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The SEDIMENTARY Record

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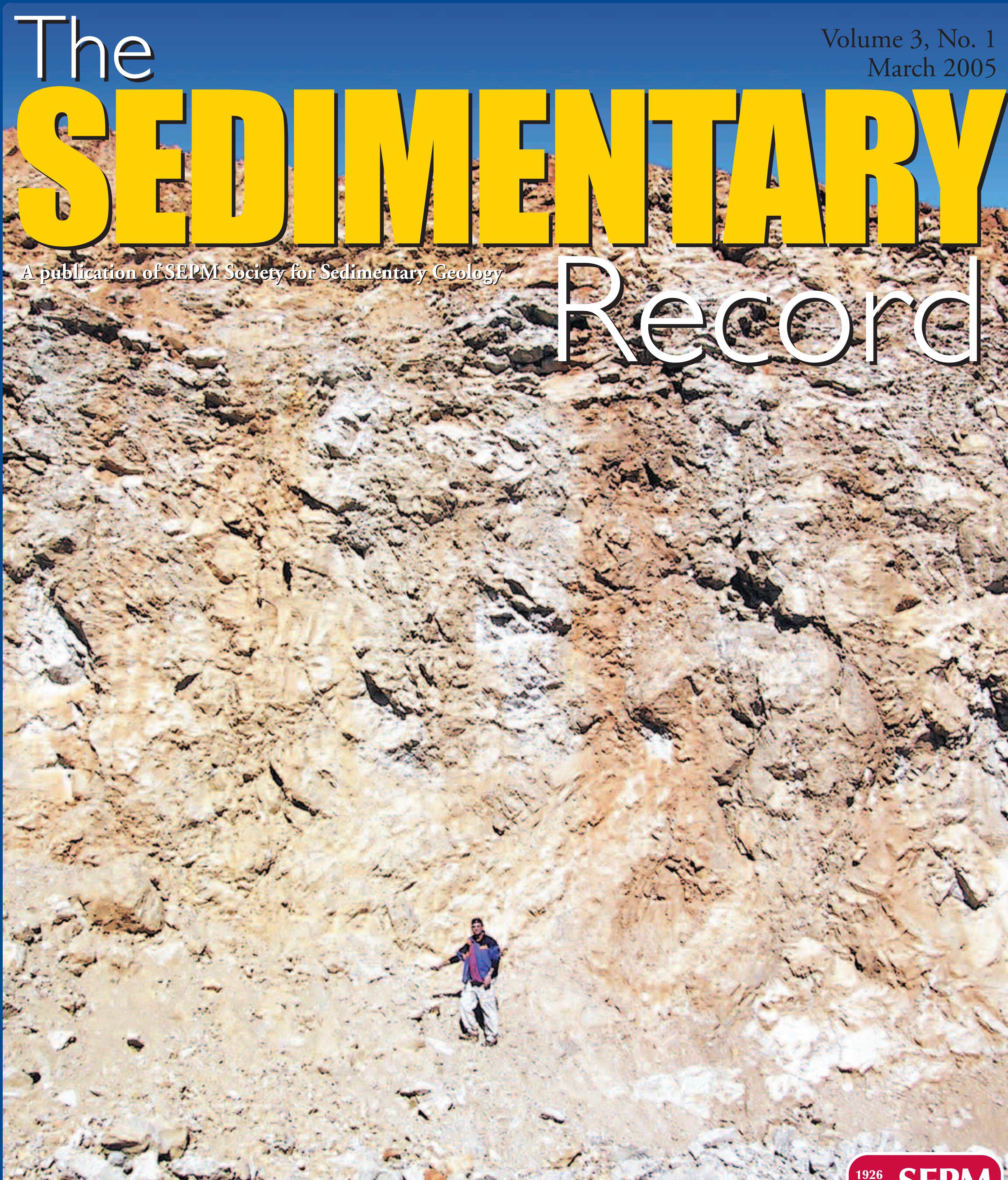

INSIDE: METEORITE IMPACT RECORD

PLUS: EVENTS SCHEDULED FOR THE ANNUAL MEETING
PRESIDENT'S OBSERVATIONS
COMMENTS FROM THE COUNCIL

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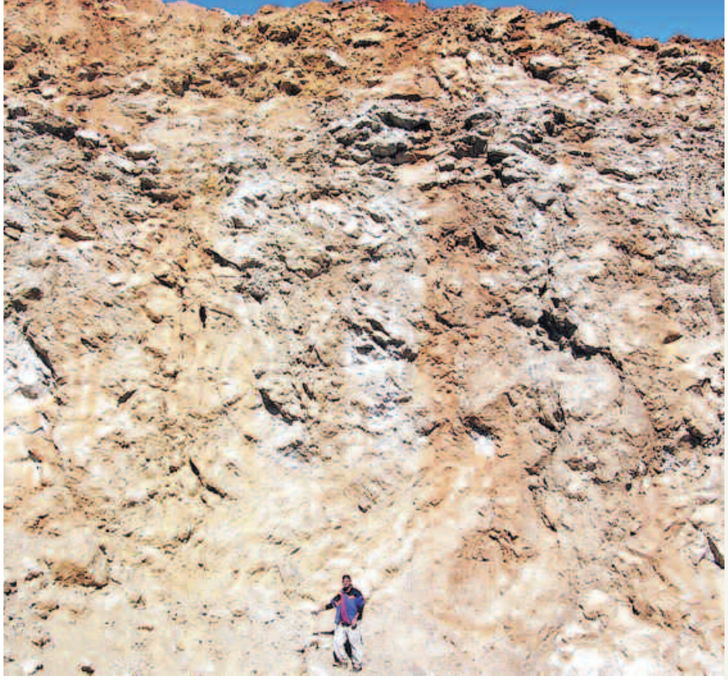

