Vol. 6, No. 1 January 1996

GSA TODAY

A Publication of the Geological Society of America

INSIDE

Alamo Megabreccia: Record of a Late Devonian Impact in Southern Nevada

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ABSTRACT

The Alamo breccia is probably the most voluminous known outcropping carbonate megabreccia. It occupies ~4000 km² across 11 mountain ranges in southern Nevada, has an average thickness of ~70 m, and contains a volume of 250+ km³. The breccia is a single bed, of early Frasnian (early Late Devonian) age, that formed in the wake of a giant slide that deposited a lower chaotic debrite, containing clasts as large as 80 × 500 m, and an upper exquisitely graded turbidite. It is anomalously intercalated with cyclic shallow-water platform carbonates of the Guilmette Formation. The Alamo breccia is interpreted as a product of the Alamo event, a nearby marine impact of an extraterrestrial object, whereby impact-generated crustal shock waves and/or marine superwaves detached the upper ~60 m of platform along a horizontal surface. Loosened bedrock slid seaward across the platform, and some of it accumulated as the lower debrite. Rock-water exchange induced landward-propagated tsunami(s), whose uprush and/or backwash deposited the upper turbidite, partly above sea level. Evidence for impact includes shocked-quartz grains, an iridium anomaly, and reworked conodonts, all found only within the breccia. Because the Alamo breccia is not known outside of Nevada, and because the early Frasnian time of the Alamo event is not noted for accelerated extinctions, being ~3 m.y. before the Frasnian-Famennian impact(s) and biotic crisis, the impact was probably only of moderate size.

INTRODUCTION

The Alamo breccia, a newly recognized carbonate megabreccia, is an anomalous event–stratigraphic bed of immense proportions, probably the largest megabreccia known in surface exposures. It was emplaced in a geologic instant of

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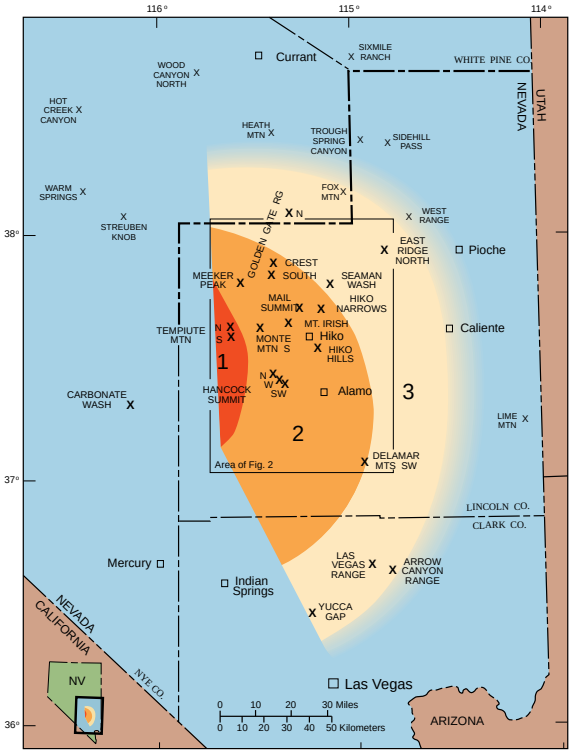

Figure 1. Study area showing towns (squares), Devonian localities (x's), and lateral distribution zones of Alamo breccia. Breccia thicknesses: zone 1, ~130 m; zone 2, ~60 m; zone 3, <1–10 m.

Figure 2. Enlargement of inset in Figure 1 showing mountain ranges, outcrop localities, and the perimeter enclosing Alamo breccia in zones 1 and 2.

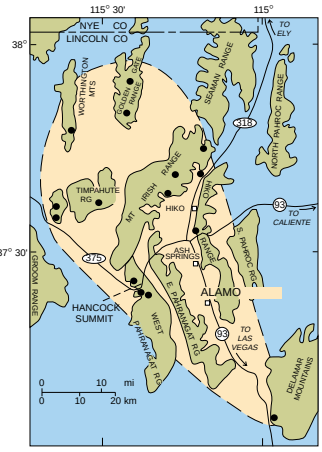

Figure 3. View northward from the Hancock Summit area (see Fig. 2) of West Pahranagat Range, showing the 55-m-thick Alamo breccia (AB) within the 600-m-thick Guilmette Formation. The Guilmette begins at the yellow slope-forming interval (YSF in Fig. 4) in the saddle ~150 m below the breccia, is underlain by the Simonson Dolostone at left, and is overlain by the West Range Limestone and/or Pilot Shale on dip slope at right.

GSA TODAY *January 1996*
Vol. 6, No. 1

GSA TODAY (ISSN 1052-5173) is published monthly by The Geological Society of America, Inc., with offices at 3300 Penrose Place, Boulder, Colorado. Mailing address: P.O. Box 9140, Boulder, CO 80301-9140, U.S.A. Second-class postage paid at Boulder, Colorado, and at additional mailing offices. **Postmaster:** Send address changes to *GSA Today,* Membership Services, P.O. Box 9140, Boulder, CO 80301-9140.

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IN THIS ISSUE

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early Late Devonian time and is now preserved within the Guilmette Formation of southern Nevada. The breccia, as yet informally named, crops out in 11 mountain ranges around the community of Alamo, Nevada (Figs. 1–3). It spans a minimum area of 4000 km^2, has an average thickness of ~70 m, and represents detachment, mobilization, and resedimentation of at least 250 km^3 of Devonian carbonate rock.

The Alamo breccia represents an extraordinary style of carbonate-platform collapse and submarine slide, now preserved as a single bed with the characteristics of a debrite (debris-flow deposit) in the lower part that evolved into a capping turbidite (Figs. 4, 5). It is anomalously intercalated within cyclical shallow-water carbonate-platform facies of the Guilmette Formation (Figs. 3–6), rather than occurring in deeper water as expected. Its huge magnitude, singular epiplatform occurrence, horizontal delamination from platform bedrock, and exotic components including shocked quartz, iridium, and reworked conodonts, all indicate genesis from the consequences of an impact of an extraterrestrial object with Earth, named the Alamo event (Warme et al., 1991; Warme, 1994).

Discovery of the Alamo breccia coincides with current intense interest in geologically short-lived but significant events (e.g., Clifton, 1988) and new appreciation for the possible physical and biological effects of extraterrestrial impacts (e.g., McLaren and Goodfellow, 1990; Sharpton and Ward, 1990). This preliminary report describes the breccia, discusses its genesis as a catastrophic bed, and presents evidence that it was triggered and magnified by a nearby marine impact of moderate size.

SUBMARINE SLIDES, CARBONATE MEGABRECCIAS, AND TSUNAMITES

Many enormous submarine debrites and/or turbidites, comparable in extent and volume to the Alamo breccia, are known from both modern (e.g., Piper et al., 1988; Moore et al., 1994) and ancient (e.g., Macdonald et al., 1993) settings. Catastrophic failure of the seaward margins of present and past carbonate platforms results in voluminous carbonate megabreccias that commonly contain huge transported blocks (e.g., Cook and Mullins, 1983; Hine et al., 1992). However, all large-scale marine mass-flow deposits described to date, whether terrigenous or carbonate, intercalate with thinner resedimented beds and were interpreted to accumulate in relatively deep water seaward from shelf or platform edges.

Massive shelf-edge slumping causes a water-for-rock volume exchange that induces an onshore tsunami. Numerous massive Quaternary underwater slumps occurred adjacent to the Hawaiian Islands, and each potentially triggered destructive onshore waves (Moore et al., 1994). One example is suspected of causing a prehistoric catastrophic tsunami that formed an uprush 375 m above sea level on Lanai, Hawaii, leaving a deposit (tsunamite) of coral and other rubble in its wake (Moore and Moore, 1988). However, tsunamis produced by underwater landslides would likely be dwarfed compared with those from oceanic extraterrestrial splashdowns; the waves could be as high as the target water depth, conceivably 1000 m or more (Silver, l982), but few deposits from such waves have been identified. Probable impact-related slump deposits and tsunamites were described at the Cretaceous-Tertiary (K-T) boundary in cores from the Gulf of Mexico as well as in circum-gulf outcrops (e.g., Smit et al., 1994). An

Megabreccia *continued on p. 3*

Megabreccia *continued from p. 2*

Eocene breccia in the subsurface under Chesapeake Bay was first regarded as the tsunamite from a North Atlantic impact, then was reinterpreted as brecciated target rock (impactite) within the actual crater (Poag and Aubry, 1995). Owing to the numerous exposures and well-understood stratigraphic framework of the Alamo breccia, it provides a useful comparison and basis for interpreting other less accessible catastrophic deposits.

GEOLOGIC SETTING OF THE ALAMO BRECCIA

Southern Nevada falls within the Basin and Range physiographic province, where Paleozoic rocks are exposed along linear mountain ranges, buried deeply in intervening valleys (Fig. 2), deformed by post-Devonian orogenies, and covered by Cenozoic volcanic rocks. The area of the Alamo breccia in Figures 1 and 2 is not palinspastically restored.

Stratigraphic Framework

From Cambrian into Late Devonian time, a westward-facing linear carbonate platform rimmed the west side of the North American craton, trending approximately north-south through central Nevada (e.g., Poole et al., 1992). The Alamo breccia is within the shallow-platform facies of the Guilmette Formation, except in its westernmost known exposure at Tempiute Mountain (Figs. 1, 2) where it is overlain by ~300 m of deeper water facies of the correlative Devils Gate Limestone (Fig. 4). The Guilmette comprises ~150 shallowing-upward carbonate-platform cycles (Fig. 3) averaging ~5 m thick. The Alamo event slide consumed a stratigraphic interval ~60 m thick and containing ~10 to 15 cycles. Cycle tops directly beneath the breccia exhibit dolomitized algal laminites, desiccation cracks, and fenestral fabrics that indicate upper-intertidal to supratidal carbonate platform environments. Lithofacies directly above the breccia are more variable and demonstrate a post–Alamo event westward-dipping ramp.

Conodont Biofacies

Analyses of 75 conodont samples from the lower part of the Guilmette Formation in the study area yielded both paleoenvironmental information, crucial for understanding the Alamo breccia, and an exact biostratigraphic date for the bed. Conodont samples include 30 from the Alamo breccia and 45 from the Guilmette confining beds. The paleoecological interpretation of the lower Guilmette, including the interval of the Alamo breccia (Sandberg and Warme, 1993; Warme and Sandberg, 1995), employs the conodont biofacies scheme described by Ziegler and Sandberg (1990). As shown in Figures 4 and 5, platform cycles below the breccia contain shallow-subtidal biofacies and indicate water depths of 10 m or less. Collections from fossiliferous postbreccia beds at or above its top indicate landward shallowing, from 60–100 m on the west to 10–20 m toward the east. Samples from easternmost localities (zone 3 in Fig. 1) were largely barren of conodonts. Samples collected within the lower part of the breccia, from both platform-derived clasts and breccia matrix, yielded shallow-water biofacies, as expected. However, samples from the upper part contain admixed deep-water contemporary Devonian and reworked Ordovician species, probably derived from deeper environments far to the west.

Age and Timing of Alamo Event

Conodont age determinations show that the Alamo event is narrowly bracketed within the middle part of the *punctata* conodont Zone of Ziegler and Sandberg (1990), as shown in Figures 4 and 5, which represents ~0.5 m.y. of early Late Devonian (Frasnian) time. The *punctata* Zone was ~3 m.y. before the much-studied late Frasnian mass extinction (Sandberg et al., 1988), and has a biochronologic date of ~13 m.y. before the end of Devonian time. Because the Devonian-Carboniferous boundary has been variously dated as 340 to 360 Ma, the Alamo event was between ~355 and 370 Ma.

DESCRIPTION OF ALAMO BRECCIA

The Alamo breccia is a single bed deposited during one event. Although its internal structure varies significantly both laterally and vertically, the most obvious trends are decreasing thickness landward (eastward) and decreasing clast and matrix sizes (normal grading) upward. For descriptive purposes, the breccia is divided into lateral zones 1 to 3, from west to east (Figs. 1 and 2), and vertical units A to D, from top to base (Fig. 5).

Distribution and Lithology

To date, the Alamo breccia is known at 23 localities spread across ~4000 km^2 (Figs. 1 and 2). Thickness varies from 130 m in zone 1 to <1 m in parts of zone 3. If 70 m is taken as the average thickness, then the minimum volume of rock displaced during the Alamo event is ~280 km^3. The total distribution and volume may be much greater; they are not fully documented because of sparse outcrops and restricted access to the south and west.

The Alamo breccia is almost exclusively carbonate rock (Figs. 7–10). Its composition is limestone, except for minor synsedimentary supratidal dolostones and local but significant selective or complete dolomitization. Most clasts are recognizable components of the Devonian carbonate platform that disintegrated during the Alamo event. Quartz grains and other noncarbonate components recovered from conodont-sample insoluble residues represent ‹‹1% of the breccia volume.

Clasts and Matrix

The Alamo breccia contains a population of megascopic clasts ranging in size from sand to blocks 80 × 500 m. Breccia "matrix" is a relative term; matrix between clasts of given sizes is simply smaller fragments, regardless of their absolute scale (Fig. 8). Gravel-, sand-, and smaller sized particles are ubiquitous between blocks, but become better sorted and occupy progressively greater proportions of the volume upward, culminating in the well-graded top.

Lateral Variations: Zones 1 to 3

The Alamo breccia exhibits characteristic thicknesses, internal structures, and internal variability in each of the three zones shown in Figures 1, 2, 4 and 6.

Zone 1: Foreslope or Basin Floor. Zone 1, along the west end of Tempiute Mountain (Figs. 1 and 2), probably extends much farther westward. It is 130 m thick and is composed of a thick (~100 m) turbidite (unit A, described below) overlying a thinner debrite (unit B): the turbidite is generally finer grained than in zone 2 to the east. Maximum-sized clasts are <5 × 15 m in two dimensions. Zone 1 is interpreted as an area of platform foreslope or basin floor.

At Tempiute Mountain, twisted and fractured bedrock underlies the breccia, laced by an array of sedimentary dikes and sills injected with carbonate breccia and rich in quartz sand grains. The overlying Alamo breccia, in contrast, is relatively undeformed and weathers as a shear cliff ~100 m high. The deformation is interpreted as listric faults that moved and rotated during the Alamo event (Fig. 6; see Winterer et al., 1991). Dilated fault planes are filled with debris derived from fissure walls, overlying slope deposits, and the bypassing breccia. Margins of the fissures show liquefaction phenomena similar to that of unit D, described below, at the base of the Alamo breccia.

Zone 2: Seaward Platform. Across the broad area of zone 2, the Alamo breccia averages ~60 m in thickness, contains discontinuous giant clasts as much as 80 × 500 m, and commonly exhibits all four vertical units A to D described below.

Zone 3: Landward Platform. The Alamo breccia in zone 3 (<1 to ~10 m thick) may exhibit only a graded turbidite (unit A), with <1-m-diameter clasts, or

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may be dominantly a debrite (unit B) transitionally overlain by a thin turbidite, suggesting extensive turbidity-current bypass. The debrite contains tabular clasts up to 30 m long, oriented (sub)parallel to bedding. Zone 3 breccia was stranded above sea level and subaerially exposed for a significant time before deposition of the next platform cycle. It may be selectively eroded at the top, bleached by dolomitization, or karsted, in contrast to its confining beds.

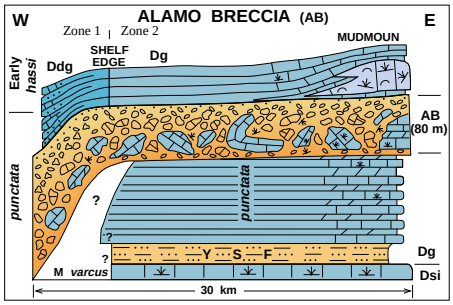

Figure 4. Diagrammatic cross section of Alamo breccia (AB) within the zone 2 shallow-water Guilmette Formation (Dg) and equivalent zone 1 deep-water Devils Gate Limestone (Ddg). The Upper Simonson Dolostone (Dsi) is within the Middle Devonian Middle *varcus* conodont Subzone, overlain by the basal Guilmette yellow slope-forming interval (YSF). Overlying cyclical carbonate rocks and the Alamo breccia are within the early Frasnian *punctata* Zone. Beds beginning 4–10 m above the breccia are in the Early *hassi* Zone.

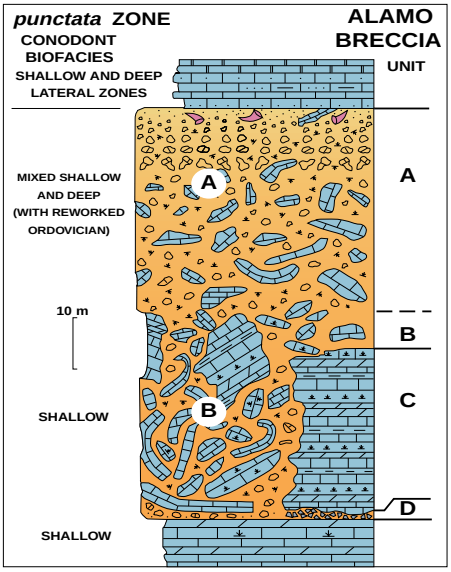

Figure 5. Vertical units A to D, and conodont biofacies paleobathymetry. Units D and C, if present, are together: D is a zone of bedrock fluidization; C is giant clasts preserved in the process of tearing loose and incorporating into the slide. Unit B is chaotic debrite, beginning at the base of the breccia where unit C blocks were removed. Unit A, transitional upward from unit B, is a well-graded turbidite capping breccia everywhere. Tufted symbols represent stromatoporoids; cones represent corals concentrated at the top.

Vertical Units

The Alamo breccia is composed of from one to four vertical units, A to D. They are arranged from top to base as follows (Fig. 5): unit A: upper turbidite—present in all zones (1–3); unit B; lower debrite—best developed in zone 2; unit C: basal megaclasts, actually or nearly in original positions—zone 2 only; unit D: diamictite under megaclasts—zone 2 only.

Units D and C—Detachment Interval and Megaclasts. Units C and D are genetically related, occur together but discontinuously along the base of the breccia (Fig. 5), and illustrate the mode of epiplatform slide detachment across zone 2. Unit D is an unusual, light-gray–weathering, calcareous diamictite, <1 cm to ~3 m thick, that developed ~60 m beneath the contemporary Devonian platform

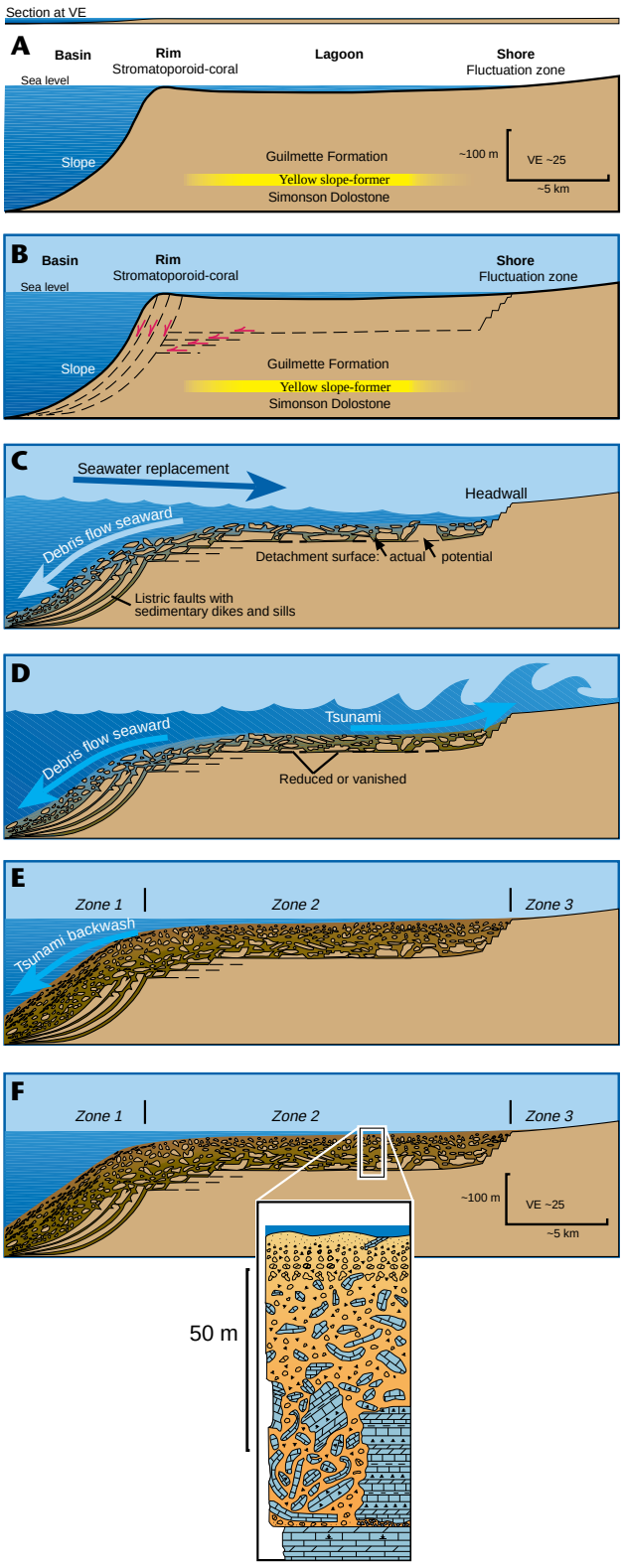

Figure 6. Interpretation of processes that produced the Alamo breccia: A: Rimmed Devonian carbonate platform at 1:1 vertical and horizontal scale. B: Platform at 25:1 vertical exaggeration. C: Platform showing two sets of fractures along which failure occurred: listric at the platform edge, and nearly horizontal across the platform. D: Platform failure: movement along listric faults created sedimentary dikes and sills, which removed lateral support from the platform. As bedrock detached and slid seaward, evacuation caused the sea surface to tilt landward. E: Tsunami caused by bedrock– sea-water exchange crossed the platform and overtopped the headward slide scar, while debris flow continued seaward. F: Tsunami backwash stranded a turbidite along the periphery of the platform (zone 3), continued across the detachment area (zone 2), and flowed into deep water beyond the platform (zone 1). G: The final product; the inset shows the giant sandwaves across the top of the breccia.

surface. The evolution of the diamictite is preserved in many localities, where within a distance of 1 m, intact bedrock changes laterally to a tight fracture-mosaic, a dilated fracture-mosaic, a melange of isolated and rotated fragments, and ultimately to the diamictite (Fig. 7). Unit D is preserved only where the huge blocks of unit C are actually or nearly in original position over it. Where unit C blocks were lifted, fragmented, and incorporated into the unit B debrite, unit D was unprotected and scoured away.

Throughout zone 2, the Alamo breccia rests at about the same stratigraphic level, where unit D cuts indiscriminately along the same or adjacent shallowing-upward carbonate-platform cycles, rarely at a bed or cycle boundary. The massive unit C blocks, directly above unit D, are (sub)parallel to bedding and have ragged, sharp lateral terminations, beyond which the debrite of unit B extends to the basal plane of the breccia (Fig. 5).

