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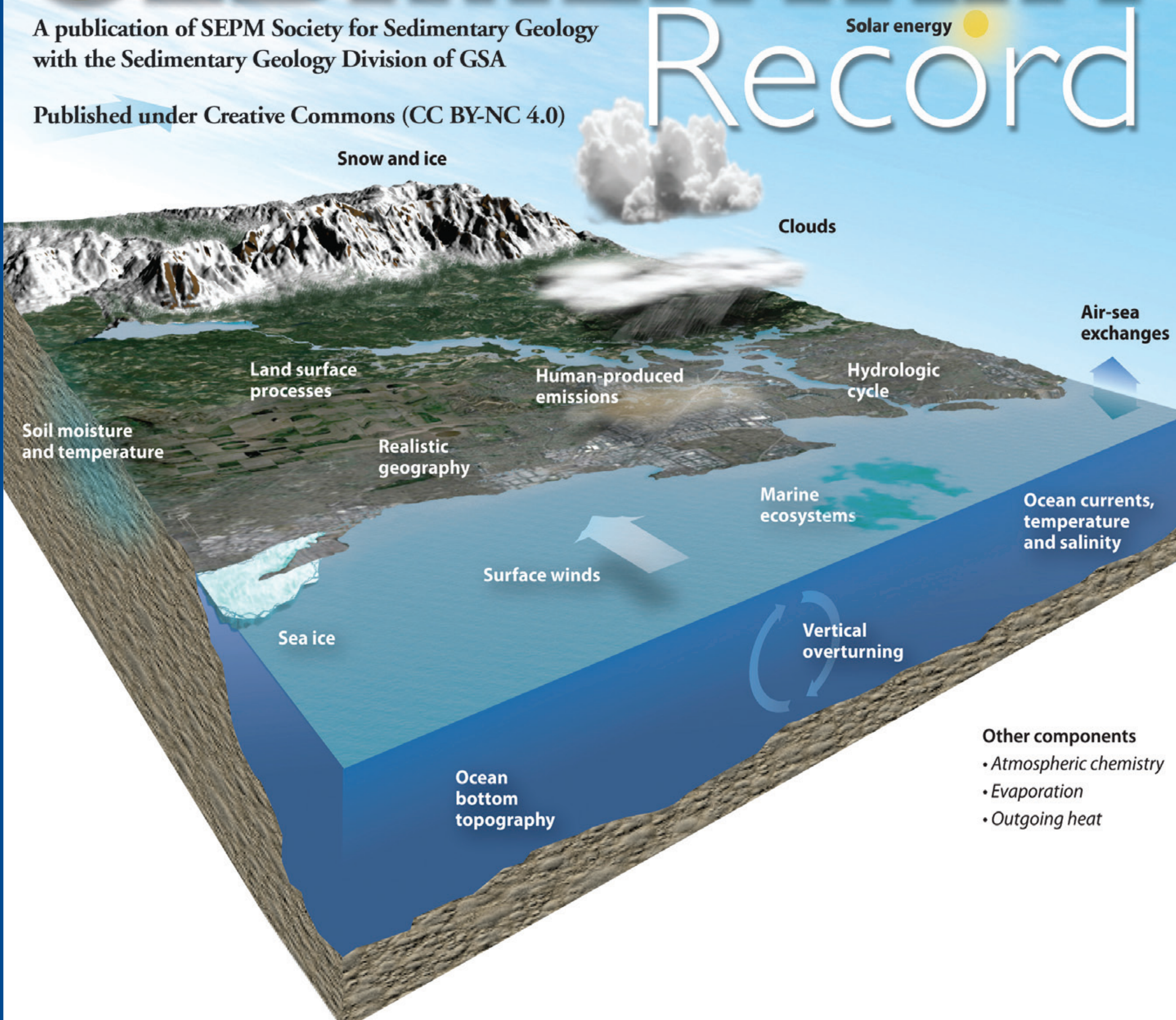

INSIDE: INJECTING CLIMATE MODELING INTO DEEP TIME STUDIES: IDEAS FOR NEARLY EVERY PROJECT

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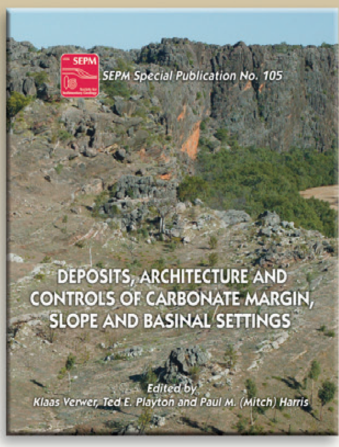

Special Publication #105

Deposits, Architecture, and Controls of Carbonate Margin, Slope, and Basinal Settings

Edited by: Klaas Verwer, Ted E. Playton, and Paul M. (Mitch) Harris

Carbonate margin, slope and basinal depositional environments, and their transitions, are highly dynamic and heterogeneous components of carbonate platform systems. Carbonate slopes are of particular interest because they form repositories for volumetrically significant amounts of sediment produced from nearly all carbonate environments, and form the links between shallow-water carbonate platform settings where prevailing in situ factories reside and their equivalent deeper-water settings dominated by resedimentation processes. Slope environments also provide an extensive stratigraphic record that, although is preserved differently than platform-top or basinal strata, can be utilized to unravel the growth evolution, sediment factories, and intrinsic to extrinsic parameters that control carbonate platform systems. In addition to many stimulating academic aspects of carbonate margin, slope, and basinal settings, they are increasingly recognized as significant conventional hydrocarbon reservoirs as well. The papers in this volume, which are drawn from the presentations made at the AAPG Annual Meeting in Long Beach, California (USA), in May 2012, as well as solicited submissions, provide insights into the spectrum of deposit types, stratal configurations, styles of growth, spatial architectures, controlling factors behind variations, and the hydrocarbon reservoir potential observed across the globe in these systems. The sixteen papers in this Special Publication include conceptual works, subsurface studies and outcrop studies, and are grouped into sections on conceptual works or syntheses, margin to basin development and controlling factors, architecture and controls on carbonate margins, and carbonate distal slope and basin floor development.

