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**A shift from lithostratigraphic  
to allostratigraphic classification  
of Quaternary glacial deposits**

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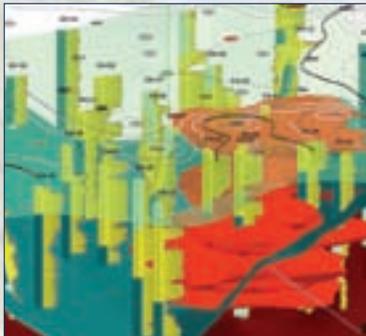
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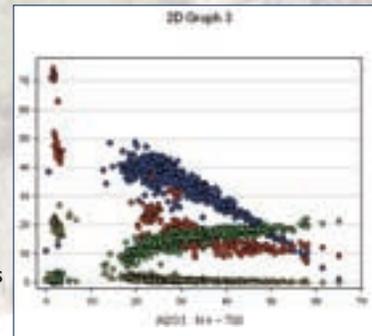
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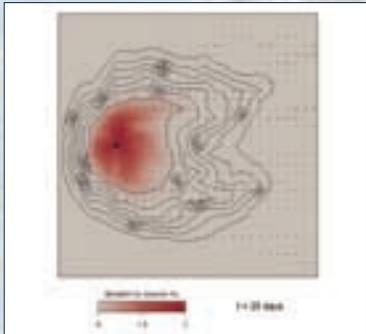
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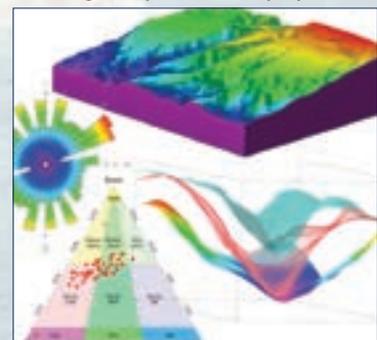
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M.E. Räsänen, J.M. Auri, J.V. Huitti, A.K. Klap, and J.J. Virtasalo

**Cover:** Glacial sequence showing a conformable succession of probable Saalian (Illinoian) upward-fining esker margin deposits, unconformably covered by a probable Late Weichselian till bed (Early Wisconsinan) (gray), which is again unconformably overlain by Holocene shoreface deposits. The site is at Jurva in western Finland and is typical for the small exposures of glaciogenic deposits upon which the regional stratigraphical frameworks for glaciated shield areas have to be based.



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# A shift from lithostratigraphic to allostratigraphic classification of Quaternary glacial deposits

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## ABSTRACT

The bedrock of the northern halves of North America and Europe is covered by Quaternary glacial deposits, forming a surficial overburden that is relatively thin, nonlithified, lithologically variable on a small scale (in terms of grain-size, mineralogy, texture, fabric, structure, and color), and often has a well-preserved depositional topography. These geologically unique characteristics and the fact that the glacial overburden was long considered to be of only restricted economic value have caused it to be treated differently in geological research from the older, regularly lithified strata. Due to the striking geomorphology of these glacial deposits, their investigation has also been incorporated into physical geography research. Thus, the segregation of the Quaternary research community into different schools of geology and geography has created multiple classification approaches and has caused the formal stratigraphic classifications successfully applied in pre-Quaternary geology to be applied less regularly to Quaternary glacial strata. This has led to inefficient use of Quaternary geological data for scientific and socio-economic purposes.

The few currently existing national Quaternary stratigraphic frameworks are based on lithostratigraphy. These are poorly suited for describing deposits in glaciated shield areas in particular; we propose a classification for such areas based on the combined use of allostratigraphic and lithostratigraphic data, with alloformations as the fundamental units and lithostratigraphic units filling out the framework where appropriate. This classification would provide a hierarchical framework for glaciogenic deposits that could potentially support stratigraphic information systems, databases, and digital spatial models more effectively than the traditional lithostratigraphic frameworks.

## INTRODUCTION

A considerable proportion of the developed societies in Europe and North America are located in temperate terrain that was repeatedly glaciated during the cold climatic cycles of the Quaternary Period (the past 2.6 m.y.). It is important for future development in these areas that geologists be able to provide society with more accurate information on the past behavior and distribution of the continental ice sheets and the present structure and nature of the resulting glacial deposits. When this spatial and descriptive stratigraphic information can be correlated with the unusually good decadal and even annual high-

resolution oxygen isotope and other geochemical or varve chronologies available from Quaternary marine, lake, and glacial ice records (Gibbard et al., 2007; Brauer and Negendank, 2004; see Fig. 1), it should be possible to construct local high-resolution chronostratigraphic and diachronic time stratigraphies (cf. Johnson et al., 1997; Karrow et al., 2000). This time stratigraphic information would in turn enable more reliable long-term local climate, glacial, and sea-level scenarios to be provided to assist in resolving the heated worldwide discussion on the anthropogenic and/or natural reasons behind the present global warming (IPCC, 2007) and to inform decisions regarding nuclear waste disposal strategies in glaciated terrains (Heathcote and Michie, 2004).

Many societies are investing heavily in infrastructure to be built on and in deposits belonging to glacial landscapes while at the same time they are dependent on the characteristics of the glaciogenic terrains, including their groundwater and extractive resources. The existence of problematic geotechnical questions, landslide risks, contaminated land, and brown field problems and the relevance of Quaternary deposits to agriculture and forestry are examples of other issues societies face with regard to glaciogenic terrains. Intensified land use in metropolitan areas has caused a particular need to improve control over all types of geotechnical and geochemical data referring to Quaternary deposits, and data management should in any case be improved in order to enhance the sustainable use of land in all types of regional planning (European Union, 2007). This land-use planning would greatly benefit from the existence of practical stratigraphic classification systems and formal stratigraphic frameworks interconnected with flexible national and international geologic databases. The existing traditional soil and lithologic-lithogenetic surface maps clearly no longer provide the level of information needed in detailed planning, construction, and environmental projects (McMillan, 2005). Instead, there is an increased need for three-dimensional (3-D) stratigraphical information.

It has generally been thought that the lithostratigraphic classification used most commonly in pre-Quaternary geology, which is based on lithostratigraphic units, which are “bodies of rocks that are defined and recognized on the basis of their observable and distinctive lithologic properties or combination of lithologic properties and their stratigraphic relations” (Salvador, 1994), cannot be used as successfully in the case of glaciogenic Quaternary deposits, at least not in glaciated shield areas. This is due to the complexity and small-scale variation of the lithologic units in these deposits (cf. Flint, 1957; Eyles et al., 1984; Miall, 1997).

Some developed countries have recently made countrywide efforts to develop lithostratigraphic procedures for classifying their Quaternary glacial and non-glacial overburden, as exemplified by the work of the Deltares (Weerts et al., 2005; Weerts

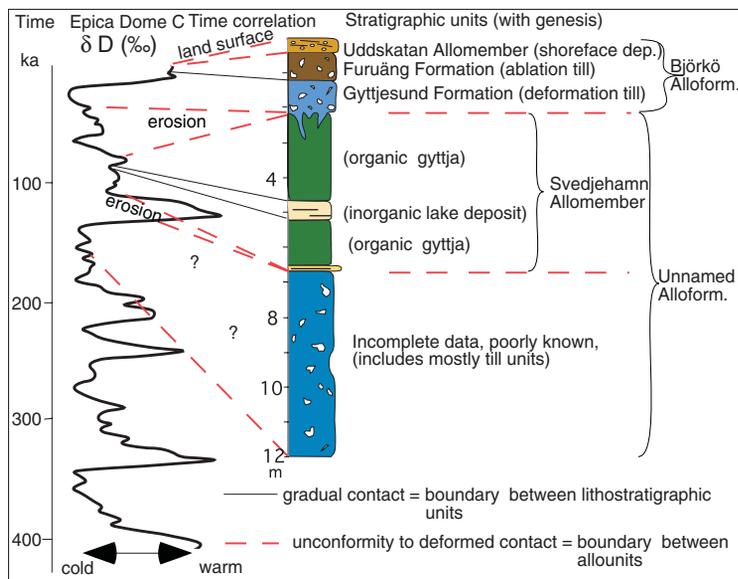


Figure 1. A principal example of correlating stratigraphic units with ice-core geochemical stratigraphy with high-resolution chronology. Stratigraphic units (modified from Auri, 2006) at a location in the central area of the Scandinavian glaciation are tentatively time-correlated with the ice-core chronology from Antarctica (EPICA community members, 2004). The  $\delta D$  (‰) (D is deuterium) values of the EPICA Dome C data are interpreted as reflecting global temperature changes during the past 400 k.y. In this case, the stratigraphic units are interpreted to have deposited in the course of the cool stadials and warmer interstadials. The correlation is rough, and the diachronism of climatic and glacial processes has to be taken into account in these types of correlations. Organic gyttja—organic lake deposit.

and Westerhoff, 2007), the Minnesota State Geological Survey (MGS; Johnson, 2005), and the British Geological Survey (BGS; McMillan, 2005).

But how successfully do the Deltares, MGS, and BGS classifications overcome the problem of high-frequency lithological variation in glaciated terrains? The Deltares and MGS approaches follow a tradition in which lithostratigraphic classification is applied quite freely, so that the lithostratigraphic formations defined in the Deltares classification, for example, represent depositional systems and basin fills, with a great variety of lithologies (Weerts et al., 2005). The Deltares and MGS usages follow the definition of the international guides (Salvador, 1994; North American Commission for Stratigraphic Nomenclature [NACSN], 2005) quite loosely, so that the higher hierarchy subgroups, groups, and supergroups in the Deltares classification are interpretative or geographically determined units and are not always related to the principles of lithostratigraphic classification.

The BGS classification defines a formation in a somewhat stricter manner, and the resulting lithostratigraphic formations are smaller in scale and generally show greater lithologic homogeneity (understood in a more petrographic sense). At the higher subgroup and group levels, the BGS scheme intends to show the lithologic (= petrographic) homogeneity in formations derived from the same provenance areas.

Because unconformities and small-scale lithologic variations are so abundant and are of primary importance in Quaternary glaciogenic deposits (Flint, 1957; Eyles et al., 1983; Miall, 1997), especially in shield areas, a practical approach involving the **combined use of allostratigraphy and lithostratigraphy** (CUAL) is proposed here. The new features in this descriptive CUAL approach are (1) *unconformity-bounded allostratigraphic units are given preference as basic units*, which means that all depositional units within an area will belong to a certain alloformation; and (2) *these allounits are then subdivided into lithostratigraphic or lower-order allounits as appropriate* (Figs. 1 and 4–6). As in sequence stratigraphy (Vail et al., 1977; Gutteridge, 2008) or glacial sequence stratigraphy (Powell and

Cooper, 2002), the unconformity-bounded units are the primary genetic units to be identified, with predictive textural and structural architecture.

#### QUATERNARY STRATIGRAPHY IN GLACIATED TERRAINS

The major reasons Quaternary researchers have had problems applying lithostratigraphy to glaciated terrain deposits can be summarized as follows (cf. Flint, 1957; Eyles et al., 1984; Miall, 1997):

1. *Quaternary glaciogenic deposits often miss the fundamental gross lithologic changes* (in grain-size, mineralogy, texture, fabric, structure, and color), which are more common in older rock series and aid in their lithostratigraphic classification. Quaternary deposits represent shorter periods of time and less fundamental paleoenvironmental changes in the provenance areas or in the post-depositional weathering or diagenesis of the sediments than in older strata.
2. *Minor-scale gross lithological variation and local provenance is common* when the bedrock type varies considerably, and transport distances are generally short in glacial systems (Figs. 2 and 3).
3. *Lithologically similar units can be relatively small in scale, their thicknesses can vary frequently, and the units often occur as isolated deposits*. This is because deposition occurred within laterally migrating, advancing, or retreating zones of glacial deposition, where rapid base-level changes occurred due to glacio-isostasy and/or eustasy or because the sediment input channels changed position laterally along the glacial margin (cf. Flint, 1957; Brookfield and Martini, 1999). These characteristics are especially prominent in the Canadian and Fennoscandian shield areas, where the pre-Quaternary bedrock topography tightly controlled the accommodation space during deposition.
4. Finally, due to the dynamic erosional and depositional processes combined with the repeated pattern of glacial cycles, *unconformities and diastems are very common in Quaternary deposits*, and lithostratigraphy does not use these features as primary classification criteria (Walker and James, 1992; Miall, 1997; NACSN, 2005).

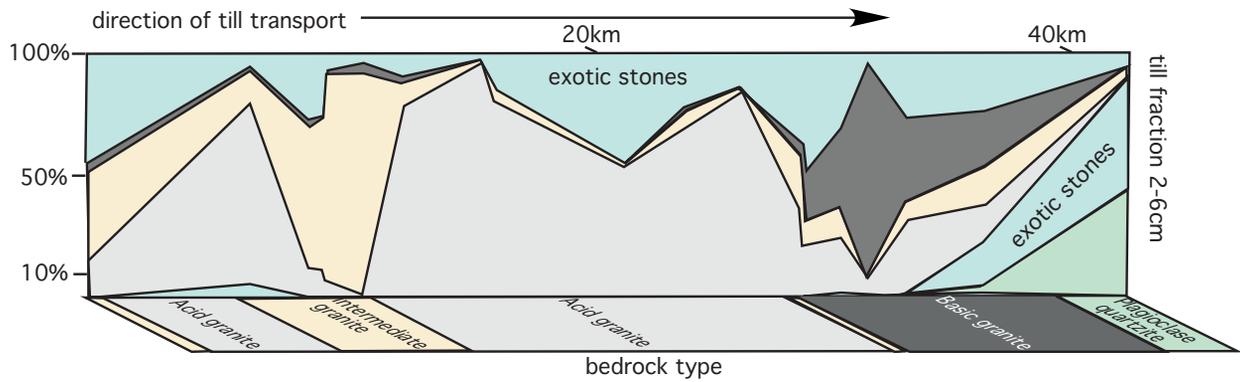


Figure 2. Petrographic variations in the coarse fraction of the Late Weichselian till bed in relation to the underlying Precambrian bedrock type within a 40 km transect parallel to the Late Weichselian ice movement in central Sweden. Only one till bed has been reported within the area. The exotic stone types refer to types that have not been encountered in the bedrock of the transect. Gray—acid granite; tan—intermediate granite; black—basic granite; teal—plagioclase quartzite; blue—exotic stones. Modified from Linden (1975).

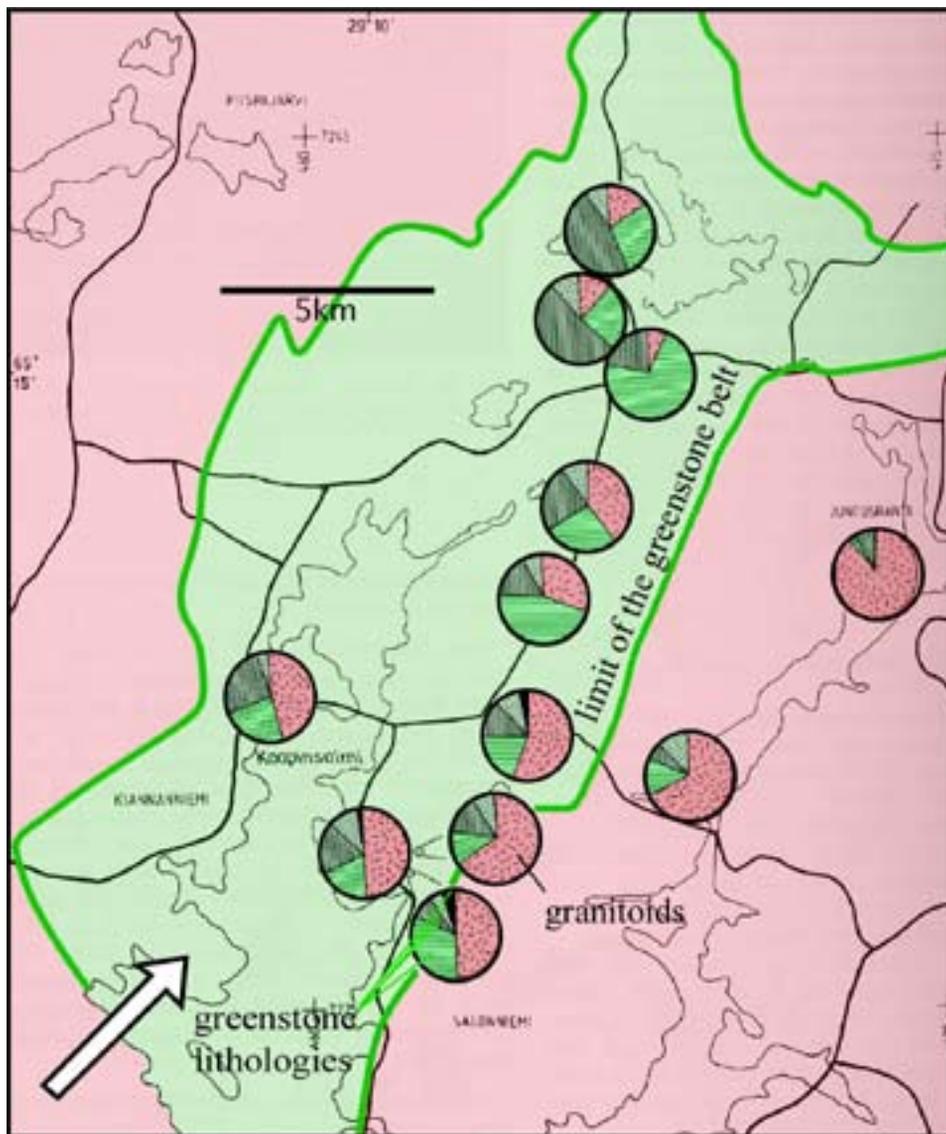


Figure 3. Petrographic variation of the coarse fraction of an unconformity-bound till bed (pie charts) showing the influence of an Archean greenstone belt surrounded by granitoids on the composition of the coarse fraction of the till bed. Arrow shows direction of ice flow during deposition. The studied till bed is the lowermost of the tree unconformity-bound till beds in eastern Finland. Modified from Saarnisto and Peltoniemi (1984).

