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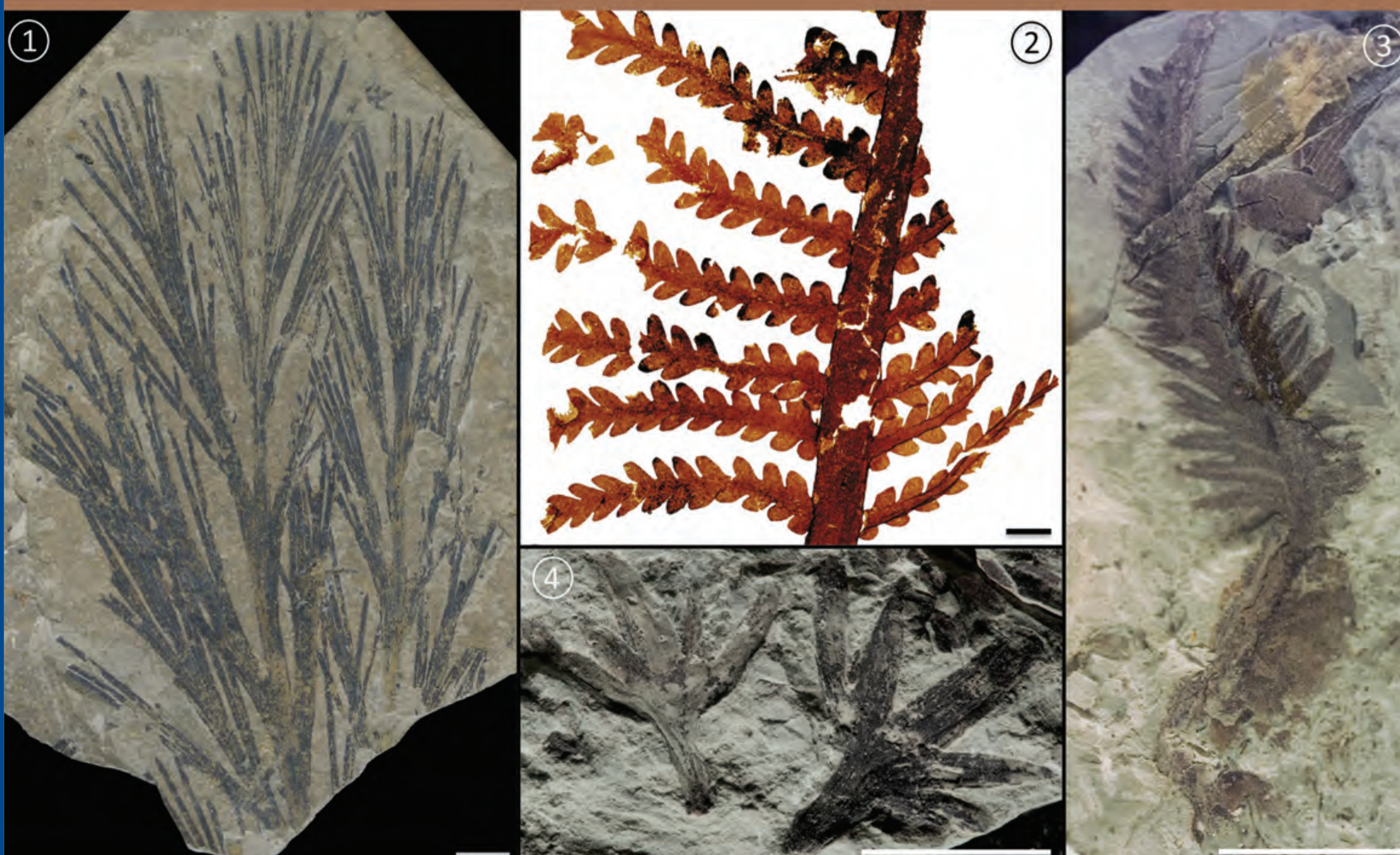

INSIDE: THE LATE PALEOZOIC ECOLOGICAL-EVOLUTIONARY LABORATORY, A LAND-PLANT FOSSIL RECORD PERSPECTIVE

PLUS: PRESIDENT'S COMMENTS, SEPM RESEARCH CONFERENCE SUMMARY, SEPM AND STEPPE, SEPM AT 2015 AAPG "ICE"

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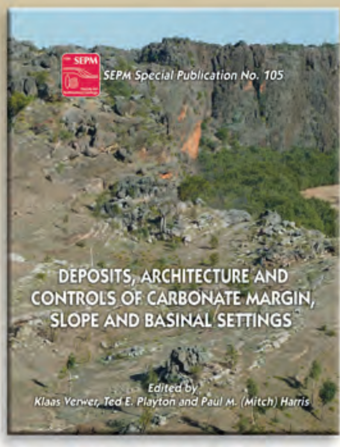

Special Publication #105

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 11

Phanerozoic Paleoclimate: An Atlas of Lithologic Indicators of Climate

By: Arthur J. Boucot, Chen Xu, and Christopher R. Scotese, with contributions by Robert J. Morley

This publication combines the interpretations of two major sets of data. One is the geophysical data that is used to interpret the position of the tectonic plates through geologic time. The other is based on a long time search of the geological literature to find, record, and evaluate the lithologic descriptions of countless reports around the globe; paying careful attention to those lithologies that have climatic implications. The introduction to this volume includes a detailed discussion of the lithologies, mineralogies and biogeographies that are considered to be the most reliable in identifying the climatic conditions existing during their formation and how they are used or not used in this compilation. Global paleoclimatic zones based on the climatically interpreted data points are identified during twenty-eight time periods from Cambrian to Miocene using paleotectonic reconstructed maps. The paleoclimate of each time period is summarized and includes a discussion of the specific referenced data points that have been interpreted to be the most reliable available for that time period and location.

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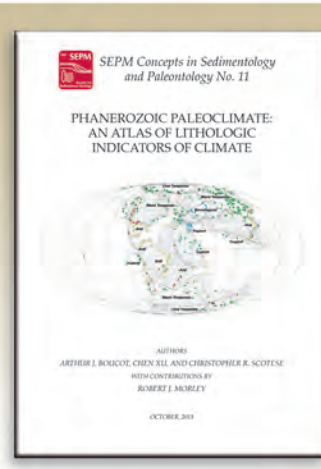

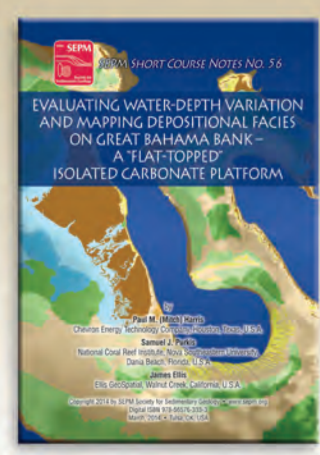

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Evaluating Water-Depth Variation and Mapping Depositional Facies on the Great Bahama Bank – a "Flat-Topped" Isolated Carbonate Platform

By: Paul M. (Mitch) Harris, Samuel J. Purkis, and James Ellis

Great Bahama Bank (GBB) has long served as a frequently visited and well-studied example of a flat-topped, isolated carbonate platform. As such, GBB stands behind much of our understanding of modern processes and products of carbonate sedimentation. The geological models derived from studies on GBB are commonly used to illustrate depositional facies variations and frequently serve as reservoir analogs.

