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INSIDE: EXPLORING THE SEDIMENTARY, PEDOGENIC, AND HYDROLOGIC FACTORS THAT CONTROL THE OCCURRENCE AND ROLE OF BIOTURBATION IN SOIL FORMATION AND HORIZONATION IN CONTINENTAL DEPOSITS: AN INTEGRATIVE APPROACH

PLUS: SGD NEWS, PRESIDENT'S COMMENTS

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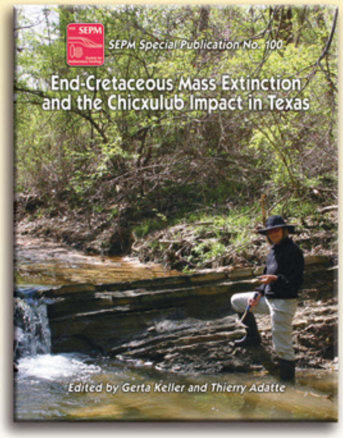
Special Publication #100

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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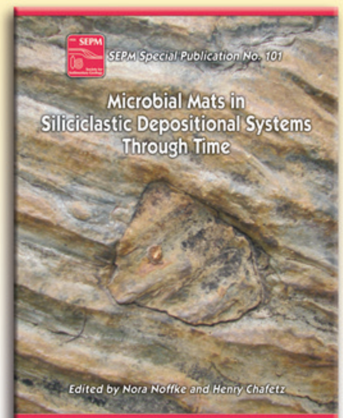
Special Publication #101

Microbial Mats in Siliciclastic Depositional Systems Through Time

Edited by: Nora Noffke and Henry Chafetz



The research field on microbial mats in siliciclastic environmental settings has greatly developed since its establishment by studies of pioneering scientists such as Gisela Gerdes, Wolfgang Krumbein, Jürgen Schieber, David Bottjer and others. This SEPM Special Publication is the result of the SEPM Field Conference on Sandy Microbial Mats (modern and ancient), which was held in May 21st to 23rd, 2010 at Dinosaur Ridge, Denver, Colorado, USA. The volume presents peer reviewed individual case studies on microbial mats and on sedimentary structures (often called “microbially induced sedimentary structures—MISS”) that occur in modern and ancient marine and terrestrial environments. The conference brought together sedimentologists, microbiologists, and paleontologists from 30 countries and all five continents. Topics discussed ranged from the evolution of cyanobacteria, the detection of quorum sensing in biofilms to the taxonomy of MISS and microbial mat ecology. The talks and posters presented fossil material from 3.2 Ga old rock successions to microbial mat samples from sediments of the present day. This volume is designed to present the wide spectrum of research in this multidisciplinary scientific field, and to integrate the many different points of views and approaches.

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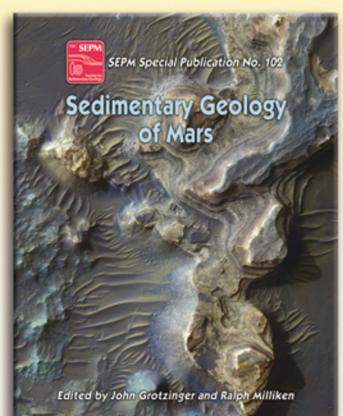
Special Publication #102

Sedimentary Geology of Mars

Edited by: John P. Grotzinger and Ralph E. Milliken



Often thought of as a volcanically dominated planet, the last several decades of Mars exploration have revealed with increasing clarity the role of sedimentary processes on the Red Planet. Data from recent orbiters have highlighted the role of sedimentary processes throughout the geologic evolution of Mars by providing evidence that such processes are preserved in a rock record that likely spans a period of over four billion years. Rover observations have provided complementary outcrop-scale evidence for ancient eolian and fluvial transport and deposition, as well as surprisingly Earth-like patterns of diagenesis that involve recrystallization and the formation of concretions. In addition, the detection of clay minerals and sulfate salts on Mars, coupled with large-scale morphologic features indicative of fluvial activity, indicate that water-rock interactions were once common on the martian surface. This is in stark contrast to the dry and cold surface environment that exists today, in which eolian processes appear to be the dominant mode for sediment transport on Mars. These issues and others were discussed at the First International Conference on Mars Sedimentology and Stratigraphy, held in El Paso, Texas in April of 2010. The papers presented in this volume are largely an extension of that workshop and cover topics ranging from laboratory studies of the geochemistry of Martian meteorites, to sediment transport and deposition on Mars, to studies of terrestrial analogs to gain insight into ancient Martian environments. These papers incorporate data from recent orbiter and rover missions and are designed to provide both terrestrial and planetary geologists with an overview of our current knowledge of Mars sedimentology as well as outstanding questions related to sedimentary processes on Mars.

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Cover photo: Ribbon sandstones, sheet sandstones, and pedogenically modified overbank mudstones, Salt Wash Member, Upper Jurassic Morrison Formation, Garfield County, Utah, USA. Ribbon in lower half of image is 1 m thick.

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Exploring the sedimentary, pedogenic, and hydrologic factors that control the occurrence and role of bioturbation in soil formation and horizonation in continental deposits: An integrative approach

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ABSTRACT

Interpretation of paleosols involves deciphering the complex interplay between multiple biotic and abiotic processes. Previous ichnological research has shown that trace fossils, which record biotic influences on pedogenesis, are particularly useful for reconstructing physicochemical conditions during soil formation, which, in turn, can yield important data about paleoenvironment, paleohydrology, and paleoclimate. Our goal is to integrate ichnology with the substantial body of research that exists in the areas of sedimentology and pedology to present an integrative framework with which to interpret paleosols in the continental rock record. Tiering of traces is particularly prominent in terrestrial settings because the vertical distribution of soil biota is controlled largely by the groundwater profile. Interpretations of trace fossils are therefore facilitated by assigning traces to one of four moisture regimes: epiterraphilic, terraphilic, hygrophilic, and hydrophilic. The balance between deposition and pedogenesis is expressed by the paleosol profile, which can range from simple to compound, composite, or cumulative. The combination of sedimentation and pedogenesis, including groundwater-influenced bioturbation, can act to enhance or destroy horizonation within soils; these processes ultimately determine the paleosol characteristics that are preserved in the stratigraphic record. We illustrate our conceptual model with examples of multiple paleosol types that contain evidence of varying amounts of bioturbation attributable to crayfish.

INTRODUCTION

Trace fossils, studied via their architectural and surficial morphologies and the material that fills them, record information about the tracemaker and the physicochemical conditions of its surroundings (Bromley, 1996; Hasiotis, 2002). Deciphering the occurrence, depth, and tiering of plant and animal trace fossils in paleosols is paramount to interpreting the sedimentological, pedological, and hydrological conditions under which paleosols formed in continental deposits (Bown and Kraus, 1983; Hasiotis, 2002, 2007). This is particularly important for reconstructing the postdepositional histories of landscapes and the physicochemical conditions experienced by the organisms and soils, and recorded by sedimentary and pedogenic (i.e., biotic and abiotic) fabrics (Jenny, 1941; Hasiotis, 2004, 2008; Schaetzl and Anderson, 2005; Hembree and Hasiotis, 2007; Smith et al., 2008). Bioturbation in modern soils, particularly by animals, is known to be extremely effective at mixing sediment at and within the subsurface, and helping to build and destroy pedogenic structures and voids while playing a major role in nutrient cycling (Wallwork, 1970; Hole, 1981).

