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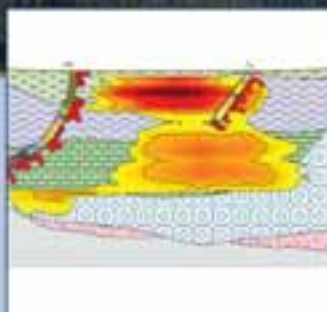
OCTOBER 2010

Caldera collapse: Perspectives from comparing Galápagos volcanoes, nuclear-test sinks, sandbox models, and volcanoes on Mars

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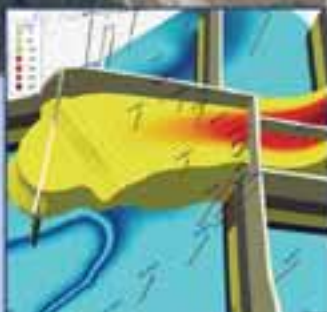
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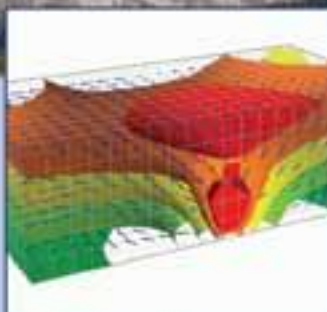
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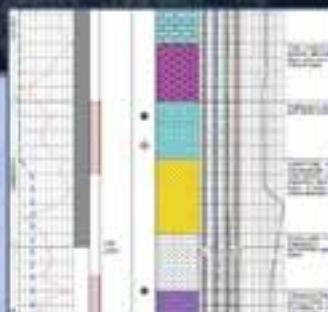
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SCIENCE ARTICLE

- 4 **Caldera collapse:** Perspectives from comparing Galápagos volcanoes, nuclear-test sinks, sandbox models, and volcanoes on Mars
Keith A. Howard

Cover: Fernandina caldera, Galápagos Islands, seven years after its 1968 collapse, when its floor lowered as much as 350 m. A floor monocline and zone of faults (left) formed during the collapse event, and a preexisting tuff cone (on lake shore) was tilted and lowered 250 m. Galápagos iguanas quickly reestablished habitat on ash on the caldera rim that was deposited by an eruption accompanying the event. Photo copyright and courtesy of Tui De Roy, author-photographer of *Galápagos, Islands Lost in Time* and *Galápagos, Preserving Darwin's Legacy*. See "Caldera collapse: Perspectives from comparing Galápagos volcanoes, nuclear-test sinks, sandbox models, and volcanoes on Mars," p. 4–10.



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Caldera collapse: Perspectives from comparing Galápagos volcanoes, nuclear-test sinks, sandbox models, and volcanoes on Mars

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ABSTRACT

The 1968 trapdoor collapse (1.5 km³) of Fernandina caldera in the Galápagos Islands developed the same kinds of structures as found in small sandbox-collapse models and in concentrically zoned sinks formed in desert alluvium by fault subsidence into underground nuclear-explosion cavities. Fernandina's collapse developed through shear failure in which the roof above the evacuating chamber was lowered mostly intact. This coherent subsidence contrasts to chaotic piecemeal collapse at small, rocky pit craters, underscoring the role of rock strength relative to subsidence size. The zoning at Fernandina implies that the deflated magma chamber underlay a central basin and a bordering inward-dipping monocline, which separates a blind inner reverse fault from an outer zone of normal faulting. Similar concentric zoning patterns can be recognized in coherent subsidence structures ranging over 16 orders of magnitude in size, from sandbox experiments to the giant Olympus Mons caldera on Mars.

INTRODUCTION

Calderas are ubiquitous features of many volcanic terrains, and field, numerical, and analog studies have generated numerous models of their collapse structure. This paper analyzes the structure of the largest well-documented historic caldera collapse to illustrate how comparisons to large and small scaled analogs shed light on the subsidence mechanics of structures in varied settings and over a huge size range. When the caldera floor of basaltic Volcán Fernandina in the Galápagos Islands subsided by 1.5 km³ in 1968 (Simkin and Howard, 1970; Filson et al., 1973), it preserved structural details that can be compared directly to large, concentrically zoned sinks subsided into underground nuclear-explosion cavities, to laboratory sandbox models, and to other volcanic collapses.

The mechanical significance of caldera collapse structure has been apparent since Anderson's (1936, 1951) classic analyses of stress and faulting and his conclusion that outward-dipping faults would form above a deflating magma chamber, whereas inward-dipping fractures would form above an expanding chamber. Field studies have documented inward-dipping, outward-dipping, or vertical boundary faults at various calderas around the world (Lipman, 1997; Cole et al., 2005). Exposed caldera faults are limited, however, to mostly small vertical extents and the few

exceptions where tilted calderas expose natural cross sections (John, 1995). Insightful mechanical models of caldera substructure have come from sandbox experiments in which material is withdrawn at depth (e.g. Roche et al., 2000). Such analogs were shown to mimic the 0.6 km³ collapse in 2000 of Miyakejima caldera on both outward-dipping and inward-dipping faults (Geshi et al., 2002; Acocella, 2007).

The roof in most calderas is lowered mostly intact by shear failure along faults (Lipman, 1984, 1997). This describes a *coherent* style of subsidence, the style addressed in this paper, which characterizes large structures or weak collapse media so long as size and material strength scale together. These structures may vary in shape from saglike to pistonlike and from symmetrical to like a trapdoor. Coherent collapse contrasts with failure by chaotic piecemeal spalling, which characterizes most pit craters and other small collapses in rock that is strong relative to size. This underscores the influence of material strength relative to size on whether a collapse is piecemeal or coherent.

FERNANDINA CALDERA COLLAPSE, GALÁPAGOS

The well-preserved forms of Galápagos collapse calderas have prompted many studies and comparisons to other calderas on Earth and Mars. The 4 × 6.5-km-wide summit caldera of Fernandina was 700 m deep before the 1968 collapse, when it deepened another 350 m (Fig. 1; Simkin and Howard, 1970; Filson et al., 1973). Old benches at each end of the elliptical caldera exemplify earlier cycles of partial basalt filling and stranding by collapse, showing that, like many other basaltic calderas, Fernandina's has experienced repeated collapse and filling episodes (Peterson and Moore, 1987; Chadwick and Howard, 1991; Rowland and Munro, 1992; Mouginiis-Mark and Rowland, 2001). Since 1968, many lava flows and a huge (1 km³) 1988 landslide have accumulated ~200 m of caldera fill, hiding the collapse features (Chadwick et al., 1991; Allan and Simkin, 2000).

Before the 1968 collapse, Fernandina caldera's floor was 2.4 × 4.0 km across (Figs. 1 and 2). The floor was nearly flat except for a pre-1946 tuff cone 750 m wide and 130 m high. Large hydromagmatic eruptions vented from the caldera wall in early June 1968 (volcanic explosivity index [VEI] 4), likely triggered by groundwater flowing toward a lowering magma column, as is common when magma withdraws downward (Stearns and MacDonald, 1946; Hildreth, 1991; Dvorak, 1992). The volume of ash from that eruption and lava from an eruption on the volcano's flank three weeks earlier amounted to only a small percentage of the subsequent ~1.5 km³ collapse (Simkin and Howard, 1970).

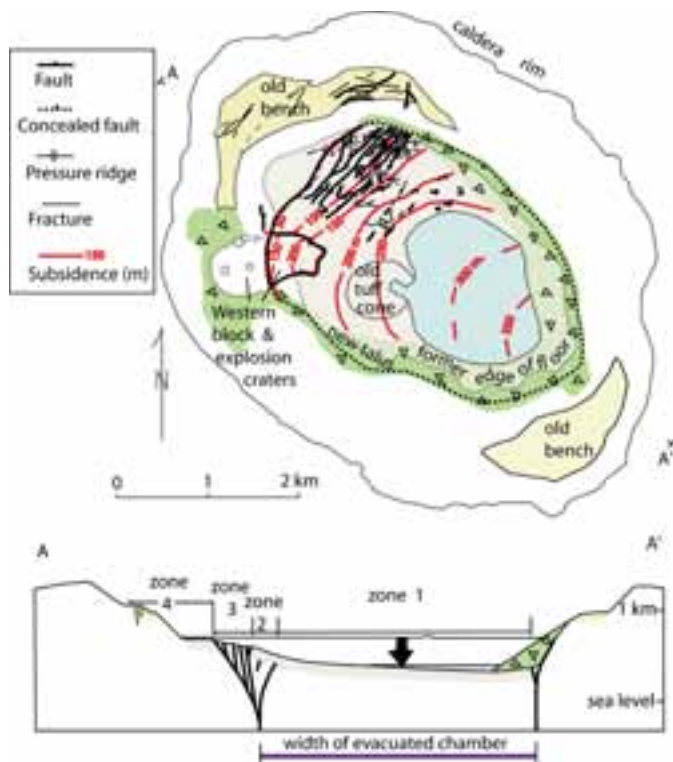


Figure 1. Sketch map of Fernandina caldera floor in July 1968 (central tinted area) showing new faults, subsidence contours, and new lake. Talus (green) covered much of the ring fault at the base of steep preexisting caldera walls. Interpretive cross section is based on resemblance of the collapsed floor to numbered zones in nuclear-test sinks and sandbox models. Faults are mapped from observations and photos in 1968 (Simkin and Howard, 1970), 1970, and 1971. Subsidence contours from pre-collapse and post-collapse photogrammetric mapping. Filson et al. (1973) reported lake depth, and mapped floor dips as steep as 30°. Location 0°22'S, 91°33'W.

A 10-day pulsating swarm of earthquakes (M_s 4 to 5.2) followed a day after the VEI-4 eruption and was modeled as ~75 incremental drops, ~5 m each, of a 2-km-wide piston as the floor subsided (Filson et al., 1973). The collapsed floor was faulted and strongly asymmetric, hinged trapdoor-like at one

end and lowered 350 m at the other (Fig. 2). The preexisting tuff cone was tilted and lowered 250 m intact. A lake fed by groundwater during collapse drowned the most-lowered southeast end of the caldera floor. Avalanche debris derived from the south wall during the collapse draped part of the tuff cone and projected onto the submerged lake floor.

Subsidiary collapse dropped a smaller block at the western end of the caldera wall and floor, adjacent to the vent area for the hydromagmatic eruptions. The sunken western block accounted for <1% of the total collapse volume and likely relates to a cupola-like volume evacuated by ejected ash. The main floor collapse presumably resulted when magma vacated from under the caldera through withdrawal at depth, intrusion into another part of the edifice (Simkin and Howard, 1970), or venting out the submarine flank of the volcano (Geist et al., 2006; Glass et al., 2007). Caldera collapse commonly accompanies drainage to distant eruptions or intrusions (Sigardsson and Sparks, 1978; Nakada et al., 2005).

The edge of main collapse coincided mostly with the old edge of the caldera floor, where a talus-covered new fault can be inferred to coincide with a buried ring fault from previous collapse episodes. This coincidence in position suggests persistence of magma chamber position and possible influence by the preexisting faults and caldera shape.

The small, unfaulted northwest end of the caldera floor transitioned into the lowered part of the floor across a region of step faults and grabens. This faulted zone graded inward into an inward-dipping monocline, which bordered a broad inner basin.

SUBSIDENCE ANALOGS OVER NUCLEAR-TEST CAVITIES

Sink depressions formed by subsidence into deep, mostly spherical cavities made by underground nuclear explosions provide analogs much larger than sandbox models and intermediate in size to Fernandina and other volcanic calderas. Hundreds of these cavities formed at the Nevada Test Site eventually collapsed to the surface in desert alluvium, taking anywhere from minutes to years, and they were richly documented (Houser, 1969, 1970a, 1970b). The resulting sink depressions vary in steepness and size (6–500 m wide, 1–60 m

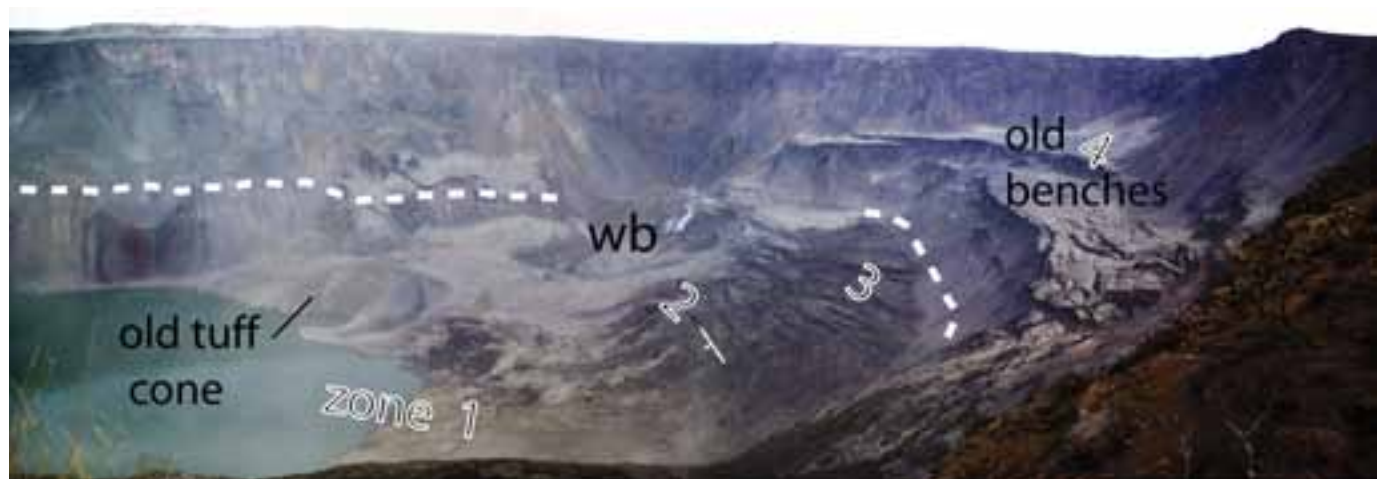


Figure 2. Fernandina caldera in July 1968, just after its floor collapsed from its former position (dashed line). View west shows sagged central floor (zone 1), monocline (zone 2), area of step faults and graben (3), and site of peripheral fractures (4) on old benches. Site of VEI-4 eruption is behind fuming western collapse block (wb).

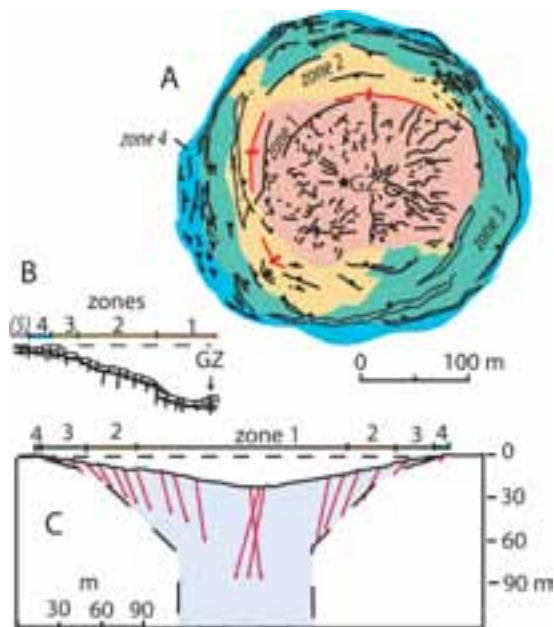


Figure 3. Structure of three typical sinks formed over buried nuclear-test cavities at Yucca Flat, Nevada, USA, from Houser (1969, 1970a). The shot cavities were centered below ground zero (GZ). (A) Map view of zones and faults in Aardvark sink. (B) Generalized morphologic zones in a sink; dashed line indicates original valley surface. Landslide debris coats a scarp boundary between zones 1 and 2. Zone 5 consists of outer fractures produced by the explosion and is unrelated to the subsequent collapse. (C) Representative surface displacements (red vectors exaggerated 4 \times) of the faulted subsided floor of a moderate-relief sink. Cross section of the deformed zone indicates cylindrical shape projected above the deeper shot cavity and the upward flaring inferred by Houser (1969), consistent with displacements toward a shallow focus.

deep); a typical sink may be 200 m wide and 20 m deep, and most have a faulted but intact floor (Fig. 3). The unique effects of the nuclear tests, namely the gas-filled, typically spherical explosion cavity and explosion-produced bulking and fracturing, appear to have relatively minor influence on the collapse geometry. Deeper nuclear-test cavities produced shallower and less voluminous collapse sinks in alluvium than did shallower nuclear-test cavities, even though the cavity depth did not much affect sink width (Houser, 1969). Some deep sinks did not collapse to the surface until years later, or not at all for the deepest ones (Houser, 1970a).

