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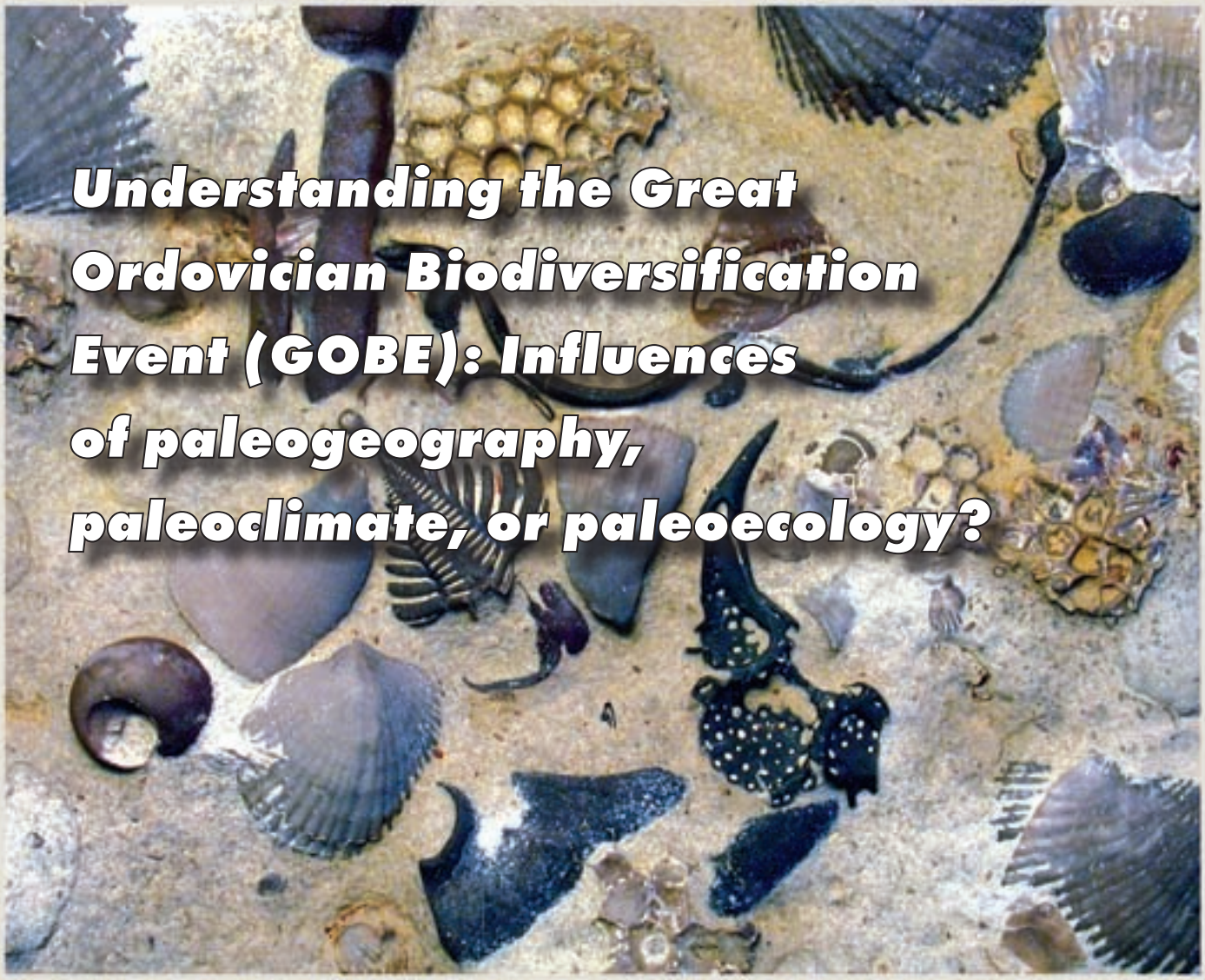

Understanding the Great Ordovician Biodiversification Event (GOBE): Influences of paleogeography, paleoclimate, or paleoecology?

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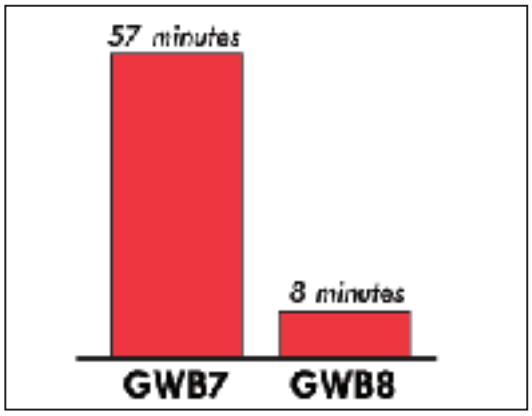

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SCIENCE ARTICLE

Cover: Shell bed with trilobites, brachiopods, tabulate corals, and gastropods from the middle Middle Cybèle Member, Jupiter Formation (Early Silurian), Anticosti Island, Canada. Photo by Axel Munnecke. See "Understanding the Great Ordovician Biodiversification Event (GOBE): Influences of paleogeography, paleoclimate, or paleoecology?" by Thomas Servais et al., p. 4–10.

Erratum: See p. 55 of this issue.

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Understanding the Great Ordovician Biodiversification Event (GOBE): Influences of paleogeography, paleoclimate, or paleoecology?

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ABSTRACT

"The Great Ordovician Biodiversification Event" (GOBE) was arguably the most important and sustained increase of marine biodiversity in Earth's history. During a short time span of 25 Ma, an "explosion" of diversity at the order, family, genus, and species level occurred. The combined effects of several geological and biological processes helped generate the GOBE. The peak of the GOBE correlates with unique paleogeography, featuring the greatest continental dispersal of the Paleozoic. Rapid sea-floor spreading during this time coincided with warm climates, high sea levels, and the largest tropical shelf area of the Phanerozoic. In addition, important ecological evolutionary changes took place, with the "explosion" of both zooplankton and suspension feeding organisms, possibly based on increased phytoplankton availability and high nutrient input to the oceans driven by intense volcanic activity. Extraterrestrial causes, in the form of asteroid impacts, have also been invoked to explain this remarkable event.

INTRODUCTION

Although the five major mass extinctions (in particular, the Permian-Triassic and the Cretaceous-Tertiary events) have been extensively documented, until recently, the major biodiversifications and radiations of life on Earth have attracted much less attention. The so-called "Cambrian explosion" is in many ways much better known than the Ordovician and Mesozoic-Cenozoic radiations of marine invertebrates. Although the Cambrian explosion resulted in a range of new and spectacular animal body plans, mostly known from famous Fossil-Lagerstätten, such as the Burgess Shale (Canada), Chengjiang (China), and Sirius Passet (Greenland), the Ordovician radiation is dramatic in different ways (Droser and Finnegan, 2003) and is evident in the "normal" shelly fossil record.

The term "The Great Ordovician Biodiversification Event" (GOBE) has been introduced to designate what is arguably the most important increase of biodiversity of marine life during Earth's history (Webby et al., 2004). While the "Cambrian explosion" involved the origins of skeletalization and a range of new body plans, the Ordovician biodiversification generated few new higher taxa but witnessed a staggering increase in disparity and biodiversity (e.g., Harper, 2006).

Barnes et al. (1995) reviewed the global bio-events during the Ordovician, and two international research projects have since targeted the Ordovician biodiversification. International Geoscience Programme (IGCP) Project 410, "The Great Ordovician Biodiversification Event" (1997–2002), resulted in a compilation of biodiversity curves for all fossil groups of the Ordovician biota (Webby et al., 2004). In this compilation, the dramatic increase of diversity of all groups at the specific and/or the generic level became obvious and confirmed the patterns based on previous diversity counts (e.g., Sepkoski, 1981). IGCP 503 started in 2004 under the banner of "Ordovician Palaeogeography and Palaeoclimate" and has focused on the causes and the geological context of the Ordovician biodiversification, including radical changes in the marine trophic chains. Possible triggers of the GOBE may include the near-unique paleogeography, the distinctive paleoclimate, the highest sea levels of the Paleozoic (if not the entire Phanerozoic), enhanced nutrient supply as a result of pronounced volcanic activity, and major ecological changes. In addition to these Earth-bound physical and biological drivers of biodiversity change, Schmitz et al. (2008) linked the onset of the major phase of the Ordovician biodiversification with the largest documented asteroid breakup event during the past few billion years. It seems likely that the GOBE was linked to a variety of coincident and interconnected factors. Here we review recent studies, ask "What generated the GOBE?" and indicate the perspectives for future research in this exciting and rapidly advancing field.

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THE GREAT ORDOVICIAN BIODIVERSIFICATION EVENT (GOBE)

The "Cambrian explosion" and the GOBE were the two most significant evolutionary events in the history of Paleozoic marine life. Most animal phyla were already present by the mid-Cambrian, but a dramatic diversity increase at the order, family, and genus levels took place in the Ordovician, during which marine paleobiodiversity tripled (Harper, 2006). Based on multivariate statistical analyses, Sepkoski (e.g., 1981, 1991) defined three Evolutionary Faunas (EF—the Cambrian, Paleozoic, and Modern Evolutionary Faunas) and indicated that during the Ordovician, the Paleozoic EF, dominated by groups of suspension-feeding organisms, became the most significant component of the marine shelf biotas (Fig. 1). In addition to the EFs, other authors have defined Ecological-Evolutionary Units (EEUs)—long intervals of Phanerozoic time during which marine communities maintained stable ecological structures. The 12 EEUs, defined by Boucot (1983), were revised by Sheehan (1996, 2001a), who reduced their number to nine. Four EEUs are defined primarily on the Paleozoic EF, with two (P1 and P2) recognized in the Ordovician (Fig. 1A), and distinguished on the basis of taxonomic diversity, morphological disparity, and ecological change (Sheehan, 1996; Droser et al., 1997; Droser and Sheehan, 1997).

Several authors have considered the GOBE to be rooted in the 545–530 Ma Cambrian explosion (e.g., Droser and Finnegan, 2003). Our knowledge of Cambrian faunas is enhanced by exceptionally preserved assemblages (e.g., the Burgess Shale) that allow a glimpse of the range of new body plans generated by the Cambrian explosion. Early molecular-clock data suggested that animal lineages split some 800 Ma or more ago before their appearance in the fossil record (Wray et al., 1996), but this has been recalibrated to ca. 670 Ma (e.g., Peterson et al., 2005). After the Cambrian explosion, ~40–80 Ma passed before the diversity of the new phyla "exploded" during the Early and Middle Ordovician (485–460 Ma). This "explosion" in terms of diversity at the order, family, genus, and species level occurred during a short time span of only 25 Ma, which is why the GOBE is considered the most rapid diversity increase in marine life during Earth's history. By the end of the Middle Ordovician, the so-called Paleozoic Plateau, evident in the diversity curves generated by Sepkoski, was reached, and it persisted until the abrupt Permian-Triassic extinction ~200 Ma later (Fig. 1A). Even in the more recent biodiversity curves that take account of potential biases in the earlier analyses, the major biodiversification that occurred during the Ordovician is clear (e.g., Alroy et al., 2008).

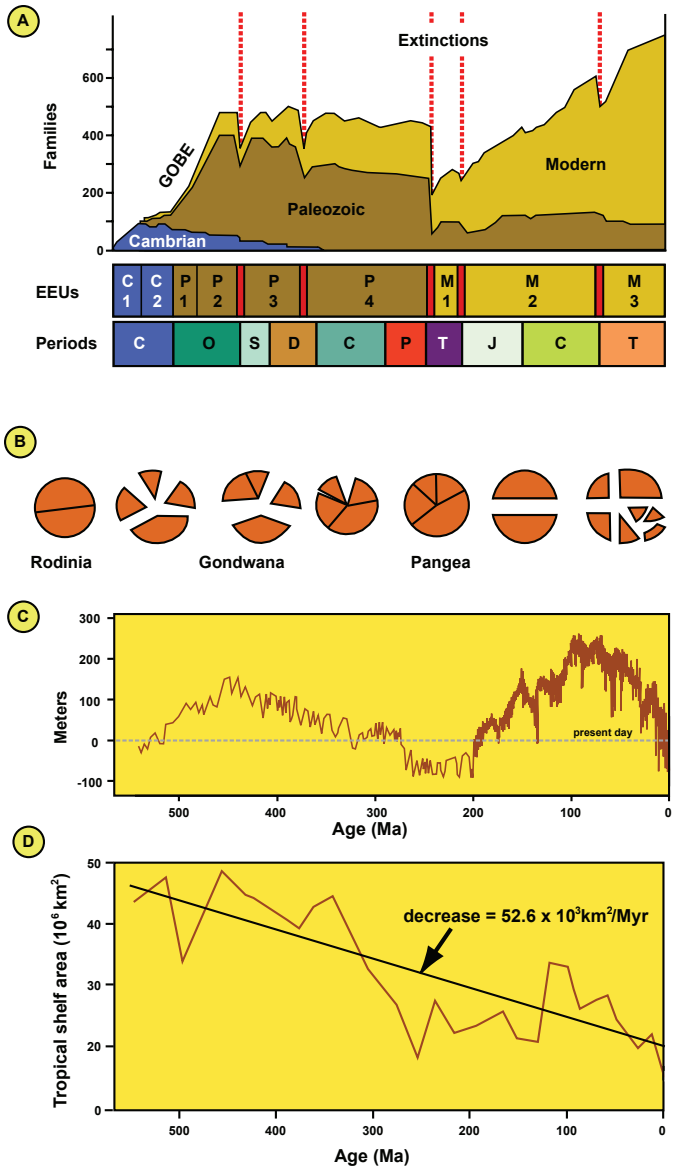

Figure 1. (A) The classical "Sepkoski" diversity curve of marine invertebrate families through Phanerozoic time, documenting the Cambrian, Paleozoic, and Modern Evolutionary Faunas, the Great Ordovician Biodiversification Event (GOBE), and the "Big Five" mass extinctions of marine invertebrates. Ecological-Evolutionary Units (EEUs) after Sheehan (1996): C1–2—Cambrian; P1–4—Paleozoic; M1–3—Modern. Geological periods, from left to right: C—Cambrian; O—Ordovician; S—Silurian; D—Devonian; C—Carboniferous; P—Permian; T—Triassic; J–Jurassic; C—Cretaceous; T—Tertiary. (B) Model of continental spreading with the supercontinents Rodinia and Pangea, based on Valentine and Moores (1972). (C) Phanerozoic global sea-level curve after Miller et al. (2005). (D) Abundance of tropical shelf areas over Phanerozoic time, after Walker et al. (2002).

ORDOVICIAN PALEOGEOGRAPHY

The Cambrian-Ordovician and the Mesozoic-Cenozoic increases of marine diversity have long been related to large-scale paleogeographical changes (e.g., Crame and Owen, 2002; but see also Alroy et al., 2008, who considered the younger of the two diversifications to have culminated in the mid-Cretaceous). Valentine and Moores (1972) proposed a link between the break-up of the Neoproterozoic supercontinent (subsequently termed Rodinia or Pannotia) and the Cambrian-Ordovician diversification on the one hand, and the rifting of the Late Paleozoic supercontinent Pangea with the Mesozoic-Cenozoic radiations on the other. According to this model, geological intervals with supercontinents correlate with lower marine diversity, while periods with widely separated continents and large numbers of microcontinents can be related to intervals of higher diversity (Fig. 1B).

The Ordovician had the greatest continental dispersal of the Paleozoic and was a time of rapid sea-floor spreading. A number of separate continents had emerged and separated after the

break-up of the Proterozoic Rodinia supercontinent, including Gondwana, South China, Laurentia, Baltica, and Siberia (Cocks and Torsvik, 2002, 2006). Rifting of the margins of Gondwana gave birth to a number of terranes and microcontinents, such as Avalonia, that drifted rapidly away. Magmatic and tectonic processes generated a number of archipelagos, such as those of the Celtic province (Harper et al., 1996). These paleocontinents and additional minor terranes reached their maximum separation during the Ordovician (Fig. 2); this separation, differences in latitude, and changes in major ocean circulation currents brought about the greatest geographical differentiation of faunas on Earth. While the description of bioprovinces was originally limited to benthic fossil groups (see Fortey and Cocks, 2003), faunal and microfloral provinces have subsequently also been recognized in many planktonic and nektonic organisms (Servais et al., 2003, 2005).

By the late Ordovician, several of these crustal blocks were moving toward each other again, with a consequent loss of biogeographical identity. Baltica and Laurentia, together with Avalonia, formed Laurussia during the Silurian. In the Devonian, Gondwana started to collide with Laurussia, and the Carboniferous amalgamation of all the continents led to the supercontinent Pangea, with a consequent reduction of flooded continental shelf areas (Cocks and Torsvik, 2006).

It is interesting to compare the Ordovician oceanic distribution with the modern-day oceans; today, the centers of marine diversification are in the tropical shelf sea areas of Southeast Asia and, to a lesser extent, the Caribbean Sea. The Ordovician was not only a period with the greatest continental separation but also the geological interval with the largest tropical shelf area in Earth's history (Walker et al., 2002). The extent of global shelves increased from the Early Cambrian to a maximum during the Middle Ordovician; they decreased to their lowest levels at the Permian-Triassic boundary (Walker et al., 2002). A similar extent of global shelves was reached in the Late Cretaceous, but it was not as great in the tropics as it was during the Middle Ordovician (Fig. 1D).

ORDOVICIAN CLIMATE AND SEA LEVEL

A primary objective of IGCP 503 has been to understand the relationship between biodiversification of the different fossil organisms and changes in seawater temperatures, sea level, and atmospheric CO_2. Until recently, the Ordovician was considered to be part of an extended greenhouse period, punctuated by the short-lived Late Ordovician Hirnantian glaciation (e.g., Brenchley et al., 1994). This glaciation was a causal factor in the first of the five major mass extinctions in the Phanerozoic (Harper and Rong, 1995; Sheehan, 2001b)

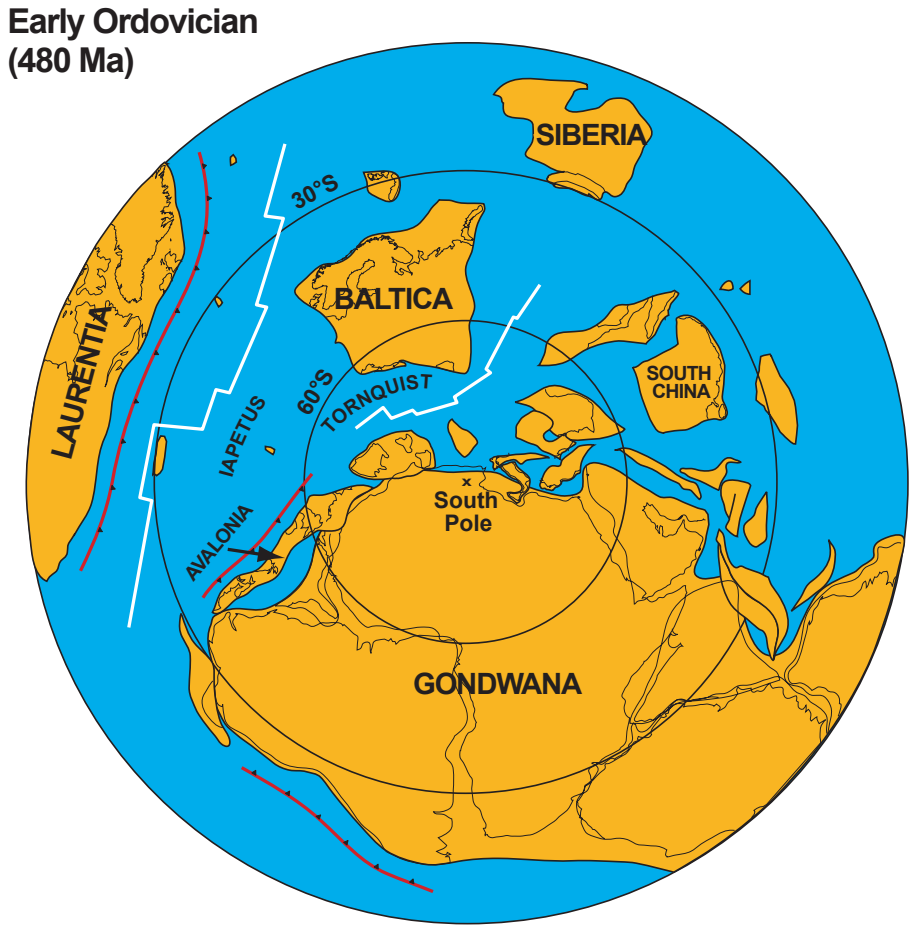

Figure 2. Early Ordovician paleogeographical reconstruction, based on Cocks and Torsvik (2002).

that severely interrupted the biodiversification process. The late Ordovician cooling is now recognized to have taken place over a more extensive period as a sequence of cooling and warming events that started during the Katian (mid- to late Caradoc) (e.g., Saltzman and Young, 2005) and culminated in the Hirnantian glaciation.

Saltzman (2005) argued that during the greenhouse period, which spanned most of the Cambrian and Ordovician, large positive $\delta^{13}C_{carb}$ excursions were absent, indicating a stable interval between the Late Cambrian Steptoan and the Late Ordovician isotope excursions. The stable conditions during most of the Early and Middle Ordovician may have been conducive to the development of the GOBE. However, Trotter et al. (2008) argued that a significant cooling of the Ordovician oceans triggered the biodiversification. They used ion microprobe oxygen isotope analyses of Early Ordovician–Silurian conodonts to indicate a steady cooling of the Ordovician tropical seawater from levels >40 °C in the lowermost Ordovician to values of 28–32 °C by the Middle Ordovician, when the GOBE took place. These values correspond to temperature ranges in modern oceans. However, the Trotter et al. model contradicts previous temperature models (e.g., Veizer et al., 2000), and further investigations are needed to clarify whether conodont thermometry is a reliable tool for inferring the seawater temperatures of ancient oceans.

In terms of atmospheric CO_2, the Cambrian-Ordovician levels of pCO_2 are considered to be the highest in the Phanerozoic, reaching up to 15 times present day (Quaternary average) values (e.g., Berner and Kothavala, 2001). These high levels of pCO_2 were critical for maintaining a favorable climate for life, because solar luminosity was much lower than today (e.g., Gibbs et al., 1997). The presence of a mantle superplume, as postulated by Barnes (2004b), could have contributed to high pCO_2 levels but may also have increased seawater temperature.

During the dispersal of tectonic plates in the Ordovician, which resulted in abundant young oceanic crust, sea levels were high—possibly the highest in Earth's history (e.g., Hallam, 1992; Barnes, 2004a). There are few precise Ordovician sea-level curves, and intercontinental correlations remain speculative (e.g., Ross and Ross, 1992; Nielsen, 2004); however, there is a consensus that sea levels were on a rising trend, albeit interrupted by regressions, from the earliest Cambrian (when they were similar to those of the present day) to the Late Ordovician, when levels reached >200 m above present-day levels (e.g., Haq and Schutter, 2008). Sea levels decreased during the latest Ordovician to reach a minimum during the glaciation near the Ordovician-Silurian boundary before a further significant rise took place during the Llandovery. The Cambrian to mid-Ordovician interval, therefore, is characterized by a long-term sea-level rise that took place over 90–100 Ma. This sea-level rise can be correlated with an extended Cambrian-Ordovician radiation. The sea-level fall in the latest Ordovician can be related to the first of the "Big Five" mass extinctions, while the subsequent sea-level rise in the Llandovery accompanied the post-extinction recovery (Fig. 3C). Smaller-scale sea-level changes of second or third order are difficult to interpret, and future research is needed to relate regional sea-level curves with the biodiversification of fossil groups from individual paleocontinents.

ORDOVICIAN PALEOECOLOGY: REVOLUTION IN THE TROPHIC CHAIN?

Paleoecological changes can be considered at four hierarchical levels: (1) the appearance and/or disappearance of an ecosystem; (2) structural changes within an ecosystem; (3) community-type changes; and (4) community-level changes (Bottjer et al., 2001; Harper, 2006). Bottjer et al. (2001) identified changes at the second, third, and fourth levels throughout the GOBE. The most obvious change is the transition from the trilobite-dominated Cambrian EF to the suspension-feeder–dominated Paleozoic EF. Other important changes in the benthos include the evolution of deep-mobile burrowers, above-substrate tiering, and the set-up of new reef communities based on stromatoporoids and corals.

Early work suggests that the increased presence of phytoplankton after the Late Cambrian stimulated the evolution of organisms to feed on this new food source and to extend their ranges into new benthic and pelagic habitats (Bambach, 1983, 1993). A "phytoplankton explosion" may, therefore, have been a trigger for the GOBE (Vecoli et al., 2005; Lehnert et al., 2007). Servais et al. (2008) considered the major arrival of planktonic organisms during the GOBE as a revolution in the marine trophic chain. According to these authors, the Early Cambrian to Late Ordovician increase of sea level and the related expansion of continental shelf areas to their maximum extent in the Middle to early Late Ordovician led to a slow but continuous increase in the diversity of organic-walled microphytoplankton (acritarchs). This is analogous to the development of the dinoflagellates (now the dominant part of Recent organic-walled microphytoplankton), which reached their greatest diversity at the end of the Cretaceous, some 100 Ma after their first appearance in the Triassic.

Servais et al. (2008) showed that the acritarch diversity increased during the Early and Middle Ordovician to reach its highest Paleozoic values during the late Middle Ordovician (Fig. 3B). Similar high levels of acritarch diversity were maintained during the subsequent Silurian and Devonian "Paleozoic phytoplankton plateau." The acritarchs probably represent an important part of the Paleozoic organic-walled microphytoplankton, but it is not possible to relate acritarch diversity directly to increased bioproductivity (abundance). It seems likely, however, that the increased presence of food in the water column promoted the expansion of suspension feeders in the benthos and the development of zooplanktic groups in the pelagic realm (e.g., Vannier et al., 2003).

