B., 1957, Separation of manganese iron in sedimentary processes. Geochemica et Cosmochimicha Acta., v. 19, p. 61 –81.

LULL, R.S., and WRIGHT, N.E., 1942, Hadrosaurian dinosaurs of North America: Geological Society of America Special Paper 40, p. 1-242.

LYNN, D.C., and BONATTI, E., 1965, Mobility of manganese in diagenesis of deep-sea sediments: Marine Geology, v. 3, p. 457-474.

McKENZIE, R.M., 1976, The manganese oxides in soils, in Varentsov, I. M., and Grasselly, G. eds., Geology and geochemistry of manganese: Proceedings of the 2nd International Symposium on Geology and Geochemistry of Manganese, Sydney, Australia, p. 259-269.

MURPHY, N.L., TREXLER, D., and THOMPSON, M., 2002, Exceptional soft-tissue preservation in a mummified ornithopod dinosaur from the Campanian Lower Judith River Formation: Journal of Vertebrate Paleontology, v. 22, no. 3, p. 91A.

OSBORN, H.F., 1912, Integument of the iguanodont dinosaur Trachodon. American Museum of Natural History, Memoirs, Part II, p. 31-54.

STERNBERG, C.H., 1909, A new trachodon from the Laramie beds of Converse County, Wyoming. Science, V. 29, p. 753-754.

STERNBERG, C.M., 1925, Integument of Chasmosaurus belli: Canadian Field Naturalist, v. 39, p. 108-110.

WEBB, M.W., 1998, A revised summary of Lancian (Latest Cretaceous) mammal localities with introduction to a new Lancian locality (Lance Formation) in the southwestern Bighorn Basin, in Keefer, W.R. and Goolsby, J.E., eds., Wyoming Geological Association, Thirty-Sixth Annual Field Conference Guidebook, Casper, p. 131-136.

WEGWEISER, M.D., 2002, Sequence Stratigraphy and Paleoecology of Late Cretaceous Campanian-Maastrichtian Transition Strata in the Western Bighorn Basin Region: Proceedings of the Tate Conference, Casper, Wyoming, p. 120-131.

WEGWEISER, M.D., BREITHAUPT, B. H., BABCOCK, L. E., SKINNER, E. S., and SHEFFIELD, J. W. 2003. Dinosaur skin fossils from This Side Of Hell, Wyoming: paleoenvironmental implications of an Upper Cretaceous konservat-lagerstätte. Journal of Vertebrate Paleontology, v. 23, no. 3, Supplement, p. 108

WHITMORE, J.L., 1985, Fossil mammals from two sites in the Late Cretaceous Lance Formation in northern Niobrara County, Wyoming, in Martin, J.E., ed., Fossiliferous Cenozoic deposits of western South Dakota and northwestern Nebraska: Dakoterra, v. 2, p. 353-367.

WHITMORE, J.L. and MARTIN, J.E., 1986, Vertebrate fossils from the Greasewood Creek locality in the Late Cretaceous Lance Formation of Niobrara County, Wyoming: South Dakota Academy of Science, Proceedings, v. 65, p. 33-50.

FIELD NOTES

Sedimentology in Deepwater Exploration

INTRODUCTION

Deepwater exploration geologists use sedimentology to develop and mature oil and gas prospects. The goal of exploration is to economically find significant hydrocarbon reserves. Properly assessing the risk and reserve potential of prospects is critical to making sound business decisions to achieve that goal.

Four geologic risk elements are useful in characterizing the risk of drilling exploration prospects: 1) trap (closure), 2) seal (containment), 3) hydrocarbons (source, timing, and migration), and 4) reservoir (stratigraphy and diagenesis) (e.g. Rose, 2001). One of the common causes of failure in deepwater exploration is insufficient reservoir. Deepwater wells (water depths greater than 1,500 ft) cost tens of millions of dollars, making the ability to accurately predict thick, high-quality pay sands a critical factor for project success.