Collapse over the nuclear-test cavities proceeded toward the surface via a vertically elongating domed chimney until the topmost ~30 m dropped as a central plug. A peripheral near-surface zone then immediately collapsed inward, yielding a cross-sectional geometry that flares upward to a diameter at the surface about 2.5 times the cavity and chimney diameter (Fig. 3C). Points on the ground moved downward and inward toward a shallow focus consistent with the upward-flared near-surface structure.

Houser (1969) recognized four concentric structural-morphologic collapse zones at >90% of these sinks (Figs. 3A and 3B). The central, flat or saucer-shaped lowest part of a nuclear-test sink was designated zone 1. Ringing zone 1 and commonly separated from it by a fault scarp is zone 2, defined by a consistently inward tilt and showing the most inward

displacement. Annular zone 3 is marked by concentric fault blocks that are subsided but not tilted and may include a bounding outer fault scarp. Fractured ground outside the area of major subsidence was designated zone 4. (A peripheral zone 5 of outer fracturing produced by the pre-collapse nuclear explosion is not important to the collapse.)

When a sink formed, the first surface expression was lowering of zone 1 overlying a central plug. This was followed immediately by widening and inward motion successively on zone 2 and then zone 3. Similar sequences were later documented at the collapse of Miyakejima caldera (Geshi et al., 2002) and in some sandbox caldera models (Roche et al., 2000; Kennedy et al., 2004). As the surface subsidence of a sink expanded outward, concentric fractures formed, and some then closed as successively outer zones moved centripetally inward and compressed the interior zones while outer zones distended (Houser, 1969). Zone 2 showed the greatest inward motion. Contractile pressure ridges formed in zones 1 and 2. The near-surface fault pattern in zones 2 and 3 could be highly complex in detail (Houser, 1970b), but the overall geometric and kinematic patterns of collapse were consistent among most sinks.

COMPARISON TO LABORATORY SANDBOX MODELS

Scale modeling of caldera collapse where support is withdrawn at depth in laboratory sandboxes has produced a consistent picture and sequence of coherent collapse (e.g., Roche et al., 2000; Acocella et al., 2000; Walter and Troll, 2001; Kennedy et al., 2004; Acocella, 2007; Martí et al., 2008). Commonly, these structures have been produced using material such as rough sand, wet sand, or sand mixed with a little powder to provide some cohesion as evidenced by the capability of sustaining small cliffs and faults (Fig. 4). The presence of faults, sags, and folds indicates failure primarily in compression and shear.

The surface in many sandbox caldera models mimics zones 1–4 at the nuclear-test sinks (Fig. 4). These experimental sandbox collapses begin with upward propagation of steep faults from the margins of a lowering or deflating magma-chamber analog, such as a buried bladder, balloon, piston, or dry ice (Roche et al., 2000; Acocella, 2007). Elegant laboratory sandbox structures reported by these and other research teams in the past decade can be imitated qualitatively in simple experiments. In some by the author in 1974, for example, deflation of a buried air balloon could be made to duplicate the surface morphology of nuclear-test sinks (Fig. 4). As a bell-shaped central block (zone 1) dropped along reverse faults, peripheral rings of material moved toward it, compressing it and helping to keep it intact while distending the outer zone-3 part of the structure and widening the structural diameter along normal faults, as at nuclear-test sinks.

Other features also simulated the sinks: the deformation field flared upward, funnel-like (Acocella, 2007); the models collapsed sequentially from depth to the surface and outward from the interior to the structural periphery; and increasing the chamber depth decreased the depth but not the width of surface subsidence (Roche et al., 2000). An inward-tilted zone 2 made up the hanging wall of the reverse-fault system. Size, shape, depth, and rate of evacuation of the modeled magma chamber influence details of the coherent sandbox collapse,

but overall deformation patterns found by several research teams using different experimental apparatus, shape, and properties of deflation chamber, as well as similarity analysis, remain strikingly consistent (e.g., Roche et al., 2000; Kennedy et al., 2004).

Collapses in laboratory media having too much cohesion relative to the size of structure produce analogs to pit craters rather than to coherent calderas (cf. Martí et al., 1994; Roche et al., 2001). For example, deflation of a small toy air balloon buried in dry powder generally will create vertical or overhanging pits floored by a pile of rubble resulting from tensile failure and piecemeal spalling. The spalled sandbox pits resemble hard-rock collapses smaller than calderas, including some mines and volcanic pit craters.

Similarity laws indicate that experimental analogs can scale kinematically to calderas in stronger media if physical properties such as size, strength, and stresses from weight scale proportionally (Hubbert, 1937; Michon and Merle, 2003). Fractured rocks in situ may have different strength properties than samples measured in the lab, so precise scaling from models to the larger structures is challenging. To semi-quantitatively test scaling of models that fail in shear, the height of maximum fault scarp can be a good proxy for strength. This is because the critical maximum height (H_{cr}) of a vertical cliff that the material can support provides a useful approximation of relative cohesive strength (Tschebotarioff, 1951). Roche et al. (2001) also used this relation. Similar ratios of structural width (D) to cliff height for morphologically similar sandbox collapse models ($D:H_{cr} = 3$ to 12), nuclear-test sinks ($D:H_{cr} = 8$ to 25), and Fernandina caldera ($D:H_{cr} = 7$ to 8) are consistent with geometric and mechanical similarities among them¹.

INTERPRETATION OF FERNANDINA COLLAPSE

The shape and structures of Fernandina's 1968 collapsed floor compare well, despite the collapse asymmetry, with the concentric zoning at nuclear-test sinks and coherent sandbox models. Cliffs as high as 300–500 m in Fernandina and Volcán Wolf calderas establish the H_{cr} and relative strength of Galápagos basalt, and similar ratios of H_{cr} to collapse diameter suggest kinematic and dynamic similarity to the sinks and sandbox models (see footnote 1). The typical zones are identifiable at Fernandina as the broad inner sag (zone 1), monocline (zone 2), step faults and grabens (zone 3), and peripheral cracks (zone 4) (Figs. 1 and 2). Analogy to sandbox models suggests that a blind reverse fault underlies the zone-2 monocline at Fernandina and bounds it against the central plug. Experience from the models suggests that greater surface faulting would have resulted if collapse had been deeper, as it was at Miyakejima caldera (Acocella, 2007; Geshi, 2009).

The lowered block was likely about as thick as it was wide, because magma chambers underlying Galápagos summit calderas typically are modeled as flat-topped and at depths of ~2 km (e.g., Chadwick and Dieterich, 1995; Geist et al., 2005; Yun et al., 2006). A width to thickness ratio of ~1 is consistent with the highly faulted zone 3, akin to sandbox collapses of thin roofs in which

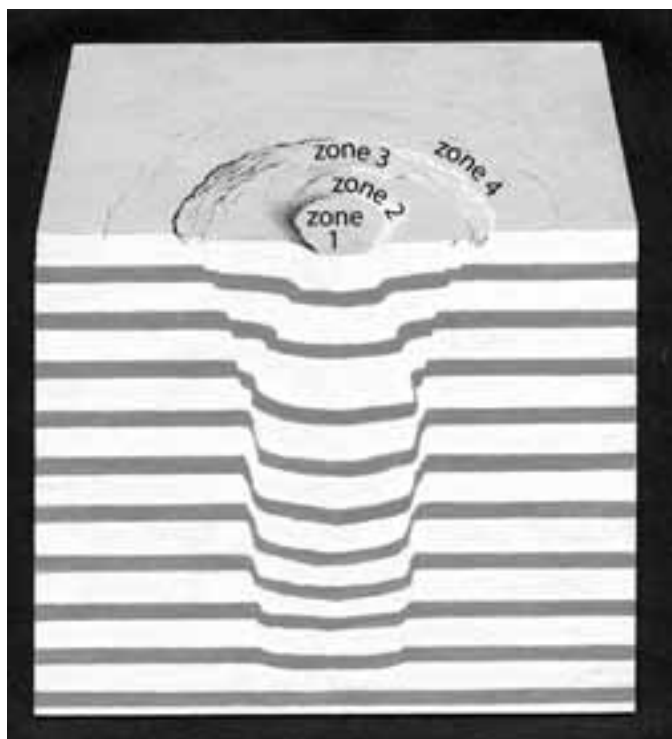


Figure 4. Artist's illustration of sandbox-model deformation caused by deflating an air balloon 6.5 cm across and 4.5 cm high buried under colored layers behind a plastic window. Layers were a mix of five parts sand to one part plaster of Paris powder. The pre-inflated balloon was flattened by the weight above it. As the balloon was deflated, faults propagated upward, dropping a central plug (zone 1) between reverse faults or monoclines (zone 2), followed by inward movement along peripheral normal faults in zone 3. (The balloon withdrew back from the window as it deflated.) The surface morphology mimicked similar experiments centered in the sandbox, showing that window friction had little effect. Collapse geometry was insensitive to deflation speed. A second set of reverse faults sometimes developed (see also Martí et al., 1994; Roche et al., 2000). Painted by Don Davis in 1974, idealized slightly from imperfectly parallel initial layering in sandbox experiments performed under the author's direction.

the normal faults are better developed than for thicker roofs (Roche et al., 2000). Lack of an outcropping reverse fault at the boundary between zones 1 and 2 in Fernandina is more akin to relatively thicker roofs in sandbox analogs (Roche et al., 2000).

A trapdoor asymmetry as at Fernandina's collapsed floor is also seen at many other calderas (Lipman, 1984), a nuclear-test site (Crowley et al., 1971), and in some sandbox models (Roche et al., 2000; Acocella et al., 2000; Kennedy et al., 2004). Trapdoor model geometries resulted from small heterogeneities in the models or from a variety of differences in chamber tilt or shape (Acocella, 2007).

Comparison of Fernandina's collapsed floor to the analogs implies that the subsided block at depth and the deflated chamber underlay zones 1 and 2 (Fig. 1). Magma chambers in basaltic shields commonly are thought to consist in detail of a network of small, interconnected chambers (Fiske and Kinoshita, 1969). If

¹ GSA supplemental data item 2010265, typical dimensions and densities for coherent experimental sandbox collapses, nuclear-test sinks in desert alluvium, Fernandina caldera in basalt, and calderas on Mars, is available online at www.geosociety.org/pubs/ft2010.htm. You can also request a copy from *GSA Today*, P.O. Box 9140, Boulder, CO 80301, USA; gsatoday@geosociety.org.

the Galápagos chambers are like this, interconnected magma flow must be unimpeded enough to allow rapid, large-volume lateral drainage $\geq 1.5 \text{ km}^3$, because the rapidity and steady rate of seismic energy release of Fernandina's 1968 collapse (Filson et al., 1973; Michon et al., 2009) suggest that magma migrated from beneath the caldera at a rate exceeding $0.1 \text{ km}^3/\text{day}$.

Basaltic chamber systems typically only partly drain; chamber volumes estimated for Kilauea, Hawaii, USA, for example, range from 2 to 240 km^3 , much larger than recorded subsidence or eruptive volumes there (Johnson, 1992; Denlinger, 1997). Fernandina and the two other deepest Galápagos calderas, at Volcán Wolf and Cerro Azul, all lie on the western edge of the Galápagos submarine platform where the unbuttressed flanks (Geist et al., 2006, 2008) may allow submarine eruptions occasionally to drain large thicknesses from the magma chambers.

OTHER CALDERAS

Post-collapse lava flows obscure floor collapse shapes in most other Galápagos calderas, except for the Bahia Darwin caldera that indents the low Genovesa Island volcano ($0^\circ 19' \text{ S}$, $89^\circ 57' \text{ W}$). Physiographic analysis suggests that the 2-km-wide circular bay (bahia) is floored by a zone 1 that subsided 260 m and by a narrow submerged zone-2 slope; a 1-km-wide array of exposed concentric normal faults that rings the bay (Harpp et al., 2002) is subsided 30–60 m and is zone 3. This collapse structure, unlike Fernandina's, does not follow any preexisting caldera faults.

The caldera floor structures observed at Fernandina, Bahia Darwin, and Miyakejima are all on basaltic volcanoes, but some volcanic calderas of a wide compositional range show inward-tilted and sagged beds (zone 2) below the (commonly buried) collapsed floor. Outward-dipping ring faults comparable to the zone 1–2 reverse-fault boundary are detected seismically at some moderate-sized calderas (Mori and McKee, 1987; Nettles and Ekström, 1998).

The caldera of Olympus Mons (Fig. 5) and other giant calderas on Martian shield volcanoes also show the familiar structural zoning (Branney, 1995). The oldest and widest (65 km) of several intersecting, nested parts of the Olympus Mons caldera exhibits a fault-distended zone 3 with outer scarp and a zone-2 monocline with mapped concentric pressure ridges (Mouginis-Mark and Robinson, 1992; Zuber and Mouginis-Mark, 1992). Younger lava flows flood the inferred zone 1 and some other nested collapses. Other martian calderas, such as on Ascræus Mons (40 km wide) and Arsia Mons (120 km wide), contain fault zones classifiable as zones 4, 3, or 2, partly concealed by younger infilling flows. The calderas on Mars formed under a gravitational field only 38% of Earth's and exhibit scarps up to 3–4 km high (see footnote 1), so they would model correspondingly smaller terrestrial analogs, but they are still huge collapses, 16 orders of magnitude larger in volume than sandbox analogs. The similarities imply that the large Martian calderas collapsed upon deflation of very broad magma chambers and behaved mechanically much like Fernandina, Miyakejima, and the nuclear-test and sandbox analogs.

DISCUSSION

The consistent structural zoning in collapse structures varying from symmetric to Fernandina's trapdoor floor suggests

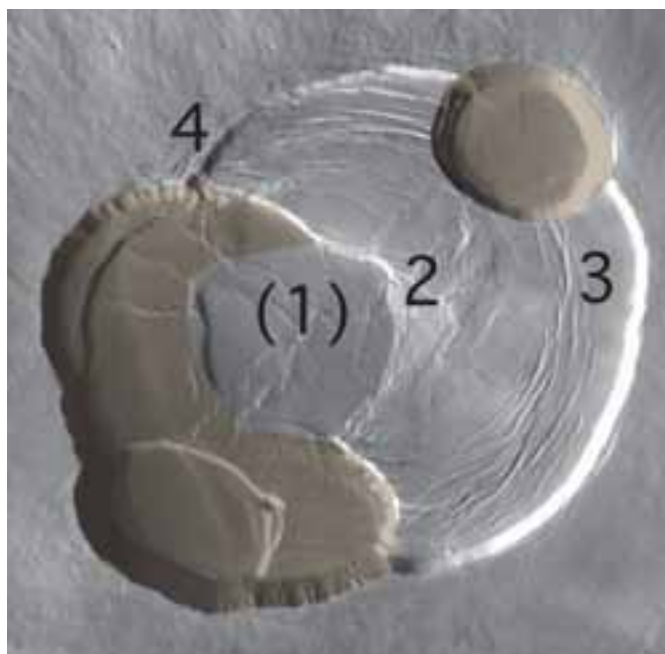


Figure 5. Olympus Mons caldera, Mars, 3–4 km deep (THEMUS image). The widest (65 km) and oldest part of the caldera (gray; crater 1 of Mouginis-Mark and Robinson, 1992; younger nested structures are shown tinted) shows the characteristic zoning. The zones are peripheral fractures (zone 4); a faulted zone 3, including bounding fault scarp; and a monocline, zone 2, in which Mouginis-Mark and Robinson (1992) mapped numerous concentric pressure ridges. A central plug, zone 1, is inferred to underlie younger, bowl-shaped and pressure-ringed lava fill.

analogous underlying fault geometries and mechanisms. Caldera types ranging from downsags to pistonlike also may be variations on a common mechanism, depending mainly on degree of collapse (Acocella, 2007). This idea is consistent with the gradation of Fernandina's floor from hinged at one end to deeply lowered, more like a piston, at the other.

