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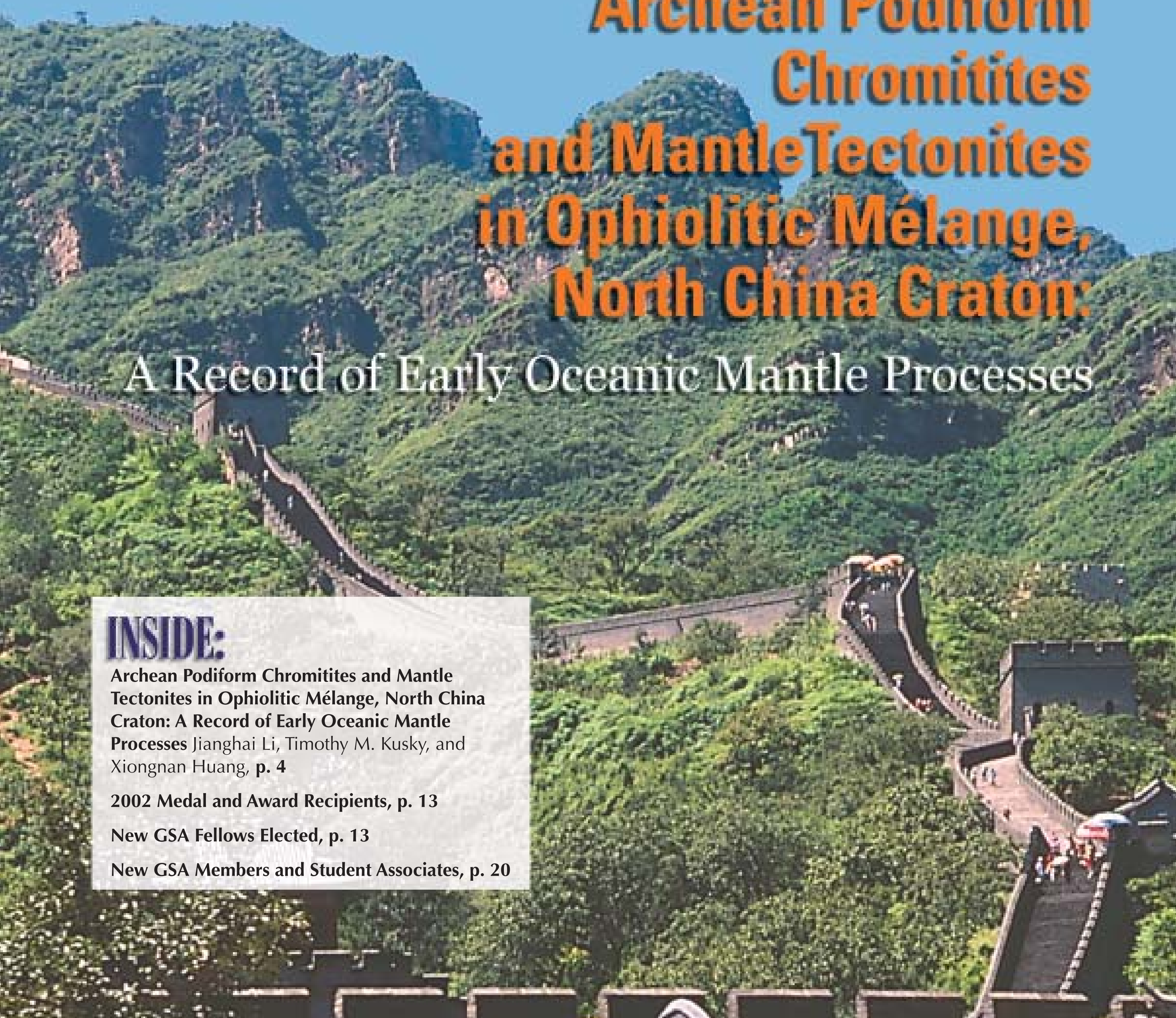
Archean Podiform Chromitites and Mantle Tectonites in Ophiolitic Mélange, North China Craton:

A Record of Early Oceanic Mantle Processes



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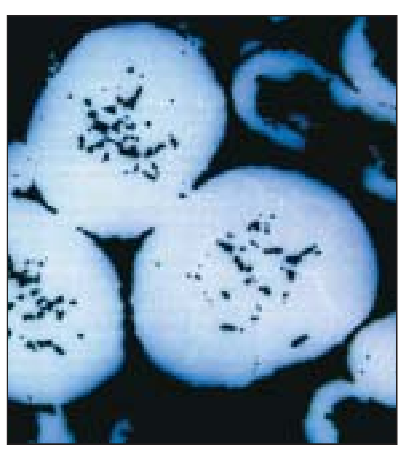

On the cover: The Great Wall of China northwest of Zunhua, built about 600 years ago during the Ming Dynasty, runs across the top of Yanshan Mountain, the largest and longest mountain in North China. It is built upon Mesoproterozoic sedimentary rocks (1.85–1.40 Ga) of the Changcheng System, which unconformably overlies Neoarchean (2.5 Ga) metamorphic rocks, including ophiolitic fragments and podiform chromites. Photo by Tim Kusky. **Left:** Photomicrograph of nodular and orbicular chromite grains from a 2.5 Ga podiform chromitite deposit in ophiolitic mélange in the Zunhua area, North China Craton. The texture is one of the most characteristic of oceanic mantle rocks. Field of view is 12 mm. Image courtesy of Tim Kusky.

Archean Podiform Chromitites and Mantle Tectonites in Ophiolitic Mélange, North China Craton: A Record of Early Oceanic Mantle Processes

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ABSTRACT

We report 2.5 billion-year-old oceanic mantle podiform chromitite and mantle tectonite in ophiolitic mélange in the North China craton. Tectonic blocks of peridotite, wehrlite, pyroxenite, harzburgitic tectonite, dunite, podiform chromitite, layered gabbro, sheeted dikes, and pillow lava are embedded in a strongly deformed metasedimentary and metavolcanic matrix. The blocks are traceable along strike into the relatively complete ca. 2.505 Ga Dongwanzi ophiolite. Textures in the ultramafic blocks provide a window into igneous and structural processes active in Archean suboceanic mantle. Chromitites in dunitic envelopes preserve igneous nodular, orbicular, antinodular, banded, massive, and disseminated textures. Dunite envelopes are common features of podiform chromitites, forming almost exclusively in the upper mantle or the crust-mantle transition zone of suprasubduction zone (harzburgite-type) ophiolites of younger geological ages. Nodular and orbicular chromite textures are known *only* from ophiolites and are interpreted to form during partial melting of flowing upper mantle, conditions needed to keep chromite suspended and growing concentrically into the magma. Minor orthopyroxene porphyroclasts with asymmetrical recrystallized tails and kink-banded olivine inclusions in chromite grains record plastic deformation and high-temperature shearing, before or during growth of the chromite. We attribute this deformation to flow in the Archean oceanic mantle. Later deformation is related to dismemberment of the ophiolite and incorporation into a mélange during collision of the Eastern and Western blocks of the North China craton. This collision formed the 1600-km-long ophiolite-rich Central Orogenic

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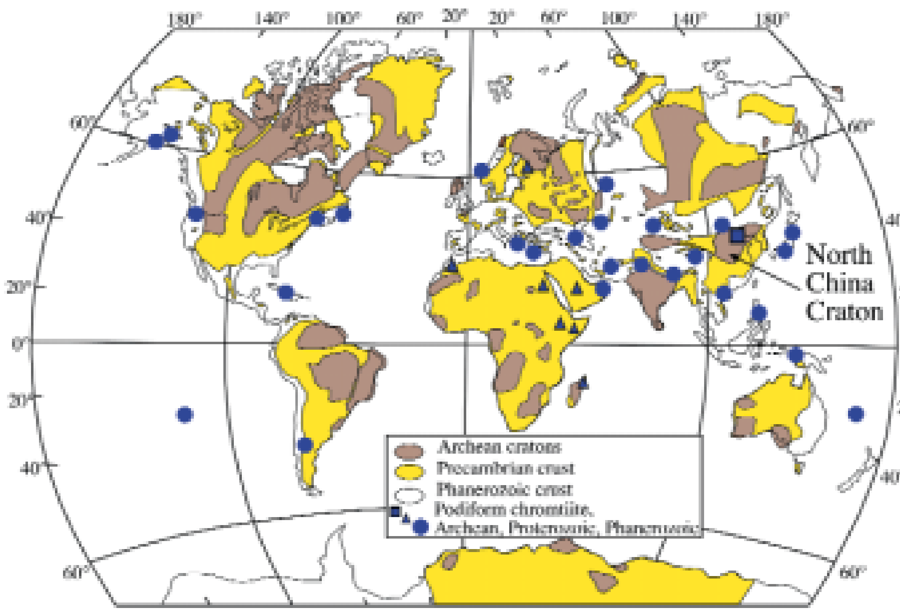

Figure 1. Distribution of Archean cratons, areas underlain by Precambrian crust, and Phanerozoic crust and podiform chromite deposits (modified after Kusky and Polat, 1999). Filled patterns show locations of major ophiolitic podiform chromite deposits in relation to crust and accretionary orogens of different ages. Squares—Archean; triangles—Proterozoic; circles—Phanerozoic. Zunhua podiform chromitites are associated with the 2.505 Ga Dongwanzi and related ophiolites of North China craton.

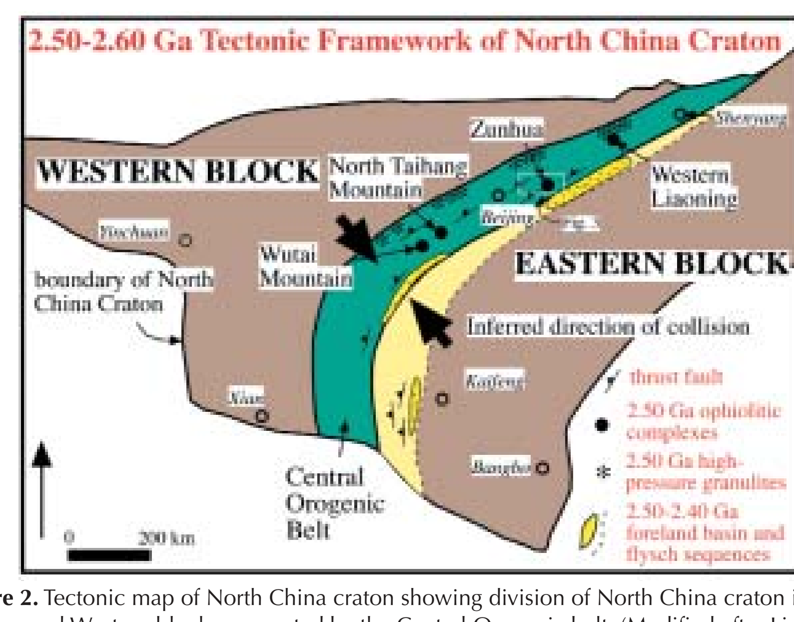

Figure 2. Tectonic map of North China craton showing division of North China craton into Eastern and Western blocks, separated by the Central Orogenic belt. (Modified after Li et al., 2000a, 2000b; Kusky et al., 2001).

belt, and the 2.5–2.4 Ga Qinglong foreland basin and fold-thrust belt on the Eastern block, and provides an important record of the operation of plate tectonics in the Archean.