Subsurface exploration and development utilize biased data that make understanding depositional systems very important. Wellbores are biased as they sample only a minute fraction of the reservoir. Seismic is biased because such data is limited by its resolution, typically 200 ft or more depending on frequency content. In subsalt reservoirs, areas of poor illumination can obscure seismic reflectivity. Understanding outcrop analogs is important to provide models that help predict reservoir heterogeneity, a difficult factor to characterize with subsurface data sets (e.g. Slatt, 2000). Exploration, therefore, commonly requires that we be model driven in predicting the distribution of deepwater turbidite sands.

Regional work is a key to better understanding the spatial and temporal distribution of turbidite sands. Characterizing sequences along sediment fairways, understanding shifting deltaic sources, and utilizing sea-level curves are important for developing predictive models. Mapping of sediment fairways shows pathways for sediments from the deltaic source to a prospect. It is very important to map the geometry of salt bodies at a given time interval, as they commonly form topographic highs that may deflect sands away from or pond sands at a prospect. Changes in sea-level not only affect sand deliverability to deepwater prospects, but sea-level highstands can create regional seals that can hold large columns of hydrocarbons.

Gulf of Mexico Turbidites

In this overview I will briefly discuss three turbidite depositional settings: 1) bypass, 2) confined/ponded, and 3) weakly confined. It is important to understand these depositional settings to properly focus exploration efforts. Deposition in these settings has complexities that are beyond the scope of this brief paper, but such details can be found in the selected references below.

Regions of steeper slope gradient that lack significant slope accommodation space define slope bypass settings. Slope gradient affects if bypass is partial (less steep) or complete (e.g. steeper pre-existing topography). Slopes are commonly marked by erosional channel or constructional channel-levee complexes. Basin-margin sands are typically channelized sheets that pass basinward to sheets, with deposition resulting from a decreasing gradient. Slope reservoirs typically have smaller reserves than base-of-slope reservoirs. Examples of slope turbidite systems are part of the Lower Tertiary of the western Gulf of Mexico and the middle Miocene of the eastern Gulf of Mexico. The Ram-Powell Field (Kendrick, 2000) is an example of base-of-slope reservoirs, and the sinuous channel-levee complex of the Main Pass 108 Field is an example of smaller slope reservoirs.

Intraslope basins that produce accommodation space that can trap turbidite sands on an otherwise bypass slope define confined/ponded depositional settings. Deposition in ponded settings has been described by the well-known fill-and-spill model (Prather et al, 1988; Beaubouef and Friedmann, 2000). Salt movement results in lower gradients and topographic highs that cause turbidity flows to slow and deposit. Sedimentation works to heal this topography, commonly resulting in successions of ponded sheet sands overlain by bypass channel-levee complexes. In some cases, depositional lows are later structurally inverted to create structural highs with very thick sands. The thick sands of inverted structures may contain large reserves, such as the turtle structure of the Thunder Horse discovery (Yielding et al., 2002) in Mississippi Canyon.

Slope topography that is not high enough to completely confine turbidity flows defines weakly confined depositional settings. Contractional tectonics of the Mississippi Fan Foldbelt produced structures that correspond to minor depositional thinning, but these topographic highs did not completely block flows. Sands were deposited as turbidity currents slowed as they ran up and over such positive features. Flow striping may occur on some topographically higher contractional structures, where only the upper, lower-concentration portion of turbidity currents pass across the structure. The Mad Dog Field (Apps et al., 2002) in southeast Green Canyon is an example of a reservoir in a weakly confined system in the Mississippi Fan Foldbelt.

SUMMARY

Sedimentology is an important aspect of deepwater exploration. Using geologic models to predict thick accumulations of reservoir sands will help target lower-risk prospects with higher reserves.