Geometric and mechanical similarities of collapse structures ranging in volume over 16 orders of magnitude (see footnote 1) imply that, despite complexities in the natural systems, many basaltic calderas over a large size range may founder by similar fault mechanisms and geometries.

The structural collapse details observed on Fernandina's floor are now buried. A wide variety of other calderas, although also obscured, show at least some features that suggest structural similarity to the sandbox analogs (Acocella, 2007). Some catastrophically collapsed silicic ash-flow calderas are included, even though other factors, such as magma stirring (Kennedy et al., 2008) or fluidized material surging up ring fractures, might be expected to influence their collapse.

Inward tilting or folding in zone 2 reflects both the inward and downward displacement and also the convex-upward geometry of the exterior bounding faults (Fig. 4). In contrast to the back-tilting that occurs on listric, concave-upward faults, downsliding on convex-upward caldera boundaries naturally tends to tilt rocks inward (but not necessarily by fault drag; cf. Branney, 1995). Inward tilt typically results where vertical support is withdrawn, as in calderas, whereas backward tilt often results from loss of lateral support, as in landslide Toreva

blocks, slumped walls of impact craters (Howard, 1975) and some calderas (e.g., Ascraeus Mons), and tectonically extended terrains (Hamblin, 1965).

The inner contraction and peripheral extension from centripetal inward displacement during sandbox and nuclear-test subsidence is also seen at lava-lake crusts, some large volcanic pit craters, and in subsidence caused by mining and by fluid extraction (Swanson and Peterson, 1972; Castle and Yerkes, 1976; Branney, 1995; Rymer et al., 1998; Odone et al., 1999). Ice-melt collapse pits and subsidence structures caused by dissolution can also show the familiar structural zoning (Branney and Gilbert, 1995; Maione, 2001).

It has been a common perception that doming would be required to solve a supposed caldera room problem: Like a cork in a bottle, downward-tapered collapse couldn't proceed unless a volcano first swells. Although inflation may precede and influence some caldera collapses, analog modeling shows that tumescence is not a prerequisite, nor are preexisting faults. Characteristic reverse in addition to normal faulting, and the weakness of earth materials compared to gravitational forces, explain how deflation can be sufficient cause for collapse.

CONCLUSIONS

Structural-morphologic zoning identified at the nuclear-test sinks in desert alluvium guides a way to link analogs and many volcanic collapse structures. Despite limitations of the sandbox and nuclear-test analogs for modeling complex volcanic systems, structural consistency and similarity analysis reinforce the usefulness of such analogs for interpreting caldera collapse. The structural comparisons help guide analysis of kinematics, reverse and normal faulting, and shape of the deflated chamber at volcanic collapses varying in size, shape, setting, and symmetry. That similar structural zoning is identifiable over 16 orders of volume magnitude up to giant Martian calderas suggests that similar geometries and mechanics can apply to many calderas.

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REFERENCES CITED

- Acocella, V., 2007, Understanding caldera structure and development; an overview of analog models compared to natural calderas: *Earth-Science Reviews*, v. 85, p. 125–160.
- Acocella, V., Cifelli, F., and Funicello, R., 2000, Analogue models of collapse calderas and resurgent domes: *Journal of Volcanology and Geothermal Research*, v. 10, p. 81–96.
- Allan, J.F., and Simkin, T., 2000, Fernandina Volcano's evolved, well-mixed basalts; mineralogical and petrological constraints on the nature of the Galapagos plume: *Journal of Geophysical Research*, v. 105, B3, p. 6017–6041.
- Anderson, E.M., 1936, The dynamics of the formation of cone sheets, ring dykes, and cauldron subsidence: *Royal Society of Edinburgh Proceedings*, v. 56, part 2, p. 128–163.
- Anderson, E.M., 1951, The dynamics of faulting and dyke formation with applications in Britain, second edition: London, Oliver and Boyd, 206 p.
- Branney, M.J., 1995, Downsag and extension at calderas; new perspectives on collapse geometries from ice-melt, mining, and volcanic subsidence: *Bulletin of Volcanology*, v. 57, p. 303–318.
- Branney, M.J., and Gilbert, J.S., 1995, Ice-melt collapse pits and associated features in the 1991 lahar deposits of Volcan Hudson, Chile; criteria to distinguish eruption-induced glacier melt: *Bulletin of Volcanology*, v. 57, p. 293–302.
- Castle, R.O., and Yerkes, R.F., 1976, Recent surface movements in the Baldwin Hills, Los Angeles County, California: U.S. Geological Survey Professional Paper 882, 125 p.
- Chadwick, W.W., and Dieterich, J.H., 1995, Mechanical modeling of circumferential and radial dike intrusion on Galápagos volcanoes: *Journal of Volcanology and Geothermal Research*, v. 66, p. 37–52.
- Chadwick, W.W., and Howard, K.A., 1991, The pattern of circumferential and radial eruptive fissures on the volcanoes of Fernandina and Isabela Islands, Galápagos: *Bulletin of Volcanology*, v. 53, p. 259–275.
- Chadwick, W.W., De Roy, T., and Carrasco, A., 1991, The September 1988 intracaldera avalanche and eruption at Fernandina volcano, Galápagos Islands: *Bulletin of Volcanology*, v. 53, p. 276–286.
- Cole, J.W., Nilner, D.M., and Spudis, K.D., 2005, Calderas and caldera structures; a review: *Earth Science Reviews*, v. 69, p. 1–26.
- Crowley, B.K., Glenn, H.D., and Marks, R.E., 1971, An analysis of Marvel—a nuclear shock-tube experiment: *Journal of Geophysical Research*, v. 76, p. 3356–3374.
- Denlinger, R.P., 1997, A dynamic balance between magma supply and eruption rate at Kilauea volcano, Hawaii: *Journal of Geophysical Research*, v. 102, B8, p. 18,091–18,100.
- Dvorak, J.J., 1992, Mechanism of explosive eruptions of Kilauea volcano, Hawaii: *Bulletin of Volcanology*, v. 54, p. 638–645.
- Filson, J., Simkin, T., and Leu, L.K., 1973, Seismicity of a caldera collapse, Galápagos Islands 1968: *Journal of Geophysical Research*, v. 78, p. 8591–8622.
- Fiske, R.S., and Kinoshita, W.T., 1969, Inflation of Kilauea volcano prior to its 1967–1968 eruption: *Science*, v. 165, p. 341–349.
- Geist, D.J., Naumann, T.R., Standish, J.J., Kurz, M.D., Harpp, K.S., White, W.M., and Fornari, D.J., 2005, Wolf volcano, Galápagos archipelago; melting and magmatic evolution at the margins of a mantle plume: *Journal of Petrology*, v. 46, p. 2197–2224, doi:10.1093/petrology/egi052.
- Geist, D.J., Fornari, D.J., Kurz, M.D., Harpp, K.S., Soule, S.A., Perfit, M.R., and Koleszar, A.M., 2006, Submarine Fernandina; Magmatism at the leading edge of the Galápagos hot spot: *Geochemistry Geophysics Geosystems*, v. 7, Q12007, 27 p., doi:10.1029/2006GC001290.
- Geist, D.J., Diefenbach, B.A., Fornari, D.J., Kurz, M.D., Harpp, K.S., and Blusztajn, J., 2008, Construction of the Galápagos platform by large submarine volcanic terraces: *Geochemistry Geophysics Geosystems*, v. 9, no. 3, Q03015, doi:10.1029/2007GC001795.
- Geshi, N., 2009, Asymmetric growth of collapsed caldera by oblique subsidence during the 2000 eruption of Miyakejima, Japan: *Earth and Planetary Science Letters*, v. 280, p. 149–158, doi:10.1016/j.epsl.2009.01.027
- Geshi, N., Shimano, T., Chiba, T., and Nakada, S., 2002, Caldera collapse during the 2000 eruption of Miyakejima volcano, Japan: *Bulletin of Volcanology*, v. 64, p. 55–68.
- Glass, J.B., Fornari, D.J., Hall, H.F., Cougan, A.A., Berkenbosch, H.A., Holmes, M.L., White, S.M., and de la Torre, G., 2007, Submarine volcanic morphology of the western Galápagos based on EM300 bathymetry and MR1 side-scan sonar: *Geochemistry Geophysics Geosystems*, v. 8, no. 3, doi:10.1029/2006GC001464.
- Hamblin, K., 1965, Origin of “reverse drag” on the downthrown side of normal faults: *Geological Society of America Bulletin*, v. 76, p. 2231–2251.
- Harpp, K.S., Wirth, K.R., and Korich, D.J., 2002, Northern Galapagos Province; hotspot-induced, near-ridge volcanism at Genovesa Island: *Geology*, v. 30, p. 399–402.

- Hildreth, W., 1991, The timing of caldera collapse at Mount Katmai in response to magma withdrawal toward Norarupta: *Geophysical Research Letters*, v. 18, p. 1541–1544.
- Houser, F.N., 1969, Subsidence related to underground nuclear explosions, Nevada Test site: *Seismological Society of America Bulletin*, v. 59, p. 2233–2251.
- Houser, F.N., 1970a, A summary of information and ideas regarding sinks and collapse, Nevada Test Site: U.S. Geological Survey Report USGS-474-41 (NTS-216), 129 p.
- Houser, F.N., 1970b, Near-surface sink structure, Nevada Test Site: U.S. Geological Survey Report USGS-474-36 (NTS-217), 30 p.
- Howard, K.A., 1975, Geologic map of the crater Copernicus: U.S. Geological Survey Miscellaneous Geological Investigations Map I-840; scale: 1:250,000.
- Hubbert, M.K., 1937, Theory of scale models as applied to the study of geologic structures: *Geological Society of America Bulletin*, v. 48, p. 1459–1519.
- John, D.A., 1995, Tilted middle Tertiary ash-flow calderas and subjacent granitic plutons, southern Stillwater Range, Nevada; cross sections of an Oligocene igneous center: *Geological Society of America Bulletin*, v. 107, p. 180–200, doi: 10.1130/00167606(1995)107<0180:TMTAFC>2.3.CO;2.
- Johnson, D.J., 1992, Dynamics of magma storage in the summit reservoir of Kilauea volcano, Hawaii: *Journal of Geophysical Research*, v. 97, B2, p. 1807–1820.
- Kennedy, B., Stix, J., Vallance, J.W., Lavallée, Y., and Longpre, M.-A., 2004, Controls on caldera structure; results from analog sandbox modeling: *Geological Society of America Bulletin*, v. 116, p. 515–524.
- Kennedy, B.M., Jellinek, A.M., and Stix, J., 2008, Coupled caldera subsidence and stirring inferred from analogue models: *Nature Geoscience*, v. 1, p. 385–389.
- Lipman, P.W., 1984, The roots of ash-flow calderas in western North America; windows into the tops of granitic batholiths: *Journal of Geophysical Research*, v. 89, p. 8801–8841.
- Lipman, P.W., 1997, Subsidence of ash-flow calderas; relation to caldera size and magma-chamber geometry: *Bulletin of Volcanology*, v. 59, p. 198–218.
- Maione, S.J., 2001, Discovery of ring faults associated with salt withdrawal basins, Early Cretaceous age, in the East Texas Basin: *The Leading Edge*, v. 20, p. 818–829, doi: 10.1190/1.1487290.
- Martí, J., Ablay, G.J., Redshaw, L.T., and Sparks, R.S.J., 1994, Experimental studies of collapse calderas: *Journal of the Geological Society*, v. 151, p. 919–929.
- Martí, J., Geyer, A., Folch, A., and Gottsmann, J., 2008, A review on collapse caldera modeling, *in* Gottsmann, J., and Martí, J., eds., *Caldera volcanism; analysis, modelling, and response: Developments in Volcanology*, v. 10, p. 233–283.
- Michon, L., and Merle, O., 2003, Mode of lithospheric extension; conceptual models from analogue modeling: *Tectonics*, v. 22, 1028, 15 p., doi: 10.1029/2002TC001435.
- Michon, L., Villeneuve, N., Catry, T., and Merle, O., 2009, How summit calderas collapse on basaltic volcanoes; new insights from the April 2007 caldera collapse of Piton de la Fournaise volcano: *Journal of Volcanology and Geothermal Research*, v. 184, p. 138–151, doi:10.1016/j.jvolgeores.2008.11.003.
- Mori, J., and McKee, C., 1987, Outward-dipping ring-fault structure at Rabaul caldera as shown by earthquake locations: *Science*, v. 235, p. 193–195.
- Mouginis-Mark, P.J., and Robinson, M.S., 1992, Evolution of the Olympus Mons caldera, Mars: *Bulletin of Volcanology*, v. 54, p. 347–360.
- Mouginis-Mark, P.J., and Rowland, S.K., 2001, The geomorphology of planetary calderas: *Geomorphology*, v. 37, p. 201–223.
- Nakada, S., Nagai, M., Kaneko, T., Nozawa, A., and Suzuki-Kamata, K., 2005, Chronology and products of the 2000 eruption of Miyakejima Volcano: *Bulletin of Volcanology*, v. 67, p. 205–218.
- Nettles, M., and Ekström, G., 1998, Faulting mechanism of anomalous earthquakes near Bardarbunga volcano, Iceland: *Journal of Geophysical Research*, v. 103, p. 17,973–17,983.
- Odonne, F., Menard, I., Massonnat, G.J., and Rolando, J.-P., 1999, Abnormal reverse faulting above a depleting reservoir: *Geology*, v. 27, p. 111–114.
- Peterson, D.W., and Moore, R.B., 1987, Geologic history and evolution of geologic concepts, island of Hawaii, *in* Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., *Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350*, p. 149–189.
- Roche, O., Druitt, T.H., and Merle, O., 2000, Experimental study of caldera formation: *Journal of Geophysical Research*, v. 105, B1, p. 395–416.
- Roche, O., VanWyk de Vries, B., and Druitt, T.H., 2001, Sub-surface structures and collapse mechanisms of summit pit craters: *Journal of Volcanology and Geothermal Research*, v. 105, p. 1–18.
- Rowland, S.K., and Munro, D.C., 1992, The caldera of Volcán Fernandina; a remote sensing study of its structure and recent activity: *Bulletin of Volcanology*, v. 55, p. 97–109.
- Rymer, H., van Wyk de Vries, B., and Stix, J., 1998, Pit crater structure and processes governing persistent activity at Masaya volcano, Nicaragua: *Bulletin of Volcanology*, v. 59, p. 345–355.
- Sigardsson, H., and Sparks, R.S.J., 1978, Lateral magma flow within rifted Icelandic crust: *Nature*, v. 274, p. 126–130.
- Simkin, T., and Howard, K.A., 1970, Caldera collapse in the Galápagos Islands, 1968: *Science*, v. 169, no. 3944, p. 429–437.
- Stearns, H.T., and MacDonald, G.A., 1946, *Geology and ground-water resources of the island of Hawaii: Hawaii Division of Hydrography Bulletin 9*, 363 p.
- Swanson, D.A., and Peterson, D.W., 1972, Partial draining and crustal subsidence of Alae lava lake, Kilauea volcano, Hawaii: U.S. Geological Survey Professional Paper 800C, p. C1–C14.
- Tschebotarjoff, G.P., 1951, *Soil Mechanics, Foundations, and Earth Structures*: New York, McGraw-Hill Book Co. Inc., 645 p.
- Walter, T.R., and Troll, V.R., 2001, Formation of caldera periphery faults; an experimental study: *Bulletin of Volcanology*, v. 63, p. 191–203.
- Yun, S., Segall, P., and Zebker, H., 2006, Constraints on magma chamber geometry at Sierra Negra volcano, Galápagos Islands, based on InSAR observations: *Journal of Volcanology and Geothermal Research*, v. 150, p. 232–243.
- Zuber, M.T., and Mouginis-Mark, P.J., 1992, Caldera subsidence and magma chamber depth of the Olympus Mons volcano: *Journal of Geophysical Research*, v. 97, E11, p. 18,295–18,307.