The presence of dinoflagellate-like microphytoplankton in Ordovician seas thus not only led to the development of the suspension feeders that dominate the Paleozoic EF, but also to the rise of zooplanktonic organisms (graptolites, chitinozoans and radiolarians, etc.), which probably served as food for the many predators swimming freely in the water column. This "plankton revolution" fits with the development of above-substrate tiering (Ausich and Bottjer, 1982) and the view that the increased food supply in the water column was responsible for the rise of suspension feeders (Signor and Vermeij, 1994). Rigby (1997) noted that planktic groups mostly developed from the benthos; groups of animals with planktic larvae were able to become planktic adults by paedomorphosis. The migration to the planktic realm occurred throughout the late Proterozoic

and Phanerozoic and seems to have occurred randomly through time (Rigby, 1997); however, it is now evident that some groups already present in the Cambrian only diversified in the Ordovician, and this was possibly related to the increased presence of microphytoplankton (but possibly of picoplankton and bacterioplankton as well) in the water column.

Interestingly, the plankton revolution is also observed within larval stages of various organisms. Planktonic feeding larvae developed after the Late Cambrian, possibly as an escape strategy from increasing predation pressure due to the appearance of benthic suspension feeders (Signor and Vermeij, 1994). Nützel et al. (2006) found the first direct evidence for planktotrophy in gastropods at the Cambrian-Ordovician transition. Molecular-clock data and analysis of the fossil record also support this interpretation, with Peterson (2005) noting that planktotrophy evolved independently between the latest Cambrian and Middle Ordovician at least four different times in multiple lineages.

There is thus now enough evidence to suggest that the evolution from the Cambrian EF to the Paleozoic EF, as recognized some 30 years ago, is the result of an important change in the base of the food chain between the Cambrian and Ordovician. While Precambrian and Cambrian communities were mostly limited to the sea bottom, the Ordovician radiation filled the water column as animals adapted to life in previously unoccupied ecospace. Benthic organisms tiered higher above the substrate and increased burrowing depth while plankton increased dramatically. Furthermore, habitats that had been occupied in the Cambrian were invaded by new groups.

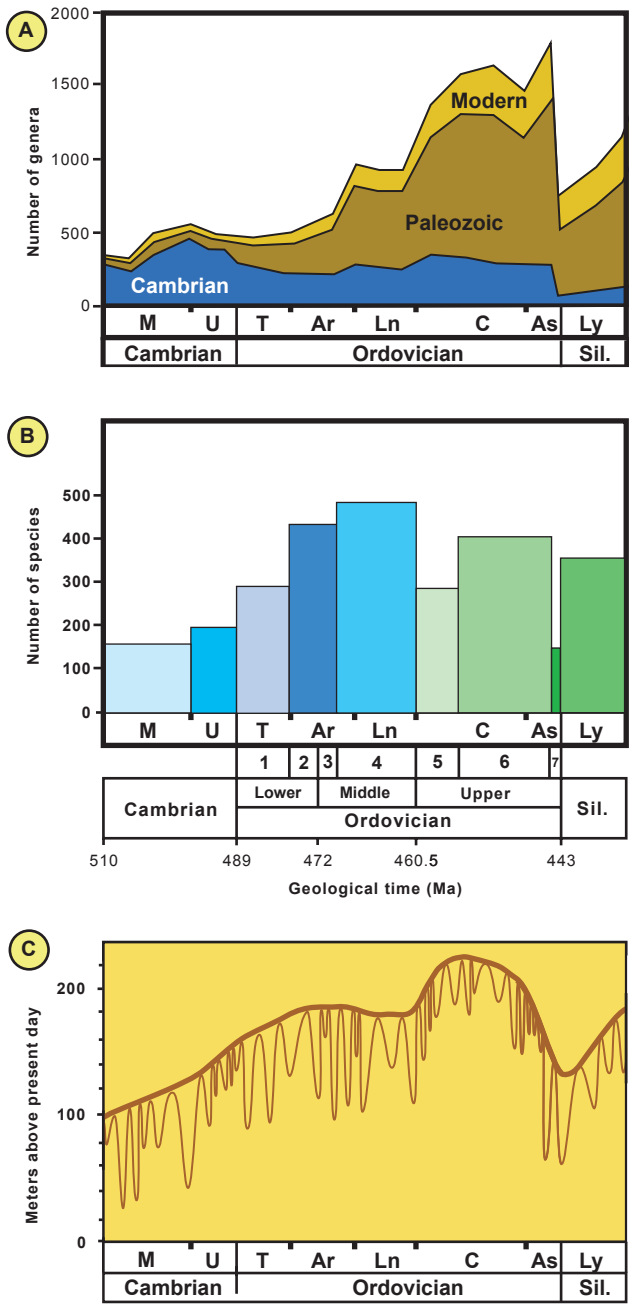

Figure 3. Correlation of diversity curves of (A) marine invertebrates (Webby et al., 2004, their figure 1.1.); (B) organic-walled microphytoplankton (Servais et al., 2008, their figure 1); and (C) the global sea level (Haq and Schutter, 2008). M—Middle Cambrian; U—Upper Cambrian; T—Tremadoc; Ar—Arenig; Ln—Llanvirn; C—Caradoc; As—Ashgill; Ly—Llandovery (British series); 1—Tremadocian; 2—Floian; 3—Dapingian; 4—Darriwilian; 5—Sandbian; 6—Katian; 7—Hirnantian (Global Stages); Sil.—Silurian.

OTHER POSSIBLE TRIGGERS OF THE GOBE

Coupled with the movement of the continents and terranes, the Ordovician (together with the Cretaceous) saw the most extensive volcanism in the Phanerozoic (e.g., Bergström et al., 2004; Barnes, 2004b), possibly including superplume activity during the main interval of the GOBE (Barnes, 2004b). As well as affecting global climate, volcanism would deliver large amounts of inorganic nutrient to the oceans, as would the erosional products of the mountain belts produced by collision of terranes with continental margins, such as the Caledonian-Appalachian orogen. It is likely that the abundant trace elements supplied to the oceans provided fuel for the GOBE.

A more spectacular but controversial proposal is that the GOBE is related to the 470 Ma disruption in the asteroid belt of the L-chondrite parent body, the largest documented asteroid breakup event in the past few billion years (Schmitz et al., 2008). Parnell (2009) considered the Middle Ordovician megabreccias found on several palaeoplates and terranes to have formed as a result of seismic activity following a high influx of meteorites. Schmitz et al. (2008) recorded meteorites and craters from Baltoscandia together with extraterrestrial chromite and osmium isotopes in strata from Baltoscandia and China and suggested that the impacts on Earth of kilometer-sized asteroids accelerated the biodiversification. Paris (2008) pointed out that the major problem with the data set of Schmitz et al. (2008) is that the GOBE does not match the timing of the impacts. However, Schmitz et al. (2008) noted that the global stratigraphic data set is too crude to test for correlation of the GOBE with the increased flux of meteorites and extraterrestrial chromite on Baltica, but where accurate faunal data are available, from, for example, western Russia (Rasmussen et al., 2007), there is a precise match.

The asteroid impact hypothesis highlights two important points. First, bed-by-bed collection of data is necessary to test many of the emerging and provocative models for the GOBE. Second, some aspects of the GOBE are diachronous (e.g., Zhan and Harper, 2006); what may work for Baltica may not neces-

sarily apply in South China. This reinforces the plea by Miller (e.g., 1997, 2004) to dissect the global patterns of biodiversity change at smaller geographical scales and in different taxonomic groups in order to understand them.

CONCLUSIONS

The GOBE may have had Cambrian roots and can be viewed as a follow-up to the Cambrian explosion. Body plans had to be in place before diversifications at lower taxonomic levels could follow. The "Cambrian explosion" and the GOBE seem indeed to be linked as part of a single, large-scale evolutionary package of marine life that developed over ~100 Ma, but the significant time lag between the two requires explanation. On the global scale, some of the terrestrial processes that may have promoted the GOBE were part of a continuum from the Cambrian into the Middle Ordovician: continental divergence and the development of new terranes with their own provincial structures, the increase in shelf area (including that in the tropics), and climate and sea-level change. Volcanic activity and tectonism may have been more episodic as, certainly, was asteroid impact. Many of the terrestrial processes were interrelated and impinged on both the benthos and the plankton, and the revolution in the latter probably had a major effect on the former. The GOBE probably had more to do with positive feedbacks and the crossing of thresholds than with abrupt triggers. The recent international research effort has enhanced our understanding of many of the processes involved. The cumulative effect of these processes was a massive increase in diversity within the major clades that developed in the Cambrian explosion and set the scene for the rest of the Paleozoic.

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REFERENCES CITED

Alroy, J., and 34 others, 2008, Phanerozoic trends in global diversity of marine invertebrates: Science, v. 321, p. 97–100, doi: 10.1126/science.1156963.

Ausich, W.I., and Bottjer, D.J., 1982, Tiering in suspension-feeding communities on soft substrata throughout the Phanerozoic: Science, v. 216, p. 173–174, doi: 10.1126/science.216.4542.173.

Bambach, R.K., 1983, Ecospace utilization and guilds in marine communities through the Phanerozoic, *in* Tevesz, M., and McCall, P., eds., Biotic Interactions in Recent and Fossil Benthic Communities: New York, Plenum, p. 719–746.

Bambach, R.K., 1993, Seafood through time: Changes in biomass, energetics, and productivity in the marine ecosystem: Paleobiology, v. 19, p. 372–397.

Barnes, C.R., 2004a, Ordovician oceans and climates, *in* Webby, B.D., Droser, M.L., Paris, F., and Percival, I., eds., The Great Ordovician Biodiversification Event: New York, Columbia University Press, p. 72–76.

Barnes, C.R., 2004b, Was there an Ordovician Superplume event? *in* Webby, B.D., Droser, M.L., Paris, F., and Percival, I., eds., The Great Ordovician Biodiversification Event: New York, Columbia University Press, p. 77–80.

Barnes, C.R., Fortey, R.A., and Williams, S.H., 1995, The pattern of global bio-events during the Ordovician Period, *in* Walliser, O.H., ed., Global Events and Event Stratigraphy: Berlin, Springer-Verlag, p. 139–172.

Bergström, S.M., Huff, W.D., Saltzman, M.R., Kolata, D.R., and Leslie, S.A., 2004, The greatest volcanic ash falls in the Phanerozoic: Millbrig and Kinekulle K-bentonites: The Sedimentary Record, v. 2, no. 4, p. 4–7.

Berner, R.A., and Kothavala, Z., 2001, GEOCARB III: A revised model of atmospheric CO_2 over Phanerozoic time: American Journal of Science, v. 301, p. 182–204, doi: 10.2475/ajs.301.2.182.

Bottjer, D.J., Droser, M.L., Sheehan, P.M., and McGhee, G.R., Jr., 2001, The ecological architecture of major events in the Phanerozoic history of marine life, *in* Allmon, W.D., and Bottjer, D.J., eds., Evolutionary Paleoecology. The Ecological Context of Macroevolutionary Change: New York, Columbia University Press, p. 35–61.

Boucot, A.J., 1983, Does evolution take place in an ecological vacuum? II: Journal of Paleontology, v. 57, p. 1–30.

Brenchley, P.J., Marshall, J.D., Carden, J.A.F., Robertson, D.B.R., Long, D.G.F., Meidla, T., Hints, L., and Anderson, T.F., 1994, Bathymetric and isotopic evidence for a short-lived late Ordovician glaciation in a greenhouse period: Geology, v. 22, p. 295–298, doi: 10.1130/0091-7613(1994)022<0295:BAIEFA>2.3.CO;2.

Cocks, L.R.M., and Torsvik, T.H., 2002, Earth geology from 500 to 400 million years ago: A faunal and palaeomagnetic review: Journal of the Geological Society, v. 159, p. 631–644, doi: 10.1144/0016-764901-118.

Cocks, L.R.M., and Torsvik, T.H., 2006, European geography in a global context from the Vendian to the end of the Palaeozoic, *in* Gee, D.G., and Stephenson, R.A., eds., European Lithosphere Dynamics: London, Geological Society Memoir 32, p. 83–95.

Crame, J.A., and Owen, A.W., eds., 2002, Palaeobiogeography and Biodiversity Change: The Ordovician and Mesozoic-Cenozoic Radiations: London, Geological Society Special Publication 194, 206 p.

Droser, M.L., and Finnegan, S., 2003, The Ordovician radiation: A follow-up to the Cambrian explosion: Integrative and Comparative Biology, v. 43, p. 178–184, doi: 10.1093/icb/43.1.178.

Droser, M.L., and Sheehan, P.M., 1997, Palaeoecology of the Ordovician Radiation: Resolution of large-scale patterns with individual clade histories, palaeogeography and environments: Geobios, v. 30, p. 221–229, doi: 10.1016/S0016-6995(97)80027-7.

Droser, M.L., Bottjer, D.J., and Sheehan, P.M., 1997, Evaluating the ecological architecture of major events in the Phanerozoic history of marine invertebrate life: Geology, v. 25, p. 167–170, doi: 10.1130/0091-7613(1997)025<0167:ETEAOM>2.3.CO;2.

Fortey, R.A., and Cocks, L.R.M., 2003, Palaeontological evidence bearing on global Ordovician–Silurian continental reconstructions: Earth-Science Reviews, v. 61, p. 245–307, doi: 10.1016/S0012-8252(02)00115-0.

Gibbs, M.T., Barron, E.J., and Kump, L.R., 1997, An atmospheric pCO_2 threshold for glaciation in the Late Ordovician: Geology, v. 25, p. 447–450, doi: 10.1130/0091-7613(1997)025<0447:AAPCTF>2.3.CO;2.

Hallam, A., 1992, Phanerozoic Sea-Level Changes: New York, Columbia University Press, 266 p.

Haq, B.U., and Schutter, S.R., 2008, A chronology of Paleozoic sea-level changes: Science, v. 322, p. 64–68, doi: 10.1126/science.1161648.

Harper, D.A.T., 2006, The Ordovician biodiversification: Setting an agenda for marine life: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 232, p. 148–166, doi: 10.1016/j.palaeo.2005.07.010.

Harper, D.A.T., and Rong, J.Y., 1995, Patterns of change in the brachiopod faunas through the Ordovician-Silurian interface: Modern Geology, v. 20, p. 83–100.

Harper, D.A.T., Mac Niocaill, C., and Williams, S.H., 1996, Palaeogeography of early Ordovician Iapetus terranes: Integration of faunal and palaeomagnetic data: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 121, p. 297–312, doi: 10.1016/0031-0182(95)00079-8.

Lehnert, O., Vecoli, M., Servais, T., and Nützel, A., 2007, Did plankton evolution trigger the Ordovician diversifications?: Acta Palaeontologica Sinica, v. 46, p. 262–268.

Miller, A.I., 1997, Dissecting global diversity patterns: Annual Review of Ecology and Systematics, v. 28, p. 85–104, doi: 10.1146/annurev.ecolsys.28.1.85.

Miller, A.I., 2004, The Ordovician Radiation: Towards a new global synthesis, *in* Webby, B.D., Droser, M.L., Paris, F., and Percival, I., eds., The Great Ordovician Biodiversification Event: New York, Columbia University Press, p. 380–388.

Miller, K.G., Kominz, M.A., Browning, J.V., Wright, J.D., Mountain, G.S., Katz, M.E., Sugarman, P.J., Cramer, B.S., Christie-Blick, N., and Pekar, S.F., 2005, The Phanerozoic record of global sea-level change: Science, v. 310, p. 1293–1298, doi: 10.1126/science.1116412.

Nielsen, A.T., 2004, Ordovician sea level changes: A Baltoscandian perspective, *in* Webby, B.D., Droser, M.L., Paris, F., and Percival, I., eds., The Great Ordovician Biodiversification Event: New York, Columbia University Press, p. 84–93.

Nützel, A., Lehnert, O., and Frýda, J., 2006, Origin of planktotrophy—evidence from early molluscs: Evolution & Development, v. 8, p. 325–330, doi: 10.1111/j.1525-142X.2006.00105.x.

Paris, F., 2008, Meteoritic spur to life?: Nature Geoscience, v. 1, p. 18–19, doi: 10.1038/ngeo.2007.63.

Parnell, J., 2009, Global mass wasting at continental margins during Ordovician high meteorite influx: Nature Geoscience, v. 2, p. 57–61, doi: 10.1038/ngeo386.

Peterson, K.J., 2005, Macroevolutionary interplay between planktic larvae and benthic predators: Geology, v. 33, p. 929–932, doi: 10.1130/G21697.1.

Peterson, K.J., McPeek, M.A., and Evans, D.A.D., 2005, Tempo and mode of early animal evolution: Inference from rocks, Hox, and molecular clocks: Paleobiology, v. 31, supplement, p. 36–55, doi: 10.1666/0094-8373(2005)031[0036:TAMOEA]2.0.CO;2.

Rasmussen, C.M.Ø., Hansen, J., and Harper, D.A.T., 2007, Baltica: A mid Ordovician diversity hotspot: Historical Geology, v. 19, p. 255–261, doi: 10.1080/08912960601151744.

Rigby, S., 1997, A comparison of the colonization of the planktic realm and the land: Lethaia, v. 30, p. 11–17.

Ross, J.R.P., and Ross, C.A., 1992, Ordovician sea-level fluctuation, *in* Webby, B.D., and Laurie, J.R., eds., Proceedings of the Sixth International Symposium on the Ordovician System, University of Sydney, Australia, 15–19 July 1991: Global Perspectives on Ordovician Geology: Rotterdam, A. Balkema, p. 327–335.

Saltzman, M.R., 2005, Phosphorus, nitrogen, and the redox evolution of the Paleozoic oceans: Geology, v. 33, p. 573–576, doi: 10.1130/G21535.1.

Saltzman, M.R., and Young, S.A., 2005, Long-lived glaciation in the Late Ordovician? Isotopic and sequence-stratigraphic evidence from western Laurentia: Geology, v. 33, p. 109–112, doi: 10.1130/G21219.1.

Schmitz, B., Harper, D.A.T., Peucker-Ehrenbrink, B., Stouge, S., Alwmark, C., Cronholm, A., Bergström, S.M., Tassinari, M., and Wang, X.F., 2008, Asteroid breakup linked to the Great Ordovician Biodiversification Event: Nature Geoscience, v. 1, p. 49–53, doi: 10.1038/ngeo.2007.37.

Sepkoski, J.J., Jr., 1981, A factor analytical description of the Phanerozoic marine fossil record: Paleobiology, v. 7, p. 36–53.

Sepkoski, J.J., Jr., 1991, A model for onshore-offshore change in faunal diversity: Paleobiology, v. 17, p. 157–176.

Servais, T., Li, J., Molyneux, S.G., and Raevskaya, E., 2003, Ordovician organic-walled microphytoplankton (acritarch) distribution: The global scenario: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 195, p. 149–172, doi: 10.1016/S0031-0182(03)00306-7.

Servais, T., Blieck, A., Caridroit, M., Chen, X., Paris, F., and Tortello, F., 2005, Use and utility of plankton and nekton for Ordovician palaeogeographical reconstructions: Bulletin de la Société Géologique de France, v. 176, p. 531–543, doi: 10.2113/176.6.531.

Servais, T., Lehnert, O., Li, J., Mullins, G.L., Munnecke, A., Nützel, A., and Vecoli, M., 2008, The Ordovician biodiversification: Revolution in the oceanic trophic chain: Lethaia, v. 41, p. 99–109, doi: 10.1111/j.1502-3931.2008.00115.x.

Sheehan, P.M., 1996, A new look at Ecological Evolutionary Units (EEUs): Palaeogeography, Palaeoclimatology, Palaeoecology, v. 127, p. 21–32, doi: 10.1016/S0031-0182(96)00086-7.

Sheehan, P.M., 2001a, History of marine diversity: Geological Journal, v. 36, p. 231–249, doi: 10.1002/gj.890.

Sheehan, P.M., 2001b, The Late Ordovician mass extinction: Annual Review of Earth and Planetary Sciences, v. 29, p. 331–364, doi: 10.1146/annurev.earth.29.1.331.

Signor, P.W., and Vermeij, G., 1994, The plankton and the benthos: Origins and early history of an evolving relationship: Paleobiology, v. 20, p. 297–319.

Trotter, J.A., Williams, I.S., Barnes, C.R., Lécuyer, C., and Nicoll, R.S., 2008, Did cooling oceans trigger Ordovician biodiversification? Evidence from conodont thermometry: Science, v. 321, p. 550–554, doi: 10.1126/science.1155814.

Valentine, J.W., and Moores, E.M., 1972, Global tectonics and the fossil record: The Journal of Geology, v. 80, p. 167–184.

Vannier, J., Racheboeuf, P.R., Brussa, E.D., Williams, M., Rushton, A.W.A., Servais, T., and Siveter, D.J., 2003, Cosmopolitan arthropod zooplankton in Ordovician seas: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 195, p. 173–191, doi: 10.1016/S0031-0182(03)00307-9.

Vecoli, M., Lehnert, O., and Servais, T., 2005, The role of marine microphytoplankton in the Ordovician Biodiversification Event: Carnets de Géologie/Notebooks in Geology, Memoir v. 2005/02, p. 69–70.

Veizer, J., Goddéris, Y., and François, L.M., 2000, Evidence for decoupling of atmospheric CO_2 and global climate during the Phanerozoic eon: Nature, v. 408, p. 698–701, doi: 10.1038/35047044.

Walker, L.J., Wilkinson, B.H., and Ivany, L.C., 2002, Continental drift and Phanerozoic carbonate accumulation in shallow-shelf and deep-marine settings: The Journal of Geology, v. 110, p. 75–87, doi: 10.1086/324318.

Webby, B.D., Droser, M.L., Paris, F., and Percival, I., eds., 2004, The Great Ordovician Biodiversification Event: New York, Columbia University Press, 484 p.

Wray, G.A., Levinton, J.S., and Shapiro, L.M., 1996, Molecular evidence for deep pre-Cambrian divergences amongst metazoan phyla: Science, v. 274, p. 568–573, doi: 10.1126/science.274.5287.568.

Zhan, R.B., and Harper, D.A.T., 2006, Biotic diachroneity during the Ordovician Radiation: evidence from South China: Lethaia, v. 39, p. 211–226, doi: 10.1080/00241160600799770.

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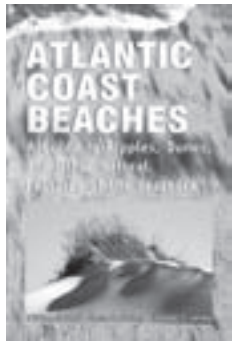

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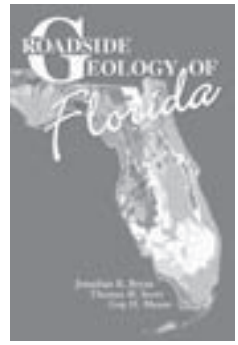

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- You will be provided one horizontal, freestanding 8-ft by 4-ft display board and Velcro for hanging your poster at no charge.
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- The normal length of an oral presentation is 12 minutes, plus three minutes for Q&A.
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- If you purchase an annual meeting *Abstracts with Programs* book, please know that it will not be mailed prior to the meeting, due to the later abstracts submission deadline.
- Joint Technical Program organizers will decide whether to place your paper in an oral session, and their decision is final.

DISCIPLINE CATEGORIES

Can't find a topical session that fits your abstract? No problem! In addition to the topical sessions, there will be quite a few discipline categories for which you can submit an abstract. Discipline sessions are equally vital to our technical program, so check the following discipline categories, and please feel free to contact the JTPC member associated with your discipline if you have any questions regarding your abstract.

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Richard C. Berg, berg@isgs.illinois.edu

GSA Technical Program Manager
Nancy Wright, nwright@geosociety.org

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GSA Limnogeology Division	limnogeology	Michael Rosen, mrosen@usgs.gov
Marine/Coastal Geology	marine/coastal science	Mark Kulp, mkulp@uno.edu
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Paleoceanography/Paleoclimatology	paleoclimatology/paleoceanography	Sharon Kanfoush, skanfoush@utica.edu
Paleontological Society	paleontology, biogeography/biostratigraphy; paleontology, diversity, extinction, origination; paleontology, paleoecology/taphonomy; paleontology, phylogenetic/morphological patterns	Rowan Lockwood, rxlock@wm.edu; Andrew Bush, andrew.bush@uconn.edu; Ellen Currano, ecurrano@smu.edu
GSA Planetary Geology Division	planetary geology; remote sensing/ geographic info system	Louise Prockter, louise.prockter@jhuapl.edu; Jayne Aubele, jayne.aubele@state.nm.us
Precambrian Geology	Precambrian geology	Joe Meert, jmeert@geology.ufl.edu
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GSA Sedimentary Geology Division	sediments, carbonates; sediments, clastic; stratigraphy	Mark Kulp, mkulp@uno.edu; Troy Rasbury, troy.rasbury@sunysb.edu
Society of Economic Geologists	economic geology	John H. Dilles, dillesj@geo.oregonstate.edu
GSA Structural Geology and Tectonics Division	neotectonics/paleoseismology; structural geology; tectonics	Michele Cooke, cooke@geo.umass.edu; Scott Johnson, johnsons@maine.edu

TOPICAL SESSIONS

T1. Geological Mapping: Key to Successful Management of Water and Land Resources

Cosponsor(s): *GSA Geology and Society Division; Association of American State Geologists; U.S. Geological Survey; British Geological Survey; GSA Geology & Public Policy Committee*

Discipline(s): geoscience information/communication; hydrogeology; engineering geology

Advocate(s): Richard C. Berg, Illinois State Geological Survey, Champaign, Ill.; Holger Kessler, British Geological Survey, Keyworth, Nottingham, UK; E. Donald McKay, Illinois State Geological Survey, Champaign, Ill.; H.A.J. Russell, Geological Survey of Canada, Ottawa, Ontario; David R. Soller, USGS, Reston, Va.; L. Harvey Thorleifson, Univ. of Minnesota, St. Paul, Minn.; Linda Jacobsen, USGS, Reston, Va.