INTRODUCTION

Ophiolites are remnants of oceanic lithosphere that have been tectonically emplaced onto continents. They provide valuable information on the nature of seafloor processes, global heat loss, and paleogeographic reconstructions of the continents through ancient times. The question of whether ophiolites are present in the earliest rock record (>2.0 Ga) is one of the most hotly debated scientific questions in early Earth history (Kusky and Polat, 1999; Karson, 2001). This is largely because until recently, complete ophiolite sections consisting of (in descending stratigraphic order) pillow lava, sheeted dike complex, gabbro, cumulate ultramafics, and tectonized mantle, had not been documented in rocks older than 2 Ga (Kontinen, 1987). The recently discovered 2.505 Ga Dongwanzi ophiolite of the North China craton (Kusky et al., 2001) is a complete ophiolite, but most original mantle textures and mineral parageneses are overprinted. In this paper, we report newly discovered podiform chromitites from Archean mantle harzburgite tectonite and dunite host rocks that are 60 km southwest of and related to the complete Dongwanzi ophiolite. Podiform chromitites with nodular- and orbicular-textured chromite balls in a harzburgite tectonite matrix are known only from ophiolitic settings (Fig. 1), and thus serve as a diagnostic marker of oceanic mantle, potentially as useful as the ophiolite suite itself for identifying fragments of ancient oceanic lithosphere and asthenosphere.

The 2.5 Ga Zunhua podiform chromitites have remarkably well preserved delicate magmatic and deformational textures that provide a glimpse into igneous and structural processes active in the suboceanic mantle in the Archean. These types of structures were known previously only from much younger oceanic mantle rocks and, thus, preserve a unique remnant of Archean oceanic mantle.

GEOLOGICAL SETTING

The North China craton is divided into two major blocks, the Western block and the Eastern block, separated by the Neoarchean Central Orogenic belt that extends across the craton (Fig. 2). The Western block contains a thick platformal sedimentary cover (Ordos block) intruded by a narrow belt of 2.55–2.5 Ga arc plutons along its eastern margin. The Eastern block contains a variety of ca. 3.80–2.5 Ga gneissic rocks and greenstone belts locally overlain by 2.6–2.5 Ga sandstone and carbonate. The 700-km-long Hengshan high-pressure granulite belt (2.5 Ga) is located along the western side of the Central Orogenic belt (Li et al., 2000a). Isotopic ages available from the Central Orogenic belt mainly range between 2.58 and 2.50 Ga (Li et al., 2000a; Wu et al., 1998). A younger age peak of 1.90–1.80 Ga is related to late tectonic extension (Li et al., 2000a). Central parts of the Central Orogenic belt include a complex assemblage of ca. 2.55–2.5 Ga deformed metavolcanic, metaplutonic, banded iron formation and metasedimentary rocks, intruded by ca. 2.5–2.4 Ga granite. A belt of 2.5–2.4 Ga

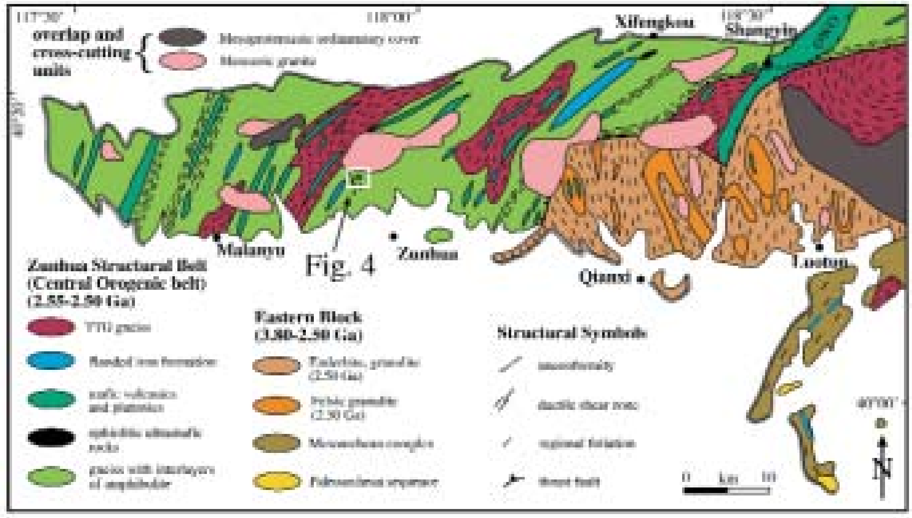

Figure 3. Structural sketch map showing distribution of Archean ophiolites and major structural boundaries of Zunhua Structural belt, eastern Hebei.

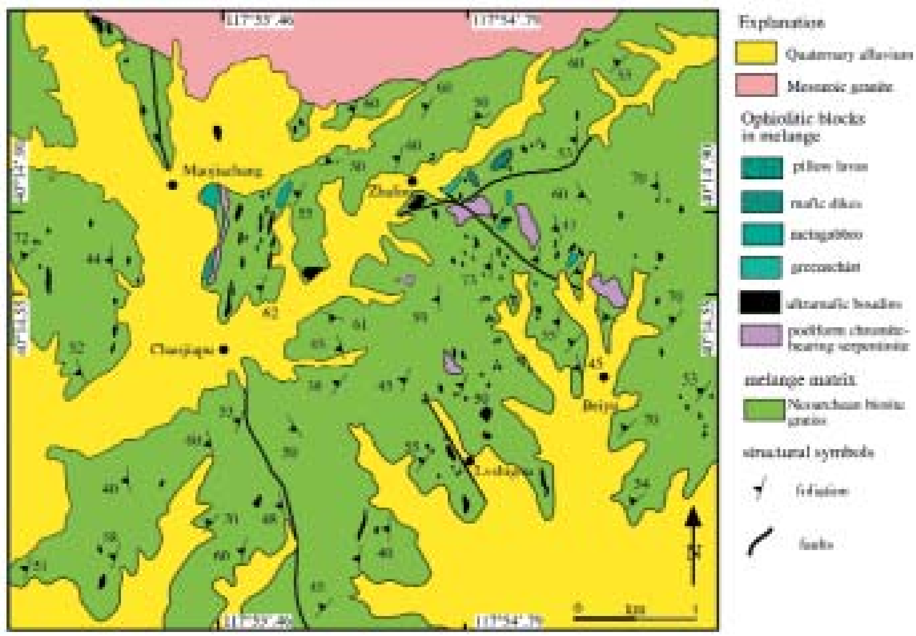

Figure 4. North Zunhua area showing distribution of ophiolitic blocks in a matrix of biotite gneiss and hornblende-biotite (modified from local geological maps and remapping by the authors).

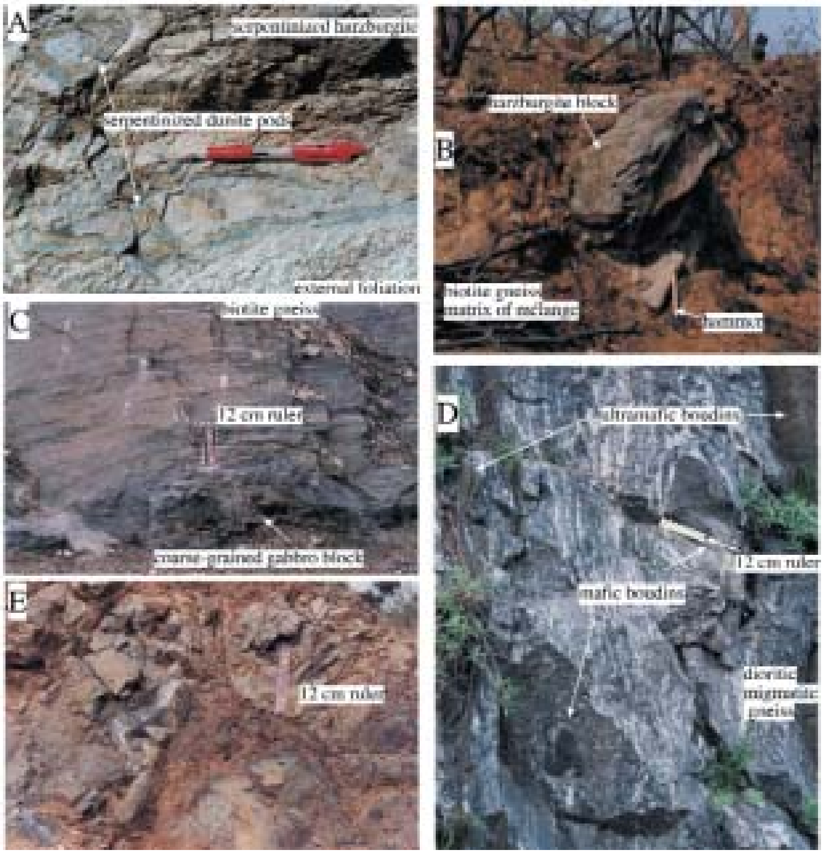

Figure 5. Field photos of podiform chromite and related outcrops, North Zunhua area. **A.** Flattened lenses and pods of dunite in a foliated serpentinized harzburgite matrix. **B.** Serpentinized harzburgite block in mélange, matrix of weathered biotite gneiss. **C.** Gabbroic block within sheared biotite gneiss. **D.** Mafic and ultramafic boudins as inclusions with dioritic gneiss. **E.** Pillow lava from block in mélange.

weakly metamorphosed flysch and molasse basins that extends along the eastern margin of the Central Orogenic belt (Fig. 2) is interpreted here as remnants of a foreland basin related to the collision of the Western and Eastern blocks. Rocks in this belt, colloquially named the Qinglong foreland basin, are now deformed in an east-vergent fold-thrust belt.

