

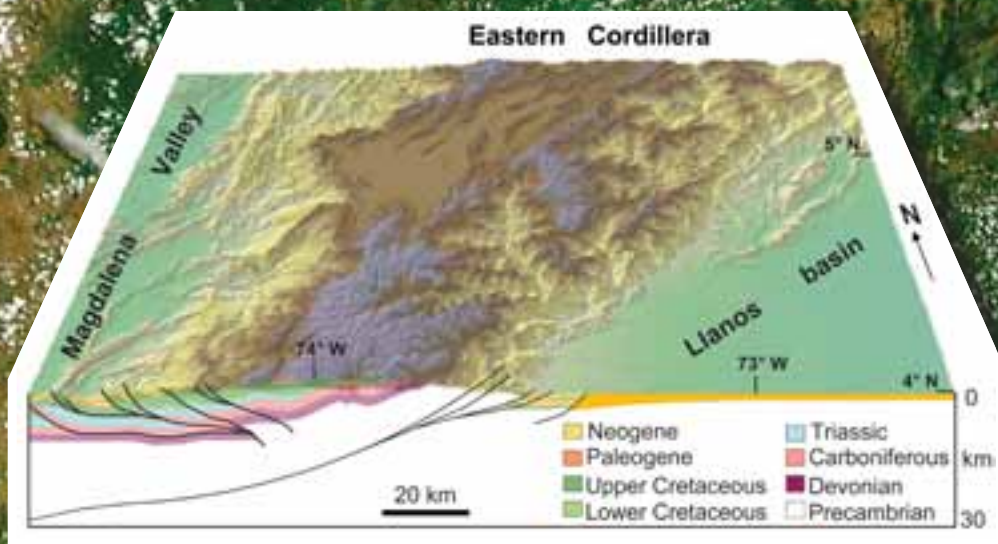
GSA TODAY

VOL. 20, No. 7

A PUBLICATION OF THE GEOLOGICAL SOCIETY OF AMERICA

JULY 2010

Resolving uplift of the northern Andes using detrital zircon age signatures



Inside:

- ▲ **2010 Medal & Award Recipients**, p. 10
- ▲ **2010 GSA Research Grant Recipients**, p. 17
- ▲ **Commentary:** GSA Position Statement on Climate Change, p. 40
- ▲ **Groundwork:** Super-rotation of Earth's inner core and the structure of scientific reasoning, p. 52

Not Just Software . . . RockWare. For Over 27 Years.

RockWorks® Academic Site License

Stratigraphic/Lithologic Modeling

- 2D and 3D striplogs
- Cross-sections
- Profiles
- Fence diagrams
- Contour maps and 3D surfaces
- Solid models and isosurfaces
- Relational database for storage of lithology, stratigraphy, geophysical, analytical, geotechnical, water levels, fracture data and more!

Directional Analysis

- Rose diagrams
- Stereonets
- Statistical analysis
- Lineation mapping and gridding
- Arrow maps
- Slope and direction models
- Strike and dip maps, and more!

Hydrochemistry Diagrams

- Piper
- Stiff diagrams and maps
- Durov
- Ion balance
- TDS calculations and more!

Gridding Tools

- Contours
- 3D surface diagrams
- Several interpolation options
- Grid math and grid filters
- Boolean logic tools
- Polynomial trend fitting

Graphics/Imports/Exports

- Customizable 2D and 3D visualization
- Several import/export formats
- Connectivity to ArcGIS

All of these tools (and more!) are now available in an annual license for academic use: unlimited installations within a department for the same price as a single, standard license.

\$2,499



RockWare®

Since 1983

303.278.3534 • 800.775.6745 • RockWare.com



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.

Copyright © 2010, The Geological Society of America (GSA). All rights reserved. Copyright not claimed on content prepared wholly by U.S. government employees within the scope of their employment. Individual scientists are hereby granted permission, without fees or further requests to GSA, to use a single figure, a single table, and/or a brief paragraph of text in other subsequent works and to make unlimited photocopies of items in this journal for noncommercial use in classrooms to further education and science. For any other use, contact Permissions, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA; fax +1-303-357-1073, editing@geosociety.org.

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

GSA TODAY STAFF:

Executive Director and Publisher: John W. Hess

Science Editors: David E. Fastovsky, Dept. of Geosciences, University of Rhode Island, Woodward Hall, Rm. 317, Kingston, Rhode Island 02881, USA, defastov@uri.edu; Bernard Housen, Geology Dept. (ES 425) and Advanced Materials Science and Engineering Center (AMSEC), Western Washington University, 516 High Street, Bellingham, Washington 98225-9080, USA, bernieh@www.edu.

Managing Editor: K.E.A. Giles, kgiles@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.



SFI

Certified Fiber Sourcing

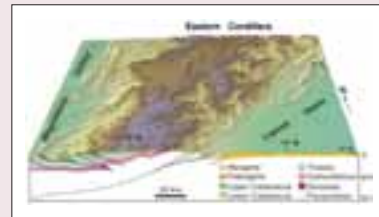
www.sfiprogram.org

VOLUME 20, NUMBER 7 ▲ JULY 2010

SCIENCE ARTICLE

4

Resolving uplift of the northern Andes using detrital zircon age signatures. Brian K. Horton, Mauricio Parra, Joel E. Saylor, Junsheng Nie, Andrés Mora, Vladimir Torres, Daniel F. Stockli, and Manfred R. Strecker.



Cover: View of the northern Andes of Colombia. Block diagram by Andrés Mora depicts modern topography and generalized subsurface structure of the Eastern Cordillera and bordering Magdalena Valley (left) and Llanos basin (right). Background image courtesy NASA. See "Resolving uplift of the northern Andes using detrital zircon age signatures" by B.K. Horton et al., p. 4–9.

10

2010 GSA Medal & Award Recipients

11

2010 GSA Divisions Named Awards

12

2010 GSA Fellows

16

GSA Celebrates 50-Year Member Anniversaries

17

2010 GSA Research Grant Recipients

22

2010 Cole Award Recipients

22

Kerry Kelts Student Research Award

23

GSA Research Grants—International Program

23

About People

24

In Memoriam

25

Call for Committee Service

27

Meet Your NEW 2010 GSA Officers and Councilors

28

New GSA Members

36

GSA Foundation Update

38

Congressional Science Fellow Report

39

GSA Today Science Editor Changes

40

Commentary: GSA Position Statement on Climate Change

44

2010 GSA Annual Meeting Lunchtime Lecture 1

45

2010 GSA Annual Meeting & Exposition Call for Papers

46

Five Reasons to Come to Denver

49

International Section Travel Grants

50

Classified Advertising

52

Groundwork: Super-rotation of Earth's inner core and the structure of scientific reasoning

54

Coming in August to GSA Today

54

Publications Highlights

Corrections & Clarifications

The receipt and acceptance dates for the Groundwork article in the June issue of *GSA Today* (v. 20, no. 6, p. 52–53) were inadvertently left out of the issue. The article, Innovations in the built environment for earth science, by M.A. Chan, was received 23 February 2010 and accepted 19 March 2010.

Resolving uplift of the northern Andes using detrital zircon age signatures

Brian K. Horton, Dept. of Geological Sciences and Institute for Geophysics, Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas 78712-0254, USA; **Mauricio Parra**, **Joel E. Saylor**, **Junsheng Nie**, Dept. of Geological Sciences, Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas 78712-0254, USA; **Andrés Mora**, **Vladimir Torres**, Instituto Colombiano del Petróleo, Ecopetrol, Bucaramanga, Colombia; **Daniel F. Stockli**, Dept. of Geology, University of Kansas, Lawrence, Kansas 66045, USA; and **Manfred R. Strecker**, Institut für Geowissenschaften, Universität Potsdam, 14476 Potsdam, Germany

ABSTRACT

Uplift of the Eastern Cordillera in the northern Andes has been linked to orographic climate change and genesis of South America's largest river systems. The timing of initial uplift remains poorly constrained, with most estimates ranging from ca. 60 to ca. 5 Ma. New detrital zircon U-Pb ages from proximal fill of the Llanos foreland basin in Colombia reveal a pronounced mid-Cenozoic shift in provenance from an Amazonian craton source to an Andean fold-thrust belt source. This shift corresponds with changes in detrital zircon (U-Th)/He ages, a conglomeratic unroofing sequence, and a sharp increase in foredeep accumulation rates. These nearly simultaneous changes in zircon age spectra, clast compositions, and sediment accumulation are attributable to latest Oligocene uplift of the eastern flank of the Eastern Cordillera. The timing relationships suggest an early activation of the frontal thrust system, implying a long-term (up to 25 m.y.) cessation of orogenic wedge advance, potentially driven by structural inheritance and/or climate change.

INTRODUCTION

Surface uplift of the Eastern Cordillera in the northern Andes has had a profound effect on orographic climate change (Mora et al., 2008), growth of large continental drainage systems (Fig. 1) (Amazon, Orinoco, and Magdalena rivers; Hoorn et al., 1995; Díaz de Gamero, 1996), and biologic evolution of neotropical rainforests (Hooghiemstra and Van der Hammen, 1998; Jaramillo et al., 2006). Most estimates for the onset of uplift along the eastern flank of the Colombian Andes (Fig. 2) range from Paleocene to Pliocene time (Van der Hammen et al., 1973; Dengo and Covey, 1993; Cooper et al., 1995; Bayona et al., 2008; Parra et al., 2009a).

Initial uplift has proven difficult to constrain by conventional methods. First, recent zircon fission track data provide a minimum age but do not uniquely pinpoint the precise onset of earliest uplift-induced exhumation (Parra et al., 2009b). Second, insights from synorogenic growth strata are commonly limited by inadequate exposure, poor seismic resolution, and

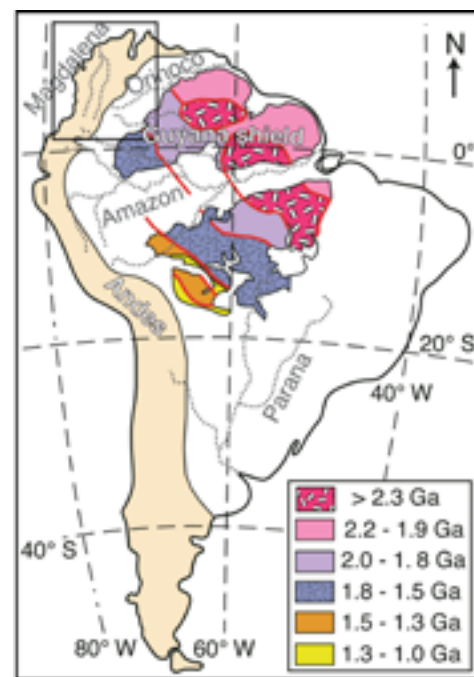


Figure 1. Map of South America showing main river systems (Magdalena, Orinoco, Amazon, and Parana) and Precambrian crustal provinces of the Amazonian craton (after Cordani et al., 2000; Chew et al., 2007).

minimal variation in stratal dip (e.g., Toro et al., 2004). Third, clastic compositional records of erosional unroofing are hindered by the uniformly high-maturity (quartz-dominated) sand compositions imposed by intense tropical weathering (e.g., Johnsson et al., 1988).

In this study, we utilize U-Pb and (U-Th)/He ages of detrital zircon grains from the Colombian Andes to demonstrate that initial uplift-induced exhumation along the eastern flank of the fold-thrust belt had commenced by ca. 26–23 Ma. Timing relationships revealed by geochronological data coincide with shifts in conglomerate clast compositions and sediment accumulation rates and provide new insights into the pace of orogenic wedge advance.

GEOLOGIC SETTING

The Eastern Cordillera of Colombia forms a 1–4-km-high orographic barrier separating the intermontane Magdalena Valley from the Llanos foreland basin (Fig. 2). The 100–200-km-wide range is bounded by a frontal thrust system consisting of inverted normal faults and newly formed fold-thrust structures (Cooper et al., 1995; Mora et al., 2006). Following Jurassic–Early Cretaceous rifting, Andean orogenesis began with latest Cretaceous–Paleocene shortening in the Central Cordillera and early foreland basin evolution in the present-day Magdalena



Figure 2. Shaded relief map showing tectonomorphic provinces of the northern Andes (after Mora et al., 2006) and 12 sample locations (white dots). CC—Central Cordillera; EC—Eastern Cordillera; MV—Magdalena Valley; WC—Western Cordillera.

Valley and Eastern Cordillera (Cooper et al., 1995; Gómez et al., 2003). The locus of deformation advanced eastward, reaching the western edge of the Eastern Cordillera by middle Eocene–Oligocene time (Restrepo-Pace et al., 2004; Gómez et al., 2005a; Montes et al., 2005; Parra et al., 2009b; Nie et al., 2010).

The Eastern Cordillera consists of Cretaceous quartzose sandstone and mudrock with subordinate Cenozoic, Jurassic, and Paleozoic clastic units capping localized occurrences of crystalline basement. Phanerozoic clastic units are quartz rich (Villamil, 1999), rendering sandstone petrography less effective in addressing provenance history (Johnsson et al., 1988). Prior to Andean uplift, terrigenous clastic sediment was derived from basement exposures to the east, in the Guyana shield of the northern Amazonian craton (Fig. 1) (Cooper et al., 1995). A reversal in sediment transport was triggered by uplift of principally magmatic-arc rocks in the Central Cordillera (Villamil, 1999; Gómez et al., 2005b) followed by uplift and erosional recycling of sedimentary rocks in the Eastern Cordillera (Cooper et al., 1995; Bayona et al., 2008).

The Cretaceous–Cenozoic stratigraphic successions of the Eastern Cordillera and Llanos basin (Fig. 3) consist of clastic units assigned to synrift, postrift, and foreland basin deposition (Cooper et al., 1995). Principally marine facies characterize the 3–8-km-thick Cretaceous succession, including diagnostic glauconitic sandstones in the Une, Chipaque, and Guadalupe units.

The overlying 2–3-km-thick Paleogene section contains a range of nonmarine sandstone units that can be correlated from the interior of the Eastern Cordillera into the Llanos basin (e.g., Cacho, Barco, Regadera, and Mirador Formations). The youngest basin fill includes an upward coarsening, 3–5-km-thick Neogene section composed of mudstone, sandstone, and conglomerate of the Carbonera, León, and Guayabo Formations (Fig. 3).

U-Pb GEOCHRONOLOGY

Methods

Zircon grains from 12 samples of Cenozoic sandstones were separated by standard heavy liquid techniques, selected randomly, and analyzed by laser-ablation–inductively coupled plasma–mass spectrometry. Analyses and associated age calculations followed methods outlined by Chang et al. (2006), utilizing results for zircon standards Peixe (564 ± 4 Ma) and Temora (416.8 ± 1.1 Ma).

We report a total of 1107 U-Pb ages (see supplemental data Table DR1¹) obtained by analyses that generally yielded <10% discordance, <5% reverse discordance, and <10% uncertainty. Interpreted ages represent $^{206}\text{Pb}/^{238}\text{U}$ ages for grains younger than 900 Ma and $^{207}\text{Pb}/^{206}\text{Pb}$ ages for grains older than 900 Ma. Results are plotted on relative age probability diagrams (Fig. 4) and normalized such that age-distribution curves for all

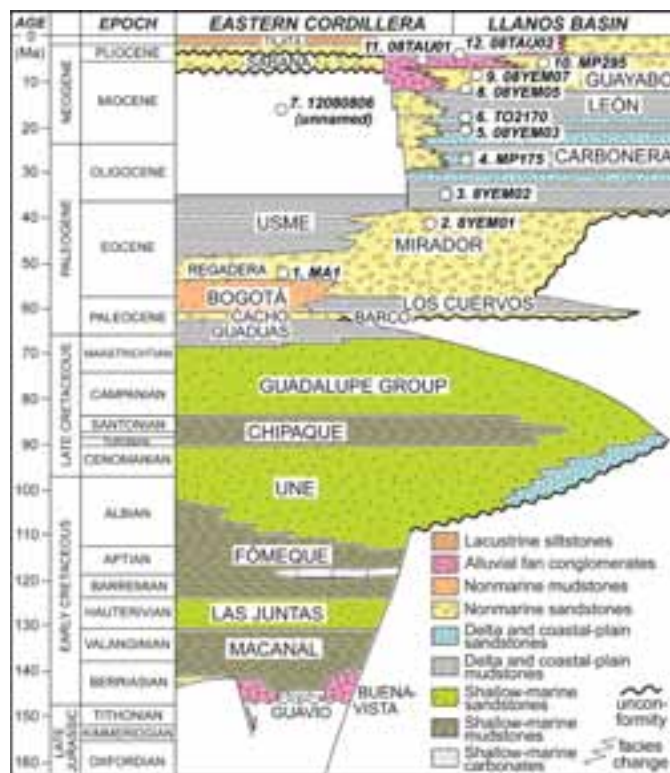


Figure 3. Generalized Mesozoic–Cenozoic stratigraphy of the Eastern Cordillera and Llanos basin, Colombia (after Parra et al., 2009a), showing approximate stratigraphic levels of 12 samples (circles).

¹GSA Data Repository item 2010140, Table DR1, U-Pb geochronologic analyses, and Table DR2, (U-Th)/He results, is available at www.geosociety.org/pubs/ft2010.htm; copies can also be obtained by e-mail to gsatoday@geosociety.org.

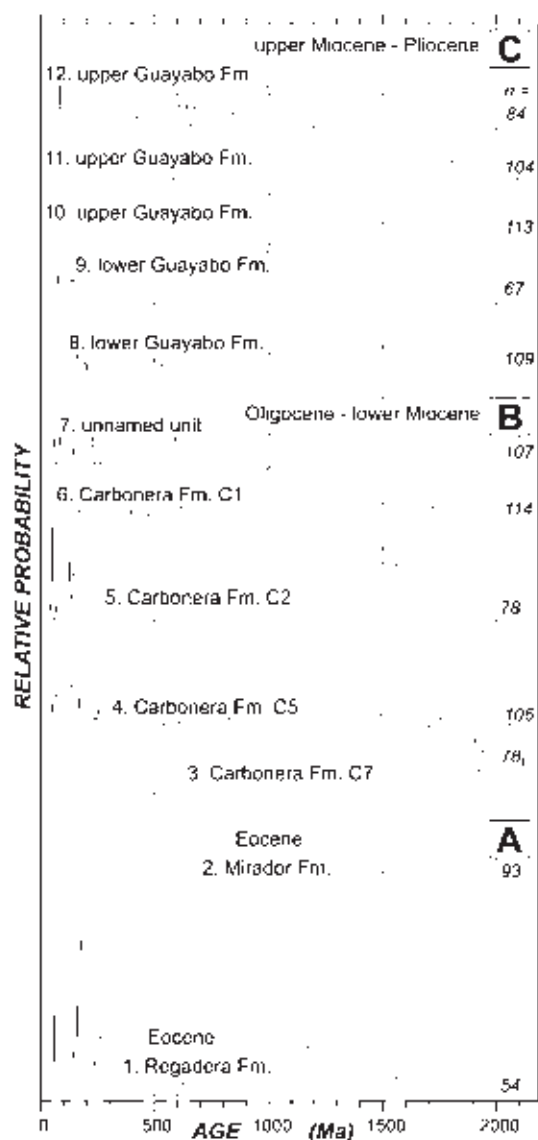


Figure 4. Detrital zircon U-Pb ages for Cenozoic strata in the proximal Llanos basin (samples 2–6 and 8–12) and axial Eastern Cordillera (samples 1 and 7). Age probability plots arranged in stratigraphic order.

samples contain the same area. Interpretations are based on age peaks defined by three or more grains.

Results and Interpretations

An Eocene sample from the upper Mirador Formation (Fig. 3) in the proximal Llanos basin is characterized by Precambrian age peaks of 1850–1350 Ma (Fig. 4A). In contrast, a sample from the Mirador-equivalent Regadera Formation in the axial Eastern Cordillera shows principally Phanerozoic ages, with peaks at 85–75, 65–55, and 190–170 Ma (Fig. 4A). We ascribe the Llanos age distributions to a dominant eastern source of Proterozoic rocks in the Guyana shield, consistent with previous studies (Cooper et al., 1995; Villamil, 1999; Roure et al., 2003). Age spectra for the axial Eastern Cordillera, however, signify exhumation of Jurassic–Paleogene magmatic-arc rocks from a western source region in the Central Cordillera or Magdalena Valley region (Fig. 2). During Paleocene to Oligocene

time, the Eastern Cordillera and proximal Llanos basin likely formed a single integrated basin with sediment supplied from the east and west (Dengo and Covey, 1993; Cooper et al., 1995; Villamil, 1999) and potentially from localized structural highs (Gómez et al., 2005a; Bayona et al., 2008).

Five Oligocene to lower Miocene samples (Fig. 4B) reveal a major provenance shift. A basal sample of the Oligocene C7 member of the Carbonera Formation (Fig. 3) shows exclusively Precambrian age peaks older than 1500 Ma, indicating a cratonic signature. Upsection, the four lower Miocene samples from the C5, C2, and C1 members and an unnamed equivalent unit in the Eastern Cordillera exhibit Precambrian age peaks (1850–1300, 1050–950 Ma) and a collection of Phanerozoic ages (65–45, 90–80, 155–135, 175–170 Ma) that include the first appearance in the Llanos basin of Jurassic–Paleogene zircons, grains that must originate in the west. Although such Phanerozoic zircons could be first-cycle grains from magmatic-arc rocks of the Central Cordillera and Magdalena Valley, the presence of a Grenville age peak at 1050–950 Ma and Paleoproterozoic to Mesoproterozoic grain ages at 1850–1300 Ma (Fig. 4B) suggests recycling of sediments originally derived from the easternmost Andes and/or Guyana shield (e.g., Horton et al., 2010). We attribute the U-Pb ages to initial unroofing of the Upper Cretaceous–Paleogene stratigraphic succession along the axis and eastern flank of the Eastern Cordillera during latest Oligocene–early Miocene time. Unroofing of this cover section produced composite age spectra reflecting recycled contributions from arc-derived Paleogene strata (e.g., Regadera; Fig. 4A), craton-derived Paleogene strata (e.g., Mirador; Fig. 4A), and craton-derived Cretaceous strata.

Five upper Miocene–Pliocene samples from the lower and upper Guayabo Formation (Fig. 3) exhibit age spectra (1850–1300, 1050–950 Ma) comparable to Proterozoic basement in the Guyana shield, with limited Phanerozoic and few Jurassic–Paleogene ages (Fig. 4C). Paleocurrent data and conglomerate clast compositions show that these deposits were derived from western Andean sources rather than the Guyana shield in the east (Parra et al., 2010). We ascribe the U-Pb results to continued unroofing of the Eastern Cordillera, with recycling of principally Cretaceous strata originally sourced from the Guyana shield. Notably, for the upper Miocene–Pliocene upper Guayabo Formation, the conspicuous absence of Jurassic–Paleogene age populations that typified the underlying lower Miocene section (Fig. 4B) rules out the western magmatic arc as a potential source and suggests nearly complete erosional stripping of the arc-derived Paleogene section in the Eastern Cordillera (e.g., Regadera; Fig. 4A). Further, continued erosional recycling of craton-derived Cretaceous strata accounts for the upsection increase in Grenville-aged (1050–950 Ma) detritus at the expense of Jurassic–Paleogene ages (compare Figs. 4B and 4C). Removal of most of the ~2–3-km-thick Paleogene section during early to middle Miocene time suggests an average one-dimensional exhumation rate of ~0.2–0.3 mm/yr, a rate comparable to values estimated from low-temperature thermochronometry (Parra et al., 2009b).

(U-Th)/He THERMOCHRONOMETRY

Zircon (U-Th)/He thermochronometry is an established technique involving a closure temperature of ~180–200 °C (e.g.,

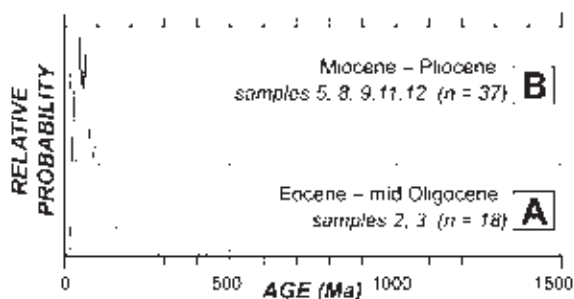


Figure 5. Detrital zircon (U-Th)/He ages for Cenozoic strata in the proximal Llanos basin. Age probability plots arranged in stratigraphic order.

Reiners, 2005) and a partial retention zone of ~120–180 °C (Stockli, 2005). Detrital (U-Th)/He age determinations were carried out following laboratory procedures described in Biswas et al. (2007). All ages were calculated using Fish Canyon and Durango zircon age standards and alpha-ejection corrections based on morphometric analyses (Farley et al., 1996). Reported age uncertainties reflect the reproducibility of replicate analyses of the two standards, with estimated analytical uncertainties of ~8% (2 σ) for zircon (U-Th)/He ages (Reiners, 2005; Biswas et al., 2007).

We report 55 (U-Th)/He ages from seven of the aforementioned samples (see supplemental data Table DR2 [footnote 1]). Results are plotted on normalized relative age probability diagrams (Fig. 5). Detrital zircon (U-Th)/He ages for Eocene to mid-Oligocene sandstones of the Mirador and lowermost Carbonera Formations show a strong component of Neoproterozoic ages (11 of 18 grains in the 850–550 Ma range) with subordinate Paleozoic and Jurassic ages (Fig. 5A). In sharp contrast, Miocene-Pliocene sandstones of the middle-upper Carbonera and Guayabo Formations are dominated by Cretaceous-Cenozoic age signatures (28 of 37 grains younger than 150 Ma), with a minor 1000–850 Ma subpopulation of possible Grenville origin (Fig. 5B).

The (U-Th)/He results indicate a substantial shift in detrital age signatures during lower Carbonera deposition that coincides with the provenance shift expressed in the U-Pb data. However, rather than crystallization ages, the detrital zircon (U-Th)/He results provide insight into the integrated cooling history of the sediment source areas. In this case, we interpret the dominantly Precambrian cooling signatures of the Eocene to mid-Oligocene sandstones as the product of extremely long residence time at shallow burial depths (<5–10 km) in the stable cratonic interior of the Guyana shield. The significantly younger (U-Th)/He ages identified in the Miocene-Pliocene sandstones are considered to be the product of Cretaceous-Cenozoic exhumation in the Andean orogenic belt and/or possible contribution from igneous sources. Similar to the U-Pb data, these (U-Th)/He results reveal a pronounced shift in provenance from the ancient Guyana shield in the east to the Andean orogenic belt in the west.

CLAST COMPOSITIONS AND ACCUMULATION RATES

The new detrital zircon data are compatible with the unroofing record suggested by conglomerate clast compositions and sediment accumulation rates in the proximal Llanos basin. Clast

composition data for the Eocene to upper Miocene succession (Fig. 6A) record the first appearance of large proportions of sandstone clasts followed by increased amounts of distinctive clasts of glauconite-bearing quartzose sandstones (Fig. 6B). Reworked microfossils (pollen, dinoflagellates, and foraminifera; Bayona et al., 2008) suggest a Paleocene or older age for these sandstone clasts. This history indicates late Oligocene–early Miocene unroofing of Paleocene-Eocene sandstones and widespread middle to late Miocene exposure of glauconitic sandstones that are diagnostic of specific mid- to Upper Cretaceous units (Uñe, Chipaque, and Guadalupe units).

An Eocene to late Miocene sediment accumulation history (Fig. 6C) for the proximal Llanos basin has been constructed on the basis of stratigraphic sections temporally calibrated by detailed palynological assemblages (Parra et al., 2010). The data show a major increase in accumulation rates, starting ca. 26–23 Ma, from ~100 to ~460 m/m.y. Although this stratigraphic transition shows only modest changes in lithofacies or paleocurrents, it corresponds with the abrupt change in detrital zircon age signatures (Figs. 4 and 5) discussed in previous sections.

DISCUSSION AND IMPLICATIONS

Coeval shifts in U-Pb and (U-Th)/He zircon age spectra, clast composition, and sediment accumulation rates in the Llanos

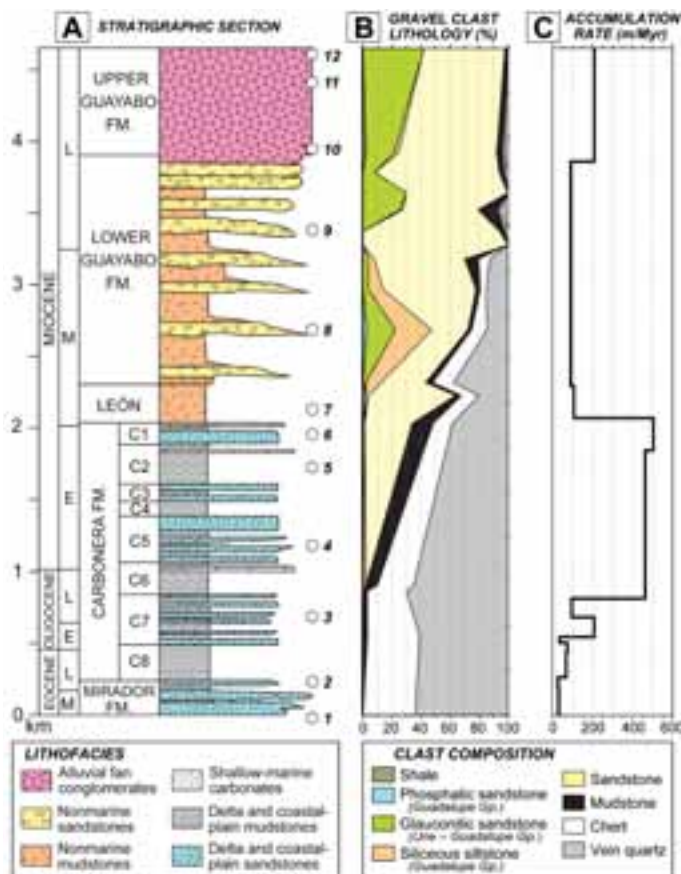


Figure 6. (A) Stratigraphic log of ~4.7-km succession showing approximate levels of 12 samples (circles); (B) corresponding conglomerate clast compositions; and (C) sediment accumulation rates derived from one-dimensional decompacted thicknesses for Eocene-Miocene deposits of the proximal Llanos basin at ~5°N (after Parra et al., 2009a, 2010).

foreland basin can be attributed to initial uplift of the eastern flank of the Eastern Cordillera (Fig. 2) during latest Oligocene time, consistent with zircon fission-track cooling histories (Parra et al., 2009b). Eastern Cordillera uplift is considered fundamental to the genesis and/or reorganization of the largest drainages in northern South America (Fig. 1). Therefore, initial deformation by ca. 26–23 Ma suggests that precursors of the Amazon, Orinoco, and Magdalena river systems may have originated >10–20 m.y. earlier than envisioned (e.g., Hoorn et al., 1995; Díaz de Gamero, 1996; Campbell et al., 2006). Evidence for protracted drainage histories should be preserved in the depositional records of the respective river deltas and submarine fans (e.g., Dobson et al., 2001; Harris and Mix, 2002), recognizing that changes in sediment accumulation rates could also be the product of climatic effects (Molnar, 2004). We speculate that reduced sediment accumulation rates in the Amazon fan during the early and middle Miocene (Dobson et al., 2001) may be the product of enhanced loading during Eastern Cordillera uplift and a corresponding increase in flexural accommodation and proximal storage of sediment in the Llanos foreland basin (e.g., Bayona et al., 2008; Parra et al., 2009a).