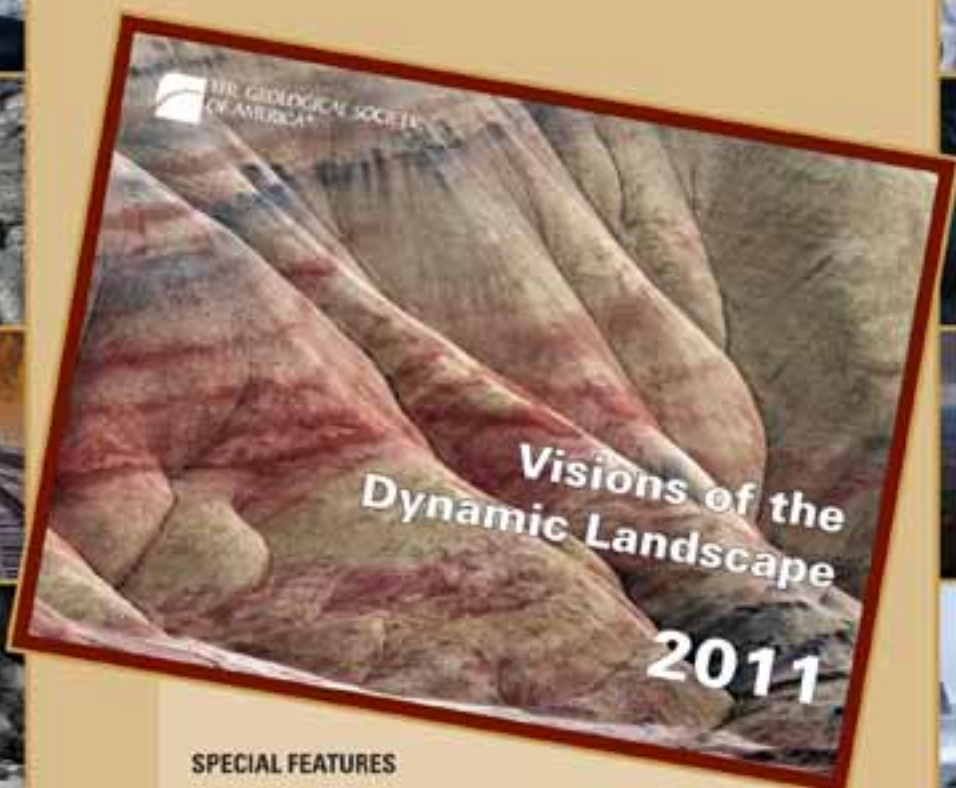
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The Penrose Medal was established in 1927 by R.A.F. Penrose Jr. to recognize eminent research in pure geology, outstanding original contributions, and/or achievements that mark a major advance in geological science. Penrose's sole objective was to encourage original work in purely scientific geology, which applies to all scientific disciplines represented by GSA. A nominee's scientific achievements should therefore be considered over contributions in teaching, administration, or service. Nominations of mid-career scientists who have already made exceptional contributions are encouraged. This award is made at the discretion of GSA Council, and nominees need not be members of the Society.

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The Day Medal was established in 1948 by Arthur L. Day to recognize distinction in the application of physics and chemistry to the solution of geologic problems. *Day's intent was to recognize outstanding achievement and to inspire further effort rather than to reward a distinguished career;* therefore, scientific accomplishments should be considered over contributions in teaching, administration, or service. This medal is awarded annually, or less frequently, at the discretion of GSA Council.

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Supporting documents (send as e-mail attachments or via post):

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- summary (300 words or fewer) of the candidate's *scientific* contributions to geology;
- Penrose and Day Medals: a selected bibliography of no more than 20 titles;
- Donath Medal: a selected bibliography of 10–20 titles;
- Penrose and Donath Medals: letters from each of five GSA Fellows or members in addition to the person making the nomination;
- Day Medal: letters from five scientists, at least three of which should be from GSA Fellows or members, with up to two from fellows or members of the Mineralogical Society of America, the Geochemical Society, or the American Geophysical Union.

Award Notes

Nomination forms and submission instructions are online at www.geosociety.org/awards/nominations.htm. Paper submissions will still be accepted; however, we encourage electronic submission.

Candidates whose names were submitted for consideration to GSA Council by the respective award committees but who did not receive an award will remain under consideration by those committees for three years; however, it is recommended that an updated nomination letter be sent to GSA. For more information, contact GSA Grants, Awards, and Recognition, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, USA, +1-303-357-1028, awards@geosociety.org.

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2011 GSA Medals and Awards

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GSA Council established the GSA Public Service Award in 1998 in honor of Eugene and Carolyn Shoemaker. This annual award recognizes contributions that have materially enhanced the public's understanding of the earth sciences or have significantly served decision makers in the application of scientific and technical information to public affairs and earth science-related public policy. This may be accomplished through the following:

- authorship of educational materials of high scientific quality that have enjoyed widespread use and acclaim among educators and/or the general public;
- acclaimed presentations (books and other publications, mass and electronic media, or public presentations, including lectures) that have expanded public awareness of the earth sciences;
- authorship of technical publications that have significantly advanced scientific concepts or techniques applicable to the resolution of earth-resource or environmental issues of public concern; and/or
- individual accomplishments that have advanced the earth sciences in the public interest.

This award normally goes to a GSA member, with exceptions approved by Council, and may be presented posthumously to a descendant of the awardee.

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- letter of nomination (300 words or fewer);
- brief biographical sketch that clearly demonstrates the applicability of the selection criteria;
- selected bibliography of no more than 10 titles.



**Nominations
due
1 February 2011**

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The Bromery Award for the Minorities, established by Randolph W. (Bill) and Cecile T. Bromery, recognizes a member of a minority group, preferably an African American, who qualifies under at least one of the following categories:

1. **Significant contributions to research in the geological sciences** through publications that have had a measurable impact on the geosciences; outstanding original contributions or achievements that mark a major advance in the geosciences; and/or an outstanding lifetime career that demonstrates leadership in geoscience research.
2. **Instrumental in opening the geoscience field to other minorities** through demonstrable contributions in teaching or mentoring that have enhanced the professional growth of minority geoscientists; outstanding lifetime career service in a role that has highlighted the contributions of minorities in advancing the geosciences; and/or authorship of educational materials of high scientific quality that have enjoyed widespread use and acclaim among educators and/or the general public.

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- letter of nomination (300 words or fewer);
- letters from three scientists with at least two from GSA Fellows or members and one from a member of another professional geoscience organization;
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The deadline for receipt of all GSA medal, award, and recognition nominations is 1 February 2011.



2011 GSA Medals and Awards

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GSA Council established this award in 1988 to recognize individuals for their exceptional service to the Society. GSA members, Fellows, associates, and employees may be nominated, and any GSA member or employee may submit a nomination. GSA's Executive Committee selects the awardee, and GSA Council must ratify the selection. Awards are made annually, or less frequently, at the discretion of Council.

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GSA Fellowship

Fellowship is an honor bestowed annually upon the best of our profession at the spring GSA Council meeting. If you are a GSA Fellow, please review the following for updated instructions: A GSA Fellow may support only two nominees per election cycle and only one as a primary nominator. A GSA member who is not a Fellow may *not* be a primary nominator, but may be a secondary nominator for no more than two nominees per election cycle.

The primary nominator is responsible for collecting the entire nomination packet (including letters of support), which should then be submitted as one e-mail (with supporting documents as attachments) or as one package via post.

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- letter of nomination, including a summary of the nominee's significant contributions (up to one page);
- paragraph stating the nominee's total number of publications and a selected bibliography (up to four pages); and
- supporting letters of nomination from each of the secondary nominators.

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Supporting documents (send as e-mail attachments or via post):

- curriculum vitae;
- letter of nomination that clearly states the impact of the Ph.D. research on the geosciences;
- selected bibliography of no more than 10 titles; and
- dissertation title and abstract.

AGI Medal in Memory of Ian Campbell

The AGI Medal in Memory of Ian Campbell recognizes singular performance in and contribution to the profession of geology. Candidates are measured against the distinguished career of Ian Campbell, whose service to the profession touched virtually every facet of the geosciences. Campbell was a most uncommon man of remarkable accomplishment and widespread influence, and in his career as a geologist, educator, administrator, and public servant, he was noted for his candor and integrity. **Nominate online** at www.agiweb.org/direct/awards.html.

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The Marcus Milling Legendary Geoscientist Medal recognizes consistent contributions of high-quality scientific achievements and service to the earth sciences that have lasting, historic value. The medal goes to a senior geoscientist nearing completion or having completed full-time regular employment who has been recognized for accomplishments in his or her field(s) of expertise by professional societies, universities, or other organizations. Prior to 2007, this award was called the AGI Legendary Geoscientist Award. **Nominate online** at www.agiweb.org/direct/awards.html.

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Call for Nominations

John C. Frye Environmental Geology Award

Nomination deadline: 31 March 2011

In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by a state geological survey.

Anyone may submit a nomination, following these criteria:

1. The paper must be from a GSA or state geological survey publication;
2. The paper must have been published during the preceding three full calendar years; and
3. The nomination must include a paragraph stating the pertinence of the paper (see *basis for selection*).

Please send nominations to Grants, Awards, and Recognition, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA.

Basis for Selection

Each paper will be judged on its uniqueness or significance as a model of its type of work along with its overall worthiness. It is preferred that the paper be directly applicable to informed

laypersons (e.g., planners, engineers). In addition, nominated papers must

1. Establish an environmental problem or need;
2. Provide substantive information on the basic geology or geologic process pertinent to the problem;
3. Relate the geology to the problem or need;
4. Suggest solutions or provide appropriate land-use recommendations based on the geology;
5. Present the information in a manner that is understandable and directly usable by geologists; and
6. Address the environmental need or resolve the problem.

2010 Award Recipients

The 2010 award will be presented at the GSA Annual Meeting in Denver to William R. Lund, Tyler R. Knudsen, Garrett S. Vice, and Lucas M. Shaw for *Geologic Hazards and Adverse Construction Conditions, St. George-Hurricane Metropolitan Area, Washington County, Utah*: Utah Geological Survey Special Study 127, 2008.

2011 National Awards

Nomination deadline: 1 February 2011

GSA members are encouraged to nominate colleagues for the following awards:

The annual **William T. Pecora Award**, sponsored jointly by NASA and the U.S. Dept. of the Interior, recognizes outstanding contributions by individuals or groups toward understanding Earth by means of remote sensing. The award recognizes the work of those in the scientific and technical community as well as those involved in the practical application of remote sensing. Consideration will be given to sustained or single contributions of major importance to the art and/or science of understanding Earth through observations from space. Learn more at <http://remotesensing.usgs.gov/pecora.php>.

The **National Medal of Science** is awarded by the president of the United States to individuals "deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, engineering, or social and behavioral sciences." The award committee is giving increasing attention to younger U.S. scientists and engineers, who may now be reaching a point at which their contributions merit recognition, as well as to outstanding women and minority scientists. Learn more at www.nsf.gov/od/nms/medal.jsp.

The **Vannevar Bush Award** is presented periodically to a senior statesperson of science and technology who, through public service in science and technology, has made an

outstanding contribution toward the welfare of humankind and to the United States. Nominations should be accompanied by a complete biography and a brief citation summarizing the nominee's scientific or technological contributions to our national welfare in promotion of the progress of science. Learn more at www.nsf.gov/nsb/awards/bush.jsp.

The **Alan T. Waterman Award** is presented annually by the National Science Foundation (NSF) and National Science Board to an outstanding young researcher in any field of science or engineering supported by the NSF. Candidates must be U.S. citizens or permanent residents 35 years of age or younger OR not more than five years beyond receipt of a Ph.D. by 31 Dec. of the year in which they are nominated. Candidates should have completed sufficient scientific or engineering research to have demonstrated outstanding capability and exceptional promise for significant future achievement through personal accomplishments. This award complements the Vannevar Bush Award, which recognizes senior statespersons of science and technology; both are designed to encourage individuals to seek the highest levels of achievement in science, engineering, and service to humanity. Learn more at www.nsf.gov/od/waterman/waterman.jsp.

The **G.K. Warren Prize** is awarded by the National Academy of Sciences for noteworthy and distinguished accomplishment in fluvial geology and closely related aspects of the geological sciences. Learn more at www.nasonline.org/site/PageServer?pagename=AWARDS_warren.

2011 Birdsall-Dreiss Distinguished Lecturer



Jeffrey J. McDonnell

Jeffrey J. McDonnell has been selected as the 2011 Birdsall-Dreiss Distinguished Lecturer by GSA's Hydrogeology Division. This is the 33rd Birdsall-Dreiss Lectureship awarded, and McDonnell is the first from the field of watershed science.

McDonnell holds the Richardson Chair in Watershed Science at Oregon State University (OSU) and is OSU Distinguished Professor of Hydrology. He is also 6th Century Chair in Hydrology at the University of Aberdeen (UK) and a visiting professor at the Nanjing Hydraulic Research Institute and Hohai University in China. McDonnell is a Fellow of the American Geophysical Union and the International Water Academy. He is recipient of the Dalton Medal from the European Geophysical Union, the Gordon Warwick Award from the British Geomorphological Research Group, the Nystrom Award from the Association of American Geographers, and a D.Sc. from the University of Canterbury. He has co-authored ~150 journal articles on watershed hydrology and also co-edited the textbook *Isotope Tracers in Catchment Hydrology*. As well, McDonnell served as the senior advisory editor of the *Encyclopedia of Hydrological Sciences* and is currently editor-in-chief of the International Association of Hydrological Sciences (IAHS) Book Series *Benchmark Papers in Hydrology*.

At the request of interested institutions, McDonnell will present one of the following lectures. Learn more and access a lecture request form at www.cof.orst.edu/cof/fe/watershd/.

Where does water go when it rains?

Conceptualizing runoff processes in headwater catchments.

Streamflow generation concepts have remained largely unchanged since the First International Hydrological Decade (1965–1974), despite numerous case studies from an ever-widening array of catchments. Two broad classes of streamflow-generation behavior have been described and conceptualized into widely used model structures: infiltration-excess overland flow and saturation-excess overland flow. These concepts rely on the description of spatial patterns of soil surface infiltration rates and “variable source areas” of saturation (from rising near-stream water tables) with known boundary conditions. While subsurface flow during storm events occurs (and in steep, wet areas may greatly exceed overland flow contributions), its location and behavior are poorly conceptualized and predicted. The mechanisms of subsurface flow delivery to the stream are seemingly endless and range from lateral preferential flow, to flow along impeding layers, to flow in highly conductive soil and sub-soil layers—all largely unpredictable from conditions at the soil surface.

So, how can we conceptualize subsurface flow and its many manifestations and such poorly known boundary conditions? Can we simplify the myriad subsurface response mechanisms

to be consistent with infiltration excess and saturation excess overland flow concepts?

This talk examines the future of runoff conceptualization and advances a simple concept of subsurface “storage excess.” McDonnell will offer evidence in support of storage excess using field data from catchments distributed across a wide array of climate, geology, vegetation, and topographic conditions. These data show that subsurface storage filling and then spilling is a simple concept that makes sense at many scales and may help explain runoff amount and timing, geographic and time source components, and residence time. McDonnell will also address how such measures might be used for “gauging” the ungauged catchment as part of the IAHS Decade on Prediction in Ungauged Basins (2003–2012) and informing questions of “what to measure, in what order, and why”? This lecture is intended for those interested in water resources, land-use planning, hydrogeology, and water quality.