The Zunhua structural belt is a mainly amphibolite-facies terrane in the northern sector of the Central Orogenic belt, separated from an Archean granulite-gneiss dome (3.85–2.50 Ga) of the Eastern block by a major shear zone (Fig. 3). The Zunhua structural belt contains mainly northeast striking, intensely strained gneiss. Various thrust slices, including tonalite-trondhjemite-granodiorite gneiss, mafic plutonic rocks, supracrustal sequences, and granites are tectonically intercalated with each other (Kusky et al., 2001; Wu et al., 1998). More than 1000 ultramafic boudins have been recognized in the Zunhua structural belt, and these range from several meters to several kilometers in length (Figs. 3 and 4). These were intruded by ca. 2.56–2.5 Ga tonalitic gneiss, then 2.5–2.4 Ga granites (Wu et al., 1998). Geochemical analyses reveal that mafic volcanics in the Zunhua structural belt have an oceanic affinity. They exhibit flat rare earth element to light rare earth element–depleted patterns that are similar to basalts from suprasubduction and mid-oceanic ridge settings (Wu et al., 1998; Zhao et al., 1993; Kusky and Li, 2002).

A complete 2.505 Ga ophiolite has been described from the northeastern part of the Zunhua structural belt (Kusky et al., 2001). The Dongwanzi ophiolite is in the same belt as the ultramafic blocks described in this contribution, and many blocks can be traced into the complex mélange zone along strike with the Dongwanzi ophiolite. The Dongwanzi

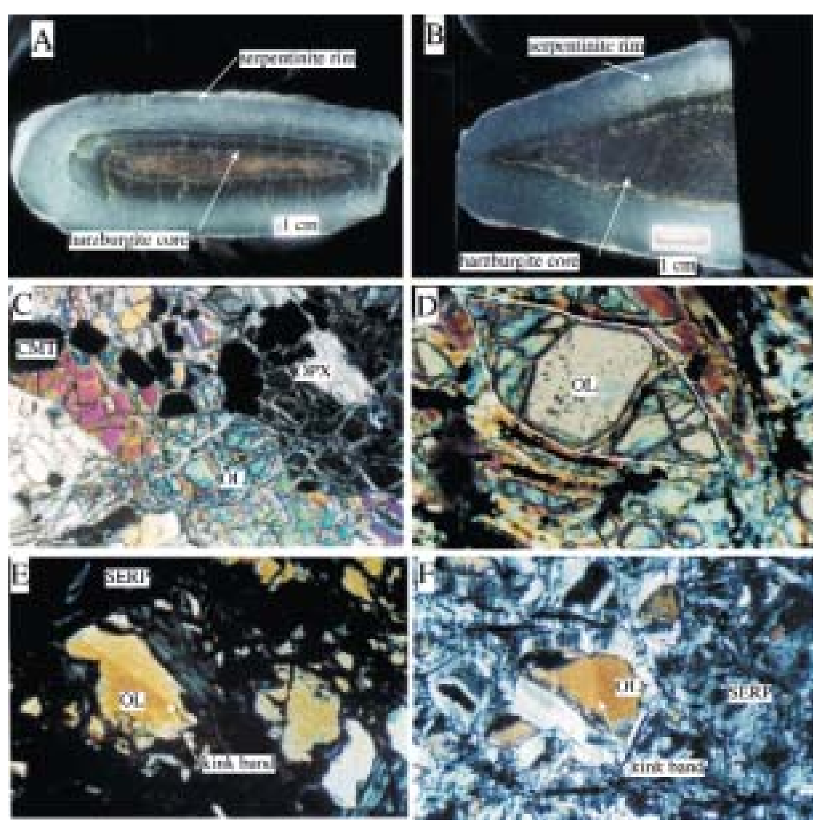

Figure 6. Structures and microscopic textures of peridotite blocks in mélange. **A, B**. Polished surfaces of hand specimens illustrating principal textures of flattened harzburgite core with outer rings of serpentinite. Early high-temperature mantle-tectonite foliations are preserved in cores of pods. **C.** Harzburgite showing orthopyroxene (OPX), chromite (CMT), and olivine (OL) crystals (field of view is 3.2 mm horizontally). **D.** Asymmetrical olivine porphyroclast with recrystallized tail (outlined in white) within harzburgite tectonite (field of view is 3.2 mm horizontally). **E, F**. Kink bands within relict olivine (OL) in serpentinized harzburgite (field of view is 3.2 mm horizontally in both photomicrographs).

ophiolite may be interpreted as the largest block in the mélange that preserves preferentially the upper (crustal) part of the ophiolitic sequence. The blocks described here preserve deeper parts of the ophiolitic lithosphere than have so far been recognized in the Dongwanzi ophiolite.

Ophiolitic mélange in the Zunhua structural belt

Detailed field and petrographic analysis of mafic and ultramafic blocks in the southwestern Zunhua structural belt has revealed an assemblage of typical ophiolitic rock types. These include partly serpentinized harzburgite, peridotite tectonite, dunite, serpentinite, podiform chromitite, hornblendite, wehrlite, pyroxenite, metagabbro, cumulates and pillow lavas, massive metabasalt, and greenschist (Figs. 3 and 4). Locally, well-preserved sheeted dikes, layered gabbro, and cumulates are recognized. All these units are intruded by ca. 2.5–2.4 Ga granite (Wu et al., 1998), demonstrating their Archean ages. All the Archean units are overlain unconformably by ca. 1.85 Ga sedimentary cover.

Ultramafic and mafic pods and tectonic blocks are stretched and occur within a strongly deformed matrix of foliated and sheared, fine-grained biotite-gneiss and hornblende-gneiss with some layers of amphibolite and banded iron formation (Figs. 3 and 5). These blocks are intensely sheared and tectonically transposed along their margins. In contrast, internal structures of the blocks commonly show distinct foliation and fold patterns, discordant to the external foliations outside the blocks in the surrounding shear zones. Gabbro and pyroxenite boudins (Fig. 5) exhibit well-preserved relict cumulate textures and cyclic cumulate banding of clinopyroxene, olivine, and plagioclase. Within the cores of peridotite blocks and pods, metamorphic tectonite fabrics are well preserved as oriented orthopyroxene porphyroclasts, strings of chromite, and elongated ribbons of olivine (Fig. 6). The early tectonic fabrics defined by compositional layering include chromite seams, disseminated chromite, oriented nodular chromite, and flattened antinodular chromite. In younger ophiolite complexes, these textures are generally interpreted to form during high-temperature (>1000 °C) plastic deformation in the mantle (Nicolas and Arzi, 1991; Holtzman, 2000).

Late steeply dipping shear zones parallel to tectonic contacts with country rocks cut the early high-temperature–tectonite fabrics in the peridotite. Serpentinization is concentrated along late shear zones and fractures cutting across the earlier foliation. Within these shear zones, ultramafic protoliths are separated into numerous small-scale pods and lenses, which are further flattened and stretched. The late tectonic fabric and hydrous metamorphism that overprints the harzburgitic mantle tectonites probably occurred during obduction-related emplacement of the ophiolite in the Archean.

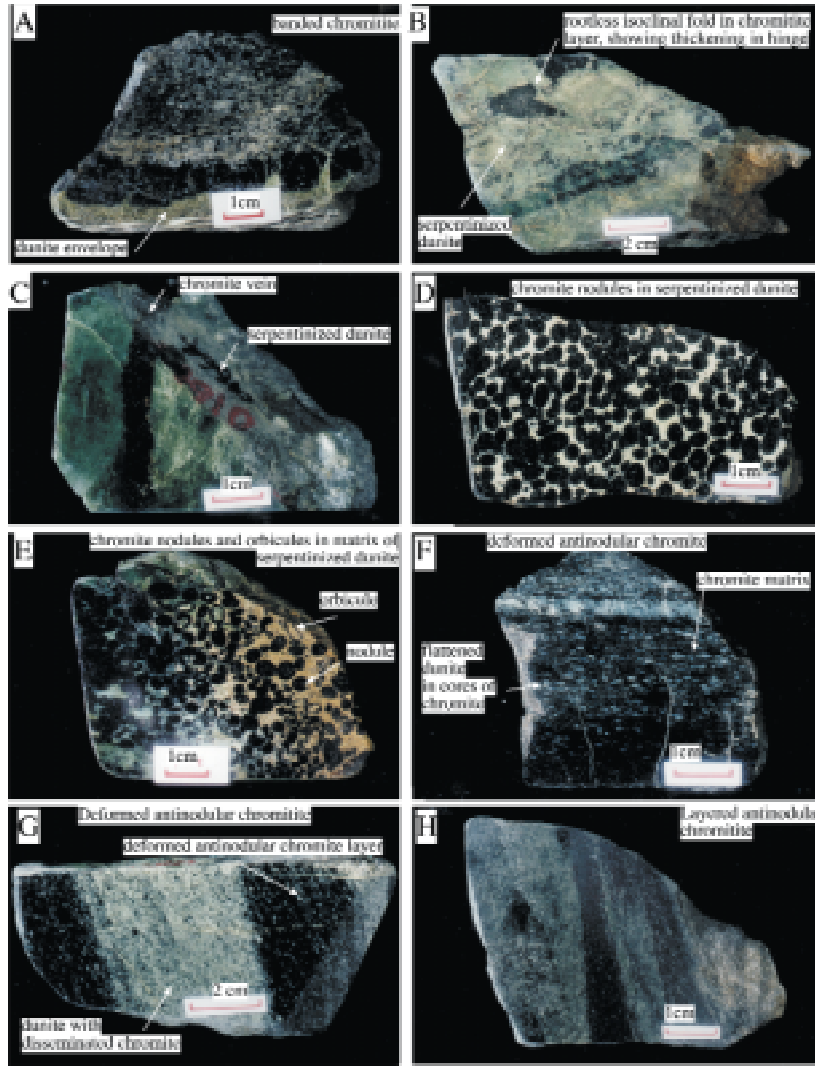

Figure 7. Polished surfaces of hand specimens illustrating principal microstructures and textures of chromitites ores. **A.** Banded chromitites with dunite envelop preserved at base of sample. **B.** Rootless fold showing thickening of chromitite band in a serpentinized dunite matrix. **C.** Chromite vein within serpentinized dunite. **D.** Nodular chromite in weakly deformed domain. **E.** Nodular and orbicular chromite. **F, G.** Antinodular chromite, showing flattening of dunite in cores of chromite rings. **H.** Layered antinodular chromites.