As the principal orographic barrier to easterly air masses, surface uplift of the Eastern Cordillera has influenced the paleogeography and biodiversity of South America's neotropical rainforests (e.g., Hooghiemstra and Van der Hammen, 1998; Albert et al., 2006). We hypothesize that aridification in the intermontane Magdalena Valley of Colombia (Fig. 2) represents the leeward orographic response to Eastern Cordillera uplift (e.g., Strecker et al., 2007). Although critical threshold elevations were likely reached in late Miocene to Pliocene time (Mora et al., 2008), paleoprecipitation estimates based on mammal faunal assemblages (Kay and Madden, 1997) are consistent with a sediment provenance reversal (Guerrero, 1997) suggesting that initial aridification due to an emerging orographic barrier may have been under way by middle Miocene time.

A further intriguing implication of latest Oligocene uplift along the eastern flank of the Eastern Cordillera is an apparent long-term reduction in the average rate of thrust front advance over the past ~25 m.y., the period of maximum shortening and surface uplift. This seeming contradiction underscores the potential importance of precipitation-driven erosion and inherited mechanical properties on structural evolution of the orogenic wedge in the humid northern Andes.

ACKNOWLEDGMENTS

Funding was provided by Ecopetrol's Instituto Colombiano del Petróleo as part of a collaborative research agreement with the University of Texas at Austin. M. Parra, A. Mora, and M.R. Strecker also acknowledge funding from the German Academic Exchange Service and Deutsche Forschungsgemeinschaft. The manuscript benefited from discussions with many Ecopetrol employees and Colombian researchers along with reviews by Isabelle Coutand, James Mortensen, and Stephen Johnston.

REFERENCES CITED

- Albert, J.S., Lovejoy, N.R., and Crampton, W.G.R., 2006, Miocene tectonism and the separation of cis- and trans-Andean river basins: Evidence from Neotropical fishes: *Journal of South American Earth Sciences*, v. 21, p. 14–27.
- Bayona, G., Cortés, M., Jaramillo, C., Ojeda, G., Aristizabal, J.J., and Reyes-Harker, A., 2008, An integrated analysis of an orogen-sedimentary basin pair: Latest Cretaceous-Cenozoic evolution of the linked Eastern Cordillera orogen and the Llanos foreland basin of Colombia: *GSA Bulletin*, v. 120, p. 1171–1197.
- Biswas, S., Coutand, I., Grujic, D., Hager, C., Stockli, D., and Grasemann, B., 2007, Exhumation and uplift of the Shillong plateau and its influence on the eastern Himalayas: New constraints from apatite and zircon (U-Th-[Sm])/He and apatite fission track analysis: *Tectonics*, v. 26, TC6013, doi: 10.1029/2007TC002125.
- Campbell, K.E., Frailey, C.D., and Romero-Pittman, L., 2006, The Pan-Amazonian Ucayali Peneplain, late Neogene sedimentation in Amazonia, and the birth of the modern Amazon River system: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 239, p. 166–219.
- Chang, Z., Vervoort, J.D., McClelland, W.C., and Knaack, C., 2006, U-Pb dating of zircon by LA-ICP-MS: *Geochemistry Geophysics Geosystems*, v. 7, Q05009, doi: 10.1029/2005GC001100.
- Chew, D.M., Schaltegger, U., Košler, J., Whitehouse, M.J., Gutjahr, M., Spikings, R.A., and Miškovíc, A., 2007, U-Pb geochronologic evidence for the evolution of the Gondwanan margin of the north-central Andes: *GSA Bulletin*, v. 119, p. 697–711.
- Cooper, M.A., Addison, F.T., Álvarez, R., Coral, M., Graham, R.H., Hayward, A.B., Howe, S., Martínez, J., Naar, J., Peñas, R., Pulham, A.J., and Taborda, A., 1995, Basin development and tectonic history of the Llanos basin, Eastern Cordillera, and Middle Magdalena Valley, Colombia: *AAPG Bulletin*, v. 79, p. 1421–1443.
- Cordani, U.G., Sato, K., Teixeira, W., Tassinari, C.G., and Basei, M.A.S., 2000, Crustal evolution of the South American Platform, in Cordani, U.G., Milani, E.J., Thomaz Filho, A., and Campos Neto, M.C., eds., *Tectonic Evolution of South America: Rio de Janeiro, 31st International Geological Congress, Institut de Recherche pour le Développement*, p. 19–40.
- Dengo, C.A., and Covey, M.C., 1993, Structure of the Eastern Cordillera of Colombia: Implications for trap styles and regional tectonics: *AAPG Bulletin*, v. 77, p. 1315–1337.
- Díaz de Gamero, M.L., 1996, The changing course of the Orinoco River during the Neogene: A review: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 123, p. 385–402.
- Dobson, D.M., Dickens, G.R., and Rea, D.K., 2001, Terrigenous sediment on Ceara Rise: A Cenozoic record of South American orogeny and erosion: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 165, p. 215–229.
- Farley, K.A., Wolf, R., and Silver, L., 1996, The effects of long alpha-stopping distances on (U-Th)/He ages: *Geochimica et Cosmochimica Acta*, v. 60, p. 4223–4229.
- Gómez, E., Jordan, T.E., Allmendinger, R.W., Hegarty, K., Kelley, S., and Heizler, M., 2003, Controls on architecture of the Late Cretaceous to Cenozoic southern Middle Magdalena Valley Basin, Colombia: *GSA Bulletin*, v. 115, p. 131–147.
- Gómez, E., Jordan, T.E., Allmendinger, R.W., and Cardozo, N., 2005a, Development of the Colombian foreland-basin system as a consequence of diachronous exhumation of the northern Andes: *GSA Bulletin*, v. 117, p. 1272–1292.
- Gómez, E., Jordan, T.E., Allmendinger, R.W., Hegarty, K., and Kelley, S., 2005b, Syntectonic Cenozoic sedimentation in the northern middle Magdalena Valley Basin of Colombia and implications for exhumation of the Northern Andes: *GSA Bulletin*, v. 117, p. 547–569.
- Guerrero, J., 1997, Stratigraphy, sedimentary environments, and the Miocene uplift of the Colombian Andes, in Kay, R.F., Madden, R.H., Cifelli, R.L., and Flynn, J.J., eds., *Vertebrate Paleontology in the Neotropics: The Miocene Fauna of La Venta, Colombia: Washington D.C., Smithsonian Institution Press*, p. 15–42.
- Harris, S.E., and Mix, A.C., 2002, Climate and tectonic influences on continental erosion of tropical South America, 0–13 Ma: *Geology*, v. 30, p. 447–450.

- Hooghiemstra, H., and Van der Hammen, T., 1998, Neogene and Quaternary development of the neotropical rain forest: The forest refugia hypothesis, and a literature overview: *Earth-Science Reviews*, v. 44, p. 147–183.
- Hoorn, C., Guerrero, J., Sarmiento, G.A., and Lorente, M.A., 1995, Andean tectonics as a cause for changing drainage patterns in Miocene northern South America: *Geology*, v. 23, p. 237–240.
- Horton, B.K., Saylor, J.E., Nie, J., Mora, A., Parra, M., Reyes-Harker, A., and Stockli, D.F., 2010, Linking sedimentation in the northern Andes to basement configuration, Mesozoic extension, and Cenozoic shortening: Evidence from detrital zircon U-Pb ages, Eastern Cordillera, Colombia: *GSA Bulletin*, v. 122, p. 1423–1442, doi: 10.1130/B30118.1.
- Jaramillo, C., Rueda, M., and Mora, G., 2006, Cenozoic plant diversity in the Neotropics: *Science*, v. 311, p. 1893–1896.
- Johnsson, M.J., Stallard, R.F., and Meade, R.H., 1988, First-cycle quartz arenites in the Orinoco River basin, Venezuela and Colombia: *Journal of Geology*, v. 96, p. 263–277.
- Kay, R.F., and Madden, R.H., 1997, Mammals and rainfall: Paleoeology of the middle Miocene at La Venta (Colombia, South America): *Journal of Human Evolution*, v. 32, p. 161–199.
- Molnar, P., 2004, Late Cenozoic increase in accumulation rates of terrestrial sediment: How might climate change have affected erosion rates?: *Annual Review of Earth and Planetary Sciences*, v. 32, p. 67–89.
- Montes, C., Hatcher, R.D., Jr., and Restrepo-Pace, P.A., 2005, Tectonic reconstruction of the northern Andean blocks: Oblique convergence and rotations derived from the kinematics of the Piedras-Girardot area, Colombia: *Tectonophysics*, v. 399, p. 221–250.
- Mora, A., Parra, M., Strecker, M.R., Kammer, A., Dimaté, C., and Rodríguez, F., 2006, Cenozoic contractional reactivation of Mesozoic extensional structures in the Eastern Cordillera of Colombia: *Tectonics*, v. 25, TC2010, doi: 10.1029/2005TC001854.
- Mora, A., Parra, M., Strecker, M.R., Sobel, E.R., Hooghiemstra, H., Torres, V., and Vallejo-Jaramillo, J., 2008, Climatic forcing of asymmetric orogenic evolution in the Eastern Cordillera of Colombia: *GSA Bulletin*, v. 120, p. 930–949.
- Nie, J., Horton, B.K., Mora, A., Saylor, J.E., Housh, T.B., Rubiano, J., and Naranjo, J., 2010, Tracking exhumation of Andean ranges bounding the Middle Magdalena Valley basin, Colombia: *Geology*, v. 5, p. 451–454.
- Parra, M., Mora, A., Jaramillo, C., Strecker, M.R., Sobel, E.R., Quiroz, L., Rueda, M., and Torres, V., 2009a, Orogenic wedge advance in the northern Andes: Evidence from the Oligocene-Miocene sedimentary record of the Medina Basin, Eastern Cordillera, Colombia: *GSA Bulletin*, v. 121, p. 780–800.
- Parra, M., Mora, A., Sobel, E.R., Strecker, M.R., and González, R., 2009b, Episodic orogenic front migration in the northern Andes: Constraints from low-temperature thermochronology in the Eastern Cordillera, Colombia: *Tectonics*, v. 28, TC4004, doi: 10.1029/2008TC002423.
- Parra, M., Mora, A., Jaramillo, C., Torres, V., Zeilinger, G., and Strecker, M.R., 2010, Tectonic controls on Cenozoic foreland basin development in the northeastern Andes, Colombia: *Basin Research*, doi: 10.1111/j.1365-2117.2009.00459.x.
- Reiners, P., 2005, Zircon (U-Th)/He thermochronometry, in Reiners, P.W., and Ehlers, T.A., eds., *Low-temperature thermochronology: Techniques, interpretations, and applications: Reviews in Mineralogy and Geochemistry*, v. 58, p. 151–179.
- Restrepo-Pace, P.A., Colmenares, F., Higuera, C., and Mayorga, M., 2004, A fold-and-thrust belt along the western flank of the Eastern Cordillera of Colombia. Style, kinematics, and timing constraints derived from seismic data and detailed surface mapping, in McClay, K.R., ed., *Thrust Tectonics and Hydrocarbon Systems: American Association of Petroleum Geologists Memoir 82*, p. 598–613.
- Roure, F., Bordas-Le Floch, N., Toro, J., Aubourg, C., Guilhaumou, N., Hernández, H., Lecornec-Lance, S., Rivero, C., Robion, P., and Sassi, W., 2003, Petroleum systems and reservoir appraisal in the sub-Andean basins (eastern Venezuela and eastern Colombian foothills), in Bartolini, C., Buffler, R.T., and Blickwede, J., eds., *The Circum-Gulf of Mexico and the Caribbean: Hydrocarbon Habitats, Basin Formation, and Plate Tectonics: American Association of Petroleum Geologists Memoir 79*, p. 750–775.
- Stockli, D.F., 2005, Application of low-temperature thermochronometry to extensional tectonic settings, in Reiners, P.W., and Ehlers, T.A., eds., *Low-Temperature Thermochronology: Techniques, Interpretations, and Applications: Reviews in Mineralogy and Geochemistry*, v. 58, p. 411–448.
- Strecker, M.R., Alonso, R.N., Bookhagen, B., Carrapa, B., Hilley, G.E., Sobel, E.R., and Trauth, M.H., 2007, Tectonics and climate of the southern central Andes: *Annual Review of Earth and Planetary Sciences*, v. 35, p. 747–787.
- Toro, J., Roure, F., Bordas-Le Floch, N., Le Cornec-Lance, S., and Sassi, W., 2004, Thermal and kinematic evolution of the Eastern Cordillera fold-and-thrust-belt, Colombia, in Swennen, R., Roure, F., and Granath, J.W., eds., *Deformation, Fluid Flow, and Reservoir Appraisal in Foreland Fold and Thrust Belts: American Association of Petroleum Geologists Hedberg Series*, v. 1, p. 79–115.
- Van der Hammen, T., Werner, J.H., and Van Dommelen, H., 1973, Palynological record of the upheaval of the northern Andes: A study of the Pliocene and lower Quaternary of the Colombian Eastern Cordillera and the early evolution of its high-Andean biota: *Reviews of Palaeobotany and Palynology*, v. 16, p. 1–122.
- Villamil, T., 1999, Campanian-Miocene tectonostratigraphy, depocenter evolution and basin development of Colombia and western Venezuela: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 153, p. 239–275.

Manuscript received 12 Aug. 2009; accepted 6 Jan. 2010.



Recent, Rare, And Out-Of-Print Books



geoscience, paleontology, mineralogy, mining history,
ore deposits, USGS and USBM publications, petroleum,
Trails illustrated and National Forest Service Maps

<http://booksgeology.com>

msbooks@booksgeology.com

WE PURCHASE BOOKS AND ENTIRE COLLECTIONS

MS Book and Mineral Company

P.O. Box 6774, Lake Charles, LA 70606-6774 USA.

GSA Today is Open Access Online

Go to www.geosociety.org/pubs/
and click on the *GSA Today* cover.





2010 MEDAL & AWARD RECIPIENTS

GSA PUBLIC SERVICE AWARD

Jonathan G. Price,
University of Nevada
and Nevada Bureau
of Mines & Geology



GSA DISTINGUISHED SERVICE AWARD

David A. Stephenson,
The Geological Society of
America Foundation



AGI MEDAL IN MEMORY OF IAN CAMPBELL

Vicki Cowart, Colorado
Geological Survey and
Planned Parenthood of the
Rocky Mountains (PPRM)



Awardees to Be Honored at 2010 GSA Annual Meeting & Exposition

The 2010 GSA Medals & Awards will be presented at the **Presidential Address & Awards Ceremony** on Saturday, 30 Oct., from 7–9 p.m. at the Colorado Convention Center in Denver, Colorado, USA. The 2010 Penrose, Day, and Donath medalists will present the second annual **GSA Gold Medal Lectures** on Sunday, 31 Oct.—three half-hour talks, each reflecting on their scientific careers. GSA's awardees will also be highlighted in the annual Hall of Fame.



PENROSE MEDAL

Eric J. Essene*, University of Michigan



ARTHUR L. DAY MEDAL

George E. Gehrels, University of Arizona



YOUNG SCIENTIST AWARD (DONATH MEDAL)

Dana L. Royer, Wesleyan University



PRESIDENT'S MEDAL OF THE GEOLOGICAL SOCIETY OF AMERICA

Keyhole Inc. founders **John Hanke,**
Chikai Ohazama, Mark Aubin, Phil Keslin,
and **Avi Bar-Zeev**; and advisory founders
Brian McClendon, Michael Jones, Chris
Tanner, and **Remi Arnaud** (developers of
Earth Viewer, now Google Earth).

RANDOLPH W. "BILL" AND CECILE T. BROMERY AWARD FOR THE MINORITIES

Marilyn J. Suiter, National
Science Foundation



SUBARU OUTSTANDING WOMAN IN SCIENCE AWARD

Sponsored by Subaru of America Inc.

Kateryna Klochko,
Carnegie Institution
for Science



JOHN C. FRYE ENVIRONMENTAL GEOLOGY AWARD

William R. Lund,
Tyler R. Knudsen,
Garrett S. Vice, and
Lucas M. Shaw, 2008,
Geologic hazards and
adverse construction
conditions, St. George–
Hurricane Metropolitan Area,
Washington County, Utah:
Utah Geological Survey
Special Study 127.

*deceased (20 May 2010)



2010 GSA DIVISION NAMED AWARDS

RIP RAPP ARCHAEOLOGICAL GEOLOGY AWARD

Archaeological Geology Division

Ervan G. Garrison, University of Georgia



GILBERT H. CADY AWARD

Coal Geology Division

Colin R. Ward, University of New South Wales



E.B. BURWELL, JR., AWARD

Engineering Geology Division

William L. Bilodeau, Sally W. Bilodeau, Eldon M. Gath, Mark Osborne, and Richard J. Proctor, 2007, *Geology of*

Los Angeles, California, United States of America:
Environmental & Engineering Geoscience, v. XIII,
no. 2, p. 99–160.



GEORGE P. WOOLLARD AWARD

Geophysics Division

Timothy H. Dixon, University of Miami



BIGGS AWARD FOR EXCELLENCE IN EARTH SCIENCE TEACHING

Geoscience Education Division

Michael C. Rygel

SUNY College at Potsdam



MARY C. RABBITT

HISTORY OF GEOLOGY AWARD

History of Geology Division

Gabriel Gohau, Lycée Janson de Sailly, Paris (emeritus)

O.E. MEINZER AWARD

Hydrogeology Division

Mary Jo Baedecker, U.S. Geological Survey–Reston, for
Baedecker, M.J., Cozzarelli, I.M., Eganhouse, R.P., Siegel, D.I.,
and Bennett, P.C., 1993, Crude oil in a shallow sand and
gravel aquifer—III. Biogeochemical reactions and mass
balance modeling in anoxic groundwater: *Applied*
Geochemistry, v. 8, p. 569–586.



DISTINGUISHED CAREER AWARD

International Division

W. Gary Ernst, Stanford University (emeritus)



ISRAEL C. RUSSELL AWARD

Limnogeology Division

William M. Last, University of Manitoba



G.K. GILBERT AWARD

Planetary Geology Division

Carle M. Pieters, Brown University



KIRK BRYAN AWARD

Quaternary Geology and Geomorphology Division

Rolfe D. Mandel, Kansas Geological Survey, University of
Kansas, 2008, Buried paleoindian-age landscapes in stream
valleys of the central plains, USA: *Geomorphology*,
v. 101, p. 342–361.



LAURENCE L. SLOSS AWARD

Sedimentary Geology Division

Hugh Jenkyns, University of Oxford



CAREER CONTRIBUTION AWARD

Structural Geology and Tectonics Division

George H. Davis, University of Arizona



2010 GSA FELLOWS

Elected by Council 17 April 2010



The following GSA Fellows, elected by GSA Council on 17 April 2010, will be recognized at the 2010 GSA Annual Meeting Presidential Address & Awards Ceremony on Saturday, 30 Oct., at the Colorado Convention Center in Denver. Brief citations for each Fellow are posted at www.geosociety.org/members/newFellows.htm.

.....
David J. Anastasio, Lehigh University. GSA Affiliations: Northeastern Section; Structural Geology and Tectonics Division. **Nominator:** Kenneth P. Kodama.

.....
Hassan A. Babaie, Georgia State University. GSA Affiliations: Southeastern Section; International Section; Structural Geology and Tectonics Division; Geoinformatics Division. **Nominator:** W. Crawford Elliott.

.....
Andrew P. Barth, Indiana University–Purdue University–Indianapolis. GSA Affiliations: Cordilleran Section; Mineralogy, Geochemistry, Petrology, and Volcanology Division; Structural Geology and Tectonics Division. **Nominator:** Eric H. Christiansen.

.....
Sydney L. Brown, California Dept. of Parks & Recreation. GSA Affiliations: Cordilleran Section; Engineering Geology Division; Quaternary Geology and Geomorphology Division; Geology and Society Division. **Nominator:** J. David Rogers.

.....
Steven C. Cande, Scripps Institute Oceanography. GSA Affiliations: Cordilleran Section; Geophysics Division. **Nominator:** Peter H. Molnar.

.....
Michael A. Clynne, U.S. Geological Society. GSA Affiliations: Cordilleran Section. **Nominator:** Charles R. Bacon.

.....
Michele L. Cooke, University of Massachusetts–Amherst. GSA Affiliations: Northeastern Section; Structural Geology and Tectonics Division; Geoscience Education Division. **Nominator:** Michael L. Williams.

.....
Larry S. Crumpler, New Mexico Museum of Natural History & Science. GSA Affiliations: Rocky Mountain Section; Planetary Geology Division. **Nominator:** James R. Zimbelman.

.....
John H. Cushman, Purdue University. GSA Affiliations: North-Central Section. **Nominator:** Stephen W. Wheatcraft.

.....
Zhenxue Dai, Los Alamos National Laboratory. GSA Affiliations: Rocky Mountain Section; Hydrogeology Division. **Nominator:** Robert W. Ritzi.

.....
P. Thompson (Thom) Davis, Bentley University. GSA Affiliations: Northeastern Section; Quaternary Geology and Geomorphology Division. **Nominator:** John T. Andrews.

.....
W. Mike Edmunds, Oxford Centre for Water Research. GSA Affiliations: International Section; Hydrogeology Division. **Elevated to Fellowship** as the 2009 Meinzer awardee.

.....
Maya Elrick, University of New Mexico. GSA Affiliations: Rocky Mountain Section; Sedimentary Geology Division. **Nominator:** John W. Geissman.

.....
Robert W. Embley, National Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory. GSA Affiliations: Cordilleran Section. **Nominator:** Robert J. Stern.

.....
James P. Evans, Utah State University. GSA Affiliations: Rocky Mountain Section; Cordilleran Section; Structural Geology and Tectonics Division. **Nominator:** Laurel B. Goodwin.

.....
C. Mark Fanning, The Australian National University. GSA Affiliations: Rocky Mountain Section; Sedimentary Geology Division; Structural Geology and Tectonics Division. **Nominator:** John W. Goode.

.....
Christopher M. Fedo, University of Tennessee. GSA Affiliations: Cordilleran Section; Geobiology & Geomicrobiology Division; Sedimentary Geology Division; Structural Geology and Tectonics Division. **Nominator:** Robert D. Hatcher Jr.

.....
Ray E. Ferrell, Louisiana State University. GSA Affiliations: South-Central Section; Geoscience Education Division. **Nominator:** Lynda B. Williams.

.....
Neil S. Fishman, U.S. Geological Survey. GSA Affiliations: Rocky Mountain Section; Cordilleran Section; Northeastern Section; Southeastern Section; North-Central Section; South-Central Section; International Section; Sedimentary Geology Division. **Nominator:** Bart J. Kowallis.

.....
Gordon E. Grant, USDA Forest Service. GSA Affiliations: Cordilleran Section; Quaternary Geology and Geomorphology Division; Mineralogy, Geochemistry, Petrology, and Volcanology Division. **Nominator:** Jon J. Major.

.....
Eric B. Grosfils, Pomona College. GSA Affiliations: Cordilleran Section; Geoscience Education Division; Planetary Geology Division. **Nominator:** Vicki L. Hansen.

.....
Djordje Grujic, Dalhousie University. GSA Affiliations: Northeastern Section. **Nominator:** Lincoln S. Hollister.

Todd Halihan, Oklahoma State University. GSA Affiliations: South-Central Section; Hydrogeology Division; Geology and Society Division. **Nominator:** F. Edwin Harvey.

Joseph T. Hannibal, Cleveland Museum Natural History. GSA Affiliations: North-Central Section. **Nominator:** Joanne Kluessendorf.

T. Mark Harrison, University of California–Los Angeles. GSA Affiliations: Cordilleran Section. **Elevated to Fellowship** as the 2009 Day Medalist.

William K. Hart, Miami University of Ohio. GSA Affiliations: Cordilleran Section; Geoscience Education Division. **Nominator:** Grant H. Heiken.

Judson W. Harvey, U.S. Geological Survey. GSA Affiliations: Northeastern Section. **Nominator:** George M. Hornberger.

Darrell J. Henry, Louisiana State University. GSA Affiliations: South-Central Section; Mineralogy, Geochemistry, Petrology, and Volcanology Division. **Nominator:** Sorena S. Sorensen.

Robert S. Hildebrand, Utah State University. GSA Affiliations: Cordilleran Section; Structural Geology and Tectonics Division. **Nominator:** Paul F. Hoffman.

Mark R. Hudson, U.S. Geological Survey. GSA Affiliations: Rocky Mountain Section. **Nominator:** V.J.S. (Tien) Grauch.

Oldrich Hungr, University of British Columbia. GSA Affiliations: Cordilleran Section; Engineering Geology Division. **Elevated to Fellowship** as the 2009 Burwell Awardee.

Jiin-Shuh Jean, National Cheng Kung University. GSA Affiliations: International Section; Geobiology & Geomicrobiology Division; Geology and Health Division; Hydrogeology Division. **Nominator:** Richard R. Parizek.

Robert M. Joeckel, University of Nebraska. GSA Affiliations: North-Central Section. **Nominator:** David B. Loope.

Karl E. Karlstrom, University of New Mexico. GSA Affiliations: Rocky Mountain Section; Structural Geology and Tectonics Division; Geoscience Education Division. **Elevated to Fellowship** as the 2009 GSA Distinguished Service Awardee.

Richard A. Ketcham, University of Texas. GSA Affiliations: Cordilleran Section. **Nominator:** William D. Carlson.

Michal J. Kowalewski, Virginia Tech. GSA Affiliations: Southeastern Section. **Nominator:** Karl W. Flessa.

Cin-Ty Aeolus Lee, Rice University. GSA Affiliations: South-Central Section. **Elevated to Fellowship** as the 2009 Donath Medalist.

John T. Leftwich, Halliburton Company. GSA Affiliations: South-Central Section. **Elevated to Fellowship** as the 2009 Bromery Awardee.

Thomas E. Lisle, Redwood Sciences Laboratory. GSA Affiliations: Cordilleran Section; Quaternary Geology and Geomorphology Division. **Nominator:** Thomas C. Pierson.

Richard I. Macphail, University College London. GSA Affiliations: International Section; Quaternary Geology and Geomorphology Division; Archeological Geology Division. **Elevated to Fellowship** as the 2009 Rip Rapp Awardee.

Cathryn A. Manduca, Carleton College. GSA Affiliations: North-Central Section. **Nominator:** Barbara L. Dutrow.

Michael McCurry, Idaho State University. GSA Affiliations: Rocky Mountain Section; Mineralogy, Geochemistry, Petrology, and Volcanology Division. **Nominator:** Paul K. Link.

Joseph G. Meert, University of Florida. GSA Affiliations: Southeastern Section; Structural Geology and Tectonics Division. **Nominator:** Neil D. Opdyke.

Dorothy J. Merritts, Franklin and Marshall College. GSA Affiliations: Northeastern Section. **Nominator:** Ellen E. Wohl.

David W. Mogk, Montana State University. GSA Affiliations: Rocky Mountain Section; Cordilleran Section; Structural Geology and Tectonics Division; Geology and Health Division; Geoscience Education Division. **Nominator:** Paul A. Mueller.

Alessandro Montanari, Osservatorio Geologico di Coldigioco. GSA Affiliations: International Section. **Nominator:** Walter Alvarez.

Dante Moran-Zenteno, Universidad Nacional Autónoma de México. GSA Affiliations: Cordilleran Section. **Nominator:** Luca Ferrari.

Paul M. Myrow, Colorado College. GSA Affiliations: Rocky Mountain Section. **Nominator:** John P. Grotzinger.

Roseanna M. Neupauer, University of Colorado. GSA Affiliations: Rocky Mountain Section. **Nominator:** Janet S. Herman.

James G. Ogg, Purdue University. GSA Affiliations: Cordilleran Section. **Nominator:** William J. Zinsmeister.

Scott R. Paterson, University of Southern California. GSA Affiliations: Cordilleran Section. **Nominator:** Robert B. Miller.

Virginia L. Peterson, Grand Valley State University. GSA Affiliations: Southeastern Section; Geoscience Education Division; Mineralogy, Geochemistry, Petrology, and Volcanology Division. **Nominator:** Laurie L. Brown.

.....
Kevin T. Pickering, University College London.
GSA Affiliations: International Section. **Nominator:** Michael B. Underwood.

.....
Kenneth D. Ridgway, Purdue University. GSA Affiliations: Cordilleran Section; Sedimentary Geology Division; Structural Geology and Tectonics Division. **Nominator:** Terry R. West.

