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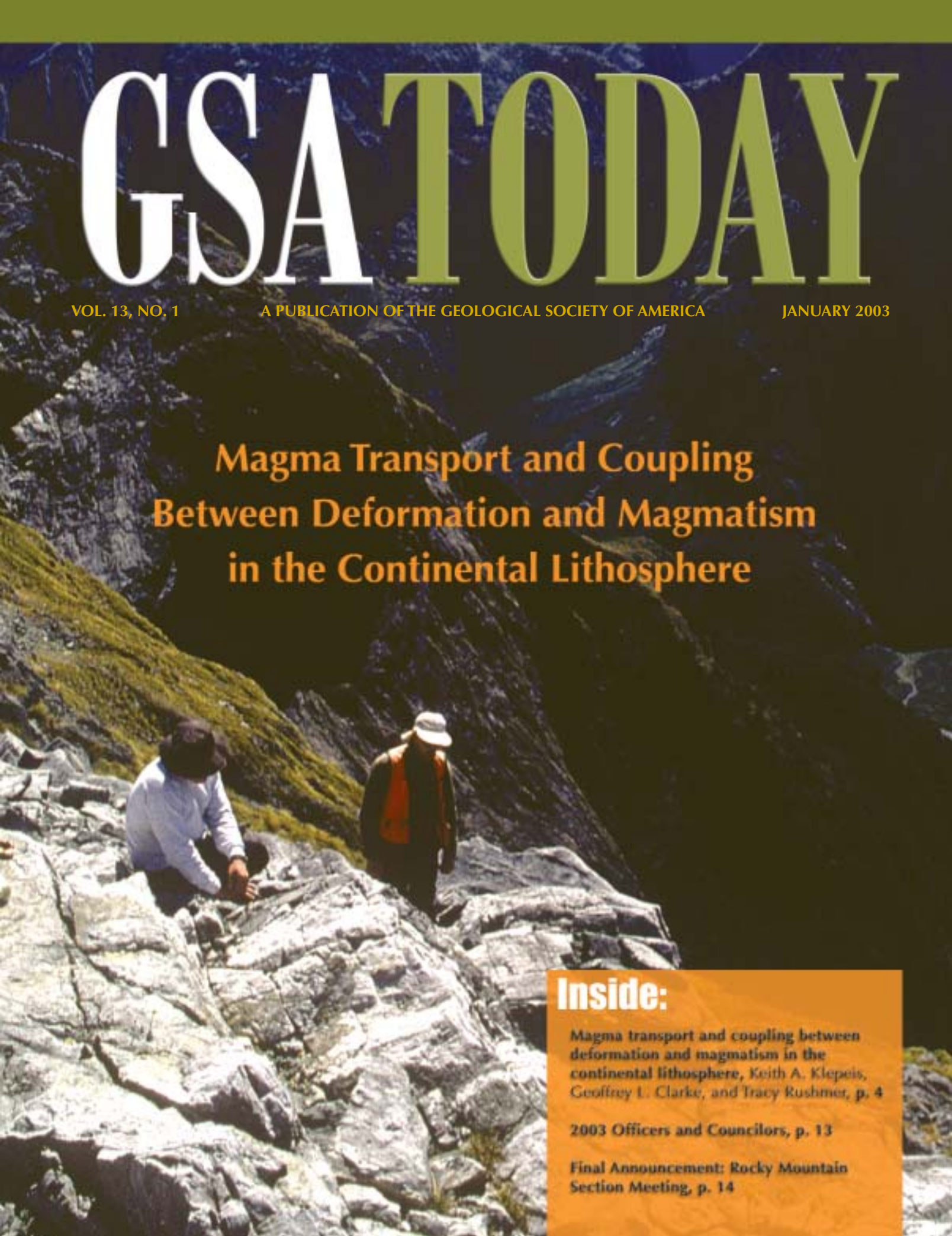
Magma Transport and Coupling Between Deformation and Magmatism in the Continental Lithosphere



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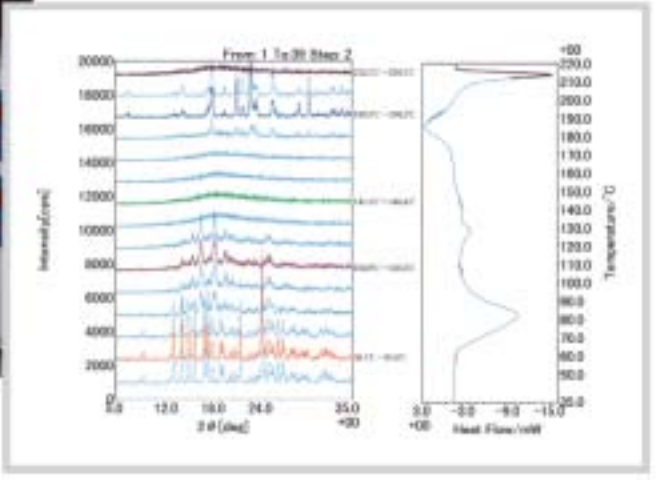

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ON THE COVER: Geoffrey Clarke (left) and Keith Klepeis (right) examine exposures of a lower crustal batholith on top of Mount Daniel in the deeply eroded terrain of Fiordland, New Zealand. Photo by Nathan Daczko. See "Magma transport and coupling between deformation and magmatism in the continental lithosphere," by K.A. Klepeis et al., p. 4–11.

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Magma transport and coupling between deformation and magmatism in the continental lithosphere

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ABSTRACT

The mechanisms by which magma is generated and transported through continental crust and how these processes affect the chemical and mechanical evolution of the lithosphere are some of the least understood issues of continental dynamics. We report here on the evolution of an unusually well-exposed early Mesozoic arc that originally formed along the ancient margin of Gondwana and is now located in western New Zealand. The pre-Cenozoic configuration and deeply eroded character of this arc lead us to the following conclusions about magmatism and deformation at 10–50 km paleodepths: (1) The mafic-intermediate composition of the lower crust and the mineral reactions controlling melt production strongly influenced pathways of melt transfer and controlled the mechanical behavior of the lithosphere during orogenesis. (2) Evolving lithospheric strength profiles during magmatism and convergence produced transient periods of vertical coupling and decoupling of crustal layers. (3) Late orogenic extension was driven by plate interactions rather than by gravitational forces and a weak lower crust.

INTRODUCTION

Many of the Mesozoic Cordilleran plutonic complexes located in western North America (Tepper et al., 1993), the Andes (Petford and Atherton, 1996), Antarctica (Wareham et al., 1997), and New Zealand (Muir et al., 1995) contain tonalite to granodiorite batholiths that are thought to originate from the partial melting of mafic lower crust. However, considerable uncertainty surrounds how these magmas are produced and move through the lower crust, and how these processes influence crustal evolution. Much of this uncertainty arises because Phanerozoic arc systems that allow direct examination of mafic lower crust are rare. There are even fewer field sites where exposures of tilted crustal sections allow us to examine structural and magmatic features that evolved simultaneously at lower, middle, and upper crustal levels.

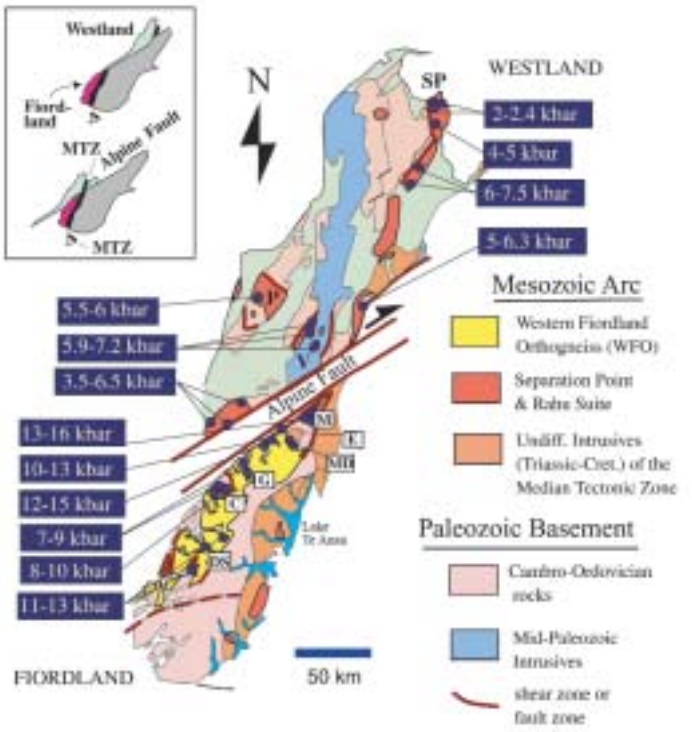

Figure 1. Inset shows present configuration (top) and Cretaceous reconstruction (bottom) of western New Zealand assembled by restoring the Median Tectonic Zone (MTZ) to its pre–late Cenozoic position. Main diagram shows Cretaceous reconstruction. Metamorphic pressures from Fiordland (7–16 kbar) represent the peak of Early Cretaceous metamorphism at ca. 120 Ma. Data show a south-tilted lower crustal section and are from J.Y. Bradshaw (1985, 1989), Clarke et al. (2000), Daczko et al. (2001a, 2001b), and Daczko et al. (2002a). Pressures from Westland show shallower Early mid-Cretaceous (125–105 Ma) pluton emplacement depths (after Tulloch and Challis, 2000). Abbreviations show key locations or features: SP—Separation Point, P—Paparoa Range, V—Victoria Range, M—Milford Sound, E—Mount Edgar, MD—Mount Daniel, G—George Sound, C—Caswell Sound, DS—Doubtful Sound, WFO—Western Fiordland Orthogneiss.

Exposures of early Mesozoic arc crust in western New Zealand allow us to examine directly how deformation interacted with magma generation and transport processes at outcrop to lithospheric scales. The Fiordland part of this belt (Fig. 1) contains >5000 km^2 of high-pressure (P = 14–16 kbar) migmatites, granulite facies mineral assemblages, and layered mafic-intermediate intrusions that formed in the lower and middle crust of the arc (25–50 km paleodepths) during the Early Cretaceous. The Westland part (Fig. 1) preserves the middle to upper crustal levels of this same arc (10–27 km paleodepths) where sodic, high Sr/Y granitoids were emplaced following partial melting of mafic-intermediate lower crust (Muir et al., 1998; Tulloch and Challis, 2000). This unusual degree of exposure allowed us to examine the evolution of a 50-km-thick column of deforming continental crust over a 35 Ma cycle of orogenesis (Fig. 2). Reconstructing this type of composite crustal column is based on metamorphic pressure data and on inferences about how outcrops can be restored to their original depth-stratified paleogeometry (see also Karlstrom and Williams, 1998, 2002; Miller and Paterson, 2001).

RECONSTRUCTING THE FIORDLAND-WESTLAND OROGEN

On the South Island of New Zealand, a segment of the present-day boundary between the Australian and Pacific plates occurs along an 800-km-long transform called the Alpine fault (Fig. 1). This fault has accommodated ~460 km of dextral strike-slip displacement since the Miocene (Wellman, 1953). By removing this amount of slip, the pre-Cenozoic configuration of western New Zealand can be reconstructed (Tulloch and Challis, 2000). Cretaceous reconstructions (Fig. 1) show a continuous NE-trending belt of calc-alkaline granitoids, layered mafic igneous complexes, and volcano-sedimentary terranes that define an early Mesozoic (247–105 Ma) composite arc (Kimbrough et al., 1994; Mortimer et al., 1999).

Near continuous exposure along coastlines and in the mountainous terrain of Fiordland reveal the three-dimensional structure of the deepest parts of the arc. Fiordland (Fig. 1) contains a layered, dome-shaped mid-lower crustal section where the shallowest paleodepths (~25 km) occur in the center at Caswell Sound (C, Figs. 1, 2A, 2B) and the deepest paleodepths (45–50 km) occur at Milford Sound (M, Figs. 1, 2A, 2B) and Doubtful Sound (DS, Figs. 1, 2C). In Westland, high Sr/Y sodic granitoids of the 125–105 Ma Separation Point Suite (Fig. 1) record Early Cretaceous emplacement depths of 8–27 km (Tulloch and Challis, 2000).

The ages of major intrusive features and of Cretaceous deformation and metamorphism are well constrained by published geochronology (Mattinson et al., 1986; McCulloch et al., 1987; Gibson and Ireland, 1995; Muir et al., 1998; Ireland and Gibson, 1998; Nathan et al., 2000; Tulloch et al., 2000). Published dates and new analyses of zircon (Klepeis et al., 2001; Hollis et al., 2002; G. Gehrels, 2002, personal comm.) from within the section reveal three tectonic phases (Fig. 2): (1) the addition of mafic-intermediate magma into the lower crust (126–116 Ma) and the partial melting of lower crustal host gneisses; (2) contractional deformation and the emplacement of sodic, high Sr/Y granitoids in the middle and upper crust (116–105 Ma); and (3) late orogenic extension, cooling and exhumation (105–90 Ma). This last phase preceded inception of seafloor spreading in the Tasman Sea (ca. 84 Ma) by ca. 15 Ma (Gaina et al., 1998) and was accompanied by the formation of extensional metamorphic core complexes in Westland, New Zealand (Tulloch and Kimbrough, 1989).

MAGMA EMPLACEMENT AND PARTIAL MELTING IN THE LOWER CRUST

During the period 126–116 Ma (Fig. 2A), the lower crust of the Fiordland belt accumulated at least 10 km (thickness) of mafic-intermediate magma (Mattinson et al., 1986). The first phases were gabbroic with minor ultramafic compositions; later phases were dominated by diorite. This intrusion formed a >3000 km^2 tabular batholith called the Western Fiordland Orthogneiss (WFO, Figs. 1, 2A) and has been interpreted to have added sufficient

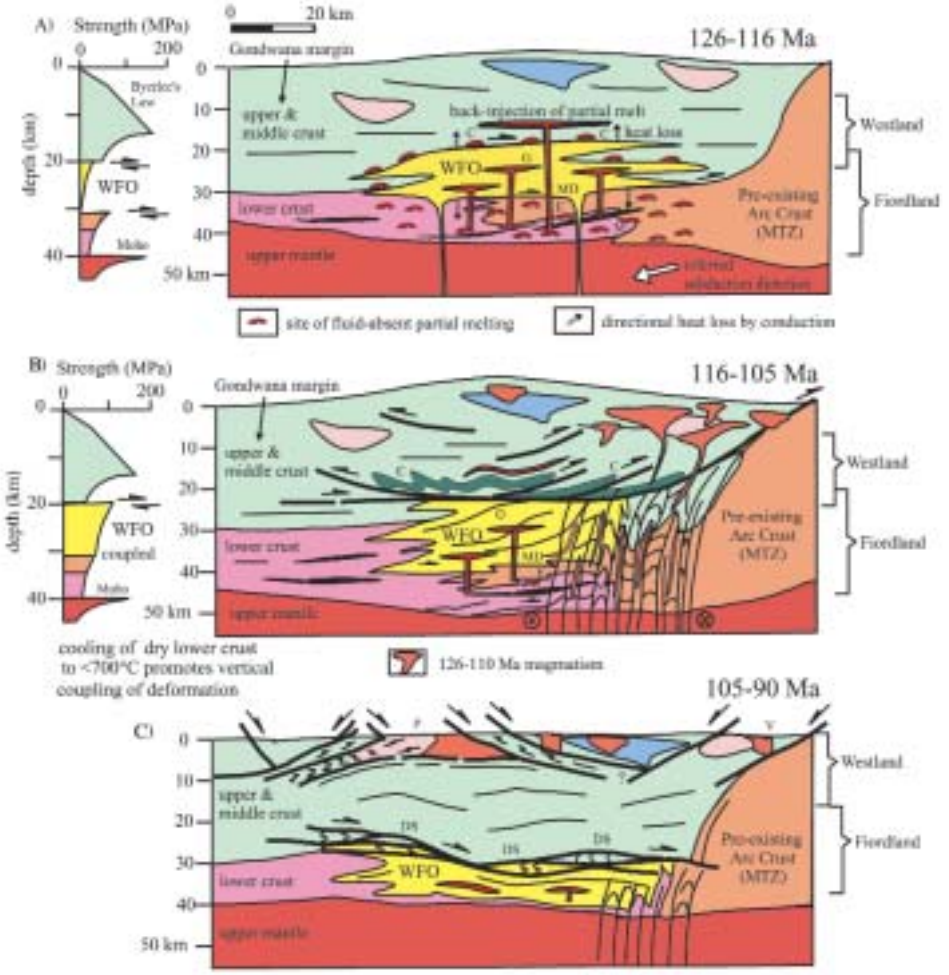

Figure 2. Cartoons illustrating the tectonic evolution of the Fiordland-Westland belt. Abbreviations and color scheme are as in Figure 1. **A:** During interval 126–116 Ma, mafic-intermediate magma (WFO, yellow) was added to the middle (bottom part of green color) and lower (dark pink and tan) crust. Upper crust was composed mostly of Paleozoic Gondwana margin rocks (green) and granitoid plutons (light blue and light pink). Lower crust was composed of older (>126 Ma) arc-related rocks, including parts of the Median Tectonic Zone (MTZ) and Mount Edgar diorite (E) in tan and Paleozoic gneisses of Gondwana in dark pink. **B:** Contractional deformation (116–105 Ma) followed magmatism and melt production. **C:** Late orogenic extension (105–90 Ma) formed metamorphic core complexes (P and V) in mid-upper crust and the Doubtful Sound shear zone (DS) in the lower crust. Schematic strength profiles illustrate variations in the strength of the lower crust during two stages of orogenesis. Lower crust in A was weakened by magmatism. Lower crust in B was strengthened by dehydration and the cooling of the Western Fiordland Orthogneiss (WFO) to T < 700 °C following data presented in Daczko et al. (2002b).

heat to the lower crust to partially melt host gneisses (Daczko et al., 2001b). At the time of this intrusion, the lower crust was composed of older (>126 Ma) vertically stratified mafic-intermediate intrusive phases of the early Mesozoic arc, including the western Median Tectonic Zone (MTZ) and Mount Edgar (E) diorite (Figs. 1, 2; Hollis et al., 2002), and Paleozoic gneisses of Gondwana margin affinity (Tulloch et al., 2000).