Ophiolitic crust and mantle blocks in mélange

Peridotites in the Zunhua structural belt are mainly composed of serpentinized olivine, relict orthopyroxene, chromite, and minor magnetite (Fig. 6A, 6B, and 6C). Stretched orthopyroxene grains enclosed in a serpentinite matrix with ribbon-shaped tails form augen up to 2–3 mm in diameter. Some orthopyroxene porphyroclasts preserve embayed outlines due to corrosion by melt. Minor subhedral to euhedral chromite is present. Some peridotite tectonites show penetrative foliations and stretching lineations. High-temperature metamorphic tectonite fabrics defined by aligned and stretched olivine are well preserved in cores of blocks (Fig. 6D). Relict olivine forms extended ribbons with asymmetrical geometry. Augen of olivine exhibit deformational kink bands (Figs. 6E and 6F). These fabrics are attributed to high-temperature flow in the mantle. Olivine crystals are

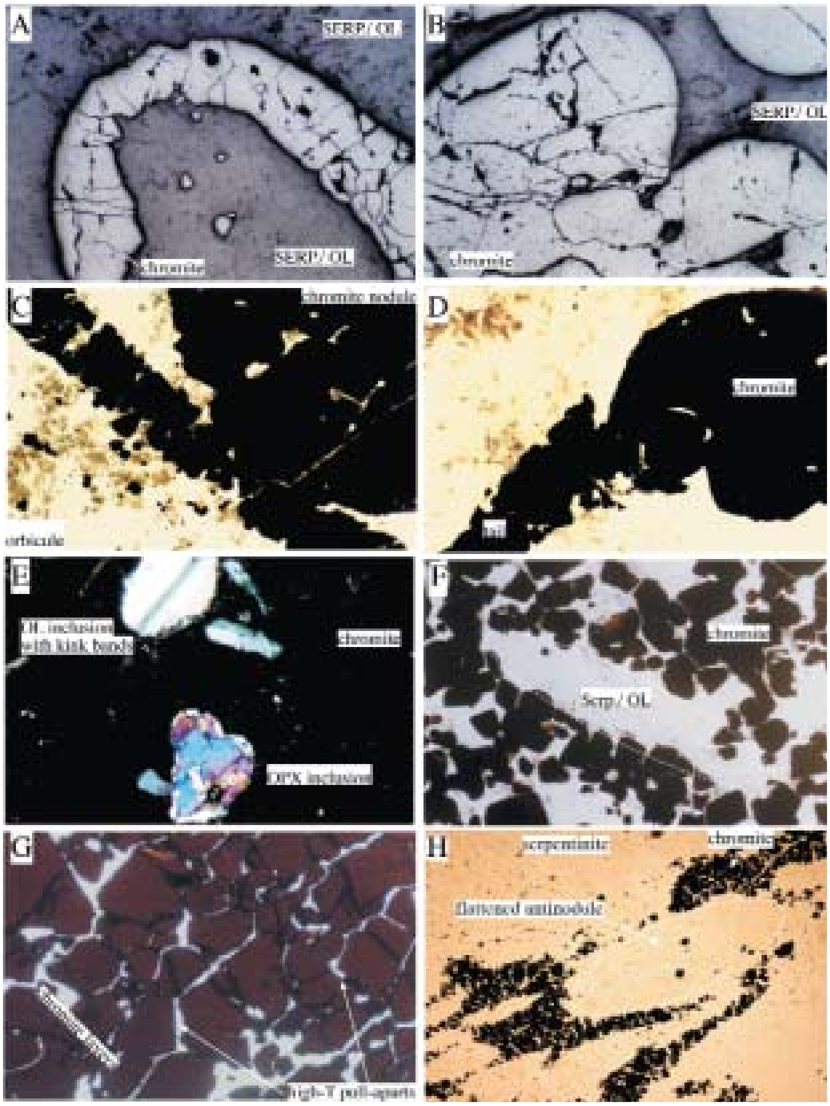

Figure 8. Microscopic textures of chromite ores. **A.** Flattened orbicule of chromite (reflected light). **B.** Flattened nodules of chromite and igneous contact between two nodules (reflected light). **C.** Flattening of contact between orbicule and nodule of chromite. **D.** Flattening of chrome nodule with asymmetrical tail. **E.** Inclusion of orthopyroxene (OPX) and olivine (OL) showing kink bands within chromites. **F.** Deformation textures of chromitite ore showing stretched olivine crystals in dunite core (strain ellipse outlined in white) with antinodular chromite. **G.** Pulled-apart chromites. **H.** Flattened antinodule forming concentrated bands of chrome and apparent folds from initial chrome network structure that originally surrounded antinodule. Field of view is 8 mm (horizontally) in A, B, C, D, and F, 3.2 mm for G, and 1.6 mm in E and H.

commonly serpentinized, with magnetite distributed along the foliation planes.

Boudins and tectonic blocks of various types of gabbro and ultramafic cumulate within intensely sheared garnet-bearing gneiss range in size from a few centimeters to hundreds of meters. Rarely, pods of dunite are recognized within olivine gabbro (troctolite). These rocks are generally less deformed than the ultramafic rocks. Alternating pyroxene-rich and plagioclase-rich modal and textural layering, 2–5 cm thick, locally preserve primary cumulate textures. The pyroxenite and olivine pyroxenite layers commonly transformed into foliated hornblendite along their margins as the gabbros underwent amphibolite-facies metamorphism.

Blocks of sheeted dikes, up to 100 m along strike, occur within the Zunhua structural belt (Fig. 4). The chilled margins are recognized as 2–3-cm-thick boundaries defined by strong alignment of fine-grained hornblende. They have only one chilled margin, which is a consequence of repeated intrusions in the center of a single opening fissure. The width of individual half-dikes is generally tens of centimeters. The mineral assemblage is plag + cpx + hb, characteristic of upper amphibolite facies conditions.

Spectacular pillow basalts are preserved locally in weakly deformed domains (Figs. 4 and 5E). Pillows vary in size from tens of centimeters to one meter. Pillowed flows are interbedded with amygdular massive basalt. The pillow lavas are pervasively altered to albite and chlorite assemblages. Rarely, the pillows preserve dark cryptocrystalline margins, representing original glassy selvages. The shapes of pillows indicate younging toward the northwest. Layers of pillow breccia and volcanoclastic sediment are intercalated with the pillow basalt, and these units are metamorphosed to plagioclase-biotite schist and biotite schist. Some ultramafic lenses are intercalated with pillow lavas, indicative of large amounts of shearing (either on the seafloor or during emplacement).

At least six large and numerous smaller chromite-rich peridotite massifs are recognized within the southwestern Zunhua structural belt (Figs. 4 and 7). The chromitites are commonly lens shaped within dunite envelopes and are concordant with the foliation of the enclosing intensely serpentinized harzburgite. Serpentinized pods and lenses show concentric rings with systematic variations in mineral composition and texture. Outer rings, commonly 2–10 cm thick, are composed of serpentine, whereas inner cores preserve dunite or massive harzburgite. Narrow, branching pyroxenite dikes (1–10 cm wide) are deformed within serpentinized harzburgite. The dikes are interpreted as channels of melt parental to oceanic basalt. Tectonic fabrics defined by folded chromite bands are well preserved in the cores of the serpentinized pods. Dunite envelopes are common features of podiform chromitites. They are known to form almost exclusively in the mantle or crust-mantle transition zone of suprasubduction zone (harzburgite type) ophiolites of different ages (Nicolas and Arzi, 1991; Zhou et al., 1996; Edwards et al., 2000).

Most of the chromitites are strongly deformed by high-temperature plastic flow, although nodular, orbicular, banded, massive, antinodular, and disseminated chromitite textures (sensu Johnston, 1936) are all locally preserved, especially in discordant pods (Fig. 7). Nodular textures consist of small balls of chromite in a dunite matrix (Fig. 8B, whereas orbicular chromites consist of thin rings of chromite surrounding rounded to flattened cores of dunite (Fig. 8A). Nodular and orbicular chromites, with diameters of 2–10 mm and occasionally larger than 10 mm, are generally flattened into elliptical shapes, and some orbicules form flattened rings. Nodular and orbicular textures are the most typical magmatic structures of ophiolitic chromitites (Nicolas, 1989; Nicolas and Arzi, 1991). Abundant deformed olivine occurs as inclusions in the chromite (Fig. 8E), although they are widely altered into serpentine. Preliminary work on the crystallographic preferred orientations of olivine shows preferred slip on (010)[100] slip systems, which occurs at temperatures >1200 °C (Nicolas, 1989). Orthopyroxene porphyroclasts show asymmetrical recrystallized tails indicating high-temperature shearing.

Nodules are locally sorted into layers by their sizes. The nodules and orbicules show patterns of flattening and mutual impression along their contacts with each other (Figs. 8A, 8B, and 8C), suggesting that they settled while in a melt. These features are interpreted to be a result of rapid deposition of chromite nodules while they were still plastic. The nodules and orbicules commonly exhibit stretching fabrics (lineation and foliation), interpreted to have formed soon after crystallization, while the interstitial olivine was still in liquid form. Some are also elongated by plastic strain and show a preferred orientation. Most nodules are oriented parallel to the foliation. The outer boundary of single nodules is typically smooth and rounded (Fig. 8B). In contrast, the inner boundaries display individual chromite grains that grew inward (Fig. 8A). These textures are interpreted to record dynamic magmatic flow or partial melting conditions, needed to keep chromite suspended and growing concentrically into the magma. The delicate magmatic structures preserved show that they have not been significantly deformed after their formation, and they preserve the primary interaction between Archean melts and the upper mantle.

In some cases, nodules grade into antinodules in the same hand specimen. They record magmatic growth and settling in the upper mantle (e.g., Zhou et al., 1996; Edwards et al., 2000). Rounded