On the Cover: *Extensively fractured Mississippian carbonates are overlain by a thin interval of horizontally bedded limestone and breccia in the Ash Grove Aggregates quarry near Osceola, Missouri.*

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The Sedimentary Record of Meteorite Impacts:
An SEPM Research Conference

Kevin R. Evans, Department of Geography, Geology, and Planning, Southwest Missouri State University, Springfield, MO 65804-0089; kre787f@smsu.edu
J. Wright Horton, Jr., U.S. Geological Survey, 926A National Center, Reston, VA 20192; whorton@usgs.gov
Mark F. Thompson, Kentucky Geological Survey, University of Kentucky, Lexington, KY 40506-0107; thompson@uky.edu
John E. Warme, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401; jwarme@mines.edu

ABSTRACT
Large meteorite impacts are important agents of sedimentation and sediment modification that vary according to geologic settings, ranging from marine to non-marine. Impact structures and deposits that they generate are hosts for hydrocarbons and ore deposits, and influence water quality and availability. By preserving a record of ancient meteorite impacts, rocks and sediments provide insight into the distribution of these resources as well as modern risks for life and civilization. SEPM is sponsoring a research conference to address the sedimentary record of meteorite impacts around the world using multidisciplinary approaches.

INTRODUCTION
Large meteorite impacts generate shock-metamorphic fabric in rocks, and they are also bona fide agents of sedimentation. Impacts generate, transport, and deposit sedimentary particles in marine and non-marine settings, and deform and alter pre-existing rocks and sediments. Until the 1960s, the geologic community largely relegated studies of meteorite impacts to geologic sidelights and curiosities, which were inherently controversial. Today, it is widely recognized that large impacts have played a pivotal role in the evolution of Earth's biota and sculpted the surface of the planet. Although impacts are even rarer than large-scale earthquakes, volcanic eruptions, and tsunamis on human time scales, the probability of a future impact is a certainty in geologic time. This should remind us of our perpetual exposure to natural catastrophes of all sorts. Stratigraphers can play an essential role in documentation and evaluation of impact structures for the benefit of all.

IMPACT PROCESSES AND PRODUCTS
Impacts of large meteorites on Earth are beyond the scope of normal human experience. Even so, studies of conventional and thermonuclear explosions, experiments with high-velocity projectiles, and computer modeling have helped to develop our understanding of impact processes. Melosh (1989) recognized three stages of impact cratering: contact and compression, excavation, and modification.

The contact and compression stage entails generation of the shock wave that instantaneously provides extreme pressure and disruption of the target material. Typically, this stage lasts only a fraction of a second, but the shock pressures pass through the target well into the excavation stage. Shock pressure and the release from such pressure forms three of the four diagnostic features associated with meteorite impacts: high-pressure mineral species such as coesite and stishovite, diaplectic glasses and planar deformational features (PDFs) in shocked minerals such as quartz, and shatter cones (French, 1998; Koeberl and Martinez-Ruiz, 2003). The fourth diagnostic criterion is a geochemical signature of highly siderophile elements (HSEs) associated with the impactor.

The excavation stage involves the formation of the transient crater, where the impactor penetrates the target, deforms, vaporizes, and explodes, creating a balloon-like cavity within the surrounding rock. An enormous amount of material is displaced downward, outward, and upward during excavation. This leads to a "space-problem" in strata surrounding the transient crater. Folding of strata and motion along reverse and transpressive faults accommodate the en masse lateral displacement and emplacement of flow material. Ultimately, the explosive forces breach the roof of the tran-

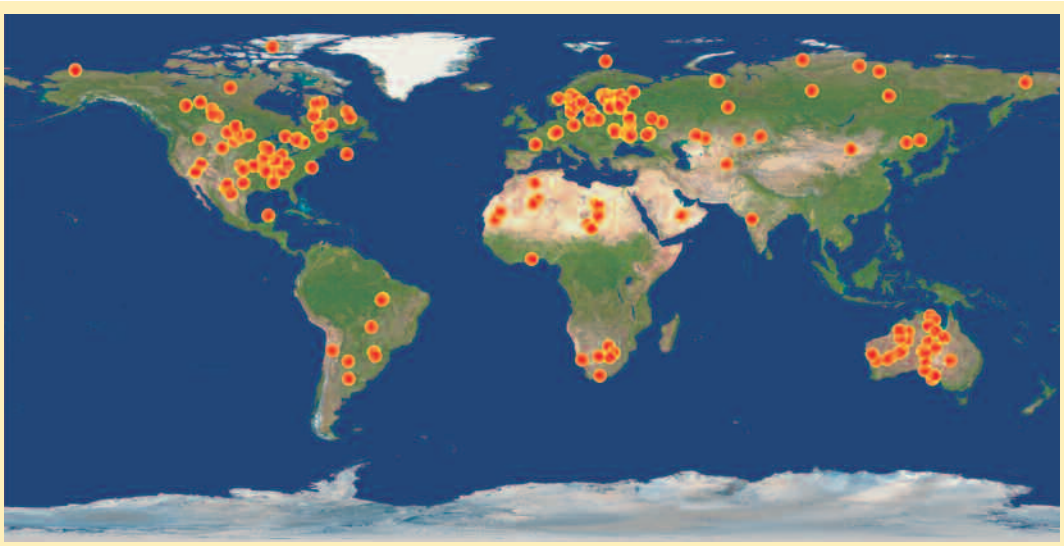

Figure 1: At this time, 172 impact structures are recognized in the Earth Impact Database (2005). The vast majority are located on landmasses. Many marine impacts have likely been destroyed by subduction. Despite this skewed pattern of occurrences, several impacts in the Balto-Scandia region of Europe and North America were impacts in shallow seas (see Dypvik et al. 2004). Impact locations and map modified from Earth Impact Database (2005). "Blue Marble" image courtesy of NASA (http://earthobservatory.nasa.gov/Newsroom/BlueMarble/).

