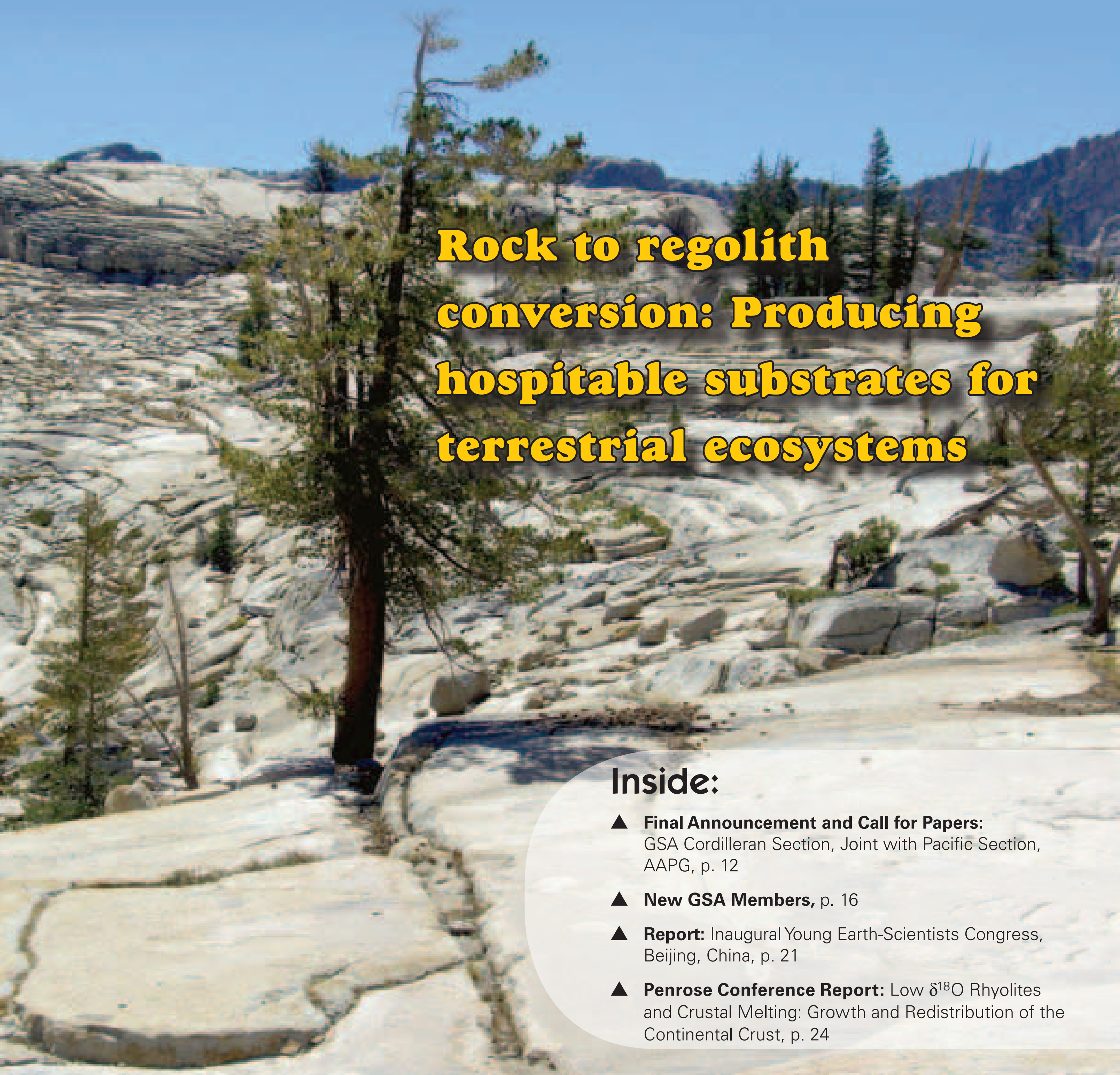
Penrose Conference Announcement: Origin and Uplift of the Sierra Nevada, California, USA, p. 11

GSA TODAY

VOL. 20, No. 2 A PUBLICATION OF THE GEOLOGICAL SOCIETY OF AMERICA FEBRUARY 2010



Rock to regolith conversion: Producing hospitable substrates for terrestrial ecosystems

Inside:

GSA TODAY

GSA TODAY publishes news and information for more than 22,000 GSA members and subscribing libraries. *GSA TODAY* (ISSN 1052-5173 USPS 0456-530) is published 11 times per year, monthly, with a combined April/May issue, by The Geological Society of America®, Inc., with offices at 3300 Penrose Place, Boulder, Colorado. Mailing address: P.O. Box 9140, Boulder, CO 80301-9140, USA. Periodicals postage paid at Boulder, Colorado, and at additional mailing offices. Postmaster: Send address changes to *GSA Today*, GSA Sales and Service, P.O. Box 9140, Boulder, CO 80301-9140, USA. GSA provides this and other forums for the presentation of diverse opinions and positions by scientists worldwide, regardless of their race, citizenship, gender, religion, or political viewpoint. Opinions presented in this publication do not reflect official positions of the Society.

SUBSCRIPTIONS: GSA members: Contact GSA Sales and Service at +1-888-443-4472, +1-303-357-1000, option 3, or gsaservice@geosociety.org for information. Nonmembers & Institutions: Free with paid subscription to *GSA Bulletin, Geology, Lithosphere,* and *Geosphere* (all four); otherwise US$70. Contact AIP Customer Service, subs@aip.org. Claims: For nonreceipt or for damaged copies, GSA members should contact GSA Sales and Service; all others contact AIP Customer Service, subs@aip.org. Claims are honored for one year; please allow sufficient delivery time for overseas copies, up to six months.

VOLUME 20, NUMBER 2 ▲ FEBRUARY 2010

SCIENCE ARTICLE

Cover: Hard, virtually unweathered bedrock in the Sierra Nevada, California, USA, supports a sparse ecosystem in which plants only grow in joint fractures (photo credit: Malcolm M. Clark). Porosity produced by weathering converts such biologically inert rock into regolith that holds water and supports more productive ecosystems. See "Rock to regolith conversion: Producing hospitable substrates for terrestrial ecosystems," by R.C. Graham et al., p. 4–9.

Rock to regolith conversion: Producing hospitable substrates for terrestrial ecosystems

Robert C. Graham, Ann M. Rossi, *Soil & Water Sciences Program, Dept. of Environmental Sciences, University of California, Riverside, California 92521-0424, USA, and* ***Kenneth R. Hubbert,*** *USDA Forest Service, Pacific Southwest Research Station, 3644 Avtech Parkway, Redding, California 96002, USA*

ABSTRACT

Weathering processes transform hard fresh rock into friable weathered rock, which is then physically disrupted to become soil. These regolith materials mantle the land masses and support terrestrial life but their formation involves some of the least understood of Earth's surficial processes. The conversion of biologically inert hard rock to a hospitable substrate for organisms begins with the production of porosity by weathering. Porosity allows water to flow through weathered rock, but it also imparts a water-holding capacity so that water can be stored for prolonged use by organisms. Organisms themselves, in the form of microbes and plant roots, invade the rock as porosity forms. Production of porosity is the fundamental process responsible for converting rock into a medium capable of supporting terrestrial ecosystems. Consequently, the rate of porosity formation during rock weathering is the ultimate measure of the production and sustainability of ecosystem-functional substrates.

INTRODUCTION

Fresh bedrock exposed at the land surface is an inhospitable substrate for most life. Exposed bedrock has very low porosity and hydraulic conductivity (Zhao, 1998; Schild et al., 2001); consequently, rain and snowmelt run off from it immediately. Water is not stored, so plants do not have a reservoir from which they can extract moisture as needed during dry periods. Furthermore, although hard bedrock contains elements such as P, Ca, Mg, and K that are essential for life, they are not readily accessible to organisms because they are bound within crystalline mineral structures. Once hard rock is weathered, it develops abundant porosity, first as friable bedrock, and later, when this weathered bedrock is physically disrupted, as soil. The development of extensive porosity is the key process in converting rock from a biologically inert material to a medium from which biota can gain nutrients, stored water, and a vast underground habitat. Here we describe the mechanisms and implications of transforming nonporous hard rock into porous regolith. We focus on granitic rock because it is a major component of Earth's crust (15% of the land area) and because it is relatively consistent in its weathering behavior (Twidale and Vidal Romaní, 2005).

POROSITY FORMATION AND GRANITIC ROCK WEATHERING

Unweathered granitic plutons are commonly jointed. The joints are the result of stresses on the rock mass, including those associated with thermal, tectonic, and erosional unloading processes. Joint spacings range from several decimeters to several meters, can be orthogonally oriented, and depend on the geologic history of the rock. In unweathered bedrock, the joint fractures are empty planar voids that range in width from a fraction of a millimeter to more than a centimeter (Bergbauer and Martel, 1999). Fractures are the main source of hydraulic connectivity in unweathered bedrock (Paillet, 1993). The rock mass between the joints contains minor porosity, usually 1% or less (Twidale and Vidal Romaní, 2005), in the form of microfractures <1 µm wide and microporosity within mineral grains (Sardini et al., 2006). The microfractures are generated by stresses incurred during cooling, hydrothermal activity, or tectonism (Schild et al., 2001). Micropores within mineral grains form during crystallization and cooling. Meteoric water flowing down joint fractures initially enters the bedrock mass through inherent microfractures, thereby beginning the chemical weathering process (Meunier et al., 2007).

In biotite-bearing granites, ion exchange weathering is an important first step in generating bulk rock porosity. The replacement of interlayer K by hydrated Mg cations results in expansion of the biotite structure as the mineral is transformed to vermiculite (Wahrhaftig, 1965; Nettleton et al., 1970; Isherwood and Street, 1976). This expansion, which involves a 30%–40% increase in volume, exploits the weakness imparted by the lithogenic microfractures and shatters the rock. A smaller expansion of biotite has been noted to occur upon oxidation of the Fe within its structure (Buss et al., 2008). In either case, the rock matrix loses much of its mechanical strength (Arel and Önalp, 2004) and is transformed into a regolith material referred to as *saprock* (Anand and Paine, 2002) (Fig. 1A). The rock mass is now permeated by a continuous network of mesofractures (Fig. 1B). It maintains the original rock texture (Fig. 1C) but is friable and can be crumbled by hand into its individual grain sizes (Fig. 1D). Individual mineral grains in saprock are not extensively chemically altered (Wahrhaftig, 1965; Girty et al., 2003).

The mesofracture network in saprock opens up the rock mass to extensive percolation of water and vastly increases the surface area for weathering. At this point, hydrolysis becomes an effective weathering process, attacking feldspars and other weatherable minerals. Feldspars are weathered preferentially along twin planes (Fig. 1B), and are eventually

E-mails: robert.graham@ucr.edu, arossi1@umd.edu, khubbert@fs.fed.us

GSA Today, v. 20, no. 2, doi: 10.1130/GSAT57A.1

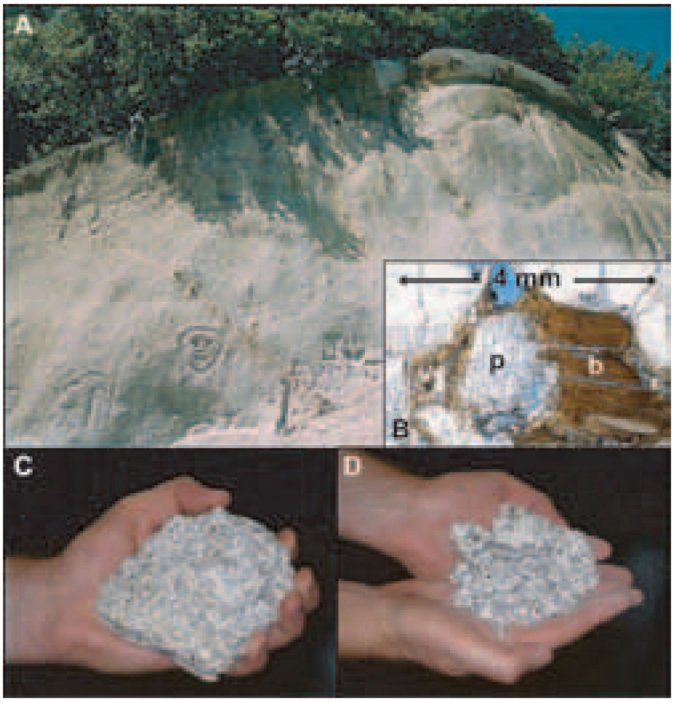


Figure 1. (A) Saprock in the central Sierra Nevada, California. Note graffiti easily carved into this friable bedrock material (tile spade for scale: 1.15 m). (B) Thin section micrograph (plane light) showing porosity (in blue) and partially weathered biotite (b) and plagioclase (p). Primary minerals predominate, and very little clay has been produced by weathering. Saprock maintains rock texture (C), but is easily crushed in bare hands (D).

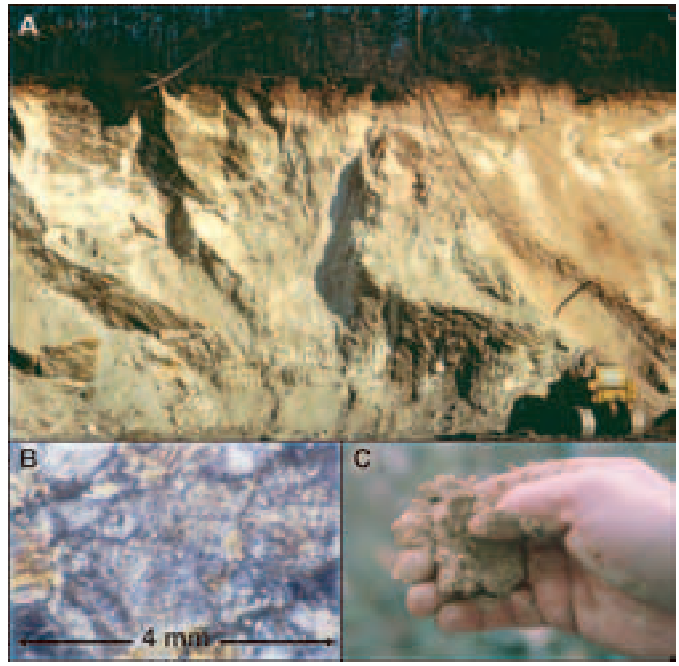


Figure 2. (A) Saprolite on the North Carolina Piedmont. Rock structural features are preserved, yet saprolite is soft and easily excavated. (Note bulldozer for scale, lower right; photo credit: G. Simpson). (B) Thin section micrograph (cross-polarized light) showing thorough alteration of weatherable primary minerals to clay minerals (photo credit: M. Vepraskas). (C) Due to this extensive weathering and clay production, saprolite is plastic when wet.

pseudomorphically replaced by kaolin or gibbsite (Inskeep et al., 1993; Taboada and García 1999; Jiménez-Espinosa et al., 2007). The highly weathered bedrock mass, termed *saprolite,* still retains rock texture (Fig. 2A), but most weatherable minerals, such as feldspars, micas, and amphiboles, are altered to clay minerals (Fig. 2B). Saprolite can be crumbled by hand and is plastic when wet (Fig. 2C). New sources of porosity in saprolite are produced in the form of dissolution pits in relict primary minerals and as interstitial pores within masses of precipitated clay minerals (Frazier and Graham, 2000; White et al., 2001; Turner et al., 2003).

