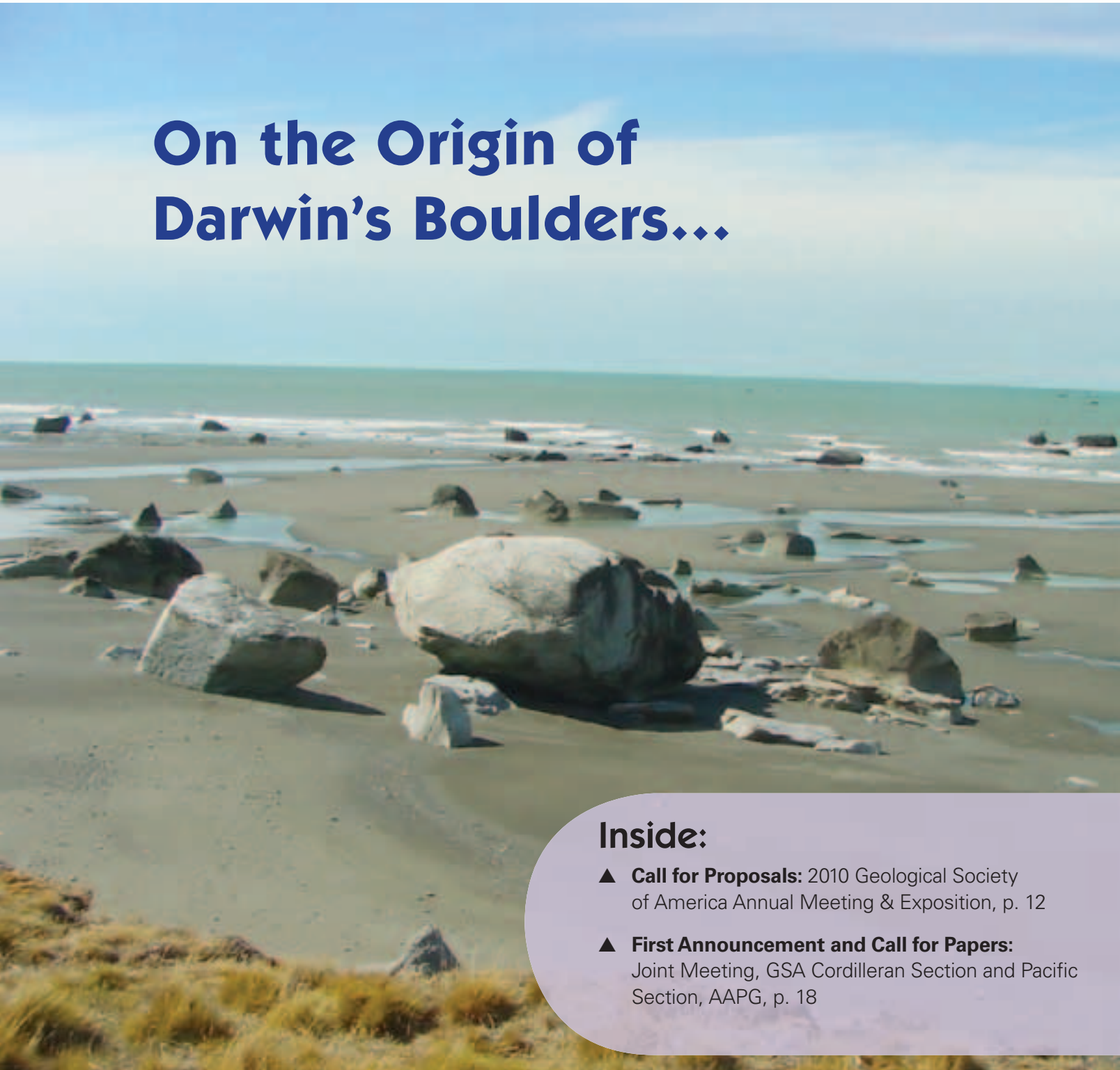
GSA TODAY

VOL. 19, No. 12 A PUBLICATION OF THE GEOLOGICAL SOCIETY OF AMERICA DECEMBER 2009



On the Origin of Darwin's Boulders...

Inside:

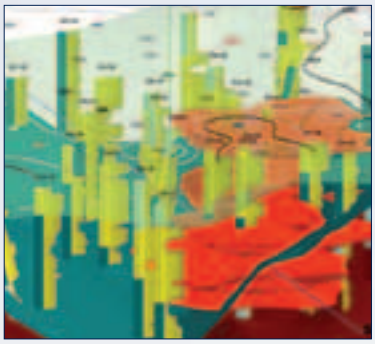
Not Just Software. . .
RockWare.

For Over 27 Years.

New Version!

RockWorks™

3D Data Management, Analysis & Visualization



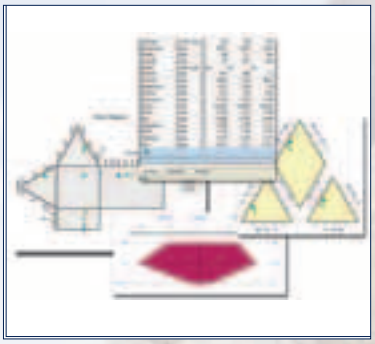
- Powerful measured-section/ borehole database for managing:
  - Lithology
  - Stratigraphy
  - Hydrology
  - Fractures
  - Hydrochemistry (e.g. Contaminants)
  - Geophysics
- Contour data in 2D and 3D (isosurfaces)
- Create striplogs, cross-sections, fence diagrams, and block models
- Extensive on-line help and sample data sets
- Includes RockWorks Utilities

Free trial available at www.rockware.com

$2,499

AqQA™

Spreadsheet for Water Analysis



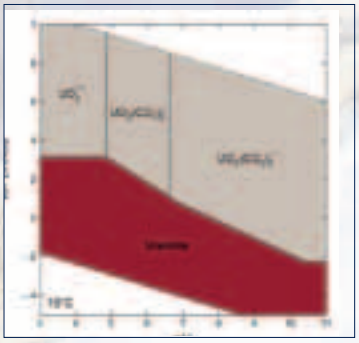
- Create Piper diagram, Stiff diagram, Ternary, and eight other plot types
- Instant unit conversion – shift effortlessly among units
- Check water analyses for internal consistency
- Manage water data in a spreadsheet

Free trial available at www.rockware.com

$249

The Geochemist's Workbench™

GWB is the premiere software solution for simulation of:



- Migration of landfill leachate
- Acid rock drainage
- Metal mobility
- Redox control on solute mobility
- Solute attenuation

Free trial available at www.rockware.com

GWB Standard
Reaction Path Modeling

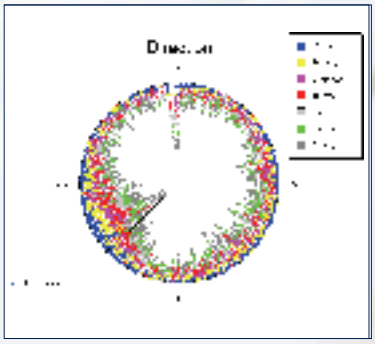
$3,499

GWB Professional *1D/2D Reactive Transport Modeling*

$7,999

Oriana™

Circular Data Statistics Software



- Calculate the special forms of sample and inter-sample statistics required for circular data
- Analyses include basic statistics, single sample distribution tests, pairwise and multisample tests, and pairwise correlations
- Graphs data in a variety of ways, including rose diagrams, allowing you to easily demonstrate patterns

Free trial available at www.rockware.com

$435

RockWare®
Since 1983

303.278.3534 • 800.775.6745
RockWare.com

GSA TODAY

VOLUME 19, NUMBER 12 ▲ DECEMBER 2009

SCIENCE ARTICLE

Cover: "Darwin's boulders" in the Atlantic Ocean, Tierra del Fuego. Charles Darwin described this large, barn-shaped boulder in June 1833. See "Enigmatic boulder trains, supraglacial rock avalanches, and the origin of 'Darwin's Boulders'—Tierra del Fuego" by Evenson et al., p. 4–11.

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 for the 2009 calendar year: Society Members: *GSA Today* is provided as part of membership dues. Contact GSA Sales and Service at +1-888-443-4472, +1-303-357-1000, option 3, or gsaservice@geosociety.org for membership information. Nonmembers & Institutions: Free with paid subscription to both *GSA Bulletin* and *Geology*, otherwise US$60. Contact AIP Customer Service, subs@aip.org. Claims: For nonreceipt or for damaged copies, members 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.

***GSA TODAY* STAFF:**
Executive Director and Publisher: John W. Hess
Science Editors: Stephen T. Johnston, University of Victoria, School of Earth & Ocean Sciences, Victoria, British Columbia V8W 3P6, Canada, stj@uvic.ca; and David E. Fastovsky, University of Rhode Island, Department of Geosciences, Woodward Hall, Rm. 317, Kingston, Rhode Island 02881, USA, defastov@uri.edu.
Managing Editor: Kristen E. Asmus, kasmus@geosociety.org; gsatoday@geosociety.org
Graphics Production: Margo Y. Sajban

ADVERTISING:
Classifieds & Display: Ann Crawford, +1-800-472-1988, ext. 1053, +1-303-357-1053, Fax +1-303-357-1070; acrawford@geosociety.org

GSA ONLINE: www.geosociety.org

Printed in the USA using pure soy inks.

THE GEOLOGICAL SOCIETY OF AMERICA®

Mixed Sources
Product group from well-managed forests, controlled sources and recycled wood or fiber
www.fsc.org Cert no. SW-COC-002272
© 1996 Forest Stewardship Council

planetearth® Earth Sciences for Society

GSA celebrates our three-year association with the International Year of Planet Earth.

Enigmatic boulder trains, supraglacial rock avalanches, and the origin of "Darwin's boulders," Tierra del Fuego

Edward B. Evenson, *Dept. of Earth and Environmental Sciences, Lehigh University, Bethlehem, Pennsylvania 18015, USA;* ***Patrick A. Burkhart*,*** *Dept. of Geography, Geology, and the Environment, Slippery Rock University, Slippery Rock, Pennsylvania 16057, USA;* ***John C. Gosse,*** *Dept. of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada;* ***Gregory S. Baker,*** *Dept. of Earth and Planetary Sciences, University of Tennessee, Knoxville, Tennessee 37996, USA;* ***Dan Jackofsky,*** *Esso Australia, Victoria 3006, Australia;* ***Andres Meglioli,*** *Environmental Resources Management, 6455 South Yosemite Street, Suite 900, Greenwood Village, Colorado 80111, USA;* ***Ian Dalziel,*** *Institute for Geophysics, Jackson School of Geosciences, University of Texas, Austin, Texas 78713, USA;* ***Stefan Kraus,*** *Instituto Antarctico Chileno, Punta Arenas, Chile;* ***Richard B. Alley,*** *Dept. of Geosciences, Pennsylvania State University, University Park, Pennsylvania 16802, USA;* ***Claudio Berti,*** *Dept. of Earth and Environmental Sciences, Lehigh University, Bethlehem, Pennsylvania 18015, USA*

ABSTRACT

Charles Darwin considered himself to be a geologist and published extensively on many geologic phenomena. He was intrigued with the distribution of erratic boulders and speculated upon their origins. In his accounts of the voyage of the *HMS Beagle*, Darwin described crystalline boulders of notable size and abundance near Bahía San Sebastian, south of the Strait of Magellan, Tierra del Fuego. Influenced by Charles Lyell's reflections upon slow, vertical movements of crust, submergence, and ice rafting to explain drift, Darwin proposed that the boulders of Bahía San Sebastian were ice-rafted. Benefiting from 170 years of subsequent study of the glacial history of Tierra del Fuego, petrography, and terrestrial cosmogenic nuclide measurements, we revisit the origin of "Darwin's Boulders" at Bahía San Sebastian. We suggest that they, as well as another train of boulders to the west, at Bahía Inútil, represent rock falls of Beagle-type granite from the Cordillera Darwin onto glacial ice flowing into the Bahía Inútil–Bahía San Sebastian lobe. These supraglacial rock avalanche deposits were subsequently elongated into boulder trains by glacial strain during transport and then deposited upon moraines. The cosmogenic nuclide exposure dates support the correlation of Andean glaciations with the marine oxygen isotope record and the glacial chronologies recently proposed for Tierra del Fuego.

INTRODUCTION

Influenced by Adam Sedgewick and Charles Lyell's *Principles of Geology* (v. 1, 1830), Charles Darwin became established as a geologist as a result of his voyage on the *HMS Beagl*e. In his writings, he portrayed himself so: "I, a geologist, have ill-defined notion of land covered with ocean…" (Darwin notebook M, no. 40, 1838, p. 39–40). Darwin belonged to the Geological Society of London (GSL) and was elected secretary in 1838. He provided us with the first geological map of southern South America. Over his career, he published more than 20 geologic articles, and in 1859, was awarded the Wollaston Medal—the highest honor of the GSL—in recognition of his contributions. In fact, his push to disseminate the geological work, including the three geology volumes of the *Beagle* voyage, delayed the publication of *On the Origin of Species* until 1859 (coincidentally when the Wollaston Medal was awarded).

Darwin's records as naturalist on the *HMS Beagle* reveal his curiosity concerning landscape evolution. For instance, his interpretation of atolls "forming as land sunk" and his measurements of raised marine terraces in South America attest to his interest in monitoring landscape change. Darwin's thinking was profoundly influenced by Lyell's obsession with large-scale, slow, vertical movements of the crust, especially as manifested in his theory of submergence and ice rafting to explain drift. In turn, Lyell profited greatly from Darwin's observations, including uplift of the Pacific coast of Chile during the Talcahuano earthquake. Lyell celebrated these observations because they supported his idea of uniformitarianism—that continued small changes, as witnessed in the field, could account for dramatic changes of Earth's surface over geologic time.

Here we report another example of Darwin's predilection for interpreting landscape anomalies with inductive reasoning. One-hundred-seventy years later, we share his fascination with the gigantic granitic boulders on the Atlantic coast of Tierra del Fuego. Under Lyell's influence, Darwin invoked the submergence–ice-rafting hypothesis to explain them, which was further supported by reports of icebergs transporting boulders. His ice-rafting hypothesis is herein superseded by one involving supraglacial transport of rock avalanche debris from one coast of Tierra del Fuego to the other, where they were abandoned upon a coastal till plain. Nevertheless, Darwin's request to delay the voyage of the *HMS Beagle* in order to document the unusual boulders has led to a clearer understanding of

*corresponding author: patrick.burkhart@sru.edu

GSA Today, v. 19, no. 12, doi: 10.1130/GSATG72A.1

Cordillera Darwin glaciodynamics and should serve to encourage geologists to explore unexpected encounters that fall beyond the defined tasks at hand.

DARWIN'S INTERPRETATION OF TIERRA DEL FUEGO ERRATICS

Darwin was long intrigued by erratic boulders, noting their locations and speculating on their origins in numerous papers (Darwin, 1839a, 1839b, 1839c, 1841a, 1841b, 1845, 1848, 1849, 1855). He dedicated one article (Darwin, 1842) exclusively to South America. The boulders at Bahía San Sebastian were discussed in several papers (Darwin, 1839a, 1842, 1848), and his description (1841a, p. 419) that enticed this investigation reads,

> …great boulders of various and peculiar crystalline rocks, which have undoubtedly travelled from the south-west coast, lie scattered over the whole of the eastern part of Tierra del Fuego. One enormous block of syenite near St. Sebastian Bay was barn-shaped, and had a girth of 47 feet.

Darwin consistently attributed erratics to ice rafting (1839a, 1839b, 1839c, 1841, 1842, 1845, 1848, 1849, 1855). On more than one occasion, Darwin made reference to observations by Charles Lyell of how sediment-laden icebergs off the coast of Newfoundland would deposit debris onto the sea floor. Later, Darwin observed calving glaciers in Tierra del Fuego that produced icebergs containing boulders, writing in his second-edition account of the *Voyage of the Beagle* (1845, p. 234) that "some of the icebergs were loaded with blocks of no inconsiderable size, of granite and other rocks, different from the clay-slate of the surrounding mountains." Further, in his 1841 paper (1841a, p. 430), Darwin wrote,

> As one of the two methods of conveying erratic boulders, namely, that by icebergs from glaciers, is now in action on the South American shores, we are naturally led to conclude, that this was the chief agent in the enormous amount of transportal formerly effected over a more extended area.