REFERENCES

Apps, G.M., Moore, M.G., Woodall, M. A., and Delph, B.C., 2002, Using sequence hierarchy to subdivide Miocene reservoir systems of the Western Atwater Foldbelt, ultra deep water Gulf of Mexico, in Armentrout, J.M. and Rosen, N.C., eds., Sequence Stratigraphic Models for Exploration and Production: Evolving Methodology, Emerging Models and Application Histories: Gulf Coast Section SEPM Foundation, 22nd Annual Bob F. Perkins Research Conference, p. 77-78.

Beaubouef, R.T., and Friedmann, S.J., 2000, High resolution seismic/sequence stratigraphic framework for the evolution of Pleistocene intra slope basins, western Gulf of Mexico: depositional models and reservoir analogs, in Weimer, P., Slatt, F.M., Coleman, J., Rosen, N.C., Nelson, H., Bouma, A.H., Styzen, M.J., and Lawrence, D.T., Deep-Water Reservoirs of the World: Gulf Coast Section SEPM Foundation, 20th Annual Bob F. Perkins Research Conference, p. 40-60.

Kendrick, J.W., Turbidite reservoir architecture in the northern Gulf of Mexico deepwater: insights from the development of Auger, Tahoe, and Ram/Powell fields, in Weimer, P., Slatt, F.M., Coleman, J., Rosen, N.C., Nelson, H., Bouma, A.H., Styzen, M.J., and Lawrence, D.T., Deep-Water Reservoirs of the World: Gulf Coast Section SEPM Foundation, 20th Annual Bob F. Perkins Research Conference, p. 450-468.

Prather, B.E., Booth, J.R., Steffens, G.S., and Craig, P.A., 1998, Classification, lithologic calibration, and stratigraphic succession of seismic facies of intraslope basins, deep-water Gulf of Mexico: American Association of Petroleum Geologists Bulletin, v. 82, p. 701-728.

Rose, P.R., 2001, Risk Analysis and Management of Petroleum Exploration Ventures: American Association of Petroleum Geologists, Methods in Exploration Series, Number 12, 164p.

Slatt, R.M., 2000, Why outcrop characterization of turbidite systems, in Bouma, A.H., and Stone, C.G., Fine-Grained Turbidite Systems: AAPG Memoir 72/SEPM Special Publication 68, p. 181-186.

Yielding, C.A., Yilmaz, B.Y., Rainey, D.I., Pfau, G.E., Boyce, R.L., Wendt, W.A., Judson, S.G., Peacock, S.G., Duppenbecker, S.D., Ray, A.K., and Hollingsworth, R., 2002, The history of a new play: Crazy Horse Discovery, Deepwater Gulf of Mexico: AAPG Annual Meeting (Abstract).

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The Hand Lens—a student forum

INTELLIGENT DESIGN: EXHUMATION OF AN OLD, FAILED IDEA

The deep history of the Earth, replete with shifting continents, fluctuating sea levels, and evolving life, is what sustains my fascination with geology. Unfortunately, this rich history is also what makes geology and paleontology particularly tempting targets for creationists of all kinds. Ironically enough, creationists have become highly skilled at adapting to the fact that the courts in this country have consistently ruled against the teaching of creationism in public school science classrooms. Their latest strategy involves lobbying state school boards to adopt watered-down science standards that de-emphasize or eliminate the teaching of evolution, as well as other key concepts such as the ancient age of the earth. This strategy uses a manifestation of old-earth creationism called Intelligent Design (ID) to claim that there is conflict in the scientific community regarding evolution. Playing to the need for "fairness," ID supporters argue that this conflict should be taught in science classrooms because ID is a legitimate scientific alternative to evolution. On the contrary, ID is simply an attempt to sneak creationism into the backdoor of our public schools.