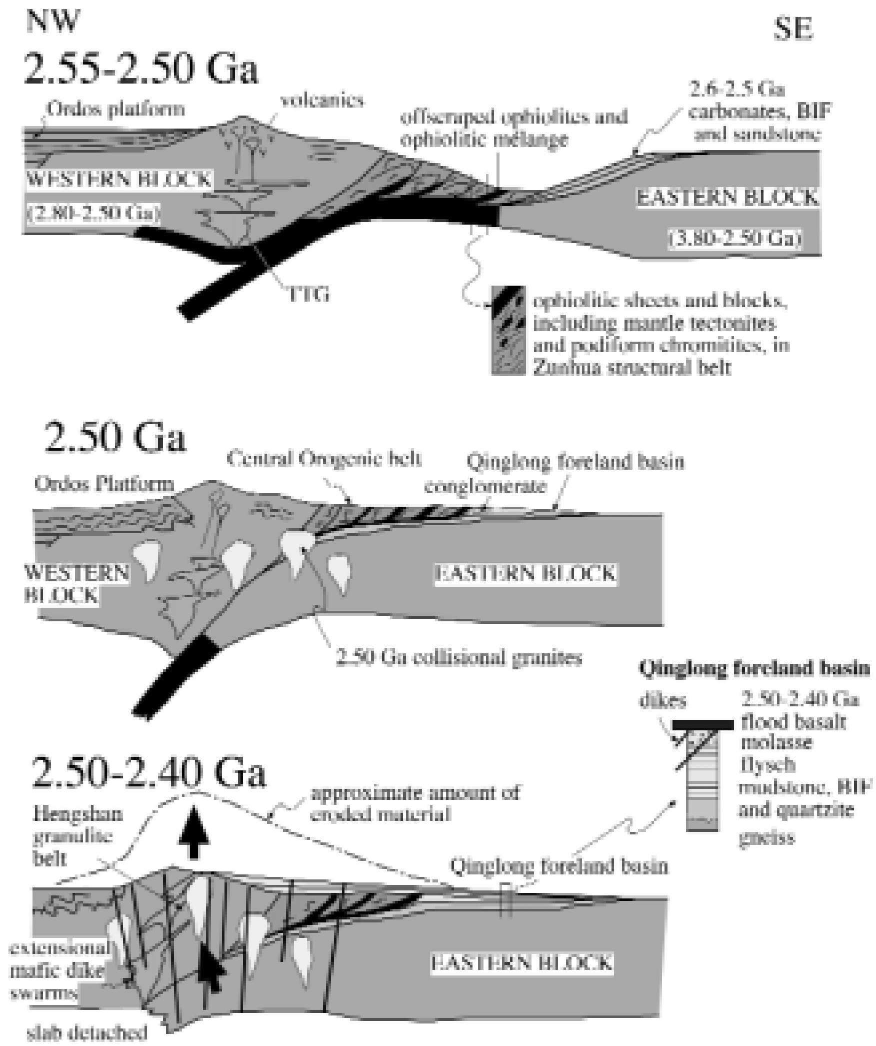

Figure 9. Model for the Late Archean tectonic evolution of the North China craton. An arc terrane built on the Western block at 2.55 Ga collides with the Eastern block at 2.5 Ga, forming an ophiolitic mélange with fragments of forearc and other ophiolites in an accretionary wedge during closure of the intervening ocean basin. The Central Orogenic belt overrides the passive margin of the Eastern block during attempted subduction of the margin of the Eastern block, forming the Qinglong foreland basin and foreland fold-thrust belt. Numerous 2.50–2.40 Ga granites intrude during and slightly after the collision. The partially subducted margin of the Eastern block rebounds isostatically and flexurally, causing the rapid uplift, extensional collapse, and exhumation of high-pressure granulites of the Hengshan belt at 2.5–2.4 Ga, along with the intrusion of an extensional mafic dikes swarm.

inclusions of olivine, orthopyroxene, and other silicates occur within chromite grains (Fig. 8E), and some inclusions of olivine show kink bands that record plastic deformation before or during growth of the chromite. A few fluid inclusions have also been observed within the silicate inclusions in chromite. These original magmatic structures are commonly destroyed with higher shear strain. For example, nodular and orbicular textures are strongly stretched and transposed into layering, folded bands, or antinodular chains. Compared with nodules, orbicules are more strongly stretched, their ratio of X/Z being up to 5:1 (Figs 7E and 8A). We attribute this deformation to mantle flow in the oceanic mantle, as suggested for similar structures in many younger ophiolites (e.g., Nicolas, 1989).

Antinodular chromitites consist of flattened dunite aggregates with lengths of 2–10 mm surrounded by fine-grained chromite chains or flattened networks (Figs. 7, 8F, and 8H). Flattened antinodular texture is typical of high-temperature plastic deformation in oceanic mantle, which is a result of straining of weaker olivine inclusions in a rigid chromite-rich matrix. Alignment of needle-like chromite also indicates strong shearing. Layered and banded textures consist of anastomosing 2–4 cm thick bands and chains of chromite surrounding ovoids of olivine (Figs. 7F and 7H), which were generated by shearing of antinodular and nodular chromite layers, rather than by crystallization and accumulation. Tight folds are common in the banded chromitite. In a few places, narrow pyroxenite, dunite, and gabbroic dikes crosscut them. Some chromite layers occur as rootless folds or asymmetric lensoidal boudins, and other layers and lenses consist of nodules. Pull-apart textures are common in the massive and layered chromitite deposits (Fig. 8G). These form extensional veins perpendicular to the chromite layers, filled by serpentinized dunite. Nicolas (1989) and Holtzman (2000) show that such textures form only at temperatures >1000–1200 °C.

DISCUSSION AND CONCLUSIONS

We interpret the mafic and ultramafic blocks in the biotite gneiss matrix to represent a strongly dismembered ophiolite in a metasedimentary and metavolcanic matrix. Relationships are strongly reminiscent of younger ophiolitic mélange terranes, where blocks of ophiolite are preserved in a metasedimentary accretionary prism and/or trench complex (e.g., Kusky et al., 1997). The Zunhua ophiolitic blocks in mélange do not preserve an overall younging direction, although a few of the blocks show younging directions toward the west. Similarly, the Dongwanzi ophiolite to the northeast preserves a westward-younging sequence.

These relationships suggest, although do not require, that the ophiolites were emplaced into the mélange during westward directed subduction, then thrust over the Eastern block during closure of the intervening ocean basin (Fig. 9). In this model the contemporaneous arc would be located to the west of the Zunhua structural belt. We interpret a narrow belt of deeply eroded and strongly metamorphosed 2.55–2.5 Ga arc-type tonalite-trondhjemite-granodiorite plutonic rocks and a greenstone belt in the Wutai-Hengshan-Taihang Mountains to the southwest to represent the remnants of this arc (Li et al., 2000b; Wilde et al., 1998). The ca. 2.5–2.4 Ga Qinglong, Hutuo, and Dengfeng sedimentary sequences and other similar basinal deposits east of the Central Orogenic belt (Figs. 2 and 9) may represent the foreland basin sequence resulting from the collision of the east and west blocks. These basin sequences consist of lower turbidite and upper molasse sequences, with more intense thrusting and folding in the west adjacent to the Central Orogenic belt. The 2.5–2.4 Ga granitoids that intrude the base of the ophiolite and much of the Central Orogenic belt could represent collisional-to-postcollisional granites formed during crustal thickening during orogenesis. This model also explains the exhumation of ca. 2.5 Ga high-pressure granulites and retrograde eclogites in the Hengshan belt to the west (Li et al., 2000a) (Fig. 9).

Harzburgite blocks in the mélange host podiform chromitites with dunite envelopes. The blocks grade up-section into wehrlite, pyroxenite, olivine gabbro (troctolite), and gabbro. Podiform chromitites are a normal component of ophiolites of different ages. They are located in the transition zone between layered gabbro and peridotite tectonite, and the lherzolite-harzburgite transition in ophiolites (Nicolas and Arzi, 1991). Their geological occurrence is closely associated with oceanic spreading processes (Nicolas and Arzi, 1991). Late Proterozoic podiform chromitites in ophiolites have been described in several areas, and Phanerozoic examples are numerous (Fig. 1). The oldest relatively intact podiform chromitite previously recognized is that from the Jourma and Outokumpu ophiolite complexes (2 Ga), Finland (Kontinen, 1987; Vuollo et al., 1995). The Zunhua chromite ores exhibit remarkable similarities to the podiform ores described from the examples mentioned above.

The Zunhua nodular and orbicular chromites are characteristic of alpine-type peridotites or ophiolitic chromite ores (Nicolas, 1989; Peters et al., 1991; Dilek et al., 2000). It is now believed that this type of chromite accumulated below the transition between oceanic crust and mantle based on numerous investigations in ophiolites. The origin of the podiform chromitites is attributed to melt-rock reaction, or dynamic magmatism within melt channels in the upper oceanic mantle (Nicolas and Arzi, 1991; Zhou et al., 1996). The presence of water in the melt is thought to be important for the formation of podiform chromite (e.g., Edwards et al., 2000). Inclusions within chromites, olivine, and orthopyroxene of the host peridotites in the Zunhua structural belt record high-temperature plastic deformation. The flattening and elongation of chromite parallel to foliation and lineation are indicators of intensive high-temperature shear strain. These textures probably record the plastic flow of the upper mantle, now mainly preserved in the core of tectonic blocks. These early lineations defined by deformed magmatic inclusions and the elongation of ore zones are not parallel to later lineations related to the emplacement of the blocks along shear zones, supporting the idea that they represent early mantle-deformation–related fabrics. Podiform chromitites are remarkably resilient to later deformation and metamorphism since they are generated at high temperatures (1200–1300 °C) and become very rigid when cooled, thus resisting later shear. These asthenospheric chromite pods are miniature time capsules preserving extraordinary amounts of information about the Archean mantle that we have only begun to tap and understand.

Coupled with the presence of a full ophiolite sequence in the Dongwanzi complex, the documentation of the Zunhua chromitites provides evidence for the operation of seafloor spreading and plate tectonics during the Archean before 2.5 Ga. We prefer to ascribe a faster-to-moderate spreading rate to the formation of the Zunhua podiform chromitites, as podiform chromite is mainly associated with harzburgite-type ophiolites (Nicolas and Arzi, 1991). Although the field and petrographic observations are consistent with the Neoarchean ophiolites of the Central Orogenic belt preserving relatively hot mantle features, we do not have evidence that this mantle record was any hotter than the present-day range of mantle temperatures. However, the hot Archean North China mantle is consistent with some of the higher heat production during the Archean being accommodated by faster creation of oceanic lithosphere from a slightly hotter oceanic asthenosphere.

ACKNOWLEDGMENTS

This research was supported by the National Science Foundation of China (No. 49832030), Peking University (Project 985), the U.S. National Science Foundation (Tectonics Program EAR-0221567), and by St. Louis University. Li thanks X.L. Qian for discussions and his extensive help. Jesse Dann, Claude Herzberg, John Encarnacion, and Igor Puchtel provided thoughtful reviews of this work. This is a contribution to International Geological Correlation Program Project 453.

