The SEDIMENTARY Record

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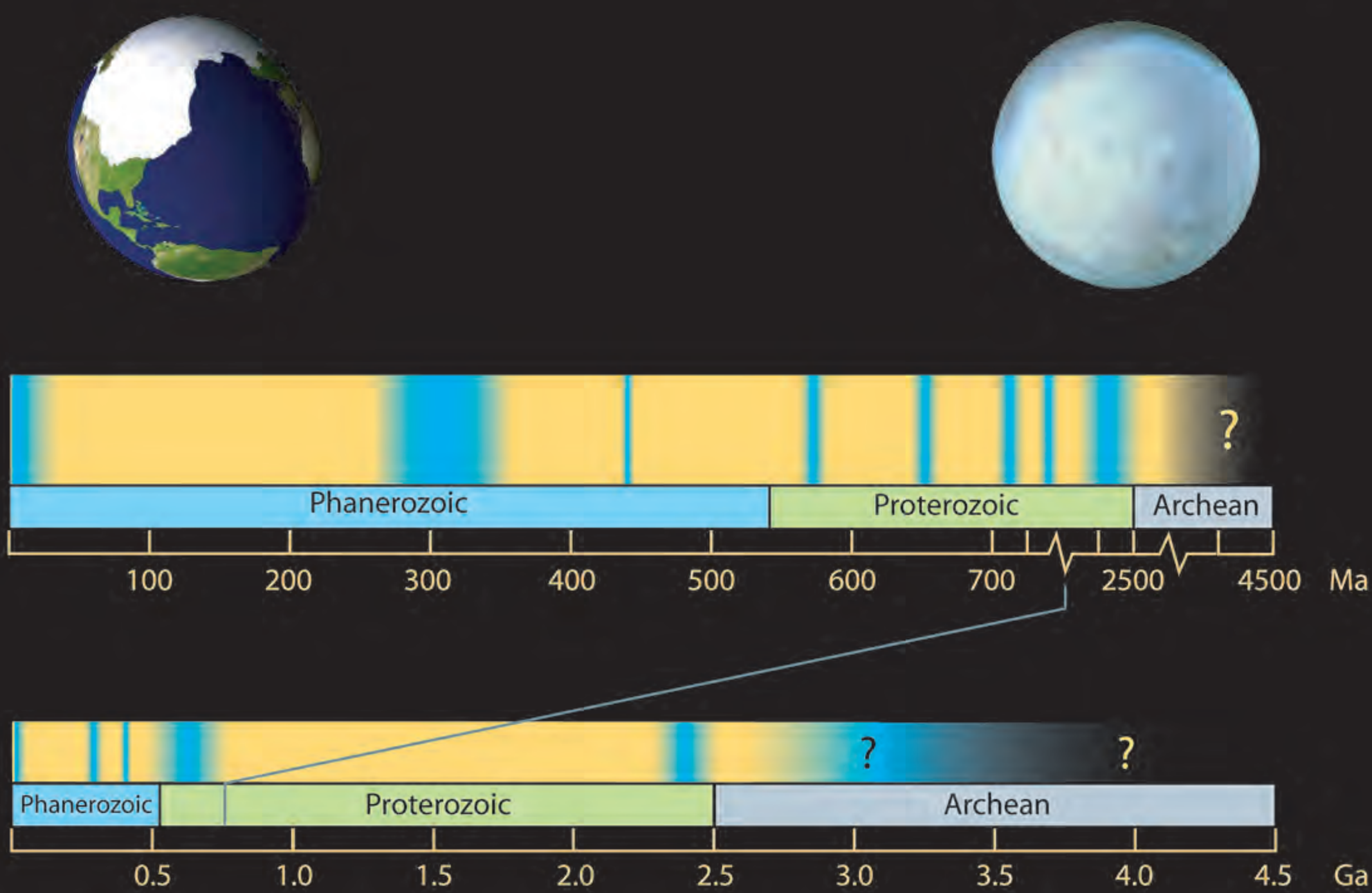

INSIDE: SEDIMENTARY GEOLOGY AND THE FUTURE OF PALEOCLIMATE STUDIES

PLUS: President's Comments; MYRES V – The Sedimentary Record of Landscape Dynamics; Volcanism, Impacts and Mass Extinctions: Causes and Effects; EarthCube and Sedimentary Geology for the Future; North American Commission on Stratigraphic Nomenclature

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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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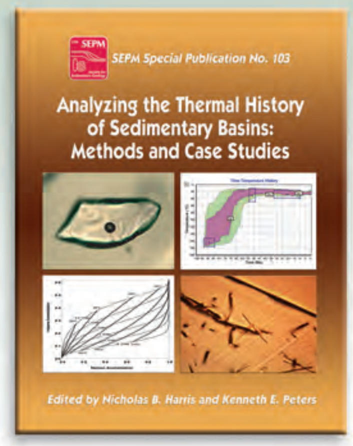
Special Publication #103

Analyzing Thermal Histories of Sedimentary Basins: Methods and Case Studies

Edited by: Nicholas B. Harris and Kenneth E. Peters



Thermal histories of sedimentary basins are critical sources of scientific and practical information. They provide us with windows into past and present tectonic processes and the configuration of the crust and mantle. Using records of present and past temperature distributions, we can identify and constrain interpretations of tectonic events, distinguish different basin types and interpret pathways of fluid flow. These insights can be used calibrate basin and petroleum system models and to interpret and predict the distribution of minerals and petroleum, diagenesis and reservoir quality, and the geomechanical properties of rock units. This volume summarizes the current state of the art for many modern approaches used to estimate paleotemperature. Many techniques are now available based on both organic and inorganic components in the rock. Even techniques that are now many years old, such as apatite fission track analysis, have undergone significant advances in the past decade. This volume provides comprehensive reviews of the fundamental science underpinning each method and the basic principles used to interpret data, as well as case studies illustrating practical applications and the complexity of paleotemperature interpretation. Geoscientists from all sectors will find this volume to be a valuable resource in their work.

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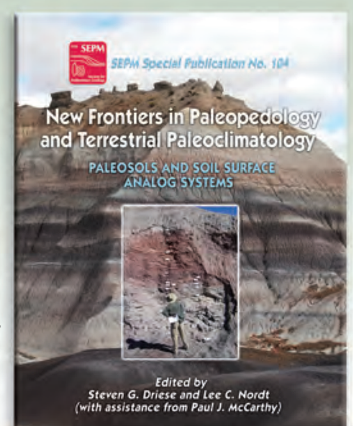
Special Publication #104

New Frontiers in Paleopedology and Terrestrial Paleoclimatology: Paleosols and Soil Surface Analog Systems

Edited by: Steven G. Driese and Lee C. Nordt, with assistance by Paul J. McCarthy



After initial breakthroughs in the discovery of fossil soils, or paleosols in the 1970s and early 1980s, the last several decades of intensified research have revealed the much greater role that these deposits can play in reconstructing ancient Earth surface systems. Research currently focuses on terrestrial paleoclimatology, in which climates of the past are reconstructed at temporal scales ranging from hundreds to millions of years, using paleosols as archives of that information. Such research requires interdisciplinary study of soils conducted in both modern and ancient environments. These issues and many others were discussed at the joint SEPM-NSF Workshop “Paleosols and Soil Surface Analog Systems”, held at Petrified Forest National Park in Arizona in September of 2010. The papers presented in this volume are largely an extension of that workshop and cover topics ranging from historical perspectives, followed by lessons from studies of surface soil systems, with examples crossing between soils and applications to paleosols. The remainder of the volume begins with an examination of the relationship between paleosols and alluvial stratigraphy and depositional systems, and ends with three case studies of ancient soil systems. Because some readers may find the nomenclature rather “foreign” the editors have included a glossary of pedological terms at the end of this volume. These papers incorporate data from studies of surface soil systems as well as deep-time sedimentary rock successions and are designed to provide sedimentary geologists with an overview of our current knowledge of paleosols and their use in interpreting past climates, landscapes, and atmospheric chemistry.