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Concepts in Sedimentology and Paleontology 12

Mudstone Primer: Lithofacies Variations, Diagnostic Criteria, and Sedimentologic–Stratigraphic Implications at Lamina to Bedset Scales

By: Remus Lazar, Kevin M. Bohacs, Juergen Schieber, Joe Macquaker, and Timothy Demko

More than two-thirds of the sedimentary record is composed of rocks dominated by grains smaller than 62.5 micrometers. These fine-grained sedimentary rocks serve as sources, reservoirs, and seals of hydrocarbons, influence the flow of groundwater, and can be rich in metals. These rocks have long been mined for clues into the past global carbon, oxygen, sulfur, and silica cycles, and associated climate and oceanography. These rocks are heterogeneous at many scales and formed via a range of depositional processes. Recent developments in drilling and completion technologies have unlocked significant hydrocarbon reserves in fine-grained sedimentary rocks and have triggered an explosion of interest in the sedimentology, stratigraphy, and diagenesis of these rocks. This Mudstone Primer covers this variability to better characterization and interpretation of mudstones. Definitions of key terms and a naming scheme for mudstones are provided followed with practical steps for studying mudstones in thin sections. Additional guidelines and a set of tools that facilitate consistent, repeatable, and efficient (time wise) description and capture of mudstone variability at thin section, core, and outcrop scale are included in seven appendices. This Mudstone Primer includes hundreds of Paleozoic to Tertiary examples of physical, biological, and chemical features that illustrate mudstone heterogeneity at lamina to bedset scales. The authors hope that individual workers will take the provided examples and interpretations and use them to enhance their own investigation strategies.

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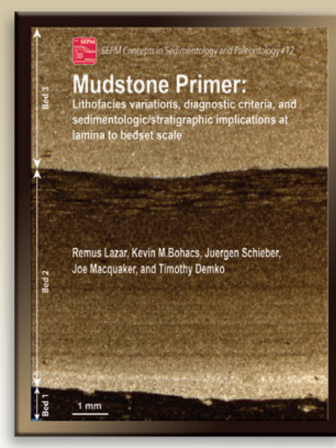

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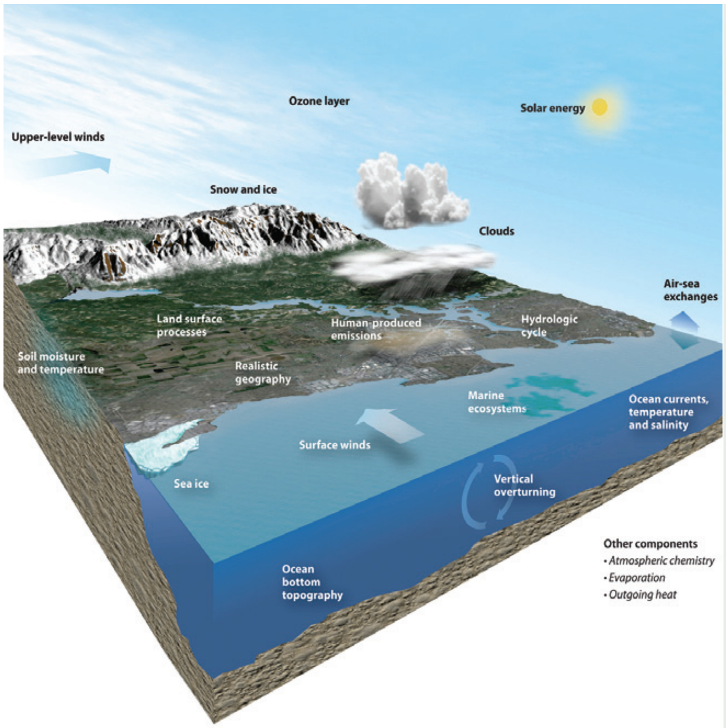

Cover image: The Community Earth System Model (UCAR)

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Injecting Climate Modeling Into Deep Time Studies: Ideas for Nearly Every Project

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ABSTRACT

Global climate models (GCMs) primarily exist to describe the present-day climate system and simulate its response to inputs in order to attribute observed change to its causes and predict the future of climate. It has been proposed to enable GCMs to simulate potentially large future climate transitions by testing their ability to attribute climate change against new and existing data concerning past transitions in Earth's history. These proposals emphasize the technical challenges and large uncertainties of climate modeling in deep time as well as the need for substantial culture change to bring modelers and observers together to solve challenges like the climate dynamics of icehouse–greenhouse transitions. This essay proposes that the creation or just the use of climate model output could bring added value to many deep time studies, even those small in scale; and thus should be considered in project design. Examples are mainly provided from studies of Carboniferous and Permian strata that suggest potential in areas such as macrogeological databases, high-resolution depositional records, and uncertainties in atmospheric composition and paleogeography.

INTRODUCTION

Studies of present and future climate change and of the connected issues of energy, pollution, and mineral resources strongly connect the geosciences with society. Global climate models (GCMs) have become an important tool in the study of climate. Their development since the late 1980s has been shaped by two needs: (1) to attribute the rapid rise in global mean temperature in the 20th and 21st centuries to its causes (2) to predict how climate will change in the future, particularly because much of recent climate change is attributed to human activities, as described in the reports of the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 1990, 1996, 2001, 2007, 2014).

Modeling contributions to the IPCC have mostly focused on the very recent past and near future of climate (1850–2100) (e.g., Taylor et al., 2012). However, it was soon recognized that models that could simulate a wider range of climates than during the instrumental record might simulate future climate better. Therefore, standardized GCM simulations of the middle Holocene (6 ka) and Last Glacial Maximum (LGM, 21 ka) were undertaken soon after the first IPCC Report in 1990. They are now considered valuable enough to merit an entire chapter in IPCC's (2007) Report (Joussaume et al., 1998; Crucifix et al., 2005).

Geoscientists interested in the deep past, the history of the Earth solely recorded in the rock record (prior to the Pleistocene, 2.588 Ma), have suggested that climate change throughout Earth history is also relevant to the direction of climate today. They propose studying icehouse–greenhouse transitions during Earth's history and designing standardized global climate model (GCM) experiments to understand them (NRC, 2011). Comparing these experiments with the geological record would (among other things) test the ability of GCMs to simulate the response of climate to large, rapid changes in greenhouse gases (Valdes, 2011; Zeebe, 2011; NRC, 2011).

GCM simulations of the Earth's deep past are nothing new (e.g., Kutzbach and Gallimore, 1989), but, to borrow from medical parlance, they long have been an off-label use. However, there are at least three reasons why observers of deep time (geologists, geochemists, paleobiologists, etc.) should continue to engage with the broader climate science enterprise represented by the IPCC by further integration of observational studies with GCM simulations.

First, deep time climate studies relevant to present day climate could open new funding opportunities for the academic sedimentary geology and paleobiology community, which has significantly contracted in recent years in the U.S. (Parrish et al., 2011). Second, many GCMs do not just model the atmosphere but consider the ocean, the land surface, and the cryosphere in their abiotic and (increasingly) biotic characteristics (see Heavens et al., 2013 for an overview). These new capabilities may allow more direct simulation of some aspects of the geological record. Finally, the expanding capabilities of GCMs can pose new technical challenges for modeling deep time climates, which also would merit more attention from GCM developers and funding agencies if deep time grew in relevance (e.g., Heavens et al., 2012).

Yet modelers and observers of deep time face difficult technical challenges, including uncertainties in how to set up and test simulations. They also may face cultural challenges, which may be broadly summarized as obstacles to finding the time, financial support, tools, and collaborators to solve those technical challenges (NRC, 2011).