HYDRAULIC BEHAVIOR OF WEATHERED ROCK

When bedrock has been weathered to saprock, joint traces remain distinct (Fig. 3A) but are wider and filled with a sandy loam material that has been dislodged from the joint walls (Sternberg et al., 1996; Graham et al., 1997). These joint fractures in saprock are pathways for rapid preferential movement of water (Fig. 3B) (Frazier et al., 2002), but fractures in saprolite can become plugged with translocated materials such as clay and iron and manganese oxides, diminishing their ability to transmit water (Schoeneberger and Amoozegar, 1990; Vepraskas, 2005). Mesofractures between joints in saprock are sufficiently wide to allow gravitational flow of water, but they present a tortuous path for water flow (Fig. 3C), resulting in a lower hydraulic conductivity than the joints (Frazier et al., 2002). Clay produced by weathering is translocated in suspension and deposited on mesofracture walls (Fig. 3D) (Graham et

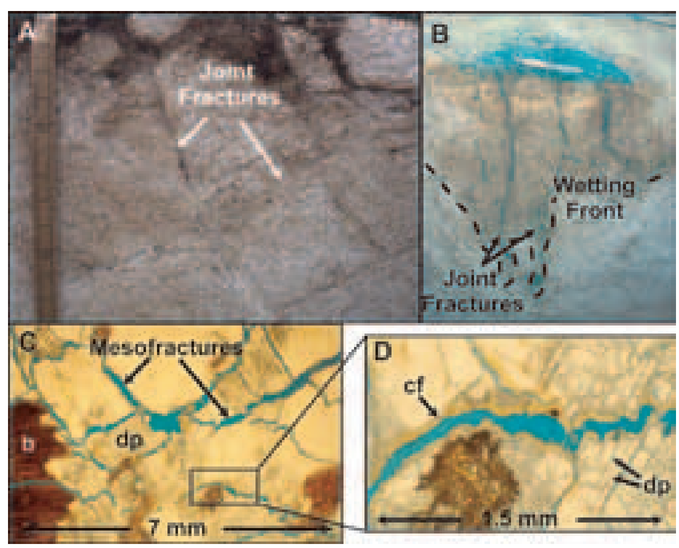


Figure 3. Illustration of porosity types in granitic saprock of the San Jacinto Mountains, California. (A) Joint fractures bound matrix blocks. (B) Joint fractures stained by preferential flow of blue dye tracer; note wetting front in matrix lags behind that in joints (photo credit: S. Frazier). (C) Thin section micrograph (plane light) of saprock matrix showing porosity in blue. Note mesofractures, partially expanded biotite (b), and dissolution-pitted plagioclase (dp). (D) Close-up of outlined area in (C), showing dissolution pitting (dp) following albite twin planes and clay films (cf) lining the mesofracture wall.

al., 1994; Frazier and Graham, 2000). Dissolution pits in primary minerals and interstitial pores in the clay materials are micropores (<10 μm diameter), so they retain water against the force of gravity (Luxmore, 1981). Thus, as primary minerals are altered, the weathered rock gains the ability to store appreciable amounts of water (Jones and Graham, 1993; Hubbert et al., 2001b). Below a depth of several decimeters, this water is not readily lost by evaporation and is available to support plants during the dry season.

BIOLOGICAL ACCESS

Terrestrial plants require a porous substrate in order for their roots to gain structural support and to access water and nutrients. The roots transfer water and nutrients to the aboveground part of the ecosystem and return photosynthetically fixed atmospheric carbon to the belowground part of the ecosystem in the form of root biomass. The roots provide energy to a multitude of soil organisms, promote further weathering, and physically alter regolith morphology (Graham et al., 1994; Frazier and Graham, 2000; Schenk and Jackson, 2005).

Depth of rooting is directly related to climate. Woody plants that experience seasonal drought have roots that extend deep into the substrate to access stored water (Schenk and Jackson, 2002). When bedrock occurs within this potential rooting depth, plant roots penetrate below the soil into fractures in the rock. This phenomenon is common in upland areas where thin soils (<1 m thick) overlie bedrock. For example, roots of ponderosa pine seedlings reach the subsoil saprock within their first two years in the central Sierra Nevada, California (Witty et al., 2003). Mature ponderosa pine roots can extend 24 m deep into fractured bedrock, and juniper roots can go much deeper (>61 m) (Stone and Kalisz, 1991). Roots of chaparral shrubs (Sternberg et al., 1996), oaks (Bornyasz et al., 2005), and conifers (Anderson et al., 1995; Hubbert et al., 2001a, 2001b) extend deeper than 4 m into saprock in the mountains of California.

Plant roots grow along paths of least resistance, so they follow fractures in bedrock. Even in saprock, roots remain confined to joint fractures, forming dense root mats (Sternberg et al., 1996; Hubbert et al., 2001b; Bornyasz et al., 2005). On the other hand, the porous rock matrix is where the water is stored. Because roots are confined to joint fractures and the water is stored in the matrix between the fractures, there must be a mechanism by which water is moved from the center of the weathered matrix block toward the fractures, a distance of 0.25–0.5 m. Water might move via unsaturated flow along a moisture potential gradient set up by the roots. However, the unsaturated hydraulic conductivity of saprock is very low. We estimate that, at water potentials of <–0.1 MPa, unsaturated flow occurs at a rate of $<10^{-3}$ cm h^{-1} (Hubbert et al., 2001b). Hence, more than a year would be required for water to move from the center of a matrix block to the joint fractures. This exceeds the length of the dry season and does not explain the annual depletion of water observed in saprock (Arkley, 1981; Sternberg et al., 1996; Hubbert et al., 2001a; Bornyasz et al., 2005).

The gap between root occurrence in fractures and water storage in the weathered rock matrix is bridged by a symbiosis between plants and fungi. The roots of wildland trees and shrubs are infected with mycorrhizal fungi in a symbiotic relationship in which the fungus obtains carbon from, and delivers water and nutrients to, the root (Allen, 2007). Mycorrhizal fungi have hyphae that extend more than a meter from the host root and are <20 μm in diameter; thus, they can easily explore mesofractures in the saprock matrix (Fig. 4). In the process, mycorrhizal hyphae may promote biotite weathering (Balogh-Brunstad et al., 2008), the critical first step in saprock production. The presence of mycorrhizal hyphae as deep as four meters within the saprock matrix under oak woodland (Bornyasz et al., 2005) and chaparral (Egerton-Warburton et al., 2003) suggests that water is being tapped from the capillary-size pores.

SUPPORT FOR ECOSYSTEMS

In upland granitic terrain in California, thin soils overlie a thick zone of saprock. Although soil has a greater water-holding capacity, the saprock, because of its greater thickness, constitutes the greatest reservoir of plant-available water. For example, in a Jeffrey pine forest in the southern Sierra Nevada, the regolith consists of an upper 75-cm-thick layer of soil with a plant-available water capacity (PAWC) of 20% that overlies a 275-cm-thick layer of saprock with a PAWC of 12%. The result is that the soil retains 15 cm of water in its 75 cm thickness, whereas the saprock holds more than twice this amount (33 cm). Since this forest site loses at least 40 cm of water by evapotranspiration annually, mostly during the summer dry season, water stored within the soil cannot support the water demands of the forest (Rose et al., 2003). For example, in 1996, plant-available water in the soil was depleted by the end of June (Fig. 5), and the plants had to rely on water stored within the saprock for the remainder of the summer dry season (which extended to the end of October).

In arid and semi-arid regions, water availability is the major limitation to plant growth, whereas mineral-derived nutrients such as Ca, Mg, K, and P are generally present in sufficient

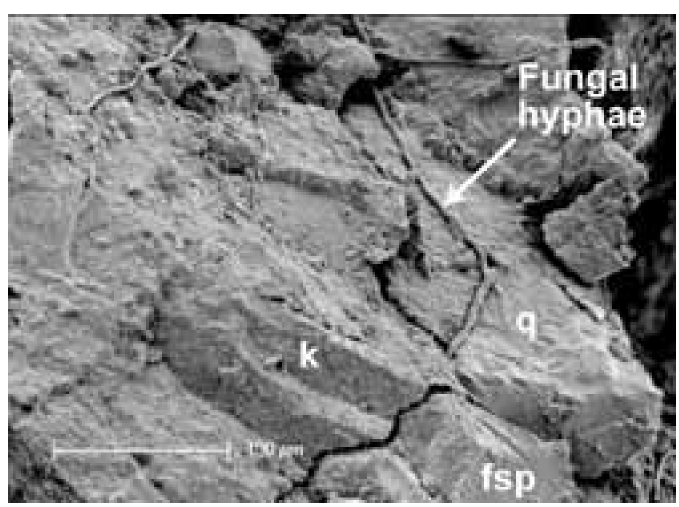


Figure 4. Scanning electron micrograph of mycorrhizal fungal hyphae penetrating a saprock microfracture between feldspar (fsp), quartz (q), and partially kaolinized feldspar (k) grains. Scale bar: 100 μm. Sample was taken from the 40-cm depth in saprock shown in Figure 3A.

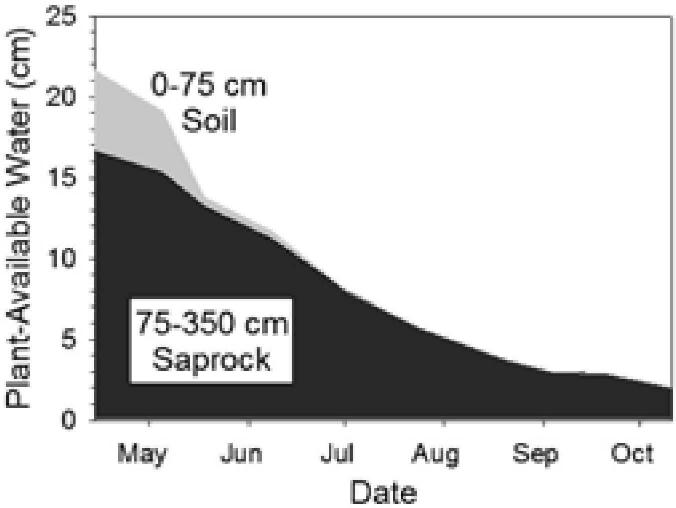


Figure 5. Plant-available water of the soil and saprock zones under a Jeffrey pine forest in the southern Sierra Nevada, California, as a function of time during the dry season of 1996. Note plant-available water was depleted from the soil zone by the end of June. For the remainder of the dry season, forest vegetation relied on water stored in the saprock.

quantities (e.g., Hubbert et al., 2001b). In these regions, weathered bedrock benefits ecosystems primarily by increasing the water-storage volume beyond that provided by the overlying soil. In more humid regions, soils are usually moist, so water availability is not limiting, but mineral-derived nutrients are often depleted by leaching (e.g., Oh and Richter, 2005) or are specifically adsorbed to Fe- or Al-oxide weathering products and unavailable for plant uptake (Buol et al., 2003). In such cases, weathered rock may benefit the ecosystem by supplying nutrients to plants whose roots and symbiotic fungi reach bedrock or exploit rock fragments in the soil (Ugolini et al., 2001; Heisner et al., 2004).

SOIL SUSTAINABILITY

Soils are recognized as the foundation for terrestrial ecosystems (Doran and Parkin, 1994) and are a major factor in ecosystem and agricultural sustainability (Montgomery, 2007). But what should we consider to be "soil"? While traditional views hold that soil lacks rock structure (Soil Survey Staff, 1999), and a "soil production function" has been developed based on the rate of disruption of weathered bedrock (Heimsath et al., 1999, 2000), weathered bedrock (saprock and saprolite) itself functions much like soil in an ecosystem and hydrologic sense. The rate at which functional substrate for plants is produced is determined by the rate of porosity formation during rock weathering. This is particularly true for ecosystems in which weathered bedrock is a component of the water storage reservoir that is heavily drawn upon during dry seasons. If the rate of soil erosion exceeds the rate of porosity formation, the existing ecosystem is not sustainable (Fig. 6A). Therefore, the rate at which hard rock is converted to porous saprock is the appropriate measure of the production and sustainability of ecosystem-functional substrate.

The rate of subsurface rock weathering has been addressed from a geochemical view (e.g., Colman and Dethier, 1986; Brantley et al., 2008; Burke et al., 2009), but less emphasis has been placed on the rate of porosity formation. By studying granitic clast weathering in moraines of the Sierra Nevada, California, Rossi and Graham (2010) determined that 10-cm-diameter clasts were altered to saprock only in those moraines older than 81 ka. These clasts held plant-available water and hosted mycorrhizal fungal hyphae (i.e., they were functioning as part of the ecosystem substrate). We use this observation to estimate the rate of ecosystem-functional substrate production from granitic bedrock.

Because the weathering front moves inward from all sides of the clasts, the clast weathering profile is best approximated as the radius. If we assume the clasts to be spherical, this corresponds to a radius of 5 cm. In other words, in 81 k.y., a rock thickness of 5 cm has been transformed to ecosystem substrate (Rossi and Graham, 2010). This is equivalent to 0.6 m k.y.$^{-1}$ of weathering front movement. In contrast, saprolite production from granodiorite in southeastern Australia ranges from 4 to 46 m k.y.$^{-1}$, depending on landscape position (Dosseto et al., 2008). While higher weathering rates in southeastern Australia may be expected due to a higher mean annual precipitation (910 m yr^{-1}) than the Sierra Nevada site (200 m yr^{-1}), the manner in which weathering occurs also needs to be considered for this comparison.

Weathering fronts in granitic bedrock are not smooth planar features (Fig. 6B). Instead, they consist of a zone defined by the depth to which meteoric water penetrates (i.e., the

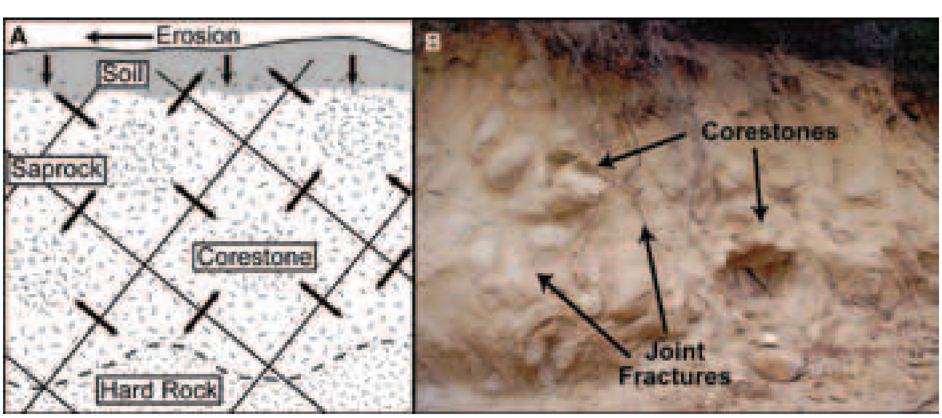


Figure 6. (A) Bedrock weathering fronts move inward from fractures. The entire vadose zone is subjected to weathering processes. From an ecosystem-sustainability standpoint, functional substrate thickness is maintained when erosional losses are balanced by saprock production. (B) Weathered rock profile showing joint fractures and less-weathered corestones at the center of joint blocks. Below arrow on right, note roots along fracture plane where corestone has fallen out.

vadose zone). Within this zone, bedrock blocks are weathered from all sides by water percolating through joint fractures (Fig. 6A). The vadose zone in residual profiles of granitic rock in the southern Sierra Nevada and the Peninsular Ranges in California is commonly 4–8 m deep (Hellmers et al., 1955; Hubbert et al., 2001a) with joint spacings of 50 cm (Wahrhaftig, 1965; Sternberg et al., 1996; Witty et al., 2003). Based on the granitic clast weathering rates determined by Rossi and Graham (2010), hard granitic bedrock with joints spaced 50 cm apart could be weathered to saprock in ~400 k.y. The rate of saprock production would be 0.01 m yr^{-1} if the rock weathering zone was 4 m thick, or 0.02 m yr^{-1} if it was 8 m thick. These rates (0.01–0.02 m yr^{-1}) assume simultaneous weathering throughout the vadose zone and are similar to the southeastern Australia saprolite production rates (0.004–0.046 m yr^{-1}) (Dosseto et al., 2008).

If erosion rates exceed the rate of saprock production (Fig. 6A), the substrate (soil plus saprock) is not sustainable, and consequently neither is the ecosystem. Erosion rates in granitic terrain of the northern Sierra Nevada range from 0.015 to 0.06 m yr^{-1}, with higher rates on steeper slopes (Granger et al., 2001). Our calculated rates of saprock production (0.01–0.02 m yr^{-1}) are the same magnitude as the erosion rate, implying that the regolith has attained an equilibrium thickness on stable landscape positions but is depleted on steep slopes.

CONCLUSIONS

Porosity produced by weathering converts biologically inert rock into a material that supplies organisms with habitat, stored water, and nutrients. Initial weathering of granitic rock produces saprock, which retains rock texture and fresh primary minerals, but has an extensive network of mesofractures, is friable, and holds plant-available water. Roots are confined to and fully occupy joint fractures to at least 4 m in depth. Matrix water is delivered to them via mycorrhizal fungal hyphae that explore the mesofractures. Further weathering produces saprolite, which is plastic when wet, has abundant capillary-size pores in clay masses and dissolution-pitted primary minerals, and holds more water than saprock. Deep-rooted trees and shrubs rely on water stored in weathered bedrock to survive summer drought. Because these porous rock materials function intimately in terrestrial ecosystems, the rate of porosity formation during rock weathering is the appropriate measure of ecosystem-functional substrate production.

ACKNOWLEDGMENTS

Preparation of this paper was supported in part by funding from the University of California Kearney Foundation of Soil Science. We thank Krassimir Bozhilov for scanning electron microscopy and Mike Allen for comments on the fungal hyphae (Fig. 4). Reviews by Douglas Morton, Ronald Amundson, and Marjorie Schulz, and editing by Stephen Johnston, helped improve the paper.

REFERENCES CITED

Allen, M.F., 2007, Mycorrhizal fungi: Highways for water and nutrients in arid soils: Vadose Zone Journal, v. 6, p. 291–297, doi: 10.2136/vzj2006.0068.

Anand, R.R., and Paine, M., 2002, Regolith geology of the Yilgarn Craton, western Australia: Implications for exploration: Australian Journal of Earth Sciences, v. 49, p. 3–162, doi: 10.1046/j.1440-0952.2002.00912.x.