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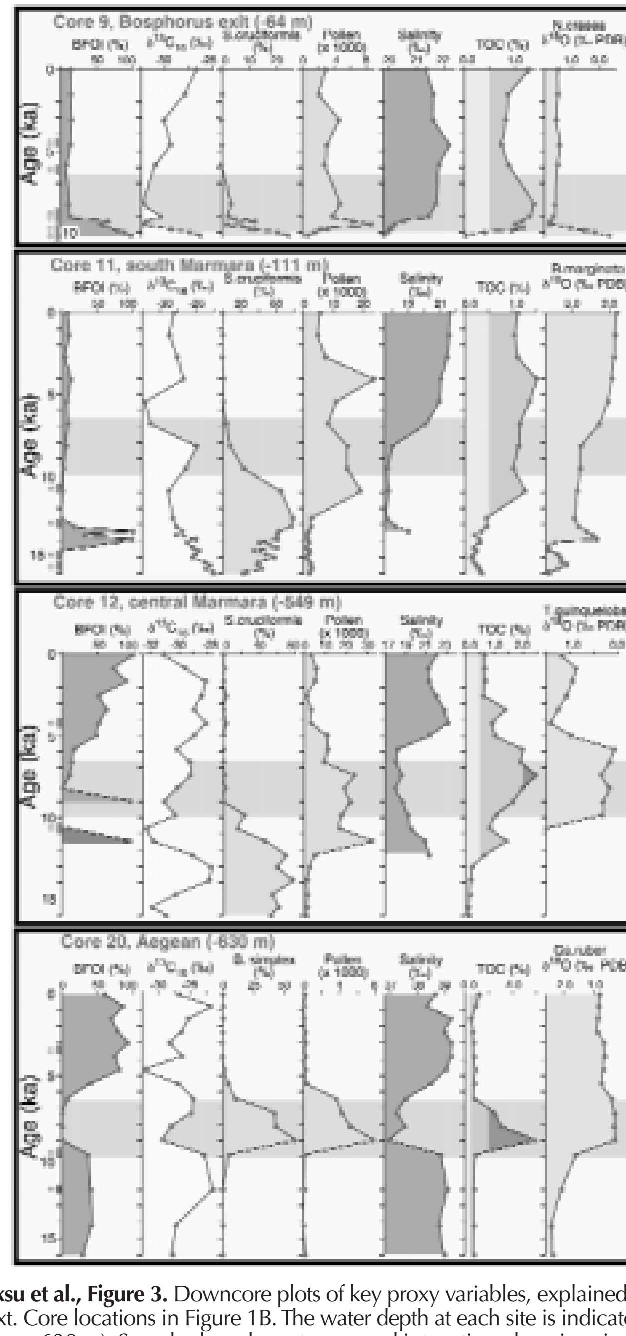
CORRECTION

Persistent Holocene Outflow from the Black Sea to the Eastern Mediterranean Contradicts Noah's Flood Hypothesis

GSA Today, v. 12, no. 5, p. 4–10 (May 2002)

In final production, some graph axes and scale tick marks were inadvertently deleted from Figure 3, "Downhole plots of key proxy variables." A corrected full-size, color figure can be found in the article posted at www.geosociety.org. Go to "Online Journals," then to "Archive." *GSA Today* regrets the error.



Aksu et al., Figure 3. Downcore plots of key proxy variables, explained in text. Core locations in Figure 1B. The water depth at each site is indicated (e.g., –630 m). Samples have been transposed into a time domain using radiocarbon dates tabulated in Aksu et al. (2002a), and the oxygen-isotope and ash record in Core 20. Control points are marked by red * symbols along the age scale. Where red dots (sample positions) cluster, the accumulation rate was highest (e.g., deltaic strata at the base of Cores 11 and 9). Where red dots are missing for some variables, the species required for determinations were absent (e.g., *Turborotalita quinqueloba* before ca. 10 ka for Core 12). The mauve-colored band from ca. 10–6.5 ka coincides with sapropel deposition and significant changes in several proxy variables.

DIALOGUE

Shaping GSA's Financial Future

Tony Naldrett, *President, and* ***Jack Hess,*** *Executive Director*

In a 1998 Environmental Scan, the American Society of Association Executives reported on 14 trends affecting associations, all of which presently impact GSA. This month, we highlight one of those trends—"Revenue Sources: The need for new revenue will drive associations to become more innovative in seeking out new partners and nontraditional sources of income"—and share with you how GSA is responding.

In February's "Dialogue" you read about GSA's finances and how the Society must reduce the size of its operating budget. We're now on a diet, so to speak, and you may have already noticed some changes at headquarters. While lowering expenditures is an important first step toward improving our financial health, there is more to be done. We must also increase revenue.

The Current Picture

At present, publications produce approximately one-third of GSA's total revenue. Meetings and member dues account for another third. Investment income provides about one-fifth of the total, and the GSA Foundation, grants, and other miscellaneous sources make up the balance.

If we are to maintain GSA's profile as a major earth science society beyond the next decade, we must be prepared for changes in these revenue streams.

Consider publications, for example. GSA's journals are among the most highly cited in the geosciences; they are vibrant and doing well. At the same time, we know that the structure of the publications business is changing. GSA plans to change with it by participating in an aggregate of online society journals that offers increased convenience and research horsepower. (See "Dialogue," March 2002, for details on the aggregate.)

While we are confident moving ahead, we don't know how this change in the structure of our publications business will alter the revenue stream. We do know that we cannot assume the picture will remain the same. This can be said for all of GSA's major sources of revenue, as well as for their proportional relationships to one another.

On the plus side, GSA is one of only a few scientific societies presently growing in membership. In a recent address to the Council of Scientific Society Presidents, Sharon Mosher analyzed reasons for this; she concluded that a decline that was also affecting GSA ended in 1995–1996 as a result of planned changes to address the problem. These changes involved: revamping the approach to annual meetings (which had become stuffy and regionally focused) to address significant disciplinary, interdisciplinary, and global problems (Pardee and Topical sessions); making a special effort to encourage students to join and then stay as GSA members; and bringing a more global perspective to the Society when it comes to addressing key scientific issues (e.g., the recent GSA-GSL 2001 joint meeting on earth science systems).

The open-minded, innovative approach that has been applied to meetings must be taken to the Society as a whole: As our environment changes, we must be prepared to change with it on any and all fronts.

A New Entrepreneurial Spirit

It is our view that a new entrepreneurial spirit is required within GSA. We need to look ahead, think outside the box, and plan for the future.

Recognizing this, we have formed an ad hoc Long-Range Planning Committee to investigate ways of changing GSA and adding new revenue streams from a variety of sources to meet future needs. Possible new revenue streams include a much higher income from grants; marketing and selling services to industry, the community, and government that are based on the skill set of our headquarters staff; new classes of membership; and better utilization of our building.

We have asked this committee's members to prepare an interim report by this October and a final report by May 2003. We know that they would welcome all suggestions from you, our members. Please submit your thoughts to Ann Cairns, acairns@geosociety.org, at GSA headquarters. Thank you.

THE GEOLOGICAL SOCIETY OF AMERICA

GSA Names 2002 Medal and Award Recipients

Medals and awards for 2002 will be presented to the following people at the GSA Annual Meeting in Denver.

Penrose Medal
Walter Alvarez
University of California at Berkeley

Arthur L. Day Medal
Richard G. Gordon
Rice University

Young Scientist (Donath) Medal
To be announced.

GSA Distinguished Service Awards
Samuel S. Adams
Lincoln, New Hampshire
David E. Dunn
University of Texas at Dallas
John W. Geissman
University of New Mexico

GSA Public Service Award
John A. McPhee
Princeton, New Jersey

Honorary Fellow
John F. Lovering
Australia

Doris M. Curtis Women in Science Award (Sponsored by Subaru of America, Inc.)
Miriam E. Katz
Rutgers State University

AGI Medal in Memory of Ian Campbell
Frank H. Rhodes
Cornell University

John C. Frye Environmental Geology Award
To be announced.

Rip Rapp Archaeological Geology Award
Paul Goldberg
Boston University

Gilbert H. Cady Award (Coal Geology Division)
Ronald W. Stanton, (deceased)
U.S. Geological Survey, Reston, Virginia

E.B. Burwell, Jr., Award (Engineering Geology Division)
Thomas E. Eastler
University of Maine
Donald J. Percious
Washington, D.C.
Paul R. Fisher
Green Valley, Arizona

George P. Woollard Award (Geophysics Division)
To be announced.

History of Geology Award
Dennis Dean
Evanston, Illinois

O.E. Meinzer Award (Hydrogeology Division)
Thomas C. Winter
U.S. Geological Survey, Lakewood, Colorado

G.K. Gilbert Award (Planetary Geology Division)
James W. Head III
Brown University

Kirk Bryan Award (Quaternary Geology and Geomorphology Division)
Frank J. Pazzaglia
Lehigh University
Mark T. Brandon
Yale University

Laurence L. Sloss Award (Sedimentary Geology Division)
Allison R. (Pete) Palmer
Institute for Cambrian Studies

Structural Geology and Tectonics Division Career Contribution Award
Robert E. Wallace
Reno, Nevada

New GSA Fellows Elected

GSA Council elected the following Fellows at its spring 2002 meeting.

Julie Brigham-Grette
University of Massachusetts
Kerry D. Cato
Earth Consultants International
Eric H. Christiansen
Brigham Young University
Allen J. Dennis
University of South Carolina
Yildirim Dilek
Miami University
Thomas E. Eastler
University of Maine
Judy Ehlen
USA Engineer Research & Development Center
Charles H. Fletcher III
University of Hawaii
Karen S. Harpp
Colgate University
W. Burleigh Harris
University of North Carolina at Wilmington
Kirk R. Johnson
Denver Museum of Nature and Science
Jeffrey D. Keith
Brigham Young University
Allan Kolker
U.S. Geological Survey, Reston, Virginia
Bart J. Kowallis
Brigham Young University
Chia-Yu Lu
National Taiwan University
Douglas J. Nichols
U.S. Geological Survey, Denver, Colorado
Carrie Jennings Patterson
Minnesota Geological Survey
Frank J. Pazzaglia
Lehigh University
Gerald M. Ross
Geological Survey of Canada
William W. Simpkins
Iowa State University of Science & Technology
Barbara J. Tewksbury
Hamilton College
H.L. Vacher
University of South Florida
Terry R. West
Purdue University
Thomas C. Winter
U.S. Geological Survey, Denver, Colorado

THE GEOLOGICAL SOCIETY OF AMERICA

Call for Geological Papers: 2003 GSA Section Meetings

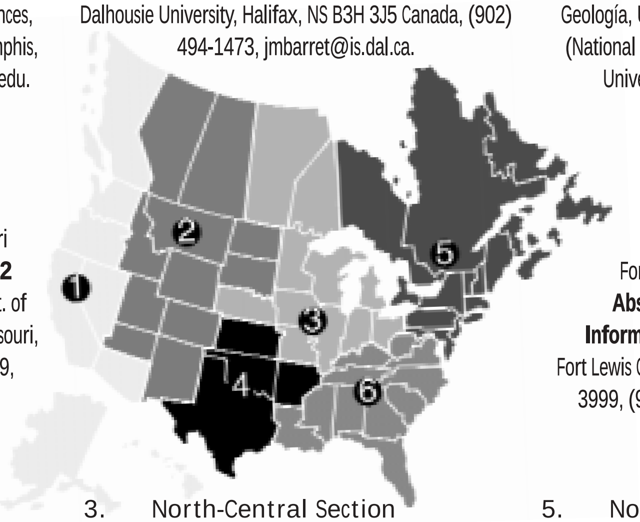
South-Central–Southeastern Sections Joint Meeting
March 12–14, 2003
University of Memphis, Memphis, Tennessee
Abstract deadline: December 10, 2002
Information: Dan Larsen, Dept. of Earth Sciences, University of Memphis, 421 J.M. Smith Bldg., Memphis, TN 38152, (901) 678-4358, dlarsen@memphis.edu.

