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Buckling an orogen: The Cantabrian Orocline

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 THE GEOLOGICAL SOCIETY OF AMERICA®

GSA TODAY (ISSN 1052-5173 USPS 0456-530) prints news and information for more than 25,000 GSA member readers and subscribing libraries, with 11 monthly issues (April/May is a combined issue). *GSA TODAY* is published by The Geological Society of America® Inc. (GSA) with offices at 3300 Penrose Place, Boulder, Colorado, USA, and a mailing address of 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 race, citizenship, gender, sexual orientation, religion, or political viewpoint. Opinions presented in this publication do not reflect official positions of the Society.

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Printed in the USA using pure soy inks.

4 **Buckling an orogen: The Cantabrian Orocline**

G. Gutiérrez-Alonso, S.T. Johnston,
A.B. Weil, D. Pastor-Galán, and
J. Fernández-Suárez

Cover: Field photo taken from the northern hinge zone, looking south, of the doubly plunging La Cueta Syncline, located between Asturias and León, in northern Spain. Notice the dramatic change in strike of the fold limbs from NE-SW in the foreground to N-S in the center of the photo to NW-SE in the southern plunging hinge zone. The Devonian St. Lucia and Portilla limestones delineate the La Cueta Syncline, a typical sinuous structure from the hinge zone of the larger Cantabrian Orocline. Photo taken by Stephen T. Johnston. See related article, p. 4–9.



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Buckling an orogen: The Cantabrian Orocline

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ABSTRACT

The Paleozoic Variscan orogeny was a large-scale collisional event that involved amalgamation of multiple continents and micro-continents. Available structural, geological, geochemical, and geophysical data from Iberia are consistent with a model of oroclinal bending at the lithospheric scale of an originally near-linear convergent margin during the last stages of Variscan deformation in the late Paleozoic. Closure of the Rheic Ocean resulted in E-W shortening (in present-day coordinates) in the Carboniferous, producing a near linear N-S-trending, east-verging orogenic belt. Subsequent N-S shortening near the Carboniferous-Permian boundary resulted in oroclinal bending, highlighted by the formation of the Cantabrian Orocline. Together, these data constrain oroclinal bending in Iberia to have occurred during the latest Carboniferous over about a 10-million-year time window, which agrees well with recent geodynamical models and structural data that relate oroclinal bending with lithospheric delamination in the Variscan. This late-stage orogenic event remains an enigmatic part of final Pangea amalgamation.

INTRODUCTION

Orogenic belts that are bent in plan view are a ubiquitous feature of recent and ancient orogens (e.g., Marshak, 2004; van der Voo, 2004; Sussman and Weil, 2004; Weil and Sussman, 2004). Where a bend is formed by buckling of an originally linear orogen about a vertical axis of rotation, it is classified as an orocline (Carey, 1955, 1958). Oroclines are amongst the largest geological structures on Earth and have formed from Archean to recent times. Their existence has profound implications for the tenets of plate tectonics and challenges the fundamental assumption of plate rigidity.

We describe the well-studied Cantabrian Orocline of northern Spain. This is one of the first bent orogens reported in geoscience literature, referred to as the “Asturian Knee” by Eduard Suess in the late nineteenth century in his massive work *Das Antlitz der Erde* (1885–1908) (translated to English in 1909). Suess recognized that the structures, now attributed to the Early Carboniferous collision between Laurussia and Gondwana during Pangea

amalgamation, define a significant bend in northern Iberia. Since Suess’ description, the curved portion of the Variscan orogen has been the object of numerous studies aimed at unraveling the timing and kinematics of orogenic development, with more recent emphasis on exploring the orogen’s impact at the lithospheric scale (e.g., Julivert, 1971; Julivert and Marcos, 1973; Ries et al., 1980; Pérez-Estaún et al., 1988; Weil et al., 2000, 2001; Gutiérrez-Alonso et al., 2004, 2011a, 2011b; Johnston and Gutiérrez-Alonso, 2010). In the following sections, we summarize the results of recent studies in the Cantabrian Orocline that help constrain its timing, kinematics, and geometry. We also utilize insights from analogue experiments to develop models of orocline formation and speculate on possible causes of oroclinal bending. Finally, we consider the assumption of plate rigidity in the light of our current understanding of the Cantabrian Orocline.

THE CANTABRIAN ARC OROCLINE

The Cantabrian Orocline (Fig. 1) defines the core of a larger curved orogenic system that weaves through Western Europe, and it is located at the apex of the Ibero-Armorican Arc (Fig. 1). The orocline is recognized by geometrical changes in the structural trend of thrust-related folds that formed during the Carboniferous Variscan orogeny. The orocline has a convex-to-the-west shape, an E-W axial trace, and an isoclinal geometry in plan view. Both the northern and southern limbs of the orocline strike E-W, thus defining an arc with 180° of curvature. The Cantabrian Orocline is characterized as a foreland fold-thrust belt with thrust vergence toward the oroclinal core (Julivert, 1971). Thrusts imbricate a Carboniferous foreland basin sequence, an underlying Lower Paleozoic passive margin sequence, and a basal Ediacaran slate belt. The distribution of sedimentary facies and paleocurrent data show that the Lower Paleozoic passive margin faced outward, away from the core of the orocline (Shaw et al., 2012). The Variscan metamorphic hinterland surrounds the core of the orocline to the west and south, and is overthrust in the west by ophiolitic assemblages along foreland-verging thrusts. Recent structural (Aerden, 2004; Martínez-Catalán, 2011) and sedimentological (Shaw et al., 2012) studies in central and southern Iberia have revitalized an early suggestion of du Toit’s (1937) that the Cantabrian Orocline continues to the south, forming a second bend (the Central Iberian Orocline) that together define a continental-scale S-shaped orocline pair.

KINEMATICS AND TIMING

To constrain the kinematics and timing of orocline development, two approaches have been used that yield complementary results: joint analysis and paleomagnetism in pre- syn- and post-orocline sedimentary sequences (Fig. 2).

Joint sets are developed in strata that span the duration of Variscan orogenesis, including late-stage orocline formation (Pastor-Galán et al., 2011). Joints in structurally imbricated strata

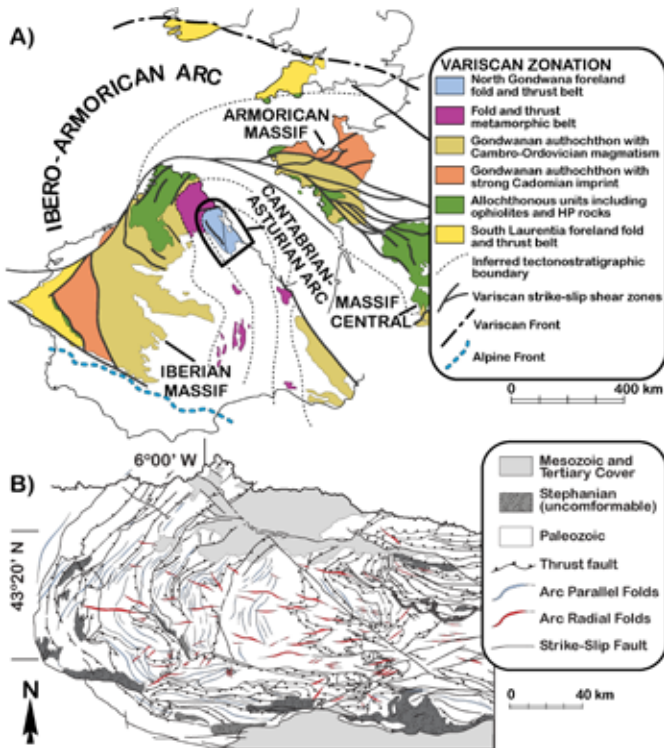


Figure 1. (A) Correlation of tectonostratigraphic zones across the Variscan orogen in southwestern Europe (modified from Franke, 1989; Martínez-Catalán et al., 2007). Iberia has been restored to its paleogeographic position prior to the opening of the Cantabrian Sea (Bay of Biscay). Inset box indicates the location of Cantabrian Orocline. (B) Simplified structural map of the Cantabrian Orocline, highlighting the geometry of major thrusts and the orientation of major folds.

that are continuously exposed around the orocline are shown to be related to thrust formation and buckling. Thrust-related synorogenic strata constrain thrust fault formation to have occurred by 315 to 310 Ma (e.g., Alonso, 1987; Keller et al., 2007; Merino-Tomé et al., 2009). In pre-orocline sedimentary sequences, two orthogonal joint sets are identified, one parallel to and another normal to arc-parallel thrust traces and the axes of thrust-related fault-bend folds. The joint sets systematically trace the curvature of the arc, changing orientation with regional strike around the orocline (Fig. 2). Upper Pennsylvanian strata are deposited in continental basins that unconformably overlie the older, thrust imbricated strata. These strata have younger orthogonal joint sets that trace 60% of total arc curvature (Fig. 2). These sediments are interpreted to have been deposited, and their joint sets developed, during orocline formation (Pastor-Galán et al., 2011). Finally, joint sets in Early Permian strata that unconformably overlie the curved Variscan structures show no systematic change in orientation around the trace of the Cantabrian Orocline and are therefore interpreted to post-date orocline formation (Fig. 2). Hence, the pre-, syn- and post-orocline sedimentary sequences and the joint sets they contain limit the Cantabrian Orocline to have formed after about 315 Ma and prior to the Early Permian (pre-299 Ma). This time frame is consistent with the deposition of Upper Pennsylvanian strata (307 to 299 Ma) during orocline formation.

Paleomagnetic data have also been used to constrain the timing of orocline formation. The rocks of the Variscan foreland in the core of the Cantabrian Orocline were remagnetized during and after early imbricate thrusting, yielding two syntectonic magnetizations that have been used to constrain the kinematics of subsequent deformation (Hirt et al., 1992; Parés et al., 1994; Stewart, 1995; van der Voo et al., 1997; Weil et al., 2000, 2001). In situ paleomagnetic site means were individually restored to a known

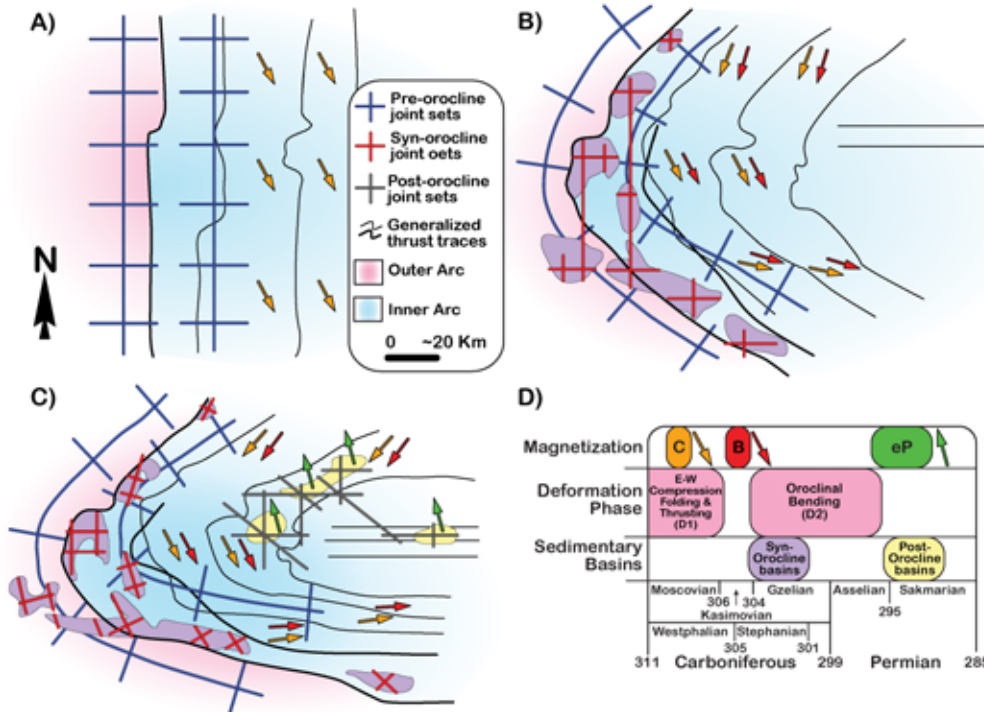


Figure 2. Cartoon summarizing the development of joint sets (Pastor-Galán et al., 2011) and the acquisition of multiple magnetizations (Weil et al., 2001, 2010) in the Cantabrian arc during formation of the Cantabrian Orocline. (A) Joints and paleomagnetic vectors interpreted to develop contemporaneously with formation of a nearly linear Variscan orogen in pre-Moscovian and Moscovian times. (B) Arc during the uppermost Kasimovian and Gzhelian times when between 30% and 50% of the arc's present-day curvature was attained, deposition of the Stephanian B-C basins occurred, and development of fold-axis subparallel and subperpendicular Stephanian joint sets were formed. (C) Present-day geometry of the Cantabrian Orocline and the orientation of the Early Permian paleomagnetic vectors showing no rotation. (D) Proposed timeline for successive magnetizations recorded in the Cantabrian Orocline and their relationships to the main phases of orocline formation and formation of sedimentary basins.

reference direction based on observed geologic structures (e.g., local fold axis orientation) and geometric constraints. Such restorations have an intrinsic error based on restoration path uncertainty, constraints on the reference direction, and the timing of magnetization acquisition, all of which have been well established in the Cantabrian Orocline (e.g., van der Voo et al., 1997; Weil et al., 2000, 2001; Weil, 2006; Tohver and Weil, 2008). Analyses of paleomagnetic sites from structural domains distributed around the arc of the orocline indicate clockwise rotations in the northern limb of the Cantabrian Orocline, counter-clockwise rotations in the southern limb, and complex interference folding in the hinge zone (Fig. 2). The unconformably overlying Early Permian continental strata from both limbs of the orocline preserve a primary magnetization that records no vertical axis rotation (Weil et al., 2010) (Fig. 2). These data limit orocline development to have started after acquisition of the syntectonic remagnetization of thrust imbricated strata at 315 to 310 Ma and to have ended prior to deposition of the unconformable Early Permian strata at 299 Ma, consistent with the constraints provided by joint-set orientation data.

LITHOSPHERIC RESPONSE

One of the most challenging questions concerning orocline formation is the evolution of their three-dimensional (3-D) geometry. Do oroclines evolve as thick-skinned, lithospheric-scale structures, or are they thin-skinned features that terminate against crustal detachments? Extensive magmatism accompanied formation of the Cantabrian Orocline, which is interpreted to reflect a thick-skinned, lithospheric-scale response to active buckling (Gutiérrez-Alonso et al., 2004, 2011a, 2011b). Syn-orogenic Variscan granitoid magmatism was active from 345 Ma to 315 Ma and recorded the building and collapse of the Variscan belt (Fernández-Suárez et al., 2000). Subsequent post-orogenic magmatism comprises intrusive and volcanic rocks emplaced from 310 to 285 Ma, which are penecontemporaneous with, and slightly post-date, oroclinal buckling. The post-orogenic magmatic record consists of mantle and crustal derived melts that show systematic changes in their age, spatial distribution, petrology, and geochemistry and include significant foreland magmatism in the core of the Cantabrian Orocline (Gutiérrez-Alonso et al., 2011b).

Magmatism began in the orogenic hinterland region with intrusion of mantle and lower crustal derived mafic melts from 310 to 305 Ma (Fig. 3C). These mafic rocks and their accompanying granitoids are interpreted as a byproduct of decompressive mantle and lower crustal melting, caused by lithospheric extension around the outer orocline arc during buckling (Fig. 3). Thinning of the lithosphere in the outer arc, a concomitant rise of the asthenosphere, and coupled intrusion of gabbros resulted in a regionally elevated geothermal gradient across the arc. This increase in thermal energy resulted in melting of middle-upper crustal rocks still hot from Variscan orogenesis and led to intrusion of felsic, crustal derived magmas into the outer arc of the orocline between 305 and 295 Ma (Fernández-Suárez et al., 2000; Gutiérrez-Alonso et al., 2011b).

A different (albeit intimately related) magmatic history characterizes the inner arc of the orocline, where magmatism did not begin until 300 Ma and did not end until 285 Ma (Fig. 3D). Magmatism in the core of the orocline (foreland) began with the

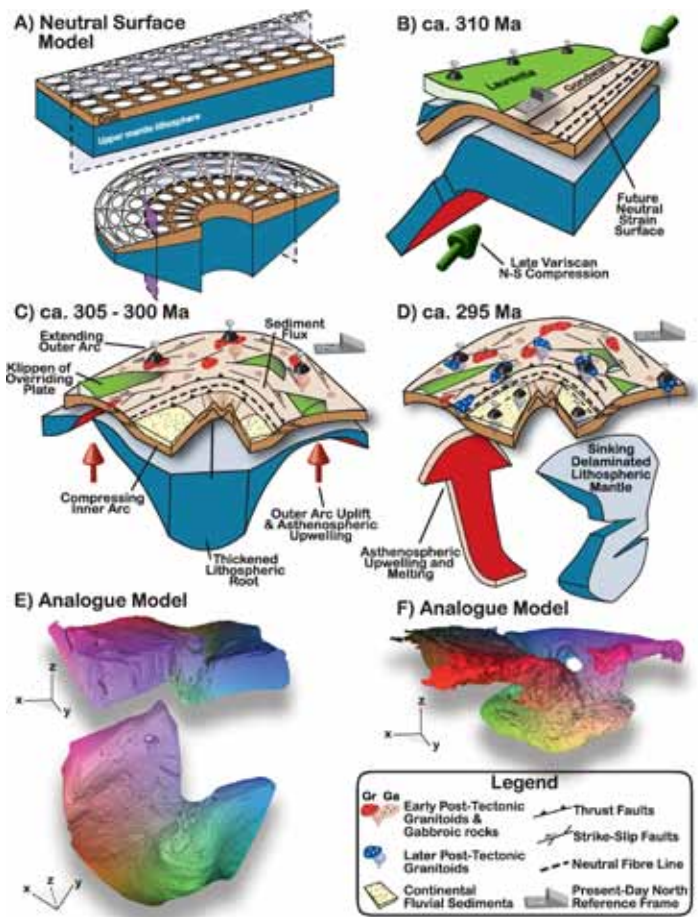


Figure 3. (A) Block diagram depicting the effect of lithospheric bending around a vertical axis and the resultant strain field (modified tangential longitudinal strain). Strain ellipses depict arc-parallel shortening in the inner arc and arc-parallel stretching in the outer arc. Note the different behavior of the mantle lithosphere in the inner and outer arcs and the increase in thickness of mantle lithosphere below the inner arc and thinning below the outer arc. (B) Snapshot illustration of arc development starting with a linear belt resulting from a Gondwana-Laurentia collision. (C) Second snapshot illustrating oroclinal bending, which causes lithospheric stretching in the outer arc and thickening beneath the inner arc (Gutiérrez-Alonso et al., 2004). (D) The final stage of oroclinal bending, depicting delamination and collapse of thickened lithospheric root beneath the inner arc, replacement of sinking lithosphere by upwelling asthenospheric mantle, and associated magmatism in the inner and outer arc regions. (E) Two tomographic views of the analogue modeled mantle lithosphere geometry after buckling around a vertical axis where the lithospheric root is developed under the inner arc (top—frontal view from the concave part of the model; bottom—view from below); 3-D coordinate axes given. (F) Tomographic 3-D image of the delaminated lithospheric root obtained with analogue modeling; 3-D coordinate axes given.

intrusion of mantle and lower crust-derived mafic rocks and granitoids and with widespread volcanism that continued until 292 Ma (Fig. 3D). This was followed by felsic, crustal-derived leucogranite magmatism that continued for another 7 m.y. in the foreland (Gutiérrez-Alonso et al., 2011b). The delayed onset of magmatism within the foreland is interpreted to reflect initial thickening of the lithospheric mantle in the core of the orocline, forming an orogenic root that subsequently became gravitationally unstable (Fig. 3). Delamination and sinking of the unstable root facilitated upwelling of hot asthenospheric mantle beneath

the foreland core of the orocline, giving rise to mantle-derived mafic magmatism and melting of the lower crust. The subsequent felsic melts are attributed to melting of the fertile (pelite- and greywacke-rich) middle crust upon upward migration of the thermal anomaly above the high-standing asthenosphere.

The study of Sm/Nd isotopes from mantle-derived rocks provides further evidence of mantle lithosphere involvement during orocline development (Gutiérrez-Alonso et al., 2011a; Ducea, 2011). Pre-Variscan mantle-derived volcanic rocks indicate that the mantle lithosphere in NW Iberia was emplaced, or metasomatized, at ca. 1.0 Ga, while post-Variscan mantle-derived magmatic rocks yield neodymium model ages (TDM) of ca. 0.3 Ga. This change in mantle lithosphere age indicates that orocline formation was coeval with removal of an older mantle lithosphere and its subsequent replacement by a new, juvenile mantle lithosphere (Fig. 3D). The syn-orocline mantle-derived melts were contaminated by crustal sources during orocline formation and yield model ages that span the inferred age of the underlying pre-Variscan lithosphere and the new lithospheric mantle. The resultant contamination indicates that melting of the continental mantle lithosphere and lower crust, and the subsequent mixing with upwelling asthenosphere, is likely responsible for generating the new lithospheric mantle (Gutiérrez-Alonso et al., 2011a).

Major topographic changes in Earth's surface usually reflect lithospheric processes (Jiménez-Munt and Platt, 2006); therefore, the major changes in lithosphere thickness and shape associated with oroclinal buckling likely produced important topographic changes that would be recorded in syn-orocline deposits. As stated previously, oroclinal bending resulted in lithospheric thinning in the outer arc and thickening in the inner arc. Due to the more buoyant nature of the thinner outer arc (underlain by hot asthenosphere) compared to the thicker inner arc (underlain by a growing lithospheric root), a regional topographic slope was established from a high in the outer arc to a low in the inner arc (Fig. 3C). This orocline-induced topographic gradient is recorded in the thick, conglomerate-rich continental deposits of Upper Pennsylvanian age preserved throughout the inner arc. Subsequent floundering of the lithospheric root under the inner arc (Fig. 3D), and its replacement by hotter, more buoyant, asthenospheric mantle, resulted in a topographic inversion that is recorded in the unconformable Lower Permian sediments present in this region that postdate the orocline formation (Weil et al., 2010). These topographic changes agree with simple numerical isostatic balance models of the lithosphere thickness variations inferred from geological data (Muñoz-Quijano and Gutiérrez-Alonso, 2007).

The structural, paleomagnetic, geochronologic, and geochemical data summarized in this section indicate that mantle replacement and orocline formation were coeval, suggesting that the two processes were linked. Hence, magmatic, isotopic, and sedimentological data are all consistent with our model of Cantabrian Orocline formation involving the entire lithosphere.

ANALOGUE MODELING

One of the lingering questions regarding lithospheric-scale orocline development is the physical and geometric response to lithospheric buckling. To better understand the lithospheric consequences of forming this scale of bending, we used thermo-

mechanical analogue modeling to gain insight into the feasibility of lithospheric-scale orocline formation. Plasticines with contrasting rheological behavior scaled to the mechanical properties of the crust, mantle lithosphere, and sub-lithospheric mantle were employed to model lithospheric-scale buckling about a vertical axis (Figs. 3E and 3F). The modeling set-up imparted a vertical thermal gradient during experimental runs. After buckling, the models were imaged using 3-D computer tomography (CT). Details of the experiments can be found in Pastor-Galán et al. (2012).

The experimental set-up consisted of a 30 × 12 × 8 cm elongate model plate (crust and lithospheric mantle and its underlying asthenospheric mantle), which was shortened into a buckle fold about a vertical axis. Multiple experimental set-ups were used with variable strain rates and lithospheric thicknesses. All experimental runs were performed under a constant temperature profile designed to maintain a stable viscosity contrast between the different layers. Model results indicate that, regardless of layer thicknesses used, or the strain rate employed during oroclinal buckling, the mantle lithosphere thickened beneath the orocline core and thinned around the outer orocline arc (Fig. 3). Thinning in the outer arc was accommodated by radial tension fractures, whereas thickening in the inner arc was dependent upon initial lithosphere thickness; initially thick lithospheric mantle thickened through formation of a tight, steeply plunging conical fold, while initially thin lithospheric mantle thickened through formation of recumbent conical nappes. Importantly, the lithospheric-scale processes inferred to have taken place during generation of the Cantabrian Orocline are well reproduced in the analogue experiments.