Unit B—Chaotic Debrite. A bewildering spectrum of clast sizes, shapes, and orientations characterizes unit B. The largest clasts are tabular, tens to hundreds of meters in longest dimension, and fully encased in unit B matrix, in contrast to the unit C clasts along the base of the breccia. Smaller unit B clasts are tabular to equidimensional (Fig. 8), and some are intricately deformed or preserved in the process of peripheral fragmentation into finer grained matrix. At some localities, multiple slabs >100 m long rode over one another toward the top of the breccia and formed logjamlike megafabrics. Beds at the base of unit B are preserved in all stages of being ripped up, injected below by matrix, torn away, and incorporated into the breccia. Figure 9 shows a spectacular example.

Figure 7. Characteristics of unit D fluidization, showing nearly intact bedrock (right), a mosaic of fractures (center), dilation (left-center and across base), and complete fluidization to calcareous diamictite (upper left).

Unit A—Graded Bed. Unit A is a well-organized turbidite that transitionally overlies the chaotic fabric of unit B. It ranges from roughly graded meter-sized clasts near the middle of the breccia to an exquisitely graded 5–30 m interval (100 m in zone 1) at the top. The sorting process left zones rich in domal boulder- to cobble-sized stromatoporoids and their hydraulically equivalent lithoclasts, fragments of tabular stromatoporoids and their hydraulic equivalents, and, near the top, concentrations of fragmented corals, brachiopods, and their equivalents. The topmost 1 m commonly exhibits calcarenite cross-bed sets up to 30 cm high, representing the climbing ripples of Bouma turbidite interval C, overlain by a thin, finer grained, horizontally laminated Bouma interval D. At some localities the upper 1 m exhibits compound grading caused by repeated scour and fill during waning runoff.

The top of unit A also contains rare large clasts, as much as 10 × 30 m, that interrupt the graded profile. They suggest that the underlying debris flow still moved as a viscous mass and that clasts from below were buoyed upward and incorporated into the accumulating turbidite.

Upper Boundary

Unit A usually exhibits complete grading from boulder conglomerate upward to calcareous mudstone. In zone 1, the very fine grained top of the breccia merges with overlying deep-water limestones, and in zone 3 the karsted top is overlain by peritidal carbonate-platform beds. However, zone 2 is more variable. Pebble-sized clasts at the top may represent the broad crests of giant sediment waves, hundreds of meters apart (e. g., Bretz, 1969; Moore and Moore, 1988), perhaps stranded above sea level. They may have separated parallel linear lagoonal depressions, evidenced at other localities by bioturbation across the upper contact.

EXOTIC COMPONENTS

Three significant exotic components occur within the Alamo breccia and are not present in overlying and underlying beds.

Shocked Quartz Grains

Insoluble residues of conodont samples from the Alamo breccia concentrate unusual quartz grains (Fig. 10), common in zone 1 and progressively scarcer land-

Megabreccia *continued on p. 6*

Figure 8. Upper part of the Alamo breccia showing large clasts (beneath the person) that are transitional to the graded bed above. The small, dark clasts are mostly whole or fragmented domal stromatoporoids. West Pahranagat Range.

Figure 9. A spectacular example of beds deformed and preserved in the process of detachment and incorporation into the Alamo breccia, West Pahranagat Range. A folded package, ~20 m thick, was pried up along the base of the slide by a huge, chisel-shaped clast moving from the right. The massive bed over the fold is 30-m-thick graded units B and A. Total breccia thickness is 60 m.

Megabreccia *continued from p. 5*

ward. By optical petrography, these grains exhibit one to six sets of internal parallel lamellae and mosaic extinction, both typical of shock metamorphism associated with impacts (e.g., Stöffler and Langenhorst, 1994). By transmission electron microscopy (TEM), they reveal micrometer-scale parallel deformation structures and fractured and rotated crystal fragments between lamellae (Leroux et al., 1995). The grains display unusual peripheral studding by crystals of iron oxides and sulfides (Fig. 10), which may represent diagenetic products or even impact phenomena. The shocked grains were air- or water-borne from target rock.

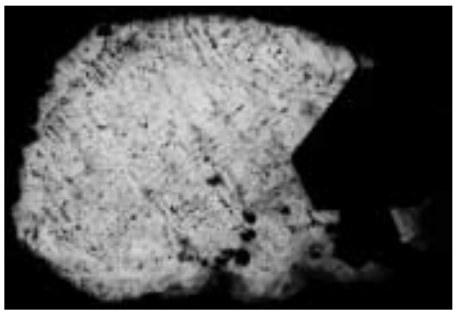

Figure 10. Thin section of a shocked-quartz grain showing four to six directions of shock lamellae, trains of inclusions along lamellae, and large displacive hematite crystals; the longest grain dimension is ~150 µm.

Iridium

Samples from within and above the Alamo breccia were analyzed for Ir and other elements that signify extraterrestrial material (Alvarez et al., 1980). Two sample profiles across the top of the breccia, ~100 m apart in the Worthington Mountains (Figs. 1 and 2), showed similar results. Background Ir in the area is <10 parts per trillion (ppT). Sixteen samples spread ±0.5 m from the breccia top showed slight Ir elevation, averaging 20.1 ppT, the maximum being 39 ppT. Eight samples from 0.5–1.5 m below the top averaged 69.4 ppT, the maximum being 139 ppT. Results are not available for samples from 1.5–12 m, but six samples from 12–55 m averaged only 8.5 ppT. The Ir may have been diagenetically mobilized a few meters downward from the breccia top. Alternatively, the Ir was water-borne to the site (see Displaced Conodonts below) and accumulated with the thick unit A graded bed, making the anomaly very significant because of the overwhelming carbonate debris that must have greatly diluted any accumulating Ir (and shocked quartz).

Displaced Conodonts

Collections from zone 1 and from pebbly zones of units B and A in zone 2 contain rare reworked Ordovician conodonts, probably derived from admixed target-rock fragments, and *punctata* Zone deep-water conodonts, which were probably preserved in the matrix. Both represent exotic elements, likely transported from the west beyond the platform margin.

DEPOSITIONAL HISTORY

Our scenario for the origin of the Alamo breccia, shown in Figure 6, is consistent with our field observations and sample data. (1) The setting for the breccia is the rimmed, flat-topped, Late Devonian carbonate platform of Nevada (Fig. 6, A and B). (2) Movement on two sets of fractures (Fig. 6C) detached the platform. Failure along the first set, representing relatively high angle listric faults, removed lateral support at the platform margin. Horizontal delamination along the second set allowed seaward transport of overlying beds across zone 2 (Fig. 6D). (3) The resulting debris flow created a westward-facing, flat-floored, epiplatform depression, equal in volume to the bedrock removed, and induced gravity-driven landward-propagated tsunami(s). By inertia the wave(s) overstepped the headward slide scar and flooded the adjacent platform of zone 3 (Fig. 6E). (4) Backwash stranded the thin breccia across zone 3, and dumped excess debris as a seaward-thickening turbidite over the debrite of zones 2 and 1 (Fig. 6F). The debrite was still moving seaward, indicated by absence of a clear debrite-turbidite contact and by the oversized clasts that were rafted upward into the accumulating turbidite. (5) Air- and/or water-borne shocked-quartz grains, Ir-bearing particles, and exotic conodonts were incorporated into the breccia matrix.

(6) As sea level equilibrated, the breccia in zone 3 was exposed (and eventually karsted), the shoreline was near the slide scar, giant sandwaves crossed the top and may have separated linear lagoons, and water depths increased across zone 2 into Zone 1 (Fig. 6F). The platform was temporarily converted from a rim to a ramp. (7) Post–Alamo event deep-water limestones accumulated in zone 1 and outer zone 2, and shallow-water cyclic deposition eventually resumed across inner zone 2 and zone 3.

The events shown in Figure 6 fail to account for the excess volume of breccia that was spread across zone 3, approximately filled the slide area of zone 2, and left a 130-m-thick deposit in zone 1. We believe that a nearby extraterrestrial impact intensified the processes diagrammed in Figure 6 and accounts for the volume observed. Superwave uprush and backwash amplified the tsunami generated by the debris-flow–sea-water exchange, enlarged the landward flood and withdrawal, and transported the sediment required to fill the space evacuated by the debris flow. Such superwaves best account for the exotic deep-water *punctata* Zone conodonts, which indicate a probable water depth of >300 m at the impact site, and the reworked Ordovician conodonts recovered from the breccia. The waves or associated currents may also have transported Ir and shocked quartz from the impact site. An impact could have generated immense runoff from water ejecta and rainfall from condensed vapor, which swept debris off large areas of the adjacent craton and flowed across all three lateral zones of the Alamo breccia.

DISCUSSION

Distinctive attributes of the Alamo breccia separate it from all other known catastrophic carbonate megabreccias. It was first recognized for its anomalous epiplatform framework. Its shocked quartz and Ir strongly suggested an impact trigger. Given an impact, seismic shock could have induced movement on the platform-margin listric faults, causing loss of lateral support, and generated horizontal epiplatform fractures, leading to platform delamination and failure. Radial shock waves, similar to those accompanying thermonuclear detonations, may have delaminated the platform at a uniform depth below the surface (unit D) and fractured overlying beds into approximately equal horizontal segments (unit C blocks). Concurrently, or alternatively, abrupt loading and unloading of superwaves over platform bedrock, and/or shear from catastrophic wave uprush and backwash, caused rapid oscillation of subsurface pore pressures and induced fluidization along unit D.

Several characteristics of the Alamo breccia suggest that the impact was relatively small, located near our study area, and created waves and/or currents that brought a significant volume of debris onto the platform. The reworked conodonts and shocked quartz grains are progressively less abundant in landward samples, and may have been water-borne. The broad Ir spike 0.5–1.5 m below the top of the breccia suggests subaqueous accumulation simultaneous with waning-phase deposition. Most significantly, the volume of the Alamo breccia appears too great to have come only from the shallow submarine slide shown in Figure 6. Zone 3 contains significant breccia volume, but it is landward of the slide; the depression across zone 2 is brim-full with breccia, but should have been initially almost empty and have temporarily accumulated deeper water sediments; the deposit in zone 1 is 130 m thick, and extends westward for an unknown distance. All these relations suggest that catastrophic waves, debris-laden

Megabreccia *continued on p. 7*

Megabreccia *continued from p. 6*

from a nearby impact, brought the exotic breccia components and required rock volume onto the platform.

A relatively small, local impact is also implied, because accelerated biotic extinctions are not documented within the *punctata* Zone. However, the Late Devonian in general and the Frasnian-Famennian (F-F) boundary specifically are times of extinction and rapid biotic turnover perhaps unequaled in the Paleozoic (e.g., Sandberg et al., 1988; McLaren and Goodfellow, 1990). The Alamo event occurred ~3 m.y. before the F-F boundary, but may represent one of several sequential events during the Devonian (McGhee, 1994) that destabilized many existing taxa and rendered them prone to extinction by the flux of subsequent impact, volcanic, eustatic, or other natural events (e.g., Hut et al., 1987).

CONCLUSIONS

The Alamo breccia is one of the largest catastrophic megabreccias known in terms of its area, thickness, volume, and clast sizes. In 1990 the breccia was recognized within a formation that had been well studied by previous researchers. It commonly forms the thickest cliff within Guilmette Formation outcrops (Fig. 3) but was unnoticed or misinterpreted as reef, storm, karst, or tectonic breccias, and its huge clasts were unwittingly measured and described as being in situ.

We interpret the Alamo breccia to be one result of a nearby extraterrestrial impact. We have yet to understand the details of its genesis—we seek the crater.

ACKNOWLEDGMENTS

Supported by grants from the National Science Foundation (EAR-9106324) and UNOCAL. We thank B. W. Ackman, J. E. Estes-Jackson, Yarmanto, H.-C. Kuehner, and A. K. Chamberlain for results of their theses research (Colorado School of Mines) on the Guilmette Formation and the Alamo breccia; W. Alvarez, A. K. Chamberlain, P. Claeys, H. E. Cook, P. E. Gretener, D. O. Hurtubise, W. N. Kent, J. R. Morrow, W. R. Page, W. J. Perry, F. G. Poole, and many others for field assistance and discussions; E. L. Winterer for interpretation of the detachment zone at the base of the breccia; J. L. Butler and J. R. Morrow for processing conodont samples; H.-C. Kuehner for separating quartz grains; J. Skok for making thin sections; M. Attrep and the late C. Orth for providing iridium analyses; H. Leroux for TEM identifications of shocked quartz; and R. R. Charpentier, P. Claeys, W. J. Perry, and E. L. Winterer for manuscript reviews.

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Manuscript received May 1, 1995; revision received August 18, 1995; accepted September 20, 1995 ■

GSA ON THE WEB

What's new on the GSA home page on the World Wide Web? If you haven't yet connected to the Web, the Uniform Resource Locator (URL) is http://www.aescon.com/geosociety/index.html.

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The **Publications** section has a monthly table of contents and abstracts of articles for the *GSA Bulletin* and *Geology*. Also in this section is a guide for authors preparing manuscripts for submission to GSA publications. *GSA Today* issues are posted here for downloading and viewing.

For Congressional Contact Information, see the Administration section. ■

Rock Stars

Here is the second Rock Star profile (the first appeared in the November 1995 issue of *GSA Today*). Readers are encouraged to comment on this profile to History of Geology Division Chair William Brice, Department of Geology and Planetary Science, University of Pittsburgh, Johnstown, Johnstown, PA 15904, bbrice@upj.pitt.edu. To be more involved with the history of geology, join GSA's active History of Geology Division.

—Robert N. Ginsburg, for the GSA History of Geology Division

From Farmer-Laborer to Famous Leader: Charles D. Walcott (1850–1927)

Ellis L. Yochelson
U.S. Natural History Museum, Washington, DC 20560

In today's vernacular, Charles D. Walcott was probably a high school dropout. Without formal scientific training, and Horatio Alger–like, he became an outstanding scientist, member and president of the National Academy of Science, director of the Geological Survey, and secretary of the Smithsonian Institution.

Walcott became interested in collecting local fossils before he was a teenager; it seemed to be the thing boys did in Utica, New York. His father died when he was two. The whole family was in the cotton milling business, and there is no indication that Walcott received any guidance into science from any of his relatives. Fortunately he met a retired curator from the New York State Museum who had moved to Utica, and it was Colonel Jewett who first gave him a notion of what fossils meant. It was equally fortunate that at age twelve, Walcott started spending summers at nearby Trenton Falls, New York, helping out on a farm during the Civil War. To the paleontologist interested in the Middle Ordovician, Trenton Falls is another name for heaven, for the rocks are crowded with fossils. Every rock in the farm fields was fossiliferous.

Walcott's schooling at the Utica Free Academy, where there were only two or three teachers, ended when he was 18, and he may not have graduated; the records of this period are lost. He tried working in a hardware store for a year, and hated it. At age 20 he went to live with William Rust, sometimes paying board and sometimes helping with the farming, which included spreading manure from the cows. Rust, a farmer who also was interested in the local fossils, showed Walcott where and how to collect and prepare. As collectors, Walcott and Rust were so good that in 1873 they sold one collection to Louis Agassiz, the preeminent naturalist of the day, for what would be $70,000 in 1995 dollars. In 1879, Alexander Agassiz, Louis's son, paid them the modern equivalent of $80,000 for another collection.

A young Charles Doolittle Walcott. The back of this picture, copied from his daily pocket diary, bears the date 1873. At this time Walcott was living on the Rust farm, east of Trenton Falls, New York, and collecting fossils commercially with William Rust. Photographs of Walcott are easy to date relatively, because a few years after 1873, he grew a mustache. Subsequently, the amount of hair on both the top and bottom of his head was less in each succeeding photograph.

Walcott spent a week at the Museum of Comparative Zoology at Harvard in September 1873, unpacking and arranging the fossils he sold. This was his total involvement with college, but Professor Agassiz impressed Walcott with the importance of learning about the appendages of trilobites. Later, in the course of collecting at a quarry a few hundred yards from the farm house, Walcott noticed fragments that might have been of trilobite legs and hit on the notion of studying them by cutting thin sections. Cutting the rock and then grinding it down was all hand labor, but Walcott persisted through several hundred sections. No trilobite legs were known up to that time; in 1876 Walcott proved conclusively from the presence of jointed appendages that trilobites were arthropods.

Late in 1876, Walcott became a special assistant to James Hall, the state paleontologist of New York, and the second most prolific paleontologist in the world. Hall had known Walcott for years and kept stating that he would buy Walcott's collection. R. P. Whitfield had left, and Hall was in need of an assistant, especially to run operations during 1877 when he went to Europe. Another volume of the *Palaeontology of New York* had to be seen through the press, and the collections and exhibits in the New York State Museum were in terrible shape. Hall was autocratic and operated generally by terrorizing his assistants; Walcott is the only one who did not coauthor with Hall and who continued to publish under his own name.

Walcott was employed for little more than a year, but he remained in Albany, where he learned a great deal from studying Hall's collections and library; he also learned practical politics from lobbying for Hall in the state legislature. By good fortune, he was hired in July 1879, as one of the original members of the new United States Geological Survey. Hall had written a letter of support for Walcott, but it was R. P. Whitfield who obtained the position for him.

Walcott's first year was as a temporary geological assistant at $50 per month. He worked on the Colorado Plateau and found the position of the Paleozoic-Mesozoic boundary in the course of measuring a section from the Cenozoic-Mesozoic boundary in southern Utah down to the Devonian at Kanab Creek in the Grand

A trio at Rust farm, Trenton Falls, New York. The center figure with the black beard and black hat is the young C. D. Walcott. The dandy on the right side of the picture is questionably identified as A. C. Peale, a geologist with the Hayden Survey and, later, the U.S. Geological Survey. The bearded older man is unknown, but he could be one of the elder members of the Rust family. Smithsonian Institution Archives, Record Unit 95, Box 24, No. SA 187.

Canyon, more than two miles of rock. His work was so satisfactory that he was given a permanent position as assistant geologist and a 100% raise, to $100 a month. Although Walcott made contributions to paleobiology, throughout his career with the USGS his efforts were directed to biostratigraphy—advising field geologists on the age of sedimentary rocks by studying fossils.

If there was ever a geologist who deserves to be better known in America, and incidentally one who had the most inappropriate middle name, it is Charles Doolittle Walcott. In 15 years, he wrote a major monograph on Paleozoic fossils of the est, resolved the fundamental stratigraphic problems of the position of the "Taconic" system, confirmed the sequence of trilobite zones in the Cambrian, and summarized the stratigraphy of the Cambrian System of North America.

In 1894, Walcott became the third director of the U.S. Geological Survey; he served for 13 years in this post. Toward the end of his directorship, John Wesley Powell had gotten crosswise with Congress. The Congress slashed the budget of the Geological Survey and then, when that did not work, they slashed the salary of Powell. When Walcott took over, it was at a lower salary than Powell had received and it was to head a nearly broken organization. In just a couple of years, Walcott had the agency back on track. The USGS then expanded into work on water resources, more topographic mapping, and study of the national forests. While Walcott was administering all these different activities, he was still an active scientist. He wrote on Cambrian jellyfish and Cambrian trilobites from China, and he made significant advances in the understanding of Precambrian life. During this interval, Walcott also did most of the preliminary study for U.S. Geological Survey Monograph 51, *Cambrian Brachiopoda*, for which the volume of plates is as thick as the volume of text. Also during this time, Walcott essentially ran the Carnegie Institution of Washington (1902–1905) and deserves full credit for establishing the Carnegie Institution of Washington Geophysical Laboratory.

Charles Doolittle Walcott, in 1913, posing with a pry bar in the fossil quarry he opened to collect from the Middle Cambrian Burgess Shale. In five seasons, he obtained more than 50,000 specimens from this locality, by splitting slabs day after day. In 1907, Walcott began a systematic study of the Precambrian and lower Paleozoic rocks of western Canada. His discovery of spectacular fossils in 1909 distracted him for some years from his basic program, but he was able to study the Cambrian rocks and fossils of the region and made a start on the Early Ordovician. His last field season was in 1925.

Isotelus gigas (DeKay) from the Rust farm. The matrix is late Middle Ordovician limestone of the Trenton Group. This beautifully preserved trilobite is representative of the quality of the fossils that Walcott and Rust sold to Louis Agassiz. On the matrix are tool marks, an indication of some of the careful preparation done; in later years, William Rust worked for the U.S. Geological Survey as both a collector and preparator. Walcott's Rust farm trilobites, which had the appendages preserved, were more significant biologically than this specimen, but they were studied by cutting thin sections and are not photogenic.

In 1907, Walcott became the fourth secretary of the Smithsonian Institution. He immediately began a program of field investigations, mainly in Alberta and British Columbia, and he was in the field every year until 1926. His research program was essentially the same as when he was at the USGS: to make known the stratigraphy and paleontology of the pre-Trenton rocks.

Walcott worked long and hard on the stratigraphy and paleontology adjacent to Banff, Alberta, though he had two significant distractions from his field program. First, he was the first geologist to attempt geologic investigations around Mount Robson, the highest part of the Canadian Rockies. Second, he found the Middle Cambrian Burgess Shale and its incredible biota. Walcott collected for five seasons to bring this treasure trove back to civilization. He described the fossils, both animal and plant, of the incredible deposit, and then continued on with the stratigraphy and paleontology of the overlying beds.

Walcott had at his disposal the Smithsonian Miscellaneous Collections and was never one to waste an opportunity. He filled five entire volumes of that series. James Hall was the most prolific writer on American fossils, but if Walcott was not second, I cannot imagine who deserves that place.

Besides doing research part-time while running the Smithsonian Institution, Walcott had other duties. After 10 years as vice-president of the National Academy of Sciences, he became president (1916–1922). Before the start of World War I, G. E. Hale, the astronomer, and Walcott had formed the National Research Council, and they applied science to warfare, setting a pattern for the years of World War II, 1941–1945.

Quite apart from all this, Walcott decided that research on aviation was lagging in America. He steered the National Advisory Committee for Aeronautics through Congress and was its chairman for years. NACA is no more, but it laid the foundation for the National Aeronautics and Space Agency. If there is a great-grandfather of the space age, it is the paleontologist Charles Doolittle Walcott. ■

For more on Walcott:

Yochelson, E. L., 1967, Charles Doolittle Walcott, 1850–1927: National Academy of Sciences Biographical Memoirs, v. 39, p. 471–540.

If Geoscientists Went on Strike, Would Anybody Notice?

David A. Stephenson
South Pass Resources, Inc., Scottsdale, Arizona

When it was obvious a year ago that the eminently fair GSA system of electing officers would ensure my ascendancy to the presidency, I began planning what my Presidential Address should focus on as a theme. It was my intent to develop a scientific debate on the concept of "connate water." I planned to structure for you the role of ground-water flow systems in creation of saline-water environments in deep sedimentary basins. I also considered speaking about the "science" of water-witching, using ample demonstrations that would have included audience participation.

These thoughts became academic, for I was soon immersed in the geopolitical issues that dominated much of this year. It became obvious that we in the geosciences have a monumental void; one that should receive our utmost attention. In January, the outlook for a healthy community was rather dismal. There was much concern for the survival of a number of key activities, including the U.S. Geological Survey. There was frenzied activity to promote the geosciences, and the outlook brightened.

However, a postmortem on 1995 would reveal a number of unresolved issues: even though representatives of this Society joined others to exert damage control in meetings with Congress and other public representatives, the fateful hour is not the time to educate Congress or any other portion of the public.

Questions remain. Can we identify the right question and implement solutions so that our community does not continue in a crisis mode? I believe an appropriate question is: "If geoscientists went on strike, would anyone notice?"

Unfortunately, we do not have the luxury of geologic time on our side on this issue. It would be a fair conclusion to state and accept that the "public" has precious little knowledge of what we do, how we do it, and why we do it. I'm afraid that few would notice were we to strike.