.....
Michael R. Rosen, U.S. Geological Survey. GSA Affiliations: Cordilleran Section; Hydrogeology Division; Limnogeology Division. **Nominator:** Gail M. Ashley.

.....
Joseph G. Rosenbaum, U.S. Geological Survey. GSA Affiliations: Rocky Mountain Section; Limnogeology Division; Quaternary Geology and Geomorphology Division. **Nominator:** Richard Lee Reynolds.

.....
Lisa A. Rossbacher, Southern Polytechnic State University. GSA Affiliations: Southeastern Section. **Nominator:** Rex C. Buchanan.

.....
Christine S. Siddoway, The Colorado College. GSA Affiliations: Rocky Mountain Section; Structural Geology and Tectonics Division. **Nominator:** Basil Tikoff.

.....
Robert G. Strom, University of Arizona. GSA Affiliations: Rocky Mountain Section; Planetary Geology Division. **Elevated to Fellowship** as the 2009 Gilbert Awardee.

.....
Bonnie W. Styles, Illinois State Museum Research. GSA Affiliations: North-Central Section; Archaeological Geology Division; Quaternary Geology and Geomorphology Division. **Nominator:** Rolfe D. Mandel.

.....
Keith A. Sverdrup, University of Wisconsin. GSA Affiliations: North-Central Section; Geoscience Education Division. **Nominator:** Vincent S. Cronin.

.....
Margaret A. Townsend, Kansas Geological Survey. GSA Affiliations: North-Central Section; Hydrogeology Division; Geology and Health Division. **Nominator:** Ralph K. Davis.

.....
Slawek M. Tulaczyk, University of California–Santa Cruz. GSA Affiliations: Cordilleran Section; Quaternary Geology and Geomorphology Division. **Nominator:** Eli A. Silver.

.....
Jaime Urrutia-Fucugauchi, Universidad Nacional Autónoma de México–Coyoacan. GSA Affiliations: Cordilleran Section. **Nominator:** Enrique Gómez de la Rosa.

.....
David W. Valentino, SUNY-Oswego. GSA Affiliations: Northeastern Section. **Nominator:** Jeffrey R. Chiarenzelli.

.....
Michael L. Wells, University of Nevada–Las Vegas. GSA Affiliations: Cordilleran Section; Structural Geology and Tectonics Division. **Nominator:** Richard W. Allmendinger.

.....
Kelin X. Whipple, Arizona State University. GSA Affiliations: Cordilleran Section; Quaternary Geology and Geomorphology Division. **Nominator:** Frank J. Pazzaglia.

.....
Richard Wirth, Helmholtz Centre Potsdam, GFZ Potsdam. GSA Affiliations: International Section. **Nominator:** Larissa Dorbrzhinetskaya.

.....
Tsanyao Frank Yang, National Taiwan University. GSA Affiliations: International Section; Mineralogy, Geochemistry, Petrology, and Volcanology Division. **Nominator:** L. Lynn Chyi.

.....
Davis A. Young, Calvin College (emeritus). GSA Affiliations: Cordilleran Section; History of Geology Division. **Elevated to Fellowship** as the 2009 Mary C. Rabbitt Awardee.

.....
Yan Zheng, Queens College. GSA Affiliations: Northeastern Section; Hydrogeology Division. **Nominator:** Chunmiao Zheng.



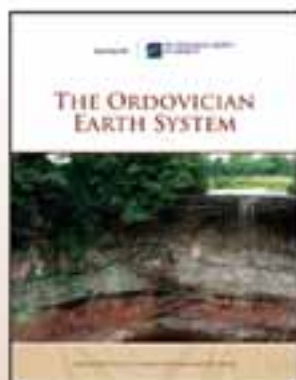
Society Fellowship is an honor bestowed on the best of our profession by election during each spring GSA Council meeting. GSA members are nominated and elected to Fellowship in recognition of distinguished contributions to the geosciences through such avenues as publications, applied research, teaching, administration of geological programs, contributing to the public awareness of geology, leadership of professional organizations, and taking on editorial, bibliographic, and library responsibilities. **Only GSA Fellows may be the primary nominators** of colleagues for elevation to GSA Fellowship. Guidelines and nomination forms are online at www.geosociety.org/members/fellow.htm. If you have questions, please e-mail awards@geosociety.org or call +1-800-472-1988, ext. 1028, or +1-303-357-1028.



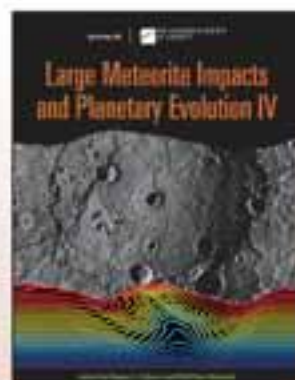
New at the GSA Bookstore



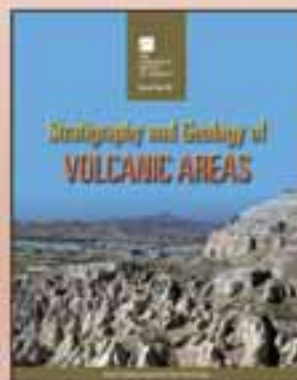
Mining and Metallurgy in Ancient Peru
by Georg Petersen G.,
translated by William E. Brooks, 2010
SPE467, 90 p., ISBN 9780813724676
\$40.00 | member price \$28.00



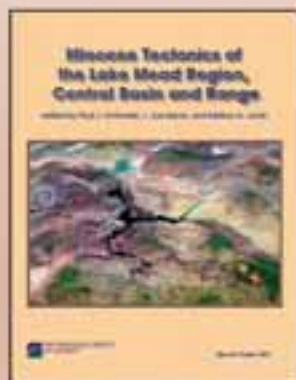
The Ordovician Earth System
edited by Stanley C. Finney
and William B.N. Berry, 2010
SPE468, 193 p., ISBN 9780813724683
\$60.00 | member price \$42.00



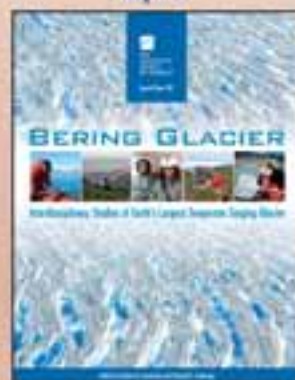
Large Meteorite Impacts and Planetary Evolution IV
edited by Wolf Uwe Reimold
and Roger L. Gibson, 2010
SPE465, ISBN 9780813724652
in press



Stratigraphy and Geology of Volcanic Areas
edited by Gianluca Grappelli
and Lothar Vireck-Gentle, 2010
SPE464, 291 p. plus CD-ROM, ISBN 9780813724645
\$95.00 | member price \$66.00



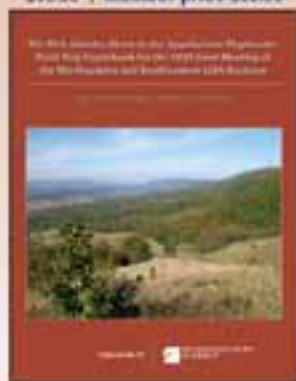
Miocene Tectonics of the Lake Mead Region, Central Basin and Range
edited by Paul J. Unhouser, L. Sue Beard,
and Melissa A. Lamb, 2010
SPE463, 441 p. plus CD-ROM, plates,
ISBN 9780813724638
\$95.00 | member price \$66.00



Bering Glacier: Interdisciplinary Studies of Earth's Largest Temperate Surging Glacier
edited by Robert A. Shuchman
and Edward G. Juszberger, 2010
SPE462, 384 p., ISBN 9780813724621
\$99.00 | member price \$70.00



From Precambrian Rift Volcanoes to the Mississippian Shelf Margin: Geological Field Excursions in the Ozark Mountains
edited by Kevin R. Evans and James S. Aber, 2010
FLD017, 158 p., ISBN 9780813700175
\$50.00 | member price \$35.00



The Mid-Atlantic Shore to the Appalachian Highlands: Field Trip Guidebook for the 2010 Joint Meeting of the Northeastern and Southeastern GSA Sections
edited by Gary M. Fleegeer
and Steven J. Whitmeyer, 2010
FLD016, 125 p., ISBN 9780813700168
\$40.00 | member price \$28.00



The Geoscience Handbook, AGI Data Sheets, Fourth Edition
compiled by J. Douglas Walker
and Harvey A. Cohen, 2010
DATASHEETS, 310 p., 5" x 8", spiral bound,
ISBN 9780922152841
\$49.95 | member price \$39.95

www.geosociety.org/bookstore

GSA Celebrates 50-Year Member Anniversaries

Thanks for Your Membership!

GSA salutes the following colleagues as they reach their 50-year anniversary of membership in GSA. We appreciate your dedication and loyalty to GSA for all these years!

Asterisks indicate those members who have not yet been elevated to Fellowship status. **GSA Fellows:** You can help maintain a dynamic, vibrant cohort by nominating deserving

geoscience colleagues for Fellowship. Guidelines and nomination forms are online at www.geosociety.org/members/fellow.htm. If you have questions, please e-mail awards@geosociety.org or call +1-800-472-1988, ext. 1028, or +1-303-357-1028.



Monem Abdel-Gawad
John K. Adams
John C. Balla*
C.S. Venable Barclay*
Harold H. Beaver
Myron G. Best
M.E. Bickford
Donald J. Brown
Eugene E. Brucker*
J. Allan Cain
Wilfred J. Carr
Edward H. Chown
Lorence G. Collins
Curtis Dean Conley
Edward Cotter
E. Julius Dasch
Gregory A. Davis
James Robert Dodd
Alan C. Donaldson
Kenneth E. Eade
Donald J. Easterbrook
Farouk El-Baz
Jack A. Ellingson
John William Erickson*
Tomas Feininger
Cyrus W. Field
Richard C. Fountain
M. Charles Gilbert
Patrick A. Glancy
Harold J. Gluskoter
Bruce K. Goodwin

William C. Goth
Andrew Griscom
James W. Hawkins Jr.
William H. Hawkins*
James F. Hays
Arnold R. Henderson*
Theodore C. Herman*
M.J. Hibbard
Robert A. Hodgson
Jimmie E. Jinks Jr.*
Robert R. Jordan
James W. Knox*
Max E. Kofford*
Ronald Howard Konig
Peter Lehner
Paul A. Lindberg
Peter W. Lipman
Edmund Livingston*
William C. Luth
William D. MacDonald
Earle F. McBride
Cole R. McClure Jr.
Carleton B. Moore
Glenn B. Morey
Gail F. Moulton Jr.*
Charles G. Mull*
Michael A. Murphy
James Neiheisel
Donald C. Noble
Richard Howard Pearl*
Fred Peterson

Kenneth L. Pierce
John W. Porter
Paul H. Reitan
William D. Romey
Kingsley W. Roth*
Nathaniel W. Rutter
Lowell R. Satin*
Robert Gordon Schmidt
John S. Scott
Donald T. Secor Jr.
James H. Shea
Ebrahim Shekarchi*
Arthur W. Shelden*
Theodore D. Sheldon*
Robert C. Shumaker
Gene Simmons
Dale R. Simpson
John J. Sisler*

Scott B. Smithson*
David L. Southwick
Donald J. Swift
D.H. Tarling
William A. Thomas
Richard R. Thompson
William B. Travers
Albert S. Van Denburgh
Georges R. Verrier*
Louis P. Vlangas*
Don L. Warner
Carl Merrick Wentworth
Edmund G. Wermund Jr.
Owen L. White
Robert G. Wiese Jr.
William E. Wilson
Robert F. Yerkes*

Note: This list shows only those members and Fellows who are celebrating their 50-year membership anniversary in 2010. Complete lists of members and Fellows who have surpassed the 50-year mark are online at <http://rock.geosociety.org/membership/50YearMembers.asp> and <http://rock.geosociety.org/membership/50Yearfellows.asp>, respectively.



2010 GSA Research Grant Recipients



The GSA Committee on Research Grants has awarded US\$612,042 to 276 of the 538 graduate students who applied (51%); the average grant was US\$2,218. The committee also selected ten alternate candidates in the event that any grantees return all or part of their funds due to a change in their research project or receipt of funds from another source.

Committee members: Patricia Holroyd (Chair), Nan Crystal Arens, Julia A. Baldwin, David Borrok, Elizabeth Jones Crafford, Rupali Datta, Robert V. Demicco, James E. Evans, David P. Gillikin, Allen M. Gontz, Darren Grocke, Anita Grunder, Stephen S. Harlan, Antun Husinec, Oliver Korup, Jeffrey Lee, Tim Lowenstein, Michelle Markley, Susannah M. Porter, Michael

F. Roden, Paul Tomascak, Julia Smith Wellner, Peter D. Wilf, and Kevin M. Yeager.

The GSA Graduate Student Research Grant Program is funded by The Geological Society of America, the GSA Foundation, GSA Divisions, and the National Science Foundation.

The following awards related to the research grant program will be presented at the 2010 GSA Annual Meeting in Denver, Colorado, USA: Outstanding Mentions, Specialized Awards, Diversity in the Geosciences Minority Research Grant Awards, Farouk El-Baz Student Grants, and The Maurice "Ric" Terman Fund.

2010 OUTSTANDING MENTIONS

The committee recognized 20 of the proposals to be of exceptionally high merit in conception and presentation.

Alexis K. Ault, University of Colorado–Boulder: "Tectonic connections to burial and unroofing of the Rae craton, Baffin Island: Evidence from apatite (U-Th)/He thermochronometry."

Scott E.K. Bennett, University of California–Davis: "Testing the role of obliquity in rupturing continental lithosphere: Dating rift-related transtensional structures in coastal Sonora."

Chloe Bonamici, University of Wisconsin–Madison: "Linking deformational and geochemical processes through intragrain oxygen-isotope diffusion profiles."

Alvin J. Bonilla, University of Kansas: "Paleoceanographic conditions of tropical oceans in the Caribbean region during the Cretaceous greenhouse world."

Greg Brennecka, Arizona State University: "Establishing $^{238}\text{U}/^{235}\text{U}$ as a new paleoredox proxy."

Christopher F. Cassle, Colorado State University: "Detailed sedimentological and stratigraphic analyses of organic rich successions within the Permian Phosphoria Formation of Idaho and Wyoming, USA."

Rafael Cavalcanti de Albuquerque, Simon Fraser University: "Hydrogeochemical assessment of arsenic occurrences in groundwaters in complex glaciomarine sediment aquifers."

Laura Craig, University of Nevada–Reno: "Developing locally based methods for controlling excess fluoride in drinking water in Ghana, West Africa."

Brian J. Hanson, Boise State University: "Evaluating the source and release mechanism of dissolved uranium in the Treasure Valley Aquifer, ID."

Breanna L. Huff, University of Kansas: "Microbial response in a CO_2 -injected aquifer."

Britta J.L. Jensen, University of Alberta: "A chronostratigraphic framework for the middle Pleistocene in eastern Beringia."

Caitlin Keating-Bitonti, University of Wisconsin–Madison: "Deep-sea sedimentation as an archive and driver of the global climate system: The influence of North Atlantic deep water on carbon sequestration."

Kirsten L. Kennedy, Dalhousie University: "Sedimentology and paleobiological importance of the Campbellton Formation, New Brunswick."

Denise M. Levitan, Virginia Tech: "Precipitation kinetics of autunite minerals: Implications for uranium immobilization."

Jennifer Levy, Columbia University: "Tree composition impact on the belowground carbon budget of a northeastern forest: A case study from a tree girdling experiment in Black Rock Forest."

John Sommerfeld, San Francisco State University: "Microstructural control on $^{40}\text{Ar}/^{39}\text{Ar}$ ages from a young leucogranite."

Mindi Summers, Scripps Institute of Oceanography: "aDNA extraction from sediments: Training in techniques and study of community changes over the past glacial."

Ryan J. Thress, University of Washington: "Structural and stratigraphic analyses of Messinian chaotic mass-flow deposits in the Sicilian foredeep basin."

Sarah H. Vorhies, Yale University: "Using intracrystalline diffusion to quantify timescales of metamorphism in the Barrovian zones, Scotland."

David Weinstein, University of Miami: "Rates of coral substrate bioerosion across the depth range of modern Caribbean reefs: Implications on past and future reef structures."



2010 SPECIALIZED AWARDS, SPONSORED BY THE GSA FOUNDATION



The committee selected the following recipients for specialized awards named in honor of Foundation donors or as memorials to former Society members.

Gretchen L. Blechschmidt Award

Carlie Pietsch, *University of Southern California*. This award supports research by women interested in achieving a Ph.D. in the geological sciences and a career in academic research, especially in the fields of biostratigraphy and/or paleoceanography, and who have an interest in sequence stratigraphy analysis, particularly in conjunction with research into deep-sea sedimentology.

John T. Dillon Alaska Research Award

Casey J. Huff, *University of California–Davis*. John Dillon was particularly noted for his radiometric age-dating work in the Brooks Range of Alaska; this award supports research that addresses field-based studies dealing with the state's structural and tectonic development and/or those that include some aspect of geochronology (either paleontologic or radiometric) to provide new age control for significant rock units in Alaska.

Robert K. Fahnestock Award

Erica Bigio, *University of Arizona*. This award honors the memory of Fahnestock, a former member of the GSA Committee on Research Grants who died as a result of service on the committee, and recognizes the best proposal in sediment transport or related aspects of fluvial geomorphology, Fahnestock's field.

Lipman Research Award

Sarah A. Bromley, *Oregon State University*. Established in 1993, this award is supported by gifts from the Howard and Jean Lipman Foundation; the president of the Lipman Foundation, Peter W. Lipman, was the recipient of a GSA research grant in 1965. The fund's purpose is to promote and support student research grants in volcanology and petrology.

Minority Award

Robert W. Boessenecker, *Montana State University*. This award was established to promote and support minority students in the geosciences.

John Montagne Fund

Kerry Riley, *Boise State University*. Established in 2000, this award supports one recipient's research in the field of Quaternary geomorphology.

Bruce L. "Biff" Reed Scholarship Award

Joel Unema, *Northern Arizona University*. This award provides research grants to graduate students pursuing studies primarily on the tectonic and magmatic evolution of Alaska but can also fund other geologic research.

Charles A. & June R.P. Ross Research Fund

Michael D. D'Emic, *University of Michigan*. Established in 2002, this fund supports research in the fields of biostratigraphy, stratigraphy and stratigraphic correlation, paleogeography and paleobiogeography, interpreting past environments of deposition and their biological significance, and the integration of these research areas into better global understanding.

Alexander Sisson Research Award

George Daly, *Miami University*. Family members of Alexander Sisson established a fund in his memory to promote and support research for students pursuing studies in Alaska and the Caribbean.

Parke D. Snavelly, Jr., Cascadia Research Award Fund

Pasquale Del Vecchio, *University of Nevada–Las Vegas*. This award provides funds to support field-oriented graduate-student research that contributes to understanding the geologic processes and history of the Pacific Northwest convergent margin or to evaluation of its hazard or resource potential.

Harold T. Stearns Fellowship Award

Kayla D. Holleman, *University of Hawaii–Manoa*; **Sarah M. White**, *University of California–Davis*. Established in 1973, this fellowship supports student research on aspects of the geology of the Pacific Islands and the circum-Pacific region.

Alexander & Geraldine Wanek Fund

Jennifer R. Dierauer, *Southern Illinois University*. Established in 2002, the Wanek Fund supports research dealing with coal and petroleum resources, mapping, and engineering geology, marine resources, petroleum economics, appraisal, and evaluation, and the geology of phosphate resources.

SPECIALIZED AWARDS



DIVERSITY IN THE GEOSCIENCES MINORITY RESEARCH GRANT AWARDS

Two research grant applications, selected from minority graduate student submissions, were found to be of exceptionally high merit in conception and presentation by the GSA Diversity in the Geosciences Committee, and will be recognized with a cash award of US\$500 each: **Yamira Adorno-Negron**, University of Nebraska, "Isotope geochemistry, petrography and diagenesis of Permian carbonates from the Yuzhno Kilchuyu (YK) field, Timan-Pechora Basin, Russia"; and **Orlando Teran**, Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), "Kinematics and tectonic evolution of the rifted margin of the Rio Grande rift, Culebra Range, Colorado."

FAROUK EL-BAZ STUDENT RESEARCH GRANT

This fund was established to encourage and support desert studies by students worldwide who are either in their senior year of undergraduate studies, or at the master's or Ph.D. level. This year's two awardees will receive a cash award of US\$2,500 each: **Justine R. Cullen**, University of the Fraser Valley–British Columbia, "Determining an optimal protocol for optically-stimulated luminescence of sand dunes in the drylands of central Canada"; and **Stefan T. Knopp**, University of Calgary–Alberta, "Near-surface diagenetic processes and their implication for landscape evolution in desert environments: An example from the Late Jurassic to Early Cretaceous of the western interior U.S.A."



THE MAURICE "RIC" TERMAN FUND

This grant fund provides support for one year of Ph.D. and post-doctoral research for scientists from the following East Asian countries: Cambodia, China, Indonesia, Japan, Korea, Malaysia, Papua New Guinea, Thailand, and Vietnam. The recipients for 2009 were **Nguyen Thi Hai Van** of Vietnam and **Namphon Khampilang** of Thailand.

ALL 2010 GSA RESEARCH GRANT RECIPIENTS



Hannah Aird
David Aldridge
Megan Arnold
Alexis Ault
Eric Avalos
Karen Aydinian
Jonathan Baker
Thomas Baltz
Bharat Banjade
Jane Barnes
Lee Barnett
Chandranath Basak
Samuel Beal Jr.
Rachel Beavins
Catherine Beck
Scott Bennett
Blair Benson
Thomas Bianchette
Erica Bigio
Timothy Blazina
Grant Boardman
Robert Boessenecker

Wendy Bohon
Chloe Bonamici
Alvin Bonilla
Michael Bonomo
Deblina Bose
Greg Brennecke
Kirstin Brink
Sarah Bromley
Christine Brown
Kenneth Brown
Lucy Brudnak
Daniel Burnham
Matthew Burton-Kelly
Jesse Carlucci
Alison Carter
Christopher Cassle
Richard Casteel
Rafael Cavalcanti de Albuquerque
Kuldeep Chaudhary
Ming-Chu Chen
Kenneth Christle
Christopher Clinkscales

Joseph Collette
Elise Conte
Jennifer Cotton
Laura Craig
Megan Crocker
Brandi Cron
Ryan Crow
Michael D'Emic
George Daly
Michael Darin
Stephanie Day
Maarten de Moor
Jacob Deitz
Tanya del Valle
Pasquale Del Vecchio
Kathryn Denommee
Michael DeVasto
Jennifer Dierauer
David Dixon
Thomas Donahoe
Daniel Doolittle
Emily Eastridge

Clint Edrington
Austin Elliott
Timmons Erickson
Elena Evans
Joseph Felix
Adam Forte
Herbert Fournier
Travis Foy
Sarah Friedman
Andrew Friedrich
Evan Frye
Juan Luis García
Yann Gavillot
Michael Giallorenzo
Kelly Gibson
Nick Graehl
Alison Graettinger
Lauren Greene
Danielle Grogan
William Guerra

(continued on p. 20)

ALL 2010 GSA RESEARCH GRANT RECIPIENTS *(continued from p. 19)*



Alan F. Halfen
 Brian Hanson
 Austin Hart
 Janet Harvey
 Joern Hauer
 Bretani Heron
 Gordon Hicks III
 Luke Hilchie
 Shari Hilding-Kronforst
 Jenna Hojnowski
 Kayla Holleman
 Forrest Horton
 Breanna Huff
 Casey Huff
 Kenneth Hughes
 Rachel Hunt
 Andrew Hutto
 Ethan Hyland
 Kayla Ireland
 Kelly L. Jackson
 Kristin Jacob
 Matt Jenkins
 Brittany Jenner
 Britta Jensen
 Adam Johnson
 Casey Jolley
 Matthew Jungers
 Lisa Kanner
 Leif Karlstrom
 Andrew Kay
 Caitlin Keating-Bitonti
 Christopher Kelley
 Neil Kelley
 Kirsten Kennedy
 Emiko Kent
 Rimma Khodjanyazova
 Jonathon LaCarrubba
 Daniel Lancaster
 Charity Lander
 Rachel Landman
 John Lee
 Sophie Lehmann
 Denise Levitan
 Jennifer Levy
 Robert Lewis
 Zachery Lifton
 Philip Lindner
 Brad Lipovsky
 MaryEllen Loan
 Sandra Londono
 David Lovelace
 Christopher Lowery

Jason Loxton
 Michael Lucas
 Daniel Luna
 Keith Ma
 Robert Mahon
 Guadalupe Maldonado Sanchez
 Ahmadreza Malekpour Alamdarie
 Richard Malizia
 Thomas Malizia
 Nobuaki Masutsubo
 Malysa Maurer
 Aaron Mayfield
 Windy Jo McBride
 Bree McClenning
 Sophie McCoy
 B. Rex McLachlin
 Michael Meyer
 Melanie Michalak
 Lauren Michel
 Christen Miller
 Diana Miller
 Joseph Miller
 Jason Mintz
 Kristen Mitchell
 Robin Moore
 Beau Morris
 Jesse Mosolf
 Sarah Nagorsen
 Pauline Paul Nesaraja
 Laura Nesar
 Ghanashyam Neupane
 Kathryn Nold
 Andy Nunnery
 Eric Obrock
 Marcie Occhi
 Abraham Padilla
 Mike Passarello
 Ernesto Pecoits
 Sara Peek
 Andrew Perkins
 Joseph Perkins
 Jared Peters
 Carlie Pietsch
 Jean-Luc Pilote
 Zachary Ploskey
 Zachary Poland
 Lina Polvi
 Vladislav Powerman
 Jeremy Prouhet
 Jonathan Prouty
 Thejashwini Ramarao
 John Ramirez-Avila

Christine Rasoazanamparany
 Joanna Redwine
 Melanie Reed
 Christine Regalla
 David Reieux
 Francis Rengers
 Paul Richardson
 Leigh Anne Riedman
 Kerry Riley
 Nicholas Rosenau
 Roxana Safipour
 Esteban Sagredo
 Morgan Salisbury
 Carlos Sanchez
 Aaron Sappenfield
 Amanda Savrda
 Nicole Schoolmeesters
 Thomas Schramm
 Eric Seeger
 Jacob Selander
 Steven Shaw
 Xuhua Shi
 Owen Shufeldt
 Ashley Shuler
 Karri Sicard
 Marion Sikora
 Maciej Sliwinski
 Zackery Smith
 Jonathan Snatic
 John Sommerfeld
 Zachary Spahn
 Eleanor Spangler
 Molly Staats
 Edward Starns
 Justin Starr
 Gary Stinchcomb
 Elizabeth Stock
 Ashley Streig
 Ciprian Stremtan
 Justin Stroup
 Debra Stults
 Richard Styron
 Mindi Summers
 Kurt Sundell
 Elizabeth Swanner
 Dawn Sweeney
 Rafferty Sweeney
 Jordan-Leigh Taylor
 Orlando Teran
 Susanna Theroux
 Jennifer Thompson
 Ryan Thress

Justin Tiffany
 Jessica Till
 Tobgay Tobgay
 Lauren Toth
 Kaori Tsukui
 Michael Tuite
 Joel Unema
 Morgan Unrast
 Alexander Van Plantinga
 Sarah Vorhies
 Alina Walcek
 Victoria Walker
 Zackary Wall
 Zachary Wallace
 Talor Walsh
 David Weinstein
 Sarah White
 Martha Whitney
 Andrew Wickert
 Inoka Widanagamage
 Eric Wilcox Freeburg
 Karen Williams
 Matthew Winnick
 Corinne Wong
 John Wood
 Ryan Wood
 William Woodruff
 Teresa Wriston
 Tao Wu
 Tracy Wulf
 Lindsey Yann
 Hongjiao Yu
 Adam Zeiza
 Ashley Zung

2010 Alternates

Jordan Armstrong
 Christian Christofferson
 Evan Kochelek
 John Kroon
 Ryan Mills
 Reed Myers
 Nathan Peters
 Jeanne Roningen
 Tabitha Trosper
 Kathryn Warren

2010 GSA DIVISION & SECTION STUDENT RESEARCH AWARDS

DIVISION AWARDS

Five GSA Divisions have recognized the following graduate student research grant recipients for submitting proposals of exceptionally high merit in conception and presentation in their fields. These students will be honored by these Divisions at the 2010 GSA Annual Meeting in Denver.

GEOPHYSICS DIVISION

Allan V. Cox Student Research Grant
Sarah Friedman, Southern Illinois University
Geophysics Student Research Grant Award
Deblina Bose, Auburn University

HYDROGEOLOGY DIVISION

Student Research Grant Awards
Kuldeep Chaudhary, The University of Texas at Austin–Jackson School of Earth Sciences;
Jennifer Dierauer, Southern Illinois University;
Emily Eastridge, University of Kentucky;
Marcie Occhi, University of Maryland

QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION

J. Hoover Mackin Student Research Award
Juan Luis Garcia, University of Maine
J. Hoover Mackin Student Research Award
Honorary Mention
Matthew C. Jungers, Arizona State University
Arthur D. Howard Student Research Award
Ryan W. Wood, San José State University
Arthur D. Howard Student Research Award
Honorary Mention
Serin Duplantis, Portland State University
Marie Morisawa Student Research Award
Britta J.L. Jensen, University of Alberta
Marie Morisawa Student Research Award
Honorary Mention
Erica Bigio, University of Arizona

SEDIMENTARY GEOLOGY DIVISION

Sedimentary Geology Division Student Research Grant Award
Jennifer Cotton, University of Michigan

STRUCTURAL GEOLOGY AND TECTONICS DIVISION

Student Research Grant Awards

Adam Forte, University of California–Davis;
Janet C. Harvey, California Institute of Technology;
Melanie Michalak, University of California–Santa Cruz;
Richard H. Styron, University of Kansas;
Justin M. Tiffany, University of Missouri–Columbia

SECTION AWARDS

Two GSA Sections have recognized exceptional students within their geographic region.