We have used Landsat TM and ETM+ imagery and an extensive set of water depth measurements to first critically evaluate the magnitude and patterns of bathymetry across GBB. We then integrated the seafloor sample data of Reijmer et al (2009) along with a small number of additional samples with the Landsat imagery compiled into ArcGIS and analyzed with eCognition to develop a depositional facies map that is more robust than previous versions. The new maps, in our opinion, can serve as a template for better characterizing GBB at all scales, highlight future research areas where "ground-truthing" is needed to further investigate facies patterns, and facilitate better use of this isolated carbonate platform as an analog for both exploration- and reservoir-scale facies analysis. As examples of information that can be extracted from the maps, we analyze the platform margins of GBB with respect to their orientation, examine the relationship between water depth and facies type, interrogate facies position and breadth across the platform top, and relook at the occurrences of whitings relative the distribution of mud on the platform.

The geospatial data for GBB are compiled into a 3.9 GB GIS database which is included on the DVD of this digital publication. The GIS contains raw data, interpretive products, and visualization examples that were produced during development of the water depth and facies maps of GBB, including the Landsat TM imagery, DEM, images developed by combining layers in the GIS, and facies and whitings maps. In addition, the Projects folder of the GIS contains files that automatically display images, maps, and DEMs with an appropriate symbology in ArcGIS version 10.1 (.mxd), ArcGIS Explorer version (Build) 1750 and 2500 (.nmf), and GlobalMapper version 14-1 (.wks).

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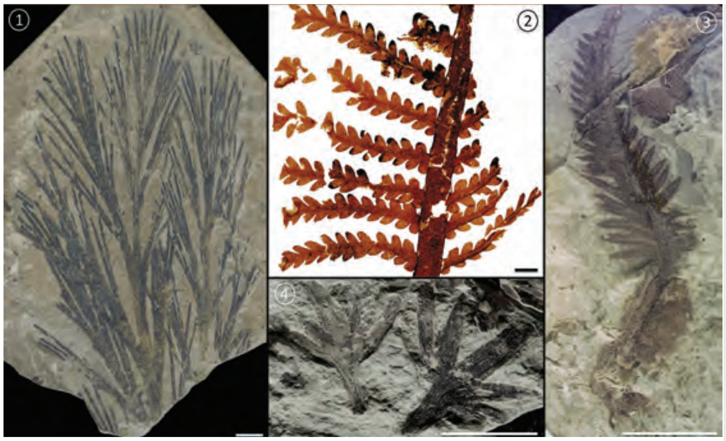

Cover image: Examples of precociously appearing Methusela taxa. (1) Dichophyllum moorei, Garnett, Kansas, early Late Pennsylvanian. Baxter and Hartman, 1954. (2) Dicroidium jordanensis, Dead Sea Region, Jordan, late Permian. Kerp et al., 2006. (3) Dioonitocarpidium sp., King County, Texas, late early Permian. DiMichele et al., 2001. (4) Manifera talaris, late early Permian, King County, Texas. Looy and Stevenson, 2014. Scale bars, I cm.

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The late Paleozoic ecological-evolutionary laboratory, a land-plant fossil record perspective

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INTRODUCTION

In this essay we examine the fossil record of land plants, focusing on the late Paleozoic. We explore the nature of this record in terms of what is preserved, where, why and with what biases. And as a consequence, how it can be used to answer questions posed at various spatial and temporal scales, what cautions we must consider when interpreting it, and what surprises it may hold. Generally speaking, the record of terrestrial plants is rich and reveals clear directional trends in phenotypic complexity, biodiversity, and ecosystem organization. It also has reasonably well understood taphonomic biases. It must be used with considerable caution, however, when researching time and location of evolutionary innovations and the development of ecological structure and interactions.

THE LATE PALEOZOIC LABORATORY

Earth experienced a 70-million-year period of intermittent glaciation (Montañez and Poulsen 2013) from the middle Mississippian to early Permian. This interval is characterized by 10^5-year glacio-eustatic cycles (Heckel 2008), superimposed on longer, 10^6-year scale intervals of global warming and cooling (Birgenheier et al. 2009). These are further superimposed, in the equatorial regions, on a long-term, 10^7-year scale trend of warming and increasing aridity (Montañez et al. 2007, Tabor and Poulsen 2008). Consequently, the world of the time had many similarities to that of today, captured in the fossil and geological records. The Earth's continental landmasses, however, were aggregated into the supercontinent of Pangea, which differed greatly from today's high elevation world of dispersed continents (Figure 1).

The Pennsylvanian and Permian are known for vast coal deposits, which formed in extensive peat swamps. In the tropics, these wetlands were populated by old, evolutionarily conservative plant lineages, the subjects of dioramas in natural history museums and illustrations in nearly every paleo-textbook. At the same time, however, large areas of the tropics harbored more evolutionarily derived plants adapted to seasonal drought (e.g., DiMichele 2014). There were also distinct north- and south-temperate floras segregated into wetland and drought tolerant assemblages, but subject to strong seasonal temperature contrasts (Rees et al. 2002). Such areas also tended to be populated by more derived evolutionary lineages.

Our understanding of the origin and spread of major late Paleozoic plant groups is based on these patterns of ecosystem-scale and biogeographic-scale patterns. Some of the groups originating in the late Paleozoic are still important today, such as conifers. Others, now extinct or diminished, dominated many pre-angiosperm, Mesozoic ecosystems. These include cycadalean, peltaspermalean, and corystospermalean seed-plants and ferns such as the osmundaleans and primitive filicaleans (Lidgard and Crane 1990). Until recently, many of these groups were thought to have had Mesozoic or latest Paleozoic origins. Over the past few decades, however, some have been found in Paleozoic deposits, often as isolated occurrences, suggesting that significant evolutionary innovation took place in parts of the terrestrial landscape poorly represented in the fossil record. This is not a matter for despair, however. Such patterns may mean we cannot easily or confidently "stack up" the record for a direct, temporal reading. Nonetheless, through linkage of sedimentological and ecological factors to patterns of spatial and temporal plant distribution, we can still infer a lot about the locus and nature of the evolutionary process.