The void that I mentioned deserves our attention. It has to do with our relationship to the public. It is this void that I wish to emphasize, recognizing that there is not universal acceptance of GSA's role relative to addressing the void. The public is not particularly friendly to the sciences at this time. In fact, the geosciences community is the recipient of a disproportionate share of this unfriendliness.

Part of the problem is that we hold a time-honored belief that the search for geologic understanding deserves a high-priority position relative to political attractiveness. We haven't paid a whole lot of attention to a politician's viewpoint. We have not paid much attention to a premise that we are citizens with a special responsibility to the public.

How am I using this word "public"? Hopefully, not as "a public nuisance," but more as "conducted in public" or "to make public" (to cause to become generally known).

It was decided to look to history for what other GSA presidents have said. A surprising number of the 106 previous presidents have implored this Society to be involved with the public. The first to do so was John Stevenson, president #10.

"To retain the respect of the community and to retain influence for good, we must be able to justify the existence of a society devoted to investigation…. The question '*Cui bono*?' [to whose benefit] will be asked, and the answer cannot be avoided."

"… the Society must have more to do with the outside world … if the outcome for science is to be what it should be."

John J. Stevenson
1898 GSA Presidential Address:
"Our Society"

What is striking to me about Stevenson's words is they came just 10 years after GSA was founded for the promotion of pure science. "We must justify our existence … *Cui bono* … the answer *cannot be avoided.*" Let us look quickly at what others have said:

"The support of the geologist depends on public appreciation of the value of his services."

Charles D. Walcott
1901 GSA Presidential Address:
"Outlook of the Geologist in America"

"The spirit of the hour seems to impel me to … portray … some part of the obligation of the State to our science and the responsibility of this science to the State."

John M. Clarke
1916 GSA Presidential Address:
"The Philosophy of Geology and the Order of the State"

"More clearly than ever before, is it necessary for us to view world affairs, and in them our own connections…."

John C. Merriam
1919 GSA Presidential Address:
"Earth Sciences as the Background of History"

"Those who have a knowledge of geology have a vast educational advantage over those who have none."

"As geology becomes rounded out, … it will have surpassing value in the education of mankind."

R. A. F. Penrose, Jr.
1930 GSA Presidential Address:
"Geology as an Agent in Human Welfare"

"If we are not skilled in literary arts—at least we can be brief. How often in plodding through elaborate introductory passages, petrographic descriptions, and the like, do we feel like exhorting with Petruchio 'Come on, O God's Sake!'"

"We derive our livelihood from a society of non-geologists, and our moral strength is sustained by serving that society."

"Geologists must convey more to society…. When the interval between intellectual classes and the practical classes is too great, the former will possess no influence, the latter will reap no benefit. The interval is widening."

"In the mid-1850s, leaders of geology were physicians, lawyers, clergymen … now leaders are a group of highly-specialized scientists barricaded to the public by technique and learned jargon."

W. H. Collins
1934 GSA Presidential Address:
"Geology and Literature"

[An opposing viewpoint] "… in the sense of acceptance of [geology's] relation to life, to society, and to the problems of civilization, its pioneering days are over."

"[Geology] has no responsibility to an impatient public…. It has no obligations other than to geologic science itself."

W. C. Mendenhall
1936 GSA Presidential Address:
"Development and Present Status of Geology in North America"

"… the expert scientist is under great obligation to deserve the confidence of the public."

"To insure a well-informed and intelligent people is a most difficult task…. It means educating more people and educating most of them longer…."

"… the great majority should understand what Science is, what it stands for, and its value to society."

"… part of the general public has a rather confused impression about Science…."

Eliot Blackwelder
1940 GSA Presidential Address:
"Science and Human Prospects"

"There is a scarcity of geologists among the scientific advisors to Congress … on matters of national policy."

"… by 'role' I do not mean simply the normal day-to-day activities of the geologist (no matter how important these may be to the institution or industry with which he or she may be connected), but rather the active advisory and consultative function that can be performed only by one with the perspective and range of knowledge possessed by the geologist." (Nolan was the first GSA president to use the word "she" in a presidential address.)

"… the profession can contribute to … public service by … emphasis on interpretation and prediction in our geologic thinking. The Geological Society of America … might well seek ways by which it could take the lead in this endeavor."

Thomas B. Nolan
1961 GSA Presidential Address:
"Role of the Geologist in the National Economy"

"… this public disinterest in scientific questions is in considerable measure the consequence of the deplorable state into which instruction in mathematics and science in our … public schools has been allowed to degenerate…."

M. King Hubbert
1962 GSA Presidential Address:
"Are We Retrogressing in Science?"

"… there is the urgent need to carry our science and our message to the people…."

"If our science is to stay fully solvent, geologists must find out how to present their research and … its values in terms that John D. Citizen can appreciate. To a greater degree … we must become … more people-oriented."

"… it becomes most important that we should strive for public understanding … or our science will neither get support nor merit support."

"… such a goal should become part of GSA's manifest destiny, however much it might cause some of our founding fathers … to shudder at the thought that we might risk getting our feet a little bit muddy in the political arenas…"

Ian Campbell
1968 GSA Presidential Address:
"Mene, Mene, Tekel, Upharsin"

Presidential Address *continued on p. 12*

Presidential Address *continued from p. 11*

"Let us … lend our knowledge of the earth to those public and private men whose responsibility it is to use the earth more wisely…."

"We should never become so preoccupied with our science … that we neglect the one activity that … will do the most to assure us unquestioned, professional respect: service to our communities, our schools, our cities, our states, and our nation."

"… we must embrace change."

Morgan J. Davis
1969 GSA Presidential Address:
"The New Geology"

"… there is need, also, for GSA to involve itself more outwardly in national and public affairs, where geology has an important role to play. "

Howard R. Gould
1981 GSA Presidential Address:
"GSA—A Legacy and a New Era"

"If we want the world to pay greater attention to geology, and if we want decision makers to allocate more resources for geology, then we need to demonstrate the importance of geology in public affairs, and we must accept our public obligation to be good citizen-geologists."

E-an Zen
1992 GSA Presidential Address:
"The Citizen Geologist"

"We must become part of the decision-making process in the policy arena, not just providers of data."

Robert D. Hatcher, Jr.
1993 GSA Presidential Address:
"Is Our Past the Key to Our Future?"

In all of my emphasis on the urgency of *recognizing* and *implementing* our public responsibility, I do not want to detract from the mission or goals of this Society. Our *purpose* is to advance the science of geology. Our goals include public scientific awareness through geoscience education. Good science is equally as important today as it was in 1888 to our founding fathers, but balance is a key concept. With the issue of public awareness before us, some key questions are:

1. What should the geological community hope to achieve through public awareness and outreach? Some achievements could include: creation of an environment of freedom of choice, job continuity, financial support for research, education of the public regarding the role of geology in everyday life, or public appreciation for the application of geology to the wise use of the earth. Radford Byerly Jr. and Roger A. Pielke Jr., in the September 1995 issue of *Science* (v. 269, p. 153), argued that, in addition to meeting its own internal standards, "science must meet two related external conditions: (1) democratic accountability including accountability to social goals, and (2) sustained political support." Whatever the geoscience goal for public interface may be, to achieve that goal requires that we be wise and creative.

2. How can the average geoscientist—either as an individual or within his professional associations—address the public outreach issue? Again, Byerly and Pielke described the scientist's response to those changing expectations: "Some scientists observe that the changing environment [between scientists and society] necessitates fundamental change, others think that science just needs to tell its story better, and others … hunker down, waiting for the storm to pass. "

The main issue, from my perspective, is not *why* geoscientists should become involved with public perceptions. I believe the crux of the problem is *how* the geoscientist should or can become more effective. Among the possible solutions are:

- Consider the value of your geoscience research or projects and actively communicate that value to the public by whatever means is available to you or your institution. Include nongeoscientists among the immediate beneficiaries of knowledge that we garner and disseminate.
- Use jargon-free language: surprisingly few nongeoscientists understand geologic terminology. According to Murphy's Law, "If a [reader] does not understand a particular word in a piece of technical writing, ignore it. The piece will make perfect sense without it. "
- Work with teachers at all grade levels.
- Convey views to your elected representatives; make it a point to introduce yourself and offer your expertise as a reference on geologic or environmental issues that evolve during the course of formatting legislation.

I cannot more eloquently state what other GSA presidents have urged. The need for geologists to interface with the public is no longer simply a philosophical debate. If the value of geosciences is not understood or recognized outside of our own esteemed community, and funding is denied or reduced, then we as a community are in for a different kind of change. Whether we choose to change and become more proactive—or we are forced to act—either way, change is upon the geoscience community. To paraphrase another Murphy's Law: For any situation, the proper course of action is always determined by subsequent events.

I say, enjoy your science in whatever venue most interests you, be it as a purist or a multidisciplined, outreach-oriented person. But share your spirit and discoveries with other than your colleagues. Participate in non-GSA activities.

Consider the change upon us by viewing the differences between a 1968 report to Council and a 1987 report to Council: *1968 Committee for the Promotion of the Science of Geology:* Recommended that the Society should not carry out or inaugurate programs specifically oriented toward geologic education. *1987 Committee on the Path to the Year 2000:* Specifically recommended that GSA establish a public education office. (The expressed belief was that the earth science profession has a responsibility for the education of the general public.)

The year 1968 must have been an exciting year to be on the GSA Council. Campbell was president and Davis was vice-president. Look back on their respective comments in their presidential addresses. Campbell said GSA has a manifest destiny to carry our message to the public (including, presumably, engaging in geologic education). Davis said that we must embrace change. Quite a contrast to the 1968 committee report.

We've come a long way in recent years. We have numerous highly qualified scientists in GSA, as exemplified by the awards presented at the 1995 meeting. We, however, have a fairly low percentage of the membership who are scientists reaching out to the public. Those few need your help. Now!

Starting with at least Bert Bally as GSA president and continuing through Bill Dickinson, there has been an ever-growing support of GSA's involvement in public education and outreach. Let's keep it going and aggressively grow those activities.

In closing, I wish to acknowledge the strong support from GSA headquarters staff in making my term in office so satisfying. In particular, my sincere appreciation goes to Don Davidson, Royann Gardner, Pat Chenworth, and Sue Beggs. To my fellow Officers and Council colleagues, I also say "Thank you." ■

GSA Bulletin Update

***Lynn Walter, John Geissman**—Editors, GSA Bulletin*

Welcome to 1996! The past year was an active one for the *GSA Bulletin*, with new manuscript submissions up more than 20% from 1994. The diversity of the science submitted to the *Bulletin* has increased—more manuscripts are coming from the fields of surface processes, active tectonics, and hydrogeology. The *Bulletin* is also becoming more international, with several high-quality contributions from overseas. You may have noticed the evolution in cover art. We have made these changes in the interest of updating the look and reflecting the diverse content of the *Bulletin*.

Perhaps most significantly, we have streamlined many manuscript handling procedures. Our editorial assistants, Vicky Hover and Catherine Ratcliff, make the electronic mail, phone, and postal contacts with reviewers and Associate Editors. The new practices have paid off in more rapid publication of most contributions. Right now, the average time from submission to publication is about 7 months!

In 1996 we plan to solicit, with the help of our Associate Editors, overview manuscripts summarizing the state of research in actively developing areas of broad interest in the earth sciences. These critical overviews will be both timely because of improved manuscript handling practices and of sufficient length to be valuable in-depth contributions.

The *Bulletin* will continue to provide an opportunity for publication of relatively long papers involving fully detailed and comprehensive research. However, we are also publishing shorter, topical papers of broad interest. There is nothing wrong with a 5 or 6 page *Bulletin* article! Our turnaround time is now competitive, so please consider the *Bulletin* as a well-read outlet for these shorter, timely articles.

The success of our system and the ultimate quality of the *Bulletin* depend largely on the Associate Editors, who provide their time and expertise to the authors, the readers, and the Society. We thank the *Bulletin* Associate Editors who completed their terms with us in 1995:

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University of Utah
George H. Brimhall Jr.
University of California, Berkeley
Douglas W. Burbank
University of Southern California
Robert F. Butler
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David A. Clague
U.S. Geological Survey, Hawaii
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University of Alberta
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Exxon Production Research Co.
Robert A. Gastaldo
Auburn University
Bernard Hallet
University of Washington, Seattle
John R. Henderson
Geological Survey of Canada
Charles F. Kahle
Bowling Green State University
Susan M. Kidwell
University of Chicago
Willem Langenberg
Alberta Research Council
Walter L. Manger
University of Arkansas
Hugh H. Mills
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Geological Survey of Canada
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University of Buenos Aires
Marith Reheis
U.S. Geological Survey, Denver
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WASHINGTON REPORT

Bruce F. Molnia

Washington Report provides the GSA membership with a window on the activities of the federal agencies, Congress and the legislative process, and international interactions that could impact the geoscience community. In future issues, Washington Report will present summaries of agency and interagency programs, track legislation, and present insights into Washington, D.C., geopolitics as they pertain to the geosciences.

National Assessment of U.S. Oil and Gas Resources

The U.S. Geological Survey (USGS) recently released the *1995 National Assessment of United States Oil and Gas Resources*, a report summarizing the results of a three-year study by more than 50 earth scientists of the oil and gas resources of onshore areas and state waters (generally out to the three-mile limit) of the United States. A similar analysis of the oil and gas resources of the federal outer continental shelf (the area beyond the three-mile limit) is being performed by the Minerals Management Service (MMS).

The USGS assessment was conducted at the play level. The methodology used required estimation of the sizes, numbers, and types of undiscovered conventional accumulations of oil and gas and estimation of play risk. Numerous techniques were employed to make the estimates. They included reservoir-simulation modeling, discovery-process modeling, application of analogs, and spatial analysis. Commodities assessed were crude oil, natural gas, and natural gas liquids (NGL) that can be expected to be produced from the subsurface through a well. Excluded from the assessment were gas dissolved in geopressured brines, resources in tar deposits, resources in oil shales, and gas hydrates.

The results of the assessment are available in both printed form and CD-ROM from the USGS, Information Services, Box 25286, Federal Center, Denver, CO 80225. The 20-page paper version has been released as USGS Circular 111, while the CD-ROM, subtitled *Results, Methodology, and Supporting Data* is available as USGS Digital Data Series (DDS) release number 30. Additional information can be obtained from Don Gautier at MS-960 at the above address.

The purpose of the assessment is to estimate and develop, using the best available scientific methodology, a set of scientifically based hypotheses concerning the amount of oil and gas that can be added to the already measured (proven) reserves of the United States. The *Assessment* consists of a series of constructs or hypotheses, based on the best information and theory available.

The term "assessment" is frequently used to describe an inventory. With this *Assessment*, this is not the case. The *Assessment* deals with largely unknown quantities of oil and gas. It attempts to bound the uncertainties concerning potential additions to oil and gas reserves existing in the onshore United States and beneath state waters. This geological assessment, done without regard to political or economic considerations, makes no attempt to predict at what time or what part of potential additions will be added to reserves.

Accompanying the *Assessment* are several pages of necessary vocabulary, consisting of useful terms needed to fully grasp the methodology and significance of the *Assessment*. These include:

- undiscovered resources—resources postulated from geologic information and theory to exist outside of known oil and/or gas fields.
- technically recoverable resources—resources in accumulations producible using current recovery technology but without reference to economic profitability.
- measured (proved) reserves—that part of the identified economic resource that is estimated from geologic evidence supported directly by engineering data.
- conventional accumulation—a discrete deposit, usually bounded by a down-dip water contact, from which oil, gas, or NGL can be extracted using traditional development practices.
- NGL—natural gas liquids.
- continuous-type deposit—a hydrocarbon accumulation that is pervasive throughout a large area, for which the standard methodology for assessment of sizes and numbers of discrete accumulations is not appropriate.
- unconventional deposit—hydrocarbon deposits of a type that historically has not been produced using traditional development practices.
- field growth (inferred reserves)—identified resources over and above measured (proved) reserves that will be added to existing fields through extension, revision, improved recovery efficiency, and the addition of new pools or reservoirs.
- inferred reserves—the difference between proved reserves and the remaining recoverable resources in known fields.
- indicated reserves—identified oil resources in known productive reservoirs in existing fields in addition to measured reserves that are expected to respond to improved recovery techniques (part of inferred reserves).
- field—an individual producing unit consisting of a single pool or multiple pools of hydrocarbons grouped on, or related to, a single structural or stratigraphic feature.
- accumulation—a single oil or gas deposit as defined by the trap, charge, and reservoir characteristics of the play.
- play—a set of known or postulated oil and/or gas accumulations sharing similar geologic, geographic, and temporal properties.
- play area—the two-dimensional plan extent over which a play concept is considered to be valid and within which all known accumulations and potential for undiscovered accumulations or other additions to reserves within the play exists.
- play attributes—geologic characteristics that describe principal properties of and necessary conditions for the occurrence of oil and/or gas accumulations of the minimum size (1 million barrels [MB] of oil or 6 billion cubic feet [BCF] of gas) within the defined parameters of a play.
- charge (a play attribute)—the occurrence of conditions of hydrocarbon generation and migration adequate to cause an accumulation of the minimum size.
- reservoir (a play attribute)—the occurrence of reservoir rocks of sufficient quantity and quality to permit the containment of oil and/or gas in volumes sufficient for an accumulation of the minimum size.
- trap (a play attribute)—the occurrence of those structures, pinch-outs, permeability changes, and similar features necessary for the entrapment of oil and/or gas in at least one accumulation of the minimum size.
- confirmed play—a play within which one or more accumulations of the minimum size had been discovered.
- hypothetical play—a play that was identified and defined based on geologic information but for which no accumulations of the minimum size had been discovered.
- play probability—the product of the probabilities of the three play attributes; an estimate expressed as a decimal fraction.
- conditional estimates—sizes, numbers, or volumes of oil or natural gas that are estimated to exist in an area, assuming that they are present.
- risked estimates—resources that are estimated to exist, including the possibility

Washington Report *continued on p. 15*

Washington Report *continued from p. 14*

that the area may be devoid of oil or natural gas.
- cumulative probability distributions from resource estimates—graphical depictions of estimated resource volumes presented with associated cumulative probabilities of occurence.

The *Assessment* addresses three categories of resources: undiscovered conventional accumulations of oil and gas; future additions to reserves of known fields (reserve growth or field growth—an estimate of inferred reserves); and oil and gas in continuous-type accumulations (a category similar to "unconventional" categories of other analyses). For this study, the United States was divided into eight regions, encompassing 72 separate provinces. The provinces are based on natural geologic entities and may include a single dominant structural element or several contiguous elements. Geographically, 560 plays were identified, of which about 100 were continuous-type plays and the remainder were conventional plays. Of the 460 conventional plays, 373 conventional plays were assessed. Of these, 290 are confirmed plays and 83 are hypothetical plays.

According to Gautier, there are approximately 110 billion barrels (BB) of technically recoverable oil onshore and beneath state waters. The mean estimate of undiscovered technically recoverable conventional oil resources is slightly more than 30 BB. Of this amount, more than 6 BB of oil exist in accumulations smaller than 1 million barrels of oil. Reserve growth in conventional fields has a mean value of 60 BB, while continuous-type accumulations in sedimentary rocks have a mean value of 2.1 BB. Measured (proven) reserves total 20.2 BB.

The mean estimate of undiscovered technically recoverable conventional natural gas is about 259 trillion cubic feet (TCF). About 45 TCF exist in fields of less than 6 billion cubic feet. Measured reserves total 135.1 TCF. The mean estimate of undiscovered NGL is about 7 BB.

The *Assessment* estimated that reserve growth could add 60 BB to oil reserves in known fields, and 322 TCF of natural gas could be added to reserves in known fields during the period until the year 2071. Technically recoverable hydrocarbon resources from continuous-type accumulations are substantial. The mean estimate for natural gas resources in continuous-type deposits exceeds 300 TCF; for crude oil it is about 2 BB; and for NGL it is about 2 BB.

The *Assessment* confirms observations that oil production in the United States is in decline, as it has been since 1971. Oil's future is uncertain. The natural gas situation is different. Production is still increasing, and the resource is more plentiful. The *Assessment* shows that industry will need to increase drilling and the nation will have to address a variety of technological and land-use considerations even to maintain delivery at present levels.

As the United States approaches the next century, more energy is being consumed, most of it from fossil fuels. The *1995 Assessment* is a critical tool in the battle to keep pace with this ever-growing demand for energy. It provides a scientifically based, nonadvocacy approach for providing the nation with critically needed information for future energy decision making. ■

The Geological Society of America

Congressional Science Fellowship 1996–1997

The Geological Society of America is accepting applications for the 1996–1997 Congressional Science Fellowship. The Fellow selected will spend a year (September 1996–August 1997) in the office of an individual member of Congress or a congressional committee for the purpose of contributing scientific and technical expertise to public policy issues and gaining firsthand experience with the legislative process. The American Association for the Advancement of Science conducts an orientation program to assist the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

Criteria

The program is open to highly qualified postdoctoral to mid-career earth scientists. Candidates should have exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside the Fellow's particular area, and a strong interest in working on a range of public policy problems.

Award

The GSA Congressional Science Fellowship carries with it a $42,000 stipend, and limited health insurance, relocation, and travel allowances. The fellowship is funded by GSA and by a grant from the U.S. Geological Survey. (Employees of the USGS are ineligible to apply for this fellowship. For information about other programs, contact AAAS or the Geological Society of America.)

To Apply

Procedures for application and detailed requirements are available in the geology departments of most colleges and universities in the United States or upon request from: Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

DEADLINE FOR RECEIPT OF ALL APPLICATION MATERIALS IS FEBRUARY 1, 1996

SAGE REMARKS

As we approach the 21st century, dramatic changes are taking place in higher education. Shrinking budgets and escalating tuition costs are increasing financial pressures on institutions. At the same time, public and legislative concerns are forcing a reexamination of items such as the balance between faculty teaching and research, the rationale and need for tenure, and the responsibility of colleges and universities to society.

The following article by P. Geoffrey Feiss of the University of North Carolina highlights some of the problems geology departments face as they attempt to remain viable academic units. (A previous version of this article was published in the GSA Southeastern Section newsletter, no. 7, Fall 1995.) Comments and suggestions about this issue should be sent to Edward E. Geary, Coordinator for Educational Programs, Geological Society of America, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301. (303) 447-2020; fax: 303-447-1133; E-mail: egeary@geosociety.org.

The Survival of Academic Geology Programs

P. Geoffrey Feiss, *University of North Carolina*

We all need to care about the stability of academic geology programs in perilous times. If we do not, we may wander out of the field one August to find that our alma mater has moved Materials Science or, scarier, Cultural Studies into the earth science building.

Part of the geomystique is that real earth scientists don't have to put up with petty bureaucrats and silly deans. We let English professors and sociologists mess with campus politics, since we have real science to do. We blow off academic committees and bypass administrative assignments to revel in the mudrocks and mosquitoes, the briars and basaltic andesites.

As one who is swimming upstream of this geological tradition of anti-administrative fervor, and needing to justify my class treason, I mount this pedestal to argue that the tradition of leaving the petty details of academic administration to others is hazardous to our health. My warning: Do not let intellectual arrogance close you out of important conversations that are, I assure you, going on in your central administration building as I write.

You do not need to be told that, public or private, large or small, the golden days of the past 50 years in academia are over. Every college and university is looking to downsize, reengineer, reallocate—euphemisms aside, to cut programs. For too many deans, provosts, vice-chancellors, and others of that stripe, geology as a discipline looks expendable.