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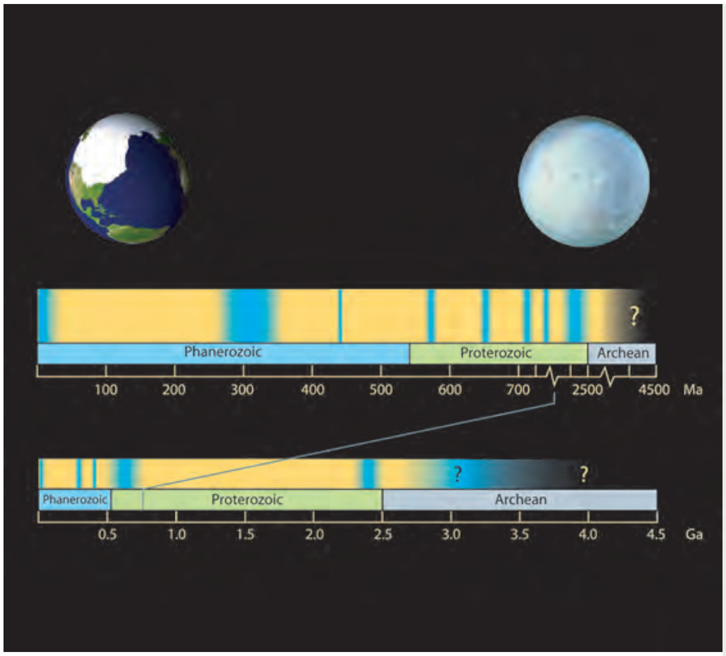

Cover image: Schematic representation of icehouse-greenhouse intervals through Earth history. Lower bar illustrates all of Earth history, whereas upper bar focuses primarily on the Phanerozoic-Neoproterozoic. Icehouse times are inferred from published records of well-accepted glacial deposits recording the former presence of land-based ice sheets. Thus, greenhouse times are inferred on negative evidence of such deposits. The globes illustrate schematically the shift in icehouse modes--from the so-called "snowball" states of the Neoproterozoic (right) to reconstructed Last Glacial Maximum ice of the Pleistocene. Figure from G.S. Soreghan.

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Sedimentary Geology and the Future of Paleoclimate Studies

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ABSTRACT

Recent community efforts have highlighted the importance of deep-time paleoclimatology to the understanding of Earth processes as a way of expanding our understanding of the vast range of states possible in the Earth System. Advances in our collective understanding of these "alternative-Earth" states shed light on forcings and feedbacks of the climate system, as well as responses of the biosphere, ultimately bringing more rigor and predictability to the study of current and future global change. Sedimentary geology and paleontology are squarely in the middle of these efforts. Geoscientists from both subdisciplines have posed the major questions that must be answered and have implemented an action plan to answer those questions. Furthermore, increasing resolution of time and parameters (climatic and biotic) enabled by technological advances are bringing new rigor to paleoclimate studies, extending our collective reach to strata dating to ever-deeper reaches of geologic time. New advances will require, increasingly, the actions and coordination of large multidisciplinary teams galvanized around critical science questions, and armed with the latest proxies and geochronologic tools.

INTRODUCTION

In the March issue of The Sedimentary Record, Montañez and Isaacson (2013) outlined recent developments in which the sedimentary geology and paleontology communities have "loudly and clearly through various venues articulated a research agenda for the future" (Montañez and Isaacson, 2013, p. 8). These venues include NRC reports (National Research Council, 2011, 2012); a new, community-driven initiative, TRANSITIONS (Parrish et al., 2012); and a new NSF funding initiative, Earth-Life Transitions (NSF Program 12-608), which was based on TRANSITIONS and on recommendations in the National Research Council (2012) report that examined research opportunities in the Earth sciences. In this article, we would like to focus on the community's research agenda for paleoclimate studies, and give a glimpse into the critical role of this research.

CHALLENGES AND QUESTIONS

The TRANSITIONS team (Parrish et al., 2012) reviewed more than 10 years of white papers and initiatives, which collectively illustrate that all parts of our very large and diverse community are and have been for many years united around a singular intellectual challenge: "Understanding the full range of Earth-life process behaviors through all of Earth history, including deep time, is vital for addressing urgent societal issues, and these processes must be addressed in a systematic and interdisciplinary fashion" (Parrish et al., 2012). The importance of paleoclimate studies is demonstrated by the four overarching questions identified in TRANSITIONS that must be answered in order to meet this challenge:

1. What is the full range of potential climate system states and transitions experienced on Earth?
2. What are the thresholds, feedbacks, and tipping points in the climate system, and how do they vary among different climate states?
3. What are the ranges of ecosystem response, modes of vulnerability, and resilience to change in different Earth-system states [including climate]?
4. How have climate, the oceans, the Earth's sedimentary crust, carbon sinks and soils, and life itself evolved together, and what does this tell us about the future trajectory of the integrated Earth-life system?

Deep time (before 2 Ma) records contain information about climate that must be understood in order to confidently model and predict future climates. The TRANSITIONS initiative specifically delineated **deep-time climate** as one of the key directions this research will take; others include landscapes, and biology and environments. Specifically with respect to the deep-time research direction, TRANSITIONS emphasized the following questions:

1. What is the full range of potential climate states and transitions on Earth?
2. What are the thresholds and feedbacks in Earth's climate system?
3. What is the biotic response and resilience to changes in climate states?

Answering these questions falls directly under the purview of sedimentary geology and paleontology communities. The deep-time sedimentary record is the repository of nearly all evidence of climate and environmental change, including, for example, previous abrupt climate-