THE OVERPRINT OF TAPHONOMY

Rule #1: Plants are crystalized climate

> *"Ja, man kann die Pflanzendecke das kristallisierte, sichtbar gewordene Klima nennen, in dem sich so manche Züge deutlicher zeigen als in den Angaben unserer Instrumente."*
>
> Wladimir Köppen (1936, p.6)

This may be translated: "Yes, **one may call vegetation materialized, visible climate,** in which quite a few climate traits are more readily discernible than in the readings of our instruments", or, the part in bold above, somewhat more graphically as "plants are crystalized visible climate" (Claussen 1998). There are few more compelling rules for understanding the fossil record of land plants. And it is safe to assume that terrestrial plants have conformed to this axiom since their earliest appearances, which should strongly condition our interpretations of their spatial and temporal distributions and evolutionary patterns.

In the Pennsylvanian-Permian, perhaps the best examples of this are the striking differences in taxonomic composition among equatorial Euramerican, equatorial Cathaysian, south-temperate Gondwanan and north-temperate Angaran assemblages (Figure 1, Wnuk 1996). At a spatially more refined level, several compositionally distinct biomes have been recognized in the Euramerican floral realm, each associated with physical indicators of greater seasonal dryness (Falcon-Lang and Bashforth 2004, Tabor et al. 2013). Within the best known of these biomes, the wetlands, environmental preferences have been determined for particular taxa or lineages (e.g., DiMichele and Phillips 1996a) that can be traced back to the earliest radiations of terrestrial plants (Bateman et al. 1998).

Figure 1: The Late Paleozoic supercontinent, Pangea. Four major floral zones are indicated, tropical Euramerica and Cathaysia, and temperate Angara and Gondwana. **Paleogeography after Scotese (1997)**

The other fundamental controls

There are other important taphonomic factors that strongly influence interpretation of the land-plant macrofossil record (Gastaldo and Demko 2011). Taphonomic rule #2 is that short-term preservation of plant remains is most likely to occur under a background of perhumid to wet sub-humid conditions (terminology of Cecil 2003), though dry sub-humid and even arid climates may harbor some habitats where preservation is possible.

Taphonomic rule #3 is that plant macrofossils rarely can be recycled by reworking. Impressions or fragile coalified compressions are easily destroyed, exceptions being wood or wood-like resistant tissues. Thus, the plant macrofossil record preserves fine levels of temporal resolution and high stratigraphic integrity. In practice, however, a collection of plant fossils is usually analytically time averaged by sampling (Behrensmeyer et al. 2000). This happens mostly because of the difficulty of tracing a "T^0" time horizon (Johnson 2007) laterally for any distance unless it is tied to an "event" of determinable short-term duration, say an ash fall (Wing et al. 1993; Opluštil et al. 2014). Parautochthonous and some allochthonous assemblages generally represent either members of the same community or plants that lived in close proximity to the depositional environment, in time and space.

Rule #4: Plant organic matter will be destroyed rapidly by the combined actions of physicochemical (e.g., mechanical breakage, fire, slow oxidation) and biotic agents (e.g., microorganismal decay, roots), particularly if on or above the soil surface, or in the soil vadose zone of water table fluctuation (Gastaldo and Demko 2011). Consequently, most of the plant macrofossil record represents

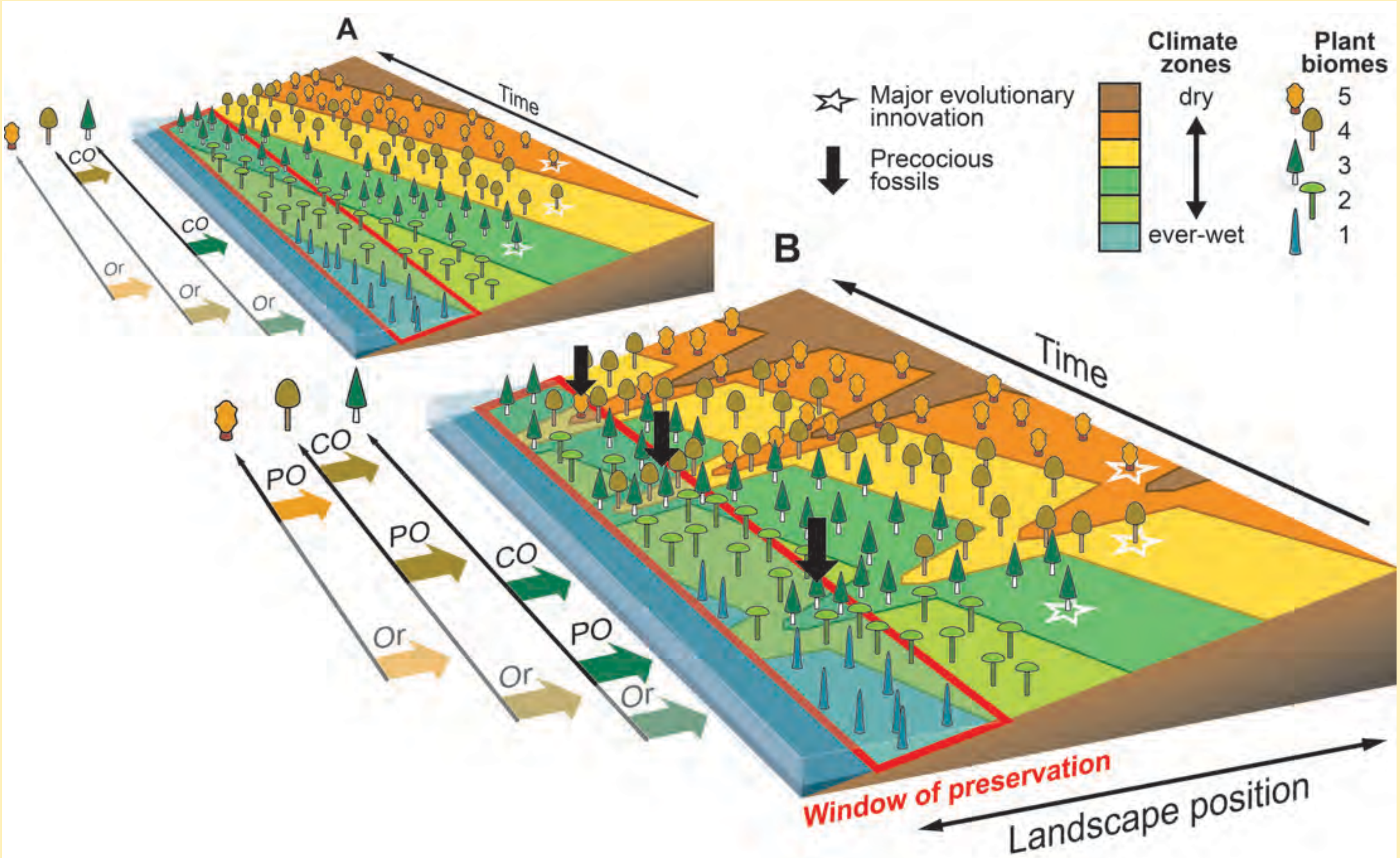

Figure 2: Plant evolutionary innovation and environment, Late Paleozoic. A. General pattern based on an early, incomplete knowledge of the fossil record. Major evolutionary innovations appear in stressful, extrabasinal habitats and track climate changes, moving into basinal habitats, where preservational potential is highest, during the progressive global warming and drying of the late Paleozoic. B. Emerging pattern with an increased sampling of the fossil record. Seemingly precocious floras change our general view depicted in A. Precocious appearances reflect climate oscillations and accompanying tracking by plants, bringing new forms initially temporarily into the window of preservation during drier episodes. Or – origination of clades forming new plant biomes outside the window of preservation, PO – precocious occurrence of fossil floras, CO – common occurrence of fossil floras.

wetland assemblages or vegetation fringing standing water bodies, growing within channels or on wet floodplains (Scheihing and Pfefferkorn 1984), where chances of preservation are highest.