Academic administrators schooled in the canon of western culture cannot conceive of a university or college without physics, chemistry, mathematics, biology, and so on. They can see, and may have graduated from, an institution without a geology department. Such departments may be small and relatively powerless. We are seen as peripheral to the main intellectual action. We show up at faculty meetings in boots and flannel shirts—if we show up.

I can list places in the GSA Southeastern Section where geology has disappeared or been given the fright of its life: University of Virginia, Old Dominion University, Virginia State, George Mason University, Birmingham-Southern College, University of Maryland, Emory University. Aside from the obvious conclusion that Virginia is a very dangerous place for us to practice our profession, this list should give us all pause. We can take no pleasure in the fate of many valuable and conscientious colleagues; we should learn a lesson. This list of schools spans the gamut: public and private research institutions, comprehensive universities, historically black colleges and universities, liberal arts colleges.

How, we ask incredulously, can anyone cut geology at a time when global change, earth systems science, environmental degradation are on everyone's lips? As an academic administrator charged with strategic planning for a college of arts and sciences, I can tell you. Such questions and viewpoints are unlikely to be addressed (unless there is a geoscientist in the room). Rather, the kinds of issues that are raised and, which, therefore, you should prepare to address are: (1) Demand. What is the demand for your graduates? What do they do? (2) Quality. How good are you? What is required to keep you this good? To make you better? (3) Cost. How expensive are you? Or, put crassly, how much money can be realized by axing you? (4) Centrality. How important are you to the mission and overall goals of your school or college?

SAGE Remarks *continued on p. 17*

PEP TALK

Barbara L. Mieras, Partners for Education Program Manager

PEP Members Update

We were delighted to see so many PEP members at GSA's 1995 Annual Meeting in New Orleans and to meet the more than 60 new members who registered at the PEP booth. We'd also like to offer a special greeting to more than 100 new PEP members who joined us in response to GSA's fall membership mailing. Welcome!

Thanks to everyone who sent a photo to light up our PEP booth in New Orleans. Your smiles added a lot to our display, and exhibit-goers enjoyed looking for (and occasionally finding!) familiar faces among the Partners. We were glad to see all of you who attended the PEP Reception—thanks for coming to talk about Partnering issues and concerns or just to visit with other Partners. The Earth Science Educators' Social Hour, Rock Raffle, and Share-A-Thon were hits; we know from the PEP Rock Raffle coupons you turned in that at least a couple dozen Partners were there bidding on the outstanding rock and mineral specimens. Thanks to all participants and donors for your support!

Finally, a huge thanks from PEP and SAGE to all the donors and participants in the GeoRaffle. The raffle raised over $200 to benefit programs for K–12 teachers, and the raffle prizes will be put to good use in classrooms across the country and in Canada. The generous folks who contributed prizes include:

American Geological Institute
Earth Magazine
Earth'nware
Geological Society of America Bookstore
Geological Society of America Educational Programs
Jet Propulsion Laboratory
National Earth Science Teachers Association
Oklahoma Geological Survey
Scott Resources
Tasa Graphics
University of Chicago Press
W.H. Freeman & Company
Wright State University

SAGE Remarks *continued from p. 16*

You should not wait to be asked. Begin to think this through. With respect to each of the issues above, here are some suggested answers or strategies from the perspective of someone who worries about these things:

Demand. Track your students; keep in touch and find out what they are doing. If they are nongeologists, let them tell you how much being a geomajor has helped them as teachers, insurance saleswomen, cabbies. Use American Geological Institute, National Science Foundation, and National Academy of Science–National Research Council documents to support your contention that the earth sciences are important to the nation's future. Find an example of a student who is making a huge difference in the welfare of your region or the nation as a geoscientist. (If it turns out that such people do not exist, it's time to rethink the way you are doing things!) Parenthetically, contacting these same people can help you in rallying their support if the budget knife descends. Depending on your institution's sensitivity to alumni concerns, they may be a major asset.

Quality. Be honest. Use rankings, both good and bad, but be sure to compare yourself with peer institutions (this can be difficult). In other words, don't waste your breath rationalizing why you are not as good as Cal Tech. Discuss how much better you are than the program at Moo U, which has the same institutional mission and is comparable in other regards. Be sure to compare yourself with other physical sciences, with geography, with environmental science on your own campus. Talk about how you could improve *with no additional resources.* (Deans like the sound of that.) How can this be done, you ask? Work harder. Focus on the things you do well and stop doing it all. There is a very fine line between being entrepreneurial and opportunistic and chasing every trend and request for proposals that comes along. Invest in defining the things you are good at and thinking about the things you should discontinue. Make some hard decisions. Always remember that administrators need successes. That could be you, and if you do all the work, they are more than happy to take the credit.

Cost. This is a hard one. You need a sense of the goals of your administration. Are you at risk because they desperately need money from someone to balance the budget this year, or are they more generically trying to achieve financial stability through right-sizing? If the former, it's too late to make changes, and you are in the thick of the battle. If the latter, go on the offensive now. Devise your own five-year financial plan that demonstrates how, if you are allowed to control your own fate, you will reallocate your own resources to save money, raise additional external funds, get better and more efficient. Set some objectives that you know will resonate with your administration, ask their blessing in pursuing them within your current resource base, and emphasize how they will know that you have achieved these goals in 4–5 years. Then, achieve them.

Centrality. Here is where the real work can be done by any geology program worth its salt. Look at your curriculum. Is it working? If the bean-counters want bodies, devise courses in global change, geology of the national parks, and the like. Geology is an interdisciplinary science. Build curricular and research linkages with marine science, environmental science, evolutionary biology, public policy, geography. Participate in math or writing across the curriculum, your honors program, the freshman experience. It is a lot harder for an administrator to excise a unit that is teaching half the freshman science courses or is team-teaching with a bunch of other departments, which would be negatively impacted if you are cut. If merger with other programs is in the offing, accept it and be sure you keep an identity and control your fate.

Finally, get involved with policy-making and decision making on your campus. A paradigmatic quote, on the Republican revolution, that I jotted down in a notebook a few years ago: "While the Democrats were arguing over who would be chair of the English department, the Republicans were selecting a President of the United States." We academic geologists have to be very careful that while we are debating the existence and location of the Central Piedmont suture, the academic powers-that-be don't transfer our resources to condensed-matter physics or environmental studies. ■

Alternates Receive 1995 Research Grants

Each year when the Committee on Research Grants selects grant recipients, they also select an alternate group of recipients in the event that some of the grantees return part or all of their funds because they have received funding elsewhere or have changed their research plans. As the returned funds become available, they are re-awarded by the Research Grants Administrator to the alternates named by the committee.

In 1995 seven alternates received funding following the initial awarding of grants. They are: Dale Alan Brunotte, Iowa State University; Lawrence L. Coats, Northern Arizona University; Amy L. Ellwein, University of New Mexico; Andrew D. Hanson, Stanford University; Kelly Elizabeth Keighley, Utah State University; Matthew K. Larsen, University of Wyoming; and James H. Shirley, California State University, Northridge.

GSA Divisions News

Divisions recognized the following individuals at the 1995 Annual Meeting in New Orleans for their service to the Division and/or contributions to the geological sciences. (For a listing of other award recipients honored at the New Orleans meeting, see page 190 of the October 1995 issue of *GSA Today*.)

Coal Geology Division
John C. (Jack) Crelling, Distinguished Service Award
Harold J. (Hal) Gluskoter, Distinguished Service Award

Engineering Geology Division
J. David Rodgers, 1996 Richard H. Jahns Distinguished Lecturer

Northeastern Section offers Undergraduate Student Research Grants

The Northeastern Section of the Geological Society of America announces its student research grant program for 1996. The grants are competitive and available to undergraduate students.

To be considered for a research grant:

- The student must be enrolled at an institution within the Northeastern Section
- The student must be a Student Associate or Member of GSA.
- Applications must be postmarked no later than February 15, 1996.
- Grants will be awarded following the Northeastern Section meeting in Buffalo in March 1996.

For further information or a copy of the research grant application form, contact: Kenneth N. Weaver, Secretary NEGSA, Maryland Geological Survey, 2300 St. Paul St., Baltimore, MD 21218, (410) 554-5532, fax 410-554-5502.

GSAF UPDATE

Robert L. Fuchs

Is There a Trust in Your Future?

A recent article in one of the national business magazines began with the question, "Have you set up a trust?" and went on to state, "If you haven't, get cracking. No middle-class family should be without one."

Trusts have always been the financial tools of the rich, but inflation and changes in tax laws have lowered the income and asset level at which trusts start to make sense for many people. You may be one of these. There are several reasons why this has happened.

First, trusts are a very effective way to minimize taxes. As inflation has caused individual incomes and estates to increase, the estate tax exemption, which is not indexed for inflation, has remained at $600,000. Many now find themselves above this exemption level. Estate and income taxes can be reduced by shifting assets to a charitable remainder trust or a life insurance trust.

Trusts can be used to avoid probate. In about a third of the states this is a costly, time-consuming process. A living trust can transfer assets to heirs outside of a will, and this is usually done within a short time after death. Fees for lawyers and court administration are greatly reduced in the process, or even eliminated. Not only is such a trust important in states such as California, New York, and Florida, ownership of property in more than one state can cause your will to be probated in several states at the same time.

Privacy is an attribute of the establishment of a trust. While probate records and real estate deeds are open to the public, trusts protect the privacy of an estate. The world does not need to know what you have when you are alive, and to whom your assets are left.

Finally, a trust can be used to segregate your estate from certain heirs. This may be impossible to do in some states, where, for example, you cannot totally disinherit a spouse or children. Relatives who have been cut off have a much more difficult time attacking your trust than your will.

There are a number of trust types to suit particular needs in particular locations, such as the qualified terminable interest trust (QTIP), the generation-skipping trust, the kiddie trust for college tuition, and the grantor-retained income trust (GRIT). The revocable living trust may make a lot of sense for you if you live in one of the "heavy probate" states or have residences or property in more than one state. There is some work involved in setting one up—for instance, ensuring that all your assets are in fact transferred to the trust. Your heirs may very well some day appreciate your time and effort.

The charitable remainder trust comes in two versions, the annuity (CRAT) or unitrust (CRUT), and can have significant tax advantages during your lifetime. The process of forming one of these trusts is not particularly difficult. You transfer assets to a trust that names a charity or charities such as the GSA Foundation as the remainder beneficiary. The trustee, who could be you, the Foundation, or a third party, sells the assets and places the proceeds in income-producing securities (which can be tax-free municipal bonds). The income from the trust is paid to you (or your spouse) for life, and the principal reverts to the Foundation after death. There is no capital gains tax to pay on the asset sale; your trust receives the full value of the proceeds. In addition to avoiding this tax, there is a year-of-gift tax deduction, adjusted for life expectancy and for the future income stream. These tax advantages together can add up to a very powerful economic incentive to create a CRAT or a CRUT.

There is a lot of literature and software available to learn more about trusts. Call the Foundation at (303) 447-2020, extension 154, and we can give you a few titles. In fact, we can send you an introductory booklet entitled *Trusts in Financial Planning* which can help you decide if there really is a trust in your future. You may use the accompanying coupon to order this booklet. ■

New Orleans Trustees Meeting Report

The Foundation's Board of Trustees held its annual meeting during the GSA meeting in New Orleans in November. Officers of the Foundation were elected for 1996: Chair, Charles Mankin; Vice-Chair, Paul Bailly; President, Robert Fuchs; Vice-President, Don Davidson; and Secretary-Treasurer, Donna Russell. In addition, the trustees prepared and forwarded to the GSA Council a list of 10 candidates from which board vacancies are to be filled.

The board accepted the recent resignation of Trustee Fred Donath, and appointed him an Honorary Trustee, noting in particular his philanthropy that established the Young Scientist Award and Medal and the dedicated work he had done for GSA in organizing and managing the Institute for Environmental Education through 1994. An appointment of a new trustee from the list of Council-approved candidates to fill this position is expected in the near future.

The board approved a 1996 direct operating budget of $279,573, of which 50% will be directed toward Second Century Fund activities. The 1996 budget will support a Foundation staff of two full-time and three part-time employees. Also on financial matters, a 1996 disbursements budget of approximately $500,000 for GSA student support, research grants, scientific conferences, awards, and educational and outreach programs was approved.

GSAF Update *continued on p. 19*

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☐ I would like to learn more about trusts. Please send me a copy of the booklet entitled *Trusts in Financial Planning.*

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GSAF Update *continued from p. 18*

Other business included a report on Second Century Fund progress, with emphasis on the membership campaign and the current Industry Support Program for Earth Science. The trustees suggested various sources of funding, for follow-up by the Second Century Fund Committee and the Foundation staff. Education Coordinator Ed Geary reviewed the SAGE program, and IEE Program Manager Dan Sarewitz reported on his plans for future IEE activity. GSA Executive Director Don Davidson provided an overview of GSA operations and developments. ■

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continued on p. 20

New *Geology* Editor Appointed

Lee Kump

Lee Kump, Pennsylvania State University, is the newest co-editor of *Geology*. He succeeds Henry Mullins, who finished a second term as a co-editor at the end of 1995. Kump is working with Editor David Fountain, University of Wyoming (Fountain's second term ends at the end of 1996).

Kump, an associate professor of geosciences at Penn State, received his A.B. in geophysical sciences at the University of Chicago, and his Ph.D. in marine sciences at the University of South Florida. His area of interest includes modeling the evolution of atmospheric and oceanic composition, global biogeochemical cycles, and low-temperature geochemistry. He served two 3-year terms on the *Geology* Editorial Board before taking on the co-editorship.

"My goal as co-editor is to maintain or reduce the time to publication while improving the visibility of *Geology*," Kump said in a recent interview. "The press should be waiting for the publication of *Geology* as they do for *Science* and *Nature*. I hope that we begin to see statements such as '… as published in this month's issue of *Geology* …' regularly in the *New York Times*, *Washington Post*, *Earth*, *Discover*, and other quality popular media—even on CNN. This would be good not only for the journal, but for the geosciences in general, and will help to ensure that the best, most innovative and provocative papers are published in *Geology*."

To submit a paper to *Geology*, see information for contributors in selected issues (November 1995, p. 1056, for example). Submissions must be sent to *Geology*, GSA, P.O. Box 9140, Boulder, CO 80301, not to editors Fountain or Kump. ■

Kay Takes On *GSA Today* Science Editor Post

Suzanne M. Kay

Suzanne M. Kay, Cornell University, is the newly appointed science editor for *GSA Today*. She will handle review and acceptance or rejection of all science articles submitted to *GSA Today*.

Kay's work in the use of geochemistry and petrology for solving tectonic problems and for understanding the evolution of the continetal lithsophere has focused on the Aleutian arc and the Andes. Since 1985, she has been active in both the South and North American Geological Committees. In South America she has taught (in Spanish) short courses on geochemistry and petrology in Argentina, has given talks at geological congresses, and actively participated in International Geologic Correlation Program projects. She is the first native-born North American (and the first woman) to be elected (in 1995) a miembro correpondiente (equivalent to a GSA honorary fellow) of the Asociación Geológica Argentina.

Kay earned B.S. and M.S. degrees at the University of Illinois at Urbana-Champaign, and her Ph.D. at Brown University. She has held positions at the University of California, Los Angeles, the University of Buenos Aires, and the California Institute of Technology, as well as at Cornell University, where she is currently a professor.

"*GSA Today* offers high visibility for high-quality, newsworthy science articles," Kay said. "I hope to encourage submission of papers of both national and international interest."

To submit a science paper to *GSA Today*, first contact Suzanne Kay, Department of Geological Sciences, Snee Hall, Cornell University, Ithaca, NY 14853-1504, (607) 255-4701, E-mail: kay@geology.cornell.edu. ■

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About People

GSA member **David Applegate** has been appointed Director of Government Affairs at the American Geological Institute, Alexandria, Virginia.

Fellow **Ralph J. Bernhagen,** Worthington, Ohio, has received the American Institute of Professional Geologists (AIPG) Honorary Membership award. GSA Fellow **Donald Blackstone,** University of Wyoming, Laramie, received AIPG's 1995 Ben H. Parker Memorial Medal. AIPG's John T. Galey Public Service Award for 1995 went to GSA member **Edward Nuhfer,** University of Colorado at Denver. Fellow **Russell G. Slayback,** Greens Farms, Connecticut, received the AIPG Martin Van Couvering Memorial Award.

Fellow **William D. Rose Jr.,** Westford, Massachusetts, retired at the end of August from the Ocean Drilling Program at Texas A&M. His editing and publishing service, Rose Perspectives, is in Westford.

Fellow **Donald D. Runnells,** Fort Collins, Colorado, retired from the University of Colorado, Boulder, and has joined an environmental consulting firm, Shepherd Miller, Inc.

BOOK REVIEWS

Hypersea: Life on Land. *Mark A. S. McMenamin and Dianna L. S. McMenamin, Columbia University Press, New York, 1994, $27.95.*

The term "hypersea" has undeniable appeal as a poetic allusion to a supposed marine origin of body fluids of life on land, and also for the microcosms of symbionts, parasites, and hyperparasites within land organisms. The McMenamins' reference to our interior sea, the rising tide of life, hypermarine upwelling and currents on land do indeed strike a resonant chord. But the McMenamins intend hypersea to be much more than mere allusion, allegory, and analogy. They take some pains to establish hypersea as a physical entity of the sum of animal and plant life on land, as a scientific theory and as a scientific perspective. They also exclude prokaryotic and protoctistan life assumed to have been on land before the "invasions" of larger creatures. I looked in vain for reasons why they would define hypersea so narrowly but had even greater difficulty following the logical relation of theoretical predictions of hypersea, which are as follows (summarized from p. 216–222). (1) Hyperparasites are more common on land than in the sea. (2) Land biota has had several more levels of hyperparasitism than marine biota for at least the past 350 million years. (3) Symbiotic organisms are more widely distributed than those with less symbiotic flexibility. (4) Land biota has more hosts in the life cycle of parasites than marine biota. (5) Land biota has more host-killing parasites and asymptomatic parasites than marine biota. (6) Photoautotrophic land animals will be discovered, either living or fossil. These are all interesting hypotheses, even if difficult to falsify, and are all related to a theme, which pervades the book, of the greater diversity, complexity, biomass, and nutrient supply of life on land. However, these are all differences, rather than similarities, between the sea and interior fluids of land organisms. So why would they be united under the label of "hypersea"? In my opinion, "hypersoil" would be a more apt characterization of the various theories marshaled in *Hypersea.* Vacuoles, lungs, and skeletons are evidence that life on land has gases and minerals like soil, in addition to dilute energy-transforming solutions.

Despite my misgivings about the logical connection between the various hypotheses credited to hypersea, there is much of interest here. The McMenamins do a good job in portraying land biota as more complex than marine in parasites and symbionts, with examples including problematic fossils, mycorrhizae, tapeworms, and AIDS. Also included are primers on lichenology and paleobotany. These are all underappreciated subjects dear to my heart from my own proposals (overlooked in this volume) that Ediacaran fossils were lichens and that life itself evolved in soil. This omission is accompanied by other small errors. For example, the oldest fossil shelf fungus is Early Triassic, not Jurassic. Amyelon is a cordaite, not a sphenophyte. Psilotum is a fern, not a primitive land plant. Even so, the enthusiasm of the McMenamins for biological land chauvinism is infectious. I liked hypersea as a poetic allusion and as a research agenda, but the theories attributed to it here lack logical connection. For me at least, hypersea does not hold water.

Greg Retallack
University of Oregon
Eugene, OR 97403-1272

Geology of an Evolving Island Arc: The Isthmus of Southern Nicaragua, Costa Rica, and Western Panama. *Edited by H. Seyfried and W. Hellmann. Profil, Band 7, Institut für Geologie und Paläontologie, Universität, Stuttgart, 1994, 433 p., DM158, US$114.*

This volume contains 22 papers (17 in English, 4 in Spanish, and 1 in German) concerning the tectonic, lithologic, and paleontologic evolution of Costa Rica and neighboring parts of Nicaragua, Panama, and Colombia. The storyline runs from the Jurassic to the present and covers the evolution of this region from deep seafloor basaltic crust covered by radiolarian chert, through the growth of an island arc, and finally coalescence of the volcanic islands into the modern volcanic isthmus connecting North and South America. The papers are divided into six sections: (1) geologic and tectonic history, (2) igneous basement, (3) igneous cover rocks and neotectonics, (4) pre-Neogene sedimentation, (5) Neogene sedimentary basins, and (6) paleontological aspects.

The 45 authors who contributed to this volume are dominantly of German (19) and Costa Rican (18) affiliation, with just two each from France and the United States and one each from the United Kingdom, Argentina, the Netherlands, and Uruguay. Evolution is the theme of the volume and is a strong element in every paper. Most of these results appear not to have been published previously. As an igneous petrologist, I was surprised to find myself most interested in the last group of paleontological papers. Fischer and Aguilar review the evolution of fossil assemblages as the arc of volcanic islands grew from the sea floor and coalesced into the isthmus, isolating the Pacific and Caribbean marine faunas and floras by late Pliocene time. These authors emphasize the strong controls plate-tectonic activity had on the biological successions. Likewise, the paper following, by Lucas and Alvarado, stresses the role of the evolving arc in land-vertebrate dispersals since the Late Cretaceous. They argue that Central America only became an important trackway in the Pliocene. Hooghiemstra follows with an analysis of pollen records from two boreholes near Bogotá, Colombia, spanning late Pliocene to late Quaternary time. Closure of the Panamanian Isthmus, immigration of Alnus and Quercus, and shifting vegetation patterns corresponding to glaciations are all recorded in this high-resolution record (1–5 ka).

With such a high percentage of contributors from non–English-language countries, this volume needed a great deal of editorial work, which it did not receive. Many papers contain more than two typographical errors per page. Some sentences terminate abruptly at the end of a line, indicating that other lines were inadvertently deleted. Very few of the papers contain cross references to other papers in the volume. There are many contradictions from one paper to another, none of which is pointed out, let alone reconciled. Many cited references are not to be found in the reference lists. The title of the paper on p. 87 seems to be missing some words. Rare earth element patterns on p. 103 were inadvertently flipped left to right, and axis labels for Figures 6 and 8 of the same paper are missing. In summary, this volume was apparently assembled in a hurry without much editorial oversight. It has a paper cover, but sells for the high price of US $114. On the positive side, few of these results have been available to English-reading scientists previously. Geology libraries should have this volume, but only dedicated Central American specialists will want to pay the price for a personal copy.

James F. Luhr
National Museum of Natural History
Washington, DC 20560

Potential Theory in Gravity and Magnetic Applications. *Richard J. Blakely. Cambridge University Press, Cambridge, UK, 1995.*

The gravity and magnetic fields are fundamental geophysical properties of our planet, and research on them has played a major role in furthering understanding of Earth's interior, at many scales. The magnetic field has been studied for over two millennia, the gravity field for several centuries. A complete understanding of grav-

Book Reviews *continued on p. 22*

Book Reviews *continued from p. 21*

ity and magnetism and their importance in geology and geophysics requires a solid foundation in potential theory, and although many texts cover the broad topics of applied geophysics, few dig sufficiently into the underlying theory to provide for a more comprehensive knowledge of the subject(s). Richard Blakely has bridged the gap between theory and application in this book. This outstanding contribution to the geological sciences reflects Blakely's extensive, high-quality research, involving application of crustal- and lithosphere-scale geophysics in solving fundamental geological problems. By necessity and design, this book is firmly rooted in the fundamentals of potential theory. However, geologists with less than strong mathematical backgrounds should not feel that the book is beyond comprehension. Beginning with Chapter 1, The Potential, Blakely has made a concerted and most successful attempt to provide a readable and approachable text for all geoscientists who wish to broaden their background in gravity and magnetics. The first six chapters give a thorough discussion of potential theory, ending with spherical representation of the potential. The remaining six chapters deal with applications of potential theory to gravity and magnetic studies of the crust and lithosphere, the first two of these exploring how gravity and magnetic measurements at the global and regional scales are transformed into field anomalies. The last four chapters provide a thorough (and mathematically meaty) overview of interpreting gravity and magnetic anomalies, including forward method, inverse method, and inverse and forward manipulations in the Fourier domain, and offer several geologically important examples from the literature. Several mathematical methods discussed in these chapters are included as computer subroutines in an Appendix. For both the practicing geophysicist and the geologist interested in a solid understanding of potential theory applied to gravity and magnetics, Blakely's book is a wise investment.