This leads to a situation in which reasonably homogeneous lithostratigraphic units are often so small in scale that they are not easily mappable (cf. Eyles et al., 1983, 1984; Miall, 1997). This contrasts markedly with the lithostratigraphic classification of most pre-Quaternary rocks, where the units are more broadly representative in time and space.

## DEVELOPMENT OF THE CLASSIFICATION APPROACHES

In order to elucidate the relation of the proposed CUAL classification to the stratigraphic classification systems applied earlier, their backgrounds are briefly reviewed here.

### The Lithologic and Lithogenetic Approach

The most widely applied systems for classifying the Quaternary overburden are based on varying combinations of lithological information (grain-size, mineralogy, color) and the genesis of the surficial (<1 m or >1 m) deposits. The stratigraphic aspect is normally very limited (North American Geologic Map Data Model Science Language Technical Team, 2004; McMillan and Powell, 1999). These classifications give the necessary surficial base data for wide areas, but seldom meet any more demanding scientific or applied needs.

### The Morphogenetic and Morphostratigraphic Approach

Morphostratigraphical schemes have been published by Willman and Frye (1970) and Nystuen (1986), and physical geographers have also traditionally favored this approach. This approach may apply in areas of sediment cover derived from one glacial cycle, but it cannot apply to terrains with deposits from multiple glacial events (cf. Möller, 2006).

### The Lithostratigraphic Approach (*sensu lato*)

At the very beginning of systematic Quaternary research in Canada, Logan (1863) classified Quaternary units into lithostratigraphic formations in a similar manner to the strata from the older geological column. Later, in the late nineteenth and early twentieth centuries, when glacial geology was becoming increasingly segregated from Paleozoic and Precambrian geology (Willman and Frye, 1970), the lithologic and lithogenetic approach and the morphostratigraphic approach described above were developed.

In later years, however, a return to the application of lithostratigraphy occurred. Willman and Frye (1970) presented a systematic classification of the Pleistocene glacial deposits covering the Paleozoic bedrock of Illinois in terms of rock-stratigraphic units (= lithostratigraphic units) to be “defined and recognized on the basis of observable lithology without necessary regard to biological, time, or other types of criteria. They (rock-stratigraphic units) must be sufficiently distinctive to be recognizable by common field and subsurface methods” (p. 40). They added, however, “Once described, a rock-stratigraphic unit may be traced laterally, even though its lithologic character changes gradationally, so long as the integrity of the unit as a continuous body of rock can be recognized” (p. 40). They made this addition in order to amplify their lithostratigraphic classification criteria to meet the changing lithologies in their strata. The members in their scheme are lithologically

distinctive, but most of them do not have the regional continuity to be mappable.

Lithostratigraphic units have been used in abundance to identify Quaternary deposits in the UK. In the 1970s, it was already common practice that lithologically varying units were accepted as formations, and members have come to be used for the lithologically more uniform parts of those formations (cf. Rose and Allen, 1977; Rose and Menzies, 1996). Earlier, Lüttig et al. (1969, p. 35) had proposed that a formation “is to be understood as a document of a genetically uniform sedimentation process, which may have led to the formation of a rock sequence more or less, in some cases even highly differing in single subunits, but of a uniform facies and genetic character.” In this scheme, a member shows “a reasonable lithologic similarity ... so that the strata may belong to one cycle of sedimentation.”

Although mixing genetic interpretation and descriptive criteria, the definitions of Rose and Allen (1977) and Lüttig et al. (1969) for a lithostratigraphic formation and member resemble the more descriptive criteria of Willman and Frye (1970). These definitions can be regarded as the basis for the BGS, Deltares, and MGS stratigraphical frameworks (cf. Rawson et al., 2002).

### Morpho(/Litho)-Stratigraphic Approach

Recently in the UK, Hughes et al. (2005) presented a combined morpho(litho)stratigraphical approach in which the landform morphology was taken as an elemental part of the definition of the lithostratigraphic unit from which the landform was composed. This evidently works well with deposits derived from one glacial cycle but will meet problems when deposits of polygenetic landforms derived from multiple glacial cycles are classified (cf. Möller, 2006).

### The Depositional System Approach

Some Quaternary researchers who have considered lithostratigraphy more strictly have tended to avoid its use, adopting instead the concept of *depositional systems*, for example, to classify their strata (Eyles et al., 1983). A depositional system was originally defined by Fisher and McGowen (1967) as *an assemblage of genetically related facies*.

### Allostratigraphic Approaches

Geologists have always accepted unconformities as the limits between lithostratigraphic formations in pre-Quaternary stratigraphies, although it is the lithological change occurring at an unconformity that has been taken as the defining criterion for delimiting the units (Salvador, 1994).

One of the first researchers to define sedimentary packages that would today be called unconformity-bounded units/allostratigraphic units/synthems (Salvador, 1994) was Caster (1934), who studied the Devonian coastal sequences of Pennsylvania and referred to sequences of differing age as *parvafacies*. Later, Forcotton (1957) spoke of the unconformity-bounded units as *formats* and other synonymous terms, such as the *sequence of facies*, *facies tracts*, *facies families*; the terms *facies suites* of Teichert, the *holosome* of Wheeler, and the concept of *genetic increment of strata* of Bush have also been used (cf. NACSN, 2005, and ref. therein). Chang (1975) developed the

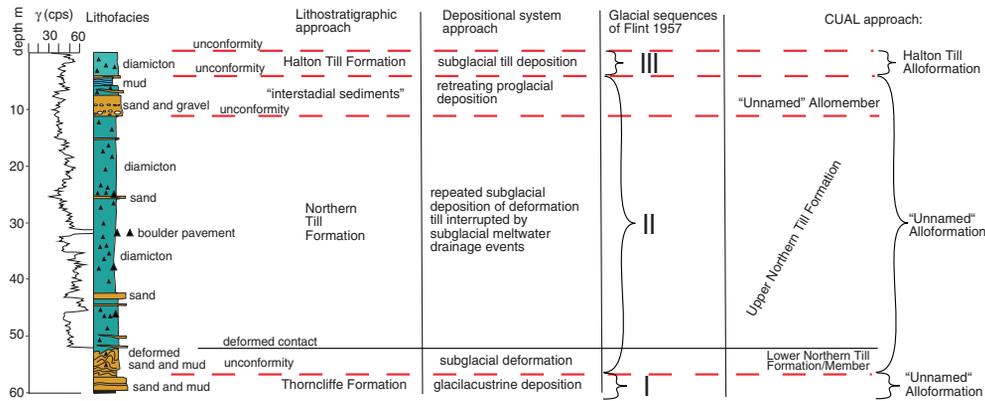


Figure 4. Application of the “combined use of allostratigraphy and lithostratigraphy” (CUAL) approach to a Quaternary glacial sequence in the Toronto area, Canada. The figure demonstrates the basic principles of CUAL classification in relation to the lithostratigraphic, depositional system, and glacial sequence approaches. The figure shows the natural gamma-ray emissions (cps—counts per second) and a simplified lithofacies column together with the positions of the major unconformities and deformed contacts within the section (modified from Boyce and Eyles, 2000), providing a basis for the CUAL classification. This tentative CUAL classification shows only the categories of the units (lithostratigraphic/allostratigraphic) and their hierarchy, with the most obvious possible names, deliberately leaving most of the units unnamed. The allounits are bounded by unconformities, while the lithostratigraphic units are separated by gradational or deformed contacts.

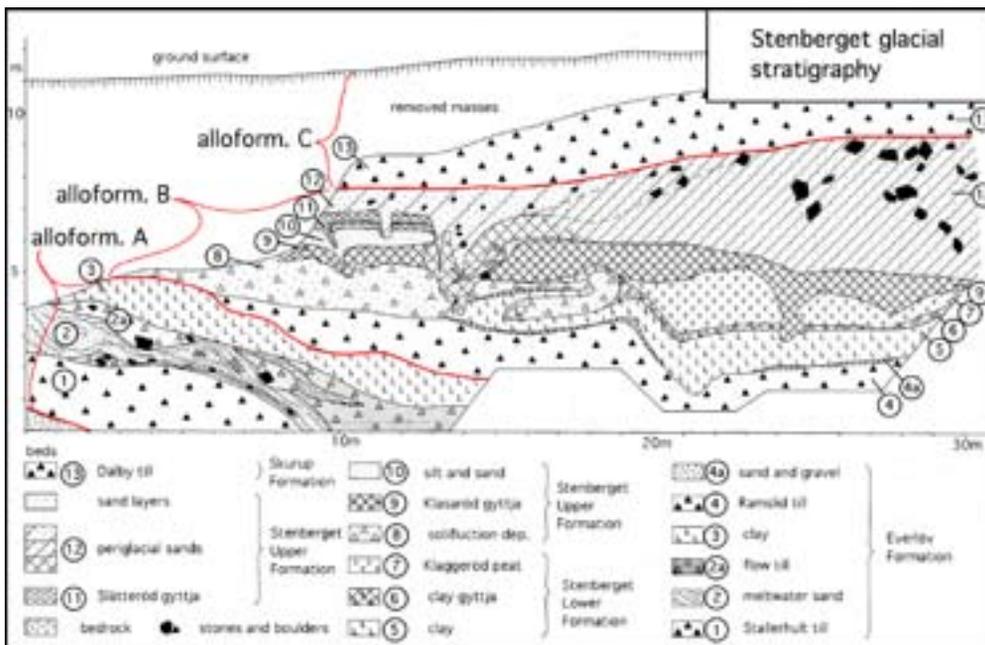


Figure 5. A glacial section located in a Precambrian gneiss-granite bedrock area at Stenberget, southern Sweden, divided into three alloformations (A–C) according to the erosive unconformities at the bases of the three till layers (red lines). Each of these alloformations shows a succession from till to sorted sediments. The tills of the alloformations and the alloformations as such have a better mappability than the sorted units. Modified from Lagerlund (1980), who applied detailed formal and informal lithostratigraphic nomenclature for the units in the section.

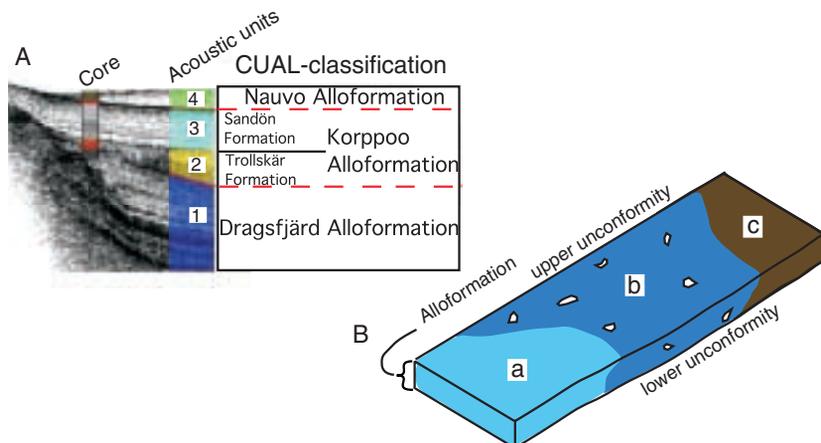


Figure 6. Application of the “combined use of allostratigraphy and lithostratigraphy” (CUAL) approach. (A) Classification of offshore Baltic Sea sediments based on acoustic soundings and core data, modified from Virtasalo et al. (2005). Dashed line—unconformity; continuous line—gradual contact. The Korppoo Alloformation is divided into two lithostratigraphic formations according to the gradual lithological change at their boundary. (B) Hypothetical example of an unconformity-bounded till bed defined as an allostratigraphic formation. The lateral variation in the lithology within the till bed is used to define lithostratigraphic units (a–c) where appropriate.

term *synthem* for the unconformity-bounded units in South Korean Paleozoic-Mesozoic sequences.

Walker and James (1992) stressed the advantages of the allostratigraphic approach in their textbook and presented a number of good case studies of its application. The NACSN (2005) also proposed that allostratigraphic units should be used as formal units, especially in Neogene and Quaternary strata.

Allostratigraphy and lithostratigraphy have in some cases been used together, and Chang (1975) showed how lithostratigraphic formations form elemental parts of his synthems. The term *folgen* has been used recently for unconformity-bounded units in the Triassic sequences of Germany (Lutz et al., 2005), with lithostratigraphic formations constituting parts of these (Nitsch, 2005).

### **Allostratigraphy in Quaternary Deposits**

The allostratigraphic approach has proved easy to apply in the case of fluvial Quaternary deposits, where the unconformities are well developed (Zuchiewicz, 1988; Autin, 1992; Benvenuti, 1997; Straffin et al., 1999; Sinha et al., 2005). Similarly, in offshore studies, the seismic and acoustic profiles reveal the unconformities quite clearly (Hiscott, 2001; Virtasalo et al., 2005). In mountainous regions, the differences in elevation of the glacial deposits have facilitated delimitation of the allostratigraphic units in the field (cf. Hughes et al., 2005, and references therein; Hughes, 2006).

The only work with which we are familiar that combines lithostratigraphic and allostratigraphic approaches is that of Rijdsdijk et al. (2005), who covers the Neogene and Quaternary deposits of the Netherlands. Here the broadly defined lithostratigraphic formations of Weerts and Westerhoff (2007) are included within allostratigraphic formations. This work deals with deposits on the same scale as in sequence stratigraphy. When allostratigraphy has been applied to Quaternary glaciated terrain deposits other than in mountainous regions, it has been used in an interpretative manner (Little, 2005) and not descriptively.

### **The Glacial Sequence Stratigraphic Approach**

It is notable that Flint (1957) already used the term *glacial sequence* to refer to a basic depositional element composed of a till bed and overlying sorted sediments in a Quaternary glaciated terrain, but its use has never been firmly established in the same manner as *sequence* in the sequence stratigraphy context of Vail et al. (1977). However, Powell and Cooper (2002) have recently applied a *glacial sequence stratigraphic* nomenclature to seismically well-studied deposits in temperate continental shelves.

In summary, it can be concluded that all the approaches described—lithostratigraphic classification (*sensu lato*), the morpho(litho)stratigraphic, the depositional system, and the allostratigraphic and glacial sequence stratigraphic approaches—are in practice quite identical *in the way in which they have been applied* to Quaternary deposits, as they mostly define unconformity-bounded genetic units (Fig. 4). Although exceptions always exist, many of the groups and formations defined in the Deltares, BGS, and MGS lithostratigraphic frameworks could often be alternatively, or even more likely, regarded as unconformity-bounded allostratigraphic units

(cf. Chang, 1975; McMillan, 2005) or glacial sequences. They are often delimited by major transgressive and regressive regional unconformities or by unconformities and diastems caused by glacial erosion or shifts in the focus of glaciofluvial deposition. It is simply that the segregation of the research community into different geology/geography schools and traditions with different paradigmatic backgrounds has caused multiple terminologies to develop.

### **The CUAL Approach**

The true nature of the Quaternary depositional units in glaciated shield areas is that they are arranged in unconformity-bounded, lithologically varying packages, so allostratigraphy may be regarded as the most promising descriptive approach for stratigraphic classification (cf. NACSN, 2005). Lithostratigraphy is undoubtedly applicable as well, but it should be used in a stricter manner than in the examples herein.

In the CUAL approach, the allounits are given preference, and the lithostratigraphic units are subordinate to the allostratigraphy. It is in this aspect that the scheme differs from the proposals of the NACSN (2005). This modification in relation to the previous Quaternary classifications may sound purely semantic, but it is important in that lithostratigraphy can now be applied more strictly (Shultz, 1982) to fill in the lithostratigraphically mappable “details” in the allostratigraphic framework. When the present land surface forms the upper bounding surface of a superficial allounit, then the spatial morpho(litho)stratigraphical information can be applied to the delimitation of the unit.

The main principles and characteristics of the CUAL stratigraphic classification are as follows:

1. A preference for defining mappable allostratigraphic formations. These are normally larger than the lithostratigraphic units in glaciated terrains (Figs. 1 and 4–6).
2. When lithologically identifiable, reasonably homogeneous, and mappable lithostratigraphic formations (*sensu stricto*) can be defined within an alloformation, this should be done (Figs. 1, 4, 6A, and 6B).
3. Where appropriate, an entire alloformation can be subdivided into either lithostratigraphic units (formations, members; Figs. 1, 6A, and 6B), lower-rank allostratigraphic units (allomembers), or a combination of these (Figs. 1 and 4).
4. Allomembers or members need not be mappable, but can be. It is accepted that a lithostratigraphic member does not need to be part of a lithostratigraphic formation but can be a part of an alloformation.
5. If an alloformation has such a diverse or chaotic lithology that its subdivision is not reasonable, its internal lithological variation should be broadly described when it is defined.
6. The preference for defining allostratigraphic units means that in cases where a lithologically uniform unit is cut by unconformities, which is less common in glaciogenic terrains, the unit should be named in accordance with the allostratigraphy.
7. The single definition criterion for an allounit should always be its bounding unconformities, the nature of which need to be properly described. The nature of a boundary between allounits may change from that of a clear unconformity to a deformed bed or even a conformable

bed in the same way as a correlative conformity surface in sequence stratigraphy.