Herein we explore the hydrological, sedimentological, and pedological factors that control the spatial and temporal distribution of terrestrial and aquatic bioturbation that results in pedogenic fabrics and horizonation, and the physicochemical expression of organism-sediment interactions. Our objective is to demonstrate that trace fossils can be equally as powerful in reconstructing paleoenvironments and the depositional histories of continental sedimentary successions as marine trace fossils based on their occurrence, tiering, depth, and relation to the sedimentary facies (Figure 1). Despite the similarities between continental and marine trace fossils and their resultant bioturbation, their genesis and significance are distinctly different from each other because the specific organism behaviors and biophysicochemical conditions under which the traces formed are exclusive to each realm of deposition (e.g., Hasiotis and Bown, 1992; Hasiotis, 2002, 2008).

MATERIAL AND METHODS

Actualistic studies of the spatial and temporal distribution of terrestrial and aquatic organisms in continental environments provide the dataset from which we explore ichnopedologic fabrics—sedimentary fabrics that result from bioturbation and pedoturbation (Appendix A)(Hasiotis, 2007; Hasiotis et al., 2007, in press, and references therein). These and other actualistic studies were synthesized to understand how organisms interact with sediment to produce bioturbation that results in soils and horizonation through organism activity. Tracemakers of ichnofossils in paleosols are inferred from the trace fossil and its relationship to the sedimentary and pedogenic fabric. These interpretations are also made via comparison to similar structures found in modern depositional systems, continental environments, and pedogenically modified sediment that are analogous to the studied geologic deposits.

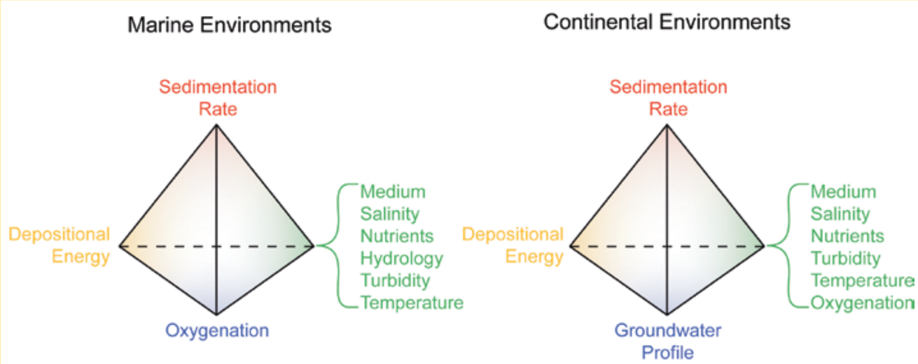

Figure 1: Tetrahedra illustrating the major physicochemical controls on trace-making organisms in marine and continental environments. Though parallel in many respects, the major difference between the two is the role of the groundwater profile and subaerial exposure in continental environments that allows soil formation to take place.

We integrated the concepts from several major reviews on processes that link various aspects of pedogenesis to sedimentation and pedoturbation (i.e., both biotic and abiotic aspects), bioturbation to sedimentation, and bioturbation to pedogenesis (Jenny, 1941; Wallwork, 1970; Hole, 1981; Johnson et al., 1987; Kraus, 1999; Schaetzl and Anderson, 2005; Hasiotis, 2002, 2007; Hasiotis et al., 2007). We used Hasiotis (2004, 2007, and references therein) to understand how the spatial and temporal distribution of the hydrologic regime and groundwater profile effect terrestrial and aquatic organisms and communities. We used Kraus (1999, and references therein) to recognize the interplay between sedimentation and pedoturbation under nonsteady and steady state conditions of deposition to produce soils of various developmental stages and pedogenic fabrics. We used Johnson et al. (1987, and references therein) to comprehend the production and destruction of horizonation in soils due to biotic and abiotic pedoturbation through time

DEVELOPING AN INTEGRATIVE APPROACH TO DECIPHER ICHNLOGIC PATTERNS IN PEDOGENICALLY MODIFIED DEPOSITS

Organism Tiering and Moisture Regimes

Organisms in terrestrial and aquatic environments are distributed vertically in sediments and soils based on biological and physicochemical characteristics with respect to their affinity for water (Cloudsley-Thompson, 1962; Wallwork, 1970; Whittaker, 1975; Glinski and Lipiec, 1990; Hasiotis, 2007; Hasiotis et al., in press). This vertical distribution is referred to as tiering, which also takes place in the marine realm (Bromley, 1996; Hasiotis, 2002). Modern and ancient traces can be assigned to one of four moisture regimes based on the space occupied, trophic use, and moisture zones of the groundwater profile, which behaviorally classifies the tracemaker as 1) epiterraphilic—organisms living on the surface, 2) terraphilic—organisms living above the water table to the upper vadose zone, 3) hygrophilic—organisms living in the vadose zone, or 4) hydrophilic—organisms living below the water table within a soil or living in aquatic settings and make traces on or below the sediment surface in open bodies of water (Hasiotis 2000, 2004, 2008). This moisture-regime classification is based on the well-established concept that moisture is a major control on the distribution of soil fauna (Cloudsley-Thompson, 1962; Wallwork, 1970; Hasiotis 2002, 2008; Hasiotis et al. 2007, in press; Counts and Hasiotis, 2009). Even though Bromley et al. (2007) questioned the methods of Hasiotis (2004), an abundance of life history studies of modern tracemakers demonstrate that moisture levels control the behavior, depth, distribution, and reproductive success of continental organisms (Appendix A; Hasiotis 2008).

Terrestrial environments, in contrast to aquatic environments, exhibit the overall greatest depth of tiering (Figure 2), based on studies of modern plant, invertebrate, and vertebrate traces (Hasiotis et al., in press). The depth, diversity, and abundance of organism traces are controlled mostly by the groundwater profile and climate, which is measured by temperature, precipitation, seasonality, solar insolation, and controlled by continentality, latitude, wind patterns, and orographic effects (e.g., Jenny, 1941; Thornthwaite and Mather, 1955; Birkeland, 1999). These subaerial bioturbation patterns are distributed between up to all four zones of moisture-regime behavior and play a major role in sediment mixing that leads to the construction and destruction of soil structures and horizons (e.g., Thorp, 1949; Hole, 1981; Halfen and Hasiotis, 2010).

Aquatic environments exhibit the shallowest tiering depth, which is restricted to the hydrophilic zone. The depth of burrowing and feeding in freshwater rivers and lakes is controlled mostly by bottom-water oxygen, redox conditions in the sediment, and the size and ability of an organism to modify its microenvironment (Fisher, 1982; McCall and Tevesz, 1982; Ward, 1992; Hasiotis, 2002). The relative permanency of an aquatic environment and absence of subaerial exposure limit the penetration and mixing depth of bioturbation, which also prevents the movement of physicochemical constituents and formation of secondary structures typical of soils and paleosols.

Thus, a community of organisms that inhabits a landscape at any one moment in space and time will exhibit different behaviors representative of each moisture regime that reflect the groundwater profile under a particular climatic and hydrologic regime. The resultant depths of burrowing and rooting behaviors (Figure 2) through time (i.e., seasonal and annual activities) will mirror the development of soil horizons and their inherent pedogenic fabrics.