John Wm. Geissman
University of New Mexico
Albuquerque, NM 87131-1116

Invasions of the Land. *Malcolm S. Gordon and Everett C. Olsen, with contributions by David C. Chapman. Columbia University Press, New York, 1995, $65.*

The title says it all. According to this book, early Paleozoic land environments were assaulted on many fronts by an armada of plants and animals with an increasingly sophisticated array of weaponry in the struggle for existence on hostile barren land slapped by lakes and seas teeming with life. One by one, we are led through the heroic travails of each group of organisms thought to have been involved in this primordial struggle from evidence of the fossil record and the biology of modern amphibious organisms. Along the way the authors savage alternative current views such as cladism and dismiss as unprovable approaches exploring the distinctive synecology of early land ecosystems, the nature of early soil faunas, and physiological hypotheses. Paradoxically, their self-styled flexible, polyphyletic, uniformitarian, and adaptationist approach is presented as a new view on the problem. Their approach seems to me little evolved from the 1950s: an era of men, materials, technological progress, and just the facts, please. Alternative views of evolution of life on land from soil microbes promoted by Stebbins, Hill, and others are dismissed without argument. As I see things, new approaches to the problem are cladist, paleoecological, paleopedological, ecophysiological, and (at least in *Hypersea* by the McMenamins) metaphysical.

Book Reviews *continued on p. 23*

Invasions of the Land was written for a narrow academic audience with a strong background in biological systematics. One reads of pterygote insects, rather than winged insects. Why bother to give the whole binomial (*Archidesmus loganensis*) of a fossil regarded as indeterminate? Another minor annoyance is obeisance to the Temple of Scientific Literature. Whole sentences and even paragraphs communicate no more than a recommendation to go to the library and read someone else's views on the subject. Conclusions are urged on the basis of authority, whereas the evidence for those views is glossed over or unexplained. The authors do not claim to be encyclopedic, but the reference list is one of the most complete I have seen, with entries up to 1993. Unfortunately, this was too early for inclusion of Jenny Clack's work on aquatic adaptations of Late Devonian tetrapods and Bill Stein's and my research on potential Precambrian and Paleozoic lichens. Illustrations are surprisingly sparse and uninviting for a subject so rich in anecdotes of beasts and battles. All these things make *Invasions of the Land* dull reading.

Despite stylistic and philosophical reservations, I am glad to have *Invasions of the Land* nearby, and I recommend that you pester your librarian to obtain a copy. It is a useful reference work covering most of the available evidence, and a concise statement of traditional views on the subject of early life on land. I was depressed to find how little we know, but the pessimistic and unadventurous conclusions of this book should spur us all to do better.

Greg Retallack
University of Oregon
Eugene, OR 97403-1272

Climate Since A.D. 1500. *Edited by Raymond S. Bradley and Philip D. Jones. Routledge, London and New York, 1995, $39.95.*

In the last decade, there has been a rising interest in climate change, along with a realization that climate will be a key player as we seek to find a stable future for rapidly growing populations. A new appreciation of climate is reflected in the success of the book *Climate Since A.D. 1500,* first published in 1992 and now republished in paperback.

The volume, with more than 50 authors, provides an overview of the status of research on climate change and climate variability of the past 500 years. More than one-third of the book, in 12 articles, brings together long instrumental records and other documentary historical evidence of climate change from various regions of the globe.

The second one-third of the book, in 11 articles, is a summary of dendroclimatic evidence from each continent. These articles provide an excellent summary of the status of tree-ring research and show the value and limitations of tree rings as climate proxies. Five articles on ice-core records from the Yukon, South America, and Antarctica show, rather convincingly, that interdecadal changes in climate are reasonably consistent over large areas of the globe.

Articles on solar variations and volcanism consider two possible climate-forcing mechanisms, but these articles seem somewhat out of place in a volume whose main purpose is to examine records of variability. The 1992 volume reprints the Quinn and Neal article on historical El Niños and also has an introduction and summary by the editors that add perspective and references. If the book has a weakness it is the minimal treatment of climate records related to ENSO and the large body of accumulating information from coral records. The republished volume contains a brief new article on developments in high-resolution climate-proxy research since the original date of publication and cites some of the coral research.

By focusing on instrumental, dendroclimatic, and ice-core records, the editors have assembled an exceptional series of well-documented articles on recent climate variability. The new edition includes an expanded index to information contained in the articles and serves as a valuable reference point for future investigations. Taken together, the articles reveal the enticing prospect that climate changes since 1500, and on the time scale of decades to centuries, are hemispherically coherent, and provide hope for understanding both the causes and effects of climate change within a societal time frame.

Roger Y. Anderson
Albuquerque, NM ■

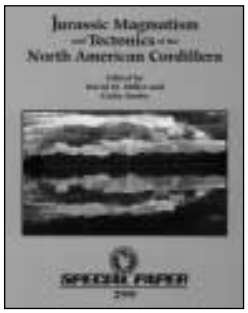
Letter Policy

GSA Today welcomes signed letters expressing individual opinions and addressing issues of broad interest. We cannot publish unproven allegations or unsigned letters. Send letters to Editor, GSA Today, P.O. Box 9140, Boulder, CO 80301

JURASSIC MAGMATISM AND TECTONICS OF THE NORTH AMERICAN CORDILLERA

edited by D. M. Miller and C. Busby, 1995

There is a growing realization that in about mid-Jurassic time, both magmatism and tectonism were widely initiated in the western North American continental crust, earlier subduction-driven magmatism and tectonics being localized near the plate margin. The 19 papers in this book discuss diverse approaches to characterize the Jurassic tectono-magmatic event, identify variations in its timing and other characteristics from region to region, and consider its ultimate origin in terms of lithospheric processes. Crucial aspects of the Jurassic tectonic events from the Yukon to southernmost United States are described. The lead paper presents a broad synthesis of Cordilleran subduction cycles, and is followed by papers arranged in three groups, from north to south: Canadian Cordillera; U.S. Great Basin; and southwestern U.S. desert regions. Within each group, papers are arranged from magmatic arc eastward to craton. This is an important look into now-eroded initial subduction-driven orogeny of the Cordillera, the precursor to later events that so strongly shaped present geology. Most papers are data-intensive first-order studies, although some fresh synthesis studies are also present.



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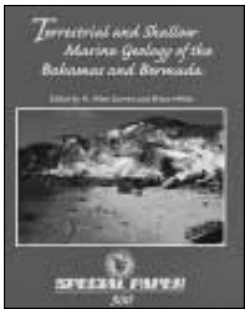
NEW FROM GSA

SPECIAL PAPERS

TERRESTRIAL AND SHALLOW MARINE GEOLOGY OF THE BAHAMAS AND BERMUDA

edited by H. A. Curran and B. White, 1995

The authors review the current knowledge of the Quaternary geologic history ofthe Bahama Archipelago and Bermuda, an area with unique terranes for the study of carbonate rocks, sediments, and environments. The exposed stratigraphic sequences of the islands reveal much about the history of global sea-level changes during Quaternary time. The focus is an interpretation of the characteristics of Bahamian and Bermudan rocks units, their fossil faunas and floras, and the karst surface features of the islands. Information from studies of the modern shallow marine environments are used to help understand the rock record. Up-to-date summaries of the geologic history are presented along with models of stratigraphic development. Other articles cover a broad spectrum of subdisciplines, from paleontology to carbonate systems geochemistry. Chapters are case-book examples of the investigation of important aspects of carbonate island geology.



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The Geological Society of America

Treatise on Invertebrate Paleontology

Revised Cretaceous Ammonoids Volume Now at Press

A revised volume of the *Treatise on Invertebrate Paleontology* is now at press: *Part L, Mollusca 4, Ammonoidea,* volume 4. The volume, most of which was prepared by W. C. Wright, with sections by J. H. Calloman and M. K. Howarth, deals with Cretaceous ammonoids. The volume is 385 pages, is hardbound, and is identified with ISBN 0-8137-3112-7. Treatise volumes are prepared at the University of Kansas.

This is the first of four volumes of the revised *Part L* to be completed. The revised set replaces the original *Part L,* first published in 1957, which is still available. Volumes 1 to 3 in the revised *Part L* series will follow as they are completed. They will cover such introductory material as morphology, biostratigraphy, and classification and will present diagnoses, stratigraphic ranges, and illustrations of Paleozoic to Jurassic ammonoids in traditional *Treatise* style.

Past volumes of the *Treatise* dealt with taxa throughout their ranges rather than with fossils from restricted intervals of geologic time. It is possible to treat the ammonoids stratigraphically because few genera from the Jurassic ranged into the Cretaceous, and all ammonoids became extinct by the end of the Cretaceous.

Other *Treatise* volumes dealing with the cephalopods are *Part K, Nautiloidea,* for which a revision is now underway, and *Part M, Coleoidea,* which is in preparation for the first time. All *Treatise* volumes are sold exclusively by the Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140, (800) 472-1988 or (303) 447-2020.

ORDER FORM—1996 *GSA Abstracts with Programs*

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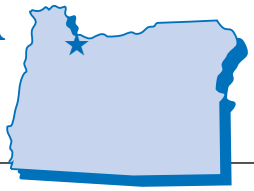
Due to prohibitive postal costs and delays in overseas mailings, this offer for the advance copies is for U.S., Canada, and Mexico only.

Final Announcement

CORDILLERAN SECTION, GSA 92nd Annual Meeting

Portland, Oregon • April 22–24, 1996



The Department of Geology at Portland State University will host the 1996 meeting of the Cordilleran Section of the Geological Society of America. The meeting will be held jointly with the Pacific Northwest Metals and Minerals Conference (PNMMC) sponsored by local sections of the Society for Mining, Metallurgy, and Exploration, (AIME), the the American Welding Society, ASM International, and the Association of Engineering Geologists.

All technical sessions will be held at the Red Lion Hotel—Lloyd Center, 1000 N.E. Multnomah, Portland, OR 97232. Late April is pleasant in Portland, with intermittent "sun breaks"; average high temperatures are near 60°F, and the average low is 41°F.

REGISTRATION

Preregistration Deadline: March 15, 1996

Name badges and tickets to special functions will be mailed to those who take advantage of lower registration costs by preregistering before the March 15, 1996, deadline. Save yourself time and money—preregister today!

Advance registration is encouraged for many of the activities because of participation limits. Use the preregistration form provided in this announcement. All registrations received after March 15 will be held for on-site processing and charged the on-site rates.

Badges must be worn for access to ALL activities, 5:00 p.m. Sunday through 5:00 p.m. Wednesday.

Registration discounts are given to members of GSA and the Associated Societies listed on the registration form. Please indicate your affiliation(s) to register using the member rates. Speakers not affiliated with member societies may receive the discount by checking the speaker box.

Full payment MUST accompany registration. Unpaid purchase orders are NOT accepted as valid registration. Charge cards are accepted as indicated on the preregistration form. Please recheck the card number given as errors will delay your registration. The confirmation card will be your receipt. No other receipt will be sent.

Register one professional or student per form. Copy the form for your records.

Guest registration is required for those attending guest activities, technical sessions, or the Exhibit Hall. Guest registrants MUST be accompanied by either a registered professional or a student. A guest is defined as a nongeologist spouse or friend of a professional or student registrant.

Students and K–12 professionals must show a CURRENT ID on site in order to obtain these rates. Students or educators not having a current ID when registering on site will be required to pay the professional fee.

On-site registration will be in the Ballroom Foyer of the Red Lion Hotel—Lloyd Center Monday morning through Wednesday noon. Sunday evening on-site registration will be in the Exhibit Hall at the Red Lion Hotel—Lloyd Center.

Cancellations, Changes, and Refunds

All requests for registration additions, changes, and cancellations must be made in writing and received by March 22, 1996. GSA will refund or credit preregistration fees for cancellations received in writing by that date. NO REFUNDS OR CREDITS WILL BE MADE ON CANCELLATION NOTICES RECEIVED AFTER MARCH 22. Refunds will be processed after the meeting. There will be NO refunds for on-site registration and ticket sales.

REGISTRATION FEES

	Advance *(by March 15)*		On-site	
	Full Meeting	One Day	Full Meeting	One Day
Professional—Member	$60	$30	$75	$40
Professional—Nonmember	$70	$35	$85	$45
Student—Member	$20	$10	$35	$20
Student—Nonmember	$30	$15	$45	$25
K–12 Professional	$15	$ 5	$15	$ 5
Guest/Spouse	$10	N/A	N/A	N/A

Accessibility for Registrants with Special Needs

GSA is committed to making the Cordilleran Section Meeting accessible to all people interested in attending. If you need any auxiliary aids or services because of a disability, check the appropriate box on the registration form. If you have suggestions or need further information, contact Michael Cummings *(see Contact Information, p. 26)*.

FIELD TRIPS

For details regarding specific field trips, please contact the trip leader(s). Address general questions to Scott Burns or Jeff Markstaller *(see Contact Information, p. 26)*. Preregistration for all field trips is required (see preregistration form). Participants will be accepted on a first-come, first-served basis. Be aware of cancellation penalties imposed by the airlines. Plan alternatives in advance in case the trip you are registered for is full or canceled. Field studies listed under the earth science education program are designed for K–12 educators, but a limited number of spaces, at a higher cost, are available for interested geoscientists. All field trips will leave from the Red Lion Hotel south side entrance.

Premeeting

1. **The Rattlesnake Tuff and High Lava Plains of Southeastern Oregon.** April 19–21. Anita Grunder, Department of Geosciences, Oregon State University, 104 Wilkinson Hall, Corvallis, OR 97333, (541) 737-1249, fax 541-737-1200; Martin Streck, Department of Volcanology and Petrology, Christian Albrecht University, Kiel, Germany, E-mail: mstreck@geomar.de. We will concentrate on the 7 Ma Rattlesnake Tuff of the High Lava Plains, a possible mirror image to the Yellowstone hotspot. Cost: $130 (includes van transportation, lunches, field guide, refreshments, two nights double-occupancy lodging). Limit: 20. Leave 4:00 p.m. Friday and return at 6:00 p.m. Sunday.

2. **Applied Paleoflood Hydrology in North-Central Oregon.** April 19–21. Dan Levish and Dean Ostenaa, Bureau of Reclamation, Seismotectonic Geology, Mail Code D8330, P.O. Box 25007, Federal Center, Denver, CO 80225-0007, (303) 236-4195, ext. 274 or 270, E-mail: dlevish@do.usbr.gov or dostenaa@do.usbr.gov. We will examine the geologic record of three of the largest flash floods ever reported in the United States and the Holocene paleoflood record of the Crooked River. We will discuss use of geologic data in evaluating peak discharge estimates and long-term flood frequency. Cost: $125 (includes two nights double-occupancy lodging, van transportation, three lunches, field guide). Limit: 29. Leave 8:00 a.m. Friday and return at 6:00 p.m. Sunday .

Cordilleran *continued on p. 26*

Cordilleran *continued from p. 25*

3. **Landslides of the Oregon Coast Range.** April 20. Scott Burns *(see Contact Information)* and Dave Michael, Oregon Department of Forestry, Forest Grove. We will visit four recent landslides: West Tidewater earthflow (30-acre failure in 1995); Osweg slide (problems of building homes and a major highway on a reactivated paleoslide; Karban slide (which closed a quarry); Wilson River slide (largest historical slide in Oregon, 1991). Cost: $25 (includes van transportation, lunch, field guide). Limit: 40. Leave 8:00 a.m. Saturday and return at 6:00 p.m.

4. **The Building Stone and Landscaping Boulder Industries of Western Washington.** April 20–21. David Knoblach, Marenakos Rock Center, 30250 SE Highpoint Way, Issaquah, WA 98027, (206) 392-3313, fax: 206-222-7292. This survey of major building and landscaping stone quarries and companies includes industry history, mining and milling technology, aspects of national and international markets, geologic characteristics of stone, and landscaping and architectural examples. Cost: $99 (includes double-occupancy lodging, van transportation, lunches, field guide). Limit: 50. Leave 7:45 a.m. Saturday from the Red Lion Hotel and return at 10:30 p.m. Sunday.

5. **Quaternary Crustal and Subduction Earthquakes in the Coos Bay area, Southern Oregon Coast.** April 20–21. Ian Madin, Oregon Department of Geology and Mineral Industries, 1831 First Street, Baker City, OR 97814, (541) 523-3133, fax 541-523-5992. We will examine evidence for Quaternary earthquakes in the Coos Bay area of the southern Oregon coast, an onshore extension of the Cascadia fold and thrust belt, visit several sites exposing faulted Quaternary marine terraces, and look at evidence from marsh coring for possibly coseismic Holocene land-level changes. Cost: $90 (includes one night double-occupancy lodging, van transportation, some meals, field guide). Limit: 30. Leave 7:00 a.m. Saturday and return at 8:00 p.m. Sunday.

6. **Deschutes Basin: A Medial and Distal Record of Cascades Volcanism.** April 20–21. Gordon G. Goles, Department of Geological Sciences, University of Oregon, Eugene, OR 97403-1272, (541) 346-4589, E-mail: goles@oregon.uoregon.edu. This trip will focus on tectonic setting of structural deformation and Neogene volcanism in and near the Deschutes Basin of central Oregon; Deschutes Formation (volcaniclastic units and lava); John Day Formation "local expression"; Miocene bimodal volcanic complexes; Columbia River basalts; Cove Palisades State Park. Cost: $50 (includes van transportation, field guide, refreshments; camping option for Saturday night (recommended—contact leader, but motel lodging available). Limit: 20. Leave 7:45 a.m. Saturday and return Sunday night.

7. **Columbia River Basalt Intracanyon Flows in Western Oregon and Washington: Ginkgo, Rosalia, and Pomona.** April 20–21. Marvin Beeson and Terry Tolan, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207, (503) 725-3024, fax 503-725-3025, E-mail: marvin@ch1.ch.pdx.edu. Remnants of intracanyon Columbia River basalt flows preserve a record of ancestral Columbia River channels that crossed the Cascade Range into western Oregon and Washington; we will visit exposures of the Ginkgo, Rosalia, and Pomona intracanyon flows and consider conditions under which stream channels were formed and then invaded by lava and later abandoned. Cost: $35 (includes van transportation and field guide; participants must arrange for own lodging in Portland on Saturday night; no meals included). Limit: 20. Leave 7:00 a.m. and return by 6:00 p.m. both days.

8. **Mount St. Helens: Engineering Geology of Highway 504, Sediment Retention Structure, and the Spirit Lake Tunnel.** April 21. Scott Burns *(see Contact Information)*. In addition to the general geology of the Mount St. Helens blast zone, we will focus on engineering geology along the Toutle River and will visit Silver Lake Visitor Center, ancient lahar outcrops, Sediment Retention Structure, three landslide sites, spectacular viewpoints of debris avalanche deposits, rock bolting sites, debris avalanche deposits, South Coldwater Canyon landslides, Spirit Lake Outlet Tunnel, and David Johnston Ridge. Cost: $25 (includes van transportation, lunch, field guide). Limit: 48. Leave 8:00 a.m. Sunday and return at 6:00 p.m..

9. **Geologic History of Mount Hood Volcano.** April 21. Willie Scott and Cynthia Gardner, U.S. Geological Survey—Cascades Volcano Observatory, 5400 MacArthur Blvd. Vancouver, WA 98661, (360) 696-7909, fax 360-696-7866, E-mail: wescott@pwavan.wr.usgs.gov. We will sample highlights of the geologic history and vistas of Mount Hood along the scenic loop through the Columbia Gorge and along the Hood and Sandy River Valleys, and examine lava flows, pyroclastic- and debris-flow deposits, and glacial sediments that record the evolution of Mount Hood throughout the Quaternary. Cost: $25 (includes van transportation, lunch, field guide). Limit: 30. Leave 7:30 a.m. Sunday and return at 6:00 p.m.

Postmeeting

10. **Tour of Oregon Steel Mills.** April 24. Susan Graham and Jeff Markstaller, Oregon Steel Mills, P.O. Box 2760, Portland, OR 97208, (503) 978-6168, fax 503-240-5268. We will visit the Schnitzer Steel Mill in the morning in north Portland, to learn about the scrap-steel processing industry, and Oregon Steel Mills, where scrap is purchased for remelting into steel plate. Cost: $25 (includes bus transportation, field guide, lunch). Limit: 90. Leave 9:00 a.m. Wednesday and return at 4:00 p.m.

11. **Geologic and Tectonic Evolution of a Middle to Late Jurassic Marginal Ocean Basin, Northern Klamath Mountains Province.** April 24–27. Doug Yule and Jason B. Saleeby, California Institute of Technology, Division of Geological and Planetary Sciences 170-25, Pasadena, CA 91125, (818) 395-6590, fax 818-683-0621, E-mail: yule@legs.gps.caltech.edu; Cal Barnes, Texas Tech University, Lubbock; Art Snoke, University of Wyoming, Laramie; Greg Harper, SUNY—Albany, New York. We will visit exposures in the western Jurassic belt and the western Paleozoic and Triassic belt of the Klamath Mountains province in the California-Oregon border region to examine the various petrotectonic elements and the general structural features of suprasubduction-zone oceanic lithosphere that formed a Middle to Late Jurassic marginal ocean basin fringing western North America. Cost: $275 (includes van transportation, three nights double-occupancy lodging, field guide, most meals). Limit: 30 (minimum 20). Leave 5:00 p.m. Wednesday and return late afternoon Saturday.

12. **Evidence of the Missoula Floods and Quaternary Geology in the Portland Area.** April 25. Scott Burns *(see Contact Information)*. We will visit erosional and depositional features of the Missoula floods in the Portland area—scouring around Rocky Butte, flood-produced surfaces of east Portland, scouring around Oregon City and Lake Oswego, delta formation at Durham—and will discuss the new Quaternary geology map of Portland. Cost: $20 (includes van transportation, lunch, field guide). Limit: 40. Leave Thursday 8:00 a.m. and return at 5:00 p.m.

CONTACT INFORMATION

General Chair:

Michael Cummings, Dept. of Geology, Portland State Univ, PO Box 751, Portland, OR 97207, (503) 725-3022, fax 503-725-3025, E-mail: michael@ch1.ch.pdx.edu

Field Trip Chairs:

Scott Burns, Dept. of Geology, Portland State Univ, PO Box 751, Portland, OR 97207, (503) 725-3389, fax 503-725-3025, E-mail: scott@ch1.ch.pkx.edu

Jeff Markstaller, Oregon Steel Mills, PO Box 2760, Portland, OR 97208, (503) 978-6168, fax 503-240-5268

SYMPOSIA and THEME SESSIONS

Please contact the conveners for information about a specific symposium or theme session. Individuals needing gen-

eral information should contact Michael Cummings *(see Contact Information).*

Three themes have been selected to unify the interests of the sponsoring organizations.