In the remainder of this essay, I will argue that a closer relationship between climate modeling and observational studies of deep time does not need to be a daunting prospect. Indeed, current developments in sedimentary geology can encourage closer collaboration between observers of deep time, modelers of deep time climates, and perhaps the community that focuses on the changing climate of the Earth today. In addition, I will show how observational uncertainties in deep time can stimulate climate modeling.

The opportunities are already here to build the scientific culture and research infrastructure that can make the past of Earth's climate relevant to predicting its future. Indeed, seizing those opportunities may help prioritize what technical and cultural problems need to be solved. My examples mostly focus on my own research interests in late Paleozoic continental climate. Nevertheless, the points I make should be broadly relevant and perhaps could be better supported by examples from other parts of Earth history.

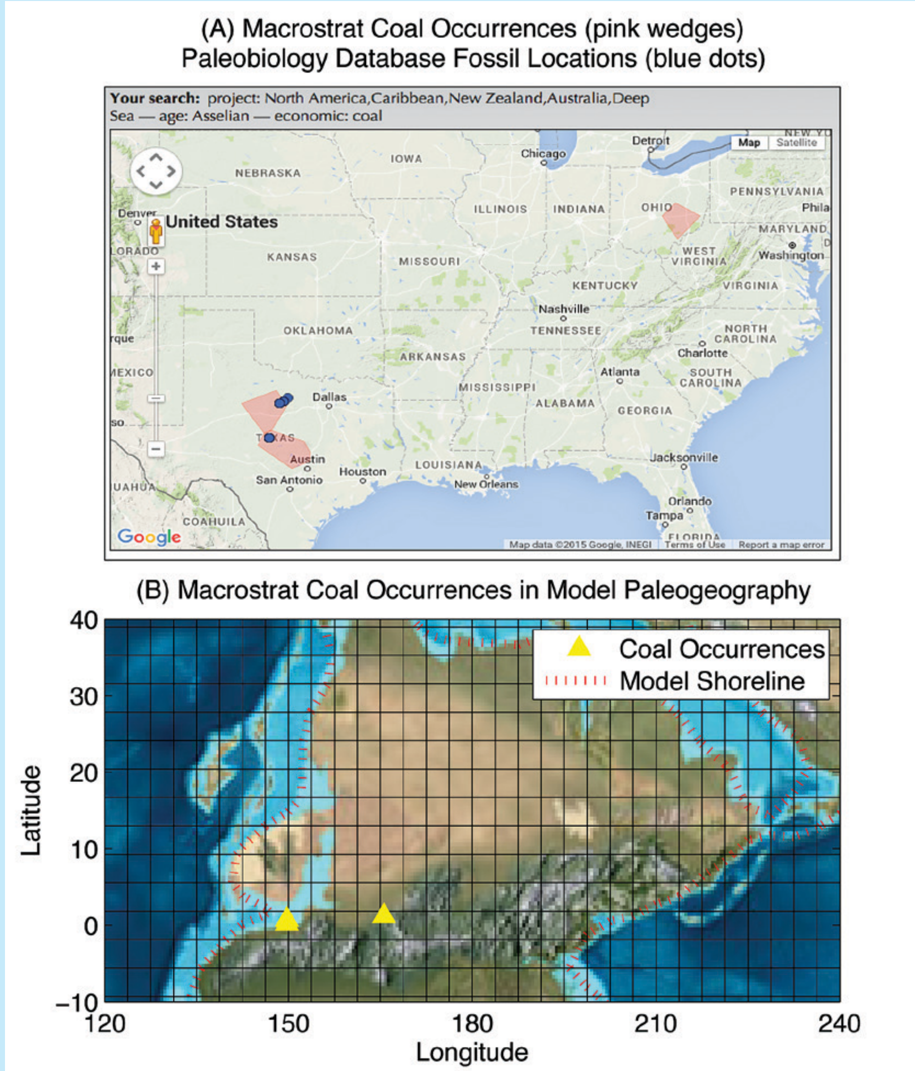

Figure 1: (A) Asselian coal occurrences in Macrostrat; (B) Asselian coal occurrences from (A) in model paleogeography of Heavens et al. (2015) overlaid on the Blakey (2015) paleogeographic map on which it was based, whose uncertainties are not known. The intersections between gridlines indicate model gridpoints, so the square size is indicative of model resolution but does not correspond to the true gridboxes.

CLIMATE MODELING OPPORTUNITIES

Using Digital Macrogeological Databases To Test GCM Simulations

Compiling and organizing geological data over scales much greater than outcrops is at least as old as Smith's (1815) map of Great Britain. Digital computers and the Internet can make compilation faster, cheaper, and easier to query. One result is digital databases like the Paleobiology Database and Macrostrat, which have been developed to quantitatively test hypotheses that span large geographic scales and/or wide swathes of the Earth's history.

Peters and Heim (2011) classifies the purpose behind quantitative analyses of these databases under the head of "macrostratigraphy" and "macroevolution", reviving the concept of "macrogeology," in historical studies of geology (Schneer, 1981; Bretsky, 1983). These studies contrast deriving broad general principles analogous to the laws of physics (macrogeology) with incremental exploration and accurate description of individual rock units (microgeology). Databases like Macrostrat therefore are macrogeological in vision (and in name) but synthesize abundant, high-quality microgeological studies in the form of existing syntheses (Childs, 1985) or data mining of the peer-reviewed literature (Zhang et al., 2013). It soon may be possible to make direct data queries about the distribution of facies in seconds that previously would have required months of bibliographic research.

Macrogeological databases also enable GCM simulations to be compared

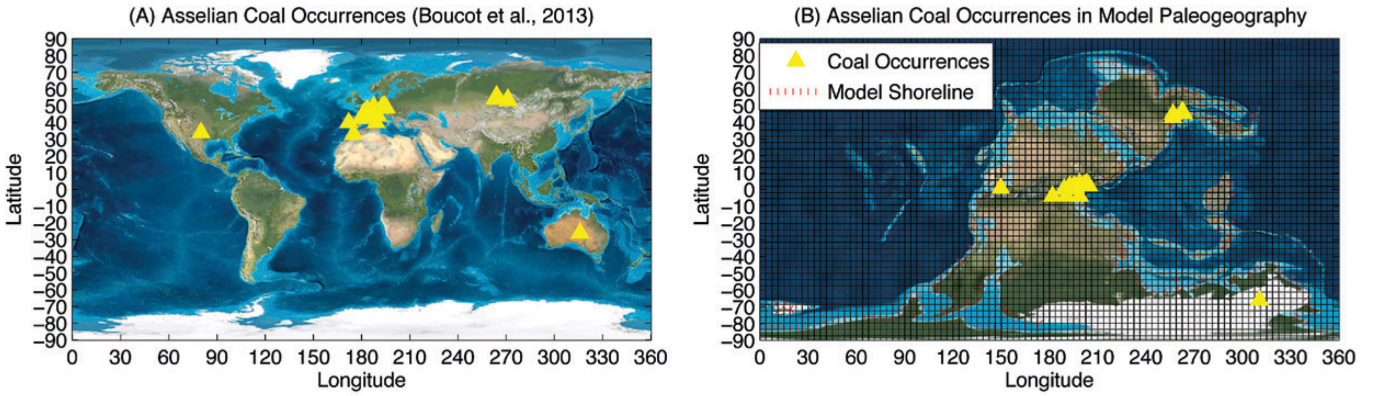

Figure 2: (A) Asselian coal occurrences in Boucot et al. (2013); (B) Asselian coal occurrences from (A) plotted as in Figure 1B. "Very earliest Wolfcampian" and Autunian are considered to be equivalent to Asselian.