Description: This session will highlight new mapping and innovations in geological mapping, including data management, web accessibility, 3-D, and applications in water and land management.

T2. Geologic Maps, Digital Geologic Maps, Geophysical Maps, and Derivatives from Geologic Maps

Cosponsor(s): *GSA Geology and Society Division; GSA Structural Geology and Tectonics Division; Association of American State Geologists; U.S. Geological Survey; British Geological Survey; GSA Geology & Public Policy Committee*

Discipline(s): geoscience information/communication; hydrogeology; structural geology

Advocate(s): Michael W. Higgins, The Geologic Mapping Institute, Clayton, Ga.; Ralph F. Crawford, The Geologic Mapping Institute, Atlanta, Ga.; Richard C. Berg, Illinois State Geological Survey, Champaign, Ill.; Holger Kessler, British Geological Survey, Keyworth, Nottingham, UK; E. Donald McKay, Illinois State Geological Survey, Champaign, Ill.; David Soller, USGS, Reston, Va.; Hazen Russell; Harvey Thorleifson, Univ. of Minnesota, St. Paul, Minn.; Linda Jacobsen, USGS, Reston, Va.

Description: Almost all geoscience research is based on geologic maps. This session highlights innovations in mapping, data management, Web accessibility, 3-D, and applications in water and land management, as well as using geophysical maps for interpreting crustal features.

T3. Buried Valley Aquifers: From Bedrock to Sediment Hosted Tunnel Valleys

Cosponsor(s): *GSA Hydrogeology Division; GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division*

Discipline(s): hydrogeology; geomorphology; sediments, clastic

Advocate(s): Hazen Russell; Alan Kehew, Western Michigan Univ., Kalamazoo, Mich.

Description: This session will profile emerging knowledge and concepts of buried-valley aquifer geometry, character, hydrochemistry, hydraulics, and the importance of this setting for water supply and shallow energy resources.

T4. Colossal Floods

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*

Discipline(s): Quaternary geology; planetary geology; geomorphology

Advocate(s): Roger Patrick Denlinger, USGS, Vancouver, Wash.

Description: Great floods from huge ice-dammed lakes swept vast tracts of Earth. Topics include geology, geomorphology, sedimentology, and hydraulic modeling.

T6. Luminescence Dating of Overbank (Flood) and Other Fluvial Deposits: Recent Advances and Applications

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*

Discipline(s): Quaternary geology; paleoclimatology/paleoceanography; geomorphology

Advocate(s): Shannon A. Mahan, USGS, Denver, Colo.; Kenneth Lepper, North Dakota State Univ., Fargo, N.Dak.

Description: Optically stimulated luminescence (OSL) dating of fluvial deposits always presents challenges, especially if the deposits were left as a result of floods. Advancements or diverse studies of all fluvial deposits currently being dated by OSL are welcome.

River Place Marina, Portland. Photo courtesy Travel Portland/Edward Nugent and the Portland Oregon Visitors Association.

Portland, Oregon, USA. Photo courtesy Travel Portland/Steve Terrill and the Portland Oregon Visitors Association.

T7. Paleoseismology, Arid-Region Soils, and Quaternary Geology: A Tribute to Michael Machette's 35 Years of Quaternary Research

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*

Discipline(s): Quaternary geology; geomorphology; paleoclimatology/paleoceanography

Advocate(s): Jeffrey R. Knott, California State Univ., Fullerton, Calif.; Janet L. Slate, USGS, Denver, Colo.; C.A. Ruleman, USGS, Denver, Colo.

Description: This session seeks to bring together a variety of scientists to present work directly influenced by Michael Machette. This includes Quaternary topics, such as soils, paleoseismicity, geochronology and geomorphology, and arid-land stratigraphy.

T8. Terroir—The Relationship of Geology, Soils, Hydrology, and Climate to Wine: A Special Tribute to George Moore

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division; GSA Geology and Society Division*

Discipline(s): Quaternary geology; hydrogeology; geomorphology

Advocate(s): Scott F. Burns, Portland State Univ., Portland, Ore.; Vicki Kretsinger, Luhdorff and Scalmanini, Consulting Engineers, Woodland, Calif.; Kevin Pogue, Whitman College, Walla Walla, Wash.; Alan Busacca, Hygiene, Colo.

Description: This session will present papers that communicate the differences in wines relative to geology, soils, hydrology, and climates. The northern Willamette Valley is a great place to study terroir; papers will cover local and regional terroir topics.

T9. Climate Signals in Rivers and Streams

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*

Discipline(s): geomorphology; Quaternary geology; engineering geology

Advocate(s): Christopher Magirl, USGS, Tacoma, Wash.; Daniel Malmon, USGS, Menlo Park, Calif.

Description: Climate shifts are often manifested in the geomorphic response of fluvial systems. This session seeks contributions from theoretical, empirical, and field analyses that examine all scales of river responses to modern and ancient climate shifts.

T10. Geoheritages, Geoantiquities, and Geomorphosites

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division; GSA Geoinformatics Division; GSA History of Geology Division; GSA Geology and Society Division*

Discipline(s): geomorphology; geoscience education; geoscience information/communication

Advocate(s): John F. Shroder, Univ. of Nebraska, Omaha, Neb.

Description: The geological heritage of any nation, especially the United States, lies in the unusual rock and landform sites that need attention and conservation in order to preserve them for future generations and improve and promote education, scientific research, and geotourism.

T11. Geomorphology, Stratigraphy, and Soils, in Upper Willamette Valley Lowlands

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*

Discipline(s): geomorphology; Quaternary geology; stratigraphy

Advocate(s): Frank Reckendorf, Portland State Univ., Portland, Ore.

Description: The geomorphology, stratigraphy, and soils of the Willamette Valley have various interpretations of the origin, age, and geomorphic history. Studies of Irish Bend, before it was covered by riprap, and other areas add new data to the controversy.

T12. Holocene Alluvial Records: New Investigations of Archives of Millennial Change

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*

Discipline(s): geomorphology; Quaternary geology; archaeological geology

Advocate(s): Tammy Rittenour, Utah State Univ., Logan, Utah; Joel Pederson, Utah State Univ., Logan, Utah

Description: This session provides a venue for reporting new approaches and records regarding Holocene fluvial archives of millennial-scale and shorter-term climate response. Papers may include aspects of fluvial geomorphology, cosmogenic sediment yield, paleoflood hydrology, geoarchaeology, and geochronology.

T13. Hydrogeomorphic and Ecohydrologic Consequences of Extraordinary Sediment Loading

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division*

Discipline(s): geomorphology; sediments, clastic; engineering geology

Advocate(s): Jon Major, Cascades Volcano Observatory, Vancouver, Wash.; Jim O'Connor, Portland, Ore.

Description: Many natural and anthropogenically induced events deliver sediment to rivers in amounts that greatly exceed mean annual loads. We seek contributions that examine the physical and biological consequences (at all scales) of extraordinary sediment inputs to river systems.

T14. Sequential and Repeat Photography as a Tool for Earth and Environmental Science Research and Education (Posters)

Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Geoscience Education Division*

Discipline(s): geomorphology; geoscience education; Quaternary geology

Advocate(s): Paul Bierman, Univ. of Vermont, Burlington, Vt.; Christine Massey, Univ. of Vermont, Burlington, Vt.; Jamie Russell, Univ. of Vermont, Burlington, Vt.

Description: Photographs document Earth's dynamic surface, revealing climate change and human impact on the landscape. This session will involve researchers and educators using images to study how rivers, glaciers, volcanoes, and other landforms change over time.

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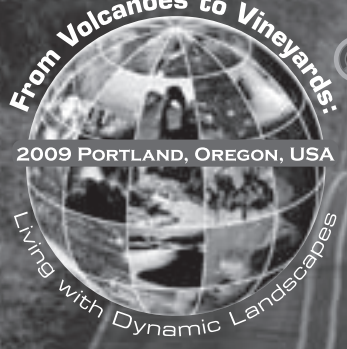

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Washington County winery driving loop. Photo by Mr. Janis Miglavs courtesy the Portland Oregon Visitors Association.

Punchbowl Falls, Columbia River Gorge, Oregon. Photo courtesy Travel Portland/Jeff Krausse and the Portland Oregon Visitors Association.

T15. Streambanks in Theory and Practice
Cosponsor(s): *GSA Hydrogeology Division; GSA Quaternary Geology and Geomorphology Division*
Discipline(s): geomorphology; Quaternary geology; environmental geoscience
Advocate(s): Patrick Belmont, Univ. of Minnesota, Minneapolis, Minn.; Katherine Skalak, Univ. of Delaware, Newark, Del.
Description: This session explores the dynamic nature of streambanks, including processes forming and eroding banks. Specific attention will be given to understanding when bank erosion constitutes a net sediment source and when bank stabilization is appropriate.

T16. 50 Years of Hydrogeology at GSA: Looking Back and Looking Forward
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; history of geology
Advocate(s): Jean Bahr, Univ. of Wisconsin, Madison, Wisc.
Description: As GSA's Hydrogeology Division celebrates its 50th anniversary, this session is intended to review the evolution of hydrogeologic science since 1959 and to look forward to challenges and opportunities in the next 50 years.

T17. Applications of Groundwater–Surface Water Interactions to Management and Restoration of Streams
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; environmental geoscience; geomicrobiology
Advocate(s): Stephen Van der Hoven, Illinois State Univ., Normal, Ill.; Eric Peterson, Illinois State Univ., Normal, Ill.
Description: This session will explore applications of our understanding of groundwater–surface water interactions to the management and restoration of streams. Topics include interactions from hydrologic, biogeochemical, sedimentary, and ecological perspectives.

T18. Applied Hydrogeology: In Honor of Dr. Roy Williams
Cosponsor(s): *GSA Hydrogeology Division; International Association of Hydrogeologists; International Mine Water Association; GSA Geology and Health Division*
Discipline(s): hydrogeology
Advocate(s): Gerry V. Winter, Idaho Dept. of Environmental Quality, Boise, Idaho; Neil Coleman, U.S. Nuclear Regulatory Commission, Washington, D.C.
Description: This memorial session is proposed to honor Dr. Roy Williams, founder of the Hydrology Program at the University of Idaho. Technical presentations on hydrogeology, mine hydrology, radioactive waste, and other topics are requested.

T19. Characterizing, Predicting, and Managing Long-Term Contaminant Flux for Complex Subsurface Environments
Cosponsor(s): *GSA Hydrogeology Division; GSA Geology and Health Division*
Discipline(s): hydrogeology; environmental geoscience; geochemistry
Advocate(s): Gwynn R. Johnson, Portland State Univ., Portland, Ore.; Mark L. Brusseau, Univ. of Arizona, Tucson, Ariz.; Mike Truex, Pacific Northwest National Laboratory, Richland, Wash.; John McCray, Colorado School of Mines, Golden, Colo.
Description: Submissions are solicited that address the factors and processes influencing contaminant flux in subsurface environments for sites with recalcitrant contamination. Methods for characterizing and predicting mass flux are relevant, as are methods for managing long-term flux.

T20. Contaminant Hydrogeology: Contaminant Fate and Transport in Geological Systems
Cosponsor(s): *GSA Hydrogeology Division; GSA Geology and Health Division; International Association of Hydrogeologists–U.S. National Committee*
Discipline(s): hydrogeology; environmental geoscience
Advocate(s): Lois Ongley, Unity College, Unity, Maine

Description: Experimental and field work are both necessary to characterize the fate and transport of contaminants in geologic systems around the world; this session seeks papers from both points of view.

T21. Coupled Surface-Subsurface Modeling across a Range of Temporal and Spatial Scales
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; environmental geoscience
Advocate(s): Reed Maxwell, Colorado School of Mines, Golden, Colo.
Description: The interaction of surface water, groundwater, and the land surface has gained much recent scientific attention. Contributions on integrated numerical studies of the water and energy cycles over a wide range of temporal and spatial scales are encouraged.

T22. Fate, Transport, and Effects of Pesticides in the Environment
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; geochemistry; environmental geoscience
Advocate(s): Timothy J. Reilly, USGS, West Trenton, N.J.
Description: This session is intended to bring together field, laboratory, and modeling studies addressing the complexities of the fate, transport, and effects of legacy and modern-use pesticides in the environment.

T23. Geochemistry of Arsenic and Other Toxic Elements and Assessment of Environmental Risks in Global Groundwater Systems
Cosponsor(s): *GSA Hydrogeology Division; GSA International Division; GSA Geology and Health Division; GSA Geology and Society Division; Geochemical Society; International Society of Groundwater for Sustainable Development (ISGSD)*
Discipline(s): hydrogeology; geology and health; geomicrobiology
Advocate(s): Prosun Bhattacharya, Royal Institute of Technology (KTH), Stockholm, Sweden; Alan E. Fryar, Univ. of Kentucky, Lexington, Ky.; Abhijit Mukherjee, Alberta Geological Survey, Edmonton, Alberta
Description: Groundwater environments are contaminated by geogenic arsenic and other toxic elements across the world. This interdisciplinary session serves as a platform for scientific exchange leading to improved understanding of the dynamics of arsenic and other toxic elements.

T24. Groundwater Resources in Developing Countries—The Contributions and Legacy of Robert N. Farvolden: A Memorial Session to Commemorate the 50th Anniversary of the Hydrogeology Division
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; geoscience information/communication; environmental geoscience
Advocate(s): David L. Rudolph, Univ. of Waterloo, Waterloo, Ontario; Randy L. Stotler, Univ. of Waterloo, Waterloo, Ontario
Description: This session provides an opportunity to present new research inspired by Robert Farvolden's career, including cooperative international projects in underdeveloped areas and techniques for the development, management, and long-term protection of groundwater resources in developing countries.

T25. Groundwater in Ecosystems: Effects of Physical, Chemical, and Biological Processes and Feedback Mechanisms
Cosponsor(s): *GSA Hydrogeology Division; U.S. National Chapter of the International Association of Hydrogeologists; GSA Geobiology and Geomicrobiology Division*
Discipline(s): hydrogeology; public policy; environmental geoscience
Advocate(s): Randall Hunt, USGS, Middleton, Wisc.; Masaki Hayashi, Univ. of Calgary, Calgary, Alberta
Description: Groundwater can be critical to the establishment and persistence of ecosystems. This session focuses on methods for characterizing groundwater-ecosystem interaction, the effects of human activities on this interaction, and potential ramifications for resource sustainability.

T26. Hydrogeology in an Ice-House World: Effects of Glaciation on Surface and Groundwater Systems
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; environmental geoscience; paleoclimatology/paleoceanography
Advocate(s): Victor Bense, Univ. of East Anglia, Norwich, UK; Jennifer McIntosh, Univ. of Arizona, Tucson, Ariz.; Mark Person, New Mexico Tech, Socorro, N.Mex.; C.E. Neuzil, USGS, Reston, Va.; Neal Iverson, Iowa State Univ., Ames, Iowa
Description: This session seeks contributions (field data and/or modeling studies) focusing on the hydrogeology during and directly following ice-house conditions.

T27. Hydrologic Characterization and Simulation of Neogene Volcanic Terranes
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; volcanology
Advocate(s): Marshall W. Gannett, USGS, Portland, Ore.; Gordon Grant, U.S. Forest Service, Corvallis, Ore.
Description: This interdisciplinary session will highlight research on the characterization, quantification, and modeling of the hydrology of Neogene volcanic terranes, including the atmospheric and biologic components of the hydrologic cycle, with a focus on mountainous areas.

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T28. Investigating and Characterizing Groundwater Contaminant Fate and Transport in Deep Unconsolidated River Valley Deposits
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; environmental geoscience; engineering geology
Advocate(s): Aaron R. Frantz, CDM, Wayne, Pa.
Description: River valleys filled with deep sequences of Quaternary deposits are complex environments for contaminants to persist and migrate. Innovative tools and procedures used to investigate, evaluate, and display the fate and transport of contaminants in these deposits will be discussed.

T29. Recent Advances in the Conceptualization, Characterization, and Interpretation of Fluid Movement and Transport Dynamics in Fractured and Karst Aquifers
Cosponsor(s): *GSA Hydrogeology Division; GSA Structural Geology and Tectonics Division*
Discipline(s): hydrogeology; engineering geology; structural geology
Advocate(s): Tristan P. Wellman, USGS, Lakewood, Colo.; David F. Boutt, Univ. of Massachusetts, Amherst, Mass.
Description: Karst and fractured aquifers are structurally complex systems that offer great challenges for delineating subsurface fluid movement and transport hydrodynamics. This session showcases some of the recent advances toward understanding these important systems.

T30. Snow Science as Related to Water Supplies in the West
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; environmental geoscience; geoinformatics
Advocate(s): Michael L. Strobel, Natural Resources Conservation Service, Portland, Ore.
Description: The session on snow research addresses issues in field data collection and transmission, climate change impacts on snow conditions, water supply forecasting tools and models, and future developments in the field of snow surveys.

T31. Stream-Groundwater Interaction: New Understanding, Innovations, and Applications at Bedform, Reach, and River Network Scales
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; environmental geoscience; geomorphology
Advocate(s): Anne Jefferson, Univ. of North Carolina, Charlotte, N.C.; Laura Lautz, Syracuse Univ., Syracuse, N.Y.; Jeffrey McKenzie, McGill Univ., Montreal, Québec
Description: This session will feature novel approaches to investigating stream-groundwater interaction and hyporheic exchange across spatial scales. Results featuring modeling, flume studies, heat and chemical tracers, and field techniques are encouraged.

T32. Survey of International Geothermal Developments 2009
Cosponsor(s): *GSA Hydrogeology Division; Geothermal Resources Council*
Discipline(s): hydrogeology; geophysics/tectonophysics/seismology; economic geology
Advocate(s): Curt Robinson, Geothermal Resources Council, Davis, Calif.
Description: As the global demand for clean, reliable, renewable energy increases, geothermal energy is becoming an attractive solution to quell some of the world's energy hunger pangs and respond to the desire to reduce greenhouse-gas emissions.

T33. The Subterranean Estuary—Examining the Geochemical and Physical Processes of These Subsurface Mixing Zones
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): hydrogeology; geochemistry; marine/coastal science
Advocate(s): Christopher G. Smith, USGS, St. Petersburg, Fla.; Moutusi Roy, Univ. of Florida, Gainesville, Fla.
Description: This session will focus on the physico-chemical processes that control the formation of subterranean estuaries as well as the biogeochemical processes occurring within these interfaces that affect the cycling of dissolved constituents.

T34. Toward Integrating Cave and Karst Science
Cosponsor(s): *GSA Hydrogeology Division; National Cave and Karst Research Institute; GSA Geobiology and Geomicrobiology Division*
Discipline(s): hydrogeology; geomicrobiology; paleoclimatology/paleoceanography
Advocate(s): John L. Wilson, New Mexico Institute of Mining and Technology, Socorro, N.Mex.; Penelope Boston, National Cave and Karst Research Institute, Socorro, N.Mex.
Description: Speleology is separated by discipline in spite of multifaceted scientific questions, with little integration except concerning exploration. This session will bring disciplines together to work toward integrated understanding of speleology at the whole-system level.

T35. Cenozoic Lakes
Cosponsor(s): *GSA Limnogeology Division; GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division*
Discipline(s): limnogeology; sediments, clastic; sediments, carbonates
Advocate(s): Elizabeth Gierlowski-Kordesch, Ohio Univ., Athens, Ohio; Broxton W. Bird, Univ. of Pittsburgh, Pittsburgh, Pa.; Nathan D. Stansell, Univ. of Pittsburgh, Pittsburgh, Pa.
Description: Many lake deposits accumulated under the influence of divergent and convergent tectonics as well as climate changes through the Cenozoic to today. Sediment accumulation patterns from cores and outcrops will be highlighted.

T36. Living with Volcanic Lakes: Geologic and Limnologic Tools for Disaster Management
Cosponsor(s): *GSA Limnogeology Division; GSA Geology and Health Division*
Discipline(s): limnogeology; geology and health; volcanology
Advocate(s): Michael Rosen, USGS, Carson City, Nev.; Carol Stewart, Consultant, Vogeltown, Wellington, New Zealand
Description: Volcanic lakes are beneficial but also have risks. This session will focus on the impacts of volcanic hazards on water supplies, how abrupt changes can affect the sedimentary record of lake deposits, and how to determine recurrence intervals for hazardous events.

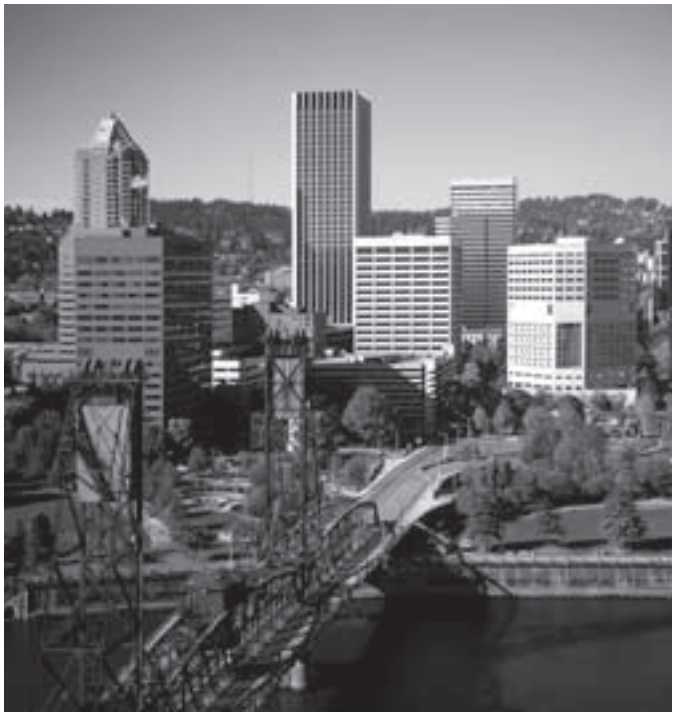
T37. Microbial Mats, Biogeochemical Markers, and Microbial Evolution: The Co-Evolution of Early Earth and Microbial Life
Cosponsor(s): *GSA Geobiology and Geomicrobiology Division; Paleontological Society*
Discipline(s): geomicrobiology; Precambrian geology; paleontology, phylogenetic/morphological patterns
Advocate(s): Carrine E. Blank, Univ. of Montana, Missoula, Mont.; Jack Farmer, Arizona State Univ., Tempe, Ariz.
Description: This session focuses on paleontological and geochemical analysis of ancient microbial environments (including Archean crustal environments) and on evolutionary studies of microorganisms to promote a better understanding of the geologic record of life on Earth.

T38. Improving Coastal Hazards Mitigation through Advances in Coastal Geomorphology
Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*
Discipline(s): marine/coastal science; geomorphology; neotectonics/paleoseismology
Advocate(s): Peter Ruggiero, Oregon State Univ., Corvallis, Ore.; Jonathan Allan, Oregon Dept. of Geology and Mineral Industry, Newport, Ore.; Rob Witter, Oregon Dept. of Geology, Newport, Ore.
Description: This session welcomes contributions on recent studies in coastal geomorphology and morphodynamics that elucidate coastal geohazards from a wide variety of geomorphic settings at a variety of timescales.

T39. Methods of Reconstructing Quaternary Sea Levels
Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*
Discipline(s): marine/coastal science; Quaternary geology
Advocate(s): Alexander Simms, Oklahoma State Univ., Stillwater, Okla.; Benjamin Horton, Univ. of Pennsylvania, Philadelphia, Pa.
Description: This session will review new and established methods for reconstructing Quaternary sea levels and address the methods of data analysis and hypothesis testing to determine driving mechanisms behind sea-level change.

T40. Environmental Magnetism, Magnetic Stratigraphy, and Magnetic Field Modeling
Cosponsor(s): *GSA Geology and Health Division*
Discipline(s): paleoclimatology/paleoceanography; limnogeology; planetary geology
Advocate(s): Joseph Stoner, Oregon State Univ., Corvallis, Ore.; Bernard Housen, Western Washington Univ., Bellingham, Wash.; Catherine Louise Johnson, Univ. of British Columbia, Vancouver, British Columbia
Description: Magnetism provides a vast set of tools for studying Earth's environment through time. We solicit environmental magnetic, magnetic stratigraphic, or magnetic field modeling contributions that focus on reconstructing Earth's environment and studying its past variability.

T41. High-Resolution Terrestrial and Marine Geochemical Proxies of Global Change: Progress, Problems, and Utility
Cosponsor(s): *Paleontological Society; Geochemical Society; GSA Geobiology and Geomicrobiology Division*
Discipline(s): paleoclimatology/paleoceanography; geochemistry; paleontology, paleoecology/taphonomy
Advocate(s): David P. Gillikin, Vassar College, Poughkeepsie, N.Y.; Alan D. Wanamaker, Bangor Univ., Menai Bridge, UK
Description: High-resolution geochemical proxies provide records of past climate, weather, and environments. We encourage papers presenting geochemical records of global change, including calibration/validation studies, in biologic carbonates, speleothems, or tree rings from terrestrial or marine environments.



View of Hawthorne Bridge and Gov. Tom McCall Waterfront Park, Portland. Photo courtesy Travel Portland/Robert Reynolds and the Portland Oregon Visitors Association.

T42. Convergent Margin Tectonics Reflected in Forearc Basin Sedimentary Fills: Integrated Geologic and Geophysical Studies
Cosponsor(s): *GSA Structural Geology and Tectonics Division; GSA Geophysics Division; GSA Sedimentary Geology Division; Society for Sedimentary Geology (SEPM); GSA International Division*
Discipline(s): tectonics; sediments, clastic; geophysics/tectonophysics/seismology
Advocate(s): Andrea Fildani, Chevron ETC, San Ramon, Calif.; Jeff Trop, Bucknell Univ., Lewisburg, Pa.
Description: Resolving forearc basin evolution requires integration of geological and geophysical datasets through time and space. This multidisciplinary session will explore new findings on diverse processes responsible for the development of modern and ancient forearc basins.