Another reason Darwin universally applied the concept of long-distance ice rafting was the report by the crew of the schooner *Eliza Scott* of an iceberg far out at sea carrying a large erratic block, estimated at 12 ft high by 6 ft wide. In "Note on a rock seen on an iceberg…" (1839b), Darwin elucidated why this sighting was significant:

> Every fact on the transportation of fragments of rock by ice is of importance, as throwing light on the problem of "erratic boulders," which has so long perplexed geologists.

Darwin also deduced from his study of marine invertebrate–bearing, "step-formed" surfaces of eastern South America, and observations of uplift associated with the 20 February 1835 Chilean earthquake, that the east and west coasts of South America had been elevated from beneath the sea. His observations of calving glaciers producing debris-bearing icebergs, sighted great distances from possible sources, combined with his firm belief in land emergence, gave him a mechanism to explain emplacement of erratics, which he inferred were deposited too far from mountains to permit direct glacial deposition.

Darwin applied this assumption to the boulders at Bahía San Sebastian ("Darwin's Boulders"). In his account of the *Voyage of the Beagle* (1845, p. 236), his conviction about ice rafting was strengthened by the shared opinion of other geologists:

> Few geologists now doubt that those erratic boulders which lie near lofty mountains have been pushed forward by the glaciers themselves, and that those distant from mountains, and embedded in subaqueous deposits, have been conveyed thither either on icebergs or frozen in coast-ice.

To Darwin, ice rafting was the only model to explain the erratic boulders of Tierra del Fuego because he found no other evidence for glaciation of the Atlantic coast. In "On the distribution of erratic boulders…" (1841b, p. 430), Darwin stated,

> The boulders… are strewed on land, which certainly has been modelled by the action of the sea… this little inclination of the surface, with the absence of mounds or ridges on it, and the angularity of the fragments, are opposed to the notion that the blocks have been pushed to this great distance by glaciers. Hence I conclude… that the boulders were transported by floating ice.

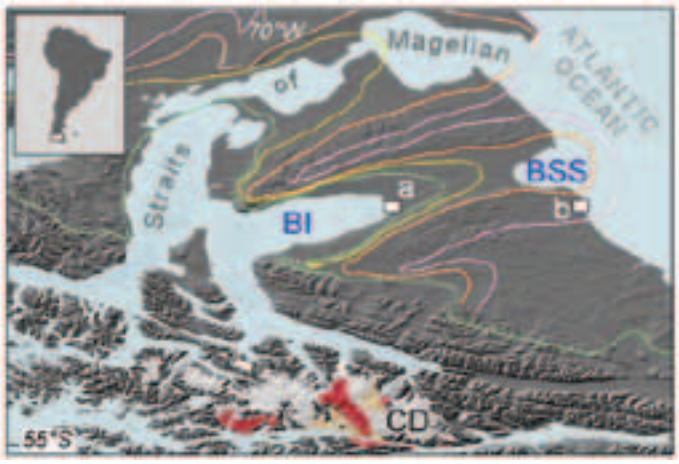


Figure 1. Digital elevation model of the Strait of Magellan region showing location of the erratic boulder trains: a—Bahía Inútil (BI); n—Bahía San Sebastian (BSS). See Figure 5 for detailed maps. The outer limits of four glacial drifts according to Meglioli (1992) are depicted by colored lines. CD—Cordillera Darwin. Shades within Cordillera Darwin depict the Beagle Granite (red), Darwin Granite (orange), and glacier ice fields (white).

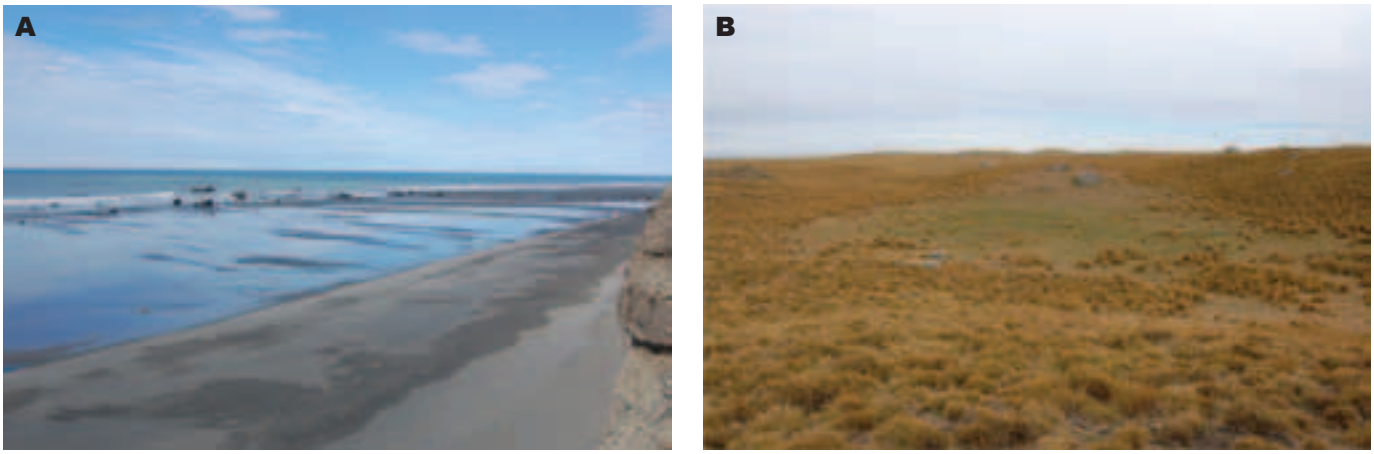


Figure 2. Darwin's boulders (A) in the surf of the Atlantic Ocean and (B) upon till plains.

REINTERPRETATION OF ORIGIN OF THE DISTAL TIERRA DEL FUEGO ERRATICS

Figure 1 depicts the Cordillera Darwin, the Strait of Magellan, and the location of the two boulder trains discussed in this paper. "Darwin's boulders" are located in the surf at Bahía San Sebastian (Fig. 2A) and on the elevated till plain (Fig. 2B) above a 20 m sea cliff at Punta Sinaí on the Atlantic coast of Tierra del Fuego. They consist of an isolated train of ~500 huge, angular, variably weathered boulders, all of which are medium-grained hornblende granodiorites. Outside of the train, large boulders are rare. The boulders lie on the terminal moraine of the Daniglacial advance of Caldenius (1932) or Rio Cullen Drift of Meglioli (1992), which is bracketed from older than 0.36 m.y. to younger than 1.07 m.y. (Meglioli, 1992; Rabassa et al., 2000; Kaplan et al., 2007).

Meglioli (1992) described a second train of gigantic boulders at the head of Bahía Inútil on the western coast of Grande Isle. Darwin was apparently unaware of the existence of the Bahía Inútil boulder train, which interestingly also consists of an isolated group of about 1000 huge, angular, granodioritic boulders. They lie upon the terminal moraine of the Finiglacial advance of Caldenius (1932) or the Bahía Inútil Drift of Meglioli (1992).

Of the three plausible mechanisms for emplacement of these distal erratics—iceberg rafting, stream-ice rafting, or direct deposition from glaciers—we support the latter. Overwhelming evidence for complete glaciation of Tierra del Fuego, from coast to coast, has been unchallenged for almost a century. It is unlikely that stream ice could have transported such large boulders over hundreds of kilometers while maintaining such a tight distribution, and there is no evidence of a capable fluvial environment in the immediate vicinity of either boulder train. On the basis of boulder size, angularity, lithology, and isolation, Meglioli (1992) proposed that the boulders originated as rock avalanches that were transported supraglacially, and Coronato et al. (1999) and McCulloch et al. (2005a) concurred. We supplement the observations that led to this interpretation and propose the bedrock source and timing of deposition of both boulder trains.

Multiple lines of evidence support a rock avalanche–supraglacial transport interpretation for the boulder trains. The evidence includes the (1) great size, (2) angularity, (3) monolithologic composition, and (4) surficial positioning of the boulders, as well as the (5) restricted areal extents, (6) orientations, and (7) locations of the boulder trains on left lateral moraines (looking upstream) of the Bahía Inútil–Bahía San Sebastian ice lobe.

The maximum diameter of the majority of boulders in both trains ranges from 1 m to 16 m, but the size distribution is skewed toward the larger. While glaciers and icebergs can carry large boulders, it would be unlikely for iceberg rafting or subglacial processes to transport such clusters of numerous, extremely large boulders. It is well known, however, that landslides from competent, jointed rocks produce large boulders, which can be supraglacially transported the entire lengths of glaciers.

Almost all of the boulders are sharply angular and show no sign of subglacial abrasion (Fig. 3). The sides of many boulders are roughly planar, suggesting that some surfaces may be original fracture planes. Their angularity and lack of curved faces are indicative of rockfall and supraglacial—not subglacial—transport, and although transport by icebergs could also yield far-traveled angular boulders, we have essentially eliminated this interpretation.

Figure 3. Darwin's boulders are distinctively angular, lacking evidence for glacial abrasion.

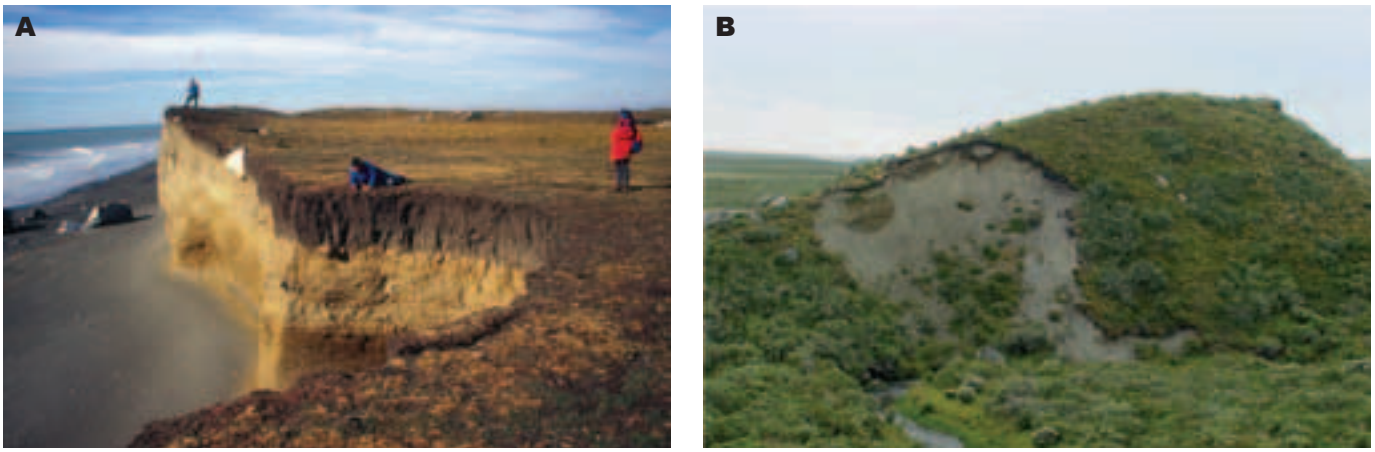


Figure 4. Darwin's boulders, which are exposed in (A) sea cliffs and (B) stream valley cuts, lie upon the moraine surface (<2 m depth) and not within tills.

Both boulder fields have a limited areal extent, and boulders >1 m in diameter beyond the fringe are rare. Ice rafting would be unlikely to produce concentrations of 500–1000 boulders in the restricted areas occupied by these boulder trains. The boulder trains are not situated in steep-sided valleys, where currents might have concentrated icebergs.

The glacier lobes that extended eastward across Tierra del Fuego had accumulation zones in the Cordillera Darwin. Owing to a complex geological history, the cordillera comprises a wide range of lithologies, including arc volcanics, I- and S-type granitoids, sediments, metasediments, and high-grade metamorphic rocks. Subglacial tills deposited near the termini of the last (Bahía Inútil) and pre-ultimate (Bahía San Sebastian) glaciations are characterized by a wide range of lithologies; however, the erratics in both boulder fields are monolithological, essentially identical, hornblende granites, possessing a coarse tabular jointing pattern. On the basis of petrography and glacial reconstructions, the most likely origin of the erratics is the Beagle Granite in the Cordillera Darwin (Fig. 1) (Nelson et al., 1980). The singular composition of the erratics indicates that subglacial processes, which would commingle all lithologies present throughout the glaciated basin, were unlikely, and instead supports a supraglacial origin by rock avalanche from a subcatchment incising the Beagle Granite.

Careful examination of coastal (Fig. 4A) and stream exposures (Fig. 4B) demonstrates that the boulders lie on or within the upper 2 m of the underlying till units, indicating that the boulders were delivered to the surface of the glacier and subsequently deposited on top of the glacial drift in the last phases of glaciation (Bahía Inútil) or during the initial phase of deglaciation (Bahía San Sebastian). The geometries of both boulder trains were determined by GPS mapping of large boulders. At Bahía San Sebastian, we mapped all boulders larger than 3 m using real-time differential corrected GPS (horizontal precision, ±0.1 m), and at Bahía Inútil, we mapped long and short axes of the train with a Garmin® handheld GPS (horizontal precision, ±5.0 m). The Bahía Inútil boulder train forms an east-west ellipse (Fig. 5A). Similarly, with the exclusion of a small number of "outliers" to the north of the main concentration at Bahía San Sebastian, the train forms an east-west oriented ellipse that has a deflection (Fig. 5B), which we believe relates to deformation of the underlying ice near the lobe terminus prior to deposition.

In each train, boulders were deposited atop an extended section of the lateral, verging-on-end moraine. This pattern is fully consistent with the glaciological expectation for transport

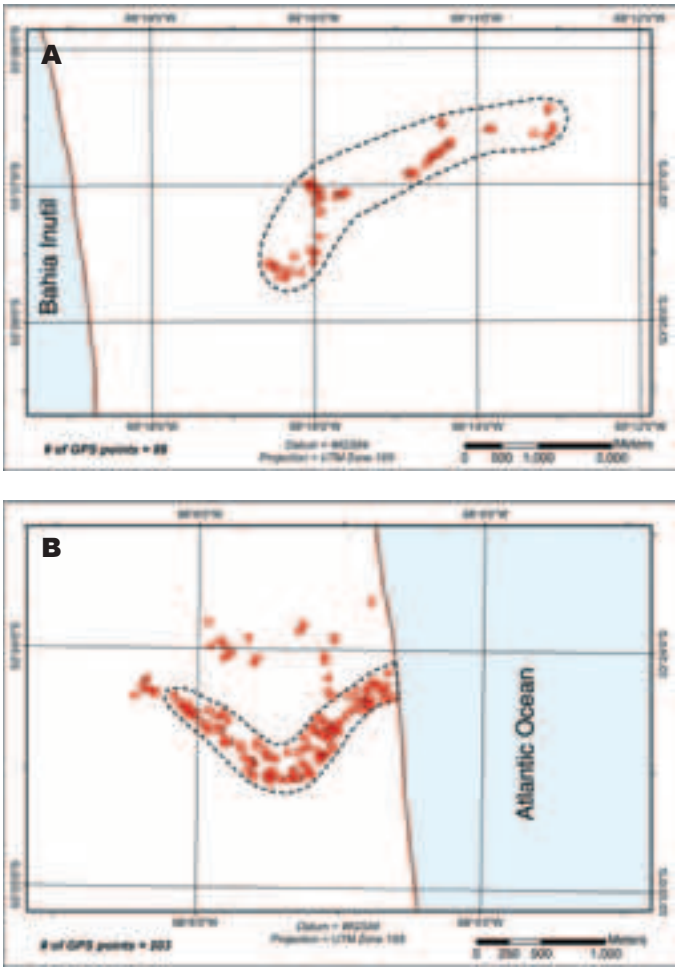


Figure 5. Boulders at (A) Bahía Inútil and (B) Bahía San Sebastian (Darwin's boulders) exist as trains whose distributions support emplacement through supraglacial transport and deposition.

of supraglacial boulders from a debris fall. End moraines form only in the ablation zone (e.g., Denton et al., 2005), demonstrating that a component of ice-flow velocity was toward the moraine. Because the moraine is longer than the ice-lobe width at its upglacier end, flowlines must diverge toward the moraine, spreading any supraglacial materials along it. Such spreading may be enhanced by additional supraglacial processes of mass transport across the surface of the glacier (e.g., Anderson, 2000; Kowalczuk et al., 2002; Vacco, 2009). Thus, it appears that boulders were carried atop a glacier onto a tongue that had deposited a moraine, and then the boulders were dropped upon the moraine as flow balanced melting. Divergence of flowlines in the tongue spread the boulders along the moraine, probably enhanced by supraglacial mass-transport processes.