WHAT CAUSED THE CANTABRIAN ARC OROCLINE?

All available structural, geological, geochemical, and geophysical data are consistent with the Cantabrian Orocline developing by buckling of an originally linear orogen (Weil et al., 2000, 2001; Gutiérrez-Alonso et al., 2004, 2008, 2011a, 2011b; Martínez-Catalán, 2011). The question remains, however: What was the geodynamic setting that gave rise to the buckle? Iberia lay close to the center of the Pangea supercontinent during orocline formation. The east margin of the supercontinent was characterized by a westward-tapering Tethyan oceanic embayment that pinched out near Iberia. The Tethys is inferred to have had an E-W trending mid-ocean ridge (Gutiérrez-Alonso et al., 2008), a north-dipping subduction zone along its northern margin that descended beneath the Laurasian portion of Pangea, and a passive southern margin developed along the Gondwanan portion of Pangea.

The unique paleogeography of the Tethyan realm is the basis for one possible explanation for orocline formation. Subduction of the Tethyan mid-ocean ridge to the north resulted in Pangean oceanic lithosphere being subducted beneath the Pangean continental crust of Laurasia, a process referred to as self-subduction (Gutiérrez-Alonso et al., 2008) (Fig. 4). Because of the continuity of the oceanic lithosphere with Pangean continental lithosphere across the northern Gondwanan passive margin, subduction-related slab pull forces are predicted to have transmitted into continental Pangea. The result would have been a profound change in the Pangean strain regime, with shortening and contraction within the inner region of Pangea that surrounded the western end of the Tethys, and extension around the

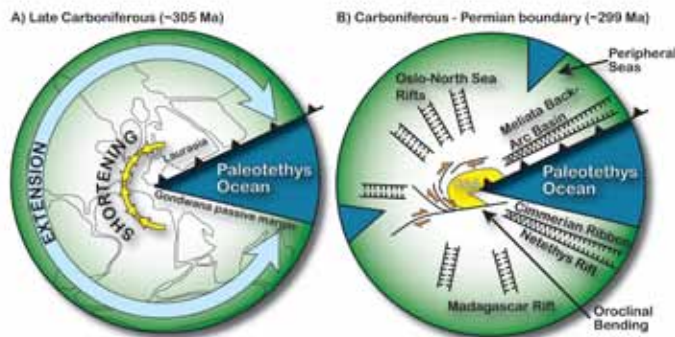


Figure 4. Schematic diagrams showing simplified Pangea reconstructions for (A) the middle Pennsylvanian at 305 Ma, and (B) the Carboniferous-Permian boundary at 299 Ma (Gutiérrez-Alonso et al., 2008). Cartoon depiction of Pangea configuration given in (A) for geographic reference. CAA—Cantabrian-Asturian arc.

supercontinent's periphery (Fig. 4A). We suggest that it is the contraction within the inner tract of the Pangean superplate that gave rise to the Cantabrian Orocline, its concomitant lithospheric delamination, and its related magmatic activity. Late Palaeozoic radial rift basins characterize the periphery of northern Pangea, which supports the idea of widespread extension around the edges of the superplate (Fig. 4B). Slab pull forces subsequently resulted in failure of the continental lithosphere along what was the northern Gondwanan margin, creating a rift basin south of and parallel to the southern Tethys margin. Self-subduction ended with the formation of the Neotethys mid-ocean ridge, which separated continental Pangea from the subducting slab. This final stage is likely recorded in the widespread Permian-Carboniferous unconformity in the continental basins of Europe.

OROCLINES: THICK OR THIN SKINNED?

Curved mountain belts that are demonstrably the result of the buckling of originally linear orogens have commonly been interpreted as thin-skinned features involving only the uppermost crust. Thin-skinned interpretations of oroclines are reconciled with the plate tectonic assumption of plate rigidity by having the orocline form above a crustal detachment that separates the deforming orogen from the underlying plate. However, this model commonly results in important space problems associated with large-scale thrust sheet rotation. It is demonstrated that formation of the Cantabrian Orocline was concomitant with profound magmatism, and deformation best explained as the result of buckling of the entire lithosphere about a vertical axis. Lithospheric buckling can also explain other ancient oroclines, such as the Alaskan oroclines of the North American Cordillera (Johnston, 2001, 2008) and the New England Orocline (Cawood et al., 2011), and provides a model for explaining magmatism and deformation attending currently forming oroclines, like the East Carpathian (Fillerup et al., 2010), the Calabria (Johnston and Mazzoli, 2009), and the Melanesian oroclines (Johnston, 2004).

ACKNOWLEDGMENTS

Comments by two anonymous reviewers and the editor greatly improved the original manuscript. Financial support for this work was supplied by Research Project ODRE II ("Oroclines and Delamination: Relations and Effects") number CGL2009-1367, from the Spanish Ministry of Science and Innovation. J. Fernández-Suárez wishes to acknowledge financial support

from project CONSOLIDER CGL2007-65338-C02-01/BTE by the Spanish Ministry of Science and Technology. S.T. Johnston thanks NSERC for a Discovery Grant. This is a contribution to IGCP 497.

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Manuscript received 28 Oct. 2011; accepted 20 Feb. 2012. ☐

2012 GSA Medal & Award Recipients

Please join us at the GSA 2012 Annual Meeting & Exposition in Charlotte, North Carolina, USA, to honor and greet the GSA medal and award recipients for 2012.

PENROSE MEDAL

Raymond A. Price
Queen's University
(Professor Emeritus)

NEW SCHEDULE!

GSA Presidential Address and President's Medal Presentation: Sunday, 4 Nov., 12:15–1:15 p.m.: GSA President George H. Davis will deliver his Presidential Address; and Past President John W. Geissman will present the 2012 President's Medal to **William Ernest "Bill" McKibben**, author, educator, and environmentalist.

Monday, 5 Nov., 12:15–1:15 p.m.: Join GSA's President George H. Davis and GSA's Vice President Suzanne Mahlburg Kay for the presentation of GSA's medals and awards.

Monday, 5 Nov., 2–3:30 p.m.: Immediately following the awards presentation, please be sure to attend the GSA Gold Medal Lectures for the opportunity to hear the 2012 Penrose, Day, and Donath medalists reflect on their scientific careers.

ARTHUR L. DAY MEDAL

John M. Eiler
California Institute
of Technology

GSA PUBLIC SERVICE AWARD

Roger A. Pielke Jr.
University of Colorado
Center for Science and Technology



SUBARU OUTSTANDING WOMAN IN SCIENCE AWARD

Phoebe A. Cohen
Massachusetts Institute of
Technology

YOUNG SCIENTIST AWARD (DONATH MEDAL)

Katharine W. Huntington
University of Washington

GSA DISTINGUISHED SERVICE AWARD

Elizabeth (Lisa) Norby
National Park Service,
Geologic Resources Division

Bob Stewart
ExxonMobil Exploration
Company

JOHN C. FRYE AWARD **John T. Neubert, Jeffrey P. Kurtz, Dana J. Bove,**

and Matthew A. Sares
"Natural acid rock drainage
associated with hydrothermally
altered terrane in Colorado":
*Colorado Geological Survey
Bulletin* 54 (2011).



PRESIDENT'S MEDAL OF THE GEOLOGICAL SOCIETY OF AMERICA

William Ernest "Bill" McKibben
Author, Educator, and Environmentalist

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

Kenneth D. Ridgway
Purdue University

AGI MEDAL IN MEMORY OF IAN CAMPBELL

Gordon E. Brown Jr.
Stanford University



2012 GSA Division Primary Awards

RIP RAPP ARCHAEOLOGICAL GEOLOGY AWARD

Archaeological Geology Division

John W. Weymouth, University of Nebraska (emeritus)



GILBERT H. CADY AWARD

Coal Geology Division

Leslie F. ("Jingle") Ruppert, U.S. Geological Survey–Reston



E.B. BURWELL, JR., AWARD

Environmental and Engineering Geology Division

Shinya Nakamura (University of the Ryukyus, Okinawa, Japan), **Gibo, S., Egashira, K., and Kimura, S.**, 2010, Platy layer silicate minerals for controlling residual strength in landslide soils of different origins and geology: *Geology*, v. 38, no. 8, p. 743–746, doi: 10.1130/G30908.1



GEORGE P. WOOLLARD AWARD

Geophysics Division

Robert B. Smith, University of Utah



BIGGS AWARD FOR EXCELLENCE IN EARTH SCIENCE TEACHING

Geoscience Education Division

Kathleen D. Surpless, Trinity University in San Antonio



MARY C. RABBITT HISTORY OF GEOLOGY AWARD

History and Philosophy of Geology Division

Gary D. Rosenberg, Indiana University–Purdue University



O.E. MEINZER AWARD

Hydrogeology Division

David L. Parkhurst, U.S. Geological Survey–Denver, for Parkhurst, D.L., Thorstenson, D.C., and Plummer, L.N., 1980, "PHREEQE: A computer program for geochemical calculations": U.S. Geological Survey Water–Resources Investigations Report 80-96, 210 p., <http://pubs.er.usgs.gov/publication/wri8096>.

DISTINGUISHED CAREER AWARD

International Section

Richard H. Sibson, University of Otago, New Zealand



ISRAEL C. RUSSELL AWARD

Limnogeology Division

Tim K. Lowenstein, SUNY at Binghamton



DISTINGUISHED GEOLOGIC CAREER AWARD

Mineralogy, Geochemistry, Petrology, and Volcanology Division

Jason B. Saleeby, California Institute of Technology



G.K. GILBERT AWARD

Planetary Geology Division

Peter H. Schultz, Brown University



KIRK BRYAN AWARD

Quaternary Geology and Geomorphology Division

Neal R. Iverson (Iowa State University), **T.S. Hooyer, J.F. Thomason, M. Graesch, and J.R. Shumway**, 2008, The experimental basis for interpreting particle and magnetic fabrics of sheared till: *Earth Surface Processes and Landforms*, v. 33, p. 627–645.



LAURENCE L. SLOSS AWARD

Sedimentary Geology Division

Gail M. Ashley, Rutgers State University



CAREER CONTRIBUTION AWARD

Structural Geology and Tectonics Division

Richard W. Allmendinger, Cornell University



2012 GSA Fellows

Society Fellowship is an honor bestowed on the best of our profession by election at the spring GSA Council meeting. GSA members are nominated by existing GSA Fellows in recognition of their 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. Learn more at www.geosociety.org/members/fellow.htm.

GSA's newly elected Fellows will be recognized at the 2012 GSA Annual Meeting Awards Ceremony on Monday, 5 Nov., at the Charlotte Convention Center. We invite you to read some of what their nominators had to say:

M. Lee Allison, Arizona Geological Survey, "is an accomplished scientist, a successful administrator of state geological surveys, and a dedicated public servant for the geosciences. Lee is generous, gracious, and humble, and brings great credit to the geoscience profession." —John C. Steinmetz

Irina Artemieva, University of Copenhagen, is nominated in recognition of "innovative geophysical imaging and interpretation of thermal, structural and compositional heterogeneity and evolution of the continental lithosphere." —Kevin P. Furlong

Eliot Anong Atekwana, Oklahoma State University, "As an instructor, Dr. Eliot Atekwana has always had a focus on students. Whether a Ph.D. student writing his third paper or an undergraduate who is just interested in geology, he guide and mentors them to successful outcomes." —Todd Halihan

Richard J. Behl, California State University–Long Beach, "Behl's extraordinary contributions include fundamental advances in knowledge of sediment diagenesis and the sediment record of climate change, superb teaching, path-breaking applied research, and outstanding service to professional organizations and to the public at large—accomplishments that set a high standard for our profession's commitment to society." —Robert E. Garrison

Prosun Bhattacharya, Royal Institute of Technology, Sweden, "has made seminal and sustained contributions on the problem of arsenic mobility and toxicity in aquifers. His work not only addresses the source, mechanism, and distribution of arsenic in sediments and groundwaters, but also remediation and management of arsenic-contaminated groundwaters in underdeveloped countries." —Alan E. Fryar

Robert H. Blodgett, Austin Community College, is recognized "for his contributions as a passionate geoscience educator, a noted textbook author, a persuasive advocate for faculty and students at two-year colleges (2YC), and a strong leader for the Geo2YC Division of the National Association of Geoscience Teachers." —Heather Macdonald

Peter T. Bobrowsky, Geological Survey of Canada; elected to Fellowship as the 2011 E.B. Burwell Award recipient.

Dwight C. Bradley, U.S. Geological Survey–Anchorage, is "a creative, agile, and energetic researcher [who] has made fundamental contributions to the field of tectonics at global and regional scales. His work has broadened our understanding of plate movement through time, the configuration of continents, orogenic processes, and tectonic influences on the generation of ore deposits." —Alison B. Till

Susan L. Brantley, Penn State University; elected to Fellowship as the 2011 Arthur L. Day Medal recipient.

Patrick A. Burkhardt, Slippery Rock University, is nominated for "his significant impact in training and support of students and professional geologists and for his strong and enthusiastic service to GSA and other professional organizations including the Pittsburgh Geological Society and the NASA Lunar and Planetary Science Academy." —Daniel K. Holm

Marc W. Caffee, Purdue University, "has distinguished himself through publications on the theory and application of cosmogenic nuclides for a vast range of geological applications, including meteorite studies, Quaternary paleoclimate research, geomorphic and landscape evolution studies and tectonics." —Lewis A. Owen

Steven M. Cather, New Mexico Bureau Geology, is nominated "in recognition of his outstanding publication record in stratigraphic, structural, and tectonic research during a 25-year career at the New Mexico Bureau of Geology and Mineral Resources." —Charles E. Chapin

Moonsup Cho, Seoul National University, "has traced the Triassic convergent HP/UHP suture zone across Korea westward into east-central China, and eastward into western Honshu. His phase equilibrium studies of Ca-amphibole solid solutions have provided main *P-T* control on the blueschist-greenschist transition. Cho's Salton Sea geothermal research is still quoted in terms of mineral parageneses." —W. Gary Ernst

Philippe Claeys, Vrije Universiteit Brussel, "is a world leader in the study of planetary science through his research, administrative, and teaching skills. His publications include pioneering work on the consequences of asteroid and comet impacts and varied but related topics such as mass extinctions, chemical and event stratigraphy, astrobiology, and geohazards." —John E. Warme

Frank A. Corsetti, University of Southern California, is nominated in recognition of his "exceptional geological research in sedimentology, paleobiology and geochemistry, with a focus on developing novel geobiological approaches; outstanding record

2012 GSA Fellows

of training young earth scientists, particularly as co-director of the International Geobiology Summer Course; [and] laudable commitment to serving professional organizations, including as chair of the GSA Geobiology-Geomicrobiology Division.”

—David J. Bottjer

Randel Tom Cox, University of Memphis, “has 24 significant articles pertaining to active faults and tectonic geomorphology in the New Madrid seismic zone, the greater Mississippian embayment, South Carolina, the Bay of Honduras, and Spain. His 16 other articles include five on cicadas and several on hotspots and regional tectonics.” —Mervin J. Bartholomew

Jean M. Crespi, University of Connecticut, “is an unselfish contributor to GSA, including three years on the NE section Management Board, and Chair of the NE section meeting for 2012. Her research in structural geology of ancient and modern orogens, both in the Taconic slate belt and Taiwan, is innovative and enlightening.” —Laurie L. Brown

Dennis E. Dahms, University of Northern Iowa, “is an authority on the glacial geologic history of the Wind River Range of Wyoming, demonstrated with his 2004 review paper in *Quaternary Glaciations - Extent and Chronology, Part II: North America*, and a 46-page treatise published as GSA Digital Maps and Charts Series no. 7 in 2010.” —P. Thompson Davis

Shanaka L. de Silva, Oregon State University, is nominated for “his extensive contributions to the scientific literature in volcanology, petrology, and geochemistry, for being a highly effective mentor to numerous graduate and undergraduate research students, and for his deep involvement with education/outreach and improving diversity in the geosciences.” —Diane R. Smith

David P. Dethier, Williams College, “excels at producing exceptional undergraduate students who go on to graduate school, collaborate on innovative senior thesis research, and co-author solid papers. His research in the geomorphology of weathering and soils is varied, quantitative, and high quality. He also excels at applied research, mainly involving mass movements.” —Peter W. Birkeland

Tamara L. Dickinson, Office of Science & Technology (OSTP) and USGS, “is nominated for her exceptional contributions to administration of geologic programs and to science policy. Having held positions at NASA, NSF, NAS-NRC, USGS, and OSTP, her work has advanced the geosciences, organizations and informed Congress and the President.” —Barbara L. Dutrow

Robert Dunn, University of Hawaii–Mānoa, “has made numerous contributions to the understanding of the seismic structure of oceanic spreading centers, back-arc basins and hotspots. His ground-breaking results document the distribution of melt beneath spreading centers placing fundamental constraints on the accretion of oceanic lithosphere across a range of tectonic settings.” —Jeffrey A. Karson

Annette S. Engel, University of Tennessee, “has made important scientific contributions to the field of biogeochemistry of the subsurface environment, particularly in karst terrain. Her work has led to new insights into biological processing of chemical compounds in aphotic and hydrothermal settings and more recently along the Gulf Coast.” —Carol M. Wicks

Ismael Ferrusquia-Villafranca, Universidad Nacional Autónoma de México, is a “senior researcher at the Instituto de Geología at UNAM; a UNAM lecturer in stratigraphy; initiated UNAM Vertebrate Paleontology studies—a lifetime undertaking; authored >190 scientific papers; supervised >30 thesis/dissertations; peer-reviewed >60 scientific papers; former chair, North American Commission on Stratigraphic Nomenclature; member, eight professional organizations and founder of two.” —Robert A. Levich

John M. Ferry, Johns Hopkins University; elected to Fellowship as the 2011 MGPV Division Distinguished Geologic Career Award recipient.

Malcolm S. Field, U.S. Environmental Protection Agency, “is EPA’s expert on water tracing and contaminant transport in karst, with an international reputation. He is author of several computer software packages and about 60 publications on karst hydrogeology, and is editor-in-chief of the *Journal of Cave and Karst Studies*, the world’s leading journal in that field.” —Arthur N. Palmer

Ronald V. Fodor, North Carolina State University, is nominated for Fellowship for outstanding publication of geologic research and training geologists. Ron has published papers on chondritic meteorites; oceanic volcanics; mafic and ultramafic xenoliths; silicic intrusive rocks; and volcanic rocks in Arizona, Brazil, Hawaii, Hungary, and Slovakia. He is an enthusiastic and dedicated teacher.” —M. James Aldrich

Lisa R. Gaddis, U.S. Geological Survey–Flagstaff, “is one of the foremost researchers in lunar pyroclastic volcanism. She has also made significant contributions to planetary research on Mars, Venus and the Earth. She is adept at utilizing complementary datasets to resolve key questions, has served her community in numerous leadership roles, and has made important contributions to public education.” —Louise M. Prockter

Stephen Gao, Missouri University of Science & Technology, “is an internationally recognized geophysicist whose research has focused on geological questions at both the regional and local scale. He is also an excellent teacher and mentor. His research focuses on lithospheric structure, understanding the structure and evolution of rift zones, and studies of earthquake phenomena.” —G. Randy Keller

Ronald T. Green, Southwest Research Institute, is nominated for “his applied research contributions in the conceptualization and development of instruments and numerical codes that have allowed hydrogeologists to more completely assess and better understand controlling influences of flow and transport in karst aquifers.” —John Van Brahana

Tracy K.P. Gregg, University at Buffalo, is nominated for “significant contributions to the study of volcanism throughout the solar system, mentoring numerous successful geosciences students, and support of the Planetary Geology Division of GSA.” —James Ray Zimbelman

Howard E. Harper Jr., Society for Sedimentary Geology, is nominated for “his professional society leadership as Executive Director of the Society for Sedimentary Geology (SEPM). SEPM is one of GSA’s key Associated Societies. SEPM and GSA have cooperated on GeoScienceWorld, the technical program at GSA Annual Meetings with Sedimentary Geology Division, and proposals to NSF.” —John W. Hess

Barry J. Hibbs, California State University–Los Angeles, is nominated for “his studies on the hydrogeology of arid basins and the effects of urbanization on water quality, his applied research on water and environmental issues, the training of geologists, and his service to the GSA.” —John M. Sharp

Lynn Highland, U.S. Geological Survey–Denver; elected to Fellowship as the 2011 E.B. Burwell Award recipient.

John M. Holbrook, Texas Christian University; elected to Fellowship for service to GSA Council.

Carl E. Jacobson, Iowa State University, “has deciphered the complex history of the Pelona–Orocopia–Rand Schists, based on meticulous study of structure, petrology, geochemistry, geochronology and provenance. He and coworkers have provided compelling constraints on the history of magmatism, erosion, sedimentation, subduction, deformation and uplift of the Mesozoic/Cenozoic continental margin of California.” —Raymond V. Ingersoll

Angela S. Jayko, U.S. Geological Survey–Bishop, “is an extremely versatile field geologist who has used her mapping skills to solve many important geologic problems ranging from uplift mechanisms for deeply-subducted blueschists to the nature and timing of Quaternary faulting in Death Valley.” —Milton C. Blake Jr.

Alan Jay Kaufman, University of Maryland–College Park, “unravels ancient climates through the application of stable isotopes and biomarkers to sedimentary sequences, including helping to develop and test the ‘Snowball Earth’ hypothesis. He has mentored a large number of diverse students, including high school, undergraduate, and graduate students, several of whom have won GSA awards.” —Roberta L. Rudnick

Jonas Kley, Universität Jena, is recognized for “his seminal contributions to understanding the 3D structure and restoration of the Central Andes and other mountain belts. His work demonstrates exemplary international collaboration and dedication to teaching generations of German and South American students.” —Richard W. Allmendinger

Christian Koeberl, University of Vienna, “is a leading authority on terrestrial impact structures and the use of geochemical tracers

for impacts. He has been a leader in examining impact structure, including playing a major role in drilling campaigns to the Chesapeake Bay, Bosumtwi, and Chicxulub structures.” —Kenneth G. Miller

Fred A. Kruse, Horizon GeoImaging LLC: “Kruse and associates developed the ENVI software for extracting geologic, and other, information from the huge volumes of remote sensing imagery. He has published papers and conducted worldwide user training courses. ENVI is installed at 10,000+ sites worldwide and is largely responsible for the geologic applications of remote sensing.” —Floyd F. Sabins

Daniel Larsen, University of Memphis; elected to Fellowship for service to GSA Council.

George O. Linkletter, ENVIRON International Corp., “is a professional geologist with expertise in environmental geology. Senior Vice President and Principal at Environ Corporation, he provides technical advice and litigation support to major corporations, banks, federal and state agencies, and individuals. Currently, he serves as vice-chair on the Board of Trustees of the GSA Foundation.” —P. Geoff Feiss

Ning Lu, Colorado School of Mines, is nominated for Fellow status “on the basis of his substantial ground-breaking research and publication record in the field of vadose zone hydrology, its relation to unsaturated soil mechanics, and the resulting impacts on the understanding, analyzing, and forecasting of shallow landslides.” —Paul M. Santi

Gregory A. Ludvigson, University of Kansas, “has made significant research contributions in paleoclimatology and administration of geologic mapping programs at the Kansas Geological Survey and the Iowa Geological Survey. He advises graduate students at the University of Kansas, lectures widely, and has chaired and convened sessions at national and sectional meetings of GSA.” —Rex C. Buchanan

W. Andrew Marcus, Montana State University, “has focused on the dynamics of fluvial sediment contaminated by mining; human effects on rivers; interactions among wood and rivers; and the use of remote sensing technology to understand rivers. His contributions have been original, insightful, and well-cited, and have influenced the questions that other scientists ask.” —Ellen E. Wohl

Kevin L. Mickus, Missouri State University, is nominated for “outstanding research involving the acquisition of gravity, magnetic and electromagnetic data and using these results for understanding crustal and upper mantle structure as well as for environmental and archaeological applications.” —Robert J. Stern

Brendan Murphy, Saint Francis Xavier University, Canada; elected to Fellowship as the 2011 GSA Distinguished Service Award recipient.