Northeastern Section
March 27–29, 2003
Westin Hotel, Halifax, Nova Scotia
Abstract deadline: December 12, 2002
Information: Jane Barrett, Dept. of Earth Sciences, Dalhousie University, Halifax, NS B3H 3J5 Canada, (902) 494-1473, jmbarret@is.dal.ca.

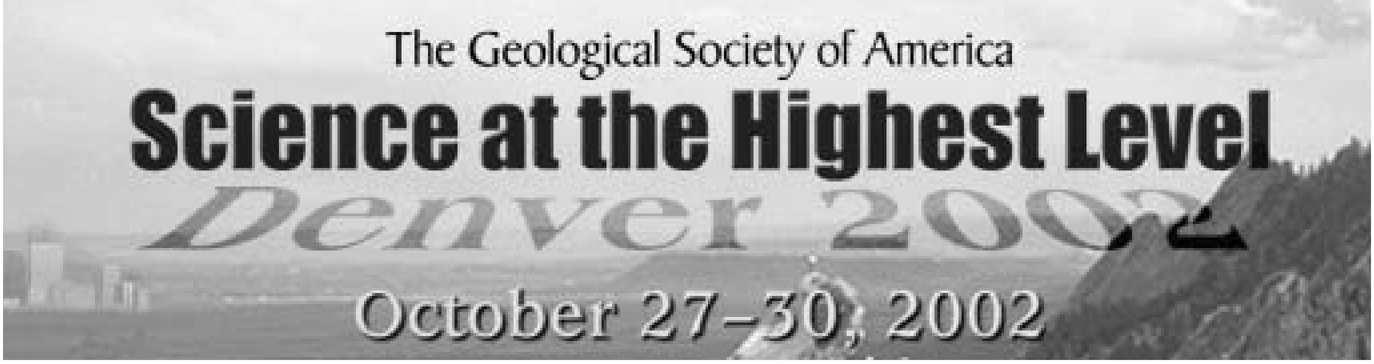
Cordilleran Section
April 1–3, 2003
Hotel NH Krystal, Puerto Vallarta, Mexico
Abstract deadline: December 16, 2002
Information: Elena Centeno-García, Instituto de Geología, Universidad Nacional Autónoma de México, (National Autonomous University of Mexico), Ciudad Universitaria, México, D.F. 04510, México, centeno@servidor.unam.mx.

North-Central Section
March 24–25, 2003
Kansas City Airport Hilton, Kansas City, Missouri
Abstract deadline: December 10, 2002
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.

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



GSA Short Courses Offered at GSA Annual Meeting

For a high level of understanding and knowledge, sign up for a great short course at the GSA Annual Meeting in Denver. For registration information and details on student scholarships offered by several GSA Divisions, see the June issue of *GSA Today* or visit www.geosociety.org. All courses will be held at the Colorado Convention Center. Questions? Contact Edna Collis, ecollis@geosociety.org, (303) 357-1034.

Preregistration deadline: September 20

1. **Anisotropy of Magnetic Susceptibility and Applications to Granitic Rocks**
   Fri. and Sat., Oct. 25–26, 8 a.m.–5 p.m. both days. Cosponsored by *GSA Structural Geology and Tectonics Division*. Limit: 30. Fee: $320, students $300; includes course manual and lunches. CEUs: 1.6.
   Intended for researchers and graduate students, this course will include rock magnetism and mineralogy applied to granites, variations of susceptibility with temperature, field, grain size, sampling and orienting procedures, measurements, data processing, orogenic and anorogenic granites, paramagnetic and ferromagnetic granites, case studies in various tectonic contexts, experimental studies. Participants may bring their own data for discussion. **Faculty:** Eric C. Ferré, Dept. of Geology and Geophysics, University of Wisconsin; Ph.D., University of Toulouse, France; Mike Jackson, Institute for Rock Magnetism, University of Minnesota; Ph.D., University of Michigan.
2. **Managing Environmental Projects**
   Fri. and Sat., Oct. 25–26, 8 a.m.–5 p.m. both days. Cosponsored by *GSA Engineering Geology Division*. Limit: 30. Fee: $300, students $280; includes course manual and lunches. CEUs: 1.6.
   Presenting an overview of all aspects of the field of environmental project management, this course includes in-depth discussions of all federal and many state environmental laws and regulations and how they are applied to ensure regulatory compliance and protection of human health and the environment. The course will present the "science" of environmental management including applications of chemistry, biology, toxicology, and geology-hydrology. It will also cover pollution prevention, emergency preparedness, health and safety issues, regulatory permitting, risk assessments, sampling and monitoring protocols, remediation methods, professional liability and ethics, and project management skills. An optional exam will be offered on the afternoon of the second day for those interested in Registered Environmental Manager (REM) certification through the National Registry of Environmental Professionals (NREP). There is an additional fee for the exam that also includes one year's registration with NREP. **Faculty:** Raymond C. Kimbrough, P.E. LaMoreaux and Associates; B.A., University of Alabama.
3. **Abrupt Climate Changes**
   Sat., Oct. 26, 8 a.m.–5 p.m. Cosponsored by *GSA Quaternary Geology and Geomorphology Division*. Limit: 30. Fee: $240, students $220, includes course manual and lunch. CEUs: 0.8.
   The record in Greenland ice tells us that Earth's climate system has undergone large and abrupt changes, raising the question as to whether the ongoing increase in atmospheric CO_2 will lead to a similar nonlinear response. The course will emphasize the record of these climate jumps and what they are trying to tell us about the joint operation of our ocean-atmosphere system. **Faculty:** Wallace S. Broecker, Lamont-Doherty Earth Observatory, Columbia University; Ph.D., Columbia University.
4. **Estimating Rates of Groundwater Recharge**
   Sat., Oct. 26, 8 a.m.–5 p.m. Cosponsored by *GSA Hydrogeology Division*. Limit: 30. Fee: $275, students $255; includes course manual and lunch. CEUs: 0.8.
   Good estimates of groundwater recharge are required to accurately assess water resources and evaluate aquifer vulnerability to contamination. This course will review theory, assumptions, uncertainties, advantages, and limitations of different approaches for estimating recharge rates. We will discuss physical, tracer, and numerical modeling techniques based on surface water, unsaturated zone, and saturated zone data. The course content is aimed at practicing hydrologists and advanced hydrology students. **Faculty:** Richard W. Healy, U.S. Geological Survey, Denver; B.S., University of Illinois; Bridget R. Scanlon, Bureau of Economic Geology, University of Texas, Austin; Ph.D., University of Kentucky.
5. **Laser Ablation ICP-MS: Fundamentals and Applications to Environmental and Biological Samples**
   Sat., Oct. 26, 8 a.m.–5 p.m. Cosponsored by *GSA Archaeological Geology Division*. Limit: 30. Fee: $275, students $255; includes course manual and lunch. CEUs: 0.8.
   Laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) is a solid sampling technique that allows the quantitative determination of elements at trace (ppm) levels whilst preserving the textural context of the analysis. LA-ICP-MS is seeing widespread use in geochemistry as new analytical methods come online and is beginning to be used for the analysis of biological materials. The short course introduction will focus on the fundamentals of LA-ICP-MS and leads into discussion of specific examples where LA-ICP-MS is used to address environmental issues. The structure allows for the active interchange of experiences and ideas between the course participants. **Faculty:** Alan E. Koenig, Cetac Technologies, Omaha; M.S., Colorado State University; Ian Ridley, U.S. Geological Survey, Denver; Ph.D., Royal School of Mines, University of London.
6. **Practical Methods in Applied Contaminant Geochemistry: From Characterization to Remediation**
   Sat., Oct. 26, 8 a.m.–5 p.m. Cosponsored by *GSA Hydrogeology Division*. Limit: 30. Fee: $250, students $230; includes course manual and lunch. CEUs: 0.8.
   Geochemical data obtained as part of regulatory-driven hydrogeologic investigations are commonly too incomplete, of scant number, and of insufficient quality to use the kinds of geochemical approaches that are normally learned in university courses on acid-base and chemical-equilibrium geochemistry. This course will teach the "practical" essentials of contaminant geochemistry and how to effectively apply them in consulting (and, arguably, academic!) practice. **Faculty:** Donald I. Siegel, Dept. of Earth Sciences, Syracuse University; Ph.D., University of Minnesota.

Call for Field Trip Proposals

2003 GSA Annual Meeting
November 2–5, 2003
Seattle, Washington

We are interested in proposals for half-day, single-day, and multi-day field trips beginning or ending in or near Seattle and dealing with all aspects of the geosciences.

Please contact the 2003 Field Trip Chair:

Terry Swanson
Department of Earth & Space Sciences
University of Washington
63 Johnson Hall, Box 351310
Seattle, WA 98195
(206) 543-1923
fax 206-543-0489
tswanson@u.washington.edu

Due date for field trip proposals:
October 1, 2002

2003 Officer and Councilor Nominees

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Attention Voting Members:

GSA Election Starts July 30, 2002

The success of GSA depends on the work of the elected officers who serve on its Executive Committee and Council. Make your wishes for GSA known by voting.

In late July, you'll receive a postcard with instructions on how to access a secure Web site and your electronic ballot listing officer nominees for 2003 and councilor nominees for the term 2003–2005. Biographical information on each candidate and the 2001 Annual Report also will be available on the site.

Paper versions of ballots, candidate information, and the 2001 Annual Report will be readily available to those who do not have Internet access or choose not to vote online.

Watch for your ballot information and vote! Ballots must be submitted electronically or postmarked by August 30, 2002.

COMMENTARY

Geoinformatics: A Nascent Revolution in the Earth Sciences

M. Lee Allison, *Kansas Geological Survey, Lawrence, Kansas*

Walter S. Snyder*, *National Science Foundation, Arlington, Virginia*

J. Douglas Walker, *University of Kansas, Department of Geology, Lawrence, Kansas*

Many disciplines outside the earth sciences are building consensus and preparing comprehensive plans to design and implement informatics systems. Within the spatially based scientific communities, including earth sciences, ocean and atmosphere sciences, and the biodiversity field, there is rapidly growing and widespread appreciation of the need to collaborate on this mission. Scores of independent *geo*informatics activities are under way in the earth sciences but with no overarching plan for coordination. We in the earth sciences community must assess our own needs, capabilities, and desires to join the informatics revolution.

The rationale for this is clear. With the advent of large-scale digital data gathering and conversion capabilities, we are becoming overwhelmed with data and must tackle the issues of management and dissemination of large and often disparate data sets. Managing and exploring data to create information is generally a task undertaken by information science or *informatics* efforts.