T43. Detachment Dynamics: Heat, Deformation, and Fluids in Extensional Systems
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; structural geology; petrology, metamorphic
Advocate(s): Christian Teyssier, Univ. of Minnesota, Minneapolis, Minn.; Donna L. Whitney, Univ. of Minnesota, Minneapolis, Minn.
Description: This session explores new thoughts about extensional detachment systems, including the dynamic relationships among strain localization, fluid flow, and heat exchange at these fundamental boundaries between brittle and ductile crust.

T44. Evaluating Channel Flow in Orogens
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; structural geology; petrology, metamorphic
Advocate(s): Seth C. Kruckenberg, Univ. of Minnesota–Twin Cities, Minneapolis, Minn.; Rory McFadden, Univ. of Minnesota–Twin Cities, Minneapolis, Minn.; Christine S. Siddoway, Colorado College, Colorado Springs, Colo.
Description: This session will assess the viability of channelized flow in active and exhumed orogens through data-rich contributions in tectonic and geodynamic research. We seek diverse viewpoints clarifying the possibilities and limitations of channel flow models.

T45. Growth and Stabilization of Continental Crust in Circum-Pacific Accretionary Orogens
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; petrology, metamorphic; geochemistry
Advocate(s): Christine S. Siddoway, Colorado College, Colorado Springs, Colo.; David Foster, Univ. of Florida, Gainesville, Fla.
Description: This session addresses growth of continental crust during circum-Pacific ocean-continent convergence, with examination of transient extensional, contractional, and transcurrent events affecting the overriding plate. Geodynamics, tectonics, metamorphism, magmatism, and geochemistry perspectives are encouraged.

T46. Linking Shallow to Deep Crustal Processes in Arc and Collisional Orogens
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; geomorphology; structural geology
Advocate(s): Stacia Gordon, Univ. of California, Santa Barbara, Calif.; Leonardo Cruz, Stanford Univ., Stanford, Calif.
Description: Processes occurring in the mid-crust may be intimately connected to processes occurring in both the mantle and at the surface. Understanding lithospheric-processes rates and styles provides crucial information concerning the growth and collapse of orogens.

T47. Lithospheric Delamination, Continental Magmatism, and Crustal Uplift in Mountain Evolution
Cosponsor(s): *GSA International Division; GSA Structural Geology and Tectonics Division; Geophysics Division; GSA History of Geology Division; GSA Sedimentary Geology Division*
Discipline(s): tectonics; geophysics/tectonophysics/seismology; petrology, igneous
Advocate(s): Yildirim Dilek, Miami Univ., Oxford, Ohio; Paul T. Robinson, Dalhousie Univ., Halifax, Nova Scotia; John Wakabayashi, California State Univ., Fresno, Calif.
Description: The aim of this session is to bring together international earth scientists to have a comparative discussion on the geological and geophysical phenomena and pertinent questions related to well-documented cases of lithospheric delamination in Phanerozoic and Precambrian orogenic belts.

T48. Living on the Edge in the Cascadia Forearc
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; geophysics/tectonophysics/seismology; stratigraphy
Advocate(s): Russell C. Evarts, USGS, Menlo Park, Calif.; Ray E. Wells, USGS, Menlo Park, Calif.
Description: This session addresses all aspects of the structure, history, neotectonics, and hazards of the active forearc basins and adjacent terranes of the Cascadia forearc from California to British Columbia.

T49. Neoproterozoic through Cretaceous Evolution of the North American Cordilleran Margin: Contrasting Tectonics, Paleogeography, and Paleoenvironments
Cosponsor(s): *GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division*
Discipline(s): tectonics; sediments, clastic; paleontology, biogeography/biostratigraphy

Advocate(s): Christopher S. Holm-Denoma, USGS, Denver, Colo.; Paula J. Noble, Univ. of Nevada, Reno, Nev.

Description: This session is dedicated to understanding the tectonic and paleogeographic evolution of the Cordilleran margin from the Neoproterozoic passive margin to the effects of the onset of deformation in the Devonian through the Cretaceous.

T50. New Developments in Understanding the Mesozoic Cordilleran Orogen: Linking Forearc, Arc, and Backarc Processes

Cosponsor(s): *GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division; GSA Geophysics Division*

Discipline(s): tectonics; petrology, metamorphic; structural geology

Advocate(s): Michael Wells, Univ. of Nevada, Las Vegas, Nev.; Mihai Ducea, Univ. of Arizona, Tucson, Ariz.

Description: New advances in geochronology; geochemical, kinematic, and *P-T-t* path modeling; and plate kinematics and dynamics allow a better understanding of the linkages between forearc, arc, and backarc processes in the non-collisional Mesozoic Cordilleran orogen.

T51. Same But Different: Comparing Upper Crustal Deformation and Basin Evolution in the North and South American Cordillera

Cosponsor(s): *GSA Structural Geology and Tectonics Division*

Discipline(s): tectonics; stratigraphy; geochemistry

Advocate(s): Andrew Leier, Univ. of Calgary, Calgary, Alberta; Melissa K. Giovanni, Univ. of Calgary, Calgary, Alberta

Description: This session seeks to provide a common forum for sharing and comparing recent large-scale investigations of the North and South American Cordillera and will include interdisciplinary studies involving structural geology, sedimentology, thermochronology, paleo-altimetry, and tectonics.

T52. Sixth Columbia River Basalt Symposium: Volcanism, Tectonism, Petrology, and Hydrogeology 2009

Cosponsor(s): *Mineralogical Society of America; GSA Structural Geology and Tectonics Division; GSA Hydrogeology Division*

Discipline(s): tectonics; hydrogeology; petrology, igneous

Advocate(s): Stephen P. Reidel, Washington State Univ.–TriCities, Richland, Wash.; Terry Tolan, GSI Water Solutions, Inc., Kennewick, Wash.; Victor Camp, San Diego State Univ., San Diego, Calif.; John Wolff, Washington State Univ., Pullman, Wash.; Ray Wells, USGS, Menlo Park; Martin E. Ross, Northeastern Univ., Boston, Mass.; Barton S. Martin, Ohio Wesleyan Univ., Delaware, Ohio

Description: Portland, Oregon, situated on the Columbia River Basalt, is an ideal setting to present current research on the basalt—both its tectonic setting and hydrogeology. Also planned to mesh with the symposium are several pre- and post-meeting field trips.

Japanese Garden in Portland. Photo courtesy Travel Portland/Larry Geddis and the Portland Oregon Visitors Association.

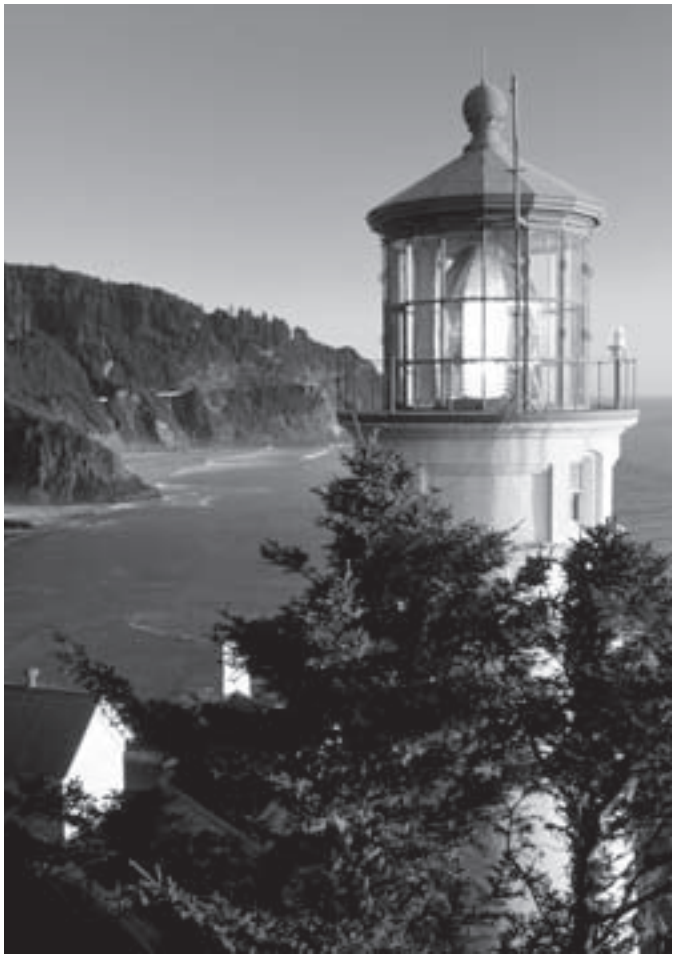
T53. Steady and Unsteady Deformation of Folds, Faults, and Orogens: Dynamics, Kinematics, and Insights to Coupled Processes
Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; geomorphology; geophysics/tectonophysics/seismology
Advocate(s): Frank Pazzaglia, Lehigh Univ., Bethlehem, Pa.; David J. Anastasio, Lehigh Univ., Bethlehem, Pa.
Description: This session explores geologic, geomorphic, paleoseismic, and geodetic data with sufficient temporal resolution and length of record that document deformation (un)steadiness as a means to understand tectonics and possible coupling to surficial processes.

T54. Structural Evolution and Timing of Orogenic Uplift in the Tertiary Mountain Ranges of Central Asia
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; geophysics/tectonophysics/seismology; neotectonics/paleoseismology
Advocate(s): Dickson Cunningham, Univ. of Leicester, Leicester, UK; Karl W. Wegmann, North Carolina State Univ., Raleigh, N.C.
Description: This session will highlight recent research into the structural evolution and timing of crustal uplift resulting from far-field stresses related to the ongoing India-Asia collision north of Tibet.

T55. Tectonic Inversion: Characteristics and Mechanisms
Cosponsor(s): *GSA International Division; GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division; GSA Geophysics Division*
Discipline(s): tectonics; structural geology; geophysics/tectonophysics/seismology
Advocate(s): John Wakabayashi, California State Univ., Fresno, Calif.; Mark Legg, Legg Geophysical, Huntington Beach, Calif.
Description: Causes of tectonic inversion are varied, and recently, much light has been shed on them. We seek contributions from around the world and from many disciplines to discuss the characteristics and mechanisms of this process.

T56. The Franciscan Assemblage and Tectono-stratigraphic Terranes of the Western United States: A Tribute to M.C. Blake Jr.
Cosponsor(s): *GSA Structural Geology and Tectonics Division; GSA Cordilleran Section; Friends of the Franciscan*
Discipline(s): tectonics; structural geology; petrology, metamorphic
Advocate(s): John Shervais, Utah State Univ., Logan, Utah; A.S. Jayko, USGS, Bishop, Calif.
Description: The Franciscan assemblage of California and associated terranes play a seminal role in understanding subduction complexes and the accretion of tectonostratigraphic terranes. This session highlights new studies that build on the early contributions of M.C. Blake Jr.

T57. The Mesozoic and Cenozoic Tectonic Evolution of Northwestern Mexico and the Southwestern United States
Cosponsor(s): *GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division*
Discipline(s): tectonics; structural geology; neotectonics/paleoseismology
Advocate(s): Paul H. Wetmore, Univ. of South Florida, Tampa, Fla.; Helge Alsleben, Texas Christian Univ., Fort Worth, Tex.; Keegan L. Schmidt, Lewis-Clark State College, Lewiston, Idaho
Description: This session will highlight the research efforts across a wide variety of subdisciplines aimed at understanding the tectonic evolution of northwestern Mexico and the southwestern United States over the past 250 million years.



Heceta Head Lighthouse. Photo courtesy Travel Portland/Larry Geddis and the Portland Oregon Visitors Association.

Mount Hood in summer. Photo courtesy Travel Portland/Jeff Krausse and the Portland Oregon Visitors Association.

T58. The Zagros Collision Zone, Past and Present
Cosponsor(s): *GSA International Division; GSA Structural Geology and Tectonics Division*
Discipline(s): tectonics; petrology, igneous; geophysics/tectonophysics/seismology
Advocate(s): Jamshid Hassanzadeh, California Institute of Technology, Pasadena, Calif.; Charlie Verdel, Univ. of Michigan, Ann Arbor, Mich.
Description: This session will address various aspects of the evolution of continental margins involved in the Zagros orogen (Iran), from its long subduction history to docking of the continents and post-collisional development. A particular focus will be placed on the controversial timing of the collision.

T59. 50th Anniversary of the 1959 Hebgen Lake, Montana, Earthquake: Lessons Learned in Extensional Tectonic Regimes
Cosponsor(s): *GSA Structural Geology and Tectonics Division; U.S. Geological Survey Earth Surface Processes Team, Denver; GSA Quaternary Geology and Geomorphology Division*
Discipline(s): neotectonics/paleoseismology; structural geology; geophysics/tectonophysics/seismology
Advocate(s): David Lageson, Montana State Univ., Bozeman, Mont.; C.A. Ruleman, USGS, Denver, Colo.
Description: 17 August 2009 is the 50th anniversary of the M7.5 Hebgen Lake, Montana, earthquake. We seek to bring multiple disciplines together to address the current understanding of the geometry, kinematics, and dynamics of neotectonic and/or active deformation in extensional continental settings.

T60. Numerical Dating of Quaternary Alluvial Fans and Terraces with Applications to Studies in Neotectonics and Surface Processes
Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division*
Discipline(s): neotectonics/paleoseismology; geomorphology; geochemistry
Advocate(s): Warren D. Sharp, Berkeley, Calif.; John Gosse, Dalhousie Univ., Halifax, Nova Scotia
Description: Presentations involving innovative uses of terrestrial cosmogenic nuclides, luminescence techniques, and U-series dating are particularly encouraged, as are those that assess the reliability and uncertainty of resulting ages for deposition of alluvial fans and terraces.

T61. Paleogeodesy at Subduction Zones
Cosponsor(s): *GSA Structural Geology and Tectonics Division; GSA Geophysics Division*
Discipline(s): neotectonics/paleoseismology; geophysics/tectonophysics/seismology; stratigraphy
Advocate(s): Andrea D. Hawkes, Woods Hole Oceanographic Institution, Woods Hole, Mass.; Aron Meltzner, California Institute of Technology, Pasadena, Calif.; Alan R. Nelson, USGS, Denver, Colo.
Description: This session seeks to explore developments in the geological methods used to quantify megathrust deformation. These include paleoseismic and paleogeodetic studies, studies highlighting new techniques for documenting vertical deformation in modern earthquakes, and studies modeling paleogeodetic data.

T62. Reducing Risk from Geologic Hazards in the Dynamic Landscape of Oregon and Washington
Cosponsor(s): *GSA Quaternary Geology and Geomorphology Division; GSA Geology and Health Division; GSA Geology and Society Division*
Discipline(s): neotectonics/paleoseismology; volcanology; public policy
Advocate(s): Vicki McConnell, Oregon Dept. of Geology and Mineral Industries, Portland, Ore.; Dave Norman, Washington State Dept. of Natural Resources, Olympia, Wash.; Cynthia Gardner, USGS, Vancouver, Wash.; W.E. Scott, USGS, Vancouver, Wash.
Description: The dynamic Pacific Northwest landscape hosts a variety of high-impact geologic hazards to growing communities. Session topics include hazards affecting the region, recurrence intervals, tools for evaluating risk and uncertainty, economic effects, and mitigation efforts.

T63. Hydrothermal Systems and Volatile Emissions of Volcanic Arcs
Cosponsor(s): *GSA Hydrogeology Division*
Discipline(s): volcanology; geochemistry; hydrogeology
Advocate(s): C. Werner, USGS, Vancouver, Wash.; S. Hurwitz, USGS, Menlo Park, Calif.; J. Varekamp, Wesleyan Univ., Middletown, Conn.
Description: This session focuses on hydrothermal and volcanic emissions in volcanic arcs, both subaerial and submarine. Topics include field studies, experiments, and modeling related to volatile budgets, magmatic/hydrothermal processes, groundwater flow/chemistry, and global contributions.

T64. Physics of Volcanic Eruptions: Implications for Hazards
Cosponsor(s): *GSA Geophysics Division; GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division*
Discipline(s): volcanology; Quaternary geology; petrology, experimental
Advocate(s): Larry G. Mastin, USGS, Vancouver, Wash.; Donald B. Dingwell, Ludwig Maximillians Univ., Munich, Germany; J. Kelly Russell, Univ. of British Columbia, Vancouver, British Columbia
Description: This session explores the physical processes involved in volcanic eruptions and the effects of these processes on hazards. We encourage process-oriented field, laboratory, theoretical, numerical, and instrumental studies with significant implications for hazards studies.

T65. Supervolcanoes, Ignimbrite Flare-ups, and Their Impacts: Definition, Debate, and New Developments
Discipline(s): volcanology; petrology, igneous; environmental geoscience
Advocate(s): Shan de Silva, Oregon State Univ., Corvallis, Ore.; Ilya Bindeman, Univ. of Oregon, Eugene, Ore.; Jake Lowenstern, USGS, Menlo Park, Calif.
Description: Super-eruptions are thought to be the most devastating of terrestrial geologic phenomena, with extreme impacts on the earth system that still remain to be fully understood. This session critically examines definitions, new developments, and the current debate.

T66. New Insights into Development of the Upper Neoproterozoic–Lower Paleozoic Western Laurentian Passive Margin
Cosponsor(s): *GSA Sedimentary Geology Division*
Discipline(s): sediments, carbonates; sediments, clastic; stratigraphy
Advocate(s): Michael Pope, Washington State Univ., Pullman, Wash.; Christopher Fedo, Univ. of Tennessee, Knoxville, Tenn.
Description: This multidisciplinary topical session will share and integrate new information about the development of the Late Neoproterozoic–Early Paleozoic passive margin of western Laurentia.

Columbia River Gorge. Photo courtesy Travel Portland/Mr. Janis Miglavs and the Portland Oregon Visitors Association.

T67. Sedimentary Geology of the Next Generation: Student Posters (Posters)
Cosponsor(s): *GSA Sedimentary Geology Division; Society for Sedimentary Geology (SEPM)*
Discipline(s): sediments, carbonates; sediments, clastic; stratigraphy
Advocate(s): John Holbrook, The Univ. of Texas at Arlington, Arlington, Tex.; Daniel Larsen, Univ. of Memphis, Memphis, Tenn.
Description: This session features student posters illustrating how the next generation of sedimentary geologists will expand our science in new and exciting directions. Best poster awards will be presented to students at the GSA Sedimentary Geology Division–Society for Sedimentary Geology (SEPM) awards reception.

T68. Uplift or Climate Change? Evaluating Surface Uplift and Deformation in Light of Climate Change in the Andes
Cosponsor(s): *GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division*
Discipline(s): sediments, clastic; tectonics; paleoclimatology/paleoceanography
Advocate(s): Joel Saylor, The Univ. of Texas at Austin, Austin, Tex.; Andres Mora, Colombian Petroleum Institute, ECOPETROL, Piedecuesta, Colombia; Gregory D. Hoke, Univ. of Rochester, Rochester, N.Y.
Description: This session will address paleoelevation in the Andes and how climate change could affect our paleoelevation proxies. It will also address the link between deformation and surface uplift.

T69. Ground-Penetrating Radar (GPR) Applications for Solving Stratigraphic and Geoarchaeological Problems
Discipline(s): stratigraphy; geophysics/tectonophysics/seismology; archaeological geology
Advocate(s): Kelsey S. Bitting, Rutgers Univ., Piscataway, N.J.
Description: Applications of ground-penetrating radar (GPR) to near-surface stratigraphic and geoarchaeological problems are wide ranging, but GPR remains underutilized. This session will bring attention to this technology and provide an opportunity to showcase unique and innovative methodologies.

T70. Interaction of Tectonics, Climate Change, and Eustasy in the Development of the North American Cordillera
Cosponsor(s): *GSA Sedimentary Geology Division; GSA Geophysics Division; GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division*
Discipline(s): stratigraphy; paleoclimatology/paleoceanography; geophysics/tectonophysics/seismology
Advocate(s): Kenneth Ridgway, Purdue Univ., West Lafayette, Ind.; Brian Hampton, Michigan State Univ., East Lansing, Mich.; Jeffrey Trop, Bucknell Univ., Lewisburg, Pa.
Description: Evaluating the role of tectonic, climatic, and eustatic processes in the North American Cordillera requires integration of diverse datasets involving geochronology, thermochronology, geochemistry, petrology, geomorphology, glaciology, sedimentology, stratigraphy, paleobiology, structure, geodesy, geophysics, paleoclimatology, and modeling.

T71. Fault and Fracture Studies in the Solar System
Discipline(s): structural geology; planetary geology; tectonics
Advocate(s): Simon A. Kattenhorn, Univ. of Idaho, Moscow, Idaho
Description: This session involves studies of the evolution and mechanics of non-terrestrial fault and fracture systems through spacecraft image analysis, theoretical models, or geophysical techniques.

T72. Geofluids and Deformation: Integrated Studies for the 21st Century
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): structural geology; tectonics; geochemistry
Advocate(s): Mark P. Fischer, Northern Illinois Univ., DeKalb, Ill.
Description: This session presents research that showcases the connection between geofluids, structures, and structural processes at all scales and in all tectonic environments. Work that integrates hydrologic, structural, mechanical, and/or geochemical analyses will be highlighted.

T73. Melt Microstructures: Evidence for the Presence of Melt and Consequences for Deforming Continental Crust
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): structural geology; petrology, metamorphic; tectonics
Advocate(s): Jamie Levine, The Univ. of Texas at Austin, Austin, Tex.; Christine S. Siddoway, Colorado College, Colorado Springs, Colo.
Description: This session explores the petrological, geochemical, and geometrical conditions that promote the formation, segregation, and movement of melt in the middle and lower crust, including melt-deformation feedbacks, as determined from microscopic-scale observation and analysis.

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T74. Pluton Assembly: Duration, Mechanisms, and Structural Controls
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): structural geology; petrology, igneous; geophysics/tectonophysics/seismology
Advocate(s): Eric Horsman, USGS, Menlo Park, Calif.; Sven Morgan, Central Michigan Univ., Mt. Pleasant, Mich.; Michel de Saint-Blanquat, Obs. Midi-Pyrénées/Un. Paul Sabatier, Toulouse, France
Description: This session will bring together different viewpoints on the assembly of igneous intrusions. Topics may include duration of assembly, petrologic/geochemical processes, space-making mechanisms, seismic imaging, and the role of structures in ascent and emplacement.

T75. Slow Slip and Non-Volcanic Seismic Tremor in Cascadia and Beyond: Observations, Models, and Hazard Implications
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): structural geology; tectonics; geophysics/tectonophysics/seismology
Advocate(s): M. Maceira, Los Alamos National Laboratory, Los Alamos, N.Mex.; J. Rubinstein, USGS, Menlo Park, Calif.; E. Roeloffs, USGS, Vancouver, Wash.; C. Larmat, Los Alamos National Laboratory, Los Alamos, N.Mex.
Description: This session welcomes presentations that include critical observational or modeling constraints that bear on all aspects of the recently discovered episodic non-volcanic tremor and slow slip events both within and outside of the Cascadia subduction zone.

T76. Continuous, Discontinuous, and Disequilibrium Reactions during the Crystallization of Heavy-Element Enriched Pegmatites
Cosponsor(s): *Mineralogical Society of America*
Discipline(s): mineralogy/crystallography; petrology, igneous; petrology, experimental
Advocate(s): Callum J. Hetherington, Texas Tech Univ., Lubbock, Tex.
Description: This session encourages contributions on the mineralogical, petrological, geochemical, isotopic, and textural consequences of discontinuous and disequilibrium reactions between minerals and fluids in crystallizing pegmatites.

T77. Frontiers in Mineral Sciences: Mineral/Melt Energetics, Mineral Surface Chemistry, Mineral Nanoscience, and High-Pressure Mineralogy
Cosponsor(s): *Mineralogical Society of America*
Discipline(s): mineralogy/crystallography; geochemistry; environmental geoscience
Advocate(s): Gordon E. Brown, Stanford Univ., Stanford, Calif.; Abby Kavner, UCLA, Los Angeles, Calif.; Nancy L. Ross, Virginia Tech, Blacksburg, Va.; Glenn A. Waychunas, Lawrence Berkeley National Laboratory, Berkeley, Calif.
Description: This session in honor of Alexandra Navrotsky and Thomas Trainor will focus on mineral/melt energetics, chemical/microbial processes on mineral surfaces, structure/property relationships of minerals/mineral surfaces, and nanomaterials found in near-surface and high-pressure environments.

T78. Issues Surrounding Exposure to Asbestos and Other Potentially Hazardous Fibrous Minerals Occurring in Their Natural Settings
Cosponsor(s): *Mineralogical Society of America; GSA Geology and Health Division*
Discipline(s): mineralogy/crystallography; environmental geoscience; geology and health
Advocate(s): Mark Bailey, Asbestos TEM Laboratories, Berkeley, Calif.; Mickey Gunter, Univ. of Idaho, Moscow, Idaho
Description: Asbestos issues have moved from occupational exposure to commercially produced asbestos to exposure to asbestos minerals in their natural settings. We bring together geologists, mineralogists, industrial hygienists, regulators, and public policy makers to discuss these issues.

T79. Eocene to Early Miocene Magmatic Evolution of the Northwest United States with Emphasis on the Distribution, Composition, and Petro-Tectonic Setting of Large Rhyolite Systems
Cosponsor(s): *Mineralogical Society of America; GSA Structural Geology and Tectonics Division*
Discipline(s): petrology, igneous; volcanology; stratigraphy
Advocate(s): Martin Streck, Portland State Univ., Portland, Ore.; Mark Ferns, Oregon Dept. of Geology and Mineral Industries, Baker City, Ore.; Paul Olin, Washington State Univ., Pullman, Wash.
Description: This session aims to bring together researchers interested in the volcanic history of Oregon and adjacent states prior to the onset of Columbia River Basalt magmatism. We seek contributions on any aspect of volcanism, petrology, and volcanic stratigraphy.