Darwin incorrectly interpreted the glacial drift at Bahía San Sebastian as "subaquatic" sediments, based on its proximity to the coast, the distance from any then-known glaciated region (the Andes), the fine-grained nature of the paleosol, and the lack of large boulders within the sediment (the soft Tertiary rocks of the Tierra del Fuegan lowlands do not produce boulders). Although Darwin initially considered the possibility that glaciers could have extended from the Cordillera Darwin, he ruled it out on the basis of such vast distance. In fact, the boulder trains at Bahía San Sebastian and Bahía Inútil lie on moraine crests, albeit the former is older and more subdued. The mapping by Caldenius a century later (1932) would have made the eastward extent of the glaciers evident to Darwin.

Since Caldenius' surficial mapping of the Andes (1932), many studies have increased our knowledge of the glacial dynamics of Tierra del Fuego. Meglioli (1992) conducted the most recent detailed glacial sediment mapping throughout all of Tierra del Fuego and southern Patagonia, relying on morphology, stratigraphy, geochronology (his and others), weathering rind development, and pedogenesis. The ages of the pre-ultimate glacial drifts were not well established due to the limited number of $^{40}Ar/^{39}Ar$ datable volcanic tuff layers interstratified within the tills, and correlations of drifts of five different lobes were based mostly upon relative position. Numerical modeling of the last glacial maximum (Bahía Inútil Lobe; Jackofsky, 2000), constrained by gradients of the lateral and interlobate moraines, provided a means of establishing the position of the paleo-equilibrium line altitude for the eastern Cordillera Darwin, and ice sheet models have provided a better constraint on the advance and retreat of the Patagonian Ice Fields and adjacent regions.

In the past decade, significant attention has been placed on the chronology of the ultimate and pre-ultimate drifts using terrestrial cosmogenic nuclides (TCN). Significant contributions to knowledge of the glacial history have been advanced by Kaplan et al. (2007, 2008), Glasser et al. (2008), and Rabassa (2008), who used combinations of radiocarbon (mostly on peat and lacustrine organics and marine macrofossils) and TCN exposure ages on boulders to date the ultimate and pre-ultimate glaciations. To this foundation, we add the following TCN ages: (i) nine ages on the terminal moraine of the ultimate glaciation of the Bahía Inútil lobe; (ii) four ages on a recessional moraine of the same lobe, but at an elevation below a post-glacial lake (McCulloch et al., 2005b), suggesting that the ages reflect the time of glacial lake drainage; (iii) nine ages on the Bahía San Sebastian boulder train that reproduce problematic exposure ages reported by Kaplan et al. (2007) that were considered too young for the stratigraphic position of the moraine according to previous maps and that are accordingly interpreted to be evidence of rapid exhumation of the drift; and (iv) other ages to constrain the timing of the penultimate glaciation, which was tentatively correlated to marine oxygen isotope stage 6 (OIS-6) glaciation (Meglioli, 1992). Unlike the areas to the north, these TCN dates indicate a significant OIS-4 ice expansion in southern Patagonia and Tierra del Fuego, which is consistent with ice extents in other parts of the mid-latitude southern hemisphere (e.g. Barrows et al., 2001), where the OIS-4 paleo-margin extends beyond the last glacial maximum. Table 1 lists these data; details of the chemistry, analysis, and ages are provided in the GSA Data Repository[1].

Overall, our new TCN exposure ages generally confirm earlier work of Kaplan et al. (2007, 2008) and McCulloch et al. (2005b) in documenting a rich, but sometimes puzzling, glacial history in the vicinity of Darwin's boulders and the Bahía Inútil boulder train. Excluding outliers, which suggest either inheritance or shielding, our Bahía Inútil dates average 22.2 + 0.9 k.y., while our Bahía San Sebastian dates reveal anomalously young ages (74.4 to 38.1 k.y.) for moraines previously interpreted to be ~1 m.y., thus requiring significant reworking. The combined data set is most consistent with a last glacial maximum age for the deposition of the Bahía Inútil boulder train, and an older age for deposition of Darwin's boulders (likely OIS-6 or older).

CONCLUSION

On the voyage of the *HMS Beagle*, Charles Darwin was struck by the observation of numerous large boulders near Bahía San Sebastian in Tierra del Fuego. In the context of field observations and the preponderant thinking of the day, he interpreted their occurrence as resulting from ice rafting of boulders entrained into icebergs. In his view, emergence of the coastline by vertical uplift then lodged the boulders into their current locations. Darwin and his contemporaries, however, did not recognize the now well-established field evidence for the eastward extent of Andean glaciers that flowed through the Strait of Magellan and the Bahía Inútil–Bahía San Sebastian lobes to the Atlantic Ocean. In light of the accumulated evidence since Darwin's time, including our observations, we maintain that the boulder trains of Bahía San Sebastian and Bahía Inútil are the vestiges of Andean rock avalanches, transported supraglacially, and spread by ice flow into linear trains upon moraines. We utilized terrestrial cosmogenic nuclide techniques to date the exposure age of the boulders, constraining the ages of the land surfaces upon which they lie, and placing them into the record of Andean glaciations.

[1]GSA Supplemental Data item 2009287, summary of terrestrial cosmogenic nuclide ages for boulders of Bahía Inútil–Bahía San Sebastian ice lobe, with discussion, is available at www.geosociety.org/pubs/ft2009.htm; copies can also be obtained by e-mail to GSAToday@geosociety.org.

TABLE 1. SUMMARY OF TERRESTRIAL COSMOGENIC NUCLIDE (TCN) EXPOSURE AGES FROM BOULDERS IN OR NEAR THE BAHÍA SAN SEBASTIAN OR BAHÍA INÚTIL BOULDER TRAINS

	Nuclide	Sample ID	Elev. (m)	Age (ka) ε = 0 mm/ka	Unc (ka)	Age (ka) ε = 1.7 mm/ka	Unc (ka)
TCN ages of Bahía Inútil Boulder Train							
Terminal or recessional above shorelines*	^{10}Be	BI-B1	80	26.0	4.4	27.0	4.7
	^{10}Be	BI-B2	75	24.3	4.0	25.1	4.3
	^{10}Be	BI-B3	85	22.4	3.3	23.1	3.5
	^{10}Be	BI-B4	80	24.8	4.3	25.7	4.6
	Mean/SE			24.4	0.9	25.2	0.9
Terminal or recessional above shorelines†	^{10}Be	TF-04-04	90	21.8	3.4	22.5	3.6
	^{10}Be	TF-04-04	90	18.2	2.1	18.7	2.3
	^{10}Be	TF-04-05	90	21.4	4.2	22.1	4.3
	^{10}Be	TF-04-06	101	20.1	3.1	20.7	3.2
	Mean/SE			20.4	0.9	21.0	1.0
Terminal above shorelines (distal-proximal)	^{10}Be	CBI-T51-99-15	160	21.0	2.5	21.6	2.7
	^{10}Be	CBI-T51-99-16	160	22.7	2.6	23.5	2.8
	^{10}Be	CBI-T51-99-17	160	26.0	2.8	26.9	3.1
	^{10}Be	CBI-T51-99-18	160	66.0	7.2	72.8	8.9
	^{10}Be	CBI-T51-99-13	145	21.2	2.6	21.8	2.8
	^{10}Be	CBI-T51-99-14	145	23.7	2.9	24.5	3.1
	^{10}Be	CBI-T51-99-20	140	17.8	2.1	18.3	2.2
	^{10}Be	CBI-T51-99-19	135	23.1	2.6	23.8	2.8
	^{10}Be	CBI-T51-99-21	135	22.3	2.7	23.0	2.9
	Mean/SE			22.2	0.9	22.9	0.9
Recessional below shoreline	^{10}Be	CBI-T52-99-10	65	8.3	1.0	8.4	1.0
	^{10}Be	CBI-T52-99-11	65	9.4	1.1	9.5	1.2
	^{10}Be	CBI-T52-99-12	65	8.9	1.1	9.1	1.2
	^{10}Be	CBI-T54-99-08	60	14.1	1.7	14.3	1.7
	Mean/SE			8.9	0.4	9.0	0.4
TCN ages for Bahía San Sebastian Boulder Train							
Southeast of Bahía San Sebastian†	^{10}Be	RC-04-01	16	21.9	6.6	22.6	7.0
	^{10}Be	RC-04-02	22	27.1	4.2	28.2	4.6
	^{10}Be	RC-04-03	21	20.0	3.4	20.6	3.6
	^{10}Be	RC-04-04	23	27.3	9.0	28.4	9.7
	^{10}Be	RC-04-05	17	26.9	6.8	27.9	7.4
	^{10}Be	RC-04-06	12	13.5	1.6	13.8	1.7
	^{10}Be	RC-04-07	21	51.4	12.3	55.5	14.4
	Mean/SE			22.8	1.2	23.6	1.3
	^{36}Cl	ARG-00-Tdf-039	34	18.7	9.0		
	^{36}Cl	ARG-00-Tdf-043	34	27.1	9.0		
	Mean/SE			22.9	5.9		
TCN ages for the penultimate drift							
	^{10}Be	CRG-T3$_1$-99-22		74.0	8.1	82.7	10.3
	^{10}Be	CRG-T3$_1$-99-24		74.4	8.2	83.2	10.3
	^{36}Cl	CRG-T3$_2$-99-23		55.2	2.7		
	^{36}Cl	CRG-T4$_1$-99-25		40.8	1.6		
	^{36}Cl	CRG-T4$_1$-99-26		38.1	1.8		

Note: See GSA supplemental data item 2009287 for AMS and chemical data, age calculation method, and TCN data interpretation. Erosion rates are as suggested by McCulloch et al. (2005), but measurement of ^{10}Be in quartz and ^{36}Cl in biotite from a single granite boulder (CBI-T51-99-16) requires much less erosion to resolve age disparity (see Table DR2A). Unc—uncertainty.
*McCulloch et al., 2005a. †Kaplan et al., 2007.

In June of 1833, Charles Darwin delayed the progress of the *HMS Beagle* to better observe the boulders at Bahía San Sebastian, and in doing so, prompted the eventual satisfactory explanation for their existence. While our interpretations, after nearly two centuries of continuing field mapping and sophisticated material analyses, have revealed inaccuracies in Darwin's geologic thoughts about the boulders, we revere his exquisite, detailed recordings of natural occurrences, as well as his pursuit of rational explanations based upon observable phenomena. "Darwin's Boulders" are not ice-rafted blocks, but rather glacially transported detritus of alpine avalanches; yet, his accounts of them beckoned us to reexamine the deposits, thus reinforcing his intent to explain landscapes within the constraints of physical evidence.

ACKNOWLEDGMENTS

We thank the Braun family and Charlie Mann of Estancia Sara, as well as the Murchison family of Tres Hermanos estancia, for access to boulder-strewn lands. Oscar Martinez and Curt Sorenson graciously accompanied us on some of the field work. Katherine Chapman, Marcy Davis, and Jack Livingston assisted with cartography. Thanks also to Guang Yang (Dalhousie) and Terry Thomas (New Mexico Institute of Mining and Technology) for the chemical preparation of certain ^{10}Be and ^{36}Cl targets, and Bob Finkel (Lawrence Livermore National Laboratory) and Marc Caffee (PRIME Lab) for high-quality accelerator mass spectrometry analyses. Our manuscript benefited from insightful comments of Robert Dott, at a nascent stage, and Norm Catto, when nearing completion. Portions of the research were supported by NSF Grant EAR-9905341 to J.C. Gosse.

REFERENCES CITED

Anderson, R.S., 2000, A model of ablation-dominated medial moraines and the generation of debris-mantled glacier snouts: Journal of Glaciology, v. 46, no. 154, p. 459–469, doi: 10.3189/172756500781833025.

Barrows, T.T., Stone, J.O., Fifield, L.K., and Cresswell, R.G., 2001, Late Pleistocene glaciation of the Kosciuszko Massif, Snowy Mountains, Australia: Quaternary Research, v. 55, no. 2, p. 179–189, doi: 10.1006/qres.2001.2216.

Caldenius, C.G., 1932, Las glaciaciones Cuaternarias en la Patagonia and Tierra del Fuego: Geografiska Annaler, v. 14, p. 1–164, doi: 10.2307/519583.

Coronato, A., Roig, C., Rabassa, J., and Meglioli, A., 1999, Erratic boulder field of pre-Illinoian age at Punta Sinaí, Tierra del Fuego, southernmost South America: XV INQUA International Congress, Durham, South Africa, p. 47–48.

Darwin, C.R., 1838, Notebook M: Metaphysics and expression.

Darwin, C.R., 1839a, Narrative of the surveying voyages of His Majesty's Ships *Adventure* and *Beagle* between the years 1826 and 1836, describing their examination of the southern shores of South America, and the *Beagle*'s circumnavigation of the globe. Journal and remarks. 1832–1836: London, Henry Colburn, 619 p.

Darwin, C.R., 1839b, Note on a rock seen on an iceberg in 61° south latitude: Journal of the Royal Geographical Society of London, v. 9, March, p. 528–529, doi: 10.2307/1797747.

Darwin, C.R., 1839c, Observations on the parallel roads of Glen Roy, and of other parts of Lochaber in Scotland, with an attempt to prove that they are of marine origin [Read 7 February]: Philosophical Transactions of the Royal Society 129, p. 39–81, 2 plates, 4 text figures.

Darwin, C.R., 1841a, On the distribution of the erratic boulders and on the contemporaneous unstratified deposits of South America [Read 14 April 1841]: Transactions of the Geological Society Part 1, 3, p. 415–431.

Darwin, C.R., 1841b, On the distribution of the erratic boulders and on the contemporaneous unstratified deposits of South America [Read 5 May]: Proceedings of the Geological Society of London Part 2, 3, p. 425–430.

Darwin, C.R., 1842, Notes on the effects produced by the ancient glaciers of Caernarvonshire, and on the boulders transported by floating ice: The London, Edinburgh and Dublin Philosophical Magazine, v. 21, September, p. 180–188.

Darwin, C.R., 1845, [The Voyage of the *Beagle*] Journal of researches into the natural history and geology of the countries visited during the voyage of *H.M.S. Beagle* round the world, under the Command of Capt. Fitz Roy, R.N., second edition: London, John Murray, 485 p.

Darwin, C.R., 1846, Geological observations on South America. Being the third part of the geology of the voyage of the *Beagle*, under the command of Capt. Fitzroy, R.N., during the years 1832 to 1836: London, Smith Elder and Co., 320 p.

Darwin, C.R., 1848, On the transportal of erratic boulders from a lower to a higher level: Quarterly Journal of the Geological Society of London, v. 4, p. 315–323.