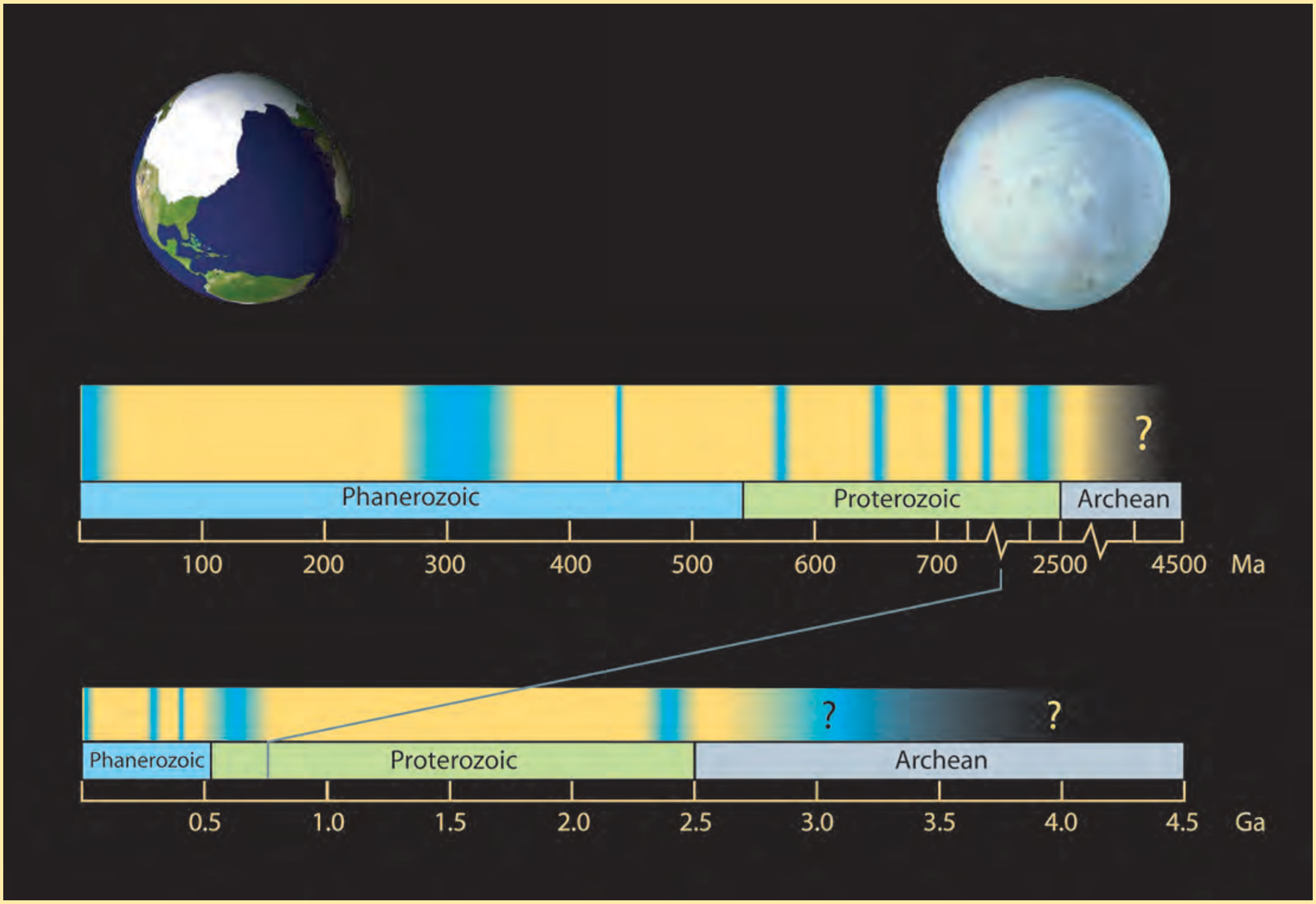

Figure 1: Schematic representation of icehouse-greenhouse intervals through Earth history. Lower bar illustrates all of Earth history, whereas upper bar focuses primarily on the Phanerozoic-Neoproterozoic. Icehouse times are inferred from published records of well-accepted glacial deposits recording the former presence of land-based ice sheets. Thus, greenhouse times are inferred on negative evidence of such deposits. The globes illustrate schematically the shift in icehouse modes--from the so-called "snowball" states of the Neoproterozoic (right) to reconstructed Last Glacial Maximum ice of the Pleistocene. Figure from G.S. Soreghan.

change events, changes in Earth's hydrological cycle, oscillatory states (Fig. 1), past ice-sheet controls and effects, and dramatically different sea level conditions that included flooded continental seaways. The current warming is changing Earth's climate state to one characterized by pCO_2 levels higher than any time since at least the Pliocene (~5 Ma; Seki et al., 2010), meaning that the current and future temperature regimes are ones that were last recorded in deep time (Figs. 2, 3). As atmospheric CO_2 concentrations increase, they reflect conditions on Earth further back in time. For example, as pointed out in TRANSITIONS (Parrish et al., 2012), the Intergovernmental Panel on Climate Change's A2 scenario (IPCC, 2007) projects CO_2 levels by 2100 that will be comparable to the Eocene, at least 35 million years ago. Even climate states beyond a doubling of CO_2 by 2100 may be possible, which will require examination of even deeper time to study analogous conditions and related impacts. This illustrates the need to understand the full range of climates that have occurred in deep time. We do not know what previous states may be duplicated in the future, so it behooves us to understand the full range of states experienced in the past. Even more importantly, should anthropogenic or natural climate changes push the Earth into a previously unrealized state, our ability to predict the consequences is enhanced by a fuller understanding of how climate has changed in the past and how the Earth has recovered from abrupt, extreme changes.

Evidence is strong in the geological record that the Earth rapidly transitioned between climate modalities, most notably in the Eocene-Oligocene greenhouse/icehouse transition (e.g., Jovane et al., 2009), and in the period leading up to the Paleocene-Eocene Thermal Maximum (PETM) and marking the transition into the Eocene Climatic Optimum (Zachos et al., 2008; McInerney and Wing, 2011; see Fig. 3). In both cases the change in CO_2 appears to have been slow relative to modern rates, but the response of the climate system appears to have been dramatically non-linear, abrupt, and unpredictable. For example, the rate of carbon emissions to the atmosphere today exceed by more than a factor of five that estimated (albeit over a much longer time) for the PETM (Kump, 2011), implying an urgent need to understand responses of Earth's climate system to such perturbations. Further concerns are that the transitions into prior greenhouse states involved substantial "overshoots" and consequent biotic effects. Warming linked to atmospheric carbon release during the PETM triggered significant biotic changes, for example, shifts in geographic range as well as some extinctions, and "recovery" of the atmosphere to pre-perturbation levels of

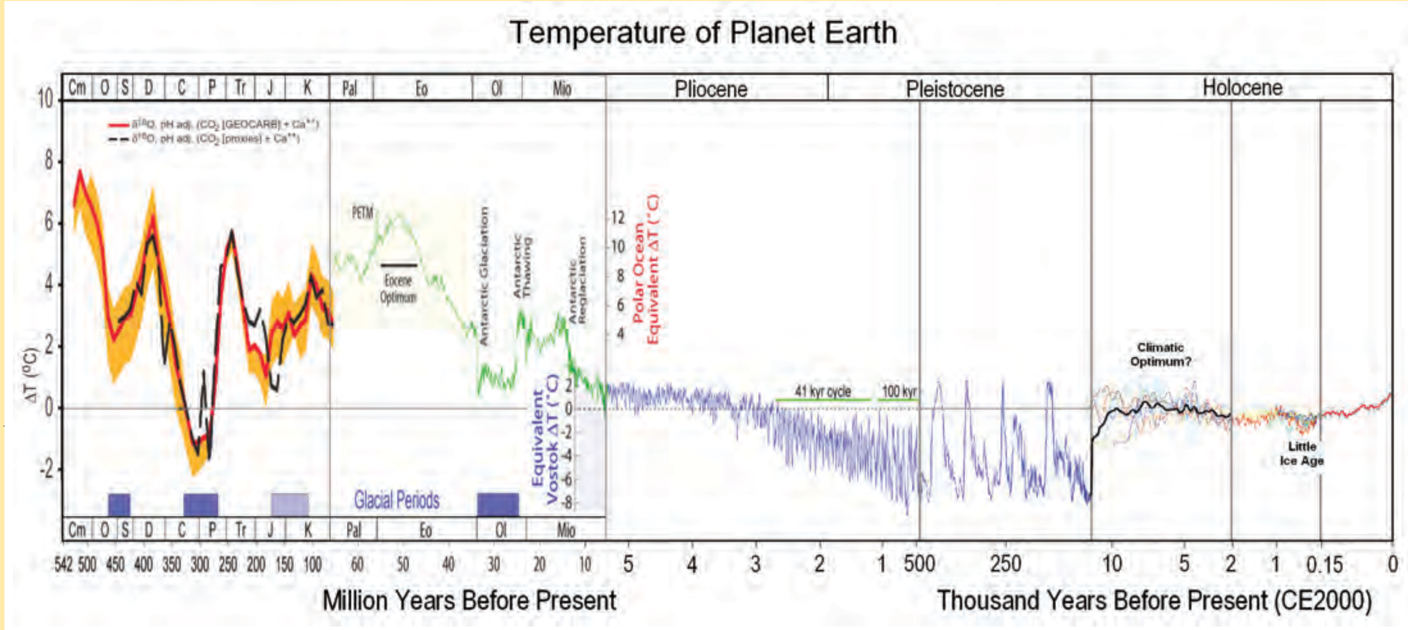

Figure 2: Schematic of paleotemperatures for the Phanerozoic. http://en.wikipedia.org/wiki/File:All_palaeotemps.png, accessed 21 May 2013. Compiled from multiple sources (information on website). As the methods used to determine temperature are not identical, the variations should be taken as relative and not absolute. However, the figure represents current thinking about relative temperature changes.