T80. Magmas and Volatiles: Linking Granites, Volcanoes, Geothermal Systems, and Mineral Deposits
Cosponsor(s): *Society of Economic Geologists*
Discipline(s): petrology, igneous; economic geology; geochemistry
Advocate(s): John Dilles, Oregon State Univ., Corvallis, Ore.; Jacob B. Lowenstern, USGS, Menlo Park, Calif.; David A. John, USGS, Menlo Park, Calif.
Description: This session seeks to link diverse observations by petrologists, geochemists, and geophysicists on active volcanic and geothermal systems as well as ancient granites and magmatic-hydrothermal ore deposits to understand magmatic volatile contents and degassing processes.

T81. Multidisciplinary Studies of Cascade Volcanism and its Tectonic Setting
Cosponsor(s): *Mineralogical Society of America; GSA Structural Geology and Tectonics Division; GSA Geophysics Division*
Discipline(s): petrology, igneous; volcanology; geophysics/tectonophysics/seismology
Advocate(s): Mariek Schmidt, Smithsonian National Museum of Natural History, Washington, D.C.; Michael Rowe, Univ. of Iowa, Iowa City, Iowa; Brian Jicha; Martin Streck, Portland State Univ., Portland, Ore.; Roger Nielsen, Oregon State Univ., Corvallis, Ore.; Thomas W. Sisson, USGS, Menlo Park, Calif.
Description: This session aims to unite efforts in the fields of geophysics, geochemistry, experimental petrology, and tectonics with the intent of understanding the development of the Cascade volcanic arc and the potential hazards associated with it.

T82. Advances in Understanding Metamorphic Processes: Nanoscale to Nappes
Cosponsor(s): *Mineralogical Society of America*
Discipline(s): petrology, metamorphic; tectonics
Advocate(s): C.T. Foster, Univ. of Iowa, Iowa City, Iowa; Frank Spear, Rensselaear Polytechnic Institute, Troy, N.Y.; John Bowman, Univ. of Utah, Salt Lake City, Utah
Description: This session seeks contributions from field, experimental, analytical, and modeling studies that focus on the mechanisms, rates, and time scales of crystal nucleation, metamorphic reactions (including melting), fluid interaction, deformation, and heat/mass transfer in metamorphic systems.

T83. Putting Biology Back into Biostratigraphy
Cosponsor(s): *Paleontological Society*
Discipline(s): paleontology, biogeography/biostratigraphy; paleontology, diversity, extinction, origination; paleontology, phylogenetic/morphological patterns
Advocate(s): Peter D. Ward, Univ. of Washington, Seattle, Wash.
Description: This session will explore why paleontological species were (and still are) often defined too narrowly and show how modern biology can inform, and in places correct, some of the more grievous examples of "biostratigraphy" that contain little "bio."

T84. Volcanism, Impacts, Mass Extinctions, and Global Environmental Change
Cosponsor(s): *Paleontological Society*
Discipline(s): paleontology, diversity, extinction, origination; volcanology; paleoclimatology/paleoceanography
Advocate(s): Gerta Keller, Princeton Univ., Princeton, N.J.; Thierry Adatte, Univ. of Lausanne, CH-1015 Lausanne, Switzerland; Paul Wignall, Univ. of Leeds, Leeds, UK
Description: This session will investigate how the roles of volcanism, meteorite impact(s), climate, and sea-level changes or alternative complex earth system processes might explain the documented phenomena or the lack thereof at various mass extinctions.

T85. Coastal Problems, Micropaleontological Approaches
Cosponsor(s): *Cushman Foundation for Foraminiferal Research; Paleontological Society*
Discipline(s): paleontology, paleoecology/taphonomy; environmental geoscience; marine/coastal science
Advocate(s): Laurel S. Collins, Florida International Univ., Miami, Fla.; David B. Scott, Dalhousie Univ., Halifax, Nova Scotia
Description: Micropaleontological research is addressing coastal problems such as pollution, sea-level rise, and increased hurricane activity. The session topic is particularly relevant because about 50% of the world's population lives within 50 miles of a coastline.

T86. Fossil Preservation and Climate Change: Trends from Polar to Tropical Regions
Cosponsor(s): *Paleontological Society*
Discipline(s): paleontology, paleoecology/taphonomy; paleontology, diversity, extinction, origination
Advocate(s): Sally E. Walker, Univ. of Georgia, Athens, Ga.; Samuel S. Bowser, Wadsworth Center, Albany, N.Y.; Karla Parsons-Hubbard, Oberlin College, Oberlin, Ohio
Description: Using both modern and fossil examples, this technical session will explore how global climate change, including ocean acidification, may alter the fossil record of organismal hardparts from polar to tropical regions.

Japanese American Historical Plaza at Gov. Tom McCall Waterfront Park, Portland. Photo courtesy Travel Portland/David Falconer and the Portland Oregon Visitors Association.

Oregon Convention Center. Photo by Bruce Forster courtesy the Portland Oregon Visitors Association.

T87. Phanerozoic Paleoenvironmental Evolution of Africa

Cosponsor(s): *Paleontological Society*

Discipline(s): paleontology, paleoecology/taphonomy; geochemistry; paleoclimatology/paleoceanography

Advocate(s): Ellen D. Currano, Southern Methodist Univ., Dallas, Tex.; Neil Tabor, Southern Methodist Univ., Dallas, Tex.; Bonnie F. Jacobs, Southern Methodist Univ., Dallas, Tex.

Description: This topical session will focus on African paleoenvironmental reconstructions with an emphasis on new Phanerozoic records and multiple lines of evidence addressing landscape, paleoclimate, vertebrate, and plant evolution.

T88. The Present is the Key to the Past: Identifying and Characterizing Isotopic Pattern and Process in Modern Ecosystems

Cosponsor(s): *Paleontological Society*

Discipline(s): paleontology, paleoecology/taphonomy; paleoclimatology/paleoceanography; geochemistry

Advocate(s): Kena Fox-Dobbs, Univ. of Puget Sound, Tacoma, Wash.; David L. Fox, Univ. of Minnesota, Minneapolis, Minn.

Description: Stable isotope techniques are routinely used to investigate ecological and paleoecological questions, but these two research communities remain disconnected. This session presents isotopic studies of contemporary ecosystems, with potential or realized application to ancient ecosystems.

T89. Greenstone Belts, Archaean Earth, and Early Life

Cosponsor(s): *GSA International Division; Precambrian (at large); GSA Structural Geology and Tectonics Division; GSA Geophysics Division; GSA Geobiology & Geomicrobiology Division; Geochemical Society; Paleontological Society; GSA History of Geology Division*

Discipline(s): Precambrian geology; tectonics; petrology, igneous

Advocate(s): Yildirim Dilek, Miami Univ., Oxford, Ohio; Harald Furnes, Bergen, Norway; Maarten de Wit, Univ. of Cape Town, Rondebosch, South Africa

Description: This session will evaluate diverse datasets from greenstone belts to better understand the nature and tempo of the physical, chemical, and biological processes involved in the development of the Archean crust, planetary evolution, and early life.

T90. Cryovolcanism in the Solar System

Cosponsor(s): *GSA Planetary Geology Division*

Discipline(s): planetary geology; geochemistry, organic; volcanology

Advocate(s): Louise Prockter, Applied Physics Lab, Laurel, Md.; A. Dominic Fortes, Univ. College London, London, UK

Description: We encourage papers that advance our knowledge of cryovolcanic processes in the solar system, including studies of composition, rheology, morphology, stratigraphy, and thermal and dynamical modeling of surface features and plumes.

T91. Eruptive Deposits as Keys to Understanding Volcanic Systems on Planetary Bodies
Cosponsor(s): *GSA Planetary Geology Division*
Discipline(s): planetary geology; volcanology; petrology, igneous
Advocate(s): Nicholas Lang, Mercyhurst College, Erie, Pa.; David Williams, GSA Planetary Geology Division, Tempe, Ariz.
Description: This session is geared toward understanding how the physical properties of volcanic landforms and deposits (composition, morphology, age, and distribution) can be used to constrain magmatic processes (magma generation, movement, and storage) on all planetary bodies.

T93. Glacial Mars
Cosponsor(s): *GSA Planetary Geology Division; GSA Quaternary Geology and Geomorphology Division*
Discipline(s): planetary geology; quaternary geology; geomorphology
Advocate(s): Roger J. Phillips, Southwest Research Institute, Boulder, Colo.; James W. Head, Brown Univ., Providence, R.I.
Description: Mars is a glacially active planet and has been for hundreds of millions of years. This session will review our present understanding of glacial Mars and present new results from ongoing Mars missions.

T94. Impact Cratering from the Microscopic to the Planetary Scale
Cosponsor(s): *GSA Planetary Geology Division; International Continental Scientific Drilling Program (ICDP); GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division; GSA Geophysics Division; Paleontological Society; GSA International Division*
Discipline(s): planetary geology; geophysics/tectonophysics/seismology; stratigraphy
Advocate(s): Christian Koeberl, Univ. of Vienna, Vienna, Austria; Jared Morrow, San Diego State Univ., San Diego, Calif.
Description: This session welcomes contributions on any aspect of the study of terrestrial impact craters, from their formation to structure, from ejecta to shock deformation, from geological to biological effects, including comparative planetology, and recent controversies.

T95. Impact Cratering in the Solar System: Implications for Planetary Ages and Processes (The G.K. Gilbert Award Session)
Cosponsor(s): *GSA Planetary Geology Division*
Discipline(s): planetary geology
Advocate(s): Louise Prockter, Applied Physics Lab, Laurel, Md.; Jay Melosh, Univ. of Arizona, Tucson, Ariz.
Description: Impact cratering is a fundamental geological process throughout the solar system. We encourage contributions on any aspect of planetary impact cratering, including impact flux modeling, crater age dating, morphology, and laboratory studies.

T96. Volcanic Caves: Geological and Microbiological Terrestrial Analogs of Potential Extraterrestrial Conditions
Cosponsor(s): *GSA Planetary Geology Division; GSA Geobiology & Geomicrobiology Division; National Cave and Karst Research Institute; NASA*
Discipline(s): planetary geology; volcanology; geomicrobiology
Advocate(s): George Veni, National Cave and Karst Research Institute, Carlsbad, N.Mex.; Carlton C. Allen, Houston, Tex.
Description: Volcanic caves provide unique insights into the origin of volcanic terrains and their extraterrestrial counterparts. Accurate interpretation is crucial as they are considered for possible human habitation and as potential optimal environments for microbial life.

T97. EARTHTIME: From Developing Tools to Teaching about Time
Cosponsor(s): *GSA Sedimentary Geology Division; GSA Geobiology & Geomicrobiology Division; Geochemical Society; Paleontological Society; GSA Geoscience Education Division*
Discipline(s): geoscience education; geochemistry; paleontology, biogeography/biostratigraphy
Advocate(s): Samuel A. Bowring, Massachusetts Institute of Technology, Cambridge, Mass.; Kirk R. Johnson, Denver Museum of Nature & Science, Denver, Colo.
Description: High-precision geochronology is revolutionizing our understanding of Earth's history. We seek contributions related to exploring the limits of precision and accuracy of geochronometers, calibration of proxy stratigraphies, and new efforts at educational in-reach and outreach.

T98. Earth Science in Place-Based Teaching
Cosponsor(s): *National Association of Geoscience Teachers; GSA Geoscience Education Division*
Discipline(s): geoscience education; environmental geoscience; geoscience information/communication
Advocate(s): Charles Ault, Lewis & Clark College, Portland, Ore.; Steven Semken, Arizona State Univ., Tempe, Ariz.
Description: Participants will share ideas on using geographically diverse "places" as contexts for teaching earth science. Place-based teaching cultivates local knowledge and encourages the appreciation of landscapes. The "place" approach also incorporates important cultural and aesthetic insights.

T99. EarthScope Education and Outreach: Connecting Students, Teachers, and the Public to the Dynamic Landscape of North America

Cosponsor(s): *GSA Geophysics Division; National Association of Geoscience Teachers; GSA Geoscience Education Div.*

Discipline(s): geoscience education; geoscience information/communication; geophysics/tectonophysics/seismology

Advocate(s): Robert J. Lillie, Oregon State Univ., Corvallis, Ore.; Susan Eriksson, UNAVCO, Boulder, Colo.; John Taber, IRIS Consortium, Washington, D.C.

Description: This session presents case studies of efforts to engage scientists, students, teachers, policy makers, and the public with EarthScope data and discoveries and their bearing on a broad range of scientific and societal issues.

T100. Field Geology Education—Historical Perspectives and Modern Approaches

Cosponsor(s): *National Association of Geoscience Teachers; GSA Geoscience Education Division; GSA Structural Geology and Tectonics Division; GSA Quaternary Geology and Geomorphology Division*

Discipline(s): geoscience education; structural geology; geomorphology

Advocate(s): David Mogk, Montana State Univ., Bozeman, Mont.

Description: This session will address numerous aspects of field instruction, including historical perspectives, alternative curricula, field technology, original research, and international experiences with a focus on learning goals, pedagogic value, and assessment of learning in the field.

T101. GIS in K–16 Geoscience Courses: Constructing Knowledge

Cosponsor(s): *National Association of Geoscience Teachers; GSA Geoscience Education Division*

Discipline(s): geoscience education; remote sensing/geographic info system

Advocate(s): Aida Awad, Maine Township High School East, Park Ridge, Ill.; Michael Taber, Colorado College, Colorado Springs, Colo.

Description: Integrating GIS into K–16 geoscience courses provides rich opportunities for students to learn geoscience concepts while exploring relevant data and problems. Visualization, critical thinking, problem solving, and computational skills are enhanced through the integration.

T102. Geological and Environmental Sciences Research Forum: Greater Visibility and Interactions between Undergraduates and K–12 Students

Cosponsor(s): *National Association of Geoscience Teachers*

Discipline(s): geoscience education; geoscience information/communication; environmental geoscience

Advocate(s): Nazrul I. Khandaker, York College of CUNY, Jamaica, N.Y.; Stanley Schleifer, York College of CUNY, Jamaica, N.Y.

Description: Undergraduate and K–12 students interested in current environmental and geological issues will be able to exchange their ideas and findings through their poster presentations and receive feedback from meeting attendees, as well as take advantage of a great venue for making well-informed decisions on future career choices.

T103. Geology in the National Parks: Research, Mapping, and Education

Cosponsor(s): *GSA Structural Geology and Tectonics Division; GSA Hydrogeology Division; GSA Sedimentary Geology Division; GSA Geoscience Education Division; National Association of Geoscience Teachers*

Discipline(s): geoscience education; geoscience information/communication

Advocate(s): Bruce Heise, National Park Service, Lakewood, Colo.; Melanie Ransmeier, National Park Service, Denver, Colo.

Description: This session addresses the role of geoscience in the National Parks. Presentations are encouraged on geologic research, mapping, surface and groundwater studies, paleontology, coastal geology, education, and resource management on National Park Service administered lands.

T104. Geoscience Programs at Community Colleges: Models for Success and Innovation

Cosponsor(s): *National Association of Geoscience Teachers; GSA Geoscience Education Division*

Discipline(s): geoscience education; geoscience information/communication

Advocate(s): Eric M.D. Baer, Highline Community College, Des Moines, Wash.; Frank D. Granshaw, Portland Community College, Portland, Ore.

Description: Community college programs are diverse and multifaceted. This session will highlight a variety of programs and how they successfully achieve their goals.

T105. Interactions and Interdependencies of Academic and Applied Geosciences: Advantages, Challenges, and Ways Forward

Cosponsor(s): *GSA Academic and Applied Geoscience Relations Committee*

Discipline(s): geoscience education; engineering geology; economic geology

Advocate(s): Emily S. Schultz-Fellenz, Los Alamos National Laboratory, Los Alamos, N.Mex.; Benjamin C. Burke, ExxonMobil Development Company, Houston, Tex.

Description: This session is a forum for discussing the reliance of the academic and applied geoscience communities on one another, describing the successes and shortcomings of academic/applied geoscience interfaces, and detailing effective mechanisms for positive change.

T106. Opportunities and Challenges for Geologic Hazards Education in Cascadia
Cosponsor(s): *GSA Geoscience Education Division; National Association of Geoscience Teachers; GSA Geology and Health Division*
Discipline(s): geoscience education; geoscience information/communication; public policy
Advocate(s): Robert F. Butler, Univ. of Portland, Portland, Ore.; Carolyn L. Driedger, USGS, Vancouver, Wash.; James Roddey, Oregon Dept. of Geology and Mineral Industries, Portland, Ore.
Description: This session will provide an opportunity for geoscience educators, K–12 earth science teachers, scientists, and officials to showcase successes in and challenges to geologic hazards education in Cascadia and other regions.

T107. Promoting Literacy about Earth System Science Concepts
Cosponsor(s): *National Association of Geoscience Teachers*
Discipline(s): geoscience education; public policy; geoscience information/communication
Advocate(s): Michael Wysession, Washington Univ., St. Louis, Mo.; Nicole LaDue, National Science Foundation, Arlington, Va.
Description: Multiple community efforts have defined the fundamental concepts of earth system science. These documents serve as tools that can unite the scientific community in conveying a common message about earth science to the public.

T108. Spatial Skills in the Geosciences
Cosponsor(s): *National Association of Geoscience Teachers; GSA Geoscience Education Division*
Discipline(s): geoscience education
Advocate(s): Cathryn A. Manduca, Carleton College, Northfield, Minn.; Basil Tikoff, Univ. of Wisconsin, Madison, Wisc.; Thomas F. Shipley, Temple Univ., Philadelphia, Pa.; Carol J. Ormand, Carleton College, Northfield, Minn.
Description: Papers in this session will describe research on the spatial skills that underpin our ability to learn about geoscience or do geoscience research, as well as educational or technical innovations that develop these skills.

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Main fork of the Salmon River a few miles downstream from where this "River of No Return" originates as a bubbling spring in the Sawtooth Mountains. Photo by K.E. Asmus.

T109. Successful Models of Collaborations between High Schools and Two-Year and Four-Year Institutions
Cosponsor(s): *National Association of Geoscience Teachers; GSA Geoscience Education Division*
Discipline(s): geoscience education
Advocate(s): Aida Awad, Maine Township High School East, Park Ridge, Ill.; Steve Mattox, Grand Valley State Univ., Allendale, Mich.
Description: This session highlights collaborations with high schools that lead to students entering the geosciences, including dual credit, high school teachers offering courses for college credit and dual enrollment, and high school students attending college classes.

T110. Teaching and Research Challenges and Successes for Solitary Geologists in Academia
Cosponsor(s): *National Association of Geoscience Teachers; GSA Geoscience Education Division; Council on Undergraduate Research*
Discipline(s): geoscience education
Advocate(s): Janis D. Treworgy, Principia College, Elsah, Ill.; Laura Guertin, Penn State–Brandywine, Media, Pa.
Description: Are you the only geologist at your institution? You are not alone! Come share your experiences and network with others like you. Discuss facilities, course load, research opportunities, challenges, successes, and what keeps you there.

T111. Techniques and Tools for Effective Recruitment, Retention, and Promotion of Women and Minorities in the Geosciences
Cosponsor(s): *GSA Minorities and Women in the Geosciences Committee; GSA Academic and Applied Geoscience Relations Committee; Association for Women Geoscientists*
Discipline(s): geoscience education; public policy
Advocate(s): Margaret Brewer-LaPorta, LaPorta and Associates, LLC, Geological Consultants, Warwick, N.Y.; Emily S. Schultz-Fellenz, Los Alamos National Laboratory, Los Alamos, N.Mex.
Description: This session provides an open discussion of successful methods for attracting and providing professional development for women and minorities within both the academic and applied geoscience sectors.

T112. The Nature of Geoscience Expertise
Cosponsor(s): *National Association of Geoscience Teachers; GSA Structural Geology and Tectonics Division; GSA Quaternary Geology and Geomorphology Division; GSA Geoscience Education Division*
Discipline(s): geoscience education; structural geology; geomorphology
Advocate(s): David W. Mogk, Montana State Univ., Bozeman, Mont.
Description: Key aspects of geoscience expertise will be explored, including spatial and temporal thinking, understanding Earth as a complex system, learning in the field, and integration of evidence across many scales of observation, methods, and subdisciplines.

T113. Using Planetary Examples to Teach about Terrestrial Volcanoes
Cosponsor(s): *GSA Planetary Geology Division; GSA Geoscience Education Division; On the Cutting Edge Leadership Development in the Geosciences (an NSF-funded program)*
Discipline(s): geoscience education; planetary geology; volcanology
Advocate(s): Jayne C. Aubele, New Mexico Museum of Natural History and Science, Albuquerque, N.Mex.; Barbara Tewksbury, Hamilton College, Clinton, N.Y.
Description: We encourage abstracts that review and provide ways of integrating volcanoes from other planets into geosciences courses to enhance student understanding of terrestrial geology and allow students to expand their skills to multiple planetary environments.

T114. What Can We Do to Help Our Students Become Better Learners? Fostering the Development of Metacognition and Self-Regulation
Cosponsor(s): *GSA Geoscience Education Division; National Association of Geoscience Teachers*
Discipline(s): geoscience education
Advocate(s): Dexter Perkins, Univ. of North Dakota, Grand Forks, N.Dak.; Karl R. Wirth, Macalester College, Saint Paul, Minn.
Description: Metacognition, knowledge, and regulation of one's thinking and learning play critical roles in learning, yet are often overlooked. This session explores approaches and challenges to teaching metacognition and self-regulation within the earth sciences.

T115. Women and Minority Careers in the Geosciences: Successful Strategies for Overcoming Challenges
Cosponsor(s): *Minorities and Women in the Geosciences Committee; Association for Women Geoscientists*
Discipline(s): geoscience education
Advocate(s): Jacquelyn Hams, Los Angeles Valley College, Valley Glen, Calif.; Margaret Brewer-LaPorta, LaPorta and Associates, LLC, Geological Consultants, Warwick, N.Y.; Amy Garbowicz, Columbia Exploration, Houston, Tex.
Description: Successful minorities and women discuss the challenges involved in starting and promoting a career in the geosciences.

T116. Challenges in Geoscience Publishing
Cosponsor(s): *Association of Earth Science Editors*
Discipline(s): geoscience information/communication
Advocate(s): Monica Easton, Association of Earth Science Editors, Sudbury, Ontario
Description: Journal editors: Use this session as your opportunity to hold an information forum with a wider audience to discuss issues of concern (e.g., copyright, confidentiality, conflicts of interest, plagiarism, electronic publication, quality of review).

T117. Geoscience Information Landscape: Pathways to Success (Posters)
Cosponsor(s): *Geoscience Information Society; National Association of Geoscience Teachers*
Discipline(s): geoscience information/communication; geoinformatics; geoscience education
Advocate(s): Jody Foote, Univ. of Oklahoma, Norman, Okla.
Description: The geoscience information landscape is highly varied and offers many opportunities for information discovery. These posters represent the many unique pathways to geoscience information.

T118. Navigating the Geoscience Information Landscape: Pathways to Success
Cosponsor(s): *Geoscience Information Society; National Association of Geoscience Teachers*
Discipline(s): geoscience information/communication; geoinformatics; geoscience education
Advocate(s): Jody Foote, Univ. of Oklahoma, Norman, Okla.
Description: The geoscience information landscape is constantly changing. Information comes in an array of formats from a multitude of sources. Successful navigation depends on the paths chosen to identify, gather, organize, and disseminate resources.

T119. Photographing Geology: The Roles of Imagery and Aesthetics in Geoscience Research and Communication—In Memory of Terry Toedtemeier
Discipline(s): geoscience information/communication; geoscience education
Advocate(s): Ellen M. Bishop, Oregon Paleo Lands Institute, Fossil, Ore.
Description: Images at all scales enhance observation and help communicate geoscience to the public and to professionals. The session showcases photography and photographic techniques as an essential tool of research, communication, and creative and analytical thought.

T120. Darwin, Geology, and Evolution: Impact of Darwinian Views on Scientific Theory-Making
Cosponsor(s): *GSA History of Geology Division; GSA International Division; GSA Sedimentary Geology Division; Paleontological Society; GSA Geology and Society Division; GSA Quaternary Geology and Geomorphology Division; GSA Geoscience Education Division; National Association of Geoscience Teachers; GSA Structural Geology and Tectonics Division*
Discipline(s): history of geology; paleontology, diversity, extinction, origination; quaternary geology
Advocate(s): Yildirim Dilek, Miami Univ., Oxford, Ohio; Michael Roberts, The Vicarage, Lancaster, UK; Léo F. Laporte, Univ. of California, Santa Cruz, Calif.
Description: This session will discuss and celebrate Darwin's thoughts and past-present impact on geosciences and will also examine the implications of Darwin's theory of evolution for geology, biology, theology, and scientific philosophy.

T121. Pacific Rim Influence on Geological Thought and History
Cosponsor(s): *GSA History of Geology Division; GSA Structural Geology and Tectonics Division; GSA International Division; GSA Geophysics Division*
Discipline(s): history of geology; geophysics/tectonophysics/seismology; petrology, metamorphic
Advocate(s): Yildirim Dilek, Miami Univ., Oxford, Ohio; Yujiro Ogawa, Univ. of Tsukuba, Tsukuba, Japan; Ken'ichiro Hisada, Univ. of Tsukuba, Tsukuba, Japan
Description: This session will explore the history and development of major geological and geophysical concepts that originated from the Pacific Rim and will evaluate how these concepts have influenced the evolution of geological thought and new ideas through time.

T122. Copper and Gold Transport in Crustal Fluids: New Advances from Field, Experimental, and Theoretical Studies
Discipline(s): geochemistry; economic geology; petrology, experimental
Advocate(s): Jamie Wilkinson, Imperial College London, London, UK
Description: The role of unconventional (non-Cl) ligands in copper and gold transport in crustal fluids and implications for ore deposit genesis will be explored via case studies of natural systems and experimental and theoretical modeling.