## DISCUSSION

Formal stratigraphic classification is a fundamental scientific tool for developing a regional knowledge of any period in Earth's history. For the subfield of Quaternary geology, the selection of stratigraphic classification criteria is as important a paradigmatic decision as was the adoption of sequence stratigraphy for petroleum geology in the 1980s. The CUAL approach proposed here provides a hierarchical classification system for glaciogenic deposits and creates a sound basis for detailed chronostratigraphic and diachronic work (Johnson et al., 1997) in order to improve our understanding of the complicated Quaternary couplings of astronomic forcing, climatic change, and continental glacial dynamics that have determined the distribution and nature of glacial depositional and erosional products.

Although Quaternary glaciated terrain deposits have geologically unique properties, they should be studied using the same type of stratigraphic toolbox as pre-Quaternary strata. The establishment of a stratigraphic framework system using a CUAL approach would require more excavations and surficial drilling as well as wireline geophysics, ground-penetrating radar, shallow seismics, acoustic soundings, and other geophysical methods that are still under development.

Major unconformities may sometimes be difficult to define in unconsolidated glacial-terrain deposits. This may be caused by, for example, multiple glacial scouring, which has created repeated unconformities. Although allostratigraphy and the CUAL approach are intended to be objective and descriptive methods, we have to accept that the definition and hierarchical ranking of unconformities will sometimes include more or less interpretation. In order to place our major regional unconformities, we have to evaluate the importance of (a) the possible changes in lithology, (b) the adjacent lithofacies successions/associations within the section, and (c) the physical expression of an unconformity or its reflection in the geophysical data. Therefore, we cannot completely avoid interpretation if we aim to construct a stratigraphical framework for an area. Ultimately, it may be of less importance what kind of data are used for identifying the presence of an unconformity than what kinds of stratigraphic units one defines and uses as basic units in a formal stratigraphic framework. As sequence stratigraphy has shown, unconformity-bounded units explain geologic history in a better way than lithostratigraphy (e.g., Gutteridge, 2008).

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Weedon Island Preserve, Florida, USA. Photo courtesy Visit St. Petersburg/Clearwater.



Dallas, Texas, USA; photo courtesy Melissa Fenton.



Bug Light Park, Portland, Maine, USA. Photo courtesy Convention and Visitors Bureau of Greater Portland.

## February

- 09 Early registration deadline for the **Southeastern** and **South-Central** Section Meetings.
- 15 Nominations for the Geophysics Division's **George P. Woollard Award** due online at [http://geoscience.unlv.edu/pub/GSA\\_Geop/wollard.html](http://geoscience.unlv.edu/pub/GSA_Geop/wollard.html).
- 15 Applications for the Coal Geology Division's **Antoinette Lierman Medlin Scholarship** are due to Jack C. Pashin, Geol. Survey of Alabama, P.O. Box 869999, Tuscaloosa, AL 35486, USA; fax: +1-205-349-2852; [jpashin@gsa.state.al.us](mailto:jpashin@gsa.state.al.us).
- 17 Early registration deadline for the **Northeastern** Section Meeting.
- 20 Nominations for the Sedimentary Division's **Laurence L. Sloss Award for Sedimentary Geology** are due via e-mail to Paul Link, [linkpaul@isu.edu](mailto:linkpaul@isu.edu).
- 27 Applications due for the **GSA-ExxonMobil Bighorn Basin Field Awards**. See p. 33.
- 28 Nominations for the Coal Geology Division's **Gilbert H. Cady Award** are due. Send three copies of nomination materials to Glen Stracher, East Georgia College, Div. of Science & Mathematics, 131 College Circle, Swainsboro, GA 30401-3643, USA; +1-478-289-2073; [stracher@ega.edu](mailto:stracher@ega.edu).

## March

- 02 Early registration deadline for the **North-Central** Section Meeting.
- 04 Applications to attend the **Penrose Conference**, "Plumes and Their Role in Whole Mantle Convection and Recycling," in Pico, the Azores, are due by e-mail to [penrose2008@els.mq.edu.au](mailto:penrose2008@els.mq.edu.au). Learn more at [www.geosociety.org/penrose/09azores.htm](http://www.geosociety.org/penrose/09azores.htm).
- 12–13 GSA's **Southeastern** Section meets in St. Petersburg, Florida, USA.
- 13 **GSA elections** begin. Learn more at [www.geosociety.org](http://www.geosociety.org).
- 16–17 GSA's **South-Central** Section meets in Dallas, Texas, USA.
- 20 Expressions of interest for the **Field Forum**, "Structure and Neotectonic Evolution of Northern Owens Valley and the Volcanic Tableland, California," are due via e-mail to David Ferrill, [dferrill@swri.org](mailto:dferrill@swri.org).
- 22–24 GSA's **Northeastern** Section meets in Portland, Maine, USA.

- 31 Nominations for the **John C. Frye Environmental Geology Award** are due. Learn more at [www.stategeologists.org/awards\\_honors](http://www.stategeologists.org/awards_honors), or contact GSA Grants, Awards, and Recognition at +1-303-357-1028 or [awards@geosociety.org](mailto:awards@geosociety.org).

## April

- 02 Nominations for the Quaternary Geology and Geomorphology Division's **Don J. Easterbrook Distinguished Scientist Award** and **Farouk El-Baz Award for Desert Research** are due. Send nominations for the Easterbrook award to Marith Reheis, USGS, MS980, Federal Center, P.O. Box 25046, Denver, CO 80225-0046, USA; +1-303-277-1843; [mreheis@usgs.gov](mailto:mreheis@usgs.gov). Nominations for the El-Baz award should go to Paul R. Bierman, Univ. of Vermont, Dept. of Geology, Delehanty Hall, Burlington, VT 05405-0001, USA; +1-802-656-4411; [pbierman@zoo.uvm.edu](mailto:pbierman@zoo.uvm.edu).
- 2–3 GSA's **North-Central** Section meets in Rockford, Illinois, USA.
- 06 Early registration deadline for the **Cordilleran** and **Rocky Mountain** Section Meetings.
- 12 **GSA elections**—ballots must be postmarked or submitted electronically by this date.

## May

- 01 Applications for the **History of Geology Student Award** are due. Learn more at <http://gsahist.org/HoGaward/awards.htm> or contact Jane P. Davidson at [jdhexen@unr.edu](mailto:jdhexen@unr.edu).
- 01 Applications to attend the **Penrose Conference**, "Tectonic Development of the Amerasian Basin," at the Banff Centre, Alberta, Canada, on 4–9 October 2009 are due to Victoria Pease, [vicky.pease@geo.su.se](mailto:vicky.pease@geo.su.se), or Lawrence Lawver, [lawver@utig.ig.utexas.edu](mailto:lawver@utig.ig.utexas.edu).
- 7–9 GSA's **Cordilleran** Section meets in Kelowna, British Columbia, Canada.
- 11–13 GSA's **Rocky Mountain** Section meets in Orem, Utah, USA.
- 11–15 **Penrose Conference**: "Plumes and Their Role in Whole Mantle Convection and Recycling," in Pico, the Azores.
- 26 Last day to sign up for the GSA GeoVentures **"Galapagos Islands—A Place Born of Fire"** teacher trip running 26 June–6 July 2009. See [www.geoventures.org/teachers/2009/Galapagos09.htm](http://www.geoventures.org/teachers/2009/Galapagos09.htm) for more information.



Pierce Lake, Rock Cut State Park, Illinois, USA. Courtesy Rockford Area Convention and Visitors Bureau.



Spring in the south Okanagan Valley, about an hour south of Kelowna, British Columbia. Photo courtesy Robert Young.



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# ROCK STARS

## Israel Cook Russell (1852–1906)

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### BACKGROUND

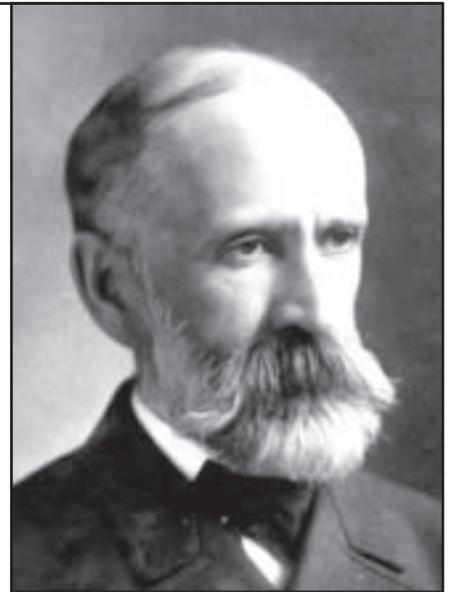
Israel Cook Russell (1852–1906) was one of America's leading early pioneers in geomorphology and glacial geology. He served as a U.S. Geological Survey geologist for most of his career, first full-time and later, after he joined the University of Michigan faculty, as a seasonal employee. He was president of the Geological Society of America in 1906, vice-president of the American Association for the Advancement of Science in 1904, president of the Michigan Academy of Science in 1902, and a member of a host of other alpinist and geographical societies. His research focused on geomorphology, reflecting his interest in surficial processes.

Russell was born in upstate New York in 1852 into a family whose ancestors were early settlers in New England. He earned a bachelor of science and civil engineering degree from the University of the City of New York in 1872 and a master of science degree in 1875. He visited New Zealand in 1874 as a member of the U.S. Transit of Venus Expedition. As no provision was made for work in natural history on this expedition, Russell obtained an appointment as "photographer" and acquired the necessary skills in a hurried course under noted physicist Ernest Rutherford (1871–1937). These skills were put to extensive use the remainder of his life and account for the majority of photographs in his publications. After New Zealand, he joined Columbia University as an assistant professor of geology in 1875.

In 1878, Russell was hired as an assistant geologist on George Montague Wheeler's (1842–1905) U.S. Geographical Survey West of the 100th Meridian, working in Colorado and New Mexico (Gilbert, 1906). In 1880, he was appointed assistant geologist in the newly formed U.S. Geological Survey and aided Grove Karl Gilbert (1843–1918) in studying pluvial Lake Bonneville. During the 1880 field season, Russell traveled alone some 5500 km on horseback through the northern Great Basin, undertaking reconnaissance in a region he was to visit repeatedly throughout his career. He rather liked the wild and, though slight of build, he had the "capacity for sustained effort and endurance," without which his more strenuous explorations would have been impossible (Gilbert, 1906, p. 667).

### PLEISTOCENE GLACIATION AND PLUVIAL LAKES

In 1881, Russell undertook a reconnaissance of both the pluvial Lake Lahontan and Mono Lake (later named pluvial "Lake Russell" in his honor) in the western Great Basin. At its maximum, Lake Lahontan covered 13,500 km<sup>2</sup>, with a maximum depth of 268 m (Russell, 1885). Active faults bound many of the mountain ranges that would have appeared as "peninsulas and islands during the existence of the lake [dividing] its surface into a number of irregular water bodies that were connected by narrow channels" (Russell, 1885, p. 31). In addition to reviewing depositional features characteristic of shorelines, such as terraces, barrier beaches, sea cliffs and deltas, he identified three tufa morphologies—"lithoid" (compact, encrusting, stony), "thinolitic" (orthorhombic prismatic crystals), and "dendritic" (branching, mushroom-shaped)—deposited in succession accompanying lowering lake levels. From tufa deposits, Russell delineated three periods in the history of the lake: the first when the lake filled its basin to within 10 m of the highest tufa, the second when the surface marked a shore line 120 m lower, and the third at an



Israel Cook Russell (courtesy the U.S. Geological Survey photo archives).

intermediate elevation some 70 m below its high stand.

Russell visited the Sierra Nevada in 1881–1883 and demonstrated that small glaciers at the heads of drainages into the Mono Lake basin had been large valley glaciers during the Pleistocene. He mapped the extent of these ancient ice tongues based upon the distribution of drift, usually well defined at lower elevations by lateral and terminal moraines, and noted that "four of the glaciers extended a short distance below the highest of the terraces formed by the ancient lake. ... The proof that the highest stage of the lake followed the maximum extension of the glaciers is thus abundant" (Russell, 1889, p. 369). He also noted the interaction between Sierran glaciers, Mono Lake, and volcanism associated with the range front fault (Russell, 1889, p. 371): "The evidence of late volcanic activity in Mono Valley is furnished by craters and lava flows which are more recent than the former high water stage of the lake and were formed after the last recession of the Sierra Nevada glaciers."

### NORTHERN GREAT BASIN GEOLOGY

Russell undertook reconnaissance mapping of the northwestern part of the Great Basin in 1881 and 1882 and described the fault-block mountains,

volcanic rocks, and playas. He recognized that the young extensional faults crosscut earlier-deformed rocks. First, rocks were plicated and crumpled into anticlinal and synclinal folds, then a second disturbance produced the present topography. He noted that the volcanic rocks are not folded, but are cut by younger faults, and thus are intermediate in age between the two periods of disturbance. The youthfulness of the second disturbance was demonstrated where faults continued through recent alluvial slopes and stream beds.

During his reconnaissance of the northern Great Basin and Columbia Plateau, Russell gave special attention to the genesis and features of plateau basalts. Lava on the Snake River Plain was extruded in two ways: by fissure eruption, which resulted in widespread blanketing sheets with extensive columnar jointing, and by more localized explosive eruptions, which produced cinder cones and a wide variety of volcanic bombs.

### ALASKAN EXPLORATION

In 1890 and 1891, Russell conducted two pioneering explorations of the Mount St. Elias region under the auspices of the U.S. Geological Survey and the National Geographical Society. Landing through the surf at Icy Bay west of Yakutat in 1891, which resulted in the drowning of six men, the expedition attempted to maintain a straight course to Mount St. Elias. From the shores of Icy Bay, Russell and his team of five assistants trekked overland through thick forest to the margin of Malaspina Glacier, braving swift streams, mosquito swarms, and abundant bears. "Reaching the inner border of the forest-covered moraine, we had before us a vast expanse of barren moraine broken by thousands of crevasses, and diversified by pits and hollows holding lakes. Between the lakes rose huge pyramids and spires of ice of the most rugged description, each one sheathed with stones and dirt, which furnished only an insecure foothold" (Russell, 1896, p. 220).

Due to delays and the characteristic inclement weather of the St. Elias Range, Russell never did achieve the



Mount St. Elias from Agassiz Glacier, Yakutat district, Alaska Gulf region, ca. 1892 (photo by Russell, courtesy U.S. Geological Survey photo archives).

summit in 1890. He made a solo attempt on the summit in 1891 but was caught in a storm. To survive, he excavated a tunnel into the snow and made a chamber in which he passed the night. However, he did determine the summit elevation at 5485 m, at that time considered the highest peak in North America. On the second expedition (1896), Russell collected a Quaternary marine fauna preserved among faceted and striated stone-bearing glacial-marine sediments in the Chaix Hills, which rose through Malaspina Glacier to an elevation of ~1000 m, attesting to rapid orogenic uplift.

### MICHIGAN YEARS

As an academician, Russell felt that it was the duty of the university to select the few students of exceptional ability and encourage them to devote their lives to the task of carrying on research in the direction in which they were especially qualified. He wrote four textbooks on lakes, rivers, glaciers, and volcanoes, which he viewed as reading lessons for students of geography and geology. A fifth textbook was a treatise on the geography of North America that included not only coverage of physical and geological features, but also ethnology and political geography. Gilbert (1906, p. 666) wrote that Russell was not a theorist, but was "pre-eminently a scientific observer. His best work was in seeing, recording, and discussing the phenomena of a new field. His observation was sharpened by knowledge of existing theories, but not biased by them."

### REFERENCES CITED

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- Russell, I.C., 1889, The Quaternary history of Mono Valley, California: U.S. Geological Survey Annual Report 8, p. 267–438.
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"Rock Stars" is produced by the GSA History of Geology Division. Editorial Committee: Kennard Bork, Robert Dott\*, Robert Ginsburg, Peter von Bitter, and E.L. (Jerry) Winterer. \*Editor of this article.

# 2008 OEST AWARD RECIPIENTS NAMED

The National Association of Geoscience Teachers (NAGT) has announced their 2008 Outstanding Earth Science Teacher (OEST) Award recipients. These awards are given to outstanding pre-college teachers who have made exceptional contributions to the stimulation of interest in the earth sciences.

The OEST award is administered by The Geological Society of America. For further information, go to [www.geosociety.org/awards/oest.htm](http://www.geosociety.org/awards/oest.htm).