Rule #5: Most deep-time, fossil-plant accumulations will be confined to what were, at the time, actively subsiding basins. Even if preserved for the short-term, organic deposits must be protected from decay on intermediate time scales of thousands to tens of thousands of years to permit sufficient subsidence and burial below the level of active erosion. Intermediate-term preservation is most likely where ocean transgressions or inland water bodies could flood the site of burial. This must be followed or accompanied by tectonic creation of accommodation space, permitting deeper burial and protection from erosion on million-year time scales. Thus, except in unusual tectonic circumstances (e.g., Opluštil 2005), the late Paleozoic terrestrial record contains primarily lowland deposits, leaving much room for speculation about what was going on evolutionarily and ecologically elsewhere.

That fossil floras occur throughout most of the Phanerozoic is empirical documentation that there is potential for the preservation of plant remains when the conditions are right. Conditions for intermediate and long-term burial of epicontinental sediments (e.g., Davies and Gibling 2013) are favorable in Pennsylvanian-Permian basins, leaving a reasonably good record. Within these deposits, organic remains of plants from wetlands and localized high-moisture habitats are best represented, including swamp, peri-lacustrine, lagoonal fringe, coastal mudflat, floodplain and stream corridor habitats.

From a climatic perspective, the best record of lowland vegetation comes from times of perhumid to wet sub-humid climate, which most favor the first step of fossilization: short-term preservation. Due to unfavorable conditions for short-term preservation, the plant record from dry sub-humid to arid conditions is very limited. There are also few records of true "upland" floras, those from continental interiors or other places where erosion was the dominant sedimentological force on intermediate and long-term, million-year time scales.

WHAT'S HAPPENING "OUT THERE" AND HOW DO WE KNOW?

Due to the climatic and taphonomic factors discussed above, much of the natural experimentation that characterized Paleozoic plant evolution seems to have occurred outside of areas or time windows with the best chances for preservation. These include basins during the times they experienced climates unfavorable for short-term preservation and extrabasinal regions, lowland and true upland (Pfefferkorn 1980). How can we tell if major evolutionary breakthroughs occurred in such places? Fortunately, plants faithfully reflect climate. Because climate is generally insensitive to tectonic regime, particularly subsidence, basins are sometimes subject to drier climate at the same time they experience conditions conducive to intermediate-term preservation. When that happens, plants from habitats that rarely become fossilized will appear as isolated, seemingly anomalous occurrences.

Stratigraphic anomalies

There has long been attention, particularly among marine invertebrate biostratigraphers, to occurrences of taxa outside of previously known temporal ranges. Given such names as "Lazarus" taxa (Jablonski 1986) for those appearing well beyond inferred range termini, equally important are cameo appearances well before known ranges. In either case, these appearances strongly imply significant biases in the record or in the patterns of organismic distribution on the landscape. Such evidence is particularly powerful where the occurrences straddle extinction boundaries, indicating unsuspected earlier existence and/or survival in unseen areas. Regarding plant evolution, precocious occurrences may indicate evolutionary innovation at times and in places outside of our detection abilities, and can carry significant implications regarding climate and habitat.

Precocious occurrences: Methuselah taxa

Of greater interest than Lazarus taxa, from an evolutionary perspective, are precocious taxonomic occurrences, millions to tens of millions of years preceding otherwise well-established ranges. Unexpectedly "old" occurrences like these lead us to suggest the term "Methuselah" taxa for those with a much older origin than assumed possible, given the bulk of earlier existing observations. Upon re-evaluation of all data, the epithet 'precocious' really only exists in the eye of the myopic beholder, and turns out to mean nothing more than "inconceivably old", just like Methuselah in Hebrew Scripture. In the plant fossil record, these Methuselah genera and species typically occur in seasonally dry environments, often in deposits sandwiched among those with typical wetland floras. They also are composed of or contain many derived elements of evolutionary lineages, implying a linkage between environmentally "peripheral" habitats and major innovation in plant evolution (DiMichele and Aronson 1992).

Among the most noteworthy Methuselah occurrences is the callipterid peltasperm *Dichophyllum* (Cover, 1), from the early Late Pennsylvanian of Kansas (Cridland and Morris 1963). This occurrence, in a seasonally dry, channel complex (Feldman et al. 2005), falls within the midst of the Midcontinent USA coal measures and is conifer-dominated; an assemblage quite unlike that of shales associated with surrounding coal beds. This occurrence caused considerable debate about the age of the deposit, leading some biostratigraphers to argue for Permian age (e.g., Bode 1975). Since this time, other Late Pennsylvanian callipterid occurrences have been documented, but these are rare and none are as old as this.

Several other noteworthy examples of Methuselah occurrences include: (1) Four species of the corystosperm *Dicroidium* from the late Permian of Jordan (Cover, 2), then equatorial Pangea, in a floodplain deposit formed under seasonally dry climate (Kerp et al. 2006). This genus is a characteristic element of late Early to Late Triassic high-latitude Gondwanan floras. (2) *Dioonitocarpidium*, a cycad-like reproductive structure typical of the Late Triassic and Early Jurassic of central Europe (Cover, 3). It occurs in a late early Permian deposit from Texas, in association with a peculiar assemblage, deposited under seasonally dry climate (DiMichele et al. 2001). (3) Voltzian conifers, a derived group (Cover, 4), also occur in seasonally-dry habitats of the Texas late early Permian (Looy 2007, Looy and Stevenson 2014). Their earliest prior occurrence was late Permian of central Europe. (4) The seed-bearing structure of highly derived, typically Mesozoic Peltaspermales has been reported from isolated occurrences in latest Pennsylvanian equatorial regions of Europe and North Africa (Kerp et al. 2001), and the early Permian of China (Liu and Yao 2000) and the Urals (Naugolnykh and Kerp 1996, Kerp 1996). The species, *Peltaspermum retensorium*, was found at several localities in the same Angaran horizon, a chance basinal occurrence of a rarely found "upland" plant associated with a flora indicating seasonal moisture stress. (5) Another peltasperm, *Germaropteris martinsii*, from dryland settings of late Permian age (Lopingian) of Central and Southern Europe (Kustatscher et al. 2014), was recently reported from early Permian seasonally dry deposits in southern France (Galtier and Broutin 2008) and from allochthonous offshore settings in Texas, presumably derived from coastal, mangrove-like habitats (Erik Kvale, personal communication, 2014 – specimens examined by Kerp and DiMichele). Other precociously appearing conifers include (6) the "Mesozoic" genus *Podozamites* from seasonally dry early Permian deposits of Texas (DiMichele et al., 2001) and Late Pennsylvanian of New Mexico (Mamay and Mapes 1992). (7) Walchian conifers, rare but known from the Late Pennsylvanian equatorial regions (e.g., Kerp 1996, Hernandez-Castillo et al. 2001), have been reported from Middle Pennsylvanian age localities, two in the Illinois Basin, a sinkhole in limestone at the basin margin (Plotnick et al. 2009) and a channel fill within a seasonally dry landscape (Falcon-Lang et al. 2009), and two from allochthonous deposits in New Mexico (Lucas et al. 2013). (8) A number of genera reported from the early Permian seasonally dry habitats of southwestern Euramerica, most notably *Comia*, *Supaia* and *Compsopteris*, are both significantly more abundant and have much broader distributions in the late Permian of Angaraland and Cathaysia (Mamay et al. 2009, Halle 1927). (9) The enigmatic gigantopterids, abundant in the late Permian of China occur in early Permian seasonally dry environments of southwestern Euramerica (DiMichele et al. 2005), the Arabian Peninsula (Berthelin et al. 2003), Sumatra (Booi et al. 2009) and Venezuela (Ricardi-Branco 2008).