Anderson, M.A., Graham, R.C., Alyanakian, G.J., and Martynn, D.Z., 1995, Late summer water status of soils and weathered bedrock in a giant sequoia grove: Soil Science, v. 160, p. 415–422, doi: 10.1097/00010694-199512000-00007.

Arel, E., and Önalp, A., 2004, Diagnosis of the transition from rock to soil in a granodiorite: Journal of Geotechnical and Geoenvironmental Engineering, v. 130, p. 968–974, doi: 10.1061/(ASCE)1090-0241(2004)130:9(968).

Arkley, R.J., 1981, Soil moisture use by mixed confer forest in a summer-dry climate: Soil Science Society of America Journal, v. 45, p. 423–427.

Balogh-Brunstad, Z., Keller, C.K., Dickinson, J.T., Stevens, F., Li, C.Y., and Bormann, B.T., 2008, Biotite weathering and nutrient uptake by ectomycorrhizal fungus, *Suillus tomentosus,* in liquid-culture experiments: Geochimica et Cosmochimica Acta, v. 72, p. 2601–2618, doi: 10.1016j.gca.2008.04.003.

Bergbauer, S., and Martel, S.J., 1999, Formation of joints in cooling plutons: Journal of Structural Geology, v. 21, p. 821–835, doi: 10.1016/S0191-8141(99)00082-6.

Bornyasz, M.A., Graham, R.C., and Allen, M.F., 2005, Ectomycorrhizae in a soil-weathered granitic bedrock regolith: Linking matrix resources to plants: Geoderma, v. 126, p. 141–160, doi: 10.1016/j.geoderma.2004.11.023.

Brantley, S.L., Kubicki, J.D., and White, A.F., editors, 2008, Kinetics of Water-Rock Interaction: Berlin, Springer, 840 p.

Buol, S.B., Southard, R.J., Graham, R.C., and McDaniel, P.A., 2003, Soil Genesis and Classification: Ames, Iowa State Press, 494 p.

Burke, B.C., Heimsath, A.M., Dixon, J.L., Chappell, J., and Yoo, K., 2009, Weathering the escarpment: Chemical and physical rates and processes, south-eastern Australia: Earth Surface Processes and Landforms, v. 34, p. 768–785, doi: 10.1002/esp.1764.

Buss, H.L., Sak, P.B., Webb, S.M., and Brantley, S.L., 2008, Weathering of the Rio Blanco quartz diorite, Luquillo Mountains, Puerto Rico: Coupling oxidation, dissolution, and fracturing: Geochimica et Cosmochimica Acta, v. 72, p. 4488–4507, doi: 10.1016/j.gca.2008.06.020.

Colman, S.M., and Dethier, D.P., eds., 1986, Rates of Chemical Weathering of Rocks and Minerals: Orlando, Academic Press, 603 p.

Doran, J.W., and Parkin, T.B., 1994, Defining and assessing soil quality, *in* Doran, J.W., Coleman, D.C., Bezdicek, D.F., and Stewart, B.A., eds., Defining Soil Quality for a Sustainable Environment: Soil Science Society of America Special Publication Number 35, p. 3–21.

Dosseto, A., Turner, S.P., and Chappell, J., 2008, The evolution of weathering profiles through time: New insights from uranium-series isotopes: Earth and Planetary Science Letters, v. 274, p. 359–371, doi: 10.1016/j.epsl.2008.07.050.

Egerton-Warburton, L.M., Graham, R.C., and Hubbert, K.R., 2003, Spatial variability in mycorrhizal hyphae and nutrient and water availability in a soil-weathered bedrock profile: Plant and Soil, v. 249, p. 331–342, doi: 10.1023/A:1022860432113.

Frazier, C.S., and Graham, R.C., 2000, Pedogenic transformation of fractured granitic bedrock, southern California: Soil Science Society of America Journal, v. 64, p. 2057–2069.

Frazier, C.S., Graham, R.C., Shouse, P.J., Yates, M.V., and Anderson, M.A., 2002, A field study of water flow and virus transport in weathered granitic bedrock: Vadose Zone Journal, v. 1, p. 113–124, doi: 10.2113/1.1.113.

Girty, G.H., Marsh, J., Meltzner, A., McConnell, J.R., Nygren, D., Nygren, J., Prince, G.M., Randall, K., Johnson, D., Heitman, B., and Nielsen, J., 2003, Assessing changes in elemental mass as a result of chemical weathering of granodiorite in a Mediterranean (hot summer) climate: Journal of Sedimentary Research, v. 73, p. 434–443, doi: 10.1306/091802730434.

Graham, R.C., Guertal, W.R., and Tice, K.R., 1994, The pedologic nature of weathered rock, *in* Cremeens, D.L., Brown, R.B., and Huddleston, J.H., eds., Whole Regolith Pedology: Soil Science Society of America Special Publication Number 34, p. 21–40.

Graham, R.C., Schoeneberger, P.J., Anderson, M.A., Sternberg, P.D., and Tice, K.R., 1997, Morphology, porosity, and hydraulic conductivity of weathered granitic bedrock and overlying soils: Soil Science Society of America Journal, v. 61, p. 516–522.

Granger, D.E., Riebe, C.S., Kirchner, J.W., and Finkel, R.C., 2001, Modulation of erosion on steep granitic slopes by boulder armoring, as revealed by cosmogenic ^{26}Al and ^{10}Be: Earth and Planetary Science Letters, v. 186, p. 269–281, doi: 10.1016/S0012-821X(01)00236-9.

Heimsath, A.R., Dietrich, W.E., Nishiizumi, K., and Finkel, R.C., 1999, Cosmogenic nuclides, topography, and the spatial variation of soil depth: Geomorphology, v. 27, p. 151–172, doi: 10.1016/S0169-555X(98)00095-6.

Heimsath, A.R., Chappell, J., Dietrich, W.E., Nishiizumi, K., and Finkel, R.C., 2000, Soil production on a retreating escarpment in southeastern Australia: Geology, v. 28, p. 787–790, doi: 10.1130/0091-7613(2000)28<787:SPOARE>2.0.CO;2.

Heisner, U., Raber, B., and Hildebrand, E.E., 2004, The importance of the soil skeleton for plant-available nutrients in sites of the Southern Black Forest, Germany: European Journal of Forest Research, v. 123, p. 249–257, doi: 10.1007/s10342-004-0041-7.

Hellmers, H., Horton, J.S., Juhren, G., and O'Keefe, J., 1955, Root systems of some chaparral plants in southern California: Ecology, v. 36, p. 667–678, doi: 10.2307/1931305.

Hubbert, K.R., Beyers, J.L., and Graham, R.C., 2001a, Roles of weathered bedrock and soil in seasonal water relations of *Pinus jeffreyi* and *Arctostaphylos patula*: Canadian Journal of Forest Research, v. 31, p. 1947–1957, doi: 10.1139/cjfr-31-11-1947.

Hubbert, K.R., Graham, R.C., and Anderson, M.A., 2001b, Soil and weathered bedrock: Components of a Jeffrey pine plantation substrate: Soil Science Society of America Journal, v. 65, p. 1255–1262.

Inskeep, W.P., Clayton, J.L., and Mogk, D.W., 1993, Naturally weathered plagioclase grains from the Idaho Batholith: Observations using scanning electron microscopy: Soil Science Society of America Journal, v. 57, p. 851–860.

Isherwood, D., and Street, A., 1976, Biotite-induced grussification of the Boulder Creek granodiorite, Boulder County, Colorado: Geological Society of America Bulletin, v. 87, p. 366–370, doi: 10.1130/0016-7606(1976)87<366:BGOTBC>2.0.CO;2.

Jiménez-Espinosa, R., Vázquez, M., and Jiménez-Millán, J., 2007, Differential weathering of granitic stocks and landscape effects in a Mediterranean climate, Southern Iberian Massif (Spain): CATENA, v. 70, p. 243–252, doi: 10.1016/j.catena.2006.09.001.

Jones, D.P., and Graham, R.C., 1993, Water-holding characteristics of weathered granitic rock in chaparral and forest ecosystems: Soil Science Society of America Journal, v. 57, p. 256–261.

Luxmore, R.J., 1981, Micro-, meso-, and macroporosity of soil: Soil Science Society of America Journal, v. 45, p. 671.

Meunier, A., Sarsdini, P., Robinet, J.C., and Prêt, D., 2007, The petrography of weathering processes: facts and outlooks: Clay Minerals, v. 42, p. 415–435, doi: 10.1180/claymin.2007.042.4.01.

Montgomery, D.R., 2007, Is agriculture eroding civilization's foundation?: GSA Today, v. 17, p. 4–9, doi: 10.1130/GSAT01710A.1.

Nettleton, W.D., Flach, K.W., and Nelson, R.E., 1970, Pedogenic weathering of tonalite in southern California: Geoderma, v. 4, p. 387–402, doi: 10.1016/0016-7061(70)90055-8.

Oh, N.-H., and Richter, D.D., 2005, Elemental translocation and loss from three highly weathered soil-bedrock profiles in the southeastern United States: Geoderma, v. 126, p. 5–25, doi: 10.1016/j.geoderma.2004.11.005.

Paillet, F.L., 1993, Using borehole geophysics and cross-borehole flow testing to define hydraulic connections between fracture zones in bedrock aquifers: Journal of Applied Geophysics, v. 30, p. 261–279, doi: 10.1016/0926-9851(93)90036-X.

Rose, K.L., Graham, R.C., and Parker, D.R., 2003, Water source utilization by *Pinus jeffreyi* and *Arctostaphylos patula* on thin soils over bedrock: Oecologia, v. 134, p. 46–54, doi: 10.1007/s00442-002-1084-4.

Rossi, A.M., and Graham, R.C., 2010, Weathering and porosity formation in sub-soil granitic clasts, Bishop Creek moraines, California: Soil Science Society of America Journal (in press).

Sardini, P., Siitari-Kauppi, M., Beaufort, D., and Hellmuth, K.-H., 2006, On the connected porosity of mineral aggregates in crystalline rocks: The American Mineralogist, v. 91, p. 1069–1080, doi: 10.2138/am.2006.1939.

Schenk, H.J., and Jackson, R.B., 2002, The global biogeography of roots: Ecological Monographs, v. 72, p. 311–328.

Schenk, H.J., and Jackson, R.B., 2005, Mapping the global distribution of deep roots in relation to climate and soil characteristics: Geoderma, v. 126, p. 129–140, doi: 10.1016/j.geoderma.2004.11.018

Schild, M., Siegesmund, S., Vollbrect, A., and Mazurek, M., 2001, Characterization of granite matrix porosity and pore-space geometry by in situ and laboratory methods: Geophysical Journal International, v. 146, p. 111–125, doi: 10.1046/j.0956-540x.2001.01427.x.

Schoeneberger, P., and Amoozegar, A., 1990, Directional saturated hydraulic conductivity and macropore morphology of a soil-saprolite sequence: Geoderma, v. 46, p. 31–49, doi: 10.1016/0016-7061(90)90005-T.

Soil Survey Staff, 1999, Soil Taxonomy: Washington, D.C., U.S. Government Printing Office, 869 p.

Sternberg, P.D., Anderson, M.A., Graham, R.C., Beyers, J.L., and Tice, K.R., 1996, Root distribution and seasonal water status in weathered granitic bedrock under chaparral: Geoderma, v. 72, p. 89–98, doi: 10.1016/0016-7061(96)00019-5.

Stone, E.L., and Kalisz, P.J., 1991, On the maximum extent of tree roots: Forest Ecology and Management, v. 46, p. 59–102, doi: 10.1016/0378-1127(91)90245-Q.

Taboada, T., and García, C., 1999, Pseudomorphic transformation of plagioclases during the weathering of granitic rocks in Galacia (NW Spain): CATENA, v. 35, p. 291–302, doi: 10.1016/S0341-8162(98)00108-8.

Turner, B.F., Stallard, R.F., and Brantley, S.L., 2003, Investigation of in situ weathering of quartz diorite bedrock in the Rio Icacos basin, Luquillo Experimental Forest, Puerto Rico: Chemical Geology, v. 202, p. 313–341, doi: 10.1016/j.chemgeo.2003.05.001.

Twidale, C.R., and Vidal Romaní, J.R., 2005, Landforms and Geology of Granitic Terrains: A.A. Balkema Publishers, Leiden, Netherlands, 351 p.

Ugolini, F.C., Corti, G., Dufey, J.E., Agnelli, A., and Certini, G., 2001, Exchangeable Ca, Mg, and K of rock fragments and fine earth from sandstone and siltstone derived soils and their availability to grass: Journal of Plant Nutrition and Soil Science, v. 164, p. 309–315, doi: 10.1002/1522-2624(200106)164:3<309::AID-JPLN309>3.0.CO;2-8.

Vepraskas, M.J., 2005, Predicting contaminant transport along quartz veins above the water table in a mica-schist saprolite: Geoderma, v. 126, p. 47–57, doi:10.1016/j.geoderma.2004.11.006.

Wahrhaftig, C., 1965, Stepped topography of the southern Sierra Nevada, California: Geological Society of America Bulletin, v. 76, p. 1165–1190, doi: 10.1130/0016-7606(1965)76[1165:STOTSS]2.0.CO;2.

White, A.F., Bullen, T.D., Schulz, M.S., Blum, A.E., Huntington, T.G., and Peters, N.E., 2001, Differential rates of feldspar weathering in granitic regoliths: Geochimica et Cosmochimica Acta, v. 65, p. 847–869, doi: 10.1016/S0016-7037(00)00577-9.

Witty, J.H., Graham, R.C., Hubbert, K.R., Doolittle, J.A., and Wald, J.A., 2003, Contributions of water supply from the weathered bedrock zone to forest soil quality: Geoderma, v. 114, p. 389–400, doi: 10.1016/S0016-7061(03)00051-X.

Zhao, J., 1998, Rock mass hydraulic conductivity of the Bukit Timah granite, Singapore: Engineering Geology, v. 50, p. 211–216, doi: 10.1016/S0013-7952(98)00021-0.

Manuscript received 22 May 2009; accepted 15 September 2009.

NOTICE

of Spring 2010 GSA Council Meeting

Meetings of the Council of The Geological Society of America are open to GSA 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.

GSA Headquarters,
Boulder, Colorado, USA

Saturday, 17 April 2010
8 a.m.–5 p.m.

Sunday, 18 April 2010
8 a.m.–noon

THE GEOLOGICAL SOCIETY OF AMERICA®

The Geological Society of America, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA | +1-303-357-1000, option 3, or +1-888-443-4472

CALL FOR PAPERS

GSA TODAY

SCIENCE:

High-quality, focused, peer-reviewed articles that appeal to a broad geoscience audience.

GROUNDWORK:

Short, hot-topic, peer-reviewed articles that focus on issues important to the earth sciences.

www.geosociety.org/pubs/gsatguid.htm

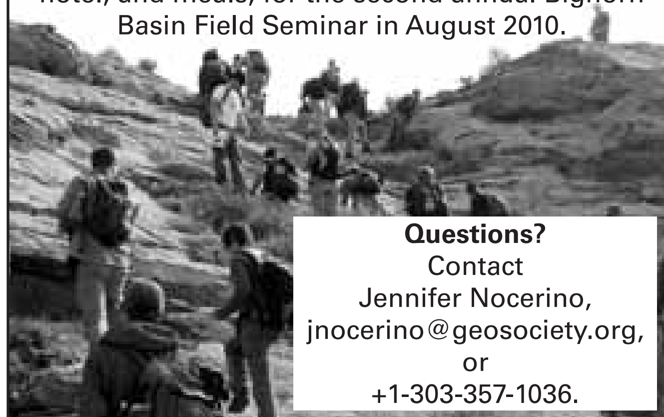
GSA–ExxonMobil

BIGHORN BASIN FIELD AWARD

Professional Development Opportunity for Undergraduate Students and Faculty

Award application deadline: 1 April

This award covers all expenses, including airfare, hotel, and meals, for the second annual Bighorn Basin Field Seminar in August 2010.



Questions?
Contact
Jennifer Nocerino,
jnocerino@geosociety.org,
or
+1-303-357-1036.

Learn more at

http://rock.geosociety.org/ExxonMobilAward/.

Origin and Uplift of the Sierra Nevada, California, USA

16–20 August 2010
Bridgeport, California, USA

CONVENERS

Cathy J. Busby, Dept. of Earth Science, University of California, Santa Barbara, California 93106, USA, busby@geol.ucsb.edu
Keith D. Putirka, Dept. of Earth and Environmental Sciences, California State University, Fresno, 2345 E. San Ramon Ave., MS/MH24, Fresno, California 93720, USA, kputirka@csufresno.edu

DESCRIPTION AND OBJECTIVES

The Sierra Nevada mountain range in California is perhaps the archetype of lithosphere delamination. The Sierras are an important natural laboratory for understanding a disparate array of geologic processes, including plate tectonics and associated range uplift and volcanic activity, changes in regional climate, and the assembly of plutons and batholiths. Data derived from these seemingly disparate research areas are wholly interrelated. For example, the paleodepths of pluton intrusion or roof pendant metamorphism inform estimates of the magnitude of Cenozoic range uplift, as do the timing and composition of Miocene and Pliocene volcanic rocks. Similarly, paleoclimate models are important for understanding rates of downcutting of the modern canyons that cross the Sierra Nevada. Successful models of uplift, climate change and downcutting history, and regional volcanism must explain or be consistent with geophysical observations of the crust and lithosphere, and the age and composition of the basement rocks.