*GSA congratulates these outstanding earth science teachers!*

## SECTION AWARDEES

*No awardees were selected for the Midcontinent, North Central, and Texas sections.*

### CENTRAL SECTION

#### **Teresa Lee Huckleberry**

Indianapolis, Ind., USA  
Indiana School for the Deaf

### EASTERN SECTION

#### **John D. Moore**

Laurel Springs, N.J., USA  
Burlington County Institute of Technology

### FARWEST SECTION

#### **Anna Foutz**

Highland, Calif., USA  
North High School

### NEW ENGLAND SECTION

#### **Gregg Wachtelhausen**

Hingham, Mass., USA  
Hingham Middle School

### PACIFIC-NORTHWEST SECTION

#### **Jeff Hashimoto**

Ellensburg, Wash., USA  
Ellensburg High School

### SOUTHEAST SECTION

#### **Tina Coleman**

Martin, Tenn., USA  
Martin Middle School

### SOUTHWEST SECTION

#### **Suzi Shoemaker**

Casa Grande, Ariz., USA  
Casa Verde High School

## STATE AWARDEES

*(in alphabetical order by state)*

#### **Jennifer Grant**

Autaugaville, Alabama, USA

#### **Adam Low**

Cordova, Alaska, USA

#### **Kathryn Bylsma**

West Chapel, Florida, USA

#### **Rebecca E. Chunn**

Brunswick, Georgia, USA

#### **Robert Walker**

Boise, Idaho, USA

#### **Kelda N. Hutson**

Murdelein, Illinois, USA

#### **Teresa Lee Huckleberry**

Indianapolis, Indiana, USA

#### **Wendy DeMers**

New Orleans, Louisiana, USA

#### **Susan E.P. Phillips**

Laytonsville, Maryland, USA

#### **Chris Bolhuis**

Hudsonville, Michigan, USA

#### **John D. Moore**

Laurel Springs, New Jersey, USA

#### **Christopher Visco**

Patchogue, New York, USA

#### **Robert Greenberg**

Chapel Hill, North Carolina, USA

#### **Jamie Rumage**

Corvallis, Oregon, USA

#### **Richard W. Schmidt**

Broomall, Pennsylvania, USA

#### **Dina Ledford**

Summerville, South Carolina, USA

#### **Tina Coleman**

Martin, Tennessee, USA

#### **Christopher Kaznosky**

Weyers Cave, Virginia, USA

#### **Jeff Hashimoto**

Ellensburg, Washington, USA

#### **Tiffany Litton**

Weston, West Virginia, USA

## State Awards Honorable Mention Certificates

#### **Charles Simer**

Mt. Vernon, Illinois, USA

#### **Jim Rock**

Golden Valley, Minnesota, USA



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# CORDILLERAN

105th Annual Meeting  
Kelowna, British Columbia, Canada

7–9 May 2009



Kelowna, British Columbia, Canada. Photo courtesy Tourism Kelowna–SATW.

## Welcome

The Cordilleran Section of The Geological Society of America will hold its 2009 annual meeting on the University of British Columbia–Okanagan (UBC-O) campus in Kelowna, south-central British Columbia. The UBC-O Earth and Environmental Sciences Program is pleased to serve as host.

Kelowna, surrounded by lakes, mountains, and vineyards, is a geographic and geologic paradise. Located in the northern end of the North American extensional regions on the interior plateau and situated between major mountain belts, Kelowna and the Okanagan Valley offer many excellent field trip opportunities. The accessible geology includes Proterozoic basement complexes, Eocene and Miocene volcanic-plutonic complexes, and Quaternary glacial and deglacial landforms and sediments. Kelowna is also within a few hours' drive of the Burgess Shales area.

### CONTACT INFORMATION

Find up-to-the-minute information at [www.geosociety.org/meetings/](http://www.geosociety.org/meetings/). If you have questions or have special requirements, contact the general meeting co-chairs, Rob Young, +1-250-807-9523, [robert.young@ubc.ca](mailto:robert.young@ubc.ca), and Craig Nichol, +1-250-807-8087, [craig.nichol@ubc.ca](mailto:craig.nichol@ubc.ca).

### PASSPORTS

Passports *are required* to fly into Canada. Obtaining passports may be a lengthy process; therefore, it's important to begin the passport application process immediately.

### REGISTRATION

**Early Registration Deadline:** 6 April 2009

**Cancellation Deadline:** 13 April 2009

Please register online via link at [www.geosociety.org/meetings/](http://www.geosociety.org/meetings/). Early registration qualifies for lower rates, but on-site registration will be available during the meeting. Payment with check must be drawn on a U.S. bank; no Canadian checks will be accepted. Both Canadian and U.S. currency will be accepted for on-site registration.

### REGISTRATION FEES (all fees are in U.S. dollars)

	Early		Standard	
	Full mtg.	One day	Full mtg.	One day
Professional Member	\$180	\$120	\$210	\$130
Professional Nonmember	\$200	\$140	\$230	\$150
Student Member	\$75	\$60	\$90	\$70
Student Nonmember	\$100	\$75	\$130	\$90
K–12 Teacher or Student	\$50	\$30	\$55	\$35
Guest	\$60	n/a	\$70	n/a
Field Trip or Workshop only	n/a	\$40	n/a	\$50

### On-Site Registration and Registration Packet Pick-up Schedule

*Gym Building, University of British Columbia–Okanagan, Kelowna, British Columbia, Canada*

Wed., 6 May	4–7 p.m.
Thurs., 7 May	7:30 a.m.–4:30 p.m.
Fri., 8 May	7:30 a.m.–4:30 p.m.
Sat., 9 May	7:30–11 a.m.

### ACCOMMODATIONS

GSA and UBC-O are committed to providing access to all individuals interested in attending. Please indicate any special requirements when you register. Reference the GSA Cordilleran Section Meeting when making reservations at any of the following:

**Campus:** UBC-O has made a block of campus townhouse apartments available for those wishing to stay on-site. Cost: CA\$50 plus tax. Contact UBC-O Conferences and Accommodation, 3180 University Way, Kelowna, BC, V1V 1V8; +1-877-589-6073, +1-250-807-8055, fax: +1-250-807-9157; [www.okanagan.ubconferences.com](http://www.okanagan.ubconferences.com).

**The Coast Capri Hotel:** 1171 Harvey Ave., Kelowna, BC, V1Y 6E8; +1-250-860-6060, fax: +1-250-860-9664; www.coasthotels.com. Cost: CA\$135–CA\$175 plus tax depending on room type. Reservation deadline: 6 April.

**Sandman Hotel Kelowna:** 2130 Harvey Ave., Kelowna, BC, V1Y 6G8; +1-888-526-1988, fax: +1-250-860-7377; www.sandmanhotels.com. Cost: CA\$109 single/CA\$119 double, plus tax. Use conference code 241930. Reservation deadline: 15 April.

**Kelowna Inn:** 1070 Harvey Ave., Kelowna, BC, V1Y 8S4; +1-800-667-6133, +1-250-762-2533, fax: +1-250-868-3874; www.kelownamotorinn.com. Cost: CA\$79 single/CA\$89 double, plus tax. Reservation deadline: 15 April.

## TECHNICAL PROGRAM

Inquiries about the technical program can be directed to Rob Young, robert.young@ubc.ca.

### Theme Sessions

1. **Paleozoic Paleogeography of Cordilleran Terranes.** JoAnne Nelson, British Columbia Geological Survey, joanne.nelson@gov.bc.ca; Maurice Colpron, Yukon Geological Survey, mcolpron@northwestel.net.
2. **Effective Geoscience Education Using Innovative Models in Google Earth.** Declan Depaor, ddepaor@odu.edu; Steve Whitmeyer.
3. **Mid- and High-Latitude Quaternary Paleolimnological Research in Western North America.** Scott W. Starratt, U.S. Geological Survey, sstarrat@usgs.gov; Ian Walker, Univ. of British Columbia–Okanagan, ian.walker@ubc.ca.
4. **Assessing and Developing the Water Resources of Inter-Basin Valleys.** Craig Nichol, Univ. of British Columbia–Okanagan, craig.nichol@ubc.ca; Brian Smerdon, brian.smerdon@gmail.com.
5. **Subglacial Environments and Landforms.** D. Sjogren, Univ. of Calgary, sjogren@ucalgary.ca; John Shaw, Univ. of Alberta, john.shaw@ualberta.ca.
6. **Extensional Tectonics in the Cordillera.** Carrie Whitehill, Stanford, cwhitehill@gmail.com; Julie Fosdick, Stanford.
7. **Recent Developments in Paleontology.** Paul Johnson, Mount Royal College, pajohnson@mtroyal.ca.
8. **Terroir, Wine, and Geology.** L.D. Meinert, Smith College, lmeinert@smith.edu; R.W. Macqueen, Geological Survey of Canada.

9. **Geoscience Framework for Metallogeny in the Southern Cordillera.** R.G. (Bob) Anderson, Geological Survey of Canada, boanders@nrcan.gc.ca.
10. **Pulling Apart the Cordilleran Orogen: Tectonic and Magmatic Processes Revealed within Extensional Terranes.** Dan Gibson, Simon Fraser Univ. (SFU), hdgibson@sfu.ca; Derek Thorkelson, SFU; Sarah Brown, SFU.
11. **Rivers, Humans, and Fish: River Morphology and Ecohydraulics.** Leif Burge, Okanagan College, lburge@okanagan.bc.ca.

## FIELD TRIPS

Direct inquiries to the field trip committee co-chairs, Craig Nichol, craig.nichol@ubc.ca, and John Greenough, john.greenough@ubc.ca. Find up-to-the-minute details at www.geosociety.org/meetings/.

1. **Geological Highlights, Terroir, and Wines of the Okanagan Valley.** Mon.–Wed., 4–6 May. Robert Fulton, Geological Survey of Canada (GSC), retired, robert\_fulton@telus.net; Patricia Bowen, Pacific Agri-Food Research Centre (PARC); Andrew Okulitch, GSC emeritus; Scott Smith, PARC.
2. **Highland Valley District.** Tues.–Wed., 5–6 May. Bob Anderson, Geological Survey of Canada, boanders@nrcan.gc.ca.
3. **Tertiary Volcanism in the B.C. Interior: Calderas, Domes, Plateaus.** Tues.–Wed., 5–6 May. Neil B. Church, nchurch@shaw.ca.
4. **Late Quaternary Landscapes of the Central Okanagan Basin.** Wed., 6 May. Skye Thomson, Univ. of British Columbia–Okanagan, skye.thomson@gov.bc.ca.
5. **Tour of CF Mineral Research.** Thurs., 7 May. Free—must register to attend. Charles Fipke, CF Minerals Research Ltd.
6. **Water Contributions to the Channeled Scablands from the Cordillera.** Sat.–Wed., 9–13 May. John Shaw, Univ. of Alberta, john.shaw@ualberta.ca; Darren Sjogren, Univ. of Calgary, sjogren@ucalgary.ca; Rob Young, Univ. of British Columbia, robert.young@ubc.ca.
7. **Effects of Channelization on Rivers.** Sun., 10 May. Leif Burge, Okanagan College, lburge@okanagan.bc.ca; Norman Corbett, Okanagan College, ncorbett@okanagan.bc.ca.

Squally Point, Okanagan Lake, British Columbia, Canada. Photo courtesy Robert Young.



8. **Geoarchaeology in the Southern Interior B.C. Plateau Culture Area.** Sun.–Mon., 10–11 May. James Baker, Okanagan Univ. College (retired), [ajwbaker@shaw.ca](mailto:ajwbaker@shaw.ca); Dan Bruce, Univ. of British Columbia–Okanagan (UBC-O); John Greenough, UBC-O, [john.greenough@ubc.ca](mailto:john.greenough@ubc.ca).
9. **Mount Stephen: Low Level Equivalents to the Burgess Shales.** Sun.–Mon., 10–11 May. Paul Johnston, Mt. Royal College, [pajohnston@mtroyal.ca](mailto:pajohnston@mtroyal.ca).
10. **The Okanagan Valley Fault System, An Early Tertiary Extensional Collapse.** Sun.–Mon., 10–11 May. Cost: US\$300. Min.: 10; max.: 30. Dan Gibson, Simon Fraser Univ. (SFU), [hdgibson@sfu.ca](mailto:hdgibson@sfu.ca); Derek Thorkelson, SFU; Sarah Brown, SFU.

## WORKSHOPS

1. **Ground Penetrating Radar.** Wed., 6 May, 8 a.m.–5 p.m. Cost: US\$223. Min.: 15; max.: 30. Greg Johnson, Sensors and Software, Mississauga, Ontario, [gjb@sensoft.ca](mailto:gjb@sensoft.ca).
2. **Helping K–12 Teachers Explore GSA Geoscience Resources.** *Cosponsored by GSA Education & Outreach and the GSA Education Committee.* Fri., 8 May, 8–11 a.m. Free—must register to attend. Refreshments included. Min.: 5; max.: 20. Chris McLelland, GSA, [cmcllland@geosociety.org](mailto:cmcllland@geosociety.org).

## OPPORTUNITIES FOR STUDENTS

### Mentoring Programs

1. **Roy J. Shlemon Mentor Program in Applied Geoscience.** *Sponsored by the GSA Foundation.* **Thurs., 7 May,** 11:30 a.m.–12:30 p.m. *and* 12:30–1:30 p.m. This is a chance for students to enjoy a FREE lunch and discuss career opportunities and challenges with professional geoscientists from multiple disciplines. Learn more at [www.geosociety.org/mentors/shlemon.htm](http://www.geosociety.org/mentors/shlemon.htm).
2. **The John Mann Mentors in Applied Hydrogeology Program.** *Sponsored by the GSA Foundation.* Fri., 8 May, 11:30 a.m.–1:00 p.m. This event gives students and recent graduates with an interest in applied hydrogeology or hydrology as a career an opportunity to interact and network with professionals practicing in these fields of interest over a FREE lunch. Learn more at [www.geosociety.org/mentors/mann.htm](http://www.geosociety.org/mentors/mann.htm).

### Volunteering

**Deadline to Volunteer:** 1 March 2009

The local committee and section officers of GSA's Cordilleran Section are pleased to offer student volunteers free registration for the meeting in return for ~6 hours of work. Contact Rob Young, [robert.young@ubc.ca](mailto:robert.young@ubc.ca), for more information.

### Travel Grants

**Deadline to Apply:** 6 April 2009

Students must be Cordilleran Section members, currently enrolled, and registered for the meeting in order to apply for support. Find information and an application at [www.geosociety.org/sectdiv/cord/](http://www.geosociety.org/sectdiv/cord/). If you have questions, contact Cordilleran Section secretary Joan Fryxell at +1-909-880-5311 or [jfryxell@csusb.edu](mailto:jfryxell@csusb.edu).

### Student Field Trip Grants

Students may also apply for 50% grants on field trip fees. Go to [www.geosociety.org/sectdiv/cord/](http://www.geosociety.org/sectdiv/cord/) to apply.

### GUEST ACTIVITIES

Kelowna is quickly becoming known worldwide as a major tourist attraction because of its close proximity to superior venues for outdoor activities and for its high-quality wines and restaurants. It is surrounded by freshwater lakes that provide recreational opportunities in spring and summer, and boat rentals and/or charters are available. The Spring Wine Festival will coincide with the conference. Wine tasting tours can be undertaken independently or through any of several local charter services, which will also provide a vehicle and informed interpretation.



# ROCKY MOUNTAIN

61st Annual Meeting  
Utah Valley University, Orem, Utah, USA

11–13 May 2009

## REGISTRATION

**Early Registration Deadline:** 6 April 2009

**Cancellation Deadline:** 13 April 2009

## REGISTRATION FEES (all fees are in U.S. dollars)

	Early		Standard	
	Full mtg. One day		Full mtg. One day	
Professional Member	\$140	\$80	\$170	\$100
Professional Nonmember	\$160	\$110	\$190	\$140
Professional Member 70+	\$75	\$45	\$100	\$65
Student Member	\$45	\$35	\$65	\$55
Student Nonmember	\$55	\$45	\$75	\$65
K–12 Teacher	\$45	\$30	\$55	\$40
Guest or Spouse	\$30	\$15	\$40	\$25
Field Trip or Short Course Only	n/a	\$30	n/a	\$30

## On-Site Registration and Badge Pickup Schedule

Utah Valley University, Orem, Utah, USA

Sun., 10 May	4–8 p.m.
Mon., 11 May	7:30 a.m.–4 p.m.
Tues., 12 May	7:30 a.m.–4 p.m.
Wed., 13 May	7:30 a.m.–10 a.m.

## ACCOMMODATIONS

Blocks of rooms have been reserved for attendees at the following hotels. Attendees should call the hotel directly to make reservations and reference the 2009 GSA Rocky Mountain Section Meeting to get the group rate.

**Hampton Inn & Suites**, 851 West 1250 South, Orem, UT 84058, USA, +1-801-426-8700; standard room: \$104+tax.

**Comfort Inn & Suites**, 427 W. University Pkwy, Orem, UT 84058, USA, +1-801-431-0405; standard room: \$79.99+tax.

**LaQuinta Inn & Suites**, 521 W. University Pkwy, Orem, UT 84058, USA, +1-801-226-0440; standard room: \$89+tax.

## TECHNICAL SESSIONS

**Abstract Deadline:** 10 February 2009

### Stratigraphy, Sedimentology, Paleontology

- Neoproterozoic Geology of the Rocky Mountains.** Paul Link, Idaho State Univ., linkpaul@isu.edu; Carol Dehler, Utah State Univ., chuaria@cc.usu.edu.
- New Developments and Discoveries in Paleozoic Stratigraphy and Paleontology in the Rocky Mountains and Basin and Range.** Scott Ritter, Brigham Young Univ., scott\_ritter@byu.edu; Forest Gahn, Brigham Young Univ.–Idaho, gahnf@byui.edu.
- Mesozoic Paleontology, Sedimentology, and Geochronology of the Rocky Mountains and Colorado Plateau.** Brooks Britt, Brigham Young Univ., brooks\_britt@byu.edu.

### Hydrology, Surficial Geology, and Engineering Geology

- Hydrologic Studies in the Basin and Range and Rocky Mountains.** Lucy Jordan, Utah Geological Survey, lucyjordan@utah.gov.