Field data show that the spatial distribution of rocks that partially melted following magma emplacement was highly heterogeneous. Above and near the top of the batholith, at Caswell (C, Figs. 1, 2A) and George sounds (G, Figs. 1, 2A), migmatites formed in a narrow zone 200–500 m thick near the batholith-country rock contact. In contrast, below the batholith a region of lower crust at least 10 km thick partially melted (Fig. 2A). Petrologic analyses suggest that the partial melting of mafic-intermediate gneisses below the batholith was patchy and mostly involved hornblende breakdown to form garnet surrounded by leucosome (Daczko et al., 2001b).

To test possible mechanisms of melt generation in gneisses below the batholith, piston-cylinder experiments were performed on an unmelted sample of dioritic gneiss at P = 14 kbar and T = 800–975 °C (Antignano et al., 2001). The mineral assemblage consisted of plagioclase + quartz with hornblende, clinozoisite, and biotite as the hydrous phases. At T = 825 °C, biotite undergoes melting in the absence of free water (fluid-absent), followed by the reaction of hornblende and clinozoisite resulting in garnet + melt as reaction products. Melt compositions initially are granitic due to the influence of biotite but become granodioritic to tonalitic with increasing temperature as the main reaction shifts to fluid-absent melting of hornblende ± clinozoisite (Fig. 3A). Calculated water activities of the melts are low (0.39 to 0.12) and trace element data from experimentally produced glasses show high Sr/Y ratios. Melt fractions remained low (≤10 vol%) at all temperatures up to T = 975 °C. This suggests that although partial melting occurred in large parts of the section below the batholith (Fig. 2A), the volume of melt produced probably remained low. These results may explain the low percentage of leucosome observed in mafic lower crust in the field and contrasts with the much higher melt fractions observed in migmatitic paragneiss above the batholith.

MELT SEGREGATION AND TRANSPORT

In migmatite formed at paleodepths of 45–50 km (Fig. 3D), diffuse patches of leucosome parallel gneissic layering and feed laterally into vertical (layer-perpendicular), vein-filled extension fractures (Figs. 3E, 3F, 3G). The sharp, straight edges of the veins and curved vein tips are typical of brittle extension fractures. The fracture sets cut across all lithologic boundaries and occur within hundreds of square kilometers of the lower crustal section, including the batholith. These features provide strong geological evidence that melt segregation and transport were aided by diking and fracture propagation following batholith emplacement.

The physical links that occur between leucosome in migmatitic gneiss and the vein-filled fractures and dikes suggest that positive volume changes and the development of high melt fluid pressures during melt production induced brittle failure by lowering effective normal stresses in the lower crust (e.g., Clemens and Mawer, 1992; Davidson et al., 1994). In this scenario, the leucosome observed in the field reflects melt migration along fractures. We tested this hypothesis in the field and laboratory using metamorphic and geochemical relationships that record how partial melts interacted chemically with gabbroic gneiss during their migration. Adjacent to leucosome in gabbroic gneiss, hornblende-bearing assemblages recrystallized to garnet granulite (Figs. 3E, 3F) at conditions of T > 750 °C and P = 14 kbar (Clarke et al., 2000). Early theories (e.g., Blattner, 1976; Bradshaw and Kimbrough, 1989) suggested that these recrystallized zones formed by dehydration as CO_2-rich fluids were introduced along fractures. However, the garnet-bearing dehydration zones only occur in gabbroic gneiss and are physically continuous with leucosome formed in migmatitic diorite. These relationships led Daczko et al. (2001b) to infer that dehydration of the gabbroic gneiss reflected the scavenging of water by migrating, water-poor partial melt sourced from the melted diorite gneiss.

Distinctive trace and rare earth element (REE) patterns in the dioritic and gabbroic gneisses provided another means of testing the interconnectivity and chemical communication between the partial melt produced in the diorite and the dehydration zones in the gabbroic gneiss. Hornblende in partially melted dioritic gneiss displayed a progressively increasing heavy REE content relative to that of chondrite. In contrast, hornblende in the fractured gabbroic gneiss showed a progressively decreasing heavy REE content. These distinctive patterns were inherited by garnet that formed in both the migmatitic structures in diorite (Fig. 3D) and in veins where partial melts invaded the gabbroic gneiss (Fig. 3E). This result is important because it supports the interpretation that hornblende ± clinozoisite produced garnet + melt in the dioritic gneiss and that these melts migrated into gabbroic gneiss along fracture networks.

To further test the hypothesis that fractures can be produced by the fluid-absent melting of hornblende + clinozoisite, we established experimentally that this reaction involves a positive volume change. Partial melting experiments on solid rock cores show that the dilational strain associated with the hornblende + clinozoisite reaction is high enough to induce fracture in matrix feldspar and quartz (Fig. 3B) and confirms the low water activity of these melts (Antignano, 2002). These results support the interpretation that fluid-absent melting reactions with high dilational strain can produce fracture networks that allow for interconnectivity and melt transfer. These data combined with the development of vein arrays within large parts of the Fiordland section suggest that fracture networks aided melt segregation and that melt migration was linked to dehydration in the surrounding gabbroic rocks.

Field relationships also show that fracture propagation and diking were not the only mechanisms of melt transfer following intrusion of the batholith. Foliation planes, lithologic contacts, boudin necks, and fold hinges in ductile shear zones that developed after batholith emplacement also contain leucosome. These observations suggest that a combination of fracture networks and deformation in shear zones moved partial melt horizontally and vertically through the crustal column.

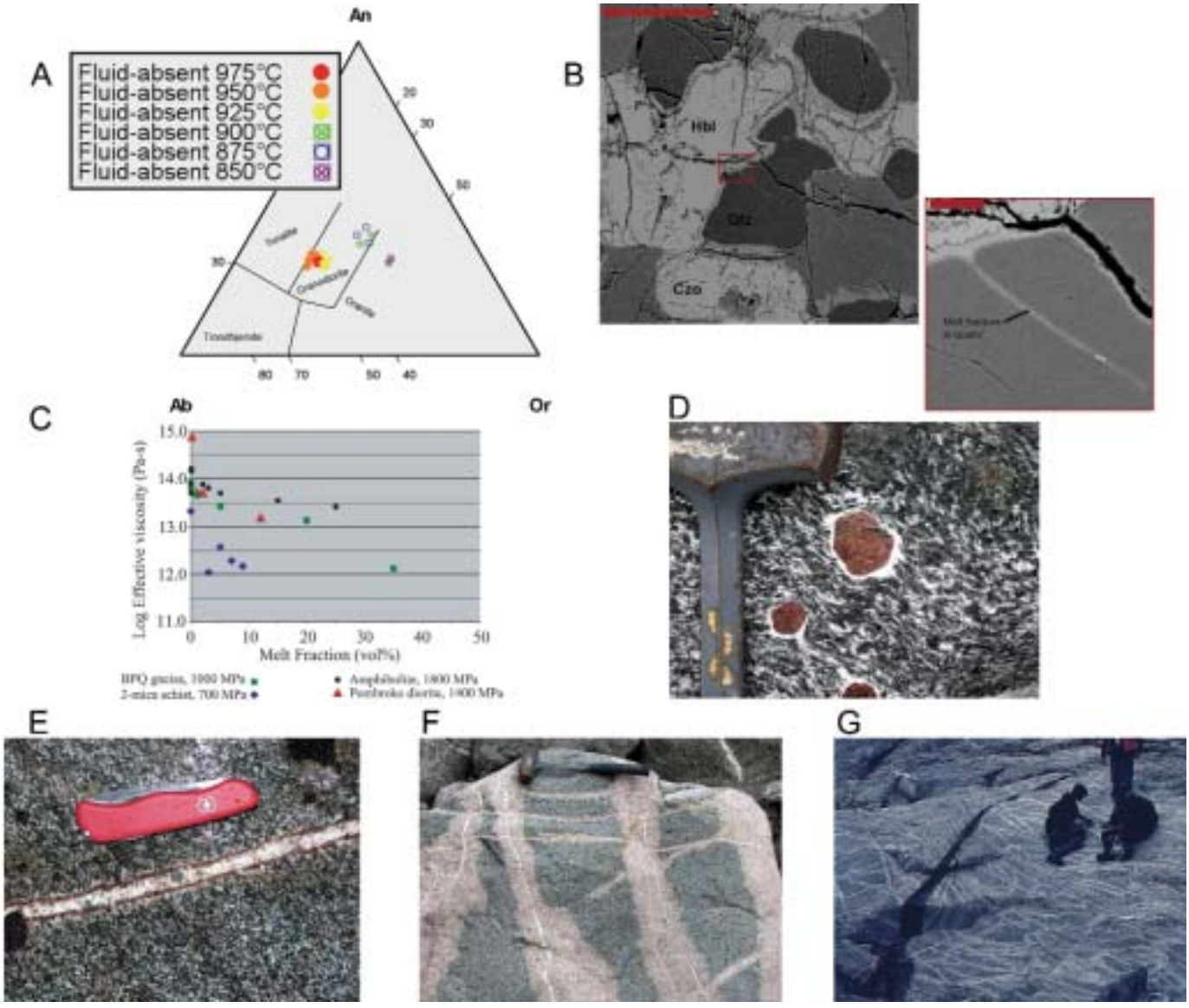

Figure 3. A: Compositions of partial melts in metadiorite plotted on an Ab-An-Or diagram. **B:** Backscatter image showing textural evidence of the melting reaction: hornblende + clinozoisite + quartz + plagioclase ≥ clinopyroxene + garnet + melt + plagioclase ± Fe-oxides in solid diorite core experiment. Reaction products surround quartz grain and melt is observed in a fracture (red box). Scale is 200 microns. Inset shows close-up of melt fracture in quartz grain, product clinopyroxene is shown in top left corner. Black crack is due to unloading of experiment. Scale is 20 microns. **C:** Effective viscosity vs. melt fraction plot showing results from solid-media deformation experiments. Metadiorite sample displayed a high effective viscosity compared to pelite under subsolidus conditions and is similar to amphibolite (Rushmer, 1995) and biotite-plagioclase-quartz (BPQ) gneiss (Holyoke and Rushmer, 2002) with partial melt present (Antignano, 2002). **D:** Migmatitic dioritic gneiss showing leucosome surrounding peritectic garnet. **E:** Garnet-bearing leucosome filling extension fracture in gabbroic gneiss. **F:** Granulite facies dehydration haloes surrounding leucosome and fracture networks. Haloes contain clinopyroxene + garnet assemblage that replaces hornblende-bearing assemblage in gabbroic gneiss. **G:** Reorientation of extension fractures record ductile deformation following brittle failure of the lower crust.

CHANGES IN LOWER CRUSTAL STRENGTH AND RHEOLOGY

In Fiordland, magma compositions and the liquidus temperature of basalt indicate that the initial intrusion temperatures of the WFO were likely ≥1200 °C following the estimates of Petford and Gallagher (2001). Mineral assemblages that formed in the batholith and its host rocks following its emplacement record progressive changes in temperature and fluid activities. Partial melting and granulite facies metamorphism occurred at 750 °C < T < 850 °C (Daczko et al., 2001b). With time, kyanite- and paragonite-bearing assemblages replaced older garnet-clinopyroxene-plagioclase assemblages reflecting isobaric cooling of the lower crust to ~650 °C prior to 108–105 Ma (Daczko et al., 2002b). These observations and the well-known dependence of lower crustal strength and rheology on melt fraction, temperature, and fluid activity imply that the lower crust must have had a different mechanical strength at different times between 126 and 105 Ma. These results are consistent with evidence of complex rheological stratifications in sections of arc crust exposed in the U.S. Cordillera (Miller and Paterson, 2001).

During the earliest stages of magmatism (126–116 Ma) suprasolidus shear zones formed at the upper and lower boundaries of the batholith. At Mount Daniel (MD, Figs. 1, 2A) these shear zones contain tightly folded tonalite sheets that are cut by less deformed sheets, indicating that deformation coincided with the periodic emplacement of magma. Coarse biotite in tightly folded layers exhibits radial patterns and tabular plagioclase lacks evidence of subsolidus recrystallization. These features reflect deformation under magmatic conditions and suggest that the flow of magma participated in, and may have facilitated, the imbrication of crustal slices during crustal thickening.

Inside the batholith all magmatic features are cut by the fracture arrays that have been linked physically and chemically to sites of partially melted host rock (Fig. 3). The fact that these fractures cut the lower contact of the batholith (MD, Fig. 2A) provides direct evidence that by ca. 116 Ma the batholith had mostly crystallized and was strong as it deformed together with its host rocks at high effective viscosities. Finally, ductile shear zones that record subsolidus temperatures of 650 °C < T < 800 °C deform many of the fractures and dikes inside and below the batholith (Daczko et al., 2001a). These transitions suggest that during the period ca. 116–105 Ma, the lower crust initially was weakened by the addition of heat and magma and later strengthened as melt moved out of the lower crust and the lower crust cooled. Experimental data confirmed the relatively high strengths of lower crustal mafic rocks even as they underwent mineral reactions involving partial melting (Fig. 3C). These changes are illustrated qualitatively in the strength-depth profiles showing a weak lower crust in Figure 2A and a stronger lower crust in 2B.

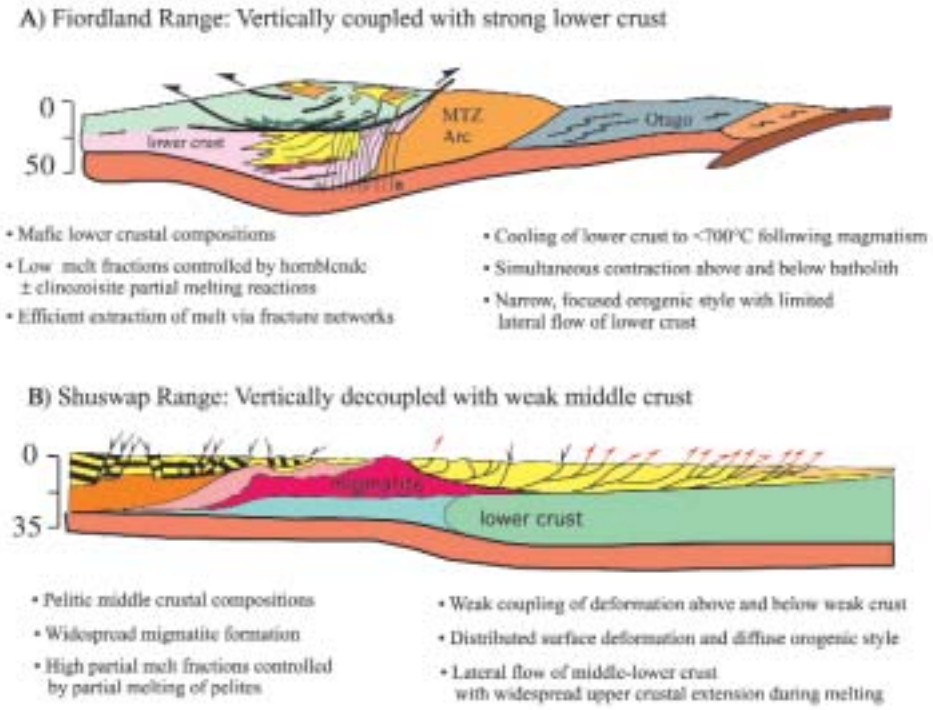

Figure 4. Cartoons showing the different possible mechanical responses of continental lithosphere following partial melting of the deep crust. **A:** The Fiordland-Westland belt reflects a strong lower crust during the period 116–105 Ma that promoted vertical coupling of deformation. **B:** The Shuswap range of southern British Columbia, Canada is characterized by a weak middle crust (after Vanderhaege and Teyssier, 1997; 2001). Text below diagrams highlights differences in the characteristics and boundary conditions that influence orogenic styles.