Figure 2: Map of continental United States showing confirmed and proposed impact structures. Most exposed structures are located on stable cratonic platforms in Paleozoic strata in the mid-continent. Map modified from Earth Impact Database (2005).

sient cavity, and a curtain of ejecta is expelled from the crater.

During the modification stage, the compression wave has passed and rarefaction causes relaxation and inward flow of disrupted material. Normal faults develop around the periphery of the structure, forming a tectonic rim. Ultimately, crater morphology is a function of the size of the impactor, the angle of incidence, and properties of the target material. Simple craters generally form bowl-shaped depressions with crater rims that are elevated above the original land surface. Complex craters are generated by larger impacts, where, during the modification stage, rocks rebound to form central uplifts or peak ring structures within craters. Crater rims are rarely preserved in ancient impacts, so the eroded remains of impact cratering are commonly referred to as impact structures. Currently, 172 impacts are recognized in the Earth Impact Database (2005; Fig. 1). Roughly 30 accepted or plausible impact structures are located in the continental United States (Fig. 2).

Impacts on continental "dry" targets and those on oceanic "wet" targets show significant variation, although water is present in dry targets where the rocks are saturated with ground water (Fig. 3). The principal differences are related to the mitigating effects of variable water depths, deposition from the violent resurge of seawater back into the crater, a variety of post-impact crater-fill deposits, and possible distal tsunami deposits (French, 2004). Distal deposits from both wet and dry impacts include ejecta such as microkrystites, microspherules, and tektites.

IMPACTITES

Shock-metamorphosed rocks, including breccias and melt rocks, are called impactites. Evidence for shock metamorphism is based on criteria such as microscopic planar deformation features within grains or shatter cones. A proposed international classification of impactites (Stöffler and Grieve, 2003) was recently endorsed with slight modifications by the North American Geologic-map Data Model Science Language Technical Team (2004). The three main classes of impactites are shocked rock, impact melt rock, and impact breccia. Shocked rock is non-brecciated rock that shows unequivocal effects of shock metamorphism exclusive of whole-rock melting. Impact melt rock is a rock (crystalline or glassy) in which ≥50% of the rock volume is solidified from impact melt. Impact breccia is breccia in the general sense that has unequivocal evidence of shock metamorphism. The three subclasses of impact breccia are suevite (containing impact melt particles), polymict impact breccia (containing fragments of different composition and free of impact-melt particles), and monomict impact breccia (containing fragments of essentially the same composition and free of impact melt particles). The field identification of impactites can be difficult because of their similarity to other breccias and fragmental rocks of sedimentary, volcanic, and tectonic origin, and field interpretations can be subject to debate.

RISK OR RESOURCE

Although the future holds risks of impact, ancient impact structures may be viewed as resources, where breccia bodies and peripheral strata host accumulations of ore deposits, hydrocarbons, and ground water. An estimated 25% of the world's impact structures are associated with mineral production (Mory et al., 2000). Sudbury in Ontario hosts the world's richest nickel deposit. Vredefort in South Africa, at 300 km diameter, is the world's largest impact structure and also host to the world's largest gold deposit.

The evolution of porosity in the target rocks, fault networks, subsequent burial, and up-dip migration of hydrocarbons are important factors in impact-related petroleum accumulations. Petroleum production is associated with impact structures at Ames, Oklahoma; Calvin, Michigan; Newporte and Red Wing, North Dakota; and Marquez and Sierra Madera, Texas (Fig. 2). At 50 MMBO, Ames has the largest estimated reserves among impacts in the continental United States (Donofrio, 1997). A major oil field in Mexico appears to be associated with the Chicxulub impact (Grajales-Nishimura et al., 2000). Two enigmatic structures in Texas, at Lyle Ranch and Viewfield, have oil and gas accumulations that may or may not be impact related (Donofrio, 1997). Oil and gas production near Middlesboro, Kentucky, is mostly related to thrust plays (Kuehn et al., 2003). The Avak structure near Barrow, Alaska, hosts three gas accumulations (Kumar et al., 2001).

RESEARCH CONFERENCE

SEPM is hosting a Research Conference on The Sedimentary Record of Meteorite Impacts, May 21-22, 2005, in Springfield, Missouri. The conference will feature talks and posters on the sedimentary aspects of impact structures around the world. It includes a field trip to the Weaubleau-Osceola structure and an optional field trip to the well known Decaturville and Crooked Creek impact structures. The co-conveners of the Research Conference are Kevin Evans (Southwest Missouri State University), Wright Horton (U.S. Geological Survey), Mark F. Thompson (Kentucky Geological Survey), and John Warme (Colorado School of Mines). The sedimentary record of meteorite impacts will be addressed using multidisciplinary approaches, which include scientific drilling, geologic mapping, sedimentology, stratigraphy, paleoecology, paleontology, petrology, mineralogy, hydrology, geophysics, remote sensing, and astrobiology.