PRECOCIOUS OCCURRENCES AND PLANT EVOLUTION

Three patterns stand out when considering the significance of precocious, Methuselah occurrences. (1) These taxa nearly always appear in deposits formed under seasonally dry background climates, even if the fossils themselves are from wet substrate sites, consistent with constraints on short-term preservation. (2) The taxa are almost always among the more derived members of their respective evolutionary lineages at some taxonomic level. (3) The earliest host deposits tend to be "one-offs" – single deposits or thin stratigraphic horizons – found in basinal lowlands or in allochthonous, offshore deposits, reflecting taphonomic controls.

This pattern may be contrasted with Paleozoic wetland communities dominated by evolutionarily less-derived lycopsids, pteridosperms, marattialean tree ferns, cordaitaleans and sphenopsids. These floras show long-term compositional conservatism and intra-assemblage species turnover strongly constrained by evolutionary-lineage ecological centroids (DiMichele and Phillips 1996b), a pattern reflective of "phylogenetic niche conservatism" (e.g., Prinzing 2001; Wiens 2004). Such conservatism led Knoll (1985) to refer to swampy lowlands throughout geological history as "museums". They are characterized by long-term persistence of ecological organization and evolutionary innovation and of taxonomic composition and ecomorphic characteristics. When disrupted by major environmental disasters, they are recolonized from "outside" species pools, restructured and, subsequently, again demonstrate conservatism for millions of years.

When considered together we draw two conclusions from these patterns (summarized in Figure 2). First, evolution of major body-plan innovations (meaning ancestor-descendant divergence reflected in higher, traditional-Linnean ranks) occurred more commonly in environments that were environmentally challenging to established plant lineages and unfavorable for organic preservation on the short-term and intermediate-term time scales. Such environments, likely, were of initially low diversity and encompassed new and different resources that were available for use. Increasing drought and temperature stress, in particular, may have simultaneously limited range expansion of existing plants and created opportunities for innovation. Initially permissive, survival likelihood of variant forms was enhanced due to relaxed natural selection. Second, we first see the results of such innovation when environmental change in the lowlands, caused by increased seasonality of rainfall and perhaps temperature, permit these lineages to move into and occupy basinal areas temporarily. Based on the low number and typically singular appearance of Methuselah taxa we infer that conditions permitting their basinward biogeographic shifts most often occurred at times when intermediate-term preservation was unlikely. This makes them rare to start with, and the deposits difficult to find, even if present, thus causing initial myopia in the eye of the paleobotanical beholder (i.e. the pattern seen within the window of preservation in Figure 2 A). In the longer-term, evolutionarily derived lineages became dominant in basinal lowlands. They did so not by *displacing* the incumbent, ancestral forms, but by *replacing* them as long-lasting environmental change opened basins to long-term colonization (DiMichele and Bateman, 1996). Consequently, whenever fossiliferous sites are found outside of preservation-friendly regions or in settings of generally drier climates, seemingly precocious occurrences will result (Figure 2 B). Plants appearing well before previously known stratigraphic ranges should be expected rather than considered anomalous.

We interpret these patterns to suggest that the window for innovation in ecologically permissive environments is brief and the survival of new forms declines as resource pools are occupied (e.g. in the extreme, Valentine 1980; DiMichele and Bateman, 1996). Intrabiome and intra-species-pool turnover tend to be dominated by niche-conservatism and within-clade, near ancestor-descendant replacements, reflected by paired intra-generic extinction and origination. The result is minor compositional fluctuation at the level of the dominant lineages through time during which assemblages became hide-bound and niche construction (Odling-Smee et al. 2013) was a rare phenomenon. The existing hegemony was broken-up by periodic, extrinsically induced disruptions (i.e., Vermeij 1993).

We also note an inversion between the generalized evolutionary patterns in marine invertebrates and land plants. The onshore-offshore pattern of evolutionary innovation and radiation in marine invertebrates (Jablonski et al. 1983) actually may contribute to high amounts of Lazarus taxa. There, heterotroph innovations occur in shallow marine environments within the window of preservation followed by radiation outside this window into the deep. Lazarus taxa wander back into the preservational window after ecological crises. Exactly the opposite happens with autotrophs in the terrestrial realm. Major innovations happen outside the window of preservation, with subsequent migration, and sometimes radiation into the window following environmental change. So one can expect this process to produce the opposite of Lazarus taxa, the apparent precociously appearing Methuselah taxa.

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PRESIDENT'S COMMENTS

SEPM's mission is to support the sedimentary geosciences. That is quite a broad charge. For example, through its website and also organized events, SEPM sponsors educational activities that benefit communities that range from high school science teachers, to university students at both undergraduate and graduate levels, to highly specialized researchers. For the professionals that form the core of the SEPM's membership SEPM creates opportunities for engagement such as technical sessions at meetings and research conferences and publication outlets in our journals and special publications. Ideas for how SEPM can better fulfill its mission are periodically generated in strategic planning meetings such as the one I described in the last issue's column. On a more regular basis though, it is the SEPM Council that is tasked with choosing the path by which SEPM can meet its goals. Our Council meets face-to-face twice a year, at the annual meeting and at the GSA meeting, and has on-going interactions via email. The current list of ideas the Council is exploring is rather long, partly as a consequence of the rich trove of ideas that flowed from the planning meeting. I would like to share with you some of the more notable items, especially ones that could benefit from member input.