Isotope tracers in catchment hydrology: How far can we go?

The use of stable isotopes as tracers of water has fundamentally changed the way we view catchment hydrology. Notably, isotope tracers have shown that the mean transit time for water through catchments can be orders of magnitude longer than the timescale of hydrologic response. This recognition of prompt delivery of old water to the stream changes the way we consider catchment response to land-use and climate change. Findings from catchment isotope studies have now matured to the point that such information is informing rainfall-runoff model development and testing and a new hydrological scaling theory.

So, how far can we go with isotope tracers in catchment hydrology? This talk explores future avenues of study made possible by the recent development of laser spectrometers—a technology poised to radically alter the field by facilitating increased sample frequencies in time and space and, ultimately, routine and widespread field-based deployment. McDonnell will show laser spectrometer examples that demonstrate the power of this approach for understanding ecohydrological interactions and rainfall and snowmelt mixing from the plot- to hillslope- to catchment-scale, as well as transit time distributions and “hydrological memory” of catchments. This lecture is intended for those interested in environmental science, ecohydrology, water resources, and water quality.



2011 Jahns Distinguished Lecturer



William C. Haneberg

GSA Fellow **William C. Haneberg** has been named the 2010–2011 Richard H. Jahns Distinguished Lecturer in Engineering Geology. Haneberg is a Cincinnati-based consultant specializing in engineering geology, physical hydrogeology, applied structural geology, computational geology, and the use of geologic information to support planning and policy decisions.

An author or co-author of more than 100 published papers and abstracts, Haneberg has worked on topics as diverse as landslide and debris flow hazards, land subsidence, the influence of faults on subsurface fluid flow, the mechanics of geologic structures, and the geologic evolution of the Himalaya. His consulting practice emphasizes the application of modern technologies, such as LiDAR, digital photogrammetry, image processing, and computer modeling. He received the 2006 Association of Environmental & Engineering Geologists (AEG) Claire P. Holdredge Award for his book *Computational Geosciences with Mathematica* and has served as chair of the GSA Engineering Geology Division.

In addition to his consultancy, Haneberg is an adjunct professor at the University of Cincinnati, where he teaches structural geology. He has also taught at Northern Kentucky University, Portland State University, and New Mexico Tech.

Before establishing his consulting practice in 1999, Haneberg was senior engineering geologist and assistant director of the New Mexico Bureau of Mines & Mineral Resources, a division of New Mexico Tech. He earned a B.S. (cum laude) in geology from Bowling Green State University, and both M.S. and Ph.D. degrees in geology from the University of Cincinnati. He is a licensed engineering geologist and licensed hydrogeologist (Washington), professional geologist (Wisconsin), and certified professional geologist (American Institute of Professional Geologists [AIPG]).

About the Lectureship

The Jahns lectureship, established in 1988, is sponsored by AEG and GSA's Engineering Geology Division. Its purpose is to provide funding for distinguished engineering geologists to present lectures at colleges and universities in order to increase student awareness of careers in engineering geology. The lectureship is named in honor of Richard H. Jahns (1915–1983), an engineering geologist who had a diverse and distinguished career in academia, consulting, and government. Titles, descriptions, and instructions for arranging a lecture are available on the Jahns Lectures page at www.haneberg.com.

GSA's specialty Divisions represent 17 far-reaching yet focused professional and technical disciplines impacting science, society, education, and geoscience policy. They are the backbone of the GSA Annual Meeting technical program and provide opportunities for leadership, mentoring, service, and recognition.



www.geosociety.org/divisions/



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The goal of the *GSA Today* "Groundwork" series is to *lay the groundwork* for furthering the influence of earth science on education, policy, planning, and funding. Articles can include in-depth geoscience commentary, short observations and analysis of hot topics, and discussion of policy news and issues.

Characteristics of a "Groundwork" Article:

1. This should be a complete, stand-alone article (ongoing or serial commentary or meetings summaries are not appropriate).
2. If authors have supplemental information, they may include it as an online GSA Supplemental Data item.
3. Articles must be *no longer than* 1,400 words with two small figures or 1,600 words with one figure (which equals two typeset pages in *GSA Today*).
4. Color figures may be included at no cost to authors.
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GEOLOGIC PAST

Highlighting articles from past issues of GSA Bulletin

“Earth Sciences as the Background of History”

John C. Merriam, *GSA Bulletin*, March 1920

In his address to the Society on 29 Dec. 1919 (published in the March 1920 *GSA Bulletin* [v. 31, p. 233–246]), then-GSA president John C. Merriam discusses the lack of context in historical discourse, stating that history “as read and taught” rarely includes “all influences actually involved” (p. 234–235). Fore-shadowing a discussion heard frequently in the twenty-first century, Merriam speaks of technology’s role in establishing the global community, commenting that the world of 1919 “cannot return to the kind of isolation possible in the age before space was narrowed by electricity and steam” (p. 233). He argues that in this smaller, more interconnected world, historical debate must be grounded in context, and that society must achieve an understanding of its past in order to recognize the direction of its future.

Merriam next considers the sciences involved in studying humankind’s past—including astronomy, geology, geography, paleontology, biology, and anthropology—and points out that the synthesis of these fields forms the lens through which history must be evaluated. He goes on to discuss the contributions of each of these sciences and how their influences have shaped human perception, noting that “what [comes] first is commonly, if not always, fundamental” (p. 241).

Merriam concludes his address by suggesting that science can aid in broadening human perspective, writing that “the wider outlook of science in all of its phases lifts us up to the

identical viewpoint from which the philosopher and the poet obtain their comprehensive vision” (p. 245). True to his geoscience roots, Merriam continues, “it is the geologist and paleontologist only who see the panorama of ages unrolled in fullest length and in truest reality” (p. 246). Merriam casts the scientist as interpreter, teacher, and guide, declaring that it is the scientist’s responsibility to “point out the lesson of the foundations of the earth, and to show that strength may still come from the hills” (p. 246).

John Campbell Merriam (1869–1945) served as GSA president in 1919. A geologist and paleontologist, Merriam taught at the University of California at Berkeley, chairing Berkeley’s newly minted paleontology department in 1920 and leaving the university that same year to serve as president of the Carnegie Institute of Washington. Perhaps most famous for his studies of fossils found in California’s La Brea tar pits, Merriam discovered remains of *Smilodon californicus*, otherwise known as the saber-toothed tiger, which went on to become California’s state fossil. Reference: www.ucmp.berkeley.edu/about/history/jcmerriam.php.

Editor’s note: The Geologic Past series is usually written by regular staff without byline; this month, editorial intern Stephen Craft put his hand to the task and thus we give credit where it is due.

PURCHASE CARBON OFFSETS FOR YOUR TRIP

The Geological Society of America encourages its meeting attendees to offset travel emissions via the Colorado Carbon Fund. All contributions to the fund support new clean energy projects in Colorado that reduce greenhouse gas emissions.

To participate, please check the box on your registration form, and we’ll collect US\$25 for the fund. If 10% of this year’s 6,500 attendees donate, we could offset more than 800 tons of CO₂—that’s equal to the emissions from burning nearly 90,000 gallons of gasoline.



Quick Reference

GSA MEMBER News & Information on the Web

More news about GSA members:

www.geosociety.org/news/memberNews.htm

Information about current, past,
and future GSA meetings:

www.geosociety.org/meetings/

Dates and information about other
geoscience-related meetings:

www.geosociety.org/calendar/

Resources for K–12 earth science educators:

www.geosociety.org/educate/resources.htm

Find your science at GSA:

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GSA Mentor Programs



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Plan now to attend a Roy J. Shlemon Mentor Program in Applied Geoscience and/or a John Mann Mentors in Applied Hydrogeology Program at your 2011 Section Meeting to chat one-on-one with practicing geoscientists. These volunteers will answer your questions and share insights on how to get a job after graduation.



PROFESSIONALS

Interested in Mentoring Students about Applied Geoscience Careers?

Being a mentor is a rewarding experience. If you would like to serve as a mentor at one of the GSA Section Meetings, or need more information, please contact Jennifer Nocerino, jnocerino@geosociety.org.



2011



NORTHEASTERN/ NORTH-CENTRAL

Joint Section Meeting

Pittsburgh, Pennsylvania, USA

20–22 March 2011

Abstract deadline:

14 December 2010

SOUTHEASTERN Section Meeting

Wilmington, North Carolina, USA

23–25 March 2011

Abstract deadline:

14 December 2010

SOUTH-CENTRAL Section Meeting

New Orleans, Louisiana, USA

27–29 March 2011

Abstract deadline:

18 January 2011

ROCKY MOUNTAIN/ CORDILLERAN

Joint Section Meeting

Logan, Utah, USA

18–20 May 2011

Abstract deadline:

15 February 2011

GSA Section Meeting Schedule

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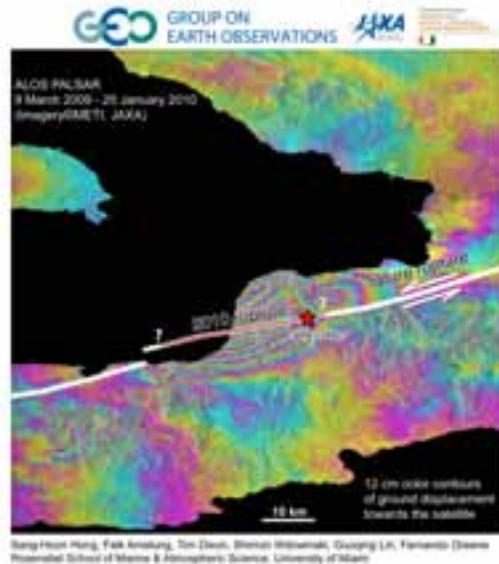
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Lunchtime Lectures Series



GSA Lunchtime Lecture 4

Haiti's Catastrophic Earthquake of 12 January 2010: Lessons Learned

Colorado Convention Center, Room 103/105
Wed., 3 Nov., 12:15–1:15 p.m.

Moderator: Timothy H. Dixon, University of Miami

Panelists: Roger Bilham, University of Colorado; Eric Calais, Purdue University; Carol S. Prentice, U.S. Geological Survey;

On 12 Jan. 2010, Haiti suffered a catastrophic earthquake, killing more than 200,000 people and devastating the capital, Port au Prince. Previous seismic, geologic, and geodetic studies had highlighted earthquake risk in the region, but the country was ill-prepared, in part reflecting the extreme poverty of the region. In this forum, experts who have worked in the area will review the geologic and seismic background to the 12 Jan. event, describe recovery efforts to date, and suggest steps that can be taken to mitigate future hazards in this and other earthquake-prone countries.

Timothy H. Dixon is a professor at the University of Miami's Rosenstiel School of Marine and Atmospheric Sciences and director of the Space Geodesy Laboratory. His research focuses on the application of space geodetic and remote sensing data to understanding Earth's surface and subsurface processes, including earthquakes, crustal deformation, coastal subsidence, and groundwater extraction. Dixon is also the recipient of the GSA Geophysics Division's 2010 George P. Woollard Award.

Roger Bilham is a professor of geosciences at the University of Colorado and Fellow at the Cooperative Institute for Research in Environmental Sciences (CIRES). Bilham holds

degrees in both physics and geology, and his research interests include tectonics and seismic hazards. He is the author of "Lessons from the Haiti earthquake" (2010, *Nature*, v. 463, p. 878–879).

Eric Calais is a professor of geophysics at Purdue University and serves as science advisor to the United Nations' Disaster Risk Reduction Program in Haiti. He co-chaired the United Nations Haiti Earthquake Task Force after the Jan. 2010 earthquake and serves as an expert consultant for the World Bank and other international organizations. Calais' research uses GPS geodesy and deformation modeling to understand the geodynamics of tectonic processes at plate boundaries and plate interiors.

Carol S. Prentice is project chief for the U.S. Geological Survey's San Francisco Bay Area Earthquake Hazards program. Her research focuses on active faults in northern California, the Caribbean, and Asia, and on paleoseismology in Hispaniola, Puerto Rico, and Trinidad. Prentice traveled to Haiti on 24 Feb. 2010 for four weeks of field work as part of the Earthquake Disaster Assistance Team program, a new initiative between the USGS and the USAID Office of Foreign Disaster Assistance. She has been a GSA Fellow since 2008 and served on the Board of Directors of the Seismological Society of America from 2005–2007.

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<http://gsa.confex.com/gsa/2011AM/fieldtrip.htm>.

TECHNICAL SESSIONS

Deadline: 11 January 2011

Help ensure that your area of research and expertise is represented in next year's technical program. Any individual or geoscience organization is welcome to suggest topics and submit proposals for both **Topical Sessions** and **Pardee Keynote Symposia**. Pardee Symposia are high-profile sessions on significant scientific developments, with invited speakers only. Topical Sessions are a combination of invited and volunteered papers. Unique formats are allowed, but must be outlined in the proposal along with the technical support needs. Sessions that promote discussion are encouraged.

<http://gsa.confex.com/gsa/2011AM/sessionproposals.epl>

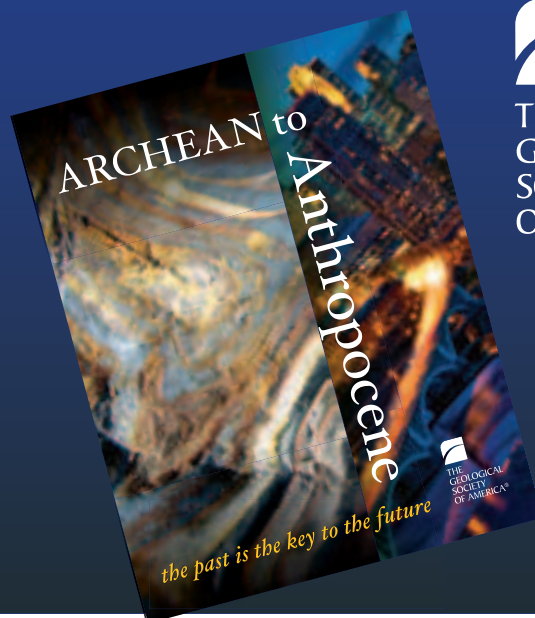
SHORT COURSES

Deadline: 1 February 2011

GSA Short Courses are excellent conduits by which to pass on your expertise and interests to a wider audience. Educate your peers, mentor students and K–12 educators, share how-to information on the latest geoscience and related technologies, and lead the way for others to develop and improve their professional skills. Proposal guidelines are available online or by contacting Jennifer Nocerino at jnocerino@geosociety.org.

www.geosociety.org/meetings/2011/scProposals/index.htm

Looking Ahead to 2011



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Photo by Marli Bryant Miller; www.marlimillerphoto.com.

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GSA e-Bulletin Board: Start a discussion or arrange for ride-sharing or roommates.

Text Messaging: When you register online, you can also sign up for timely updates and reminders via text message from GSA during the meeting.

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meetings/2010/fusion.htm](http://www.geosociety.org/meetings/2010/fusion.htm).



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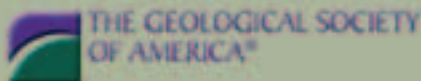
Fossil wasp (*Palaeovespa*) from Florissant Fossil Beds National Monument (trip 422); photo by Herb Meyer.

Geology and Tectonic Evolution of the Central-Southern Apennines, Italy

by **Livio Vezzani, Andrea Festa, and Francesca C. Ghisetti**

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ABOUT PEOPLE

GSA Fellow **Carol A. Finn**, a U.S. Geological Survey geophysicist working in Denver, Colorado, USA, has been elected as President of the American Geophysical Union (AGU). According to the USGS, “Finn, an AGU member since 1980 and USGS scientist since 1978, will be the third female president of the 91-year-old organization, and third USGS employee to hold the post.”

GSA Member **Stephen Silliman**, professor of civil engineering and geological sciences at the University of Notre Dame, has been named the 2011 Henry Darcy Distinguished Lecturer by the National Ground Water Research and Educational Foundation. As the 2011 lecturer, Silliman will present lectures on groundwater hydrology to schools and universities upon their invitation. Established by the National Ground Water Association in 1986, this series honors French hydraulic engineer Henry Darcy.