carbon required more than 80 ky (McInerney and Wing, 2011). Our current warming could require drastic lowering of pCO_2 to pre-industrial levels in order to restore our current icehouse climatic state (Hansen et al., 2008). The prospective unpredictability of these abrupt changes and possible hysteresis (lag in response followed by an abrupt shift to a new state) is the result of an incomplete understanding of thresholds and feedbacks. Deeper, more detailed study of abrupt events, occurrences of similar starting conditions that failed to lead to dramatic warming, and a thorough understanding of times of relative climate stability is required to be able to anticipate the response of climate to anthropogenic forcing. It is increasingly clear that, although pCO_2 is a primary control on temperature (Alley, 2011), how climate change plays out in the face of pCO_2 change is highly complex and non-linear, and the better we understand the complexities, the better prepared we will be as a society to address future changes.

Although atmospheric carbon emissions garner the bulk of attention, oceanic uptake of carbon poses increasing concerns owing to the resultant ocean acidification. Acidification is a well-verified consequence of rising atmospheric CO_2 (Fig. 4) and results in reduced pH and lower $CaCO_3$ saturation in surface waters (Doney et al., 2012); mean surface pH of the oceans since preindustrial times has dropped by ~0.1 units (The Royal Society, 2005). Ocean acidification has recently been proposed as directly linked to the end-Permian mass extinction (Hinojosa et al., 2012)-- yet another example of the past shedding light on potential futures.

Earth's archives contain untold numbers of climate states and transitions--a virtual laboratory book of completed experiments with results waiting to be tapped. Deciphering these results can shed light on potential geoengineering applications increasingly being considered as a means to control future warming (The Royal Society, 2009). Such schemes are fraught with ethical and political issues, and may ring of science fiction. Yet, scenarios such as ocean fertilization are already being seriously considered (Wallace et al., 2010), and even (illegally?) implemented (Service, 2012). Similarly debated are thoughts of reducing incoming shortwave radiation via injection of reflective particles into the atmosphere, mimicking volcano-induced cooling, but the risks remain largely unknown (Hegerl and Soloman, 2009). As society begins to grapple with the prospect of geoengineering our climate future, sedimentary geologists and paleobiologists can shed light on both causes and consequences of such tinkering, drawing upon Earth's past.

Finally, understanding biotic response to climate change is critical, not only to enhance our ability to anticipate the impact of anthropogenic warming on the biota but because of biotic feedbacks to climate itself. Some large, abrupt changes in climate appear to have had global, widespread impacts on biota, whereas other, apparently equally large and abrupt changes appear to have had much smaller impacts (Barnosky et al., 2012). Clearly, identifying the factors in these disparate responses is critical for informing our response to warming.

AN ACTION PLAN

The previous paragraphs highlight some "big" questions for deep-time paleoclimatology going forward. Inherent in this agenda is the ability to identify critical and revealing sedimentary sections and study them in great detail, taking advantage of new and evolving approaches to both geochronology (e.g., EARTHTIME, 2012), and to proxy development. These studies will require team-based, multi-disciplinary approaches, as called for in the new NSF program (12-608), "Earth-Life Transitions," involving, in each study, not only sedimentary geologists and/or paleontologists, but stratigraphers, geochronologists, modelers, geochemists, and so on, as appropriate, to fully unlock the climate information. Sedimentary geologists and paleobiologists have a long and

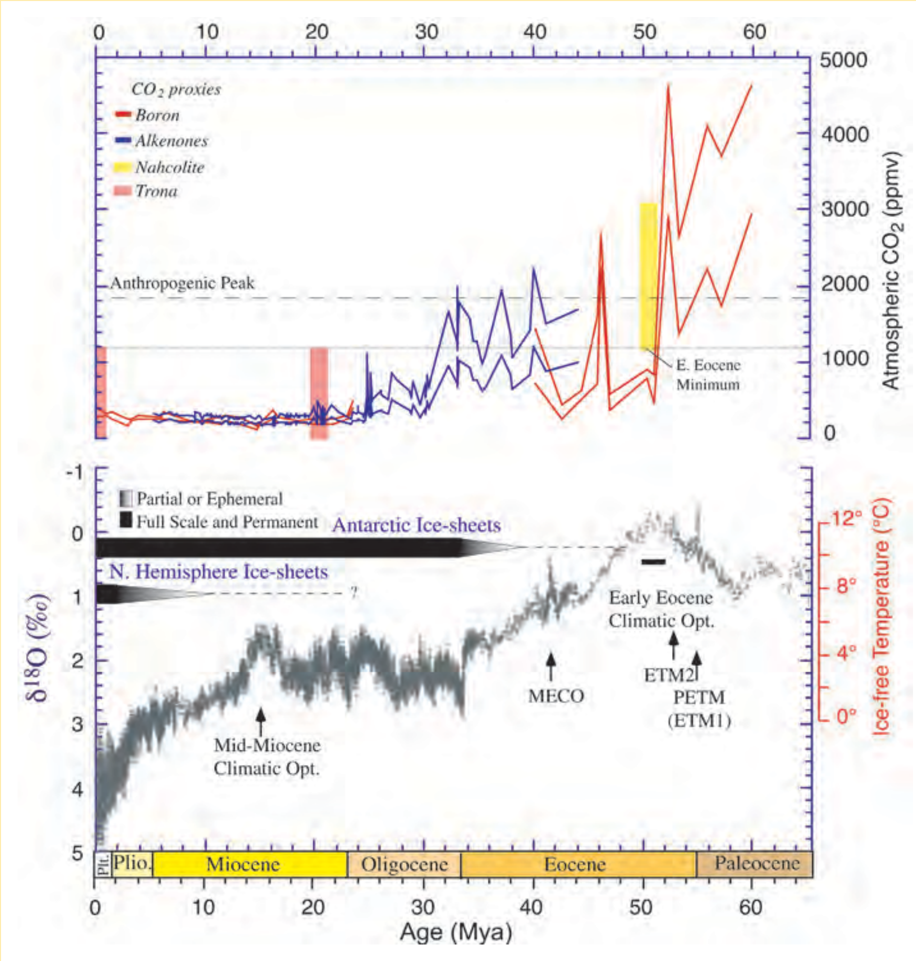

Figure 3: Record of changes in atmospheric pCO_2 and temperature during the Cenozoic (from Zachos et al, 2008). Top: CO_2 determined from marine and lacustrine proxy records. The dashed horizontal line indicates the maximum pCO_2 for the Neogene and minimum for the early Eocene. Bottom: $\delta^{18}O$ from foraminifera and interpreted ice-free ocean temperature; horizontal bars indicate development of polar ice sheets. For more information, see Zachos et al. (2008).