Interplay of Sedimentation and Pedoturbation: How Bioturbation is Expressed

Soil formation, and thus paleosol formation, is the result of the interplay between the sedimentation regime, hydrologic regime, pedoturbation, and the traditional soil-forming factors (Figures 2–3A). Together, they control the sediment accumulation rate and stacking pattern of finer grained vs. coarser grained sediment and the relative duration of soil formation (Bull, 1991; Kraus, 1999 and references therein). When combined with nonsteady and steady state deposition in alluvial systems, a variety of soil categories are produced (Figures 3–4). A paleosol representing pedogenesis in a body of sediment during a period of landscape stability—i.e., no substantial deposition or erosion—is considered

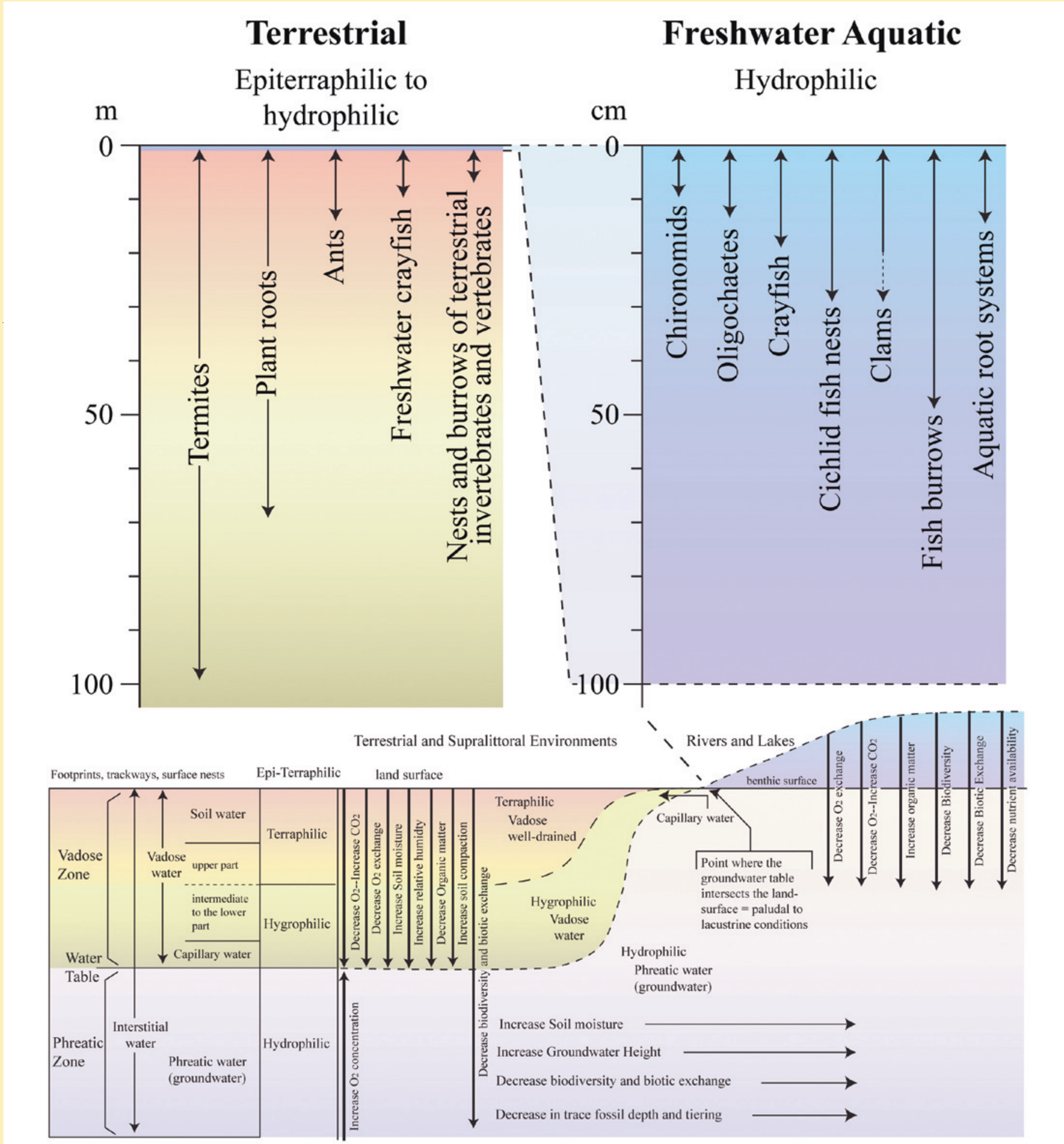

Figure 2: Schematic of the spatial distribution of the groundwater profile, physicochemical controls, behavioral categories, and their effects on tiering in conterminous terrestrial and freshwater aquatic environments. In general, the deepest tiered and penetrative organisms and their biogenic structures are in terrestrial settings; the shallowest are in freshwater settings. The spatial and temporal distribution of these components as well as the tiering depth and distribution of trace fossils, however, are also influenced strongly by the sedimentation rate, including the frequency and magnitude of flooding, and the major soil-forming factors. All together, these factors influence the degree of pedoturbation experienced by the sediment cover of the landscape. Modified from Hasiotis (2007) and Hasiotis et al. (in press).

a simple paleosol (Kraus and Aslan, 1993). Alluvial paleosols, however, are often complex and can be viewed as the result of a balance between sedimentation and pedogenesis (Kraus 1999). Rapid, nonsteady deposition produces vertically stacked, weakly developed soils separated by minimally weathered sediment, preserved as compound paleosols. Composite paleosols exhibit partly overlapping profiles that result from rates of pedogenesis that outstrip sedimentation rates. Steady deposition of small increments of sediment that become