PRESENTATIONS

Keynote speakers for the Research Conference are Jay Melosh (University of Arizona) and

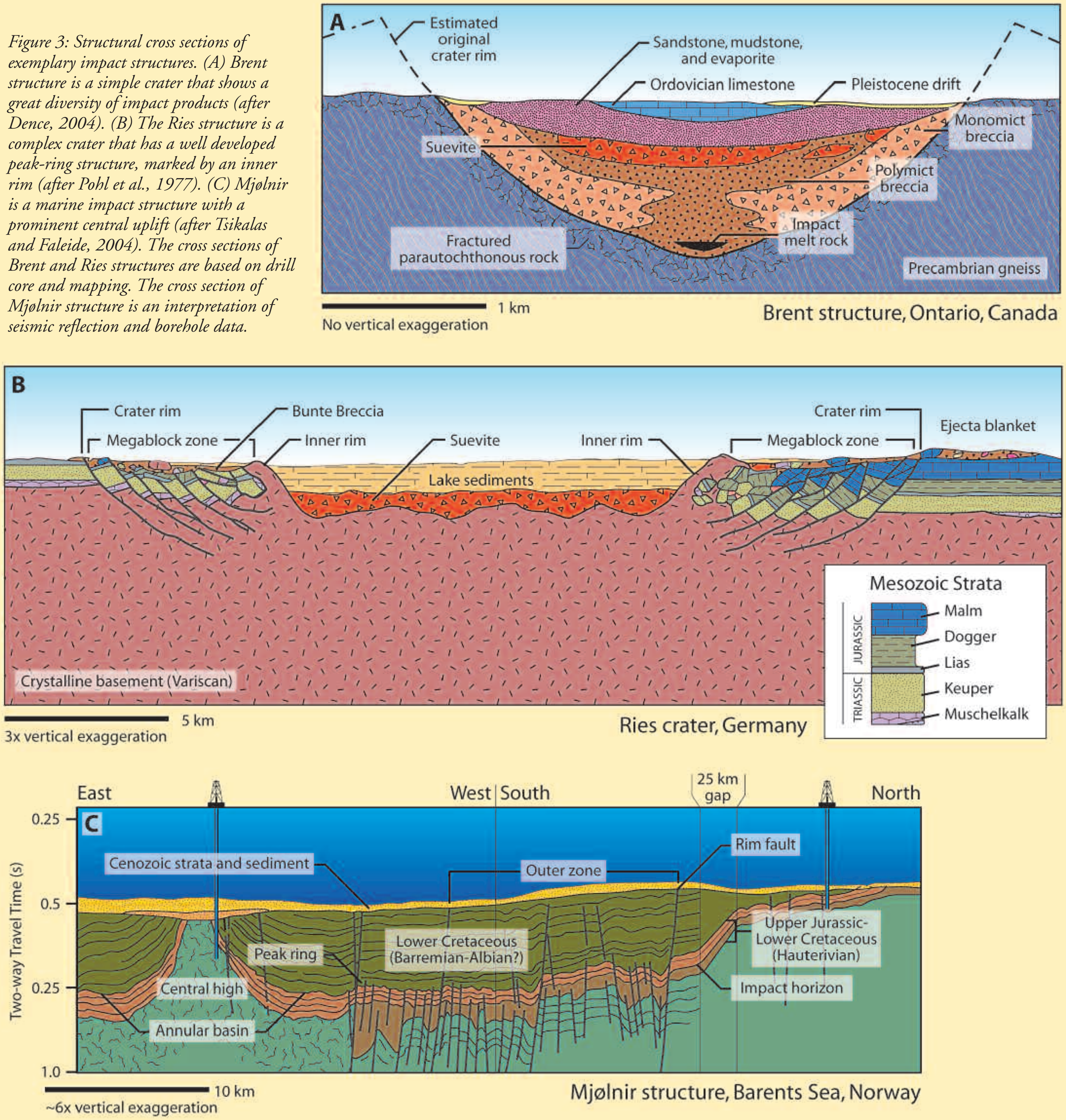

Figure 3: Structural cross sections of exemplary impact structures. (A) Brent structure is a simple crater that shows a great diversity of impact products (after Dence, 2004). (B) The Ries structure is a complex crater that has a well developed peak-ring structure, marked by an inner rim (after Pohl et al., 1977). (C) Mjølnir is a marine impact structure with a prominent central uplift (after Tsikalas and Faleide, 2004). The cross sections of Brent and Ries structures are based on drill core and mapping. The cross section of Mjølnir structure is an interpretation of seismic reflection and borehole data.

Bevan French (Smithsonian Institution). Jay Melosh, author of Impact Cratering, A Geologic Process (Melosh, 1989), is an expert on numerical modeling of impact processes who will present information on the generation of particles and stratigraphic significance of distal ejecta. Bevan French, author of the book *Traces of Catastrophe, A Handbook of Shock-Metamorphic Effects in Terrestrial Meteorite Impact Structures* (French, 1998), has had a long career investigating impact products and will discuss the importance of these geologic structures.