fruitful tradition in independent research that could be conducted by individuals armed with tools as simple as a hammer, compass, and Jacob's Staff. Perhaps our biggest challenge as the sedimentary geology community moves forward is to envision and embrace a much broader approach to our science, conducted in large teams, to address large questions. A full understanding of climate behavior requires simultaneous integration of all of our individual, detailed talents for clues to similarities and differences in climate behavior at different times and in different geographic settings. Doing so also requires careful coordination with climate modelers, and iterative integration of climate models with data. Only by integrating this information can we begin to understand true causes, effects, and feedbacks. Increasingly, the records we will need in order to conduct such integrated science will require drilling to obtain long, continuous, unweathered sections, on which to apply the new generation of climate proxy analyses. The near-time paleoclimate community has long embraced this approach (Cohen, 2011), to great success (e.g., Scholz et al., 2011; Melles et al., 2012), and such efforts are beginning to gain ground for deep-time studies (e.g., Clyde et al., 2012) .

Sedimentary geologists and paleontologists, together with low-temperature and isotope geochemists have led the way in the development of paleoclimate proxies so key to accumulating the high-resolution data sets needed to fully document changes in the rate of climate change and different climate states. Many examples of the new energy in the development and integration of paleoclimate proxies exist. For example, paleotemperature proxies can be combined with paleo-CO_2 proxies to better constrain CO_2-temperature sensitivity for projections of future climate change (Royer et al., 2007). Analysis of triple oxygen isotope compositions of sulfate from ancient evaporites enables assessment of pCO_2 in the Precambrian (Bao et al., 2008). We now have proxies for climate parameters that previously were resistant to quantification, including mean annual precipitation based on paleosol chemical composition (Sheldon et al., 2002; Nordt and Driese, 2010) and leaf 13C composition (Diefendorf et al., 2010). A variety of biomarker proxies, e.g. the tetraether index of lipids with 86 carbon atoms (TEX86), provide insights

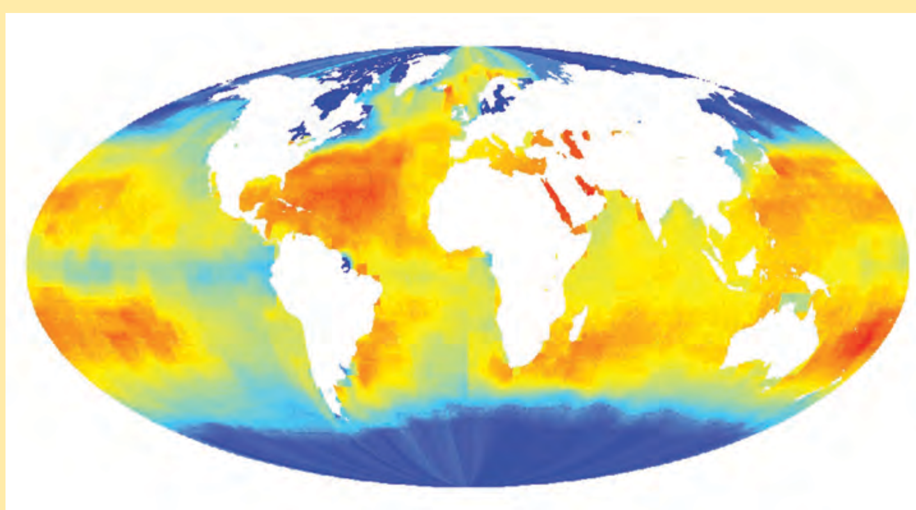

Figure 4: Acidification of the modern oceans. Acidification is at least partly attributable to increases in atmospheric CO_2, and it is likely that ocean acidification was a significant factor in deep time during times of high pCO_2 levels. From Halpern et al. (2008, supplement).

Figure 5: Graduate students (from the University of Oklahoma) conducting water and sediment sampling in Taylor Valley, Antarctica, to assess weathering signals in this extreme end-member climate. Some of these weathering signals might be preservable and thus useful for assessing climate signals in deep time. Antarctica's Matterhorn appears in the background. Photo by Lynn Soreghan.

into paleotemperature (Eglington and Eglington, 2008), and can extend to deep time (Mesozoic). Stable isotope geochemistry has provided insights to paleoceanography for half a century, but the field has now expanded to transition metals to track seawater chemistry and oxygenation, extending to the Precambrian (e.g., Anbar and Rouxel, 2007; Lyons et al., 2009; Pufajl and Hiatt, 2011). Refinements in instrumentation now enable rapid U-Pb analyses of even silt-sized detrital zircons, increasingly useful as a means to assess atmospheric circulation by tracking provenance of loess deposits (Soreghan et al., 2008; Xiao et al., 2012). Remarkably, evaporite fluid inclusions yield measurements of temperature down to the diurnal (paleoweather) scale (Zambito and Benison, 2013), and document extremes in Permian continental temperatures previously unimagined. Other climate parameters important for understanding climate change and feedbacks—including seasonal precipitation and temperature changes, weathering rates, cold-month mean temperatures, and evapotranspiration rates—remain more poorly constrained, but on-going research on various fronts strives to fill our knowledge gaps (Fig. 5). Nevertheless, the gap between capabilities of near-time and deep-time proxies is narrowing.

These proxies will also be the information against which new paleoclimate model results can be tested, leading in turn to refinement of climate models that can simulate the full range of climate states. The data sets may challenge current climate models and require substantial modification of them, and this is why it is so critical for sedimentary geologists and paleontologists to work with Earth-system modelers. The latest climate models, which have been used extensively to study climatic variability in the glacial-interglacial mode of the last million years, are of unknown applicability to the greenhouse or hothouse climate state that the Earth may be heading to--and clearly was in--at various times in the geologic past. Through Cenozoic and Mesozoic time, and perhaps throughout the entire Phanerozoic, the Earth was operating in a greenhouse state much more of the time than it was in an icehouse state. Therefore, to discover what controls the climatic behavior of the Earth when it is in a greenhouse state, and how those controls might differ from those associated with an icehouse state, we must examine and document the wide variety of environmental and ecosystem information archived in key sedimentary deposits of greenhouse periods—and this is work only the sedimentary geology and paleontology community can do. Similarly, we need to understand behavior of Earth's climate system during transitions between icehouse and greenhouse states, especially as Earth edges toward such a possible transition. Moreover, we need to push models to incorporate parameters that are currently ignored for deep-time modeling, and to do that, we must continue to produce new and refined paleoclimate proxies. Despite wide recognition of the importance of aerosols on Earth's radiative balance, these effects are typically ignored for deep time modeling (Heavens et al., 2012), even though geologic data exist to constrain aerosol loading (e.g., Sur et al., 2010).