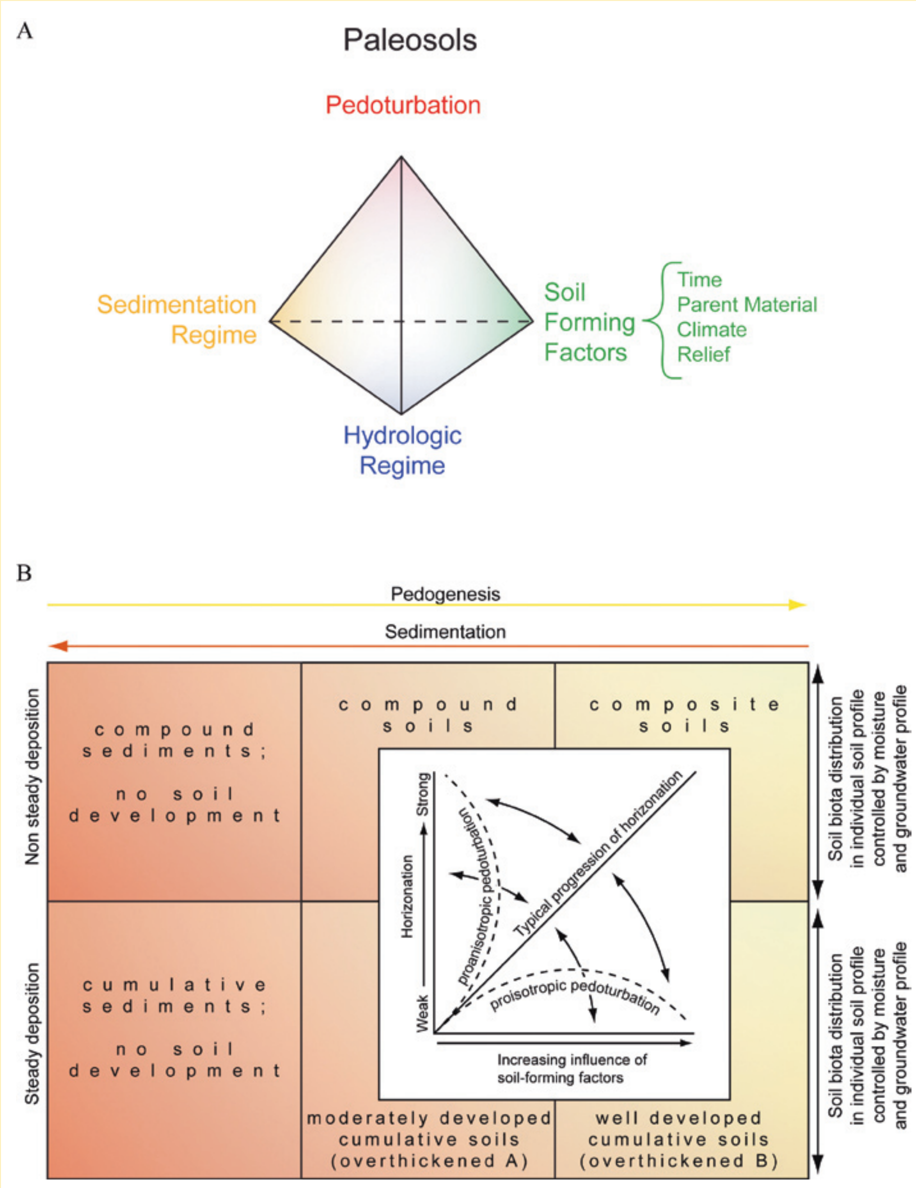

Figure 3: Controls on pedogenesis and horizonation reflected by bioturbation patterns in poorly to well-developed paleosols. The expression of trace fossils in paleosols is the result of the interplay between the local abiotic soil-forming factors, sedimentation and hydrologic regimes, and pedoturbation (see also Figure 2). The balance between sedimentation and pedoturbation under nonsteady and steady deposition will produce no soils, or compound, composite, or cumulative paleosol profiles. The degree and depth of biotic and abiotic pedoturbation will produce soils with either few horizons (proisotropic) or many well defined horizons (proanisotropic). The depth and degree of horizonation of soils is also influenced strongly by the groundwater profile. Modified from Johnson et al. (1987) and Kraus (1999).

incorporated into a soil profile by pedogenesis results in cumulative (Kraus 1999), cumulate (Marriott and Wright 1993), or cumulic (Retallack 2001; Smith et al. 2008) soils and paleosols.

In general, the depth, density, and diversity of trace fossils will create bioturbation patterns that follow the same degree of soil development as expected for simple, compound, composite, and cumulative soil (paleosol) profiles based on the same controls, with a few caveats. Simple paleosols formed over short time spans (10^0-10^2 years) will have relatively low diversity, low to high abundance, low to high density, and mostly shallow to few deep burrows (Figure 4A). This pattern reflects the lack of time available for a variety of different moisture-regime inhabiting organisms to colonize and exploit the landscape. The dominant fabric in these soils will be that of the parent material, i.e., primary bedding. These same soils formed over relatively longer durations (10^3-10^6 years) could display a range of bioturbation patterns: relatively low to high diversity, low to high abundance, low to high density, and shallow to deep burrows. When bioturbation diversity, abundance, and density are observably high, the dominant fabric is patterned after the activity of animals and plants produced by multiple generations of activity (Figure 4E). Lower intensities of bioturbation are expressed at the expense of pedogenic fabrics in which diversity, abundance, and density of bioturbation is masked by one or more soil structures (Figure 4F) (Johnson et al., 1987).

Bioturbation patterns in composite and cumulative soil profiles will also be distinct from one another in general. Composite paleosols, for the most part, will have several tiers of trace fossils and/or bioturbation textures indicative of shallow subsurface and deeper subsurface communities welded without preservation of any original primary bedding (Figure 4B). These patterns might be reflective of A, AB, and/or B horizons of thicknesses typical for each horizon (Birkeland, 1999; Kraus, 1999; Retallack 2001). Cumulative soil profiles will have over-thickened bioturbation patterns reminiscent of A, AC, AB, or B horizons that reflect continual bioturbation patterns and similar moisture regime conditions through time (Figure 4C–D).

Johnson et al. (1987) examined different pedogenic processes, including bioturbation, which act to enhance horizonation (proanisotropic pedoturbation) and destroy horizonation (proisotropic pedoturbation) through time. Proanisotropic pedoturbation may reflect longer duration simple and composite pedogenic conditions in which multiple horizons are developed (e.g., Figure 4B). Proisotropic pedoturbation may reflect cumulative pedogenic conditions in which bioturbation (including root patterns) form continuous patterns without any indication of horizonation or over-thickened horizons, which may be relatively immature or mature depending on the balance between sedimentation and pedoturbation (Figure 4C–D); these patterns may or may not form composite pedogenic sequences in alluvial packages.

Figure 4 is composed of examples of continental deposits that were pedogenically modified by crayfish bioturbation, and are interpreted in using the integrated concepts described here. Figure 4A shows pedoturbation by shallow (~50 to 60 cm deep) but complex crayfish burrow system of shafts, tunnels, and chambers attributed to *Camborygma* *symplokonomos* in interbedded siltstone and mudstone (Hasiotis and Mitchell, 1993). The host sediment still exhibits some of its primary bedding and was interpreted as a floodplain paleoenvironment in a fluvio-lacustrine setting (see also Dubiel and Hasiotis, 2011). The crayfish burrows suggest a high water table that would have been 30-40 cm deep; the number of burrows suggests a relatively short-lived landscape. This succession would be interpreted as a simple paleosol that, if multiple simple paleosols were stacked one atop the other, the entire complex would qualify as a compound paleosol in which crayfish burrowing acted to produce proanisotropic pedoturbation and begin the process of horizonation. Figure 4B exhibits stacked successions of interbedded siltstone and sandstone pedogenically modified primarily by moderately deep (~60 to 90 cm) and simple crayfish burrows attributed to *Camborygma eumekenomos* (Hasiotis and Mitchell, 1993). The host sediment exhibits no primary bedding, tabular to columnar structures, rhizoliths, and nondistinct small-diameter burrows, and was interpreted as a channel-levee-floodplain paleoenvironment in a fluvial setting (Hasiotis and Honey, 2000). The crayfish burrows suggest fluctuating water-table levels. The succession represents composite paleosols with partly overlapping profiles resulting from nonsteady deposition where pedogenic rates outstrip sedimentation rates. Bioturbation patterns acted to produce proanisotropic pedoturbation and encourage horizontation. Figures 4C and 4D depict outcrops that contain hundreds of thousands or more crayfish burrows of 2 to 4 m depths, attributed to *Camborygma eumekenomos* (Hasiotis and Mitchell, 1993), that represent multiple generations of activity. The host sediment exhibits no primary bedding, tabular to columnar structures, as well as rhizoliths and *Naktodemasis*, in which no definitive bed boundaries are present within the 6 m interval; these successions are interpreted as proximal to distal floodplain paleoenvironments with fluctuating water table levels (Dubiel et al., 1992; Hasiotis et al., 1993). Each outcrop represents cumulative paleosols produced by steady deposition of small increments of sediment that became incorporated into the soil profile where pedogenic rates outpaced sedimentation rates, while the soil biota incorporated new material. Crayfish bioturbation acted to produce proisotropic pedoturbation so that no distinct horizonation could form; Figure 4C represents an accumulation akin to an A horizon characterized by little modified sediment, whereas Figure 4D represents an accumulation akin to a B horizon in which sediment is the form of glaebules of hematite, maghemite, and simple clays.