T123. Diurnal Biogeochemical Processes in Rivers, Lakes, and Shallow Groundwater
Cosponsor(s): *Geochemical Society; GSA Hydrogeology Division; GSA Geobiology & Geomicrobiology Division*
Discipline(s): geochemistry; hydrogeology; geomicrobiology
Advocate(s): Christopher Gammons, Montana Tech of The Univ. of Montana, Butte, Mont.; David Nimick, USGS, Helena, Mont.
Description: This interdisciplinary session will explore 24-hour cycles in physical, biological, and chemical processes in the terrestrial hydrosphere. Examples include diurnal changes in microbial dynamics and the concentration and speciation of trace metals, nutrients, and stable isotopes.

T124. Fluid-Driven Geochemical Transformations: In Honor of Harold Helgeson
Cosponsor(s): *Society of Economic Geologists; Geochemical Society*
Discipline(s): geochemistry; economic geology; petrology, experimental
Advocate(s): Everett L. Shock, Arizona State Univ., Tempe, Ariz.; Dennis Bird, Stanford Univ., Stanford, Calif.; William Murphy, California State Univ., Chico, Calif.; John Dilles, Oregon State Univ., Corvallis, Ore.
Description: Theoretical modeling is ubiquitous to aqueous geochemistry, because most fluids responsible for geochemical transformations no longer exist. This session will highlight theoretical, experimental, field, and analytical developments that push the current limits of modeling capabilities.

T125. Geochemical Approaches to Sedimentary Provenance Studies
Cosponsor(s): *Geochemical Society; GSA Sedimentary Geology Division*
Discipline(s): geochemistry; sediments, clastic; tectonics
Advocate(s): Troy Rasbury, Stony Brook Univ., Stony Brook, N.Y.; Sidney R. Hemming, Columbia Univ., Palisades, N.Y.
Description: We encourage presentations on new and established geochemical/geochronological provenance tools for constraining geological problems, including mountain and basin development, weathering, dynamics of sedimentary systems, ice sheet dynamics, aridity and winds, river discharge, and ocean currents.

T126. Large Igneous Provinces (LIPs) through Geologic Time
Cosponsor(s): *GSA Geoinformatics Division; GSA Structural Geology and Tectonics Division; GSA International Division*
Discipline(s): geochemistry; geoinformatics; petrology, igneous
Advocate(s): A. Krishna Sinha, Virginia Tech, Blacksburg, Va.; Barry B. Hanan, San Diego State Univ., San Diego, Calif.; John Shervais, Utah State Univ., Logan, Utah
Description: The origin and distribution of LIPs through geologic time is related to large-scale catastrophic mantle melting events. Understanding the causes of such events is relevant to a better understanding of mantle dynamics and lithosphere evolution.

T127. Science of Geologic Carbon Sequestration
Discipline(s): geochemistry; hydrogeology; geophysics/tectonophysics/seismology
Advocate(s): Alexis Navarre-Sitchler, Univ. of Wyoming, Laramie, Wyo.; John Kaszuba, Univ. of Wyoming, Laramie, Wyo.
Description: Papers in this session will highlight current research and results in the field of geological carbon sequestration. Papers will be drawn from all disciplines, including geomechanics, geochemistry, hydrology, and geomicrobiology.

T128. Soil Geochemistry in Mineral Exploration
Discipline(s): geochemistry; economic geology; environmental geoscience
Advocate(s): Paul R. Gammon, Geological Survey of Canada, Ottawa, Ontario; David B. Smith, USGS, Denver, Colo.
Description: This topical session aims to explore the state-of-the-art in soil geochemical research as applied to the discovery of buried mineral deposits.

T129. Combining Geophysics and Geology: The George P. Woollard Award Session
Cosponsor(s): *GSA Geophysics Division*
Discipline(s): geophysics/tectonophysics/seismology; tectonics
Advocate(s): Catherine M. Snelson, New Mexico Institute of Mining and Technology, Socorro, N.Mex.; Kevin Mickus, Missouri State Univ., Springfield, Mo.
Description: This session honors the recipient of the George P. Wollard Award for his or her outstanding contribution in geophysics that advances our understanding of geology. General contributions combining geophysics and geology to solve geologic problems are welcome.

T130. Deformation of the Cascadia Accretionary Prism
Cosponsor(s): *GSA Structural Geology and Tectonics Division*
Discipline(s): geophysics/tectonophysics/seismology; tectonics; structural geology
Advocate(s): Chris Goldfinger, Oregon State Univ., Corvallis, Ore.; Kelin Wang, Sidney, British Columbia
Description: The lack of instrumental great earthquakes in Cascadia, combined with the certainty of a future event, has driven great interest in this enigmatic subduction zone. This session will explore the structure, deformation, and seismotectonics of the Cascadia Subduction Zone.

T131. Ancient Coastal and Sub-Sea Sites: New Findings and Problems
Cosponsor(s): *GSA Archaeological Geology Division; Smithsonian Institution*
Discipline(s): archaeological geology
Advocate(s): Jean-Daniel Stanley, Smithsonian Institution National Museum of Natural History, Washington, D.C.; Daniel F. Belknap, University of Maine, Orono, Maine, USA
Description: The session focuses on ancient land sites and former anthropogenic features now submerged off world coasts, a topic directly applicable for archaeologists working offshore, sea-level change specialists, and managers formulating protections measures for vulnerable coastlines.

T132. Forensic Geology
Cosponsor(s): *GSA Geology and Health Division*
Discipline(s): geology and health; environmental geoscience; geochemistry
Advocate(s): Cherukupalli E. Nehru, Brooklyn College–CUNY, Brooklyn, N.Y.
Description: This session centers on the interrelationships between forensic science, geology, and health.

T133. Geochemistry of Atmospheric Particulates: From Sources to Impacts on the Environment and Health
Cosponsor(s): *GSA Geology and Health Division*
Discipline(s): geology and health; geochemistry; environmental geoscience
Advocate(s): Jean M. Morrison, USGS, Denver, Colo.; JoAnn M. Holloway, USGS, Denver, Colo.; Suzette Morman, USGS, Denver, Colo.; Geoffrey Plumlee, USGS, Denver, Colo.
Description: This session highlights the impact of dusts and other atmospheric particulates from geogenic sources (rocks, soils, volcanic eruptions, wildfires, etc.) on the environment and health.

T134. Risks and Realities: Current Advances in Understanding Societal Risk and Resilience to Natural Hazards

Cosponsor(s): *GSA Geology and Health Division; GSA Geology and Public Policy Committee; GSA Geoinformatics Division; GSA Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division*

Discipline(s): geology and health; public policy; remote sensing/geographic info system

Advocate(s): Nathan J. Wood, USGS, Vancouver, Wash.; Monica E. Gowan, Univ. of Canterbury, Christchurch, New Zealand

Description: Understanding disaster potential requires the synthesis of natural and social science to gauge pre-event risk and post-event resilience. This session focuses on methods and outcomes of assessing societal risk to and recovery from disasters.

T135. Geology in the National Forests and Grasslands—Stewardship, Education, and Research

Cosponsor(s): *GSA Geology and Society Division; USDA Forest Service, Minerals & Geology Management and Watershed, Fish, Wildlife, Air & Rare Plants Programs; GSA Hydrogeology Division; GSA Quaternary Geology and Geomorphology Division; GSA Engineering Geology Division; National Association of Geoscience Teachers*

Discipline(s): environmental geoscience; public policy; geoscience education

Advocate(s): Christopher P. Carlson, USDA Forest Service, Arlington, Va.; Paul K. Doss, Univ. of Southern Indiana, Evansville, Ind.; J. Courtney Cloyd, USDA Forest Service, Portland, Ore.; Michael A. Crump, USDA Forest Service, Russellville, Ark.

Description: This session will explore some of the many aspects of the geological sciences conducted on the National Forests and grasslands. Topics include paleontology, cave and karst geology, engineering geology and natural-hazard mitigation, hydrogeology, interpretive and recreational geology, geo-ecology, and more.

T136. He Sapa Oyate (Geoscience Community at the Heart of Everything That Is)—Native American Perspectives on Geoscience

Discipline(s): environmental geoscience; geoscience information/communication

Advocate(s): Jacquelyn Bolman, Humboldt State Univ., Arcata, Calif.

Description: This session highlights the unique perspectives of Native Americans in the geosciences, including knowledge of balancing the needs of people with the needs of our natural environments. Indigenous science is integrated with contemporary science.

T137. Plateau Native Cultures and Resource Management: First Foods Strategy

Discipline(s): environmental geoscience; geoscience information/communication

Advocate(s): Katherine E. Ely, Confederated Tribes of the Umatilla Indian Reservation, Pendleton, Ore.

Description: This session focuses on Tamanwit: The Native American understanding that science, natural processes, and religion do not conflict, guiding all law, including nature law.

T138. Sigma Gamma Epsilon Undergraduate Research (Posters)

Cosponsor(s): *Sigma Gamma Epsilon*

Discipline(s): environmental geoscience; stratigraphy; petrology, igneous

Advocate(s): Richard Ford, Weber State Univ., Ogden, Utah; Donald Neal; Charles Mankin, Sigma Gamma Epsilon, Norman, Okla.

Description: The goal of this session is to highlight recent and ongoing undergraduate research in the geosciences in a student-friendly forum. The session is open to students and faculty co-authors working in any area of the geosciences.

T139. Sources, Transport, and Fate of Trace and Toxic Elements in the Environment

Cosponsor(s): *GSA Hydrogeology Division; International Association of Geochemistry; GSA Geology and Health Division*

Discipline(s): environmental geoscience; geochemistry; geology and health

Advocate(s): LeeAnn Munk, Univ. of Alaska Anchorage, Anchorage, Alaska; David T. Long, Michigan State Univ., East Lansing, Mich.; W. Berry Lyons, The Ohio State Univ., Columbus, Ohio

Description: The environmental chemistry of trace and toxic elements is an important and growing field of research in applied geochemistry. The session will examine the sources, transport, and fate of these elements in natural environments and areas impacted by anthropogenic activities.

T140. Undergraduate Investigations of Geologic Hazards on Dynamic Landscapes

Cosponsor(s): *Council on Undergraduate Research; GSA Quaternary Geology and Geomorphology Division*

Discipline(s): environmental geoscience; geomorphology; public policy

Advocate(s): Patrick Burkhart, Slippery Rock Univ., Slippery Rock, Pa.; Jeffrey Marshall, California State Polytechnic Univ., Pomona, Calif.

Description: Abstracts are solicited from students, particularly undergraduates, completing investigations of geologic hazards—both classic hazards, such as flooding and earthquakes, and contemporary hazards, such as climate change, landscape disruption, and associated declines in biodiversity.

T141. What Does Biology Have to Do with It? Biota in Weathering, Nutrient Cycling, Mineral Surface Interactions and Mineral Precipitation
Cosponsor(s): *GSA Geobiology & Geomicrobiology Division*
Discipline(s): environmental geoscience; geomicrobiology; geochemistry
Advocate(s): Marjorie Schulz, USGS, Menlo Park, Calif.; Zsuzsanna Balogh-Brunstad, Hartwick College, Oneonta, N.Y.; C. Kent Keller, Washington State Univ., Pullman, Wash.
Description: This session seeks submissions from all investigators of water-mineral/soil-microbe/plant interactions. Our goal is an increased understanding of biological effects on various processes such as chemical weathering, nutrient cycles, and mineral formation.

T142. Applications of Landslide Inventories: Creating Hazard Maps and Guiding Policy
Cosponsor(s): *GSA Geology and Society Division; Association of Environmental & Engineering Geologists; GSA Geology and Public Policy Committee*
Discipline(s): engineering geology; geomorphology; public policy
Advocate(s): William J. Burns, Oregon Dept. of Geology and Mineral Industries, Portland, Ore.
Description: The session is designed to gather and share information on the value of landslide inventories and their use toward risk reduction, including creation of hazard maps and policy guidelines.

T143. Debris Flows
Cosponsor(s): *GSA Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division*
Discipline(s): engineering geology; geomorphology; volcanology
Advocate(s): Richard M. Iverson, USGS, Vancouver, Wash.; Jonathan Godt, USGS, Denver, Colo.; William Schulz, USGS, Denver, Colo.
Description: This session will include presentations on all aspects of debris flows, including initiation processes, flow mechanics and modeling, depositional processes and products, magnitude-frequency relations, and methods of hazard assessment.

T144. Landslides in the Pacific Northwest: Advances in Research and Practice
Cosponsor(s): *GSA Engineering Geology Division; Association of Environmental & Engineering Geologists; U.S. Geological Survey; GSA Quaternary Geology and Geomorphology Division*
Discipline(s): engineering geology; geomorphology; public policy
Advocate(s): William J. Burns, Oregon Dept. of Geology and Mineral Industries, Portland, Ore.
Description: This session will explore recent advances in understanding landslides and landslide hazards in the Pacific Northwest and encourages contributions from landslide researchers and practitioners that address problems associated with any type of landslide.

T145. Use of High-Resolution LiDAR DEMs for Geologic, Geomorphic, and Geohazards Mapping
Discipline(s): engineering geology; Quaternary geology; remote sensing/geographic info system
Advocate(s): Ian Madin, Oregon Dept. of Geology and Mineral Industries, Portland, Ore.
Description: High resolution LiDAR digital elevation models (DEMs) are becoming widely available and can revolutionize geomorphic, geohazards, and geologic mapping. This session will provide current examples of the use of this data.

T146. Ensuring That Geologic Controversies Are Addressed with Good Science in the Classroom, the Community, and the Capitol
Cosponsor(s): *National Association of Geoscience Teachers; GSA Geology and Public Policy Committee; GSA Geoscience Education Division; American Geological Institute*
Discipline(s): public policy; geoscience education; geoscience information/communication
Advocate(s): Michael A. Phillips, Illinois Valley Community College, Oglesby, Ill.; Linda Rowan, American Geological Institute, Alexandria, Va.
Description: Geologic controversies may be real or manufactured, but they always capture the public's attention. This session will present ideas and examples of ways to ensure the scientific perspective is included and given precedence when controversies arise.

T147. Sustainability of Water Resources for Energy Needs
Cosponsor(s): *GSA Hydrogeology Division; GSA Geology and Public Policy Committee*
Discipline(s): public policy; hydrogeology; environmental geoscience
Advocate(s): William Shilts, Champaign, Ill.; E. Donald McKay, Illinois State Geological Survey, Champaign, Ill.; Richard C. Berg, Illinois State Geological Survey, Champaign, Ill.
Description: Energy production requires vast amounts of water for cooling and other operations. Ensuring that all water resource needs are met without compromising present and future generations requires a systematic approach to energy and water planning.

T148. The Columbia River Basin—From Mantle Plumes to Emerging Contaminants
Discipline(s): public policy; environmental geoscience; tectonics
Advocate(s): Jim O'Connor, USGS, Portland, Ore.
Description: We seek contributions addressing all aspects of the special geologic environment of the Columbia River basin and its influence on physiography, hydrology, resource utilization, cultural development, and present issues faced by regional policy makers.

T149. Copper in Central Eurasia and Russia: Linking Mineral Resource Assessment, Tectonics, and Metallogeny
Cosponsor(s): *Society of Economic Geologists; Centre for Russian and Central EurAsian Mineral Studies (CERCAMS); U.S. Geological Survey; GSA International Division*
Discipline(s): economic geology; tectonics; remote sensing/geographic info system
Advocate(s): Jane M. Hammarstrom, USGS, Reston, Va.; Reimar Seltmann, Natural History Museum, London, UK
Description: This session will highlight recent research on the geologic framework for copper deposits (emphasis on porphyry and sediment-hosted deposits) in the former Soviet Union and neighboring territories and applications to regional-scale mineral resource assessment.

T150. Melt and Fluid Inclusion Analysis in Resource Investigations
Cosponsor(s): *Society of Economic Geologists; U.S. Geological Survey*
Discipline(s): economic geology; geochemistry; petrology, igneous
Advocate(s): Albert H. Hofstra, USGS, Denver, Colo.; Robert J. Bodnar, Virginia Polytechnic Institute and State Univ., Blacksburg, Va.
Description: This session will highlight methods for melt and fluid inclusion analysis and applications of inclusion compositional data to mineral resource and geothermal resource investigations.

T151. Clean Coal: Can It Be a Reality?
Cosponsor(s): *GSA Coal Geology Division; GSA Engineering Geology Division; GSA Geology and Society Division; GSA Geology and Health Division*
Discipline(s): coal geology; environmental geoscience; public policy
Advocate(s): Leslie Ruppert, USGS, Reston, Va.; Allan Kolker, USGS, Reston, Va.; Sean Brennan, U.S. Geological Survey, Reston, Va.
Description: This session examines what it will take to make "clean coal" a reality and what would happen if we cannot. Topics include the science and technology of carbon capture, geologic sequestration, and partial capture environmental consequences.

T152. Frontiers in Coal Science: From Basic Research to Applied Technology
Cosponsor(s): *GSA Coal Geology Division; GSA Sedimentary Geology Division; GSA Geology and Health Division*
Discipline(s): coal geology; sediments, clastic; geology and health
Advocate(s): R.M. Flores, USGS, Denver, Colo.; Maria Mastalerz, Indiana Univ., Bloomington, Ind.
Description: This session highlights recent advances in basic research on coal geology, including petrology, geochemistry, and sedimentology, as well as advances in applied technology on coal utilization, environmental issues of combustion, coalbed methane, and CO_2 sequestration in coal.

T153. Geoarchaeology and Late Quaternary Landscapes of North American River Valleys
Cosponsor(s): *GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division*
Discipline(s): archaeological geology; geomorphology; Quaternary geology
Advocate(s): Todd Grote, Allegheny College, Meadville, Pa.; Lara Homsey, Murray State Univ., Murray, Ky.
Description: This session will focus on recent interdisciplinary investigations of North American river valleys occurring from the landscape to site-specific scale. Submissions should contribute to understanding the archaeological record and late Quaternary lowland landscapes.

T154. Geoarchaeology, Reconstructions of Paleoenvironments and Past Human–Environment Interactions
Cosponsor(s): *GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; Paleontological Society*
Discipline(s): archaeological geology; geomorphology; Quaternary geology
Advocate(s): Kathleen Nicoll, Univ. of Utah, Salt Lake City, Utah; Catherine Yansa, Michigan State Univ., East Lansing, Mich.
Description: Analysis of sediment and fossil records inform interpretations of cultural activity and late Neogene–Quaternary environments. This session welcomes interdisciplinary papers on geoarchaeology and allied methodologies that reconstruct past landscapes, environments, and the human footprint on natural systems.

T155. Geochemical Geoarchaeology: Artifacts and Contexts
Cosponsor(s): *GSA Archaeological Geology Division*
Discipline(s): archaeological geology; geochemistry; Quaternary geology
Advocate(s): Katherine A. Adelsberger, Knox College, Galesburg, Ill.; Cynthia M. Fadem, Washington Univ., St. Louis, Mo.
Description: Geochemical methods increasingly provide the critical tools for understanding paleoenvironments, site formation processes, and human behavioral decisions. This session will highlight the variety of geochemical methods used in geoarchaeology across cultural and temporal boundaries.

Sand Point, Columbia County, Oregon. Photo by Tim Jewett courtesy the Portland Oregon Visitors Association.

T156. New Advances in the Theory and Application of Luminescent and ESR Dating

Cosponsor(s): *GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division; Paleontological Society*

Discipline(s): archaeological geology; Quaternary geology; paleontology, biogeography/biostratigraphy

Advocate(s): Bonnie A.B. Blackwell, Williams College, Williamstown, Mass.; Joel Blickstein, RFK Science Research Institute, Glenwood Landing, N.Y.

Description: This session will highlight new theoretical developments and their applications within geology, paleontology, and archaeology for the thermoluminescent, optically stimulated luminescent, and electron spin resonance (ESR) dating methods, including new applications for dating barnacles, foraminifera, and sedimentary deposits.

T157. Obsidian from Magma to Artifact: Geological and Archaeological Perspectives

Cosponsor(s): *GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division; Geochemical Society*

Discipline(s): archaeological geology; petrology, igneous; volcanology

Advocate(s): Ellery Frahm, Univ. of Minnesota, Minneapolis, Minn.; Joshua Feinberg, Univ. of Minnesota, Minneapolis, Minn.

Description: This session brings together archaeologists and geoscientists from diverse fields—geochemistry, igneous petrology, volcanology, geomorphology, and more—to present on the topic of obsidian research, from magma formation and eruption to dating and sourcing artifacts.

T158. Best Practices and Solutions for Geological and Geophysical Data Preservation

Cosponsor(s): *GSA Geoinformatics Division; U.S. Geological Survey; Association of American State Geologists*

Discipline(s): geoinformatics; geoscience information/communication

Advocate(s): Brian Buczkowski, USGS, Woods Hole, Mass.

Description: Preservation of geologic and geophysical data is an issue that many repositories and institutions face. This session will highlight best practices employed by these groups in preserving the access, longevity, and viability of these resources.

T159. Climate Change Impacts on Society: Interface between Earth Systems Science and Policy Making

Cosponsor(s): *GSA Geology and Health Division*

Discipline(s): geoinformatics; public policy; environmental geoscience

Advocate(s): Gordon N. Keating, Los Alamos National Laboratory, Los Alamos, N.Mex.; Frank Perry, Los Alamos National Laboratory, Los Alamos, N.Mex.

Description: Climate change poses numerous challenges to society and natural systems. We encourage presentations of integrative theoretical or applied research in areas such as energy and water resources, environmental sustainability, land use, and natural hazards.

T160. From Virtual Globes to Geoblogs: Digital Innovations in Geoscience Research, Education, and Outreach

Cosponsor(s): *GSA Geoinformatics Division; GSA Geoscience Education Division; GSA Geology and Society Division; Google, Inc.; National Association of Geoscience Teachers*

Discipline(s): geoinformatics; geoscience education; geoscience information/communication

Advocate(s): Kyle House, Univ. of Nevada, Reno, Nev.; John E. Bailey, Univ. of Alaska, Fairbanks, Alaska

Description: The application of digital technologies, such as Web 2.0 services, virtual globes, geobrowsers, and new applications of digital photography can enhance the understanding of geology at every level and across all subdisciplines. This session will highlight particularly innovative examples.

T161. Monitoring Climate through Glacier Change Using Geoinformatics (Posters)

Cosponsor(s): *University of Alaska at Fairbanks Geophysical Institute*

Discipline(s): geoinformatics; paleoclimatology/paleoceanography; marine/coastal science

Advocate(s): Cathy L. Connor, Univ. of Alaska Southeast, Juneau, Alaska; Anupma Prakash, Univ. of Alaska Fairbanks, Fairbanks, Alaska

Description: Transformation of the cryosphere creates global water shortages, coastal erosion, and sea-level inundation. Huge data volumes from space and Earth's sensors must be organized and made available to the public to monitor this change.

T162. Your Attention Please! Advances in Natural Hazard Warning and Information Systems

Cosponsor(s): *GSA Geoinformatics Division; GSA Geology and Society Division; GSA International Division; GSA Structural Geology and Tectonics Division; GSA Geophysics Division; GSA Geology and Public Policy Committee; U.S. Geological Survey*

Discipline(s): geoinformatics; geophysics/tectonophysics/seismology; public policy

Advocate(s): Linda Gundersen, USGS, Reston, Va.

Description: The combination of technology and the geosciences can provide real-time natural hazard warnings to emergency managers, the public, and scientists through a variety of media. This session highlights the state-of-the-art in local to global warning and forecasting.

Check for changes and updates at
www.geosociety.org/meetings/2009/techprog.htm.

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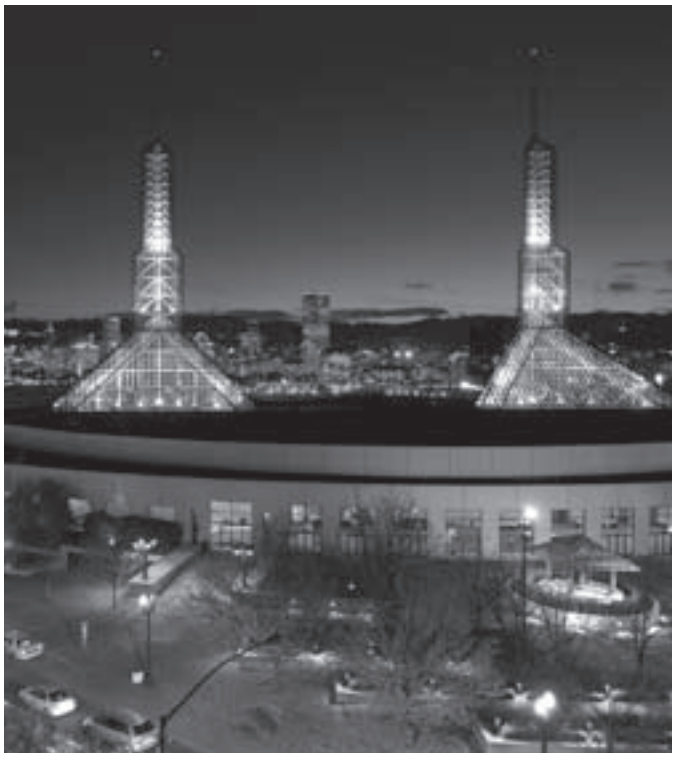

Oregon Convention Center. Photo by Bruce Forster/Viewfinders courtesy the Portland Oregon Visitors Association.

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Guest Program

Are you bringing a guest to the Meeting?

Look for a complete listing of 2009 Guest Program benefits and activities in the June *GSA Today*. Through GSA's Guest Program seminars and tours, your guest can discover firsthand the region's natural beauty and lively urban culture.