with the distribution of facies restricted to particular climatic conditions (e.g., coals, bauxites, evaporites, tillites). The distribution of such sediments has been used to reconstruct past climate and/or geography (Patzkowsky et al., 1991; Ziegler et al., 1997; Tabor and Poulsen, 2008). GCM simulations are fully quantitative climate reconstructions, so it is reasonable to ask whether climate-sensitive facies occur within the expected climate conditions.

As a concrete illustration, I use coal occurrence during the Asselian (295.0–298.9 Ma) to test climate simulations by Heavens et al. (2015) that are focused on tropical climate dynamics during this time. The test is whether precipitation and evaporative balance in the simulations at the location of coal occurrence is consistent with the conditions under which peat deposition is thought to be possible (Patzkowsky et al., 1991; Cecil et al., 2003).

Because most of its continental data is concentrated in North America, Macrostrat currently contains minimal Asselian coal data (Figures 1A and 1B). So I have used a more expansive, non-digitized global compilation of climate-sensitive facies (Boucot et al., 2013) to demonstrate Macrostrat's future potential. Nevertheless, there is room for improvement in characterizing the record even at this temporal resolution. Most of the Asselian coal occurrences are in Europe and Eurasian Russia (Figure 2A). Early Permian coal occurrences from China are abundant, but age control to Age/Stage level is lacking (Boucot et al., 2013). The full set of occurrences covers equatorial Pangaea as well as parts of both the northern and southern extratropics (Figure 2B).

Three of the Heavens et al. (2015) simulations, which span low pCO_2 icehouse climates similar to today as well as high pCO_2 greenhouse climate conditions, are broadly consistent with peat deposition at tropical coal occurrences (Figure 3). Most of the exceptions are in southern tropical Pangaea, where all simulations overestimate climate seasonality/evaporation and the icehouse simulations are overly dry (Figure 3). The greenhouse simulation *(greenhouse.noglaciation)* is similarly incorrect with respect to the Texas occurrence (Figure 3). All simulations appear overly dry in the extratropics, but the greenhouse simulation is wet enough for peat deposition in some extratropical locations (Figure 3). Peat deposition where Asselian coals occur is inconsistent with a simulation in which there is glaciation at the equator at altitudes of 500–1000 m *(icehouse.glaciation.equatorial)*. Climate conditions of this extremity would have interrupted peat deposition globally (Figure 3).

In all simulations, the amount and seasonality in precipitation in tropical Pangaea is affected by the monsoon over Pangaea (Heavens et al., 2015). This monsoon is stronger under greenhouse conditions. Under icehouse conditions and when the Earth's orbit is eccentric, the monsoon is strong when the longitude of perihelion is in phase with the summer solstice. However, the effects of orbital variability on this coal occurrence test are minor (Figure 4). A strong northern summer monsoon *(ih.g.orb4)* dries most areas of coal occurrence near the equator and a strong southern summer monsoon moistens the same areas. But these changes are not sufficient to move any location in or out of the zone of peat deposition (Figure 4).

Fully interpreting the results of this experiment is beyond the scope of this essay. Nevertheless, using digital macrogeological databases to test models in this way could help separate and attack discipline-spanning uncertainties that have so far proven difficult to separate (Heavens et al., 2015; Soreghan et al., 2015). Such an error could come from the model itself, due to poorly resolved or poorly represented processes and could be isolated by model intercomparison tests along the lines proposed in this section. This error could be the result of incorrect dating or paleogeographic assignment, which could be assessed by geological and geochemical techniques. Or the coals all could be Asselian but were deposited in different climates within Asselian time, which could be assessed geologically as well. Or the systematic errors could arise from errors that directly bridge observations and modeling, such as those related to greenhouse gas inputs or paleogeography.

Climate model tests like this do not need to be limited to lithology. Fossils themselves can be analogous to a climate-sensitive facies. Biophysical analysis and simulations of plants and animals can estimate the environmental tolerance of extinct species and/or properties from which such tolerances can be estimated (e.g., Head et al., 2009; Wilson and Knoll, 2010). Indeed, at least one attempt at paleobiological validation of GCM simulations predates the Paleobiology Database (Rees et al., 1999).

Climate model tests of this kind only will be common when climate modelers provide output in ways that interface well with macrogeological databases. For the experiment described above, I relied on direct inspection of the source maps for the paleogeographic model of Heavens et al. (2015) to match the modern location of the facies with its location in the simulations. This is not a scientifically reproducible technique. Archiving output will require more rigorous definition of the translation between paleo-space and present space.

GCM Investigations of Hypothetical High-Resolution Climate Signals

One uncertainty in predicting future climate is the relationship between change in the mean state and higher order moments of climate (e.g., Schneider, 2004). Put another way: does climate change gradually and linearly or non-linearly and abruptly? One approach has been to investigate and/or model climate variability in the recent or deep past at a variety of timescales, even those approaching the annual or seasonal (Alley, 2000; Zachos et al., 2001; Crowley and Hyde, 2008). However, as global temperatures warm, the climates recorded by deep ocean or ice core oxygen isotope records become poorer analogs for the future. High-resolution data during icehouse–greenhouse climate transitions throughout Earth history could be valuable.