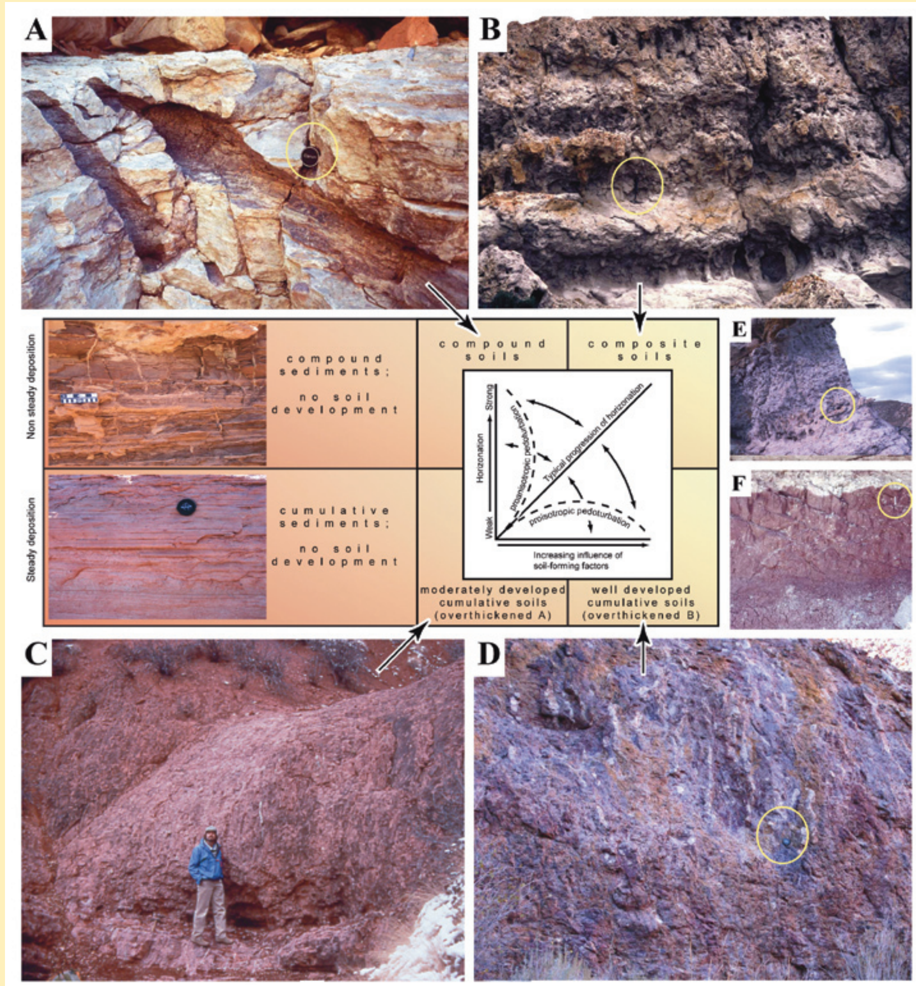

Figure 4: Crayfish bioturbation patterns as related to sedimentation and pedoturbation rates in nonsteady and steady state deposition. Compound sediment example from the upper part of the Moenkopi Formation, Fry Canyon, Utah; note sand-filled desiccation cracks; scale 15 cm. Cumulative sediment example from the lower part of the Salt Wash Member of the Morrison Formation, Montezuma, Utah; lens cap 5 cm. A) Owl Rock Member of the Chinle Formation, Stevens Canyon, Utah; lens cap 5 cm. B) Paleocene Fort Union Formation, Castle Gardens, Wyoming; rock hammer ~35 cm. C) Chinle Formation, undifferentiated, Eagle Basin, Dotesero, Colorado; person ~1.5m tall. D) Mottled Strata of the Shinarump Member, Chinle Formation, Professor Valley, Moab, Utah; lens cap 6 cm. E) Paleocene Fort Union Formation, Washakie Basin, locality 12, Wyoming; rock hammer ~40 cm. F) Paleovertisol with little visible bioturbation in the Petrified Forest Member, Petrified Forest National Park, Arizona; scale 10 cm.

SUMMARY

Continental trace fossils record organism behaviors that contributed to the depth and degree of pedogenesis, and are informative for interpreting paleosols when integrated with interpretations of the sedimentologic, hydrologic, and pedologic histories of the sedimentary succession. Bioturbation is one of the five major soil-forming factors, whose depth, distribution, and amount of time active in the soil is controlled by the sizes and behaviors of organisms, zonation of the groundwater profile (soil moisture and water table levels), and type and seasonality of climate. Combining continental bioturbation patterns with the patterns of sedimentation and pedoturbation enables a tripartite approach to interpreting the ichnopedogenic landscape that unites the controls on the development of soils (preserved as paleosols) in relation to the frequency and magnitude of sedimentation events, biotic and abiotic pedogenesis, and groundwater profile through time in alluvial basinal settings. Pairing the approach of

Johnson et al. (1987) with that of Kraus (1999) incorporates sedimentation and erosion—i.e., landscape evolution—with the soil-forming processes responsible for features preserved in paleosols. Ichnofossils record organismal behaviors that contributed to the depth and degree of pedogenesis, and are informative for interpreting paleosols because soil moisture and water table levels control the distribution of soil biota.

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Sedimentary Geology Division

Geological Society of America

The Charlotte GSA meeting is coming soon. There's a lot for us to do and learn

The 2012 GSA Annual Meeting is a little later this year and will be held on the 3rd through the 7th of November in Charlotte North Carolina. SEPM did a wonderful job of organizing sessions with some help from SGD and the technical program is both diverse and strong. It's time to let you know about, what our Division is offering this year.

2012 Laurence L. Sloss Award Recipient

The GSA Sedimentary Geology Division is pleased to announce that Dr. Gail Ashley of Rutgers University is the 2012 Laurence L. Sloss Award recipient. Dr Ashley is truly one of the pillars of the sedimentary geology community and has been a pioneer in expanding the boundaries of sedimentary research. She was a pioneer in the application of sedimentologic concepts to glacial environments and in applying the then new principals of facies modeling to glacial environments. Most of us are familiar with her work unifying the different concepts of what we now call (thanks to Gail) dunes. Most recently, her articles that integrate studies of archeology and wetlands ecology with sedimentology have highlighted the importance of environment in early hominid ecology. She came up with the term "critical zone", one of the key concepts guiding interdisciplinary research. Perhaps her greatest impact has been in her role integrating sedimentary research with Quaternary studies, archeology and ecology, bringing sedimentary geology an increased importance to the entire scientific community.

As important as her research contributions, most of us also know that she has made a tremendous impact as an educator. Serving as both a role model and mentor she has guided 37 graduate students into our profession. She has also been a great scientific colleague, serving as editor of JSR, President of SEPM, President of AGI and as President of GSA.

2012 Laurence L. Sloss Award winner Gail Ashley

2012 SGD Student Research Award Recipient

Congratulations to Erika Colaiacomo, this year's winner of the Student Research Grant! Erika is a master's student in fluvial geomorphology at the University of Montana. She is studying the downstream geomorphic effects of the removal of Condit dam on the White Salmon River, WA with her advisor, Dr. Andrew Wilcox. She is integrating active sedimentation and geomorphology and has a commitment to data collection.

Please join us at the SEPM-sponsored SGD and Limnogeology Division Joint Business Meeting and Awards Reception as we recognize Erika's efforts as well as those of the SGD/SEPM Student Poster awardees and student travel award recipients.

Erika Colaiacomo
SGD Student Research award winner.

The 2012 Stephen E. Laubach Structural Diagenesis Research Award

The Stephen E. Laubach award is an interdisciplinary award that promotes research combining structural geology and diagenesis. The award is given jointly by the Sedimentary Geology and Structural Geology and Tectonics divisions and is presented at our respective awards ceremonies. This year it is the Structure and Tectonics Division's turn. Please check out their awards ceremony and Erica Swanson.

Erika Swanson,
2012 winner of the Stephen E. Laubach Award

Erika's project addresses a long-standing controversy in structural geology: the speed and mechanism of emplacement of the Heart Mountain block. She will use a unique approach combining optical microscopy and SEM with clumped isotopes to determine the temperatures and role of fluids in the formation of the gouge and secondary carbonate. With these data, she can test various models of emplacement.

Do you know a colleague who would be particularly deserving of the Laurence L. Sloss Award for Sedimentary Geology? Please forward nominations to Richard Langford at riplangford@gmail.com.