For a time in the mid-1980s to early 1990s SEPM held mid-year meetings on a two-year cycle. Unlike our annual joint meeting with AAPG, the mid-year meeting was a 100% SEPM event. These meetings were relatively small with around 200 participants and the topical focus was designed around whatever subjects SEPM members were jazzed about at the time. Members loved the mid-year meetings, but sadly, these meeting were not a financial success, and you can easily imagine the outcome of that---no more mid-year meetings! Time has gone by, financially we are in a better place, and now Council is investigating whether the mid-year meeting should be resurrected. In the years since the last mid-year meetings were held the research interests and specialties of the SEPM membership have grown even more diverse and there's a sense that a mid-year meeting (held once every two years) could open up sessions on a range topics and in a range of formats that go beyond what is offered at our annual joint meeting with AAPG. It's too soon to predict what the outcome of Council's investigation of renewing the mid-year meeting will be, but it would definitely be a good time to make your voice heard. **Do you think that mid-year meetings would be a good thing for SEPM? Would you like to attend a mid-year meeting? Organize a session? What could we do at mid-year meetings that would fulfill needs that are not currently being met?**

Another possibility on the horizon is that our headquarters may eventually begin to operate as a virtual office, a model that has worked very successfully with our journals for many years now. The headquarters staff would connect to members and each other through our website, email, telephone conferences, and internet meetings. Opportunities to meet and work together in person at our meetings and conferences will remain and perhaps, even gain added value. To no longer maintain a bricks and mortar location would be a considerable savings to the Society and a practical option as we lose the need to have a warehouse and mail hard-copy publications. **What do you think? Is it time to go with a virtual headquarters?**

Another proposal that has come forward is to establish an SEPM distinguished lecture series that could be used to highlight and draw attention to sedimentary geoscience. The selected speaker might visit with SEPM sections, regional societies, and universities to communicate on some exciting and current area of research. My plan is to work with a small ad hoc committee that includes the early career and student councilors to present to Council a proposal for this new endeavor. **Do you think a distinguished lecture series would benefit SEPM?**

Finally, much thought is being given to building and strengthening connections with other organizations that have interests that overlap with those of SEPM. Foremost among these are the eight SEPM sections. Past-President Evan Franseen made outreach to SEPM sections the focus of his presidential project.. SEPM also benefits from its long-time and highly successful relationships with AAPG and with GSA's Sedimentary Geology Division. The Council is currently seeking ways to add to these collaborations with more field trips, conferences, short courses and other joint activities. The world of sedimentary geoscience is also a major component at AGU and SEPM will for the first time sponsor technical sessions and also have a booth at the 2014 AGU fall meeting. SEPM pursuits also align perfectly with IAS and there is much current interest in exploring ways for these two organizations to work together. Sedimentary geoscience is so important to the modern world---it behooves us to look for every opportunity to promote it.

As always, I'm eager to have input from SEPM members (kittym@utexas.edu) and Executive Director Howard Harper (hharper@sepm.org) is also available to take your comments. Please let us hear your thoughts on the topics listed above and on any activity you can imagine that will help SEPM to carry out its mission more effectively.

Kitty Milliken, SEPM President

Summary: SEPM Research Conference on Autogenic Dynamics of Sedimentary Systems

David A. Budd, Elizabeth Hajek, and Sam Purkis, co-conveners

On August 3-6, 2014 over 50 enthusiastic scientists gathered in Grand Junction, CO, to discuss autogenic dynamics in sedimentary systems. A broad range of disciplines was represented by experts in geomorphology and ecology along with sedimentologists and stratigraphers focused on carbonate, clastic, and diagenetic systems. Generous support from SEPM and ExxonMobil subsidized costs for more than 15 graduate-student participants, helping to promote up-and-coming perspectives alongside those of established scientists from industry and academia.

Over two and a half days, participants shared talks and posters on approaches to studying and evaluating autogenic dynamics and self-organization in sedimentary and ecological systems. Keynote talks focused on how autogenic dynamics are manifested and detected in biological (Johann von de Koppel and Tom Olszewski), geomorphic (Laurel Larsen), diagenetic (Enrique Merino), clastic (Chris Paola), and carbonate (Peter Burgess) systems. Martin Perlmutter also provided an overview of how autogenic dynamics are being incorporated into modeling and subsurface prediction in industry.

Other participants presented a wide variety of cutting-edge experimental, numerical, and field research on contemporary and ancient autogenic processes and their sedimentary products. Some common themes in those presentations included: correlation of specific autogenic processes to specific stratigraphic patterns and responses; roles of landscape dynamics and sediment storage and release as autogenic drivers; clustering of fluvial channels; autogenic vs. allogenic shoreline dynamics; the filtering of stratigraphic records by both autogenic and allogenic processes; signal shredding by autogenic processes; the strong autogenic signal of biogenic deposits and the possibility of biogenic shredding of allogenic signals; and the potential for a number of mathematical and statistical tools to identify and model both autogenic and self-organized stratigraphic signals.

Daily discussions revealed several outstanding questions and opportunities identified by conference participants. One common question was how do we define autogenic and self-organized systems? The answer is fairly narrow and clear in fields such as biology, physics, and chemistry (i.e., systems where disequilibrium and positive feedbacks exist, resulting in new behaviors spontaneously emerging from the interaction of components of the system), but no so straightforward where stratigraphers, often aiming to interpret past climate or tectonic changes from the sedimentary record, sometimes consider "autogenic" deposits those that cannot clearly be connected to, for example, a change in basin boundary conditions. This difference in aim and usage sparked much discussion throughout the meeting. Related issues included distinguishing autogenic from allogenic products in a greater range of depositional settings (most work currently related to fluvial, deltaic, and eolian systems), and defining the characteristic time and spatial scales of autogenic processes and strata. A number of workers suggested autogenic processes should be the default interpretation of sedimentary records, with that null hypothesis evaluated with more robust field tests (including statistical methods). The salient point is that allogenic processes have, to date, perhaps been taken as the go-to control on the accumulation of strata when autogenic forcing might offer an equally reasonable interpretation.

Another common theme was how to link insights from experimental and numerical models to field data and vice versa. This is a non-trivial challenge, but participants viewed opportunities for self-consistent scaling comparisons and statistical descriptions of processes and strata as promising avenues for making progress on this front. Reduced complexity and automata modeling and experimentation in more types of sedimentary analogs were also judged fruitful avenues of research.

A daylong field trip to Colorado National Monument allowed participants time to continue discussion and confront issues raised during the workshop directly in a field setting. It became clear that defining a system (including its temporal and spatial scales, boundary conditions, and internal components or agents) is an important first step in being able to effectively study and communicate about autogenic and allogenic processes in the sedimentary record.

As part of a final plenary discussion, participants shared action items they intended to take away and implement after the meeting. These included re-examining field data from new perspectives, reading more broadly outside their main disciplines, writing papers with broader audiences in mind, working to clarify the scope and boundaries of their studies, trying new methods of data collection and analysis, developing new interdisciplinary collaborations with other researchers, and training students more broadly, including developing exercises to introduce undergraduates to the concept of autogenic dynamics in sedimentary environments.