GSA ANNUAL MEETINGS LOOK TOWARD THE FUTURE

2011

Minneapolis, Minnesota, USA
(9–12 October)

2012

Charlotte, North Carolina, USA
(4–7 November)

2013

Denver, Colorado, USA
(27–30 October)

2014

Vancouver, British Columbia, Canada
(19–22 October)

2015

Baltimore, Maryland, USA
(1–4 November)



GSA Foundation Update

Donna L. Russell, Director of Operations

Visit the GSA Foundation in Denver!

Stop by the Foundation Booth during the GSA Denver Annual Meeting and:

- Meet the **Foundation Trustees**;
- Participate in the Foundation's **11th Silent Auction**;
- **Make a donation** to your favorite Foundation fund;
- **Penrose Circle donors** receive a "token of appreciation";
- Meet **Geoff Feiss**, the new Foundation president, and **Anna Christensen**, chief development officer, and the rest of the Foundation staff; and
- Check out the **Student Opportunities** Section of the Booth.

I hope to see you there!



Most memorable early geologic experience:

My intense search for vertebrate remains in the White River Formation yielded a beautifully preserved skeleton. Unfortunately the teaching assistant in the 1947 University of Wyoming Field course identified it as that of a very recent squirrel!

—Heinrich D. Holland

Silent Auction Fun at the GSA Foundation Booth

We hope you will make it a priority to participate in the Foundation's 11th Silent Auction at the GSA Annual Meeting in Denver. The auction, located at the Foundation Booth in the Colorado Convention Center, will be open for bidding during Exhibit Hall hours Sun.–Tues., 31 Oct.–2 Nov., and will close at 10 a.m. on Wed., 3 Nov. This is a great place to pick up holiday gifts, vacation packages, gift certificates for meals and entertainment, rock and mineral specimens, and other fun items donated by our loyal Foundation supporters.

All auction proceeds support our Greatest Needs Fund, which provides support for student travel grants (both domestic and international), research grants, and education and outreach programs. Come help us make this year's auction as successful in its 11th year as it has been for the past 10.

Planned Giving Seminar

The Foundation will be hosting a Planned Giving Seminar during the annual meeting. Janet Doolan of Doolan Training & Consulting will be conducting this seminar, which will cover planned giving and endowment options, and the basic steps and benefits of both.

Don't delay—attendance to this seminar is free, but you MUST make a reservation because seating is limited. Please call or e-mail Donna Russell, +1-303-357-1054, drussell@geosociety.org, to reserve a place in this informative seminar.

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In Memoriam

GSA regrettably reports the deaths of the following members. Notifications were received 1 May–31 July 2010.

Donald R. Baker
Denver, Colo., USA
19 July 2010

Alfred E. Boerner
Priddis, Alberta, Canada
notified 29 July 2010

Daniel A. Bradley
St. Laurent, Québec, Canada
30 April 2010

John Thomas Dutro Jr.
Washington, D.C., USA
13 June 2010

Eric Essene
Ann Arbor, Mich., USA
20 May 2010

Bruce K. Goodwin
Williamsburg, Va., USA
5 September 2008

Vernon J. Henry
Savannah, Ga., USA
notified 25 May 2010

Hans Hofmann
Montreal, Québec, Canada
19 May 2010

S. Francis Thoumsin Jr.
Audubon, Pa., USA
notified 10 May 2010

John E. Utgaard
Carbondale, Ill., USA
8 September 2009

Harry B. Whittington
Cambridge, England
20 June 2010

Henry H. Wilson
Lothian, Md., USA
notified 6 May 2010

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

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

Classified Rates—2010

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

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First 25 lines	\$0.00	\$4.50
Additional lines	\$4.50	\$4.50
Fellowship Opportunities	\$8.85	\$8.60

Positions Open

CHEMICAL ANALYST, DEPARTMENT OF GEOLOGY AND GEOPHYSICS, UNIVERSITY OF WYOMING

The Department of Geology and Geophysics, University of Wyoming, seeks applicants for a Chemical Analyst position in the Geochemistry Analytical Laboratory (GAL). The GAL contains analytical instrumentation ranging from standardized titrations to quadrupole ICP-MS for analysis of water, gasses and solids. The GAL's mission is to provide analytical support for Geology and Geophysics faculty as well as to serve some of the broader analytical needs of the university community. The Chemical Analyst will maintain and run instrumentation for users, teach a course in analytical geochemistry, train students to use instrumentation independently, and lead continuous efforts to upgrade and modernize GAL equipment as needed. In addition to performing these service duties, the Chemical Analyst will be classified as an Academic Professional Research Scientist and will be expected to perform independent research. Minimum qualifications include experience with wet-chemical analysis and a strong track record in analysis and research. The research component of this position would normally require a Ph.D., but we will consider applicants with an MS degree and an unusually strong track record in both analytical service and research. Applications should consist of a cover letter, a CV, a statement of analytical and research areas of expertise, and a list of at least three independent referees compiled in electronic form and sent to ChemSearch@uwyo.edu, referencing the Chemical Analyst position. Applications are due by 15 Nov. 2010. The University of Wyoming is an equal opportunity/affirmative action employer.

SEDIMENTARY GEOLOGY UNIVERSITY OF WYOMING

The Department of Geology and Geophysics (<http://geology.uwyo.edu>) invites applications for a tenure-track, Assistant Professor position in sedimentation/stratigraphy. Ph. D. is required at the time of appointment. We seek an individual who shows the potential to develop an internationally recognized, externally funded research program, will be involved in the undergraduate and graduate teaching mission of the Department, and will complement departmental strengths. Speciality is open and may include such diverse fields as petroleum geology, quantitative basin analysis, seismic stratigraphy, carbonate sedimentation, paleoclimate reconstruction, and physical sedimentology. Relevant instrumentation in the Department includes: fission-track laboratory, multi-sensor core logger, micro-analytical facility, high-abundance sensitivity TIMS, LA-ICP-MS, a next generation multi-collector ICP-MS, and a modern reflection seismology lab. The University includes the School of Energy Research (www.uwyo.edu/ser/) and a centralized Stable Isotope Facility (<http://uwacadweb.uwyo.edu/SIF/>).

Applications should include a statement of research and teaching interests and accomplishments, curriculum vita, and the names and contact information of three references. Review of completed applications will begin 15 Nov. 2010. Send a compiled electronic copy (PDF version preferred) of your application to the Search Committee (sedsearch@uwyo.edu). If you have additional application materials to send, please direct

them to Sedimentary Search Committee, Dept. 3006, Geology & Geophysics, University of Wyoming, 1000 E. University Ave., Laramie, WY 82071.

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

TENURE-TRACK POSITION IN HYDROGEOLOGY UNIVERSITY OF IOWA

The Department of Geoscience at the University of Iowa (www.uiowa.edu/~geology) invites applications for a tenure-track Assistant Professor with a specialty in hydrogeology. The position is part of a significant university-wide initiative that seeks to build interdisciplinary expertise in water sustainability. We seek an outstanding researcher and teacher with interests in groundwater, and who complements strengths in the Department and other campus organizations, such as IHR-Hydroscience and Engineering (www.ihr.uiowa.edu) and the Center for Global and Regional Environmental Research (www.cgrer.uiowa.edu). Research involving field and laboratory studies of groundwater hydrology and water pollution will be considered a desirable quality. He/she is expected to develop an active, externally-funded program of research and to develop ties with other faculty in our department and across campus working in the environmental and hydrologic sciences and sustainability. In addition to attracting and mentoring graduate students, the successful applicant will be expected to teach at the graduate and undergraduate levels.

The appointment will begin August 2011. A Ph.D. in geoscience or a related field is required by the time of appointment. Candidates must submit applications online at <http://jobs.uiowa.edu/> (requisition #58210). Attachments to the application should include a letter of application and curriculum vitae. The letter of application should include: a statement of teaching interests, evidence of teaching ability, and a statement that describes current and future research activities. Three letters of recommendation should be mailed to: Dr. Art Bettis, Search Committee Chair, Department of Geoscience, University of Iowa, Iowa City, IA 52242; +1-319-335-1831; e-mail: art-bettis@uiowa.edu.

Screening of applications begins 30 Nov. 2010 and will continue until the position is filled. Questions regarding this position can be directed to Dr. Bettis or Dr. Mark Reagan, Geoscience Department Chair; +1-319-335-1820; mark-reagan@uiowa.edu. The department and the College of Liberal Arts and Sciences are strongly committed to gender and ethnic diversity; the strategic plans of the University and College reflect this commitment. The University of Iowa is an equal opportunity/affirmative action institution. Women and minorities are encouraged to apply.

ASSISTANT/ASSOCIATE PROFESSOR SEISMOLOGY/SEISMIC EXPLORATION UNIVERSITY OF UTAH

The Department of Geology and Geophysics at the University of Utah seeks applicants for a Tenure-Track position at the Associate or Assistant Professor level in Seismology/Seismic Exploration.

Priority will be given to candidates whose research has a focus on seismic imaging, including but not limited to processing and interpretation of seismic array data, reflection seismology, inversion and integrated interpretation with other geophysical data. Preference will be given to a candidate with a strong background in quantitative sciences and with experience in solving practical geological and geophysical problems. The successful candidate should have a proven ability or potential to attract external funds and to build a vibrant research program involving graduate students and post docs. Applicants must hold a Ph.D. in geophysics, or a closely related discipline.

Applicants should e-mail an application letter describing research, teaching, and career interests, a curriculum vitae, and the names and contact information for three referees, all in PDF format to: searchcommittee-seism-expl@lists.utah.edu. Review of applicants will begin 1 Jan. 2010 and continue until the position is filled.

The University of Utah is fully committed to affirmative action and to its policies of nondiscrimination and equal opportunity in all programs, activities, and employment. Employment decisions are made without regard to race, color, national origin, sex, age, status as a person with a disability, religion, sexual orientation, gender identity or expression, and status as a protected veteran. The University seeks to provide equal access for people with disabilities. Reasonable prior notice is needed to arrange accommodations. Evidence of practices not consistent with these policies should be reported to: Director, Office of Equal Opportunity and Affirmative Action, +1-801-581-8365 (V/TDD).

The University of Utah values candidates who have experience working in settings with students from diverse backgrounds, and possess a [strong or demonstrated] commitment to improving access to higher education for historically underrepresented students.

DEPARTMENT OF INTEGRATIVE BIOLOGY FACULTY POSITION IN INVERTEBRATE PALEOBIOLOGY, UNIVERSITY OF CALIFORNIA AT BERKELEY (POSITION ID # 1512)

The Department of Integrative Biology at the University of California at Berkeley is soliciting applications for a tenure track position (Assistant Professor) in Paleobiology. We seek a colleague to join a department with a strong interdisciplinary emphasis who demonstrates an understanding of the fossil record of marine invertebrates, and will use it to develop a vigorous, independent research and teaching program in paleobiology. The successful candidate will also serve as a curator in the University of California Museum of Paleontology, and will be encouraged to promote the use of UCMP's extensive holding of fossil and Recent invertebrates, supervise student research, work with museum staff to pursue opportunities for collection improvement and growth, and participate in UCMP activities and events. Candidates with active field programs, and who make use of neontological analysis and data are strongly encouraged to apply. Candidates must have a Ph.D. (or equivalent) in the biological or geological sciences, or a related field. Areas of interest include, but are not limited to, patterns and processes of macroevolution, investigations of tempo and mode in evolution, systematics of fossil and recent marine invertebrates, paleoecology, and paleobiological approaches to climate change, macroecology, and paleobiogeography. Candidates must also have a strong interest in undergraduate and graduate teaching and will be expected to contribute to instruction in general and specialized courses. Candidates will also have commitment to education, outreach and service to groups under-represented in the sciences. The expected start date is the beginning of the academic year, 2011–2012.

Applicants should send a cover letter, CV, bibliography, a brief description of research accomplishments and objectives, statement of interest and experience in teaching, outreach and service to under-represented groups in the sciences, pdfs of selected reprints, and the names and addresses of three referees. The applicants should arrange to have their referees send letters to Department to meet the application deadline. Applications should be submitted electronically via <http://ib.berkeley.edu/admin/jobs/invertepaleo.php> or via e-mail to: InvertPaleoB@gmail.com.

If electronic submission is not possible, materials may be sent by regular mail to Invertebrate Paleobiology Search Committee, Dept. of Integrative Biology, 3060 Valley Life Sciences Building, University of California, Berkeley, CA 94720-3140, USA.

Applications must be received electronically or post-marked by 1 Nov. 2010. Review of applications will begin 2 Nov. 2010.

Applicants should refer their referees to the UC Berkeley Statement of Confidentiality at <http://apo.chance.berkeley.edu/evaltr.html>.

The University of California is an Affirmative Action/Equal Opportunity Employer.

PHYSICAL HYDROGEOLOGY POSITION AVAILABLE DEPARTMENT OF GEOSCIENCES UNIVERSITY OF WISCONSIN-MILWAUKEE

The Department of Geosciences at the University of Wisconsin-Milwaukee invites applicants for a tenure-track faculty position in physical hydrogeology at the rank of Assistant Professor with a start date of August 2011. Applicants must hold a Ph.D. in geology or related field at the time of appointment, and have demonstrated research experience in physical hydrogeology. Postdoctoral experience is desirable. Scientific publications, conference publications, and funding experience preferred but not necessary. Teaching experience (TA and/or lecture) is desirable. The successful candidate is expected to conduct an active, internationally recognized, externally funded research program. The successful candidate will teach an undergraduate/graduate course in physical hydrogeology, an introductory course, upper level undergraduate and graduate level courses in their field of expertise, and advise graduate student thesis projects. A normal teaching load is three courses per academic year. This job posting is available online along with information regarding the Department of Geosciences and the College of Letters and Sciences at http://www4.uwm.edu/lets/sci/geosciences/dept_life/job_ad.cfm.

Review of applications will begin 1 Nov. 2010. Priority will be given to applications received by this date, but the position remains open until filled. To apply, please go to <http://jobs.uwm.edu/postings/4880>. Candidates will upload cover letter, curriculum vitae, teaching philosophy, research interests, and published works with online application. Published works may be uploaded with application as "Other Document." In addition, three letters of recommendation are required and should be mailed to Lisa Alzalde, Search & Screen Support, Dept. of Geosciences, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53201 or lalzalde@uwm.edu.

The University of Wisconsin-Milwaukee is a large, research-oriented institution located on the northeast side of Milwaukee, five blocks from Lake Michigan. The Dept. of Geosciences offers B.S./B.A., M.S., and Ph.D. degree programs and is staffed by 12 full-time faculty. UWM is an AA/EEO employer.

**TENURE-TRACK POSITION, CLIMATE SCIENCE
JOINT SCIENCE DEPARTMENT OF CLAREMONT
MCKENNA, PITZER, AND SCRIPPS COLLEGES**

The Joint Science Department, which houses the biology, chemistry, and physics faculty for Claremont McKenna, Pitzer, and Scripps Colleges (three of the five undergraduate Claremont Colleges), seeks a climate scientist who is committed to excellence in teaching and who will develop a vibrant research program that fully engages undergraduate students. The appointment will be made at the Assistant Professor level to begin July 2011. All areas of climate science will be considered, ranging from the most biological to the most physical. The new hire will be an integral participant in the Mellon Foundation-funded Claremont Colleges Intercollegiate Environmental Analysis Program, which also includes faculty from Harvey Mudd and Pomona Colleges. Many Joint Science faculty actively participate in collaborative research projects with research groups at nearby colleges and universities, and such collaborations are welcomed for this position. The teaching opportunities will include introductory courses in a core discipline (biology, chemistry, or physics) and in environmental science, as well as both upper-division electives and courses for non-science majors in climate science. A Ph.D. and a record of scholarly publication are required. Postdoctoral experience is preferred.