LOOKING TO THE FUTURE

Sedimentary geology and paleontology are key disciplines in a push toward Earth-system modeling, including, perhaps human social and economic processes (Slingo et al., 2009). The ability to study the full range of Earth system behaviors, including those in deep time, will come about because of two developments: (1) vastly improved geochronology, permitting examination of Earth-surface processes on human or near-human time scales for all climate states reaching arguably to the last half-billion years (Parrish et al., 2012); and (2) the development and application of Earth-system models, which are outgrowths of climate models and include fully coupled ice, ocean, and vegetation models along with other land-surface and deep-ocean feedbacks. This work, much of which must be carried about by sedimentary geologists and paleontologists in collaboration with climate modelers, geochronologists, and others, will permit full integration of the climate processes revealed in studies of Quaternary climates with those revealed in deep-time climate studies, so that a continuous record of climate change and dynamics can be produced. Integrating the deep-time and Quaternary records has been, until now, at best imperfect owing to the 1) higher resolution of pre-Quaternary geologic records, 2) difficulties of acquiring quantitative proxy data in deep time, and 3) traditional approaches to sedimentary geology research, which have long thrived on successes of individual and small-group researchers in field-based studies. New developments, coupled with integration of Earth-system models with human-system (economics and social) models, could lead to a new paradigm in our understanding of humanity's place on Earth. In many respects, sedimentary geologists and paleontologists have always been on the forefront of such thinking because of our commitment to understanding the geology of resources (minerals, fossil fuels, water) not just as geological problems but as human problems as well. Thus, our community is well positioned to provide leadership in defining the new paradigm.

ACKNOWLEDGMENTS

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2014 SEPM Science Awardees

Wilson Award: **Brian Romans,** Virginia Tech, (romans@vt.edu)

Honorary Membership: **Mary Kraus,** University of Colorado, (mary.kraus@colorado.edu)

Shepard Medal: **Gerold Wefer,** University of Bremen, (gwefer@marum.de)

Pettijohn Medal: **Andrew Miall,** University of Toronto, (miall@es.utoronto.ca)

Moore Medal: **David Bottjer,** University of Southern California, (dbottjer@usc.edu)

Twenhofel Medal: **John Southard,** MIT, (southard@MIT.EDU)

PRESIDENT'S COMMENTS

The landscape on which SEPM operates to achieve its mission of disseminating the best quality science is ever evolving. SEPM's success in adapting to the changing environment and maintaining a leadership role for sedimentary geology relies on the dedicated work of Headquarters staff, members, and all of the SEPM "volunteers" who serve on committees and SEPM Council. In this last regard, I want to take the opportunity to thank Past President Dave Budd for his work and dedication to keep the society moving forward.

The world of scientific publications continues to evolve rapidly. Over the last several years, SEPM has focused on transitioning its journals to the digital world. With the journal transitions well in order, attention has turned to digital publication of SEPM books. Several recent developments are worth mentioning to give you an idea of what will be available in the near future.

A first step is that SEPM soon will begin putting its book series (Special Publications, Concepts, Short Course Notes, Core Workshop Notes, Field Guides) online as they are first published both in the new GeoScienceWorld (GSW) eBooks and at SEPM Online. The five-year/out-of-print embargo will end. A major advantage of this step is that SEPM will be able to begin publishing individual Special Publications chapters online at the SEPM Website as soon as they are approved by volume editors and formatted. No longer will the authors that get their parts done on time have to wait until the last author finishes before the book is published.

As many of you may know, GSW is a database aggregation of peer-reviewed geoscience journals that are indexed and fully searchable. SEPM has participated in GSW from its inception, and GSW houses all current and past issues of the Journal of Sedimentary Research and Palaios. Recently GSW has turned its attention to building a similar eBooks database. In joining the GSW eBooks project, SEPM will not only make new book publications available at GSW, but will also archive all past book publication there as well. GSW eBooks is planning a launch in 2014.

As we address the need to get publications into digital formats, we also know there is still a need and desire to have the ability to get print versions of journals and book publications for a variety of reasons. The traditional way of making print copies is no longer a viable option from an economic standpoint. Fortunately, the evolving world of digital publication has also resulted in viable options for obtaining print copies of publications that can also provide additional benefits over traditional methods. SEPM will be partnering with High Wire Press and Sheridan Press to allow Print on Demand (POD) features for both journals and books. These ventures are planned to begin in 2014. There will be several options available for journal POD. An entire issue can be purchased for print, or articles across issues can be selected and combined for printing to create course packs or anthologies, for example. For book publications, SEPM will develop a new bookstore option to purchase Print on Demand books (both softcover and hardcover) of the newest publications and selected out-of-print volumes.

In his last President's Comments section in the Sedimentary Record (March 2013), Dave talked about opportunities in which SEPM can, and is, broadening out to include all geoscientist disciplines working on sedimentary themes. He mentioned the new Sedimentary Record editors, Isabel Montanez and Peter Isaacson, and their vision of the Record providing a forum for emerging research opportunities, and promoting multidisciplinary research. I encourage you to read Isabel's and Peter's prospectus in the March 2013 Record and contribute to the discussion.

In addition to the Sedimentary Record as a forum, I want to emphasize SEPM Research Conferences as another ideal venue for these emerging and multidisciplinary research themes. Benefits for research conferences include:

A venue for small groups (<100) of industry, academic, and government researchers and students coming together to focus on designated themes.

The opportunity to bring together researchers from multiple disciplines to develop new synergies.

Conveners have great latitude in determining the mix between formal talks, posters, informal discussions and field trips.

SEPM advertises the conference, provides significant organizational and logistical support, and provides on-site support during the conference.

To learn more about SEPM Research Conferences, including how to propose a conference, please visit the following link on the SEPM website:
Conference Proposal Guidelines

Evan Franseen, SEPM President

Meeting Report: *MYRES V – The Sedimentary Record of Landscape Dynamics*

Meetings of Young Researchers in Earth Science (MYRES) is a community-driven initiative aimed at promoting interdisciplinary research efforts among early-career scientists from across the world (www.myres.org). MYRES V: The Sedimentary Record of Landscape Dynamics brought together a wide range of early-career geomorphologists, sedimentologists, stratigraphers, and geodynamicists interested in bridging Earth-surface and solid-Earth research in order to better understand the evolution of Earth's environments over a range of temporal and spatial scales.

MYRES V took place August 8-12, 2012, in Salt Lake City, Utah. The meeting was funded by the Society for Sedimentary Geology (SEPM) and NSF (EarthCube, Sedimentary Geology and Paleobiology, and Geomorphology and Land Use Dynamics programs) and brought 54 early-career scientists from the US and abroad together for five days of science discussions and community building. The goals of the meeting were to 1) promote community building and knowledge transfer among early-career geomorphologists, sedimentologists, stratigraphers, and geodynamicists, 2) identify key research targets and opportunities for interdisciplinary research, and 3) develop a white paper that outlines specific needs and priorities for research bridging these fields.

The first three days of the meeting each focused on a broad topic: 1) The erosional engine (when, where, how and with what characteristics is sediment released from upland catchments and how is sediment production linked to tectonic and climate forcing?), 2) Dynamics of sediment-routing systems (how is sediment transported, routed and deposited through Earth-surface systems over a range of temporal and spatial scales?), and 3) Assembling the stratigraphic record (how are surface-process dynamics actually recorded in sedimentary basins and how can this information be used to reconstruct paleolandscapes and ancient tectonic and climatic conditions?). Throughout the meeting discussions were guided by five cross-cutting themes relevant to each of these topics: 1) How can we up- or downscale between disparate datasets in time and space? 2) What tools and data are needed to constrain uncertainty in interdisciplinary studies? 3) What methods should we use for geomorphic and stratigraphic prediction? 4) How sensitive are geomorphic and stratigraphic systems to external forcing? 5) How are geomorphic and geodynamic signals transferred into the sedimentary archive?

Each day included keynote talks designed to introduce the key topics to a broad audience, define the primary challenges and opportunities within the focus area, and begin to build a lexicon for interdisciplinary communication. Afternoon talk and poster sessions highlighted specific research examples related to the daily theme. Presentation sessions were open-format and casual, allowing for extended question-and-answer and discussion with the whole group, and ample time for informal discussions and interactions among participants.