Fortuitous high-resolution data of at least one sort is known in the stratigraphic record. Length of day in Proterozoic time can be inferred from laminar tidal rhythmite deposits, some of which have diurnal resolution (Williams, 1997). Perhaps more common and more climatologically useful are potential speleothems from

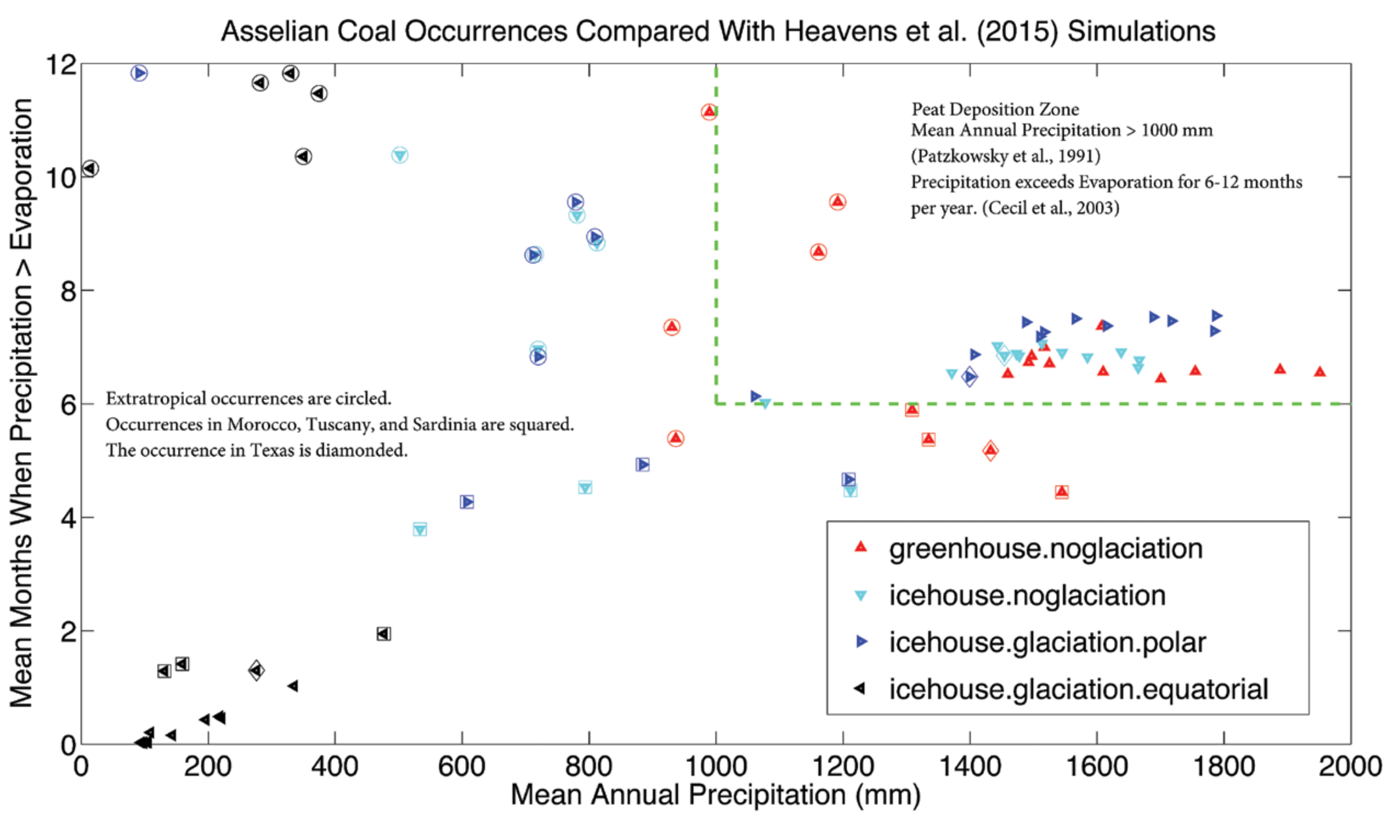

Figure 3: Predicted conditions critical for peat deposition at the locations of Asselian coal occurrences for four climate model simulations of Heavens et al. (2015), as labeled. The chosen simulations sample a range from extreme icehouse to extreme greenhouse conditions. See text for discussion.

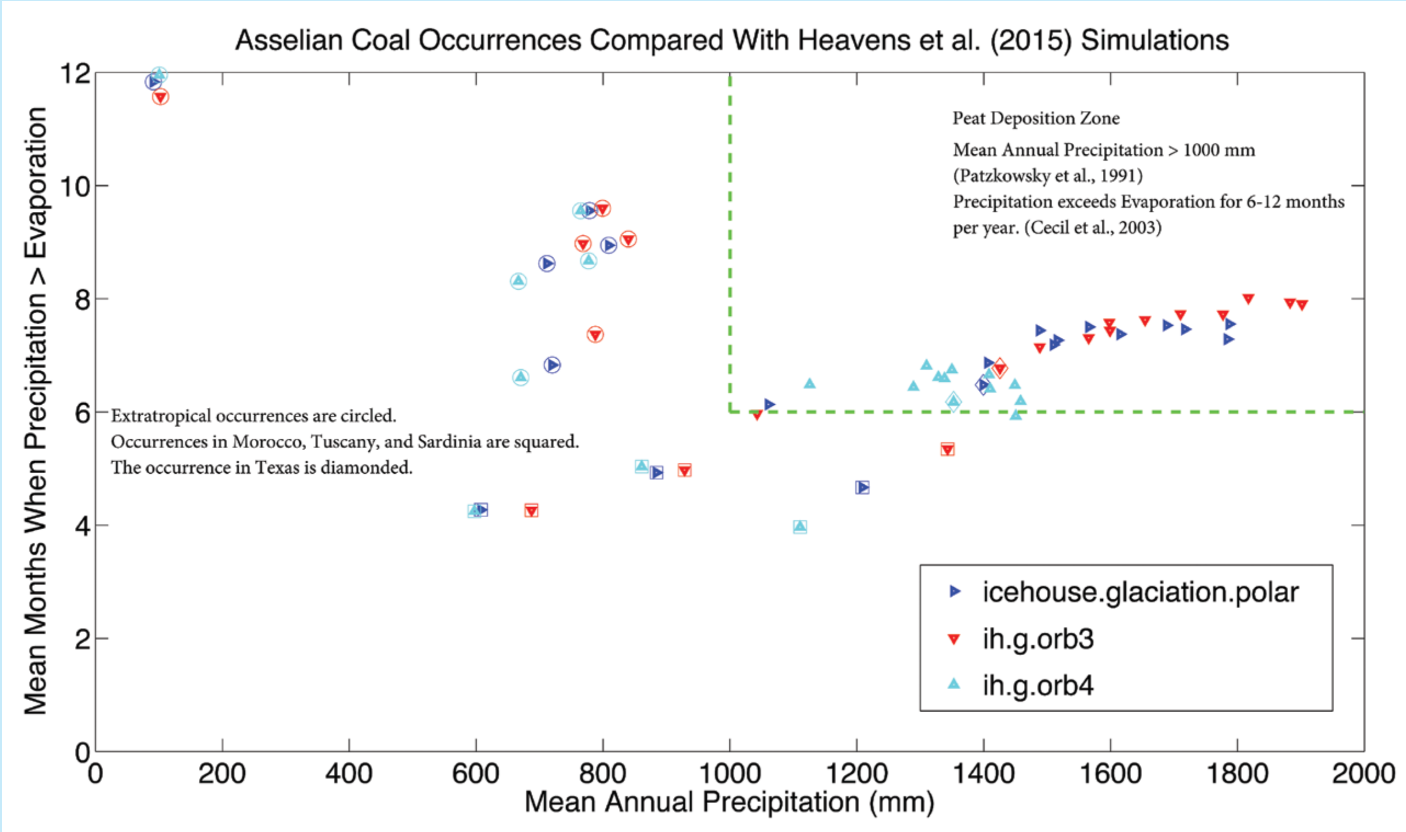

Figure 4: Predicted conditions critical for peat deposition at the locations of Asselian coal occurrences for three climate model simulations of Heavens et al. (2015), as labeled. The chosen simulations sample different monsoonal conditions over Pangaea. See text for discussion.

deep time, which may sample annual or even seasonal variability in the chemical and isotopic composition of precipitation influx to the cave (Woodhead et al., 2010).