Please apply online at <https://webapps.cmc.edu/jobs/faculty/home.php>. Upload a cover letter, a curriculum vitae, a description of your proposed research, a statement of your proposed approach to teaching science in a liberal arts setting, and the names and e-mail addresses of three references. Inquiries regarding the position may be e-mailed to Professor Donald McFarlane at dmcfarlane@jdsd.claremont.edu. Additional information about the department may be found at www.jdsd.claremont.edu. Review of applications will begin 29 Oct. 2010, and the position will remain open until filled.

In a continuing effort to enrich its academic environment and provide equal educational and employment opportunities, The Claremont Colleges actively encourage applications from women and members of historically under-represented social groups in higher education. The Claremont Colleges are an equal opportunity employer.

**LOW-TEMPERATURE GEOCHEMISTRY/
MINERALOGY, DARTMOUTH COLLEGE**

The Department of Earth Sciences at Dartmouth College invites applications for a junior rank, tenure track position in the general areas of low-temperature geochemistry and mineralogy. We welcome applications from candidates with research interests in geochemical processes in wide ranging environments, especially cold regions and/or fluvial systems; geochemical controls on floodplain and hillslope processes; evolution of organic-rich environments in high-latitude, high-altitude settings; geologic controls on contaminant transport and fate in soils and aqueous environments with a view to ecosystem health and applications in medical geology. Particular attention will be given to candidates who combine a focus on understanding fundamental processes with a state-of-the-art field research program that provides synergy with existing research activities at Dartmouth. The successful candidate will continue Dartmouth's strong traditions in undergraduate and graduate research and teaching, and will contribute to existing strengths within the department. Send curriculum vitae, description of teaching and research interests and objectives, reprints or preprints of up to three of your most significant publications, and the names, address (including street address), e-mail address and



**Research Assistant Professor
in Electron Microscopy**

The Geoscience Department seeks candidates for a full-time Research Assistant Professor to operate both a JEOL JXA-8900 EPMA and a JSM-5610 SEM, equipped with an Oxford EBSD. The successful candidate will train all users in data acquisition and interpretation, establish standard operating procedures, develop new analytical methods, solicit and oversee work from outside users, and teach a course on electron beam methods. The primary focus of the position is to maintain and enhance the capabilities of the facility and to assist UNLV and outside users. However, the candidate will be encouraged to conduct research, mentor graduate students, and collaborate on competitive funding proposals with both internal and external faculty as time permits; opportunities exist for teaching. Applicant must have a Ph.D. from an accredited university and extensive EPMA experience.

Submit a cover letter, CV, and letter of interest detailing your interest in the position as described above, and contact information for four referees to Dr. Adam Simon (702-895-2916), Search Committee Chair via on-line application at <https://hrsearch.unlv.edu>. Review of application materials will begin immediately. For assistance with UNLV's on-line applicant portal, contact Jen Martens at (702) 895-2894 or hrsearch@unlv.edu. Salary competitive; contingent upon labor market and contingent upon funding.

UNLV is an Affirmative Action/Equal Opportunity educator and employer committed to excellence through diversity.

fax/phone numbers of at least three references to: Search Committee, Dept. of Earth Sciences, Dartmouth College, 6105 Fairchild Hall, Hanover, NH 03755, e-mail: earth.sciences@dartmouth.edu, Web pages: <http://www.dartmouth.edu/~earthsci>.

Review of applications will begin 15 Oct. 2010 and continue until the positions are filled. The appointment will be effective 1 July 2011.

Dartmouth College is an equal opportunity/affirmative action employer, is committed to diversity, and encourages applications from women and minorities.

**TENURE-TRACK FACULTY POSITION(S)
SEDIMENTOLOGY/STRATIGRAPHY, VIRGINIA TECH**

The Department of Geosciences at Virginia Tech invites applicants for a tenure-track faculty position in sedimentology/stratigraphy starting in the Fall of 2011. Particular subareas of interest include, but are not limited to, physical sedimentology, sedimentary basin analysis with emphasis on marine seismic stratigraphy, high-resolution sequence stratigraphy, sedimentary (bio) geochemistry, chemostratigraphy, and Earth systems history. The position is at the assistant professor level, but outstanding senior candidates will also be considered. The successful candidate is expected to develop an internationally recognized, externally funded, multi-disciplinary research program; and to actively participate in the undergraduate and graduate teaching mission of the university. This position is one of several hires in the Departments of Geosciences and Biological Sciences to support the Virginia Tech College of Science research clusters in Integrated Studies of Earth Systems and Energy/Environment. To receive full consideration, the applicant must have a Ph.D. degree in Geosciences or a related discipline at the time of appointment and a demonstrated capability/promise to develop an active research program. Preference will be given to candidates whose research areas complement existing strengths in the department.

Consideration of applications will begin as early as 8 Nov. 2010 and will continue until the positions are

filled. Salary will be commensurate with rank and experience. Please visit www.hr.vt.edu/employment/ (posting # 0100596) to apply on-line for this position. Applicants should provide a cover letter, resume, research statement, teaching statement, and a list of at least four referees who are familiar with their work. For further information, visit the Dept. of Geosciences website (www.geos.vt.edu) or contact Search Committee chair Dr. Shuhai Xiao by e-mail (xiao@vt.edu). Virginia Tech is an Equal Opportunity/Affirmative Action Institution and the recipient of a National Science Foundation ADVANCE Institutional Transformation Award to increase the participation of women in academic science and engineering careers.

**TENURE-TRACK FACULTY POSITION
PETROLOGIC PROCESSES, VIRGINIA TECH**

The Department of Geosciences at Virginia Tech is seeking to fill a tenure-track faculty position to start in the Fall of 2011 in Petrologic Processes. This position is part of the Integrated Studies of Earth Systems cluster hiring initiative of the College of Science. Potential focus areas include magmatism, metamorphism, evolution of the crust and upper mantle, high temperature geochemistry, isotope geochemistry, and geochronology, with an emphasis on plate tectonics and how the material properties of rocks, minerals, and geofluids influence dynamics of the whole Earth system.

The position will likely be at the Assistant Professor level, but outstanding senior candidates are encouraged to inquire and apply. Rank will be determined by the qualifications of the successful applicant and salary will be commensurate with rank and experience. To receive full consideration, applicants must have a Ph.D. in Geosciences or related discipline at the time of appointment and a proven record of successful research. The successful candidate will be responsible for developing and maintaining a vigorous, internationally recognized, externally funded research program that emphasizes multi-disciplinary collaborations, as well as active participation in the undergraduate and graduate

teaching mission of the university. Preference will be given to candidates whose research areas complement existing strengths in the department.

Review of applications will begin as early as 8 Nov. 2010 and will continue until the position is filled. Please visit www.hr.vt.edu/employment/ (posting # 0100587) to apply on-line for this position. Applicants should provide a cover letter, CV, research and teaching statements, and a list of at least four references who are familiar with their work. For further information, visit the Dept. of Geosciences Web site (www.geos.vt.edu) or contact search committee chair Dr. James Spotila by e-mail (spotila@vt.edu).

Virginia Tech is an Equal Opportunity/Affirmative Action Institution and recipient of a National Science Foundation ADVANCE Institutional Transformation Award to increase the participation of women in academic science and engineering careers.

**CLIMATE SCIENCE
(TENURE-TRACK, ASSISTANT PROFESSOR)
CENTRAL MICHIGAN UNIVERSITY**

The Department of Geology and Meteorology at Central Michigan University invites applications for a tenure-track Assistant Professor position in Climate Science. The successful candidate will collaborate with faculty in Geology and Meteorology as well as interdisciplinary initiatives. Responsibilities include teaching courses in geology or meteorology, curriculum development, mentoring student research, and department and university service. In addition, the candidate is expected to develop an active research program in climate science, participate in CMU's Great Lakes research initiative, and submit competitive external funding proposals. Classified by the Carnegie Foundation as a doctoral research university, CMU is recognized for strong undergraduate education and a range of focused graduate and research programs. Minorities and women are especially encouraged to apply. Required qualifications include a Ph.D. in the Earth, Atmospheric or Hydrologic Sciences with a focus on climate science before starting in the position on 15 August 2011. The candidate

will demonstrate effective communication skills and the potential for excellence in teaching and research. Preference will be given to those whose primary interest is the relation between global or regional climate change and the hydrologic cycle, and especially to those who can contribute to our growing program of research on the Great Lakes. The department has 16 full-time faculty members and offers undergraduate degrees in both Geology and Meteorology. The department is well equipped and has a strong record of supporting undergraduate research. For more information, go to www.cst.cmich.edu/geology/. Interested persons must submit a letter of application, curriculum vitae, a statement of proposed research agenda, a statement of prior teaching experience and philosophy to www.jobs.cmich.edu. Three letters of reference must be mailed to: Climate Science Search Committee, Dept. of Geology and Meteorology, Brooks 314, Central Michigan University, Mount Pleasant, MI 48859, USA. All applications and materials must be received by 1 Nov. 2010. CMU, an AA/EO institution, strongly and actively strives to increase diversity within its community (see www.cmich.edu/aaeo/).

**UNIVERSITY SYSTEM OF GEORGIA, CHAIR
DEPARTMENT OF GEOLOGY AND GEOGRAPHY
SEARCH #56714, ALLEN E. PAULSON COLLEGE
OF SCIENCE AND TECHNOLOGY (COST)
GEORGIA SOUTHERN UNIVERSITY**

The Department of Geology and Geography in the College of Science and Technology invites nominations and applications for the position of the Chair of the Dept. of Geology and Geography. Georgia Southern University (www.georgiasouthern.edu), a member institution of the University System of Georgia and a Carnegie Doctoral/Research University, is one of Georgia's premier universities. A residential university serving more than 20,000 students in fall 2010, Georgia Southern is recognized for providing all of the benefits of a major university with the feeling of a much smaller college. Founded in 1906, the University offers more than 100 campus-based and

online degree programs at the baccalaureate, master's, and doctoral levels through eight colleges. The nearly 700 acre park-like campus is located in Statesboro, a classic Main Street community near historic Savannah and Hilton Head Island.

Within this setting, the department has a strong commitment to teaching and scholarly excellence and provides undergraduate programs of study. A master's degree for the department is envisioned for the near future. The department has been designated as an Environmental Systems Research Institute Development Center and recognized as an Academic Leadership Department by the American Geological Institute. Because the department is closer to the coast than any similar program in the University System, the geology and geography programs pursue a shared identity as the center for the study of the coast and coastal plain of Georgia, providing unique opportunities for teaching, learning, research, and service. The department has 13 tenure-track faculty members (the chair, seven in geology, and five in geography) and is one of seven academic units in COST. The mission statement of the Dept. of Geology and Geography is: The Dept. of Geology and Geography at Georgia Southern University functions as an integrated student-centered unit to support the core curriculum by providing students an understanding of the variety and complexity of the earth's geologic, environmental, cultural, political, and socioeconomic systems and their interactions. The department is committed to providing specialized undergraduate programs of study leading to BS or BA degrees with majors in Geology or Geography, with an optional Geographic Information System (GIS) minor. The department is dedicated to producing high quality geology and geography graduates well prepared for graduate school or immediate employment in fields such as education, urban and county planning, geology, hydrology, environmental protection, and geospatial technology. The department utilizes its location in coastal Georgia to meet the educational needs of the regional populace, promote a healthy regional environment, and promote sustainable growth and development through teaching, service, and

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- Access to the database is only US\$300 through 30 April 2011.

Please take advantage of our interview services at the 2010 GSA Annual Meeting & Exposition on 1–2 November in Exhibit Hall B of the Colorado Convention Center. This service includes an interview booth, appointment scheduling, an area for job postings, and access to the applicant database.



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research. The department faculty members value the integration of research, education, and practical application in scholarship that leads to high-quality publications and external contracts and grants.

Position Description: Reporting to the Dean of the College of Science and Technology, the chair will provide leadership for the teaching, scholarship, and service mission of the department. The chair will advance a culture of academic excellence where distinction in teaching, research, and service is expected and rewarded. The chair will provide leadership for curriculum development, assessment of student learning, research programs, and initiatives that further the department and College strategic plans. The position is a tenured, 12-month appointment and the salary is competitive and commensurate with the candidate's qualifications and experience.

Required Qualifications:

- Candidates must have a doctoral degree in geology, geography, or geosciences.
- Credentials consistent with those of tenured faculty members holding the rank of full professor in the College of Science and Technology at Georgia Southern University.
- The successful candidate will be an accomplished scholar with an established investigator-initiated research program.
- Demonstrated commitment to teaching excellence.
- Demonstrated strong administrative and leadership skills.
- Effective communication and interpersonal skills.
- Minimum of five years college/university, full-time, teaching experience at the associate professor level is required for the rank of professor along with a strong record of research and service with substantial publications and presentations in professional venues.

Preferred Qualifications:

- A strong understanding and knowledge of Geology, Geography, and Geospatial technology.

- Demonstrated understanding of scholarship and research in a collaborative, multidisciplinary context.
- Demonstrated commitment to undergraduate research and desire to encourage the scholarly activities of faculty.
- Demonstrated commitment to shared collegial governance.
- Evidence of strong commitment to excellence in undergraduate and graduate education and fostering intellectual community.

Screening of applications begins 1 Oct. 2010 and continues until the position is filled. The position starting date is 1 July 2011. A complete application includes a letter addressing the qualifications cited above; a curriculum vita; a statement of research interests; a statement of leadership and management philosophy; and the names, addresses, telephone numbers, and e-mail addresses of five persons who may be contacted as professional references. Other documentation may be requested. Georgia Southern University seeks to recruit individuals who are committed to working in diverse academic and professional communities. Applications and nominations should be sent to Dr. Mohammad Davoud, Search Chair (Search #56714, Dept. of Mechanical and Electrical Engineering, Georgia Southern University, P.O. Box 8046, Statesboro, GA 30460, e-mail: mdavoud@georgiasouthern.edu; phone: +1-912-478-5761.

More information about the institution is available through www.georgiasouthern.edu or <http://cost.georgiasouthern.edu/geo/>, or <http://cost.georgiasouthern.edu/>. Georgia Southern University seeks individuals who are committed to excellence in teaching, scholarship, and professional service within the University and beyond. Finalists will be required to submit to a background investigation. Georgia is an Open Records state. Georgia Southern University is an AA/EO institution. Individuals who need reasonable accommodations under the ADA to participate in the search process should contact the Associate Provost.

**ASSISTANT PROFESSOR
TENURE-TRACK POSITION
BOWDOIN COLLEGE**

Bowdoin College Department of Earth and Oceanographic Science invites applications for a tenure-track position. Assistant professor rank. Ph.D. required (advanced ABDs considered). We seek candidates whose research is within the solid-earth field including such specializations as volcanology, structural geology, tectonics or mineralogy.

Bowdoin College accepts only electronic submissions. Please visit <https://careers.bowdoin.edu> to apply.

Application review date: **10 December 2010.**

Bowdoin College is committed to equality through Affirmative Action, and is an equal opportunity employer. For a full position description and further information about Bowdoin, please visit <https://www.bowdoin.edu>.

**FACULTY OPENING
ECONOMIC GEOLOGY AND GEOTHERMAL
SYSTEMS
RESEARCH ASSISTANT PROFESSOR
UNIVERSITY OF NEVADA-RENO**

The Nevada Bureau of Mines and Geology (NBMG), University of Nevada-Reno (UNR), seeks applicants for a tenure-track, Research Assistant Professor faculty position beginning on or after 1 July 2011, with interests in research on both mineral deposits and geothermal systems. Doctoral research must include one or more of the following disciplines: economic geology, structural geology, igneous petrology, geochemistry, exploration geophysics, and hydrogeology. Nevada is one of the most exciting regions in the world to do research in the geosciences and the best in the U.S. for the study of metallic mineral deposits and geothermal energy. For a complete position description and requirements, view the position announcement at www.nbmgs.unr.edu and <http://jobs.unr.edu/> or contact



USGS Mendenhall Postdoctoral Research Fellowship Program (Fiscal Year 2012)

The U.S. Geological Survey (USGS) invites applications for the Mendenhall Research Fellowship Program for Fiscal Year 2012.