SOUTHEASTERN SECTION

The following graduate students from universities within the geographic boundaries of GSA's Southeastern Section were recognized by the Section for submitting research grant proposals of exceptionally high merit in conception and presentation:

Max Christie, University of Georgia;
Tina L. Colbert, Georgia Institute of Technology;
Kristin M. Dorfler, Virginia Polytechnic and State University;
Subhadip Mandal, University of Alabama;
Adeola Oyewumi, Virginia Polytechnic and State University;
Oluyinka Oyewumi, Virginia Polytechnic and State University;
Dalene Smith, Western Kentucky University.

NORTHEASTERN SECTION

GSA's Northeastern Section offers student research grant awards to support research by sophomore or junior undergraduates attending universities within the geographic boundaries of the Section:

Daniel J. Arcadi, SUNY Potsdam;
Matthew Dunlop, SUNY Potsdam;
Caitlin Herbert, Lesley University;
Elizabeth Petsios, Cornell University;
Chelsea L. Richard, SUNY Potsdam;
Allen J. Schaen, Bridgewater State College;
Marissa Tremblay, Barnard College.

2010 Cole Award Recipients

The 2010 Cole Awards for postdoctoral research are funded by the GSA Foundation.

GLADYS W. COLE MEMORIAL RESEARCH AWARD

Kathleen Nicoll, University of Utah, was awarded US\$6,500 from the Gladys W. Cole Fund for research in geomorphology of semi-arid and arid terrains for her research project "Revisiting G.K. Gilbert's 'Great Bar at Stockton, Utah'—documenting a site in peril." The award will be presented at the Quaternary Geology and Geomorphology Division Awards Ceremony at the 2010 GSA Annual Meeting.

W. STORRS COLE MEMORIAL RESEARCH AWARD

Richard H. Fluegeman, Ball State University, was awarded US\$6,000 from the W. Storrs Cole Fund for research in invertebrate micropaleontology for his research project "Eocene planktonic foraminiferal biostratigraphy and the timing of ophiolite obduction, New Caledonia, southwest Pacific." The award will be presented at the Cushman Foundation for Foraminiferal Research Awards Ceremony at the 2010 GSA Annual Meeting.

GSA LIMNOGEOLOGY DIVISION Kerry Kelts Student Research Award

Application deadline: 2 August 2010

GSA's Limnogeology Division is offering an award of US\$1,000 for research related to limnogeology, limnology, or paleolimnology. To apply, send a summary in PDF format (include your name in the PDF file name) of the proposed research, its significance, and how the award will be used (five-page max.) along with a short (two-page max.) CV to the chair of the Limnogeology Division, Michael Rosen, mrosen@usgs.gov. For more information, go to <http://rock.geosociety.org/limno/Kelts%20Award%202010%20announcement.htm>.

The award recipient will be announced at the Limnogeology Division Business Meeting and Reception at the 2010 GSA Annual Meeting.

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

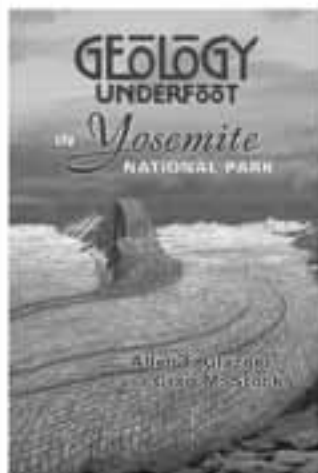
Discover the Geologic Wonders of the Golden State

California ROCKS! A Guide to Geologic Sites in the Golden State

Katherine J. Baylor

From erupting geysers and boiling mud pots to collapsing sea arches and crawling landslides, these 65 geologic sites show how California is a land in motion.

9 x 8 1/2 • 128 pages • \$16.00
45 color maps and illustrations

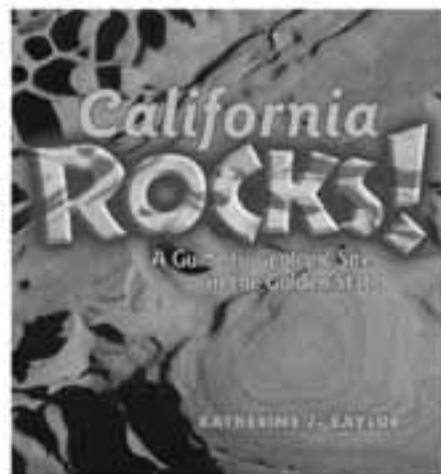


Geology Underfoot in Yosemite National Park

Allen F. Glazner
and Greg M. Stock

While visiting these more than twenty-five amazing sites, you'll learn the stories behind Yosemite's unique geologic formations.

6 x 9 • 304 pages • \$24.00
150 color photographs • 61 color illustrations and maps



MP Mountain Press
PUBLISHING COMPANY

P.O. Box 2399 • Missoula, MT 59806 • 406-728-1900
toll free: 800-234-5308 • fax: 406-728-1635
info@mtncpress.com • www.mountain-press.com

*Funding Student Research as
Global as Our Science*

GSA Research Grants— International Program

GSA is pleased to announce the expansion of our North American-based Graduate Student Research Grants Program to include international student members. We are asking for your help with funding the international component of this program.

GSA's research grants make up one of the largest and most prestigious funding programs for geoscience graduate students in North America. It helps cover the field and laboratory costs of geoscience projects conducted by master's and doctoral students at universities in the United States, Canada, Mexico, and Central America. Since the program's inception in 1933, GSA has awarded over US\$11.6 million to almost 10,000 students. This program is an essential element in supporting the education and training of future geoscientists, while instilling in our student members a sense of loyalty to the Society.

The new *GSA Research Grants—International Program Fund* will provide funding opportunities for those outside of North and Central America, because the current program (partially funded by the National Science Foundation) has geographical restrictions.

Before we can start helping our international student members with their research, we need to build up the funds for this program. You can contribute in two ways:

1. Send your check, payable to the GSA Foundation, to P.O. Box 9140, Boulder, CO 80301, USA. Please note on the memo line that your donation is for "GSA Research Grants—International Program."
2. Go to the GSA Foundation's Web site (www.gsafweb.org/) and click on the "Make a Donation" tab at the top-center of the page. Enter the amount of your donation and select "GSA Research Grants—International Program" from the pull-down menu.

*Thanks for your interest
in and support of international
student research!*

www.geosociety.org

ABOUT PEOPLE

GSA Fellow **William F. Ruddiman**, professor emeritus at the University of Virginia, has been awarded the 2010 Lyell Medal by the Geological Society (London) for his "significant contribution to 'soft rock' geology by means of a substantial body of research."

GSA Fellow **Barbara K. Bekken** was honored with two awards from Virginia Tech this spring—the 2010 Edward S. Diggs Teaching Scholars Award and the 2010 Alumni Award for Excellence in Teaching—recognizing her exceptional contributions to the Virginia Tech teaching program and learning environment.

The National Academy of Sciences (NAS) has named its new members and "foreign associates," elected "in recognition of their distinguished and continuing achievements in original research." Congratulations to GSA Fellow **Douglas W. Burbank** of the University of California—Santa Barbara and GSA Fellow **Roberta L. Rudnick** of the University of Maryland—College Park for their election to NAS membership and to GSA Honorary Fellow **Victor A. Ramos** of Universidad de Buenos Aires for his election as an NAS foreign associate.

GSA Fellow and Foundation Trustee **Farouk El-Baz** has been appointed chair of the steering committee of the 2010 National Academies Keck *Futures Initiative* (NAKFI) on imaging science. The Futures Initiative is a 15-year effort to stimulate interdisciplinary inquiry and to enhance communication among researchers, funding agencies, universities, and the general public.

GSA Member **Rebecca Flowers** of the University of Colorado at Boulder has received an NSF CAREER Award for her work studying the southern African Plateau.

GSA Member **Kenneth H. Nealson** has been selected the 2010 D.C. White Research and Mentoring Award laureate by the American Society of Microbiology in recognition of his scientific research and mentoring activities.

In March, GSA Fellow **Richard Alley** presented the 2010 George Gamow Memorial Lecture, "Learning while burning: Peak (whale) oil, climate change, and our future," at the University of Colorado at Boulder, where physicist George Gamow taught from 1956 to 1968.

You'll find more news about GSA members at **www.geosociety.org/news/memberNews.htm**. Keep your colleagues up to date and help to honor excellence among the GSA membership by sending your member news to GSAToday@geosociety.org.

Last Call for 2010 Officers and Councilor Nominations

Nominations accepted
through 15 July

The GSA Committee
on Nominations requests
nominations for
GSA Officers (vice president and
treasurer) and
Councilors to serve beginning
in 2011.

Each nomination should
be accompanied by
basic data and a description of
the qualifications
of the individual for the position
recommended.

You can access the online
nomination form at
[www.geosociety.org/aboutus/
officers.htm](http://www.geosociety.org/aboutus/officers.htm),
or you may send nomination
materials to
Pamela Fistell,
GSA, P.O. Box 9140,
Boulder, CO 80301-9140, USA,
pfistell@geosociety.org.



THE
GEOLOGICAL
SOCIETY
OF AMERICA®

In Memoriam



GSA regrettably reports the death of the following members
(notifications received between 1 Feb. 2010 and 30 Apr. 2010).

George O. Bachman

Centennial, Colorado, USA
Notified 16 February 2010

Saleh M. Billo

Riyadh, Saudi Arabia
1 April 2010

Charles A. Boland

Rock Hill, South Carolina, USA
Notified 18 March 2010

Eric Lloyd Cohen

East Hampton, New York, USA
Notified 22 March 2010

Anthony B. Gibbons

Wheat Ridge, Colorado, USA
Notified 28 April 2010

Leland H. Gile

Las Cruces, New Mexico, USA
16 November 2009

Nikki T. Hemmesch

Paynesville, Minnesota, USA
10 July 2009

Albert C. Holler

Saint Paul, Minnesota, USA
Notified 1 February 2010

Walden P. Pratt

Arvada, Colorado, USA
30 August 2008

William S. Shaw

Antigonish, Nova Scotia, Canada
1 August 2009

Jeffrey D. Spooner

Rolla, Missouri, USA
19 January 2010

George C. Stephens

Washington, D.C., USA
Notified 8 April 2010

Edgar L. Weinberg

Austinville, Virginia, USA
Notified 2 March 2010

Stuart S. Wilson

Boulder, Colorado, USA
Notified 10 March 2010

M. Gordon Wolman

Baltimore, Maryland, USA
24 February 2010

Richard A. Zimmermann

Heidelberg, Germany
28 February 2010



Each year, GSA publishes a memorial volume dedicated to deceased GSA members. The memorials are written by associates, friends, or relatives of those who have passed away and are priceless, indispensable records of the fascinating individuals who have been part of GSA. To honor one of the colleagues listed here with a memorial, please go to www.geosociety.org/pubs/memorials/index.asp. This page also lists completed memorials, some of which are available for download.

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

Call for GSA Committee Service

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

2011–2012 COMMITTEE VACANCIES

Deadline to apply or submit nominations: 15 July 2010

GSA invites you to volunteer or nominate one of your fellow GSA Members to serve on Society committees or as a GSA representative to other organizations. Learn more about each committee and access the nomination form at www.geosociety.org/aboutus/committees/. You can also download the form and send a hardcopy nomination to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA; fax: +1-303-357-1074; phone +1-303-357-1044 or +1-800-472-1988, ext. 1044; pfistell@geosociety.org. **Terms begin 1 July 2011** (unless otherwise indicated).

COMMITTEE, SECTION, AND DIVISION VOLUNTEERS:

COUNCIL THANKS YOU!

GSA Council acknowledges the many member-volunteers who, over the years, have contributed to the Society and to our science through involvement in the affairs of the GSA. Your time, talent, and expertise help build a solid and lasting Society.

COMMITTEES REQUIRING VOLUNTEERS/NOMINEES:

COMMITTEE	NO. OF VACANCIES	LENGTH OF TERM
Academic and Applied Geoscience Relations (AM, T/E)	one	3 years
Annual Program (AM, B/E)	one	2 years
	one	4 years
Arthur L. Day Medal Award (T/E)	two	3 years
Diversity in the Geosciences (AM, T/E)	three	3 years
Education (AM, B/E, T/E)	one	2 years
	two	4 years
Geology and Public Policy (AM, B/E, T/E)	two	3 years
Joint Technical Program (T/E)	one	3 years, starts 1 Jan. 2011
Membership (B/E)	three	3 years
Nominations (B/E, T/E)	one	3 years
Penrose Conferences and Field Forums (T/E)	one	3 years
Penrose Medal Award (T/E)	two	3 years
Professional Development (T/E)	two	3 years
GSA Public Service Award (T/E)	one	3 years
Publications (AM, B/E, T/E)	one	4 years
Research Grants (B/E, C)	eleven	3 years
Young Scientist Award (Donath Medal) (T/E)	two	3 years

GSA REPRESENTATIVES TO OTHER ORGANIZATIONS

COMMITTEE	NO. OF VACANCIES	LENGTH OF TERM
GSA Conferee to the AAPG Publication Pipeline Committee (B/E, T/E)	one	3 years
North American Commission on Stratigraphic Nomenclature (NACSN) (AM, possibly B/E)	one	3 years, starts Nov. 2011

AM—Meets at the Annual Meeting • B/E—Meets in Boulder or elsewhere

C—Extensive time commitment required during application review period (15 Feb.–15 Apr. 2012) • T/E—Communicates by phone or electronically

Lithosphere

Lithosphere welcomes contributions from a wide variety of earth science disciplines, including (but not limited to) structural geology, seismology, geodynamics, geophysics, tectonic geomorphology, petrology, geochemistry, and sedimentary geology as well as results from integrative, interdisciplinary projects. The journal particularly encourages articles that address how complex systems in the solid Earth operate and how coupling between those systems occurs.

► Have a **FREE LOOK** at papers in *Lithosphere* at

<http://lithosphere.geoscienceworld.org>

Subscribe to *Lithosphere*.
Available bimonthly in print and online.

Order online:
www.geosociety.org/pubs/ (Click on Subscription Rates)
or www.gsapubs.org/ (Click on Subscriber Services)

Order by phone:
1-888-443-4472 or +1-303-357-1000

GSA Sales & Service: gsaservice@geosociety.org

Formats include:

- short research contributions that present new and innovative ideas and concepts;
- longer research articles with complete presentations of data sets, experimental results, theoretical analyses, or numerical simulations;
- review articles that facilitate communication among disciplines;
- brief overviews of articles in the issue; and
- special issues or sections devoted to a topic.

SCIENCE EDITORS:

James P. Evans, Utah State University
Jon D. Pelletier, University of Arizona
Raymond M. Russo, University of Florida

Submit your manuscript online:
<http://www.editorialmanager.com/lithosphere/>

Author information:
<http://www.geosociety.org/pubs/lithosphere/lsGuide.htm>



THE
GEOLOGICAL
SOCIETY
OF AMERICA®

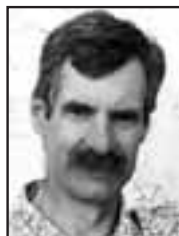
Lithosphere is online at www.gsapubs.org and www.geoscienceworld.org

Meet Your NEW 2010 Officers and Councilors

GSA OFFICERS (July 2010–June 2011)



PRESIDENT
Joaquin Ruiz
University of Arizona
Tucson, Arizona, USA



VICE PRESIDENT
John W. Geissman
University of New Mexico
Albuquerque, New Mexico, USA



TREASURER
Jonathan G. Price
Nevada Bureau
of Mines & Geology
Reno, Nevada, USA



PAST PRESIDENT
Jean M. Bahr
University of Wisconsin
Madison, Wisconsin, USA

GSA COUNCILORS

NEWLY ELECTED GSA COUNCILORS

Term: July 2010–June 2014



Bruce R. Clark
The Leighton Group, Inc.
Irvine, California, USA



Monica E. Gowan
University of Canterbury
Christchurch, New Zealand

CURRENT GSA COUNCILORS

Term: July 2008–June 2012



Brian R. Pratt
University of Saskatchewan
Saskatoon, Saskatchewan, Canada

Term: July 2009–June 2013



Lisa D. White
San Francisco State University
San Francisco, California, USA



Barbara L. Dutrow
Louisiana State University
Baton Rouge, Louisiana, USA



Jacqueline E. Huntoon
Michigan Technological University
Houghton, Michigan, USA



Murray W. Hitzman
Colorado School of Mines
Golden, Colorado, USA



Ricardo A. Astini
Universidad Nacional de Córdoba
Córdoba, Argentina



Daniel Larsen
University of Memphis
Memphis, Tennessee, USA



G. Randy Keller
University of Oklahoma
Norman, Oklahoma, USA



Claudia I. Mora
Los Alamos National Laboratory
Los Alamos, New Mexico, USA



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



The following 2,515 new GSA members, who joined GSA between Sept. 2009 and Feb. 2010, were elected to membership by GSA Council at its spring 2010 meeting.

New Members: GSA Welcomes You!

PROFESSIONALS

Sarah Aciego
Jonathan Adrain
Tom A. Al
Stephen R. Alcorn
Allison R. Aldous
Ahmad Al-Dousari
Julien Marius Allaz
Richard M. Allen
Steve Alm
Bader Khezam Al-Mahri
Sadraddin Amini
Hiroyoshi Arai
Rosemary A. Askin
Russell Blaik Axelrod
Brad Bacon
Elizabeth A. Baker
Kathleen Baker
Julian Tucker Barksdale
Paul M. Barlow
Constanza H. Jara Barra
Richard Lester Bartels
David Bary
Behrooz Bashokoo
Douglas L. Bates Sr.
Christopher Behnke
Claire M. Belcher
Claudia Benitez-Nelson
D. Wayne Bernan
Claudio Berti
Rick A. Bieber
Justin Edward Birdwell
Sean Bistoff
Steven C. Bjornstad
James Joel Blair
James Luke Blair
Alberto Blanco Piñón
Sergio Blanco
Bhaskar Bondada
Michael G. Bostock
William V. Bour III
Dana Bove
Darren Box
Christine D. Bradford
Benjamin John Brady
Michael J. Brayton
Larry D. Bristedine
Grant Bromhal
Jennifer Jo Brown
Eric Buer
Shondricka Burrell
Walter Burt
Rob Butler
Kenneth Paul Cannon
Richard Walter Carlson
Simon Anthony Carn
Daniel Glenn Carpenter
Lauren Gee Carroll
Lisa G. Carter
Bruce Richard Cassem

Michael Andrew Casso
Renee Cataneo
Kurt E. Cato
Anne Marie Chaka
Helder I. Chaminé
Sze-Ling Chan
Renee Chantrill
Clark R. Chapman
Chang-Hwa Chen
Jui-Sheng Chen
John Alan Chermak
Andrei Chitalin
Robert W. Clayton
Robert W. Clayton
Richard Lee Coffman
James W. Cole
Jamus Collier
Anna Colvin
Curtis A. Cooper
Steven Corder
Diane J. Cornelius
Chris Cottingham
Vincent E. Courtillot
Brian C. Crooks
Michael A. Danahy
Amy Daniell
Melinda Dawn Daniels
Dana Maurice D'Aria
Stephanie Davidson
Ashley Davies
Robert Dedoes
Seth Dee
Kevin Dennehy
Thomas A. DePriest Jr.
Rui M.S. Dias
Rose Difley
Rebecca Domingo-Neumann
Colin Doolan
Debra Dooley
Ken Allan Drabinsky
Daniel Driscoll
Joel Glenn Duncan
Tooba A. Durrani
Wyndham M. Edmunds
James Egnew
Gregg W. Eichorn
Edward G. Epp
Ken W. Ettlinger
Andrew Evans Jr.
Helen C. Fairley
James Farquhar
Neal Farrar
James L. Fastook
Bart Faulkner
Adriana Fernandez
Katherina Fiege
Harry F. Filkorn
Ilya Reuben Fischhoff
David Fischman
Miguel Franco-Rubio

Julia Frazier
Corey R. Froese
John Gale
Miguel Gallardo Sr.
Jose F. García-Hidalgo
Aude Gebelin
Ady Geda
David George
William J. Gibbons
Jan Gillespie
S. Dianne Gillespie
Helge Gonnermann
Erika B. Gonzalez
Michael T. Gottler
Kelly E. Graf
David E. Grandstaff
Robert J. Graziano
Murray W. Grigg
Alfred Herman Guhl
Joseph Guido
Weixing Guo
Vikram P. Gupta
Larry D. Gurrola
Scott S. Hackman
Sarah R. Hale
Minard L. Hall
Vance Hall
Rebecca S. Hamilton
Bruce Handel
Jennifer L. Hare
John Harris
Joe Hathaway
Erik H. Hauri
Nico Mark Hauwert
Matthew C. Hawley
Robert B. Hawman
William Heffron
Franklin T. Heitmuller
Russell J. Hemley
Sidney R. Hemming
Ricky T. Hildebrand
Devina Horvath
Md. Sakawat Hossain
Richard W. Howe
Ling Hu
Hai Huang
Jeremy Hughes
Richard Hugo
David Hulslander
Oldrich Hungr
Todd Michael Hurd
Gretchen L. Hurley
Catherine F. Ibes
Jamie Lee Inwood
Danny Itkin
Louis L. Jacobs
Matthew James
Kandy Sue Jarvis
Calvin Johnson
Gwynn R. Johnson

L. Bruce Jones
Linda S. Jones
Maobi Enyioma Justin
Heather L. Justus
Roland Kaitna
Sean Michael Kaldahl
Craig L. Kennedy
Marcia Kiese
Karl Kim
David Victor King
Jason L. King
Gary A. Kingston
Sarah Knowlton
Alan Koenig
Kirsti I. Korkka-Niemi
Niranjala Kottachchi
Krystyna Kowalik
Kate L. Kramer
Mark P.S. Krekeler
Kevin Kroeger
Mukesh Kumar
Gregory J. Kurras
Giuseppina K. Mattiotti
Martin LaFevers
Ian Bruce Lambert
Thomas Lang
Kristine Larsen
John Wesley Lauer
Mark C. Lawler
Daniel Le Heron
Nicholas T. Legg
Qin Leng
Thomas H. Leroy
Zhen Li
Francesca Liberi
Sebastian Lindhorst
Liliana Lizarraga Mendiola
Dion R. Lobreau
Andrew Love
Zhiming Lu
Erin Lynch
Rui Ma
Richard Ian Macphail
Ann Maest
Joseph Zebulon Maharrey
Cornel-Dorel Manecan
Jingdong Mao
Danny Marks
Roger Eugene Marlin
Ronald L. Martin
Jeffrey Mason
Sara E. Mason
Hans-Joachim Massonne
W V Graham Matthews III
Marek Matyjasik
Reed Maxwell
Ronald Mayerle
Diane F. Maygarden
Ryan Joseph McAleer
Robert M. McKay

Charles F. McLane III
Patrick James McQuillan
John Charles Menzies
Beverly D. Meyer
Kevin M. Meyer
Enrico Miccadei
Peter Michael
Phyllis Midkiff
Heidi R. Minkler
Deepak Mishra
Santanu Misra
Edward Mitchell
Beate Mocek
Monika Moore
Richard S. Moreland
Linda Morgan-O'Connor
Katherine Ann Morris
Patricia A. Mothes
Peter Muckenaupt
James J. Myers
Ralph H. Nafziger
Shinya Nakamura
Michael P. Nelson
Ronald Franklin Nichols
Lemessa Mekonta Nono
Jodi Norris
Jeffrey Nuttall
Cary J. Oakley
Olufunso A. Ogunleye
Henry N. Ohlin
Matthias Ohr
Shelley E. Olds
Tina Ornduff
Tim Orr
Holger Ott
Terry L. Ozbun
Nichole Pagano
Jessica Ann Palmer
Selena T. Pang
Samuel Vincent Panno
Cathy Pappas-Maenz
Margaret Christina Parks
Anthony Pasquella
Bruce L. Pataky
Steven Michael Pawley
Joshua H. Payne
Bill Pearson
Graham F. Peaslee
Sally J. Pehrsson
David Percy
Courtney A. Perkins
James Edward Pettifor
Tommaso Piacentini
Fabrizio Piana
John Piccininni
Carle M. Pieters
Roman C. Pineda
Monica Pondrelli
John J. Porcello
Stephen Porder
David P. Powell
Matthew D. Powers
Ronal Price
Stacey Priestley
Doug Prose
Nathaniel E. Putzig
Bern J. Qualheim
Kristin J. Quell-Garguilo

New Members: GSA Welcomes You!

Michael James Quillici
Jennifer Ramstad
Jyotiranjana S. Ray
Peter Burland Read
Michele L. Reba
Geoffrey Reichold
Joseph P.A. Remenick
Alejandro Mario Ribot
Glenn Alden Richard
Bryan William Richter
Janet Marian Riddell
Mark A. Ripper
Reynaldo Rivera
Clare Elizabeth Robinson
Mark Rockhold
Liber Galban Rodriguez
Chris Michael Rohe
Don L. Rondema
John Michael Rose
Guillermo Carlos Rossi
John S. Roulston
Karrie A. Runles
Robin Rupp
Ann D. Russell
Alison Rust
James Robert Rustad
Roberto Ventura Santos
Charles L. Saunders III
Thomas Patrick Schmidt
Susana Serrano
Shams E.M. Shaheen
Subodh Kumar Sharma
Allen Shaw
John Shaw
Michele E. Shepard
Timothy W. Shields
Mark Siddall
Carlos Sierra
Stephen E. Silliman
Martin Simmons
Brad S. Singer
Donald Singer
Nikolaos Skarpelis
John McGregor Skinner
Deborah Slawson
Robert Smit
Donna Lee Smith
Paul A. Smith
Thomas Donald Smith
Xiaodong Song
Mark Stephen Sonntag
John Alexander Speer
Alexandros Spiliotopoulos
Robert William Spoelhof
Phineas Sprague Jr.
Kathleen Springer
Steven W. Squyres
Jeremy Stalker
Benjamin W. Stanton
Justin Jefferey Strauss
Rob Striegl
Robert G. Strom
Mark Sturgess
Todd A. Surowell
Paul E. Swafford
Tiffany N. Swann
Keith H. Swenson
Robert F. Swenson

Jessica Szafranski
John C. Tacinelli Jr.
Tokichiro Tani
Yuri Taran
Christopher N.A. Taylor
Mark Teague
David Terry
Garrett Michael Thornton
Andy Tiedeman
Brian Paul Tillquist
Hengmao Tong
Rex Roger Torrez
Theofilos B. Toulkeridis
Shashank S.P. Tripathi
Frank Urban
Lara Lanyon Urizar
Peter Kent Van de Water
Simon E. van der Wielen
Nick Varnum
Carol Bolam Verrier
Nathan Voorhies
Heidi M. Wadman
Becca Walker
Richard T. Walker
Timothy J. Walsh
Fletcher S. Walters III
Fengqin Wang
Hamidullah Wani
Eric Wannamaker
Robert S. Wardwell
Nicholas Hale Warner
Judith A. Warren
Deborah Watson
Barry Weaver
Eileen Weppner
Christopher B. Wesley
Stephen R. Westrop
Don Wheeler
Tom Wiley
Stephanie Ann Williams
Todd Williams
Sandy Williamson
Julie B. Willis
Joanna Marie Wills
John M. Wilson
Paul Winberry
Jason Woodcock
Jennifer Wright
Andrew Trevor Wurst
Shangping Xu
Tatsuhiko Yamaguchi
Yoseph Yechieli
David R. Yesner
Yusuke Yokoyama
Zhenlei Yuan
Victor Zabielski
Yannick Zaczek
Zoltan Zajacz
Thomas Zdeb
Lifei Zhang
Manjiang Zhang
John Zutman

RECENT GRADUATES

Md. Ibrahim Ababneh
Sevda Ralenova Adamova
Eric Allen

Kellie A. Arthur
Susan M. Avre
Jacob Baggerman
Iestyn Barr
Cheila Benavides
Jeremy Bergeron
Eros Antoine Bilyeu
Thomas Michael Bone Jr.
Caitlin Borbely
Lindsay Bourgoine
Clinton Brickner
Anthony Brillante
Eileen Capitoli
Kenneth Cooper Carroll
Mandy Jo Charles
Peipei Chen
Scott Conrad
Clay Corbin
Milton Cortez III
Fiona K. Couperthwaite
Stephen Ellis Cox
Scott Craig
Andrew M. D'Agostine
Audrey Dakan
Danielle D'Alfonso
Maia C. Davis
Samuel L. Dayton
Marleiah Denka
Corinne R. Disenhof
Ian P. Donovan
David Dow
Jenna Ellis
Hossam E.M. El-Sayed
Meaghan Emery
Jennifer K. Evans
Ake Fagereng
Anthony Fair
Reid C. Fenning
Alex James Ferguson
Matteo Ferrucci
Brian Peter Ferwerda
Nathaniel Jon Fischer
Steven Fisk
Kaitlin Brookes Fleming
Thomas L. Fowke II
Megan Lynn Foye
Elizabeth Mari Francisco
Thomas Garrett Freeman
Ben Friedman
Samuel Galenty
Seth Goad
Amit Kumar Guru
Manuel Vargas Gutierrez
Ryan James Haupt
Kathryn Ann Hazlehurst
Brett E. Heist
David Ryan Hickey
Nazim Hodzic
Ruth Indrick
Joseph Michael Ivanowski
Rob Jaecks
James Robert Jahnz
Michelle James
Scott H. Jewell
Matthew B. Johnson
Devin Michael Justman
Jennifer D. Keese
Dana Marie Kitchell

Denise Kay Kulhanek
Robert George Lee
Selina S. Lee
Chu-Ching Lin
Maren Lindow
David M. Livingston
David Lugo
Leigh Colby Mastin
Charles A. McCaffree
Tiffany Dawn McClennen
Leisa Meitl
Frederick Marc Michel
James Jeffrey Miller
Marc Miller
Stuart J. Mills
Josh Mohler
Megan M. Montgomery
Maureen Nancy Moore
Adrian Morales
Vince Morton
Matthew Mrozek
Marcus R. Muccianti
Rachel Helen Murray
Andrew Lloyd Myers
Lisa Navarro
Jeremy David Nicoletti
Jasin Olsen
Onisobuana R. M.
Osuamkpe
Joseph F. Oszuscik
Andrea Pain
Kautubh Patwardhan
Jonathan Payne
Rachael Simon Peavler
Mark E. Poindexter
Veronica Poteat
Matthew Ryan Prusinski
Gina René Raymond
Clarence William Reece
Anna Marie Reimer
Wil Reyes
Ursula Rick
Jed Roberts
Anthony Romanoski
Michael Rupright
Marissa A. Saccente
Vincent J. Schlageter
Andrew Schneider
Gregory A. Schrader
Jacob Tyler Schwenk
Matthew Scullin
Andrea M. Seymour
Terri Lynn Shattuck
Steven J. Shaw
Andrew D. Shireman
Daniel R. Simpson
Drexel Siok
Brittany Smith
Alexander Snyder
Daniel E. Soda
Patrick I. Spurgeon
Andrew A. Starland
Alex Strugatskiy
Summer Joy Sturhan
Katelyn Sutcliffe
Gary Swan
Carl D. Swanson II
Paul Brett Talmage

Alicia Thompson
Mathew Arvid Tilman
Colby D.H. Tisdale
Nicholas Tranter
Joshua Troyer
Michael Tutt
Heather Van Strydonk
Casey Nicholas Varnum
Ryan Foster Vazquez
Nicole Velasco
Camilla Jane Watts
Daniel Paul White
Nicholas Wiclaw
Carsten Wiczorrek
Stephanie Ann Woicik
Steven Randall Woodley
Reid Isao Yano
Janet Marie Yates
Stephen A. Zdan

STUDENTS

Christa Abatamarco
Hasan Abdeljawad
Ashley Adams
John Kendall Adams
Sharon Ann Adams
Christina D. Adkins
Jonathan Adkins
Rebecca Abigail Adler
Yamira Adorno-Negron
Sofia Agopian
LaOde Ahdyar
Madeeha Ahmed
David Aaron Ahumada
Hannah Mary Aird
Kathryn Helene Akerman
Sara J. Akin
Eric A. Akoko
Itohowo Akpabio
Austin Elihu Akridge
Ahmadreza M. Alamdarie
Md. Iftexhar Alam
Seyed Matin Alavi
Meredith Albers
Henio Danilson Alberto
Andrew M. Alderman
David Aldridge
Joseph C.R. Alejandro
Meghan E. Alesce
Aaron M. Alexander
Kathryn Alexander
Andrew Wayne Allen
Kent C. Allen
Marsha Allen
Ashley Erin Almon
Omar M. Al-Qudah
Yaqoub Yousef Alrefaei
Christopher D. Althoff
Kathryn Marie Altman
Hewewutei Amakali
Caroline Mary Amelse
Reda Amer
Daniel B. Amoakoh
Erin L. Anderson
Leif Stefan Anderson
Péter András
Michael Paul Andrew

New Members: GSA Welcomes You!