An SEPM Special Publication containing the work presented at the meeting is in preparation and will hopefully be available within 18 months. The volume will include a combination of overviews and perspective papers plus case studies. The intent is to stimulate further research and discussion on the role of autogenic dynamics in sedimentology, paleobiology, and sedimentary geochemistry/diagenesis.

SEPM a Global Network of Support

SEPM has Global Ambassadors in 15 countries (see www.sepm.org "Ambassador" menu item). These Ambassadors help represent SEPM to their local regions to better build SEPM's global network. SEPM also supports and participates in numerous meetings around the world. I highlight a couple of recent ones below.

One was the AAPG International Exhibition and Convention (ICE) in Istanbul, September, 2014. SEPM Executive Director, Howard Harper was on the organizing committee and manned the exhibit booth, along with help from Diane Harper (spouse), Steve Franks (SEPM and Headquarters and Business Committee member) and Ercan Ozcan (SEPM Global Ambassador, Turkey). Additionally, Ercan lead and field trip as part of the meeting. The booth was busy with and added 29 new members and well as visiting with current members and the meeting was considered an outstanding technical success.

SEPM also supported the Geological Society of London 2014 William Smith Meeting in London, UK, September, 2014. This meeting themed: *Sequence Stratigraphy: Evolution or Revolution* brought together both industry and academic users of the sequence stratigraphy method. Howard Harper attended representing SEPM but there were numerous SEPM members participating in the meeting. If a single summary could be made of the meeting, it would be that there is still a much different approach to how many academics use and view it versus the industry users.

Additionally, SEPM supported the following meetings:

- **Argentina – International Paleontological Congress – September, 2014**
- **India – Research in Sedimentary Geology – September, 2014**
- **India - Annual Meeting of Indian Association of Sedimentologists- November, 2014**
- **USA – AGI Critical Issues Forum- America's Increasing Reliance on Natural Gas: Benefits and Risks of a Methane Economy, November, 2014**

SEPM and STEPPE

If you have not investigated STEPPE (Sedimentary geology, Time, Environment, Paleontology, Paleoclimate, Energy) the NSF supported consortium to promote multidisciplinary research and education on the Earth's deep-time sedimentary crust, then here is a brief update of recent activity. SEPM is one of the founding partners of this consortium, which is just ending its first full year of existence.

Major accomplishments of the STEPPE office in the last several months have included further development of the STEPPE website (www.steppe.org), establishment of STEPPE's social media presence (Face Book, Twitter and blogging), development and testing of STEPPE's online collaboration platform, establishment and implementation of the STEPPE internship program and the distribution of student travel awards for the 4th International Palaeontological Congress in Argentina, Mendoza. STEPPE has worked to support cyberinfrastructure initiatives and to develop international partnerships. Major accomplishments within Education and Outreach include the development and implementation of the internship program, a field-based teacher professional development program for middle school science teachers and submission of a multi-institution collaborative NSF-DRK12 proposal.

A highlight of the 4th International Palaeotological Congress included 15 student travel grants (12 –USA; 3-Outside US) via an NSF award to STEPPE. A full report about the meeting authored by the STEPPE student awardees is included in Appendix A (online only).

STEPPE 4th IPC Grant Recipients

SEPM had its own separate grant program, restricted to support South American students with travel grants to attend the meeting. These specific students were awarded SEPM travel grants.

Jorge Maximiliano Alvarez, Argentina
Mónica Buono, Argentina
Caviglia Nicolás, Argentina
Matias Do Nascimiento Ritter, Brasil
Estebenet González, Argentina
Lorente Malena, Argentina
Agustín Martinelli, Brasil
Gastón Martínez, Argentina
William Mikio Kurita Matsumura, Brasil
Daniela Soledad Monti, Argentina
Diego Fernando Muñoz, Argentina
Mª Eugenia Raffi, Argentina
Mariano Ramírez, Argentina
Raúl Vezzosi, Argentina

UPCOMING 2015 CONFERENCES

STRATI 2015 – 2nd International Congress on Stratigraphy

July 19-23, 2015, Graz, Austria

This congress is organized for the International Commission on Stratigraphy (ICS) of the International Union of Geological Sciences (IUGS). The congress content covers all topics in stratigraphy with more than 30 technical sessions. The technical program will range from the Archean to the Holocene, across all techniques and applications of stratigraphy and the discoveries that the stratigraphic record reveals about the Earth system. There is also a great set of field trips available. In addition, it will also serve as the primary venue for ICS business, for ICS sub-commissions to meet and awarding of ICS stratigraphy prizes.

Meeting is sponsored by University of Graz, ICS and SEPM.

http://strati2015.uni-graz.at/

Mountjoy I – Advances in Characterization and Modeling of Complex Carbonate Reservoirs

A joint SEPM and CSPG Conference
August 23-29, 2015, Banff, Alberta, Canada
ABSTRACT SUBMISSIONS OPENING SOON!

Themes

- The Nature of Unconventional Carbonate Reservoirs
- Carbonate Reservoirs in Structurally Complex Regions
- The Nature of Intensely Fractured, Vuggy Carbonates
- Advances in Modeling Carbonate Systems, Reservoirs, and Flow in Carbonates
- Advances in Diagenesis
- Dolostones – The nature of dolostones in the geologic record

Conveners

Dr. Alex J. MacNeil Osum Oil Sands (Calgary) amacneil@osumcorp.com
Dr. Jeff Lonnee – Shell International Exploration & Production Inc. (Houston) jeff.lonnee@shell.com
Dr. Rachel Wood – School of GeoSciences, University of Edinburgh (Edinburgh) rachel.wood@ed.ac.uk

2015 34th Annual GCSSEPM Foundation Bob F. Perkins Research Conference – Petroleum Systems in “Rift” Basins

DECEMBER 6–9, 2015, OMNI Houston Westside, Houston, Texas
ABSTRACTS DEADLINE – DECEMBER 1, 2014!

Extensional and transtensional “rift” and overlying/related sag basins have been targeted by petroleum explorationists for nearly 200 years. These basins are “**disproportionately rich**,” containing ~30% of all ‘giant’ (>500 MMBOE) fields (Mann et al., 2001, 2003, 2006, 2007); but **frustrating and confounding** to explorationists and developers because each is a unique geological entity; yet all are variations on a common theme (Lambiase, 1994).

http://www.gcssepm.org/conference/2015_conference.htm

SEPM at the 2015 AAPG International Conference and Exhibition (ICE)

Photo: Devonian Merennie Sandstone in the Outback of the Northern Territory, Australia.

SEPM will sponsor several sessions at the 2015 AAPG International Conference and Exhibition (ICE) that will be held September 13-16 in the beautiful city of Melbourne, Australia. The meeting will be hosted by the Petroleum Exploration Society of Australia (PESA) and will be the first ever ICE that will be co-presented by AAPG and the Society for Exploration Geophysicists (SEG). The Call for Abstracts for the conference is now open and closes on January 15, 2015 – see http://ice.aapg.org/2015.