There is thus a critical need to bring together researchers active in a wide range of activities—connected by their interests in tectonics, magmatism, stratigraphy, structural geology, geophysics, paleobotany, geomorphology, geochronology, and thermochronology, using the Sierra Nevada as a case study. This interdisciplinary Penrose Conference will allow researchers from diverse backgrounds to share ideas and research results. The five-day conference will include three days of meetings and two days of field trips into the central Sierra Nevada. During the meetings, keynote talks and poster sessions will be organized relative to the following geologic themes (depending, of course, on the research scope of the people who attend the conference): (1) nature and origin of bedrock geology; (2) geophysical observations of the crust and lithosphere; (3) observations and models related to range uplift; and (4) volcanism and potential links to tectonic events. Perhaps the cumulative geologic, geochemical, and geophysical data may point toward a single coherent model that explains all observations. But, if nothing else, this conference should lead to clearer paths of research and potential avenues of collaboration. A special volume summarizing some of the research areas presented is a potential follow-up to this conference.

PROPOSED ITINERARY

Day 1—Mon., 16 August: Talks and posters with a focus on basement geology and geophysical observations.

Day 2—Tues., 17 August: Field day in the central Sierra Nevada.

Day 3—Wed., 18 August: Talks and posters with a focus on volcanic activity, tectonic models.

Day 4—Thurs., 19 August: Field day in the central Sierra Nevada.

Day 5—Fri., 20 August: Talks and posters with a focus on geomorphology, range uplift.

LOGISTICS

Participants must arrive in Bridgeport, California, USA, the night of 15 August and are responsible for their own travel arrangements. If you are flying to the meeting, we recommend you fly in and out of Reno, Nevada, USA. We will assist with transportation arrangements between Reno and Bridgeport. Additional details regarding transportation will be provided in registration materials.

The registration fee (to be determined) will cover five nights hotel lodging (15–19 Aug.), all meals, a guidebook, and transportation while in Bridgeport and on the field days. All meals will be taken together at the meeting hall to facilitate discussion. Airfare is not included.

REGISTRATION APPLICATIONS

Deadline: 26 April 2010

Interested persons should send a letter of application by e-mail to either Cathy Busby, busby@geol.ucsb.edu, or Keith Putirka, kputirka@csufresno.edu. The letter should include a brief statement of your research interests and the relevance of those interests to the focus of the conference, the topic you would like to present, and if you are interested in submitting a paper to a special issue.

Photo by Cathy Busby, taken from the vicinity of Sonora Pass, shows the Relief Peak formation (middle foreground) resting on top of Mesozoic granitoids (bottom), and overlain by Table Mountain Latite (top background).

THE GEOLOGICAL SOCIETY OF AMERICA®

JOINT MEETING

106th Annual Meeting of the Cordilleran Section, GSA
85th Annual Meeting of the Pacific Section, AAPG
Anaheim, California, USA
27–29 May 2010

www.geosociety.org/sectdiv/cord/2010mtg/

Orange County, Calif., USA (bottom, center), and surrounding region. Image acquired 3 Oct. 1994 by space shuttle *Endeavour* using Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar (SIR-C/X-SAR). Courtesy NASA–Jet Propulsion Laboratories, http://visibleearth.nasa.gov/view_rec.php?id=438.

CONTACT INFORMATION

The local organizing committee is committed to making this an exciting and accessible meeting for all. If you have questions or concerns, please contact the meeting co-chairs: Phil Armstrong, Cordilleran Section GSA, parmstrong@fullerton.edu; Curtis Henderson, Pacific Section AAPG, curtis.henderson@longbeach.gov.

REGISTRATION

Standard registration deadline: 26 April 2010
Cancellation deadline: 3 May 2010
Please register at www.geosociety.org/sectdiv/cord/2010mtg/.

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

	Early	Standard	One-Day
Professional member	$185	$235	$125
Professional nonmember	$220	$295	$185
Student member	$65	$90	$45
Student nonmember	$80	$105	$65
Professional member 70+	$95	$115	$60
K–12 professional	$60	$75	$40
Guest or spouse	$60	$75	N/A
Field trip/workshop only	$35	$45	N/A

On-Site Registration and Badge Pickup Schedule
Anaheim Marriott
Wed., 26 May, 4–8 p.m.
Thurs., 27 May, 7 a.m.–4 p.m.
Fri., 28 May, 7:30 a.m.–4 p.m.
Sat., 29 May, 7:30 a.m.–noon

Cancellations, Changes, and Refunds

Requests for additions, changes, and cancellations must be received in writing at GSA Headquarters by 3 May 2010. No refunds will be made on cancellation notices received after this date. Refunds will be mailed after the meeting; refunds for fees paid by credit card will be credited to the card identified on the registration form. GSA cannot provide refunds for on-site registration, *Abstracts with Programs,* or event ticket sales.

ACCOMMODATIONS

Reservation deadline: 26 April 2010

GSA has reserved a block of rooms at the Anaheim Marriott, 700 West Convention Way, Anaheim, CA 92802, USA. The discounted rate is US$99 plus tax per night for one to four occupants. Parking at the hotel is at a discounted rate of US$10/day. Reserve your room by phone, +1-800-228-9290, or online, www.marriott.com/hotels/travel/laxah-anaheim-marriott/; be sure to specify the Anaheim Marriott located on Convention Way and use group code **GSA-AAPG.**

CALL FOR PAPERS

Abstract deadline: 9 March 2010
Submit abstracts at www.geosociety.org/sectdiv/cord/2010mtg/

If you have problems with electronic submission, contact Nancy Wright, +1-303-357-1061, nwright@geosociety.org.

TECHNICAL PROGRAM

For general information about the technical sessions and symposia, contact the Technical Program co-chairs: Jeff Knott, jknott@fullerton.edu, Cordilleran Section, GSA; Hilario Camacho, camachoh@shpi.net, Pacific Section, AAPG.

Symposia

Cordilleran Section, GSA

1. Debating the Connections between the Plutonic and Volcanic Rock Record.

Pacific Section, SEPM

2. Using Basin Analysis and Geochemistry to Reconstruct the San Andreas Fault System: A Symposium in Honor of John Crowell, Tor Nilsen, Tom Dibblee, and Perry Ehlig.

Theme Sessions

Cordilleran Section, GSA

1. Sierra Nevada Microplate-Basement and Basins.
2. Tectonic Evolution of the Southern Big-Bend Region, San Andreas Fault.
3. Terrestrial and Marine Records of Late-Quaternary Climate from Western North America/Eastern Pacific: Developments, Comparisons, and Directions.
4. Advances in Understanding Magma Petrogenesis and Eruption Dynamics at Basaltic Monogenetic Volcanoes.
5. Active Tectonics of the Eastern California Shear Zone–Walker Lane Belt.
6. New Insights into Tectonics of the Central California Coast Ranges—The Link between Los Angeles and San Francisco.
7. Late Neogene Tectonics and Deformation along Active Faults East of and Including the San Andreas–San Jacinto Fault Zones.
8. Late Pleistocene and Holocene Glaciation in Western North America.
9. Enhancing Societal Relevance in Introductory Geoscience Education.
10. Theory and Practice: Engineering Geology in the Cordillera.
11. New Insights into the Petrology of Cordilleran Batholiths.
20. Detrital Zircon Studies in Western North America.

Pacific Section, SEPM/The Paleontological Society

12. The Triassic Aftermath and Recovery from the End-Permian Mass Extinction.
13. Climate-Biosphere Interactions through Time.

Pacific Section, AAPG

14. Reservoir Modeling.
15. Fault-Associated Diagenesis and Fluid Flow.
16. Miocene Tectonics and Structural Evolution of Coastal Southern California.
24. Wilmington Oil Field.
25. Newport-Inglewood Fault Zone.
26. Oligocene and Early Miocene Clastic Reservoirs of California.
27. California Oil Fields (Posters).
28. Technology and Techniques (Posters).

Pacific Section, AAPG/Society of Petroleum Engineers (SPE)

17. Society of Petroleum Engineers (SPE)—General Sessions.
21. Carbon Sequestration and Oil Fields.
22. Petroleum Resources Offshore California.
23. Reservoir Geophysics: Extract More out of Your Reservoir.

Cordilleran Section, GSA/Pacific Section, AAPG

18. Managing Groundwater in the Cordillera.

Cordilleran Section, GSA/Pacific Section, AAPG/Pacific Section, SEPM/Council of Undergraduate Research (CUR)

19. Undergraduate Research in Geoscience (Posters).

FIELD TRIPS

Full field-trip information is online at www.geosociety.org/sectdiv/cord/2010mtg/fieldTrips.htm.

1. Pliocene-Quaternary Tectonic Evolution of the Northern Eastern California Shear Zone.
2. Late Proterozoic, Paleozoic and Mesozoic Rocks and Structures in the Victorville-Helendale Region, Mojave Desert, California.
3. Anatomy of an Anachronistic Carbonate Platform: The Lower Triassic of the Southwestern United States and its Relationship to the Recovery from the Permian-Triassic Mass Extinction.
4. Soledad and Plush Ranch Basins: Mid-Tertiary Extensional Terrane Dismembered by the San Andreas Fault System.
5. Exploring the Whittier and San Andreas Faults.
6. Hydrogeology of Icehouse Canyon, San Gabriel Mountains, California.
7. Quaternary Geology of the San Bernardino Mountains and Their Tectonic Margins.
8. Geologic History, Eruptive Stratigraphy and Ongoing Volcanic Unrest at Long Valley Caldera and Mammoth Mountain.

SHORT COURSES AND WORKSHOPS

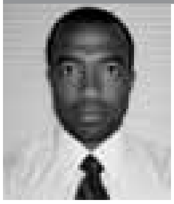
See www.geosociety.org/sectdiv/cord/2010mtg/courses.htm for more information.

1. Introduction to U-Th-Pb Geochronology using a Laser-Ablation Multicollector ICP–Mass Spectrometer.
2. Introduction to Geographic Information Systems (GIS) using ArcGIS for Geological and Environmental Science Applications.
3. When the Classroom Shakes: Tools for Teaching K–12 Students about Earthquakes in Their Front Yard.
4. Less Talk, More Action: Strategies that Improve Learning by Engaging Students.

OPPORTUNITIES FOR STUDENTS

Mentor Luncheons: Roy J. Shlemon Mentor Programs in Applied Geoscience (Fri., 28 May) and the John Mann Mentors in Applied Hydrogeology Program (Sat., 29 May). If you have questions, contact Jennifer Nocerino, jnocerino@geosociety.org, +1-303-357-1036, or go to www.geosociety.org/mentors/. *Cosponsored by the GSA Foundation.*

Travel Grants: Application details are at www.geosociety.org/sectdiv/cord/travelGrants.htm. **Deadline:** 26 April 2010. If you have questions, contact Rod Metcalf, rod.metcalf@unlv.edu.



Notes from the Staff Bench

Mark G. Little

My GSA-USGS Congressional Science Fellowship began with an intensive orientation prepared by the American Association for the Advancement of Science (AAAS). Once the engaging workshops and informative lectures on the inner workings of Congress and executive branch agencies were completed, the thirty-odd Congressional Science Fellows were faced with a deceptively simple question, "Where do you want to work?" Unlike any opportunity I can think of, the Congressional Science Fellowships (sponsored by GSA and a host of other scientific societies) are designed to allow the recipients a remarkable level of flexibility in their ultimate placement. We can work in the Senate or House; on a committee or personal staff; for a Republican, Democrat, or Independent.

I embarked on this endeavor with an inchoate understanding of how my choice might impact my life for the upcoming year. Beyond a cursory understanding of the differences in election cycles, size of constituencies, and other trivia from grade-school civics, I had no feel for the tremendously important cultural and procedural divides between the two houses of the U.S. legislature. I had no idea what committee staff actually did, and I misunderstood the role of the majority party. My ignorance was quickly rectified as I joined my fellow Fellows in a two-week, multi-component practicum, including advice from Hill staffers, many of whom had been AAAS fellows in the past. The placement interviews themselves offered perhaps the best insight into what life might be like in a particular office. We were also encouraged to independently research committees and members of Congress about which we had interest as well as take plenty of time for introspection about our own beliefs and goals. As a result of these combined efforts, we were brought quickly up to speed and were able to make informed decisions. This placement process concluded with my decision to join the majority staff of the House Committee on Foreign Affairs.

The first question I get from most everyone, scientist or not, when I mention my placement is, "What does foreign affairs have to do with science?" I freely admit that the earth-science connection to foreign affairs is not as readily apparent as it is to energy and natural resources or to agriculture. In fact, no AAAS Congressional Fellow of any discipline, from psychology to nuclear physics to medical biology, has ever been placed on the Committee on Foreign Affairs in the 36-year history of the program. However, the committee is involved with issues that are informed by most academic disciplines. In the realm of the earth sciences, the committee deals with issues like tsunamis in the Pacific, water resources in East Africa, and the international ramifications of climate change. For me, the committee held the promise of satisfying both a desire to bring more science-based perspectives into the policy realm and a deep interest in finding solutions to the common problems of human beings across the planet.

During my first month with the committee, I was fortunate to be able to help with the final planning and execution of a hearing on negotiations leading up to the United Nations Climate Change Conference in Copenhagen. As most readers of *GSA Today* are aware, climate change involves *global* issues because many of the causes (e.g., combustion of petroleum), impacts (e.g., sea-level rise), and potential solutions (e.g., financing of technology transfers to developing nations) are international in nature. As such, the Committee on Foreign Affairs and its subcommittees have jurisdiction over legislation and hearings related to negotiations and assistance to developing countries. Therefore, climate change has been a significant focus of the House Committee on Foreign Affairs.

At the time of this article's publication, the United Nations Climate Change Conference in Copenhagen will be history; however, our hearing in November 2009 provided an opportunity to highlight the key roadblocks to an international agreement. Because of the hard work of the committee staff and the chairman, the hearing was a success. The testimony of expert witnesses who have been following this issue since the original United Nations Framework Convention on Climate Change in 1992 and of Todd Stern, the head U.S. negotiator in Copenhagen, laid the groundwork. Members of Congress made statements and asked questions that rendered a complicated picture of interests and objectives that were sometimes in conflict with the concerns of other nations. I think that the audience was left with a sophisticated appreciation of the difficult path that lies ahead for the United States and other nations. But for me, seeing the preparation—orchestration is a better word—was as important as the content.

I have watched hearings on C-SPAN, but never understood how much is required to produce a hearing that is interesting, timely, and makes a statement. Selecting competent witnesses who can speak effectively to the issue at hand, understanding the positions of opposing witnesses, knowing the opinions of all Committee members, and anticipating surprises are all part of the process. As the committee tackles more science-related issues, I hope to be more involved in the legislative and hearing processes. And, I must admit, I look forward to returning to the best seats for viewing a hearing—from the staff bench behind the Members of Congress!

This manuscript is submitted for publication by Mark G. Little, 2009–2010 GSA-USGS Congressional Science Fellow, with the understanding that the U.S. government is authorized to reproduce and distribute reprints for governmental use. The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. G09AP00158. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government. Little can be reached at MarkGabriel.Little@mail.house.gov.

THE GEOLOGICAL SOCIETY OF AMERICA®

GSA ELECTIONS

GSA's success depends on its members and the work of the officers serving on GSA's Executive Committee and Council. In late February, 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.

2010 Officer and Council Nominees

PRESIDENT
(July 2010–June 2011)
Joaquin Ruiz
University of Arizona
Tucson, Arizona, USA

VICE PRESIDENT
(July 2010–June 2011)
John W. Geissman
University of New Mexico
Albuquerque, New Mexico, USA

TREASURER
(July 2010–June 2011)
Jonathan G. Price
Nevada Bureau of Mines & Geology
Reno, Nevada, USA

COUNCILOR POSITION 1
(July 2010–June 2014)
Bruce R. Clark
The Leighton Group Inc.
Irvine, California, USA
Scott Tinker
University of Texas
Austin, Texas, USA

COUNCILOR POSITION 2
(July 2010–June 2014)
Barbara L. Dutrow
Louisiana State University
Baton Rouge, Louisiana, USA
Martin B. Goldhaber
U.S. Geological Survey
Denver, Colorado, USA

COUNCILOR POSITION 3
(July 2010–June 2014)
Daniel Larsen
University of Memphis
Memphis, Tennessee, USA
Allen J. Dennis
University of South Carolina
Aiken, South Carolina, USA

Ballots accepted beginning 25 February 2010

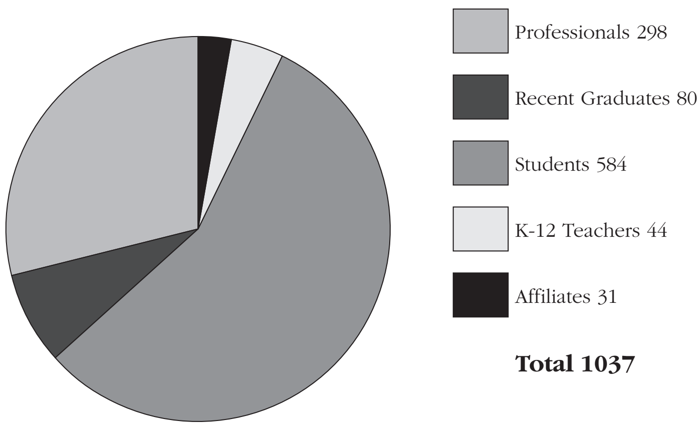
Ballots due electronically or postmarked by 26 March 2010

THE GEOLOGICAL SOCIETY OF AMERICA®

SCIENCE ▪ STEWARDSHIP ▪ SERVICE

New Members: GSA Welcomes You!