Oral and poster presentations will feature studies from several impacts, including:

- K/T impact breccia, Belize; multiple debris-flow units up to 7 m thick record variations in turbulent and laminar flow in the aftermath of this Earth-shattering impact.
- Alamo Breccia, Nevada; why is this deposit asymmetrical, and why does it show only shallow disturbance over a huge area? Alternative solutions include impact directly on the Devonian continental margin, a massive impact in deep water, or multiple impacts.
- Avak structure, Alaska; distal ejecta in core may provide tighter age constraints for the age of impact.
- Bosumtwi crater, Ghana; drilling in the 8 km diameter lake that fills this structure is providing valuable information on orbital-scale climatic variations of monsoons and droughts.
- Chesapeake Bay structure, Virginia; studies

Figure 4: NX core from the MoDOT-SMSU Vista 1 borehole penetrated nearly 220 ft (~67 m) of breccia. Each core segment is five ft (~1.5 m) in length. Top is at upper left and bottom at lower right. Total depth (TD) reached 247.8 ft. The yellow-brown polymict breccia in the upper part of the core contains angular clasts of dolomite, siltstone, sand grains, chert, and chert concretions supported by a fine-grained limestone matrix. This unit is interpreted as ejecta or a resurge deposit. Rounded crystalline basement clasts were recovered at approximately 200 ft (61 m), and the lower 20 ft (4.5 m) of core contains crystalline basement clasts. Drilling records from this area indicate crystalline basement at a depth of about 1,400 ft.

of drill core and geophysical surveys provide insights into the sedimentology, mineralogy, petrology, paleontology, paleoecology, morphology, and hydrology of this 85-km diameter marine impact structure.

- Crooked Creek, Decaturville, and Weaubleau-Osceola structures, Missouri; compelling sedimentological and geophysical evidence suggest that the latter may become the third impact structure recognized among the 38th parallel structures. Why are they in a row, and what are their ages? Faunal studies of the "Weaubleau breccia" give a tightly constrained age of latest Osagean (middle Mississippian).
- Mjølnir structure, Barents Sea; sooty remains in breccia from this Late Jurassic marine structure suggest that the impact ignited petroleum-rich material on the seafloor target. Slumps and debris flows later blanketed the crater with sediment. A display of drill cores from the structure will provide for lively discussion.
- Gardnos structure, Norway; drill core is providing a new look at avalanche and debris flow processes that record the collapse of the central peak and crater walls. A segment of drill core will be available for examination.
- Silverpit structure, North Sea; "impact taphonomy" is a new approach looking at impact-damaged microfossils. In this late Paleocene structure, microfossils provide information on the temperature and pressure conditions.
- Tvären structure, Sweden; after the impact event, marine craters can provide a sheltered ecosystem for pioneer species. This Ordovician impact crater contains a richly diverse assemblage of post-impact fauna.
- Lockne crater, Sweden; core drilling is providing information on the processes associated with excavation and ejection in marine impacts.
- Wetumpka structure, Alabama; sedimentology based on drill cores suggests two crater-filling episodes; a rapid fallback of material followed by the violent return of seawater.

Other presentations will focus on distal ejecta in areas such as the North American tektite strewn field, the Barberton greenstone belt of South Africa, and the Western Desert of Egypt, and the widespread stratigraphic record of a 4 kyr BP impact of uncertain location.

Following presentations, a workshop will feature core from the Weaubleau-Osceola structure of Missouri (Fig. 4). The MoDOT-SMSU Vista 1 core features more than 200 feet (~60 m) of breccia to a TD of 247.8 ft (67 m); it includes rocks that are interpreted as carbonate ejecta or resurge breccia, as well as crystalline basement breccia that has been uplifted approximately 1,200 ft (360 m). Other cores from Weaubleau-Osceola and Decaturville will tie into the field trip stops.

FIELD TRIPS

Weaubleau-Osceola, Crooked Creek and Decaturville are three of the "cryptoexplosive" structures that have been proposed along the 38th parallel (Fig. 5). The field trip to the Weaubleau-Osceola structure, led by Kevin Evans and Charles Rovey, Southwest Missouri State University, will feature roadcuts and quarry exposures, where the rocks are folded and brecciated (Fig. 6 and cover). Structural complexity around the Weaubleau Creek area has been known for more than half a century, but digital-map images in 2002 revealed a much broader, 19-km diameter, circular area of deformation. The age of the Weaubleau-Osceola structure is tightly constrained by the youngest ages from mixed faunas recovered from the breccia (middle Mississippian, latest Osagean). Features of the Weaubleau-Osceola structure that have been reported as evidence of an impact origin include a circular outline, brecciation, intense laterally-directed folding and thrust faulting, peripheral normal faults, circular Bouguer gravity anomaly low, basement ring(?) uplift, a possible shatter cone recovered from core, and preliminary petrographic evidence for planar fractures and planar deformational features in quartz (Evans et al., 2003).

An optional Monday field trip (May 23), led by George Davis, Missouri Department of Transportation, and Pat Mulvany, Missouri Department of Natural Resources, will feature the well known Crooked Creek and Decaturville impact structures. Shatter cones and shocked quartz have been reported from both structures (Fig. 7; Dietz and Lambert, 1980; Hendriks, 1954; Offield and Pohn, 1979).

SCHEDULE OF EVENTS

Saturday, May 21:	Daytime talks and posters Evening reception and workshops (core, remote sensing)
Sunday, May 22:	Field trip to Weaubleau-Osceola structure
Monday, May 23:	Optional field trip to Decaturville and Crooked Creek structures
Tues.-Wed., May 24-25:	Short course "Traces of Catastrophe" by Bevan M. French* *This short course, although not affiliated with SEPM or the Research Conference, will be offered at Southwest Missouri State University for a nominal fee.