Thistle Landslide, which formed in 1983 during an unusually wet spring, in Spanish Fork Canyon near Provo/Orem, Utah, USA. Photo by B. Kowallis.

## *Reaching for Greater Heights: Geology in the Rocky Mountains*

The 2009 meeting of the Rocky Mountain Section of GSA will be held in the new library on the Utah Valley University (UVU) campus. The library, recognized by Utah Governor Jon Huntsman Jr. as the most energy-efficient building in the Utah higher education system, features large, comfortable open spaces, sweeping views of the Wasatch Range and Utah Valley, and a full-service café. The fastest growing institute of higher learning in Utah, UVU is within easy walking distance of hotels and restaurants.

## CONTACT INFORMATION

Find up-to-the-minute meeting information at [www.geosociety.org/meetings/](http://www.geosociety.org/meetings/). If you have questions or special requirements, please contact the general meeting co-chairs, Bart Kowallis, +1-801-422-2467, bkowallis@byu.edu, and Daniel Horns, +1-801-863-8582, hornsda@uvu.edu.

5. **Getting a Better Handle on the “Dirt” Covering the Bedrock—Mapping and Dating of Surficial Deposits.** Tammy Rittenour, Utah State Univ., tammy.rittenour@usu.edu.
6. **Quaternary Tectonics and Earthquake-Hazard Characterization in the Rocky Mountain Region.** Christopher B. DuRoss, Dept of Geology & Geophysics, Univ. of Utah, cbduross@hotmail.com; Ivan Wong, URS Corp., ivan\_wong@urscorp.com.
7. **Geologic Hazards in the Rocky Mountain Region and Their Impacts on Development: A Tribute to the Career of Gary Christensen.** Danny Horns, Utah Valley Univ., hornsda@uvsc.edu.

#### **Structure and Tectonics**

8. **Compression and Extension—Thrusts and Normal Faults and Their Interplay in the Rocky Mountains and Basin and Range.** Adolph Yonkee, Weber State Univ., ayonkee@weber.edu.
9. **Contributions from Geophysics to Better Understanding the Structure and Tectonics of the Western United States.** John McBride, Brigham Young Univ., john\_mcbride@byu.edu.

#### **Energy and Economic Geology**

10. **Energy Resources and Developments in the Rocky Mountain Region.** Michael Vanden Berg, Utah Geological Survey, mvandenber@mines.utah.edu; Bill Keach, Brigham Young Univ., bill\_keach@byu.edu.
11. **Ore Deposits in the Great Basin and Rocky Mountains.** Ken Krahulec, Utah Geological Survey, kenkrahulec@utah.gov.
12. **Industrial Mineral Deposits of the Rocky Mountain Region.** Bryce Tripp, Utah Geological Survey, brycetripp@utah.gov.

#### **Igneous and Metamorphic Rocks**

13. **Magmatism from the Mesozoic to the Present in the Great Basin and Colorado Plateaus: A Tribute to the Career of Myron G. Best.** Eric Christiansen, Brigham Young Univ., eric\_christiansen@byu.edu.
14. **New Developments in Understanding Metamorphic Rocks in the Rocky Mountains and Great Basin.** Bill Dinklage, Utah Valley Univ., dinklawi@uvsc.edu; Mark Colberg, Southern Utah Univ., colberg@suu.edu.

#### **Other Theme Sessions**

15. **Geologic Mapping Supported by EDMAP and STATEMAP in the Rocky Mountains Region.** Bart Kowallis, Brigham Young Univ., bkowallis@byu.edu; Grant Willis, Utah Geological Survey, grantwillis@utah.gov.
16. **Geological Studies in National Parks and Monuments of the Rocky Mountains Region.** Paul Anderson, consulting geologist, paul@pbageo.com.
17. **Geoinformatics.** Walt Snyder, Boise State Univ., wsnyder@boisestate.edu.
18. **Geology and Public Policy in the West.** Christine Turner, U.S. Geological Survey, cturmer@usgs.gov.
19. **Undergraduate Research (Posters).** *Cosponsored by the Council on Undergraduate Research.* Bill Dinklage, Utah Valley Univ., dinklawi@uvsc.edu.

#### **FIELD TRIPS**

##### **Pre-Meeting**

1. **Hot Springs of Utah Valley and the Wasatch Range.** Sun., 10 May, 8 a.m.–6 p.m. Cost: US\$50. Max.: 25. Steven H. Emerman, Utah Valley Univ.

This trip includes visits to hot springs in Saratoga Springs, Diamond Fork Canyon, Spanish Fork Canyon,

Early Jurassic strata in Capitol Reef National Park at sunset, 2007. Photo by B. Kowallis.



and Wasatch Mountain State Park, with a discussion of recent research on the arsenic cycle in hot springs. At Wasatch Mountain State Park, we will see 70-ft-thick deposits of calcareous tufa along with both flowing hot springs and hot pots.

### During the Meeting

2. **Behind the Scenes at the Museum of Paleontology.** Tues., 12 May, 1–5 p.m. Cost: US\$15. Max.: 30. Brooks Britt, Brigham Young Univ. (BYU), brooks\_britt@byu.edu; Rod Scheetz, BYU, rod\_scheetz@byu.edu.

Participants will experience preparing bones, get an introduction to the taphonomy of select quarries, and learn how global information systems (GIS) are used to better map and analyze bone locations in quarries.

### Post-Meeting

3. **Geologic Hazards of the Southern Wasatch Front.** Thurs., 14 May, 8 a.m.–6 p.m. Cost: US\$60. Max.: 25. Christopher DuRoss, Utah Geological Survey, cbduross@hotmail.com.

This trip focuses on the most significant geologic hazards expressed along the southern Wasatch Front, from about Lehi to Levan. We will examine surface faulting related to large prehistoric earthquakes on the Wasatch fault zone, discuss the results of paleoseismic trenching studies, observe recent fire-related debris flows and risk-reduction measures, and examine the morphologies and damaging effects of active landslides.

4. **Tectonics and Stratigraphy of the Western Colorado Plateau.** Three-day trip, Thurs.–Sat., 14–16 May. Cost: US\$370. Max.: 24. Bill Keach, Brigham Young Univ. (BYU), bill\_keach@byu.edu; Tom Morris, BYU, tom\_morris@byu.edu; Scott Ritter, BYU, scott\_ritter@byu.edu.



Mount Timpanogos, the second highest mountain in Utah's Wasatch Range (11,749 ft [3,582 m]), in May 2008. View from Provo, Utah, near the Rocky Mountain Section Meeting site in Orem, Utah, USA. Photo by B. Kowallis.

This robust field trip will visit and study classic Utah exposures of fluvial, shoreline, eolian, and carbonate sediments within Sevier and Laramie structures and the transition between two of North America's great geologic provinces, the Colorado Plateau and the Basin and Range.

5. **Classic Geology of the Central Wasatch Mountains: Almost Two-Billion Years of Geologic History.** Two-day trip, Thurs.–Fri., 14–15 May. Departing 8 a.m. Thursday; returning 6 p.m. Friday. Cost: US\$170. Max.: 38. Grant Willis, Utah Geological Survey, grantwillis@utah.gov; Robert Biek, Utah Geological Survey, bobbiek@utah.gov; Mark Milligan, Utah Geological Survey, markmilligan@utah.gov.

This trip will highlight the geologic history of the central Wasatch Mountains between Salt Lake City and Provo, traveling north and east with stops at Cedar Hills, Alpine City, the eastern Traverse Mountains, the G.K. Gilbert geologic park at the mouth of Little Cottonwood Canyon, Big Cottonwood Canyon, Park City, Heber Valley, the Keetley volcanics at the Jordanelle Dam, the Midway hot springs, the Charleston-Nebo thrust near Deer Creek, lower Provo Canyon, the Indian Hills subdivision landslide, and Rock Canyon.

6. **Geology of the Kennecott Open-Pit Mine.** Thurs., 14 May, 8 a.m.–6 p.m. Cost: US\$40. Max.: 22. David Simon, Simon Bymaster Inc., david@sbigeo.com; Geoff Bedell, Kennecott Utah Copper Corp.

This trip addresses the engineering, geologic, and mining aspects of operating one of the largest open-pit copper mines in the world and includes entering the bottom of the pit. Topics covered: the geology of the ore deposit, history of mining activities, slope stability, engineering geology, ore control, groundwater and surface-water control, and blasting techniques.

## OPPORTUNITIES FOR STUDENTS

### Mentor Programs

Questions? Contact Jennifer Nocerino, jnocerino@geosociety.org.

#### **Roy J. Shlemon Mentor Program in Applied Geoscience.**

*Sponsored by the GSA Foundation.* Mon., 11 May, 11:30 a.m.–1 p.m. This is a chance for students to enjoy a FREE lunch and discuss career opportunities and challenges with professional geoscientists from multiple disciplines. Learn more at [www.geosociety.org/mentors/shlemon.htm](http://www.geosociety.org/mentors/shlemon.htm).

#### **The John Mann Mentors in Applied Hydrogeology Program.**

*Sponsored by the GSA Foundation.* Tues., 12 May, 11:30 a.m.–1 p.m. This event gives students and recent graduates with an interest in applied hydrogeology or hydrology as a career an opportunity to interact and network with professionals practicing in these fields of interest over a FREE lunch. Learn more at [www.geosociety.org/mentors/mann.htm](http://www.geosociety.org/mentors/mann.htm).

### Travel Grants

**Deadline to apply:** 6 April 2009

Students must be Rocky Mountain Section members, currently enrolled, and registered for the meeting in order to apply for support. Find information and an application via a link at [www.geosociety.org/sectdiv/](http://www.geosociety.org/sectdiv/).

# 2009 Section Meeting Mentor Programs

*Missed the annual meeting  
mentor programs?*

*Didn't want them to end?*



Plan now to attend one or more of the following mentor luncheons at your 2009 Section Meeting.

## MEET YOUR CAREER MENTORS

Chat one-on-one with practicing geoscientists. Our quality group of volunteer mentors will answer your questions and share insights on how to get a job after graduation. Space for these events is limited, so plan to arrive early. If you have questions, please contact Jennifer Nocerino, [jnocerino@geosociety.org](mailto:jnocerino@geosociety.org). *Both programs are sponsored by the GSA Foundation.*

## DESCRIPTIONS

### **Roy J. Shlemon Mentor Program in Applied Geoscience**

This luncheon provides an occasion for students to discuss career opportunities and challenges with professional geoscientists from multiple disciplines. Students will receive tickets for this FREE lunch in their meeting registration packets.

### **John Mann Mentors in Applied Hydrogeology Program**

This event presents opportunities for students and recent graduates interested in a career in applied hydrogeology or hydrology to network with practicing professionals. Whether you've already decided to head down the hydro career path or would just like to know more about career options, this luncheon is for you! Students will receive a ticket for this focused, small-scale event and FREE lunch in their meeting registration packets.



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## **SOUTHEASTERN**

St. Petersburg, Florida, USA

### **Shlemon Mentor Program Luncheons**

Thurs., 12 March, 11:30 a.m.–12:30 p.m.  
**and** 12:30–1:30 p.m.

### **Mann Mentors in Applied Hydrogeology Luncheon**

Fri., 13 March, 11:30 a.m.–1 p.m.

## **SOUTH-CENTRAL**

Dallas, Texas, USA

### **Shlemon Mentor Program Luncheon**

Mon., 16 March, 11:30 a.m.–1 p.m.

### **Mann Mentors in Applied Hydrogeology Luncheon**

Tues., 17 March, 11:30 a.m.–1 p.m.

## **NORTHEASTERN**

Portland, Maine, USA

### **Shlemon Mentor Program Luncheons**

Mon., 23 March, 11:30 a.m.–12:30 p.m.  
**and** 12:30–1:30 p.m.

### **Mann Mentors in Applied Hydrogeology Luncheon**

Tues., 24 March, 11:30 a.m.–1 p.m.

## **NORTH-CENTRAL**

Rockford, Illinois, USA

### **Shlemon Mentor Program Luncheons**

Fri., 3 April, 11:30 a.m.–12:30 p.m.  
**and** 12:30–1:30 p.m.

### **Mann Mentors in Applied Hydrogeology Luncheon**

Thurs., 2 April, 11:30 a.m.–1 p.m.

## **CORDILLERAN**

Kelowna, British Columbia, Canada

### **Shlemon Mentor Program Luncheons**

Thurs., 7 May, 11:30 a.m.–12:30 p.m.  
**and** 12:30–1:30 p.m.

### **Mann Mentors in Applied Hydrogeology Luncheon**

Fri., 8 May, 11:30 a.m.–1 p.m.

## **ROCKY MOUNTAIN**

Orem, Utah, USA

### **Shlemon Mentor Program Luncheon**

Mon., 11 May, 11:30 a.m.–1 p.m.

### **Mann Mentors in Applied Hydrogeology Luncheon**

Tues., 12 May, 11:30 a.m.–1 p.m.



# GSA Foundation Update

Donna L. Russell, Director of Operations

## Meet the Foundation's Current Board of Trustees



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To learn more about the Foundation's Trustees please go to [www.gsafweb.org](http://www.gsafweb.org).

The GSA Foundation has five Standing Committees, each comprised of at least three Trustees:

- ▲ Executive Committee
- ▲ Nominating Committee
- ▲ Development Committee
- ▲ Finance Committee
- ▲ Donor Intent Committee

### Digging up the Past

*Most memorable early geologic experience:*  
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—Bruce F. Molnia

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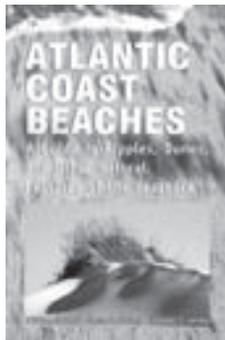
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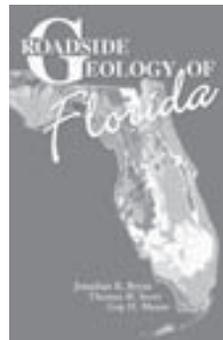


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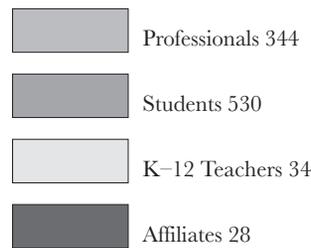
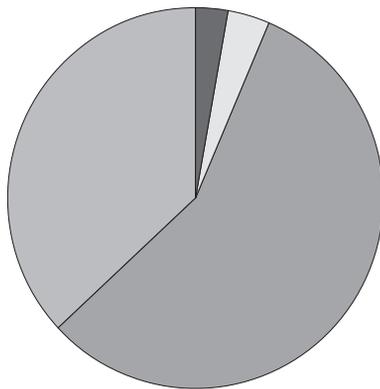


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## New Members: GSA Welcomes You!

*The following people were elected into membership by GSA Council at its October 2008 meeting.*



**Total 936**

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Erin Hollebeak  
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Shari Houston  
Tracy Howe  
Evan Richard Howell  
Ping Hu  
Brian Michael Huber  
Christian Huber  
Jillian Amy Hudgins  
Barbara Hudson  
Aubrey Humbolt  
Daniel Robert Hummer  
Joseph John Hutnik  
Chinomso Ogechi Ibe  
Salman Ijazi  
Lisa K. Irvine  
Tomoko Ishikawa  
Laura Izzo  
David Jakim  
Kelli Anna Janos  
Peter Jastrzembksi  
Catherine Jedrzejczyk  
Brad Jeffrey  
Alexander Jensen  
Tamara Nicole Jeppson  
Stephanie Brinson Jiles  
Josh Johns  
Kristine Winn Johnson  
Amber Johnson-Carroll  
Laura K.Z. Jones  
Adam Barrett Jost  
Nathan Andrew Jud  
Nefeli Kafousia  
Christopher Kakolewski  
Andis Kalvans  
Moshghan Kani  
Amir Karimian Torghabe  
Jessica Blair Kash  
Michele Viola Kashouh  
Cynthia A. Kearns  
Evan Keffeler  
Michael Landvig Keller  
Lindsay Diane Kelley  
Michael James Kennedy Jr.  
Megan Kenworthy  
Joseph Loren Kessinger  
Alexander Ketchpaw  
Katherine L. Ketterer  
Jahmillah Khabir  
Shamin A.K. Uddin Khan  
Kelsey Leigh Kidd  
Catherine Kim  
Hyung Jeek Kim  
Kimberly Kline  
Zach Koch  
Matrika Prasad Koirala  
Douglas Alan Kolb Jr.  
Matthew Konkler  
Adel Diab Mohammed Kotb  
Kristopher Kotouch  
Ranae Kowalczuk  
Douglas Edward Kowalewski  
Suzanne Krahn  
Drew Michael Kreman  
Sean Krepski  
Kayla Kroll