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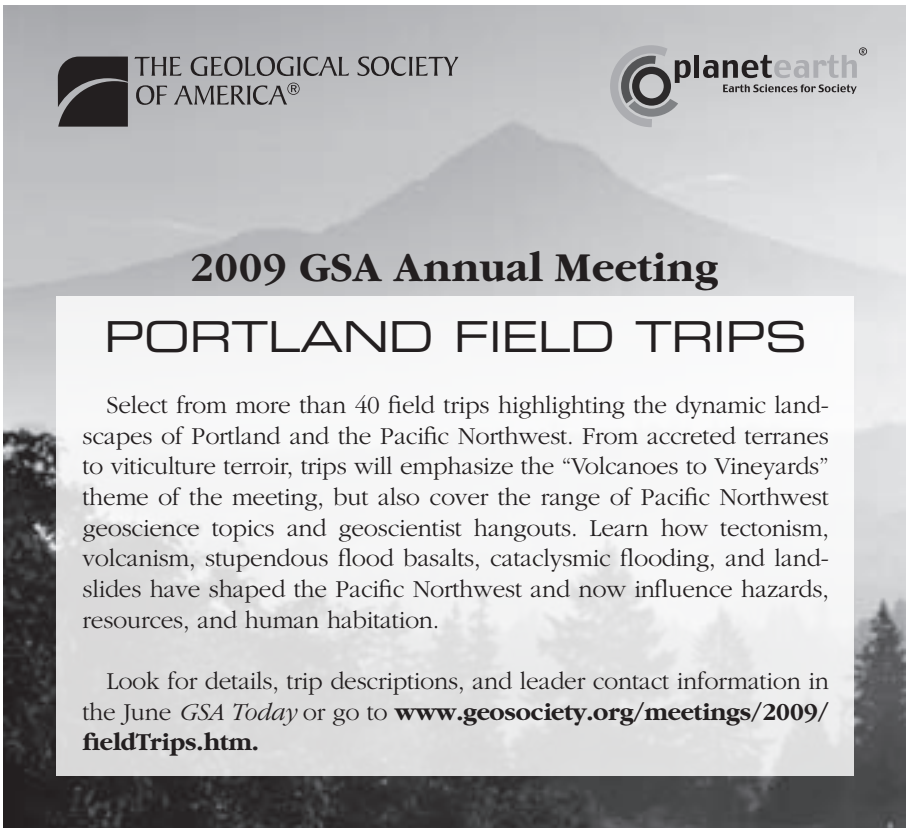

Photo by Mr. Janis Miglavs courtesy the Portland Oregon Visitors Association.

SHORT COURSES

Twenty short courses have been proposed for the 2009 GSA Annual Meeting. Topics include crisis communication for scientists and emergency management personnel, LiDAR-derived elevation models, teaching climate change and earth history, and geoscience education research. For details and course descriptions, check the upcoming June issue of *GSA Today* or go to **www.geosociety.org/meetings/2009/courses.htm**.

This is a great opportunity to earn continuing education credits!

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planet Earth Sciences for Society

Warrior Rock Lighthouse, Sauvie Island, Oregon. Photo by Tim Jewett courtesy the Portland Oregon Visitors Association.

Graduate School Information Forum

Located in the Exhibit Hall, between the exhibits and poster sessions

Take full advantage of this opportunity to promote your school and meet face-to-face with over 1,500 prospective students in a relaxed, informal setting at the upcoming 2009 GSA Annual Meeting & Exposition in Portland, Oregon, USA.

The forum will be open Sunday through Wednesday, 18–21 October.

Booths may be booked for one day or up to all four days. Sunday and Monday will be the first to sell out, and schools reserving multiple days will be assigned first and to the most visible booths. Space is limited, so reserve early!

Participating schools will be promoted in the September *GSA Today* (pending reservation form submittal date), the 2009 Annual Meeting Program, and e-mail links on the GSA Web site, so prospective students may schedule appointments prior to the meeting.

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REGISTRATION

Early registration deadline: 14 September
Cancellation deadline: 21 September

Further registration information will be available in the June *GSA Today* and on the GSA Web site, www.geosociety.org, in early June. Online registration begins in early June.

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

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	Early Registration June–14 Sept.		Standard/On-site Registration after 14 Sept.	
	Full Mtg.	One day*	Full Mtg.	One day*
Prof. Member	$320	n/a	$399	$230
Prof. Member >70	$255	n/a	$340	$175
Prof. Nonmember	$420	n/a	$499	$300
Student Member	$99	n/a	$135	$75
Student Nonmember	$135	n/a	$170	$90
K–12 Professional	$50	n/a	$60	n/a
Field Trip/Short Course only	$40	n/a	$40	n/a
Guest or Spouse	$85	n/a	$90	n/a
Low-income country§	50%	n/a	50%	50%

This year, GSA will provide each meeting registrant† with an electronic copy of the *Abstracts with Programs*, which includes the 2009 Section Meeting abstracts.

* One-day registration will be available on-site only.
§ Participants from countries classified as low or low-middle income by the World Bank need only pay 50% of their registration category fee for full-meeting or one-day registration.
† Field trip or short course only & guest or spouse registrants excluded.

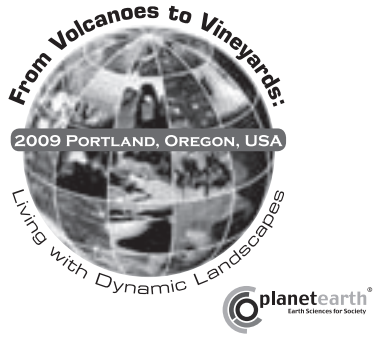
2008 Joint Annual Meeting registration.

LODGING

The 2009 GSA Annual Meeting in Portland will headquarter at the Hilton Portland & Executive Tower located in the heart of city center. The co-headquarters hotel is the Doubletree Hotel & Executive Meeting Center Portland–Lloyd Center. Most activities will take place at the Oregon Convention Center and the Hilton Portland & Executive Tower. Portland offers many affordable hotels near the convention center and in the city center, which are connected by the MAX light rail transit system. GSA has booked rooms at 12 hotels and is offering special convention rates, between US$102 and US$169 per night. Housing registration will open in June; you will be able to find additional housing information in the June *GSA Today* and on the GSA Annual Meeting Web site, **www.geosociety.org/meetings/2009.**

HOUSING ALERT!

GSA has selected Travel Portland as our *official* housing bureau. Housing through Travel Portland will not begin until the first part of June. Neither GSA nor Travel Portland will telephone or send faxes offering "special" Portland hotel reservations. You will be able to make reservations through the GSA Annual Meeting Web site or by faxing or mailing the *official* GSA housing form to Travel Portland. In the event you have any problems with your reservation or accommodations, GSA can only assist in reconciling those issues if the reservation was booked through the official housing bureau. If you have questions about an unauthorized solicitation, the online system, or about housing in general, please contact Becky Sundeen at bsundeen@geosociety.org.



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Impact the Future of Geoscience— Serve on a GSA Committee!

2010–2011 COMMITTEE VACANCIES
Deadline: 15 July 2009

This is your chance to influence the future of your Society and your science. GSA invites you to volunteer or nominate one of your fellow GSA members to serve on Society committees or as a GSA representative to other organizations. Students and younger members are especially encouraged to participate, both as committee volunteers and as nominators.

Go to **www.geosociety.org/aboutus/committees** and follow the link to our online form, or download the form and complete it on paper. If you use the paper form, please return it to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA; fax +1-303-357-1070. *Please use one form per candidate.* **Questions?** Contact Pamela Fistell, +1-303-357-1044; +1-800-472-1988 ext. 0; pfistell@geosociety.org.

If you volunteer or nominate another, please give serious consideration to the specified qualifications for serving on a particular committee, as outlined in this article, and be sure that your candidates are GSA members or Fellows.

Nominations received at GSA headquarters by **15 July 2009** on the official online or mailed one-page form will be forwarded to the Committee on Nominations. The committee will present at least two nominations for each open position to the GSA Council at its fall meeting. Appointees will then be contacted and asked to serve, thus completing the process of bringing new expertise into Society affairs. **Terms begin 1 July 2010 (unless otherwise indicated).**

Academic and Applied Geoscience Relations (AM, T/E)
Two member-at-large vacancies (three-year terms)

Strengthens and expands relations between GSA members in the academic and applied geosciences. Proactively coordinates the Society's effort to facilitate greater cooperation between academia, industry, and government geoscientists. **Qualifications:** must be a member of academia, industry, or government who is committed to developing better integration of applied and academic science in our meetings, publications, short courses, field trips, and education and outreach programs and must also be a member of a GSA Division.

Annual Program Committee (AM, B/E)
One member-at-large vacancy (four-year term)

Develops a long-range plan for increasing the quality of the annual meeting and other Society-sponsored meetings in terms of science, education, and outreach. Evaluates the technical and scientific programs of the annual meeting. **Qualifications:** broad familiarity with different disciplines, previous program experience, and/or active involvement in applying geologic knowledge to benefit society and raise awareness of critical issues.

Arthur L. Day Medal Award (T/E)
Two member-at-large vacancies (three-year terms)

Selects candidates for the Arthur L. Day Medal. **Qualifications:** knowledge of those who have made "distinct contributions to geologic knowledge through the application of physics and chemistry to the solution of geologic problems."

Education (AM, B/E, T/E)
Four vacancies: one graduate educator representative vacancy (graduate student supervisor), one two-year college faculty representative, one informal science educator (museum, visitor center, interpretation officer) (four-year terms), and one undergraduate student (two-year term)

Work with other members representing a wide range of education sectors in the development of informal, pre-college (K–12), undergraduate, and graduate earth science education and outreach objectives and initiatives. **Qualifications:** ability to work with other interested scientific organizations and science teachers' groups to develop pre-college earth science education objectives and initiatives.

Geology and Public Policy (AM, B/E, T/E)
One member-at-large vacancy (three-year term)

Translates earth science knowledge into forms most useful for public discussion and decision making. **Qualifications:** experience with public policy issues involving the science of geology; ability to develop, disseminate, and translate information from the geologic sciences into useful forms for the general public and for GSA members; and familiarity with appropriate techniques for the dissemination of information.

Joint Technical Program Committee (T/E)
One environmental geoscience representative (three-year term begins 1 Jan. 2010)

Assists in finalizing the GSA Annual Meeting technical program: reviews abstracts or provides names of reviewers to evaluate abstracts, participates in Web-based activities in the selection and sched-

***Extensive time commitment required • AM—Meets at the Annual Meeting • B/E—Meets in Boulder or elsewhere • T/E—Communicates by phone or electronically**

uling of abstracts, and participates in topical session proposal review. **Qualifications:** must be familiar with computers and the Web, be a specialist in one of the specified fields, and be available in mid-late July for the organization of the electronic technical program.

Membership (B/E)
Two member-at-large vacancies (three-year terms)

Contributes to the growth of GSA membership and attends to members' changing needs. Focuses on attracting and retaining students, professionals working in industry, and those studying and working outside the United States. Reviews and makes recommendations for Fellowship to Council. **Qualifications:** experience in benefit, recruitment, and retention programs is desired.

Minorities and Women in the Geosciences (AM)
Three member-at-large vacancies (three-year terms)

Stimulates recruitment and promotes positive career development of minorities and women in geoscience professions. **Qualifications:** familiarity with the employment issues of minorities and women; expertise and leadership experience in such areas as human resources and education is desired.

Nominations (B/E, T/E)
Two member-at-large vacancies (three-year terms)

Recommends nominees to GSA Council to serve as GSA Officers and Councilors, committee members, and Society representatives to other permanent groups. **Qualifications:** familiarity with a broad range of well-known and highly respected geological scientists.

Penrose Conferences and Field Forums (T/E)
Two member-at-large vacancies (three-year terms)

Reviews and approves Penrose Conference proposals and recommends and implements guidelines for the success of the conferences. **Qualifications:** past convener of a Penrose Conference or a Field Forum.

Penrose Medal Award (T/E)
Two member-at-large vacancies (three-year terms)

Selects candidates for the Penrose Medal. Emphasis is placed on "eminent research in pure geology, which marks a major advance in the science of geology." **Qualifications:** familiarity with outstanding achievers in the geosciences that are worthy of consideration for the honor.

Professional Development (T/E)
Two vacancies: one student representative and one Councilor/former Councilor (three-year terms)

Directs, advises, and monitors GSA's professional development program, reviews and approves proposals, recommends and implements guideline changes, and monitors the scientific quality of courses offered. **Qualifications:** familiarity with professional development programs or adult education teaching experience.

Publications (AM, B/E, T/E)
Two vacancies: one member-at-large and one Councilor (four-year terms)

Nominates candidates for editor positions, approves editorial boards, reviews the quality and health of Society publications, and explores the initiation of new ventures, including electronic publishing. **Qualifications:** extensive publications experience.

Research Grants* (B/E)
Six member-at-large vacancies (three-year terms)

Evaluates student research grant applications and selects grant recipients. **Qualifications:** should have experience in directing research projects and in evaluating research grant applications.

Young Scientist Award (Donath Medal) (T/E)
Two vacancies: one member-at-large and one Councilor/former Councilor (three-year terms)

Investigates the achievements of young scientists to be considered for this award and makes recommendations to Council. **Qualifications:** should have knowledge of young scientists with "outstanding achievement(s) in contributing to geologic knowledge through original research which marks a major advance in the earth sciences."

GSA REPRESENTATIVES TO OTHER ORGANIZATIONS

GSA and AASG Selection Committee for the John C. Frye Memorial Award in Environmental Geology
One GSA Representative vacancy (three-year term begins 1 July 2010)

Fosters communication within the community about issues related to serving the broader international community; helps identify and focus on the highest priority environmental informational needs and issues best addressed by the geoscience community. **Qualifications:** well-acquainted with GSA programs in environmental geoscience.

North American Commission on Stratigraphic Nomenclature (AM, possibly B/E)
One GSA Representative vacancy (three-year term runs November 2010–November 2013)

Develops statements of stratigraphic principles, recommends procedures applicable to classification and nomenclature of stratigraphic and related units, reviews problems in classifying and naming stratigraphic and related units, and formulates expressions of judgment on these matters.

COMMITTEE, SECTION, AND DIVISION VOLUNTEERS:

COUNCIL THANKS YOU!

GSA Council acknowledges the many member-volunteers who have contributed to the Society and to our science through involvement in the affairs of the GSA. GSA would not be what it is today without you.

***Extensive time commitment required • AM—Meets at the Annual Meeting • B/E—Meets in Boulder or elsewhere • T/E—Communicates by phone or electronically**

Donna L. Russell, *Director of Operations*

The Teacher Advoocate Program: A Geological Society of America Education & Outreach Program Funded by the GSA Foundation

What is the Teacher Advocate Program?

The Geological Society of America (GSA) recognizes that the future of geology rests in the hands of our nation's school teachers. They will encourage and empower generations of students with the knowledge of earth science. GSA's Teacher Advocate Program (TAP) promotes geoscience to K–12 students and their families through active and enthusiastic teacher advocates.

Current Resource Offerings

GSA's TAP provides exciting, up-to-date, curriculum-linked geoscience teaching resources to K–12 teachers across the United States and beyond. These resources have been developed by educators with classroom teaching experience. In particular, the Explore Geoscience Series CD-ROMs are helping teachers better understand the geoscience subjects they teach.

The program also provides activities through which teachers experience the importance, relevance, and wonder of geoscience first-hand in the field (Teacher GeoVentures) or laboratory and at science teacher convention workshops around the country.

Support also comes through GSA's Distinguished Earth Science Educator in Residence and GSA's Education & Outreach Web page, where lesson plans and links to additional resources can be accessed.

Who Benefits?

GSA's Teacher Advocate Program ultimately aims to help educators convey the importance of earth science to their students. It is important to have a pool of teacher advocates who are passionate and enthusiastic about Earth to ensure that students will be exposed to the excitement and relevance of our science.

From 2004 to 2008, over 16,000 CDs have been sold or distributed, and over 650 teachers have attended field trips and workshops. Our purchasers on average teach 102 students per school year; therefore, the number of students affected by this program increases dramatically over time. The long-term benefit will be students who are interested in earth science, many of whom will take a geology course when they attend college. Geoscience programs across the country will be stronger because of GSA's initiative to reach out to the educators of our future geologists.

For more information about the Teacher Advocate Program, go to www.geosociety.org/educate, or contact Donna Russell at the GSA Foundation, +1-303-357-1054, drussell@geosociety.org.

Most memorable early geologic experience:

Doing field work in the Four Corners area in 1955 by horseback and mules. This was the only way to get access to the remote areas.

—Dee D. Trent

Support GSA Programs

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THE GEOLOGICAL SOCIETY OF AMERICA®

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.

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.

Ballots must be submitted electronically or postmarked by 12 April 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

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

COUNCILOR Position 2
July 2009–June 2013

George O. Linkletter
ENVIRON International Corporation
Irvine, Calif., USA

Ricardo A. Astini
Universidad Nacional de Córdoba
Córdoba, Argentina

COUNCILOR Position 3
July 2009–June 2013

Robert B. Finkelman
University of Texas–Dallas
Richardson, Tex., USA

J. Douglas Walker
University of Kansas
Lawrence, Kans., USA

The Kerry Kelts Research Awards of the Limnogeology Division

The application process for the Kerry Kelts Research Awards of the Limnogeology Division is now open. These awards for undergraduate or graduate student research are named in honor of Kerry Kelts, a visionary limnogeologist and inspiring teacher. Up to three awards of US$400 each for use in research related to limnogeology, limnology, and paleolimnology are available. Application for this award is simple and consists of a summary of the proposed research, its significance, and how the award will be used (five-page maximum). Please send your summary in PDF format along with your name and a short (two-page maximum) CV to the chair of the Limnogeology Division, Michael Rosen, mrosen@usgs.gov. **Application Deadline:** 3 August 2009. Awards will be announced at the Limnogeology Division Business Meeting and Reception at the October 2009 GSA Annual Meeting in Portland.

We hope to increase the amount of the awards in succeeding years. If you are interested in supporting this awards program, please send your donations, designated for the Kerry Kelts Research Awards of the Limnogeology Division, to GSA Foundation, P.O. Box 9140, Boulder, CO 80301-9140, USA.

In Memoriam

Daniel A. Busch
Providence, Rhode Island, USA
notified 12 January 2009

Byrl D. Carey Jr.
Houston, Texas, USA
17 November 2008

Catharine S. Castro
Sacramento, California, USA
1 April 2008

Joseph J. Durek
Gainesville, Virginia, USA
1 November 2008

William J. Gregg
Houghton, Michigan, USA
notified 18 December 2008

Robert B. Hall
Lakewood, Colorado, USA
27 December 2008

Richard H. Howe
Camp Hill, Pennsylvania, USA
notified 23 January 2009

Carl Kisslinger
Boulder, Colorado, USA
31 December 2008

John B. McKeon
South Bristol, Maine, USA
19 December 2008

Joseph E. Upson II
North Sandwich, New Hampshire, USA
8 September 2008

Victor Vacquier
La Jolla, California, USA
11 January 2009

Laura M. Vaugeois
Olympia, Washington, USA
1 April 2008

If you would like to honor a friend or colleague with a GSA Memorial, please go to www.geosociety.org/pubs/memorials/mmlGuid.htm. Contact the GSA Foundation at +1-303-357-1054, drussell@geosociety.org, or www.gsafweb.org, to contribute to the Memorial Fund.

The Salmon River near where this "River of No Return" originates as a bubbling spring in the Sawtooth Mountains, Idaho, USA. Photo by K.E. Asmus.

Elk in the Rocky Mountains, Colorado, USA. Photo by K.E. Asmus.

April

12 Ballots for **GSA's elections** must be either postmarked or submitted electronically by this date. Learn more at www.geosociety.org/Ballot.asp.

20 Applications to attend the **Penrose Conference,** "Low $\delta^{18}O$ rhyolites and crustal melting: Growth and redistribution of the continental crust," in Twin Falls, Idaho, and Yellowstone National Park, Wyoming, USA, on 9–13 Sept. 2009 are due by e-mail to Peter Larson, plarson@wsu.edu; Ilya Bindeman, bindeman@uoregon.edu; or John Wolff, jawolff@wsu.edu.

May

01 Applications due for the GSA History of Geology Division's **History of Geology Student Award.** Learn more at http://gsahist.org/HoGaward/awards.htm or contact Jane P. Davidson at jdhexen@unr.edu.

04 Deposit due for the 29 Aug.–4 Sept. 2009 GSA GeoVentures trip for everyone, **Geology of the Middle Fork of the Salmon River, Idaho.** Learn more at www.geoventures.org.

07–09 GSA's **Cordilleran Section** meets in Kelowna, British Columbia, Canada, with **Shlemon Mentor Program Luncheons** on 7 May at 11:30 a.m.–12:30 p.m. *and* 12:30–1:30 p.m., and a **Mann Mentors in Applied Hydrogeology Luncheon** on 8 May, 11:30 a.m.–1 p.m.

11–13 GSA's **Rocky Mountain Section** meets in Orem, Utah, USA, with a **Shlemon Mentor Program Luncheon** on 11 May at 11:30 a.m. to 1 p.m. and a **Mann Mentors in Applied Hydrogeology Luncheon** on 12 May from 11:30 a.m. to 1 p.m.

11–15 **Penrose Conference:** "Plumes and Their Role in Whole Mantle Convection and Recycling," convenes in Pico, the Azores.

26 Last day to sign up for the GSA GeoVentures teacher trip, **Galapagos Islands—A Place Born of Fire,** running 26 June–6 July 2009. Learn more at www.geoventures.org.

NOTICE *of Council Meeting*

GSA Headquarters,
Boulder, Colorado, USA

Saturday, 2 May 2009
8 a.m.–5 p.m.

Sunday, 3 May 2009
8 a.m.–noon

Meetings of the GSA Council are open to Fellows, members, and associates of the Society, who may attend as observers, except during executive sessions. Only Councilors and officers may speak to agenda items, except by invitation of the chair.

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June

05 Last day to sign up for the GSA GeoVentures teacher trip, **Hawaii—*The Big Island:* Living on an active hot spot volcano,** running 5–11 July 2009. Learn more at www.geoventures.org.

18 Last day to sign up for the GSA GeoVentures teacher trip, **Australian Earth Adventure: Earth Science and Technology,** running 18–29 July 2009. Learn more at www.geoventures.org.

26 **June–06 July** GSA GeoVentures **Galapagos Islands—A Place Born of Fire** teacher trip convenes.

July

18–29 GSA GeoVentures **Australian Earth Adventure: Earth Science and Technology** teacher trip convenes.

31 **July–10 Aug.** GSA GeoVentures trip for everyone, **Geology of the Galapagos Islands** convenes. Learn more at www.geoventures.org.

August

11 Last day to submit abstracts for the **2009 GSA Annual Meeting** in Portland, Oregon, USA. Go to www.geosociety.org/meetings/2009 for a link and instructions.

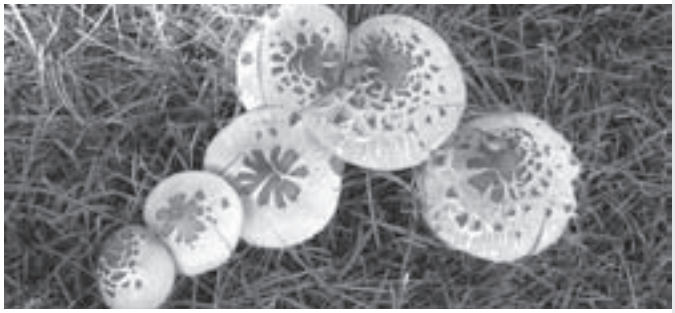
29 **Aug.–04 Sept.** GSA GeoVentures trip for everyone, **Geology of the Middle Fork of the Salmon River, Idaho,** meets in Stanley, Idaho, USA.

September

09–13 **Penrose Conference:** "Low $\delta^{18}O$ rhyolites and crustal melting: Growth and redistribution of the continental crust," meets in Twin Falls, Idaho, USA. Learn more at www.geosociety.org/meetings/.

13–19 **Field Forum:** "Structure and neotectonic evolution of northern Owens Valley and the Volcanic Tableland, California," meets in Bishop, California, USA. Go to www.geosociety.org/meetings/ for more information.

Red crab on basalt, Galapagos Islands (see teacher trip, 26 June).



Late summer's abundant *Lepiota rhacodes,* Boulder, Colorado, USA. Photo by K.E. Asmus.

Abstract Deadline: 11 August 2009
Technical Program: 18–21 October 2009

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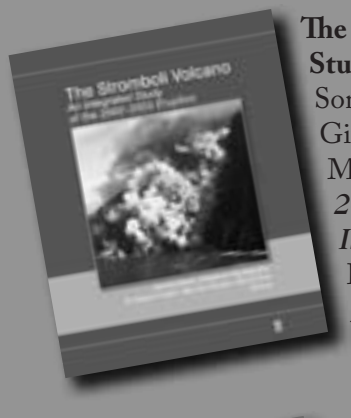
www.geosociety.org/meetings

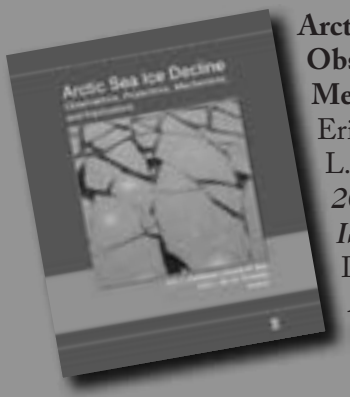
New Books from AGU!

AGU publishes the highest quality in peer reviewed research that will enhance your Earth Science library.