John E. Mylroie, Mississippi State University, is nominated for “his development of the Carbonate Island Karst Model, extensive educational contributions, and support of professional organizations.” —Ira D. Sasowsky

2012 GSA Fellows

Alan R. Nelson, U.S. Geological Survey—Denver: “For over three decades, Alan R. Nelson has been making contributions to earthquake and tsunami geology in the Western USA and in other areas such as Chile and Alaska. He has been a leader in developing rigorous approaches to deciphering changes in relative sea levels associated with these phenomena.” —John T. Andrews

Edmund Nickless, Geological Society of London, “has advanced the geosciences in many ways including as a researcher, an Assistant Director of the British Geological Survey and as Executive Secretary of The Geological Society of London. He has been instrumental in developing successful intersociety collaborations with societies in the U.S. and across the world.” —Patrick P. Leahy

John C. Pitlick, University of Colorado, is nominated for “significant contributions to understanding sediment transport in gravel-bed river systems and its applications to river restoration.” —Jon J. Major

Anthony (Tony) R. Prave, University of St. Andrews, is nominated for “his leading role in elucidating the Cryogenian-Ediacaran stratigraphic record in western North America, northern Namibia and the British Isles; his pivotal contributions to the multinational FAR-DEEP scientific drilling project, targeting the Paleoproterozoic Great Oxidation; and for mentoring outstanding young scientists who have made important contributions to geology.” —Paul F. Hoffman

Paul R. Renne, Berkeley Geochronology Center, “and his colleagues focus on dating the major events that have shaped the Earth (and the Earth’s Moon). He has worked on intercalibration of astronomical and radioisotopic time and the timing of major flood basalt events, catastrophic events, impacts, and important events in primate evolution.” —Grant H. Heiken

Harry H. Roberts, Coastal Studies Institute—LSU, “is a distinguished geologist. His pioneering research in the Gulf of Mexico and elsewhere has covered topics as diverse as hydrocarbon seepage, mass-movement processes in deltaic sedimentation, and wave/current interaction with fringing and barrier reefs. This research is beautifully documented in his exceptionally large body of publications.” —Barun K. Sen Gupta

Scott K. Rowland, University of Hawaii at Mānoa, is nominated for his “unique blend of enthusiasm, scholarship and communication skills in teaching and mentoring university students at all levels, for his community outreach, and for significant contributions in advancing research and education in volcanology, natural hazards and planetary geosciences (40 published papers) during the last 25 years.” —Michael O. Garcia

Kenneth H. Rubin, University of Hawaii at Mānoa: “There is ample evidence in Ken’s publication record for the development of significant new ideas in multiple geological disciplines and the generation and interpretation of new data sets. Rubin is primarily a geochemist, although his research program is cross- and

multidisciplinary. Rubin’s body of work demonstrates consistent innovation, thoughtfulness, high quality of design and execution, attention to detail and high overall impact. The work is well cited (with over a thousand career citations, over half of which have come since 2006).” —Charles H. Fletcher

Nathan D. Sheldon, University of Michigan, “is nominated for innovative and ingenious contributions using the isotopic and elemental geochemical compositions of paleosols that have enabled novel reconstructions of ancient atmospheric CO₂ levels, past climate histories, and paleoenvironmental settings to as early as 1.1 Ga and for notable dedication to the education of young earth scientists.” —Philip A. Meyers

Claus Siebe, Universidad Nacional Autónoma de México, is nominated “because of his many published contributions to volcanology, for implementing improved techniques in applied volcanology, for providing essential expertise to government agencies during volcanic crises, and for public outreach to explain volcanic hazards to a concerned populace.” —Fraser E. Goff

John M. Sinton, University of Hawaii at Mānoa, “has dedicated his professional career to the understanding of volcanic processes in mid-ocean ridges, back-arc basins, and hot-spot islands. In 86 peer-reviewed publications, he successfully integrated detailed field observations on land and in the ocean basins with geochemical/petrologic analysis of samples to document his fundamental discoveries.” —Gregory Frank Moore

Schaun M. Smith, Chevron: “Over the past 30+ years, Dr. Smith has consistently contributed to the body of innovative geoscientific knowledge, both applied and interdisciplinary, in the areas of environmental geology, and hydrogeological and paleohydrogeological research.” —Kenneth E. Kolm

Steven W. Squyres, Cornell University, elected to Fellowship as the 2011 G. K. Gilbert Award recipient.

Bob Stewart, ExxonMobil Exploration Company, “is the true embodiment of ExxonMobil Exploration Company’s efforts to teach the best geoscience to the best geoscientists. His passion for recruiting the best and the brightest goes beyond his professional job, as reflected by his deep concern for the geoscience workforce and its diversity.” —John W. Geissman

Robert Hadley Sydnor, consulting engineering geologist, is nominated for “his contribution to public safety as a regulatory reviewer for the California Geological Survey, responsible for ensuring incorporation of geologic information into more than 4,000 reports for construction of hospitals and schools, as well as environmental impact under the California Environmental Quality Act.” —Robert A. Larson

Scott W. Tinker, The University of Texas at Austin, “has made distinguished contributions to the geosciences as Director of the Bureau of Economic Geology, a major geologic research organization and state geologic survey. His extensive geologic outreach to the general public and government agencies, as well as leadership of professional societies, including AAPG, support his nomination.” —Shirley P. Dutton

Robert J. Tracy, Virginia Polytechnic Institution & State University; elected to Fellowship for service to GSA Council.

Robert D. Tucker, U.S. Geological Survey–Reston, is nominated for “his indelible mark on field geology and tectonics of metamorphic and igneous rocks in the northern Appalachian, Norway, and Madagascar orogenic belts, combined with high-precision TIMS U-Pb geochronology there and worldwide, including training of geochronologists and critical contributions to the Paleozoic time scale.” —Peter Robinson

Jasper A. Vrugt, University of California, Irvine; elected to Fellowship as the 2011 Donath Medal (Young Scientist Award) recipient.

John Wakabayashi, California State University, is recognized as a GSA Fellow “because of his impressive publication record on the structural petrology and tectonics of the California Coast Ranges, Franciscan Complex, and Sierra Nevada, his wide-reaching applied research on seismic hazard analysis, and his significant and long editorial service to the GSA.” —Yildirim Dilek

Robert C. Walter, Franklin and Marshall College; elected to Fellowship as the 2011 Kirk Bryan Award recipient.

Chenshan Wang, China University of Geosciences, is nominated for Fellowship “on the basis of his extensive published contributions to a variety of aspects of the geology of eastern Asia, and concepts transportable to other parts of the world; for his extensive mentoring of earth sciences students; for his work as a high-level university administrator; and for his contributions to the economic geology of China.” —Stephan A. Graham

Ray E. Wells, U.S. Geological Survey–Menlo Park, is nominated “in recognition of his seminal contributions to the study of forearc deformation and earthquake hazards of subduction zones. Ray puts geologic mapping in a geophysical context, yielding viable and quantitative tectonic models for the Cascadia forearc and for subduction zones around the Pacific.” —Richard J. Blakely

Scott L. Wing, Smithsonian Institution, “is a field paleobotanist who has contributed substantially to our understanding of Cretaceous and Paleogene vegetation and climate. In particular, his discovery of plant megafossils in the Bighorn Basin from the Paleocene-Eocene thermal maximum underscores his vast field knowledge, dogged determination, and attention to detail.” —Dana Royer

Fu-Yuan Wu, Institute of Geology and Geophysics, “is one of the top geochemists in China and has led the world in studying the continental growth processes in Asia. His major scientific achievements are (1) the petrogenesis of granitoids and mantle xenoliths from China and elsewhere, and (2) the development of in-situ isotopic analysis using LA-ICP-MS.” —Sun-Lin Chung

Don G. Wyckoff, University of Oklahoma (emeritus); elected to Fellowship as the 2011 Rip Rapp Archaeological Award recipient.

Ming Ye, Florida State University, “has contributed to the numerical simulation of groundwater flow and solute transport in saturated and unsaturated porous and fractured media and to uncertainty analysis and risk assessment using stochastic methods, GIS, and high performance computing.” —Mary C. Hill

Hund-Der Yeh, National Chiao Tung University–Taiwan, is nominated “based on his exceptional contribution in mathematical modeling of subsurface flow and transport and aquifer heat extraction and thermal energy transfer system, and his distinguished mentorship and educational service in subsurface hydrology.” —Hongbin Zhan

Mei-Fu Zhou, The University Hong Kong, “is one of the most productive and prolific scientists in China. He is particularly known for his groundbreaking research on large igneous provinces, oxide and sulfide ore deposits, ophiolites and podiform chromitites, and the Proterozoic tectonic evolution of Southeast Asia. He is an internationally recognized research scientist of the highest caliber.” —Paul T. Robinson

Thanks for your membership!

GSA Celebrates New 50-Year Members for 2012

GSA salutes the following members and Fellows on their 50-year membership anniversaries—their dedication and loyalty to GSA is much appreciated.

For a list of members who have *surpassed* the 50-year mark, see <http://rock.geosociety.org/membership/50YearMembers.asp>. Go to <http://rock.geosociety.org/membership/50Yearfellows.asp> for a list of GSA Fellows.

GSA Fellows: Asterisks in this list indicate members who have not yet been honored by election to GSA Fellowship. You can help maintain a dynamic, vibrant cohort by nominating these and other deserving geoscience colleagues; guidelines and nomination forms are online at www.geosociety.org/members/fellow.htm. If you have questions, please e-mail awards@geosociety.org.



Arden L. Albee	Rodney M. Feldmann	Charles W. Martin	Heinrich A. Toots*
Vincent P. Amy	Donald L. Fife*	Jereld E. McQueen*	Samuel J. Tuthill
Richard K. Bambach*	Helen B. Fink*	Robert C. Milici	Ken C. Wehrman*
Richard W. Berry	Kenneth F. Fox	Richard M. Mitterer	John T. Whetten
Somdev Bhattacharji	Sherwood M. Gagliano	David W. Moody	James H. Williams*
Bruce A. Blackerby	Charles H. Gardner	Duane M. Moore	Richard S. Williams
Jim McCaslin Brown	George D. Garlick*	Frederick N. Murray*	John E. Wolfe*
Robert E. Carver	John F. Gartner	Emilio Mutis-Duplat	Manfred P. Wolff*
Paul A. Catacosinos	Edward D. Ghent	Anthony J. Naldrett	Doy Lawrence Zachry
Kenneth W. Ciriacks	Jackson E. Goffman*	Stephen A. Norton	
Charles E. Davis*	Charles J. Gossett*	David G. Nussmann*	
James F. Davis	William F. Guyton	A. Thomas Ovenshine	
Dwight E. Deal*	Douglas H. Hamilton*	Emile A. Pessagno	
Phili Deboo*	Eugene R. Hampton	Henry N. Pollack	
William J. Dickerson Jr.*	Robert D. Hatcher Jr.	Richard H. Ragle	
Marlin L. Dickey*	Charles E. Helsley	William C. Schetter*	
Gordon L. Dolton*	Leo J. Hickey	Robert F. Schmalz	
David E. Dunn	Rudolph K. Hoagberg	David W. Scholl	
Ballard E. Ebbett*	Arthur Mekeel Hussey II	R.F. Jon Scoates*	
R. John Edmonds*	Alan V. Jopling	Kevin M. Scott	
Wilfred A. Elders	Frank R. Karner	Charles H. Shultz	
William C. Elsik*	Richard R. Kennedy*	Harry L. Siebert	
John W. Emerson	James G. Kirchner	Brian J. Skinner	
Richard L. C. Enright*	Darwin Knochenmus*	Robert B. Smith	
James W. Erwin	James B. Koenig	Alfred C. Spreng	
Rodger T. Faill	Chester Lao	David B. Stewart	
James E. Fassett	Wesley E. LeMasurier	Donald A. Swanson	
Gunter Faure	Arthur P. Loring	Harry E. Thomas*	





2012 GSA Research Grant Recipients

The 2012 GSA Committee on Research Grants awarded US\$554,164 to 303 graduate students (out of 636 applicants), with an average grant of US\$1,829. The committee also selected 10 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: Allen Gontz (chair), Diana Anderson, Julia Baldwin, Luis Buatois, Shanaka de Silva, Elizabeth Diesel, Amy Draut, Robert Gastaldo, David Gillikin, Madeline

Gotkowitz, V.J.S. Grauch, Stephen Harlan, JoAnn Holloway, Antun Husinec, Stephen T. Johnston, Oliver Korup, Francisca Oboh-Ikuenobe, Frederick Partey, Michael Pope, Dawn Sumner, Sarah Titus, Barry Warner, Julia Wellner, and Paul Wetmore.

The following awards will be presented Monday, 5 Nov., at the 2012 GSA Annual Meeting in Charlotte, North Carolina, USA.



2012 OUTSTANDING MENTIONS

(proposals of exceptional merit in conception and presentation)

Benjamin W. Blonder, University of Arizona

Amy L. Brown, University of Florida

Seth Brazell, University of North Carolina–Charlotte

Brad Buerer, San José State University

Brian M. Culp, Pennsylvania State University

Shelly Donohue, Vanderbilt University

Ryan P. Gordon, Syracuse University

David A. Grunat, Rutgers University

Noelle C. Guernsey, Idaho State University

Zackry S. Guido, University of Arizona

Amanda L. Howard, University of Colorado–Boulder

Mauricio Ibanez-Mejia, University of Arizona

Mitra B. Khadka, University of Florida

Bronwen Konecky, Brown University

Lin Li, University of Rochester

Lindsay A. MacKenzie, University of Montana

Megan Rohrsen, University of California at Riverside

Stephen Sellwood, University of Wisconsin–Madison

Justin C. Stout, Utah State University

Alph S. Wright, Texas A&M University



2012 SPECIALIZED AWARDS

Sponsored by the GSA Foundation

Gretchen L. Blechschmidt Award

Verena Schoepf, *The Ohio State University*

The Gretchen Louise Blechschmidt Award was established for women in the geological sciences who have an interest in achieving a Ph.D. in the fields of biostratigraphy and/or paleoceanography, sequence stratigraphy analysis, particularly in conjunction with research in deep-sea sedimentology, and a career in academic research.

John T. Dillon Alaska Research Award

Sara Federschmidt, *University of Kentucky*

This award honors Dillon's work on radiometric age-dating in the Brooks Range, Alaska, USA. Selection of the awardee is guided by method of study, including field-based studies dealing with the structural and tectonic development of Alaska and/or studies 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

John Templeton, *Columbia University*

This award honors the memory of Robert Fahnestock, a former member of the Research Grants Committee. The grant is awarded for the best proposal in sediment transport or related aspects of fluvial geomorphology, Fahnestock's field.

Lipman Research Award

Jenni Hill, *Texas Christian University*

The Lipman Research Award was established in 1993 and is supported by gifts from the Howard and Jean Lipman Foundation; the current president of the Foundation, Peter W. Lipman, was the recipient of a GSA research grant in 1965. This award promotes and supports student research grants in volcanology and petrology.



2012 SPECIALIZED AWARDS

Sponsored by the GSA Foundation (*continued*)

Bruce L. “Biff” Reed Scholarship Award

James Worthington, *University of Arizona*

This award was established to provide research grants to graduate students pursuing studies in the tectonic and magmatic evolution of Alaska, primarily, and can also fund other geologic research.

Alexander Sisson Research Award

Dolores A. van der Kolk, *The University of Texas at Austin*

Family members of Alexander Sisson established an award in his memory to promote and support research by students pursuing studies in Alaska and the Caribbean.

Harold T. Stearns Fellowship Award

Richard K. Bono, *University of Rochester*

David O. Oakley, *Pennsylvania State University*

Harold Stearns established this award in 1973 to support student research on the geology of the Pacific Islands and the circum-Pacific region.

John Montagne Award

Nicholas Sutfin, *Colorado State University*

This award was established in 2000 to support student research on Quaternary geomorphology.

Alexander & Geraldine Wanek Award

Stephen C. Phillips, *University of New Hampshire*

The Wanek Award was established in 2002 to support research dealing with coal and petroleum resources, mapping, and engineering geology; marine resources, petroleum economics, appraisal, and evaluation; and the geology of phosphate resources.

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

Kathleen A. Ritterbush, *University of Southern California*

The Ross Research Award was established in 2002 to support research in 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 of (1) past plate motions (plate tectonics and sea-floor spreading); (2) past sea-level events, including their identification and ages; and/or (3) changes in climate and the effects of those climate changes on Earth’s inhabitants through geologic time.

Parke D. Snively, Jr., Cascadia Research Award

Joshua E. Shinpaugh, *North Carolina State University*

This award supports field-oriented graduate student research that contributes to the understanding of the geologic processes and history of the Pacific Northwest convergent margin and/or to the evaluation of its hazard or resource potential.

Diversity Award

Aileen Chea, *San Francisco State University*

The Diversity Award was established to promote and support minority students in the geosciences.



DIVERSITY IN THE GEOSCIENCES MINORITY RESEARCH GRANT AWARDS

Two minority graduate student research grant submissions were deemed of exceptionally high merit in conception and presentation by GSA’s Diversity in the Geosciences Committee. Each recipient will be awarded US\$500.

Magdalena S. Donahue, *University of New Mexico*: “Multi-stage uplift in the Rocky Mountains: exploring uplift mechanisms and timing using low-temperature thermochronology, detrital zircon geochronology and geomorphic analysis.”

Timothy A. Shin, *The University of Texas at Austin*: “Exhumation of high pressure rocks in the Aegean backarc: Tug-of-War of Greek Titans.”



FAROUK EL-BAZ STUDENT RESEARCH GRANTS

These grants were established to encourage and support desert studies by students worldwide, either in their senior year of undergraduate studies or at the master’s or Ph.D. level. Each student will receive a cash award of US\$2,500.

Ethan G. Hyland, *University of Michigan*: “Assessing spatial variability and calibrating paleosol moisture proxies in dry environments.”

Omer Yetemen, *University of Washington*: “Modeling the role of solar radiation on catchment development in semi-arid ecosystems.”



THE MAURICE “RIC” TERMAN FUND AWARD

This fund provides one-year grants to support the Ph.D. theses and post-doctoral research of East Asian scientists in Cambodia, China, Indonesia, Japan, Korea, Malaysia, Papua New Guinea, Thailand, and Vietnam. The 2012 recipient will be announced later this year.



2012 GSA Research Grant Recipients

(listed in alphabetical order by university)

Sarah Sheffield, Auburn University
James Taylor, Auburn University

Emily Beverly, Baylor University
Amos Culbertson, Baylor University

Meghan Dovick, Binghamton University

Daniel Dabrowski, Boston College

Mathew Knauss, Bowling Green State University

Amanda Getsinger, Brown University
Bronwen Konecky, Brown University
Shannon Loomis, Brown University
Jessica Rodysill, Brown University
Satrio Wicaksono, Brown University

Jonathan Goodell, California State University–Bakersfield

Yi Fang, California State University–Long Beach
Denise Marie Weide, California State University–Long Beach

Heather Clifford, California State University–Los Angeles

Joshua Graham, California State University–Northridge

Andrew Macumber, Carleton University

Ian Delaney, Central Washington University
Molly Partridge, Central Washington University
James Patterson, Central Washington University

Patrick Geesaman, Colorado School of Mines

Ian Hogan, Colorado State University
Nicholas Sutfin, Colorado State University
Richard Zaggie, Colorado State University

John Templeton, Columbia University

Stephen Durham, Cornell University

Hehe Jiang, Dartmouth College
Samuel Michalak, Dartmouth College

Ryan Poythress, East Carolina University
Mitchell Ward, East Carolina University

Jill Ghelerter, Georgia State University

Bridget Alex, Harvard University
Bastien Varoutsikos, Harvard University

Emily Charaska, Idaho State University
Noelle Guernsey, Idaho State University
David Huber, Idaho State University
Benjamin Rendall, Idaho State University

Richard Bykowski, Indiana University
Mark Leatherman, Indiana University
Ryan Wilson, Indiana University

Bethany Welke, Indiana University–Purdue
University–Indianapolis

Alexander Morrison, Iowa State University
Joshua O'Brien, Iowa State University
Ning Zhang, Iowa State University

Kate Amrhein, Kansas State University
William Busch, Kansas State University

Lorita Mihindikulasooriya, Kent State University

Sheri O'Connor, Lakehead University

Johanna Blake, Lehigh University
Daniel Minguez, Lehigh University

Jamey Cooper, Loma Linda University
Jimmy Wilhelm, Loma Linda University

Kathryn Denommee, Louisiana State University
Dian He, Louisiana State University

Gregor Lucic, McGill University

Dario Harazim, Memorial University

Camilla Crifo, Miami University
Rajesh Singh, Miami University
Cynthia Tselepis Loertscher, Miami University

Nicole Ladue, Michigan State University

Gerson Laura, Missouri State University

Jonathan Obrist, Missouri University of Science & Technology

Lauren Kay, Montana State University
Terra Spotts, Montana State University
Daigo Yamamura, Montana State University

Cora Gannaway, New Mexico State University
Sean Gaynor, New Mexico State University

2012 GSA Research Grant Recipients

Sarah Hendrickson, New Mexico Tech
Ahmadreza Malekpour Alamdarie, New Mexico Tech
Andrea McHugh, New Mexico Tech
Robert Salaz, New Mexico Tech
Matthew Sophy, New Mexico Tech

Joshua Shinpaugh, North Carolina State University

Kathryn Altman, Northern Arizona University
Brandon Boldt, Northern Arizona University
Matthew Cochran, Northern Arizona University
Jonathan Griffith, Northern Arizona University
Patrick Maloney, Northern Arizona University
David Sherwood, Northern Arizona University
Daniel Solway, Northern Arizona University

Kasey Todd, Northern Illinois University

Hannah-Maria Brame, Ohio University

Robert Reynolds, Oklahoma State University

Dale Burns, Oregon State University
Jason Kaiser, Oregon State University

Ellen Chamberlin, Pennsylvania State University
Max Christie, Pennsylvania State University
Alicia Cruz-Uribe, Pennsylvania State University
Brian Culp, Pennsylvania State University
Michael Donovan, Pennsylvania State University
Matthew Gonzales, Pennsylvania State University
Lauren Milideo, Pennsylvania State University
Christen Miller, Pennsylvania State University
Claire Mondro, Pennsylvania State University
David Oakley, Pennsylvania State University
Matthew Travis, Pennsylvania State University

Emily Jenkins, Portland State University
Courtney Savoie, Portland State University
Elizabeth Westby, Portland State University

Kyle Samperton, Princeton University

Clement Bataille, Purdue University

Chiara Borrelli, Rensselaer Polytechnic Institute
Veronika Homolova, Rensselaer Polytechnic Institute

Emily Chin, Rice University

Catherine Beck, Rutgers University
David Grunat, Rutgers University
Anna Hermes, Rutgers University

Aileen Chea, San Francisco State University

Brad Buerer, San José State University
Susan Gervais, San José State University

Martin Zaleski, Simon Fraser University

Eric Gottlieb, Stanford University
Adam Jost, Stanford University

Mariana Bonich, Syracuse University
Ryan Gordon, Syracuse University
Sarah Ledford, Syracuse University
Margaret Zimmer, Syracuse University

Jennifer Hendricks, Texas A&M University
Alph Wright, Texas A&M University

Jenni Hill, Texas Christian University
Peyton Lisenby, Texas Christian University

Jeremy Deans, Texas Tech University

Kelly Best, The Ohio State University
Stephen Levas, The Ohio State University
Verena Schoepf, The Ohio State University

Meredith Bush, The University of Texas at Austin
Amanda Calle, The University of Texas at Austin
Kyung Won Chang, The University of Texas at Austin
Adam Goldsmith, The University of Texas at Austin
Mariya Levina, The University of Texas at Austin
Nicholas Perez, The University of Texas at Austin
Michael Prior, The University of Texas at Austin
Caleb Rhatigan, The University of Texas at Austin
Spencer Seman, The University of Texas at Austin
Jeffrey Senison, The University of Texas at Austin
Dolores van der Kolk, The University of Texas at Austin
Natalia Vitek, The University of Texas at Austin
John Warden, The University of Texas at Austin