The following people were elected into membership by GSA Council at its October 2009 meeting.



PROFESSIONALS

Ismo Aaltonen
Petteri Alho
Dani J. Alldrick
Gerold Dee Allen
Phillip Allen
Heather Almquist
Desideria Anderson
Brian F. Aubry
Steven Neal Bacon
John E. Bailey
Justin M. Bailey
Rasheed S. Baraba
Paul Z. Barnes Jr.
Jamie Marie Bartel
Henry Patrick Bean
John T. Beard
Bailey A. Beitscher
Kelly Ann Beck
John H. Berry
Taco den Bezemer
Kenneth Biegert
Dennis K. Bird
Stephen J. Blakely
Debra Block
David R. Blood
Carl G. Borkland
Sarah Jean Boulton
Bradley L. Boyle
Dianne Lynn Brien
Justin W. Brown
Richard J. Brown
Ryan P. Brumbaugh
Kelvin J. Buchanan
Natalie Bursztyn
Shane Byrne
Antoni Camprubа
Dianhua Cao
Barbara Carrapa
Joshua L. Caulkins
Bernardo Cesare
Nancy Chabot
Jennifer Chambers
David Champion
Sameer Chandra
Finny Cherian
Sara Chudnoff
Richard Clement Jr.
Roger Clissold
Robert Cockerham
David K. Coffman
Curtis Cohen
Trevor Contreras
Hugo Corbella
Joseph Cotten
Anna M. Courtier
Elizabeth H. Craig
Robert G. Cuffney
Ann Kielkopf Deakin
Tamara A. DeMorest
Gregory M. Dering
Michael K. DeSantis
Donald B. Dingwell
Richard S. Dinicola
Eric Doehne
Karen Rowe Dorrell
Michael P. Doukas
Walter Dragoni
Patrick Druckenmiller
Brent Scott Duncan
Robert A. Duncan
Nurdan S. Duzgoren-Aydin
Ali Aykut Ece
James F. Echols
Richard L. Ehrman
Murray D. Einarson
David K. Elliott
Rolf Emmermann
Nancy L. Engelhardt-Moore
Gwen Erickson
Carolyn Ernst
Amanda M. Evans
Stephen G. Evans
Timothy Ewing
Caleb I. Fassett
Tracey J. Felger
David H. Felter
Charles A. Ferguson
Rachel M. Fields
James Fisher
Julie Carol Fisher
David J. Franc
Erlend Frederickson
Rebecca Freeman
Peter M. Frenzen
Paul G. Gagnon
Cheryl Gansecki
Terri Garside
Laura Giambiagi
William Gilmour
Mihaela Glamoclija
Joan Susan Gomberg
Hector F. Gonzalez
Melissa Goodman-Elgar
Lori M. Gouge
Jeffrey G. Gould
Carine Grelaud
Teddy Gumbi
Forest E. Haines
Jochen Halfar
Anne Larson Hall
David Ray Hansen
Umesh K. Haritashya
Jason Kent Harris
Sara E. Harris
Christoph Hartkopf-Froeder
Jean-Claude Heidmann
Michael Martin Heil
Craig Heindel
Stefan Heuberger
Steven R. Higgins
Michael Le Roy Hiner
Billy B. Hobbs
Axel Hofmann
Grace Holder
Sally L. Holl
Owen R. Hopkins
Susan S. Hubbard
Michael R. Hudson
Audrey Dean Huerta
Jonathan F. Hughes
Robert C. Hulse
Richard W. Hurst
Michael K. Hyde
David E. Jackson
Scott Jackson
Joachim Jacobs
Neeraj Jain
Paula Jefferis-Nilsen
Stuart D. Johnson
James D. Joy
Moinoddin Kadri
Yoshiyuki Kaneko
Jordan Katz
Matthew E. Keith
Peter Kelly
Lorcan Kennan
Lori A. Kennedy
Nancy June Ketrenos
Amy J. Keyworth
Kelly H. Kilbourne
Richard A. Kissel
Matthew F. Knop
Frank Koerner
Lenny Kouwenberg
Kate Duffy Krug
Newton Krumdieck
John J. Kudlac
Jean Lafleur
Edyta Lagomarsini
Stephen T. Lancaster
Gary P. Landis
Steven Lanter
David W. Lappi
Jessica Larsen
Nicholas D. Legere
Katie Leone
Melissa Lester
Michael J. Lincoln
Lowell Lindsay
Gil T. Linenberger
Kenneth E. Lite

Matthew Logan
Susan Lomas
Cynthia Virginia Looy
Christina L. Lopano
Fred Loxsom
Susan Lupinski
Kirby R. Manley Jr.
W. Bruce Masse
Bernhard Mayer
Kelli McCormick
Doug McKeever
Heather McKillop
Javier J. Meneses-Rocha
Leland L. Mink
Rajeevan Moothal
Peter Mouginis-Mark
David A. Murphy
Marian J. Myers
Rajeev Nair
Barbara P. Nash
Richard Newport
Wendy A. Niem
Edwin Nissen
Aaron O'Dea
Darcy E. Ogden
Wayne L. Olsen
Deborah M. Olson
Gerald Osborn
William L. Osburn
Robert M. Owen
Elizabeth R. Page
Michael Adam Pagel
Otto Paris
Daniel G. Parrillo
James Daniel Paulson
Douglas Peeler
Sarah C. Petitto
Michael G. Petterson
Colin Conway Polk
Stella Poma
Geoffrey C. Poole
Kenneth B. Price
Haijun Qiu
Mark Quigley
Deepak Rawat
Rich Reed
Marcus V.D. Remus
Howard P. Renick Jr.
Edward John Rhodes
C. Bradley Rickard
Karl J. Roa
John William Roberts
Jack R. Rogers
Allan Rouse
David L. Rudolph
James K. Russell
Holly Ryan
Richard F. Ryan
Stuart Ryman
Jennifer Saltonstall
David A. Sauer
Steve Schilling
Perry Schneider
Lawrence Segerstrom
Luis Sepulveda
Zhixiong Shen
Ian Shennan
Thomas F. Shipley
Antonio Simonetti
Christopher W. Sinton
Craig M. Smith
Deborah Smith
Eleanour Snow
Ron Sonnevil
Donald E. Spencer
Randall K. Spencer
Terry Ann Sprecher
Terry C. Spurgeon
Dennis Staley
Henry M. Steiner
Fred Stephenson
Cindy L. Stewart
Gregory Stewart
Ruth A. Stockey
Iain D. Stott
Michael C. Sukop
Jonathan Swinchatt
Willa Kern Taliancich
Charles J. Tapper
Edward M. Taylor
James M. Thorson
Marco Ticci
Geoffrey Ray Tick
Dennis Tower
Stephen Trimble
Desiree Tullos
Sergey V. Ushakov
Joseph A. Valentine
Scott David Van Hoff
Michael Vanden Berg
Eugenio E. Veloso
Keiji Wada
Brian Jeffrey Wagner
Charles Wahl
Stephen Watry
Dianne M. Weinert
Houston I. Welch Jr.
Elise M. Weldon
Cynthia Werner
Gregory R. Wessel
Stella J. Williams
Philip A. Wilshire
Douglas Alan Wood
Sarah A. Woodroffe
Mathew D. Workman
Michiko Yajima
Hund-Der Yeh
Leighton Young Jr.
Claudia B. Zaffarana
Lucas G. Zamora
Jorge Antonio Zapata
Zivile Zigaite
Udo Zimmermann

RECENT GRADUATES

Motunrayo Akinpelu
Nathaniel Lee Arave
Mary Aileen Bartkus
Casey E. Bartlett
Jeff A. Berger
Wilson Bonner
Warren T. Brown
Brad Buerer
Daniel A. Burk
Joshua Burns
Camilo Bustamante
Kristi Carlucci
Rebecca Collins
Keith Crossland
Tami Darden
Minyahl Teferi Desta
Mary Karen Dietrich
Stephen R. Durham
Elizabeth Ruth Dutton
Sarah Hope Edwards
Ingrid Dara Fedde
Dylan Ferry
Jennifer G. Fuentes
Ian Michael Ferguson
Joshua A. Glauch
Charlotte I. Goddard
Erica Helton
Michael J. Higgins
Motoko Igisu
Takeshi Imayama
Michael Jarvis
Michael Clinton Jarvis
Lucas Van Wyk Joel
Brett A. Jordan
Robert Michael Kelso
Jackie Evan Kendrick
Dalia B. Kirschbaum
Margot Klein
Man Jae Kwon
Kathleen Lohff
Kristian Lomas
Karin Lydia Louzada
Lichun Ma
Jessica K. Marks
Robert Martin
Elyse Mauk
Taylor Mikell
Heather Ann Miller
Omar Montenegro Jr.
Hesham Moubarak
Dennis Oertel
Steven Garrett Okubo
Danielle A. Olinger
Colin O'Rourke
Bill Pennington
John M. Perreault
Michele Marie Perry
Daniel B. Pollock
Rachel Ribaudo
Sarah F. Richmond
Jamie S. Robinson
Eric Sandusky
Corey Scheip
Trevor Schlossnagle
William Sensibaugh
Benjamin M. Shapiro
Matthew Scott Smith
Melinda Solomon
Daniel E. Stills
Christopher Sutherland
Vaughn G. Thompson
Shana Volesky
Michael Vredevoogd
Charlotte Vye
Brian Yelen

STUDENTS

Tamer S. Abu-Alam
Khalid A. Ali
Justin L. Allen
Justin M. Allen
Jesse J. Amundsen
Dellar Wee Ananoo
Maria M. Anderson
Bradley Andres
James Howard Angus
Christina A. Appleby
Suzan Aranda Luna
Scott A. Arndt
Katherine Arntzen
Stephen N. Austin
Christine L. Austman
Eric B. Avalos
Lori Nicole Babcock
Kira Anna Badyrka
Kristen P. Baechtle
Claire H. Bailey
Nathan M. Barber
Natasha Barlow
Shawn Paul Barnby
Jessica L. Barnes
Lucas Barr
Lauren E. Barton
Alan T. Baxter
Carol Leigh Beahm
Wilfrid Beauzile
Melissa Danielle Beck
Timothy Becker
Erin C. Beirne
Blair E. Benson
Christopher J. Benn
Luca Bertoldi
Phil Blecher
Tina M. Bledsoe
Katherine L. Block
Kristin M. Block
Kelsey Blongewicz
David Boes
Kevin Boggs
Erin Kelly Booth
David Bord
Joseph R. Boreman
Gordon J. Borne Jr.
Sara Lynn Bostelman
John Botos
Luke Jared Bowman
Clint A. Boyd
Erin E. Brady
Shawn Michael Bragg
John J. Braswell
Philip Allen Bremer
Martin Briggs
Douglas Brinkerhoff
Kyle Houston Broach
Whitney D. Brooks
Justin R. Brown
Matthew J. Bruenn
Justin N. Brundin
Holly A. Buehler
Kevin D. Bunger
Katrina Burch
Brian M. Burgess
Taylor G. Burnham

STUDENTS (*continued*)
Daniel Burnett
Candice Lee Burnette
Polly M. Burns
Greg Burzynski
Neal Bush
Ronald Craig Byrum
Brent Campbell
Luca Caracciolo
Megan E. Cardenas
Sarah Carriger
Joseph A. Caruso
Samuel Castonguay
Federico Cernuschi
Emily J. Chin
Piotr Cienciala
Jaclyn Danielle Clark
Lindsey Rene Clark
Robin M. Cobb
Emily Dana Colin
Christopher Colla
Michael D. Collazo
Cindy Marie Colon
Giselle Conde
Rachel Anne Conde
Jamey Cooper
Andrew M. Corcoran
Phillip Costello
Ken Patrick Coulson
Luke Crawford
Mellissa S. Cross
Angel A. Cuellar
Jason Cunningham
Jennifer Cunningham
Sireesh K. Dadi
Terra Ann Dalton
George Daly
James Datko
Louise Daurio
Bradley William Davis
Klarissa Davis
Maria A. Davis
Lies De Mol
Anke G.V. Deeken
Assonman D. Degny
Keith Delaney
Mekdes T. Demo
Mark J. Dempsey
Keith Alan DePew
Megan Derrico
Amanda Dickey
Diana R. DiLeonardo
Julian Roy Dillon
Victoria Maria Doñé
Darcee Lee Douglas
Jennifer Douglass
Matt Downen
Matthew Drahnak
Chelsie Dugan-Lawrence
Jeremy E. Dunfield
Kallina Dunkle
Maria Dunlavey
James Perry Durand
Kevin A. Duvernay
Steve Louis Dykstra
Mary E. Dzaugis
Matthew A. Earthman
Evan Hanson Eckles
Stewart Edie
Jordan Edmunds
Carol A. Engelmann
O.C. Enyinna Eke
Laila A. El-Ashmawy
Erin T. Elliott
Abdou El-Magd
Matthew Emery
Christopher Englert
Cullen John Erbacher
Eli Erickson
Jennifer Estrada
Guy Nathaniel Evans
Stephanie Kay Ewald
Michael D. Fairbanks
Allison Fang
Linda Farley
Melanie Scott Felts
Kelsey Mariah Feser
Sarah Finne
Shawn C. Fisher
Taya T. Flaherty
Claire R. Fleeger
Christopher R. Florian
Katherine F. Fornash
Andrew L. Frahm
Ben M. Frieman
Andrew J. Frierdich
Taylor Friesenhahn
Laura N. Fronabarger
Rebecca J.M. Frus
Allison Fundis
Julie Galloway
Federico A. Galster
Joshua M. Garber
Marlo Rose Gawey
Thomas A. Gebhardt
Kateri Gecewicz
Greg Russell Geise
George Georgiadis
Katelyn E. Gerecht
LeAnn Marie Germer
Badr Ghorbal
Matthew G. Gibson
Lori Gideon
Paul Gifford
Jose R. Gil
Rachel E. Gilgen
Liz Gilliam
Kirby J. Gimson
Eric Goetz
David A. Gosselin
Joseph Graly
Elizabeth A. Graybill
Mark William Green
David C. Greenawald
Alexander B. Grim
Bryan Grimshaw
Jim F. Grindley
Joy Taylor Gryzenia
Eli Gurian
Mary Gustafson
Ryan Thomsen Guth
Ana L. Gutierrez
Samuel A. Gygli
Grace Ha
Mark Hagemann
David Charles Hahn
Ian R. Hamilton
Christina N. Hancox
Sabry F.B. Hanna
Jestina Anne Hansen
Søren E. Hansen
Maxwell Hanusa
Renee Harkins
Jonathan Harrington
Korey Tae Harvey
Bridget Mary Hass
Jennifer Hathaway
Elizabeth R. Hatley
Garrett A. Hatzell
T. Jade M. Haug
John F. Hawkins
Scott Hawley
Brendan Headd
Rachel Headley
Gary Dale Henley II
Wesley R. Henson
Dale A. Hernandez
Adam M. Hester
Sabine Hippchen
Kari Hochstatter
James Daniel Hoelke
Kaitlin C. Holmes
Nicholas D. Holschuh
Renee S. Holt
Kenneth Horkley
Jane Hornsby
Mohammed Hossain
Lumeng Huang
Thomas R. Hudgins
Christian A. Hunkus
John V. Hurley
Mary Hutson
Shavonne N. Hylton
Yadira Ibarra
Rafiqul Islam
Nakita S. Jacobs
Brianne S. Jacoby
Rachel Jamieson
Jonathan Jamison
Nadia Binte Jamil
Robert E. Jarrett
Stephanie K. Jarvis
Steven A. Jenevein
Arianna Jimenez
Charissa J. Johnson
Dawn Marie Johnson
Peter J. Johnson
Alison Jolley
Kyle Warren Jones
Craig E. Joseph
Phoebe A. Judge
Tristan J. Kading
Nimesh Kapadia
Jonathan P. Kay
Lara Ford Keeling
Jason Damian Kegel
Winifred Kehl
Jack Evans Kehoe
Michael Kelly
Richard Scott Kelly
Julie A. Kemble
Paige M. Kercher
Sean Kerrin
Chad A. Killcreas
James Logan King
Luke E. Kingsbury
Jessica C. Kinninger
Demet Kiran Yildirim
Emily J. Kleber
Robert Klenner
Jessica Knapp
Cassi Knight
Karinne Knutsen
Daniel J. Kohlruss
Chris Kopietz
Katrina Koski
Jinal B. Kothari
Lucy Amelia Kruesel
Alexandria S. Kuhl
Ian James La Charite
Doris P. Lajas
Bao Vu Lam
Cristiano Lana
Lindsey Langsdon
Paul Laraway
Erik Larson
Jodi Lau
Koa Lavery
Jennifer S. Le Blond
Chabok Lee
Hoil Lee
Erin LeGalley
Caitlin Lewis
Michael Lewis
Willis D. Leyendecker
Kevin Richard Liebe
Randi M. Liescheidt
Yunung Lin
Pollyanna Lind
Eva Lipiec
Aaron John Littlefield
Daniel Nelson Lolos
Andrew J. Lonero
Matthew P. Loocke
James Daniel Lopez
Jonathan Love
Darrin Lane Lowery
Liang Luo
Brandon Micheal Lutz
Thomas J. Lynch
Michael J. Lyzwa
Julia MacDougall
Holly M. MacGillivray
Sheridan Mack
Dev K. Maharjan
Kerri Maikut
Jacob M. Maillot
Lauren Maistros
Sarah Maithel
David John Majewski
Kyle Aaron Makovsky
Hester Catherine Mallonee
Jonathan M. Malzone
Jennifer L. Manion
Phillip Ira Marcy
Matthew M. Markley
Naomi Marks
Peter Marsala