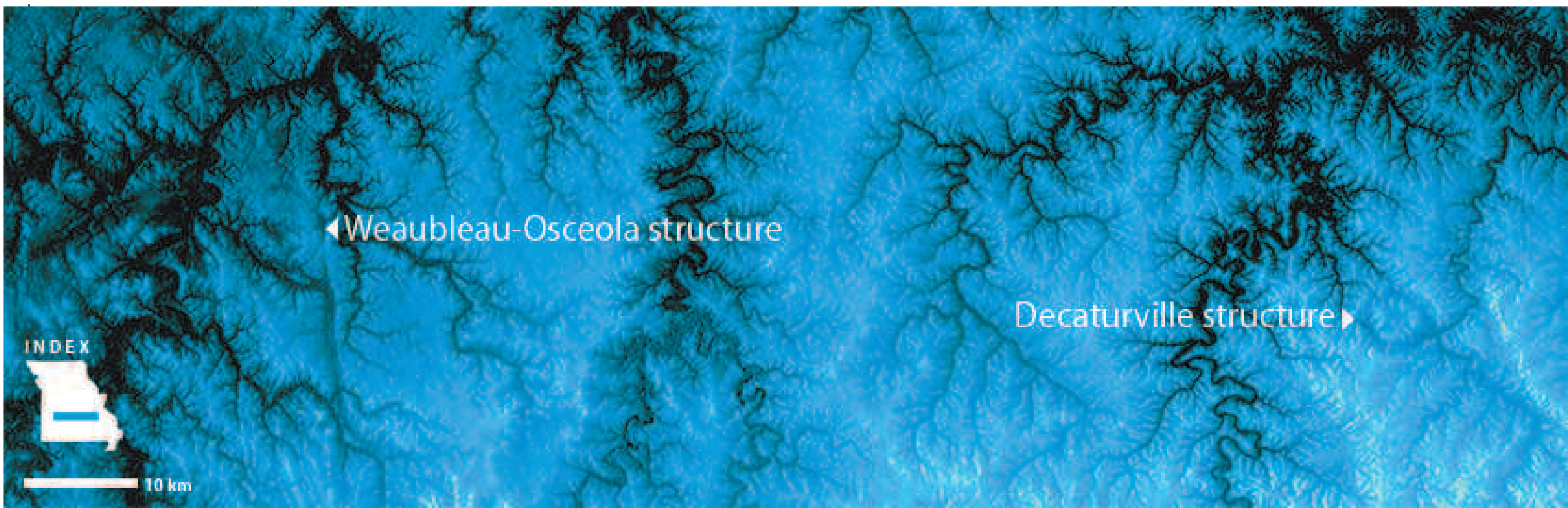

Figure 5. Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) image across central Missouri shows circular features associated with the Weaubleau-Osceola, Decaturville, and Crooked Creek structures. This DEM is in shaded relief, where dark blue and black indicate low elevations (~700 ft), and light blue indicates higher elevations (~1,200 ft). DEMs, such as this, led to the discovery of new features of the Weaubleau-Osceola structure (Evans et al., 2003). SRTM data obtained from USGS EROS Data Center in 2004 (<http://seamless.usgs.gov.).

Figure 6. Recumbent fold and thrust fault in Mississippian carbonates are overlain by brittlely fractured rocks and paleo-karst at the Ash Grove Aggregates quarry near Osceola, Missouri.

Figure 7. Shatter cones are well developed in the Potosi Formation (Cambrian) in the central uplift area of the Crooked Creek structure. Knife is 90 mm.

REGISTRATION AND INFORMATION

Information on the Research Conference, including details such as registration and accommodations, is available online at: http://www.sepm.org/events/research-conferences/rconferencehome.htm

Any additional questions can be addressed to Kevin Evans [e-mail: kre787f@smsu.edu].

ACKNOWLEDGMENTS

We are grateful to Lucy E. Edwards (USGS) and Jean M. Self-Trail (USGS) for constructive reviews of an earlier draft, and to Howard E. Harper (SEPM Executive Director) for encouraging us to upgrade the meeting announcement as a science article.