Essentially, ID holds that some things in nature, such as vertebrate eyes or complex biomolecules, are "irreducibly complex", so complex that if you remove one part, then the entire mechanism fails to function (Behe, 1996). Such failure to function, the argument goes, indicates that natural selection could not have led to the evolution of such a structure, because any "intermediate" evolutionary forms would not be functional. Such "irreducibly complex" objects therefore defy our explanatory powers and so must then by default have been designed by some, presumably "higher", form of intelligence. Such arguments are nothing new. William Paley first promoted these ideas in his book Natural Theology nearly 200 years ago (Paley, 1836). Paley's arguments have been repeatedly tested and rejected by science ever since. So the current proponents of ID, rather than being the innovators they claim to be, are merely resurrectors of a stale idea from the dustbin of science.

Even if one ignores the failed history of ID, this re-born idea of ID ostensibly as a scientific theory has fatal flaws rooted in its simplistic view of biological evolution. We now know that form and function are fluid through time such that the same morphological feature or biomolecule can be used for different functions at different times in the evolutionary history of an organism. And there are abundant examples in biology of seemingly simple, or "partial", forms of organs working perfectly well for certain animals. ID also relies heavily on the fact that there are gaps in our scientific knowledge. But science requires such knowledge gaps as fuel for the development of testable hypotheses. The moment humanity acquires complete knowledge of the natural universe, which will never happen, then science, by definition, will cease to exist.

I happen to have quite a bit of first-hand experience with ID and its proponents because of a scientific meeting that I attended in China a few years ago. Unbeknownst to the organizers of this meeting, who did a wonderful job, it was sabotaged, if you will, by prominent ID supporters from the Discovery Institute in Seattle, a conservative think tank that funds much of the ID movement. The meeting provided a glimpse at their techniques and into their world. I learned that ID proponents are essentially trying to create their own alternative pseudoscientific universe, complete with "Senior Fellows" with advanced degrees, often in philosophy and religion, free-lance "science" writers whose job is to blatantly misquote scientists in later newspaper articles, and even a young-earth creationist paleontology graduate student who goes "deep undercover" at scientific meetings. Of course, the ultimate goal of everyone in this little universe is to get ID, and subsequently creationism, into the science classrooms of our public schools by whatever means necessary.

So what can students do to help defend science education against such insidious forces? I know that many students feel powerless to do anything, but that is not the case. First of all, students can support the National Center for Science Education (NCSE). They are on the front lines in the fight for science education. Among many other activities, NCSE provides crucial information for school boards approving new curricula and textbooks, conducts speaking tours, and keeps the scientific community aware of the latest creationist maneuvers. Go to their website (www.ncseweb.org) to learn more.

Aside from supporting the NCSE, students can also defend science by respectfully countering creationist propaganda wherever and whenever they encounter it. If this happens in the classroom, emphasize that people certainly have the right to believe in any form of religion, including those that teach strict creationism, but that this is a science class. As such, evolution, or deep time as may be the case, will be taught because it is the scientific perspective. They do not have to accept evolution or deep time, but they are responsible for learning it.

It is unfortunate that so much time and energy has to be spent defending science education in this country. But it really is a necessary part of our chosen profession as geologists, and students can certainly lend their weight to the fight.

REFERENCES

Behe, M., 1996, Darwin's Black Box. The Free Press, New York, 320 pp.
Paley, W., 1836, Natural Theology. C. Knight, 392 pp.

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PRESIDENT'S OBSERVATIONS

What is SEPM and Who Runs It?

This is my last letter as president of SEPM. The year has certainly gone by fast, but I've had a great time and am grateful for this opportunity to serve this society.

A few weeks ago I was headed out my door for yet another meeting and ran into my neighbor Harvey. I'm going to the GCS-SEPM meeting I replied when he asked where I was going. Well, he said, I can think of what the GCS stands for but what is SEPM? It's the Society for Sedimentary Geology, I replied.

I guess when you get right down to it, names don't matter much. It's what the society is all about that matters. I have belonged to SEPM since I was a graduate student, more years than I care to mention. It was through this society that I came to know many of my best friends and colleagues. I would hardly get to see them if it where not for the annual meetings and research conferences. Those meetings also provide great opportunities to learn and generate new ideas. I usually leave physically and mentally exhausted, but also energized and ready to push on with my teaching and research. I try to take as many of my students to the meetings as I can because I see them mature professionally at every one. It is also a time for them to meet and talk with those people whose papers they have read and to learn more about career opportunities.