Fotios-Christos Kafantaris, The University of Texas at El Paso

Fernando Nuñez, Universidad Nacional Autónoma De México

Olivia Gibb, Université du Québec Montréal

Peter Johnson, University at Buffalo

Timothy Astrop, University of Akron
Patrick Newman, University of Akron

John Ellis, University of Alabama

Rachel Frohman, University of Alaska–Fairbanks
Hirosugu Mori, University of Alaska–Fairbanks
Grant Shimer, University of Alaska–Fairbanks

Ben Collins, University of Alberta
 Matthew Mahony, University of Alberta
 Emily Stafford, University of Alberta
 Rui Wang, University of Alberta

Elizabeth Balgord, University of Arizona
 Benjamin Blonder, University of Arizona
 Jordon Bright, University of Arizona
 Nathan Evenson, University of Arizona
 Zackry Guido, University of Arizona
 Adam Hudson, University of Arizona
 Tyler Huth, University of Arizona
 Mauricio Ibanez-Mejia, University of Arizona
 Andrew Laskowski, University of Arizona
 Rebecca Lybrand, University of Arizona
 Caitlin Orem, University of Arizona
 Devon Orme, University of Arizona
 Clayton Painter, University of Arizona
 Martin Pepper, University of Arizona
 Courtney Porter, University of Arizona
 Amy Schott, University of Arizona
 Jenna Shelton, University of Arizona
 James Worthington, University of Arizona

Christian Barron-Ortiz, University of Calgary

Emily Lindsey, University of California at Berkeley
 Marisa Palucis, University of California at Berkeley
 Sarah Werning, University of California at Berkeley

Cara Harwood, University of California at Davis
 Leslie Moclock, University of California at Davis
 Laura Santare, University of California at Davis

Jeanine Ash, University of California at Los Angeles

Sara Henry, University of California at Riverside
 Jeremy Owens, University of California at Riverside
 Megan Rohrsen, University of California at Riverside

Gary Motz, University of Cincinnati
 Natasha Pierce, University of Cincinnati
 Nicholas Sullivan, University of Cincinnati
 Andrew Zaffos, University of Cincinnati

Evan Anderson, University of Colorado–Boulder
 Cailey Condit, University of Colorado–Boulder
 Amanda Howard, University of Colorado–Boulder

Nicholas Blegen, University of Connecticut
 Philip Glauber, University of Connecticut

Susanna Blair, University of Florida
 Amy Brown, University of Florida
 John Ezell, University of Florida

Mitra Khadka, University of Florida
 Tania Villasenor Jorquera, University of Florida

Danielle Haskett, University of Georgia
 Adam Sarafian, University of Georgia
 Judith Sclafani, University of Georgia

Daniel Cukierski, University of Iowa
 Neo McAdams, University of Iowa
 Kathryn Rathbun, University of Iowa
 M. Kathryn Rocheford, University of Iowa

Tandis Bidgoli, University of Kansas
 Maureen Logan, University of Kansas

Ashley Barton, University of Kentucky
 Cory Black Eagle, University of Kentucky
 Sara Federsmidt, University of Kentucky
 Lucas Rohrer, University of Kentucky

Daniel Eldridge, University of Maryland–College Park
 Yadviga Zhelezinskaya, University of Maryland–College Park

Marissa Mnich, University of Massachusetts–Amherst

Christopher Maio, University of Massachusetts–Boston

Sarah Aarons, University of Michigan
 Lydia Staisch, University of Michigan
 Petr Yakovlev, University of Michigan

Michele Stillinger, University of Minnesota

Didem Onen, University of Missouri

Whitney Bausch, University of Montana
 Erika Colaiacomo, University of Montana
 Fred Kellner, University of Montana
 Lindsay Mackenzie, University of Montana

Audrey Boerner, University of Nebraska–Lincoln
 Juan C. Jaimes, University of Nebraska–Lincoln

Jonathan Baker, University of Nevada–Las Vegas
 Aubrey Bonde, University of Nevada–Las Vegas
 Sarah Evans, University of Nevada–Las Vegas

Joel Edwards, University of Nevada–Reno
 David Shaw, University of Nevada–Reno

Abigail D'Ambrosia, University of New Hampshire
 Stephen Phillips, University of New Hampshire
 Avriel Schweinsberg, University of New Hampshire

Jeffrey Carritt, University of New Mexico
 Brad Jeffrey, University of New Mexico
 Kelsey McNamara, University of New Mexico

2012 GSA Research Grant Recipients

Magdalena Ellis, University of North Carolina–Chapel Hill
Jesse Hill, University of North Carolina–Chapel Hill
Roger Putnam, University of North Carolina–Chapel Hill
Ethan Theuerkauf, University of North Carolina–Chapel Hill

Jennifer Aldred, University of North Carolina–Charlotte
Kimberly Aquino, University of North Carolina–Charlotte
Seth Brazell, University of North Carolina–Charlotte
Brandt Kayser, University of North Carolina–Charlotte

Chelsea Korpanty, University of North Carolina–Wilmington

Shannon Dulin, University of Oklahoma

Nicholas Famoso, University of Oregon
James McNabb, University of Oregon

Diane Skipton, University of Ottawa

Andrew McDonald, University of Pennsylvania
Colin Phillips, University of Pennsylvania

Matthew Finkenbinder, University of Pittsburgh
David Pompeani, University of Pittsburgh

Richard Bono, University of Rochester
Nilotpal Ghosh, University of Rochester
Nandini Kar, University of Rochester
Lin Li, University of Rochester

Brittney Marshall, University of South Carolina
Benjamin Oliver, University of South Carolina

Elizabeth Petsios, University of Southern California
Kathleen Ritterbush, University of Southern California
Lydia Tackett, University of Southern California

Brian Ferwerda, University of South Florida
Matt Jarrett, University of South Florida
Shubhabrata Paul, University of South Florida
Joshua Slattery, University of South Florida

Claire Astore, University of Tulsa

Jonathan Calede, University of Washington
Logan Chinn, University of Washington
Danika Globokar, University of Washington
Brendan Miller, University of Washington
Caroline Pew, University of Washington
Jillian Schleicher, University of Washington

Nathan Andersen, University of Wisconsin–Madison
Tyler Blum, University of Wisconsin–Madison
Meagan Bosket, University of Wisconsin–Madison
Laura Hayes, University of Wisconsin–Madison
Gabriella March, University of Wisconsin–Madison
Anthony Pollington, University of Wisconsin–Madison
Dana Marion Smith, University of Wisconsin–Madison
Sellwood Stephen, University of Wisconsin–Madison
Andrew Walters, University of Wisconsin–Madison
Kelsey Winsor, University of Wisconsin–Madison

Justin Calhoun, University of Wisconsin–Milwaukee
Steven Greenwood, University of Wisconsin–Milwaukee

Jonathan Hoffman, University of Wyoming
Claire Lukens, University of Wyoming
Deirdre Ratigan, University of Wyoming

Natalie Bursztyn, Utah State University
Robin Nagy, Utah State University
Elijah Portugal, Utah State University
Justin Stout, Utah State University

Shelly Donohue, Vanderbilt University
Lindsey Yann, Vanderbilt University

Nikolaos Apsilidis, Virginia Tech
Sarah Eagle, Virginia Tech
Sarah Mazza, Virginia Tech
Jacalyn Wittmer, Virginia Tech

David Majewski, Washington State University

Lauren Bugdalski, Wayne State University

Matthew McKay, West Virginia University

Rachel Bowles, Western Kentucky University

Eliza Andrews, Western Washington University
Graham Messe, Western Washington University

2012 GSA Division & Section Student Research Awards

Six GSA Divisions and four GSA Sections have recognized the following student research grant recipients who submitted proposals of exceptionally high merit in conception and presentation in their fields. These students will be honored at the 2012 GSA Annual Meeting in Charlotte, North Carolina, USA.



DIVISION GRADUATE RESEARCH AWARDS

Geophysics Division

Allan V. Cox Student Research Grant

David A. Grunat, Rutgers University

Geophysics Student Research Grant Award

Daniel A. Minguez, Lehigh University

Hydrogeology Division

Hydrogeology Division Student Research Grant Awards

Amy L. Brown, University of Florida

Ryan P. Gordon, Syracuse University

Mitra Khadka, University of Florida

Stephen Sellwood, University of Wisconsin

Mineralogy, Geochemistry, Petrology, and Volcanology Division

MGPV Division Student Research Grant Awards

Anthony D. Pollington, University of Wisconsin–Madison

Kyle M. Samperton, Princeton University

Quaternary Geology and Geomorphology Division

J. Hoover Mackin Student Research Award

Sharon Bywater-Reyes, University of Montana

J. Hoover Mackin Student Research Award Honorary Mention

Matthew Finkenbinder, University of Pittsburgh

Arthur D. Howard Student Research Award

Danika Globokar, University of Washington

Arthur D. Howard Student Research Award Honorary Mention

Nicholas Sutfin, Colorado State University

Marie Morisawa Award

Elizabeth Thomas, Brown University

Sedimentary Geology Division

Sedimentary Geology Division Student Research Grant Award

Erika J. Colaiacomo, University of Montana

Structural Geology and Tectonics Division

Structural Geology and Tectonics Division Student Research Grant Awards

Aileen Chea, San Francisco State University

Brian M. Culp, Pennsylvania State University

David O. Oakley, Pennsylvania State University

John Templeton, Columbia University

James Worthington, University of Arizona

Alph S. Wright, Texas A&M University

SECTION RESEARCH AWARDS

Northeastern Section Undergraduate Research Grants

Douglas Barber, Allegheny College

James Carrigan, University of Massachusetts–Amherst

Max Davidson, Union College

Christopher J. Honess, Syracuse University

Kyle Kissock, Bucknell University

Jason Muhlbauer, Bucknell University

Rodrigo Perez, McMaster University

Seth Pratt, SUNY Oswego

Juliet Ryan-Davis, Middlebury College

Samantha Sinclair, SUNY Syracuse

Ekatherina Wagenknecht, University of Massachusetts

Jaci White, Lafayette College

North-Central Section Undergraduate Research Grants

Olivia Barbee, Eastern Illinois University

Jason Coenen, University of Wisconsin–Oshkosh

Chelsy A. Herring, University of Wisconsin–Oshkosh

Neal Ringerwole, Grand Valley State University

Rocky Mountain Section Undergraduate Research Grants

Kathleen D. Cox, Fort Lewis College

Logan Hartle, Fort Lewis College

Lily Jones, Oglala Lakota College

Tim McCallum, Fort Lewis College

Adam Zurn, Fort Lewis College

Southeastern Section Graduate Research Grants

Gopal Bera, University of Southern Mississippi

Joseph Boreman, University of Georgia

Sahale Casebolt, Virginia Tech

Mohammad Huq, Auburn University

Evan Kelly, University of Kentucky

Allison Platsky, University of Georgia

Jingyuan Sun, University of North Carolina

David Szynal, East Carolina University

2012 Cole Awards

The 2012 Gladys W. Cole and W. Storrs Cole Memorial Research Awards for postdoctoral research are funded by the GSA Foundation.



GLADYS W. COLE MEMORIAL RESEARCH AWARD

Vance T. Holliday of the University of Arizona will be awarded US\$7,000 from the *Gladys W. Cole Fund for research in geomorphology of semiarid and arid terrains* for his project, "Paleoshorelines and their bearing on alluvial geomorphology in the American Southwest." The award will be presented at the Quaternary Geology and Geomorphology Division Awards Ceremony at the 2012 GSA Annual Meeting in Charlotte, North Carolina, USA, on Tues., 6 Nov.



W. STORRS COLE MEMORIAL RESEARCH AWARD

Eduardo Leorri of East Carolina University will be awarded US\$6,500 from the *W. Storrs Cole Fund for research in invertebrate micropaleontology* for his project, "Geochemical composition of foraminiferal tests: Implications for environmental monitoring and paleoenvironmental reconstructions." The award will be presented at the Cushman Foundation for Foraminiferal Research Awards Ceremony at the 2012 GSA Annual Meeting in Charlotte, North Carolina, USA, on Tues., 6 Nov.

If you would like to contribute to the GSA Foundation, please go to www.gsafweb.org or contact GSA Foundation Chief Development Officer Anna Christensen at +1-303-357-1007 or achristensen@geosociety.org. See page 50 of this issue for more information on how GSA and the GSA Foundation are working together to support geoscience research.

2012 Subaru Minority Student Scholarship Recipients



Subaru of America Inc., in partnership with the GSA Foundation, has generously funded a scholarship program to benefit minority undergraduates considering a degree in the geosciences. The Subaru Minority Student Scholarship Program provides US\$1,500 to one student in each of GSA's six North American regional Sections and to one student in a low-income country from GSA's International Section (nominated by a GSA Campus Representative). The students also receive free registration to attend the GSA Annual Meeting and a one-year complimentary membership in GSA.

The purpose of this scholarship is to encourage minority students to continue studies in the geosciences as a degree choice. Nomination forms for the 2013 program will be e-mailed to GSA Campus Reps later this year. *Questions?* Contact Diane Lorenz-Olsen, awards@geosociety.org, +1-303-357-1028.



Nicolette Buckle, Oberlin College (North-Central Section)

Kiara J. Gomez, Smith College*

Kelly E. Hattori, University of North Carolina–Wilmington (Southeastern Section)

David A. Lukudu, North Dakota State University (Rocky Mountain Section)

Selva Marroquin, Tufts University (Northeastern Section)

Maria Fernanda Podesta, University of Buenos Aires (International Section)

Angela Roman, Santa Barbara City College (Cordilleran Section)

* No nominations were received from the South-Central Section. As a result, the second highest rated student from all U.S. Sections was selected to receive this scholarship.

2012 GSA/ExxonMobil Field Camp Award Recipients

GSA/EXXONMOBIL FIELD CAMP EXCELLENCE AWARD

This award recognizes one geology field camp instructor based on his or her safety awareness, diversity, and technical excellence. The following field camp leader has been awarded US\$10,000 to assist with his summer field season: **Bruce Douglas**, Indiana University.



GSA/EXXONMOBIL FIELD CAMP SCHOLARS AWARD

This award funds summer field camp attendance for the following undergraduate students, who will receive US\$2,000 each, based on diversity, economic/financial need, and merit, to attend the field camp of their choice.

Hehewutei Amakali, Appalachian State University
Olivia Barbee, Eastern Illinois University
Na Hyung Choi, University of Georgia
Peter Chutcharavan, University of Michigan
Angelica Connelly, Fort Lewis College
Rania Eldam, The University of Texas
John Decker, North Carolina State University
Elizabeth Gammel, Northeastern Illinois University
Jeanette Harlow, California State University–Long Beach
Jory Lerback, Franklin & Marshall College
Abigail Maxwell, University of Georgia
Miranda Mikesh, North Carolina State University
Kelsey Padilla, California State University–Bakersfield
Bach Pham, The University of Texas at Dallas
Ethan Shavers, St. Louis University
Yen Joe Tan, Lafayette College
Samuel Ybarra, Arizona State University

GSA/EXXONMOBIL BIGHORN BASIN FIELD AWARD

The following students and faculty will receive scholarships to participate in the fourth annual GSA/ExxonMobil Field Seminar in the Bighorn Basin of north-central Wyoming, which emphasizes multidisciplinary integrated basin analysis.

UNDERGRADS

Dudley Baker, The University of Texas at Austin
Douglas Barber, Allegheny College
Naomi Barshi, Smith College
Conner Burt, University of Colorado at Boulder
Jonathan Delph, Arizona State University
Jeanette Harlow, California State University–Long Beach
James Jolles, Franklin & Marshall College
Tucker Keren, Hamilton College
Caitlin Leslie, Grand Valley State University
Ian McCary, Eastern Connecticut State University
Julia Mulhern, Wesleyan University
Mark Nahabedian, Santa Barbara City College
Brett Perry, University of Nevada–Las Vegas
Ryan Purcell, Miami University
Melissa Zambrano, Texas A&M

GRADS

Ian Hogan, Colorado State University
Dylan Loss, University of Florida
Karin Ohman, University of California at Santa Cruz
Amanda Owen, Royal Holloway University of London
Chantelle Parrish, West Virginia University
Austin Reed, Wesleyan University
Dane Sheldon, University of Rhode Island
Kathryn Stack, California Institute of Technology

PROFESSORS

Steven Lundblad, University of Hawaii–Hilo
Stephen Nathan, University of Massachusetts–Amherst

Welcome New GSA Members!

The following individuals (more than 2,650!) submitted their applications for GSA membership between August 2011 and January 2012 and were approved by GSA Council at its April 2012 meeting.

PROFESSIONALS

John Patrick Abraham
Steve Adamek
James K. Adamson
Timothy G. Alessi
Jaclyn Allen
Pam Allison
Raquel Alonso-Perez
Jan P. Amend
Mohammed Dahiru Aminu
Alison M. Anders
Tania Maria Anders
Ronald Francis Andrews Jr.
Liath Appleton
Chris Armistead
Joan L. Aron
Gabriel Asato
Michael E. Augustyniak
Brett Baker
Robert T. Bakker
Mansoor A. Baloch
Steven S. Barrell
David Andrew Barry
Sarah Hosken Bartling
Francine Baumann
Travis K. Bavin
Jacob Beale
Daniel W. Bean
Jim Beaver
Wayne Adriance Belding
Chris Berg
Marian P. Berndt
Todd Anthony Bianco
Roger Wayne Biebl
Mark A. Borchartd
Julie Bowles
Brent Breithaupt
Arjan Brem
Jason G. Brown
Kathleen M. Browne
Patricia Morris Bryan
Paul Buck
Roland P. Buehlmann
Thomas J. Burbey
William Burgess
Recep Cakir
Anthony A. Caldarelli
Victor R. Calloway
Tracy H. Campbell
Dylan G. Canales
Michele Carbone
Alexandre Carnier
Neil E. Carriker
Honza Catchpole
Leonardo Ceballos Joven
Poul Christoffersen
Tracy Christopherson
Robert D. Cicerone

Lee Clapp
Allan Clark
Patricia A. Cobb
Christopher B. Cogan
Russ Colson
Xavier Comas
Dawn Conroy
Joseph Powell Cook
Michelle L. Coombs
Jonathon L. Cooper
Aaron Michael Correll
Steven R. Corsi
James B. Cotner
Robert Coward
Mia Marie Cowgill
Dan M. Cox
Barbara Crawford
James A. Creighton
Gardiner W. Cross
Frederick Curtis
Janet Cushing
Paul Cutler
Diana M. Dalbotten
Toby Christian Dawborn
David Joseph De Simone
Geza I. Demeter
Yoann Denéle
Adam Michael Dennis
Vincent de Paul
Barrett Taylor Dixon
N.N. Dogra
Brett Dooley
William Doran
Robert Alan Drake
Guillaume Duclaux
Don Duggan-Haas
Christopher John Dunbar
Richard Dunning
Adam Duskocy
Stephen Dymmcock
Douglas Robert Eck
Doug Edmonds
Heather Lynn Egger
Jean Taylor Ellis
Jennifer Engstrom
Ian Lee Everhard
Elaine Katherine Fagner
Trent Farnum
Donald Glenn Fay
Steven Fechner
John Folsom Ferguson
Nick Ferina
Nelson Ferreira Fernandes
Lynn S. Fichter
Stephen W. Field
Sean Fitzsimons
Donald Forsyth
S.I. Fraser
Barry A. Frey

Kathryne Frey
Hannah Friedrich
Jason Furlow
Santiago B. Gangotena
Joseph Edward Garcia
William Payton Gardner
Paul A. Garner
Joan Marie Gawloski
Dedre Gentner
John L. German
Cyrus Park Gillett
William E. Glassley
Dennis Michael Gleason
Philippe Goncalves
David John Good
Matthew Charles Gottfried
Dustin Graves
Scott A. Green
Christopher A. Greenhoot
Baohua Gu
Andrew Gustin
Maksym A. Gusyev
Scott A. Hageman
Cynthia Hall
Kevin J. Hanson
Glenn F. Harrison
Altug Hasozbek
Sarah Marie Hayes
David Hayward
Kevin Patrick Hefferan
Mary Hegmann
David R. Hembree
John F. Hennessy
Joshua P. Hepler
Dean Leslie Hewson
David Michael Hillix
Gustavo Hincapié Jaramillo
Heide Hlawaty
Brian Leon Hoffman
Terri Hood
Dwight T. Hoxie
Jyr-Ching Hu
John Hunter
Amber Huntoon-Colvin
Edward J. Huskinson Jr.
Kelvin Hussey
Mads Huuse
Narimitsu Ito
Ellen A.R. Iverson
Giridharan Jagannathan
Anthony Jakeman
Sveinn Peter Jakobsson
Rick Johnson
Robert Simpson Johnson
Leigh Justet
Ed Floyd Kaiser Jr.
Ozge Caglayan Kaya
Nuretdin Kaymakci
Gareth Mark Keevil

Ronald Kies
Quinn T. Kiley
James Wesley King
Jimmy R. Kirk
John P. Klein
Sheri L. Klug Boonstra
William Koehn
Matthew A. Konfirst
Erin Kraal
Christopher Krajicek
Larry R. Kramka
Ned William Kruger
Ravindra Kumar
Michael James Lace
Charles H. Lake
Nancy Lamm
Rebecca S. Lange
Barry W. Larson
Peter Leiggi
Christian F. Lenhart
Richard Jason Lenz
Mark R. Lewis
Robert Lewis
Qiong Li
Weiqiang Li
Jih-Pai Lin
David C. Logan
Lloyd Loope
Stephen Lorentz
Thomas Lyttle
James Grant MacBroom
Jose Luis Macias
Michael P. Madison
Suzanne Magdalene
Maria G. Mangano
Garrett Manion
Michael E. Mann
Luiz Eduardo Mantovani
Courtney Joanne Marshall
Keith Neil Martins
Charles Martin
Dennis Martin
Kylara Margaret Martin
Joshua B. Massey
Mark Mathison
Lisa Herring Mayo
Rory McFadden
M. Tish McKee
Samuel A.A. McLeod
John McRobbie Jr.
Elton McWilliams Jr.
Ronald B. Meade
Carol Beaton Meyer
Sidrah Haider Mirza
Sumit K. Mishra
David Mohrig
Jan Russell Moles
Eric Monteil
Mainak Mookherjee
John Edward Mooney
Daniel J. Moore
Eric Morales-Casique
Briana Mordick
Mario Moreno-Sanchez

Daniel P. Morris
 Linda D. Morse
 Veronica Alicia Munoz
 Tony Murphy
 John F. Mustard
 James D. Myers
 Edward Nater
 Bethany T. Neilson
 Richard J. Nevle
 Andrew Vern Newman
 Horton Newsom
 Wai Yi Ng
 Jason Allen Nichols
 Matt W. Oberhelman
 Brian E. O'Brien
 Tonia Dee O'Brien
 Mary H. Ohren
 Alex Okello
 Olalekan Dare Olawale
 Ole Olmanson
 Amy J. Ording
 Beatriz Ortega
 Edgardo A.R. Ortiz-Corps
 Tugba Özdogan
 Ken Papp
 Timothy Kevin Parker
 Renee Parkhurst
 Robert P. Pascoe
 Sergio Pastor
 Anne Paterson
 Tyler D. Patrick
 Donald A. Pattalock
 David Peck
 Katherine Louise Pedley
 Shanchi Peng
 Wayne Pennington
 Dean Michael Peterson
 David C. Pieri
 Robert Lee Pigott II
 Alexander Popovici
 Richard Potts
 Anu R. Pradhan
 Joseph A. Preusser
 Nathan E. Pritchard
 Liangwei Qu
 Sudipta Rakshit
 Joy M. Ramstack Hobbs
 Jackie Randell
 Ruey-Juin Rau
 Robert Harris Ray
 Carol Anne Raymond
 Colleen Reda
 James F. Reilly II
 Bradley T. Reitz
 Zbigniew Remin
 Michael Riettini
 Douglas B. Rigby
 Ioannis Rigopoulos
 John Rodgers
 Barry Roser
 Kimberly A. Roush
 Terence Geoffrey Rowley
 Dalia Rubin
 Arlan Ruen