The Mendenhall Program provides opportunities to conduct postdoctoral research in association with selected members of the USGS professional staff. Through Mendenhall appointments the USGS will acquire current expertise in science to assist in implementation of the scientific goals of its programs. Fiscal Year 2012 begins in October 2011.

Opportunities for research are available in a wide range of topics including: global and climate change; continental margin processes; stream ecosystem function; karst geomorphology and hydrology; seismic hazard and risk modeling; coastal change processes; uranium geochemistry; environmental health; magnetic storms; earthquake and tsunami hazards; computational modeling of floods, avalanches, debris flows, and ash clouds; vulnerability of coupled human-environmental systems; 3D geologic mapping; hydrology of intermittent streams; applied remote sensing; Holocene droughts; monitoring volcanic processes; neotectonics; paleoseismology; risk and vulnerability of communities to natural hazards; biochar; costs and benefits of energy development; earthquake monitoring; preferential-flow impacts on water quality and ecosystems; socio-economic interactions of climate, vegetation phenology and ecosystem properties.

The postdoctoral fellowships are 2-year appointments. The closing date for applications is November 15, 2010. Appointments will start October 2011 or later, depending on availability of funds. A description of the program, research opportunities, and the application process are available at <http://geology.usgs.gov/postdoc>. The U.S. Geological Survey is an equal opportunity employer.

Program Contacts: Dr. Rama K. Kotra, rkotra@usgs.gov, 703-648-6271

U.S. Department of the Interior
U.S. Geological Survey

Geoscience Search, NBMG, Mail Stop 0178, UNR, Reno, NV 89557-0178. Applications received through <http://jobs.unr.edu/> by 23 Dec. 2010 will receive full consideration. EEO/AA. Women and under-represented groups are encouraged to apply.

DIRECTOR—KANSAS GEOLOGICAL SURVEY THE UNIVERSITY OF KANSAS, LAWRENCE

Full-time position serving as the Director of the Kansas Geological Survey (KGS) and State Geologist. Must develop and articulate a vision of KGS programs, understand the concept of serving Kansas through high-quality research in the applied geosciences, and embrace a collegial leadership style. Requires doctorate in the geosciences with 10 years professional experience, three years administrative experience, national recognition in geoscience research, excellent communication skills, knowledge of natural resources and the environmental aspects of their use, and demonstrated ability to deal with natural-resource policy issues.

The KGS is a research and service division of the University of Kansas (KU). Created in 1889, the Survey studies the geology of Kansas, develops new techniques for exploring and analyzing geologic data, and produces and disseminates maps, reports, and scientific papers. Among the premier earth-science research and service institutions in the U.S., the KGS has an annual state budget of \$6 million and employs more than 90 researchers, support staff, and students in four research sections and a number of service sections. Staff collaborate extensively with faculty and students in academic departments at KU.

Complete announcement/application information at www.kgs.ku.edu/General/jobs.html. Review will begin 19 Nov. 2010; position open until filled. For further information, contact Jim Butler, jbutler@kgs.ku.edu. KU is an EO/AA employer.

FACULTY FELLOW IN GEOLOGY

MINERALOGY/GEOCHEMISTRY, COLBY COLLEGE

The Department of Geology invites applications for a one-year, non-tenure track, Faculty Fellow in mineralogy/geochemistry beginning 1 Sept. 2011. The successful applicant will be expected to teach a core-curriculum Mineralogy course with laboratory and an upper division course of his/her choice for geology majors during the academic year. The upper division course should complement those already offered in the department. The remainder of the teaching assignment will focus on an introductory course offering for potential majors and non-majors (100-level). Additionally, the candidate may have the opportunity to direct one or more independent research projects. Colby is a highly selective liberal arts college recognized for excellence in undergraduate education and for close student-faculty interaction. Ph.D. with teaching experience at time of employment preferred; ABDs encouraged to apply. Applicants should submit a letter of application, curriculum vitae, statements of teaching and research interests, and three letters of reference to Dr. Robert A. Gastaldo, Chair, Dept. of Geology, 5807 Mayflower Hill Drive, Waterville, ME 04901. Review of applications will begin on 22 Nov. 2010 and will continue until the position is filled. Colby is an Equal Opportunity/Affirmative Action employer, committed to excellence through diversity, and strongly encourages applications and nominations of persons of color, women, and members of other under-represented groups. For more information about the College, please visit the Colby Web site: www.colby.edu.

EARTH SURFACE PROCESSES

ASSISTANT PROFESSOR, DENISON UNIVERSITY

The Department of Geosciences at Denison University invites applications for a tenure track position to begin in Fall 2011. We seek a broadly trained scientist engaged in the study of Earth surface processes and/or environ-

mental change, who shows potential as an outstanding teacher/scholar and who will enhance the diversity of our program. Specific areas of interest include (1) active tectonics, geomorphology, geophysics, or (2) climate or ocean sciences, low-temperature geochemistry, sedimentology/stratigraphy.

We seek a colleague who is committed to teaching excellence in the liberal arts tradition, is field-oriented, has broad interests beyond their specialty, and will provide a balance of classroom, field and laboratory experiences for our students. Denison is a selective liberal arts college strongly committed to, and supportive of, excellence in teaching and active faculty research that involves undergraduate students. A Ph.D. at the time of appointment is required.

All application materials will be handled electronically at <https://employment.denison.edu>. Please include a letter of application; statements of your approaches to teaching and research in a liberal arts setting as well as ways in which your expertise would expand, enrich and complement our program; a curriculum vitae; academic transcripts; and contact information for three references. Please contact Dr. David Greene, Dept. of Geosciences, Denison University, Granville, OH 43023; +1-740-587-6476; greened@denison.edu for more information about the position. Application materials should arrive by 25 Oct. 2010 for full consideration, although the search will remain open until the position is filled. We plan to meet with selected candidates attending GSA in early November. Denison University is an Affirmative Action, Equal Opportunity Employer. To achieve our mission as a liberal arts college, we continually strive to foster a diverse campus community, which recognizes the value of all persons regardless of religion, race, ethnicity, gender, sexual orientation, disability, or socio-economic background.

TWO ENDOWED FULL PROFESSOR POSITIONS OSU BOONE PICKENS SCHOOL OF GEOLOGY OKLAHOMA STATE UNIVERSITY (OSU)

The Boone Pickens School of Geology at Oklahoma State University (OSU) seeks applications for two endowed chairs: the Chesapeake Energy Corporation Chair of Petroleum Geoscience and the Devon Energy Corporation Chair of Basin Research. We are particularly interested in candidates with interests in one or more of the following: unconventional energy resources, petrophysics, reservoir characterization/modeling, tectonics of sedimentary basins, depositional and diagenetic systems, and basinal fluids. These chairs will be filled at the level of Professor, will carry tenure in the School of Geology, and will be effective August 2011. Applicants must have a Ph.D. degree in geology or related field and have an outstanding record of research. The applicant must be committed to excellence in teaching both undergraduate and graduate students, will be expected to supervise M.S. and Ph.D. level graduate students and develop courses in her or his specialty.

The successful candidates will join a faculty of eleven geoscientists and will take leadership roles in a department that has close ties to the petroleum industry. The School's teaching and research facilities include state of the art geophysical field and laboratory equipment and software, the Devon Visualization Laboratory, and a wide range of petrographic and geochemical instrumentation. The School also has a recently renovated field camp facility near Cañon City, Colorado.

Candidates should submit a letter of application, including a discussion of research interests and approach to teaching, along with a curriculum vitae and contact information for three references to: Endowed Chair Search, Boone Pickens School of Geology, 105 Noble Research Center, Oklahoma State University, Stillwater, Oklahoma 74078-3031. Screening of candidates will begin on November 8, 2010 and continue until the position is filled. More information about the Boone Pickens School of Geology can be found on the Web at <http://geology.okstate.edu> along with additional information about these opportunities. Inquiries may be directed to Dr. Todd Halihan (todd.halihan@okstate.edu) or Dr. Jay Gregg (jay.gregg@okstate.edu). Committed to health and safety Oklahoma State University maintains a tobacco free work environment. Oklahoma State University is an Affirmative Action/Equal Opportunity/E-Verify employer committed to diversity.

FACULTY POSITION GEOLOGY DEPARTMENT

PETROLOGY/MINERALOGY, BRYN MAWR COLLEGE

The Department of Geology at Bryn Mawr College invites applications for a full-time, tenure-track Assistant Professor position to begin 1 July 2011 in the general areas of mineralogy/geochemistry/petrology. Applicants



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DEAN OF INSTRUCTION

Chief Academic Officer (Posting# 0807296)

The University of New Mexico (UNM) is seeking an experienced leader for the position of Dean of Instruction of the UNM Gallup Campus (<http://www.gallup.unm.edu>). UNM-Gallup is one of four branch community colleges of the University of New Mexico and serves approximately 3,000 students. The Dean of Instruction is the College's chief academic officer who reports directly to the Executive Director and has overall responsibility for leadership and administration of the instructional program.

This is a tenured position with the ideal candidate holding the qualifications to be appointed at the rank of professor in one of the academic disciplines at UNM. Salary is dependent upon experience with a range in the upper \$90's to low \$100's.

The University of New Mexico actively seeks and encourages nominations of and applications from individuals who are members of under-represented groups. A complete application includes (1) a letter of interest that succinctly addresses the qualifications for the position, (2) a curriculum vitae, (3) a statement of teaching philosophy, (4) a statement describing how you will encourage life-long pursuit of scholarship among instructional faculty, (5) the names, addresses and contact information of five professional references, and (6) three letters of recommendation.

The Search Committee will begin screening applications on September 15, 2010, but the search will remain open until filled.

For further information and to apply please go to
<https://unmjobs.unm.edu>, posting # 0807296.

The University of New Mexico - Gallup Branch
200 College Road, Gallup, NM 87301 (505) 863-7500

The University of New Mexico is an Equal Opportunity/
Affirmative Action Employer and Educator.

should demonstrate strong potential for excellent teaching and creative research, as well as interest in offering courses in mineralogy, geochemistry and petrology. The hire will be expected to participate in Bryn Mawr's interdisciplinary environmental studies program. The candidate's research specialty is open, but ideally will complement those of other faculty members at the College. Demonstrated teaching ability and a Ph.D. at the time of appointment are required, and a commitment to supporting women and underrepresented groups in the geosciences is desired.

Located in suburban Philadelphia, Bryn Mawr College is a highly selective liberal arts college for women who share an intense commitment to intellectual inquiry, an independent and purposeful vision of their lives, and a desire to make meaningful contributions to the world. Bryn Mawr comprises an undergraduate college with 1,300 students, as well as coeducational graduate programs in social work and in some humanities and sciences. The College promotes faculty excellence in both research and teaching, and has strong consorcial relationships with Haverford College, Swarthmore College, and the University of Pennsylvania. Bryn Mawr College is an equal-opportunity employer; minority candidates and women are especially encouraged to apply.

Applicants should submit a CV, a statement of teaching and research goals, a list of possible courses that could be offered, and the names and contact information of three references to: Geology Search, Dept. of Geology, Bryn Mawr College, 101 N. Merion Ave., Bryn Mawr, PA 19010; e-mail contact: jjacoby@brynmawr.edu. Members of the department will be available for preliminary interviews at the Geological Society of America meeting in October, and formal review of applications will begin on 15 Nov. 2010. Details about the department are available at www.brynmawr.edu/geology/.

Opportunities for Students

Graduate Student Fellowships, American Museum of Natural History (AMNH) / Lamont Doherty Earth Observatory (LDEO) (Columbia U). Ph.D. student(s) sought in the fields of high-T and high-P geochemistry, meteoritics and planetary science, mineralogy, mineral deposits, petrology, or volcanology. Non-US citizens are eligible. Students must apply simultaneously to Columbia U.; research is under the direction of a museum curator or senior scientist; work is carried out at AMNH and/or LDEO. Fellows receive a full 12-month stipend and full tuition for four years for students in good standing.

Applicants should discuss their interests and background with a potential advisor, then send an application due 12/15/10 to Dr. Ed Mathez, +1-212-769-5379, mathez@amnh.org.

For an application, see <http://rggs.amnh.org/files/uinst10.pdf> or http://rggs.amnh.org/pages/academics_and_research/fellowship_and_grant_opportunities; <http://research.amnh.org/earthplan>; <http://www.ldeo.columbia.edu/>; and <http://www.columbia.edu/cu/gsas/>.

Fellowship Opportunities

POSTDOCTORAL FELLOWSHIPS AMERICAN MUSEUM OF NATURAL HISTORY

The Department of Earth and Planetary Sciences of the American Museum of Natural History invites applications for Research Fellowships in residence for post-doctoral investigators and established scientists to carry out projects in collaboration with department staff. Appointments are for six months to two years. Areas

of interest include high-T and high-P geochemistry, meteoritics and planetary science, mineralogy, mineral deposits, petrology, or volcanology.

Please follow the guidelines at <http://rggs.amnh.org/files/pdinst10.pdf> and discuss potential research projects with research staff before applying by 11/15/10 to Dr. Ed Mathez, +1-212-769-5379, mathez@amnh.org.

For further information see <http://research.amnh.org/earthplan> or http://rggs.amnh.org/pages/academics_and_research/fellowship_and_grant_opportunities.

AMNH is an equal opportunity employer.

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	(1) Sales through dealers and carriers, street vendors, and counter sales (not mailed)	0	0
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www.agu.org/meetings/fm10/



Follow AGU on Twitter, twitter.com/theAGU (Use hashtag #FM10 for all Fall Meeting posts)

GSA Luchtime Lectures

Colorado Convention Center, Room 103/105
Sun.–Wed., 12:15–1:15 p.m.

The second year of GSA's new Luchtime Lecture series promises to be as good as the first! Please pencil these lunchtime events into your schedule and check coming issues of *GSA Today* for topic highlights.

- ☑ Sunday, 31 Oct.: **Marcia Kemper McNutt**, Director of the United States Geological Survey
- ☑ Monday, 1 Nov.: **Timothy Killeen**, Assistant Director for the Geosciences, National Science Foundation
- ☑ Tuesday, 2 Nov.: *2010 Halbouty Lecturer* **Thomas Ahlbrandt**, Vice President of Exploration, Falcon Oil and Gas Ltd.
- ☑ Wednesday, 3 Nov.: **Haiti's Catastrophic Earthquake of 12 January 2010: Lessons Learned**, with moderator **Timothy H. Dixon**, University of Miami, and panelists **Roger Bilham**, University of Colorado; **Eric Calais**, Purdue University; and **Carol S. Prentice**, U.S. Geological Survey.

Coming to *GSA Today* in November 2010

- * **Science Article:** Tropical shoreline ice in the late Cambrian: Implications for Earth's climate between the Cambrian Explosion and the Great Ordovician Biodiversification Event
- * **First Announcement and Call for Papers:** 2011 GSA South-Central Section Meeting
- * **First Announcement and Call for Papers:** 2011 GSA Joint Rocky Mountain/Cordilleran Section Meeting
- * **2010 GeoCorps™ America Participants**
- * **Groundwork:** A contribution to our dialogue on energy choices

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

Publications Highlights



Impact Factors on the Rise

Thomson Reuters released its 2009 numbers, and all of GSA's impact factors increased:

Geology is the #1 ranked geology journal (of 50) according to impact factor and five-year impact factor. Its impact factor, which is currently 4.368, has increased six years in a row.

Geological Society of America Bulletin's impact factor rose to 3.101, with a five-year impact factor of 4.324. It is the #17 ranked multidisciplinary geosciences journal (of 153).

Geosphere, which is in the multidisciplinary geosciences category, had an impact factor of 1.681 this year, climbing from 1.627 in 2008.

Lithosphere has been accepted into the Science Citation Index and the Web of Science, but it has not yet received an impact factor.

Browse GSA's journals and books at <http://www.gsapubs.org/>.



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