Each day concluded with breakout and plenary discussions intended to refine ideas and develop consensus about priority research and educational needs and opportunities. Group discussion on Day 3 also included an EarthCube Workshop during which Barbara Ransom (NSF) introduced EarthCube and conference participants identified ways in which the EarthCube Cyber Infrastructure program could support science related to the conference theme (EarthCube workshop outcomes can be found here).

The final two days of the meeting comprised a field workshop that focused on the stratigraphic deposits and erosional landscapes of central Utah. This excursion facilitated further discussion and community building by bringing all participants to the field to evaluate how key research priorities can be addressed with geomorphic and stratigraphic measurements in natural systems. Field highlights included: 1) paleoshorelines of glacial Lake Bonneville, described by G.K. Gilbert and later used to study crustal rebound and mantle viscosity; 2) a large landslide that dammed the Spanish Fork River in 1983; 3) classic outcrops of the Cretaceous Western Interior Seaway deposits, which show sedimentary and stratigraphic architecture in exceptional detail at multiple spatial scales and demonstrate basin response to tectonic and climatic signals; 4) river terraces and Pleistocene colluvial hillslope deposits at the mouth of Desolation–Gray Canyon on the Green River; and 5) Laramide tectonic features of the San Rafael Swell, with its window into Mesozoic and Paleozoic strata.

Meeting participants identified six high-priority science questions that should be the focus of interdisciplinary efforts during the next 5-10 years.

1. What processes are relevant to understanding landscapes and mass flux (i.e. sediment budgets) in the past, present, and future across different temporal and spatial scales?
2. How is sediment generated and changed as it moves through the landscape?
3. How does downstream transmission of Earth-surface materials filter and record the frequency and magnitude of Earth's environmental changes?
4. How does life influence surface processes and transform environmental signals preserved in the sedimentary archive?
5. To what extent do extreme events control landscape evolution and stratigraphy?
6. How do the effects of tectonic and climate conditions propagate through the landscape and depositional system? At what scales?

Participants felt the meeting goal of strengthening interdisciplinary communities was successfully accomplished, as many new collaborators and connections were found during the meeting. Ongoing efforts to maintain and expand this community include a meeting website https://sites.google.com/site/myresv/ and a Google Group where notices and information about announcements related to the sedimentary record of landscape dynamics are posted. We encourage all interested researchers to join and contribute to these groups. A manuscript reviewing the conference themes and outcomes in detail is currently being prepared by the conference organizers.

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Meeting Report: *Volcanism, Impacts and Mass Extinctions: Causes and Effects* International Conference, March 27-29, 2013 Partially Sponsored by SEPM

Gerta Keller, Department of Geosciences, Princeton University, Princeton NJ, USA; Andrew C Kerr, School of Earth & Ocean Sciences, Cardiff University, Cardiff UK; Norman MacLeod, The Natural History Museum, London UK

The Natural History Museum in London recently hosted an international, multi-disciplinary conference that brought together 150 researchers in geology, geophysics, geochemistry, volcanology, sedimentology, paleontology and astronomy to review and assess recent research into the causes of mass extinction events. Participants included seasoned experts as well as younger researchers and students. Through listening and learning from each other and by spirited constructive discussions, a new, collaborative and multi-disciplinary approach to resolving outstanding problems in this field was explored. The data and concepts presented and discussed at the meeting also have value well beyond the geosciences, particularly with regard to understanding modern environmental crises.

The main conclusions of the conference were:

- Large igneous province volcanism, along with associated climate and environmental changes, is likely to have played a significant role in at least four of the five major mass extinctions in earth history: the end-Cretaceous, end-Triassic, end-Permian (comprising two distinct extinction events) and end-Devonian. However, the exact causal mechanisms by which 50-90% of the species preserved in the fossil record went extinct at each event remains to be worked out. Better age control for individual lava units and extinction events is critical to establish the relationship between the causes and effects.
- There was overwhelming agreement that a single large asteroid or comet impact (Chicxulub) could not have been the sole cause of the end-Cretaceous mass extinction, but rather was a contributing factor. The long-term biological, environmental and climatic changes before, at and after the bolide impact horizon call for a multi-causal scenario, certainly involving volcanism and possibly multiple impacts or comet showers.
- Participants gained an improved understanding of how large igneous province eruptions affect the biosphere. This included data and conclusions derived from atmospheric chemistry, geochronology of eruptions, associated mechanisms of climatic changes and the direct effects on species-level extinctions.
- Mass extinction patterns can tell us much about the age, tempo and nature of the catastrophe and the type of environments that were most affected. We know most about the end-Cretaceous mass extinction. However, similarly detailed records are still needed for the other mass extinctions. If common patterns, or critical differences, between all mass extinctions are found these can yield critical evidence for or against specific extinction mechanisms.
- Ultimately, the effects of volcanism, impacts, sea-level and climate changes (warming and cooling), ocean acidification, ocean anoxia and atmospheric changes have to be considered in any extinction scenario in order to understand the causes and consequences of mass extinctions. Moreover, these data hold keys to help us understand, and cope with, the looming environmental and extinction crises in the modern world.

A planned GSA Special Paper will serve not only as a lasting record of the meeting, but will also act as important guide for the multi-disciplinary studies still needed to resolve the outstanding problems in understanding the causes and effects of mass extinctions. See also Keller et al. (2013): http://www.geolsoc.org.uk/Geoscientist/Archive/November-2012/Volcanism-impacts-and-mass-extinctions-2

EarthCube and Sedimentary Geology for the Future

New global information technology, tools, and access have dramatically changed our lives and how we communicate. It can similarly transform how we conduct our science. EarthCube is a new National Science Foundation (NSF) initiative with the goal of building a comprehensive data and knowledge management system in the Earth, atmospheric, and oceanic sciences within a decade. Through this initiative, information and data will be integrated into a single, geovisualization and management portal, accessible through the internet to all scientists and the public.

NSF is utilizing domain (subdiscipline) workshops to help spread the word about the EarthCube initiative (earthcube.ning.com), and to provide opportunities for input on how to build the best structure to fit our science needs. In March 2013, the Sedimentary Geology Community (SGC) workshop brought together 57 geoscientists with expertise in modern and ancient sedimentology, stratigraphy, basin analysis, paleontology, paleoclimatology, sedimentary geochemistry, sedimentary petrology, petroleum geology, paleopedology, and geochronology.

The workshop discussions addressed many issues including: challenges to integrating the community into EarthCube, important scientific drivers, research themes that could be pursued with an ideal EarthCube, impediments to sharing and using data, current cyber resources, needed data sets and tools for the future, and potential impact of EarthCube on teaching. Three overarching societal issues emerged as the drivers that will condition research within the SGC community over the next 5-15 years:

1. Securing the energy and water resources needed for an increasing global population while balancing resources for a sustainable Earth.
2. Understanding the Earth as a system, the nature of global climate change, and its impact of climate change on life, the environment, and Earth resources.
3. Understanding anthropogenic influences on Earth surface processes will be necessary to minimize risks to society and insure environmental sustainability, particularly in deltaic, coastal zone, reefs, lake, and fluvial settings.