Technical Program Co-Chairs, Pete McCabe (University of Adelaide) and Steve Mackie (Santos), aim to build an exciting program of talks, posters, short courses and field trips that focus on recent advances in petroleum geology and geophysics along the theme of "A Powerhouse Emerges: Energy for the Next Fifty Years." Although the conference will be worldwide in scope, particular attention will be paid to the petroleum potential of the Asia Pacific region, including sessions on unconventional reservoirs of the region and new and emerging E&P provinces in China, Southeast Asia, New Zealand and Australia. Of particular interest will be a session on the Great Australian Bight, a large frontier basin offshore South Australia, that is an area of very active exploration by several international companies.

In addition to the general sessions, the technical program will feature three special symposia. Of particular interest to many SEPM members will be a symposium to honour the career of Dr Marita Bradshaw. Marita recently retired from Geoscience Australia, Australia's geological survey, after a career of more than 30 years. Marita has always been willing to share her deep knowledge of Australia's sedimentary basins and petroleum systems. This symposium will focus on the paleogeographic evolution of Australia through time and its relationship to petroleum accumulations.

The Reg Sprigg Memorial symposium will focus on Australia's major petroleum provinces: the Gippsland Basin, Cooper Basin and Northwest Shelf, each celebrating 50 years of exploration and production. Reg Sprigg (1919-1994) was a prominent Australian petroleum geologist who is also famous as the discoverer of the unusual fossils in the Ediacara Hills of the Flinders Ranges in South Australia. Though his fossil discoveries were met with disbelief at the time and his paper submitted to Nature rejected, the importance of the Ediacaran fauna was eventually recognized and led to the establishment of the Ediacaran Period in 2004, making it the first new geologic period to be internationally recognized in 120 years.

The third symposium, on Eastern Australasian Basins (EABS), will be coordinated by PESA and will feature recent advances in our understanding of sedimentary basins along Australia's eastern margin and across the Tasman Sea to New Zealand. EABS and the Western Australian Basin Symposium (WABS), alternately held biannually by PESA, form the key up-to-date discussions of the petroleum basins on the Australian plate.

Diversity in all its forms: IPC4 as an invaluable opportunity for STEPPE grant recipients

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Earth's biological diversity comprises ~1.7 million extant species known to science, and there are many millions yet to be discovered (1,2). Today's biodiversity, however, is thought to represent only ~1% of the life that has ever existed on our planet. Moreover, much of this life is currently in peril from what has been called the "6th great extinction event", largely precipitated by the overwhelming influence humans have had on the biosphere (3). If modern biodiversity represents only a small fraction of the flora and fauna that once lived, what can we learn from past diversity to understand the future of modern biota? What processes acted to shape our current diversity? How do living species relate to other branches on the tree of life?

Paleontology, from the Greek '*palaios*' (old, ancient), '*ontos*' (being, creature), and '*logos*' (thought, study), involves the study of life through geological time. The fossil record provides a historical ledger that sheds light on the origins of today's biodiversity and how organisms relate to each other via ancestor-descendant relationships. Over the last several years, new paleontological discoveries and technologic developments have allowed for more efficient and innovative ways to analyze the fossil record. This, in turn, has improved our understanding of how life on Earth has waxed and waned through time.

The vigor and relevance of contemporary paleontological research were on full display at the 4th International Palaeontological Congress (IPC4) in the city of Mendoza, Argentina (September 28 to October 3), where nearly 1,000 paleontologists from around the world converged to celebrate paleontology. The research presented at IPC4—the largest International Palaeontological Congress to date—was highly diverse in its topical, organismal, geographical, and temporal coverage. The workshops, symposia, short courses and field trips were similarly varied, as were the conference attendees, who hailed from 50 different countries and represented many different stages of their paleontological careers, from students to emeritus professors. In short, diversity in all its forms was the very heart of IPC4.

We write this article as the fortunate recipients of 15 travel grants offered by STEPPE, an NSF-supported consortium whose purpose is to promote multidisciplinary research and education on Earth's deep-time sedimentary crust (4). The funding opportunities provided by STEPPE, in collaboration with the Geological Society of America, the Paleobotanical Section of the Botanical Society of America, the Paleontological Society, the Society for Sedimentary Geology, and the Society for Vertebrate Paleontology, helped to alleviate a substantial financial burden for many students. For many of us, IPC4 provided our first opportunity to visit Argentina, South America, or even the Southern Hemisphere, and without STEPPE's aid, we would not have experienced the new research and diverse perspectives the conference offered, including following in the footsteps of Charles Darwin's travels in the Andes on the many conference field trips. The student funding offered by the STEPPE consortium and collaborative professional societies has greatly assisted all of us in our nascent careers, and in this instance provided an incredibly motivating, reassuring, and intellectually stimulating experience that benefitted all of our futures in paleontology.

As STEPPE awardees, we are as diverse as the conference proceedings. We study taxa as disparate as tetrapods, plants, arthropods, and early eukaryotes, and research topics from paleoecology, paleobiogeography, and biomechanics, to exceptional preservations, functional morphology, visual systems, and predator-prey interactions (5,6). The temporal range of our research also spans from the very old (Proterozoic) to the very young (Neogene to Recent). We had the opportunity to showcase our research to world experts as poster and oral presentations, generate novel research ideas that cut across disciplines, make useful contacts for future research questions, and learn of research similar to ours from around the globe. These interactions, both amongst the STEPPE awardees and our fellow paleontologists at the conference, will hopefully lay the groundwork for new discoveries, technological advances, and paradigm shifts that will unfold over the coming decades. It is interesting to note that though the overwhelming majority of the STEPPE grant recipients are student members of the 5 partner institutions above mentioned, many of us had never met before IPC4. Thus, in addition to the benefits of meeting established experts in our fields, we had a unique opportunity to form new, lasting research collaborative relationships with other early-career scientists, and particularly among us. This goes to show that it is through collaborative networks such as the STEPPE consortium, among many others, that the inherently multidisciplinary areas of our study can truly come together in a way they could not as individual entities.

It is an incredibly exciting time to be a young paleontologist. Owing to the accessible nature of research in our discipline, paleontology enjoys wide media coverage and enthusiastic contributions from amateurs. Further, the advent of exciting new analytical methods, combined with seemingly endless fossil discoveries, is shedding new light on the history of life and the evolution of our planet. As the field of paleontology continues to enjoy a renaissance, the role of young, motivated researchers will be invaluable. As junior researchers on the cusp of careers in this discipline, we believe that the opportunity for early career scientists to attend this kind of meetings, facilitated by granting agencies and institutions such as the STEPPE consortium, are pivotal to achieve our goals of becoming future leaders in the field, and contribute to our ever-improving knowledge of the origin of Earth's overwhelming diversity through deep time.

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