Darwin, C.R., 1849, [Letter on floating ice], *in* Murchison, R.I., On the distribution of the superficial detritus of the Alps, as compared with

that of Northern Europe: Proceedings of the Geological Society of London, v. 4, Part 1, p. 65–69.
Darwin, C.R., 1855, On the power of icebergs to make rectilinear uniformly directed grooves across a submarine undulatory surface: The London, Edinburgh and Dublin Philosophical Magazine, v. 10, August, p. 96–98.
Darwin, C.R., 1859, On the Origin of Species: London, John Murray.
Denton, G.H., Alley, R.B., Comer, G.C., and Broeker, W.S., 2005, The role of seasonality in abrupt climate change: Quaternary Science Reviews, v. 24, p. 1159–1182, doi: 10.1016/j.quascirev.2004.12.002.
Glasser, N.F., Jansson, K.N., Harrison, S., and Kleman, J., 2008, The glacial geomorphology and Pleistocene history of South America between 38 degrees S and 56 degrees S: Quaternary Science Reviews, v. 27, no. 3–4, p. 365–390, doi: 10.1016/j.quascirev.2007.11.011.
Jackofsky, D.S., 2000, Quaternary glacial chronology and climate dynamics in Tierra del Fuego, Chile, and at Lago Nahuel Huapi, Argentina [M.Sc. Thesis]: Lawrence, Kansas, The University of Kansas, 187 p.
Kaplan, M.R., Coronato, A., Hulton, N.R.J., Rabassa, J.O., Kubik, P.W., and Freeman, S.P.H.T., 2007, Cosmogenic nuclide measurements in southernmost South America and implications for landscape change: Geomorphology, v. 87, p. 284–301, doi: 10.1016/j.geomorph.2006.10.005.
Kaplan, M.R., Fogwill, C.J., Sugden, D.E., Hulton, N.R.J., Kubic, P.W., and Freeman, S.P.H.T., 2008, Southern Patagonian glacial chronology for the Last Glacial Period and implications for Southern Ocean climate: Quaternary Science Reviews, v. 27, no. 3-4, p. 284–294, doi: 10.1016/j.quascirev.2007.09.013.
Kowalczuk, R., Strasser, J.C., Evenson, E.B., Burkhart, P., Ensminger, S.L., and Lawson, D., 2002, Rotation, translation, and vertical displacement of supraglacial clasts during summer ablation, Matanuska Glacier, Chugach Mountains, Alaska: Geological Society of America Abstracts with Programs, v. 34, no. 2, p. 84.
Lyell, C., 1830, Principles of Geology, v. I–III: London, John Murray.
McCulloch, R.D., Fogwill, C.J., Sugden, D.E., Bentley, M.J., and Kubik, P.W., 2005a, Chronology of the last glaciation in central Strait of Magellan and Bahía Inútil, southernmost South America: Geografiska Annaler, v. 87, p. 289–312, doi: 10.1111/j.0435-3676.2005.00260.x.
McCulloch, R.D., Bentley, M.J., Tipping, R.M., and Clapperton, C.M., 2005b, Evidence for late-glacial ice dammed lakes in the central Strait of Magellan and Bahía Inútil, Southernmost South America: Geografiska Annaler, v. 87, p. 335–362, doi: 10.1111/j.0435-3676.2005.00262.x.
Meglioli, A., 1992, Glacial geology and chronology of southernmost Patagonia and Tierra del Fuego, Argentina and Chile [Ph.D. thesis]: Bethlehem, Pennsylvania, Lehigh University, 330 p.
Nelson, E.P., Dalziel, I.W.D., and Milnes, A.G., 1980, Structural geology of the Cordillera Darwin; collisional-style orogenesis in the southernmost Chilean Andes: Eclogae Geologicae Helvetiae, v. 73, p. 727–751.
Rabassa, J., 2008, Late Cenozoic glaciations of Patagonia and Tierra del Fuego: Developments in Quaternary Science, v. 11, p. 151–204.
Rabassa, J., Coronato, A., Bujalesky, G., Roig, C., Salemme, M., Meglioli, A., Heuser, C., Gordillo, S., Borromei, A., and Quatrocchio, M.J., 2000, Quaternary of Tierra del Fuego, southernmost South America: an updated review: Quaternary International, v. 68–71, p. 217–240, doi: 10.1016/S1040-6182(00)00046-X.
Vacco, D.A., 2009, Modeling of glacial response to climate changes, including moraine deposition and stagnation events [Ph.D. thesis]: University Park, Pennsylvania, Pennsylvania State University, 101 p.

Received 9 August 2009; accepted 9 September 2009. ■

GSA AWARD, RECOGNITION & GRANT DEADLINES

Learn more and submit nominations at
www.geosociety.org/awards/nominations.htm
(unless otherwise noted) or contact
GSA Grants, Awards & Recognition,
P.O. Box 9140,
3300 Penrose Place, Boulder, CO 80301-9140, USA,
+1-303-357-1028, awards@geosociety.org.

2010 GSA Medals and Awards (due 1 Feb.): Penrose Medal, Day Medal, Young Scientist Award (Donath Medal), GSA Public Service Award, GSA Distinguished Service Award, Bromery Award for the Minorities, and the Subaru Outstanding Woman in Science Award.

GSA Fellowship (due 1 Feb.).

AGI Medal in Memory of Ian Campbell (due 1 Feb.): Submit to www.agiweb.org/direct/awards.html.

John C. Frye Environmental Geology Award (due 31 March).

2010 Student Research Grants: Apply online by 11:59 p.m. MST on 1 Feb. at www.geosociety.org/grants/gradgrants.htm.

2010 Post-Doctoral Research Awards (due 1 Feb.): Gladys W. Cole Memorial Research Award, and W. Storrs Cole Memorial Research Award.

2010 GSA Annual Meeting & Exposition

Reaching New Peaks in Geoscience

CALL FOR PROPOSALS
Denver, Colorado, USA
31 October–3 November 2010

Proposal deadline: 12 January 2010
Submit proposals at www.geosociety.org/meetings/2010/

With the 2009 GSA Annual Meeting in Portland behind us, it's time to begin planning for the 2010 GSA Annual Meeting in Denver. Every three years, thousands of geoscientists visit this now-familiar city with its incredible Rocky Mountain backdrop. The Denver 2010 theme, *Reaching New Peaks in Geoscience*, is a play on words based on this backdrop, but it also conveys the urgency for geoscientists to continue to be (1) innovative in their research; (2) diligent that their findings are repeatable and/or models are based on the best available information and peer reviewed by equally qualified scientists; and (3) effective communicators of their research, not only to their peers, but to appropriate decision makers and potential funding entities. Very importantly, we have become increasingly aware that geoscience research must also have relevance to real-world issues, and often the relevance must be immediately obvious.

While we may feel comfortable with the 2010 Denver Annual Meeting venue, we must ensure that the "peaks" of our ever-evolving science will be highlighted during thousands of presentations in our numerous technical and Pardee sessions and special events. We must strive to support the large geoscience education contingent that will attend the meeting as K–12 and college educators search for new and innovative ways to inspire students to seek careers in the geosciences and ensure that these students are the ones reporting on their scientific achievements in future years. Our field trips, short courses, and workshops must be creatively conceived and plentiful to satisfy the diversity of geoscientists who will attend the meeting. Field trip options are especially challenging because the annual meeting recycles so frequently to Denver; we must work to identify new field trip leaders with new ideas and locations for exciting and educationally rewarding field stops. Finally, special lectures and events on relevant hot topics should effectively link the Denver 2010 theme of *Reaching New Peaks in Geoscience* with topical and Pardee sessions. Particularly important will be identifying emerging hot topics and elucidating those that persist.

Indeed, there is much to be done for the 2010 Annual Meeting—all directly reflective of GSA's mission to *advance the geosciences in the service of humankind* and its motto, *Science, Stewardship, Service*. A real opportunity exists for you to have an impact on the next program, as GSA openly solicits a bottom-upward approach by members in annual meeting development. It is members who propose sessions and actively invite top scientists to participate; members who conduct workshops, short courses, and field trips; members who inform us and remind us of relevant issues of importance; and members who are learning best practices to educate our future geoscientists.

You can make a real difference by proposing topical and Pardee sessions for the 2010 meeting. This meeting indeed does belong to you—to enjoy, to learn, and to experience the collaboration of others with similar endeavors.

Dick Berg, *2010 Technical Program Chair, berg@isgs.illinois.edu*

DENVER 2010 DATES AND DEADLINES

12 Jan. 2010	Deadline for Technical Session Proposals (midnight, Pacific Standard Time).
April	Electronic abstract form posted at www.geosociety.org and first meeting announcement in *GSA Today*.
June	2nd meeting announcement in *GSA Today*.
12 August	Abstracts due by midnight, Pacific Standard Time.
26 August	Technical program schedule finalized.
mid-September	Accepted abstracts with links to speakers and titles posted at www.geosociety.org.

PROPOSE A SESSION

When you propose a session, you take the first step in directly impacting next year's annual meeting. We say this often, because it's true: *This is your meeting*. Your involvement, starting now, is what makes GSA annual meetings GO, maximizing both your meeting experience and that of others. When you organize a session, you ensure that your area of expertise is spotlighted, published in the widely cited *Abstracts with Programs* volume, reaching and informing meeting attendees, generating media attention, and possibly resulting in a GSA Special Paper.

Propose a session—then watch your efforts unfold as abstracts are submitted and your initiative becomes part of science history.

Topical Sessions

Submit proposals electronically on or before 12 Jan. 2010 via link at www.geosociety.org. Topical sessions promote the exchange of timely or state-of-the-art information with respect to a focused topic and allow scheduling of interdisciplinary talks that bear on a specific topic. Organizers (advocates) may request specific papers to ensure a successful and excellent session and are encouraged to solicit volunteered contributions. Advocates may invite up to three speakers or poster presenters and are encouraged to solicit volunteered abstracts for the topical session. Sessions will include a mixture of requested and volunteered abstracts. Once the topical session is approved, an announcement in *GSA Today* will solicit volunteered abstracts. Topical sessions must receive a minimum of 12 abstracts to be part of the technical program. Advocates are encouraged to submit their proposals as poster sessions to accommodate the growing technical program. All session proposals are reviewed by the Joint Technical Program Committee.

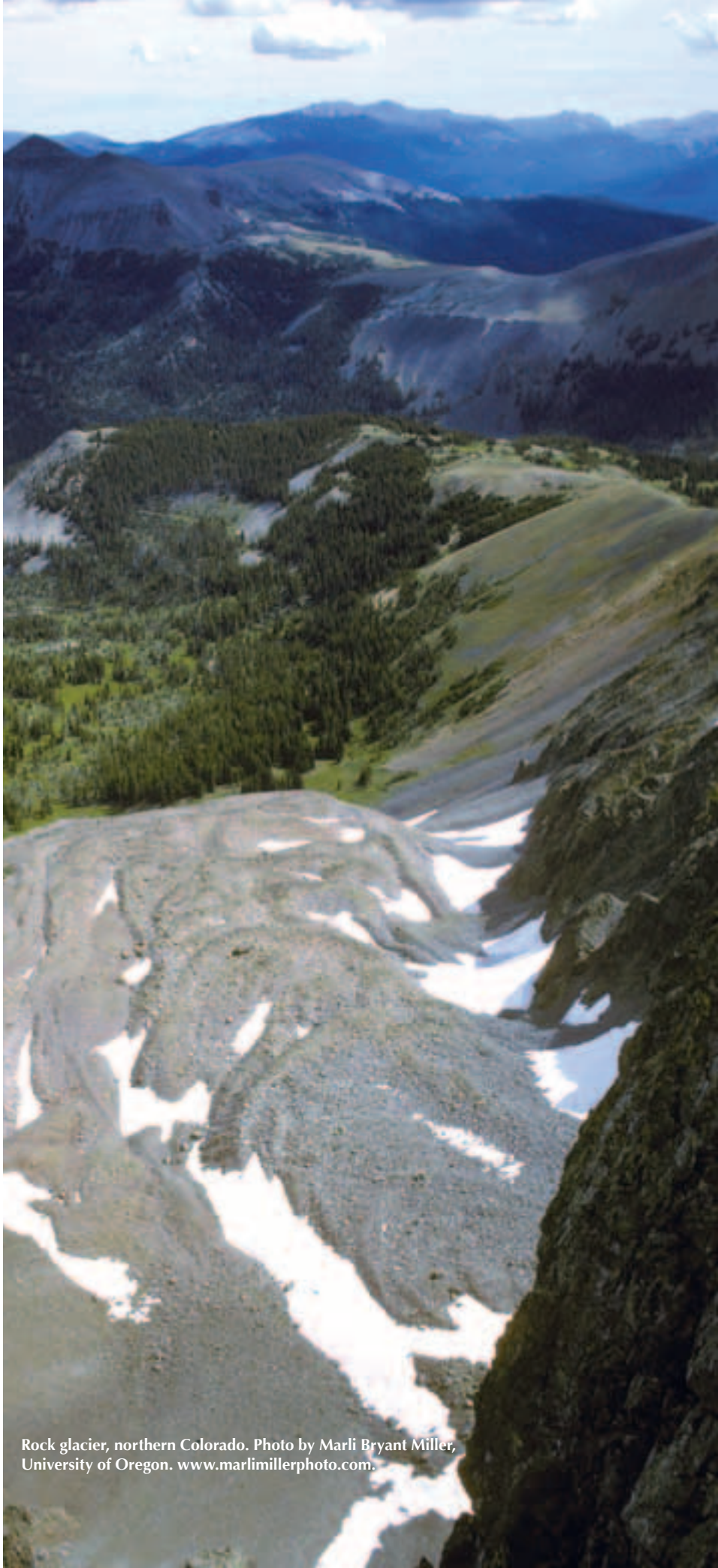
Pardee Keynote Symposia

The Annual Program Committee (APC) plans to take a proactive role in selecting topics and soliciting conveners for Pardee Keynote Symposia in order to enhance the range and significance of science presented at the annual meeting and to highlight topics of particular relevance to the Denver area.

As always, we expect that these topics will be on the leading edge in scientific disciplines or areas of public policy and address broad, fundamental issues. We want to stress that the ideas will not be limited to those of just the APC. GSA highly encourages members and colleagues to pool their resources and submit ideas related to new breakthroughs and transformative science within their areas of geoscience. We also encourage members to work with the Divisions and Associated Societies to come up with suggestions for Pardee Keynote Symposia topics.

Keynote sessions are now flexible in terms of session format; for example, these sessions may included only two or three speakers, or they may revolve around a panel discussion of a technical nature. They can follow a typical half-day session format or even just a two-hour slot. You have the flexibility to create a session that works best for the topic at hand.

Pardee Keynote Symposia are made possible by a grant from the Joseph T. Pardee Memorial Fund and are special events of broad interest to the geoscience community.



Rock glacier, northern Colorado. Photo by Marli Bryant Miller, University of Oregon. www.marlimillerphoto.com.

CALL FOR NOMINATIONS

2010 GSA DIVISION AWARDS

Nominations are requested for the following GSA Division awards. These awards will be presented at the 2010 GSA Annual Meeting in Denver, Colorado, USA.

All funds are administered by the GSA Foundation.

Recognition
Leadership
SERVICE
STEWARDSHIP
Networking
Mentoring
SCIENCE

THE GEOLOGICAL SOCIETY OF AMERICA®

SCIENCE ▪ STEWARDSHIP ▪ SERVICE

GSA Division: Sedimentary Geology

LAURENCE L. SLOSS AWARD FOR SEDIMENTARY GEOLOGY

Nominations due 20 February 2010

Submit (1) a cover letter describing the nominee's accomplishments in sedimentary geology and contributions to GSA and (2) a curriculum vitae electronically to Paul Link, secretary, Sedimentary Geology Division, linkpaul@isu.edu.

The Laurence L. Sloss Award for Sedimentary Geology is given annually to a sedimentary geologist whose lifetime achievements best exemplify those of Larry Sloss—i.e., achievements that contribute widely to the field of sedimentary geology and service to GSA. The Sedimentary Geology Division's management board will choose the recipient from two nominees selected by the nominations committee, and the award will be presented at the 2010 GSA Annual Meeting in Denver. Monies for the award are derived from the annual interest income of the Laurence L. Sloss Award for Sedimentary Geology Fund, administered by the GSA Foundation.