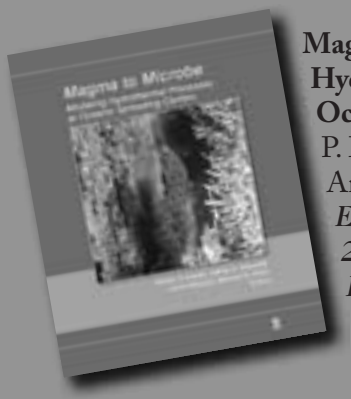
Post-Perovskite: The Last Mantle Phase Transition
Kei Hirose, John Brodholt, Thorne Lay, David Yuen, *Editors*
2007, 287 pp., hardbound.
ISBN 978-0-87590-439-9
List Price: $104.00
AGU Member Price: $72.80



The Stromboli Volcano: An Integrated Study of the 2002–2003 Eruption
Sonia Calvari, Salvatore Inguaggiato, Giuseppe Puglisi, Maurizio Ripepe, Mauro Rosi, *Editors*
2008, 399 pp., hardbound.
ISBN 978-0-87590-447-4
List Price: $128.00
AGU Member Price: $89.60



Arctic Sea Ice Decline: Observations, Projections, Mechanisms, and Implications
Eric T. DeWeaver, Cecilia M. Bitz, L.-Bruno Tremblay, *Editors*
2008, 269 pp., hardbound.
ISBN 978-0-87590-445-0
List Price: $128.00
AGU Member Price: $89.60



Magma to Microbe: Modeling Hydrothermal Processes at Oceanic Spreading Centers Robert P. Lowell, Jeffrey S. Seewald, Anna Metaxas, Michael R. Perfit, *Editors.*
2008, 285 pp., hardbound.
ISBN 978-0-87590-443-6
List Price: $124.00
AGU Member Price: $86.80

Active Tectonics and Seismic Potential of Alaska
Jeffrey T. Freymueller, Peter J. Haeussler, Robert L. Wesson, Göran Ekström, *Editors*
2008, 431 pp., hardbound.
ISBN 978-0-87590-444-3
List Price: $128.00
AGU Member Price: $89.60

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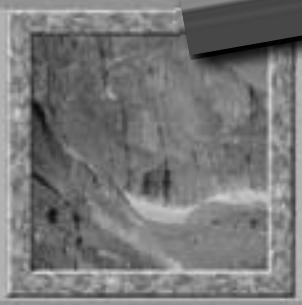


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AGU

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, +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.

Classification	Per Line for 1st month	Per line each addt'l month (same ad)
Positions Open	$8.50	$8.25
Opportunities for Students		
First 25 lines	$0.00	$4.50
Additional lines	$4.50	$4.50
Fellowship Opportunities	$8.50	$8.25

Positions Open

GEOSCIENCES, VISITING POSITION
HAMILTON COLLEGE

The Geosciences Department at Hamilton College invites applications for a one-year visiting position for the calendar year 2010 (Jan. 1 to Dec. 31). The successful candidate will be expected to teach a course on sedimentary geology, a topical introductory course, and a sophomore-level elective course in the candidate's specialty (e.g., glacial geology or soils). In addition, the candidate will be encouraged to supervise senior projects for several Geosciences concentrators. The ideal candidate will be committed to teaching undergraduate students, have a broad field and laboratory background, and will provide our students with a balance of classroom, field, and laboratory experiences. The Department has extensive laboratory and field equipment, including a laser particle size analyzer, isotope mass spectrometer, XRF and XRD, ion chromatograph, and SEM/TEM. Send curriculum vitae, transcripts, and recommendation letters to Todd Rayne, Chair, Geosciences Department, Hamilton College, 198 College Hill Road, Clinton, NY 13323, USA. Application deadline is September 1, 2009.

Hamilton College (www.hamilton.edu) is a residential liberal arts college located in the Mohawk Valley of upstate New York; for applicants with dual-career considerations, Hamilton participates in the regional Higher Education Recruitment Consortium, which posts additional area employment opportunities at www.upstatenyherc.org. Hamilton College is an affirmative action, equal opportunity employer and is committed to diversity in all areas of the campus community. Hamilton provides domestic partner benefits. Candidates from underrepresented groups in higher education are especially encouraged to apply.

The Mississippi Mineral Resources Institute (MMRI) seeks a scientist or engineer to assume the directorship of the Institute. The Director must have a broad interest in mineral resources, both onshore and offshore, and be both an innovative scientist and skilled leader. Active MMRI onshore projects include metallic, industrial, energy-related minerals and hazard assessments while the offshore efforts are concentrated on the completion of the world's first seafloor observatory devoted to the study and monitoring of gas hydrates in the Gulf of Mexico. The position expects the Director to lead a professional staff of 12, provide oversight for approximately 20 research projects and manage a fabrication shop. The Director will also maintain their own basic and applied research in a non-tenured position that reports to the Dean of the School of Engineering.

A successful candidate must have a Ph.D. from an accredited university in the field of geology, geological oceanography, geological engineering, geochemistry or a relevant field of science or engineering. The candidate must have a strong, documented record of funding, research, and management to promote the Institute's leadership role, and to pursue growth opportunities. The candidate should have experience in technology development and transfer as well as working with the academic community. For details and application, visit www.jobs.olemiss.edu.

The University of Mississippi is an EEO/AA/Title VI/Title IX/Section 504/ADA/ADEA employer.

Opportunities for Students

Research assistantships (geophysics) for M.S. students starting Fall 2009. Two openings, one funded-conduct gravity survey and analysis in the Afar region of Ethiopia, requires one trip to the Afar; and one funding-pending conduct gravity and electromagnetic survey and analysis for a CO_2 sequestration project. M.S. degree is in Geospatial Sciences–Geology Option, Missouri State University. Contact Kevin Mickus, kevinmickus@missouristate.edu. Preference for students with some background in geophysics. More info at http://geosciences.missouristate.edu.

Research Opportunities at the Institute for Rock Magnetism (U. of Minnesota). The Institute for Rock Magnetism (IRM) is one of 15 national multi-user facilities in the Earth Sciences supported by NSF (www.nsf.gov/geo/ear/if/guidelines2008.pdf) to provide advanced laboratory instrumentation to the geoscience research and education communities. Research at the IRM ranges from fundamental investigations of the physics of fine-particle magnetism, to applied studies using the magnetic characteristics of rocks and sediments to investigate a wide variety of geological and surficial Earth processes. We provide access and support for visiting scientists in three categories, for which we encourage you to apply: (1) Visiting Research Fellows, (2) U.S. Student Fellows, and (3) Long-Core (U-Channel) Magnetometer Fellows. Brief summaries follow, and more complete details are available at www.irm.umn.edu. Applications are due April 30 for visits during the period from July 1 through December 30, 2009, and will be reviewed by IRM staff and members of our external Review and Advisory Committee (RAC).

Visiting Research Fellowships. These fellowships provide free access to the full set of IRM instruments for up to 10 days, and partial reimbursement of travel costs. Topics for research are open to any field of study involving fine particle magnetism, but preference will be given to projects relating magnetism to geological or environmental studies, or to fundamental physical studies relevant to the magnetism of Earth materials. Travel grants of up to $750 are available to cover actual travel costs. No funds are available for per diem expenses.

U.S. Student Fellows (New in 2009!) This program provides financial and instrumental support for advanced U.S. undergraduates and graduate students who seek to acquire state-of-the-art rock magnetic and/or paleomagnetic data for an individual research project. Special consideration is given to students requiring data for the completion of a senior thesis or preliminary data for a proposal to support continued graduate research. Visiting Students spend up to five days at the IRM and work closely with IRM staff to (1) Learn how to design and conduct rock-magnetic experiments; (2) Process and interpret the generated data; and (3) Identify specific, attainable research goals that can be achieved with future magnetic measurements.

The Student Fellowships program is meant to help cultivate young U.S. researchers with an interest in paleomagnetism and rock magnetism. We encourage Visiting Students to apply for full fledged Visiting Research Fellowships at any point after their Visiting Student Program is completed.

U-Channel Visitors (New in 2009!) The IRM's new u-channel magnetometer system is available for use by visitors with continuous cores (4.2-cm access diameter optimized for standard u-channels) or discrete samples for paleomagnetic and basic rock-magnetic or environmental-magnetic work. U-channel visitors may also request access to a limited number of additional instruments for a few days, for more detailed rock magnetic analyses on a small number of pilot samples. This data may be used to explore the feasibility of returning to the IRM as a Visiting Fellow with a targeted rock magnetic study.

A usage fee of $150 per day (ten-day maximum) covers unlimited use of the u-channel system, training and assistance with the equipment, and (if desired) some help with data interpretation and analysis. A fee waiver may be granted in cases of financial hardship, and proposals will not be evaluated on the basis of ability to pay.

Application Deadlines: Applications for all three programs will be accepted twice per year (April 30 and October 30). We recognize that some lake- and ocean-core projects are time sensitive because of the potential for rapid, post-coring, sediment diagenesis. Therefore, time-sensitive applications will be entertained year round and allowed as scheduling permits.

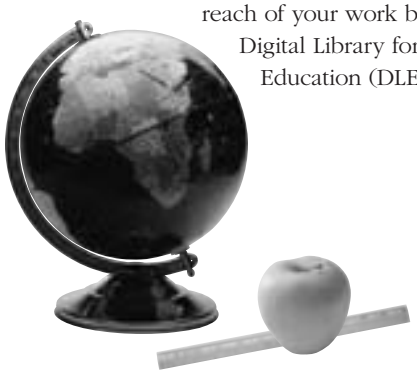
FREE K–12 LESSON PLANS

Need a lesson plan or resource for that earth science class?

GSA has loads of free teacher resources. Go to www.geosociety.org/educate/ to view and download quality lesson plans, developed and classroom-tested by your fellow teachers.

Have a lesson plan you want to share?

Go to **www.geosociety.org/educate/**, complete our lesson plan template (Microsoft Word format), then send it via e-mail to Chris McLelland, GSA's earth science educator, at educator@geosociety.org. GSA will extend the reach of your work by including it in the Digital Library for Earth System Education (DLESE; www.dlese.org).



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Erratum

- **The February 2009 *GSA Today*** (v. 19, no. 2, p. 14–15) included a Rock Stars article by K.R. Aalto about Israel Cook Russell. An extended article on Russell, also written by Aalto, was published in *Rocky Mountain Geology* (v. 43, no. 2, p. 201–214) in their Fall 2008 issue. *GSA Today* Rock Stars articles are chosen by GSA's History of Geology Division for their quality and interest and are reviewed prior to publication. *GSA Today* was not aware of the parallel submission, and it was not the intention of Aalto or the History of Geology Division to disregard the prior publication in *Rocky Mountain Geology*. Acknowledgment of the earlier publication should have been made as a reference in the Rock Stars article. *GSA Today* apologizes for this oversight.

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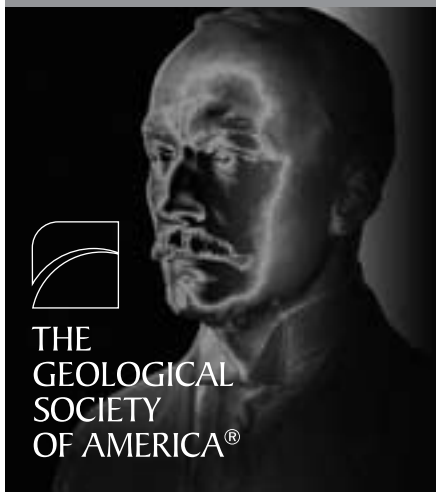

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Capitol Reef National Park at sunset. Photo by B. Kowallis.

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Recruiting students to undergraduate geoscience programs through dual-credit and dual-enrollment classes

Aida A. Awad, *Science Dept. Chair, Maine East High School, 2601 W. Dempster Street, Park Ridge, Illinois 60068, USA; aawad@maine207east.k12.il.us*

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INTRODUCTION

The GSA's Committee on Education shares the concern of numerous geoscience agencies about the looming shortage of geoscientists in the workforce. Geoscience departments are actively seeking new students to add stability and diversity to their programs. We encourage GSA members to consider supporting broader use of existing dual-enrollment and dual-credit course options. Dual-enrollment courses for high school students are taught by college faculty, commonly at the university. Dual-credit courses are taught in high school by qualified high school teachers. A majority of states allow high schools, two- and four-year colleges, and universities to offer dual-credit and/or dual-enrollment courses for academically qualified high school students. At present, such courses are most frequently offered in mathematics, chemistry, and physics. As members of the GSA Committee on Education, we believe it is time that GSA members with departments at two-year and four-year institutions should explore the possibility of dual-credit or dual-enrollment courses to better promote the geosciences.

Your institution probably already allows dual-enrollment courses in other disciplines. When in direct partnership with a school district, such courses are often conducted during regular public school hours. Other models include course offerings provided at times suitable for high school students, such as late afternoon or evening. Many of your general education courses, such as environmental or physical geology, would qualify and greatly benefit the upper-division high school student.

Allowing dual-enrollment courses in your department has numerous benefits. For example, your faculty would have an opportunity to engage talented students in geoscience before they have selected a career or even a college. At some colleges and universities, these courses are directly drawing new students to their programs. At a minimum, allowing these students in your classroom elevates public geoscience literacy.

Dual-credit courses require a well-trained high school teacher, commonly with an M.S. in geology or geoscience education, partnered with a faculty member from a two- or four-year institution.

EXAMPLES

The Oneonta Earth Sciences Outreach Program was developed by James Ebert. This program allows high school students to enroll in advanced earth-science courses at their high schools and earn college credit from the State University of New York (SUNY)-Oneonta. Students can apply their credits to SUNY-Oneonta or other SUNY institutions, or apply for transfer credit to another college they choose to attend. Since its inception in 2007, the program has grown to include ten high schools from across the state. High school teachers have offered ten different courses for college credit, including "Science of Natural Disasters," "Planet Earth" (formerly "Introduction to Geology"), "Introduction to Forensic Geology," and "Water and the Blue Planet." Ebert believes that teachers' passions should determine the course content. Furthermore, he doesn't impose a standardized test as a threshold toward earning credit. Instead, he relies on the rigor reflected in the course syllabi and materials selected by the high school teachers. The grade earned by the student in these advanced high school courses is the basis for college credit.

In California, Wendy Van Norden has developed a year-long honors geology course that is accepted at the University of California–Los Angeles (UCLA). The course uses Reynold's *Exploring Geology* (Reynolds et al., 2008) as a text and the National Association of Geoscience Teachers lab manual. The high school grade is based on homework, labs, tests and quizzes, field trips, a winter final, and a year-end final. Each student must pass an exam prepared by Ray Ingersoll of UCLA to be eligible for the college credit. UCLA requires US$400 to process the credit award. As part of the course requirements, Van Norden runs field trips to Death Valley and the Santa Monica Mountains and optional field trips to the Mojave Desert and Santa Paula.

In north suburban Chicago, Xiaoming Zhai of the College of Lake County developed a dual-credit four–credit hour equivalent earth-science program that is now in its second year. The course has

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Editor's note: *Both authors are members of GSA's Committee on Education.*

flourished in large part because of the opportunity it provides students to earn college science laboratory credit in a non-traditional way. Zhai works closely with the high school faculty to ensure the rigor of the course. He strongly believes that many students participating in the program are motivated and engaged by the content and its relevance to their lives in a way they have not experienced in their previous science classes. This program is generating enthusiasm for the geosciences!

Hudsonville High School is in a small, rural Michigan town with a population of about 8,000. Ninth-grade students are required to take two trimesters of earth science, a rigorous course series that includes inquiry-based labs, providing a solid foundation in geology. The geology course for 11th- or 12th-grade students is taught by Chris Bolhuis. Students earn credit for the course by taking an exam prepared by faculty at Grand Valley State University (GVSU). The course includes two extended field trips: In the fall, students travel to the Porcupine Mountains; in the spring, they travel to Pictured Rock National Lakeshore. Bolhuis also co-teaches a summer class called Summer Science Institute. The class is a one credit–hour, three-week field course in geology and ecology in the western United States. Since 2001, 197 students have taken the exam provided by GVSU. One hundred and seventy-two students have passed the exam (an impressive 87%, which is probably higher than the university pass rate). At least 32 students have become geology or earth-science majors.

CONCLUSIONS

Students may earn both high school and college credits during dual-credit and/or dual-enrollment experiences. If using the high school design, the high school teacher is required to have a master's degree in geology or earth science and must work closely and collaboratively with a nearby institution of higher education. Examples include cooperation between public school systems and community colleges and universities. Whether on a high school or post-secondary campus, the courses are expected to maintain the same academic rigor as a standard college course.

GSA members probably already know of skilled earth-science teachers in their communities. What better way to promote geoscience than to support our best local teachers?

REFERENCE CITED

Reynolds, S., Johnson, J., Kelly, M., Morin, P., and Carter, C., 2008, Exploring Geology: New York, McGraw Hill, 575 p.

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Commentary

2009 GSA Geologic Time Scale

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J.W. Geissman*, *Department of Earth and Planetary Sciences, MSC 03 2040, Northrop Hall, 1 University of New Mexico, Albuquerque, New Mexico 87131-0001, USA*

Last year marked the 25th anniversary of the first Geological Society of America Geologic Time Scale (Palmer, 1983). The effort to prepare the first Society time scale was concurrent with the preparation of the 27 volumes of The Geology of North America to celebrate the Decade of North American Geology (DNAG). In 1982, an ad hoc time scale advisory committee was formed by the DNAG steering committee to encourage "uniformity among DNAG authors in the citation of numerical ages for chronostratigraphic units of the geologic time scale" (Palmer, 1983). The Time Scale Advisory Committee consisted of Z.E. Peterman (chairman), J.E. Harrison, R.L. Armstrong, and W.A. Berggren. Allison (Pete) Palmer, as centennial science program coordinator for GSA, was given the charge of compiling the committee's efforts.

The goal of the then-unique layout of the GSA-DNAG Geologic Time Scale, with each Phanerozoic era given identical column length, along with the Precambrian, was to provide a compact, succinctly organized yet suitably detailed (e.g., including uncertainties in ages of chronostratigraphic boundaries) compilation of our current knowledge of geologic time. In a recent communication to the second author, Pete wrote,

> I do remember that I hand-drafted it at 2 or 3 times publication scale and pasted up the words. I also had to figure out how to format it so that it would all fit on one sheet (thus changing the scale for the numerical ages as things got older). I think the small plastic cards came later. I also think I consulted with various geochronologists to see which of several published numerical time scales was considered the most reliable, so none of the compilation was original—I just cribbed existing information. Fortunately, the stage-level nomenclature was a bit less messy than it is now…

Just think of how much has changed in 25 years (!), as recent and future modifications to the GSA Geologic Time Scale have and will continue to be done in a moment, in front of a computer.

Work on the current time scale started in 2007, and revision efforts focused on three aspects. The first was to update names and boundaries to capture changes documented in Gradstein et al. (2004) and to reflect more recent results of the many working groups of the International Commission on Stratigraphy. Other relevant work was also incorporated as needed (e.g., new publications on the Triassic time scale). Second, we updated the boundary ages using whatever sources were available. Last, the magnetic polarity time scale was extensively modified, especially for the early Mesozoic, in particular from the earliest Jurassic to the Permian-Triassic boundary. Some aspects of the GSA Geologic Time Scale do not conform to the recommendations of the International Commission on Stratigraphy. The names "Tertiary" and "Precambrian" were not dropped on the new time scale. The Quaternary, the status and boundaries of which are still being debated, was modified to reflect some of the pending recommendations. These differences were retained to best reflect the needs of GSA members and Divisions.

The compilers plan to keep the GSA Geologic Time Scale more up-to-date by having yearly reviews of important changes adopted by the International Commission on Stratigraphy, new publications, and information made available through other efforts, such as the Earth-Time Initiative. Loren Babcock (Ohio State University) will join us as a Geologic Time Scale compiler for the next revision. In the past, the time scale has been static for 10 years at a time, but we now anticipate more frequent updates. The time scale will be given a posting date and be available online, in both color and black-and-white versions.

GSA encourages the use of the time scale, boundary ages, and its terminology in all publications; strict enforcement, however, is not planned. The time scale will be kept as current as possible. Constructive comments are encouraged and should be addressed to editing@geosociety.org.

REFERENCES CITED

Gradstein, F., Ogg, J., Smith, A., et al., 2004, A Geologic Time Scale 2004: Cambridge University Press, 589 p.

Palmer, A.R., 1983, The Decade of North American Geology 1983 Geologic Time Scale: Geology, v. 11, p. 503–504, doi: 10.1130/0091-7613(1983)11<503:TDONAG>2.0.CO;2.

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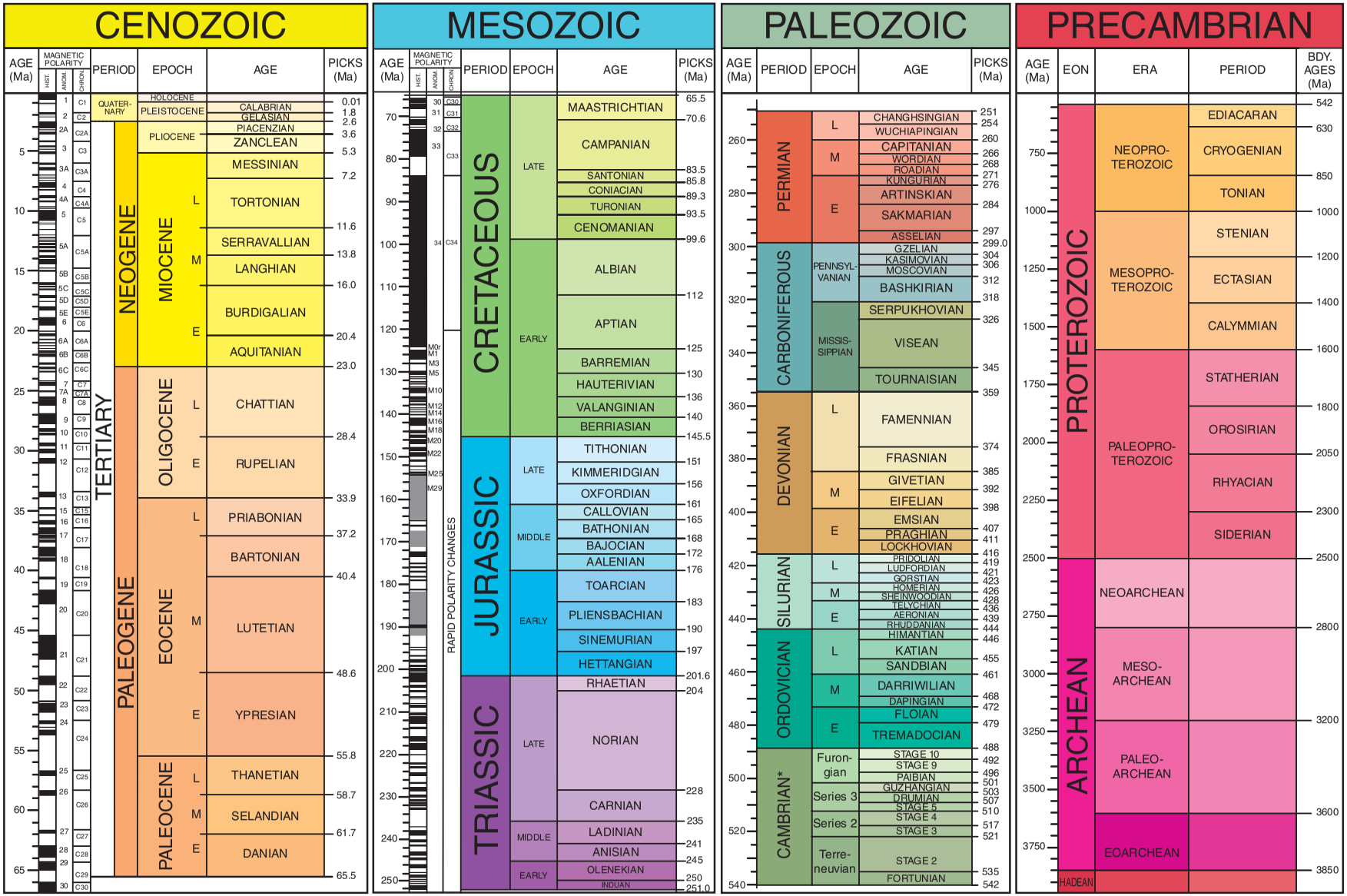
2009 GEOLOGIC TIME SCALE



*International ages have not been fully established. These are current names as reported by the International Commission on Stratigraphy.

Walker, J.D., and Geissman, J.W., compilers, 2009, Geologic Time Scale: Geological Society of America, doi: 10.1130/2009.CTS004R2C. ©2009 The Geological Society of America.

Sources for nomenclature and ages are primarily from Gradstein, F., Ogg, J., Smith, A., et al., 2004, A Geologic Time Scale 2004: Cambridge University Press, 589 p. Modifications to the Triassic after: Furin, S., Preto, N., Rigo, M., Roghi, G., Gianolla, P., Crowley, J.L., and Bowring, S.A., 2006, High-precision U-Pb zircon age from the Triassic of Italy: Implications for the Triassic time scale and the Carnian origin of calcareous nannoplankton and dinosaurs: Geology, v. 34, p. 1009–1012, doi: 10.1130/G22967A.1; and Kent, D.V., and Olsen, P.E., 2008, Early Jurassic magnetostratigraphy and paleolatitudes from the Hartford continental rift basin (eastern North America): Testing for polarity bias and abrupt polar wander in association with the central Atlantic magmatic province: Journal of Geophysical Research, v. 113, B06105, doi: 10.1029/2007JB005407.

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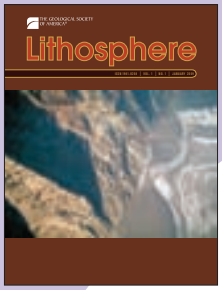

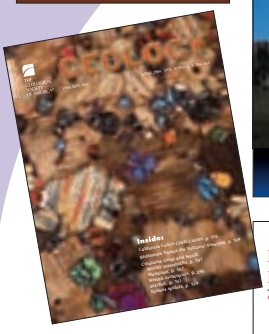

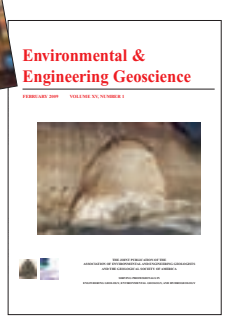

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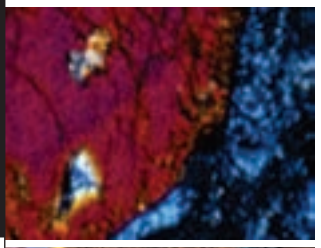

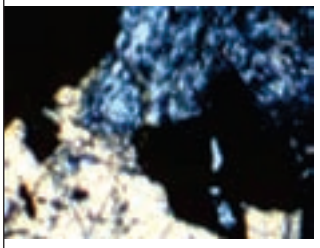

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