Georg Rumpker
 Joel Thomas Russell
 Mike Sandiford
 Paul Schenk
 Chris L. Schneider
 Martin A. Schoonen
 William M. Schuh
 Kathryn Schuller
 Alexandra Schultejaann
 Robert K. Schwartz
 David R. Scott
 Seymour M. Sears
 Tomohiro Sekiguchi
 Mark D. Shapley
 Robert Bruce Shaver
 Evgenya Shelobolina
 Steve Sheppard
 Hironao Shinjoe
 Scott T. Shipley
 Allison M. Shumway
 Martin E. Siem
 Ndinannyi Kenneth Singo Sr.
 Anup Kumar Sinha
 Alexander Smirnov
 Robert D. Smith
 Olena Smyntyna
 David R. Snoeyenbos
 Richard J. Soare
 Elizabeth Solleiro-Rebolledo
 Michael Soreghaan
 Kenneth Springer
 Jack Parsell Stewart
 David E. Stilwell
 Scott Stine
 Clay Sullivan
 Catherine Summa
 Colin D. Sumrall
 John F. Syphrit
 Radu Taflan
 Zaid Patrick Taha
 David Bruce Taylor
 Michael Joseph Teti
 JoAnn Thissen
 Jennifer Patricia Thomas
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 Chris L. Thompson
 Jacob Thompson
 Joel Thompson
 Robert Gordon Thompson
 Robert J. Thompson
 Luz Mary Toro
 Amy Townsend-Small
 Patrick Troy
 David Raiford Turner
 Martin Frank Turner
 Deon Van der Merwe
 Sytze van Heteren
 Vincent Joseph Varricchio
 Gaston Venegas Rodriguez
 Nicole Vermillion
 Philip Villeneuve
 Ate Visser
 Jasper A. Vrugt
 Kelin Wang

Maryann Wasiolek
 Laura Eileen Wasylenki
 Fred M. Weaver
 Andrew Weir
 Yi Hua Weng
 Melanie Werdon
 Jill Wertheim
 Richard Wigington
 DeBonne Natalie Wishart
 Jessica Witt
 Seth J. Wittke
 Jennifer Woodham
 Joe Woodske
 Bradley Worley
 Don G. Wyckoff
 Daniel B. Wynne
 Haining Yang
 Li Yat Cheung
 Brian Patrick Yurk
 Larry Zazzera
 Thor Zednik
 Liang Zhao
 Rixiang Zhu
 Maggie Zimmerman
 Sandy M. Zucker
 Justin Andrews Zumbro
 Stephanie E. Zurenko

RECENT GRADUATES

Christopher A. Acheson Jr.
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 Rosalyn Adler
 Kathryn Albright
 Kayla R. Andres
 Brenten Austin
 William A. Barnes
 Elissa Christine Barris
 Katherine G. Becker
 Krishan Bhanot
 Karl S. Bloor
 Louis Maximo Bodin
 Jennifer Bradley
 Susan Bresney
 Maria T. Brown
 Jake Budish
 John G. Buflod
 Jonathan Parks Buie
 Kyle Randall Burch
 James Bush
 Hannah Byrness Cady
 Fernando Miguel Calabozo IV
 Victoria Sarah Campbell
 Matthew Paul Castelli
 Monica Castro
 Robert Charnock
 Micah Joseph Chase
 Carus Benjamin Clarke
 Lily Rachel Cohen
 Christina E. Coulter
 Carolyn Coyle
 Josh Aaron Creamer
 Ted Rosner Crook
 Joe T. Cropsey
 Chad Michael Crotty

Ryan P. Dale
 Elizabeth Dalley
 Keegan Daly
 Joseph Scott Dargel
 Elizabeth DeFazio
 Adam Christian Denton
 Kara Marie D'Onofrio
 Matthew Drouillard
 Rachael Elizabeth Dye
 Seth Abel Edman
 Shama Ejaz
 Francis Emejeamara
 Patricia Engel
 Michelle L. Fame
 John Farmer
 Ga Ferguson
 Steven Flank
 Alexandre Jeanette Fowler
 Jennifer Lynn Galvin
 Rachel Emmele Gilgen
 Nicholas Robert John Goodwin
 Andrew M. Graham
 Daniel Edward Griffiths
 Erin Guzowski
 Scott Albert Haire
 Sean Robert Hammersburg
 Cierra Michele Hancock
 Walter Harston
 Jody Michelle Hauser
 Sean Hays
 Dana Hayward
 David Heeszal
 Jakob Heyman
 Trevor C. Hobbbs
 Montana Mae Horchler
 James Conrad Howard II
 Alyssa Ann Howlett
 Kate Ito
 William Z. Jacobson
 Stephen Tucker Johnson
 Woodong Jung
 Varsha Karki
 Brian Allan Karpes
 Britney S. Katz
 Mary Kazantseva
 Niranjan Kaur Khalsa
 Farkhondeh Kiani Harchegani
 Philip Klintmalm
 Jessica Lindberg Kozarek
 Janice Kukuk
 Justin LaForge
 Jamie Marie Laginess
 Jason Lai
 Michael Joseph Lamons
 Philip Lane
 Amelia Lanza
 Todd R. Lau
 Ryan Michael Ledin
 Daniel Joseph Levine
 Matthew Michael Lewis
 Andrew John Lindlof
 Kimberly Joanne Litz
 Michael Lord
 Rachael Lubitz

GSA Welcomes New Members

Maria Fernanda Lucantis
 Leila Malcom
 Gregg Marcinkowski
 Steven Richardson Mattocks
 Andrew McConkey
 Sarah Medley
 Ariana Mercer
 Charles Connor Messler
 Clinton Meyer
 Cristofor Michels
 Jared Lee Gerhardt Midgett
 Matthieu B. Miller
 Stephanie Mitchell
 Alex Moody
 Rick James Ray Morgan
 Julio F. Morin
 Patrick Charles Moulden
 Oguz Mulayim
 Garrett Mull
 Elizabeth Carrington Murphy
 Andrew Nesheim
 Maxwell Okure
 Meghan Ori
 Ivan Orsic
 Monica Patel
 Conor Justice Pesicka
 Anthony Orestino Pezzotti
 Aurora D. Pinkey-Drobnis
 Lynnette La Mar Pitcher
 Kara Jade Quan-Montgomery
 Steve M. Raciti
 Tyler Winston Randall
 Adam Joseph Richmond
 Stephen Robert Riley
 Meredith A. Rivin
 Vincent Joseph Roccanova
 Andrea M. Rocchio
 Steven Louis Rubinyi
 Emma Ruhmann
 Prafulla K. Sahoo
 Bridget Therese Sanderson
 Christine Saniuk
 Kurt Schmidt
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 Matthew Schumacher
 Jeffrey L. Shipman
 Daniel E. Sigward
 Amanda Desiree Smith
 Vann Edmond Smith
 Teira Solis
 Kathleen Claire Soulliere
 Ana C. Tapia
 Jessica Nichole Tashman
 Sami Taylor
 Arianne Terry
 Inemesit Brian Ezekiel Udoh
 Sarah A. Ulrich
 Brian J. Van Benschoten
 Alianora Walker
 Eileen Weigel
 Nicholas Weiner

Russelle Westermann
 Karin Ursula White
 Keridwen McLeyne Whitmore
 Paul Cranston Wilcox
 Dan Witowski
 Skyler Wood
 Rachel Yanega
 Britany Louise Young
 Sarah B. Zachrich
 Sebastian Zapata Sr.
 Taylor Zimmerman
 Callie Zuck

STUDENTS

Pamela M. Aaron
 Sarah Aarons
 Oluwasegun Oladapo Abatan
 Neil Robert Abdalla
 Mohamed Abdelkareem
 Nina Abdollahian
 Stephen Abernathy
 Pride Abongwa
 Anastasia Abramova
 Thomas E. Ackart
 Laurel Caroline Ackison
 Zablun Adane
 Ali Adnan
 James Nkansah Adu
 Liana Marie Agrios
 Steffany Fierro Aguilar
 Hifzhul Arif Ahmad Munif
 Shakib Ahmed
 Kerstin Ahrens
 Lisa K. Akers
 Mark Jonathan Akland
 Samrat Alam
 Ryan Albee
 Casey K. Albritton
 Karen Estrella Alcalá
 Binyam Alemu
 Bridget A. Alex
 Sarah Alexander
 Mohamed S. Alfaitouri
 Munazzam Ali
 Usman Ali
 Mohammed H. Aljahdali
 Amy Allen
 Brett Allen
 Daniel Allen
 Joshua James Allen
 Lindsay Nicole Allen
 Mitchell David Allen
 Sarah Dawn Allen
 Jordan Elizabeth Alling
 Evan Stanley Allred
 James Alphonse
 Saeed Saad M. Alshahrani
 Charlotte Jean Alster
 Erin H. Altick
 Elisabeth Ames
 Lisa Marie Anaya
 Lars Anderas
 Dane E. Andersen
 Nathan Andersen

Alyssa Anderson
 Daniel Steven Anderson
 Emily S. Anderson
 Heidi E. Anderson
 Jordana Krisdene Anderson
 Krista Michaela Anderson
 Eliza Mae Andrews
 Charles Stephen Andros
 Kolbe D. Andrzejewski
 Tracy K. Anunsen
 Adam Christopher Arce
 Ryan Haynie Ard
 Alejandro Arenas
 D. Ryan Arnott
 Jake Philip Arpke
 Gerardo Fernando Arrieta
 Kris E. Asp
 Claire Astore
 Katelyn Rahsan Atakturk
 Kristopher Dean Atherton
 Meghan Elizabeth Attanasio
 Beth Avram
 Mitchell Burgess Awalt
 Adebayo Olujinmi Ayorinde
 Joshua Osamudiamé Azobu
 Diana A. Azougghagh
 Esther Babcock
 Jamye Jorn Babocsi
 Lauren Marie Babuska
 Nils Rainer Backeberg
 Adam S. Backus
 M'barck Baddouh
 Daniel T. Baggot
 Christopher Thomas Bagley
 Emily Marie Bahus
 Phillip Anthony Bailey III
 Melanie Dell Bain
 Sarah Marie Bain
 Christopher Baker
 Krista Meghan Baker
 Kaveh Bakhishi
 Eric Ball
 William Aaron Ball
 Nathaniel Ballard
 Michelle Balmer
 Jillian Bambrick
 Ryan Banas
 Jessica F.M. Banaszak
 Bharat Banjade
 Vanessa Baratta
 Douglas Barber
 Taylor Michael Barbrack
 Anthony Allen Barkan
 Collin William Barker
 Kaylee Beth Barket
 Donna Marie Barlow
 Kyle Eugene Barnes
 Travis Barnett
 Jacob Byron Barnhart
 Michelle Antoinette Baroldi
 Steve Barone
 Zach Barr
 Vitor Rodrigues Barrote
 Danielle Barrs

Adam Bartok
 Rebecca M. Bartusewich
 Jeison D. Basabe
 Ramia M. Bashara
 Tammy W. Baswell
 Julie M. Bauer
 Ashlyn Baum
 Justin H. Baumann
 Kyrie Baumgartner
 Jonathan William Bay
 Michael James Beach
 Gildas Beauchamps
 Lauren Bechelli
 Ellen Margaret Bechtel
 Erin K. Beck
 Mandi Beck
 Stephen Beckage
 James Bradley Becker
 Kathy Becker
 Scott Karl Becker
 Kevin Bruce Beidelman
 Charles Vernon Beightol V
 Jeremy Bellow
 Sarah Jane Bembrick
 Stefano Benato
 Bradley Daniel Benavides
 Amanda L. Dorothy Bender
 Paolo Benelli
 Michal Ben-Israel
 Sarah Benjaram
 Kristen Bennett
 Nicole Bennett
 William Matthew Benson
 Jonathan Benton
 Gopal Bera
 Andrew W. Berkey
 John Michael Berlejung
 Katherine Bermudez
 Emily Berquist
 Sarah Frances Berry
 Mathew Beshears
 Robert Fraser Betzler
 Brandon Beuttel
 Scott Bey
 Jennifer Lynn Beyer
 Rashaad Bhamjee
 Proma Bhattacharyya
 Nanxi Bian
 Matthew Z. Bickham
 Robert G. Bickhart Jr.
 Andrew J. Biebuyck
 Michael Anthony Bierwagen
 Victoria Ashlea Bierwirth
 Jeremiah I. Bihl
 Janis Bikše
 Coralyn Kai Bingman
 Thomas Henry Birren
 Deepti Bisht
 Rosemarie Barga Bisquera
 Corrina Bissell
 Kelsey Bisson
 Joshua Bitner
 Daniel Lamar Black
 Darrin Bledsoe

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Lee Anne Bledsoe
 Nicholas Thomas Blegen
 Brittany Sarah Blevins
 Sahrah Louise Bliss
 Elias Morgan Bloch
 James Douglass Blount
 Erik Blow
 James A. Blumenschein
 Abby Kay Boardman
 Adam Robert Boardman
 Benjamin Boatwright
 Caitlin McGinnis Boblitt
 Andrew Alexander Bochko
 Brandon Richard Bockrath
 Peter Bodor
 Krystle Boks
 Uyanga Bold
 Austin Boles
 Trevor Bollmann
 Greg Bongey
 Mariana Bonich
 Nick Bonini
 Brett Joseph Bonotto
 Susannah K. Boote
 Patricia Ann Bordonaro
 Daniel John Borer
 Joseph Robert Boro
 Chiara Borrelli
 Stephanie Bosch
 Mariann Bostic
 Michael Conner Bouchard
 Casey Bouck
 Diana Marie Boudreau
 Bridgit Boulahanis
 Michael Gene Bourne Jr.
 Shiera Cristina Bova
 Andrea Bowen
 Jared Bowen
 Jack A. Bowles III
 Ryan Lee Bowman
 Rachel Meghan Boyack
 Ashley M. Boyd
 Kathryn Ann Bradbury
 William B. Bradford
 Kyle Edward Bradley
 Aidan Wolf Brady
 Shannon Brady
 Jamie Brainard
 Joel Brann
 Alana M. Brannon
 Sam Breadner
 Latisha Ashley Brengman
 Greg Brick
 James L. Bridgeman III
 Mary Elizabeth Brill
 Sarah Ashley Brinkmann
 Kathleen Brinton
 Emily Brislawn
 Jesse Broce
 Billie Jo Brockhum
 Hannah Faye Brocklehurst
 John Joseph Brockman
 Nick Brockman
 Robert Joseph Broda

Sarah Ann Broer
 Ben Brooker
 Gary Lee Brooks II
 Hilary Ann Brooks
 Richard Brooks
 Thibaut Rice Brooks
 Candice E. Brothers
 Lilianna Broussalian
 Mark Brown
 Nathan D. Brown
 Emma Broz
 Alison Rae Bruegger
 Christine Michelle Brussell
 Alexander Bryk
 Matt John Bryker
 Karen R. Buchanan
 Sean Buckley
 Natasha Budimirovic
 Katherine Renee Bueltmann
 Ty Buller
 Andrew T. Bullinger
 Jason Bullman
 Anna Bulochnikova
 Alexa Burgess
 Amanda Burke
 Amanda Rae Burke
 Jessica Burleson
 Eric David Burnham
 James Blake Burroughs
 Patti J. Burton
 John E. Burwick
 William David Busch
 Aaron Bush
 Meredith Bush
 Harris Lowell Byers
 Bryan Fred Byrd
 William Byrne
 Anastasija Cabolova
 Jordan Cahill
 Zachary Calamari
 Sarah Caldwell
 Amanda Zulema Calle
 Christopher John Callinan
 Kody J. Callister
 Heather J. Cameron
 Daniel T. Campbell
 Mark T. Campbell
 Joe Canchola
 Kerlyn Candelario
 Caroline Canelas
 Wentao Cao
 Gina Lauren Cappello
 Emily Carbone
 Sebastian Carisio
 Grant Carlson
 Jordan Ashley Carney
 David Carrell
 Diane Carrico
 Lucas Carrion
 Morgan Brittany Carson
 Carlos Patricio Carvajal
 Katharine T. Casey
 Ronald Wilson Cash
 Simeon Caskey

Michael Castelli
 Jessica Xiomara Castro
 Jackson Sinclair Cates
 Amy Cattelino
 Robert E. Causer
 Justin Paul Cave
 Emma K. Caverly
 Kyrsti Autumn Cecil
 Edin Cekic
 Anthony D. Cerruti
 Alexandria Ceschini
 Rebekah D. Cesmat
 Jason Michael Cesta
 Jesse S. Chadwick
 Matthew Ryan Chaffee
 Joanne Chan
 Kar Woon Chan
 Michael A. Channer
 Emily J. Charaska
 Marc Charette
 Sreejita Chatterjee
 Connor Neil Chatterton
 Logan Arron Chatterton
 Aileen Chea
 Yangyang Chen
 Brenton Michael Chentnik
 John Thomas Chesley
 Shelley Chestler
 Barry Chew
 Diya Chowdhury
 Eric Christensen
 Chelsie Lee Christenson
 Joe Christianson
 Amber Ciravolo
 Alejandro O. Cisneros De León
 Anthony J. Clarke
 Cornelia Clarke
 Matthew E. Clemens
 Claire Cleveland
 Michael Cloos
 Karen Clyne
 Alexander Owen Cobley
 Kelley Jordan Davis Coker
 Elizabeth C. Cola
 Erika Jean Colaiacono
 Thomas Colby
 Abby J. Cole
 Meredith Anne Cole
 Shannon Collings
 Ben Collins
 Alexander Colon
 Clinton Colwell
 Norris Nelson Comer
 Wade Condict
 Randall Vance Conger-Best
 Marvin Keith Conn
 Amber Jean Conner
 Greg Connock
 Elizabeth Renee Connolly
 Kathryn E. Coode
 Tamara Jean Cook
 Matthew Thomas Cooley
 Leandra Cooper
 Christopher Andrew Corder

Emma Coronado
 Jankel Lucia Coronado
 Alexandra Cory
 Zachary M. Kramer Cotter
 Ernie Charles Cottle
 April M. Courtney
 Jennifer Cox
 Tristan Craddock
 Matthew Ryan Craig
 Kelsey Taylor Crane
 Alison Craven
 Alex Crawford
 Christine Lynn Crawford
 Camilla Crifo
 Julia Criscione
 Peter Scott Crislip
 Michael Cronin
 Levi Augustine Crooke
 Christine Crosby
 David Bruce Cross
 James Joshua Crowell
 Matthew Cruz
 Valerie J. Cruz-Rodriguez
 John Daniel Cuchta
 Huan Cui
 Jeff Cullen
 Alexander Robert Culpepper
 Katherine E. Cummings
 Kelli Jeanne Cummings
 Robert Murray Cundari
 William Cupples
 Steve Curlis
 Bryan Joseph Currie
 Lorelei Curtin
 Daniel Curtis
 Daniel Robert Curtis
 Charles Doug Czajka
 Joseph Theodore Dague
 Maxwell P. Boulet Dahlquist
 Dustin R.L. Dahn
 Heng Dai
 Iris Daly
 David Damby
 Christina Dance
 Suresh Dande
 Donya C. Danesh
 Terryl Daniels Jr.
 Lindsey MaDonna Danielson
 Michael William Danuser
 Margaret Darnell
 Supriya Das
 Gita Ariel Datt
 Omar Davalos
 Bryant Jefferson Davis
 Derek Davis
 Jennifer Anne Davis
 Michael Joseph Davis
 Patrice Davis
 Rebecca Davis
 Danielle N. Day
 Joshua David Day
 Sarah Day
 Paulo Steven De Sa Rego
 Jody Ann DeAraujo

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Meghann Decker	Katie Joanna Elder	Thomas M. Fontana	Jill Ghelerter
Savannah Defoe	Daniel Lee Eldridge	Jeremy Keith Foote	Sarthak Ghosh
Rebecca de Graffenried	Robert Miles Ellenberg	Chanse Michael Ford	Katherine Teresa Gibble
Benjamin DeJong	John H. Ellis	Sophia Katherine Ford	Christopher Kyle Gibson
Ian Arburua Delaney	Magdalena A. Ellis	Tanya C. Forde	Carlene Anne Gilewski
Jennifer E. Delaney	Trevor Charles Ellis	Emily J. Forsberg	Ashley Diane Gilliland
Kevin M. DeLano	Kristin Elmer	Stephen Tinley Fortney	John Gipson
Nikiforos Delatolas	Erica Emerson	Kelsey Ann Forward	John Thomas Gist
Amy Delbecq	Robert Earl Endicott	Marine Severine Foucher	Elizabeth Gitelman
Amanda DeLisle	Daisuke Endo	Andrew Peter George Fowler	Rachel Glade
Marianna Demou	Can Engin	Margaret E. Frabell	Evan R. Gladney
Barton Arthur Dengel	Benjamin Lee Engleman	Kendle James Fraley	Sarah Elizabeth Glancy
Kara Elizabeth Dennis	Matthew Enos	Rose Frank	Amy Christine Glasgow
Brandi Elaine Denton	Clarissa Lise Enslin	Amelia Franklin	Philip J. Glauberman
Shane P. DePinto	Sarah Dempsey Eppich	Carie Marie Frantz	Chase Thomas Glenister
Aubry Anne DeReuil	Cat Erickson	Christine Frasca	Danika Globokar
Alison Dernbach	Wynter M. Erickson	Benjamin Kyle Fraser	Nathan Glover
Adam Dettmer	Nicole Eriks	Marissa N. Fratturelli	John Godfrey
Nickolas Diaz	Daniel Espada	Kristen Frederick	Christy Yvonne Goffinet
Stacey DiBell	Diane Kaitlynn Estes	Kyle Fredericks	Adam Scott Goldsmith
Travis Dickinson	Nathan Evenson	David Freedman	Yonaton Goldsmith
Cory Patrick DiDonato	Tuba Evsan	James Lawrence Freeman	Courtney Goll
Courtney S. Dieruf	Christina Maria Facemyer	Adam Freierman	Cezar Gomez
Russell B. Dill	Shah Faisal	Susan Abigail French	Derik P. Gonzales
Lyndsay Mason DiPietro	Chloé Fandel	Frederick Freudenberger	Matthew Scott Gonzales
Geoff R. Dipre	Yi Fang	Claire Nicoli Friedrichsen	Jazmin Gonzalez
Theresa Marie Dits	Mark Farrugia	Allen Nicholson Frierson	Sara Gonzalez
Sherrie Dix	Dawn Farver	Lauren Frisch	Jonathan Andrew Goodell
Anna Dlugolecki	Kenneth Jared Fath	Kayla Jilayne Frisinger	Zachary L. Goodman
Nicholas Andrew Dolan	Benjamin Isaac Faulkner	Fabian Carlo Froehlich	Galen Gorski
Shelly Donohue	Daniel Anthony Favorito	Richard From	Jennifer Goshorn
Michael Philip Donovan	Shawn Andrew Favreau	Brooke Frusher	Antara Goswami
Tom Doody	Preston Thomas Fedell	Anthony M. Frushour	Kendal M. Gotthelf
Linda Doran	Sara Federschmidt	Arthur William Funk II	John Daniel Govi
Melissa Dorton	Timothy Scott Fegel	Don Fuorry	Bonnie R. Govoni
Richard Dorton	Johnathan Robert Feldman	Michael S. Fusco	Taylor Alan Grage
Neil William Dotzenrod	Louis Arthur Feldman	Seth Gainey	Evan J. Gragg
Eric Matthew Doubet	Ashley Lynn Ferguson	Ryan Gall	Robin Graham
Evan Doughty	Mackenzie Burd Fernald	Kirsten LeRay Gallagher	Ashley Grakowsky
Travis Melvin Doughty	Megan Dunleavy Ferre	Adrian Carlos Gallo	Trevor J. Grandy
Meghan Ann Dovick	Daniel R. Ferreira	Garrett Gamache	Lauren Elizabeth Graniero
Anna C. Downey	Lauren Ariel Ferreira	Joseph Patrick Gandolfi	Daniel Vincent Grant
Sarah Liam Doyle	Brandon Ferro	Jonathan Lloyd Garber	Leah Rae Grassi
Joseph Cameron Dransfield	Alisa Fersch	Lilian Garcia	Harrison James Gray
Marissa Beth Drehobl	Andrew Fields	Lizeth Caballero Garcia	Kelly Marie Gray
Nicholas Drew	Rachel Filo	Matias Nicolas Garcia	Sarah M. Gray
Nicholaus Driscoll	Katherine Megan Finan	Ollin Garcia Pliego	Aurora J. Green
Chad Drzewiecki	David Finn	Damla Gargili	Hunter Green
Lauren Dudziak	Nicole Aubree Finnegan	Ry Garlow	Jeff Green
Amanda Duggan	Evan Michael Finnes	Katherine M. Loughridge Garner	Nicholas R. Green
Joseph J. Dumont	James Mitchell Fisher	Krista Garrett	Rebecca N. Greenberger
Casey James Duncan	Timothy Farland Fitzhugh	Brandon Jordan Gaspar	Sophie Emily Greene
Ann G. Dunlea	Paul M. Fix	Eric Curtis Gaver	Sean Y. Greer
Marsha Elizabeth Dunn	Megan E. Flansburg	Sean Gaynor	Patricia Gregory
Christina Dwyer	Anson W. Flaspohler	Rachael Christina Gehrman	Jeri Ann Grevis
Eric Easley	Alexander Gist Fleshman	Adam Ansel Gehrts	Christopher Griffin
Katherine Ann Ebeling	Nicholas J. Flies	Frederick Paul Geier	Megan Charleen Griffin
Christopher Shaun Edge	Bridget Marie Floyd	Halldor Geirsson	Jonathan Gilbert Griffith
Joseph Stephen Edmonds	Barrett A. Flynn	Jennifer Lynn Georgek	Katie Rose Griffith
Joel H. Edwards	Joseph D. Flynn	Lindsey Rae Gerber	Kathleen M. Grigg
Andi Eglinton	Steph Fochtman	Questor J. German	Ashley Grijalva
Rebecca Rose Eiden	Neil Foegen	Susan Gervais	Michael Thomas Grimaldi
Mustafa Eissa	Virginia Catherine Foley	Karl Gesch	Brittany L. Grimm
Aya El Attar	Lane Berend Folkers	Amanda Getsinger	Aaron Lawrence Grissom