In addition to our regular journals, the Journal of Sedimentary Research and PALAIOS, the Society publishes special publications that encapsulate current knowledge and new ideas about specific aspects of sedimentology and paleontology. Then there are the research conferences. If you have not participated in one you really should. They are a remarkable learning experience.

I guess if Harvey asks me what SEPM does my response will be, we engage in continuing education for our membership.

During my four-year tenure as councilor for research, president-elect and president I learned a lot about how SEPM works. I also came to truly appreciate the dedicated staff in Tulsa. We can all rest assured that the society is in good hands. Officers come and go, but the society continues to operate, thanks to the staff. Howard Harper, our executive director and Theresa Scott, who manages the Tulsa office, are the mainstays in this society.

Howard is the point man for the society. He maintains communication with other societies, an increasingly important job, and makes sure tasks are completed when they are supposed to be completed. I cannot count the times I have had to rely on Howard to provide guidance when making decisions and moral support when it was most needed.

Theresa oversees the office staff and keeps the societies financial records. I must confess that, after four years and numerous meetings dealing with the society's financial matters, I am still baffled by the process. Her job is an awesome one and I have watched in awe as she and Howard have wrestled with the never-ending task of making predictions about sales of books and other income and tried to balance the books long before proceeds are seen. I still don't know how they do that, but I am confident that the society is in good hands. The rest of our small staff is just as indispensable for SEPM. Judy Tarpley is the primary point person on all of our events; Kris Farnsworth co-ordinates all of the special publications production as well as handling the website; and Michele Woods makes sure that all of the members requests for books, journals and renewals actually get done.

A good staff is essential to the success of SEPM, but the society could not, and will not, succeed without those members who volunteer their time and ideas. Among the volunteer ranks, two jobs in particular stand out as being especially demanding. That is the chairman of the Headquarters Business Committee (HBC) and the director of the SEPM Foundation. John Robinson is the current chairman of HBC. While our staff does a fantastic job, they depend on guidance from the membership, especially in making financial predictions and in providing external oversight of the business office. HBC provides that guidance. John's job is time consuming, but he has carried it out with competence and good humor. Thank you John for your services to the society.

When you see him coming, get out your checkbook. Tim Carr does a job that many of us would not want. He oversees fund raising for the Foundation and guards those funds as though they were his own retirement nest egg. If you want money from the Foundation, you had better have a good reason, and that is the way it should be. Thank you Tim for your service to this society.

My last official function as president will be to host the annual SEPM luncheon and the president's reception and awards ceremony in Dallas. John Van Wagoner will be the luncheon speaker. Those of you who have heard John speak know that it will be a lively and provocative talk. At the reception we will honor those members of our society who have achieved great things. It is a chance for us all to acknowledge their contributions to sedimentology. Please join us at the reception for what I promise will be an enjoyable gathering of mud and bug people.

John Anderson
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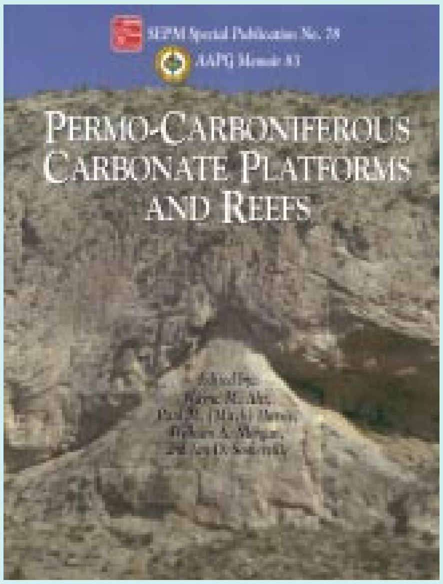
Council Members & Election Results