THEME 1: Infrastructure

Slope Stability: Assessment and Remediation. Sue D'Agnese, Oregon Department of Transportation, Roseburg, OR 97470, (541) 957-3595, fax 541-957-3604.

Infrastructure: Design and Materials. Matthew Kuhn, University of Portland, School of Engineering, 5000 N. Willamette Blvd., Portland, OR 97203-5798, (503) 283-7361, fax 503-283-7345, E-mail: mkuhn@up.edu.

Failure Analysis. D. G. Chakrapani, MEI-Charlton, Inc. 2233 SW Canyon Road, Portland, OR 97201-2499, (503) 228-9663, fax 503-228-4065.

The Future of Aggregate in the Northwest—A Vital Resource to a Growing Area. Dorian Kuper and Diane Murbach, David J. Newton Associates, Inc., 1201 SW 12th Ave., Suite 400, Portland, OR 97205, (503) 228-7718, fax 503-228-7781.

THEME 2: Environmental Concerns

Mine Waste Disposal and Cleanup. Norm Day, Recreation Lands and Minerals, P.O. Box 3623, U.S. Forest Service, Portland, OR 97208-3623, (503) 326-6705, fax 503-326-7554; Debra Mervyn, Parsons-Brinckerhoff, 400 SW Sixth Ave., Suite 802, Portland, OR 97204-1628, (503) 274-7224, fax 503-274-1412.

Discussion of cleanups and restorations within the past five years from an agency and design and engineering perspective including innovative technologies.

Waste Management and Remediation in Manufacturing. John Dash, Department of Physics, Portland State University, P.O. Box 751, Portland, OR 97207, (503) 725-4222, E-mail: dashj@sbii.sb2.pdx.edu.

Environmental Compliance. Peter Baer, 838 NE 10th St., Gresham, OR 97030, (503) 661-7995, fax 503-661-7965.

Environmental Noncompliance. Peter Baer, 838 NE 10th St., Gresham, OR 97030, (503) 661-7995, fax 503-661-7965.

Materials: From Cradle Back to Cradle. Adrian McNutt, Glenbrook Nickel, P.O. Box 85, Riddle, OR 97469, (541) 874-3171, fax 541-874-3380.

THEME 3: Energy

Geology and Geothermal Resource Potential of the Cascades Range and Northern Basin and Range Province. Michael Cummings *(see Contact Information)* and David McClain, CE Exploration Co., Portland.

Energy: Materials and Technologies. Mark Siddall, Teledyne Wah Chang, P.O. Box 460, Albany, OR, (541) 926-4211, ext. 610, fax 541-967-6987.

Symposia

1. **Mesozoic and Early Tertiary Evolution of Southern California, Arizona, and Nevada** (poster and oral sessions). Andrew Barth, Department of Geology, Indiana University, 723 West Michigan St., Indianapolis, IN 46202, (317) 274-1243, fax 317-274-7966, E-mail: ibsz100@indyvax.iupui.edu.
2. **Subduction Zone and Intraplate Earthquakes in the Pacific Northwest: Preparing for the Future** (Tuesday evening). Beverly Vogt, Oregon Department of Geology and Mineral Industries, Suite 965, 800 NE Oregon Street #28, Portland, OR 97232, (503) 731-4100, fax 503-731-4066.
3. **Geoscience Input in Water Resources Decision Making: Case Studies from Portland, Oregon.** Lorna Stickel, Regional Water Supply Project Manager, Portland Water Bureau, 1120 SW 5th Ave., Room 601, Portland, OR 97204, (503) 823-7502, fax 503-823-6133.

Portland has recently examined future water supply needs and sources for the growing metropolitan area.

This session examines the process and the contributions of the geoscience community.

GENERAL THEME SESSIONS

1. **Geologic Evolution of the Oregon Plateau** (oral and poster session). William Hart, Department of Geology, Miami University, Oxford, OH 45056, (513) 529-3217, fax 513-529-1542, E-mail: wkhart@miavx1.muohio.edu.
2. **Ground-Water Hydrology and Geology** (oral and poster session). Marshall Gannett, U.S. Geological Survey, Water Resources Division, 10615 SE Cherry Blossom Dr., Portland, OR 97216-3159, (503) 251-3233, E-mail: mgannett@usgs.gov; Kenneth E. Lite, Oregon Water Resources Department, 158 12th St. NE, Salem, OR 97310-0210, (503) 378-8455, E-mail: liteke@wrd.state.or.us.
3. **Operating Mines in the Western Cordillera.** Brian Ballou, Glenbrook Nickel, P.O. Box 85, Riddle, OR 97469, (541) 874-3171, fax 503-874-3380.
4. **Undergraduate Research: Poster Session.** Sponsored by Geology Division, Council on Undergraduate Research. Susan DeBari, Department of Geology, San Jose State University, San Jose, CA 95192-0102, (408) 924-5027, fax 408-924-5053, E-mail: susan@geosun1.sjsu.edu. Presentation must be the result of the student's own participation in an undergraduate research program. The undergraduate must be the sole or leading author on the abstract. "Best poster" award ($300).
5. **Computer Software: What's New in Research and Education?** (poster and hands-on session). Ken Cruikshank, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207, (503) 725-3383, fax 503-725-3025, E-mail: ken@ch1.ch.pdx.edu.
6. **Educating Today for Tomorrow's World.** Barbara Kirk, Chemeketa Community College, P.O. Box 14007, Salem, OR 97309, (503) 399-5247, fax 503-399-5214, E-mail: kirkfarb@teleport.com.

A collection of volunteered papers demonstrating "what works" in presenting geoscience issues that prepares students for tomorrow's world.

7. **Earthquake Potential in the Pacific Northwest** (poster and oral sessions). Ivan Wong, Woodward-Clyde, Oakland, CA 94607, (510) 874-3014, fax 510-874-3268, E-mail: igwongx0@wcc.com; Brian Atwater, U.S. Geological Survey, Seattle, Washington.
8. **Earthquake Hazards: Learning from Past Disasters** (poster and oral sessions). Mei Mei Wong, Oregon Department of Geology and Mineral Industries, Suite 965, 800 NE Oregon St., #28, Portland, OR 97232, (503) 731-4100, fax 503-731-4066; Joe Ritchey, Western Field Operations Center, U.S. Bureau of Mines, 360 E. 3rd Ave., Spokane, WA 99202, (509) 353-2700, fax 509-353-2662.
9. **The Last Glaciation in Western North America** (poster and oral sessions). Jan T. Heine, Quaternary Research Center, Box 351310, University of Washington, Seattle, WA 98195, (206) 543-1190, fax 206-543-3836, E-mail: heine@u.washington.edu.

Synthesis of research on the full- and late-glacial climate in the Cordilleran region and discussions on our understanding of last glaciation in Western North America.

10. **Integrating Geomorphic Processes in the Management of Ecological Systems** (poster and oral sessions). Alan Gallegos, Sierra National Forest, 1600 Tollhouse Road, Clovis, CA 93611, (209) 297-0706, fax 209-294-4809; Alan Yeakley, Environmental Science & Resources Program, Portland State University, P.O. Box 751, Portland, OR 97207, (503) 725-8040, fax 503-725-3888, E-mail: bwjy@psuorvm.cc.pdx.edu.
11. **Cordilleran Granites: A Symposium in Honor of Paul C. Bateman** (poster and oral sessions). Dallas Peck, U.S. Geological Survey, MS 959, Reston, VA 22092, (703) 648-6448, fax 703-648-6683, E-mail: dpeck@isdmnl.wr.usgs.gov; James G. Moore, U.S. Geological Survey, MS 910, 345 Middlefield Road, Menlo Park, CA 94025, (415) 329-5244, E-mail: jmoore@mojave.wr.usgs.gov; Scott R. Paterson, Department of Earth Sciences, University of Southern California, Los Angeles, CA 90089-0740, (213) 740-6103, fax 213-740-8801, E-mail: paterson@usc.edu.
12. **Middle Jurassic to Early Cretaceous Evolution of the Sierra**

Cordilleran *continued on p. 29*

PREREGISTRATION FORM GSA Cordilleran Section

Preregistration Deadline: March 15, 1996. **Portland Oregon • April 22–24, 1996**

Please print clearly • THIS AREA IS FOR YOUR BADGE

Name as it should appear on your badge (last name first)

Employer/University Affiliation

City State or Country

Mailing Address (use two lines if necessary)

City State

ZIP Code Country (if other than USA)

Circle member affiliation (to qualify for registration member discount):

(A) GSA (B) AEG (C) NAGT (D) PS (E) AIME (F) AWS (G) ASM (H) Speaker

GUEST INFORMATION • Please print clearly • This area is for badge

Name as it should appear on your guest's badge

City State or Country

Please indicate if you or your guest will need services to accommodate a disability: ☐ Yes

( ) – **Business Phone**

( ) – **fax**

( ) – Home Phone

Preregistration Deadline: March 15
Cancellation Deadline: March 22

MAIL TO:
GSA CORDILLERAN SECTION MEETING, P.O. BOX 9140, BOULDER, CO 80301

Remit in U.S. funds payable to:
1996 GSA Cordilleran Section Meeting
(All preregistrations must be prepaid.
Purchase Orders not accepted.)

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Signature Expires

REGISTRATION FEES

	Full Meeting	One Day	Amount
Professional Member*	(01) $60 ☐	(02) $30	$ _____
Professional Nonmember	(03) $70 ☐	(04) $35 ☐	$ _____
Student Member*	(05) $20 ☐	(06) $10 ☐	$ _____
Student Nonmember	(07) $30 ☐	(08) $15 ☐	$ _____
K–12 Professional	(42) $15 ☐	(43) $ 5 ☐	$ _____
Guest or Spouse	(09) $10 ☐	N/A	$ _____

*Member fee applies to any current professional OR Student Member of GSA or Associated Societies listed at left. Discount does not apply to guest registrants.

GUEST EVENTS

1. Columbia River Gorge National Scienic Area	April 22	(20) $20	$ _____
2. Portland Area Gardens	April 23	(21) $24	$ _____
3. Portland Downtown and West Hills	April 24	(22) $22	$ _____

SPECIAL EVENTS

NAGT-Pacific Section Breakfast	April 22	(60) $15	$ _____
Committee on Geology and Public Policy Breakfast	April 22	(61) FREE for committee	
Keynote Luncheon	April 22	(62) $16.50	$ _____
Committee on Education Breakfast	April 23	(63) FREE for committee	
Tuesday Luncheon	April 23	(64) $16.50	$ _____
Paul C. Bateman Reception	April 23	(65) $ 7.50	$ _____
Tuesday Evening Gathering	April 23	(66) $ 7.50	$ _____
K–12 Educators	April 23	(67) FREE	$ _____
Cordilleran Section Business Luncheon	April 24	(68) $16.50	$ _____

WORKSHOP

Roy Shlemon Mentors in Applied Geology Program	April 20–21	(50) FREE	$ _____

FIELD TRIPS

1. Rattlesnake Tuff	April 19–21	(101) $130	$ _____
2. Paleoflood Hydrology	April 19–21	(102) $125	$ _____
3. Landslides of Oregon Coast Range	April 20	(103) $ 25	$ _____
4. Building-Stones Industry	April 20–21	(104) $ 99	$ _____
5. Earthquakes in Coos Bay Area	April 20–21	(105) $ 90	$ _____
6. Deschutes Basin	April 20–21	(106) $ 50	$ _____
7. Intracanyon Flows	April 20–21	(107) $ 35	$ _____
8. Engineering Geology—Mount St. Helens	April 21	(108) $ 25	$ _____
9. Geological History of Mt. Hood Volcano	April 21	(109) $ 25	$ _____
10. Oregon Steel Mills Tour	April 24	(110) $ 25	$ _____
11. Petrotectonic Elements—Klamath Mtns.	April 24–27	(111) $275	$ _____
12. Missoula Floods, Quaternary Geology/Portland	April 25	(112) $ 20	$ _____

EDUCATION FIELD STUDIES

1. Mount St. Helens, April 20	K–12 Educator	(302) $ 10	$ _____
	Others	(303) $ 30	$ _____
2. Columbia Gorge, April 20	K–12 Educator	(304) $ 10	$ _____
	Others	(305) $ 30	$ _____
3. Constructed Wetland, April 21, morning	K–12 Educator	(306) FREE	$ _____
	Others	(307) $ 10	$ _____
afternoon	K–12 Educator	(308) FREE	$ _____
	Others	(309) $ 10	$ _____
4. Light Rail Tunnel, April 21, morning	K–12 Educator	(310) FREE	$ _____
	Others	(311) $ 10	$ _____
afternoon	K–12 Educator	(312) FREE	$ _____
	Others	(313) $ 10	$ _____

TOTAL FEES $ _____

Cordilleran *continued from p. 27*

Nevada Foothills and Klamath–Blue Mountains Provinces. Doug Yule, Department of Geology, Caltech, (818) 395-6590, fax 818-683-0621, E-mail: yule@legs.gps.caltech.edu.
13. **Site Characterization and On-site Remedial Solutions.** Mark Byrnes, Science Applications International Corp., 3250 Port of Benton Blvd., Richland, WA 99352, (509) 372-7715, fax 509-372-7701, E-mail: mark.e.byrnes@saic.iea.com.
14. **Area Reports: Mineral Resource Developments in Northwestern States and Canadian Provinces.** Janine Clayton, U.S. Forest Service—Siuslaw National Forest, 4077 Research Way, Corvallis, OR 97383, (541) 750-7153, fax 541-750-7234.

WORKSHOP

Roy Shlemon Mentors in Applied Geology Program. April 20–21, 8:30 a.m.–5:00 p.m., Department of Geology, Portland State University. A hands-on workshop and field study examining the science behind problems in applied geology. Limited to 15 students who are senior undergraduates or graduate students. This workshop is supported by an endowment to the Geological Society of America by Roy Shlemon. Qualified students interested in the program should contact Michael Cummings *(see Contact Information)*. No registration fee.

COMPUTER CENTER

The computer center in the Exhibit Hall will provide hands-on experience with software designed for applications in the earth sciences. Short instructional sessions will be held for software demonstrations, followed by ample time for participants to experiment with software. Each day will feature different software applications. Tuesday evening is dedicated to software of interest to K–12 educators. The computer center is coordinated with Theme and Poster Session 6 (see above). For more information, contact Ken Cruikshank, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207, (503) 725-3383, fax 503-725-3025, E-mail: ken@ch1.ch.pdx.edu.

EARTH SCIENCE EDUCATION

The GSA Cordilleran Section Committee on Education, in cooperation with participating societies, is pleased to announce the following programs.

K–12 educators are invited to participate in field studies, workshops, poster sessions, and technical sessions. Program organizers include Craig Rankine, EMCON, 15055 SW Seqouia Parkway, Suite 140, Portland, OR 97224-7712, (503) 624-7200, fax 503-620-7658; Mike Park, Stack Metallurgical Services, 6340 N. Basin, Portland, OR 97217, (503) 285-7703, fax 503-286-5681; Elaine Cullen, U.S. Bureau of Mines, 315 E. Montgomery, Spokane, WA 99207, (509) 484-1610, fax 509-640-8070.

Field Studies

Geology and Eruption History of Mount St. Helens. Saturday, April 20. Leader: Catherine Hickson, Geological Survey of Canada, Vancouver, British Columbia. Toutle River valley and Holocene eruption history of Mount St. Helens, for elementary educators and middle school–high school educators. Cost: $10 for K–12 educators; $30 for other interested geoscientists (includes transportation by 15-passenger vans, field materials). Limit: 50.
Geologic Evolution of the Columbia River Gorge. Saturday, April 20. Leader: Wayne Colony, Clark College, Vancouver, WA. Geology of the Columbia River Gorge, including stratigraphic units, geomorphic features, and river hydrology. Cost: $10 for K–12 educators; $30 for other interested geoscientists (includes transportation by 15-passenger vans, field materials). Limit: 50.
Hydrology, Geology, and Biological Productivity in a Constructed Wetland. Sunday, two sessions, morning and afternoon, April 21. Leaders: Janine Boer, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207, (503) 725-3022, fax 503-725-3025, E-mail: psu01215@odin.cc.pdx.edu; Jim Martin, Center for Science Education, Portland State University, P.O. Box 751, Portland, OR 97207. Hands-on examination of the geological and biological processes that operate in important pollution control facilities—a constructed wetland designed to handle storm water runoff in the Rivergate Industrial Area, north Portland. Cost: Free for K–12 educators; $10 for other interested geoscientists (includes transportation by 15-passenger vans, field materials). Limit: 40 at each session.
Engineering Geology of the Light Rail Tunnel Through the Portland West Hills. Sunday, two sessions, morning and afternoon, April 21. Ken Walsh, Parsons Brinckerhoff, 2140 SW Jefferson St., Suite 200, Portland, OR 97201-7713, (503) 833-6817, fax 503-833-6844. Engineering geology of tunnels under construction through the Portland Hills as part of expansion of the Portland Light Rail System. Cost: Free for K–12 educators; $10 for other interested geoscientists (includes transportation by 15-passenger vans, field materials). Limit: 40 at each session.
Workshops on Earth Science and Technology Education: National Science Standards in Earth Sciences and Technology. Sunday, April 21. A variety of sessions for different grade levels, to be repeated morning and afternoon, will examine materials and approaches to teaching national standards for earth science and technology education. Portland State University, Department of Geology. Free for K–12 educators.
Poster Session: Methods for Teaching Earth Sciences in Elementary, Middle, and High School. Tuesday, April 23, 4:30–7:30 p.m., Exhibit Hall. Contact Michael Cummings, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207, (503) 725-3395, fax 503-725-3025, E-mail: michael@ch1.ch.pdx.edu.
Theme sessions *(see details above):* **Educating Today for Tomorrow's World (all day Tuesday), Subduction Zone and Intraplate Earthquakes in the Pacific Northwest: Preparing for the Future** (Tuesday evening), **Undergraduate Research: Poster Session** (Wednesday), and the **Roy Shlemon Mentors in Applied Geology Program** (Saturday and Sunday, April 20 and 21) round out the educational program at the GSA Cordilleran Section meeting.

PROJECTION EQUIPMENT

Each lecture room will be equipped with a standard 35 mm carousel projector and screen. Overhead projectors are available upon request. A limited number of carousels will be available. Other special equipment is available but must be requested in advance. A speaker-ready room is available for loading slides and practicing talks.

EXHIBITS

The exhibit area, site of the welcoming reception, will be open 6:00–9:00 p.m. Sunday evening. Exhibits will be open Monday from 8:00 a.m. to 5:00 p.m., Tuesday from 8:00 a.m. to 7:30 p.m. (a light buffet will be served in the exhibit area Tuesday evening), and Wednesday from 8:00 a.m. to 3:00 p.m. For information on available exhibit booths, contact John Kelley, Advanced Surfaces and Processes, 85 N 26th Ave., Bldg. 2, Cornelius, OR 97119, (503)-640-4072, fax 503-640-8070, or Chuck Daellenbach, 1870 NW Meadow Wood Dr., Albany, OR 97321, (541) 928-4256.

STUDENT SUPPORT

The GSA Cordilleran Section provides grants to support GSA Student Associates who are presenting papers at the meeting. For further information and application forms, contact Cordilleran Section Secretary Bruce A. Blackerby, Department of Geology, California State University, Fresno, CA 93740, (209) 278-2955, E-mail: bruce_blackerby@csufresno.edu. Applications should include certification that the student is presenting a paper and is a GSA Student Associate of the Cordilleran Section. *All letters must be received by January 15, 1996.*

Cordilleran *continued on p. 30*

Cordilleran *continued from p. 29*

SPECIAL EVENTS

Welcoming Reception. Sunday, April 21, 6:00–9:00 p.m. Exhibit Hall. Cost is included in registration. Exhibits will be open. No-host bar.

NAGT-Pacific Section Breakfast. Monday, April 22, 7:00–8:30 a.m. Cost: $15.

Committee on Geology and Public Policy. Monday, April 22, 7:00 a.m. Breakfast free for committee members.

Keynote Luncheon. Monday, April 22, 12:00–1:30 p.m. East Ballroom. Speaker: P. Patrick Leahy, Chief Geologist for the U.S. Geological Survey, "Balancing Public Service and Science in the U.S. Geological Survey." Cost: $16.50.

Committee on Education Breakfast. Tuesday, April 23, 7:00 a.m. Breakfast free for committee members.

Tuesday Luncheon. April 23, 12:00–1:30 p.m. East Ballroom. Speaker: Maynard M. Miller, Professor of Geology and Director of Glacialogical and Antarctic Sciences, University of Idaho, and Idaho State Representative. "Glaciers and Global Climate Change." Cost: $16.50.

Paul C. Bateman Reception. Tuesday, April 23, 6:00–9:00 p.m. A reception in honor of Paul C. Bateman. Cost: $7.50. No-host bar.

Tuesday Evening Gathering. April 23, 6:00–7:30 p.m. Exhibit Hall. Exhibits will be open. Cost: $7.50. K–12 educators free as guests of the Pacific Section of the National Association of Geoscience Teachers. No-host bar.Share time with friends and enjoy a light evening meal in the Exhibit Hall before the special symposium on **Subduction Zone and Intraplate Earthquakes in the Pacific Northwest: Preparing for the Future.**

Cordilleran Section Business Luncheon. Wednesday, April 24, 12:00 to 1:30 p.m. Cost: $16.50.

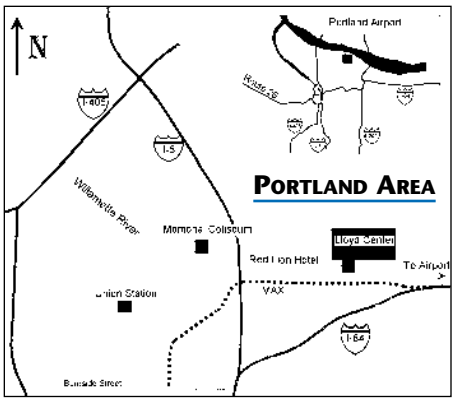
SPOUSE and GUEST ACTIVITIES

The Geological Society of the Oregon Country is host for the following spouse and guest activities.

Columbia River Gorge National Scenic Area. Monday, April 22, 8:30 a.m.–4:30 p.m. Outbound stops include Crown Point, Multnomah Falls, and Bonneville Dam's fish ladders, hatchery, locks, and power generation facilities. Cross Bridge of the Gods, have lunch at Skamania Lodge, and return on the Washington side to visit Pendleton Woolen Mills and Fort Vancouver National Historic Site. Cost: $20 (includes box lunch, transportation, and admission fees). Limit: 24.

Portland Area Gardens. Tuesday, April 23, 8:30 a.m.–4:30 p.m. Four gardens with a contrast in styles: Leach Botanical Gardens, a natural area with historic interest; Crystal Springs, rhododendrons in a lake setting; Rose Gardens, Portland's most famous view; and Berry Gardens, a private garden with a focus on primroses. Cost: $24 (includes box lunch, transportation, and admission fees). Limit: 24.

Portland Downtown and West Hills. Wednesday, April 24, 8:30 a.m.–4:30 p.m. Guided walking tour of downtown Portland, followed by travel to the heights west of downtown to visit Pittock Mansion, Hoyt Arboretum, and the Japanese Gardens. Cost: $22 (includes box lunch, transportation, and admission fees). Limit: 24.



From Airport to Red Lion Hotel—Lloyd Center

Take I-205 south to I-84 west. Follow I-84 west into Portland. Take the Lloyd Blvd. exit. Turn right at the second signal, 9th St. The hotel is one block up on the left side.