James Martin
Schae Alize Martin
Nicole D. Martinez
Ooga Masahiro
Lawrence J. Mastera
Claude D. Mathes
Sarah E. Matthews
Timothy P. Matthews
Carl Daniel Matzek
Sarah E. Mazza
David Mazzucchi
Miles A. McCammon
Andrew L. McCarthy
Curtis Andrew McCoy
Sophie Julia McCoy
Gabriella R. McDaniel
Edward R. McGlynn
Timothy R. McGrady
Mika McKinnon
Kaleb McMaster
Calla McNamee
Margaret Bosque McPherson
Peter McVary
Kimberly A. Mead
Casey D. Meirovitz
Thomas Meister
Katherine J. Meixell
April Menendez
Helen Elizabeth Metts
Katherine Anne Mickelson
Joseph C. Miller
Marc Miller
Richard Ellis Mimms
Dylan R. Miner
Morgan L. Minyard
Euan Mitchell
Marissa Mnich
Saad Abd El Ghaffar Mohamed
Claire A. Mondro
Meagan Julia Moore
Mallory Morell
Danilo Moretti
Gregory J. Mosher
Sandra Mudafort
Riley P.M. Mulligan
Zackary W. Munger
Christopher R. Murley
Michael Murphy
Nicholas M. Murphy
Katherine T. Murray
William O. Nachlas
Laurie Neilson-Welch
Kenneth D. Nelson
My M. Ngo
Shauna Nielsen
Naohisa Nishida
Erika Noll
Jennifer L. Oberst
Philip O'Brien
Aaron T. Ochsner
Michael O'Connor
Jennifer A.R. Olsen
Jeffrey D. Olson
Neil Fairchild Olson
Elise Otto
Marisa C. Palucis
Anoop Raj Pandey
Joanna M. Panosky
Konstantinos Papapavlou
James Edwin Papin
Carolyn Parcheta
Andrew F. Parisi
Jamie Maryl Parks
Nicole J. Parr
Robert Peckyno
Sara Peek
Adam J. Pelak
Lee E. Penwell
Nicholas Perez
Brian Kai Perttu
Cara Peterman-Cowmeadow
John Michael Peters
Elizabeth Petsios
Marco Matias Pfeiffer
Heiko Pingel
Carl T. Piowaty
Stefanie Pipis
Erica Pitcavage
Carlos J.S. Plazas
Charles Podolak
Holly E. Polivka
Peter M. Polivka
Courtney M. Porter
James Potts
Sharmila V. Pradhan
Brendon Quirk
Shelby Rader
Anthony J. Raimondo
Mark S. Raleigh
Amy Rath
Luke Raymond
Phillip J. Reed
Machel Rhoden
Rodney L. Rice II
Carson Richardson
Ellery R. Richardson
Kerry Riley
Jason B. Robbins
Tina Roberts-Ashby
Linda A. Rodriguez
Margarita Rodriguez
Rebecca Rodriguez
Caitlin Roeder
Nathan T. Rogers
John C. Rollins
Matthew W. Rossi
Mikhail J. Rossignol
Brian Francis Ruane
Vivian Ruiz
Simone Runyon
Ashley Kate Russell
Darcie Erin Ryan
Nathaniel A. Ryan
Joseph F. Sadorski
Jeannette C. Sager
Mary A. Samolczyk
Eduardo Sanchez
Joseph K. Sang
Ioan Vasile Sanislav
Claudia Santiago
Peri Jordan Sasnett
Tomohiko Sato
Tsurue Sato
Courtney B. Savoie
Christopher Schmidt
Sharon Schmidt
Karew K. Schumaker
Samuel Warren Scott
Spenser P. Scott
Travis Lee Scott
Daniela Selke
Carley A. Senkowski
Kevin S. Severson
Brandi M. Shabaga
Afroz Shah
Malek M. Shami
Tamika N. Shannon
Seth G.G. Shantz
Rachel Jean Shapiro
Douglas E. Shaver
Jennifer M. Shepeck
Janelle R. Sherman
Lauren R. Sherson
Jeremiah Sherwood
MooJoon Shim
Niccole K. Shipley
Danielle N. Sieger
Michael L. Siegner
Jonas Mota de Silva
Emily Ann Simon
Susan L. Sloth
Noah Slovin
Andrea Nichole Smith
Casey James Smith
Kathleen F. Smith
Katy E. Smith
Mikki Smith
Stacy E. Smith
Marilyn Smulyan
Michael J. Starks
Edward Curtis Starns
Paul A. Stefanik
Alison M. Straka
Ariel Strickland
Valerie Stucker
Ryan S. Studley
Christine L.K. Sumner
Carl Swenberg
Amanda E. Takacs
Sean Tarpey
James Paul Taylor
Allison Tether
Tracy Anna Teyssier
Theodore R. Them II
Drew B.R. Thomas
Mark Thomas
Sara E. Thomas
Jessica L. Thompson
Reuben Angel Tineo
Atiqa S. Tirmizi
Nicholas B. Traxler
Jarek Trela
Katie Tremaine
Marissa M. Tremblay
Tyler Tripplehorn
Michael Trumbower
John K. Tudek
Robin Michele Tuohy
Gulsen Ucarkus
Tina Maria Ulrich
Arati A. Umarvadia
Michael Allen Urban
Charles O. Usiaphre
Amanda Van Lankvelt
Wanda Vargas
Gale W. Vasquez
Gabriel Velin
Christopher B. Vines
Heather X. Volker
Justin M. Von Bargen
Markus Waidelich
Trevor Scott Waldien
Christine Wallace
Rose Wallick
Robert A. Walsdorf
John Wang
V. Dorsey Wanless
Jess Webber
Jerimiah T. Wedding
Jeremiah C. Wagener
Kevin D. Webster
Kaitlyn M. Weider
Codi S. Weiler
Matthew Weingarten
Elizabeth Weisbrot
Shawn Wheelock
Melissa White
Logan E. Wicks
Ashley N. Williams
Ben D. Williams
Elyse K. Williamson
Elizabeth G. Wilson
James Adams Wilson
Thomas M. Wilson
Veronica Woodlief
Bay R. Woods
Abby May Woody
Thomas S. Wright
Ernest M. Wylie II
Stacy L. Yager
John J. Yankech Jr.
Carly C. York
Eleanor A. Yudelman
Xiao Xu
Brenda Lee Zabriskie
Mohamed A. Zamdin
Leah B. Ziegler
Amanda Zimmerman
Christina Znidarsic
Nicholas Zupancich

TEACHERS

Joshua D. Abernethy
Charise Ann Adams
Theresa Apodaca
Michael Benjamin
Angela Best
Lydia T. Chase
Michelle Clark
Rebecca L. Coffman
Val Comstock
Doug Cullen
Karen J. Curtin
Joann Deakin
Bill C. Dicks
Hillary Downes-Fortune
Luis Figueroa
Paul C. Fisher

New Members: GSA Welcomes You!

TEACHERS (*continued*)
Wayne H. Fletcher
Jeffrey V. Freeman
John Willard Gaul
Sandra S. Grosso
Sky H. Harris
Grace Eva Hepler
Alison Hutt
Debra Irvin
Patricia Joyce Judd
Doru Toader Juravle
Jackie Kane
Deanna Mazanek
Louise McMinn
Debra E. Odom
David Wayne Olcott
John McA. Preacher
Ryan S. Previti
Craig Richardson
Edie Gair Shull
Urban Ingemar Skoog
Thomas G. Smith
Steve Sparkowich
Denise A. Thompson
Derek VanderHyden
Gregg T. Wachtelhausen
Frank Weisel
Dawne M. Welch
Kay Wyatt

AFFILIATES
Philipp Angehrn
Rachel Arnold
Michael Bartmon
Ronald E. Bravo
Vickery E. Cleveland
Robert Coley
Michael P. Collins
John Fuhring
Arnold Getz
Michael D. Glascock
Walter Alfred Graf III
Joseph P. Green
Mark E. Harder
Gary J. Kartye
Kathleen Kroll
Bryan Lamb
Jeffrey Nicholas Licht
Mary M. MacDonald
Ellen Marks
Dennis P. Michels
Francis M. Miller
Jim W. Miller
James D. Mullins III
Jim O'Donnell
Adam Seth Osborn
Laurie Pudwill
Mark Roos
Charles Saltzman
Cliff Thompson
Sanjay Tiwari
Ross Wade

THE GEOLOGICAL SOCIETY OF AMERICA®

SCIENCE STEWARDSHIP SERVICE

Quick Reference

GSA Member News & Information on the Web

More news about GSA members:
www.geosociety.org/news/memberNews.htm

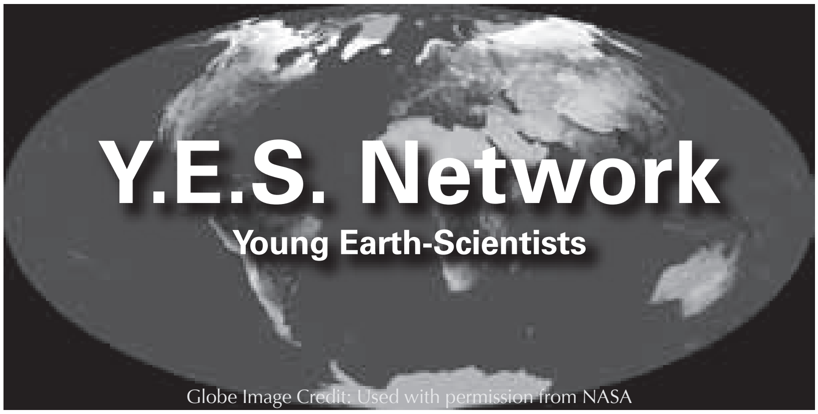
Information about current, past, and future GSA meetings:
www.geosociety.org/meetings/

Dates and information about other geoscience-related meetings:
www.geosociety.org/calendar/

Resources for K–12 earth science educators:
www.geosociety.org/educate/resources.htm

Find your science at GSA:
www.geosociety.org/themes/

GSA Connection:
www.geosociety.org/GSA_Connection/



Globe Image Credit: Used with permission from NASA

Inaugural Young Earth-Scientists Congress

Beijing, China

http://www.yescongress2009.org/

The First World Young Earth-Scientists (Y.E.S.) Congress took place on 25–28 October 2009 in Beijing, China, at the China University of Geosciences in Beijing. The rich and diverse program of technical presentations relating earth-sciences to society included talks by young geoscientists from Austria, Australia, Italy, India, Tanzania, the USA, Argentina, the UK, China, Sri Lanka, Malawi, France, South Africa, Norway, Russia, the Netherlands, Mexico, and Brazil. Talks focused on many pressing issues, including groundwater, natural disasters, health, energy and sustainability, climate, mineral resources, megacities, deep earth, oceans, soils, biodiversity, digital earth engineering, GeoParks, and Geoheritage conservation.

Combined on-site and remote discussion roundtables were unique to this conference and covered such topics as women in the geoscience workforce, climate change, natural hazards, transfer of credentials and international licensure, natural resources and energy sustainability, issues facing geoscience education and research, and industry-academic linkages, with a final synthesis and strategy roundtable.

The synthesis and strategy roundtable session identified a number of key findings on which the Y.E.S. Network will actively work. The Y.E.S. Network was envisioned by a group of earth-scientists who realized the growing need to educate policymakers on earth-science issues that will significantly affect the younger generation. This vast network of over 300 senior and junior scientists in geological surveys and industries from around the world will depend on cutting-edge science, communication, and a strong vision to come up with strategies to address the issues identified by the Congress.

The 2009 Y.E.S. Congress is considered a launching pad for the future. The Y.E.S. Network plans to grow its membership and increase awareness of the issues connecting the geosciences and society through education, visibility at numerous international conferences, and outreach in membership countries. The Y.E.S. Network will continue to build on the support of many international organizations (UNESCO, IYPE, and the IUGS) as well as those in the United States, including The Geological Society of America and the American Institute of Professional Geologists.

The 2009 Congress was organized as a direct result of the International Year of Planet Earth (2007–2009) with the goal of contributing toward making societies safer, healthier, and more prosperous by using largely underutilized earth-science knowledge in decision making and by connecting young earth-scientists from around the globe.

Global economies and the geosciences are not mutually exclusive. The future belongs to the incoming generation of earth-scientists. Well-informed politicians make better policies, and the Y.E.S. Network is committed to increasing teamwork, collaboration, outreach, and connecting the next generation of politicians with earth-scientists. With climate change and a growing world population, political support of the geosciences is an absolute necessity.

The next Y.E.S. Congress will be held in 2012 in conjunction with the 34th International Geological Congress in Brisbane, Australia.

Mary Seid, *GSA student member, seid@isgs.illinois.edu*

Pictured, left to right: Jiao Yang, Mary Seid, Dean Feller, and Sun Pengfei.

GSA Foundation Update

Donna L. Russell, *Director of Operations*

Thank You for Your Donations!

During the past year, with the support of our donors, the Foundation has provided funding for many GSA programs, including the following:

Congressional Science Fellow
EarthCache
Field Forums
GeoCorps™ America Program
Geology in Government
Geology in Industry Program
GSA Annual Meeting
GSA Public Service Award
International Travel
Mann Mentor Program
Minority Student Awards
President's Student Breakfast
Publications
Public Forum
Public Service Award
Research Grants
Section Student Travel
Shlemon Mentor Program
Student Recruitment
Teacher Advocate Program
Women in Science Award

You can help continue to provide the critical support for these and other programs with your contributions to the GSA Foundation. A gift of US$500 or more will add your name to the Penrose Circle roster. You may use the coupon below, or go to **www.gsafweb.org** and click on "Make a Donation."

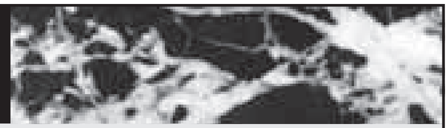
On behalf of the GSA Foundation's Board of Trustees, I extend our sincere appreciation to all those who donated over this past year. Your support of the Foundation and GSA's greatest needs is vital. Thank you so much!

Most memorable early geologic experience:

An overnight hike to the Phantom Ranch in the Grand Canyon with major Professor Stanley Beus of Northern Arizona University.

—Paul M. Crosby

In Memoriam



The Society notes with sadness the deaths of the following members (notifications received between 1 Oct. and 30 Nov. 2009):

Robert W. Blair Sr.
Durango, Colorado, USA
27 October 2009

Anton Brown
Heathfield, East Sussex, UK
19 October 2009

Alfred L. Bush
Lakewood, Colorado, USA
15 November 2009

Victor Colombini
Lima, Ohio, USA
notified 5 October 2009

John W. Morse
College Station, Texas, USA
notified 30 November 2009

To honor one of these colleagues with a memorial, please go to **www.geosociety.org/pubs/memorials.** This page also lists the memorials already completed and available for reading.

If you would like to contribute to the GSA Memorial Fund, please contact the GSA Foundation, +1-303-357-1054, drussell@geosociety.org, www.gsafweb.org.

GSA Section Meeting Mentor Program Schedule

ROY J. SHLEMON MENTOR PROGRAM IN APPLIED GEOSCIENCE LUNCHEONS

This program is designed to inform advanced undergraduate and beginning graduate students about careers in applied geoscience. The goal of the program's volunteer mentors is to provide real-world information and insight, based on their own careers, in an informal setting over FREE lunches. Shlemon mentoring luncheons are held exclusively at GSA Section Meetings.