Alexandra Andrews	Joshua David Bartley	Cassandra Bodette	Brian Butts	Nicholas Cohn
Derrick O'Neal Andrews	Jamie L. Bartling	Joshua W. Boling	Kelsey M. Butz	Blake Anthony Colaianne
Eric Andruk	Ashley Barton	Patrizia Bolz	James L. Buzzell	Tina L. Colbert
Conrad Anker	Ashley Marie Barton	Gladys E. Bonilla-Ortiz	Amber Cain	Elizabeth Cole
Suzanne M. Ankerstjerne	Tapati Barui	Michael Bonomo	Amanda Cains	Lauren Krista Cole
David Charles Annis	Chandranath Basak	Adam M. Booth	Vanessa Jill Calder	Preston Daniel Colledge
James Ansley	Lamuaail Bashir	Eric Booth	Dylan John Caldwell	Aubrey James Collie
Teryila Apera	Hridaya Bastola	Brian Boston	Todd G. Caldwell	Jennifer A. Collins
Ravi Appana	Benjamin W. Bates	Adrian James Bouknight	Katherine C. Calkins	Nathan Collins
Kimberly Aquino	Thomas R. Battenhouse Jr.	Patrick D. Boulas	Matt Stephen Callihan	Patrick Collins
Daniel J. Arcadi	Joseph C. Bauman	Simon Bourassa	Colin M. Campbell	Michael C. Conley
Ryan M. Archer	Andarge Yitbarek Baye	Brian Colby Bourgeois	Nicolas Campione	Maricate Conlon
Meesha M. Ard	Matthew William Beachly	Caroline Bovay	Sarah Cane	Heather N. Conrow
Jacob Edward Ardner	Jessica A. Bean	Jlynn Moore Bowen	Joyce E. Carbaugh	Elise Rose Conte
Asefu G. Aregawi	James Andrew Beard	Paul Nicholas Bowen	Brandy Leigh Cargo	Juan Contreras Jr.
Mohd. Hariri Arifin	Ernest W. Beasley IV	Leah Bower	Gregory L. Carlson	Benjamin K. Conway
Takahiko Arima	Robert Beauford	James Box	Mackenzie Waite Carlson	Mary Ann N. Conway
Mary Ruth Armbruster	Blaire Beavers	Ashleigh Boyd	Peter Joseph Carmichael	Christopher Cody Cook
Jordan T. Armstrong	Rachel Beavins	Richard W. Bradshaw	Natalie Caro	Michael Cook
Michael L. Armstrong	Miki Annette Beavis	Shannon M. Brady	Olivier Caron	Nicholas Taylor Cook
Taylor Armstrong	Lori Bebinger	Stephanie M. Bragg	Rebecca Carpenter	Shea Arthur Cook
William H. Armstrong Jr.	Andrew William Becker	Michael Bramnik	Tiia M. Carraway	Oliver Glenn Cooper
Summer L. Arrowood	Richard Albert Becker	Steven Braun	Alison Kyra Carter	Jesse Tiner Cope IV
Jennifer Lynn Artman	Natalie D. Beckman	Ronald J. Breitmeyer	Laura B. Carter	Natalie J. Cope
Elizabeth F. Asbury	Chloe Brett Beddingfield	Craig Michael Bremer	Megan Carter-Thomas	Kimberly Anne Copeland
Anthony Amor Asher	Leah Bedoian	Lindsey Erin Brenizer	Raymundo Casas García	Kelsey M. Copes-Gerbitz
Biniam B. Asmerom	Stephanie Beebe	Andrew N. Brennan	Ronald Wilson Cash	Lilly Corenthal
Timothy Ian Astrop	Adam D.B. Behlke	Logan Debra Brenner	Carlos F. Castro	Lisa Diane Corner
Ali Atef	Hannah Beker	Amanda L. Brewer	Angeline Catena	Phillip Adam Cornwell
Victor O. Attah	Kevin Gregory Bellamy	Nancy S.B. Brewster	Nora Catolico	Travis Corthouts
Amanda Kay Attick	Nicole Bellino	Adam Ray Brister	Ashley Cavallaro	Kimberley Anne Corwin
Clemens Augenstein	Jeremy J. Bellucci	Steven Ray Brite	Scott Carlo Ceciliani	Christopher J. Costello
Karen E. Austin	John Benedict	Jennifer L. Brizzolara	Poulami Chaki	Amanda Leigh Couch
Constantinos Avgoustou	Jessica G. Benner	Jay Broccolo	Ellen Putnam Chamberlin	Lyssa Anne Cousineau
Oladotun Awosemo	Bonnie Bennett	Candice Fawn Brock	Phoebe Chan	Maggie Cowling
Karen Aydinian	Laura Bennett	Ben Brooker	Kyung Won Chang	Mary C. Cox
Kacie Baak	Ashley Elizabeth Bens	Colin Edward Brooks	Hana Marie Chappell	Laura Craig
Margaret Baber	Andrew P.K. Bentley	Adam Brown	Daena Charles	Thomas Michael Crane
Kira Joy Baca	Subhabrata Bera	Elizabeth A. Brown	Robert David Charnock	Elizabeth Cranmer
Timothy Badger	Beau Daniel Berend	Eric Michael Brown	Sumanta K. Chatterjee	Ellen J. Crapster-Pregont
Kirsten Bahr	Vincent P. Beresford	Jason H. Brown	Kuldeep Chaudhary	Mathew David Crawford
Mike Baierlipp	Lauren M. Berg	Noranda Brown	Angela Chavez	Matthew M. Crawford
Amanda L. Bailey	Briana N. Berkowitz	Sarah Brown	Chen Chen	Jennie Crittenden
Bevin L. Bailey	Johnny Bertalott	Timothy R. Brown	Yuyan Chen	Lance Calloway Croft
Vincent Bailly-Comte	Laura C. Best	Evan T. Bruce	Christian Matthew Chin	Brandi Renee Cron
Suraj Kumar Bajgain	Hailemelekot H. Betemariam	Lucy Brudnak	Logan Daniel Chinn	Kyle Blaine Crosby
Brad Jonathan Baker	Nichole S. Bettencourt	Jason Buck	Hon Chim Chiu	Michael J.C. Crouch
Emily Hewitt Baker	Norman Betts	Samantha Buck	Elluz K. Chong Qui	Anastashia Maria Cuddihy
Jonathan Lloyd Baker	Saikat Bhakta	Daniel Buckler	Benjamin Chorn	Yanet Y. Cuddus
Patrick Baker	Sustava Bhattacharya	Kenneth A. Buell Jr.	Cleo Chou	Kristan Noel Culbert
Gregory Patrick Balch	Steven James Biars	Nicolas Buer	Adrita Choudhuri	Jeff Dennis Cullen
Dylan Baldwin	Patrick Bills	Jeremy Buffenmeyer	Sonalika Chowdhury	Justine Cullen
Carolyn Elizabeth Ball	Shishay Bisrat	Michael H. Bulas	Chase J. Christenson	Benjamin J. Currens
Michael Ball	Sanjib Biswas	Stevenson Hardy Bunn	Ryan Robert Christiansen	Adam Curry
Ted Jeffrey Balling	Benjamin A. Black	Amy Buntin	David Christie	John Curry
Lerin Marie Baltzly	Susanna Whitman Blair	Alison Burchell	Christian A. Christofferson	Wyatt Curry
Phil W. Bamback	Matthew W. Blakeslee	Mason D. Burgess	Robin Chriswell	James Cwiklik
Sikhar Banerjee	Austin P. Blaser	Theresa Marie Burkett	Michelle Chrpá	Brigitta Czauner
Bharat Banjade	Hannah J. Blatchford	Rachel Burkhart	David A. Ciccalone	Olamide Femi Dada
Rachel Anna Bankus	Vivian Blau	Andrew Wray Burleigh	Nadja Omara Cintron	Katherine Marie Dahlberg
Milo Barham	Samuel Allen Blazey	Alison Burnop	Franqui	Samit Dalal
Alex Gregory Barker	Elizabeth A. Bloch	Adamseth Adrian Burns	Alexandar Ciric	Elliot Benjamin Dale
John David Barker	Christina Snow Bloom	Dale H. Burns	John A. Citron	Richard D'Ambrosia
Theodore Basile Barnhart	Darwin R. Boardman III	Patrick Joseph Burns	Arthur Lee Clark III	Brittany Elise Dame
Gregory John Baron	Grant Stanley Boardman	Kyla Burrill	Deirdre Elizabeth Clark	Adam Joseph Damman
Bridgette A. Barr	Michael L. Boatman	Lesley Ann Butcher	Kimberly Teague Clark	Robert Michael D'Anjou
Heather A. Barrett	Jeremy Michael Bock	Nicole Jeanette Butkus	Heather Lynn Clifford	Heather D'Antonio
Sarah Anne Barrett		David Butler III	William Joseph Cochran	Enakshi Das

New Members: GSA Welcomes You!

Krittibas Das	Kevin Thomas Drake	Colin Farley	Andrew M. Gault	Christopher Hacker
Uddipan Das	Timothy Paul Dreher	Steven Eugene Farmer	Ma. Alejandra Gaviria	Georgios Hadjigeorgiou
Emily Daubenmire	Tyler Dretke	Michael Farner	Reyes	Erica Jean Hagen
Tyler R. Davidson	Megan Drinnan	Alexandra K. Farrell	Amanda Gentry	Anna D. Hager
Nicholas Davis	Lauren Anne Droege	Sarah Elaine Farzaneh	Natalie Ellyce Gentry	Molly Hagstrom
Sage Elizabeth Davis	Liza Druck	John M. Fegyveresi	Trevor Richard George	Md. Iqbal Hajana
Tiffany Rebecca Davis	John B. Drury IV	Alissa D.G. Feilen	Mary A. Gerbic	Sarah Catherine Hale
Colleen Dawes	Gerald Dubesa	Kathleen Feiner	Leslie Dickson Gergen	Trevor M. Halfhide
Rafael C. de Albuquerque	Richard E. Dudek II	Garrett Robert Felda	Omar Ghamedi	Brian Hall
Jose de la Torre	Harold L. Duffey	Joseph Felix	Nilotpal Ghosh	Lauren E. Hall
Veronique de Montety	Barry Alan Duncan Jr.	Wenting Feng	Rajkumar Ghosh	Maggie Elizabeth Hall
Alexander de Moor	Matthew Dunlop III	Jessica Emiy Fenn	Alena Maria Giesche	Meghan M. Hallam
Matthew Jared Dean	Willard Rusk Dunlop	Wendy Fenner-Aubin	Emma Giese	Tristan Taylor Hamblin
Amy DeBarrael	Crystal N. Dunn	Eleanor K. Ferguson	Jessica Giesen	Lubna K. Hamdan
Aj M. DeBee	Sarah Beth Dunn	Elizabeth Anne Ferrer	Christy L. Gilbreath	Nick Connor Hamden
Christopher James DeBoer	Gwen Dunnington	Kaitlin Fest	Jerilynn Gilbreath	Catherine M. Hamley
Kathryn Decker	Pradeep M. Durge	Walter J. Feszchak	Chesney Gilleland	Laura Hamm
Shawn Alan Dedeker	Kyle Durrett	Mary Katherine Fidler	Aimee L. Gillespie	Brian Hankins
Nikolaus J. Deems	Gordon Dushane Jr.	Nicholas Patrick Fiesler	Devin Gillum	Melissa Hansen
Simeon J. DeGraaf	Rajkrishna Dutta	Alyssa Jean Finlay	Shampa Giri	Monica Hanson
Sarah Johanna DeHoogh	Soumya Dutta	Greg Fisch	Gavin Gladsjo	Veronica Hanus
Ian Arburua Delaney	John Duvoisin	Glenn Fischer Jr.	Timothy Godaire	Stuart Eli Hardeman
Lisa V. Delaney	Caitlin D. Dwyer	Amie Fishinger	Conan Ray Godfrey	Brendan Trey Hargrove
Lorena de León Barragán	Joshua Dye	Ember Michelle Flagg	Elizabeth Goldbaum	Jeanette Harlow
Natalie DeMaioribus	Scott Barrett Dyer	Heather Aliza Flynn	Arthur J. Goldberg	Emily Lauryn Harper
Ariel Demarest	Lunde Rhianna Eads	Kelly Marie Foley	Rebecca R. Goldman	Samantha D. Harrell
Zelalem D. Demissie	Anthony Charles Earls	Attila Jonathan Folnagy	Derek Andrew Gonyea	Lindsey Harriman
Lori E. Demosthenes	Emily M. Eastridge	Timothy Lloyd Foltz	Ricardo A. Gonzalez	Frederic George Harris
Erin Caitlin Dempsey	Yaika Echevarria Roman	Elizabeth Forbes	Pinzon	Anna Harrison
Matthew Richard Dempsky	Alex Eddy	Joseph Foremski	Kyle Richard Good	Logan Cole Harrison
Elizabeth L. Dengler	Michael Patterson Eddy	Hannah Renee Fortney	Thomas Roger Good	Michael A. Harrison
Sara Caroline Denise	Alice May Egan	Renee M. Foster	Karyn Renee Goodman	Clifton Thomas Hart
Sierra J. Derby	Eric Eger	Bryan G. Fowler	Chelsea Anne Gordon	Kurt M. Hartman
Kyle Christopher Dern	Sachio Ehara	Travis Foy	Daniel Gordon	Nathan Ryan Hartman
Sylvana Nicole DeSantis	Angela Eichler	Luke Kenneth Francis	Ryan Gordon	Ross Raynor Hartwick
Aaron John DesRoches	Brooke Alane Eickhoff	Lisa Katharina Frank	Andrew J. Gorz	Omar R. Harvey
Matthieu Deville de Periere	Evan Matthew Elderbrock	Claire Fratoni	Andrew S. Gottsfield	Vanessa N. Harvey
Morgan W. Devine	Kristiana E. Elite	Kristen D. Frederick	Kristy Goughnour	Robert D. Haselwander
Rochelle Dewyer	Aileen Clare Elliott	Melissa Jane Freeman	Emily Gould	John Fancher Hawkins
Anindita Dey	Austin John Elliott	Richard Freeman	Salley Virginia Gould	John Edward Hayes
Nathan Diaz	Hannah Elliott	Christina French	Amy Elizabeth Grady	Dian He
Emilia Dicharry	Joshua A. Ellis	Kyle S. French	Michael John Gragg	Joseph Hecker
Regina Dickey	Ryan Michael Ellis	William H. French	Tara Graham	Phillip James Heckle
Michelle Dickson	Stephen Craig Elmore	Jena L. Freyermuth	Cory Ryan Grant	Christopher A. Heckle Jr.
Eric Brandon Dieck	Samuel Emerson	Mason Fried	Jordan Hunter Graw	Brian Fletcher Hedrick
Tim Diedesch	Arthur Endlein Correia	Dana Suzanne Friend	Jacob Gray	Brianne Nicole Hedrick
Bridget Colleen Diem	Tyler Engelhardt	Joseph J. Frydrych Jr.	Kyle Thomas Gray	Hollie Heesacker
Andrew Dietsche	Jennifer Katherine Engels	Evan James Frye	Alisa Marie Green	Nicholas J. Hehemann
Nicholas J. DiFrancesco	Samuel England Jr.	Evelyn Fueri	Brittney A. Gregory	Marit Heideman
Elizabeth Grace DiMezza	John Thomas English	Alexander T. Fuerst	Sarah Lynn Gregory	Reba M. Heiden
Zachary Canada Dinkins	Richard English	Ali V. Furmall	Jill Leann Gribbin	Michael Hekkers
David Dixon	Monica Erdman	Cameron T. Fusko	Neil Patrick Griffis	Maria Helbig
Konal John Dobson	Bryan Ernst	Michael Galicki	Jonathan Gilbert Griffith	Jessica Lynn Hellwig
David Lee Dockter	Jenna Erskine	Timothy M. Gallagher	Zachary Grimes	Colby D. Henderson
Christopher Michel Dodson	Nathan Lee Eschbaugh	Mequette Y. Gallegos	Lee Joseph Grimm	Edward S. Henderson III
Anastasia Doennig	Philip Eskamani	Kevin R. Gamache	Stephanie B. Grocke	Kenneth W. Henderson
Nicholas Doiron	Robert Matthew Evans	Arthur Gamirov	Danielle S. Grogan	Sarah Beth Hendrickson
Julia Dole	Sarah G. Evans	Allauidan Alan Gantyno	Chelsea Lois Gross	Emily Henkemans
Christine Doman	Kristen Kelley Ewer	Guangyao Gao	M. Benjamin Gross	Jeremy M. Henning
Thomas Donahoe	Rebekah Ellen Eyer	Jessica Michelle Garcia	Jacob Grosskopf	Jason Russell Henry
Eric Thomas Donaldson	Claire Hope Eyles	Maya Garcia	Deric Group	Jessica Karen Henson
Cody John Donofrio	Robert C. Fairchild	Ariana Garcia-Trejo	Luca Guallini	Caitlin Herbert
Daniel F. Doolittle	Samantha Ann Falcon	J. Patrick Gardner	Kirsten Guerra	Justin William Herbert
Gabriela Doria	Roseann M. Falkenberg	Karleen Gardner	Indra Gunawan	Denisse A. Hernandez
William A. Dornfeld	Nicole Kathleen Fallon	Max Gardner	Jonathan R. Gutsche	Bretani Heron
Laura Dougherty	Min Fang	Kate Garsombke	Donna R. Guy	Andrew M. Hess
Sarah Roberts Douglas	Joanna Marie Fantozzi	Karen Gastineau	Nathan Zane Gwyn	Clarion Hess
Mary Dozier	Michael Farinacci	Emma Gatti	Matthew B. Haaacker	Shawn Hibbs

New Members: GSA Welcomes You!

Megan Hicks	Ongkarnarine Ishmail	Michael Kieron	Kate D. Lawrence	Patricia Grace MacQueen
Tanner Hicks	Christa Jackson	Wayne Walter Kilgore	Craig Lawrie	Kyle Maestas
Russel Shane Hiebert	Jeremiah S. Jackson	Drea Rae Killingsworth	Alysia A. LeComte	Jessica Shirley Magers
Hannah L. Hilbert-Wolf	T. Jackson	SungHoon Kim	Audrey Jane Ledford	Seamus Johannes Magnus
Luke Hilchie	Preston D. Jacobsen	Dustin Kimbrow	Sarah H. Ledford	Nathan C. Magnusson
Jordan Hildebrandt	Hannah E. James	Martyn Geoffrey Kinder	Cory Matthew Lee	Suzanne Cozzolino Maher
Donald M. Hilenbrant	Helen A. Janiszewski	Jonathan H. King	John Lee	Lisa Marie Maida
Jesse Stuart Hill	Robert Jansen	Michael Ryan King	Sarah E. Leedberg	Prithwiraj Maiti
Aubrey Leigh Hillman	Danielle M-B. Jeffrey	Nicholas Jay King	Mike E. Lees	Partha Sarathi Maji
Carolyn Alba Hillman	Mark Richard Jenkins	Moritz Kirsch	Nathalie Lefebvre	Michael Makahnouk
Rachael Alyce Hines	Brittany Anna Jenner	Jonathan Michael Kiser	Katie Lehmann	Daniel A. Malashock
Ann Hislop	Katherine Marie Jepsen	Zachary Andrew Kita	Ginger Leib	Helen Fitzgerald Malenda
Steven Arthur Hoaglund	Barbara Sue Jessup	Margaret Anne Kitto	Jason Leist	Marc A. Malenfant
Evan T. Hobson	Melissa Kay Jenson	Michael Klaas	Jacob Moran Lemon	Juergen Mallon
Jason Hoefer	Mallorie E. Jewell	Mark F. Klawiter	Tim Lenane	Andrew Malloy
Marie Elizebeth Hoerner	Mu Ji	Joseph Klebanoff	Allan Lerner	Elana D.J. Maloni
Aryn Kinley Hoge	Jue Jiang	Erin Kimberly Knauer	Deborah Leigh Leslie	Ethan Aaron Mamer
Carl Hoiland	Batbaatar Jigjidsuren	Katharine Marie Knoph	Steven Michael Levesque	Lori Mandable
Steven Patrick Holland	Brandon Colt Jodoin	Stefan Thomas Knopp	Denise M. Levitan	Luke Mander
Kayla D. Holleman	Jennifer J. Johanson	Daisuke Kobayashi	Jennifer Levy	Gina C. Manders
Stevie L. Holmes	Jesse John	Clint Koch	Cory Robert Lewis	Andrew Manelski
Rachel Ann Hone	Elisabeth Marie Johnson	Thomas M. Koehler	Piper Elizabeth Lewis	Adam Robert Mangel
Isabel Hong	Jacques Johnson	Daniel R. Kohl	Yue Li	Maxwell Taylor Mangrum
William M. Honsaker	John J. Johnson	Kristin M. Kohls	Melissa Ann Light	Lani Manion
Brett Allen Hopt	Kathleen Burke Johnson	Wakgari Furi Konchi	Jonathon Alan Lightsey	Alex L. Mankin
David Chandler Horne	Nancy Leigh Johnson	Kevin Konrad	Junior Lindamood	Devin H. Mannix
Will Horner	Sarah Elizabeth Johnson	Kara Anne Kookan	Jennifer Lindelof	Gabriella March
Forrest Horton	Casey Gibson Jolley	Ara S. Kooser	Philip Lindner	Agnieszka I. Marchlewska
Saralyn Horvath	Michael Edward Jonas	Jason Julius Korf	Tiffany Liner	Shane Patrick Marion
Katie N. Hoskinson	Brittany R. Jones	Andrew Korzun	Harrison Paul Lisabeth	Joshua Lee Marker
Pariskeh Hosseini	Cullen Brandon Jones	Johanna Kovarik	Lacey Little	Allyson Marie Markey
Mackensie Hotz	Jamie A. Jones	Kody V. Kramer	Michael Houston Lobato	Walter L. Markin
Perry Ivan Houser	Matthew Madden Jones	Andrew Merrick Krein	Robert W.D. Lodge	Rachel Markoff
Crystal Marie Hout	Slade Jones	Laura Kremer	Marjorie Lodwick	Angela M. Markson
Heather Deanne Hoven	Sarah C. Jordan	Joseph Krikorian	Georgia A. Lofquist	Edward Marshall
Max Howard	Michael Joseph	Christie Louise Kroskie	Sandra C. Londono	Katherine Marshall
Lisa Catherine Howat	Parul Narendra Joshi	David A. Krzesni	Molly Long	Hannah El. Marshburn
Matthew T. Howe	Elyse Judice	Pooja Vinod Kshirsagar	William Loopesko	Jake Martin
Lucas Scott Howerter	Kera A. Judy	Owen Edward Kubit	Jared M. Lopes	Kimi R. Matsushima
Erin Hoxsie	Dajana Jurk	Sarah Kucera	Alejandra Lopez	Andrew V.C. Mattera
Johanna Fletcher Hoyt	Kevin Charles Kane	Marissa Kuhn	Alexander Lopez III	Amanda Renee Matthews
Anna Eve Hrywnak	Molly Mae Kane	Spenser O.E. Kuhn	Alexis Lopez	Nick A. Matthies
Chung Huang	Lisa Kanner	Tina Marie Kuhn	Andrew Paul Lopez	Michal Matysik
Xiaohui Huang	Nicholas A. Karow	Artur Andrzej Kuligiewicz	Cristina López	Benjamin Jacob Matzke
Jason M. Huberty	Andrew Karpel	Cory Kumagai	Irene Marie Lopez	Stephen W. Mauel
Adam Michael Hudson	Murat Yuksel Kaya	Amber J.M. Kuss	Edwin Kenneth Lord	Joshua T. Maurer
Breanna Leone Huff	Brandt Kayser	Kevin Kwong	Brita Lorentzen	Malysa Kay Maurer
Casey Jean Huff	Timothy Joseph Kearns	Deirdre LaBounty	Peter Louis Lostritto	Guillaume Mauri
Brian Hughes	Christopher Keefe	Jonathon LaCarrubba	Trevelyn A. Lough	Matthew William Mayerle
Kenneth S. Hughes	Emmett Todd Keeler	Kimberly Lachapelle	Donald F. Loughry Jr.	Mitchell Allen McAdoo
Clara S. Hull	Kelly Keeney	Zachary West Laforet	Robert Andrew Lovdahl	Bryan McAtee
Bryan Wallace Hunt	Holly Keimig	Tony LaGreca	Rachel S. Lowenthal	Coire McCabe
Rachel Marie Hunt	Bryan Mark Keller	Corinne Lally	Christopher M. Lowery	Annabeth McCall
Terry Wayne Hurd	Christopher J. Kelley	Brandon LaMere	Erica Elizabeth Lozoya	Tomas Stevenson McClain
Trevor Jason Hurd	Janetta Lynn Kelley	Daniel Scott Lancaster	Elise M. Luce	Joseph J. McClenahan
Joseph Hurley	Bridget B. Kelly	Claire E. Landis	Joseph Luce	James Timothy McClinton
Andrea Jane Huska	Shana Kendall	Kimberly A. Landreth	Anthony Drew Luders	Scott McComb
Ben Hutchins	Kirsten Leah Kennedy	Angela Lands	Zachary Patrick Lumley	Robert Hipp McConnell
Jesse Hutchinson	Michael S. Kennedy Jr.	Amanda Lang	Daniel A. Luna	James Kennedy McCulla
Andrew Hutto	Phil Kenroy	Dan Steven Langermann	Robert Sven Lydell	Daniel William McCune
Nicole C. Hyatt	Emiko Jane Kent	Zachary Lance Langford	Brittnee A. Lydy	Sara Muir McCune
Ethan Hyland	Molly Elizabeth Keogh	David Langston	Daniel M. Lye	Sonja L. McDanel
Yesenia Ibarra	Nicholas D. Kernan	Martin Charles Larsen	Joshua Lymburner	Tess McDaniel
Lauren M. Idleman	Monica Kerr-Riess	Stephanie LaSalle	Erin M. Lynch	Hunter T. McDermitt
Ali Imer	Maureen Kertes	Chris Robert Lattes	Cody J. MacDonald	Brianne M. McDonough
Kayla Ireland	Hank Keyser	Caitlin Grant Lauback	John Ryan MacGregor	Christine McDougal
Ahmad Z. Ishak	Namphon Khampilang	Fabien Jean Laugier	Ashley Machek	Paulette M. McFadden
Maya Ishikawa	Billie Kibler	Jeff Ryan Lawler	Kyle D. Mack	Joshua Coleman McFarland

New Members: GSA Welcomes You!