CHANGING PATTERNS OF DEFORMATION IN THE LOWER CRUST

One of the most useful features in the study of deformation in Fiordland was the penetrative arrays of extension fractures surrounded by garnet granulite dehydration zones that formed over hundreds of square kilometers of the section, including the batholith. Changes in the angular relationships among these and other vein sets provided a means of defining strain gradients and the kinematic evolution of shear zones from the outcrop to the regional scale (Fig. 3G). Within the westernmost part of the section, a penetrative, SW-dipping gneissic layering also provided a reference frame that facilitated a comparison of structural styles across the belt. In the west, where Early Cretaceous deformation was weakest, thermobarometric data indicate that this layering was oriented close to horizontal during and after batholith intrusion and fracture sets cut across layering at high angles approaching 90°.

Following partial melting of the lower crust, swarms of vertical, ≤1-m-thick, E- and NW-striking shear zones formed at the margins of dikes below the batholith. These shear zones form antithetic (dextral) and synthetic (sinistral) pairs that record arc-parallel (NE-SW) displacements and subhorizontal (layer-parallel) arc-normal (NW-SE) shortening within a dominantly sinistral flow regime (Daczko et al., 2001a). Subsequently, these shear zones were deformed by a series of SE-dipping (avg. 27°), vertically stacked (100 m spacing) shear zones that contain imbricated, asymmetric pods of mylonite. These pods form antiformal stacks that are typical of thrust duplexes and record layer-parallel (subhorizontal) shortening and layer-perpendicular (subvertical) thickening during arc-normal contraction (Daczko et al., 2001a). Mineral assemblages that define foliation planes in these thrusts record metamorphic conditions of P = 14 ± 1.2 kbar and T = 674 ± 36 °C (Daczko et al., 2001a). This style of duplex involving simultaneous deformation along steeply and shallowly dipping foliations was also noted by Karlstrom and Williams (2002) as an important mechanism in the middle crust for accommodating strain during synchronous thickening of crust and migration of melt.

As the batholith cooled further and contraction continued, the style of deformation in the lower crust changed. Along the western boundary of the MTZ (below letter M in Figs. 1, 2B), shortening resulted in a vertical, 10–15-km-wide, N-striking transpressional shear zone that cuts across the entire lower crustal section, including the lower and eastern contact of the batholith. This shear zone records an oblique-sinistral sense of shear.

Near vertical foliations that define the shear zone at deep levels (14–16 kbar) gradually flatten upward and merge into a horizontal décollement zone underlying a mid-crustal fold-thrust belt (7–9 kbar) at the top of the batholith (Fig. 2B). On the basis of thermobarometry, this shear zone transects a crustal thickness of at least 20 km (Fig. 2B). The mid-crustal fold-thrust belt is well exposed at Caswell Sound (C, Figs. 1, 2B) and exhibits features that are common in many upper crustal settings including imbricated thrust splays that sole into flat detachments, fault propagation folds, and conjugate thrusts and back thrusts (Daczko et al., 2002a).

Both the mid-crustal fold-thrust belt and the steep lower crustal shear zone below it cut the 126–116 Ma Western Fiordland Orthogneiss and are deformed by a younger set of upper amphibolite facies shear zones, including the Doubtful Sound shear zone (DS, Figs. 1, 2C). These younger shear zones cut all contractional structures in Fiordland and record decompression and cooling of the granulite belt through the closure temperature of hornblende (~550 °C) by ca. 108–105 Ma and to ≤400 °C by 90 Ma (Gibson et al., 1988; Gibson and Ireland, 1995; Klepeis et al., 1999; Nathan et al., 2000). These relationships and U-Pb geochronology (Tulloch et al., 2000; Hollis et al., 2002) indicate that as the batholith cooled during the period 116–105 Ma, contraction was coupled at different levels of the crust through an interconnected network of steeply and gently dipping shear zones.

DISCUSSION AND CONCLUSIONS

Lithospheric-Scale Interactions Among Deformation and Melt Transfer Processes

The Fiordland-Westland example provides strong geological evidence that diking and melt-enhanced fracturing was an important mechanism for the segregation and initial ascent of melt out of the lower crust. Similar melt-enhanced fracture systems have been observed in other orogenic belts (Davidson et al., 1994; Roering et al., 1995; Yamamoto and Yoshino, 1998) but to our knowledge none show this behavior on such large scales as in the Fiordland belt.

Once the batholith and its host rocks had cooled to subsolidus temperatures (T < 820 °C), structural elements in large vertical shear zones were exploited as pathways for melt transport horizontally and vertically through the crustal column. These observations agree with models that predict the buoyancy of hot felsic magma and the dynamics of transpression can create pressure gradients that help force magma through the crust (e.g., Robin and Cruden, 1994; de Saint Blanquat et al., 1998).

As transpressional shear zones evolved in the lower crust, granitoids were emplaced into the upper crust until ca. 105 Ma (Muir et al., 1995; Waight et al., 1998). The Separation Point batholith represents the final stages of this process. This batholith consists of sodic, alkali-calcic diorite to biotite-hornblende monzogranite that is similar in composition to Cordilleran adakite suites (Muir et al., 1995). The geochemical and isotopic signatures of these granitoids suggest that they were derived either from young, hot subducted oceanic crust or from mafic crust at the root of a thickened (>40 km paleodepths) magmatic arc (Muir et al., 1995, 1998). Our observations support the latter interpretation.

The isotopic (Sr, Nd) composition of the Separation Point Suite also suggests that rising magmas experienced little to no interaction with felsic arc crust (Muir et al., 1995, 1998). This implies that the mixing of mantle and crustal components to form shallow-level plutons occurred in the mafic lower crust. Fiordland provides an example where the mixing of mantle and crust components may have occurred beneath a mafic intrusion (e.g., Petford and Gallagher, 2001), and where the rapid ascent of hybrid magmas through fracture networks and shear zones inhibited crustal contamination at shallower levels. Finally, data from Fiordland reconcile the previously tenuous relationship between crustal melting and high-pressure granulite facies metamorphism. The data show that this metamorphism was related directly to the migration of water-poor partial melts through the lower crust.

Transient Coupling and Decoupling Within the Lithosphere

High melt volumes (>30%) associated with the emplacement of the WFO and the virtual absence of any Cretaceous deformation outside the batholith and its contact aureoles during emplacement indicate that the lower crust probably was decoupled from the upper and middle crust during the interval 126–116 Ma. Structural patterns indicate that subhorizontal (layer-parallel) flow between layers of colder, less deformed host rock characterized this period and reflected the localization of deformation into areas weakened by melt and heat. However, this period of vertical decoupling was transient, occurring only during the ~10 m.y. period before the batholith cooled and crystallized.

By ca. 116 Ma, the melt enhanced shear zones at the base of the batholith were abandoned. The development of granulite facies fracture arrays inside the batholith and its host indicate that decoupling had ended by this time and that these crustal layers were deforming together at similar high effective viscosities. Evidence that a 10–15 km wide transpressional shear zone in the lower crust evolved simultaneously with, and was connected physically to, a mid-crustal thrust system following batholith emplacement and crustal melting also indicates that deformation at these levels was coupled during the interval 116–105 Ma (Fig. 2B). Metamorphic data suggest that strengthening of the lower crust promoted vertical coupling during this phase and was aided by efficient melt extraction, dehydration, and cooling as the batholith crystallized and melt escaped.

Structural features in the upper crust of the arc exposed in Westland also are consistent with a relatively strong, cooling viscous lower crust after ~116 Ma. At shallow levels of the crust contractional deformation occurred within a narrow (50–75 km wide) zone focused along the western side of the MTZ (SP, Fig. 1; Tulloch and Challis, 2000). This narrow, focused structural style (Fig. 4A) supports the predictions of numerical models of orogens where a highly viscous lower crust preferentially transmits stresses vertically through the lithosphere (Royden, 1996; Ellis et al., 1998). The style also contrasts with the distributed style of near surface deformation in orogens characterized by a weak middle or lower crust (Fig. 4B).

Magmatism and Late Orogenic Extension

In some Cordilleran settings, late orogenic extension has been linked to a thermal weakening of the middle or lower crust (Vanderhaeghe and Teyssier, 1997;

Ellis et al., 1998). For example, in the Shuswap Ranges of southern British Columbia, crustal melting and magma intrusion decreased crustal viscosity by several orders of magnitude and appear to have aided the development of extensional structures within previously thickened crust (Vanderhaeghe and Teyssier, 2001). However, in Fiordland, the discovery of a vertical transpressional shear zone that formed after batholith emplacement, and evidence for a relatively strong lower crust that promoted vertical coupling prior to the onset of extension suggest an alternative mechanism at work. Late orogenic extension in western New Zealand appears to be linked to changes in plate boundary dynamics rather than a change in lower crustal rheology. The shift in structural style in Fiordland from contraction and crustal thickening to crustal thinning and decompression ca. 105 Ma corresponds to the end of subduction and a reorganization of plate boundaries outboard of Gondwana (J.D. Bradshaw, 1989). This implies that the development of a regional tensile stress field at this time resulted in the extensional failure of the lithosphere rather than a weakening of the lower crust by melt and heat.

These relationships suggest a different type of response to magmatism and melting of the lower crust in Fiordland (Fig. 4A) compared to other orogens that experienced deep crustal melting such as the Shuswap Range (Fig. 4B). One important reason for the mechanical response of the Fiordland-Westland orogen appears to be the mafic composition of the lower crust and the mineral reactions controlling melt production. In Fiordland, melt production was mostly controlled by hornblende-breakdown, which produced relatively low volumes of partial melt that were extracted from the lower crust via fracture networks and ductile shear zones. This situation contrasts with the high melt volumes and widespread development of diatexite in the Shuswap Range, where melt production in metapelitic protoliths was controlled by biotite and/or muscovite breakdown. These relationships imply that the hornblende-rich, mafic composition of the lower crust and the mineral reactions controlling melt production strongly influenced the mechanical behavior of the belt following magma emplacement.

In summary, the Fiordland setting provides a natural laboratory within which we can test our understanding of the feedbacks that develop among magmatism, metamorphism, and deformation during cycles of orogenesis. In addition, the approach of using parallel field, laboratory, and experimental studies may be one of the most important tools we have to develop a complete picture of coupled processes in the continental lithosphere. In Fiordland, this approach has revealed the mechanisms by which magma was generated and transported through lower continental crust and how these processes affected the evolution of the lithosphere over a 35 m.y. cycle.

ACKNOWLEDGMENTS

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LAST CHANCE!

UPCOMING DEADLINES

Committee Service

Nominations Due January 15, 2003

Candidates are needed for service on the following GSA committees: Annual Program; Arthur L. Day Medal Award; Education; Geology and Public Policy; Honorary Fellows; Joint Technical Program; Membership; Minorities and Women in the Geosciences; Nominations; Penrose Conferences and Field Forums; Penrose Medal Award; Professional Development; Research Grants; and Young Scientist Award. Candidates are also needed for a GSA representative to the North American Commission on Stratigraphic Nomenclature (NACSN). Service begins July 2003 for all positions except NACSN, which begins November 1, 2003, and Joint Technical Program, which begins January 1, 2004.

For complete information on committee service, current vacancies, and required qualifications, see the October 2002 issue of *GSA Today*. Nomination form and instructions are available at www.geosociety.org/aboutus/commtees/.

Officers and Councilors

Nominations Due January 15, 2003

The GSA Committee on Nominations requests nominations for officers (vice president and treasurer) and councilors to serve on the GSA Council beginning in 2004. Each nomination should be accompanied by basic data and a description of the qualifications of the individual for the position recommended.

Send materials for committee, officer, and councilor nominations to Ruth Harrison, GSA, P.O. Box 9140, Boulder, CO 80301-9140, (303) 357-1000, ext. 0, 1-800-472-1988, ext. 0, rharrison@geosociety.org.

Congressional Science Fellowship

Applications Due January 24, 2003

For application information for the 2003–2004 GSA–U.S. Geological Survey Congressional Science Fellowship, visit www.geosociety.org/science/csf/, or contact Karlon Blythe, Program Officer, GSA Headquarters, (303) 357-1036, kblythe@geosociety.org.

Medals and Awards

Nominations Due February 1, 2003

Nominations of candidates are requested for the following medals and awards: Penrose Medal, Day Medal, Honorary Fellows, Young Scientist Award (Donath Medal), GSA Public Service Award, and Distinguished Service Award. For details on the awards and nomination procedures, see the October 2002 issue of *GSA Today*, go to www.geosociety.org, or call (303) 357-1037. Materials and supporting information for any of the nominations may be sent to GSA, Grants, Awards, and Medals, P.O. Box 9140, Boulder, CO 80301-9140.

Student Research Grants

Applications Must Be Postmarked by February 1, 2003

For information on 2003 Research Grant Program for Students, see the October issue of *GSA Today* or visit www.geosociety.org. Application forms are available online, at the geology departments of colleges and universities offering graduate degrees in earth sciences, or from Grants, Awards, and Medals, GSA, P.O. Box 9140, Boulder, CO 80301, lcarter@geosociety.org.

2003 Doris M. Curtis Memorial Fund for Women in Science Award

(Sponsored by Subaru of America, Inc.)

Nominations Due February 1, 2003

This award is given to a woman or group of women who have impacted the field of the geosciences in a major way based on their Ph.D. research. For nomination, eligibility, and award details, see the October issue of *GSA Today*, or visit www.geosociety.org. Send nominations and supporting material to Grants, Awards, and Medals, P.O. Box 9140, Boulder, CO 80301-9140.

GSA Fellows

Nominations Due February 15, 2003

The Committee on Membership requests nominations of members to be elevated to GSA Fellow status. Any GSA Fellow may nominate a member for this honor. Two other supporting signatures are needed, along with a letter stating the member's qualifications to be evaluated on the basis of eight established criteria. For more information, a list of the criteria, and a nomination form, please see www.geosociety.org/members/fellow.htm or contact Nancy Williams, (303) 357-1017, nwilliams@geosociety.org.

John C. Frye Environmental Geology Award

Nominations Due March 31, 2003

In cooperation with the Association of American State Geologists, GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. For details, see the October issue of *GSA Today* or visit www.geosociety.org. Nominations must be sent to Program Officer, Grants, Awards, and Medals, GSA, P.O. Box 9140, Boulder, CO 80301-9140.

National Awards

Nominations Due April 30, 2003

Candidate nominations are needed for the following national awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, and Alan T. Waterman Award. For details, see the October issue of *GSA Today*. Nominations should be sent to GSA, Grants, Awards, and Medals, P.O. Box 9140, Boulder, CO 80301-9140.

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Final Announcement

55th Annual Meeting Rocky Mountain Section, GSA

THE GEOLOGICAL SOCIETY OF AMERICA

Fort Lewis College, Durango, Colorado • May 7–9, 2003

The 55th Annual Meeting of the Rocky Mountain Section will be hosted by the Department of Geosciences, Fort Lewis College and will be held on the campus of Fort Lewis College.

Durango is located in southwestern Colorado, in an area commonly referred to as the Four Corners. Known for its spectacular natural beauty and outdoor recreation, Durango is a popular tourist destination. Fort Lewis College sits at an elevation of 6,850 feet on a mesa of glacial outwash with spectacular views of the glacio-fluvial Animas River Valley and the historic mining districts of the La Plata and San Juan mountains. Approximately 16,000 feet of sedimentary rocks are exposed in the Durango area, representing a nearly complete stratigraphic column. Precambrian igneous and metamorphic rocks and Tertiary volcanic rocks can be reached by a short drive. Examples of virtually every type of geological phenomenon can be found within a short distance of Fort Lewis College. Of particular interest to this meeting is the San Juan Basin to the south, which has become one of the nation's largest coalbed methane-producing districts. Also, recent wildfires have created an opportunity to study the effects of fire on geologic processes (to the dismay of homeowners and the delight of geomorphologists).