Northeastern/Southeastern: Sun., 14 March & Mon., 15 March

North-Central/South-Central: Mon., 12 April & Tues., 13 April

Rocky Mountain: Wed., 21 April

Cordilleran: Fri., 28 May (two luncheons this day)

JOHN MANN MENTORS IN APPLIED HYDROGEOLOGY LUNCHEONS

This program is designed to inform undergraduate, graduate, and recently graduated students about careers in applied hydrogeology through mentoring opportunities with practicing professionals in informal networking sessions over FREE lunches.

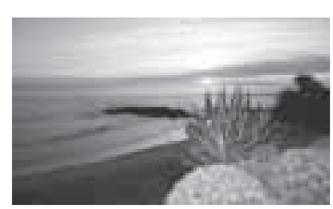
Northeastern/Southeastern: Tues., 16 March

North-Central/South-Central: Mon., 12 April

Rocky Mountain: Fri., 23 April

Cordilleran: Sat., 29 May



Photos from left to right: Baltimore at night. Photo courtesy Visit Baltimore. Worm burrows. Photo by Kevin R. Evans. Mount Rushmore, South Dakota, USA. Photo by South Dakota Tourism. Orange County coastal sunset, courtesy http://static.panoramio.com/photos/original/3679706.jpg.

Low δ^{18}O Rhyolites and Crustal Melting: Growth and Redistribution of the Continental Crust

Twin Falls, Idaho, and Yellowstone National Park, Wyoming, USA

9–13 September 2009

CONVENERS

Peter Larson Washington State University, School of Earth and Environmental Sciences, Pullman, Washington 99164-2812, USA, plarson@wsu.edu

Ilya Bindeman University of Oregon, Dept. of the Geological Sciences, 1272 University of Oregon, Eugene, Oregon 97403, USA, bindeman@uoregon.edu

John Wolff Washington State University, School of Earth and Environmental Sciences, Pullman, Washington 99164-2812, USA, jawolff@mail.wsu.edu

This Penrose Conference reflects a renewed interest in the formation of low-δ^{18}O rhyolite magmas and in melting at intermediate crustal levels, stimulated by a combination of the application of new analytical techniques and the discovery of voluminous low-δ^{18}O rhyolites in the Snake River Plain, Idaho, USA. Low-δ^{18}O rhyolites are important because significant similar processes are required to dramatically affect the isotope ratio of the most major of elements in silicic magmas.

Forty-five scientists from around the world participated in the September 2009 Penrose Conference. Hugh Taylor, who conducted some of the original fundamental work on oxygen isotope applications to igneous petrogenesis, began the first day's presentations with an historical overview of low-δ^{18}O magmas and a review of genetic models for their origin. He concluded that low-δ^{18}O meteoric hydrothermally altered wall rocks must be involved in their genesis. Karlis Muehlenbachs followed with a discussion of his early work and a review of newer data on the low-δ^{18}O basalts of Iceland. Ilya Bindeman reviewed recent developments in low-δ^{18}O magmatism and presented data for the eastern Snake River Plain and Yellowstone rhyolites. He proposed bulk shallow melting of altered rocks as the origin of the Snake River Plain/Yellowstone rhyolites based on in situ analyses of oxygen ratios in zircons. Shan de Silva discussed his research on large ignimbrite flare-ups in the central Andes and noted that the overall thermal evolution of the crust can control ignimbrite flare-ups because it controls melt production and storage. Peter Larson described the mineralogy and O-isotope characteristics of caldera hydrothermal systems, and suggested that propylitically altered rocks in the deeper parts of caldera hydrothermal systems are reasonable sources for low-δ^{18}O rhyolites.

The day concluded with poster presentations by Tamara Carley (zircon in Icelandic rhyolite), Lily Claiborne (zircon record at Mount St. Helens), Chris Folkes (O ratios in central Andean silicic ignimbrites), Allison Phillips (hydrothermal alteration of the Tuff of Sulfur Creek at Yellowstone), and Laura Waters (water concentrations in western Mexican volcanic arc siliceous magmas).

The second day focused on Snake River Plain rhyolite magmatism. Barbara Nash provided an overview of the Bruneau-Jarbidge eruptive center and found that rhyolites there erupted at relatively high temperatures. Mike McCurry pointed out that the Snake River Plain is fundamentally a basaltic magma system and noted that some of the rhyolite domes in the eastern Snake River Plain could be products of fractional crystallization. Eric Christiansen compared Snake River Plain and Great Basin rhyolites. He proposed that crustal partial melting and subsequent fractionation are reasonable explanations for their formation. Bill Leeman described a model whereby the Snake River Plain/Yellowstone rhyolites are produced by extension where subcrustal adiabatic basalt melts can rise to moderate crustal levels and produce the rhyolites via partial melting.

Scott Boroughs (central Snake River Plain low-δ^{18}O rhyolites), Ben Ellis (phreatomagmatic rhyolites in the Snake River Plain), Kathryn Watts (the Kilgore Tuff, Heise center), and Chad Pritchard (Yellowstone post-collapse Upper Basin Member rhyolites) gave short presentations in preparation for the next day's field trip. These were followed by posters: Matthew Brueseke (silicic magmatism in the Santa-Rosa Calico volcanic field, Nevada), Jeff Callicoat (spatial and temporal significance of mid-Miocene volcanism in northeast Nevada), Henny Cathey (O isotopes in zircons and geothermometry from the Bruneau-Jarbidge center, Snake River Plain), Matthew Cobble (Ti-in-quartz geothermometry for 15-Ma calderas, NW Nevada), Richard Gaschnig (timing of magmatism in the Atlanta Lobe of the Idaho batholith), Will Starkel (radiogenic isotope constraints on Snake River Plain rhyolite genesis), and John Wolff (Snake River Plain rhyolite and basalt genesis).

Day four focused on Yellowstone and other rhyolite provinces. Chris Harris began with a discussion of the oxygen and radiogenic isotopic characteristics of Archean to Mesozoic magmatic rocks in South Africa. Tom Vogel described the origin of silicic volcanic rocks in caldera settings from central America and emphasized subtle δ^{18}O decreases due to assimilation of rocks hydrothermally altered by tropical waters. Sarajit Sensarma provided an interesting review of the geochemistry of the Dongargarch bimodal igneous province, India, which, at 2.5 Ga, contains one of the oldest known ignimbrites on Earth. Jorge Vasquez described the thermo-

This conference was supported in part by National Science Foundation grant EAR 0926449.

chemical evolution of the Pitchstone Plateau rhyolite, the youngest Yellowstone rhyolite. These were followed by two presentations on rhyolites of the High Lava Plains in eastern Oregon by Martin Streck and Anita Grunder. They reviewed the distribution, timing, and geochemistry of these rhyolites and compared them with the Snake River Plain/Yellowstone rhyolites. Poster presentations included Mark Ford (High Lava Plains rhyolite $\delta^{18}O$ values), Guillaume Girard (trace elements in post-collapse Yellowstone rhyolites), and Terry Spell (extra-caldera Yellowstone rhyolites).

The last day began with a double-headed talk by George Bergantz and Jim Beard, who described thermal aspects of assimilation-fractional crystallization (AFC) controls on crustal magma evolution. Calvin Miller discussed the applications of sphene and zircon as monitors of magmatic processes. Rebecca Lange talked about the origin of low-Sr Mexican western volcanic arc rhyolites and proposed that they are the product of multiple episodes of partial melting. Finally, Craig Lundstrum presented an alternative model for forming compositionally zoned silicic magma chambers, whereby thermal diffusion plays a major role in differentiation. Poster presentations followed: Catherine Curtis (South African Koegel Fontein low-$\delta^{18}O$ rhyolites), Jim Beard (O-isotope behavior during magmatic processes), Leif Karlstrom (shallow crustal magma chamber growth and longevity), and Dorsey Wanless (mid-ocean ridge crustal assimilation models).

The attendees split into six discussion groups in the concluding session, listed here with the topics and discussion leaders. (1) How should an ^{18}O-depleted magma be defined, and is there a correlation between rhyolite magma temperature and degree of ^{18}O depletion? (Grunder and Wolff); (2) Is the ^{18}O-depleted signal produced by a unique or general process of rhyolite genesis? (Miller); (3) What chemical fingerprints correlate with $^{18}O/^{16}O$ and D/H? (Beard); (4) How are large-volume ^{18}O-depleted magmas produced? (Watts and Phillips); (5) What plausible models can be generated that include structural, thermal, and chemical constraints? (Branney); and (6) How can the mantle contribution to silicic magmas be determined, and what are the mechanisms for its involvement? (Leeman). Further discussion of these points will certainly stimulate additional ideas and research on rhyolite formation.

Participants: Jim Beard, Museum of Natural History; George Bergantz, Univ. of Washington; Ilya Bindeman, Univ. of Oregon; Scott Boroughs, Washington State Univ.; Mike Branney, Univ. of Leicester; Matthew Brueseke, Kansas State Univ.; Jeff Callicoat, Kansas State Univ.; Tamara Carley, Vanderbilt Univ.; Henny Cathey, Univ. of Utah; Eric Christiansen, Brigham Young Univ.; Lily Claiborne, Vanderbilt Univ.; Matthew Coble, Stanford Univ.; Catherine Curtis, Univ. of Cape Town; Shan De Silva, Oregon State Univ.; Ben Ellis, Univ. of Leicester; Chris Folkes, Monash Univ.; Mark Ford, Oregon State Univ. ; Richard Gaschnig, Washington State Univ.; Guillaume Girard, McGill Univ.; Anita Grunder, Oregon State Univ.; Chris Harris, Univ. of Cape Town; Leif Karlstom, UC-Berkeley; Rebecca Lange, Univ. of Michigan; Peter Larson, Washington State Univ.; Bill Leeman, National Science Foundation; Craig Lundstrum, Univ of Illlinois–Urbana Champaign; Mike McCurry, Idaho State Univ.; Calvin Miller, Vanderbilt Univ.; Karlis Muehlenbachs, Univ. of Alberta; Barbara Nash, Univ. of Utah; Mike Perfit, Univ. of Florida; Allison Phillips, Washington State Univ.; Chad Pritchard, Washington State Univ.; Sarajit Sensarma, Univ. of Lucknow; Terry Spell, Univ. of Nevada–Las Vegas; Willliam Starkel, Washington State Univ.; Martin Streck, Portland State Univ.; Kevin Tarbert, Washington State Univ.; Hugh Taylor, California Institute of Technology; Jorge Vazquez, California State Univ. Northridge; Tom Vogel, Michigan State Univ.; V. Dorsey Wanless, Univ. of Florida; Laura Waters, Univ. of Michigan; Kathryn Watts, Univ. of Oregon; John Wolff, Washington State Univ.

Snake River, Twin Falls, Idaho, USA. Photo by keasmus.

Bioturbated sandstone from the Dakota Formation on Rabbit Mountain near Longmont, Colorado, USA. Photo by keasmus.

February

15 Nominations due for the Geophysics Division's **George P. Woollard Award** at http://geoscience.unlv.edu/pub/GSA_Geop/woollard.html. Nominations should include a description of the nominee's specific contributions and their scientific impact.

20 Nominations due for the Sedimentary Geology Division's **Laurence L. Sloss Award for Sedimentary Geology.** Submit via e-mail to Paul Link, Sedimentary Geology Division secretary, linkpaul@isu.edu, (1) a cover letter describing the nominee's accomplishments in sedimentary geology and contributions to GSA and (2) a curriculum vita.

25 **GSA Officer and Councilor Elections** begin (see p. 15).

28 Nominations due for the Coal Division's **Gilbert H. Cady Award.** Send three copies of the following to Ronald H. Affolter, USGS, Denver Federal Center, MS 939, P.O. Box 25046, Denver, CO 80225-0046, USA; affolter@usgs.gov: (1) name, office or title, and affiliation of the nominee; (2) date and place of birth; (3) education, degree(s), and honors and awards; (4) major events in his or her professional career; and (5) a brief bibliography noting outstanding achievements and accomplishments.

March

01 Nominations due for the **Limnogeology Division's NEW Israel C. Russell Award.** See the January *GSA Today,* p. 27, for details.

09 **Abstracts deadline:** Cordilleran Section Meeting.

13–16 **Joint Meeting of GSA's Northeastern and Southeastern Sections,** Baltimore, Maryland, USA.

26 **GSA's Officer and Councilor election ballots due.**

31 Nominations due for the **John C. Frye Environmental Geology Award.** Learn more at www.stategeologists.org/awards_honors.php.

April

02 Nominations due for the Quaternary Geology and Geomorphology Division's **Farouk El-Baz Award for Desert Research.** Submit (1) a statement of the significance of the nominee's research, (2) a curriculum vitae, (3) letters of support, and (4) documentation of published research results that have significantly advanced the knowledge of the Quaternary geology and geomorphology of desert environments to P. Kyle House, Nevada Bureau Mines & Geology, Univ. of Nevada, MS 178, Reno, NV 89557-0178, USA; khouse@unr.edu.

11–13 **Joint Meeting of GSA's North-Central and South-Central Sections,** Branson, Missouri, USA.

21–23 **Meeting of GSA's Rocky Mountain Section,** in association with the Western South Dakota Hydrology Conference, Rapid City, South Dakota, USA.

26 **Deadline for expressions of interest for Penrose Conference** (see p. 11).

May

16–22 **Field Forum:** Significance of along-strike variations for the 3-D architecture of orogens: The Hellenides and Anatolides in the eastern Mediterranean, Samos, Greece.

27–29 **Joint Meeting of GSA's Cordilleran Section and the Pacific Section of the American Association of Petroleum Geologists,** Anaheim, California, USA.

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Assistant Professor Geoscience

The University of Nevada Las Vegas is seeking candidates for a full-time, 9-month, tenure-track position to commence Fall 2010. Review of applications will begin February 16th, 2010, and continue until the position is filled.

For a complete position description and application details, please visit **http://jobs.unlv.edu** or call 702-895-2894 for assistance.

EEO/AA Employer

Classified Rates—2010

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	$8.85	$8.60
Opportunities for Students		
First 25 lines	$0.00	$4.50
Additional lines	$4.50	$4.50
Fellowship Opportunities	$8.85	$8.60

Positions Open

MONCRIEF CHAIR IN PETROLEUM GEOLOGY
WESTERN STATE COLLEGE OF COLORADO

Western State College of Colorado invites applications for the Moncrief Chair in Petroleum Geology starting August 2010. Teaching responsibilities include courses in the petroleum geology curriculum and structural geology, as well as contributing to the geology core curriculum. A master's degree in geology or related field and experience in the oil and gas industry is required. Candidates with a Ph.D. will be considered for a tenure track appointment. For full position information and application procedures, visit www.western.edu/jobs. Applications will be accepted until the position is filled. AA/EOE.

ADVANCED MATERIALS SCIENCE AND ENGINEERING CENTER (AMSEC)
WESTERN WASHINGTON UNIVERSITY

The Advanced Materials Science and Engineering Center (AMSEC) of **Western Washington University** invites applications for **a tenure-track faculty position** at the assistant professor level in the field of materials science, broadly defined. Qualified candidates in **all subfields of materials science** will be considered, with preference given to individuals whose research and teaching interests are in the areas of inorganic materials chemistry, energy-related materials, polymers and composites, or mineral physics. A Ph.D. degree in a related field is required. This interdisciplinary position will include appointments in two departments (chemistry, physics, engineering technology, or geology), to be determined based upon the candidate's specialty discipline. AMSEC is a new $1.2 million program with a mission to educate students in materials science, support interdisciplinary research, and enhance regional industry competitiveness and innovation. The successful candidate is expected to establish a vigorous, externally-funded research program involving undergraduate and graduate students and to teach courses related to their field of expertise. Applicants should submit their application online at www.wwu.edu/jobs. Applications should include a cover letter; full CV; statement of research plans; and statement of teaching philosophy and interests. In addition, applicants should arrange to have three letters of recommendation sent to Tina Copsey, MS 9065, Western Washington University, 516 High St., Bellingham, WA 98225-9065, USA. Review of applications will begin on 15 Feb. 2010 and continue until the position is filled. WWU is an equal opportunity employer.

DEPARTMENT HEAD
ASSOCIATE PROFESSOR OR PROFESSOR
GEOLOGY AND GEOLOGICAL ENGINEERING
SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

The Department of Geology and Geological Engineering at South Dakota School of Mines and Technology invites applications for a 12-month position as Department Head at the Associate or Professor level. The successful applicant should have a background in geology and/or geological engineering, a record of academic or industrial leadership, and a history of successful research in a field that complements existing department strengths. The Department Head is expected to lead departmental growth in the areas of enrollment, research, industry relations, and fundraising, in addition to managing faculty, staff, and the academic programs. Some teaching is expected. The department offers two undergraduate and three graduate degrees in geology, geological engineering, and paleontology, with eleven faculty, 90 undergraduate students and 45 graduate students. A Ph.D. in Geology, Geological Engineering, or a closely related field is preferred. Twelve-month salary range will be commensurate with background and experience. The School of Mines is committed to recruiting and retaining a diverse workforce. To apply for this position, applicants must apply on-line at http://sdmines.sdsmt.edu/sdsmt/employment. If you need an accommodation to the on-line application process, please contact Human Resources, +1-605-394-1203. Review of applications will begin 1 March 2010 and will continue until the position is filled. SDSM&T is an EEO/AA/ADA employer & provider.