GSA Welcomes New Members

Jennifer Elizabeth Gross
 Noelle Choahna Guernsey
 Shannon D. Guffey
 Jon Kalani Guillaume
 Kristel Guimara
 Junhua Guo
 Tracy Stiles Gurule
 Laura Michelle Gwin
 James Morgan Haag
 Tiffany Marie Hackett
 Jennifer Rebecca Hage
 Skylar A. Haines
 Julia Halbur
 Christopher R. Halcsik
 Jarrett Christopher Hale
 Jennifer Hall
 Veronica O. Hall
 Jason Hallman
 Amy Hamby
 Coleman J. Hampton
 Joshua Earl Hampton
 Christopher Hancock
 Sebastian Chance Hancock
 Tracy E. Handrich
 Pete J. Hansen
 Jennifer Hanson
 Layla Hantash
 Ryan Hapeman
 Audrey Happel
 Ryan William Hardenburger
 Samer Hariri
 Evelyn Harker
 Ashley Marie Harper
 Daniel Harper
 Elisha B. Harris
 Jason Mitchell Harris
 Tyler Harris
 Whitney Christine Harris
 Chandler Stephen Harrison
 Michelle Harrison
 Ryan Michael Hartman
 Kristen Hope Hasbrouck
 Danielle Haskett
 Kathleen Marie Hauser
 Barbara M. Hauzenberger
 Jane Hawken
 David Witmer Hawkins
 Jared Blake Hawkins
 John Michael Hayes
 Simon Nicholas Heath
 Klaus H. Hebig
 Laura Anne Hedger
 Jennifer Heeth
 Jessica Heighton
 James A. Heim
 Devin Helfrich
 Sarah Heller
 Nora Rose Hauer Hencir
 Jennifer Kathleen Hendricks
 Stephen M. Hendricks
 Elizabeth Heness
 Stephanie Hennelly
 Jesse Henning
 David Hergesheimer

Fabio Hering
 Daniel Hermanns
 Anna L. Hermes
 Victoria Nicole Hermosilla
 Cynthia Elizabeth Hernandez
 Edween Leonel Hernandez
 Jessica Hernandez
 Jered J. Hernández-Elizalde
 Matt N. Herod
 Yesenia Herrera
 Dana M. Heston
 Chelsea Hethcote
 Eric Spider Heuneman
 David Keith Hewson
 Louis D. Heying
 Lainey Heyl
 John E. Hickle III
 Anthony Warren Hicks
 Aaron Hiday
 Brendan Hildum
 Aaron Butler Hill
 Daniel W. Hill
 Jenni Hill
 Brian Himes
 Erika Jean Hirst
 Ryan Hladyniuk
 Franklin Hobbs
 Chad Hobson
 Laura Hockenbury
 Lauren L. Hoffman
 Markus Hoffmann
 Daniel James Hogan
 Ian Hogan
 Stephanie Charlotte Hogan
 Daniel Robert Hoin
 Joshua Holand
 Justin Allen Holcomb
 Lauren Neala Holder
 Aaron Holland
 Mark Holland
 Spencer Thomas Holmes
 Mindy Beth Homan
 Madeena Homayoun
 Veronika Homolova
 David F. Hon
 Jeffrey S. Honke
 Seth Ian Hooper
 Rachael Hoover
 William F. Hoover
 Chris Ray Hooyboer
 Nathan Russell Hopkins
 Cassandra Jean Hornback
 Alexandra Michelle Horne
 Andreas Hotschek
 Nicole Houck
 Devin Hougardy
 Candice Houghton
 Kerry L. Howard
 Robert Howard
 Haleigh Daniel Howe
 John Thomas Howell
 John Hoyt
 Andrea C. Hrenchuk
 John A. Hribljan

Claire Hruby
 David P. Huber
 Michael Huber
 Scott Huck
 David Huckle
 Shahen Huda
 Amy Hudson
 Haley Alissa Huff
 Jarrett Shawn Huff
 David John Huffmyer
 Anna K. Hughes
 Natalie J. Hughes
 Robert B. Hull, V
 Mohammad Rezaul Huq
 Keegan Allen Hurt
 Michael John Hurth
 Yahaira Marie Hutchinson
 Alexander Huth
 Tyler Huth
 Sun Hwang
 Diar Ibrahim
 Fumie Iizuka
 Kate Ingenloff
 Jeffrey Scott Ingram
 Scott M. Ireland
 Rodrigo Iriarte
 Sergey Ishutov
 Olivia Iverson
 Kesli Ivy
 John J. Jacisin III
 Carl Jonathan Jacklitch
 Ashley Jackson
 Taylor Leigh Jackson
 Juan C. Jaimes
 Krista Lyn Jankowski
 Kimberly Jarden
 Briana L. Jasinski
 Akhtar Javaid
 Anna Sophie Jaworski
 Sarah Jeffrey
 Nicolas Jelinski
 James Edward Jenden
 Charles Wesley Jenkins IV
 Emily N. Jenkins
 Jerica Jenkins
 Christopher Jennings
 Matthew Clay Jenschke
 Hehe Jiang
 Peng Jiang
 Qiqi Jiang
 Gloria Jimenez
 Cong Jin
 India John
 Beth A. Johnson
 Brandon C. Johnson
 Chris William Johnson
 Christina F. Johnson
 Curtis Lawrence Johnson
 Dane Johnson
 Elle Elisa Johnson
 Gina M. Johnson
 Julie Johnson
 Madison Lauren Johnson
 Andreas Jack Johnsson

Joel Phillips Johnston
 James Jolles
 Atunima Emmanuel Jonathan
 Evan Jones
 Matthew Christopher Jones
 Matthew F. Jones
 Meghan R. Jones
 Steven A. Jones
 Jessica Caitlin Jordan
 James Robert Jorgensen
 Taus R. Chraemmer Jørgensen
 David H. Ju
 Karla Juarez-Lopez
 James Kaapana
 Abhy Kadakia
 Fotios-Christos A. Kafantaris
 Maureen J. Kahn
 Benjamin Carl Kaiser
 Joseph Anthony Kalbarczyk
 Stephen Kallenberg
 Taka Kanaya
 Mike Kane
 Michael Alex Kang
 Philip A. Kaplan
 Melpomeni M. Karathanos
 Bobak Karimi
 Sita Karki
 Rachel Elena Karlov
 Kalyan Karmakar
 Carol Karns
 Laura Karson
 Brian Christopher Kastl
 Aaron John Katona
 Rick M. Kauffman
 Mahir Kaya
 Thomas V. Kazmierczak
 Tyler M. Keck
 Martin Keeler
 Klaus-Peter Keilig
 Daniel C. Kelley
 Gwendolyn Virginia Kelley
 Robert James Kelley
 Caitlin Kelliher
 Fred Kellner
 Rosemary G. Kelly
 Heather Kendall
 Jamie R. Kendall
 Siobhan Kenney
 Scott Brian Kenyon
 Nathan Robert Kerns
 Phillip James Kerr IV
 Jeff Kerwin
 Sean Patrick Kerwin
 Nicole S. Khan
 Nitesh Narendra Khonde
 Jennifer Rose Kielhofer
 Meredith Ann Kiesel
 William C. Kimmel III
 Julien Kimmig
 Sara Janene King
 Arthur M. Kinne
 Sean Kinney
 Clara Jeanene Kirk
 Kelsey Kirkland

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Katie Kirsch
 Louise M. Kiteley
 Matthew Jordan Klebanoff
 Marin Jane Klinger
 Sarah Luciana Klingler
 Brian Daniel Klipp
 Scott M. Kloubec
 Timothy Charles Knapp
 Eric Nathaniel Knoedler
 Katja Knoll
 Michael Köbberich
 Brett Aric Koca
 Carrie Koch
 Robert Carl Koch Jr.
 Jennifer Kolm
 Brant Evan Konetchy
 Hamed Hooshmand Koochi
 Kraig Jerrold Koroleski
 Jesse P.J. Koroscil
 Caitlyn S. Korren
 Adam Mark Koster
 Maneh Kotikian
 Nicole Kotlan
 Sarah Railli Kowall
 Rebecca Kraft
 Adam James Kranz
 Vyt Krasauskas
 Laura Kratz
 Todd M. Kremmin
 Kevin Joel Kresch
 Stephanie Kromhout
 Timothy Andrew Kropp
 Montana J. Krukowski
 Ania Krzywicki
 Jeff Kubran
 Maja Kucharczyk
 Kyle John Kucker
 Harold Kuehn
 Cameron Scott Kuney
 Kayla Kurtz
 Kleighton Kutz
 Wesley Allen Labor
 Taylor Susan LaBrecque
 Loren Labusch
 Taylor LaCasse
 Crystal K. LaFlamme
 Anthony Taylor LaFon
 Adriane R. Lam
 Colin Patrick Lamb
 Jennifer Lynn Lamp
 Matthew N. Lancaster
 Ashley Landers
 Jeffrey Allan Landis Jr.
 Claire Landowski
 Kyle Richard Landry
 Kelley Marie Lange
 Amanda Lanning
 Kristiana Lapo
 Patrick Laquer
 Clifton Russell Largess III
 Mark Oscar Larson
 Natalie Jane Larson
 Reneilwe Lasarwe
 Keith Lassman

Parker Laubach
 Nicholas R. Lawhon
 Andrew Christian Lawrence
 James Leask
 Alexandra Lee
 Christina Lee
 Madeline Lee
 Jessica L. Lehman
 Malia Laina Lehrer
 Eric Lemke
 Anthony Lenci
 Zach P. Lenth
 Samantha Elaine Leone
 Caitlin Elizabeth Leslie
 Stephen J. Levas
 Mariya Levina
 Jana Levison
 Piper Elizabeth Lewis
 Lin Li
 Paul Lidstone
 Lauren B. Lighthart
 Brianna M. Lind
 Clinton James Lindgren
 Cary Lindsey
 Emily L. Lindsey
 Thomas Jason Liner
 Derrick Lingle
 Rachel C. Lippoldt
 Peyton Everett Lisenby
 Micah Lisk
 Ryan Cutrone Littlewood
 Huan Liu
 Junzhe Liu
 Yiduo Liu
 Yi-Wei Liu
 Bridget Livers
 Lucy Fay Livesay
 Robert Livesay
 Danijela Ljepoja
 Max Kaufmann Lloyd
 Leanna Lockhart
 Thomas Drury Lockwood
 Katherine Helen Lodder
 Christopher J. Lombardi
 Eric Matthew Lonetti
 Brian M. Long Jr.
 Brooke Lamonte Long
 Kristy Jeanne Long
 Rebecca Lopez
 Jorge Lorenzo Trueba
 Joseph Grant Losoya
 Dylan P. Loss
 Bertha Louis
 Amber Michelle Lounsberry
 Patrick Loury
 Erin Love
 Chris Lowe
 Katherine Lowe
 Erin Elizabeth Lower
 Gregor Lucic
 Michael I. Ludlam
 Deborah Ludrosky
 Kara Ludwig
 Elizabeth Anne Lundstrom

Jason Paul Lundy
 Rebecca Lybrand
 Andrew William Lyda
 Chelsea Ann Lyle
 Glenn Alan Lynde
 James Brice Mabry
 Mary Kate Cecilia MacDonald
 Christina Machak
 Melissa K. Macias
 Nicholas Paul Macintyre
 Kristen Antoinette MacKenzie
 Kirsty MacLeod
 Elizabeth H. Madden
 Pilar Madrigal
 William Magee
 Stephanie Marie Mager
 Tiffany Sue Mahan
 Masoumeh Mahdavi
 Nicole Elaine Mainwaring
 Julie Marie Makar
 Sarah Ann Makin
 David Maldonado
 Alaina Mallette
 Cathryn Mallonee
 Issa Mamam Nbiba
 Sankar Manalilkada Sasidharan
 Luca Mancinelli
 Sanjay Kumar Mandal
 Matthew Manfredonia
 Margot Mansfield
 Fernando Mantilla-Durán
 Mehmet Maral
 Sandra G. Marek
 Chris Mark
 Sarah Marks
 Amanda Marie Marquez
 Kara Marsac
 Nicolette Marie Marschke
 Brittney Joy Marshall
 Gary T. Marshall
 Haleigh Jane Marshall
 Benjamin Taylor Martin
 Carl Albert Martin
 Jean-Philippe Martin
 Josephine Martin
 Kristina Martin
 Shannon Elizabeth Martin
 Tyler Martin
 Zachary James Martin
 William Martin-Black
 Kelly Mary Marton
 Lenny Masciangioli
 Stefanie M. Massignan
 Charles B. Masters
 Andrew Douglas Matsumoto
 Rachel Matt
 James P. Mauch
 Ginny Mauldin-Kinney
 Lindsey Marie Maurer
 Skyler P. Mavor
 Abigail Arielle Maxwell
 Andrea Mayus
 Kristen E. McCall
 Laura McCaughey

Kimberly Laura Alison McCaw
 Erica L. McConkey
 Allison McConnell
 Colleen McConville
 Rebecca Gabrielle McCracken
 Charles McCrackin
 Ailsa McCulloch
 Robert Gregory McDermott
 Jacob Michael McDonald
 Bo Allen McDougald
 George S. McFadden
 Austin McGlannan
 Brendan Patrick McGowan
 Casey McGuffy
 Sherri Lynn McIlrath
 Michael Zackery McIntire
 Susan Kay McKenzie
 Samuel Tyson McKinney
 Meghan Leigh McKnight
 Victoria Elizabeth McLaughlin
 Rachel McLaughlin
 Annalize Querida McLean
 Heather Lynn McMillian
 Brian McMullen
 Justin McNabb
 Christine Marie McNiff
 Benjamin McPherson
 Caitlin Ana Meadows
 Derek Meadows
 Katherine Meek
 Lauren Michelle Meeker
 Rachael Marie Megnia
 Daniel Meidel
 Bethany Morgan Meier
 Emily Maria Mellicant
 Dianne Ruth Meltzer
 Sarah Menassian
 Steve Menges
 David Adam Mertz
 Graham Messe
 Schuyler Van Antwerp Metcalf
 Kyle Shuhert Metcalfe
 Farag Mewafy
 Aurelien Gabriel Meyer
 David Francis Meyer
 Eric Meyer
 Justin L. Miceli
 Justin Michael
 Zachary David Michels
 Tyson Robert Milbrand
 Kimberly Anne Miles
 Lauren Milideo
 Corey Thompson Miller
 Daniel Nicholas Miller
 Ian Virgil Miller
 Joshua Keith Miller
 Megan Marie Miller
 Samuel E. Miller
 Scott Rinehart Miller
 Silas Miller
 Kurtis Levi Milliron
 David C. Mills
 Arthur Scott Minar
 Lucy Miner

Joseph Robert Mingrone
 Daniel Aaron Minguez
 Thomas Miszkiel
 Frank M. Mitlin
 Mridul Mittal
 Daniel Mizsei
 Meagan E. Mnich
 Alex Moats
 Jacob Marlin Moen
 Reda Mohammed
 Emily Katherine Mohr
 Roya Monadjemi
 William Montz
 Brandi R. Moore
 Dennaë Andre Moore
 Keith David Moore
 Rebecca Moore
 Steven Joseph Moorhead
 Alexander Morgan
 Brian Morgan
 Abigail Lauryn Morris
 Derek Morris
 Dominic Morris
 John Joseph Morris
 Richard Ryan Morriss
 Savannah Morrow
 Khashayar Mortazavi
 Annie Gabrielle Mosher
 Stella G. Mosher
 Dago Andres Mosquera
 Darryl Alan Mott
 Meg Motz
 Rusty Mourning
 Seyed Zahed Mousavi Alouji
 Mohamed Salem Moustafa
 Dan Moyer
 Chase Mueller
 Jason G. Muhlbauer
 Keith N. Muhlestein
 Muhammad Ma'rif Mukti
 Isaac Mulamba
 Connor Patrick Mulcahy
 Julia Mulhern
 Riley Mulhern
 Bethany Murphy
 Megan A. Murphy
 Robert J. Murphy
 Rachel Helen Murray
 Monica Rose Mustain
 Christopher Myers
 Matthew M. Myers
 Marcy Nadel
 Brynley M. Nadziejka
 Tetsuro Nagase
 John Robert Nance
 Rodrigo Alberto Narro Perez
 Mallery May Navis
 Ahmed Amr Nayel
 Lorraine Marie Negron
 Kristin Melissa Negrycz
 Nicole Neira
 Kaitlyn Nelson
 Petros Georgios Neofotistos
 Jacquelyne Nesbit

Ian M. Nesbitt
 Levi P. Neukirch
 Mark Neumeyer
 Robert Neusel
 Johanna Nevitt
 Julie Jean New
 Alexander Scott Newberry
 Eli Newby
 Chris Newton
 Melanie N. Newton
 Tuong Nguyen
 Four Nomor Nichols
 Lydia B. Nickolas
 Alexis Nielsen
 Bryan R. Nielson
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GSA's Penrose Conferences were established in 1969 to provide opportunities for the exchange of current information and exciting ideas in geology and related fields and to stimulate and enhance individual and collaborative research. Go to www.geosociety.org/Penrose/ for guidelines and a proposal form.

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

Questions? Contact Becky Sundeen, +1-303-357-1041, bsundeen@geosociety.org.

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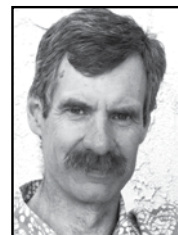
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GSA Annual Meetings Look Toward the Future

2013	<i>125th Anniversary Event</i> , 27–30 October, Denver, Colorado, USA (<i>see p. 63 to learn more</i>)
2014	19–22 October, Vancouver, British Columbia, Canada
2015	1–4 November, Baltimore, Maryland, USA
2016	6–9 November (tentative), Denver, Colorado, USA
2017	22–25 October, Seattle, Washington, USA
2018	4–7 November, Indianapolis, Indiana, USA

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Last Call for Nominations 2013 OFFICERS & COUNCILORS

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 2013.

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 <https://rock.geosociety.org/forms/officerNomform.asp> or you may send nomination materials to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA, pfistell@geosociety.org

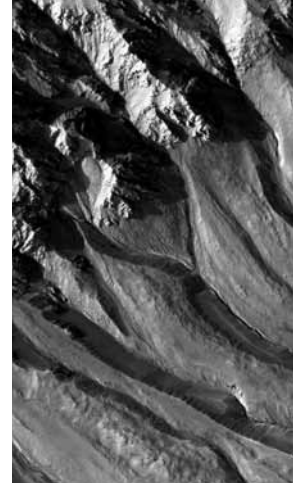


GSA International Distinguished Lecture Tour 2012
GSA Distinguished International Lecturer:
Victor R. Baker

The Geological Society of America is proud to introduce the inaugural International Distinguished Lecture Tour, arranged under the auspices of GSA's International Section.

This year's speaker, University of Arizona Regents' Professor Victor R. Baker, will be presenting talks on two different themes: "Megafloods on Earth, Mars, and Beyond" and "Geological History of Water on an Earth-Like Planet." Learn more at www.geosociety.org/Sections/International/LectureTour.htm.

GSA seeks to be a leader in promoting programs that actively involve the global community in geoscience activities, in fulfillment of our strategic goals. This tour is another step forward in communicating the importance and relevance of the geosciences in a global context.



Gullies with Characteristics of Water-Carved Channels. False-color image of gully channels in a crater in the southern highlands of Mars, taken by the High Resolution Imaging Science Experiment (HiRISE) camera on the Mars Reconnaissance Orbiter. The gullies emanating from the rocky cliffs near the crater's rim (upper left) show meandering and braided patterns typical of water-carved channels. North is approximately up and illumination is from the left. Credit: NASA/JPL/University of Arizona.