Blake McFerrin	Yves Moussallam	Lucas Kenneth Olson	Kate Pollard	Joshua Richardson
Christopher T. McGarrity	Lucas Moxey	Daniel Opalacz	Frank A. Pollock	David John Richmond
Karlene McGregor	Matthew Max Mueller	Weston Poppe Oppen	Matthew Ray Poole	Daniel Joseph Richter
Sarah D. McHenry	Krista Maria-Jo Mugavero	Julia Katharine Orr	Lee Brenson Porter II	Kaylee Richter
Kelly C. McHugh	Subham Mukherjee	Lillian Rose Ostrach	Raymond Ernest Porter	Annelise M. Riggins
Margaret E. McKee	Michon L. Mulder	Kevin Ott	JoAnna Pelayo Pounds	Jenny Michelle Riker
Holly Joanne McKelvey	Peter Muller	Jon Royal Ouverson	Amber M. Powell	Alana Riklin
Sarah McKnight	Prinith S. Munasinghe	Andrew Darrell Overbey	Julie Powell	Mark Alan Riley
Kelsey R. McLaughlin	Juanita Florence Muniz	Adeola A. Oyewumi	Vladislav Powerman	Neal Ringerwale
John McLeod	Wendy L. Murphrey	Carolyn Pack	Amanda Caitlyn Price	Carlos A. Rios-Urbe
Megan Francis	Rachel Ann Murphy	Aaron Robert Paddock	Susan G. Price	Ami L. Riscassi
McNaughton	Sean Murray	Jason Scott Padgett	Alexandra Priewisch	Andre Ritchie
Laura Diane McRae	Annelise Muscietta	Abraham de Jesus Padilla	Maria Princen	Keith Rivera
Maureen McReynolds	Charles Oliver Musekamp	Javier E. Palacios	David Probert	Nadia K. Rivera
Erica A. Medley	Jonathon Drew Myers	Cynthia Dianne Palmore	Rachel Eyon Prohoroff	Patricia Robards
Aaron Megas	Nicholas R. Myers	Andrew Olland Parker	Jonathan Michael Prouty	Jesse Robertson
Lakshmi Mehera	Kazumi Nakamura	Brandon Weston Parker	Sarah Whitney Pryce	Zachary James Robertson
Wei Min Mei	Brian Matthew Nan Sr.	James Phillip Parker	Stacey Leigh Puckering	Paul Kelly Robinson
Ethan Melville	Suzanne Yasmin Nase	Thomas H. Parkinson	Shane M. Putnam	Leigh Anne Roble
Michael A. Menchaca	Peter Naval	Chantelle Parrish	Jing Qian	Steven Rodesney
Colin Mennett	Jesica Urbina Navarrete	Gregory Parrish	Breanna Roe Quaglieri	Daynna K. Rodosovich
Anna Marie Menser	Mattathias D. Needle	Michael Charles Passarello	Codi Quimby	Erik Rodriguez
Dave Mercier	Katrina Neiss	Stefano Patruno	Page Chennille Quinton	Gerardo Rodriguez Jr.
Rose Brittany Merola	Lila Neiswanger	Russell Patton	Dylan Thomas Radford	Terri Lee Roe
Domnique Tian Merricks	Daniel Nelson	Gopal Paul	Erica Lindsey Ragland	Steven Leslie Rogers
Jonathan Arthur Meyer	Gregory Andrew Nelson	Justin Michael Paul	Audrey Caitlin Ragle	Yomayra A. Roman
Sean Meyer	Janae R. Nelson Hadley	Elizabeth Marie Paulson	Phillip John Ragonese	Daniel Romanelli
Samuel Arthur Michalak	Samantha Reeves Nemkin	Luke Anton Paulson	Kristen Elizabeth Rahilly	Gabriel A. Romero
Jennifer Middleton	Alexander L. Nereson	Daniel Francis Peacock	Sarah Ramdeen	Susanna K. Ronalds-
Nathan Mietkiewicz	Linsey Jayne Ness	Darren Pearce	Jessica Anne Ramirez	Hannon
Edward Richard Milde	Michelle E. Newcomer	Evan Pearson	John J. Ramirez-Avila	Jeanne Marie Roningén
Leticia Millán Sánchez	Michael Long Nguyen	Ernesto Pecoits	Monica Ramirez-Carvalho	Daniel Oliver Roop
Amanda L. Miller	Thien K.V. Nguyen	Peng Pei	Netashe Ann Randolph	Morgan Joshua Rosenberg
Christen Miller	Uyen Minh Nguyen	Nicholas Alan Pence	Jeff Rash	Joshua M. Rosera
Diana Morgana Miller	Van Thi Hai Nguyen	Simon Lewis Pendleton	Monica Rasmussen	Ahmad Rosli
Isaac Miller	Jessica Nichols	Jackson L. Penrod	Zak Ratajczak	Jeffrey Bryce Ross
Julia Rose Miller	Christopher Nickell	Vasthy Liana Peralta	Christian Rathkopf	Danica Li Roth
Kitri Miller	Stephanie L. Nickolas	Elizabeth Percak-Dennett	Leslie Raucher	Ryan James Rougeux
Matthew Tobias Miller	Amanda Nidros	Victor A. Pérez Crespo	Harold A. Ray	Jared Rountree
Nicole Michelle Miller	Adam B. Nielsen	Elizabeth M. Perison	Hunter Sean Rayfield	Katie Rouse
Quin Miller	Jon Niemczyk	Tyson L. Perkes	Shan M. Rayray	Peter Rowley
Graham Mills	Mallika Nillorm	Joseph W. Perkins Jr.	David Real	Ankur Roy
Brandon Milner	Nikki Nixon	Maria Kristina Perlas	John Reece	Arghya Roy
Joseph R.P. Mira	Patrick L. Norby	Gabriela Perlingeiro	Andrew Charles Reed	Koushik Roy
Cameron J.M. Mitchell	Spencer Noyes	Benjamin B. Perry	Melanie Lynn Reed	Louise Marie Roy
Toshio Miyazaki	Andy Nunnery	Jared Lee Peters	Jonathan Reeves	Elizabeth Janna Rozar
Ihab N.L. Mohamed	Brett Thomas Nyrehn	Nathan Peters	Jonathan Reeves	Joseph Ruffini
Elizabeth Molina	Zachary Allen Oberling	Stephen C. Peterson	Sean P. Regan	Christopher G. Rurik
Edward Moncayo	Joe O'Brien	Matthew James Petrowsky	Jesus Flores Rehwinkel	Kelton D. Russenberger
Swarnali Mondal	Kathleen Ariania O'Brien	Rebecca Ann Pfeufer	Curtis Reid	Rachael Rutter
Christina A. Monterrubio	Michael Patrick O'Brien	Harnarine C. Phillip	Terrence Morgan Reid	Nikole L. Rutters
Dennis Montgomery	Eric Obrock	Elizabeth Kelsey Phillips	Zachary Reineri	Katie Ryan
Andrew Hoyt Moore	Madeline O'Campo	Joseph H. Phillips IV	Chad Reinertsen	Matthew Sabetta
Cara Moore	Marcie E. Occhi	Kyle George Pickard	David Alan Reiox	David Michael Saddler
Johnathan Earl Moore	Michela K. Occhi	Alexandra Pickering	Nadine Reitman	Sharon Sadle
Robin Moore	Jeremiah O'Connor	Jennifer Pickering	Kristen M. Remington	Andrew R. Safigan III
Kelli Moran	Patrick O'Connor	Weston John Pike	Kurt Remington	Roxana Safipour
Arthur Phillip Mordaunt	Katy O'Donnell	Narek Piloyan	Nicole Marie Renella	Matthew James Sagi
Sarah Morealli	Ryan O'Donnell	Simon David Pinfield	Francis Kevin Rengers	Susana Salazar Jaramillo
Lee Andrew Moreland	Tara O'Donnell	Dominic Pitre	Crystal Teresa Replogle	Morgan James Salisbury
Tom Moriarty	Nmaezi N. Oguamah	Tyler Harrington Plante	Roman D. Reyes	Kaitlin Angela Salley
Beau T. Morris	Daniel James O'Hara	Wilmarie Plaza Muniz	Laura C. Reynolds	Rachel L. Salmon
Noah Steven Morris	Karen Ohmes	Hilary Pletta	Kary Evan Reznicek	Ferréol Marie Salomon
Alicia Frances Morrison	Sergio Rivero Ojeda	Anastasios P. Plougarlis	Caleb Rhatigan	Swati Samaddar
William Fuhrer Morrison	Lindsay S. Oldershaw	Bryce Amelia Pludow	Jefferson Rhoads	Adam Roberts Samale
Aaron P. Morse	Nikki Anne Oliver	Brendan M. Poffenbaugh	Somana Riaz	Judd Sampson
Michael Morse	Sofia Oliver	Zachary A. Poland	Chelsea L. Richard	Esuene M.A. Samson
Catherine Mortenson	Liesl Olson	Carlene Polk	Jacob A. Richardson	Cheryl Marie Sanders

New Members: GSA Welcomes You!

Michele Sanders	Michael P. Show	David Wayne Stainback	Dana Louise Thomas	Ian W. VanDonkelaar
Jon David Sanfilippo	Uttam Babu Shrestha	Kenneth Lee Stallings II	Les W. Thomas	Morgan Elizabeth Vane
James J. Sanovia	Gaurav Shukla	Gareth Stamp	Marie Louise Thomas	Peter VanHeest
Christopher J. Sant	Ashley Shuler	Douglas L. Standart	Matthew Thompson	Julie Vann
David Santaniello	Aaron Isaac Shultis	William C. Stanford	Matthew Adam Thompson	Sheela Varma
Eugenio U. Santillan	Ryan Andros Shurtliff	Lou Stankiewicz	Terry-Ann G. Thompson	Diego Alberto Vasquez
Prantick Santra	Thomas Sibley	Jared Ross Stanley	Wayne Adam Thompson	Thomas Verleye
Nathan R. Saraceno	Max Thomas Siegrist	Kathryn M. Steigerwaldt	Olivia Thomson	Taylor David Vincent
Semir Sarajlic	Kyle W. Siemer	Adar Steinitz	Matthew Thorry	Karl Volkman
Sayantana Sarkar	Sarah Elizabeth Siewert	William Dean Stephens	Ryan J. Thress	Sarah H. Vorhies
Sukesh Ranjan Sarkar	Erica Marie Sigler	Beth Eloise Stevenson	Justin Michael Tiffany	Julia Voronov
Mitra Marlene Sartipi	Anubhav Sikdar	Joshua Craig Stevenson	Carter Bradley Timbel	Peter Voss
Kirsten Benedict Sauer	Marion Teresa Sikora	Ariel B.E. Stewart	Charles Jason Tinant	Michael Scott Waibel
Stacy Sawyer	Benjamin Charles Siks	Benjamin Jacob Stewart	William Lazar Tintor	Elizabeth Waite
Kimberly Sayatovic	Richard L. Silver	Eric Charles Stifter	Scott Ryan Tipple	Alina Ann Walcek
Jordan E. Sayers	Pamela Silvestri	Matthew J. Stiles	Brian Michael Tipton	Joshua M. Walker
Kimberly Scalise	Clark Brunson Simcoe	Claire E. Still	Clare Tochilin	Lindsay Walker
Kimberly Grace Scarano	David Phillip Simmons	Michael D. Stillwagon Jr.	Ross C. Todd	Victoria M. Walker
Allen Joseph Schaen	Curtis Dean Simons	Laura Lyn Stimely	Marshal Scott Tofte	Zackary Steven Wall
Karanina Elise Scheel	Neil Duncan Simpson	Elizabeth Stock	Donald W. Tomlinson Jr.	Kimberly Walsh
Robert A. Scheerer	Zachary A. Simpson	Heather Marie Stoller	Cameron Tompkins	Talor Berek Walsh
Kara Eileen Scheitlin	Shatrughan Singh	Charles Abraham Stoloff	Mark Albert Torres	Reggie Dale Walters
Amanda Scheliga	Simret Singh	Vera Stoyanova	Rafael Torres-Orozco	Fan Wang
Naomi Scher	Elena Sipe	Brian Stozek	Rebecca Diane Tortorello	Hsiu-Wen Wang
Laura A. Schiffman	Luca Sitzia	Benjamin Thomas Strader	Meredith Rose Townsend	Nathaniel R. Warner
Troy Schinkel	Troy J. Skitt	John Baylor Street	Sheila Trampush	Kathryn Warren
Haily Marie Schlemlein	Anna Cofsky Sky	Benjamin J. Strickland	Kristina Tranel	Rebecca Watenpaugh
Brett D. Schlichtemeier	Kati K. Slater-Szirom	Lisa Stright	Robin Trayler	Courtney Ann Waters
Eric Christopher Schmitt	Susan Small	Alexander J.P. Stubbings	Whitney Treadway	Patricia M. Watson
Amber Jane Schneider	Anna Marie Smith	Franklin Sturgeon	Robert Treat	Rachel Wearne
Jesse A. Schoengut	April Rose Smith	Sara Nicole Sugarman	Andrew D. Trogstad-	Stephanie Weaver
Amanda Schuiling	Cameron Lee Smith	Paul Sundberg	Isaacson	Susanna Irene Webb
Kurt W. Schuler	Christopher T. Smith	Kurt Eric Sundell II	B. Taylor Troiani	Peiyang Wen
Emilie Louise Schur	Dana Marion Smith	Annie Marie Surette	Kevin Joseph Trosclair	Madeline Weigner
Patrick T. Schwing	Ian Smith	Elise Swan	Tabitha Trosper	Kelsey Weiler
Brian Evans Scott	Jennifer Megan Smith	Elizabeth Dawn Swanner	Kyle Daniel Trostle	Kirsten Weiner
Quentin Scoufflaire	John Calvin Smith	Jennifer J. Swartz	James Richard Trotta	Deborah Lynn Weinstein
Melissa A. Scruggs	Kimberly M. Smith	Mahima Swarup	Louisa Tsang	Richard Weiss
Rachel Lea Secrest	Lauren Smith	Lauren Swierk	Kaori Tsukui	Kevin Weldon
Mike Sedlacek	Matthew Smith	Shana Swirin	Denise Tu	Ed T. Welsh
Brittany Lorraine Segneri	Matthew Carroll Smith	Emily Rebekah Tackett	Daniel R. Tucker	Raelene Wentz
Margaret Seibel	Matthew J. Smith	Moumita Talukdar	Kera Tucker	Kerrie Nell Weppner
Mary J. Seid	Megan Marie Smith	Nikolas Taranik	Ryan Thomas Tucker	Eleanor R.A. Wershow
Megan Seitz	Melissa Ann Smith	Erick Tate	Chris Turner	Kristen Wesolowsky
Christopher Seminack	Taryn Smith	Mark Tate	Clinton Todd Turner	Debra West
Basak Sener Kaya	Varina C. Smith	Jason Daniel Tatlock	Ryan E. Turner	Natalie Diane Wheeler
Atirath Sengupta	Zackery Smith	Vita Marija Taube	Sheldon Turner	Robert J. Wheelwright
Erlangga Septama	Carolyn Snyder	Agnes Taylor	Rachael Nicole Tury	Crawford M. White
Erica Serna	Stacey Snyder	Andrew Taylor	Benjamin M. Tutolo	David C. White
Lisa Seunarine	Stevan E. Snyder	Eric Steven Taylor	Jenny Ulbricht	Justin Heahlen White
Ryan Seward	Keir Soderberg	Jessica Lauren Taylor	Mohammad S. Ullah	Sarah M. White
William Seward	Brendan Michael Soles	Richard P. Taylor	John W. Underwood	William White
Drew L. Seymour	John Sommerfeld	Ferezer Eshetu Tegegn	Joel Unema	Shawn Barbara Whiteman
Wondwosen M. Seyoum	Lee M. Sorrell	Jason Telaro	Michael L. Unger	Drew Alexander Whitman
Theodora Devaja Shafer	Jesuel Soto	Katherine Telfeyan	Morgan Unrast	Spencer Whitman
Neil Dayton Sharp	Sydney C. Souza	Laura Cecilia Tellechea	Elizabeth Piper Upton	Clinton Trevor Whitten
Nicholas Daniel Sharp	Lynsey J. Spaeth	Andrew James Temples	Bailey Robert Uran	Alyssa K. Wickard
Wade Thomas Shaver	Zachary Spahn	Christopher J. Tennant	Mabilia Urquidi	David Wicks
Drew C. Shaw	Andrew G. Sparks	Matthew Tenney	SacNite Valadez	Travis Wicks
Mindy Shaw	Christina Rae Spence	Orlando J. Teran	Matthieu Vallée	Inoka H. Widanagamage
Nicholas Leslie Shaw	Gwenne Spencer	Brian Raymond Terbush	Vanessa Vallis	Agus Haris Widayat
Zhizhang Shen	Christina R. Spielbauer	Serena Jo Terry	Laura J. Van Alst	Budijanto Widjaja
Martine Shendge	Brooke L. Spivey	Jacob Oliver Thacker	Jessica Van Atta	Michael Wiedmer
John L. Sherrill	Jacob Micah Spry	Rick Thalacker	Elisa Tess Van Orden	Nathan Daniel Wiersma
Alicia Rose Sherrin	Sanpisa Sriairat	Ernest John Thalhamer	Alexander Van Plantinga	Paige Wightman
Corey Shircliff	Molly Frances Staats	Candace L. Thatcher	Jordan Paul Van Sickle	Jacob M. Wilcox
Samuel Coe Shiverick	Kristin Staffo	S.N.S. Thibodeaux-Yost	Kathleen Vander Kaaden	Alicia Wilder
Palmer Shonk	Elizabeth B. Stagg	Jenell J. Thoen	Matthew Vanderkooy	Ashley Wilderom

New Members: GSA Welcomes You!

Sarah Wiley
 Celina Noelle Will
 Caitlyn Marie Williams
 Kendra J. Williams
 Leslie Lavinia Williams
 Lindsay Williams
 Adam N. Williamson
 Justin Kyle Williamson
 Christine Jane Willmott
 Marci Wills
 Dylan Thomas Wilmeth
 Edward Boyd Wilson
 Lance Wilson
 Stephen Wilson
 Donnie Windland Jr.
 Erica Wineland-Thomson
 Brett Wingfield
 Jennifer Diane Wingo
 Kyle Wohnoutka
 Timothy Wold
 Megan Elizabeth Wolf
 Sarah W. Wolf
 Christa Iris Wolfe
 Sophia A. Wolfenden
 Michelle D. Wolfgang
 Ryan W. Wood
 Jessica M. Woodall
 Josh B. Woodall
 Justin Woods
 Paul Martin Woodward
 James J. Wray
 Shea Renea Wright
 Gwendolyn H. Writer
 Audrey L. Wronski
 Yang Wu
 Ping Xiao
 Qun Xie II
 Sudhanshu S. Yadav

Daigo Yamamura
 Eric Yukio Yamashita
 Ya-Mei Yang
 Lindsey Yann
 Zalmay Yawar
 Jason Anthony Yonts
 Alexander J. Young
 Bissett Emily Young
 David Robert Young
 Hongjiao Yu
 Paul Zarella
 Patrick M. Zenger
 Kimberly M. Zerner
 Matthew Zimmerer
 Nicola Zimny
 Kirk A. Zmijewski
 Tyler M. Zollinger
 Spenser Clayton Zwart

TEACHERS

Nathan Adams
 Peggye Martha Ahlstrom
 Linda G. Awbrey
 Louise McLeod Balazs
 Susan Jane Baroni
 James W. Bartholomew
 Herb Bergamini
 Kathy Berry
 Bonnie Saubert Bissell
 Sharon R. Blauvelt
 Ned Bushong
 Brad Capra
 Pamalee Paula Cover
 Eric Cullander
 Elisa D'Amore
 Norm DeRosa
 Mary E. Devine
 Dennis John Dougherty

Janet Sue Douglass
 David S. Dowe
 Donald M. Drozynski
 Robert Druhan
 William J. Durden
 Elliott Edwards
 Amy Susan Furreness
 Katherine Jean Goepfert
 Kent Patrick Gordon
 Audrey Sherry Gunshor
 Steve Holmes
 Cliff Darrell Hudson
 Dale B. Lehman
 Daniel John Maturen
 Kristine McCaaron
 Philip R. McCarthy
 Joanne M. Merchant
 Richard Meyer
 Elizabeth Morris
 Desiree Murphy
 Heather Anne Pacheco
 Paul Renken
 Timothy Earl Roan
 James Lawrence Ruffa II
 Jamie Ramage
 Kaitlyn Marie Ruvel
 Glennys Sabuco
 Jan Carmella Schoonover
 Daniel Shipp
 Charles Edward Simer
 George Thomas Smith
 Verl L. Smith
 A. McKinne Stires
 Carol Strauss
 Susan Jennifer Tate
 Daniel Traub
 Victor E. Trautman
 Nina Diane Van Kleeck

Christopher Joseph Wiley
 Timothy S. Wilson
 Anna A. Yori

AFFILIATES

Herman R. Bartholomay
 Angelyn Bass
 Susan E. Burnside
 Gene Coker
 Mark G. Copeland
 Donna Calvert
 Robin H. Dasler
 Donald Keith Dickson
 Tresa Dupray
 Hartmut C. Eder
 Steven Finley
 Robert J. Fleming
 Dana R. Fowler
 Roger F. Fry
 Laura L. Gaspardo
 Sarah Gill
 George W. Goad
 Norman Goos
 Cem Han
 Ian Keith Harnett
 Raymond W. Harvey Jr.
 Carrie Honolka
 Steve Jacobson
 Stephen Jellen
 Erika Leigh Jenneman
 Donald J. Johnson
 Hilary Jane Kemp
 Freya B. Kinner
 Bonnie Kline
 Tom Lawrence
 William H. Lawrence
 James Rene Leon
 Bernadette M. Longo

John McClintock
 Larry D. Merriman
 Dennis L. Miller
 Patricia E. Monaco
 James B. Moore
 Robin Mowery
 Helen Nakos
 Gary E. Newlin
 Christophe Olson
 Joy L. Perius
 David Pierce
 James M. Reed
 Stevan C. Rich
 James E. Richards
 Terence W. Roberts
 Mary Morgan Rutter
 Jay Shankar
 Maitland Sharpe
 Christopher G. Shea
 Abigail Elizabeth Sholl
 Donald W. Snyder
 Robert Spurlock
 Bunnie J. Sullivan
 Gary R. Surprenant
 Richard Charles Sweet
 Nouvelle Tessler
 Kirk Van Brunt
 Silvia Vittozzi
 Maria C. Webb
 Thomas John Weber
 Larry Wehr
 Gerald J. Wells
 Daryl Emil Williams
 W. Bradley Young

GSA Employment Service Center

Looking for
EMPLOYMENT
in the geosciences?

CANDIDATE SERVICES

- Post your online profile
- View job postings
- Interview at the GSA Annual Meeting
- Review educational career search materials

**Registering your résumé and viewing
 our job postings is FREE for all GSA Members.**



Looking for
QUALIFIED CANDIDATES
in the geosciences?

Access an online database of hundreds of professionals
 in over 30 specialties who are actively seeking career positions
 at all levels.

EMPLOYER SERVICES

- Interview booth and scheduling
- Résumé search
- Posting of job announcement(s)

**Interview services range from a one half-day booth
 rental to multiple days, starting at US\$400.**

www.geosociety.org/employment_service/



Donna L. Russell, *Director of Operations*

Leadership Change in the Foundation



David A. Stephenson

After six years, **David A. Stephenson** stepped down as president of the Geological Society of America Foundation on 30 June 2010.

Stephenson has served GSA unselfishly for more than four decades—as an associate editor of the *GSA Bulletin* from 1979–1984; chair of the Hydrogeology Division in 1983; member of GSA Council from 1989–1991; and president of GSA in 1995. In 2001, Stephenson took on the role of acting executive director for GSA, and he assumed the presidency of the GSA Foundation in 2004. He has served on numerous committees and lent his wisdom and effort to many of the Society's activities. Stephenson's extraordinary record of service will be recognized by the Society at the 2010 Annual Meeting in Denver with the Society's Distinguished Service Award.

Stephenson received his AB in geology from Augustana College in 1958, his M.S. in geology from Washington State in 1961, and his Ph.D. in hydrogeology from the University of Illinois in 1965. He taught at the University of Wisconsin for a decade and directed the Water Resources Management Program there. Stephenson then moved into the applied geology sector for nearly 25 years, holding senior leadership positions with Woodward-Clyde Consultants, Dames & Moore, South Pass Resources, and S.S. Papadopoulos & Associates. Stephenson was also president of the American Geological Institute in 1999. He is now planning to resume his hydrogeology consulting career.

During his tenure as GSA Foundation president, Stephenson has seen the Foundation's annual donations rise by nearly 20% and a substantial increase in bequests. He has worked tirelessly to expand and diversify the Foundation's Board of Trustees so

that members now come from a wide range of academic and applied backgrounds. Under his leadership, a new Development Committee, consisting of current and past board members, former GSA leaders, and major supporters of the Foundation, has been formed and is in the process of developing a set of ambitious goals for the Foundation's future.



Geoff Feiss

Geoff Feiss began as Stephenson's successor on 1 July 2010. He has been a member of the Foundation Board of Trustees since 2006, serving as vice-chair for the past two years.

Feiss retired as provost emeritus and professor emeritus at the College of William and Mary in Virginia in 2009 and moved to Fort Collins, Colorado, USA. In his capacity as provost, he was an ex officio member of the college's Board of Visitors and the Board of Directors of the William & Mary Foundation. He also was on the Board of Directors of the Williamsburg Community Foundation.

Feiss served as William and Mary's provost for six years, and before that served as Dean of the Faculty of Arts and Sciences for six years. Prior to moving to William & Mary, he was a member of the geology faculty at Albion College from 1970 to 1975 and at the University of North Carolina at Chapel Hill from 1975 to 1997, where he also served as chair of the Department of Geological Sciences and as senior associate dean. He was the chair of the Board of the Southeastern Universities Research Association and president of both the Council of Colleges of Arts and Sciences and the National Association of Geoscience Teachers. From 1999 to 2002,

**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
 - ☐ International Section (I.S.) Travel Grants
 - ☐ 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

Donate online at www.gsafweb.org

Feiss was a member of the NAS/NRC Committee on Mineral Resources. He has chaired the GSA Committee on Public Policy and the GSA-USGS Congressional Science Fellowship Selection Committee. An economic geologist, Feiss received his AB in geology from Princeton University in 1965 and his Ph.D. from Harvard University in 1970.

Feiss takes on the presidency as the Foundation moves into its thirtieth anniversary. At the time of this writing, a search for a chief development officer is on-going; we hope to have the new development officer on board in advance of the 2010 Annual Meeting. Among the first priorities of business for Feiss and the new development officer will be implementation of the Development Committee's recommendations after its year-long review of GSA Foundation activities so as to advance GSA's priorities and fill its unmet needs.

Feiss: "I can imagine no more rewarding work than joining forces with the GSAF Board and GSA leadership and members to obtain the critical resources to support GSA. Such worthy activities as student research and travel grants, GeoCorps, awards and recognitions, increasing the international presence of GSA, and the many public education and outreach efforts of the Society are among GSA's priorities deserving all of our support in the years to come."


FUNDING for GSA's Research Grants Program


In 1933, R.V. Anderson received the first Geological Society of America research grant, using it to study the geology of the coastal Atlas Mountains in western Algeria. Seventy-seven years later, GSA's Research Grants Program is still growing and providing students with much-needed funding.

The **GEOSTAR** fund, created in 1987, augments the Research Grants Program. Contributions to GEOSTAR from individuals, industry, and institutions are vital—you can help support a young geoscientist's future by donating today.

Send your check to the GSA Foundation, 3300 Penrose Place, Boulder, CO 80301, USA; call +1-303-357-1054; or donate online at **gsafweb.org**.

GEO STAR
Supporting The Advancement of Research


**THE GEOLOGICAL SOCIETY
OF AMERICA®**


Interactive Maps

Geosphere
is the place
to publish!

Science Citation Index Impact Factor: 1.627

► **Geosphere offers:**


- rigorous peer review
- a flexible format
- free color
- rapid publication after acceptance
- a broad, international audience

Movies

► Submit your manuscript online at
www.editorialmanager.com/geosphere

► For submission details, visit
www.geosociety.org/pubs/geosphere/gsguide.htm

Animations



Submissions welcomed from all geoscience disciplines



Sustaining the Global Environment through the Foreign Assistance Act

Mark G. Little

More than fifteen African nations, including Nigeria and the Democratic Republic of Congo, won their independence from European nations in 1960. Construction of the Berlin Wall began in the middle of 1961, just months after the failed Bay of Pigs invasion. President John F. Kennedy signed the Foreign Assistance Act (FAA) into law in September of 1961 and subsequently created the United States Agency for International Development (USAID). The Foreign Assistance Act, crafted in a Cold War crucible of bipolar, Soviet-American antagonism, was based on a belief that American security required international cooperation “to use wisely the world’s limited resources” and that the “traditional humanitarian ideals of the American people ... to assist people in developing countries to eliminate hunger, poverty, illness, and ignorance” should be affirmed. The five major goals were poverty alleviation, independent economic growth, individual rights, economic integration into global markets, and good governance.

Today, we live in a much-changed world: Sub-Saharan Africa is experiencing economic growth after years of stagnation; the United States and Russia have cordial relations; and Brazil, China, India, and South Africa are surging ahead, joining the community of nations fueled by natural resources, often at the expense of the natural environment. These momentous political and economic changes have also created a more complex diplomatic world while placing further demands on our collective resources.

In the intervening decades, the Foreign Assistance Act has been amended; however, it is the judgment of many involved in development work—including the Chair of the House Committee on Foreign Affairs—that this patchwork of fixes has led to a bureaucratically fragmented foreign aid system that is inadequate to address contemporary development problems, including those related to earth systems and the environment. For example, the five original major goals of the bill make no mention of natural resources or the environment. Little thought was given to the finite nature of fossil fuels and mineral resources. Clean air, water, and soil were not given the appropriate level of importance.