	Outgoing Council (2003-2004)	*Incoming Council (2004-2005)*
President	John B. Anderson	Rick Sarg
President–Elect	Rick Sarg	William Morgan*
Secretary–Treasurer	William Morgan	Lesli Wood*
Sedimentology Councilor	Maria Mutti	Maria Mutti
Paleontology Councilor	Dawn Sumner	Dawn Sumner
Research Councilor	John Suter	Vitor Abreu*
International Councilor	Ole Martinsen	Serge Berne*
Editors—JSR	Mary Kraus/David Budd	Kitty Milliken/Colin North*
Editor—PALAIOS	Christopher Maples	Christopher Maples
Editor—Special Publications	Laura Crossey	Laura Crossey
Foundation President	Tim Carr	Tim Carr*

Special thanks to John Robinson, Fred Behnken, Janok Bhattacharya and Gary Hampson who so kindly agreed to stand for office and to all those members who actually voted.

**Newly elected to office*

NEW from the SEPM Bookstore!



SEPM Special Publication #78:

Permo-Carboniferous Carbonate Platforms and Reefs

Edited By: Wayne M. Ahr, Paul M. (Mitch) Harris, William A. Morgan, and Ian D. Somerville

Global geologic changes with magnitudes and rates among the most dramatic in earth history occurred during Permo-Carboniferous times. Dramatic shifts in global tectonics resulted in the docking of Gondwana and Euramerica to create the supercontinent *Pangaea* and the "world ocean" *Panthalassa*. Fluctuations in atmospheric and oceanic chemistry, changes in global climate, and evolutionary changes associated with the Devonian – Carboniferous transition and the devastating mass extinction at the close of the Permian Period formed the backdrop for the shifting panorama of this remarkable time. These changes had marked and global impact on carbonate sequence stratigraphy, platform architecture, reef and mound characteristics, and diagenesis and reservoir properties.

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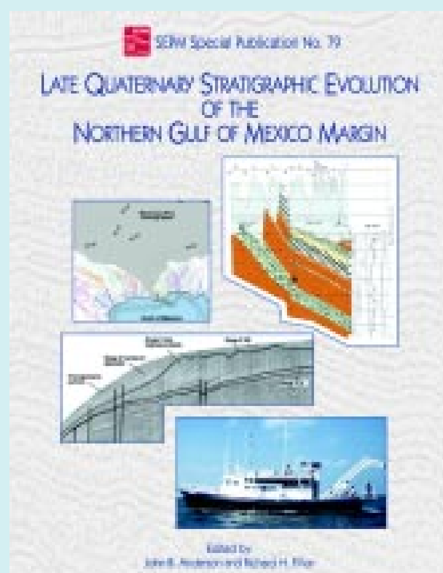
SEPM Special Publication #79:

Late Quaternary Stratigraphic Evolution of the Northern Gulf of Mexico Margin

Edited By: John B. Anderson and Richard H. Fillon



The northern Gulf of Mexico margin encompasses a variety of depositional settings characterized by different drainage basin size, physiography, fluvial morphology, climatic setting, and structural and diapiric activity. This, plus the abundance of long sediment cores and platform borings from oil industry activities, make it an unparalleled natural laboratory for sedimentological and stratigraphic studies and for testing sequence stratigraphic concepts. This volume contains twelve papers describing results from high-resolution stratigraphic studies of late Quaternary strata of the northern Gulf of Mexico, from the mouth of the Apalachicola River to the Rio Grande. These papers focus on fluvial response to climate and base-level change, variations in delta growth and evolution across the shelf, lowstand delta-fan evolution, the evolution of transgressive deposits on the shelf, the preservation of these deposits. The robust chronostratigraphic frameworks developed for the different study areas allows comparison of strata geometries produced by contemporaneous depositional systems operating under identical eustatic conditions.

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