GSA Division: Coal Geology

GILBERT H. CADY AWARD

Nominations due 28 February 2010

Submit three copies of the following to Ronald H. Affolter, U.S. Geological Survey, MS 939, Denver Federal Center, P.O. Box 25046, Denver, CO 80225-0046, USA; +1-303-236-7752; 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 that warrant nomination.

The Gilbert H. Cady Award is given for outstanding contributions in the field of coal geology. The first award, established by the Division in honor of Gilbert H. Cady, was presented in 1973. The award recognizes contributions that advance the field of coal geology within and outside North America and will be presented at the Coal Geology Division Business Meeting at the 2010 GSA Annual Meeting in Denver. Nominations will be evaluated by the Gilbert H. Cady Award Panel. Monies for the award are derived from the annual interest income of the Gilbert H. Cady Memorial Fund, administered by the GSA Foundation.

GSA Division: Geophysics

GEORGE P. WOOLLARD AWARD

Nominations due 15 February 2010

Submit nominations online 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.

The George P. Woollard Award recognizes outstanding contributions to geology through the application of the principles and techniques of geophysics. The award is presented at each annual GSA meeting in conjunction with the Geophysics Division and the Structural Geology and Tectonics Division business meetings. A highlight of the presentation is the honorary George P. Woollard Technical Lecture by the recipient before the award ceremony. Award funds are administered by the GSA Foundation.

GSA Division: Geoscience Education

BIGGS AWARD FOR EXCELLENCE IN EARTH SCIENCE TEACHING

Nominations due 1 February 2010

Submit nominations to Paul E. Baldauf, Nova SE University–Farquhar College of Arts & Sciences, Math Science & Technology Division, 3301 College Ave., Fort Lauderdale, FL 33314-7721, USA; pb501@nova.edu. To access the nomination form, please go to www.geosociety.org/awards/biggs.htm.

The Biggs Award recognizes innovative and effective teaching in college-level earth science. Earth-science instructors and faculty members from any academic institution engaged in undergraduate education who have been teaching full-time for 10 years or fewer are eligible (part-time teaching is not counted in this requirement). Both peer- and self-nominations will be accepted.

This award, administered by the GSA Foundation, is made possible by support from the Donald and Carolyn Biggs Fund, the GSA Geoscience Education Division, and GSA's Education and Outreach Program. An additional travel reimbursement is also available to the recipient to enable him or her to attend the award presentation at the GSA Annual Meeting.

GSA Division: Quaternary Geology and Geomorphology

FAROUK EL-BAZ AWARD FOR DESERT RESEARCH

Nominations due 2 April 2010

Submit nominations, including (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, University of Nevada, MS 178, Reno, NV 89557-0178, USA; +1-775-682-8750; khouse@unr.edu.

The Farouk El-Baz Award for Desert Research rewards excellence in desert geomorphology research worldwide. It is intended to stimulate research in desert environments by recognizing an individual whose research has significantly advanced the understanding of the Quaternary geology and geomorphology of deserts. Although the award primarily recognizes achievement in desert research, the funds that accompany it may be used for further research. The award is normally given to one person but may be shared by two people if the recognized research was the result of a coequal partnership. Any scientist from any country may be nominated. Because the award recognizes research excellence, self-nomination is not permitted. Neither nominators nor nominees need be GSA Members. Monies for the award are derived from the annual interest income of the Farouk El-Baz Fund, administered by the GSA Foundation.

GSA Division: History of Geology

MARY C. RABBITT HISTORY OF GEOLOGY AWARD

Nominations due 1 February 2010

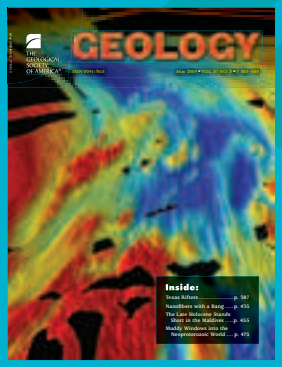
Submit nominations to Jane P. Davidson, University of Nevada, Reno, NV 89557-0001 USA; +1-775-747-2252; jdhexen@unr.edu.

The Mary C. Rabbitt History of Geology Award is presented annually to recognize an individual for exceptional scholarly contributions of fundamental importance to our understanding of the history of the geological sciences. Achievements deserving of the award include, but may not be limited to, publication of papers or books that contribute new and profound insights into the history of geology based on original research or a synthesis of existing knowledge. The award was established by the History of Geology Division in 1981 and renamed in memory of Mary C. Rabbitt in 2005. For more information, please see http://gsahist.org/HoGaward/awards.htm. Neither the nominator nor the nominee need be a member of the Division or of GSA. Monies for the award are administered by the GSA Foundation.

Enjoy Member-Only Discounts

Meetings

- Exchange science at GSA meetings
- Present research



Publications

- Journal subscriptions (includes archives)
- GSA Bookstore—30% discount on most items

Membership includes:

- *GSA Today*
- *GSA Connection*

It's Time: Renew

Renew & Subscribe

www.geosociety.org/members

Broaden Your Opportunities

- Connect with colleagues worldwide
- Join special interest Divisions and geographic Sections
- Gain insight into policies that impact your science
- Build your résumé in ways that interest you—through publications, meetings, governance, awards and recognition

THE GEOLOGICAL SOCIETY OF AMERICA®

Student Extras

- Free online access to journals (more than a US$190 annual value)
- Research funding (geographic restrictions may apply)
- Mentor programs and employment leads
- Student rates on meeting registrations, print journals, and special interest divisions
- Volunteer and travel grant opportunities at meetings

Your Membership 2010

Ensuring the future of the geosciences in the service of humankind

Renew Your Membership Now!

Save 15% through 15 December 2009.

THE GEOLOGICAL SOCIETY OF AMERICA®

JOINT MEETING

106th Annual Meeting of GSA's Cordilleran Section
85th Annual Meeting of AAPG's Pacific Section
Anaheim, California, USA

27–29 May 2010

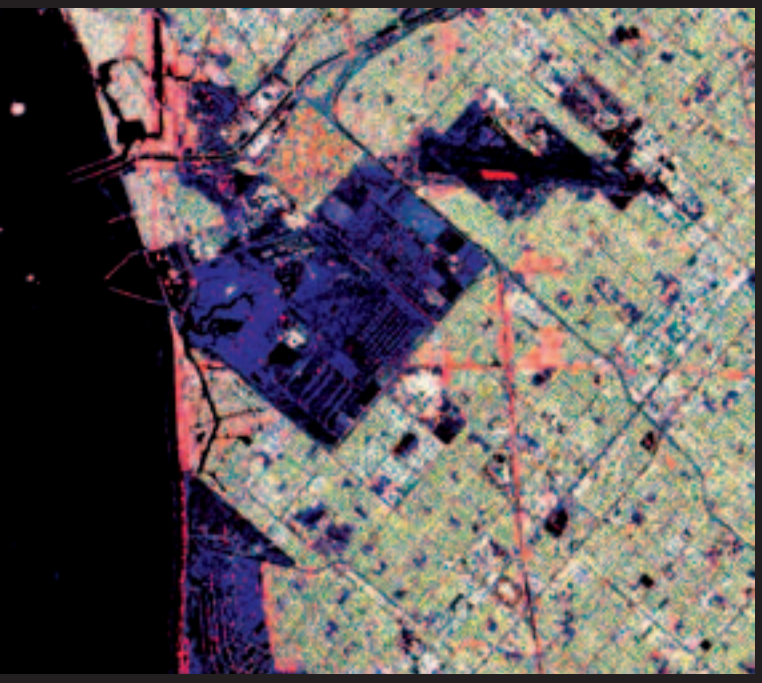


Image of Orange County, Calif., USA, acquired 3 Oct. 1994 by Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar (SIR-C/X-SAR) onboard the space shuttle *Endeavour*. Image is centered at 33.7°N latitude 117.7°W longitude, with north toward the upper right. Courtesy NASA–Jet Propulsion Laboratories, http://visibleearth.nasa.gov/view_rec.php?id=438.

From Mountains to Main Street

Please join us for the 2010 annual meetings of the GSA Cordilleran Section and the Pacific Section of AAPG at the Marriott Hotel in Anaheim, California, USA. Local host: California State University at Fullerton Dept. of Geological Sciences. Details are online at **www.geosociety.org/sectdiv/cord/2010mtg/.**

CALL FOR PAPERS

Abstract deadline: 9 March 2010
Submit online: www.geosociety.org/meetings/

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

TECHNICAL PROGRAM

For general information or to propose additional sessions, contact the Technical Program co-chairs: Jeff Knott, +1-657-278-5547, jknott@fullerton.edu (Cordilleran Section, GSA); Hilario Camacho, +1-562-326-5219, camachoh@shpi.net (Pacific Section, AAPG).

Symposia

Cordilleran Section, GSA; Pacific Section, AAPG

1. **Debating the Connections between the Plutonic and Volcanic Rock Record.** Drew Coleman, Univ. of North Carolina, dcoleman@unc.edu; Olivier Bachman, Univ. of Washington, bachmano@u.washington.edu.

Pacific Section, Society for Sedimentary Geology (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.** Ray Ingersoll, UCLA, ringer@ess.ucla.edu; Eric Hendrix, Mission Geoscience/UCLA, edhendrix@missiongeo.com; Ron Cole, Allegheny College, ron.cole@allegheny.edu.

Theme Sessions

Cordilleran Section, GSA

1. **Sierra Nevada Microplate-Basement and Basins.** Jason Saleeby, California Institute of Technology, jason@gps.caltech.edu; Zorka Saleeby, California Institute of Technology, zorka@gps.caltech.edu.
2. **Tectonic Evolution of the Southern Big-Bend Region, San Andreas Fault.** Doug Yule, CSU-Northridge, j.d.yule@csun.edu; Jonathan Matti, USGS, jmatti@usgs.gov; James Spotila, Virginia Tech, spotila@vt.edu.
3. **Terrestrial and Marine Records of Late Quaternary Climate from Western North America/Eastern Pacific: Developments, Comparisons, and Directions.** Matthew E. Kirby, CSU-Fullerton, mkirby@fullerton.edu; Sarah Feakins, USC, feakins@usc.edu; Kathleen Johnson, UC-Irvine, kathleen.johnson@uci.edu; Rob Negrini, CSU-Bakersfield, rnegrini@csub.edu.
4. **Advances in Understanding Magma Petrogenesis and Eruption Dynamics at Basaltic Monogenetic Volcanoes.** Brandon Browne, CSU-Fullerton, bbrowne@fullerton.edu; Nancy Riggs, Northern Arizona Univ., nancy.riggs@nau.edu.
5. **Active Tectonics of the Eastern California Shear Zone–Walker Lane Belt.** Kurt Frankel, Georgia Tech, kfrankel@gatech.edu; Plamen Ganev, USC, ganev@usc.edu.
6. **New Insights into Tectonics of the Central California Coast Ranges—The Link between Los Angeles and San Francisco.** Russell W. Graymer, USGS, rgraymer@usgs.gov; Victoria Langenheim, USGS, zulander@usgs.gov.
7. **Late Neogene Tectonics and Deformation along Active Faults East of and Including the San Andreas–San**

Jacinto Fault Zones. Chris Menges, USGS, cmenges@usgs.gov; Dave Miller, USGS, dmiller@usgs.gov.

8. **Late Pleistocene and Holocene Glaciation in Western North America.** Arjen Stroeven, Stockholm Univ., arjen.stroeven@natgeo.su.se; John Clague, Simon Fraser Univ., jclague@sfu.ca.
9. **Enhancing Societal Relevance in Introductory Geoscience Education.** Elizabeth Nagy-Shadman, Pasadena City College, eanagy-shadman@pasadena.edu; Martha House, Pasadena City College, mahouse@pasadena.edu; Bryan Wilbur, Pasadena City College, bcwilbur@pasadena.edu.
10. **Theory and Practice: Engineering Geology in the Cordillera.** Kim Bishop, CSU–Los Angeles, kbishop@calstatela.edu.

Pacific Section, SEPM; The Paleontological Society

11. **New Insights into the Petrology of Mesozoic Cordilleran Batholiths.** Doug Morton, USGS, douglassmmorton@gmail.com; Diane Clemens Knott, CSU-Fullerton, dclemensknott@fullerton.edu.
12. **The Triassic Aftermath and Recovery from the End-Permian Mass Extinction.** Adam Woods, CSU-Fullerton, awoods@fullerton.edu; Dave Bottjer, USC, dbottjer@usc.edu.
13. **Climate-Biosphere Interactions through Time.** Nicole Bonuso, CSU-Fullerton, nbonuso@fullerton.edu; Matthew Clapham, UC-Santa Cruz, mclapham@ucsc.edu.

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

14. **Reservoir Modeling.** Tad Gladczenko, Chevron Research, tgladczenko@chevron.com.
15. **Fault-Associated Diagenesis and Fluid Flow.** James Boles, UC-Santa Barbara, boles@geol.ucsb.edu.
16. **Miocene Tectonics and Structural Evolution of Coastal Southern California.** Nate Onderdonk, CSU–Long Beach, nonderdo@csulb.edu.
17. **Society of Petroleum Engineers (SPE) General Sessions.** Hilario Camacho, camachoh@shpi.net.

Cordilleran Section, GSA and Pacific Section, AAPG

18. **Managing Groundwater in the Cordillera.** W. Richard Laton, CSU-Fullerton, wlaton@fullerton.edu; John Foster, CSU-Fullerton, jfoster@fullerton.edu.

Cordilleran Section, GSA; Pacific Section, AAPG; Pacific Section, SEPM; Council on Undergraduate Research (CUR)

19. **Undergraduate Research in Geoscience.** Tara Kneeshaw, CSU-Fullerton, tkneeshaw@fullerton.edu; Jeff Marshall, Cal Poly Pomona, marshall@csupomona.edu.

REGISTRATION

Standard registration deadline: 26 April 2010
Cancellation deadline: 3 May 2010

Online registration will begin in early February 2010, and registration fees will be published in the February *GSA Today*.

Final Report

David Szymanski

After spending the last year working in the office of Senator Jon Tester (D-Mont.), my fellowship has come to an end. Over the last month, in a bittersweet departure from Capitol Hill and Washington, D.C., I made the transition to academia, taking a position in the Department of Natural and Applied Sciences at Bentley University, a business school located just outside of Boston in Waltham, Massachusetts. Working in Congress for a year—and specifically the opportunities afforded me by Senator Tester and his staff—was unquestionably the best professional experience of my career. Seeing the legislative process from the inside had its ups and downs, but the experience fueled my passion for teaching science to non-scientists.

Folks in our line of work often say "science isn't done in a vacuum." We use the phrase to stress the importance of communicating with colleagues (and far less frequently, the public) about the significance of our work. We also say it to remind one another that our research is subject to the same personal biases and social norms as anything else in life. To department chairs and supervisors, it's also a euphemism for "I need money to attend a conference." In any case, the statement rightly implies that science extends beyond the walls of our offices, labs, and classrooms. Everything we do is connected, because the real world is not subject to the artificial boundaries of scientific disciplines.

It's not surprising, then, that we don't use the same kind of language when we talk about policy. For Americans in general, it seems that legislation *is* done in a vacuum. After spending a year on the Hill, it's clear to me that no other institution triggers such an instinctive love-hate reaction in folks as does the U.S. Congress. We tend to have a healthy respect for the system, at least in theory. As Winston Churchill eloquently summarized, "It has been said that democracy is the worst form of government except all those other forms that have been tried from time to time." At the same time, the legislative process appears persistently bogged down by an insular Congress, mired in partisanship, election cycles, parochial interests, and, yes, money.

For many earth scientists, climate change legislation in Congress serves as a premier example of legislating in a vacuum. Although most scientists can remain dispassionate about the data, most are also passionate advocates for using scientific data well. As a whole, earth scientists agree that anthropogenic contribution of greenhouse gases to the atmosphere is the primary driver of recent climate change. In fact, at the time of this writing (Sept. 2009), GSA is in the process of revising its own position statement on climate change. The current draft succinctly outlines the strengthening basis for concluding that humans are causing climate change and explicitly recommends "public policy that includes effective strategies for the reduction of greenhouse-gas emissions."