Many of the omissions are quite understandable given that the first substantial federal acknowledgement of and commitment to environmental stewardship was not passed until 1970, in the form of the Clean Air Act. A requirement that any federal agency perform assessments of the environmental impacts of their own domestic projects was not in place until the 1970 National Environmental Policy Act (NEPA). And the watershed political moment for recognition of climate change, the United Nations Framework Convention on Climate Change, did not come to pass until 1992. There have been many subsequent amendments to address these gaps—debt-for-nature swaps to encourage conservation, mandatory environmental impact assessments, and modest funds for climate change adaptation assistance; however, the time has come for a comprehensive rewrite.

As a Congressional Science Fellow, I have been dumbfounded by the often circuitous process of crafting legislation but encouraged by a professional staff able to navigate this world without losing sight of their objectives. The diversity of concerns

within the U.S. government as it relates to Foreign Assistance Act reform is also impressive. Before coming to the Hill, I was unaware of the significance of the separation amongst Congress and each of the numerous executive branch agencies. Agencies have their own viewpoints and expertise, and we have sought input from groups as diverse as the State Department and the U.S. Geological Survey. Moreover, there are foreign governments, nongovernmental organizations, and civil society groups who all have a direct interest in our work. Through this process of reaching out to the various stakeholders, we are working out such questions as how best to encourage developing economies to mitigate emissions of greenhouse gases and how we can help poorer nations balance adaptation to substantial climatic changes, future development, and the conservation of natural resources.

In the proposed new structure of the Foreign Assistance Act, the goal of “Sustaining the Global Environment” will be elevated in importance to the level of other major goals, including poverty reduction and anti-terrorism. Within this environmental title, grand efforts will be made to broaden conservation to include fragile natural ecosystems like coral reefs, wetlands, and grasslands. Along with these efforts is a desire to make sure that there are connections between conservation and long-term economic development; between health and the environment; and between water and climate. On the horizon is a new approach to international development that understands that a peaceful world requires not only cooperation among nations, but among human beings and the earth systems in which we live.

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

GSA Today Science Editor Changes



Science co-editor **Stephen T. Johnston** has come to the end of his four-and-a-half-year term with *GSA Today*. In 2006, Johnston set as his goal for *GSA Today* to “bring forward high-quality articles that appeal to as broad an audience as possible and that spark debate within our community regarding the major societal and scientific questions facing the earth sciences.” This he has achieved. As well, under Johnston’s stewardship, the processing of *GSA Today* science articles from receipt to acceptance has grown to such an order of efficiency that instead of scheduling from month to month, we now have a steady stream of papers accepted through 2011.

Johnston’s plan now is to continue his search for “terrane wrecks” the world over. This summer, his “quixotic quest” will, ironically, see him back in the land of Cervantes, trekking from the brown hills and plains of La Mancha north to the green slopes of Asturias and Galicia. His focus, when not enjoying pulpo, vino blanco, and the odd chupito, will be to try and understand the geometry, origin, and tectonic significance of oroclines affecting the Paleozoic Variscan orogen of the Iberian massif.

Johnston is a professor in the School of Earth and Ocean Sciences at the University of Victoria. Learn more at <http://web.uvic.ca/~stj/>.



Taking over for Johnston as of 1 July is Western Washington University (WWU) professor **Bernard (Bernie) Housen**. Housen is chair of the geology department at WWU, and his main research focus is on Cordilleran tectonics and structure. Learn more at <http://myweb.facstaff.wwu.edu/bernieh/>.

As science co-editor, Housen says his primary goal will be to ensure that *GSA Today* remains an interesting venue for the presentation of new research and synopses of important topics in the geosciences. He hopes to draw on his interdisciplinary background to encourage articles and other content that will be valuable to specialists and interesting and educational to the general *GSA Today* readership, such that this may translate to an increase in the visibility and appeal of *GSA Today*, and GSA as a whole, to professional geologists and educators.



David Fastovsky, who stepped in as a *GSA Today* science co-editor in July 2007, remains on the job through January 2011. Fastovsky is a GSA Fellow and the 2006 recipient of GSA’s Distinguished Service Award, in recognition of his work as *Geology* editor from 1999 to 2005, service on numerous GSA committees, and his time as associate editor for *GSA Bulletin* (1996–2000). He is a vertebrate paleontologist and professor in the department of geosciences at the University of Rhode Island. Learn more at www.uri.edu/cels/geo/GEO_Dfastovsky.html.

GSA Today science editors are charged with obtaining first-class, focused articles that collectively reflect and summarize current topics and discoveries in the earth sciences. Science editors also solicit “Groundwork” articles, which are meant to further the influence of earth science on education, policy, planning, and funding. All submissions, whether solicited or volunteered, are peer reviewed. To submit a science or Groundwork article to *GSA Today*, please go to www.geosociety.org/pubs/gsatguid.htm for instructions and a link to our online manuscript tracking system.

GSA Position Statement on Climate Change

William F. Ruddiman, *University of Virginia (emeritus)*,
 rudds2@ntelos.net

GSA recently released its new position statement on climate change. Because this issue has been highly controversial in recent years, this article is written to provide information on the history of developing the statement and its scientific basis. I write this in my former capacity as chair of the panel that assembled the early draft statement, and as a GSA member since 1966 and Fellow since 1971.

In 2007, I was invited to become a member of the Critical Issues Caucus (CIC), a group of about two-dozen GSA scientists who exchange opinions about emerging environmental issues with the goal of suggesting new initiatives to the GSA, and specifically to the GSA Geology and Public Policy Committee (GPPC). In spring 2008, I concluded that the next GSA position statement on climate change needed to reflect the many recent advances in scientific understanding occurring in that field. I wrote a draft of a possible future statement, circulated it within the CIC, and received suggestions for improvements. In June 2008, a draft position was approved without dissent by the CIC and sent forward in July to the GPPC, chaired at that time by Dick Berg. The GPPC considered the draft during its October 2008 meeting and concluded that a revision to the existing statement was timely. The GPPC wrote a proposal recommending appointment of an expert panel, chaired by me, to develop a draft revised statement. The proposal was forwarded to and approved by Council in January 2009.

Early in 2009, the GPPC and I assembled the panel (see sidebar). We sought highly respected scientists who had international reputations and were recognized leaders in the disciplines and subdisciplines involved in the climate issue. The eight panel members, who have worked for decades in the climate/paleoclimate area, have a total of nearly 900 published papers. Three are members of the National Academy of Science, many are AGU or GSA Fellows (or both), and several have won prestigious medals from major scientific societies. Thure Cerling provided continuity to the panel that had produced the 2006 climate statement. Hydrogeologist Jean Bahr (then GSA president-elect) volunteered as a liaison to the GPPC, and Don Paul served because of his industry perspective and his interest in the climate problem. The panel members have not been outspoken advocates on either side of the global warming issue. I have spoken out against exaggerations on the climate issue in a trade book for Princeton University Press and invited contributions to the AGI publication, *EARTH*, but I have criticized both extremes.

Working by e-mail starting in early March 2009, the panel produced a draft statement by May and sent it to the GPPC. The GPPC refined the draft and approved it in June 2009. The

statement was then sent to GSA members via the e-news magazine, *GSA Connection*, on 17 August and via *GSA Today* in early September for a comment period. Because of delays some members experience in receiving their *GSA Today* issues, the comment period was extended to the end of the month.

Those GSA members who submitted statements were assured of anonymity so that they would feel free to speak out regardless of possible workplace constraints. Rex Buchanan, the new chair of GPPC, and I were charged with reading the comments and deciding on appropriate response(s). We received comments from ~60 members, or just under 0.3% of GSA's 22,000 members. The responses fell into three categories: (1) generally favorable comments, some of which suggested changes or additions to improve the statement; (2) more neutral or moderately unfavorable (but still constructive) responses that in many cases suggested changes or clarifications on various issues; and (3) responses that were critical of the entire process and in many cases dismissive of the motives of anyone who had taken part.

Faced with these highly divergent reactions from GSA members, mindful of the very controversial nature of this issue, and holding to the guarantee of anonymity for those who had commented, I proposed in late August 2009 that the panel respond to those major criticisms that we chose not to incorporate into the revised statement. I tabulated the criticisms and condensed them to a short list of seven, which I sent to the panel (with no member names attached), and we produced the response printed at the end of this article. Those GSA members who remain unsure about the anthropogenic warming issue will find within this document arguments that counter many common misconceptions about (and objections to) anthropogenic warming, as well as references with which to check out the scientific basis of the counter-arguments. A few items in the Aug.–Sept. 2009 panel response have been updated in minor ways to reflect subsequent developments, including recent publications of relevance.

In October 2009, the GSA Executive Committee voted unanimously to forward a slightly amended draft of the position statement to GSA Council for a vote. Council discussed the statement during its October meeting, held shortly after receiving the draft from GPPC, but felt the need for additional review and comment prior to voting. The comments and suggested edits from Council were referred back to GPPC for consideration, including clarification on several scientific issues. Although the panel formally disbanded on 1 February 2010, individual members helped to supply the information requested by the GPPC as it prepared a revision of the draft statement and responses to GSA Council comments. The GPPC approved a new revision of the draft statement during its March 2010 meeting and forwarded the revised draft to Council. In April

2010, GSA Council voted on and approved that version of the revised statement without modification.

I add several personal perspectives about this process:

1. The operations of the panel were remarkably consensual throughout. We soon came to basic agreement on the major issues in the statement and spent most of our time refining the wording to make sure it accorded fully with the latest science. We agreed to characterize the large climatic changes currently projected for the future as “risky,” but we did not think it was our role to try to choose among possible policy options.
2. Many members of the public and the media seem confused about which sources to trust on the subject of global warming. The members of this panel are not only highly respected but also typical of the large body of mainstream climate scientists who spend most of their time “doing the science” and rarely, if ever, speak out on policy issues. This position statement qualifies as a mainstream climate science document.
3. Given that *any* position statement on climate change was inevitably going to be seen as controversial by one part of the GSA membership or another, the GSA leadership showed excellent judgment and considerable courage in supporting this climate statement and thereby weighing in on the side of mainstream climate science.

PANEL RESPONSES TO GSA MEMBER COMMENTS

(Oct. 2009; updated Apr. 2010)

Is the panel qualified?

Cumulatively, the panel members have published ~900 peer-reviewed research papers on paleoclimate/climate, ranging across the Paleozoic, Mesozoic, and Cenozoic, and including the Pleistocene and Holocene. Barron was director of the National Center for Atmospheric Research and is now president of Florida State University. Cerling, Kutzbach, and Lean are members of the

PANEL MEMBERS

Jean M. Bahr: Hydrogeology. Professor and past chair of the Dept. of Geoscience, Univ. of Wisconsin; 2009–2010 Geological Society of America president and panel liaison to the GPPC. Fellow: GSA. Learn more at www.geology.wisc.edu/people/display.html?id=4.

Eric J. Barron: Mesozoic climate. President, Florida State Univ. Former director, National Center for Atmospheric Research; former dean, Jackson School of Geosciences, Univ. of Texas at Austin. Recipient of the NASA Distinguished Public Service Medal. Fellow: AAAS, AGU, AMS, GSA. Learn more at <http://president.fsu.edu/biography/index.html>.

Julie Brigham-Grette: Cenozoic to Holocene climate. Geosciences Dept. professor, Univ. of Massachusetts. Past chair, PAGES Steering Committee; past president, American Quaternary Association. Member, National Academy of Sciences Polar Research Board. Learn more at www.geo.umass.edu/faculty/jbg.

Thure Cerling: Mesozoic to Quaternary climate. Distinguished professor, Dept. of Geology and Geophysics, Univ. of Utah. Member, National Academy of Sciences. Fellow: GSA, AAAS, and International Association of Geochemistry. Learn more at www.biology.utah.edu/faculty2.php?inum=55.

Peter U. Clark: Quaternary climate. Professor, Dept. of Geosciences, Oregon State Univ. Recipient of the Easterbrook Distinguished Scientist Award (GSA). Fellow: GSA, AGU. Learn more at geo.oregonstate.edu/people/faculty/clarkp.htm.

John E. Kutzbach: Paleozoic to Holocene climate. Associate Director, Univ. of Wisconsin–Madison Center for Climatic Research, Gaylord Nelson Institute for Environmental Studies. Member, National Academy of Sciences; recipient of the Roger Revelle Medal (AGU), the Milankovitch Medal (EGU), and the William Smith Award (Geological Society of London). Fellow: AGU, AMS. Learn more at http://ccr.aos.wisc.edu/contact/kutzbach_john.php.

Judith Lean: Historical to Recent climate and solar physics. Senior Scientist, Naval Research Laboratory. Member, National Academy of Sciences. Fellow: AGU. Learn more at http://eosps0.gsfc.nasa.gov/ess20/docs/lean_bio.pdf.

Donald L. Paul: Exploration geologist. Director, Univ. of Southern California Energy Institute, William Keck Chair in Energy Resources. Past vice-president and chief technology officer, Chevron-Texaco Corporation. Learn more at www.usc.edu/schools/sppd/faculty/detail.php?id=74.

William F. Ruddiman: Cenozoic climate. Past professor and chair, Dept. of Environmental Science, Univ. of Virginia. Past associate director, Lamont-Doherty Earth Observatory; past director, CLIMAP project. Recipient of the Lyell Medal (Geological Society of London). Fellow: GSA, AGU. Learn more at www.evsc.virginia.edu/faculty/ruddiman-william-f.

Cathy Whitlock: Cenozoic climate. Professor, Dept. of Earth Sciences, Montana State Univ. Past geography dept. chair, Univ. of Oregon; past president, American Quaternary Association; chair, U.S. National Committee, International Quaternary Union. Learn more at www.montana.edu/wwwes/facstaff/whitlock.htm.

National Academy of Sciences. Ruddiman wrote the widely used college textbook, *Earth's Climate*. Seven are GSA members, and many are Fellows of the GSA, AGU, AMS, and past presidents of other organizations. The panel's four women and six men are distributed among eight states and the District of Columbia. None has been outspoken at either the alarmist or skeptic extreme of the spectrum of views on global warming.

Was there an “inappropriate” IPCC influence?

Some critics claim that the 2007 IPCC process was flawed and that its conclusions were accepted uncritically by the members of the National Academy and the panel. In this view, recognized experts in the field appear for some reason ill-informed and easily misled on important issues that lie within their expertise. In contrast, the panel views the 2007 IPCC statement as a valid synthesis and assessment of current knowledge of global warming that received thorough and extensive review from many members of the scientific community (despite minor errors discovered recently).

Could the last 125 years of warming be natural?

Because Earth's climate is always changing, some claim that the recent warming is natural, not anthropogenic. This criticism is refuted by a growing body of evidence closely scrutinized by panel members with a wide range of experience studying natural climate change on time scales ranging from tectonic to orbital to recent/instrumental. Given this experience, panel members took into account competing hypotheses in arriving at their conclusions. The warming of the last century is unusual in both speed and size, and it cannot be explained by natural factors, except for the modest solar contribution during the first half of the century.

Was there a larger solar influence?

Some claim that the Sun is responsible for most twentieth-century climate change, including the net warming since 1980. Contrary to this claim, satellite measurements of solar radiation over the last 30 years find no significant persistent trend other than 11-year cycles. These cycles vary in amplitude by 0.1% (1 W/m^2) around a mean value of 1361 W/m^2 , and empirically based studies indicate that global surface temperature responds with an amplitude of $\sim 0.1^\circ\text{C}$. Possible indirect effects of solar ultraviolet radiation on the stratosphere and troposphere are being investigated, with some recent studies indicating a small effect. In summary, Earth's response to solar variability during the satellite era is $\sim 0.1^\circ\text{C}$, much smaller than the projected warming of $<2^\circ\text{C}$ to $>5^\circ\text{C}$ in the next century from greenhouse gases.

Some have also claimed that solar variability over century to millennial time scales has influenced climate, but we lack direct solar irradiance observations to show how the Sun varied this far in the past. Two proposed proxies of solar forcing on centennial time scales are compromised by other factors tied to climate. The age difference between ^{14}C and tree-ring counts is affected by changes in ocean circulation and carbon reservoirs, and ^{10}Be variations in ice cores are affected by changes in snow accumulation rates. As a result, it is difficult to separate solar forcing from internal climate system responses. In addition, proxy measurements of climate during previous

millennia are highly variable both from site to site and for multiple proxies at single sites. Circumstantial evidence points to a link between solar and climatic proxies at some sites, but widespread evidence of a strong link remains ambiguous.

What is the significance of the recent cooling?

The 150-year instrumental record of global temperature shows an obvious long-term increase. Superimposed on this increase are shorter-term rises and falls caused by natural fluctuations due to ENSO (El Niño–Southern Oscillation; or decadal-scale atmosphere-ocean oscillations such as the Pacific Decadal Oscillation [PDO]), volcanic eruptions, the 11-year solar cycle, and perhaps other factors. A very small cooling occurred from 2005 to 2008, but 2009 was a warmer year. The last 10 years make up the warmest 10-year interval in the entire instrumental record, as are the averages for the last 15 years, 20 years, and longer. Every previous pause or dip in the long-term warming trend was followed by new record warmth.

What about the urban heat-island effect?

Some claim that compilations of surface temperature are compromised by anomalous warmth at stations located in “heat islands” warmed by urban growth, but urban areas cover less than 2% of Earth's land surface. Station data from the Arctic demonstrate that this non-urbanized region has experienced a warming larger than the global average, a conclusion also supported by decreasing snow cover and sea ice trends measured by satellites and borehole temperature trends. In addition, many stations from other non-urbanized areas show warming trends larger than the global average. Early attempts to estimate global average temperature were compromised by the heat-island effect, but methods have now removed most of this overprint. Any such effect remaining in the observations is estimated to contribute $<5\%$ to the warming trend in hemispheric and global-average temperatures.

Can models predict future climate?

Another criticism is that models are useless for predicting climate change far in the future. One part of this argument is that models can't even predict weather two weeks from now, so how can they predict the distant future? This criticism is based on a misunderstanding of how models are used.

Weather models start from initial observations of present weather conditions, and they rely on equations to anticipate how specific weather systems will develop in the near future. But the current “weather” is not known perfectly, and thus the model forecasts start out with small errors. As the model forecasts progress, non-linear processes inherent to the climate system cause actual weather to diverge from the model forecasts. After 10 days to two weeks, model predictions of features such as specific storm at a particular time and place are no longer reliable.

The use of models for future climate forecasts is entirely different. Climate models rely on analogous equations, but not to predict day-to-day weather in the far-distant future, which is obviously impossible. Instead, they estimate *average* annual or seasonal changes expected when factors that determine modern-day climate—such as sun strength, greenhouse gases, and aerosols—change by specified amounts.

Climate models are initially evaluated by how well they reproduce the main characteristics of modern climate, such as temperature, precipitation, pressure, and wind direction and strength. On balance, they simulate these features well, although more successfully for temperature than for regional precipitation. One criticism is that these models are “tuned” to simulate modern climate. Although tuning is a part of the modeling process, it is not an unconstrained exercise. Models have to capture basic climatic characteristics both vertically and spatially at global, hemispheric, and regional scales, and over average annual and daily cycles. Simultaneously reproducing all these features reasonably well is a highly challenging test that cannot be met by simply tweaking a few “knobs.”

In addition, climate models have been tested by their ability to simulate times in the past when the average climate was very different due to changes in well-constrained factors, such as orbital parameters (the mid-Holocene 6000 years ago) and ice sheets, carbon dioxide levels, and sea level (the last glacial maximum 20,000 years ago). This ongoing process of testing and successfully validating climate models against past observations is a major reason scientists feel confident in relying on them to predict average conditions in future centuries. Many scientists in GSA (including several panel members) have made important contributions to these scientific advances.

As the draft position statement notes, these projections of average future climate carry uncertainties tied to (1) the uncertain range of future gas emissions and atmospheric concentrations, and (2) climate feedbacks that are not yet tightly constrained. Over shorter intervals, such as the next decade or two, changes are difficult to predict because of natural variability in the climate system (“noise”) and because models assign different strengths to key factors. Farther in the future (a century from now), these uncertainties will have become progressively less important as the response to growing CO₂ concentrations increasingly overwhelms natural variability.

In summary, the model capabilities noted above show that they provide a firm basis for assessing the plausible range of future climates that could result from greenhouse-gas forcing. Even the lower end of the projected range will bring a global warming of 1.5–2 °C (~3 times larger than that experienced to date). The middle-to-upper range of the estimates (4–6 °C) would make future climate on Earth as much warmer than it was colder during the peak of the last glacial maximum 20,000 years ago.

FURTHER READING

Several scientific references that support key statements in the 2010 GSA position statement on climate change are listed with that document. The following additional references address common misconceptions about (and resulting criticisms of) mainstream scientific views on anthropogenic global warming.

Solar Influence

Lockwood, M., 2008, Recent changes in solar outputs and global mean surface temperature. III. Analysis of contributions to global mean air surface temperature rise: *Proceedings of the Royal Society A*, v. 464, p. 1387–1404, doi: 10.1098/rspa.2007.0348.

Benestad, R.E., and Schmidt, G.A., 2009, Solar trends and global warming: *Journal of Geophysical Research*, v. 114, doi: 10.1029/2008JD011639.

Urban Heat Island Effect

Peterson, T.C., 2003, Assessment of urban versus rural in situ temperature differences in the contiguous United States: No difference found: *Journal of Climate*, v. 16, p. 2941–2959.

Parker, D.E., 2006, A demonstration that large-scale warming is not urban: *Journal of Climate*, v. 19, p. 2882–2895.

Recent Cooling

Peterson, T.C., Connolley, W.M., and Fleck, J., 2008, The myth of the 1970s global cooling scientific consensus: *Bulletin of the American Meteorological Society*, Sept., p. 1325–1337, doi: 10.1175/2008BAMS2370.

Easterling, D.R., and Whener, M.F., 2009, Is the climate warming or cooling?: *Geophysical Research Letters*, v. 36, L08706, doi: 10.1029/2009GL037810.

Fawcett, R., 2007, Has the world cooled since 1998?: *Bulletin of the Australian Meteorological and Oceanographic Society*: v. 20, p. 141–148.

Murphy, D.M., Solomon, S., Portmann, R.W., Rosenlof, K.H., Forster, P.M., and Wong, T., 2009, An observationally based energy balance for the Earth since 1950: *Journal of Geophysical Research*, v. 114, D17017, doi: 10.1029/2009JD012105.

von Shuckmann, K., Gaillard, F., and Le Traon, P.-Y., 2009, Global hydrographic variability patterns during 2003–2008: *Journal of Geophysical Research*, v. 114, C00907, doi: 10.1029/2008JC005237.

Model Testing Based on Paleo Data

Ruddiman, W.F., 2007, *Earth's Climate: Past and Future*: New York, W.H. Freeman & Company, 465 p. (Note: Several chapters [and references therein] give examples of the interplay between geologic observations and modeling: Ch. 2: general use of models; Ch. 4: Supermonsoons on Pangaea; Ch. 5: Cretaceous greenhouse climate; Ch. 6: Cenozoic cooling; Ch. 8: insolation control of ice sheets; Ch. 11: orbital-scale interactions; Ch. 12: last glacial maximum; Ch. 13: last deglaciation and Holocene. Some of many studies not mentioned in the book follow.)

Lunt, D.J., Haywood, A.M., Schmidt, G.A., Salzmann, U., Valdes, P.J., and Dowsett, H.J., 2009, Earth system sensitivity inferred from Pliocene modelling and data: *Nature Geoscience*, v. 3, p. 60–64, doi: 10.1038/ngeo706.

DeConto, R.M., and Pollard, D., 2003, Rapid Cenozoic glaciation of Antarctica induced by declining atmospheric CO₂: *Nature*, v. 421, p. 245–249, doi: 10.1038/nature01290.

Oto-Bleisner, B.L., Marshall, S.J., Overpeck, J.T., Miller, G.H., Hu, A., and CAPE Last Interglacial Project members, 2010, Simulating Arctic climate warmth and icefield retreat in the last interglaciation: *Science*, v. 311, p. 1751–1753, doi: 10.1126/science.1120808.

Model Simulations of Recent/Future Warming

Meehl, G.A., Washington, W.M., Ammann, C.M., Arblaster, J.M., Wigley, T.M.L., and Tebaldi, C., 2004, Combinations of natural and anthropogenic forcings in twentieth-century climate: *Journal of Climate*, v. 17, p. 3721–3727.

Events & Deadlines

10 August

- Abstract Submission Deadline

27 September

- Early Registration Deadline
- Housing Deadline

4 October

- Registration Cancellation Deadline

27–30 October

- Premeeting Field Trips

29–31 October

- Short Courses & Workshops

30 October

- GSA Presidential Address & Awards Ceremony: 7–9 p.m.

31 October

- GSA Gold Medal Lectures
- Welcoming Party & Exhibits Opening: 6–8 p.m.

31 October–3 November Technical Program

- Oral Sessions
- Posters: Hung all day with half-day sessions, authors present a.m. or p.m.

31 October–3 November

- Lunchtime Keynote Lectures: 12:15–1:15 p.m.

1 November

- Group Alumni Reception: 7–9:30 p.m.
- Private Alumni Receptions

1–2 November

- Exhibit Hall Open: 9 a.m.–6 p.m.

3 November

- Exhibit Hall Open: 9 a.m.–2 p.m.

4–6 November

- Postmeeting Field Trips

Lunchtime Lectures



Marcia McNutt

GSA Lunchtime Lecture 1

Marcia McNutt: *Reflections on My First Year as USGS Director*

Sunday, 31 Oct., 12:15–1:15 p.m.

GSA Fellow **Marcia McNutt** was confirmed by the U.S. Senate on 22 October 2009 to serve as Director of the United States Geological Survey (USGS) and Science Advisor to the Secretary of the Interior. As USGS Director, McNutt is responsible for leading the largest water, earth, biological science, and civilian mapping agency in the United States in its mission to provide the scientific data that enable decision makers to create sound policies for a changing world.

McNutt previously served as president and chief executive officer of the Monterey Bay Aquarium Research Institute (MBARI) in Moss Landing, California, USA. She has participated in 15 major oceanographic expeditions and served as chief scientist on more than half of those voyages. Her research includes studies of ocean island volcanism in French Polynesia, continental breakup in the Western United States, and uplift of the Tibet Plateau, and she has published 90 peer-reviewed scientific articles.

McNutt earned a bachelor's degree in physics from Colorado College and a doctorate in earth sciences from Scripps Institution of Oceanography. Along with being a GSA Fellow, McNutt is a member of the National Academy of Sciences, the American Philosophical Society, and the American Academy of Arts and Sciences. She was awarded the Macelwane Medal by the American Geophysical Union (AGU) in 1988 for research accomplishments by a young scientist and AGU's Maurice Ewing Medal in 2007 for her significant contributions to deep-sea exploration.



GSA's Lunchtime Lectures series offers four one-hour presentations (one for each day of the meeting) by high-profile speakers on broad topics relevant to today's world. Bring your lunch and prepare to be challenged and inspired! Information on each speaker will appear in subsequent issues of *GSA Today* as well as on the meeting Web site, www.geosociety.org/meetings/2010/.

2010 GSA Annual Meeting & Exposition

Call For Papers

Abstract submission deadline: 10 August

<http://gsa.confex.com/gsa/2010AM/index.epl>

1. **Determine the discipline category for your paper** (see www.geosociety.org/meetings/2010/jtpc.htm or p. 39 of the June *GSA Today*). This is an essential step, even if you are submitting to a topical session. This year's 156 topical sessions (see www.geosociety.org/meetings/2010/sessions/topical.asp) are designed to promote the exchange of interdisciplinary, state-of-the-art information; discipline sessions also add to a well-rounded meeting.
2. **Select your preferred mode of presentation:** Oral, poster, or no preference. The program organizers will do their best to fit your abstract into your preferred mode.
3. **Include a title, five keywords, and name** and contact information for each author; e-mail addresses must be provided for communication purposes. No more than 10 authors may be listed on a paper, and group names will not be accepted.
4. **Abstracts must be no longer than 2,000 characters** (not counting spaces). Do not repeat title and authors in the abstract.
6. **Please proofread** your abstract; we won't edit it before publication on the Web and in the abstract book.
7. **A non-refundable fee** of US\$35 per abstract submission will be charged to professionals per submission; for students, it's US\$20 per submission. Payment by credit card must be made when you submit your abstract.
8. **You may present two volunteered abstracts** *as long as one of these abstracts is a poster presentation.*
9. **The decision by the Joint Technical Program organizers** to place your paper in an oral or poster session is final.