SEPM Goes the Extra Mile at GSA

SEPM has done it again. In a joint effort with SGD, to increase the sedimentary geology program at GSA meetings, SEPM has sponsored numerous sessions, and provided award monies to the student poster session, sponsored by Nexen. SEPM and SGD have again worked together to plan a meaningful and fun Seds and Suds this year, – see next page for details.

2012 GSA Annual Meeting Charlotte

Sedimentary Geology continues its strong presence at the GSA Annual Meeting. The GSA SGD and SEPM are sponsoring or co-sponsoring 22 theme sessions, and several short courses this year. The variety and importance of these sessions, on both scientific and societal levels highlights the importance of our discipline.

Seds and Suds got kicked out of its normal time slot and will be held on Monday November 5 at 5:45-7:00 pm and scheduled as a Town Hall meeting.

Seds and Suds will feature an open discussion about the National Science Foundation's recent synthesis document entitled "TRANSITIONS: The Changing Earth-Life System - Critical Information for Society from the Deep Past". This publication was an outgrowth of a TRANSITIONS workshop chaired by Judy Parrish, in collaboration with a committee of SGP (Sedimentary Geology & Paleobiology)-related scientists, and representatives of the SGP community. The report summarizes recommendations from numerous workshops held over the last decade into a single document that identifies common priorities and directions for the deep time/sedimentary crust communities (i.e., paleontology, stratigraphy/sedimentology, paleoclimatology, geochronology, etc.). Dr. Parrish and NSF staff will be on hand to provide additional input relevant to our Sedimentary Geology Division. Additionally there will discussions about a new effort to help unify the sedimentary crust research community called STEPPE (Sedimentary Geology, Time, Environment, Paleontology, Paleoclimate and Energy).

The 2012 SGD and Limnogeology Division Joint Business Meeting and Awards Reception on election day, Tuesday evening, November 6th, at 5:30 to 8:30 in the Convention Center. Please plan to join us for the celebration with good food and cash bar. The first 100 attendees will receive a ticket for a free beer, wine, or soft drink.

We welcome additional sponsors for the SGD and Limnogeology Divisions Joint Business Meeting and Awards Reception at GSA in Denver.

I) SPONSORED TOPICAL SESSIONS

159 - Oral - Surf's up: New Insights on the Geology, Karst, and Paleontology of Carbonate Systems of the Bahamas Archipelago
160 - Oral - Heterozoan Carbonates in Time and Space: Distribution, Deposition, and Diagenesis
161 - Oral - Detrital Zircon Provenance of Neoproterozoic to Lower Paleozoic Strata of Northern and Western Laurentia
162 - Poster - Integrative Studies of Sedimentary Marine and Fluvial Cretaceous Deposits along the Western Margin of the North Atlantic Basin (Posters)
163 - Oral - Geologic Timescale—Current Status, Future Enhancement and Applications
164 - Oral - Carolina Geological Society 75th Anniversary: The Geology of the Carolinas
165 - Oral - Preservation of Environmental Signals in Deep-Water Depositional Systems
166 - Oral - Controls On Terrestrial Dispersed Organic Carbon ä13c Values From Diagenesis to Climate
167 - Oral - The Plio-Pleistocene Section of the Atlantic and Gulf Coastal Plains: Impact on Stratigraphic Interpretations Caused by Recent Revisions to the Quaternary and Pleistocene
168 - Oral - Mid-Atlantic Coastal Plain Stratigraphy and Paleontology
169 - Oral - Cyclicity and Hierarchy in the Clastic Stratigraphic Record
114 - Oral - Coastal-Plain Watershed-River-Estuarine Connectivity, Material Transport and Sedimentation in a Changing Environment
116 - Oral - Constructing Deltaic Depositional Systems: Integrating Field Examples, Theory, and Modeling
126 - Late Triassic Climates, Environments, and Life on Pangaean North America

127 - Terrestrial Proxies of Paleoclimate and Paleoenvironment in Deep Time
134 - Advances in Cenozoic Foraminiferal Biostratigraphy, Chemostratigraphy, and Paleoecology
135 - Advances in Mesozoic Foraminiferal Biostratigraphy, Chemostratigraphy, and Paleoecology
136 - Advances in Paleozoic Foraminiferal Biostratigraphy, Chemostratigraphy, and Paleoecology
139 - Divided Oceans and Connected Continents: Advances in Geology and Paleontology of the Tropical Americas
143 - Out of Our Depth: The Paleontology, Ichnology and Sedimentology of Deeper Water Environments in the Ancient Tropics
171 - The Role Structure and Diagenesis in Governing Fluid Storage and Flow in Deep Sedimentary Basins with Applications to Unconventional Oil and Gas Reservoirs
182 - The Next Generation: Sedimentary Geology
Student Poster Session (Posters)

OTHER SESSIONS OF INTEREST

176 - Large-Scale Strike-Slip Fault Systems: Insights Into 4-D Evolution through Lateral and Vertical Juxtaposition Recorded in the Rock Record, Geophysical Imaging, and Associated Basin Formation via Large Scale Translation and Transpression.
181 - Integrated Detrital Records of Orogenic Systems
17 - Quaternary Sedimentary Architecture as a Prerequisite to Hydrogeological Modeling of Glaciated Terrains
19 - Recent Sea-Level Change in a Late Holocene Context
20 - Quaternary Atlantic Coastal Plain Formation and Evolution
26 - Linking Coastal and Aeolian Geomorphology at the Beach- Dune Interface
30 - The Fluvial System: The Legacy of Stanley A. Schumm
45 - Perspectives in Floodplain System Science
111 - Lake Systems through Space and Time
119 - The Role of Microfossils in Environmental Monitoring
28 - "Channel Morphology and Hydraulic Geometry of Channelized Flows: Linking Observations from a Variety of Environments and Scales"

We need a Logo!

Its time for the Sedimentary Geology division to update our logo. Division logo guidelines are available at http://www.geosociety.org/aboutus/documents/divlogoguide.pdf
Please send a simple mockup, in either jpg or .pdf format to Rip Langford langford@utep.edu
We will be holding a contest in the near future to select a winner.

RPL

SGD Personnel and Committee Assignments for the 2011-2012 Year.

- **Richard Langford** is the Chair.
- **Marjorie Chan** is the Vice-Chair.
- **Linda Kah** is the Secretary/Treasurer.
- The Joint Technical Program Committee (JTPC) representatives for SGD are **Tracy Frank** and **Lauren Birgenheier**
- **Kelly Dilliard** is the web manager.
- The Sloss Award Committee comprises: **Janok Bhattacharya; Pete Decelles; Maya Elrick; Ray Ingersoll; Judy Parrish, Hugh Jenkyns**
- Stephen E. Laubach Structural Diagenesis Research Award Committee comprises: **Brenda Beitler Bowen; Laura Crossy; Peter Eichhubl;** and **Linda C. Kah**

If you have any suggestions regarding information that the SGD web site should contain or useful links for the sedimentary geology community, please contact **Kelly Dilliard** at kedilli1@wsc.edu.

For more links to societies and organizations of interest to sedimentary geology, visit http://rock.geosociety.org/sed/SGD.html.

PRESIDENT'S COMMENTS

Mid-way through my term as President seems an appropriate time to assess the status of the society and report on some new initiatives that are in the pipeline.