After fits and starts in previous sessions of Congress, the election and inauguration of President Obama seemed to be a watershed moment for advocates of legislation to cap domestic CO_2 emissions. In June, with leadership from the White House, the House of Representatives narrowly passed H.R.2454, the American Clean Energy and Security (ACES) Act of 2009, by a margin of 219–212. Although significant disagreement remains as to whether the bill takes the right tack for reducing emissions, its passage was unprecedented recognition of the link between energy and climate, and more importantly, the relevance of climate and earth science.

By mid-summer, however, it was clear that the Senate was focused on healthcare reform (or "health insurance reform," if you monitor the ebb and flow of political language). By mid-September, Majority Leader Harry Reid (D-Nev.) had signaled that the Senate would not likely take up climate legislation in 2009, given the packed Senate calendar for the rest of the session. This brings us to 2010 and mid-term elections: a tough time for tough votes. As a result, many climate advocates—especially those looking toward international negotiations at the United Nations Climate Change Conference in Copenhagen, Denmark, later this year—see the delay as a major failure in leadership, if not a potentially critical failure in reducing CO_2 emissions in a timely or meaningful way.

Is the delay in Senate action on climate change an example of legislating in a vacuum? It depends. Some laws, such as those dealing with civil rights, attempt to directly remediate what is viewed as a moral or social injustice. So, in some cases, civil rights laws can be passed even in the face of strong opposition because of an equally strong appeal to the conscience of elected leaders. In the case of climate legislation, it is impossible to directly remediate the problem, and therefore a single path forward is unclear, even in the face of dwindling opposition. An August 2009 poll by Zogby International (www.zogby.com) reported that an astounding 71% of likely voters favored the ACES bill passed by the House, but when presented with arguments for and against the specific plan, 41% thought the Senate should wait on action because of perceived economic consequences of putting a price on CO_2. A majority (54%) still favored Senate action after hearing the arguments, but the split indicates a lack of understanding about the immediacy of the problem.

Mitigating anthropogenic climate change is undoubtedly one of the most difficult challenges humans have ever faced. The complexity of the global carbon cycle—the trouble people have in appropriately weighing the risks of action vs. inaction, combined with the economic and diplomatic hurdles to even slow the rate of global CO_2 emissions—is staggering. Earth scientists may agree that the United States needs public policy to reduce emissions, but none of us has a legitimate claim on the best way to do it.

I don't think the delay on climate legislation is the result of doing policy in a vacuum; I think the number of variables in the problem overwhelms the legislative process. The evidence is that a majority of the public supports action on climate but consistently ranks climate change very low or dead last on a list of imminent problems facing the U.S. And so the problem gets kicked down the road.

What to do? The solution is certainly not to give up on creating good policy based on good science. As my predecessors and I have discussed in these pages, there are numerous ways for earth scientists to take part directly in policy development—and they do. But policy alone is not enough. Systems for reducing CO_2 emissions that have been discussed or introduced in Congress have been almost exclusively based on putting a price on carbon (cap-and-trade, carbon tax, etc.). It has been

alternately argued that the price signal in such a system will be too small to change consumer behavior or too large to make timely and targeted cuts economically feasible. In any case, consumers and businesses will ultimately be responsible for the reductions.

In addition to helping create policy in the short-term, earth scientists must also do a better job educating consumers and non-science professionals about the complexity of systems rather than framing "climate change" as a discrete problem. (Even connecting climate change to the increased frequency or intensity of natural disasters seems to be inadequate for assigning appropriate weight to risks.) There is no single best way to do this either, but in the long-term, systems thinking is an indispensible tool for making personal and corporate decisions about energy use and sustainability. In moving to Bentley University, my goal is to help the next generation of business leaders integrate science-based systems thinking into their professional lives and, in turn, move toward more sustainable decisions in the use of resources.

In a final note, I want to express my sincerest gratitude to GSA members and leadership and the U.S. Geological Survey for the opportunity to spend a year working and learning in Congress. I am often asked if spending a year in D.C. improved or tarnished my views on our system for making laws. Of course, after having a year to polish my political skills, I always respond "both." In reality, my views have not changed. I had my share of frustrations, but for all its flaws, it really is a good system. As in any institution, it's up to the participants to make it work. Fortunately, we are all participants.

This manuscript is submitted for publication by David Szymanski, 2008–2009 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. 08HQGR0141. 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. *Szymanski can be reached at dszymanski@bentley.edu.*

Donna L. Russell, *Director of Operations*

Hiatus—Good News from Bad News?

Robert L. Fuchs, *Honorary GSA Foundation Trustee*

Hiatus: A break or interruption in the continuity of the geologic record; a lapse in time; a gap in sequence; any gap or opening.

If you are a post-70½ senior with an IRA, you are one of that special group of citizens required to withdraw a certain amount from your IRA each year. Except for 2009. This year, we withdrawers are enjoying a hiatus, not the geologic kind, but a one-year waiver of our required minimum distributions (RMDs).

This sounds like good news but, unfortunately, it is an outcome of a lot of bad news. The extraordinary collapse in investment values in 2008–2009 and the shocking decline in personal wealth—savings, individual retirement accounts (IRAs), real estate, personal earnings—has led to numerous incentives intended to bring the economy back to its feet—Troubled Asset Relief Program (TARP), Term Asset-Backed Securities Loan Facility (TALF), bank bailouts, Cash for Clunkers, and so on. As one of these stimuli, and in a modest attempt to ease the financial pain seniors have suffered as a result of their suddenly reduced personal estates, legislation was passed late last year suspending those pesky RMDs for 2009. (Note: This federal program is *not* called Cash for Codgers.)

So the constant deluge of bad news over several years has brought us a bit of good news in the form of some financial breathing room. Just like a hiatus in the geologic record, this event could represent a turning point—a time to do something different. If your IRA assets haven't been entirely devastated by the recession, this year's suspension of RMDs provides an opportunity to make a direct charitable donation from your IRA to the GSA Foundation. This popular giving technique, a "qualified charitable distribution" in IRS parlance, has been available for several years and has the decided advantage of avoiding the usual taxes on IRA distributions, since the money goes straight from your account to the Foundation, 100 cents on the dollar.

This is also a good year to set up the GSA Foundation as a beneficiary of your IRA, say in the percentage that you would have been required to withdraw. For example, if your 2009 RMD calculation was 5% of the 2008 year-end value, designate the Foundation as a 5% beneficiary. If the Foundation is already a beneficiary of your IRA, increase its share by this 5%. Remember that in final estate distributions, charitable gifts are 100% tax efficient—direct from the IRA to the charity and no tax due whatsoever.

The 2009 RMD hiatus may not be as monumental an event as those in the geologic record—it's not a K-T boundary, no species will disappear—but it certainly affords us the chance to make important gifts, current or future, to the GSA Foundation.

DEADLINE FOR RECEIVING A TAX CREDIT IN 2009

Your 2009 contribution to the GSA Foundation must be postmarked no later than 31 December 2009 in order for you to receive a credit on your 2009 income taxes.

You may send your contribution directly to the GSA Foundation office, attn. Donna Russell, 3300 Penrose Place, Boulder, Colorado 80301, USA; or call the GSA Foundation directly at +1-303-357-1054. You may also donate online at www.gsaf.org.

I extend my sincere appreciation to the GSA membership for all your contributions to the GSA Foundation and for your support of GSA programs. Thank you so much!

Most memorable early geologic experience:

William E. Ham (Oklahoma) never let the lack of sunlight keep him from an outcrop. "Car headlights are good enough for field work, after the sun goes down!"

—Kenneth S. Johnsen

Support GSA Programs

Donate now!

cut out or copy

1. **Enclosed is my contribution in the amount of $_____**
2. Please credit my contribution to
   - ❑ Greatest Need
   - ❑ GSA Membership Fund
   - ❑ Other:_____Fund
   - ❑ I have named GSA Foundation in my Will *(please contact me)*
3. Name _____
   Address _____
   City / State / Zip _____
   Phone _____
4. Mail to:
   GSA Foundation
   P.O. Box 9140
   Boulder, CO 80301

Or donate online at **www.gsafweb.org**

GSA Foundation Establishes Membership Fund

Do you remember why you became a GSA member? Did you want access to GSA publications, to attend a GSA meeting, or maybe to apply for a research grant?

Whether GSA is your only professional organization or one of many, being part of a scientific network is important for professional development. You can now help others gain some of these same advantages and collectively contribute to the advancement of the geosciences.

GSA Council recently approved the Membership Fund, a new program to facilitate GSA membership—members helping others to become GSA members. Contributions to the Membership Fund make it possible for individuals who cannot afford the cost of membership, or those who experience difficulty transferring funds from their country to the USA, to become GSA members. This program also provides for membership in one special interest Division.

The Membership Fund is available to qualified applicants worldwide and for all membership categories—professional, student, recent graduate, K–12 teacher, and affiliate.

You can make a contribution in any amount in support of GSA's Membership Fund by check using the GSA Foundation coupon on the opposite page; by including it with your 2010 membership renewal; or online at www.gsafweb.org.

Thank you for your consideration in helping others to become GSA members and in growing our geoscience community.

In Memoriam

GSA regretfully reports the deaths of the following members. Notifications were received between 26 July and 30 Sept. 2009.

Dwight R. Crandell
Lakewood, Colorado, USA
notified 19 August 2009

Edward C. Dapples
Centennial, Colorado, USA
10 May 2009

Edward S. Davidson
Tucson, Arizona, USA
7 August 2009

Elizabeth Gealy
La Jolla, California, USA
notified 28 September 2009

Sydney B. Lumbers
Santa Fe, New Mexico, USA
notified 7 August 2009

Robert L. Maby Jr.
Houston, Texas, USA
3 February 2009

William W. Patton Jr.
Menlo Park, California, USA
2 June 2009

Daniel B. Sass
Charlotte, North Carolina, USA
notified 7 August 2009

John C. Wilson
Denver, Colorado, USA
25 September 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 download.

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.**

Classified Rates—2009

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

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

Positions Open

VISITING ASSISTANT PROFESSOR GRAND VALLEY STATE UNIVERSITY

The Geology Dept. invites applications for at least two non-tenure-track Visiting Assistant Professor positions to for the 2010-2011 academic year to replace tenured faculty members on sabbatical. We seek creative and dynamic educators who demonstrate enthusiasm for the pursuit of geoscience knowledge and effective education of undergraduate students. Preference will be given to candidates with a geosciences background and a Ph.D. or ABD and demonstrated geoscience teaching skills, and/or previous teaching experience. Primary teaching responsibilities include introductory courses and upper-level general education theme courses. At least one of the successful candidates must be able to teach a majors' course in Global Tectonics. One of these positions has the potential to continue for up to three years. Visiting faculty members are encouraged to mentor undergraduate research projects.

The geology dept. includes 11 tenure-track faculty and ~80 majors (geology and earth science) and serves ~250 integrated science majors. The department values field experiences and collegial faculty-student interactions: **www.gvsu.edu/geology.**

Applicants should send a letter of application, vitae, a statement summarizing teaching philosophy and teaching and research interests and experiences, and the names and contact information for at least three references familiar with your teaching and/or research to: Dr. Ginny Peterson, Dept. of Geology, Grand Valley State University, Allendale, MI 49401; petersvi@gvsu.edu; +1-616-331-3728. Applications will be accepted until all needed positions are filled. Review of applications will begin on 25 January 2010. We strive to build a diverse and equitable community of scholars and teachers in our department and encourage all qualified applicants to apply regardless of gender, race, sexual orientation, disability and/or national origin. Grand Valley is an affirmative action, equal opportunity institution.

FACULTY, GEOLOGICAL SCIENCES SALEM STATE COLLEGE

Salem State College, located just 21 miles north of Boston, is the third largest public institution of higher education in Massachusetts and an important partner in the economic, cultural and intellectual vitality of the greater north-of-Boston region. Its mission is to educate and prepare a diverse community of learners to contribute responsibly to our global society.

Faculty, Geological Sciences, Full-Time, Tenure-Track, Fall 2010.

Salem State College is seeking to fill a full-time tenure track faculty position for Academic Year 2010-2011 in Geological Sciences. Faculty members also advise students, perform college service and pursue research as a part of a cooperative and collegial faculty. The faculty member will participate in the departmental field camp in Montana. This position is advertised subject to available funding.

Required qualifications include a Ph.D. in Geology.

Preferred qualifications include previous University/College teaching experience. Experience in and commitment to teaching in a multiracial, multiethnic environment with students of diverse backgrounds and learning styles, as well as in distance learning and instructional technologies, and candidates who enjoy serving as role models and mentors for a diverse student body. The salary is competitive and commensurate with education and experience.

To see the full list of benefits and review the complete job description and to apply online, go to **https://jobs.salemstate.edu** (search by department: Geological Sciences) and attach your CV/resume and cover letter. Send appropriate original transcripts and three letters of reference to Human Resources and Equal Opportunity, 352 Lafayette Street, Salem, MA 01970.

Salem State College is an Equal Opportunity/Affirmative Action Employer. Persons of color, women and persons with disabilities are strongly urged to apply.

PROFESSOR OF PRACTICE IN GEOLOGY TULANE UNIVERSITY

The Dept. of Earth & Environmental Sciences seeks to fill a non-tenure track, Professor of Practice position to teach introductory courses in geology, to supervise introductory geology laboratory courses, and to teach other courses related to their field of expertise. We seek an individual possessing an enthusiastic dedication to teaching who is willing to make a long-term commitment to the department and the university. The initial appointment will be for three years with the possibility of renewal after a performance review at the end of the second year. The deadline for applications is 10 January 2010, but the position will remain open until filled. Applications should include a curriculum vitae, a statement of teaching interests and goals, and the names and contact information of at least three referees to Dr. Stephen Nelson, Dept. of Earth & Environmental Sciences, Tulane University, 6823 St. Charles Ave., New Orleans, LA 70118-5698; snelson@tulane.edu, with e-mail preferred. Further information about the department and University can be obtained at **http://tulane.edu/sse/eens.** Tulane University is an affirmative action/equal opportunity employer. Women and minorities are encouraged to apply.

ASSISTANT/ASSOCIATE PROFESSOR OF GEOLOGY SOUTHERN UTAH UNIVERSITY

The Dept. of Physical Science at Southern Utah University is searching for a full-time, tenure track Assistant/Associate Professor of Geology to start 16 August 2010. Salary is commensurate with qualifications & experience.

Duties & Responsibilities: Teach diverse geology courses at the undergraduate level, including: freshman general, structural geology, environmental geology; advise students; Work effectively as a member of the Physical Science Dept.; establish an externally funded undergraduate research program that complements existing efforts in the department; serve on department, college, and university committees; other assignments as determined by department chair and dean.

Minimum Qualifications: Ph.D. in geology with a specialty in structural geology and demonstrated success in, and a strong commitment to, undergraduate teaching and research; demonstrated ability to teach structural and additional geology courses; strong oral and written communication skills, leadership skills and ability to work effectively with colleagues in an undergraduate academic setting are essential.

To ensure full consideration, please create your application through **http://jobs.suu.edu** and attach the following documents: cover letter, resume/CV, contact information for at least three professional references, statement of teaching philosophy, statement of research philosophy, and copies of unofficial transcripts. Full consideration will be given to applications received by 4 January 2010; open until filled. Questions can be directed to Human Resources at jobs@suu.edu or +1-435-586-7754.

Southern Utah University is an Affirmative Action/Equal Opportunity Employer.

LECTURER IN EARTH SCIENCES NORTHERN ARIZONA UNIVERSITY

The Geology Program in the School of Earth Sciences and Environmental Sustainability at Northern Arizona University invites applications for a full-time, non-tenure-track lecturer position, beginning in August 2010. Minimum qualifications for this position are an M.S. in Earth Science or related discipline AND experience teaching at least one undergraduate lecture course in an earth sciences discipline.