VISITING ASSISTANT PROFESSOR
BIOGEOSCIENCES, WITTENBERG UNIVERSITY

The Department of Geology invites applications for a visiting appointment at the assistant professor rank beginning 23 August 2010. Applicants should be broadly trained in the geosciences with expertise in the biogeosciences, specifically in the areas of paleoclimatology, geochemistry, geobiology, or geomicrobiology. Preference will be given to candidates with interest and experience in areas involving mineralogy, including biomineralization, mineral-microbe interactions, and weathering. The primary teaching responsibilities will include introductory geology and advanced courses in the candidate's area of expertise. Advanced courses would be designed to attract students from the interdisciplinary areas of the successful candidate's expertise. Contributing to interdepartmental programs such as environmental studies or the University's first-year interdisciplinary course would also be encouraged. The successful candidate will be expected to demonstrate excellence in teaching and to supervise student research in their area of expertise. Current faculty expertise in the department includes mineralogy, igneous and metamorphic petrology, economic geology, process geomorphology, and process sedimentology. This appointment is renewable for up to three years; it offers the successful entry-level candidate an opportunity to gain experience in teaching and advising student research in a liberal arts and sciences setting while participating fully in university benefits, including faculty development opportunities.

Wittenberg University is a small, private, residential undergraduate institution firmly committed to the liberal arts and sciences. Interested applicants are encouraged to visit our website (www.wittenberg.edu) for details about the University and department. Wittenberg participates in AA/EOE/ADA. We encourage women and minority applicants to apply as we are committed to creating an ethnically and culturally diverse community. Review of applications will begin 15 March 2010 and continue until the position is filled.

Please submit a resume, a brief statement about teaching and research in a liberal arts and sciences setting, and a list of at least three references (with phone numbers and e-mail addresses) to http://wittenberg.interviewexchange.com/jobofferdetails.jsp?JOBID=16327.

VISITING FACULTY OPPORTUNITY- TECTONICS
COLORADO COLLEGE

The Department of Geology at Colorado College invites applications for a one-year non-tenure track position in Tectonics, to begin in August 2010.

The faculty visitor will teach courses in field analysis of geological structures, physical geology, and subjects in the candidate's areas of specialization. Appointment will be at the assistant professor level for candidates holding a Ph.D. The Ph.D. or ABD is a requirement for employment. Specialization areas of particular interest are thermochronology, petrology, structural geology, and GIS. Undergraduate research is an integral part of the Colorado College Geology curriculum; thus an ability to advise research in the candidate's areas of expertise is highly desirable.

Applicants must be committed to high-quality innovative undergraduate teaching, including field-oriented courses. The Block System of education at Colorado College, in which professors teach and students take only one course at a time for 3-1/2 weeks, lends itself to field and project-based teaching. The visitor will teach 6 out of 8.5 blocks in the academic calendar. The department has excellent field equipment and laboratory facilities for teaching and research in all geological disciplines. Information on the positions, facilities, and department is online at www.coloradocollege.edu/dept/GY/. Colorado College is committed to increasing diversity of the community and curriculum. Candidates who can contribute to that goal are particularly encouraged to apply.

Applicants should send a statement of teaching and research interests, a curriculum vita, and the names and addresses of three referees by 26 Feb. 2010 to Christine Siddoway, Chair, Colorado College, 14 E. Cache la Poudre, Colorado Springs, CO 80903, +1- 719-389-6717; geology@coloradocollege.edu. The search will remain open until the visitor position is filled.

The Colorado College welcomes members of all groups, and reaffirms its commitment not to discriminate on the basis of race, color, age, religion, sex, national origin, sexual orientation, or disability in its educational programs, activities, and employment practices.

EQUAL OPPORTUNITY EMPLOYER.

GEOLOGY, VISITING ASSISTANT PROFESSOR
STRUCTURAL GEOLOGY/PETROLOGY/MINERALOGY
ST. LAWRENCE UNIVERSITY

The Geology Department at St. Lawrence University seeks an individual with expertise in structural geology and petrology or mineralogy to fill a Visiting Assistant Professor position that is potentially renewable for up to a maximum of three years.

We are a small, high quality, undergraduate program that emphasizes both field and laboratory aspects of the science. Our students are commonly involved with faculty in research and the nearby Adirondack Mountains, Canadian Shield, and St. Lawrence Valley offer rich opportunities for study. Field labs and trips are an important component of the training we offer our students. A high percentage of our majors advance to graduate programs. Each of the five faculty members in the department is involved in teaching introductory geology courses as well as upper-level courses for majors.

The successful candidate will be expected to teach structural geology and petrology or mineralogy, contribute to the teaching of our introductory geology course and labs, teach electives within the area of expertise and supervise student research projects.

Applicants preferably will have a Ph.D., demonstrated ability in teaching, and a proven research record in their specialty. Interested candidates should submit a curriculum vita, a letter of application expressing what the candidate feels she/he would contribute to the Geology program at St. Lawrence, and three letters of recommendation to: Dr. Catherine Shrady, Search Committee, Geology Department, St. Lawrence University, Canton, NY 13617.

Application deadline is 15 February 2010, and all materials must be received at that time.

ASSISTANT OR ASSOCIATE PROFESSOR
VERTEBRATE PALEONTOLOGY
SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

The Department of Geology and Geological Engineering at South Dakota School of Mines and Technology invites applications for a nine-month tenure track position in vertebrate paleontology at the Assistant or Associate Professor level. The successful applicant should have a robust background in field geology and vertebrate paleontology research, and will teach courses and advise students at the undergraduate and graduate level. He or she is expected to develop a funded research program that complements current departmental research emphases in Cretaceous marine reptiles and White River and late Tertiary-Quaternary mammals. Supervision of research by graduate students and undergraduate seniors is also expected. The department offers B.S., M.S. and Ph.D. degrees with emphases in geology or paleontology, including an M.S. in Paleontology. The Museum of Geology is building a new Paleontology Research Center to house its collections of 300,000+ specimens. The new faculty member is expected to work closely with faculty and staff at the Center and in the department. A Ph.D. in geology, paleontology, or a closely related field is required at the time of appointment. Nine-month salary range will be commensurate with background and experience. The School of Mines is committed to recruiting and retaining a diverse workforce. To apply for this position, applicants must apply on-line at http://sdmines.sdsmt.edu/sdsmt/employment. If you need an accommodation to the online application process, please contact Human Resources, +1-605-394-1203. Review of applications will begin 22 Feb. 2010 and will continue until the position is filled. SDSM&T is an EEO/AA/ADA employer & provider.

POSTDOCTORAL FELLOWSHIPS
SMITHSONIAN TROPICAL RESEARCH INSTITUTE
The Smithsonian Tropical Research Institute (www.stri.org) invites applications for postdoctoral positions to carry out research in Panamá and the Caribbean. The goal of the Panamá Geology Project (http://biogeodb.stri.si.edu/jaramillo/fossildb/pgp/PGP/Home.html) is to reconstruct the history of the isthmus, its relation to the Caribbean and South American plates and its biological and paleogeographic implications using field mapping, paleomagnetism, modeling, major and trace-element geochemistry data, and low- and high-temperature geochronological data. A recent Ph.D. in geology is required, as well as a demonstrated track record of recent publications. Candidate must be fluent in English and/or Spanish. The position requires residency in Panama, and candidates must be willing to carry out extensive fieldwork. This is a one-year position renewable for a second year depending on progress and availability of funding. Work starts in July 2009. Stipend is $35,000-40,000/year depending on qualifications, with additional funds for travel and fieldwork. Deadline for application: 30 April. Candidates should send a letter of interest and curriculum vita to Camilo Montes, montesc@si.edu.

Opportunities for Students

Graduate Assistantships, The University of Akron, Ohio. Graduate assistantships in the Department of Geology and Environmental Science are available for students wishing to pursue an M.S. in geology beginning in the fall term of 2010. The Department of Geology and Environmental Science faculty maintain externally funded research programs to study topics as diverse as ground water, pollution impacts, geomicrobiology, environmental change, biodiversity, geophysical subsurface characterization, mineral exploration, structural geology, and quaternary geology. The faculty provides a broad-based education focused on both academic and applied aspects of the geological and environmental sciences. Assistantships include 9-month appointment and tuition waiver. Review of applications will begin 1 Feb. 2010. For more information, please visit our Web site, www.uakron.edu/colleges/artsci/depts/geology/, or contact Dr. Verne Friberg, lfribe1@uakron.edu.

CALL FOR PAPERS

PENINSULAR RANGES BATHOLITH

Deadline for manuscript submission: June 2010

A GSA volume on the Peninsular Ranges batholith, Baja and southern California, is currently in the early stages of preparation. The volume will address both the Jurassic and Cretaceous batholiths and related extrusives. Plans are for a series of overview papers; a number of trans-batholith transects; topical papers dealing with isotopic, chemical, structural, and geophysical aspects of the batholith; as well as structural effects recorded in prebatholithic rocks during the evolution of the batholith. Also to be included are studies of individual plutons, ranging from gabbro to pegmatites, that characterize various elements of the batholith. A section is planned for geologic problems, such as Tertiary fault history, that have been solved through the analysis of batholithic data.

If you would like to submit a paper, or if you know of someone who might be interested, please contact one of the editors: Doug Morton, douglasmmorton@gmail.com; Scott Johnson, johnsons@maine.edu; Dave Kimbrough, dkimbrough@geology.sdsu.edu; Scott Paterson, paterson@usc.edu; Keegan Schmidt, klschmidt@lcsc.edu; Vicki Todd, vtodd2@comcast.net; or Paul Wetmore, pwetmore@cas.usf.edu.

THE GEOLOGICAL SOCIETY OF AMERICA®

SCIENCE ▪ STEWARDSHIP ▪ SERVICE

2010 GSA Section Meetings

Northeastern–Southeastern Joint Meeting
13–16 March, Baltimore, Maryland, USA
Early registration deadline: 8 Feb. 2010

North-Central–South-Central Joint Meeting
11–13 April, Branson, Missouri, USA
Early registration deadline: 8 March 2010

Rocky Mountain Section Meeting
21–23 April, Rapid City, South Dakota, USA
Early registration deadline: 22 March 2010

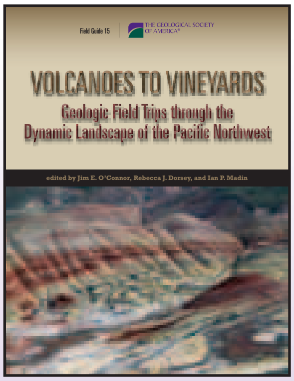
Cordilleran Section Joint Meeting with Pacific Section, AAPG
27–29 May, Anaheim, California, USA
Early registration deadline: 26 April 2010

Coming to *GSA Today* in March 2010

- **Science Article:** Evaluating lateral compaction in deepwater fold and thrust belts: How much are we missing from "nature's sandbox"? by R.W.H. Butler and D.A. Paton
- **Penrose Conference Report:** Tectonic Development of the Amerasia Basin, Banff, Alberta, Canada, 4–9 October 2009
- **DRAFT Position Statement:** Diversity of the Geoscience Community
- **GSA–ExxonMobil Bighorn Basin Field Award**

GSA Today articles from 1995 on are open access via link at **www.geosociety.org/pubs/.**

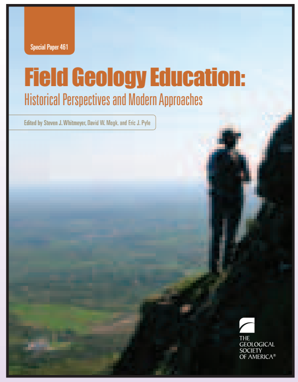
Available at the GSA BOOKSTORE



■ **Volcanoes to Vineyards: Geologic Field Trips through the Dynamic Landscape of the Pacific Northwest**

edited by Jim E. O'Connor, Rebecca J. Dorsey, and Ian P. Madin, 2009

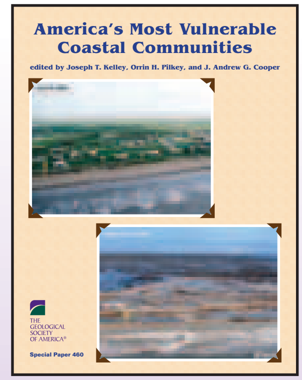
FLD015, 874 p., ISBN 9780813700151
$60.00 | **member price** $42.00



■ **Field Geology Education: Historical Perspectives and Modern Approaches**

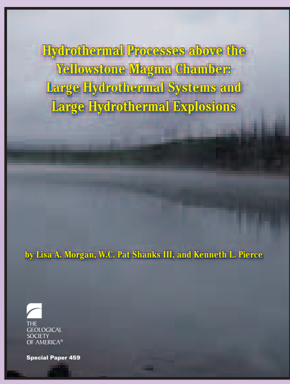
edited by Steven J. Whitmeyer, David W. Mogk, and Eric J. Pyle, 2009

SPE461, 356 p., ISBN 9780813724614
$80.00 | **member price $56.00**



■ **America's Most Vulnerable Coastal Communities** *edited by Joseph T. Kelley, Orrin H. Pilkey, and J. Andrew G. Cooper, 2009*

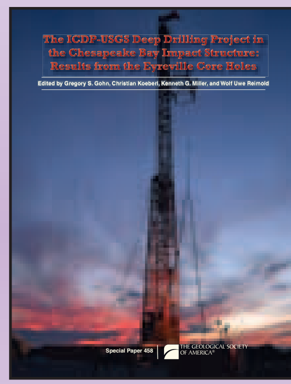
SPE460, 179 p., ISBN 9780813724607
$65.00 | **member price $50.00**



■ **Hydrothermal Processes above the Yellowstone Magma Chamber: Large Hydrothermal Systems and Large Hydrothermal Explosions**

by Lisa A. Morgan, W.C. Pat Shanks III, and Kenneth L. Pierce, 2009

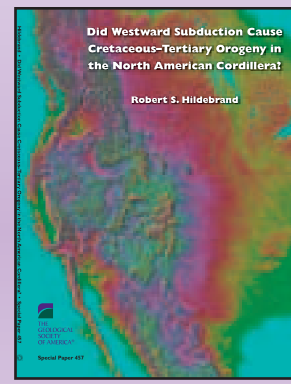
SPE459, 95 p., ISBN 9780813724591
$45.00 | **member price $33.00**



■ **The ICDP-USGS Deep Drilling Project in the Chesapeake Bay Impact Structure: Results from the Eyreville Core Holes**

edited by Gregory S. Gohn, Christian Koeberl, Kenneth G. Miller, and Wolf Uwe Reimold, 2009

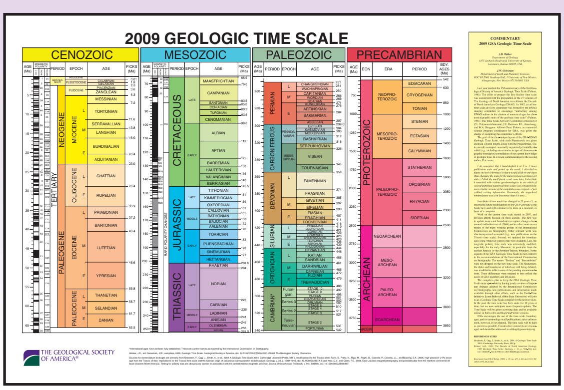
SPE458, 976 p. plus CD-ROM, ISBN 9780813724584
$135.00 | **member price $95.00**



■ **Did Westward Subduction Cause Cretaceous–Tertiary Orogeny in the North American Cordillera?**

by Robert S. Hildebrand, 2009

SPE457, 71 p., ISBN 9780813724577
$40.00 | **member price $28.00**



■ **2009 Geologic Time Scale Poster**

by J.D. Walker and J.W. Geissman, 2009

Use this colorful poster-size version of GSA's 2009 Geologic Time Scale to decorate your office or classroom. Includes explanation of the chart by the compilers.

GTSPOS, 1 rolled sheet (18" × 27")
$9.95 (sorry, no additional discounts)

www.geosociety.org/bookstore

GSA SALES AND SERVICE P.O. Box 9140, Boulder, CO 80301-9140, USA
+1.303.357.1000, option 3 • Toll-free 1.888.443.4472 • Fax +1.303.357.1071

THE GEOLOGICAL SOCIETY OF AMERICA®


A great deal you're really going to dig.
You may be eligible to save $1,300 to $3,300 off the MSRP*, plus current incentives on any new Subaru purchase or lease, including the all-new 2010 Outback. Another reason to love the VIP Partners Program. Love. It's what makes a Subaru, a Subaru.
SUBARU.