First, the Society remains on a very solid financial footing and membership remains rather steady (~3400 in total). As a result, there is no increase in 2013 for dues or member's costs of a journal. Our dues and journal subscriptions are a critical piece of the revenue stream that drives our Society's activities. They represent ~20% of SEPM's annual revenue. Non-member subscriptions (mainly libraries) and royalties from our journals (GeoScience World, BioOne) comprise ~50% of revenues. All other products and activities – books, short courses, field trips, research conferences, and meetings – provide ~30%. The Society budgets very conservatively and has run a surplus for more than nine consecutive years. The size of the surplus varies widely depending particularly on the release dates and sales volume of special publications. Last spring Council formalized a policy to distribute any yearly surplus between the SEPM Foundation, our capital projects fund, and the contingency reserve fund. These allocations are investments in SEPM's future. They help insure funds for support of students via the foundation, new initiatives that future Councils might deem worthy or necessary, and maintenance of a reserve to insure survival in the worst of times.

You will also notice in your 2013 membership renewal statement that neither JSR nor *Palaios* subscriptions will include actual paper copy of those journals. Henceforth our journals are eJournals only. However we have made arrangements with Allen Press, who will still provide a printed version of each journal to anyone requires it. The price is set by Allen Press and SEPM will only be passing it on to a subscriber. The price is the same for members or libraries and higher than SEPM's previous print surcharge, where the society was losing significant amounts each year.. This is a change that has been in the works for years. A number of past Presidents have discussed the end of printed copies in prior President's columns and members have increasingly "voted" for this by voluntarily choosing to stop taking print versions of the journals.

Discontinuing hard copy printing completely is an outcome of the on-going digital revolution affecting all aspects of publishing. It also has great advantages to SEPM. Printing and shipping costs go away, which reduces the costs of actually producing the journal. This reduction in costs will allow both journals to start publishing more pages, meaning more articles. Every figure in an article can now be printed in color if so desired, with no additional page charges. I personally think that is a huge plus. I suspect our inability to provide low-cost color over the last decade negatively influenced some authors when making the choice as to where to send their papers. (Competitor journals have been providing far greater use of color paid for by charging libraries much large prices than does SEPM.)

In keeping with an increasing digital presence, Council has also approved my request for funds to mobilize all of our web sites. This means that by the end of this year, the SEPM website, the journal sites, and journal abstracts will be available to the ~1.7 billion people worldwide with mobile broadband access. As mobile broadband is often the only access method available to people in developing countries, our mobilization efforts will increase access to SEPM by geoscientists across the globe.

Facilitating our science and its dissemination is the purpose of SEPM, and thus presumably the goal of all its members. However, meeting that mission requires more than journals, books, and digital access. It all begins with VOLUNTEERS – journal reviewers, associated editors, short course presenters, field trip leaders, technical program organizers, and research conference conveners. RC's are an invaluable vehicle for a scientific community to meet, share ideas and discoveries, network, define new directions, plan new projects, and develop collaborations. But there has been a glaring paucity of RCs proposed and held the last few years, even though there are some very exciting and new research themes that would make great RCs. Consider the sedimentology of fine-grained, organic-rich deposits; the meaning of deep-time linkages between paleoclimate, paleoceanography, and life; the role of microbes in seemingly any physical and chemical sedimentary process; or the new generation of experiments, observations and models defining the physics of sedimentary transport. These are just a few of the many new developments in sedimentology and paleontology. Whatever your subfield, why not organize a research conference through SEPM? Contact Research Councilor Beverly DeJarnett and she can help you get a conference defined and started (Bev.DeJarnett@beg.utexas.edu). SEPM's great staff in Tulsa handles all the logistics. All that is needed is for YOU to step up and VOLUNTEER to make an important contribution to your scientific community.

Diversifying the venues in North America at which we can present our research also means increasing the presence of sedimentary geology at the GSA annual meeting. As my predecessor Chris Fielding noted in this space last year, doing so is particularly important for those members whose research is not aligned with the applied focus of the AAPG/SEPM annual meeting. John Snedden served as SEPM's technical program coordinator for the upcoming 2012 GSA meeting. In collaboration with the Sedimentary Geology division of GSA, John developed what I think is the largest and most diverse sedimentary program ever presented at a GSA meeting (see the session titles elsewhere in this copy of the Record). Neil Tabor of SMU (ntabor@smu.edu) has agreed to take on the role of SEPM coordinator for the 2013 GSA. He will need you to submit topical session proposal to GSA by early January. Start planning to do so now. Be creative – let's make SEPM the hub of any and all sedimentary geology!

David A. Budd, President

SEPM Member Renewals

No increased for dues or online access for 2013!

	Professional	Student	DC-Professional	DC-Student	Emeritus	Sustaining
Dues (Basic Membership)	**$ 50**	**$ 10**	**$ 10**	**$ 5**	**$ -**	**$ 300**
Subscription Options						
JSR Online (with YE CD)	$ 50	$ 10	$ 10	$ 5	$ 50	–
PALAIOS Online (with YE CD)	$ 50	$ 10	$ 10	$ 5	$ 50	–
Books Online Archive	$ 50	$ 10	$ 10	$ 5	$ 50	–
All Online Package	**$ 180**	**$ 35**	**$ 35**	**$ 15**	**$ 130**	–
PRINT Option*						
JSR Allen Press Print version	$ 240	$ 240	$ 240	$ 240	$ 240	$ 240
PALAIOS Allen Press Print version	$ 215	$ 215	$ 215	$ 215	$ 215	$ 215
International Mailing Charge	$ 120	$ 120	$ 120	$ 120	$ 120	$ 120

*Please note that for 2013, SEPM Council had decided that we can no longer invest in printed versions of the *Journal of Sedimentary Research* or *PALAIOS* due to ever increasing costs, the growth of demand for internet access to the same content and the advantage of cheap full color and multimedia aspects of online publishing. The good news is that both journals should be able to publish more content and include color freely to all authors. A printed version will contain significantly less content than the online version. However, SEPM has arranged with Allen Press to create Print-on-Demand (POD) versions, which unfortunately will be at a significant increase in cost. Payment will still be made to SEPM but the price is just a pass through to Allen Press; SEPM is not adding anything to their price. The Allen Press price will have to be added on to the subscription total if you require print.

SEPM Society for Sedimentary Geology is proud to announce the following medalists for 2013.

- **Twenhofel Medal** for career of excellence in sedimentary geology:
  Paul Enos (enos@ku.edu) University of Kansas
- **Moore Medal** for outstanding contributions in paleontology:
  Kenton Steward Wall Campbell (ken.campbell@anu.edu.au),
  Emeritus Professor Research School of Earth Sciences, The Australian National University
- **Pettijohn Medal** for outstanding contributions in sedimentology and stratigraphy:
  J.A. D. (Tony) Dickson (jadd1@esc.cam.ac.uk), University of Cambridge
- **Shepard Medal** for outstanding contributions in marine geology:
  J. Casey Moore (cmoore@pmc.ucsc.edu), University of California at Santa Cruz
- **Wilson Medal** for outstanding contributions in sedimentary geology by an early career geologists:
  Kyle M. Straub (kmstraub@tulane.edu), Department of Earth & Environmental Sciences, Tulane University
- **Honorary Membership** for outstanding contributions to science and service to the society:
  Dale Leckie (daleleckie@nexeninc.com), Nexen, Canada

Update on GSA Annual Convention Technical Program, Charlotte, NC, Nov. 4-7, 2012

John W. Snedden, The University of Texas at Austin, JPTC Member.

The technical program for the Geological Society of America (GSA) Annual Convention, in Charlotte, NC has been finalized. Over 3500 abstracts were submitted, supporting a strong agenda of special sessions, topical sessions, and general discipline sessions. SEPM played a significant role on the joint technical program committee this year, partnering with the GSA Sedimentary Geology Division to deliver a rich sedimentary science program in areas ranging from marine/coastal science, Quaternary geology, limnology, geomorphology, paleontology, siliciclastics, carbonates, and stratigraphy. SEPM and GSA Sedimentary Geology Division jointly sponsored many sessions, along with The Paleontological Society, The Cushman Foundation for Foraminiferal Research; The Micropalaeontological Society; The Gryzbowski Foundation, the GSA Quaternary Geology Division, the GSA Limnology Division, the GSA International Section and the Eastern Section of SEPM.