Woodhead et al. (2010) qualitatively attribute the variability in their speleothem record to climate dynamics. Yet GCMs now are capable of simulating the isotopic composition of water in precipitation as well as the deposition of sea salt and/or particular elements such as P (e.g., Risi et al., 2010; Mahowald et al., 2006, 2008; Vet et al., 2014). Simulations could strengthen Woodhead et al. (2010)'s case by estimating the sensitivity of speleothem signals to climate variability, enabling comparisons with the potential effects of internal cave dynamics and/or post-burial diagenesis as well as the quantification of the higher order moments of climate variability from a suite of proxies. And this potential does not stop with speleothems but might apply to a variety of strata encountered by future continental drilling projects, such as varved lakes.

Uncertainties In Atmospheric Composition Are Opportunities In Disguise…

Observations of deep time come with uncertainty. One may identify them. One may list them. One may bemoan them. But one motivation for studying the Earth's history is to reduce them. In many cases, GCMs can help.

Oxygen has obvious significance for biology and biogeochemistry. Its role in climate is less obvious. It absorbs poorly in the infrared and so is not a greenhouse gas (IPCC, 2013). However, it currently makes up 21% of the atmosphere by volume. Oxygen molecules frequently collide with greenhouse gas molecules, enabling greenhouse gases to absorb wider bands of infrared radiation (Goody and Yung, 1989). In addition, oxygen scatters incoming solar radiation (Trenberth et al., 2009). However, recent reconstructions of atmospheric oxygen disagree, particularly for the Late Mesozoic, e.g., the Cenomanian (93.9–100.5 Ma), where estimates range from 11–24% and are inconsistent within the published uncertainties (Falkowski et al., 2005; Glasspool and Scott, 2010; Tappert et al., 2013).

GCM simulations of the Cenomanian by Poulsen et al. (2015) have shown that a Cenomanian climate with higher oxygen levels would be cooler and drier. The uncertainty quoted above was found to be equivalent to ~3° C in surface temperature. Poulsen et al. (2015) propose that the lower estimates for Cenomanian oxygen levels are correct and could explain why GCMs have trouble simulating the warmth of Late Mesozoic climate, a time in which carbon dioxide levels are much better constrained than oxygen.

…And So Are Paleogeographic Uncertainties

A frustrating aspect of simulating the Earth's climate in deep time is uncertainty in inputs related to the setup of model experiments such as the placement of continents, the heights of mountains, and greenhouse gas and aerosol levels. For geologists interested in paleogeography, this uncertainty is an opportunity: an opportunity to quantify the impact of these uncertainties on climate.

One realized example is reconstruction of the altitude and spatial extent of the Central Pangean Mountains (CPM). Slingerland and Furlong (1989) modeled the CPM as a wedge limited by the Coulomb strength of the rocks. It then used the structure of sedimentary basins to estimate crustal loading by the CPM, a partial constraint on the wedge model. Due to uncertainty in erosion rate (a climatically controlled parameter) and wedge basal slope (a tectonically controlled parameter), a range of solutions was obtained. The favored solution was of a mountain range comparable in width and altitude to the Andes.

The significance of this problem to climate was first illustrated by Otto-Bliesner (1993), who showed that a Himalayas-like CPM during the Kasimovian restricted the northward progression of the Intertropical Convergence Zone greatly enhanced precipitation rates over the CPM, which would impact the CPM's possible structural characteristics within Slingerland and Furlong's (1989) model. A direct test was undertaken by Fluteau et al. (2001) which varied the altitudes of the Appalachian and Variscan sections of the CPM to obtain the best agreement with a variety of observations about Late Permian climate. The conclusion: the CPM was closer in height to the Andes than to the Himalayas.

CONCLUSIONS

Observers of the Earth's deep past and climate modelers have found opportunities for collaboration and intellectual engagement in the past. The rise of global climate change as a defining paradigm for the earth sciences presents an opportunity to deepen and widen those collaborations. I have underlined the importance of: (1) using GCMs as a tool for constructing new hypotheses about the geological record and synthesizing many different types of geological information; (2) making geological data and GCM model output accessible and convenient to analyze. Doing so will not only help maintain the relevance of geology and paleobiology to society but also will expand our knowledge of the Earth's deep past for its own sake.

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PRESIDENT'S COMMENTS

In 1980 I paid about 12 bucks ($36 2015) to see The Who at Maple Leaf Gardens in Toronto. My latest Who tickets cost $189, despite the fact the half the band is deceased! Last year U2 gave away their new album for free on iTunes, but charged a small fortune for tickets to their concerts.

SEPM council meets twice a year at GSA and AAPG where we review the health and future of our organization. Thanks to SEPM staff, and especially Howard Harper and Theresa Scott, as well as SEPM Foundation board members (chaired by Rick Sarg) and our Investment Committee (chaired by Bill Morgan) SEPM are currently in strong financial shape. I believe that our SEPM community is ethical, helpful and hopeful. However, council has looked forward and we see trends that *might* put us in jeopardy. These include declining membership and loss of revenue from our publications as the world pushes towards "open access" digital publishing.

Many industries have experienced catastrophic loss of revenues as a result of the digital revolution, such as the record industry, video-rental industry and the publishing industry (books, magazines and newspapers) and it isn't because people have stopped reading or listening to music. Nowadays, U2 and The Who make money from their high-priced concerts, rather than record sales, because people still enjoy the energy and 3-dimensionality of their live shows, versus the impersonal (and freely-downloadable) you-tube videos. But they charge a mint for the tickets! I wonder if we can learn something here?

Council has had many discussions regarding how we keep SEPM viable and vibrant in the future, and I am increasingly convinced that it will be through our events and networking, including research meetings, conferences, field trips, short courses and volunteering opportunities. Decades ago, many of the larger corporations built virtual meeting rooms and 3D visualization rooms, but despite the capital outlay none of these technologies have fully replaced actual "face-time" meetings. There is simply no substitute (yet) for inter-personal communication. Online courses do not compete with the real thing. People still want to see their favorite bands "In The Flesh".