GETTING HERE

Durango is approximately 6 hours from Denver and 3½ hours from Albuquerque by car. A regional airport approximately 15 miles from town serves Durango, but flights are limited so make your reservations early. It is also possible to fly into Farmington, New Mexico, about 50 miles from Durango.

Most downtown Durango hotels are within walking distance of campus (20 minutes); however, be advised that there is a difference in elevation of several hundred feet between town and campus. Public transportation also serves the campus from various parts of Durango. Contact www.durangogov.org/resident/services/transit.html for information.

To assist in finding your way around campus, you can download a map at www.fortlewis.edu/about_flc/maps/campusmap.pdf.

REGISTRATION

Preregistration deadline: April 4, 2003

GSA headquarters will handle registration. Preregister to qualify for lower registration fees. To obtain lower registration fees and to assist planning by the local committee, please preregister online at www.geosociety.org/sectdiv/rockymtn/03rmmtg.htm, or download the PDF preregistration form. If you are unable to preregister this way, contact GSA Member Services, 1-888-443-4472, member@geosociety.org.

All requests for registration changes or cancellations must be made in writing and received by April 11, 2003. No refunds will be made after this date.

On-site registration will be in the College Union Building:

Tues., May 6	4:30 p.m.–8 p.m.
Wed. and Thurs., May 7–8	7:30 a.m.–4 p.m.
Fri., May 9	7:30 a.m.–10 a.m.

ACCESSIBILITY

GSA is committed to making its meetings accessible to all people interested in attending. Indicate special requirements (wheelchair accessibility, etc.) on the registration form. Fort Lewis College is ADA compliant.

Preregistration Fees

	Full Meeting	One Day
Professional Member	$80	$50
Professional Member (70 and older)	$50	$45
Professional Nonmember	$90	$60
Student or Associate Member	$50	$40
Student Nonmember	$60	$45
K–12 Professional	$30	$30
Guest or Spouse	$45	$30
Field trip or workshop only	$25	$25

FIELD TRIPS

For further details on field trips, please contact either the trip leader or the field trip chair, Gary Gianniny, (970) 247-7254, gianniny_g@fortlewis.edu. Complete descriptions are posted at www.geosociety.org/sectdiv/rockymtn/03rmmtg.htm.

Premeeting

1. **Geology, Mountains, and Mining History Along the San Juan Skyway**. Mon. and Tues., May 6–7. David Gonzales, Department of Geosciences, Fort Lewis College, Durango, CO 81301, (970) 247-7378, gonzales_d@fortlewis.edu; Duane Smith, Southwest Studies, Department of History, Fort Lewis College, Durango, CO 81301, (970) 247-7457, smith_d@fortlewis.edu; Jack Ellingson, Professor Emeritus, Department of Geosciences, Fort Lewis College, Durango, CO 81301, ellingson_j@fortlewis.edu. Max.: 18; min.: 10. Cost: $200 (includes guidebook, two lunches, one night in hotel, and transportation in vans).
2. **Advances in Mesozoic Stratigraphy of the Durango Area.** Tues., May 6. Spencer Lucas and David Blodget, (505) 841-2873, SLucas@nmmnh.state.nm.us. Max.: 27; min.: 9. Cost: $60 (includes transportation, box lunch, and guidebook).
3. **Erosion and Sedimentation Following the 2002 Missionary Ridge Fire.** Tues., May 6. Andrew Gleason, algleason@frontier.net. Max.: 27; min.: 9. Cost: $60 (includes transportation, box lunch, and guidebook).
4. **Investigations of Seeps in the Fruitland Formation, La Plata County, Colorado.** Tues., May 6. W.C. Riese, BP America, rriese1@bp.com; and Tom Ann Casey, EnerVest Operating, (970) 247-1500, ext. 204, tacasey@enervestdgo.com. Max.: 27; min.: 9. Cost: $60 (includes transportation, box lunch, and guidebook).

Postmeeting

5. **Tectonoeustatic Sedimentation on the Flanks of the Ancestral Rockies, Pennsylvanian Hermosa Group.** Sat., May 10. Gary Gianniny, (970) 247-7254, gianniny_g@fortlewis.edu. Max.: 27; min.: 9.

Cost: $60/professional, $40/student (includes transportation, box lunch, and guidebook). Trip will reach elevations of 10,000 ft and will require participants to be able to walk over uneven terrain.

6. **Proterozoic Rocks of the Tusas Mountains and the Quartzite-Rhyolite Problem**. Sat. and Sun., May 10–11 (leave from Durango on Friday night). Mike Williams, University of Massachusetts, mlw@geo.umass.edu; Karl Karlstrom, University of New Mexico, (505) 277-4346, kek1@unm.edu; Peter Davis; and Joe Kopera. Max.: 40; min.: 20. Cost: $190 (includes 2 nights accommodation, plus B, L, D on Sat. and B and L on Sun.).
8. **Natural and Prehistoric Human Systems in the Canyons of the Ancients and Durango Areas.** *Sponsored by GSA Archaeological Geology Division.* Sat. and Sun., May 10–11. Kenneth E. Kolm, Washington State University and Argonne National Laboratory, (303) 986-1140, ext. 251, kkolm@mines.edu; Mark D. Varien; Mona A. Charles; Mary L. Gillam; Kim Gerhardt. Max.: 27; min.: 10. Cost: $80 (2L, vans). All hikes except the last are suitable for the physically challenged.

TECHNICAL PROGRAM

Technical sessions will generally be 12 minutes in length with three minutes for questions. Some sessions may use a longer format. Speakers will have access to two 35mm slide projectors and screens (speakers must provide their own carousels), an overhead projector, and a PC and data projector. Speakers wishing to use digital media are restricted to PowerPoint presentations and must submit CDs prior to their sessions to test for compatibility. Speakers should also bring slides or overhead transparencies as backup. Speakers are not permitted to use their own laptops.

Poster sessions will be held in the Ballroom of the College Union Building. Poster space will be 4×8 feet (additional space available by request). Authors will be required to be present for at least two hours.

Complete descriptions are posted at www.geosociety.org/sectdiv/rockymtn/03rmmtg.htm.

SYMPOSIA

1. **The San Juan Mountains: A Dynamic Earth System.** *Sponsored by the Mountain Studies Institute.* Rob Blair, Fort Lewis College, Department of Geosciences, (970) 247-2703, blair_r@fortlewis.edu; and Thomas Casadevall, U.S. Geological Survey, (303) 202-4740, tcasadev@usgs.gov.
2. **Water Resources in the Rocky Mountains: A Holistic View Centered on Coupled Processes.** Jonathan Saul Caine, U.S. Geological Survey, jscaine@usgs.gov, (303) 236-1822; Shemin Ge, University of Colorado, Boulder, GES@spot.colorado.edu, (303) 492-8323.
3. **Relationships of Physical Systems to Archaeological Records and Prehistoric Cultures in the Four Corners Area.** Kenneth E. Kolm, Washington State University, Pullman, Wash., and Argonne National Laboratory, Lakewood, Colo., (303) 986-1140, ext. 251, kkolm@mines.edu; and Mary L. Gillam, independent geologist, 115 Meadow Road East, Durango, CO, (970) 259-0966, gillam@rmi.net.

The following four sessions will focus on topics related to the geologic evolution of the Rocky Mountains from the Precambrian to Holocene.

4. **Rise and Fall of the Rocky Mountains I: Proterozoic Lithospheric Evolution and Influence of Basement Fabric on Younger Tectonism in the Rocky Mountains.** Karl Karlstrom, University of New Mexico, Department of Earth and Planetary Sciences, (505) 277-4346, kek1@unm.edu; and David Gonzales, Fort Lewis College, Department of Geosciences, (970) 247-7378, gonzales_d@fortlewis.edu.
5. **Rise and Fall of the Rocky Mountains II: The Late Paleozoic Ancestral Rocky Mountains: Intraplate Orogeny in Equatorial Pangea.** Lynn Soreghan, University of Oklahoma, Geology and Geophysics, Norman, OK 73019, (405) 325-4482, lsoreg@ou.edu; Gary Gianniny, Fort Lewis College, Department of Geosciences, Durango, CO 81301, (970) 247-7254, gianniny_g@fortlewis.edu; Dave Barbeau, Department of Geosciences, University of Arizona, Tucson, AZ 85721, (520) 621-4910, dbarbeau@geo.arizona.edu.
6. **Rise and Fall of the Rocky Mountains III: Tectonics, Eustasy, and Climate Change During the Age of Dinosaurs.** Spencer Lucas, New Mexico Museum of Natural History and Science, (505) 841-2873, slucas@nmmnh.state.nm.us; Andrew Heckert, New Mexico Museum of Natural History and Science, (505) 841-2842, aheckert@nmmnh.state.nm.us.
7. **Rise and Fall of the Rocky Mountains IV: The Ups and Downs of the Cenozoic.** Bob Kirkham, Colorado Geological Survey, (719) 587-0139, rmk@amigo.net; Karl S. Kellogg, U.S. Geological Survey, (303) 236-1305, kkellogg@usgs.gov.
8. **Seeps, Science, and Myth: Geology and Hydrology of Shallow Hydrocarbons.** *Sponsored by the Four Corners Geological Society*. Tom Ann Casey, EnerVest Operating, (970) 247-1500 ext. 204, tacasey@enervestdgo.com; Ed Heath, independent geologist, (970) 375-1997, ewheath@frontier.net; Matt Janowiak, Bureau of Land Management, (970) 247-4874, matthew_janowiak@co.blm.gov.

THEME SESSIONS

1. **Undergraduate Research Poster Session**. *Sponsored by the Council on Undergraduate Research—Geoscience Division.* This session will showcase senior theses and other undergraduate research projects. A student must be listed as the lead author and be the major preparer of the poster. For further information, contact Kim Hannula, (970) 247-7463, hannula_k@fortlewis.edu.
2. **Artful Eye in Geology: Imagery and Photography.** Ray Kenny, (970) 247-7462, kenny_r@fortlewis.edu.
3. **National Association of Geoscience Teachers Session: Classroom and Laboratory Demonstrations of Geologic Phenomena.** Fred Lohrengel, lohrengel@suu.edu.
4. **Paleontology Society Session: Regional Topics in Paleontology.**
5. **Geologic Processes in the Post-fire Environment.** Chris Wilbur, (970) 247-1488, wilbureng@frontier.net.
6. **The Western San Juan Volcanic Field, Colorado Structural Setting, Evolution, and Geomorphology.** Allen Stork, Western State College, astork@western.edu; Steve Semken, Dine College, Shiprock, N.Mex., scsemken@shiprock.ncc.cc.nm.us, (505) 368-3630.
7. **Regional Topics in Archaeogeology.** E. Craig Simmons, Department of Chemistry and Geochemistry, Colorado School of Mines, (303) 273-3644, csimmons@mines.edu.

WORKSHOPS

1. **Roy J. Shlemon Mentor Program in Applied Geology.** *Sponsored by GSA Foundation*. Thurs., May 8, 11:30 a.m.–1 p.m. Karlon Blythe, GSA, (303) 357-1036, kblythe@geosociety.org. Free (includes lunch).This interactive and informal workshop for undergraduate and graduate students is led by practicing geoscientists and covers real-life issues such as the professional opportunities and challenges that await students after graduation. Students will receive in their registration packet a FREE LUNCH ticket to attend the Shlemon Program. However, space is limited. First come, first served.
2. **Processing and Interpretation of Satellite Imagery for Geologic Mapping.** Tues., May 6, 8 a.m.–5 p.m. Room 680, Berndt Hall, Fort Lewis College. John C. Dohrenwend, Southwest Satellite Imaging, Teasdale, Utah, (435) 425-3118, dohrenwend@rkymtnhi.com. Cost: $150 (includes course notebook with sample data sets on CD-ROM and one digital Landsat TM scene on CD covering an area of the participant's choice in the southwest U.S.). Max.: 25.

Students: **Get a free lunch** plus solid career advice. See "Workshops" (this page) for information on the Shlemon Mentor Program.

3. **Mapping Techniques using Garmin GPS and ArcView GIS.** Fri., May 9. Room 680, Berndt Hall, Fort Lewis College. Scott White, Department of Geosciences, Fort Lewis College, (970) 247-7475, white_s@fortlewis.edu. Cost: $100 (includes course notebook with GIS-ready data sets on CD-ROM). No prior experience using GIS is required.

SPECIAL EVENTS

Ice Breaker. 6 p.m., Tues., May 6. College Union Building Ballroom.

Paleontological Society Luncheon and Business Meeting. Wed., May 7, noon, College Union Building Colorado Room. Cost: $15/professionals, $12/students.

Annual Banquet and Business Meeting. 7 p.m., Thurs., May 8, College Union Building Memorial Lounge. Cost: $18.

Rocky Mountain Section Board Meeting. 7 a.m., Fri., May 9, Rochester Hotel.

SPOUSE & GUEST ACTIVITIES

The Durango area offers a variety of activities including shopping, hiking, mountain biking, white water boating, and archeological tours. Information on these and other activities is obtainable from the Durango Area Chamber Resort Association, (800) 463-8726, www.dacra.com.

STUDENT TRAVEL

The Rocky Mountain Section and the GSA Foundation have travel grants available for students who are presenting oral or poster papers. Students must be currently enrolled and must be Rocky Mountain GSA members. Students should contact Kenneth Kolm, Argonne National Laboratories, (303) 986-1140, ext. 251, kkolm@anl.gov.

STUDENT AWARDS

Awards will be given for best student oral (undergraduate or graduate) and poster (undergraduate only) presentations. To be eligible, students must be lead author and presenter and should clearly identify their abstracts as student work.

EXHIBITS

Exhibit space will be available at $250 per booth for commercial organizations and $100 per booth for non-profits. Contact Scott White, (970) 247-7475, white_s@fortlewis.edu.

ACCOMMODATIONS

The Rocky Mountain Section has arranged special rates at the following hotels. Please contact the hotels directly for reservations. Be sure to mention that you wish a Rocky Mountain GSA rate. Because Durango is a popular tourist destination, it is recommended that you make your reservations early.

Strater Hotel, 699 Main Ave., (800) 247-4431. Single $109; double $119; deluxe single $129.

General Palmer, 567 Main Ave., (970) 259-4138. Single/double $65.

Doubletree Hotel, 501 Camino Del Rio, (970) 259-6580. Single/double $79.

Best Western Rio Grande, 400 E. 2nd Ave., (970) 385-4980. Single $59; double $69.

Those wishing to stay on campus can reserve student apartments for $16/night by contacting Lynette Mayo, (970) 247-7620, mayo_l@fortlewis.edu. These are single rooms with shared baths. Descriptions and floor plans for student accommodations (West Hall) can be viewed at www.fortlewis.edu/student_services/housing/residence_halls.htm.

ADDITIONAL INFORMATION

Still have questions? Contact the general chair, James Collier, (970) 247-7129, collier_j@fortlewis.edu, the technical program chair, David Gonzales, (970) 247-7378, gonzales_d@fortlewis.edu, or the field trip chair, Gary Gianniny, (970) 247-7254, gianniny_g@fortlewis.edu, or visit www.geosociety.org/sectdiv/rockymtn/03rmmtg.htm.

2003 GSA Section Meetings

South-Central–Southeastern Sections Joint Meeting
March 12–14, 2003
University of Memphis, Memphis, Tennessee
Information: Dan Larsen, Dept. of Earth Sciences, University of Memphis, 421 J.M. Smith Bldg., Memphis, TN 38152, (901) 678-4358, dlarsen@memphis.edu.

North-Central Section
March 24–25, 2003
Kansas City Airport Hilton, Kansas City, Missouri
Information: Raymond M. Coveney Jr., Dept. of Geosciences, 420 Flarsheim Hall, University of Missouri, 5110 Rockhill Rd., Kansas City, MO 64110-2499, (816) 235-2980, coveneyr@umkc.edu.

Northeastern Section
March 27–29, 2003
Westin Hotel, Halifax, Nova Scotia
Information: Jane Barrett, Dept. of Earth Sciences, Dalhousie University, Halifax, NS B3H 3J5, Canada, (902) 494-1473, jmbarret@is.dal.ca.