Preferred qualifications include

- Ph.D. in an earth sciences discipline
- demonstrated evidence of positive teaching effectiveness
- interest in/ability to improve introductory geology lecture courses
- interest in/ability to improve introductory geology lab courses
- interest in/ability to enhance field experiences for lower division students
- experience teaching courses in geologic disasters or hazards and physical geology
- experience teaching large lecture sections
- familiarity with the geology of the Colorado Plateau
- demonstrated experience working with undergraduate students with limited background in natural or physical sciences
- demonstrated experience in use and teaching of geospatial information systems
- experience in and commitment to working with diverse faculty, students, and staff
- evidence of interest in employing successful, research-tested teaching methods in Earth Science courses.

Please see **www.nau.edu/hr** for full position announcement and application procedures. Northern Arizona University is an AA/EEO/MWDV employer.

GEOLOGIST/CLASTIC SEDIMENTOLOGIST WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY (WGNHS)

The Wisconsin Geological and Natural History Survey (WGNHS) is recruiting for a full-time, tenure-track faculty position available 1 July 2010. Duties include conducting fundamental and applied research in the areas of clastic sedimentology through field-based investigations, including geologic mapping, focusing on the stratigraphic and hydrostratigraphic framework of Quaternary and/or Paleozoic sediment and rocks of Wisconsin. Work will be performed in cooperation with other survey staff, university personnel, and collaborating local, state, and federal agencies whose interests may include geology, geophysics, hydrogeology, and mineral/energy resources. This position also has a role in the leadership of related outreach and educational functions within the WGNHS.

Salary minimum: $52,000, excellent benefits package. Office is located in Madison, Wisconsin. Applications will be reviewed beginning 12/29/2009.

For a complete position description and how to apply, please visit **www.uwex.edu/ces/hr.**

AA/EEO Employer.

FACULTY POSITION IN CLIMATE AND GLOBAL CHANGE, UNIVERSITY OF FLORIDA

The Dept. of Geological Sciences, University of Florida, invites applications for a tenure-track faculty position in climate change research to start Fall 2010. The appointment is at the rank of Assistant Professor; however, appointments at the Associate Professor rank will be considered. We seek an exceptional scientist to complement existing departmental research on the environment and past variations in Earth's climate. The successful candidate must have an established record of publication in peer-reviewed scientific journals, clear potential to lead an externally-funded research program, and enthusiasm for teaching and mentoring graduate and undergraduate students. We are interested in applicants with expertise in the broad fields of paleoclimatology, paleoceanography, paleolimnology, and global climate change, particularly geochemists who would develop existing stable isotope facilities as a center for interaction within the department as well as with other colleges and interdisciplinary institutes and centers at UF. Salary will be negotiable and commensurate with experience. For more information, visit **http://web.geology.ufl.edu/search/facultyposition.html.**

Applicants should hold a Ph.D. at the time of application, and supply: (a) a curriculum vitae, including a publication list and details of research funding; (b) a teaching statement; (c) a research statement, including future goals; (d) a list of at least three references. Submit a pdf of the application the Search Committee chair by 21 December 2009 (Ellen Martin, eemartin@ufl.edu, Ref #00025354). All applicants must complete the online data form at **http://www.hr.ufl.edu/job/datacard.htm.** The University of Florida is an equal opportunity institution dedicated to building a broadly diverse and inclusive faculty and staff. Women, minorities and members of other under-represented groups are encouraged to apply.

HYDROLOGY/ENVIRONMENTAL GEOLOGY GEORGIA COLLEGE AND STATE UNIVERSITY

The Dept. of Biological and Environmental Sciences at Georgia College & State University invites applications for a Hydrologist/Environmental Geologist. This is a tenure-track position and will be hired at the assistant

professor level. A Ph.D. in geology, environmental science, or related field is required. We seek a broadly trained individual who is committed to liberal arts education and can demonstrate excellence in teaching and research. In addition to Hydrology and Physical/Historical Geology, teaching duties could include Environmental Geology, Soils, and Environmental Science. See **www.gcsujobs.edu** for required qualifications and application details. All applications must be completed on-line. For questions about the position, contact Dr. Al Mead, Chair, Geology Search Committee, Dept. of Biological and Environmental Sciences, Georgia College & State University, Milledgeville, GA 31061; al.mead@gcsu.edu; +1-478-445-1091; Fax: +1-478-445-5290. Position to begin 1 August 2010. Review of applications to begin on 11 January 2010 and will continue until the position is filled. GCSU is an Equal Opportunity Employer.

ASSISTANT/ASSOCIATE PROFESSOR
SEISMOLOGY/SEISMIC EXPLORATION
UNIVERSITY OF UTAH

The Dept. of Geology and Geophysics at the University of Utah seeks applicants for a tenure track position at the Associate or Assistant Professor level in Seismology/Seismic Exploration.

The individual in this position will have a strong commitment to excellence in education and will teach a broad range of courses at the undergraduate and graduate levels. The individual will establish a strong externally funded research program and supervise graduate students.

The individual will participate fully in the internal governance of the department and contribute to service and outreach activities appropriate for faculty members.

Educational Requirements: Ph.D. in Geophysics or Allied Fields

Research and Teaching Specialties: The area of specialization is open but includes seismic imaging, processing and interpretation of seismic array data, inversion, and integrated interpretation with other geophysical data. Multiple opportunities for collaboration and funding exist, including capitalizing on the experience of the past and existing research and educational consortia.

Deadline: Review of applicants will begin 1 January 2010 and continue until the position is filled.

For additional information regarding the position and submission requirements, visit our Web site at **www.earth.utah.edu.**

ASSISTANT PROFESSOR
MINERALOGY/PETROLOGY
DEPARTMENT OF GEOLOGICAL SCIENCES
BALL STATE UNIVERSITY, MUNCIE, INDIANA

Tenure-track position with specialization in mineralogy/petrology with secondary area of sedimentary, metamorphic, economic geology, geoinformatics, or structural geology available 19 August 2010. Responsibilities: teaching introductory mineralogy course and advanced coursework in specialty area(s); regularly teaching introductory geology and/or oceanography; performing and advising scholarly research; developing external funding and publishing in appropriate refereed outlets; participating in service functions of the department. Minimum qualifications: Ph.D. in geology or closely related field by 1 August 2010; appropriate background to teach mineralogy and at least one of the secondary areas defined above. Preferred qualifications: college teaching and/or professional experience; research demonstrating potential for extramural funding; record of effective interaction with students and faculty on individual projects and research. Excellent benefits, including retiree health care and 100% pension contribution for eligible employees.

Electronically send letter of application, curriculum vitae, statement of teaching and research interests and goals, transcript of highest degree earned, and names and contact information for at least three professional references to knichols@bsu.edu. Application materials should be in PDF format. Dr. Kirsten Nicholson is Search Committee Chair. Review of applications will begin immediately and will continue until the position is filled; **www.bsu.edu/geology.**

The Dept. of Geological Sciences seeks to attract a culturally and academically diverse faculty of the highest caliber. Ball State University is an equal opportunity, affirmative action employer and is strongly and actively committed to diversity within its community.

ASSISTANT PROFESSOR, PHYSICAL GEOGRAPHER
DEPARTMENT OF GEOSCIENCES
MURRAY STATE UNIVERSITY

Full-time, tenure-track position to begin August 2010. **Qualifications:** Ph.D. required. ABDs with a documented plan of completion by appointment date will be considered. Excellent teaching skills including use of modern classroom technologies required. Must demonstrate research potential in physical geography as evidenced by publication or other scholarly activity. Experience with remote sensing and/or GIS methodologies required. **Responsibilities:** Teach introductory courses in the geosciences and upper-level courses in the candidate's area of expertise. Conduct research, pursue external funding, and supervise student research at the undergraduate and graduate levels. **Application deadline:** Postmarked by 15 January 2010. To Apply: Submit a letter of interest, curriculum vita, statement of teaching and research interests, copies of transcripts, and three letters of reference to Dr. Haluk Cetin, Chair, Search Committee, Dept. of Geosciences, 104A Wilson Hall, Murray State University, Murray, KY 42071. Phone: +1-270-809-2085. Women and minorities are encouraged to apply. Murray State University is an equal education and employment opportunity, M/F/D, AA employer.

ASSISTANT PROFESSOR
EARTH SURFACE PROCESSES
UNIVERSITY OF TENNESSEE AT CHATTANOOGA

The University of Tennessee at Chattanooga Geology Program invites applicants for an assistant professor tenure-track appointment to begin August 2010. We seek a Ph.D. geologist with research interests in low-temperature aqueous geochemistry, hydrology, clay mineralogy or soil science. The successful candidate will

continued on p. 26

continued from p. 25

be committed to undergraduate teaching, demonstrate familiarity with modern research and geotechnical tools and techniques, and possess excellent communication and interpersonal skills. Teaching responsibilities will include introductory geology, upper-level courses in areas of expertise, and supervision of undergraduate research. Send curriculum vitae, transcripts, a statement of teaching philosophy and research interests, and three letters of recommendation to Dr. Habte G. Churnet, Head, Dept. of Physics, Geology, and Astronomy #6556, 615 McCallie Avenue, The University of Tennessee at Chattanooga, Chattanooga, TN 37403. Review of application materials will begin 15 January 2010 and will continue until the position is filled. The University of Tennessee at Chattanooga is an equal employment opportunity/affirmative action/Title VI & IX/Section 504/ADA/ADEA institution.

TWO POSTDOCTORAL POSITIONS PLANETARY SCIENCES, PURDUE UNIVERSITY

Purdue University has launched a new initiative in Planetary Sciences, with a strong effort in planetary geodynamics and impact cratering mechanics lead by Jay Melosh and Andy Freed. We currently seek to fill two postdoctoral positions (initially one year appointments with the possibility of extension for up to three years). We seek two people with strong quantitative and modeling backgrounds. One project involves a study of impact basin ring formation on the Moon and Mercury in support of the *GRAIL* and *MESSENGER* missions. This will mainly use finite element methods. The second project applies hydrocode models of impact cratering (iSALE) and numerical equations of state to understand the formation of the core and magma oceans in the early Earth as well as extensions to the impact origin of the Moon. Both projects require a background in UNIX and FORTRAN programming.

Applicants must have a Ph.D. in a field related to planetary science and appropriate computer and modeling skills. Salary and benefits are highly competitive. The appointments can begin as early as January 2010. Applications should include a CV, bibliography, and names of at least three referees. We prefer electronic submission directly to jmelosh@purdue.edu. Applications completed by 1 January 2010 will be given full consideration, although the search will continue until the positions are filled.

Purdue University is an Equal Opportunity/Equal Access/Affirmative Action employer fully committed to achieving a diverse workforce.

FACULTY POSITION IN PLANETARY SCIENCES PURDUE UNIVERSITY

Purdue University has launched a strong new initiative in Planetary Sciences. Jay Melosh has joined the Purdue faculty and, together with Andy Freed, Marc Caffee, and Brenda Beitler Bowen, has a mandate to expand planetary sciences by adding two more faculty and several postdocs over the next two years. This year, we seek a broadly based individual for a tenure-track position at the assistant or associate professor level, depending upon the candidate's experience.

The successful candidate will be an outstanding researcher with potential for excellence in teaching at both the graduate and undergraduate levels. We seek someone who will compliment our existing strengths in modeling and isotopic cosmochemistry. We especially seek someone with expertise in planetary remote sensing. The department of earth and atmospheric sciences presently has outstanding programs in geodynamics, isotope geochemistry, terrestrial climate, and extreme weather systems.

Applicants must have a Ph.D. in field related to planetary science. Salary and benefits are highly competitive. The appointment will begin in August 2010. Candidates are expected to develop a vigorous research program, obtain external funding, supervise graduate students, and teach undergraduate and graduate courses. Interested candidates should submit their curriculum vitae, publication list, and brief descriptions of their planned research program and teaching philosophy to **planetarysearch@purdue.edu.** Names and contact information for at least three referees must be included in the application. Information on the EAS department can be found at **http://www.purdue.edu/eas/.** Applications completed by 15 January 2010 will be given full consideration, although the search will continue until the position is filled.

Purdue University is an Equal Opportunity/Equal Access/Affirmative Action employer fully committed to achieving a diverse workforce.

ASSISTANT PROFESSOR STRUCTURAL GEOLOGY BOONE PICKENS SCHOOL OF GEOLOGY OKLAHOMA STATE UNIVERSITY (OSU)

The Boone Pickens School of Geology at Oklahoma State University (OSU) seeks applications for a tenure-track faculty position in the broad area of structural geology. We are particularly interested in someone with interest in one or more of the following research areas: structural analysis of petroleum reservoirs, basin evolution, continental tectonics, neotectonics. The appointment will be at the assistant professor level and effective August 2010. The applicant is required to have a Ph.D. degree in geology or related field at the time of appointment. The applicant must show promise of an outstanding research program and be committed to excellence in teaching. The successful candidate will be expected to supervise M.S. and Ph.D. level graduate students and develop courses in her or his specialty. In addition she/he will participate in teaching introductory geology courses and teach a core geology curriculum course in structural geology.

The successful candidate will join a faculty of eleven geoscientists and will be part of the sedimentary geology, petroleum geology, and tectonics research groups that include six other faculty and has close ties to the petroleum industry. In addition to other research facilities the School of Geology has the Devon Teaching and Research Laboratory, which contains state-of-the-art 3-D image processing facilities.

Candidates should submit a letter of application, including a discussion of research interests and approach to teaching, along with a curriculum vitae and the names, addresses, e-mail addresses, and phone numbers of three references to Assistant Professor Position Search, Boone Pickens School of Geology, 105 Noble Research Center, Oklahoma State University, Stillwater, Oklahoma 74078-3031; phone: +1-405-744-6358; fax:+1-405-744-7841. Inquires about this position may be directed to Dr. Todd Halihan (todd.halihan@okstate.edu) or Dr. Jay Gregg (jay.gregg@okstate.edu) at the above address. Screening of candidates will begin 31 December 2009 and continue until the position is filled. Filling of this position will be dependant on the availability of funding.

More information on OSU and the Boone Pickens School of Geology can be found on the Web **http://osu.okstate.edu** and **http://geology.okstate.edu**, respectively. Committed to health and safety Oklahoma State University maintains a tobacco free work environment. Oklahoma State University is an Affirmative Action/Equal Opportunity/E-Verify employer committed to diversity.

TENURE TRACK FACULTY POSITION IN SEISMOLOGY, TEXAS A&M UNIVERSITY

The Department of Geology & Geophysics at Texas A&M University invites applications for a tenure-track faculty position in reflection seismology beginning September 2010. The position is offered at the Assistant Professor level.

The successful applicant will establish an active, innovative research program while complementing current departmental strengths in petroleum geology and geophysics, sedimentology, stratigraphy, and structural geology and will participate actively in the newly established Berg-Hughes Center for Petroleum and Sedimentary Systems. Furthermore, opportunities exist to participate in and build on collaborative programs with colleagues in petroleum engineering, oceanography, and elsewhere at Texas A&M University. Applicants must have a Ph.D. in Geophysics, Geology or a related field at the time of appointment. Post-doctoral research and teaching experience are desirable.

The successful applicant will be expected to teach effectively at the undergraduate and graduate levels in geology and geophysics, including classes in the petroleum seismology curriculum; supervise undergraduate, M.Sc. and Ph.D. students; and initiate and maintain a vigorous externally funded research program.

Interested candidates should submit electronic versions of a curriculum vita, statement of research interests and teaching philosophy, the names and email addresses of at least three references, and up to four reprints by email attachments, to the Chair of the Sedimentary Geology Search Committee, seismosearch@geo.tamu.edu. Screening of applications will begin 15 January 2010 and will continue until the position is filled.

The Department of Geology and Geophysics (**geoweb.tamu.edu**) is part of the College of Geosciences, which also includes the Departments of Geography, Oceanography, and Atmospheric Sciences, Sea Grant, the Geochemical and Environmental Research Group (GERG), and the Integrated Ocean Drilling Program (IODP). Texas A&M University, a land-, sea-, and space-grant university, is located in a metropolitan area with a dynamic and international community of 152,000 people. Texas A&M University is an affirmative action/equal opportunity employer committed to excellence through the recruitment and retention of a diverse faculty and student body and compliance with the Americans with Disabilities Act. We encourage applications from minorities, women, veterans, and persons with disabilities. Texas A&M University also has a policy of being responsive to the needs of dual-career partners (**hr.tamu.edu/employment/dual-career.html**).