The full list of topical sessions will provided on the SEPM website and the GSA Charlotte Program site. Among the notable SEPM sponsored or jointly sponsored sessions:

Recent Advances in Carbonate Sedimentology and Stratigraphy - A Session in Memory of Gerald M. Friedman,
Chaired by Paul Washington (Pitt) and Jim Ebert (Oneonta)
Oral: Tuesday 1:30–5:30 P.M., Room 203B, Charlotte Convention Center

T-116: ***Constructing deltaic depositional systems: integrating field examples and theory***
Chaired by Janok Bhattacharya (U. Houston)
Oral: Monday 8 A.M.–NOON, Room 203B, Charlotte Convention Center

T-165: ***Preservation of environmental signals in deep-water depositional systems***
Chaired by Jake Covault (Chevron) and John Snedden (UT-Austin)
Oral: Tuesday 1:30–5:30 P.M., Room 203A, Charlotte Convention Center

T-163: ***Geologic Timescale – current status, future enhancement and applications***
Chaired by James G Ogg (Purdue), Mark Schmidt (Boise St.), Linda Hinnov (JHU)
Oral: Monday 1:30–5:30 P.M., Room 203A, Charlotte Convention Center
Posters: Wednesday 9 A.M.–6 P.M., HALL B

T-134, T-135: ***Advances in (Cenozoic) Foraminiferal Biostratigraphy, Chemostratigraphy, and Paleoecology***
Chaired by Thomas W. Dignes (Chevron)
Oral: Monday, 8 A.M.–NOON, 217BC, Charlotte Convention Center
Oral: Monday, 1:30–5:30 p.m., 217BC, Charlotte Convention Center

T-182: ***The Next Generation—Sedimentary Geology Student Poster Session***
Chaired by Marjorie Chan (U. Utah)
Posters: Sunday, 9 a.m.–6:30 p.m., Hall B

T-162: ***Integrative Studies of Sedimentary Marine and Fluvial Cretaceous Deposits along the Western Margin of the North Atlantic Basin***
Chaired by Mike Pope (Texas A&M) and Rob Rainbird (NRCAN).
Posters: Tuesday 9 a.m.–6 p.m. Hall B
The technical program also features general discipline sessions on siliciclastics, carbonates, and stratigraphy.

SEPM is also a sponsor of a short course:

RECONSTRUCTING EARTH'S DEEP-TIME CLIMATE – THE STATE OF THE ART IN 2012, which will be held Saturday November 3, at the GSA Annual Meeting in Charlotte NC, and is led by Linda Ivany (Syracuse University) and Brian Huber (Smithsonian Institution).

Many thanks go to the overall program technical chair, Dick Berg (U. Illinois), Nancy Wright (GSA), and of course, Tracy Frank (U. Nebraska), and Lauren Girdenfeld (U. Utah) with the GSA Sedimentary Geology Division.

1926 SEPM
Society for Sedimentary Geology

Appendix A.—Moisture preferences of modern tracemakers.

Tracemaker	Common name	Primary behaviors	Maximum depth	Moisture preference	Reference	Moisture regime
Amphisbaena camurea	worm lizard	locomotion, feeding, dwelling	>60 cm	vadose zone, but not below water table	Hembree and Hasiotis 2006	terraphilic to hygrophilic
Aporrectodea caliginosa (juvenile)	grey worm	dwelling, locomotion, feeding (endogeic)	~23 cm	increased feeding in wet soil (-5 kPa matric potential), increased burrowing in drier soil (-11 kPa matric potential)	Perreault and Whalen 2006	hygrophilic
Archispirostreptus gigas; *Orthoporus ornatus*	giant African millipede; Sonoran Desert millipede, respectively	dwelling	up to 160 mm	prefer moist sediment, ~40% moisture	Hembree 2009	terraphilic

Tracemaker	**Common name**	**Primary behaviors**	**Maximum depth**	**Moisture preference**	**Reference**	**Moisture regime**
Bembix, various species	sand wasp	nesting	species fall into 3 groups: 9-16 cm; ~20 cm; ~30 cm, with depths up to 54 cm reported for *B. pallidipicta*	species fall into 3 groups: 25% water, 3-5% water, and 1% water	Evans 1957; O'Neill 2001	terraphilic
Cicadetta calliope	prairie cicada	feeding, dwelling, locomotion	~300-500 mm	well-drained soils <26% water content	Smith and Hasiotis 2008	hygrophilic
Cyclocephala immaculata	southern masked chafer beetle	brooding	2-4 cm for oviposition; >34 cm for larvae	>10.3 to 12.5% soil moisture for egg survival; ~15%-27% water for larvae	Potter 1983; Potter and Gordon 1984; Counts and Hasiotis 2009	terraphilic
Eryx colubrinus	Kenyan sand boa	locomotion, feeding, dwelling	~6 cm	loose sediment with little interstitial water	Hembree and Hasiotis 2007	terraphilic

Tracemaker	**Common name**	**Primary behaviors**	**Maximum depth**	**Moisture preference**	**Reference**	**Moisture regime**
Hadrurus arizonensis	giant desert hairy scorpion	dwelling	up to ~8 cm	vadose zone, between 20% and 50% moisture	Hembree et al. 2012	terraphilic
Heterocerus brunneus	variagated mud-loving beetle	feeding	just below the surface	moist mud or sand near the shores of rivers, ponds, and lakes	Clark and Ratcliffe 1989	hygrophilic
Lumbricus terrestris (juvenile)	nightcrawler; common earthworm	dwelling, feeding (anecic)	~28 cm	greater feeding in wet soil (-5 kPa matric potential), greater burrowing in drier soil (-11 kPa matric potential)	Perreault and Whalen 2006	hygrophilic

Tracemaker	**Common name**	**Primary behaviors**	**Maximum depth**	**Moisture preference**	**Reference**	**Moisture regime**
Macrotermes, various species	African mound-building termite	dwelling	soil disturbance down to 15 m; other termites known to burrow to 100 m	arid soils in regions with as little as 250mm/year rainfall	Turner et al. 2006; Cloud et al. 1980	terraphilic
Myospalax fontanierii	plateau zokor	dwelling, feeding	1.5 to >2 m deep	~20%-~30% soil water content	Zhang et al. 2003	terraphilic
Onitis, various species; *Onthophagus vaccus*	dung beetle	Nesting; Brooding	up to 130 cm, but differs by species; maximum depth limited by water table (*O. vacca*)	moist, sandy soil, 48%-66% dung moisture (Onitis); sand with 4%-8% water content (*O. vacca*)	Edwards and Aschenborn 1987; Sowig 1996	terraphilic to hygrophilic
Pogonomyrmex sp.	harvester ant	dwelling, brooding	~ 2 m	vadose zone	Halfen and Hasiotis 2010 and references therein	terraphilic

Tracemaker	**Common name**	**Primary behaviors**	**Maximum depth**	**Moisture preference**	**Reference**	**Moisture regime**
Procambarus clarkii; *P. acutus acutus*; *Cambarus diogenes diogenes*	freshwater crayfish	dwelling	1 to 5 m or more	saturated zone	Hasiotis and Mitchell 1993	hydrophilic
Scaptocoris divergens	burrower bug	dwelling, locomotion, feeding	~160 mm	~7%-37% soil moisture	Willis and Roth 1962	hygrophilic
various infaunal bivalves		dwelling, feeding	0-40 cm	aquatic environments	Kondo 1987	hydrophilic