HOUSING

A block of rooms at the Red Lion Hotel—Lloyd Center, the site of the meeting, has been reserved for attendees at a special reduced rates *(see housing form on this page)*. Additional housing is available within both walking and mass-transit distance of the Red Lion Hotel—Lloyd Center. Use the registration form in this announcement to register directly with the hotel. To receive the special rate, your registration must be at the hotel by **March 15.** If you are eligible for a government rate, please register using the housing form here.

CHILD CARE ROOM

A room has been set aside at the Red Lion Hotel—Lloyd Center for infant child care.

GETTING AROUND

The Red Lion Hotel—Lloyd Center operates a free shuttle service to and from Portland International Airport. Shuttle vans run every 30 minutes on the hour and half hour. Portland has a well-developed mass-transit system. Trains of the Metropolitan Area Express, MAX, pass by the Red Lion Hotel—Lloyd Center, as do several major bus lines.

DETAILED INFORMATION

Information concerning registration, accommodations, field trips, symposia and theme sessions, and other activities are updated regularly on the World Wide Web home page for the Department of Geology, Portland State University (http://131.252.71.35/, or via http://www.pdx.edu/). Requests for additional information or suggestions should be sent to General Chair Michael Cummings *(See Contact Information, p. 26).* ■

Red Lion Hotel—Lloyd Center

Cordilleran Section • Geological Society of America

April 22–24, 1996

Accommodations	One Person Rate	Two Person Rate
Standard Room, One Queen Bed	☐ $106.00	☐ $106.00
Deluxe Room, Two Queen Beds	☐ $117.00	☐ $117.00
Executive Room, One King Bed	☐ $117.00	☐ $117.00
Each Additional Person Per Room	☐ $ 15.00	☐ $ 15.00
Smoking	☐ Yes	☐ No
I qualify for Government Rate ☐ Yes	Contact hotel for rate	

Reservations must be made by: **March 15, 1996.**

Date of Arrival _____ Time _____ No. of Nights _____

Rooms held until 6:00 p.m., unless guaranteed by major credit card* or advance deposit. If delayed, a phone call will hold reservations for a reasonable time.

Name _____ Address _____

City _____ State ____ ZIP Code _____

Representing _____ Phone No. _____

Credit Card Type _____ No. _____ Exp. Date _____

If no room is available at rate requested, reservation will be made at nearest rate available. Check-out time is 12:00 noon. Check-in time after 3:00 p.m. Rates subject to local taxes and change without notice.

*American Express, Diners, VISA, MasterCard, and Thunderbird

Red Lion Hotel—Lloyd Center, 1000 N.E. Multnomah, Portland, OR 97232 • (503) 281-6111

In Memoriam

Arthur Baker III
Reno, Nevada

John H. Eric
Northampton, Massachusetts
May 30, 1995

Arthur S. Knox
Lakeridge, Virginia
October 19, 1995

Robert L. Nichols
Seminole, Florida

Vladimir Okulitch
Alberta, Canada
August 31, 1995

James P. Owens
Fairfax, Virginia

Alan H. Voisey
New South Wales, Australia
April 15, 1995

Memorial Preprints

The following memorial preprints are now available, free of charge, by writing to GSA, P.O. Box 9140, Boulder, CO 80301.

George G. Anderman
Robert R. Berg

John E. Armstrong
W. H. Mathews

Sturges W. Bailey
Eugene N. Cameron

James L. Calver
CRBH

Robert Roy Coats
Robert N. Coats

John Granville Johnson
Roy E. Smith

Robert Ferguson Legget
Allen W. Hatheway

Carlos Schubert
Thomas W. Donnelly

Donald Desmond Utterback
Thomas H. Philpott

Sherman Alexander Wengerd
Donald L. Everhart

CALENDAR

Only new or changed information is being published in *GSA Today* . A complete listing can be found in the **Geoscience Calendar** section on the Internet: **http://www.aescon.com/geosociety/index.html.**

1996 Penrose Conferences

April

April 17–22, **Tectonic Evolution of the Gulf of California and its Margins,** Loreto, Baja California Sur, Mexico. Information: Paul J. Umhoefer, Department of Geology, Box 4099, Northern Arizona University, Flagstaff, AZ 86011, (520) 523-6464, fax 520-523-9220, E-mail: pju@nauvax.ucc.nau.edu.

October

October 9–14, **Exhumation Processes: Normal Faulting, Ductile Flow, and Erosion,** Island of Crete. Information: Mark T. Brandon, Department of Geology and Geophysics, Kline Geology Laboratory, Yale University, P.O. Box 208109, New Haven, CT 06520-8109, (203) 432-3135, fax 203-432-3134, E-mail: brandon@milne.geol.yale.edu.

1996 Meetings

February

February 1–3, **Indian Geological Congress, 10th Convention and Seminar on Precambrian Crustal Evolution and Metallogenesis,** Dhanbad, India. Information: S. C. Patel, 10th IGC, Dept. of Applied Geology, Indian School of Mines, Dhanbad 826 004, India, phone 91-326-202381, fax 91-326-203042.

February 19–23, **13th Australian Geological Convention,** Canberra, Australia. Information: 13th AGC, ACTS, GPO Box 2200, Canberra, ACT 2601, Australia, phone 61-6-257-3299, fax 61-6-257-3256, E-mail: ihodgson@agso.gov.au. Internet Web site: http://www.agso.auinformation 13age.html

February 26–27, **Urban Conservation 2000,** Seattle, Washington. Information: Soil and Water Conservation Society, 7515 Northeast Ankeny Rd., Ankeny, IA 50021-9764, (515) 289-2331 or 1-800-THE-SOIL, fax 515-289-1227.

March

March 14-15, **12th Mining and Geothermal Institute,** Reno, Nevada. Information: American Association of Professional Landmen, 4100 Fossil Creek Blvd., Fort Worth, TX 76137, (817) 847-7700.

April

April 15–19, **Colorado State University 16th Annual Hydrology Days,** Fort Collins, Colorado. Information: Janet Lee Montera, Dept. of Civil Engineering, Colorado State University, Fort Collins, CO 80523, (970)491-7425, fax 970-491-7727.

April 28–May 1, **In Situ and On-Site Bioremediation 4th International Symposium,** New Orleans, Louisiana. Information: Joan Purvis, The Conference Group, 1989 West Fifth Ave., Suite 5, Columbus, OH 43212-1912, (614) 424-5461, 800-783-6338, fax 614-488-5747, Internet: 102632.3100@compuserve.com.

May

May, **Deep Lithosphere and Utilization of the Earth's Interior,** Kiev, Ukraine. Information: L. Kukshina, 8 P. Orlik Str., "Geoprognoz" Geological Co., 252024 Kiev, Ukraine, phone 7-293-57-56 and 7-293-03-15, fax 7-44-293-11-4.

May 15–19, **42nd Institute on Lake Superior Geology,** Cable, Wisconsin. Information: Laurel G. Woodruff, U.S. Geological Survey, 2280 Woodale Dr., Mounds View, MN 55112, (612)783-3291, fax 612-783-3103, E-mail: woodruff@usgs.gov.

June

June 1–3, **Friends of the Pleistocene, North-Central Cell Field Conference,** North Dakota and Minnesota. Information: Ken Harris, Minnesota Geological Survey, (612)627-4809, E-mail: Harri015@maroon.tc.umn.edu; John Reid, University of North Dakota, E-mail: joreid@badlands.nodak.edu; or Mark Luther, North Dakota Geological Survey, E-mail: Mark@eagle.ndgs. state.nd.us.

July

July 18-21, **History of Oil and Gas Exploration in North America,** Titusville, Pennsylvania. Information: W. R. Brice, Dept. of Geology, University of Pittsburgh, Johnstown, PA 15904, (814)269-2901, E-mail: bbrice@upj.pitt.edu. *(Abstracts deadline: April 10, 1996.)*

August

August 13–15, **15th International Conference on Ground Control in Mining,** Golden, Colorado. Information: Colorado School of Mines, Office of Special Programs and Continuing Education, Golden, CO 80401, (303) 273-3321 or 800-446-9488, fax 303-273-3314. *(Abstract deadline: January 15, 1996.)*

September

September 7–9, **Second International Meeting on Global Continental Paleohydrology,** Toledo, Spain. Information: Gerardo Benito or Alfredo Pérez-González, CSIC-Centro de Ciencias Medioambientales, Serrano 115 bis, 28006 Madrid, Spain, fax 34-1-564-08-00, E-mail: benito@cc.csic.es.

October

October 8-12, **American Institute of Professional Geologists Annual Meeting,** Columbus, Ohio. Information: AIPG, 7828 Vance Dr., Suite 103, Arvada, CO 80003, (303) 431-0831, fax 303-431-1332.

October 18–20, **IGCP Project 364, Geological Correlation of Ophiolites and Volcanic Arcs in the Circum-Caribbean Realm,** Cuba. Information: Lilavatti Díaz de Villalvilla, Inst. Geología y Paleontología, Via Blanca y Carretera Central, Ciudad de La Habana, CP11000, Cuba, fax 537-335345; or Grenville Draper, Dept. of Geology, Florida International University, Miami, FL 33199, (305)348-3087, fax 305-348-3877, E-mail: draper@servax.fiu.edu.

Send notices of meetings of general interest, in format above, to Editor, GSA Today, P.O. Box 9140, Boulder, CO 80301, E-mail: editing@geosociety.org.

CLASSIFIED ADVERTISING

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Positions Open

AQUEOUS GEOCHEMIST
UNIVERSITY OF COLORADO, BOULDER

The Department of Geological Sciences is recruiting for a tenure-track faculty position in low-temperature aqueous geochemistry to start August, 1996. Preference will be given to candidates at the Assistant Professor level but candidates at all levels will be considered. Research interest in rock-water interaction is desirable; preference will be given to candidates whose interests complement ongoing teaching and research programs that include contaminant and environmental geochemistry, hydrology, isotope geochemistry, mineralogy, soils and sedimentary geochemistry. Candidates should have a strong analytical background and familiarity with geochemical modeling. Ph.D. is required; post-doctoral or industry experience is preferred. The successful applicant will be expected to conduct an active research program, direct graduate students, attract external funding, teach aqueous geochemistry at the graduate and undergraduate levels, and teach in the introductory non-major program. In 1997 the Department will move into a new building which will include wet-chemical laboratory space. The building will also house a full suite of modern analytical tools. Applicants may familiarize themselves with the Department via Internet at http://xtl5.colorado.edu/~geology/home.html.

Applicants should submit a current vita, a summary of current and proposed research and teaching interests, and arrange to have at least three letters of recommendation sent to the Aqueous Geochemistry Search, Department of Geological Sciences, University of Colorado, Boulder, CO 80309-0250. The Search Committee will begin to evaluate applications on Jan. 31, 1996, but will consider new applications until March 15, 1996. It is the applicant's responsibility to see that the letters of reference are sent.

The University of Colorado at Boulder strongly supports the principle of diversity. We are particularly interested in receiving applications from women, members of ethnic minorities, disabled persons, veterans and veterans of the Vietnam Era.

UNIVERSITY OF SOUTHERN CALIFORNIA
MARINE STRATIGRAPHY/SEDIMENTATION; PALEOSEISMOLOGY

The Department of Earth Sciences, University of Southern California, is accepting applications for a faculty position in either or both of the following fields of specialization: 1) marine stratigraphy/sedimentology; and 2) paleoseismology. The tenure-track appointment(s) will be at the Assistant Professor level, beginning in September, 1996.

Applications including curriculum vitae, a statement of teaching and research interests, and the names of three references should be sent directly to: Professor Charles Sammis, Chair, Dept. of Earth Sciences, University of Southern California, Los Angeles, CA 90089-0740. The deadline for applications is March 1, 1996.

USC is an equal opportunity/affirmative action employer. The University is proudly pluralistic and firmly committed to providing equal opportunity for outstanding men and women of every race, creed, and background.

UNIVERSITÉ DE NEUCHÂTEL, SWITZERLAND
PROFESSOR IN LOW TEMPERATURE GEOCHEMISTRY MINERALOGY

The Faculty of Science at the Neuchâtel University invites applications for a full professor position at the Geology Institute which includes a strong Hydrogeology section. The candidate is expected to conduct an interdisciplinary research program in one or several of the following fields: low temperature Geochemistry, sedimentary Geochemistry including Alteration, Particle Transport, Sedimentation; Mineralogy. He/She will direct the existing Clay Mineralogy-, XRD-, and Wet Chemical-Laboratories. Teaching duties (in French) include introductory courses in Mineralogy-Crystallography, Geochemistry and Sedimentology, as well as advanced courses in his/her field. The position is available from 1st of October 1996. For more information contact the director of the institute: martin.burkhard@geol.unine.ch; fax (41)38 23 26 01.

Applications including curriculum vitae, publication list, research programs and references should be sent no later than February 29, 1996, to: Département de l'Instruction Publique du Canton de Neuchâtel, Château, CH-2001 Neuchâtel, Switzerland.

GEOTHERMAL GEOSCIENCE

Union Oil Company of California, dba Unocal, is currently accepting applications for positions in the Geothermal & Power Operations Group, based in Santa Rosa, California. Unocal is the world leader in the development of geothermal energy, and is aggressively pursuing new opportunities overseas.

The following positions will include frequent overseas assignments to remote field locations, often with primitive living conditions. The fieldwork will involve hiking in steep terrain, under physically demanding conditions. The successful applicants for these positions must possess good interpersonal and communication skills and be able to work effectively in a diverse, multinational team environment. Candidates must be willing to relocate outside the United States if required.

The exploration and development of geothermal energy involves many technical challenges, and an ability to innovate is essential. However, the focus of this work will be on finding practical solutions to problems, not on research. An essential skill for these positions is the ability to integrate diverse types of geoscientific data into conceptual models. Some training in other related geoscientific or engineering disciplines will be an advantage.

A physical examination, including a drug-screen urinalysis is required. Successful candidates will need to show authorizaion for employment in the United States before beginning work.

GEOLOGIST. Candidates should have a BS in Geology, a MS or equivalent in Geology or Geochemistry, and an excellent academic record. Skills should include field geological mapping, preferably in volcanic environments, and a knowledge of hydrothermal fluid chemistry and associated mineral assemblages. Knowledge of geochemical modeling of active geothermal systems and of state-of-the-art analytical techniques would be advantageous.

GEOPHYSICIST. Candidates should have a BS in Geology, Physics or Engineering, a MS or equivalent in Geophysics, and an excellent academic record. An understanding of electromagnetic and magnetotelluric methods, field experience conducting geophysical surveys, and proven skills in computer processing and modeling are essential. Knowledge of precision gravity, GPS techniques, and micro-earthquake monitoring would be advantageous.

The deadline for applications is January 31, 1996.

Inquiries and resumes for these positions should be sent to: Unocal, Attn: Jon Oliver, 3576 Unocal Place, Santa Rosa, CA 95403-1774.

UNOCAL is an Equal Opportunity Employer

BRIDGEWATER STATE COLLEGE

Assistant Professor of Geology, Department of Earth Sciences and Geography. Fall 1996. Full-time, tenure-track position. The successful candidate will be expected to teach introductory physical geology with laboratory; environmental geology and some combination of advanced courses in geochemistry, geophysics, mathematical geology-statistics, computer modeling, geomorphology, or advanced hydrology. Excellent and demonstrated teaching skills and interpersonal and collaborative talent required. Funded research experience desirable as well as interest in involving undergraduates in research and experience in industry. Salary: Dependent upon experience and qualifications. Deadline for complete application file: Open and continuing. Review of complete application files will begin 2/15/96. (Letter of intent, resume and name, address and telephone numbers of three (3) professional references must be submitted for a complete file). Address all inquires to: Office of Human Resources, Boyden Hall, Bridgewater State College, Bridgewater, MA 02325. Bridgewater State College is an Affirmative Action/Equal Opportunity Employer which actively seeks to increase the diversity of its workforce.

NEWTON HORACE WINCHELL SCHOOL OF EARTH SCIENCES
University of Minnesota, Minneapolis, MN 55455 USA

Applications are invited for a tenure-track assistant professor position in the Department of Geology and Geophysics from individuals with a demonstrated ability to apply chemical and physical principles to the integrated study of the solid Earth. Candidates must be capable of establishing a vigorous research program and exhibit a breadth in research interests that complements our strengths in Earth Structure and Tectonics, Geodynamics, Geofluids, Sedimentary Basin Analysis, Mineral/Rock Physics, Rock Magnetism, Aqueous and Isotope Geochemistry, Limnogeology, or Earth System studies. We emphasize opportunities for collaboration and interaction with ongoing research programs in the School of Earth Sciences and the availability of state-of-the-art instrumentation and computational facilities for geoscience research.

The successful candidate will be expected to teach at all levels through advanced graduate classes, as well as participate in teaching Petrology in our innovative curriculum and supervise graduate-student research. Applicants must have an earned doctorate degree and must demonstrate a clear promise of creative scientific achievement, leadership, and teaching ability in the geosciences.

The Department of Geology and Geophysics comprises about 60 graduate students, 28 research associates and post-doctoral fellows, and 22 faculty with an exceptional record of funded research and interdisciplinary collaboration in both research and teaching. With this appointment, we seek to augment our current atmosphere of excitement in research and teaching that focuses on interactive Earth dynamics. Our Web site, http://www.geo.umn.edu, provides additional information about the School of Earth Sciences and the Department of Geology and Geophysics.

Applicants should submit a resume with a statement of research and teaching interests, official graduate transcripts and arrange to have at least three letters of reference sent to: Professor V. Rama Murthy, Chair, Faculty Search Committee, Department of Geology and Geophysics, 310 Pillsbury Drive, S.E., University of Minnesota, Minneapolis, Minnesota 55455, USA. The deadline for receipt of the application and supporting material is February 29, 1996. The successful candidate is expected to assume the position September 1996.

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

Opportunities for Students

Keck Geology Consortium/Undergraduate Research Opportunities for Students of Color. The Keck Geology Consortium is seeking undergraduate African American, Hispanic or Native Pacific Islander earth science students to participate in its summer research program. Sophomore students who have completed at least one geology course are invited to apply for 5 weeks of field research in either Idaho or Massachusettes. Junior students who have declared a geology major are invited to apply for one of 5 senior projects. Seniors will participate in 4 weeks of summer research and complete a term to year of independent study at the student's home institution. Students receive a stipend of $1200 and expenses. Interested persons should contact Dr. Cathryn A. Manduca, Keck Geology Consortium Coordinator at (507) 663-4425, or e-mail: cmanduca@carleton.edu. Positions are contingent on NSF funding. Student selection will begin February 12.

NASA Planetary Biology Internships. The Marine Biological Laboratory, Woods Hole, Massachusetts, invites applications from graduate students and seniors accepted to graduate programs for awards of $2200 plus travel to participate in research at NASA centers and collaborating institutions for approximately 8 weeks. Typical intern programs include: global ecology, remote sensing, microbial ecology, biomineralization, and origin and early evolution of life. Application deadline: 1 March 1996. For information/applications, contact: Michael Dolan, Planetary Biology Internship, Department of Biology, Box 3-5810, University of Massachusetts, Amherst, MA 01003-5810. Email: pbi@bio.umass.edu. Tel (413) 545-3223. An Equal Opportunity/Affirmative Action Employer.

University of Colorado at Boulder
Interdisciplinary Ph.D. Program in Geophysical Sciences

Announces the NSF Doctoral Research and Training Fellowships in Hydrologic Sciences

The National Science Foundation has granted five graduate student traineeships in hydrologic sciences for interdisciplinary research leading to a Ph.D. degree in Geophysics with specialization in hydrology. We cordially invite highly motivated individuals with strong interest in any one of the following interdisciplinary research areas to apply:

- Scaling and statistical-dynamical characterization of precipitation
- Modeling of energy and moisture exchange at land surface
- Scaling and runoff prediction from ungauged basins
- Scale effects in subsurface transport in heterogeneous aquifers
- Subsurface flow in fractured rocks

Successful applicants will have unique opportunities to conduct innovative research in the above areas with a particular focus on scale issues. The interaction between the University of Colorado and several research agencies in the Boulder area such as the U.S. Geological Survey, the National Center for Atmospheric Research, and the National Oceanic and Atmospheric Administration provides an excellent environment for collaborative research. The fellowship includes full tuition and stipend and will be granted annually to the successful candidates based on their academic performance. Applicants must have a bachelors or a masters degree in a relevant discipline, e.g., hydrology, geology, geography, physics, civil and environmental engineering, mechanical engineering etc., with a solid physical and mathematical background, and must be U.S. citizens or permanent residents. Women and minorities are strongly encouraged to apply. For more information and application forms, please contact:

Ms. Lynn Jackson, Graduate Secretary
NSF Traineeship Program in Hydrology
University of Colorado
Department of Geological Sciences
Boulder, CO 80309-0250
Phone (303) 492-8141 Fax (303) 492-2606

The University of Colorado at Boulder strongly supports the principle of diversity. We are particularly interested in receiving applications from women, ethnic minorities, disabled persons, veterans, and veterans of the Vietnam era.

Call For Nominations Reminders

Materials and supporting information for any of the following nominations may be sent to GSA Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. For more detailed information about the nomination procedures, refer to the October 1995 issue of *GSA Today,* or call headquarters at (303) 447-2020, extension 136.

Penrose and Day Medals, and Honorary Fellowship

Nominations for 1996 Penrose and Day Medals and for Honorary Fellowship in the Society are due by **FEBRUARY 1, 1996.**

Young Scientist Award (Donath Medal)

The Young Scientist Award was established in 1988 to be awarded to a young scientist (35 or younger during the year in which the award is to be presented) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award, consisting of a gold medal called the Donath Medal and a cash prize of $15,000, was endowed by Dr. and Mrs. Fred A. Donath.

For the year 1996, only those candidates born on or after January 1, 1961, are eligible for consideration. In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1996 award must include

- biographical information,
- a summary of the candidate's scientific contributions to geology (200 words or less),
- a selected bibliography (no more than 10 titles),
- supporting letters from five scientists in addition to the person making the nomination.

Deadline for nominations for 1996 is **FEBRUARY 1, 1996.**

Officers and Councilors

The GSA Committee on Nominations requests your help in compiling a list of GSA members qualified for service as officers and councilors of the Society. The committee requests that each nomination be accompanied by basic data and a description of the qualifications of the individual for the position recommended (vice-president, treasurer, councilor).

Deadline for nominations for 1997 is **FEBRUARY 15, 1996.**

Distinguished Service Award

The GSA Distinguished Service Award was established by Council in 1988 to recognize individuals for their exceptional service to the Society. GSA Members, Fellows, Associates, or, in exceptional circumstances, GSA employees may be nominated for consideration. Any GSA member or employee may make a nomination for the award. Awardees will be selected by the Executive Committee, and all selections must be ratified by the Council. Awards may be made annually, or less frequently, at the discretion of Council. This award will be presented during the annual meeting of the Society. Deadline for nominations for 1996 is **MARCH 1, 1996.**

John C. Frye Environmental Geology Award

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 one of the state geological surveys. The award is a $1000 cash prize from the endowment income of the GSA Foundation's John C. Frye Memorial Fund. The 1996 award will be presented at the autumn AASG meeting to be held during the GSA Annual Meeting in Denver.

Nominations can be made by anyone, based on the following criteria: (1) paper must be selected from GSA or state geological survey publications, (2) paper must be selected from those published during the preceding three full calendar years, (3) nomination must include a paragraph stating the pertinence of the paper.