Opportunities for Students

Graduate Assistantships, Indiana State University. The Dept. of Earth & Environmental Systems at Indiana State University has graduate assistantships available for students wishing to pursue an MS degree in Earth and Quaternary Sciences beginning Fall 2010. The ISU Geoscience Program offers a new and exciting field- and laboratory-intensive curriculum emphasizing, environmental geology and geochemistry, medical geology, geoarchaeology surface processes, sediment transport, sequence stratigraphy, Quaternary paleoecology, geobiology, dendrochronology, paleoproductivity, paleoceanography, marine geology and geochemistry, biogeochemistry, climatology, and paleoclimatology. The department supports a number of state-of-the-art laboratory facilities, and our faculty are committed to providing students with hands-on learning experiences. Application review begins immediately and preference is given to applications received before 1 Feb. 2010. Application forms can be obtained by visiting **http://www1.indstate.edu/geol_anthro/geology/geology-master.html.** For more information contact Dr. Anthony Rathburn, Dept. of Earth & Environmental Systems, Indiana State University, Terre Haute, Indiana 47809, Tony.Rathburn@indstate.edu.

Graduate Fellowships in Sustainability Science. Maine's Sustainability Solutions Initiative offers unprecedented opportunities for graduate students to experience a truly interdisciplinary learning experience through a $20-million, 5-year program funded by NSF EPSCoR. SSI's mission is to create an integrative research program and strong stakeholder partnerships to generate improved solutions to intersecting ecological, social, and economic challenges. Graduate students will participate in collaborative research experiences with interdisciplinary faculty teams focused on urbanization, forest ecosystem management, and climate change. These efforts address the dynamics of social-ecological systems with an emphasis on moving from knowledge to action. Students with backgrounds in a wide range of disciplines are encouraged to apply; e.g., social sciences, biological, earth, and chemical sciences, natural resource management, communication, engineering, education, mathematics, and more.

Up to 25 Ph.D. fellowships will be awarded at the University of Maine beginning in fall 2010. Fellowships include a stipend of $20–25,000/yr, a tuition waiver, and health insurance subsidy. Masters degrees opportunities will be offered at the University of Southern Maine.

For more information, visit **www.umaine.edu/sustainabilitysolutions.**

UCLA Ion Microprobe Student Workshop (16–19 Feb. 2010). The UCLA SIMS laboratory hosts an annual 4-day workshop on ion microprobe applications in Earth Sciences. The workshop emphasizes microanalytical geochronology and stable isotope geochemistry with large radius magnetic sector SIMS. Arrival and departure dates are February 15 and 20, respectively. NSF's Instrumentation and Facilities program will sponsor student travel, accommodation costs, and course materials for domestic participants. Graduate students and advanced undergraduates (with recommendation letter of an academic supervisor) can apply via **http://sims.ess.ucla.edu/STUDENTWORKSHOP.php.** Applications will be accepted up to 12/18/09 with notifications sent on 12/18/09.

Graduate Assistantships. New Program in Planetary Sciences. Purdue University has launched a new initiative in Planetary Sciences and several Graduate Research Assistantship positions are available for quan-

titative studies of bodies that include the terrestrial planets, icy moons, comets and asteroids and topics that range from impact cratering to the origin and spread of life in the Universe.

Applicants must have a B.S. in a field related to Planetary Science and seek a M.S. or, preferably, a Ph.D. degree. Interested students are urged to apply to the Earth and Atmosphere Sciences department for admission in the Fall, 2010 semester. Applicants should visit **http://www.purdue.edu/eas/academic_programs/graduate/admissions.html** for detailed instructions on how to apply. Questions may be directed to Jay Melosh at jmelosh@purdue.edu.

Purdue University is an Equal Opportunity/Equal Access/Affirmative Action employer fully committed to achieving a diverse student body.

Fellowship Opportunities

TURNER POSTDOCTORAL FELLOWSHIP THE UNIVERSITY OF MICHIGAN

The Dept. of Geological Sciences invites applications for the Turner Postdoctoral Fellowship, a highly competitive two-year research fellowship in any field of the geological sciences. This fellowship also provides travel and research funds in addition to salary and benefits. The department is interested in innovative research with preference for proposals that have a direct connection to the ongoing research of a faculty member. Visit our department Web site for more information on faculty and research: **http://www.lsa.umich.edu/geo.** A complete application includes a curriculum vitae, a research proposal (3–5 pages) and the names and addresses of at least three references. Applications are due by 31 December 2009 and can be submitted to turnerpdf@umich.edu or Turner Postdoctoral Committee, Dept. of Geological Sciences, University of Michigan, 1100 North University Avenue, Ann Arbor, MI 48109-1005.

The University of Michigan is an affirmative action/equal opportunity employer.

INTERDEPARTMENTAL POSTDOCTORAL FELLOWSHIP IN GEOSCIENCES YALE UNIVERSITY

The Dept. of Geology and Geophysics at Yale University, **www.geology.yale.edu**, seeks applicants for a postdoctoral fellowship in research that links geosciences (studies of the solid earth, oceans, atmosphere, climate, and the evolution of life) with other sciences, including, but not limited to, astronomy and astrophysics; environmental studies; physics; chemistry; biology; engineering; anthropology; medical science and public health; economics and political science.

This Postdoctoral Associate position is awarded for two years, contingent on satisfactory progress, and provides a stipend ($49,000/yr) and base research funds ($5,000/yr), plus health care benefits and limited expenses for relocation.

The Interdepartmental Postdoctoral Fellowship will have at least two faculty collaborators: the primary sponsor will be from Geology and Geophysics, while others are from one or more other Yale departments. Interested candidates should first contact a faculty member in Geology and Geophysics to define a research theme and to identify other appropriate faculty collaborators. Applicants should submit a curriculum vita, a list of publications, an interdisciplinary research proposal (2–3 pages, in which the Yale collaborators are identified), and a brief letter of endorsement from each of the Yale faculty collaborators. Applicants should also arrange for three reference letters to be sent directly to the department. The deadline for receipt of all application materials is 15 January 2010, and decisions will be announced by or shortly after 15 March 2010. Successful candidates are expected to begin their program at Yale between 1 July and 31 December 2010.

Application materials and reference letters should be sent by e-mail (interdepartmental.fellowship@geology.yale.edu) or by post: Interdepartmental Postdoctoral Fellowship, Yale University, Dept. of Geology and Geophysics, PO Box 208109, New Haven, CT 06520-8109. Yale University is an equal opportunity/affirmative action employer; applications from women and minority scientists are strongly encouraged.

FLINT POSTDOCTORAL FELLOWSHIP IN GEOSCIENCES, YALE UNIVERSITY

The Dept. of Geology and Geophysics at Yale University, **www.geology.yale.edu,** announces the 2009 competition for the Richard Foster Flint Postdoctoral Fellowship. We welcome applicants with research interests in climatic processes as well as Cenozoic climatic history. Specific research areas include, but are not limited to, glaciology; climate dynamics; atmospheric and ocean circulation; low-temperature geochemistry; coupling between tectonics, climate and surface processes; paleoclimate; and biological response to climate change. The Postdoctoral Associate position is awarded for two years, providing a stipend ($49,000/yr) and base research funds ($5,000/yr), plus health care benefits and limited expenses for relocation. Applicants should contact a sponsor in the department to identify potential research projects, and then submit a short (2–3 page) statement of research interests and proposed research, a curriculum vita, and list of publications. The sponsor's name should be clearly identified in the research statement. Applicants should also arrange for three reference letters to be sent directly to the department. The deadline for receipt of all application materials is 15 January 2010, and decisions will be announced by or shortly after 15 March 2010. Successful candidates are expected to begin their program at Yale between 1 July and 31 December 2010.

Application materials and reference letters should be sent by e-mail (flint.fellowship@geology.yale.edu) or by post to Flint Postdoctoral Fellowship, Yale University, Dept. of Geology and Geophysics, PO Box 208109, New Haven, CT 06520-8109. Yale University is an equal opportunity/affirmative action employer; applications from women and minority scientists are strongly encouraged.

BATEMAN POSTDOCTORAL FELLOWSHIPS IN GEOSCIENCES, YALE UNIVERSITY

The Dept. of Geology and Geophysics at Yale University, **www.geology.yale.edu,** announces an annual competition for one or more Bateman Postdoctoral Fellowships. We welcome applicants with research interests across the full range of disciplines within the Earth Sciences, including studies of the solid earth, oceans, atmosphere, climate dynamics, geochemistry, paleoclimatology, and the evolution of life. Each of these Postdoctoral Associate positions is awarded for two years, providing a stipend ($49,000/yr) and base research funds ($5,000/yr), plus health care benefits and limited expenses for relocation. Applicants should contact a sponsor in the department to identify potential research projects, and then submit a short (2–3 page) statement of research interests and proposed research, a curriculum vita, and list of publications. The sponsor's name should be clearly identified in the research statement. Applicants should also arrange for three reference letters to be sent directly to the department. The deadline for receipt of all application materials is 15 January 2010, and decisions will be announced by or shortly after 15 March 2010. Successful candidates are expected to begin their program at Yale between 1 July and 31 December 2010.

Application materials and reference letters should be sent by e-mail (bateman.fellowship@geology.yale.edu) or by post to Bateman Postdoctoral Fellowship, Yale University, Dept. of Geology and Geophysics, PO Box 208109, New Haven, CT 06520-8109. Yale University is an equal opportunity/affirmative action employer; applications from women and minority scientists are strongly encouraged.

Section Meeting MENTOR PROGRAMS

STUDENTS — *Interested in a career in the applied geosciences?*

We hope you'll plan to attend a **Roy J. Shlemon Mentor Program in Applied Geoscience** and/or a **John Mann Mentors in Applied Hydrogeology Program** at your 2010 Section Meeting. These are great opportunities for you to chat one-on-one with practicing geoscientists, who will answer your questions and share insights on how to get a job after graduation.

PROFESSIONALS — *Interested in talking to students about your applied geoscience career?*

Being a mentor is a rewarding experience—if you'd like to learn more, please contact Jennifer Nocerino, jnocerino@geosociety.org.

CALL FOR APPLICATIONS

2010–2011 GSA-USGS Congressional Science Fellowship

Bring your science and technology expertise to Capitol Hill to work directly with national leaders at the interface between geoscience and public policy.

Deadline for application: 1 February 2010

The GSA-USGS Congressional Science Fellowship provides a rare opportunity for a unique individual. Prospective candidates are GSA Members with a broad geoscience background and excellent written and oral communication skills. Minimum requirements are a master's degree with at least five years professional experience or a Ph.D. at time of appointment. This fellowship is open only to U.S. citizens or permanent U.S. residents.

Find application information at **www.geosociety.org/csf/** or contact Ginger Williams, +1-303-357-1040, gwilliams@geosociety.org.

Put your academic and professional background, experience applying scientific knowledge to societal challenges, and passion for shaping the future of the geosciences to work in this coveted arena.

Apply today!

THE GEOLOGICAL SOCIETY OF AMERICA®

USGS science for a changing world

Call for Papers

2010

GSA Section Meetings

13–16 March
Northeastern-Southeastern Joint Meeting, Baltimore, Maryland, USA. **Abstract submission opens** 1 Oct.; deadline: 8 Dec. 2009.

11–13 April
North-Central–South-Central Joint Meeting, Branson, Missouri, USA. **Abstract submission opens** 1 Nov.; deadline: 19 Jan. 2010.

21–23 April
Rocky Mountain, Rapid City, South Dakota, USA.
Abstract submission opens 1 Nov.; deadline: 26 Jan. 2010.

27–29 May
Joint Meeting, Cordilleran Section, GSA, and Pacific Section, AAPG, Anaheim, California, USA.
Abstract submission opens 1 Dec.; deadline: 9 Mar. 2010.

Coming to *GSA Today* in January 2010

- **Science article:** "Impact of erosion, sedimentation and structural heritage on the structure and kinematics of orogenic wedges: analog models and case studies" by Jacques Malavieille
- **Presidential Address:** GSA President Jean Bahr on "O Brave New World—Geoscientists in an Emerging Green Economy"
- **Second Announcements for three GSA Section Meetings:** Northeastern-Southeastern, North-Central–South-Central, and Rocky Mountain
- **Exceptional Reviewers,** GSA Journals
- **New GSA Division Announcement:** Mineralogy, Petrology, Volcanology, and Geochemistry

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

Journal Highlights

New to Social Bookmarking?
Try it at www.gsapubs.org

GSA recently added social bookmarking to its online journals and books. Connotea, CiteULike, Del.icio.us, Digg, Facebook, Reddit, and Twitter links are in the footnotes section and at the bottom of the middle column of online articles or chapters.

Social bookmarking allows users to create personal collections of bookmarks. These can then be saved for future reference or shared with others. For example, a Facebook user may share an article from GSA's site with all of their Facebook friends with a click of a button. Users can also grab other people's bookmarks or subscribe to bookmark lists.

Bookmarking is another way you can stay current on the high-value research in your field.

GSA Journals online:

www.gsapubs.org

THE GEOLOGICAL SOCIETY OF AMERICA®

To subscribe, contact **gsaservice@geosociety.org, or call +1-888-443-4472, or +1-303-357-1000, option 3.**

THE
GEOLOGICAL
SOCIETY
OF AMERICA®

Call for Applications and Nominations
GSA SCIENCE EDITORS

GSA's internationally recognized journals and books rely on the expertise of dedicated science editors who ensure stringent peer review, maintain excellent content, and provide leadership in determining the future course of GSA publications. Desirable characteristics for successful candidates include:

- a broad interest and experience in geosciences;
- international recognition;
- a progressive attitude, willingness to take risks and encourage innovation;
- familiarity with many earth scientists and their work;
- a sense of perspective and humor;
- organized and productive;
- willingness to work closely with GSA headquarters staff;
- ability to make decisions;
- familiarity with new trends in geosciences; and
- willingness to consider nontraditional research in geosciences.

GSA is currently soliciting

co-editor applications and nominations

for these upcoming openings.

- *Lithosphere*, four-year term beginning January 2011
- *GSA Bulletin*, four-year term beginning January 2011
- *GSA Books*, four-year term beginning January 2011
- *GSA Today*, four-year term beginning January 2011

Each editor will work out of his or her current location at work or at home. GSA provides some funding for each position; for specifics, please contact Jeanette Hammann, +1-303-357-1048, jhammann@geosociety.org. If you wish to be considered, please submit a curriculum vitae and a brief letter describing why you are suited for the position. If you wish to nominate another, submit a letter of nomination and the individual's written permission and CV. Send nominations and applications to Jeanette Hammann, GSA Publications, P.O. Box 9140, Boulder, CO 80301, USA; jhammann@geosociety.org. Nominations or applications received by 19 February 2010 will be given first consideration.

MEMBER PRICE • MEMBER PRICE • $56

Geological Monitoring

edited by Rob Young and Lisa Norby

Geologic Monitoring is a practical, nontechnical guide for land managers, educators, and the public that synthesizes representative methods for monitoring short-term and long-term change in geologic features and landscapes. A prestigious group of subject-matter experts has carefully selected methods for monitoring sand dunes, caves and karst, rivers, geothermal features, glaciers, nearshore marine features, beaches and marshes, paleontological resources, permafrost, seismic activity, slope movements, and volcanic features and processes. Each chapter has an overview of the resource; summarizes features that could be monitored; describes methods for monitoring each feature ranging from low-cost, low-technology methods (that could be used for school groups) to higher cost, detailed monitoring methods requiring a high level of expertise; and presents one or more targeted case studies.

GEOMON, 303 p., ISBN 9780813760322, list price $80.00

THE GEOLOGICAL SOCIETY OF AMERICA®

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