Oral Presentations

- The normal length of an oral presentation is 12 minutes, plus three minutes for Q&A.
- You *must* visit the Speaker Ready Room at least 24 hours before your scheduled presentation.
- All technical session rooms are equipped with a PC.
- If your presentation was created on a Macintosh, you must save it to run on a PC. Please test it before coming to the meeting and again in the Speaker Ready Room. If you have any questions on this, please contact Nancy Wright, nwright@geosociety.org.
- If your presentation includes embedded video, please convert any .mov files to .avi format, or create a link in your

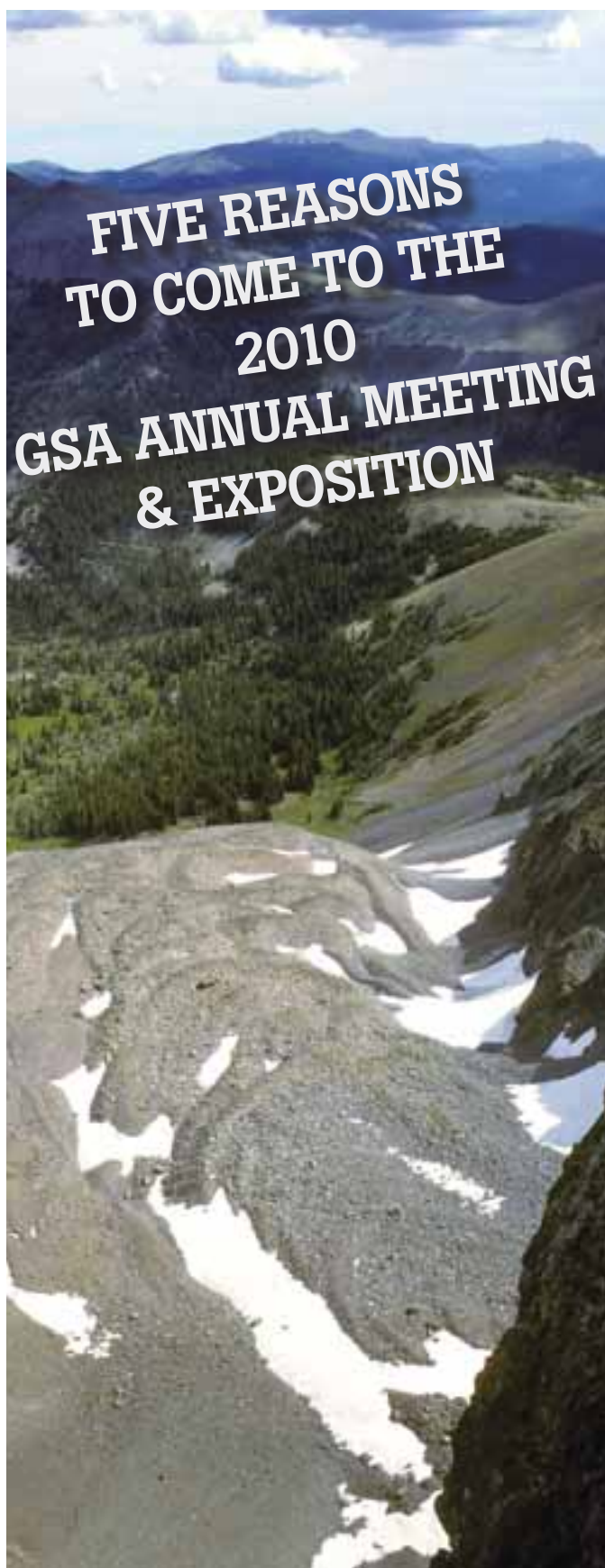
slide show to an external .mov file. If you choose the latter, your animation will play in a separate QuickTime window, outside of your PowerPoint presentation.

Poster Presentations

- You will be provided one horizontal, freestanding 8-ft-wide by 4-ft-high display board along with Velcro for hanging the poster, and each poster booth will share a 6-ft by 30-in table.
- Electricity will be available in the poster area at no charge.
- Posters will be on display 9 a.m.–6 p.m. Authors should be present either 9–11 a.m. *or* 2–4 p.m. and are encouraged to be at their posters during the 4:30–6 p.m. beer reception as well.



Standing 40 feet high, the big blue bear peers through the lobby of the Colorado Convention Center. Photo used with permission from the Denver Metro Convention & Visitors Bureau.



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

1. Location, location, location.

Centrally located just to the east of the U.S. Continental Divide and right on the edge of the Great Plains, Denver is easy to get to from just about anywhere. The city is familiar territory to those of you who have attended meetings here in the past, with just about everything you need within walking distance of the Colorado Convention Center.

2. Opportunity.

GSA meetings provide opportunities for valuable face-to-face interactions with mentors, colleagues, friends, and former students. GSA is also the perfect venue for meeting new people who can help advance your research—at Town Hall meetings, along NSF Street in the exhibit hall, and at the NSF booth, where you can meet with program officers as well as NSF Assistant Director for Geosciences, Timothy Killeen, who will be attending the Denver meeting.

3. Be inspired and hear from the best.

The 2010 Gold Medal Lectures will take place Sunday afternoon, 31 Oct. Learn more about the life and careers of these geoscience leaders:

Eric J. Essene, 2010 GSA Penrose Medalist

Essene was professor *emeritus* at the University of Michigan–Ann Arbor. His main focus of study was metamorphic petrology, and his interests spanned the fields of mineralogy, geochemistry, and general petrology.

George E. Gehrels, 2010 Arthur L. Day Medalist

As a professor of tectonics and geochronology at the University of Arizona, Gehrels has several research projects going, including stratigraphic, structural, and geochronologic analyses of Alaska's Coast Mountains, a detrital zircon provenance study of accreted terranes in the western U.S. and Canada, and analyses of the uplift and erosional history of the Tibet Plateau.

Dana L. Royer, 2010 Young Scientist Award–Donath Medalist

Dana Royer is an assistant professor at Wesleyan University who lists his general interests as “global change, paleoclimatology, carbon cycle, paleoecology, paleobotany, plant physiology, and light stable isotope geochemistry.” His research explores how plants can be used to reconstruct ancient environments.

Here's a sampling of what bloggers had to say about last year's meeting:

“Meetings like this are a great opportunity for professional scientists to catch up on the latest ideas both inside and outside their specialties.” — Callan Bentley

“It was a great conference. I had a fantastic time scientifically and socially ... I'm looking forward to these events for years to come.” — Brian Romans

“The annual GSA meeting is a large meeting if you measure by the number of scientific talks given. ... The best part of

4. Live on the leading edge.

The Pardee Keynote Symposia, made possible by a grant from the Joseph T. Pardee Memorial Fund, are interdisciplinary sessions that address broad, fundamental issues in the geosciences. The following topics were selected on a competitive basis, and all speakers are invited.

Seeing the True Shape of Earth's Surface: Applications of Airborne and Terrestrial LiDAR in the Geosciences

(session P6: Sun., 31 Oct., 8 a.m.–noon).

Why Aren't Our Ideas Getting Attention? Finding a More Convincing Voice on Controversial Issues

(session P3: Sun., 31 Oct., 1:30–3:30 p.m.).

Mineral Evolution: The Coevolution of the Geo- and Biospheres

(session P4: Mon., 1 Nov., 8 a.m.–noon).

Evolving Moon: Recent Advances in Understanding Our Planetary Neighbor from NASA's Lunar Reconnaissance Orbiter and Other Missions

(session P2: Mon., 1 Nov., 1:30–5:30 p.m.).

Symbiosis as a Driver of Global Change in Ancient and Modern Earth Systems

(session P1: Tues., 2 Nov., 8 a.m.–noon).

Exploring for Life in the Cosmos: Celebrating Five Decades of Astrobiology

(session P8: Tues., 2 Nov., 1:30–5:30 p.m.).

Rapid Environmental/Climate Change in the Cretaceous Greenhouse World

(session P5: Wed., 3 Nov., 8 a.m.–noon).

Impacts of Ocean Acidification: The Other CO₂ Crisis

(session P7: Wed., 3 Nov., 1:30–5:30 p.m.).

5. Share your expertise.

If you don't, who will? GSA meetings are designed to serve your needs, but only if you participate. Technical sessions are built from the ground up. What this means is that your colleagues have created topical sessions in order to provide you an opportunity to submit abstracts to these sessions and represent your scientific area of expertise. You can review the list of topical sessions at <http://gsa.confex.com/gsa/2010AM/cfp.epl>. **Abstracts are due on or before 10 August.**

2010 GSA Annual Meeting & Exposition Reaching New Peaks in Geoscience

meetings, though, is meeting people, which for me often involves seeing people I haven't seen in 10 to 20 years."

— Sandra Powers

"I come to meetings for several reasons:

1. To get better at teaching content.
2. To get better at teaching, period.
3. To give me ideas for my own research.
4. To see people.
5. To meet people with whom I'm currently working.
6. To support my student(s).
7. To present my own stuff." — Kim Hannula



Artist concept (Chris Meaney, NASA) of the Lunar Reconnaissance Orbiter with Apollo mission imagery in the background, http://www.nasa.gov/mission_pages/LRO/multimedia/lroconcept2.html.



"Cave of Crystals," Naica mine, Chihuahua, Mexico. April 2007 *Geology* cover photo by Javier Trueba (Madrid Scientific Films).



Large primnoid coral loaded with brittle stars on Dickins Seamount, Gulf of Alaska. Credit: National Oceanic and Atmospheric Administration (NOAA) Gulf of Alaska Seamount Expedition (library image ID expl0125), <http://www.photolib.noaa.gov/htmls/expl0125.htm>.

**Time is running out.
Register now!**

Tectonic Crossroads: **Evolving Orogens of Eurasia–Africa–Arabia**

Cultural and Convention Centre, Middle East Technical University



Ankara, Turkey, 4–8 October 2010
www.geosociety.org/meetings/2010turkey/

DEADLINES:

Standard Registration Deadline: 23 August 2010
Registration Cancellation Deadline: 30 August 2010

A Global Meeting brought to you by:

The Geological Society of America
The International Section of The Geological Society of America
Chamber of the Geological Engineers of Turkey and the
Turkish Association of Petroleum Geologists

HOST ORGANIZATION:

Middle East Technical University, Turkey

PARTNERING ORGANIZATIONS:

Directorate of the Mineral Research and Exploration Institute
GSA Structural Geology and Tectonics Division
GSA International Section
European Geosciences Union
The Geological Society of London
Turkish Petroleum Corporation
International Union of Geological Sciences (IUGS)
IGPC-UNESCO



Photos by Yildirim Dik.

We want to help get you there!

International Section Travel Grants

✓ **2010 GSA Annual Meeting**
Denver, Colorado, USA

✓ **Tectonic Crossroads Meeting**
Ankara, Turkey

GSA's International Section has limited funds to assist the participation of international scientists and students in either the Annual Meeting of the Society or the Tectonic Crossroads Meeting in Turkey. Grants will not cover the full cost of attending the meeting, but are intended to help defray the combined cost of registration, housing, and travel.

To access the application, please go to the GSA International Section's Web page, www.geosociety.org/sectdiv/International/travelGrants.htm. All applications must be submitted by **1 August 2010**. If you have questions, please contact John Wakabayashi, jwakabayashi@csufresno.edu.

For information visit: www.geosociety.org/meetings

13th Annual AAPG/SEG
Fall Student Expo

When: 20-21 September 2010
Monday-Tuesday

Where: George R. Brown Convention Center,
Houston, Texas

► **TRAVEL GRANTS AVAILABLE!**

Opportunities to help you on your **ASCENT:**

- ✓ Networking
- ✓ Interviews
- ✓ Interviewing Tips
- ✓ Ice Breaker
- ✓ Field Trips
- ✓ Resume Building and Review
- ✓ Poster Session
- ✓ Special Interest Class
- ✓ Industry Exhibition

More information and registration online at:
<http://studentexpo.info>

get the inside knowledge

Stable Isotope science

Isotopes are the key to knowledge about our past, present and our future. Our isotope analysis services can help you unlock the answers to ecological and environmental history. We provide carbon, nitrogen, sulphur, oxygen and hydrogen stable isotope analysis, accept samples in all phases and offer **discounts** for volume submissions. Our analysis is backed by world-leading scientists whose research spans climate, environmental protection and sustainability, geology, and hydrocarbons, and is supported by expert technicians.

Contact Us

To know more about benefiting from the expertise of the GNS Science Stable Isotope Laboratory and Rafter Radiocarbon Laboratory please visit

www.gns.cri.nz/nic/stableisotopes
www.rafferradiocarbon.co.nz

or Email us at:

stableisotopes@gns.cri.nz
radiocarbon@gns.cri.nz

unlock a moment in time

Radiocarbon dating services

When you seek knowledge of "a moment in time" Rafter Radiocarbon can provide the answers. We offer world-leading research scientists whose research spans climate, environmental protection and sustainability, archaeology, and geology, supported by expert technicians. We have worked with clients world-wide for over 50 years and we are a regular participant in the International Radiocarbon Intercomparisons. Contact us for a **FREE** consultation on applicability and sampling.

Location

National Isotope Centre
30 Cassfield Road
Lower Hutt 5010
PO Box 31312
Lower Hutt 5040
New Zealand
T +64 4 570 1444
F +64 4 570 4057



Classified Rates—2010

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

Classification	Per Line for 1st month	Per line each add'l month (same ad)
Positions Open	\$8.85	\$8.60
Opportunities for Students		
First 25 lines	\$0.00	\$4.50
Additional lines	\$4.50	\$4.50
Fellowship Opportunities	\$8.85	\$8.60

Positions Open

FACULTY POSITION IN GEOSCIENCES UNIVERSITY OF ARIZONA

The Department of Geosciences at the University of Arizona seeks to hire a tenure-track faculty at the Assistant or Associate Professor level in the area of geosciences related to mineral resources. The candidate's research should be original and address significant geological, geochemical or geophysical questions related to mineral resources and allied topics in fields such as petrology, tectonics, geochemistry, or geophysics. Approaches can be field, lab or theoretical and could involve settings from surficial to magmatic, scales from microscopic to global, topics from basic science to applications and policy. The Department is seeking

an individual who is able to work with diverse students and colleagues. The successful candidate is expected to engage in multidisciplinary research and teaching through the Department of Geosciences, the partnerships and initiatives of the Lowell Institute for Mineral Resources and related professional programs, and the new School of Earth and Environmental Sciences. The position has been created as part of a campus-wide initiative on the sustainability of mineral resources with support from multiple state, federal, industry and non-governmental organizations.

In addition to completing the online application (UA Job Number 44141, www.arizona.edu), a cover letter, CV, and statement of teaching and research interests, please submit up to five reprints of published work and arrange for three letters of recommendation to be sent to The Economic Geology Search Committee, Department of Geosciences, University of Arizona, 1040 East 4th Street, Tucson, AZ 85721-0077, USA, or by e-mail to egsearch@email.arizona.edu.

The deadline for applications is 15 September 2010. We anticipate a start date in 2011.

POST-DOCTORAL OPPORTUNITIES IN U-TH-PB GEOCHRONOLOGY AND COMPLEMENTARY ASPECTS OF GEOCHEMISTRY BY LA-ICP-MS, ARIZONA LASERCHRON CENTER

We seek a post-doctoral scholar to conduct research in geochronology and related aspects of geochemistry. Research would be conducted at the Arizona LaserChron Center utilizing our two LA-MC-ICP-MS systems and a new SEM facility. The two main areas of research will include:

- Development of analytical techniques and applications for U-Th-Pb analysis of U-bearing minerals such as titanite, apatite, rutile, monazite, xenotime, and baddeleyite.
- Development of analytical techniques and applications for complementary geochemical systems such as Li and Hf isotopes and Ti and Zr concentrations.

Available instrumentation includes a Nu HR ICP-MS connected to a UP193HE laser, an Isoprobe connected

to a DUV193 laser, and a Hitachi 3400N SEM with Gatan Chroma CL and Oxford EDS/EBSD systems.

Post-doctoral support is available starting immediately, and will be available for two years. Applicants should have a Ph.D. in Earth Science or Chemistry, and have demonstrated experience with geochronologic instrumentation and techniques. Will begin reviewing applications 1 June and will continue until the position is filled. Applications should be submitted at <http://www.uacareertrack.com> (job #44362). For additional information, please contact George Gehrels, ggehrels@gmail.com, and/or visit our Web site at www.geo.arizona.edu/alc.

R&D MANAGER 4, EARTH AND ENVIRONMENTAL SCIENCES DIVISION LOS ALAMOS NATIONAL LABORATORY

Los Alamos National Laboratory—a premier national security research institution delivering innovative science and engineering solutions for the nation's most crucial and complex problems—has the following opening available:

R&D Manager 4

Our Earth and Environmental Sciences Division seeks an accomplished professional to provide technical leadership and management for the Earth Systems Observation Group, EES-14. The group performs research in environmental science and geochemistry with a focus on experimental work in both the laboratory and in the field. The successful candidate will own the capability development for environmental isotopes, novel geomaterials, climate measurements and ecological processes, and be expected to help develop and implement a vision for the future of experimental geosciences that addresses the long-term needs of Energy, Environmental and Global Security customers.


Requires a Ph.D. in Science, Engineering or related field, with an emphasis in scientific leadership and management of a research organization with complex operations; or an equivalent combination of education and experience.

For the complete job description and to apply online, visit www.lanl.gov/jobs and apply to job number 219675.

IT'S A Party!
CELEBRATING DR. WAYNE'S WORLD

Dr. Wayne Pettyjohn, professor emeritus, Oklahoma State University holds the record for most piezometers (43) at a residence. Aside from training graduate students and professionals, Wayne provided a course that retooled approximately 1300 professionals from the petroleum industry to the water industry to provide employment from the oil bust during the 1980's. Due to the vagaries of federal rules, we do not have a list of these geologic professionals. However, we would like to have a party in honor of Wayne on Oct. 1st, 2010 in Stillwater, Oklahoma.

If you were a student or friend of Wayne's and would like to attend our celebration of his career, please contact **Todd Halihan** at todd.halihan@okstate.edu or OSU School of Geology, 105 NRC, Stillwater, OK 74078 for more information.



Check out the myriad ways
you can connect with GSA through
the Internet and social media

**GSA
is Online!**



THE
GEOLOGICAL
SOCIETY
OF AMERICA®

GSA Connection

GSA's monthly e-news magazine brings you current information on GSA programs, meetings, events, books, government and international affairs, pending deadlines, and media coverage. Read it now at www.geosociety.org/GSA_Connection.

GSA Today Online

GSA Today is always open access. Check out our new Web pages at www.geosociety.org/gsatoday/, and thanks for your patience as we tidy up from moving the hosting of GSA Today in-house.

Facebook

We're on Facebook both as a fan page and as a group page under "Geological Society of America" at www.facebook.com/pages/Geological-Society-of-America/67821277078. Check here for updates, photos, and links to journals, events, and more.

Twitter

Follow GSA on Twitter as "@geosociety"; and we're at <http://twitter.com/geosociety>. GSA currently has over 350 followers, most of them "geotweeps" (your fellow scientists and colleagues).

LinkedIn

The Geological Society of America is linked in at <http://www.linkedin.com/>. We invite GSA members and interested geoscience professionals to use this space for discussion and networking opportunities.



Submit Your Abstract Today!

The 2010 AGU Fall Meeting is an opportunity to review the latest issues affecting all areas of the Earth and space sciences. Help shape the meeting and submit your abstract today.

Deadline for Abstract Submission: 2 September 2010
www.agu.org/meetings/fm10/



To submit an abstract and check important dates, go online to www.agu.org/meetings/fm10/

Follow AGU and the Fall Meeting on Twitter, <http://twitter.com/theAGU>



Super-rotation of Earth's inner core and the structure of scientific reasoning

Peter Kosso, Dept. of Philosophy, Northern Arizona University, Box 6011, Flagstaff, Arizona 86011, USA; peter.kosso@nau.edu

INTRODUCTION

Recent confirmation that Earth's inner core rotates with respect to the mantle (cf. Zhang et al., 2005) presents a good case to highlight important aspects of the structure of observation and reasoning in geophysics, geology, and the physical sciences in general. In particular, it can help to clarify the relationship between theory and evidence. Determining the rotation of the inner core is a solution to a so-called "inverse problem" (Jacobs, 1987, p. 2). The defining characteristic of an inverse problem is the challenge of determining properties of an unobserved cause based on observed properties of the effect. This provides an opportunity to raise some worthwhile methodological questions.

The first question is about confirmation. How is solving an inverse problem different from other forms of confirmation in science? A second question is about the difference between explanation and description. Is an inverse problem distinct from common patterns of explanation—in particular those that explain observed effects in terms of their unseen cause? What, if anything, has been explained by the discovery of super-rotation? Or, is this a case of describing an aspect of nature without explanation?

And then there is a question of the empirical status of super-rotation. Is the image of the rotating inner-core a matter of observation (with information moving from outside in, from the physical world into our minds), or inference (with information moving from inside out, from ideas to implied situations in the world)? Following the flow of information in the case of super-rotation will shed some light on this difference.

SUPER-ROTATION

Earth's inner core is solid; it apparently also rotates a bit faster than the rest of the planet. Most recent evidence puts the super-rotation at 0.3° to 0.5° per year, or about one extra revolution each 900 years (Zhang et al., 2005).

The super-rotation was predicted by models that explain Earth's inherent magnetism (Glatzmaier and Roberts, 1996). Detecting the theorized rotation is an example of an inverse problem, in that it uses measured data of effects on the surface to draw inferences about the causes within. The problem has now been solved by analysis of seismic waveform doublets

(Zhang et al., 2005). The super-rotation is said to be "confirmed by earthquake waveform doublets" (Zhang et al., 2005, p. 1357).

The evidence is in the recording of seismic waves from earthquakes that are more or less on the opposite side of Earth. Refraction of the waves at interfaces between mantle and core, and bending of the waves through material of varying density, lead to multiple paths from source to receiver. Some of the rays go through the inner core, some go around it, and these will have different arrival times.

The key is in noting that the difference in arrival times between the through-the-core and avoid-the-core rays changes steadily over time. It increases, meaning that the through-the-core waves are being delayed more and more. This is measured by comparing data from two earthquakes that occur at the same place but at significantly different times. This is a *doublet*, identified as happening at the same place by the similarity of waveform. For earthquake doublets separated by decades or more, the arrival-time difference increases as the time between events increases. This suggests that something is steadily changing in the relative conditions between the inner core and the mantle.

The explanation, the account of what is changing and thereby causing the increase in arrival-time difference, starts with the idea that the inner core is grainy, like wood, with the grain running more or less parallel to the axis of Earth's rotation. The speed of seismic waves will depend on their orientation to the grain. If the inner core turns with respect to the mantle, the orientation of the grain will change and the speed of a wave will change. This explanation was suggested by Kenneth Creager even before the doublet data: "The most likely cause of time-varying changes in structure within the Earth is that the inner core is rotating with respect to the mantle and that the elastic structure of the inner core is not axi-symmetric" (Creager, 1997, p. 1285).

The logic of the confirmation is noteworthy. It starts with theoretical prediction of arrival times using a model with a rotating inner core. The measured arrival times then match those predicted. This is exactly the form of reasoning often called hypothetico-deductive confirmation, and it is the foundation of most descriptions of scientific method. Deduce a prediction from a hypothesis, then observe the prediction to be true.

From the original geodynamic conjecture to the more direct evidence in waveform doublets, the arguments have the same logic. They are versions of an inverse problem, inferring parameters of the core based on surface data. They pivot on a

premise in which data are predicted from aspects of a model of the core. That pivotal premise is a conditional of the form: IF the core has this feature, then the data will be such and such. In other words, IF model, then data; it is not IF data, then model.

Insofar as an inverse problem is about cause and effect, the key step in solving the problem is predicting measurable consequences of the cause. If the inner core rotates with respect to the mantle, then the difference in arrival times will steadily increase. The cause (super-rotation) is the antecedent, and the effect (arrival-time details) is the consequent. The “inverse” in an inverse problem refers to the direction of the logic. The ultimate inference, about the cause, has to work back against the conditional relation between cause and effect—the one that says, IF cause, then effect. The logic has to work back along the causal chain.

The logical challenge of an inverse problem is characteristic of the challenge of most scientific reasoning. We observe effects and work to figure out the details of the cause. Our models of causes are typically in terms of sufficient conditions for the effect. Theories and theoretical calculations can say what would lead to and explain what is observed, but they can rarely say that it is the only thing that could. That is, models of causes are not necessary conditions for the observed effects. There are always other possible explanations for the data.

The fact that there are other theories, perhaps not proposed or even imagined at this time, that would explain the data shows that what passes the tests now is always vulnerable to future refutation. What we call confirmation is neither fool-proof nor to be based on an individual test. The confirmation of super-rotation—the reason to believe it is real—is not in the latest evidence but in the overall corroboration from independent evidence and reasoning. The geodynamic modeling of Earth’s magnetic field suggests the faster rotation. The wave-form-doublet data corroborate this. And a third source of information, measurements of free oscillation of the whole Earth, how Earth rings after a large seismic event, is consistent with super-rotation as well. The logic in this last case follows the pattern in which observations are predicted by the model and then subjected to a “hypothesis test” (Laske and Masters, 2003, p. 11). We can label different results as “observations” or “evidence” or “inference” or “detection” of inner-core rotation (Song, 2003, p. 54), but there is no important difference in the logical structure or status. No particular case is the confirmation of the rotation by virtue of being more direct. The credibility of the hypothesis derives from the agreement among the different kinds of data.

CONCLUSION

The super-rotation of the inner core explains the details in differential arrival times of seismic waves from very distant earthquakes. In this way, solving the inverse problem is explanatory. In general, the model of a cause explains the observed effects, and by doing so, the model gains credibility. The logic in this case is the same as the logic of confirmation; the cause implies (and thereby explains) the observed effect.

The logic of an inverse problem is essentially the logic of hypothetico-deductive confirmation; the hypothesis implies observable effects. In no case is the evidence conclusive proof of a hypothesis. The more realistic assessment of

scientific reasoning acknowledges that the credibility of a hypothesis accumulates as it fits into broad agreement with a variety of sources, both empirical and theoretical. The hypothesis of super-rotation fits the theoretical models of Earth’s magnetic dynamo. It fits the empirical data of global free-oscillations. And it fits the more particular empirical data of wave-form doublets. This exemplifies what the philosopher of science, Karl Popper, called corroboration, “the degree to which a hypothesis has stood up to severe tests, and thus ‘proved its mettle’” (Popper, 1965, p. 251). A severe test requires the hypothesis to entail observable data, and the test is survived when the data are in fact observed. The logic of Popper’s corroboration is precisely the logic in the case of the rotation of the inner core.

REFERENCES CITED

- Creager, K., 1997, Inner core rotation rate from small-scale heterogeneity and time-varying travel times: *Science*, v. 278, p. 1284–1288.
- Glatzmaier, G., and Roberts, P., 1996, Rotation and magnetism of Earth’s inner core: *Science*, v. 274, p. 1887–1891.
- Jacobs, A., 1987, *The Earth’s Core* (second edition): London, Academic Press, 416 p.
- Laske, G., and Masters, G., 2003, The Earth’s free oscillations and the differential rotation of the inner core, in Dehant, V., et al., *Earth’s Core: Dynamics, Structure, Rotation*: Washington, D.C., American Geophysical Union Geodynamic Series, v. 31, p. 5–21.
- Popper, K., 1965, *The Logic of Scientific Discovery*: New York, Harper & Row, 479 p.
- Song, X., 2003, Three-dimensional structure and differential rotation of the inner core, in Dehant, V., et al., *Earth’s Core: Dynamics, Structure, Rotation*: Washington, D.C., American Geophysical Union Geodynamic Series, v. 31, p. 45–63.
- Zhang, J., Song, X., Li, Y., Richards, P., Sun, X., and Waldhauser, F., 2005, Inner core differential motion confirmed by earthquake waveform doublets: *Science*, v. 309, p. 1357–1359.

Manuscript received 5 Feb. 2010; accepted 26 April 2010.



GSA TODAY

SCIENCE:

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

GROUNDWORK:

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

www.geosociety.org/pubs/gsatguid.htm



GSA Short Courses are Moving Fast!

Short Courses at the GSA Annual Meeting fill up quickly, so we recommend you register as soon as you decide which course is right for you. Signing up early can also save you money: After 27 Sept., short course fees increase by US\$30.

For full course descriptions, go to www.geosociety.org/meetings/2010/courses.htm; sign up for a short course at <https://rock.geosociety.org/registration/login.asp>.

All short courses offer continuing education credits (CEUs). If you have questions about this or about any of the short courses, please contact Jennifer Nocerino at jnocerino@geosociety.org.

Coming to *GSA Today* in August 2010

* SCIENCE ARTICLE:

Structural analysis of three extensional detachment faults with data from the 2000 Space-Shuttle Radar Topography Mission

* 2010–2011 GSA Congressional Science Fellow Announcement

* 2010 GSA Annual Meeting & Exposition

Lunchtime Lecture 2 Revealed

* Groundwork: Geological mapping goes 3-D in response to societal needs



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

Publications Highlights

Geology's Research Focus

Need perspective? See the forest along with the trees with *Geology's* Research Focus articles. These one- to two-page briefs discuss the significance of a particular research problem and demonstrate how an article in that issue of *Geology* contributes to a better or more holistic understanding of the problem.

The articles are designed to serve as a broad reference on major topics for both students and established researchers.

View the entire open-access collection at <http://geology.gsapubs.org/cgi/collection/rfocus>.

GSA Journals online: www.gsapubs.org



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



BERING GLACIER

Interdisciplinary Studies of Earth's Largest Temperate Surging Glacier

edited by Robert A. Shuchman and Edward G. Josberger



Special Paper 462

Bering Glacier is the largest surging glacier in the world, having surged at least six times in the last 150 years. With the glacier advancing and retreating as much as 10 km over a surge cycle, it is one of the most physically and biologically dynamic places on Earth. This monograph presents the results of a comprehensive and diverse series of field studies and science investigations at Bering Glacier. The results reported are from a wide range of disciplines, including glaciology, geology, paleogeology, hydrology, limnology, oceanography, tectonics, geomorphology, geophysics, meteorology, remote sensing, climate change, anthropology, and ecological studies pertaining to vegetation, fish, and marine mammals. The compilation of these individual studies into a single publication allows for a more complete understanding of how the approximately 5000 km² Bering Glacier system plays a major role in the greater southeastern coastal region of Alaska and through its wastage, its impact on the circulation of the northeast Pacific Ocean and on the global sea level.

SPE462, 384 p., ISBN 9780813724621 | list price \$99.00 | member price \$70.00



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

A great deal you're really going to dig.



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



THE
GEOLOGICAL
SOCIETY
OF AMERICA®

Unearth a GSA Member Benefit here <http://www.geosociety.org/members/subaru.htm>



**The Subaru Outback.
Motor Trend's 2010
Sport/Utility of the Year***

*You may be eligible to save \$1,300 to \$3,300 off the MSRP (Manufacturer's Suggested Retail Price) depending on model and accessories, plus any applicable incentives on the purchase or lease of any new Subaru from participating dealers. MSRP does not include tax, title and registration fees. Limited time offer subject to change without notice. Terms and conditions apply. Valid in the U.S. only, except Hawaii. Cannot be combined with any other GSA promotional offers, coupons (such as auto show or Internet coupons) or direct mail offers (except Subaru Guaranteed Trade-in Program (GTP) or Subaru Reward Dollars). All rights reserved.