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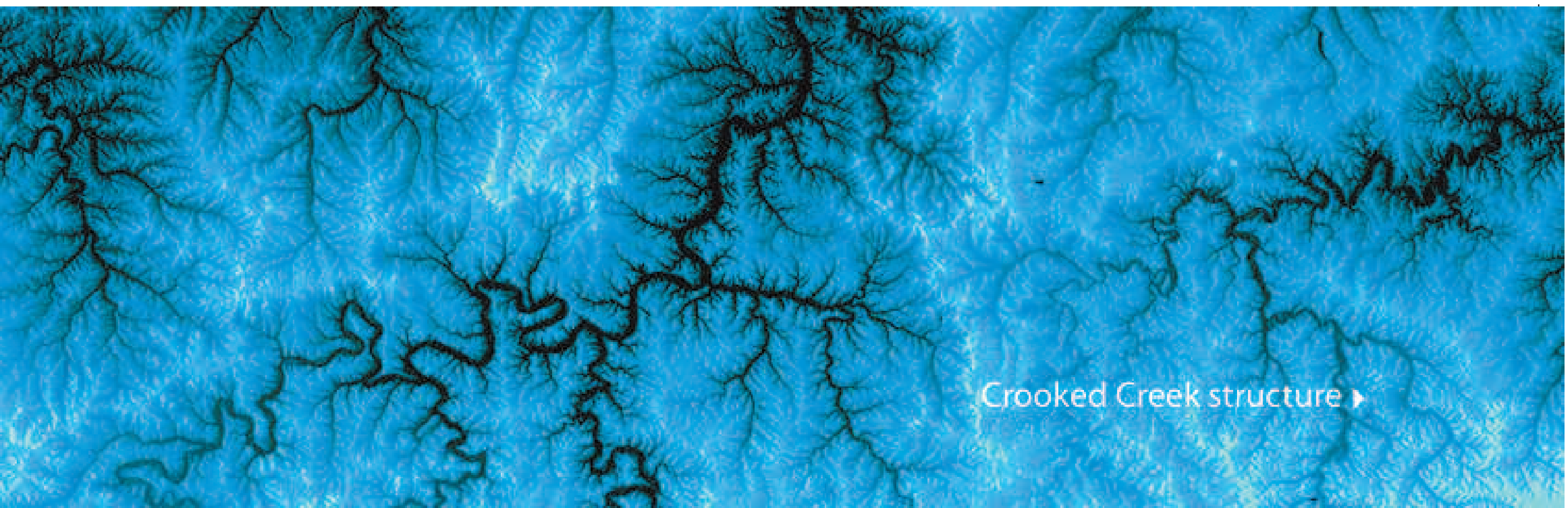

PRESIDENT'S OBSERVATIONS

OPEN ACCESS

A Concept That May Change Our Publishing World

The dissemination of scientific research results is the main mission of SEPM, and our journals and special publications are the main venue for accomplishing this goal. The money we make from our publishing activities is put to good use. It allows us, among other things, to organize cutting-edge research conferences and field seminars; helps provide a strong technical presence at our national meeting with AAPG, and helps foster community growth in our discipline, through sponsorship of workshops, meetings, and subsidizing membership. The growth and potential of the digital world and the Internet allows the possibility of open access publishing in the world of science. Open access to scientific information will affect the way, you the membership, access and use scientific data and knowledge, and has the potential to change the way SEPM does its business.

Let me first define 'open access.' There are three main components: free accessibility, widespread distribution, and proper archiving. Open access is real if: (1) the article is universally and freely accessible, at no cost to the reader; (2) the author or copyright owner irrevocably grants to any third party, in advance and in perpetuity, the right to use, copy, or disseminate the article in it's entirety, or in part, or to make derivative works provided that correct citation is given; and (3) the article is deposited, immediately, in full and in suitable electronic form, in at least one widely and internationally recognized open access repository, committed to open access and long-term preservation.

Defined like this, open access has the potential to transform the impact of scientific results. For instance, free and easy access to all literature provides the opportunity to view the full literature and possibly discern new knowledge and trends, not revealed in a fragmented world. Geoscientists tend to analyze local settings, looking for broader patterns. Open access can only enhance this effort.

Widespread open access would make it easier to avoid duplication of research effort, and would increase the public accountability of science. Open access defragments science literature, by making seamless, comprehensive searching possible. Open access would speed up understanding and closes gaps in the access to knowledge, enabling every researcher the opportunity to see the entire picture. Open access will enable effective and efficient building of databases and knowledge systems. Open access also has the potential to allow non-scientists into our world, and could stimulate a wider understanding and respect for science. These potential benefits will, in my opinion, generate a strong momentum for change in the world of scientific publishing.

Open access will have a major, but as yet unclear, impact on SEPM's mission and business model. Do we see ourselves as a fundraising entity, publishing journals and special publications to make money to further our discipline; or do we see ourselves as an entity focused on direct promotion of our discipline by making journals, our members and authors, and our society more visible and useful through open access. Put another way, open access requires a shift from 'subscriber-pays' to an 'author-pays' business model for journal publication. In a report commissioned by the Wellcome Trust, cost estimates for each model are comparable. For the journals they surveyed, total costs, per article, in a good to high quality journal are in the range of $2,000-3,000US. Direct costs per article for SEPM are between $2,700-$3,000US. Author-pays journal costs could be significantly less, if submission fees are charged for all articles submitted. These fees would defer the costs of peer-review and archiving. Publication fees for accepted articles could be potentially reduced by up to two-thirds. In this author-pays open access world, SEPM could see its role evolve to focus on fostering and maintaining technical quality through providing recognized peer review, facilitating discussion, comment and reply, and building and maintaining the archive of knowledge.

In this new world, the continued health and growth of SEPM will be directly dependent on our perceived technical strength and stature, and our ability to continue to attract the very best science to our journals. This may be our greatest future challenge. The open access movement has gained support in governments and biomedical institutes in Europe and the United States. It is likely to have wide reaching implications for all of scientific publications. I encourage all of you to inform yourselves on this issue, and to provide us here at headquarters and the council with your input. This is an idea made possible by the digital world, and it will likely change the way we do our science.

Rick Sarg, President SEPM
New E-mail: ricksarg1@aol.com

Start Planning Ahead

IF YOU ARE ATTENDING THE ANNUAL CONVENTION IN CALGARY

SEPM is planning on giving several short courses and field trips in conjunction with the Convention. For a detailed description of the course or trip including fees, instructors and locations, please visit the website at www.sepm.org

June 19-22, 2005.