Nominated papers must establish an environmental problem or need, provide substantive information on the basic geology or geologic process pertinent to the problem, relate the geology to the problem or need, suggest solutions or provide appropriate land use recommendations based on the geology, present the information in a manner that is understandable and directly usable by geologists, and address the environmental need or resolve the problem. It is preferred that the paper be directly applicable by informed laypersons (e.g., planners, engineers). Deadline for nominations for 1996 is **APRIL 1, 1996.**

National Awards

The deadline is **April 30, 1996,** for submitting nominations for these four awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, Alan T. Waterman Award.

GeoHostel

Mount St. Helens and Mount Rainier

Saturday, June 22 through Thursday, June 27, 1996
5 days, 6 nights • Packwood and Kelso, Washington

About the Leaders

Richard B. Waitt, U.S. Geological Survey, Cascades Volcano Observatory, Vancouver, Washington

Donald A. Swanson, U.S. Geological Survey, Seattle, Washington

Patrick T. Pringle, Washington Department of Natural Resources, Olympia, Washington

All three leaders have many years of geological field experience, summarized in numerous scientific publications, at Mount St. Helens and/or Mount Rainier, as well as extensive experience at other Cascades or Alaskan volcanoes.

Schedule

June 22, *Saturday* . . . . . Welcoming get-together
June 23–27, *Sunday–Thursday*. . . . . Classes and field trips
June 27, *Thursday* . . . . . Farewell party

This GeoHostel will focus on field trips to Mount St. Helens, especially to explore processes and effects of the cataclysmic eruption of May 18, 1980. Among these are decapitation of the former summit, world's largest historic landslide, a tsunami wave as high as 800 feet on Spirit Lake, a gigantic pyroclastic surge (the so-called "lateral blast"), that in four minutes mowed down 235 square miles of mature forest, and great muddy floods (lahars). Everyone should see this world-class natural extravaganza before it becomes muted by revegetation. The ever-changing processes of revegetation, reforestation, and reentry of fauna to the devastated area is part of the scientifically unique experience—one of the reasons Congress set aside the heart of the affected area as Mount St. Helens National Volcanic Monument. Two days will be devoted to the east and southeast sides of Mount St. Helens, two days to the west side, including the stunning new visitor facilities in the heart of the devastated area, and one day at spectacular Mount Rainier (northeast, east, and south flanks) within Mount Rainier National Park. While at Mount St. Helens, we will hike through a remaining stand of old-growth coniferous trees, many as tall as 230 feet. Each day involves a hike through a unique landscape, none longer than about three miles nor with an altitude change of more than about 900 feet. Snow will still be visible on the higher mountain peaks, offering stunning scenes for photography.

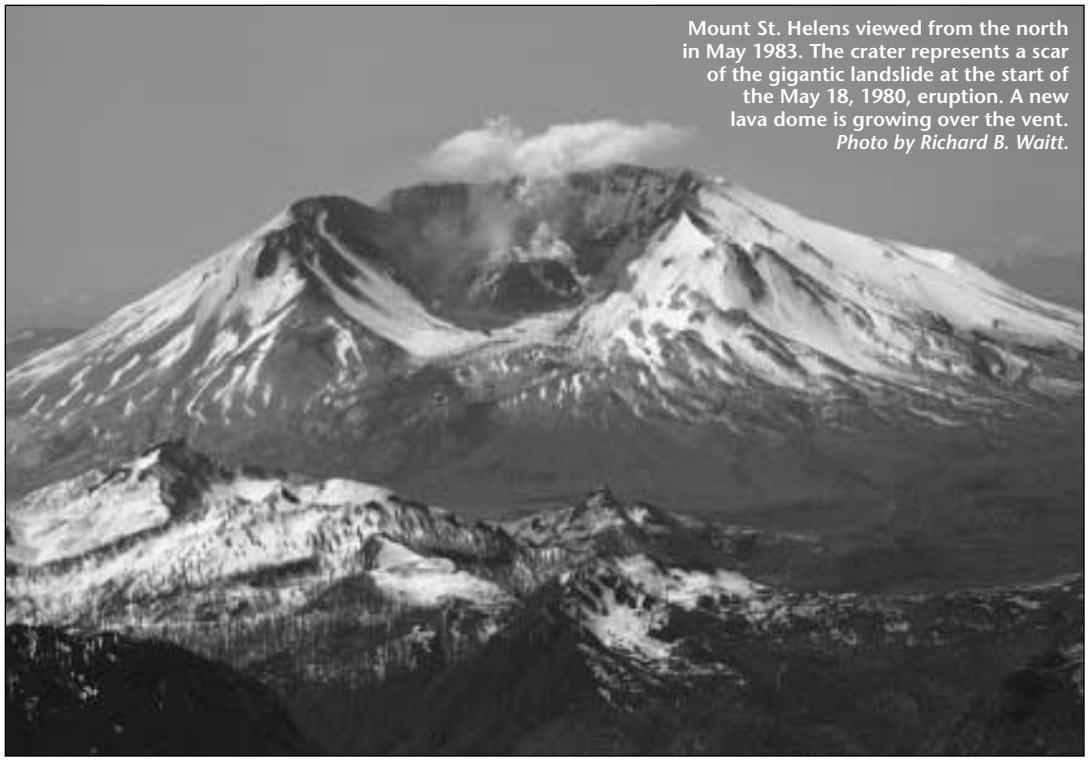
Lodging, Meals, Transportation

The group will stay on Saturday, Sunday, and Monday at the Inn of Packwood, Packwood, Washington, and on Tuesday, Wednesday, and Thursday at the Red Lion Inn in Kelso, Washington. Lodging at the Inn of Packwood is based on single occupancy, or doubles for couples. Lodging at the Red Lion Inn is based on double occupancy. Single rooms at the Red Lion Inn are available for the additional single-supplement fee of $105. Meals will include plenty of hors d'oeuvres at the Welcoming Reception and Orientation on Saturday evening, breakfast and a sack lunch daily, and a hearty farewell dinner on Thursday evening. Field trip transportation will be provided in air-conditioned, 15-passenger rental vans.

GSA Member Fee: $650 **Nonmember Fee: $700**

Included: Classroom programs and materials; field trip transportation; lodging for six nights; meals outlined above, welcoming and farewell events.

Not included: Transportation to and from Portland, Oregon; transportation during hours outside class and field trips; and other expenses not specifically included.



Mount St. Helens viewed from the north in May 1983. The crater represents a scar of the gigantic landslide at the start of the May 18, 1980, eruption. A new lava dome is growing over the vent. *Photo by Richard B. Waitt.*

GeoHostel

Geology of the Glacier Park Region

Saturday, July 20
through Thursday, July 25, 1996
5 days, 6 nights
Big Mountain Resort, Whitefish, Montana

About the Leaders

Robert C. Thomas is currently an assistant professor of geology at Western Montana College in Dillon, Montana. Rob developed a passion for geology of the Belt Supergroup under the tutelage of Don Winston at the University of Montana. A graduate of the University of Washington, Rob's research has focused on the patterns and processes of Cambrian mass extinctions, the dynamics of carbonate platform development and destruction, extensional tectonism in southwestern Montana, and geoscience teacher-education reform. Rob is currently the president of the Rocky Mountain Paleontological Society and the Tobacco Root Geological Society.

Sheila M. Roberts is also an assistant professor of geology at Western Montana College. She developed an interest in the geology of northwestern Montana while growing up in the Mission Valley of Montana. Sheila did her doctoral work at the University of Calgary, where she studied Pleistocene paleoclimates recorded in saline lacustrine sediments of Death Valley, California. Sheila has also been a geoscience editor, a mining geologist, a petroleum geologist, and a geoscience educator focused on outreach projects with K–12 schools.

Schedule

July 20, *Saturday* . . . . . Welcoming get-together
July 21–25, *Sunday–Thursday* . . Classes and field trips
July 25, *Thursday* . . . . . Farewell party

Glacial cirque on the Iceberg Lake Trail, Glacier National Park, Montana. *Photo by Rob Thomas.*

The geology of northwest Montana is some of the most spectacular in North America. It was first studied by Bailey Willis of the U.S. Geological Survey in 1902 as part of a reconnaissance study of the 49th parallel. Today, the region is best known by the geoscience community for research into the depositional history of the Proterozoic Belt Supergroup. These rocks contain some of the best sedimentary and biogenic structures in the world, and the depositional-tectonic setting of the "Belt basin" has been a matter of debate since the turn of the century. The region is also known for world-class thrust-belt structure, economic deposits of base metals, dinosaur remains in foreland-basin deposits, Cenozoic extensional tectonics, and glacial geology. The GeoHostel will include field trips in Glacier National Park to look at the stratigraphy and sedimentology of the Belt Supergroup, the Lewis thrust fault, foreland-basin deposits, alpine glacial geology of the park, and continental glacial geology of the Flathead Valley. A half-day rafting trip down the middle fork of the Flathead River will also be included. The trips are both full and half-day, and plenty of leisure time will be available to enjoy the spectacular scenery of northwestern Montana!

Lodging, Meals, Transportation

The group will stay on Saturday, Sunday, Monday, Tuesday, and Thursday at the Big Mountain Ski Resort, Whitefish, Montana, and on Wednesday at the Swiftcurrent Motor Inn, east Glacier. Lodging at Big Mountain is based on single occupancy, or doubles for couples; however, lodging at Swiftcurrent is based on double occupancy. A single room for Wednesday night is available for the additional single-supplement fee of $33. Meals will include plenty of hors d'oeuvres at the Welcoming Reception and Orientation on Saturday evening, breakfast and a sack lunch daily, a half-day river raft trip, and a hearty farewell dinner on Thursday evening. Field trip transportation will be provided in air-conditioned, 15-passenger rental vans.

GSA Member Fee: $670 **Nonmember Fee: $720**

Included: Classroom programs and materials; field trip transportation; lodging for six nights, meals outlined above; welcoming and farewell events.

Not included: Transportation to and from Whitefish, Montana; transportation during hours outside class and field trips; and other expenses not specifically included.

GeoHostel

Geology of the Wine Country in Western Oregon

Saturday, August 17, through Thursday, August 22, 1996
5 days, 6 nights
Portland State University, Portland, Oregon

About the Leader

Scott Burns is an Associate Professor at Portland State University and a native Oregonian who knows the geology of western Oregon well. In his teaching at the college level in Switzerland, New Zealand, Washington, Colorado, Louisiana, and Oregon for the past 20 years, Scott has received many outstanding teaching awards. He enjoys wine making and wine tasting, and his first published paper, in 1976, was on developing a student lab project on wine making. Much of his current research in environmental and engineering geology, geomorphology, Quaternary geology, and soil is directly related to the production of good grapes and fine wine.

Schedule

August 17, *Saturday* . . . . . Welcoming get-together
August 18–22, *Sunday–Thursday* . . . . . Classes and field trips
August 22, *Thursday* . . . . . Farewell party

The geology of western Oregon is exciting and diverse. The Coast Range is a combination of Tertiary sedimentary rocks and basalts folded into a north-plunging anticline. The Cascade Range is mainly volcanic rock with Pleistocene volcanic cones sitting on top of older Tertiary volcanics. Between the two mountain ranges is the Willamette Valley, a deep trough filled with late Cenozoic age sedimentary rock. In southwest Oregon the ancient terranes of the Klamath Mountains dominate the geology. In the past 30 years, more than 100 wineries have started production in western Oregon, and some of the fine wines produced there win international prizes. This GeoHostel will focus on the rocks that affect the soil that produces these high-quality grapes. The class will visit at least two wineries each day, while discussing the local geology of the region. We will visit the Tualatin Valley, the Yamhill Valley and the coast, the Willamette Valley near Salem, and southwest Oregon, including Crater Lake and the Oregon Caves. Participants will stay on the beautiful campus of Portland State University, near the heart of downtown Portland, a vibrant city with a multitude of cultural activities, especially in August. An overnight field trip to southern Oregon is scheduled for midweek. The weather is almost guaranteed to be perfect in August. Come to Oregon for high-quality geology and high-quality wine!

Lodging, Meals, Transportation

The group will be lodged on Saturday, Sunday, Monday, Tuesday, and Thursday at Portland State University, Portland, Oregon, in double-occupancy dormitory-style rooms. Lodging on Wednesday night will be in Grant's Pass, Oregon, in double-occupancy accommodations. A single room for Wednesday night is available for the additional single-supplement fee of $30. Meals will include plenty of hors d'oeuvres at the Welcoming Reception and Orientation on Saturday evening, breakfast and a sack lunch daily, a barbecue on Tuesday evening, and a hearty farewell dinner on Thursday evening. Field trip transportation will be provided in air-conditioned, 15-passenger rental vans.

GSA Member Fee: $580 **Nonmember Fee: $630**

Included: Classroom programs and materials; field trip transportation; lodging for six nights, meals outlined above; welcoming and farewell events.

Not included: Transportation to and from Portland, Oregon; transportation during hours outside class and field trips; and other expenses not specifically included.

Grapes on red soils, westernTualatin Valley. *Photo by Scott Burns.*

GeoHostels for GSA Members and Friends

REGISTRATION IS OPEN
CALL TODAY! HOLD A SPOT FOR YOURSELF AND FRIENDS

We encourage you to make your decision as soon as possible. There is high interest in these trips.

Single or shared Accommodation: Some trip fees are based on double occupancy. However, if you wish single accommodations, a limited number of rooms are available at an extra cost on a first-come, first-served basis. In the case of double occupancies, we will do our best to help find a suitable roommate, but if none is found, the single rate will apply. Please read the lodging information for each trip.

Age Requirement: The minimum age for participants is 21.

Health Recommendations: You must be in good physical and mental health. Any physical condition requiring special attention, diet, or treatment must be reported in writing when the reservation is made. We reserve the right to decline any person as a member of a trip. We also reserve the right to require a person to withdraw from the trip at any time when such action is determined to be in the best interests of the health, safety, and general welfare of the group.

Special Needs: We will do our best to accommodate special needs, including dietary requirements and physical disabilities. Please feel free to call and discuss your situation with us.

Air Travel: Air travel arrangements are handled by the individual unless specified as group travel in the description. Travel King, GSA's official travel agency, is ready to help you find the least expensive routing to your destination. Call Travel King at 1-800-458-6398 toll free, or (303) 776-2270 collect from outside the United States. Fax (303) 776-5170.

Cancellation Processing Fee: Deposits and payments are refundable up to the cut-off time, less a processing fee of $20. Termination of a trip in progress for any reason whatsoever will not result in a refund, and no refund will be made for unused parts of the trip.

Full Itineraries: The detailed itineraries for each GeoHostel and helpful travel information are available from GSA for the asking. Please feel free to call, fax, or E-mail. We welcome questions.

For information: Edna Collis, GSA GeoVentures, P.O. Box 9140, Boulder, CO 80301; (303) 447-2020 or 1-800-472-1988, fax 303-447-0648, E-mail: ecollis@geosociety.org.

1996 GeoHostels Fee Schedule

Name	Mt. St. Helens	Glacier Park	Oregon Wine Country
Dates	June 22–27	July 20–25	August 17–22
No. of Days	6	6	6
Member Fee	$650	$670	$580
Nonmember Fee	$700	$720	$630
Deposit	$100	$100	$100
Balance Due	May 1	June 1	July 1
100% Deposit refund date *(less $20 processing fee)*	May 1	June 1	July 1

Registration Form

1996 GeoVentures

To send a deposit to hold your reservation, please pay by check or credit card, which will be used only for this deposit. You will receive further information and a confirmation of your registration within one week after your reservation.

Name

Institution/Employer

Mailing Address

City/State/Country/ZIP

Phone (business/home)

Guest Name

GSA Member #

	Deposit Per Person	No. of Persons	Total Paid Deposit
GH961— Mount St. Helens	$100	____	$_____
GH962— Glacier Park	$100	____	$_____
GH963— Geology of Wine Country	$100	____	$_____
		TOTAL DEPOSIT	$_____

☐ I've enclosed no deposit, but I'm interested. Please send information.

☐ VISA ☐ MasterCard ☐ American Express

Credit Card # Exp. Date

Signature

MAKE CHECKS PAYABLE TO: GSA 1996 GeoVentures

PLEASE MAIL REGISTRATION FORM AND CHECK OR CREDIT CARD INFORMATION TO:
1996 GSA GeoVentures, GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301.
Non–U.S.-based registrants are encouraged to use the GSA Meetings Department fax number: 303-447-0648

CALL TODAY FOR MORE INFORMATION: Phone: 1-800-472-1988, ext. 134, or (303) 447-2020
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GSA ANNUAL MEETINGS

1996

Denver, Colorado • October 28–31
Colorado Convention Center, Marriott City Center

General Chairs: ***Gregory S. Holden*** *and* ***Kenneth E. Kolm,*** *Colorado School of Mines*

Technical Program Chairs: ***John D. Humphrey*** *and* ***John E. Warme,*** *Colorado School of Mines, Dept. of Geology & Geological Engineering, Golden, CO 80401, (303) 273-3819, fax 303-273-3859 E-mail: jhumphre@mines.edu*

Field Trip Chairs: ***Charles L. Pillmore,*** *(303) 236-1240 and* ***Ren A. Thompson,*** *(303) 236-0929 U.S. Geological Survey, MS 913, P.O. Box 25046, Denver Federal Center, Denver, CO 80225*

Theme Session Proposal Deadline is January 3, 1996.
See November *GSA Today* for theme invitation *or* the World Wide Web for invitation and proposal form. The World Wide Web address is: **http://www.aescon.com/geosociety/index.html.** Theme proposal information appears under the header for the Denver Meeting.

1997

Salt Lake City, Utah • October 20–23
Salt Palace Convention Center, Little America

General Chair: ***M. Lee Allison,*** *Utah Geological Survey*

Technical Program Chair: ***John Bartley,*** *University of Utah*

Call for Field Trip Proposals: We are interested in proposals for single-day and multi-day field trips beginning or ending in Salt Lake City, and dealing with all aspects of the geosciences. Please contact the field trip chairs listed below.

Paul Link
Department of Geology
Idaho State University
Pocatello, ID 83209-8072
(208) 236-3365
fax 208-236-4414
E-mail: linkpaul@isu.edu

Bart Kowallis
Department of Geology
Brigham Young University
Provo, UT 84602-4646
(801) 378-3918
fax 801-378-2265
E-mail: bjk@geology.byu.edu

Field trip guides will be published jointly by Brigham Young University Geology Studies and the Utah Geological Survey. Review drafts of field guides will be due March 15, 1997.

EARTH SYSTEM SUMMIT
Denver

For general information on any meeting call the GSA Meetings Department
1-800-472-1988 or (303) 447-2020, ext. 133
E-mail: meetings@geosociety.org

GSA SECTION MEETINGS — 1996

SOUTH-CENTRAL SECTION, ***March 11–12, 1996.*** University of Texas, Austin, Texas. Information: Mark Cloos, Department of Geological Sciences, University of Texas, Austin, TX 78712, (512) 471-4170, fax 512-471-9425, E-mail: cloos@maestro.geo.utexas.edu. *Preregistration Deadline: February 6, 1996.*

SOUTHEASTERN SECTION, ***March 14–15, 1996.*** Ramada Plaza Hotel, Jackson, Mississippi. Information: Darrel Schmitz, Department of Geosciences, P.O. Box 5448, Mississippi State University, Mississippi State, MS 39762, (601) 325-2904; or Charles Swann, Mississippi Mineral Resources Institute, 220 Old Chemistry Bldg., University, MS 38677, (601) 232-7320, E-mail: cts@mmri.olemiss.edu. *Preregistration Deadline: February 6, 1996.*

NORTHEASTERN SECTION, ***March 21–23, 1996.*** Hyatt Regency, Buffalo, New York. Information: Parker E. Caulkin, Department of Geology, SUNY at Buffalo, 876 NSM, Buffalo, NY 14260, (716) 645-6800, ext. 3985, fax 716-645-3999, or preferably by E-mail: glgparkr@ubvms.cc.buffalo.edu. *Preregistration Deadline: February 26, 1996.*

ROCKY MOUNTAIN SECTION, ***April 18–19, 1996.*** Rapid City Civic Center, Rapid City, South Dakota. Information: Colin Paterson, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East St. Joseph St., Rapid City, SD 57701-3995, (605) 394-5414, E-mail: paterson@silver.sdsmt.edu. *Abstract Deadline: January 5, 1996. Preregistration deadline: March 8, 1996.*

CORDILLERAN SECTION, ***April 22–24, 1996.*** Red Lion Hotel at Lloyd Center, Portland, Oregon. Information: Michael Cummings, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207-0751, (503) 725-3022. E-mail: michael@ch1.pdx.edu. *Preregistration deadline: March 15, 1996.*

NORTH-CENTRAL SECTION, ***May 2–3, 1996.*** Iowa State University, Ames, Iowa. Submit completed abstracts to: Kenneth E. Windom, Department of Geological and Atmospheric Sciences, Iowa State University, 253 Science I Building, Ames, IA 50011-3210, (515) 294-2430, E-mail: kewindom@iastate.edu. *Abstract Deadline: January 17, 1996.*

Student Travel Grants

The GSA Foundation will award matching grants up to a total of $3500 each to the six GSA Sections. The money, when combined with equal funds from the Sections, will be used to assist GSA Student Associates traveling to the 1996 GSA Annual Meeting in Denver in October and to the 1996 Section meetings. Contact your Section Secretary for application procedures.

Cordilleran	Bruce A. Blackerby (209) 278-2955
Rocky Mountain	Kenneth E. Kolm (303) 273-3932
North-Central	George R. Hallberg (319) 335-4500
South-Central	Rena M. Bonem (817) 755-2361
Northeastern	Kenneth N. Weaver (410) 554-5532
Southeastern	Harold H. Stowell (205) 348-5098

Coal Division Offers Medlin Award

The Coal Geology Division of the Geological Society of America announces the availability of the Antoinette Lierman Medlin Scholarship in Coal Geology for the 1996–1997 academic year. The scholarships provide full-time students who are involved in research in coal geology (origin, occurrence, geologic characteristics, or economic implications of coal and associated rocks) with financial support for their project for one year.

Scholarship funding can be used for field or laboratory expenses, sample analyses, instrumentation, supplies, or other expenses essential to the successful completion of the research project. Approximately $1500 will be available for the 1996–1997 scholarship award. In addition, the recipient of the scholarship may be provided with a stipend of up to $500 to present results of the research at the 1997 GSA Annual Meeting. For the academic year 1996–1997, the Coal Geology Division is also offering a field study award of $500.

Proposals for the scholarship and the field study award will be evaluated by a panel of coal geoscientists. Applicants may apply for the scholarship award, the field study award, or both; however, only one award will be made to a successful applicant.

Interested students should submit five copies of the following: (1) a covering letter indicating which award(s) is (are) sought; (2) a concise statement of objectives and methods, and a statement of how the scholarship funds will be used to enhance the project. The proposal would be no more than five (5) double-spaced pages in length, including references; (3) a letter of recommendation from the student's immediate advisor which includes a statement of financial need and the amount and nature of other available funding for the research project.

Send the material to: Peter D. Warwick, Chairman, A. Lierman Medlin Scholarship Committee, U.S. Geological Survey, MS 956 National Center, Reston, VA 22092, Phone: (703) 648-6469, E-mail: pwarwick@usgs.gov.

The proposal and letter of recommendation must arrive no later than **February 15, 1996.** Applicants will be notified of the Scholarship Committee's decision by April 1, 1996.

The scholarship was established as a memorial to Antoinette "Toni" Medlin, who for many years dedicated her efforts toward the advancement of coal geoscience and to the encouragement of students in coal geology. Monies for the scholarships are derived from the annual interest income from the scholarship fund.