John C. Kroon  
Kunthea Kry  
Debbie Kunath  
Marcus Kunzmann  
Darin Michael Lang  
Kristina Sofia Larsson  
Michael Lawson  
Daniel Jay Lee  
Janie Lee  
Crystal L. Lemon  
Dominik Letsch  
Vivian Leung  
Jana Levison  
Ryan Lee Lewis  
Jill Libby  
Fushen Liu  
John Charles Lock  
Joseph Chad Lollar  
Nicole Longinotti  
Darline Lott  
Kim Lutgen  
Marianne M. Mader  
Jessica Malone  
James Kenneth Markin  
Jill Marshall  
Fernando Martinez-Torres  
Kathryn E. McAdams  
Shauna McDonald  
Kate Jane McGinnis  
Marie McLane  
Kristie S. McLin  
Melissa McMullen  
Benjamin E. McVeigh  
Lorena Medina Luna  
John Reed Meixner  
Lauren John Michaels  
Ivan Mihajlov  
Lauren Elizabeth Miller  
Scott Lyon Miller  
Shant Minas  
Thomas Miskelly Jr.  
Jonathan Stuart Mitchell  
Kevan B. Moffett  
Audrey Mohr  
Timothy Paul Moloney  
Stanley Paul Mordensky II  
Kristin Morell  
Jason Morgan  
Michael Abram Morgan  
Cameron E. Morisette  
Becky Morlier  
Christina Morrison  
Keith David Morrison  
Theresa Morrison  
Robert M. Morrow IV  
Charles A. Munn IV  
Satoru Muraoka  
Olga I. Nedorub  
Iain Neill  
Sterling Nesbitt  
Rachel A. Neurath  
Ai D. Nguyen  
Chinh Thuc Nguyen  
Lien Kim Nguyen  
Phillip A. Nickerson  
Jasmyne Maureen Nolasco

## *New Members: GSA Welcomes You!*

Nathan Richard Noll  
Beth Novak  
Catherine O'Connell-Cooper  
Casey Dean O'Daniel  
Todd A. Odom  
Trevor M. Oester  
Ohiugo Okafor  
Megghan Oksanen  
Adam J. Oliver  
Brian Keith Oliver  
Monica A. Omulo  
Kristopher Thomas Orton  
Kristopher Richard Osterloh  
Mao Oyama  
Sinan M. Öztürk  
Manuel Paez  
Jessequa Parker  
Bonnie Lynn Parks  
Benjamin Parrish  
Caldwell Payne  
Sophie Pearson  
Katherine Mary Pelle  
Jonathan Perkins  
Ryan L. Perroy  
Luke A. Pettinga  
Mark William Piersol  
Alejandro Pinilla  
David Pompeani  
Michael J. Poulos  
Afshin Pourmokhtarian  
Stefan Punnette  
Kelsey Erin Putman  
Lacey Ann Pyle  
Simon Alexander Quinn  
Amanda Raddatz  
Sarah Radencic  
Kathleen Ann Radloff  
Emmett T. Rafferty  
Mark Daniel Raimo  
Matthew Phillip Raimo  
Joseph Ramirez  
Elizabeth Barger Rampe  
Kathryn Rathbun  
Mary Raveia  
Mariana Raviola  
Adam K. Rawe  
Laura Rebreanu  
Sarah Elizabeth Reed  
Nate R. Reel  
Brandi Kiel Reese  
Orin Dean Regier  
Marlin J. Rempel  
Russell Douglas Renfrow  
Mohsen Rezaei  
Barbara Richter  
Christopher Charles Ricker  
Alex Rinehart  
Paula Andrea Rios  
Kathleen Anita Ritterbush  
Emily DeAnne Roberts  
Sabrina Roberts  
Cristina Robins  
Daniel Evans Robinson  
Josué Rodríguez-Benítez  
Kimberly Rogers

Alexander Rohrmann  
Natalie Romanoff  
Rachael Rose  
Jessica Erin Rosenberg  
Angela B. Rosiello  
Benjamin Louis Roth  
Jacqueline Rudy  
Jessica Saffran  
Kristi Kay Salazar  
Derek Salinas  
Spencer Truman Salmon  
Hadi Samimi  
Carlos A. Sanchez Botero  
Michael E. Savale  
Lisa Maria Schaller  
Benjamin Scherzer  
Eric Paul Scheurer  
Justine L. Schneider  
Megan E. Schreiber  
Cale Bradley Sellers  
Emel Seyhan  
Michael Robert Sheehan  
Nisa Sichan  
Jeremie Sieg  
Jacob Siegel  
Sarah M. Silva  
Andrew Mahendra Singh  
Charles Sinn  
Bethania C.T. Siviero  
Jessica M. Slomka  
Benjamin Sidney Slotnick  
Noah Cornelius Sluiter  
David B. Smelser  
Carly Jan Smith  
Toni Jo Smith  
Veronika Smolková  
Linda Solarek  
Kelli Spaugh  
Amy Lynn Spaziani  
Pamela Ann Speciale  
Clifton Nikolas Star  
Jesslyn Kathleen Starnes  
Allison E. Stephenson  
Ryan Stewart  
Justin Stigall  
Thomas Shane Stilson  
James L. Strasen  
Emily Sturnfield  
Lydia Schiavo Tackett  
Michael Tackett Jr.  
Kenneth Takagi  
Kai Tao  
Michael J. Tappa  
Charity N.S. Taylor  
Jordan-Leigh Taylor  
Travis Taylor  
Victoria Lee Taylor  
Lindsay Tebo  
Mahesh Thakur  
Kathleen Renee Thompson  
Emily Anne Timmons  
Michelle Tolleson  
Nicola S. Tonkin  
Natalie Grace Toth  
Rosa E. Tovar

Tiziana Trabucchi  
Tyler Treece  
Kimberly Anne Trent  
Ganesh Nath Tripathi  
Anne Tyler  
Karen Janet Van Tiem  
Ryan Glenn Vannier  
Noel O. Velasco  
Amalia Villarreal  
Marco Igor Voinich  
Gustavo G. Voldman  
Joshua Ian Wabindato  
Davin Wallace  
Steven James Walsh  
John Douglas Walter  
Paul Byron Waltman  
Kim C. Walton  
Ting Wang  
Jared J. Warner  
Brittany L. Weeks  
Benjamin Eugene Weide  
Deborah Weiser  
Blake Paul Weissling  
Misty Lynn Wertz  
Tom White  
Nick Allen Whitfield  
Steve Whiting  
Satrio Adi Wicaksono  
Michael A. Wicker  
Nicholas James Wieclaw  
Jeremy C. Williams  
Stephanie Scholten Willis  
Richard Duane Wilson  
Ian Samuel Witt  
Brett Wittman  
Binyam W. Woldemichael  
Elizabeth Woodward  
Kimberly Yauk  
Donald Jordan Yezerski  
Daniel Kunio Yokoshima  
Adel Hormiz Youkhana  
Kodi Young  
Allen Patrick Yuill  
Brendan T. Yuill  
Annette T. Zapolis  
Fanwei Zeng  
Lori Ziolkowski  
Mohamed K. Zobaa  
Katie Zollars  
Julia Ann Zydek

### **K-12 TEACHER MEMBERS**

Anne R.J. Antony  
Robert Bergstrom  
Trevor Bernier  
Moiria Biwott  
Philip R. Caggiano  
Matt Ahmet Celenli  
Lucy Anne Condon  
Natascha Cox  
Richard Derkacs  
Robert Eugene Driscoll  
Randall A. Eckebrecht  
Aaron Eling

Meg Finn  
Dan Griffin  
Michelle Harrison  
Mary Ann Kay  
Ellen Beth Lyon  
Sohrab Maddahi  
Tammany K. Manis  
Tami Ann McConnell  
David Edward Nash  
Becky S. Ray  
Sandra Renee Reedy  
Kari Salomon  
Christine A. Saulsbury  
Scott Robert Stanley  
Ruby B. Stephens  
Steven A. Teeter  
Carol Tichio  
Karen M. Vito  
Ruth T. Wahl  
John Robert Walsh  
Anne H. Weaver  
Lorin G. Wharton

### **AFFILIATE MEMBERS**

Michael P. Bedford  
Michael A. Bill  
Gérard Breton  
John B. Bush Jr.  
Elizabeth K. Christie  
Daniel Patrick Connelly  
Meaghan Doughty  
G. Dressler  
Marilyn Gault  
Charles George  
Maria Geralyn Gerber  
Tim Glenn  
Fred Greenberg  
James E. Haase  
Sue Henderson  
George Heslep  
Sara Ketabi  
Judy (Jesse) Lowe  
Rodney Moore  
Rethinavel Raja  
Samir Ray  
David Arnold Roberts  
Tom Slaughter  
Shannon Smith  
Roy William Stoehr  
Harry H. Thomas  
Elizabeth Jean Wasserman  
Vivian A.W. Whitney



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## Call for Papers:



*GSA Today* is seeking submissions for its “Groundwork” series—articles that lay the groundwork for furthering the influence of earth science on education, policy, planning, and funding. Articles can include in-depth geoscience commentary, short observations and analysis of hot topics, and discussion of policy news and issues.

*GSA Today* “Groundwork” articles must be no longer than two print pages: ~1400 words with two small figures or ~1600 words with one figure. The philosophy behind this is twofold: (1) keeping an article short can increase the clarity and quality of the writing; and (2) a short article encourages readers to engage and seek more information.

Figures to accompany a “Groundwork” article can be color at no charge to the author.

“Groundwork” articles go to *GSA Today*'s science editors and are run through a rigorous peer review before acceptance and publication.

Submit your article today at <http://gsa-today.allentrack.net/cgi-bin/main.plex>.



## 2009 GSA OFFICER AND COUNCILOR NOMINEES

GSA's success depends on you—its members—and the work of the officers serving on GSA's Executive Committee and Council.

**In early March**, you will receive a postcard with instructions for accessing your electronic ballot via our secure Web site, and biographical information on the nominees will be online for you to review at that time. Paper versions of both the ballot and candidate information will also be available.

Please help continue to shape GSA's future by voting on the nominees listed here.

### GSA Elections Start 13 March 2009

#### PRESIDENT

July 2009–June 2010  
**Jean M. Bahr**  
University of Wisconsin  
Madison, Wisconsin, USA

#### VICE PRESIDENT

July 2009–June 2010  
**Joaquin Ruiz**  
University of Arizona  
Tucson, Arizona, USA

#### TREASURER

July 2009–June 2010  
**Jonathan G. Price**  
Nevada Bureau of  
Mines & Geology  
Reno, Nevada, USA

#### COUNCILOR Position 1

July 2009–June 2013  
**Lisa D. White**  
San Francisco State  
University  
San Francisco, Calif., USA

#### COUNCILOR Position 2

July 2009–June 2013  
**George O. Linkletter**  
ENVIRON International  
Corporation  
Irvine, Calif., USA

#### COUNCILOR Position 3

July 2009–June 2013  
**Robert B. Finkelman**  
U.S. Geological Survey  
Plano, Tex., USA

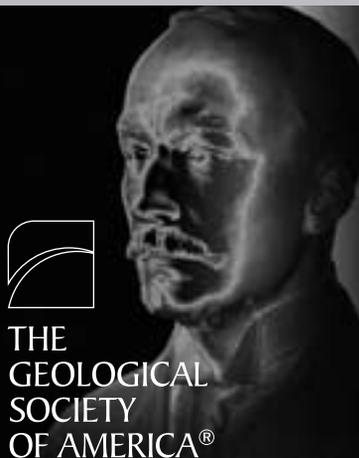
**Cassandra Runyon**  
College of Charleston  
Charleston, S.C., USA

**Ricardo A. Astini**  
Universidad Nacional  
de Córdoba  
Córdoba, Argentina

**J. Douglas Walker**  
University of Kansas  
Lawrence, Kan., USA

*Ballots must be submitted electronically or postmarked by 12 April 2009.*

## Penrose Conference & Field Forum Proposals Encouraged



### PENROSE CONFERENCES

GSA's Penrose Conferences were established in 1969 to provide opportunities for the exchange of current information and exciting ideas in geology and related fields and to stimulate and enhance individual and collaborative research. Go to [www.geosociety.org/Penrose/](http://www.geosociety.org/Penrose/) for guidelines and a proposal form.

### FIELD FORUMS

Have a great idea for a Penrose Conference that would be much more effective in a field setting or a field trip idea that captures the essence of new discoveries or a controversial topic? Then submit a Field Forum proposal! Field Forums provide an opportunity for the exchange of current knowledge and ideas that are well expressed by the geology of a specific area. Go to [www.geosociety.org/fieldforums/](http://www.geosociety.org/fieldforums/) for proposal guidelines and more information.

**Questions?** Contact Becky Sundeen, +1-303-357-1041, [bsundeen@geosociety.org](mailto:bsundeen@geosociety.org).

# In Memoriam

**Paul-Emile Auger**

Quebec, Quebec, Canada  
8 September 2008

**Robert M. Cassie**

Massillon, Ohio, USA  
16 October 2008

**Norbert Edmund Faltyn**

Baldwinsville, New York, USA  
15 October 2008

**Terrence J. Frest**

Seattle, Washington, USA  
10 April 2008

**Alan M. Goodwin**

Toronto, Ontario, Canada  
1 June 2008

**Joseph T. Gregory**

Houston, Texas, USA  
18 November 2007

**Allen V. Heyl**

Evergreen, Colorado, USA  
24 October 2008

**Seena N. Hoose**

Cupertino, California, USA  
notified 6 October 2008

**Frederic R. Kelley**

Gualala, California, USA  
8 August 2008

**Troy J. Laswell**

Starkville, Mississippi, USA  
notified 6 November 2008

**Paul E. Melancon**

Meadowlakes, Texas, USA  
9 February 2007

**John K. Osmond**

Tallahassee, Florida, USA  
notified 18 November 2008

**Carter W. Roberts**

Menlo Park, California, USA  
notified 24 November 2008

**David C. Roy**

Framingham, Massachusetts,  
USA  
30 August 2008

**H. Sakai**

Tokyo, Japan  
30 September 2008

**Gail F. Vernon Jr.**

Edmond, Oklahoma, USA  
30 September 2008

**Detlef A. Warnke**

Hayward, California, USA  
23 October 2008

**James E. Wilson**

Littleton, Colorado, USA  
notified 31 October 2008

**James Lee Wilson**

New Braunfels, Texas, USA  
11 February 2008



To honor a friend or colleague with a GSA Memorial, please go to [www.geosociety.org/pubs/memorials/mmlGuid.htm](http://www.geosociety.org/pubs/memorials/mmlGuid.htm) to learn how. If you would like to contribute to the Memorial Fund, please contact the GSA Foundation at +1-303-357-1054, [drussell@geosociety.org](mailto:drussell@geosociety.org), or go to the Foundation's Web site at [www.gsafweb.org](http://www.gsafweb.org).



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# About People

GSA Fellows **Robert G. Font** and **Larry R. Rhodes** and GSA Member **M. Lee Allison** were among the five recipients of the American Institute of Professional Geologists (AIPG) 2008 National Awards. Both Font and Rhodes received the AIPG Martin Van Covering Memorial Award, and Allison was honored with the AIPG John T. Galey, Sr., Memorial Public Service Award. Learn more at [www.geosociety.org/news/memberNews.htm](http://www.geosociety.org/news/memberNews.htm).

The Geoscience Information Society (GSIS) named Pennsylvania Geological Survey Open-File Report 06-02, *Rifts, Diabase, and the Topographic "Fishbook": Terrain and Military Geology of the Battle of Gettysburg—July 1–2, 1863*, the best field trip guidebook for 2008. Among the authors are GSA Fellows **Roger J. Cuffey** and **John D. Inners**. GSA Member **Lura E. Joseph** earned the GSIS Best Paper Award for "Comparison of retrieval performance of eleven online indexes containing information related to Quaternary research, an interdisciplinary science."



## Call for Papers:

# GSATODAY

*GSA Today* science articles are timely, focused articles on current topics and discoveries in the earth sciences that appeal to a broad geoscience audience. Each article receives a rigorous peer review, with rapid turnaround both from receipt to acceptance (avg. for 2008: 91.2 days) and from acceptance to publication (avg. for 2008: less than 3 months). *GSA Today's* circulation is over 21,500, and we offer free color and no page charges. Finally, *GSA Today* science articles are always open access online.

Please submit your article through *GSA Today's* online manuscript tracking and peer review system via link at [www.geosociety.org/pubs/gsatguid.htm](http://www.geosociety.org/pubs/gsatguid.htm).



# NEW SCIENCE EDITORS FOR GSA JOURNALS

The Geological Society of America announces the appointment of five new science editors to its journals. Each begins a four-year term this year.



From left to right:  
Patience Cowie and Sandra Wyld

## GEOLOGY

*Geology* welcomes **Patience Cowie** of the University of Edinburgh and **Sandra Wyld** of the University of Georgia. They will join continuing editors Andy Barth (Indiana University–Purdue University) and Brad Opdyke (Australian National University). Tina Niemi (University of Missouri–Kansas City) completed her term in December 2008.

Cowie (<http://xweb.geos.ed.ac.uk/~cowie/>) is professor of geodynamics at the School of GeoSciences, University of Edinburgh. Her research is concerned with the mechanics of fault and fracture development in the elastic-brittle part of the lithosphere and includes studies of continental rifts and mid-ocean ridges. She is interested in the rates of fault growth and systematic variations in space and time due to fault interaction, and the implications of rate variations for seismic hazard assessment, geomorphic processes, and sedimentation patterns in active tectonic settings. Cowie has held several editorial positions, including with the *Journal of Structural Geology*, the *Journal of Geophysical Research*, and *Basin Research*.

Wyld ([www.gly.uga.edu/Wyld/](http://www.gly.uga.edu/Wyld/)) is an associate professor in the Dept. of Geology, University of Georgia–Athens. She is one of the department's undergraduate advisors and teaches classes on structural geology, continental tectonics, and regional geology of global orogenic systems. Wyld's research interests focus on the structural and tectonic evolution of convergent plate margins, particularly on how convergent margins grow over time and how the structural evolution of these margins can be related to plate tectonic interactions. Her current areas of study are the western North American Cordillera and the Leeward Antilles of the southern Caribbean.