Cordilleran Section
April 1–3, 2003
Hotel NH Krystal, Puerto Vallarta, Mexico
Information: Elena Centeno-García, Instituto de Geología, Universidad Nacional Autónoma de México, (National Autonomous University of Mexico), Ciudad Universitaria, México, D.F. 04510, México, centeno@servidor.unam.mx.

Rocky Mountain Section
May 7–9, 2003
Fort Lewis College, Durango, Colorado
Abstract deadline: January 30, 2003
Information: James Collier, Dept. of Geosciences, Fort Lewis College, 1000 Rim Dr., Durango, CO 81301-3999, (970) 247-7129, collier_j@fortlewis.edu.

1. Cordilleran Section
2. Rocky Mountain Section
3. North-Central Section
4. South-Central Section
5. Northeastern Section
6. Southeastern Section

ADVANCE YOUR CAREER:

Apply for Grants, Awards, and Scholarships

Gladys W. Cole Memorial Research Award
W. Storrs Cole Memorial Research Award
2003 Research Grant Program for Students

For application forms or for more information, contact Leah Carter, Grants, Awards, and Medals, GSA, P.O. Box 9140, Boulder, CO 80301-9140, lcarter@geosociety.org. Application forms are also available at www.geosociety.org. Go to "Grants, Awards & Medals." **Applications must be postmarked by February 1, 2003.**

GSA Coal Geology Division's
Antoinette Lierman
Medlin Scholarship in Coal Geology

For details, see the December issue of *GSA Today* or visit www.geosociety.org. Go to "Grants, Awards & Medals," then to "Medlin Grant." Send application materials to: Leslie F. Ruppert, Coordinator, A. Lierman Medlin Scholarship Committee, U.S. Geological Survey, 956 National Center, Reston, VA 20192, (703) 648-6431, lruppert@usgs.gov. **Applications are due February 15, 2003.**

Alternates Receive 2002 Student Research Grants

Each year when the Committee on Research Grants selects student grant recipients, it also selects 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 Program Officer to the alternates named by the committee.

In 2002, seven alternates received funding following the initial awarding of grants.

They are:

Sean Sundermann, University of Colorado

Christopher Lopez, University of Nevada, Reno

Philip Ong, University of Michigan

Carl Ozyer, University of Western Ontario

Charlotte Hedlund, San Francisco State University

Mark Loewen, University of Utah

Katherine Boggs, University of Calgary

GeoVentures

GeoTrip

Basalts, 'Beests, and Bee-Eaters: The Geologic and Natural History of the Kenya Rift and Environs, Kenya and Northern Tanzania

July 30–August 14, 2003

Co-Leaders: Timothy F. Lawton, New Mexico State University, Las Cruces, and Brenda J. Buck, University of Nevada, Las Vegas

For complete information on this fabulous GeoTrip, see the December 2002 issue of *GSA Today*, visit www.geosociety.org (go to "Meetings and Excursion" then to "GeoVentures"), call (303) 357-1034, or e-mail ecollis@geosociety.org.

The focus of this GeoTrip to the Kenya rift is to explore the geologic and natural history of this unique tectonic province and its associated spectacular environments, supporting a variety of bird and wildlife habitats. Participants will have the opportunity to hike and view ice-sculpted landscapes on glaciated Mount Kenya, Kenya's highest peak, situated squarely on the equator; visit saline internally drained lakes in the rift itself; boat immense Lake Victoria, the second largest freshwater lake in the world in the topographic sag between the rift valleys; traverse the Precambrian shield on the north edge of the Serengeti Plains; explore the spectacular Ngorongoro Crater, an intra-rift caldera; visit Olduvai Gorge, the cradle of humankind; and ponder the great Kilimanjaro, Africa's highest peak. This will be an unforgettable adventure in exotic geology and wildlife!

Fees and Payment: $5,650 for GSA members; $5,750 for nonmembers. A $500 deposit is due with your reservation and is refundable (less $300 cancellation fee) through June 1. Balance is due June 1. Fee is based on double occupancy. Single supplement, based on availability, is an additional $895. Minimum number of participants (firm): 15; maximum: 40. Included: Accommodations in twin bedded rooms; all meals on tour beginning August 1; flights within East Africa; guidebook; all tips and gratuities to drivers/guides, hotel, and camp staff; temporary membership in the Flying Doctors Service; government taxes and levies. Not included: Airfare to Nairobi and return from Tanzania; optional tours; lunch in Nairobi on August 9; entry visa fees to Kenya and Tanzania (approx. $100); alcoholic beverages; and other expenses not specifically included.

Shlemon Mentor Programs Offer Students Important Career Tips

Karlon Blythe, Program Officer

If you are a geoscience student about to earn your degree and are already worrying about paying back college loans, career tips can be pretty important. Held exclusively for undergrad and graduate students at GSA Section meetings, the Roy J. Shlemon Mentor Programs in Applied Geoscience bring volunteer mentors from various disciplines together with students for informal Q & A luncheons. Free lunches were provided by the program and the GSA Foundation.

Volunteer mentors currently practicing applied geoscience shared insights on interview techniques, professional registration, getting practical summer experience, the potential job market, and much more. This year, 26 mentors met with 284 students at meetings across the nation, exemplifying the spirit of mentoring by generously sharing their personal time, professional experiences, advice, and resources.

At the Northeastern Section Meeting in Springfield, Massachusetts, mentors were Christopher Mitchell, ENSR International, Westford, Mass., Jonathan Child, Fuss & O'Neill, Inc., West Springfield, Mass., and Lyons Witten, Coler & Colantonio, South Deerfield, Mass. Thirty-five students filled the meeting room and participated in thought-provoking conversations. "The atmosphere was very relaxed and inviting, making it easy to ask questions," remarked a student. "Opinions of managerial-level geoscientists gave me a clear perspective on the relative importance of employable skills," noted another.

The combined Southeastern and North-Central Section meeting had the largest attendance in Shlemon program history, with 100 students attending over the two days of programs. Kitchen staff hustled, but mentors kept pace for a standing-room-only crowd. This event tapped eight mentors: Edward Woolery, John E. Kiefer, William (Drew) Andrews Jr., and John Hickman, all of the Kentucky Geological Survey, Lexington; Peter Goodmann, Kentucky Department of Environmental Protection; Elizabeth Haynes, Haley & Aldrich, Denver, Colorado; James Robertson, Wisconsin Geological Survey, Madison, Wisconsin; and Norm Hester, director of the Association of CUSEC State Geologists, Bloomington, Indiana. While the Kentucky Survey was well represented, students quickly learned that these professionals had a wealth of job experiences to share from previous employment. At meetings' end, students said: "A rare opportunity to be able to talk to professionals on a one-on-one basis—so much better than lectures!"; "Really interesting to hear about the educational and employment histories of the mentors—learning how they got to where they are and why"; and "I appreciate the *encouragement.*"

Again, at the Shlemon Program for the South-Central Section Meeting in Alpine, Texas, vanloads of students jammed the meeting room and additional tables and chairs were hastily unfolded for the 63 students. Six mentors rallied to field questions from enthusiastic students: James G. Buchanan, Conoco Energy Ventures, Houston, Texas; Steve Finch, John Shomaker & Associates, Inc., Albuquerque, N.M.; Eddie Collins, Texas Bureau of Economic Geology, Austin; Bob Stottlemyer, USGS; Leverett Bogle, U.S. Army Corps of Engineers, Fort Collins, Colo., and Thomas Fouch, USGS, retired, Lakewood, Colo. Students later said: "I've learned a lot about the geo industry and about different options I should consider after school"; and "I appreciate the encouraging and hopeful words."

At the Rocky Mountain Section Meeting in Cedar City, Utah, classes were out for the semester, and the campus was quiet, yet 34 eager students showed up for the Shlemon Program lunch. Six enthusiastic geoscientist mentors came ready to share advice and experience: Sue Ann Finstick; Bulloch Brothers Engineers, Cedar City, Utah; David B. Simon, Simon Bymaster, Inc., Salt Lake City, Utah; Rick Allis, Utah Geological Survey, Salt Lake City; Darlene Batatian, Salt Lake County Geologist; Janice M. Higgins, Department of Natural

Looking for a fun experience?

We need mentors from applied geoscience to help maintain the momentum of the Shlemon Mentor Programs for spring 2003. If you're planning to attend a GSA Section meeting and would be interested in joining enthusiastic students over a free lunch, please contact program officer Karlon Blythe, kblythe@geosociety.org, (303) 357-1036. For more information on the Shlemon Mentor Programs, visit www.geosociety.org/science/shlmindx.htm.

Resources, St. George, Utah; and John W. Rold, a consultant from Lakewood, Colo. Students said: "Great to have such personal attention"; and "Really liked the Q & A format—lots of different viewpoints."

The Cordilleran Section meeting at Corvallis, Oregon, wrapped up the Shlemon Programs for the year. Mentors Dorian and Tom Kuper of Kuper Consulting LLC, Tualatin, Oregon, led the first day's Shlemon program, attended by 43 students who eagerly picked up thick, bound copies of handouts provided by the Kupers. The handouts included a wealth of information on academic preparedness, challenges in securing a job, employment opportunities, employer expectations, and professional ethics and registration. The second day, the Kupers and mentor Tim Marshall, Manager of Land Planning for Morse Brothers, Inc., Tangent, Oregon, hosted a vanload of students on a field trip to Morse Brothers' mining operation for an up-close, hands-on look at applied geoscience. One student remarked: "Not many students have the opportunity to walk onto a mining operation and see reclamation in progress." Others commented, "The handout is just stuffed with information—thank you!" and "The Kupers alluded to issues of ethics and safety that I've never even thought about—what an eye-opener."

One common refrain heard repeatedly from students was their appreciation of the mentors, Roy J. Shlemon, and GSA for providing them the opportunity to explore the real world of applied geoscience. As for the free lunches, one student succinctly captured the students' gratitude saying "Roy ROCKS—thanks for the lunch!"

Shlemon Programs for 2003
Don't Miss Them!

Places and dates for the spring 2003 Shlemon Mentor programs:

South-Central—Southeastern Sections Joint Meeting
Thurs. and Fri., March 13–14, 11:30 a.m.–1 p.m.
University of Memphis, Memphis, Tennessee

North-Central Section
Mon., March 24, 11:30 a.m.–1 p.m.
Kansas City Airport Hilton, Kansas City, Missouri

Northeastern Section
Thurs. and Fri., March 27–28, 11:30 a.m.–1 p.m.
Westin Hotel, Halifax, Nova Scotia

Cordilleran Section
Tues. and Wed., April 1–2, 11:30 a.m.–1 p.m.
Hotel NH Krystal, Puerto Vallarta, Mexico

Rocky Mountain Section
Thurs., May 8, 11:30 a.m.–1 p.m.
Fort Lewis College, Durango, Colorado

NEW *GSA Today* Schedule for 2003

This year, *GSA Today* will publish a combined April/May issue, with the issue scheduled to be delivered in the beginning of April. Deadlines for ads: February 20 for display ads; March 3 for classified ads.

Call for Nominations: GSA Division Awards

Funds for the following GSA Division awards are administered through the GSA Foundation.

DON J. EASTERBROOK DISTINGUISHED SCIENTIST AWARD

The Quaternary Geology and Geomorphology Division of GSA seeks nominations for the Don J. Easterbrook Distinguished Scientist Award. This award will be given to an individual who has shown unusual excellence in published research, as demonstrated by a single paper of exceptional merit or a series of papers that have substantially increased knowledge in Quaternary geology or geomorphology. No particular time limitations apply to the recognized research. The recognition is normally extended to an individual, but in the event of particularly significant research by more than one person, two people may share the award. Monies for the award are derived from annual interest income from the Don J. Easterbrook Fund, administered by the GSA Foundation.

Although recognition of extraordinary prior research excellence is the principal goal of this award, it carries with it an opportunity for funding additional research. The Easterbrook Distinguished Scientist is eligible to draw funds for research from the GSA Easterbrook Fund in an amount to be determined by availability of funds. This opportunity for funding additional research by the winner is a secondary consideration of this award.

Members of the Quaternary Geology and Geomorphology Division Award Panel will evaluate nominations for the Easterbrook Award. Because the award primarily recognizes research excellence, self-nomination is not allowed. Nominees need not be members of the division. Nominations are not automatically carried forward to subsequent years, but the same individuals may be renominated.

Nominations must be accompanied by supporting documentation, including a statement of the significance of the nominee's research, curriculum vitae, letters of support, and any other documents deemed appropriate by the nominating committee. Send nominations by April 1, 2003, to J. Steven Kite, Dept. of Geology & Geography, West Virginia University, 425 White Hall, Morgantown, WV 26506-6300, jkite@wvu.edu.

FAROUK EL-BAZ AWARD FOR DESERT RESEARCH

The GSA Quaternary Geology and Geomorphology Division seeks nominations for the Farouk El-Baz Award for Desert Research. This award rewards excellence in research in desert geomorphology worldwide and is intended to stimulate research in desert environments by recognizing an individual whose research has significantly advanced the understanding of the Quaternary geology and geomorphology of deserts. Although the award primarily recognizes achievement in desert research, the funds that accompany it ($10,000 in 2003) may be used for further research. The award is normally given to one person but may be shared by two people if the recognized research was the result of a coequal partnership. Monies for the award are derived from annual interest income from the Farouk El-Baz Fund, administered by the GSA Foundation.

Any scientist from any country may be nominated for the award. Because the award recognizes research excellence, self-nomination is not permitted. Neither nominators nor nominees need be members of GSA. Nominations must be accompanied by a statement of the significance of the nominee's research, a curriculum vitae, letters of support, and documentation of published research results that have significantly advanced the knowledge of Quaternary geology and geomorphology of desert environments.

Send nominations by April 1, 2003, to Ellen Wohl, Dept. of Earth Resources, Colorado State University, Fort Collins, CO 80523-1482, ellenw@cnr.colostate.edu.

LAURENCE L. SLOSS AWARD FOR SEDIMENTARY GEOLOGY

The Sedimentary Geology Division of GSA solicits nominations for the 2003 Laurence L. Sloss Award for Sedimentary Geology. This award is given annually to a sedimentary geologist whose lifetime achievements best exemplify those of Larry Sloss—i.e., achievements that contribute widely to the field of sedimentary geology and through service to GSA. Monies for the award are derived from annual interest income from the Laurence L. Sloss Award for Sedimentary Geology fund, administered by the GSA Foundation.

Nominations should include a cover letter describing the nominee's accomplishments in sedimentary geology, contributions to GSA, and curriculum vitae. The management board of the Sedimentary Geology Division will choose the recipient from the two nominees forwarded from the nominations committee, and the award will be presented at the GSA Annual Meeting in Seattle in November.

Send nominations by March 1, 2003, to Paul Karl Link, Treasurer, Sedimentary Geology Division, via e-mail (with attachments) to linkpaul@isu.edu..

GILBERT H. CADY AWARD

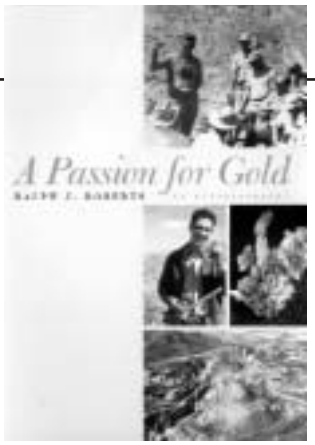
The Coal Geology Division of GSA seeks nominations for the 2003 Gilbert H. Cady Award, made for outstanding contributions in the field of coal geology. As defined in the division's bylaws, "Coal geology refers to a field of knowledge concerning the origin, occurrence, relationships, and geologic characteristics of the many varieties of coal and associated rocks, including economic implications." The first award, established by the division in honor of Gilbert H. Cady, was presented in 1973. Monies for the award are derived from annual interest income from the Gilbert H. Cady Memorial Fund, administered by the GSA Foundation. The award (a certificate and an engraved silver tray) will be made for contributions considered to advance the field of coal geology within and outside North America and will be presented at the Coal Geology Division Business Meeting at the 2003 GSA Annual Meeting in Seattle.

Nominations will be evaluated by the Gilbert H. Cady Award Panel and should include: name, office or title, and affiliation of nominee; date and place of birth, education, degree(s), and honors and awards; major events in his or her professional career and a brief bibliography; and outstanding achievements and accomplishments that warrant nomination.

Send three copies of the nomination by February 28, 2003, to Leslie F. Ruppert, U.S. Geological Survey, National Center, MS 956, Reston, VA 20192, (703) 648-6431, fax 703-648-6419, lruppert@usgs.gov.