SHORT COURSES:

Clastic Facies and Depositional Environments in Core
Wednesday-Friday, June 15-17;
8:00 am to 4:00 pm

Clastic Sequence Stratigraphy
Thursday-Saturday, June 16-18;
8:00 am to 5:00 pm

Application of Ichnology to Petroleum Exploration and Production
Saturday, June 14; *8:00 am to 4:30 pm*

Sequence Stratigraphy for Graduate Students
Saturday-Sunday, June 18-19;
8:00 am to 5 pm on Sat. and
8:00 am to 4:00 pm on Sunday.

3-D Seismic Interpretation for Geologists
Saturday-Sunday, June 18-19;
8:00 am to 5:00 pm

FIELD TRIPS:

Carbonate Reservoir Characterization: From Rocks to Fluid Flow Simulation Using Sequence Stratigraphy, Paradox Basin, Utah, USA
Tuesday-Saturday, June 14-18;
7:00 pm to 8:00 am

Shallow Gas Plays in the Great Plains: Outcrops and Cores of Upper Cretaceous Shelf to Non-Marine Reservoirs, Alberta, Saskatchewan, and Montana
Thursday-Sunday, June 16-19;
7:00 am to 8:00 pm

Dinosaur Provincial Park: Three Dimensional Exposures of the Upper Belly River Group and Exceptional Dinosaur Fossils
Saturday, June 18; *8:00 am to 9:00 pm*

Fluvial Architecture of the Lower Tertiary Paskapoo-Willow Creek Formations, Southwest Alberta
Sunday, June 19; *7:30 am to 9:00 pm*

Regional to Wellbore Scale Petroleum Structures of the Alberta Thrust Belt, Students and Faculty Advisors Only
Wednesday-Thursday, June 22-23;
5:00 pm to 8:00 pm

Badlands and Geology of the Red Deer River, and Dinosaurs of the Royal Tyrrell Museum
Thursday, June 23; *8:00 am to 9:00 pm*

Fluvial Sequence Stratigraphy and Sedimentology of the Uppermost Cretaceous to Paleocene, Alberta Foredeep.
Thursday-Saturday, June 23-25;
8:00 am to 5:00 pm

OTHER EVENTS TO MARK YOUR CALENDARS INCLUDE THE:

SEPM Student's Reception
Monday, June 20 from
6:00 pm to 7:00 pm at the
Westin Calgary Hotel.

SEPM Research Group Meetings and Receptions
Monday, June 20 from
7:00 pm to 10:00 pm at the Westin
Calgary Hotel.

SEPM Business Meeting/Luncheon
Tuesday, June 21 from
11:30 am to 1:30 pm at the Westin
Calgary Hotel. The guest speaker is Dr. John Grotzinger. His talk is titled, "Sedimentary Rocks and Evidence for Aqueous Environment on the Surface of Mars."

SEPM President's Reception and Awards Ceremony
Tuesday, June 21 from
7:00 pm to 8:30 pm at the Westin
Calgary Hotel.

Sign up to be an **SEPM Campus Representative.**

Share the Society with your students.

SEPM's Campus Representatives serve as a source of information about SEPM membership, meetings, and student and professional opportunities to college and university students and faculty. Currently, SEPM has Campus Representatives in over 70 Universities around the world.

SEPM offers students:

- **Twice-a-year "free books to students."** This is a great way for students to start their geology library.
- **An electronic membership for students at a reduced rate.** This gives students online access to the Journal of *Sedimentary Research* and *PALAIOS* for one low membership price.
- **Tuition waivers for SEPM short courses at our Annual Meeting.**
- **Several grants through the SEPM Foundation.** Money is available to support student research, travel, etc.

If you are interested in helping the Society with its mission to disseminate scientific information about sedimentary geology to the global community, please contact SEPM Headquarters for more information.

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Supporting the Publication Mission

The SEPM Foundation Bruce Harleton Fund was established in 1984 to support publications of the society. Its first major impact came from supporting the publication of Special Publication #42, *Sea Level Changes: An Integrated Approach* (1988). Recently, it has been used to help finance the digitization of the *Journal of Sedimentary Research* and *PALAIOS* and to make those files available to the membership and libraries around the world. It has also been used to help reduce the selling prices of some of our publications by funding color pages and other special printing items included within many of the SEPM publications. It has made a significant impact on the primary mission of the society; "**dissemination of the science of sedimentary geology**."

Through the years, SEPM and various authors and editors have raised money for specific publications. These efforts have made valuable contributions to reducing the price of specific publications. The Harleton Fund, however, is a way that individuals, companies and institutions can help support numerous publication projects with a single donation.

After recent outlays, the Harleton is starting to run low and it needs an infusion to allow it to keep supporting SEPM as it has been. At this time we are requesting that you and your company or institution consider a donation specifically to the Harleton Fund to allow it to continue to help the society in its publication efforts. With the ever increasing costs of printing both paper and electronic media, this particular funding is needed more than ever to keep the cost of quality books within affordable limits. SEPM has a full set of upcoming publications that can benefit from donations to this fund at this time, including:

- *Sedimentology and Sequence Stratigraphy of Carbonates*, Wolfgang Schlager
- *Deposition of Hydrocarbon Source Rocks*, Nick Harris, et al (eds.)
- *Deltas - Old and New*, Janok Bhattacharya, et al. (eds.)
- *Paleoclimate Atlas*, Chris Scotese and Art Boucot
- *Incised Valleys*, Robert Dalrymple, et al. (eds.)
- *Ichnology at the Crossroads: A Multidimensional Approach to the Science of Organism-Substrate Interactions*, George Pemberton, et al. (eds.)

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