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2013–2014 Committee Vacancies

Deadline to apply or submit nominations: 15 July 2012

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Academic and Applied Geoscience Relations (AM, T/E)	three	3 years
Annual Program (AM, B/E)	two	4 years
	one	2 years
Arthur L. Day Medal Award (T/E)	two	3 years
Diversity in the Geosciences (AM, T/E)	three	3 years
eGSA (AM, T/E)	two	3 years
Education (AM, B/E, T/E)	three	4 years
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Geology and Public Policy (AM, B/E, T/E)	one	3 years
Joint Technical Program (T/E)	three	2 years, starts 1 Dec. 2012
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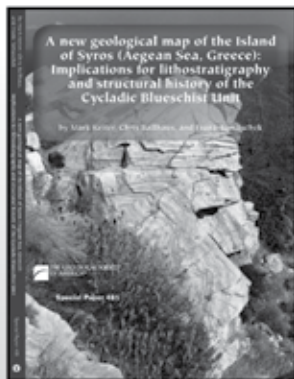
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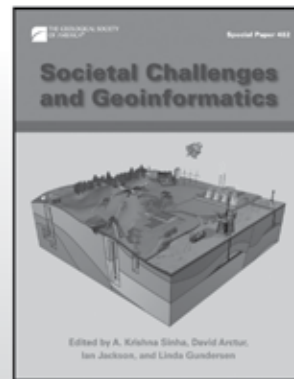
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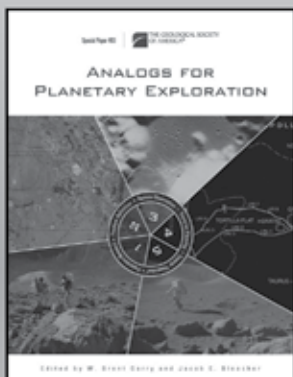
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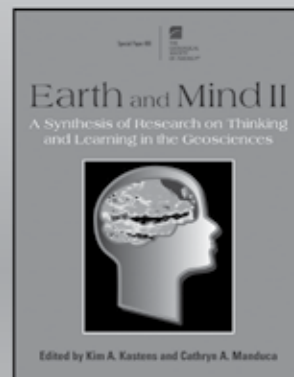
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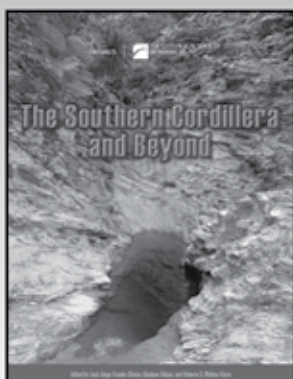
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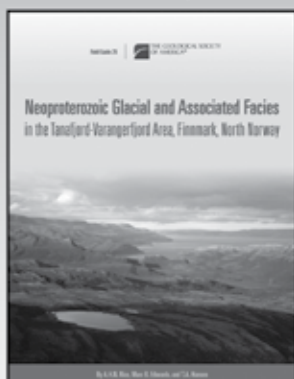
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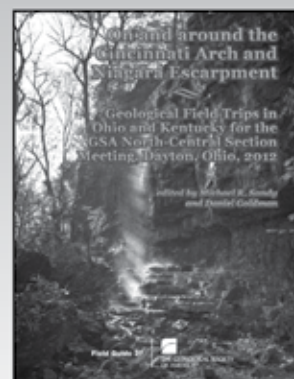
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Patrick B. Luetkemeyer (student rep), University of Saint Louis
Franz R. Neubauer, University of Salzburg
David T. Allison, University of South Alabama
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Franklin T. Heitmuller, University of Southern Mississippi
Irwin D. Novak, University of Southern Maine
Jeffrey G. Ryan, University of South Florida
Eve M. Arnold, University of Stockholm
Jonathan Aitchison, University of Sydney
R. Dietmar Muller, University of Sydney

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Robert D. Hatcher Jr., University of Tennessee–Knoxville
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Lydia K. Fox, University of the Pacific
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Richard H. Becker, University of Toledo
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John M. Bartley, University of Utah
Joanne Bourgeois, University of Washington
Glenn R. Osburn, University of Washington
J. Brian Mahoney, University of Wisconsin–Eau Claire
Steven I. Dutch, University of Wisconsin–Green Bay
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Section Meeting Talks Online



Did you hear a great talk at a recent GSA Section meeting and want to view additional information from the presenter? Or did you miss the meeting and want to view some of the material that was presented from an abstract that intrigued you? Presenters have been given the opportunity to upload their talks, handouts, and/or slides to the GSA website. Access to the uploaded files is free and easy:

1. Go to www.geosociety.org/meetings/searchabstracts.htm.
2. Find the meeting you are interested in and select "Search Abstracts."
3. On the next page, click on the link near the bottom (under the searchable days): "View Uploaded Presentations."
4. Open the abstract you are interested in, and select the item(s) under "Handouts."

Due to their size, these files may take some time to load. These files will remain linked to the searchable abstracts indefinitely.



CALL FOR AWARD NOMINATIONS & APPLICATIONS

GSA DIVISION PROFESSIONAL AWARD

Deadline: 15 July

2013 Mineralogy, Geochemistry, Petrology, and Volcanology (MGPV) Division Distinguished Geologic Career Award: Submit (1) a cover letter (three page max.) from an MGPV Division member summarizing the nominee's most important accomplishments in geologic approaches to mineralogy, geochemistry, petrology, and/or volcanology. Special attention should be paid to describing how the nominee's published work demonstrates field-based multidisciplinary geologic accomplishments of a ground-breaking nature. The letter should include (1) the name, address, and contact information of the nominator as well as those from whom letters of support can be expected (they need not be members of GSA or the MGPV Division); (2) the nominee's CV; and (3) three letters of support to J. Alex Speer, Mineralogical Society of America, 3635 Concorde Pkwy, Suite 500, Chantilly VA 20151-1110, USA; jasper@minsocam.org. Nominees need not be citizens or residents of the United States, and GSA membership is not required. For more information on this award, go to www.geosociety.org/divisions/mgpv/documents/awardNoms.pdf.

GSA DIVISION STUDENT AWARD

Deadline: 1 August

The Kerry Kelts Student Research Awards of the Limnogeology Division for undergraduate or graduate student research is named in honor of Kerry Kelts, a visionary limnogeologist and inspiring teacher. This year, **one** award of US\$1,000 for research related to limnogeology, limnology, or paleolimnology is offered. To apply, send a summary of the proposed research, its significance, and how the award will be used (five-page max.) in PDF format (include your name in all PDF file titles) along with your name and a short CV (two-page max.) to the chair of the Limnogeology Division, Daniel M. Deocampo, at deocampo@gsu.edu. Awards will be announced at the Limnogeology Division Business Meeting and Reception at the 2012 GSA Annual Meeting in November.

Division members: GSA hopes to increase the number of these awards in the future, and your membership dues help with this important activity. If you are interested in supporting this awards program more substantially, please send your donations, designated for the Kerry Kelts Research Awards of the Limnogeology Division, to GSA Grants, Awards & Recognition, P.O. Box 9140, Boulder, CO 80301-9140, USA.

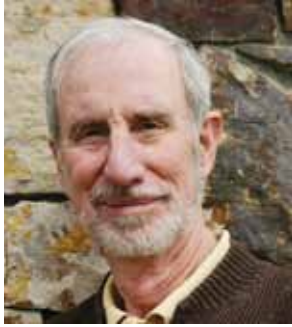
Questions? Contact GSA Grants, Awards & Recognition, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, USA, +1-303-357-1028, awards@geosociety.org.



GSA FOUNDATION UPDATE

P. Geoffrey Feiss, GSA Foundation President

GSA's Support of Research over the Past 124 Years



For GSA's first four decades, we can only document that the Society held annual meetings and published *GSA Bulletin* and various monographs in support of geological research. All that changed in 1931. The Society learned that Richard Alexander Fullerton (RAF) Penrose Jr. had named GSA, along with the American Philosophical Society,

as the recipient of the bulk of his estate—for purposes unspecified. Penrose was no stranger to GSA, having served as the Society's president in 1930. The Council minutes of 10 Dec. 1934 report that GSA received a check for US\$3,884,684.42 along with Penrose's library and office furniture. Most of the latter now resides at GSA headquarters in Boulder.

How the Society responded to its good fortune is well-chronicled by Ed Eckel, a former GSA executive director, in his centennial history of the Society (GSA Memoir 155: *The Geological Society of America: Life History of a Learned Society*). GSA had already decided, a year or two prior to the Penrose bequest, that it should support research, but only via small grants to complete and publish already mature research projects. Soon thereafter, however, GSA began awarding research grants, in their own words, "[i]n exceptional cases . . . to experienced workers to start new research projects." It surprised me to learn that among these grants in the mid-1930s were several to the USGS to allow projects to continue during the Depression when all Survey geologists were required to take unpaid furloughs.

In the 1930s, all GSA members were professional geologists, so students were ineligible for grants. That began to change in the mid-1950s—first with up to 10% of research funds designated for Ph.D. candidates. Over the next few decades, the focus shifted further, with a greater proportion of GSA research funds being allotted to students, with master's students becoming eligible, and eventually with all GSA research funds being allocated for student research—even some for undergraduates.

This brings us to today. In 2012, 636 students applied for grants. The 24-member GSA Research Grant Committee awarded 303 research grants, totaling US\$554,164. These funds came from GSA's Joseph T. Pardee Fund, contributions by GSA Divisions and Sections, the National Science Foundation, and the GSA Foundation. The Foundation's contributions are generated from the income on ~20 named funds in support of research and from unrestricted donations from generous GSA members each year.

The demand is clearly there. Could we do more? Is the 125th Anniversary of GSA an opportunity to ramp up our support of student research?

I hope each GSA member will give these questions some thought. Did you, an office mate, or a colleague receive a GSA research award? Have students in your department received such support? And, if you were not among the fortunate few, can you imagine how US\$1,829 (the 2012 average grant) could have furthered your own research when you were a student?

Imagine the impact on our profession in future decades if, to honor GSA's 125th Anniversary, we were able over the next few years to increase the number of student research grants each year by 125 (a 40% increase over 2012). That would require additional annual contributions by members, corporations, and others—gifts that over GSA's next 125 years could support the research of more than 15,000 aspiring geoscientists.

Think about joining in this effort by making a first gift or a larger than normal gift in honor of GSA's birthday to the GEOSTAR endowment for Student Research or to any of the Foundation's named research funds (see www.gsafweb.org/ProgramSupport/gsastudentreasear.html).

You can make a contribution to the GSA Foundation at www.gsafweb.org/makeadonation.html or by contacting Anna Christensen, Chief Development Officer, GSA Foundation, +1-303-357-1007, achristensen@geosociety.org.



In Memoriam



The Society notes with regret the deaths of the following members (notifications received between 6 January and 30 April 2012).

William M. Adams
Ferndale, Washington, USA
Notified 27 Apr. 2012

John F. Akerley
Silver Spring, Maryland, USA
29 Apr. 2012

Walther M. Barnard
Fredonia, New York, USA
1 Jan. 2010

Bruce F. Curtis
Boulder, Colorado, USA
15 Feb. 2012

Graham R. Curtis
Chino, California, USA
18 Mar. 2012

Robert J. Deacon
Tillamook, Oregon, USA
Notified 14 Feb. 2012

John J. Donohue
Danvers, Massachusetts, USA
Notified 27 Feb. 2012

Kenneth E. Eade
Ottawa, Ontario, Canada
10 Feb. 2011

Alfred J. Frueh Jr.
Pelham, New York, USA
23 Mar. 2012

James L. Harding
Mobile, Alabama, USA
21 Sept. 2010

Richard A. Hoppin
Iowa City, Iowa, USA
6 Jan. 2012

Rodney V. Kirkham
Delta, British Columbia,
Canada
29 Feb. 2012

Chao-Li J. Liu
Champaign, Illinois, USA
Notified 23 Apr. 2012

Jim O'Donnell
Pasadena, California, USA
Notified 8 Mar. 2012

Henry D. Olson
Houston, Texas, USA
Notified 22 Feb. 2012

Richard E. Opper
Edmond, Oklahoma, USA
12 Sept. 2011

Claude M. Quigley Jr.
Cibolo, Texas, USA
Notified 21 Feb. 2012

Robert Raskin
Pasadena, California, USA
2 Mar. 2012

Carl Reiterman
Ashland, Oregon, USA
22 Jan. 2012

Perry O. Roehl
San Antonio, Texas, USA
Notified 21 Feb. 2012

Pierre Saint-Amand
Ridgecrest, California, USA
Notified 15 Jan. 2012

James B. Thompson Jr.
Cambridge, Massachusetts,
USA
1 Nov. 2011

John H. Way
Lock Haven, Pennsylvania,
USA
Notified 20 Mar. 2012

James E. Werner
Houston, Texas, USA
21 Jan. 2012

Frank C. Whitmore Jr.
Silver Spring, Maryland, USA
18 Mar. 2012

David V. Wiltschko
College Station, Texas, USA
2 Mar. 2012

Scott Woods
Missoula, Montana, USA
Notified 23 Apr. 2012

To honor a friend or colleague with a GSA Memorial, please go to www.geosociety.org/pubs/memorials/mmlGuid.htm to learn how. Contact the GSA Foundation, www.gsafweb.org, if you would like to contribute to the Memorial Fund.



About People

GSA Fellow **Dennis Kent**, a leading expert in the history of Earth's magnetic field, has been elected to the American Academy of Arts and Sciences. Other members of the 2012 class include U.S. Secretary of State Hillary Rodham Clinton, playwright Neil Simon, and Hollywood director Clint Eastwood.

GSA member **Michael Mann** has been awarded the European Geosciences Union's 2012 Oeschger Medal "for his significant contributions to understanding decadal–centennial scale climate change over the last two millennia and for pioneering techniques to synthesize patterns and northern hemispheric time series of past climate using proxy data reconstructions."

GSA Fellow **Susan L. Brantley**, Distinguished Professor of Geosciences in the Earth and Environmental Systems Institute at Penn State, and GSA member **Patricia Dove**, C.P. Miles

Professor of Science at Virginia Tech, have been elected to the U.S. National Academy of Sciences in recognition of their distinguished and continuing achievements in original research.

GSA Fellow **Sean C. Solomon**, "a leading geophysicist whose research has combined studies of the deep earth with missions to the moon and the solar system's inner planets," has been appointed as director of Columbia University's Lamont-Doherty Earth Observatory.

GSA Fellow **David R. Lageson** of Montana State University (MSU) is a climber on the current North Face/National Geographic/MSU Mount Everest expedition and will take on the mountain's Southeast Ridge. Learn more at www.montana.edu/everest/.

Register Today!

www.geosociety.org/meetings/2012/reg.htm

Full meeting registration fees run from US\$40 to US\$430 through 1 October. Some travel grants are available (see www.geosociety.org/meetings/2012/grants.htm).

Submit an Abstract — *Oral, poster, or digital poster!*

www.geosociety.org/meetings/2012/techProg.htm

Abstract deadline: **14 August**

Our Sessions Have Something for Everyone

This year we'll have three Special Sessions, six Pardee Keynote Symposia, and 181 Topical Sessions, as well as Discipline Sessions for your particular specialty.



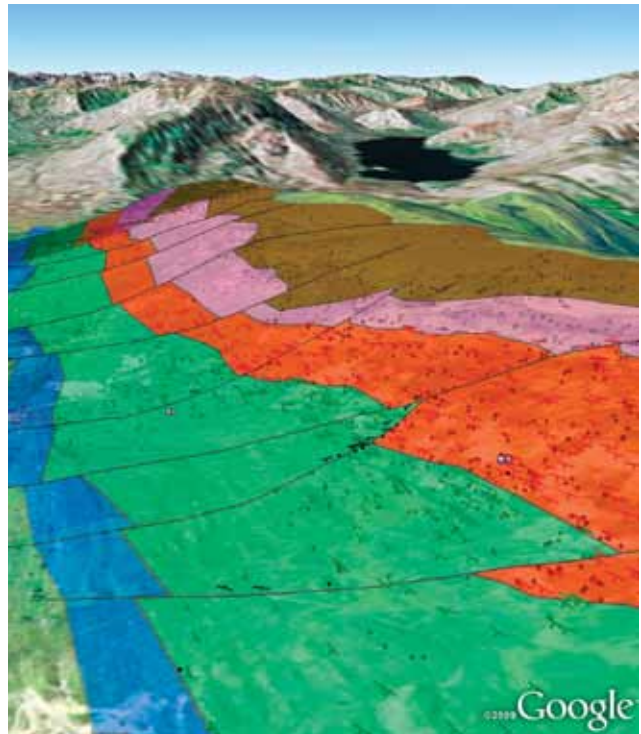
GSA ANNUAL MEETING & EXPOSITION

4–7 NOVEMBER 2012 • CHARLOTTE, NORTH CAROLINA, USA

Pardee Keynote Symposia Highlights

Symposia are special sessions consisting of invited abstracts on innovative topics presented in a creative way.

P1. Digital Geology Speed-Dating: An Innovative Coupling of Interactive Presentations and Hands-On Workshop, with Declan G. De Paor, Steven Whitmeyer, and John E. Bailey. This new style of Pardee Keynote Symposium features six simultaneous presentations that will occur at adjacent digital poster stations. Presentation topics will include digital field work, GigaPan imaging, KML and Google Earth API scripting, digital data portals and dynamic digital maps, 3D COLLADA models and Google SketchUp, and virtual field experiences and Google Earth tours. Six active participants will be invited to sit in front of each station with laptops and directly engage with the material being presented. Participants will rotate to a new station every half hour. Standing room for observers will be available behind the seated participants. *Cosponsored by the GSA Geoinformatics Division; GSA Geophysics Division; GSA Geoscience Education Division; and GSA Structural Geology and Tectonics Division.*



Cover of April/May 2010 *GSA Today*: Westward-looking view of a Google Earth-based geologic map of the mountain of Knock Kilbride, Ireland.



USGS scientists studying old organic carbon in the Yukon River, Alaska, USA. Image courtesy USGS: <http://gallery.usgs.gov/sets/Carbon>.

P6. Understanding Earth through Carbon, with Craig M. Schiffries, Robert M. Hazen, and Russell J. Hemley. The Deep Carbon Observatory (DCO) is an international, interdisciplinary, decade-long initiative to improve our knowledge of the deep carbon cycle and foster a fundamental understanding of Earth through carbon. This session addresses DCO's goals: (1) to improve our understanding of the physical and chemical behavior of carbon at extreme conditions found in planetary interiors; (2) to identify the principal deep carbon reservoirs and fluxes and to assess Earth's total carbon budget; (3) to document the nature, sources, and evolution of subsurface organic molecules, including hydrocarbons and biomolecules; and (4) to assess the nature and extent of the deep microbial biosphere. *Cosponsored by the Deep Carbon Observatory.*



**Come to Learn
Make Time
to Play!**



Photo by Patrick Schneide, courtesy of Visit Charlotte.

CHARLOTTE

Over the next few months we will highlight some of Charlotte’s eclectic neighborhoods, family-friendly adventures, and local spots for Carolina brews. In addition to having the nation’s second-leading financial district, Charlotte offers some of the most diverse streetcar-era neighborhoods and tree-lined streets scattered with boutiques and restaurants. You will be surprised when you arrive in the Queen City!

SOUTH END—A trolley-stop away from Center City, South End pairs restaurants, antique shops, and trendy stores with performing and visual arts, monthly gallery crawls, and festivals.

➔ **Places to Eat**

- **Price’s Chicken Coop** features some of the best fried chicken around.
- **Pewter Rose Bistro** serves up fresh, local dishes and boasts a wine list more than 200 selections long.
- **Icehouse** serves casual American fare complemented by more than 200 beers.
- **Amos’ Southend** offers live indie, local, and national bands.

➔ **Places to Shop**

With the world’s furniture capital just down the road, Charlotte’s furniture district gets designs from renowned showrooms.

- **The Furniture Connector** and **Boulevard Bazaar** both feature visually stunning collections.
- **Elder Gallery** hosts monthly exhibitions and represents more than 50 American and European artists working with a variety of media.
- **Canine Café:** Teach your dog new tricks with all-natural biscuits, cookies, and cakes.

NODA—This mill-community-turned-arts-district is bohemian chic, with live music, vibrant restaurants, and gallery crawls. Learn more at www.noda.org.

➔ **Places to Eat**

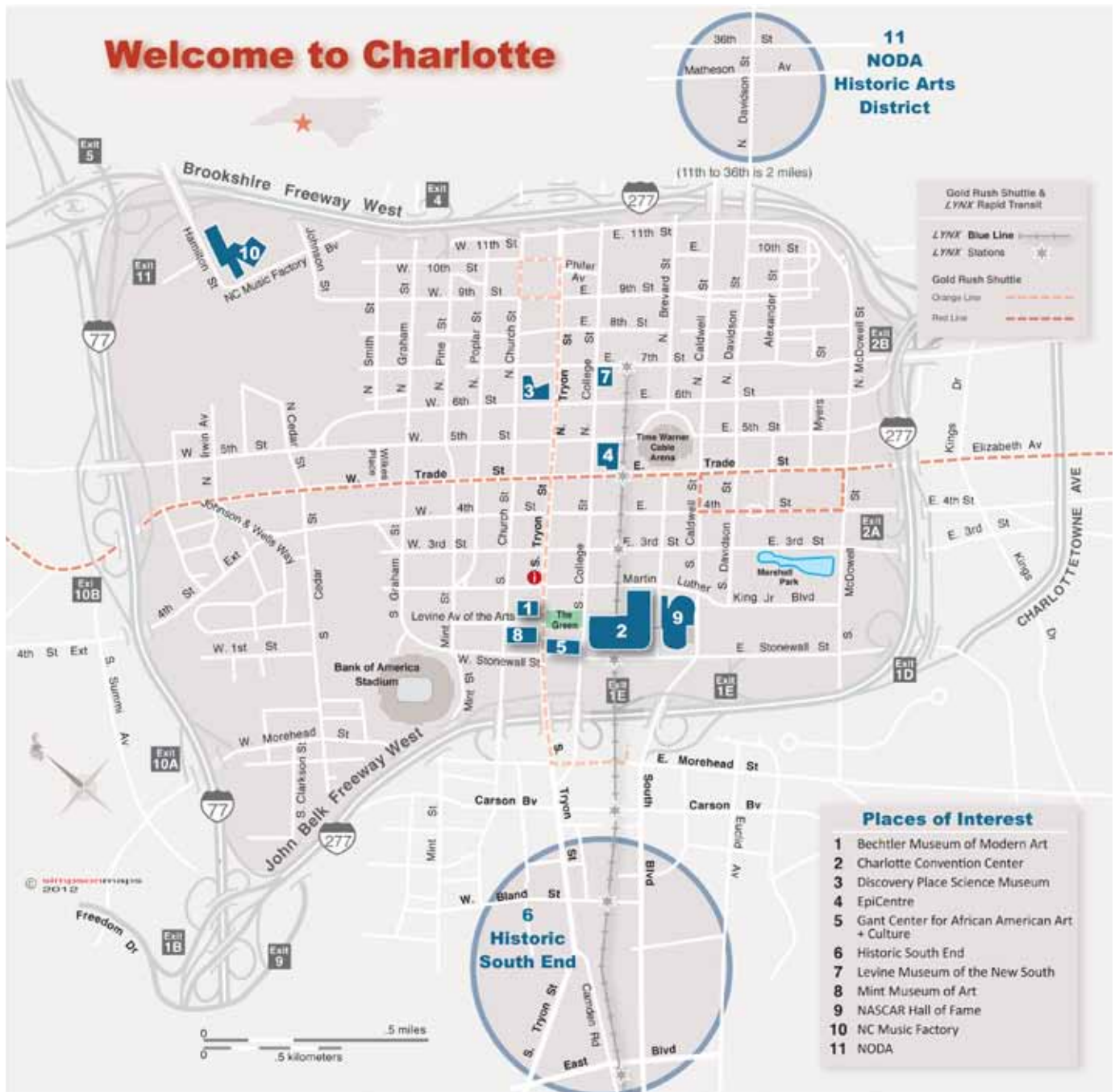
- **Cabo Fish Taco** for the best fish tacos in town.
- **Crêpe Cellar Kitchen & Pub** offers tasty French-baguette pizzas and sandwiches, but the savory crêpes are the star attraction.
- **Growlers Pourhouse** serves all-American craft beer as well as “beer food” like house-made hot dogs, peel-and-eat shrimp, and soft pretzels.
- **The Evening Muse** offers an amazing array of live music, from blues to hip-hop.

➔ **Places to Shop**

- **Red@28th** is a multicultural, independent bookstore/wine bar/community gathering spot.
- **Sunshine Daydreams’** eclectic selection includes funky jewelry, vintage concert t-shirts, and tie-dye and hemp goods.

For more information on these and other Charlotte neighborhoods go to www.charlottesgotalot.com/default.asp?charlotte=75.

GSA ANNUAL MEETING & EXPOSITION



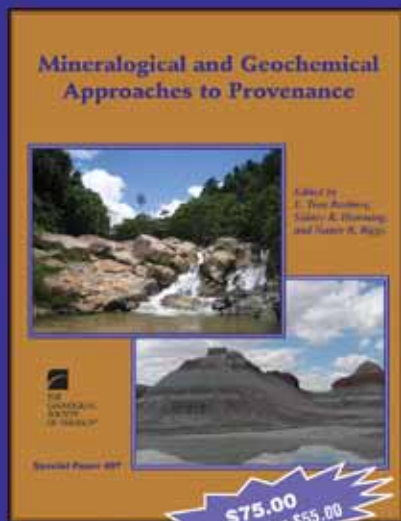
U.S. National Whitewater Center. Photo courtesy of Visit Charlotte.



U.S. National Whitewater Center. Photo courtesy of Visit Charlotte.

Mineralogical and Geochemical Approaches to Provenance

Edited by E. Troy Rasbury,
Sidney R. Hemming, and Nancy R. Riggs



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SPECIAL PAPER 487

Major advances have been made in the use of elemental and isotopic analyses of individual minerals and whole rocks in providing insights into the source of sediments and sedimentary rocks as well as the unroofing histories of the landscapes that were eroded to produce the sediments. The eleven chapters in this volume are quite varied and are arranged into three general categories, although many of the chapters combine several of these approaches to address provenance questions: (1) isotope and fission-track dating of minerals, and additional insights from geochemistry and radiogenic isotopes; (2) uses of heavy minerals, relative abundance, isotope fingerprinting, and compositions of the minerals; and (3) automated point counting.