BOOK REVIEW

A Passion for Gold: An Autobiography



Ralph J. Roberts, *University of Nevada Press, 2002, www.nvbooks.nevada.edu, 232 p., $29.95.*

"Being in the right place at the right time" landed Ralph Roberts in Nevada as a junior geologist for the U.S. Geological Survey (USGS) in 1939. Under the tutelage of Henry G. "Fergie" Ferguson and D. Foster Hewett, Roberts began a lifelong interest in the geology and mineral prospects of the region. It is fair to say that the regional studies carried out in Nevada by USGS geologists laid the foundation on which today's gold mining boom rests. It is equally fair to say that the spark needed to start the boom was provided by Roberts' work and ideas and his efforts to introduce his concepts to industry.

The name Roberts and Carlin belt belong together, but Roberts' intriguing successes do not stop there. In the 1970s, he was a member of the USGS mission assigned to study the potential for ore deposits in Saudi Arabia. Again, he was in the right place at the right time. Given a chance to examine the ancient gold workings of Mahd adh Dhahab, Roberts and co-workers carried out geochemical tests that led to exploration drilling and eventually to a revival of gold mining in this ancient mining camp.

When I worked for the USGS in the 1960s, I had the privilege of meeting Ralph Roberts. We tried to get a joint field-lab project started to study the geology and mineralization of the Bingham district. The project was to be funded and run by USGS personnel, but we needed access to all mining properties in the district. We failed to get agreement from the largest, the Kennecott Co., and the project died in the administrative echelons of that company. I also had the privilege of meeting Roberts' brilliant son Steve when he was a graduate student at Harvard. With his tragic, accidental death we lost one who was destined to be a leader in our profession.

Ralph Roberts' story weaves geology, family life, personal experiences, and professional comments in an intriguing manner. The story recounts a grand era when careful work by dedicated USGS geologists laid the groundwork by which the mining industry was maintained. I think it should be read that way—as an account of the work of many, and the role of one who was a major player who has now told his story. As I read the book, I could almost hear Ralph talking about his work and making his passionate point that an understanding of mineralization can only come with a full understanding of the geological territory in which it occurs.

I enjoyed Ralph's story for its candor and its record of the work of a generation now passing. It's neither great history nor great literature, but it is a great read.

Brian J. Skinner
Yale University

Hugh Jenkyns

GSA ANNOUNCES NEW *GEOLOGY* SCIENCE CO-EDITOR

Hugh Jenkyns of the University of Oxford joins David Fastovsky (University of Rhode Island) and Ben van der Pluijm (University of Michigan) as science co-editor for *Geology* this month.

Jenkyns began his research career in the late 1960s working on drowned carbonate platforms and deep-water pelagic sediments in western Sicily—an area now interpreted as a "starved" continental margin of the Mesozoic Tethys. "In those days, I considered myself a sedimentologist," Jenkyns says. "Participation in Legs 33 and 61 of the Deep Sea Drilling Project introduced me to the science of paleoceanography and my subsequent work has centered on this burgeoning field. In particular, I am interested in using isotopic tracers—particularly carbon isotopes, nitrogen isotopes, oxygen isotopes, strontium isotopes, neodymium isotopes—as both stratigraphic tools and as indicators of major global change, be it climatic, oceanographic or tectonic. I would probably now describe myself as a paleoceanographer or simply as a stratigrapher. I have taught various aspects of 'soft-rock' geology at the Universities of Cambridge, Durham, and Oxford."

Jenkyns sees *Geology* as the most stimulating non-specialist journal in the earth sciences. "During my own career, I have seen several fields within geology change from exciting and active to dull and inactive; some specialist journals have suffered the same fate," he says. "A generalist journal can always potentially fill an important role within the science. The ideal of all three editors is to make *Geology* the journal that regularly captures the most innovative and thought-provoking developments in our science."

THE GEOLOGICAL SOCIETY OF AMERICA

SCIENCE ▪ STEWARDSHIP ▪ SERVICE

ANNOUNCEMENTS

MEETINGS CALENDAR

2003

April 1–3	Natural Science and Public Health: Prescription for a Better Environment: A National Conference on U.S. Geological Survey Health-Related Research, Reston, Virginia. Information: http://health.usgs.gov/health2003.html.
June 2–6	2003 Canadian Society of Petroleum Geologists (CSPG) and Canadian Society of Exploration Geophysicists (CSEG) Convention: Partners in a New Environment, Calgary, Alberta, Canada. Information: www.cspg.org or www.cseg.ca.
June 2–6	IV International Convention on Environment and Sustainable Development, Havana, Cuba. Information: Rachel Bruhnke, Eco Cuba Exchange, 2017 Mission Street, Suite #303, San Francisco, CA 94708, USA, (415) 575-5531, fax 415-255-7498, rachel@globalexchange.org, www.globalexchange.org/tours/forms.html. *(Abstracts deadline: March 15, 2003.)*
June 8–13	24th Annual Conference of the Society of Wetland Scientists: Wetland Stewardship—Changing Landscapes and Interdisciplinary Challenges, New Orleans, Louisiana, USA. Information: www.sws.org/neworleans, Robert R. Twilley, Program Co-chair, Center for Ecology and Environmental Technology, University of Louisiana at Lafayette, P.O. Box 42451, Lafayette, LA 70504, USA; ceet@louisiana.edu, (337) 262-1776, fax 337-262-1866.
June 29–July 2	American Water Resources Association 2003 Summer Specialty Conference: "Watershed Management for Water Supply Systems" an International Congress, in New York City. Information: Peter E. Black, Organizing Chair, pebchair@esf.edu, www.awra.org/meetings/NewYork2003/index.html.
August 10–12	Silver Jubilee Anniversary Meeting of the Northeastern Science Foundation. Information: Gerald M. Friedman, Northeastern Science Foundation, 15 Third St., P.O. Box 746, Troy, New York 12181-0746, USA, gmfriedman@juno.com, (518) 273-3247, fax 518-273-3249, http://us.geocities.com/northeasternscifdn.
August 10–14	Earth Science for the Global Community—GeoSciEd IV: A Meeting of the International Geoscience Education Organization, Calgary, Alberta, Canada. For complete information and a downloadable flyer, visit www.geoscied.org.
October 22–24	53rd Annual Gulf Coast Association of Geological Societies Convention, Baton Rouge, Louisiana. Information: Harry H. Roberts, Technical Program Chairman, 331 Howe-Russell Geoscience Complex, Coastal Studies Institute, Louisiana State University, Baton Rouge, LA 70803; (225) 578-2964, (225) 578-2520, hrober3@lsu.edu, www.brgs-la.org/gcags.htm, www.brgs-la.org.

2004

April 14–19	5th International Symposium on Eastern Mediterranean Geology, Thessaloniki, Greece. Information: Alexandros Chatzipetros, Department of Geology, Aristotle University of Thessaloniki, 54124, Greece, Tel: +30 (231) 09-98-512, fax +30 (231) 09-98-482, ac@geo.auth.gr, 5thISEMG@geo.auth.gr, www.geo.auth.gr/5thISEMG.

NASA *Voyages* Online

The latest issue of *Voyages*, the NASA Office of Space Science Newsletter on Education and Public Outreach is now online at http://spacescience.nasa.gov/education/news/index.htm.

Voyages is published three times each year and highlights programs, events and products supported by the NASA Office of Space Science, as well as the many and diverse contributions made by the space science community in support of education as a core mission of NASA.

In Memoriam

Duwayne M. Anderson
Hamilton, Washington
October 4, 2002

Donald W. Clay
Yuma, Arizona
September 25, 2002

Clifford Frondel
Winchester, Massachusetts
November 12, 2002

Robert L. Gamer
Portland, Oregon
April 20, 2002

Raymond C. Gutschick
Medford, Oregon
October 22, 2002

Jobst Hulsemann
Wentorf, Germany
November 4, 2002

Robert L. Johnston
Laguna Hills, California
September 24, 2002

Richard H. Mahard
Newark, Ohio
April 2002

Thad G. McLaughlin
Lakewood, Colorado
September 25, 2002

Maurice J. Mundorff
Tacoma, Washington
July 10, 2002

Helen L. Nace
Boise, Idaho
September 28, 2002

Walter J. Pearson
Moose Jaw,
Saskatchewan, Canada

John Christian Ruckmick
Laguna Niguel, California
March 19, 2002

John M. Smith
Macon, Georgia
September 27, 2002

Russell G. Wayland
Arlington, Virginia
September 11, 2002

James F. Westcott
Mexico, Missouri
September 10, 2002

Please contact the GSA Foundation for information on contributing to the Memorial Fund.

About People

GSA Council member **Richard E. Gray** has been elected to Honorary Membership by the American Society of Civil Engineers. Since 1853, only 513 members of this 125,000-member organization have been so recognized.

The American Petroleum Institute bestowed its Gold Medal for Distinguished Achievement to GSA Fellow **Michel T. Halbouty**. This award is one of the highest and most prestigious in the petroleum industry.

The American Geological Institute (AGI) presented GSA Fellow **Robert W. Ridky** with the William B. Heroy, Jr. Award for Distinguished Service at the GSA Annual Meeting in Denver. The Heroy Award is presented annually to a geoscientist in recognition of outstanding service to the Institute and to the geoscience profession.

AWG Announces 2002–2003 Executive Committee

The Association for Women Geoscientists announced its 2002–2003 National Executive Committee: GSA member **Mary Gillam**, president; GSA Fellow **Helen Delano**, president elect; GSA member **Dale Springer**, past-president; Donna Carlson, secretary; GSA member **Katherine McCarville**, treasurer; GSA member **Joanne Kluessendorf**, editor; Lorraine Manz, assistant editor; GSA member **Jane H. Gill**, GAEA advertising editor; GSA member **Pranoti M. Asher**, publicist; and Carol Dicks, business manager.

GSA Foundation Update

Donna L. Russell, *Director of Operations*

Progress Report as of October 2002

2002 Marks the Foundation's 22nd Year

The Foundation raised over $679,847 during fiscal year 2002 (July 1, 2001, to June 30, 2002). Of this, $329,554 were pledges for future payment.

During fiscal year 2002, the Foundation disbursed $621,341 for GSA programs, grants, and awards. These include the Mann-supported mentor programs, GeoCorps America, Shlemon Mentor Program in Applied Geoscience, Earth Science Week, Geoindicators, Geology in Government Mentor Luncheon, the Building Fund, the Student Breakfast at the annual meeting, Field Forums, Geology and Ecosystem Field Course, the BRIDGE Mentor Program, a number of GSA Distinguished Awards, matching student travel grants, Awards for Outstanding Earth Science Teachers, Field publications, Penrose Conferences, support of the Subaru Distinguished Earth Science Educator, the Evolution Conference, and a number of special division awards and programs.

The Foundation has established a long-term plan intended to raise support for the needs as identified by the GSA Council. This plan can be reviewed at www.geosociety.org/gsaf/.

The Foundation utilizes a number of trustee subcommittees to establish and achieve the Foundation's monetary goal for GSA needs by helping to raise the funds, matching donor intent to a need, and reporting back to donors on results from their support. For example, the trustee subcommittee working on research grants is informing former grant recipients of the present-day value of their grant and asking them to make a donation for the Research Grants Program. Other Foundation subcommittees are working to support GeoCorps America, the Congressional Science Fellows, Field Forums, and the Building Maintenance Fund. To these ends, contacts have been made with potential individual supporters, and proposals for support have been submitted to a number of private and corporate foundations, and to the operating divisions of some companies whose needs could be served in part by supporting GSA.

GSA's Education and Outreach department has completed a report on activities of the department over the past fiscal year. The Foundation has forwarded this report to our major donors to keep them up-to-date on what their contributions have accomplished.

Need a List of Foundation Funds?

Please contact the Foundation office for a complete listing of Foundation funds. This list includes a description of the purpose for each of our restricted funds. We plan to post the list at www.geosociety.org/gsaf/ very soon.

We would like to express sincere thanks to the following organizations that contributed to the Foundation as of October 2002.

Academic Press Marketing
Bechtel, Parsons, Brinkerhoff
Beta Analytic, Inc.
Blue Marble Geographics
Brunton Company
CARIS—Universal Systems, Ltd.
Carolina Biological Supply Company
CH2M Hill, Inc.
Eakin Press
EnSafe, Inc.
EOG Resources, Inc.
Estwing Manufacturing Company
ExxonMobil Exploration Company
Forestry Suppliers, Inc.
Freeport-McMoRan Foundation, Inc.
Gems & Crystals Unlimited
Houghton Mifflin Company
International Centre for Diffraction Data
J.L. Darling Corporation
Kluwer Academic Publishers
Komodo Dragon
Lockheed Martin Corporation
Micromass, Inc.
Mountain Press Publishing Company
Panopticon Gallery
Philips Analytical, Inc.
Rock Detective Geoscience Education
S.S. Papadopulos & Associates
Sheraton Boston Hotel
Stephany's Chocolates
Subaru of America, Inc.
Tasa Graphic Arts, Inc.
Thomasson Partner Associates, Inc.
Trianco Corporation
Ulrich's Fossil Gallery
Unocal Corporation
Geoscience Laboratories
Maine Geological Survey
National Park Service
New York State Geological Survey
USDA Forest Service

A complete list of 2002 donors to the Foundation will appear in a future supplement to *GSA Today*.

Most memorable early geologic experience

When doing my M.S.-thesis field work, I checked on a published section contact reported "covered." It was covered all right—by poison ivy only!

—Chester L. Dodson

STUDENT? PROFESSIONAL? TEACHER? RETIREE?

YOU CAN WORK IN A NATIONAL PARK OR NATIONAL FOREST

Apply Now for GeoCorps America 2003 Summer Positions

Summer 2003 positions are posted on the GeoCorps Web site http://rock.geosociety.org/geocorps/allJobDescriptions.asp.
Application materials must be sent to GSA and postmarked by **Friday, February 7, 2003.**

Examples of GeoCorps Projects

- Research, develop, and present interpretive programs for visitors
- Develop and lead hands-on educational activities for K–12 students
- Excavate and prepare fossil specimens
- Conduct stream surveys and watershed assessments
- Monitor glacier movement
- Assess soil compaction, trail conditions, and erosion and sedimentation
- Map geologic features

What People are Saying About GeoCorps

"Our children did the Junior Geologist program with Angela Coleman. She did a wonderful job teaching them and us about Colorado Plateau geology. It was a highlight of our trip. It's staff like Ms. Coleman who make trips to our national parks both pleasurable and educational." Park visitor about Angela Coleman, 2002 participant at Capitol Reef National Park.

"William compiled an extensive list of geologic references for the Gila National Forest and provided geologic field interpretations. He was a great benefit to the forest's program and a good reflection of GSA and the GeoCorps America Program." GeoCorps supervisor about William Leggett, 2002 participant at Gila National Forest.

"I educated visitors from across the nation and around the world on the geologic resources of the park. The GeoCorps Program offers students the opportunity to gain valuable professional experience, professionals a chance to complement their existing skills, and retirees the ability to give back." 2002 participant Angela Coleman, Capitol Reef National Park.

Learn about the GeoCorps America Program at: www.geosociety.org/science/geocorps/.

Ads (or cancellations) must reach the GSA Advertising office one month prior. For 2003, the April and May issues will be combined, deadline is March 3. Contact Advertising Department, (303) 357-1053, 1-800-472-1988, ext. 1053, fax 303-357-1073, acrawford@geosociety.org. Please include address, phone number, and e-mail address with all correspondence.

Classification	Per Line for 1st month	Per line each addt'l month (same ad)
Situations Wanted	$2.25	$1.90
Positions Open	$7.00	$6.00
Consultants	$7.00	$6.00
Services & Supplies	$7.00	$6.00
Opportunities for Students		
first 25 lines	$0.00	$2.85
additional lines	$1.85	$2.85
Web Only Ads	$7.00	$6.00
live link: add $25		

Agencies and organizations may submit purchase order or payment with copy. Individuals must send prepayment with copy. To estimate cost, count 54 characters per line, including all punctuation and blank spaces. Actual cost may differ if you use capitals, centered copy, or special characters.

DEPARTMENT OF OCEANOGRAPHY
UNIVERSITY OF HAWAI'I AT MĀNOA

The Department of Oceanography within the School of Ocean and Earth Science and Technology at the University of Hawai'i at Mānoa invites applications for two tenure-track, full-time, 9-month positions at the Assistant/Associate Professor level to begin fall 2003, subject to position clearance.