From left to right:  
Christian Koeberl and Nancy Riggs

## GSA BULLETIN

Joining Brendan Murphy (St. Francis Xavier University) as co-editors for *GSA Bulletin* are **Christian Koeberl** of the University of Vienna and **Nancy Riggs** of Northern Arizona University. Karl Karlstrom (University of New Mexico) completed his term in December 2008.

Koeberl ([www.univie.ac.at/geochemistry/koeberl/](http://www.univie.ac.at/geochemistry/koeberl/)) is head of the Dept. of Lithospheric Research at the University of Vienna and is a full member of the Austrian Academy of Sciences. His main research interest is meteorite impact craters and processes, combining geology, geochemistry, petrology, mineralogy, stratigraphy, and other disciplines. He is a member of the International Continental Scientific Drilling Program (ICDP) Science Advisory Group. Koeberl has published more than 320 peer-reviewed research papers and has written or edited 12 books (including several GSA Special Papers). He has been an associate editor for several journals, including *GSA Bulletin*, and also has served on the editorial board of *Geology*.

Riggs ([www.cefns.nau.edu/Academic/Geology/people/Dr.NancyR.Riggs.shtml](http://www.cefns.nau.edu/Academic/Geology/people/Dr.NancyR.Riggs.shtml)) is a professor of geology at Northern Arizona University. Her research interests are in volcanic processes, including dome construction and destruction, cinder cone processes, volcanic effects on sedimentation, and the relation between volcanism and tectonics, as well as geology education, and she has also studied the use of detrital zircons in volcanic arc reconstruction and to trace terrane migration. Riggs is a strong advocate for undergraduate women in geosciences. She has served as an associate editor for *GSA Bulletin* since 1996, and she is on the *Geology* editorial board.



Dennis Harry

## GEOSPHERE

**Dennis Harry** of Colorado State University in Fort Collins joins Randy Keller (University of Oklahoma) as co-editor for *Geosphere*. Keller has been editing solo since the journal's inception. Harry (<http://welcome.warnercnr.colostate.edu/~dharry/dharry.htm>) is the Edward M. Warner Professor of Geophysics in the Dept. of Geosciences at Colorado State University. His research activities focus on numerical modeling of tectonic and magmatic processes involved in continental extension, geophysical imaging and geodynamic modeling of extensional and foreland sedimentary basins, and near-surface geophysical characterization of clastic aquifer systems. Harry has served as an associate editor for *Geosphere* since 2004.



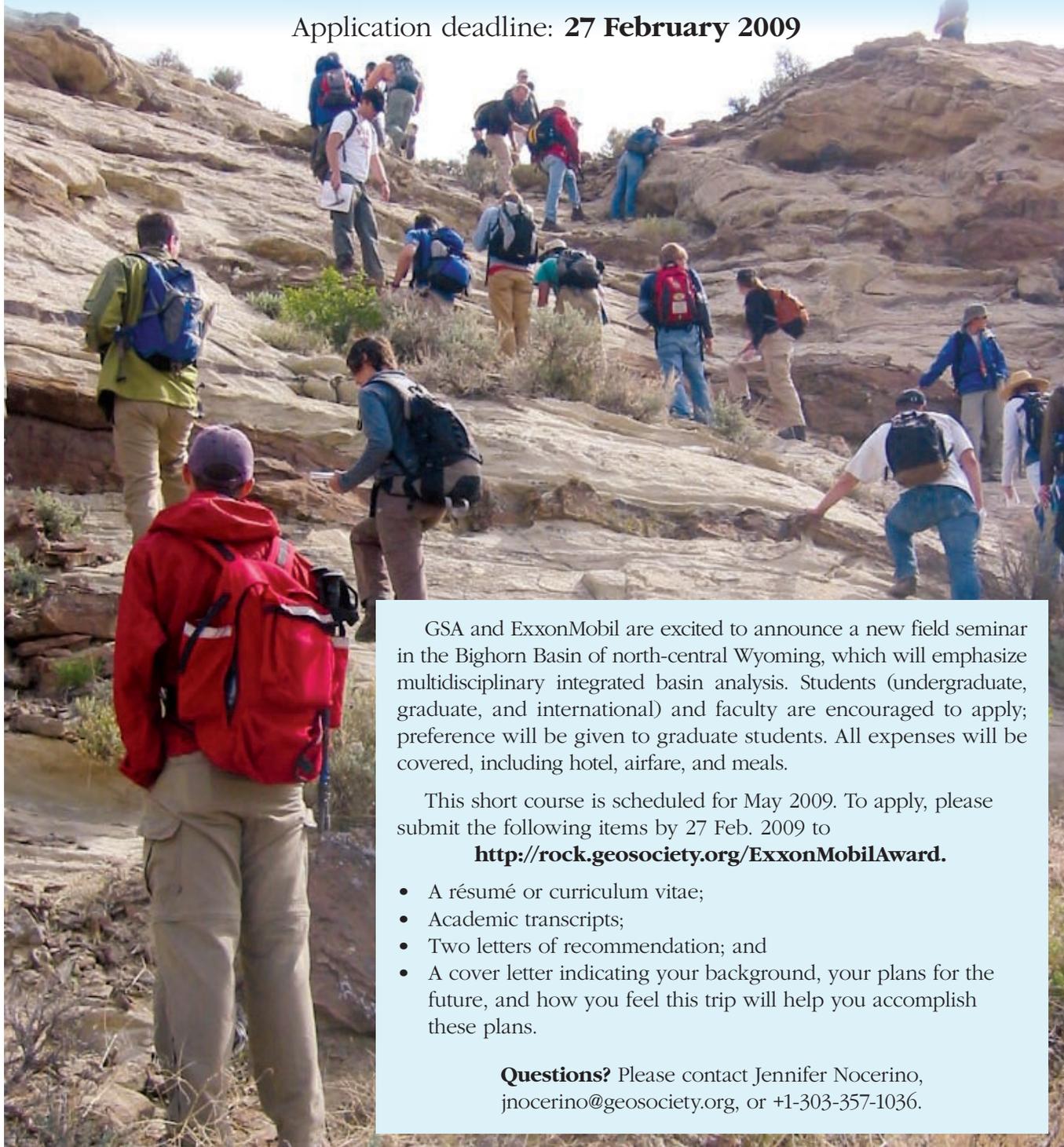
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# BIGHORN BASIN FIELD AWARD

**A FREE Professional Development Opportunity**

Application deadline: **27 February 2009**



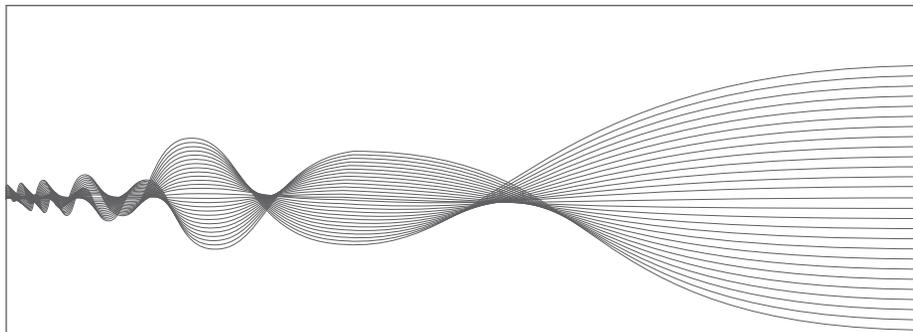
GSA and ExxonMobil are excited to announce a new field seminar in the Bighorn Basin of north-central Wyoming, which will emphasize multidisciplinary integrated basin analysis. Students (undergraduate, graduate, and international) and faculty are encouraged to apply; preference will be given to graduate students. All expenses will be covered, including hotel, airfare, and meals.

This short course is scheduled for May 2009. To apply, please submit the following items by 27 Feb. 2009 to

**<http://rock.geosociety.org/ExxonMobilAward>.**

- A résumé or curriculum vitae;
- Academic transcripts;
- Two letters of recommendation; and
- A cover letter indicating your background, your plans for the future, and how you feel this trip will help you accomplish these plans.

**Questions?** Please contact Jennifer Nocerino, [jnocerino@geosociety.org](mailto:jnocerino@geosociety.org), or +1-303-357-1036.



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or Email us at

[radiocarbon@gns.cri.nz](mailto:radiocarbon@gns.cri.nz)  
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Lower Hutt 5040  
New Zealand  
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F +64-4-570 4657



## ▶▶ Call for Applications ◀◀

and Nominations

## GSA SCIENCE EDITORS

**GSA is seeking co-editor applications and nominations for the following:**

- ▶▶ **Geosphere**—four-year term beginning July 2009
- ▶▶ **Geology**—four-year term beginning January 2010
- ▶▶ **GSA Today**—four-year term beginning June 2010

To apply, submit a curriculum vitae and a brief letter describing your qualifications; to nominate a fellow geoscientist, submit your nomination along with the individual's written permission and CV to:

Jeanette Hammann  
GSA Publications, P.O. Box 9140,  
Boulder, CO 80301, USA  
[jhammann@geosociety.org](mailto:jhammann@geosociety.org).

For first consideration, please complete your submission by  
**20 February 2009.**

Each editor will work out of his or her current location. GSA provides some funding to science editors; for specifics, please contact Jeanette Hammann, +1-303-357-1048, [jhammann@geosociety.org](mailto:jhammann@geosociety.org). For general information, see the back cover of the January *GSA Today* or go to [www.geosociety.org/pubs/editorsCall.htm](http://www.geosociety.org/pubs/editorsCall.htm).



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and click on the *GSA Today* cover.



# 2009 GSA Section Meetings

Be a part of the geoscience action with **GSA's spring meetings!**



Dallas, Texas; courtesy Dallas Convention and Visitors Bureau.



Caladesi Island State Park. Courtesy Visit St. Petersburg/Clearwater.



Mount Katahdin, Maine. Courtesy Convention and Visitors Bureau of Greater Portland.

## SOUTHEASTERN

12–13 March 2009 — St. Petersburg, Florida, USA  
Dubbed “Florida’s Beach,” the St. Petersburg area of Florida features pristine and human-influenced beaches and coastlines, sinkholes, covered karst, natural springs, and fresh- and salt-water wetlands.

**Early registration deadline: 9 February 2009.**

## SOUTH-CENTRAL

16–17 March 2009 — Dallas, Texas, USA  
The Dallas–Fort Worth Metroplex is a great central location for examining many geologic treasures, including the Woodbine Formation at Lake Grapevine, Mineral Wells in the North Texas Hill Country, and Big Bend National Park.

**Early registration deadline: 9 February 2009.**

## NORTHEASTERN

22–24 March 2009 — Portland, Maine, USA  
The Portland area offers a variety of natural attractions, including the Fore River Sanctuary and Jewell Falls, the Baxter Woods Reserve, Mount Katahdin, and extended salt- and freshwater marshes.

**Early registration deadline: 17 February 2009.**

Save  
\$\$

Don't miss your Section's  
early registration deadline.

## NORTH-CENTRAL

2–3 April 2009 — Rockford, Illinois, USA  
Rockford is so named because of its location at a rock outcrop popular for fording the Rock River, which runs through the city. Just to the northeast of town are Rock Cut State Park and Pierce Lake. Rockford is also the home of juvenile *T. rex*, Jane, on display at Rockford's Burpee Museum of Natural History.

**Early registration deadline: 2 March 2009.**



Pierce Lake, Illinois. Courtesy Rockford Area Convention and Visitors Bureau.

## CORDILLERAN

7–9 May 2009 — Kelowna, British Columbia, Canada  
Kelowna is situated along the eastern shore of Okanagan Lake in the Okanagan Valley, a geologically diverse area, with mountains, beaches, orchards, and vineyards—ideal country for a geoscience meeting.

**Early registration deadline: 6 April 2009.**



Squally Point, Okanagan Lake, British Columbia, Canada. Photo courtesy Robert Young.

## ROCKY MOUNTAIN

11–13 May 2009 — Orem, Utah, USA  
Orem is located on the eastern shore of Utah Lake in the foothills of Mount Timpanogos. Nearby is Uinta National Forest, and to the south are several national parks and recreation areas.

**Early registration deadline: 13 April 2009.**



Capitol Reef National Park at sunset.  
Photo by B. Kowallis.



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FACULTY POSITION AVAILABLE IN GEOSCIENCES

**THE UNIVERSITY OF TEXAS AT DALLAS**

The Department of Geosciences at the University of Texas at Dallas is seeking up to two tenure/tenure track faculty members in the broad field of tectonics with interests in fundamental processes and in the application of tectonic principles to energy and environmental issues. These positions are available for the 2009-2010 academic year and may be at any academic rank, depending on qualifications. We seek individuals who have developed, or have the potential to develop, vibrant, sustained externally funded research programs that complement existing departmental strengths and who will contribute effectively to the Department's educational programs at the BS, BA, MS and PhD levels.

This departmental expansion in tectonics will play a pivotal role in the University's strategic emphasis on energy and the environment. We are seeking individuals who will complement and expand departmental strengths in structural geology, active and ancient tectonics, isotope geochemistry, geophysics, geospatial science, and computational geoscience, and who will enhance collaboration with other departments in the School of Natural Sciences and Mathematics and programs in geospatial science with the School of Economics, Political, and Policy Studies and the Jonsson School of Engineering and Computer Science. We hope to build upon our traditional collaboration with the petroleum industry in areas that may encompass carbon dioxide sequestration, water and mineral resources, and to expand the use modern high-resolution positioning and imaging technology to characterize and model surface processes associated with crustal deformation.

The Department of Geosciences has strong undergraduate and graduate programs and UTD is a relatively young, growing university. It attracts very talented students (mean freshman SAT > 1200) and is situated in a vibrant metropolitan area that is undergoing rapid growth.

The search committee will begin evaluating applications as soon as possible and will continue until the positions are filled. Applications should include a complete resume, a statement of research interest and the names and contact information of five professional references and send to: Academic Search #20097, The University of Texas at Dallas, 800 W. Campbell Road, AD 42, Richardson, TX 75080-3021. Indication of gender and ethnic origin for affirmative action statistical purposes is requested as part of the application process but is not required for consideration.

Questions about the position may be directed to the Department Head, Professor John S. Oldow ([oldow@utdallas.edu](mailto:oldow@utdallas.edu)). Electronic applications can be sent to [jobsrch@utdallas.edu](mailto:jobsrch@utdallas.edu). UTD is an equal opportunity/affirmative action employer and encourages application from candidates who would enhance the diversity of the university's faculty and administration.

**Classified Rates—2009**

Ads (or cancellations) must reach the GSA advertising office no later than the first of the month, one month prior to the issue in which they are to be published. Contact [advertising@geosociety.org](mailto:advertising@geosociety.org), +1.800.472.1988 ext. 1053, or +1.303.357.1053. All correspondence must include complete contact information, including e-mail and mailing addresses. To estimate cost, count 54 characters per line, including punctuation and spaces. Actual cost may differ if you use capitals, boldface type, or special characters. Rates are in U.S. dollars.

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Fellowship Opportunities	\$8.50	\$8.25

**Positions Open****ASSISTANT PROFESSOR  
SLIPPERY ROCK UNIVERSITY OF PENNSYLVANIA**

Slippery Rock University of Pennsylvania is seeking applicants for one (1) full time, tenure track position at the Assistant Professor level in the Department of Geography, Geology, and the Environment, beginning in August 2009.

A Ph.D. at time of appointment is required. Successful performance in an on-campus interview, including teaching and research demonstrations, is also required. The candidates must demonstrate a commitment to the education of diverse populations.

The Department seeks an assistant professor with an active research and publication agenda and a research and teaching focus on environmental issues, particularly sustainability. The selected candidate will be responsible for teaching introductory environmental courses, upper division courses in her/his area of expertise, and contributing to the department's newly developed Master of Science in Sustainable Systems. Preference will be given to candidates who also demonstrate the ability to teach one or more of the following courses: Principles of Sustainability, Energy and Society, Green Building Design, and Planning for Sustainable Communities. The Department has a tradition of providing students with opportunities for research, field experiences, and travel; the successful candidate will be expected to contribute to these efforts. We encourage applicants across a broad range of research interests, theoretical frameworks, and methodological approaches.

Send letter of interest, statements of teaching philosophy and research agenda, curriculum vita, graduate and undergraduate transcripts (official transcripts are required before hiring), and letters from three references (include a list of their names, addresses and phone numbers) to: Dr. Langdon Smith, Department of Geography, Geology, and Environment, 319 Advanced Technology and Science Hall, Slippery Rock University, Slippery Rock, PA 16057, e-mail: [langdon.smith@sru.edu](mailto:langdon.smith@sru.edu) (for questions only—no electronic submissions will be accepted).

Review of complete application materials will begin on 21 February 2009, continuing until the positions are filled. Background investigation required for employment. Slippery Rock University of PA is a member of the State System of Higher Education and is an affirmative action/equal opportunity employer. Visit our Web page at [www.sru.edu](http://www.sru.edu).

Further information about the Department is available at <http://academics.sru.edu/gge/index.html>.