The message is that we, as SEPM members, must engage personally and maximize the value of SEPM events versus products. We senior SEPM members, who have benefitted from many years of networking opportunities, must mentor our younger members to attend SEPM sessions, research meetings and other events. Nobody is ever going to promote you or help you get a job through linked-in, Facebook or other social-medium unless they know you personally. I am not suggesting that all these digital virtual technologies have no value, but I do not believe that they will never fully replace interpersonal networking. There are evolutionary and psychological reasons why humans ultimately must have significant "in-the-flesh" communications that relates to how we establish trust with each other. I actually think the future of SEPM is bright, but we have to capitalize and emphasize the camaraderie and lifelong benefits of being engaged with each other. The SEPM community can be your staunchest colleagues and also your friends and support network. I know things are tough out there. I have been through many downturns and through all of them my SEPM colleagues and friends have been essential in my success. I ask all of you to help to ensure that SEPM is as important to you as it is to me. Engage with us, come to a meeting, volunteer for a committee, join your local chapter, plan a field trip (SEPM of course) and *please* bring a student.

Janok Bhattacharya,
SEPM President

Reflections on major themes in current stratigraphy by early career scientists and students

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INTRODUCTION

The second International Congress on Stratigraphy (STRATI 2015) convened in the city of Graz, Austria July 19-23, 2015. Stratigraphy is among the oldest geologic disciplines, established by William ‘Strata’ Smith in the late eighteenth century, not long after geology itself became a formal science. Being such an old practice, stratigraphy is sometimes taken for granted by students and non-stratigraphers as grunt work and an endless collection of measured sections recorded in lithologic logs and weathering profiles. However, the study of the succession of rock layers is the only way to understand the history of Earth’s surface processes, making it an invaluable discipline, and the last fifty years have seen revolutions in the breadth of information and resolution that can be gleaned from the rock record. At STRATI 2015, Geoscientists met to present and discuss research on the latest stratigraphic issues and techniques from disciplines such as paleontology, isotope geochemistry, sequence stratigraphy, paleomagnetics and others. As graduate students and early-career scientists, we are interested in understanding the current state of the field so that we can be a part of shaping future research directions in stratigraphy. Therefore, we have compiled the following summarization of the major themes and research foci of the meeting.

STANDARDIZATION OF STRATIGRAPHIC TERMINOLOGY AND NOMENCLATURE

Science communication requires consistent, internationally-accepted terminology and procedures. The International Commission on Stratigraphy (ICS) sets the global standards for expressing the history of the Earth through the formalization of stratigraphic practices and the definition of global units (systems, series, and stages). These units are the basis for the temporal intervals (periods, epochs, and age) of the International Geologic Time Scale.

Historically, the names of stratigraphic units have varied between geographic regions. Currently, the global stratigraphic community is continuously working to develop a standardized system. For example, the Swiss Committee for Stratigraphy is developing standardized geologic map legends for the Geological Atlas of Switzerland (Morard et al., 2015). Also, Easton Gaiswinkler (2015) provided insights regarding the “Stratigraphic Lexicon for Ontario” project aiming to compile detailed stratigraphic nomenclature in Ontario, Canada. Austrian and Italian researchers are working to unify the stratigraphy of the Carnic Alps in order to resolve historical differences in nomenclature across their shared mountain range (Corradini and Suttner, 2015). This movement towards nomenclatural standardization also relates to growing interest in the digitization of stratigraphic information in repositories and databases. The consolidation of synonymous terms increases the efficiency and accuracy of data recognition, entry, and analysis, which may ultimately lead to innovative stratigraphic research based on “big data” approaches.

NSF-ICS Workshop at STRATI2015

DESIGNATION OF GLOBAL BOUNDARY STRATOTYPE SECTIONS AND POINTS (GSSPS)

GSSP designation is a major theme in current stratigraphic research. With the exception of the Cretaceous, GSSPs have been designated for the bases of all Phanerozoic systems. Nonetheless, the bases of 35 of the 100 stages in the Phanerozoic and all of the systems in the Precambrian (except the Ediacaran) still lack GSSP designations. These boundaries are currently only defined by Global Standard Stratigraphic Ages, or geochronological reference points, which are not associated with stratigraphic indices and are therefore unsuitable for the correlation and relative dating of units lacking chronometric markers (Gradstein and Ogg, 2012).

An example of current GSSP research includes work on the Langhian-Burdigalian stage boundary of the Miocene. Although there are several terrestrial candidate sections for this GSSP (Iaccarino et al., 2011), recent discussions have focused on sites from the Ocean Drilling Program (Hilgen et al., 2012). Oceanic sections do offer potential alternatives to terrestrial candidate GSSPs, because they may be collected through more continuous sections and often have highly-resolvable biostratigraphic, magnetostratigraphic, and astronomic markers for stratigraphic correlation. However, ocean cores are eventually depleted through repeated sampling (with the exception of their archived components), and therefore, oceanic sections and points do not satisfy the ICS criteria that the location for GSSP cores should be easily accessible and available for sampling (Murphy and Salvador, 1999).

Other current GSSP work pertains to the stratigraphy of the Neoproterozoic designation of which GSSPs have been historically complicated because of a lack of robust lithostratigraphic, biostratigraphic, and chemostratigraphic data. However, the recognition of multiple glacial episodes, carbon isotope excursions, and micro- and macrofossil biozones have brought about new opportunities for designating GSSPs for the bases of the Tonian and Cryogenian (Shields-Zhou et al., 2015) as well as for the bases of several potential Ediacaran series (Xiao and Jiang, 2015).

INTEGRATION OF STRATIGRAPHIC DATA

Integration of data and methodologies (where possible) is a prominent theme in current stratigraphic research. Indeed, integrated research—aimed at comprehensive study and refinement of our understanding of the geologic history of Earth, through coordinated analyses of multiple data types (e.g. magnetostratigraphic, sedimentological, geochemical, and biostratigraphic data)—can overcome the limitations of discipline-specific approaches. This, in turn, allows for more robust and confident interpretations as well as local, regional, and global correlations. Major chronostratigraphic boundaries have been determined and correlated through integrated approaches. These boundaries are often resolvable in various datasets (e.g. biostratigraphic, chemostratigraphic, and lithostratigraphic). GSSPs, in particular, are generally chosen for their association with both primary and secondary stratigraphic markers representing different data types. When analyzed in tandem, these data can be used to precisely correlate among distinct stratigraphic sequences, and allow for the identification of boundaries in areas where they were not previously recognized (Bodego et al., 2015). Such integrated analyses can also be used to assess relationships between chronostratigraphic boundaries of regional and global events in the Earth System.