We seek two interdisciplinary ocean/earth scientists interested in physical, chemical, biological, and geological processes, and their coupling, at various time and space scales. Fields of interest include, but are not limited to, coastal physical oceanography, particulate transport and sedimentation processes in the coastal ocean, geomicrobiological processes, and global biogeochemical processes and modeling. Duties: Develop outstanding research and teaching/educational programs, including contributions to the undergraduate B.S. Degree Program in Global Environmental Science. Minimum Qualifications: Ph.D. in oceanography or related discipline; excellent communication skills; demonstrated capability/experience for creative, high quality research; demonstrated capability/experience and desire to contribute to teaching and mentoring of undergraduate and graduate students. Salary: Commensurate with qualifications and experience.

Applicants should submit vita, statement of research and teaching interests, three representative publications, and addresses of three references to: Dr. Fred T. Mackenzie, Search Committee Chair, Department of Oceanography, SOEST, University of Hawaii at Manoa, Honolulu, HI 96822, fredm@soest.hawaii.edu.

Closing Date: 02/01/03.

For more information about the Department: http://www.soest.hawaii.edu/oceaography/.

VANDERBILT UNIVERSITY
ASSISTANT PROFESSOR, DEPARTMENT OF GEOLOGY

The Department of Geology at Vanderbilt University is accepting applications for a two-year, non-tenure-track position at the rank of Assistant Professor. Duties will include teaching structural geology and possibly one other course, as well as developing and overseeing introductory laboratories. Interested applicants should send curriculum vitae, a teaching statement, course evaluations if available, and names and contact information of three references to: Department of Geology, 2301 Vanderbilt Place, VU Station B Box 351805, Nashville, TN 37235-1805 (structure@vanderbilt.edu). Review of applications beginning February 15, 2003.

GEOLOGY AND GEOGRAPHY
DEPAUW UNIVERSITY

GEOLOGY. Three-year entry-level position in Geology beginning August 2003. Rank and salary commensurate with credentials and experience. Candidates broadly trained in geosciences capable of teaching many courses from among Physical Geology, Physical Geography, Historical Geology, Environmental Geoscience, Sedimentology/Stratigraphy, Oceanography, and a geoscience-related First-Year Seminar preferred. The department is housed in newly renovated Julian Science and Mathematics Center with excellent facilities to support undergraduate teaching and research. For more information about the department, visit http://www.depauw.edu/acad/geology. DePauw has exceptional faculty development programs, including funding for conference travel and professional and curriculum development activities (see http://www.depauw.edu/admin/acadaffairs/facdev.htm). Submit letter of application, curriculum vitae, contact information for three references, transcripts, a statement of teaching interests/philosophy, and a statement of research interests to Dr. James G. Mills, Jr., Search Committee Chair, Department of Geology and Geography, DePauw University, Greencastle, IN 46135. Review of applications begins February 1, 2003 and continues until position is filled. DePauw University is an Equal Opportunity/Affirmative Action Employer; Women and Minorities are strongly encouraged to apply.

TENURE TRACK POSITION IN
EARTH AND ENVIRONMENTAL SCIENCE
WHITTIER COLLEGE

The Department of Earth Sciences at Whittier College invites applications for a tenure-track position at the Assistant Professor level beginning August 2003, pending budgetary approval. We seek candidates with specialties in Earth surface or near surface processes and potential for excellent undergraduate teaching within Earth and Environmental Sciences as well as college-wide programs. A Ph.D. in geology or a closely related field is required. For more detailed information see www.earthsciences.whittier.edu or contact Jan Vermilye at (562) 907-4913 or vermilye@whittier.edu. Whittier College is an equal opportunity/affirmative action employer. Women and minorities are encouraged to apply.

GEOLOGIST

BS degree in geology or water resources required. Entry-level position responsibilities include computer modeling, drilling activities, site characterizations, remedial action plans, Act 2 compliance tasks and water resource related projects. Strong computer, communication and report writing skills required. Experience with

MODFLOW, MS Excel, fate & transport modeling and ArcView GIS desirable.

For more information regarding this and other open positions, please check out at website at http://www.ssmgroup.com.

Spotts, Stevens and McCoy, Inc. is a growing employee-owned firm providing engineering and management consulting services to private and government clients in the mid-Atlantic region. We offer an excellent compensation and benefits package and a customized career development program. For immediate consideration send resume to: Spotts, Stevens and McCoy, Inc. ATTN: Lewis J. McCoy, Jr., PHR, P.O. Box 6307, Reading, PA 19610-6307 or email at careers@ssmgroup.com EOE M/F/D/V/ Drug-free workplace. Principals only.

GEOLOGY/ENVIRONMENTAL GEOLOGY: ASSISTANT PROFESSOR
MILLERSVILLE UNIVERSITY OF PENNSYLVANIA

Full-time, tenure-track, commencing August 2003.

The Department of Earth Sciences of Millersville University of Pennsylvania seeks a qualified, enthusiastic, and engaging individual to enhance a new option in Environmental Geology. The position requires a Ph.D. in Environmental Geology or Geology with expertise in environmental geology by date of appointment, and ability to share in the teaching of existing lower and upper division undergraduate geology courses including Historical Geology, and/or Sedimentation/Stratigraphy, and/or Structural Geology. The successful candidate must demonstrate effective teaching and communication skills, and complete a successful interview. Preferred qualifications include experience in soils, and/or watershed studies, and/or GIS applications, and teaching experience at the university level. The successful candidate will be expected to develop new upper level courses in environmental geology, engage in research involving undergraduates, and share in recruitment responsibilities.

Enrolling approximately 7500 students, the University is located in historic Lancaster County within convenient traveling distance to Baltimore, Philadelphia, Washington, New York and the Atlantic Ocean beaches. The Department of Earth Sciences, with its nine faculty and 180 majors, offers B.S. degrees in Geology, Meteorology, and Oceanography, a B.A. in Earth Sciences with an option in Environmental Geology, and a B.S. Ed in Earth Sciences Education. The Geology Program occupies areas in two buildings with facilities that include two newly renovated teaching labs, a soils lab and a new GIS lab, and supporting equipment. The Department maintains a three-component digital seismograph station and network licenses for Interactive Data Language (IDL), Fortran 90, MatLab, the 3D-seismic interpretation Kingdom Suite of Seismic Micro-Technology, Inc., and is an Internet 2 member institution. Additional information can be found at http://muweb.millersville.edu/~esci.

Full consideration will be given to applications received by February 3, 2003. Applicants should send a cover letter that addresses qualifications, statement of teaching and research interests, curriculum vitae, copies of undergraduate and graduate transcripts, and three current letters of reference to: Geology Search, Department of Earth Sciences/GSA0103, P.O. Box 1002, Millersville University, Millersville, PA 17551-0302. An EO/AA Institution

SEDIMENTOLOGY/STRATIGRAPHY
CALIFORNIA STATE UNIVERSITY, STANISLAUS

The Department of Physics and Geology at California State University, Stanislaus, invites applications for a tenure-track faculty position as Assistant Professor of Geology beginning in Fall 2003.

QUALIFICATIONS: A Ph.D. in a field applicable to soft-rock geology (e.g. sedimentology, stratigraphy, petrology), ability to teach courses in the Geology major as well as in general education, and ability to perform and publish research.

DEADLINE: Application screening began 11/4/02 and will continue until position is filled.

APPLICATION: Applicants should consult the full description of the position available, and follow the instructions described therein, at: http://geology.csustan.edu/.

UNIVERSITY OF NEW ORLEANS
HYDROLOGY

The Department of Geology and Geophysics at the University of New Orleans (UNO) invites applications to fill a tenure-track position in hydrology starting August 2003. The appointment is at the assistant professor level and will be held jointly with the multidisciplinary Pontchartrain Institute for Environmental Sciences within UNO's College of Sciences. We are particularly interested in individuals whose work focuses on environmental simulation of land surface or subsurface hydrology, GIS-based watershed analysis, modeling coastal marine circulation, or chemical cycling in aquatic systems. An interest in projects centered on the Lake Pontchartrain Basin, Mississippi River delta plain, or coastal restoration efforts in Louisiana is desired. We seek an individual committed to research, teaching, and supervising M.S. and Ph.D. students. A Ph.D. in hydrology or related fields is required.

Applicants should submit a curriculum vitae, a statement of research and teaching interests, and the names of at least three references to: Dr. William H. Busch, Department of Geology and Geophysics, University of New Orleans, New Orleans, LA 70148; wbusch@uno.edu. Closing date is 1 February 2003.

The University of New Orleans, a member of the Louisiana State University System, is an equal opportunity/affirmative action employer.

GEOMORPHOLOGY / SURFICIAL PROCESSES & GIS
COLLEGE OF CHARLESTON

The College of Charleston Department of Geology and Environmental Geosciences (www.cofc.edu/~geology) is accepting applications for a tenure-track Assistant Professor position to begin in August of 2003. We are looking for a dynamic geomorphologist with a commitment to undergraduate education and research excellence, who will develop an active research program involving undergraduate students in support of the College's 4th Century Initiative.

Preference will be given to those with teaching experience at the college level and demonstrated research potential, especially in areas that blend geomorphology and GIS. The successful candidate will be expected to teach introductory geology courses, introductory and advanced GIS, and one or more related courses in their field of specialty. He or she is expected to develop his/her own research program and seek outside funding for that research. A Ph.D. is required at the time of employment. Salary is dependent upon experience.

To apply, send a letter of interest, current curriculum vitae, a statement of research goals, a statement of teaching goals, and arrange for at least three letters of reference to be sent to: Dr. Cassandra Runyon, Chair, Geomorphology/GIS Search Committee, Department of Geology, College of Charleston, 66 George Street, Charleston, SC 29424 (843-953-8279), runyonc@cofc.edu.

Applications will be accepted through February 28, 2003. For additional information contact the Department Chair, Dr. Mitchell Colgan: (843-953-5589), colganm@cofc.edu.

The College of Charleston is an equal opportunity/affirmative action/equal access employer. Women and minorities are strongly encouraged to apply. Those persons requiring reasonable accommodation under the Americans with Disabilities Act should contact Dr. Cassandra Runyon at the mail or email addresses above.

TENURE TRACK POSITION—BIOGEOCHEMISTRY
UNIVERSITY OF SASKATCHEWAN

The Department of Geological Sciences at the University of Saskatchewan is accepting applications for a tenure-track position in the field of biogeochemistry. In particular, we are seeking a candidate with a research focus in the biogeochemistry of trace metals, with excellent training in analytical techniques and interest in speciation and bioavailability of metals in the environment. The candidate will be an active member of the Department (www.usask.ca/geology), as well as the Toxicology Centre (www.usask.ca/toxicology) as this position is an integral part of the University of Saskatchewan Northern Ecosystems Toxicology Initiative.

Candidates must be prepared to develop a vigorous research program and participate in undergraduate and graduate student teaching and research. Candidates must hold a Ph.D. when appointed. Appointment will be at the Assistant Professor level (tenure-track), although outstanding candidates may be considered at a higher level.

The Department has 14 full-time faculty, including two endowed research chairs in geochemistry. The analytical infrastructure is one of the finest in North America with TIMS, IRMS, MC—ICP—MS, laser ablation hexapole ICP-MS, electron microprobe, micro-XRF, XRD, SEM, and trace-metal clean room. Exceptional opportunities exist for innovative collaboration with researchers from the colleges of Agriculture, Engineering, Medicine and Veterinary Medicine, as well as the federally funded Canadian Wildlife Service and National Water Research Institute which are located on campus. The University of Saskatchewan is home to the Canadian Light Source, the only synchrotron facility in Canada (www.cls.usask.ca).

Applications, including full resume and three letters of reference will be addressed to Dr. James Basinger, Head, Department of Geological Sciences, University of Saskatchewan, Saskatoon, SK S7N 5E2, Canada. Email: jim.basinger@usask.ca. Fax: 306-966-8593. We will begin reviewing applications on 31 January, 2003.

All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority. The University of Saskatchewan is committed to increasing representation of equity groups (women, people of Aboriginal ancestry, visible minorities and/or people with disabilities). Applicants from these groups are encouraged to self-identify in their application.

ASSISTANT PROFESSOR
ENVIRONMENTAL SCIENCE & ENGINEERING
GANNON UNIVERSITY

Gannon University, a Catholic University located in Erie, Pennsylvania, invites applications for a tenure-track position of Assistant Professor for the Department of Environmental Science & Engineering, slated to begin August 2003. The successful candidate is required to have a B.S. in Civil/Environmental Engineering or Geology and an earned doctorate in Civil/Engineering specializing in geo-environmental engineering; licensure as a Professional Engineer or progress toward licensure is required. Professional experience in the practice of geo-environmental engineering is preferred, and must have training and interest in applied aspects of geo-environmental remediation, soil and groundwater pollution modeling, stream restoration, and/or brown field site characterization. Will teach undergraduate earth science and engineering courses, such as geology, soil science/mechanics, fluid mechanics, hydraulic design, and/or graduate geo-environmental courses. Must be able to support the University's mission.

Gannon University is an Equal Opportunity Employer that encourages diversity and invites women and members of underrepresented groups to apply. Submit a cover letter, resume, transcripts, and three references to Gannon University, Environmental Science & Engineering Search, Human Resources Department, 109 University Square, Erie, PA 16541-0001; Fax to (814) 871-7514; or Email to hrdept@gannon.edu. Review of applications to begin immediately. For more information about Gannon visit www.gannon.edu.

CHAIR, DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES
VANDERBILT UNIVERSITY

The Department seeks an established senior-level scholar with research interests relevant to lead a newly reorganized Department of Earth and Environmental Sciences (formerly Geology). The new Chair will be expected to build on existing departmental strengths and lead the Department in its participation in a new interdisciplinary initiative in environmental studies. The Department plans to participate in a joint Ph.D. program in environmental science with the Department of Civil and Environmental Engineering to augment an existing Master's program. The Department and the University emphasize excellence in research and teaching at all levels.

Interested individuals may contact the Search Committee at: EESearch@vanderbilt.edu, or Calvin Miller (Search Chair) at (615) 322-2232 or calvin.miller@vanderbilt.edu. Send applications to: Search Committee, Earth and Environmental Sciences Chair, 2301 Vanderbilt Place, VU Station B Box 351805, Vanderbilt University, Nashville, TN 37235-1805. Applications should include a C.V. and names and contact information for four references (inform us if you prefer to make initial contact with references). Please also include a statement of your vision for leading the Department and developing a dynamic new program in Earth and Environmental Sciences and a discussion of your experiences relevant to leadership and interdisciplinary endeavors. Vanderbilt is an Equal Opportunity/Affirmative Action employer. Applications from women and minorities are strongly encouraged.

We will begin formal review of applications on February 1, 2003 and continue until the position is filled.

ASSISTANT PROFESSOR
DEPARTMENT OF GEOGRAPHY, GEOLOGY AND THE ENVIRONMENT
SLIPPERY ROCK UNIVERSITY
SLIPPERY ROCK, PA

Slippery Rock University is seeking applicants for a tenure track position in the Department of Geography, Geology and the Environment at the Assistant Professor rank starting August 2003. The Department offers programs in geography, geology, and environmental science and studies with approximately 120 undergraduate majors.

Teaching responsibilities include introductory courses in environmental and physical geology, upper level courses in mineralogy and petrology and potential development of advanced courses in area of expertise. The successful candidate is expected to demonstrate excellence in teaching, to maintain an active program of research resulting in peer-reviewed publication, to mentor student research, and to participate in college service and student advising. The Department is strongly committed to student field experiences and active participation is expected as a faculty member. Contribution to the

OSWEGO

GEOLOGIST

The Department of Earth Sciences at the State University of New York at Oswego invites applications for a tenure-track faculty position at the rank of Assistant Professor, pending budgetary approval. We are searching for a field-oriented geologist with broad geologic expertise. The position requires teaching courses in physical geology and geochemistry, in addition to petrology or mineralogy. The successful candidate will also participate in the summer field camp, develop an elective course in geographic information systems, and direct students in the undergraduate capstone research program. Research fields of the new faculty member will complement existing research areas in sedimentology, stratigraphy, paleontology, hydrogeology, structural geology and tectonics.

Preference will be given to candidates with prior experience in teaching college-level geology. The geology program at SUNY Oswego is part of the multidisciplinary Department of Earth Sciences including major programs in Geology, Environmental Geology, Geochemistry, Meteorology and Earth Science Education, plus minor programs in these fields and Astronomy.

SUNY Oswego is a four-year comprehensive state university with an enrollment of 8,500 students. The university emphasizes excellence in teaching, service and collaborative research between students and faculty. The city of Oswego is located on the south shore of Lake Ontario, close to Syracuse, New York.