**ENDOWED PROFESSORSHIP IN ECOSYSTEMS  
AND EARTH SYSTEMS SCIENCE  
INTERNATIONAL CENTER FOR ADVANCED  
RENEWABLE ENERGY AND SUSTAINABILITY  
(I-CARES) WASHINGTON UNIVERSITY—ST. LOUIS**

The International Center for Advanced Renewable Energy and Sustainability (I-CARES) ([www.i-cares.wustl.edu/endowedprofs.html](http://www.i-cares.wustl.edu/endowedprofs.html)) at Washington University in St. Louis invites nominations and applications for endowed professorships, including one in Ecosystems and Earth Systems Science. The search is focused on tenured appointments at the rank of full professor, although

other exceptional candidates will be considered for appointments commensurate with their experience and accomplishments.

We seek individuals from such fields as biology, chemistry, earth and planetary sciences, environmental sciences, and physics who have expertise and innovative insight into global change over a range of time scales and interactions between climate and biosphere. Important research frontiers in this area include interactions between biological and geochemical processes; carbon dynamics at the regional and global level; the feedbacks between global change and natural and/or managed ecosystems; and the interactions among agriculture production, energy usage, and the biosphere.

For information regarding application procedures, please see [artsci.wustl.edu/About/facultyopenings-cares](http://artsci.wustl.edu/About/facultyopenings-cares). Questions regarding the search process can be directed to Dr. Jonathan Chase, Dept. of Biology, [jchase@wustl.edu](mailto:jchase@wustl.edu); or Dr. T.R. Kidder, Dept. of Anthropology, [trkidder@wustl.edu](mailto:trkidder@wustl.edu)—co-chairs of the Search Committee.

Review of applications will begin immediately, but applications will be received until the positions are filled. Washington University is an Equal Opportunity and Affirmative Action Employer. Applications from women and underrepresented minority groups are strongly encouraged.

**MONCRIEF CHAIR IN PETROLEUM GEOLOGY  
WESTERN STATE COLLEGE OF COLORADO**

Western State College of Colorado invites applications for the tenure-track faculty position of Moncrief Chair in Petroleum Geology starting August 2009. Teaching responsibilities include courses in an expanded petroleum geology curriculum and core courses in the geology curriculum. Requirements include a doctorate in geology or related field and a commitment to undergraduate education and excellence in teaching. For full position information and application procedures, visit [www.western.edu/hr/jobs](http://www.western.edu/hr/jobs). Applications will be accepted until the position is filled. AA/EOE.

**ASSISTANT PROFESSOR  
WATERSHED HYDROLOGY AND  
GEOMORPHOLOGY  
DEPARTMENT OF WATERSHED SCIENCES  
UTAH STATE UNIVERSITY**

The Department of Watershed Sciences ([www.cnr.usu.edu/departments/wats](http://www.cnr.usu.edu/departments/wats)) at Utah State University ([www.usu.edu](http://www.usu.edu)) is seeking to fill a 9-month, tenure track position in watershed hydrology and geomorphology at the assistant professor level. Applicants must have a Ph.D. in watershed sciences, hydrology, or a related discipline at the time of employment. The full position description and instructions for applying are available on the Web at <https://jobs.usu.edu> (requisition ID 051603). Review of applications will start 15 Feb 2009.

Utah State University is an Affirmative Action/Equal Opportunity Employer and encourages applications from women and minorities.

**GEOLOGY (PETROLOGY, SEDIMENTATION/  
STRATIGRAPHY, FORENSIC GEOLOGY): TENURE-  
TRACK POSITION, ASSISTANT PROFESSOR  
RADFORD UNIVERSITY, RADFORD, VIRGINIA**

Applications are invited for a position to begin in September 2009. A doctorate in petrology with some interest in forensic research and teaching is preferred. Candidates having a firm doctoral completion date within one year of the date hired will be considered. The successful applicant will teach courses in areas of petrology, sedimentation-stratigraphy, and general geology. Expertise in geology field methods is a plus. The successful applicant will be expected to develop and supervise undergraduate student research. Radford University offers an undergraduate geology major with a focus on Environmental and Engineering Geosciences and is home to the RU Forensic Science Institute. Candidates must provide a letter of application, current vita, copies of transcripts, and the names, addresses and phone numbers of three references. Consideration of candidates will begin immediately and will continue until the position is filled pending funding. Applications should be addressed to Dr. S.W. Lenhart, Search Committee Chair, Dept. of Geology, Radford University, Box 6939, Radford, VA 24142, or [slenhart@radford.edu](mailto:slenhart@radford.edu).

Radford University is a co-educational, comprehensive, state-supported institution with an emphasis on teaching, located in the mountains of scenic southwestern Virginia, 40 miles from Roanoke, with an enrollment of approximately 9,200 students. Visit our website at [www.radford.edu](http://www.radford.edu). Radford University is an Equal Opportunity, Affirmative Action employer. Minority and women candidates are encouraged to apply.

**ASSISTANT OR ASSOCIATE PROFESSOR  
IN HYDROCARBON GEOSCIENCE, GEOLOGY AND  
GEOPHYSICS DEPT. AND ENERGY & GEOSCIENCE  
INSTITUTE, UNIVERSITY OF UTAH**

The Geology and Geophysics (GG) Department and the Energy & Geoscience Institute (EGI) at the University of Utah invite applications for a tenure-track faculty position in GG at the Assistant or Associate Professor level, beginning 1 July 2009. The successful candidate will bring expertise in hydrocarbon energy research and will develop a strong, externally funded and internationally recognized research program involving students and industry. Teaching responsibilities will include development of new undergraduate- and graduate-level courses and integration with existing courses in GG's Petroleum Industry Career Path. The appointee will participate in collaborative efforts between GG and EGI. The GG Department and EGI share thriving research and academic programs in petroleum geology and geophysics and allied areas of the geosciences, including EGI's Corporate Associate program. The position will have offices at both organizations, and communication and leadership skills as well as teamwork experience are important. We also offer state-of-the-art facilities including the new Frederick A. Sutton Building. More information can be found online at [www.earth.utah.edu](http://www.earth.utah.edu) and [www.egi.utah.edu](http://www.egi.utah.edu).

The area of specialization is open but possibilities include geologic interpretation of geophysical data, new methodologies for subsurface imaging, petrophysics, rock fracture mechanics, reservoir characterization and engineering, multiphase fluid flow, and geostatistical modeling. Multiple opportunities for collaboration and funding exist, including capitalizing on emerging interest in unconventional resources.

Candidates must have a completed Ph.D. at the time of appointment and a strong record of research and publication. Applications are being accepted now; review of applications will begin on 15 January 2009 and will continue until the position is filled. Applicants should submit an application letter indicating research, teaching and programmatic interests and agenda, curriculum vitae, and names and contact information of three professional references to Chairs of the Hydrocarbon Geoscience Search Committee, Geology and Geophysics Dept., University of Utah, 135 South 1460 East, WBB 719, Salt Lake City, UT 84112.

Complete applications may also be sent in PDF format by e-mail to [Kristin.Christensen@utah.edu](mailto:Kristin.Christensen@utah.edu). Questions can be addressed to Cari Johnson ([Cari.Johnson@utah.edu](mailto:Cari.Johnson@utah.edu)) or Ray Levey ([RLevey@egi.utah.edu](mailto:RLevey@egi.utah.edu)).

The University of Utah is an equal opportunity/affirmative action employer, encourages applications from women and minorities, and provides reasonable accommodation to the known disabilities of applicants and employees.

The University of Utah values candidates who have experience working in settings with students from diverse backgrounds, and possess a strong commitment to improving access to higher education for historically underrepresented students.

## Opportunities for Students

**Graduate Study in Geosciences at San Francisco State University.** NSF-funded graduate research opportunities are available in igneous and metamorphic petrology, geochemistry, and geochronology toward a project focused on orogenic processes in the Himalaya. Preference will be given to students with prior research and field and/or laboratory experience. Financial support is available for a two-year M.S. project. Applications for Fall 2009 admission are due 15 March 2009. For more information, contact Mary Leech at [leech@sfsu.edu](mailto:leech@sfsu.edu) or see <http://online.sfsu.edu/~leech>.

**Graduate Assistantships, Indiana State University.** The Geoscience Program at Indiana State University has graduate assistantships available for students wishing to pursue an M.S. degree in Earth and Quaternary Sciences beginning Fall 2009. The ISU Geoscience Program offers a field- and laboratory-intensive curriculum emphasizing environmental geology and geochemistry, medical geology, surface processes, sediment transport, sequence stratigraphy, geomorphology, geoarchaeology, Quaternary paleoecology, geobiology, dendrochronology, paleoceanography, marine geology and geochemistry, biogeochemistry, climatology, and paleoclimatology. Collaborative endeavors are established with the Indiana Geological Survey, Indiana Division of Reclamation, Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, Indiana Space Grant Consortium, Bureau of Land Management, US Forest Service, and Ocean Drilling Program. The depart-

ment supports a number of state-of-the-art laboratory facilities, and our faculty are committed to providing students with hands-on learning experiences. Application review begins 03/01/09; application forms can be obtained by visiting <http://www1.indstate.edu/sogs/Students.htm>. For more information, contact Dr. James Speer, Geology Program, Indiana State University, Terre Haute, Indiana 47809, [jspeer3@indstate.edu](mailto:jspeer3@indstate.edu).

**Graduate Opportunities in the Earth Sciences: The Department of Marine, Earth and Atmospheric Sciences at North Carolina State University** invites applications from prospective M.S. and Ph.D. students in the Earth Sciences. The Department provides a multidisciplinary learning environment with core research programs in Coastal Margin Evolution, Geomorphology, Geophysics, Geoscience Education, GIS modeling, Chemical and Physical Hydrology, Marine Sediment Transport, Marine Geochemistry, Mid-Ocean Ridge Processes, Igneous Petrology, Structural Geology, Tectonics, and Vertebrate Paleontology. Financial support is available through a combination of research and teaching assistantships. Applications are invited from students with backgrounds in the physical and biological sciences, mathematics or engineering. The deadline for fall admissions is 15 February 2009. For more information, please visit [www.meas.ncsu.edu](http://www.meas.ncsu.edu).

**Graduate Research Scholarships at UT-San Antonio.** The Center for Water Research at the University of Texas at San Antonio invites applications from students interested in a M.S. program in Geological Sciences ([www.utsa.edu/geosci](http://www.utsa.edu/geosci)) or Civil and Environmental Engineering (<http://engineering.utsa.edu/CE/deptInfo.html>) beginning in the fall of 2009. The Center supports research in areas of hydrology, hydrogeology, water resources, environmental chemistry, civil and environmental engineering, environmental spatial analysis, environmental microbiology, environmental ecology, and environmental geomorphology. Students with backgrounds in geology, hydrogeology, geochemistry, environmental science, civil and environmental engineering or closely related fields are encouraged to apply. Applications are due no later than 2 March 2009 for admitted students.

Scholarships carry a stipend of up to \$12,000 plus an additional \$3,000 for tuition per year for a maximum of two years. Interested students are strongly advised to identify and communicate with potential faculty advisors associated with the Center (See [www.utsa.edu/water/staff.cfm](http://www.utsa.edu/water/staff.cfm)). Further information about scholarship requirements and application procedures can be found at [www.utsa.edu/water/scholar\\_advertisement.cfm](http://www.utsa.edu/water/scholar_advertisement.cfm).

**Graduate Student Opportunities (Ph.D. and M.Sc.) in Contaminant Hydrogeology at the University of Toronto.** The Stable Isotope Laboratory has a number of positions available for M.Sc. and Ph.D. students interested in research in environmental isotope geochemistry (compound specific isotope analysis) related to the investigation of biodegradation and remediation of organic contaminants in groundwater (including chlorinated hydrocarbons, petroleum hydrocarbons and hydrocarbon gases).

Applicants with a background in any of the following areas are invited to apply: geology, geography, chemistry, physics, engineering, microbiology.

Please send a CV plus 3 letters of reference to Dr. B. Sherwood Lollar by e-mail at

**Summer Internships Available in Scientific Drilling.** DOSECC (Drilling, Observation and Sampling of the Earth's Continental Crust) invites students to apply for summer 2009 internships in scientific drilling. The internships promote student involvement in projects where drilling has provided data and materials for study. Interns can undertake research related to ongoing or past drilling efforts. The internships are open to college students (graduate or undergraduate) and primary and secondary schoolteachers, worldwide. Applicants do not have to be attending a DOSECC Member Institution to be considered for this award. Internship funding will be available in the summer of 2009 and budgets of \$2000 to \$5000 are appropriate. Applications must be received by 1 March 2009 and awardees will be announced 1 April 2009. For additional information, consult the DOSECC Web site, [www.dosecc.org/html/internship.html](http://www.dosecc.org/html/internship.html), or e-mail David Zur, DOSECC's Education and Outreach Manager at [dzur@dosecc.org](mailto:dzur@dosecc.org).

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- \* **March Science Article:** "Pacific atoll living: How long already and until when?" by William R. Dickinson
- \* **Penrose Conference Announcement:** Low  $\delta^{18}\text{O}$  rhyolites and crustal melting: Growth and redistribution of the continental crust
- \* **Penrose Conference Announcement:** "Tectonic development in the Amerasia basin"
- \* **2008–2009 USGS-GSA Congressional Science Fellow Initial Report:** "Quantifying change on Capitol Hill"
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# Journal Highlights

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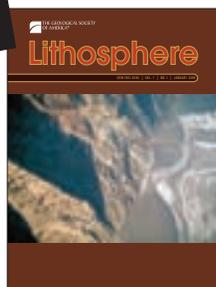
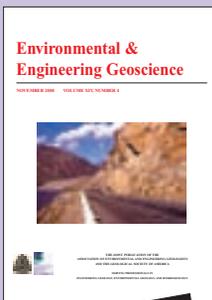
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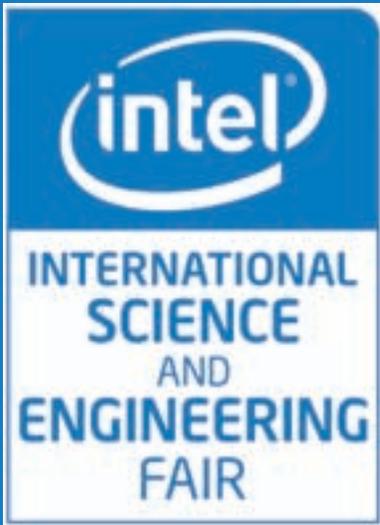
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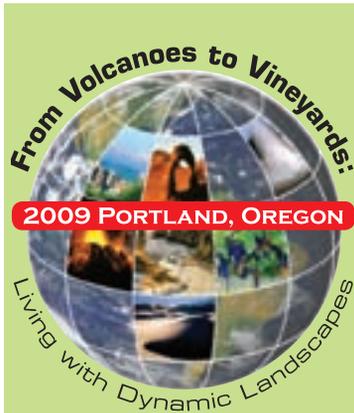
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# The Geology of Early Humans in the Horn of Africa

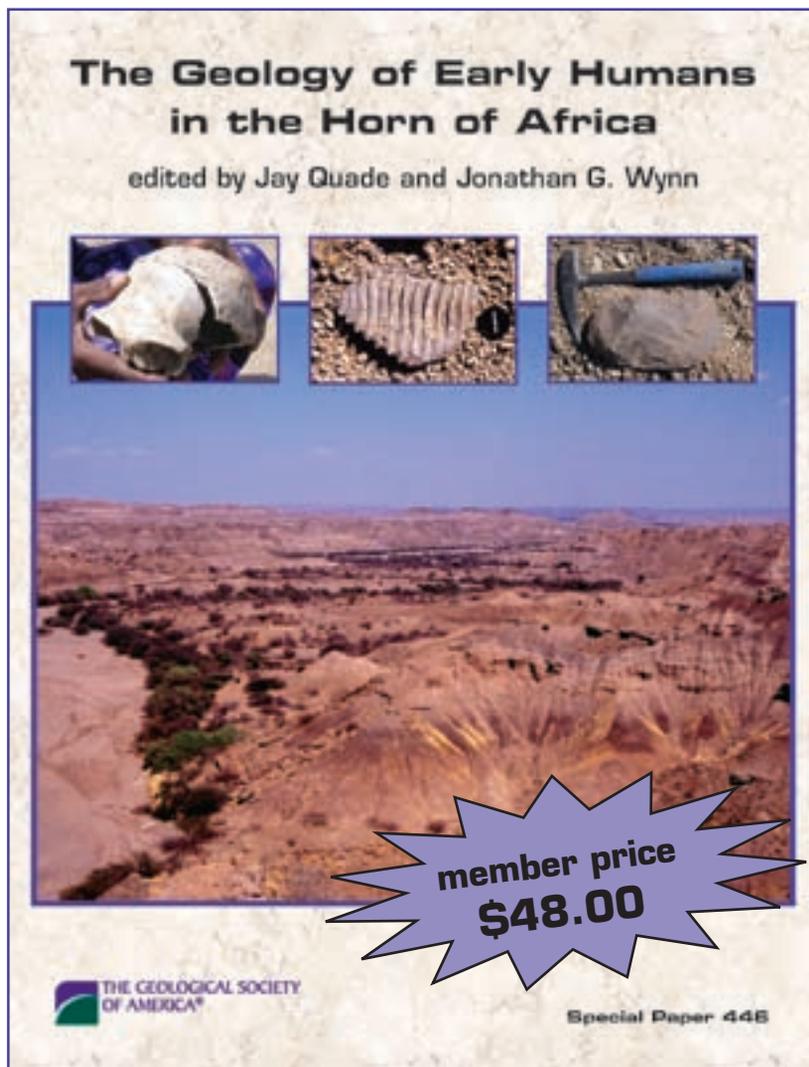
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