Participants envisioned EarthCube to have a Google Earth-like interface with topography, surface, and subsurface geology. The interface would (i) allow a wide range of queries, (ii) search, compile and visualize a variety of data for different time intervals and geographic locations, and (iii) have the ability to create cross sections from designated line paths, make maps for designated areas and time/depth intervals, and provide visualizations of other types of information and synthesized products. Achieving these goals will require construction and fusion of public-domain geo-referenced databases that include: geologic maps, cross sections, seismic and GPR lines, LiDAR data, macrostratigraphy, paleontologic and paleoclimatic data, outcrop and core descriptions and imagery, and geochronologic information.

In order to improve communication with all members of the community, a SedGeoNet listserve was immediately established after the workshop. The listserve is not intended to be limited to just EarthCube related issues, but to serve the entire sedimentary geology community for any relevant topics. The list serve is currently hosted at SUNY Oneonta and you can subscribe by either contacting James.Ebert@oneonta.edu or following the directions at http://external.oneonta.edu/mentor/listserv.html It is anticipated that this listserve will be turned over to the new STEEPE coordinating office (*Sedimentary Geology, Time, Environment, Paleontology, Paleoclimatology, and Energy*, http://www.steppe.org/).

You can learn more about EarthCube and access the full executive summary of the workshop (earthcube.ning.com). You can also become part of the EarthCube community (http://connections.earthcube.org/memberconnections). A short 2-minute, informational video on the EarthCube initiative is available (www.youtube.com/watch?v=mFBrULWYXL0 or search "YouTube EarthCube Introduction"). The student-produced video can be shown in classes to spark discussions on the potential transformations in future Earth science collaborations, data collection, management, and research. EarthCube is the wave of the future!

Marjorie A. Chan and David A. Budd

Report: *North American Commission on Stratigraphic Nomenclature*

The North American Commission on Stratigraphic Nomenclature (NACSN) has four goals: 1) develop statements of stratigraphic principles, 2) recommend procedures applicable to classification and nomenclature of stratigraphic and related units, 3) review problems in classifying and naming stratigraphic and related units, and 4) formulate expressions of judgement on these matters. NACSN website: www.agiweb.org/nacsn/. SEPM is a member of the NACSN, with Howard Harper (hharper@sepm.org) and Marie-Pierre Aubry (aubry@rci.rutgers.edu) being SEPM's representatives. If you have any questions about NACSN please contact them.

The 2012 NACSN meeting was held during the November 5th at the Geological Society of America Annual Meeting in Charlotte, North Carolina. At the GSA meeting NACSN co-sponsored session "T168. Mid-Atlantic Coastal Plain Stratigraphy and Paleontology" in partnership with the Paleontological Society, SEPM (Society for Sedimentary Geology), and the GSA Sedimentary Geology Division and chaired by David S. Powars and Lucy Edwards. This session focused on current advances and promising avenues of research in regional framework synthesis of the Coastal Plain and offshore.

Agenda items included:

An amendment to the Code of Stratigraphic Nomenclature to formalize names of intrusive complexes will be presented at the 2013 meeting and a decision will be made as to whether it should be 'placed for consideration' by the larger geoscience community.

The Commisioners proposed two sessions at the 2013 meeting of the Geological Society of America: Earth Deep Time Revolution by Global Chronostratigraphic Correlation" co-sponsored by NACSN and ICS-IUGS and a second session "Impact of GSSPs on Evolution of North American Chronostratigraphy." Both proposals have been accepted.

The Commission proposed that the next stratigraphic code be re-named as 'Stratigraphic code of Americas' and be developed in consultation with other responsible geological bodies in the hemisphere. Also the Commission will coordinate with The Commission for the Geologic Map of the World to achieve consistent stratigraphic terminology

The Task group on "Impact of the New Definition of the Pleistocene" chaired by Howard Harper, SEPM Executive Director and Robert Scott, The University of Tulsa, reported that 336 geoscientists including SEPM and AAPG members responded to the survey. The majority of respondents (80%) work with Cenozoic strata. Additional surveys of the wider geoscience communities were conducted in 2011-12. The second survey had been requested following discussion at the 66th NACSN Meeting in order to ensure that a broad range of users was surveyed including physical anthropologists. A comparison of the two surveys showed that similar results. About 35 to 40% of those surveyed only learned about the classification change through the survey. Thus, it was suggested that International Commission on Stratigraphy, while following clearly defined internal procedures, needs a more inclusive effort to inform the sedimentary geology community of proposed changes.

The *International Stratigraphic Guide* is in need of revision. A condensed version of the existing guide is on the ICS web-site (www.stratigraphy.org). Commissioners were invited to submit ideas regarding revisions to Commissioner Stan Finney, who is ICS Chair.

The term, "*Anthropocene*," is the topic of an ICS Quaternary Subcommission task group that is considering it as a time stratigraphic unit to be added to the geological time scale as an Epoch. The current North American Stratigraphic Code could treat this concept as a diachron unit – Anthropocene Diachron.

A new version of the GSA time scale is available. A pdf of it can be downloaded for free from http://www.geosociety.org/science/timescale/.

Commission Chairman for 2012-2013 is Robert Scott, The University of Tulsa and the Vice-Chairman is Richard Fluegman, Ball State University.

POSITION SEARCH – TITLE: Executive Director

DEPARTMENT: STEPPE Office* (Sedimentary Geology, Time, Environment, Paleontology, Paleoclimate and Energy)

LOCATION: STEPPE offices and administrative support will be located at GSA in Boulder, CO but applicants may propose an alternative location for this position.

STATUS: Full Time; an inter-organizational agreement can be part of this position. Full time is preferred but other situations may be considered.

SALARY INFORMATION: $80,000 to $100,000 per year. The starting salary will be commensurate with qualifications and experience and includes an excellent benefit package.

PRIMARY PURPOSE: To provide leadership and management of the STEPPE effort in engaging the sedimentary crust research community in productive interaction.

NATURE OF WORK: Reporting to STEPPE Board of Directors, this position provides the oversight of all STEPPE activities. This position interacts with all stakeholders of sedimentary crust research, including: students, academic researchers, industry researchers, government researchers, government grant agencies and the public. Work is performed with strategic supervision of the Board, in a fast-paced environment, subject to multiple deadlines and priorities. The incumbent exercises discretionary decision making.

TYPICAL DUTIES: This position will include building a communications infrastructure to inform and allow interaction within and outside of the sedimentary crust research community on a global scale. Communications will include internet based tools (website, blogs, social media, etc.); topical workshops, individual meetings and public presentations. Strategic planning with the Board and implementing action items among and between existing sedimentary crust research initiatives as well as facilitating the community in creating additional initiatives and integrative research proposals that cross specialty boundaries.

QUALIFICATIONS

Education: Advanced degree in geoscience.

Experience: Background in geoscience research; general knowledge of the overall effort in sedimentary crust research and success in winning government grants. Applicants must be able to legally work in the United States.

Skills: Ability to manage multiple tasks and maintain attention to detail; ability to effectively work independently; highly effective interpersonal, communication and organizational skills; demonstrated public relations skills including the ability to interact effectively with public, students, academic, industrial and government personnel; self-motivated and creative. Knowledge of structure and processes in procuring governmental research grants; ability to handle interactions with tact, discretion, confidentiality and cultural sensitivity. General computer skills and application of internet communication tools are essential.

To be considered for this position, please provide the following documents: cover letter and resume. These may be sent as attachments to hr@geosociety.org. Must be authorized to work in the United States.

*STEPPE Office is a scientific society (GSA, SEPM, PS) and NSF funded effort to facilitate the sedimentary crust research community in its goal of understanding the details of the Earth's past and humanity's future. It is a 3-year initial grant to develop the communications infrastructure to unite the community to achieve this goal.