SPE487, 194 p., ISBN 9780813724874, \$75.00, member price \$55.00

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Most of GSA's 4,500 followers are "geotweeps"—your fellow scientists, students, and colleagues.

LINKEDIN

GSA is LinkedIn at www.linkedin.com/company/52036. We invite GSA members and interested geoscience professionals to use this space for discussion and networking opportunities.

www.geosociety.org/community/

Classified Rates—2012

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	\$8.95	\$8.70
Fellowship Opportunities	\$8.95	\$8.70
Opportunities for Students		
First 25 lines	\$0.00	\$4.75
Additional lines	\$4.75	\$4.75

Positions Open

TWO TENURE-TRACK FACULTY POSITIONS DEPARTMENT OF EARTH SCIENCES UNIVERSITY OF MINNESOTA

We invite applications for two tenure-track faculty positions at the Assistant Professor level, one in the general area of Earth Surface Processes and one in the general area of Hydrogeologic Processes. We are seeking colleagues who will build innovative research programs and complement and extend our research and teaching strengths.

Areas of focus for the Earth Surface Processes position could include physical, chemical, and/or biological aspects of Earth-surface dynamics and evolution; for example, interactions of tectonic, glacial, and/or coastal systems with landscapes; research on changing surface environmental conditions and their causes in modern or ancient systems; critical zone processes; planetary surface dynamics; natural hazards; surface response to climate change; or near-surface processes associated with energy, mineral, and water resources.

Areas of focus for the Hydrogeologic Processes position could include physical, chemical, and/or biological aspects of groundwater geology; for example, groundwater, solute, and/or energy transfer dynamics; groundwater-lake-surface water interactions; environmental hydrogeology; groundwater and climate change; connections between hydrogeologic processes and tectonics, seismicity, landscape evolution, ore genesis; role of groundwater in biological and/or geochemical cycles; or life in extreme environments.

Successful candidates will teach courses in their fields of expertise at the undergraduate and graduate levels and will participate in the breadth of instruction in our curriculum; see www.esci.umn.edu/dept/students/.

The Department of Earth Sciences is part of the N.H. Winchell School of Earth Sciences, which also hosts NSF-funded research centers (the National Lacustrine Core Repository; the National Center for Earth-surface Dynamics; and the Institute for Rock Magnetism) and includes the Limnological Research Center, the Minnesota Geological Survey, and the Polar Geospatial Center. College and University resources include: St Anthony Falls Laboratory, Institute on the Environment, Materials Characterization Facility, Supercomputer Institute, and Digital Technology Center. Further information concerning the Department and School of Earth Sciences is at www.esci.umn.edu.

Appointment could begin as early as summer 2013. A Ph.D. degree must be earned by the time of appointment. Review of applications will begin 4 Sept. 2012 and will continue until an appointment is made.

All candidates must complete an online application via the University of Minnesota employment system at <https://employment.umn.edu> (requisition numbers 178172 for Earth Surface; 178199 for Hydrogeology). The application includes (1) a curriculum vitae that includes a complete list of publications; (2) a statement of research interests; (3) a statement of teaching interests; and (4) names, addresses, and e-mail addresses of at least three references. Questions about these positions can be directed to Professor Katsumi Matsumoto, katsumi@umn.edu (Earth Surface Processes), and Professor William Seyfried, wes@umn.edu (Hydrogeologic Processes).

The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status or sexual orientation.

FIELD GEOLOGIST/PETROLOGIST CALIFORNIA UNIVERSITY OF PENNSYLVANIA

California University of Pennsylvania invites applications for this tenure-track faculty position in the Dept. of Earth Sciences. A Ph.D. in Geology or related field is required, along with demonstrated experience in undergraduate education and a willingness to teach a broad spectrum of courses. The candidate will be an outstanding educator who can integrate classroom, technology, field, and laboratory approaches to teaching geosciences. Candidates must demonstrate experience working with diverse populations. For position details and to apply, visit <https://careers.calu.edu>.

Integrity, Civility and Responsibility are the official core values of California University of Pennsylvania. Cal U is M/F/V/D/AA/EEO.

GEOLOGY TENURE TRACK POSITION DEPT. OF EARTH SCIENCES THE UNIVERSITY OF SOUTH ALABAMA

The University of South Alabama Earth Sciences Dept. invites applications for a tenure-track faculty position at the Assistant Professor or Associate Professor level beginning 15 August 2012. Candidates with research and industry experience in petroleum geology, geophysics, and related sub-disciplines are particularly encouraged to apply. Minimum qualifications are a Ph.D. degree in geology at the time of appointment. Interested potential applicants may review position requirements at the following website: www.usouthal.edu/geography/. The University of South Alabama is an Equal Opportunity/Equal Access Employer.

ASSISTANT PROFESSOR CLIMATE CHANGE, TUFTS UNIVERSITY

Tufts University invites applications for a full-time, tenure-track position as an Assistant Professor of Earth and Ocean Sciences in the area of Climate Change beginning 1 Sept. 2013. This position resides in the Department of Earth and Ocean Sciences but is part of a multidisciplinary cluster-hiring initiative designed to deepen and broaden the Environmental Studies program as well as to enhance traditional academic departments.

The successful candidate will be expected to teach an undergraduate introductory course in climate science, and one or more upper level courses in a field related to the person's expertise. At least two courses will count toward both the EOS and

the Environmental Studies majors, and the successful candidate will work with others in the cluster hire to create a capstone experience for students in the program. We are particularly interested in those with research interests in the geological record of climate change, methods for interpreting climate change, or implications of climate change that may span a range of temporal scales.

Qualifications include a Ph.D. by time of appointment in an Earth and Ocean Science discipline; demonstrated potential for research supported by external funding; and preferably teaching experience at the college level. The applicant should be able to fit into a small, well-equipped department where teaching diverse student populations is highly valued, and will be able to work with the Environmental Studies faculty to offer courses that also complement that interdisciplinary program.

A letter of application, statement of teaching and research interests, transcripts, CV, and the names and addresses of three references should be sent to Professor Jack Ridge, Chair, Department of Earth and Ocean Sciences, Tufts University, Medford, MA 02155 (jack.ridge@tufts.edu). Review of applications will begin 15 Sept. 2012 and will continue until the position is filled. Tufts University is an Affirmative Action/Equal Opportunity employer. We are committed to increasing the diversity of our faculty. Members of underrepresented groups are strongly encouraged to apply.

INSTRUCTIONAL SUPPORT SPECIALIST SUNY GENESEO

The SUNY Geneseo Dept. of Geological Sciences invites applicants for a staff position as an Instructional Support Specialist beginning Fall 2012. Responsibilities of the position include operation and maintenance of departmental equipment (e.g., rock prep. facilities, XRF, XRD, SEM, etc.), training of undergraduate students on use of equipment, assisting with development and organization of weekly lab exercises, assisting with field trip logistics, and curating departmental collections (rocks, maps, fossils). The successful applicant must have an M.S. degree in geoscience or a related area at the time of appointment. Required experience includes demonstrated interest in and aptitude for teaching, demonstrated ability to develop laboratory exercises using current pedagogy, interest in outreach, and superior organizational, written, and oral communication abilities. Must also be able to bend and lift up to 40 pounds. Position opportunities include mentoring undergraduate students in research and club activities.

The College strives to provide a diverse learning environment in which to prepare students for an increasingly multicultural society and interconnected world. For further information about SUNY Geneseo, please see our homepage, www.geneseo.edu.

To apply, submit an online professional application at <https://jobs.geneseo.edu> and attach a cover letter, vita, and references. Applicants should arrange for academic transcripts and three recent letters of recommendation to be sent directly to Scott Giorgis, Chair, Dept. of Geological Sciences, 1 College Circle, Geneseo, NY 14414.

To ensure full consideration, complete applications should be received by 15 Aug. 2012. All applicants are subject to drug and criminal background checks.

SUNY Geneseo is an Affirmative Action/Equal Opportunity, Equal Access Employer committed to recruiting, supporting, and fostering a diverse community of outstanding faculty, staff, and students. The College actively seeks applications from women and members of underrepresented groups.

**FACULTY POSITION
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The Dept. of Geology & Geophysics at the University of Utah invites applications for a tenure-track faculty position in structural geology and/or active tectonics available as early as spring semester 2013. We anticipate hiring at the Assistant Professor level but will consider exceptional candidates at the Associate Professor level. Applicants must have a Ph.D., and the successful candidate is expected to build a productive and internationally visible research program. Expertise in structural geology is desirable, but a broad range of field-oriented tectonic specialties will be considered. For further details and to apply, please go to <http://utah.peopleadmin.com/postings/13949>.

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**TENURE-TRACK FACULTY POSITION
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DEPT. OF GEOLOGICAL SCIENCES
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The Dept. of Geological Sciences and Geological Engineering at Queen's University, which has a long history of excellence in undergraduate and graduate education and world-class research, is seeking individuals with outstanding research and teaching capabilities for a tenure-track position at either the Assistant or Associate Professor in Applied Geophysics to begin on 1 Jan. 2013 or 1 July 2013. The successful candidate will be a Professional Engineer or will be eligible to apply for Professional Engineering status immediately, by virtue of having graduated from an accredited engineering program. The candidate will build on the existing applied geophysics specialization stream in the Geological Engineering program and may also teach students from Geological Sciences and other departments at Queen's. Demonstrated excellence in teaching and field investigation in a variety of geophysical techniques, data analysis, and interpretation will be an asset. The candidate is expected to carry on an active, externally funded research program of international caliber and to supervise graduate students at the M.Sc. and Ph.D. levels. A willingness to engage in collaborative research with departmental colleagues will also be considered in the selection process. For more information about faculty research interests, the full range of undergraduate and graduate teaching programs, and our laboratory facilities, visit www.geol.queensu.ca.

The University invites applications from all qualified individuals. Queen's University is committed to employment equity and diversity in the workplace and welcomes applications from women, visible minorities, aboriginal people, persons with disabilities, and persons of any sexual orientation or gender identity. All qualified candidates are encouraged to

apply; however, Canadians and permanent residents will be given priority.

Academic professionals at Queen's University are governed by the Collective Agreement between the Queen's University Faculty Association (QUFA) and the University, which is posted at www.queensu.ca/provost/faculty/facultyrelations/qufa/collectiveagreement.html. Remuneration will be in accordance with the Collective Agreement, which considers qualifications and experience.

Applications should include a complete and current curriculum vitae, letters of reference from three (3) referees of high standing, a statement of teaching experience, a statement of research interests and future plans, and samples of research writing. Please arrange to have applications and supporting letters sent directly to Dr. D.J. Hutchinson, Head, Department of Geological Sciences and Geological Engineering, Queen's University, Room 240 Bruce Wing, Kingston Ontario Canada K7L 3N6; adminassistant@geol.queensu.ca.

Applications will be accepted until 31 August 2012 or until a suitable candidate is identified. Review of applications will commence shortly thereafter, and the final appointment is subject to budgetary approval.

**FACULTY POSITIONS IN
AQUEOUS/LOW-TEMPERATURE
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GEOCHRONOLOGY, AND GLOBAL CLIMATE
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The Dept. of Earth and Environmental Sciences at the University of Michigan is searching for tenure-track faculty candidates for a university-year appointment in the areas of Aqueous/Low-Temperature Geochemistry, Geochronology, and Global Climate Change, starting September 2013. Appointments at the assistant professor level are preferred, but exceptional candidates at higher levels will be considered. We encourage applications from candidates with records of research and teaching in any one of these areas.

Successful candidates are expected to establish an independent research program and contribute to both undergraduate and graduate teaching in a large public university. Candidates whose research and teaching complement and enhance the existing programs in the Department of Earth and Environmental Sciences will receive special consideration. Applicants must have a Ph.D. and should submit a CV, statement of current and future research plans, statement of teaching philosophy and experience, and contact information for at least four persons who can provide letters of recommendation.

Further information about the department and the positions can be found at: www.lsa.umich.edu/earth. To apply, please go to www.earth.lsa.umich.edu/facultysearch/newapplicant, complete the online form, and upload the required application documents as a single PDF file. If you have any questions or comments, please send an e-mail message to earth-search@umich.edu.

The application deadline is 24 Sept. 2012 for full consideration, but applications will continue to be reviewed until the position is filled. Women and minorities are encouraged to apply. The University is supportive of the needs of dual career couples. The University of Michigan is an equal opportunity/affirmative action employer.

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Is the Anthropocene an issue of stratigraphy or pop culture?

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THE ANTHROPOCENE DEBATE

The term *Anthropocene* recently entered into the rhetoric of both the scientific community and the popular environmental movement. Scientific proponents argue that global industrialization drives accelerated Earth-system changes unrivaled in Earth's history. The discussion now filters into geological stratigraphy with proposals to amend formal time stratigraphic nomenclature (Zalasiewicz et al., 2008, 2010). Environmentalists suggest that terms like Anthropocene foster broad social and cultural awareness of human-induced environmental changes. Advocates argue that greater awareness of humanity's role in environmental change encourages sustainable resource utilization.

Formal recognition of a new geologic epoch helps the broader scientific community solidify the idea of humanity as an Earth-system driver. Before the scientific community ventures too far, we wish to offer comment that considers the practicality of the Anthropocene to geological stratigraphy, the science to which it ultimately applies.

SUMMARY OF THE TERM ANTHROPOCENE

Crutzen and Stoermer (2000) suggest that modern technology initiated the transformation of Earth-system behavior and altered environmental processes. They offer the term Anthropocene for the time interval dominated by human activities and indicate that the onset of the human ability to significantly shape Earth's environment became notable with the Industrial Revolution. Steffen et al. (2011) argue that The Great Acceleration after World War II records a dramatic departure in monitored Earth processes from Holocene proxy trends. In contrast, Ruddiman (2005) infers that Holocene-scale anthropogenic greenhouse effects began when humans abandoned hunter-gatherer lifestyles for subsistence settlement, animal domestication, and cultivation agriculture.

The idea that humans interact with nature is not new, and philosophical ideologies about human responsibility permeate historical thinking (Hamilton, 2010; Steffen et al., 2011). *Anthropocene* offers a concept fundamentally different from

many precursors. Present human society does not have a symbiotic relationship with nature. Humanity now modifies natural processes, such as biogeochemical cycles, ocean-atmosphere transfers, and flux of surficial sediments (Steffen et al., 2011). Accelerated mass transfer of sediments (Hooke, 2000; Wilkinson, 2005) has particular interest because erosion and sedimentation produce stratigraphic records.

RELEVANCE TO STRATIGRAPHIC PRACTICE

The Anthropocene has taken root in popular culture as a new time term, and scientists embroiled in research and debate on anthropogenic climate change should benefit from formal stratigraphic adoption. However, identification of a basal boundary for the Anthropocene and the suggestion that the concept can be validated with a global stratigraphic marker is at best a bit premature. A distinct stratigraphic marker should have been forming since anthropogenic change began. As practicing stratigraphers, we are taken aback by the claim that scientists currently have sufficient evidence to define a distinctive and lasting imprint of our existence in the geologic record.

Formal stratigraphic practice (ISSC, 1994; NACSN, 2005) uses a codified approach to the development, recognition, and amendment of a timescale relevant to Earth's history. Concepts for stratigraphic units require criteria that allow for the definition, delineation, and correlation of stratiform sequences of Earth materials. Time stratigraphic units represent layers of rock containing lithologic, fossil, mineral, chemical, or geophysical signatures that allow for the recognition and measurement of geologic time.

Because the strata anticipated by the Anthropocene has not yet fully developed and it is only currently possible that a recognizable basal boundary separates it from the Holocene epoch, researchers should find difficulty in using this concept in stratigraphic practice. Stratigraphic boundaries commonly appear as abrupt in the rock record but are often imprecise in time. A boundary as broad as a few thousand years resolves most problems in deep-time stratigraphy but would be of little use to identify a boundary intended to separate events of recent centuries. Definition and delineation of a basal Anthropocene boundary would be sufficient to introduce the term, but the boundary could be potentially arbitrary if it lacks temporal precision. For example, a global marker could be diachronous across millennia if human-accelerated sedimentation were the specific attribute used to mark the basal Anthropocene.

Formal stratigraphic hierarchy (ISSC, 1994; NACSN, 2005) implies that Anthropocene would either hold the rank of epoch if equivalent to the Holocene or age if defined as a subset of the Holocene. Either way, a stratotype that records a continuous, preferably marine, sedimentation record and separates the Anthropocene from underlying units needs to be identified and correlated into the global time stratigraphy. This is a daunting task that may or may not generate significant gains in the

scientific understanding of anthropogenic Earth processes. Nonetheless, Anthropocene is in fact being used seriously among selected research circles. Workers commonly use Anthropocene informally, and stratigraphic practice does allow for informal nomenclature where suitable to resolve geological problems.

Perhaps the most relevant issue before the International Stratigraphic Commission is the establishment of a scientifically relevant concept that forwards an understanding of the problems we face as humanity interacts with the Earth system. Stratigraphic code clearly states the physical, temporal, spatial, and conceptual requirements for the development of stratigraphic units. On the other hand, the discipline of stratigraphy may also have a reputation to protect. Scientific disciplines maintain their reputation by providing the credible voice a scientific community needs in public debate.

WHAT IS IMPORTANT TO THE GEOSCIENCES?

Anthropocene provides eye-catching jargon, but terminology alone does not produce a useful stratigraphic concept. Social commentators and environmental activists benefit from the term, and it is gaining momentum among the media and writers of popular scientific literature. Scientific use of the term appears to be increasing with public acceptance, although Steffen et al. (2011) argue that the public adopted Anthropocene because of increasing scientific popularity. Perhaps this acceptance is simply because scientists from disciplines other than stratigraphy embrace the concept of Anthropocene while not appreciating the nuances of its application to formal stratigraphic practice. The most important assertion unfolding among these groups is that Anthropocene creates public awareness and formalizes the concept of human-induced environmental change.

Although we acknowledge a distinct allure for the term Anthropocene and recognize merit in the concept, pop culture does not have an interest in the stratigraphic implications of this debate. If there is an underlying desire to make social comment about the implications of human-induced environmental change, Anthropocene clearly is effective. However, being provocative may have greater importance in pop culture than to serious scientific research.

Perhaps one of the more relevant issues we in the scientific community have with terms like Anthropocene is a tendency to market catch phrases that produce questionable labels. Anthropocene has already appeared in the titles of journal papers, presentations at conferences, and proposals for research funding. Modern scientists face pressure to develop and sustain a credibility that fosters research production (Hessels et al., 2009). Could there be a clever end game in mind?

WHAT IS BEST FOR MOTHER EARTH?

We have no issue with people who recognize the ability of modern technology to transform the Earth system as humans manage a global society and economy, nor do we wish to take a stand as to whether the Earth system will eventually be enhanced, catastrophically damaged, or something in between. However, we see value in recognizing the cause and effect of one's actions. The idea that humanity should adopt the role of Earth steward is not new. Global awareness about environmental change is a separate issue from the definition of practical stratigraphic units that solve geological problems.

Modern society struggles with the implications of climate change and now ponders if humans actually alter climate. *Anthropocene* forces us to consider the implications of sending the Earth system into a completely new domain driven by our actions. Does humanity operate on such a grand scale that we drive Earth processes in ways that overshadow tectonic, climatic, and eustatic processes?

Before we amend our stratigraphy and end the Holocene, it would be best to settle the question of where in the stratigraphic record to drive the golden spike that defines when humanity became one of the preeminent forces of nature. Even so, will finding this layer lead to a globally relevant correlation? As stratigraphers, we require criteria to map the Anthropocene with relevant and consistent meaning. Presently, we are left to map a unit conceptually rather than conceptualizing a mappable stratigraphic unit.

If the prescribed conditions are met, then Anthropocene might be a useful time stratigraphic term. In essence, it describes the disruptions driven by human activities. However, elevating terms that may become iconic in pop culture is not in itself sufficient evidence to amend formal stratigraphic practice. Science and society have much to gain from a clear understanding of how humans drive Earth-system processes instead of conducting an esoteric debate about stratigraphic nomenclature. Let the Anthropocene retain its rightful place as a focal point in the culture wars over the recognition and interpretation of environmental process.

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Manuscript received 1 March 2012; accepted 9 April 2012.

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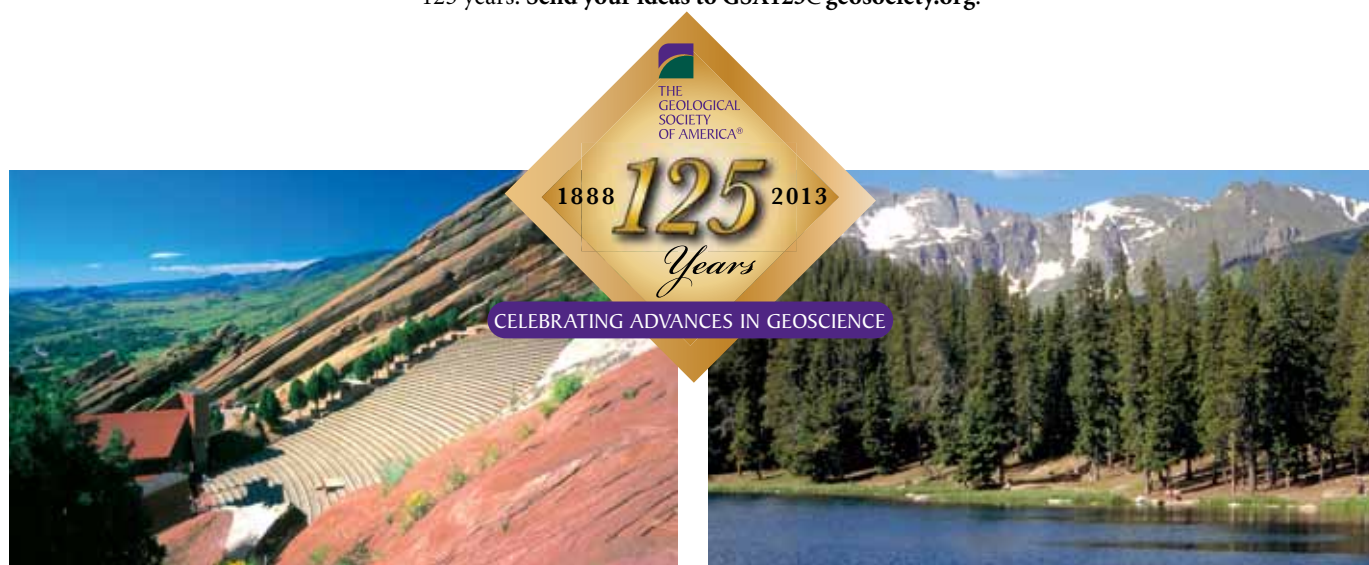
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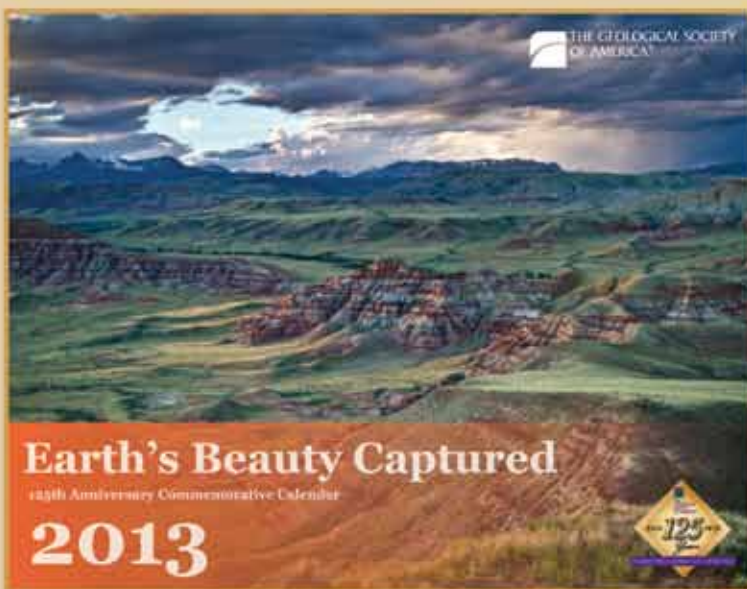
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