Candidates must have a Ph.D. at the time of application. Send a letter of application, curriculum vita, copies of college-level transcripts, three references, a statement of teaching philosophy and interests, and a statement of research interests that specifically addresses how undergraduate students will be integrated into an active research program. Application materials are due by February 15, 2003, and should be sent to:

Dr. David W. Valentino
Chair, Search Committee
Department of Earth Sciences
State University of New York at Oswego
Oswego, New York 13126

For more information about geology at SUNY Oswego please visit www.oswego.edu/geology.

SUNY Oswego is an Affirmative Action Employer

geology and environmental programs is expected.

Ph.D. in geosciences is required. Applicants should have expertise in mineralogy and petrology. Classroom and field teaching experience is desired. Successful performance in an on-campus interview, including teaching and research presentations, is required.

Send letter of interest, curriculum vitae, statement of research and teaching interests, graduate and undergraduate transcripts (official transcripts needed before hiring) and the names, addresses (postal and e-mail) and phone numbers of three references to: Dr. Patricia A. Campbell, Geoscience Search Chair, C/o Dept. of Geography, Geology and the Environment, Slippery Rock University, Slippery Rock, PA 16057, Ph. 724-738-4405, Email: patricia.campbell@sru.edu.

Review of applications will begin Jan. 15, 2003 and continue until position is filled. TTY#724-738-4881 Visit our web site at www.sru.edu. AA/EOE.

ENVIRONMENTAL GEOSCIENCE
UNIVERSITY OF PENNSYLVANIA

The Department of Earth and Environmental Science at the University of Pennsylvania invites applications for an assistant professorship in environmental geoscience. The research interests of the candidate should complement and broaden established research programs in the Department.

The successful candidate will be expected to maintain an active research program while teaching graduate courses in his/her research specialty, and undergraduate courses in environmental studies, geology, paleobiology, and oceanography.

Further information about programs in the Department of Earth and Environmental Science at the University of Pennsylvania may be sought at www.sas.upenn.edu/earth/.

Applicants should submit resumes, statements of research and teaching interests, and a selection of representative reprints to: Robert Giegengack, Environmental Geoscience Search Committee, Department of Earth and Environmental Science, University of Pennsylvania Philadelphia, PA, 19104-6316 USA, earth@sas.upenn.edu.

The Search Committee will begin to evaluate applications in January 2003; the search will remain open until the position is filled.

The University of Pennsylvania is an equal-opportunity employer. Women and minorities are encouraged to apply.

GEOPHYSICS/REMOTE SENSING/
EARTH SYSTEM SCIENCE
UNIVERSITY OF ILLINOIS AT CHICAGO (UIC)

The Department of Earth and Environmental Sciences at UIC seeks a geophysicist for a tenure-track appointment to begin August 2003 at the Assistant Professor level. Specific areas of interest may include atmospheric science, biogeoscience, geodynamics, hydrology, oceanography, structural geology, and seismology. Preference will be given to candidates with expertise in the broad area of remote sensing, who can help bridge existing strengths in geochemistry, geophysics, mineralogy, petrology, and surficial processes. The Department is an expanding, dynamic unit with a growing emphasis on integrative research approaches.

The successful candidate will be expected to establish a significant, externally funded research program and to teach effectively at undergraduate and graduate levels. The Department has extensive laboratories for earth-materials characterization, aqueous, organic, and isotopic geochemistry, experimental petrology, Quaternary geochronology and sedimentology (see http://www.uic.edu/depts/geos/ for additional details). UIC is a leader in advanced computational resources and electronic visualization capabilities.

Applicants must submit statements of research and teaching interests, CV, and contact information for four professional references to: S. L. Forman (Search Chair), Department of Earth and Environmental Sciences, University of Illinois at Chicago, 845 West Taylor Street, MC-186, Chicago, IL 60607-7059. Applications should be received by January 15, 2003, although the search will remain open until the position is filled. UIC is a Carnegie category-one research university. UIC is an AA/EOE.

TENURE TRACK POSITION
SURFACE PROCESSES/HYDROLOGY
BOSTON COLLEGE

The Department of Geology and Geophysics at Boston College seeks an Environmental Geoscientist in the broad area of surficial processes/hydrology. The applicant's specialty may also include geomorphology, environmental geophysics, soils and/or sediment transport. The applicant is expected to develop an externally funded research program integrated with excellence in teaching at both undergraduate and graduate levels. The appointment is expected to be made at the Assistant Professor level, but outstanding individuals qualified for appointment at higher rank will be considered. Information on the Department, its faculty and research strengths can be viewed on the Department's web page at www.bc.edu/geology. Applicants should send a curriculum vita, a statement of teaching and research interests and the names and contact information of at least three references to Professor Alan Kafka, Chair, Department of Geology and Geophysics, Devlin Hall 213, Boston College, Chestnut Hill, MA 02467-3809. Review of applications will begin in early January 2003, and applications will continue to be accepted until the end of January 2003. Boston College is an academic community whose doors are open to all students and employees without regard to race, religion, age, sex, marital or parental status, national origin, veteran status, or handicap.

LABORATORY MANAGER
UNIVERSITY OF ARKANSAS
STABLE ISOTOPE RATIO FACILITY

A laboratory manager is needed for the stable isotope ratio facility in the Department of Biological Sciences at the University of Arkansas. The facility, with two Finnigan Delta+'s and all necessary supporting equipment, began operation during summer of 1999. Capabilities include elemental analysis, trace gas analysis, and compound-specific isotope analysis. The facility provides in-house and commercial services for isotope ratio analysis of C, N, O, and H from biological and geological samples. It is a component of the statewide mass spectrometry facility and serves researchers of all disciplines. The successful applicant will assume day-to-day management of the facility. Responsibilities include daily operation and maintenance of the instruments, training of students and post-doctoral associates, and managing sample throughput. The salary is negotiable and will be commensurate with experience. Fayetteville is an affordable University community nestled in the Ozarks (http://biology.uark.edu/devans/fay.html). To apply for the position, send a cover letter detailing previous experience, a curriculum vitae, and three letters of reference to: Dr. Steve Beaupre, Biological Sciences, University of Arkansas, Fayetteville, AR, 72701. Applications will be reviewed until the position is filled. Questions about the position can be directed to Dr. S. Beaupre at sbeaupre@uark.edu.
The University of Arkansas is an Equal Opportunity/Affirmative Action Employer.

U.S. GEOLOGICAL SURVEY
MENDENHALL POSTDOCTORAL RESEARCH
FELLOWSHIP PROGRAM

The U.S. Geological Survey (USGS) invites applications for the Mendenhall Postdoctoral Research Fellowship Program for Fiscal Year 2004. The Mendenhall Program provides an opportunity to conduct research in association with selected members of the USGS professional staff. Through this Program the USGS will acquire current expertise in science to assist in implementation of the science strategy of its programs. The Program is also intended to provide research fellows with experiences that enhance their personal scientific skills and accomplishments. Fiscal Year 2004 begins in October 2003.

Opportunities for research are available in a wide range of areas including: microbiological characterization of soils; modeling post-wildfire sediment transport; geologic controls on low-rank coal gas; quantifying coastal hazard vulnerability; debris flows; estimation of environmental change using stable isotope and plant morphology; influence of scales in land surface characterization, process studies and modeling; statistical study of magnetic field variations for mapping of hazardous effects; remotely triggered seismicity at Alaskan volcanoes; water-organic matter interactions; sea level variations; economics of oil and gas production; and interplate and intraplate earthquake processes.

The postdoctoral fellowships are 2-year USGS appointments with full benefits and salaries. The closing date for applications is January 31, 2003. Appointments will start between October 2003 and May 2004, depending on availability of funds. A complete description of the program, research opportunities, and the application process are available at http://geology.usgs.gov/postdoc. The U.S. Geological Survey is an equal opportunity employer.

THE JOSEPH P. OBERING
POSTDOCTORAL FELLOWSHIP
DARTMOUTH COLLEGE

The Department of Earth Sciences seeks outstanding candidates for the Joseph P. Obering Postdoctoral Fellowship in Earth Sciences at Dartmouth College. This

competitive fellowship provides two years of full-time salary and a research allowance,with a third year contingent upon performance and funding. In concert with Dartmouth's philosophy that scholarship and teaching are inseparable facets of academic life, this fellowship provides recent Ph.D. recipients the opportunity to pursue independent research as well as develop a teaching portfolio. Candidates will be expected to collaborate with one or more Dartmouth Earth Sciences faculty members, taking advantage of existing resources and facilities, and will teach one course (quarter system) per year. The starting date is negotiable, but could be as early as July 1, 2003. Details about our program can be found at www.dartmouth.edu/~earthsci.

Candidates should submit a cv, statements of research and teaching interests, and selected reprints by March 1, 2003. Applications should be sent to: Obering Postdoctoral Fellowship Committee, Department of Earth Sciences, Dartmouth College, 6105 Fairchild Hall, Hanover, NH 03755. In addition, applicants should arrange for three letters of recommendation to be sent directly to the above address. Dartmouth College is an EO/AA Employer.

Opportunities for Students

Ph.D. Student Assistantships. Oregon State and Portland State Universities are offering fifteen Ph.D. research assistantships to explore all aspects of the Earth's subsurface microbial biosphere. Tuition and stipend are provided by the NSF IGERT program and the two universities. Students will work in interdisciplinary teams of engineers, oceanographers, microbiologists, microbial ecologists, geologists, soil scientists, and chemists to solve environmental problems, to understand global chemical cycles, and to determine the impact of subsurface microorganisms on surface ecosystems. More information can be found at: http://oregonstate.edu/dept/igert/, or Martin R. Fisk, College of Oceanic and Atmospheric Sciences, Oregon State University, mfisk@coas.oregonstate.edu. Students from all scientific backgrounds are encouraged to apply to departments represented by IGERT faculty at either institution. U.S. citizens or permanent residents can be supported by IGERT funds, however students of all nations can participate in the program. Review of applications starts 2/1/02. Oregon State and Portland State Universities are committed to equality in education.

Graduate Student Opportunities in Surface Processes, University of Michigan. The University of Michigan, Department of Geological Sciences welcomes applications from students interested in pursuing a M.Sc. or Ph.D. in the general field of surface processes. The Earth surface processes research group investigates the interaction between climate, tectonics, and topography. Students with interests in the hundred-thousand to million-year time scale topographic and structural evolution of active mountain ranges are encouraged to contact Dr. Todd Ehlers (tehlers@umich.edu). Research in the group provides an opportunity to acquire skills in one or more of the following areas: (1) low-temperature thermochronometry, (2) thermal, mechanical, and surface process modeling, (3) GIS and remote sensing, and 4) field work (mapping and thermochronometer sample collection). See http://www.geo.lsa.umich.edu/~tehlers for additional information. Students with backgrounds in physics, mathematics, and computer science are also encouraged to apply. Tuition waivers, fellowships, and teaching and research assistantships are available to qualified students. The deadline for applications in January 15, 2003.

Environmental and Engineering Geosciences/M.S. The Department of Geology at Radford University has funded opportunities for M.S. students to study a variety of topics in applied geology, including physical and chemical hydrogeology, groundwater modeling, contaminant transport, soil and rock mechanics, engineering geophysics, and geographic information systems. Interested students are encouraged to contact: Dr. Stephen W. Lenhart (slenhart@radford.edu), P.O. Box 6939, Department of Geology, Radford University, Radford, VA 24142 - Tel: (540)831-5257. Additional information about this graduate program can be found at http://www.radford.edu/~geol-web/grad.htm. Radford University is an equal opportunity, affirmative action employer. Minorities and women are encouraged to apply.

RICE

Wiess Visiting Professorship

Rice University
Department of Earth Science

We invite applications for the Wiess Visiting Professorship in Earth Science. We particularly encourage scientists in fields allied with our department's focus areas: computational geophysics, seismology, tectonophysics, tectonics, geochemistry, sedimentology and global change. The visiting professor funds provide one semester of salary for a visitor to conduct research at Rice, and can be used to extend a normal sabbatical leave. A research stipend is also provided. The Professorship is available for the 2003-2004 academic year.

Information on the Department of Earth Science and the Center for Computational Geophysics can be found at http://terra.rice.edu.

Please send a resume to: Chair, Wiess Visiting Professorship Committee, Department of Earth Science, MS-126, Rice University, PO Box 1892, Houston, TX 77251-1892. Rice is an equal opportunity affirmative action employer.

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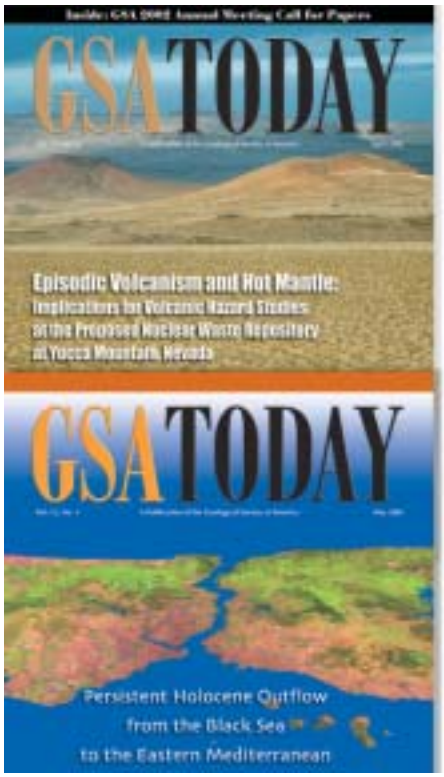

NEW *GSA Today* Schedule for 2003

This year, *GSA Today* will publish a combined April/May issue, with the issue scheduled to be delivered in the beginning of April. Deadlines for ads: February 20 for display ads; March 3 for classified ads.

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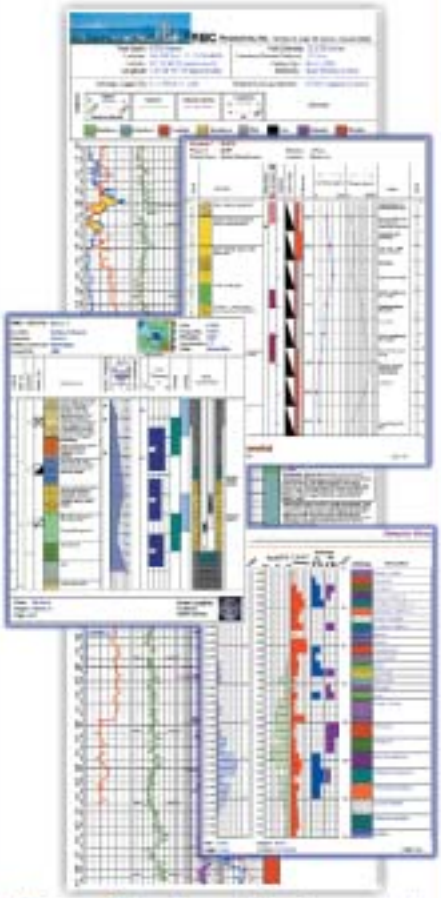

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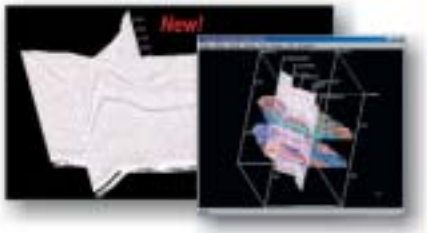

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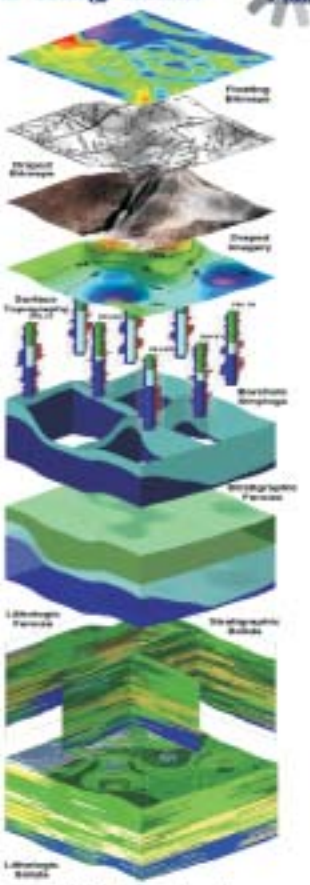

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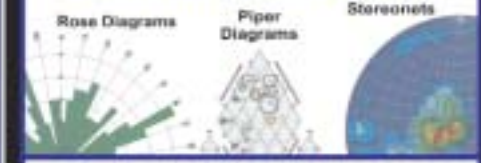

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