ARCHIVING THE STRATIGRAPHIC RECORD

Immediately following STRATI 2015, the NSF and ICS hosted a workshop on archiving the stratigraphic record. The purpose of this workshop was to bring together stratigraphers from diverse sub-disciplines and representatives from the major stratigraphic and paleontological databases to consider what is needed to synthesize all known information about the rock record into a single digital archive. Topics discussed during the workshop included the diverse types of information such a database will be required to handle, how to encourage the support and participation of the current and future geoscience community, and the digitization of historic research. Ultimately, the workshop set a framework for the type of unified archive the NSF and ICS will be working towards in the near future and tasked select individuals for carrying on the next steps for progress towards this goal.

ACKNOWLEDGEMENTS

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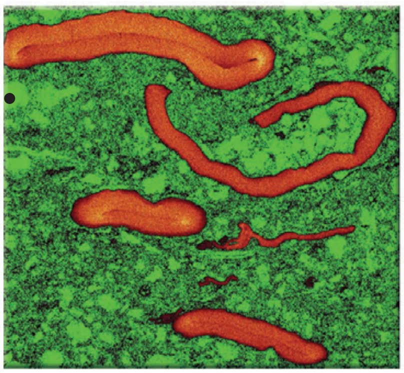
Notification: Beginning in 2016, only SEPM Members in good standing will receive printed copies of the Sedimentary Record. Sedimentary Geology Division Members of GSA will only receive notifications and links to the online version as SGD has declined to pay for printing and mailing costs for 2016.

Date: October 16-19, 2016
LOCATION: Hilton Santa Fe Historic Plaza, Santa Fe, NM



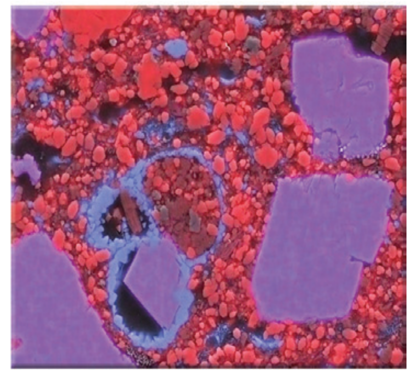
Abstracts Open: December 1, 2015

Deadline: February 15, 2016

https://www.sepm.org/MudstoneConference

Registration Opens: June, 2016

Conveners: Wayne Camp, Neil Fishman, Paul Hackley, Kitty Milliken and Joe Macquaker

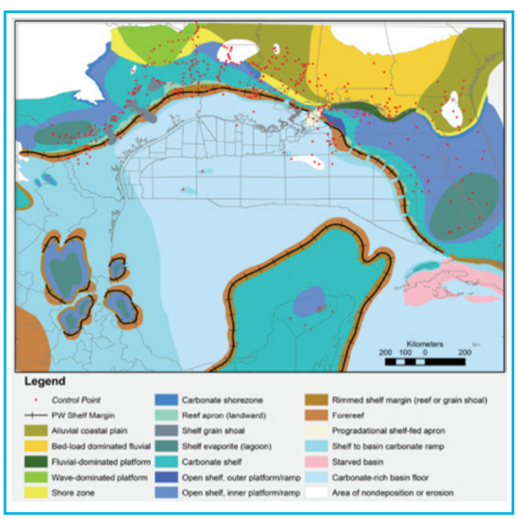


FIRST CALL FOR PAPERS AND POSTER PRESENTATIONS

Mesozoic of the Gulf Rim and Beyond: New Progress in Science and Exploration of the Gulf of Mexico Basin

35th Annual GCSSEPM Foundation Perkins-Rosen Research Conference

DECEMBER 4-6, 2016 • OMNI HOUSTON WESTSIDE • HOUSTON, TEXAS



The 2016 Perkins-Rosen Research Conference will focus upon the Mesozoic of the Gulf Basin, from mountain source terrain to deep-water abyssal plain. A significant portion of the program will be devoted to the Mesozoic of Mexico and its potential for international exploration. A highlight will be a special SEPM-sponsored research symposium on Mesozoic source to sink: provenance and process led by Mike Blum (U. Kansas).

Other Topical sessions

- Mesozoic depositional models, onshore to offshore
- Pre-salt basin paleogeographic reconstruction
- Emerging Mesozoic Plays in USA and Mexico
- The KPg impact event and sedimentary effects
- Mexico's Mesozoic reservoirs and future potential

Field Trip to the Eagle Ford Outcrops of West Texas, Friday Dec. 2 – Sunday Dec. 4

Optional Core Workshop, December 7th, 2016

Technical Program Committee Leaders: *John W. Snedden, UT-Austin; Mike Blum, U. Kansas, Chris Lowery, UT-Austin*

2000-character abstract due January 15, 2016 • Full papers and extended abstracts due May 15, 2016

Send to cmlowery@utexas.edu

UPCOMING SEPM RESEARCH CONFERENCES

2016

"Mudstone Diagenesis" Conference (with AAPG) set for October 16-19, 2016 in Santa Fe, NM. This conference is focusing on fine grained rocks and their properties. Conveners: Wayne Camp, Neil Fishman, Paul Hackley, Kitty Milliken and Joe Macquaker.
ABSTRACTS OPEN - https://www.sepm.org/MudstoneConference

"Oceanic Anoxic Events" Conference is being planned for November 2-7, 2016 in Austin, TX. Examining the features and resources of OAE's.
Conveners: Rob Forkner, Charles Kerans, Benjamin Gill and Gianluca Frijia.

35th Bob F. Perkins Conference "Mesozoic of the Gulf Rim and Beyond: New Progress in Science and Exploration of the Gulf of Mexico Basin", to be held in Houston, TX, USA, December 4-6, 2016. Technical Program Leaders: John Snedden, Mike Blum and Chris Lowery. (see details on page 15).

2017

Mountjoy II - "Characterization and Modeling of Carbonate Pore Systems " to be held in Austin, TX, USA ~ Summer, 2017 (TBD). This is an SEPM-CSPG conference as the next planned Mountjoy event, which will after 2017 be on a 4-year cycle. Organizing Committee: Mitch (Paul) Harris, Don McNeill, Gene Rankey, Jean Hsieh, and Astrid Arts.

"Multi-scale analysis of deep-water depositional systems; insights from bathymetric, shallow seismic and outcrop data" to be held in the Karoo Basin area of South Africa in Spring, 2017, in Cape Town area, South Africa. Conveners: David Hodgson, Stephen Flint, Christopher Aiden-Lee Jackson, Bradford Prather, and Emmanuelle Ducassou.

"Propagation of Environmental Signals within Source-to-Sink Stratigraphy" to be held in Ainsa, Spain. Looking at the propagation of sediment-flux signals in the stratigraphic record of correlative segments of source-to-sink sedimentary systems. Conveners: Sébastien Castelltort (University of Geneva), Cai Puigdefabregas (University of Barcelona), Julian Clark (Statoil) and Andrea Fildani (Statoil).

If you are considering a research conference within the realm of sedimentary geology be sure to consider working or partnering with SEPM Society for Sedimentary Geology.

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