Informatics is the rapidly evolving field that promises not only to handle the huge databases generated by university consortia and state and federal agencies, but to serve the needs of small teams of investigators and individual scientists. Informatics integrates and applies information technologies with scientific and technical disciplines. It provides for distributed computing and enhanced numerical modeling, advanced visualization, statistical and mapping tools, and a system to archive data that would otherwise be lost to the greater community. The results of these informatics efforts are transforming areas of research with phenomenal new capabilities. For example, *bio*informatics centers have been established around the world to maximize the benefits from information in the human genome and related databases. Many of these centers are funded up to the $100 million per year level (Stone, 2001). The draft report from a blue-ribbon National Science Foundation panel (see Additional Reading) calls for a $650 million per year program aimed at "revolutionizing the conduct of science and engineering through information technology and cyberinfrastructure."

Informatics also is integral to the creation and success of the second generation Web, sometimes referred to as the Semantic Web, where computers will understand the meaning of words and concepts and make the kinds of logical connections in searches that the human mind does.

In the private sector, informatics is implemented as "Web services," where businesses create applications they can use themselves or sell. These services allow integration of databases and software written in different languages by different vendors, running on different operating systems. Instead of many years of hand coding links among many business partners, companies find that Web services can create interactive accessibility over the Internet within months. Former Apple Computer president John Scully believes that in the next two decades, Web services "could be as important as personal computers have been during the last 20 years" (Moore, 2001).

Geoinformatics applies the informatics concept to the vast quantities of scientific data that have geographic locations or spatial coordinates. For example, it's estimated that 85% of all federal government data have a geographic component. The National Spatial Data Infrastructure is an initiative managed by the Federal Geographic Data Committee to standardize spatially based data from throughout federal agencies and make them accessible online.

By necessity, a geoinformatics system will not gather data restricted to a single Web site, but will collect pertinent information from databases distributed around the world. The system will include: efficient information and data retrieval mechanisms; 3-D search engines that can also query based on time in the past; accessibility to and application of visualization, analysis, and modeling capabilities; online workspace, software, and tutorials; and integration with online scientific journal aggregates and digital libraries. In practical terms, such a system will provide the ability to gather data over the Web from a variety of distributed sources, regardless of computer operating systems, database formats, and servers. Seamless interoperability of databases promises quantum leaps in productivity not only for scientific researchers but also for many areas of society including business and government. Search engines will gather data about any geographic location, above, on, or below ground, covering any geologic time, and at any scale or detail. A distributed network of digital geolibraries can archive permanent copies of databases that are maintained by the data authors.

The geoinformatics system will generate results from widely distributed sources. In this way the system functions as a dynamic data network. Instead of posting specific tables, charts, or maps based on static databases, the dynamic system creates these products each time an inquiry is made, using the latest information in the appropriate databases. Thus, in the dynamic system, a map generated today may differ from one created yesterday and one to be created tomorrow, because the databases used to make it are constantly (and sometimes automatically) updated.

The next step, and the challenge for all of us in the earth science community, is to come to agreement on how we will participate in the geoinformatics revolution.

References Cited

Moore, M.M., Guru Predictions: fast forward, Darwin, December 2001, p. 64 (http://www.darwinmag.com/read/120101/forward.html).

Stone, B., Wanted: Hot Industry Seeks Supergeeks, Newsweek, April 30, 2001, p. 54–56.

Relevant Links

www.geoinformaticsnetwork.org
http://bioinformatics.org
www.fgdc.gov
www.dlese.org

Additional Reading

Bioinformatics for Biodiversity, special section, Science, v. 289, Sept. 29, 2000, p. 2305–2314, and 2279.

Data Management for Marine Geology and Geophysics, Report of a workshop held May 14–16, 2001, in La Jolla, Calif., sponsored by National Science Foundation and Office of Naval Research (www.geo-prose.com).

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Revolutionizing Science and Engineering through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure, Draft 1.0, April 19, 2002 (www.cise.nsf.gov/b_ribbon/)

*The views expressed are the author's and not necessarily those of the NSF.

GEOLOGY from THE HILL: Midyear Report

Chester F. (Skip) Watts, *2001–2002 GSA–U.S. Geological Survey Congressional Science Fellow*

Much has happened since my first report to the Society (*GSA Today*, March 2002, p. 20–21). The fellowship year did have a challenging beginning. My introduction to Capitol Hill was dominated by the terror attacks of September 11 on New York and Washington, which were followed by the anthrax evacuations of the Hart Senate Office Building and then cramped working conditions, as we squeezed into makeshift office space.

Life on the Hill has settled down to a "new normal," and we are finally back home in Hart. Now it's the work itself that is challenging. The issues Congress is grappling with are both crucial and contentious. The public policy process is fascinating, although sometimes convoluted. There clearly is a need and a place for science in the formulation of national public policy, but more often than not, science turns out not to be the final deciding factor.

I am very fortunate to be on the personal staff of Senator Joseph I. Lieberman. This democrat from Connecticut was a 2001 recipient of the Pick and Gavel Award, established by the Association of American State Geologists to recognize individuals who have made significant contributions to advancing or facilitating the role of the geosciences in the public policy arena. In this article, I describe some of the geoscience issues facing the nation's 107th Congress.


Chester F. "Skip" Watts

As one of the first staffers into the Hart building on January 22, my feelings were probably not unlike those of archaeologists unearthing the ruins of Pompeii, also rapidly abandoned, but in 79 A.D. rather than 2001 A.D. A distant day seemed frozen in time as I walked through the building and the office suite. Coffee mugs sat where they were left on desks, messages from October waited to be collected from fax machines, while vital documents and works in progress that were so important months earlier lay neglected. Whenever necessary, the work of the U.S. Senate was reconstructed and completed elsewhere in temporary quarters. Government continued to function despite the efforts of terrorists.

Among the hot geoscience-related policy debates of the 107th Congress are: evolution versus creationism in the schools, drilling for oil in the Arctic National Wildlife Refuge, and disposal of high-level nuclear waste beneath Yucca Mountain in Nevada. Other hot science and technology issues include: widespread deployment of broadband Internet services and incentives to help colleges and universities produce greater numbers of physical scientists and mathematicians. Naturally, defense and homeland security matters are ever present and include dealing with the potential of more advanced bio-terrorist attacks, aircraft and airport protection, fighting the war in Central Asia, highway bridge and tunnel security in the United States, and water supply protection. Space and time prevent me from detailing all of these issues, so I will make do with some general remarks.

Members of Congress clearly strive to fulfill the wishes of their constituents. Nowhere is this more clearly demonstrated than in the two energy-related matters of (1) drilling for oil in Alaska, and (2) disposing of nuclear waste in Nevada. Both of these issues are complex, the debates are heated, and the results will be far-reaching. The debates occur against a backdrop of national and international energy concerns. How can an energy-hungry society meet its energy demands? How much dependence should there be on foreign oil from troubled regions? How do we balance the demand for energy with the desire and need to protect the environment?

The senators from Alaska are passionately in favor of drilling in the Arctic National Wildlife Refuge. Geologically speaking, the oil is there, and although the quantities are not clearly known, it is believed to be enough to reduce foreign need for a reasonable time. The technology to remove it with minimal impact exists. Notably, it would bring jobs and revenue to the people of Alaska. On the other hand, many folks have strong visceral feelings that a wildlife refuge should simply not be tampered with, especially when other sources of energy are available, and we have not yet done enough in the way of energy management and conservation. Senator Lieberman is among those and has even vowed to filibuster on the Senate floor if necessary to block the drilling in Alaska.

With regard to nuclear energy, the senators from Nevada are vehemently opposed to the disposal of high-level nuclear waste from all across the United States beneath Yucca Mountain. Their concern is the safety of the citizens of their state. There still remain some unanswered geologic questions. How much heat will the waste generate? How will the heat affect rock and water chemistry? Are the groundwater flow patterns clearly understood? Must we rely only on geologic containment or can we supplement that with engineered containment? And, there are concerns about safely transporting the waste across the country to the facility. These are only some of the many thorny issues.

Clearly, simple solutions to today's energy concerns are not easy to find. Having been involved in the debate over disposal sites in crystalline rock in the east in the 1980s, and having watched the debate for disposal sites in the salt deposits of the Gulf Coast areas with interest, I recognize that we are running out of time. Storage space at some power plants will soon be filled, and the safety and security of so many temporary storage facilities across the country is questionable.

The brief discussions here do not begin to do justice to these difficult matters. By the time this article is published, the congressional votes will have been made and the die will be cast on some of the crucial energy issues facing this country. But this discussion does, at least, provide a sense of the day-to-day complexities of geology from the Hill.

Next time: the daily work of a congressional science fellow.

THE GEOLOGICAL SOCIETY OF AMERICA

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Mobolaji O. Ajai
Guillermo L. Albanesi
David Otto Alderks
Wilma B. Aleman
Becky Alexander
David J. Allen
Jessica Allen
William Alley
Leslie D. Almberg
Mark A. Altabet
Paula R. Alves
Illa Lyn Amerson
Monique Ammidown
Ariel D. Anbar
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James R. Anderson
Lynn L. Anderson
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Robert H. Applebaum
Edwin Arbar
Louis M. Arighi
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Eleanor Ann Arnold
Ramon Arrowsmith
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Todd Aseltyne
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Carl Reiterman
Joachim Reitner
Joanna M. Reuter
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Jennifer E. Richardson
Nicole Lyn Richmond
Justin B. Ries
Sharon Ringsven
Clinton Francis Rissmann
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Harold D. Robinson Jr.
Jeremy Robinson
Eileen Rodriguez
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Karen Michelle Rowe
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Raphael Sagarin
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Joanna Scheffler
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Elizabeth A. Scholl-White
Mitzy Leight Schramke
Tim Schroeder
Russell A. Schuck
Derek Schutt
Cristina J. Schwarz
Joshua J. Schwartz
Kathleen A. Schwehr
Teresa Scolamacchia
Craig R. Scott
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Emily Kay Seidel
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Leslie A. Shaver
David Shaw
W. Cullen Sherwood
Nassar Shoham
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Eric R. Sikora
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Carl Simpson
Megan K. Simpson
Ramya Sivaraj
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Dina Smith
Glenn E. Smith Jr.
Lisa R. Smith
Steven William Smith
Daniel Snyder
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Susan L. Sowards
Taryn Sparacio
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Michael N. Spilde
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William J.A. Stavast
David Steadman

Tamara A. Stette
Vanja M. Stevanovic-Walls
Samuel Cowan Stewart
Marilena Stimpfl
Julie Stopar
Jess P. Stottsberry
William R. Straw
Jason C. Stringer
Pamela S. Struffolino
Kevin R. Strumpler
Mary Ann Studer
Thomas Richard Styles
Yong Jun Su
William M. Sullivan
Scott Summerside
Paula M. Sumpter
Sean Sundermann
Anna Sutton
Erin F. Sutton
Kenneth G. Sutton
Bernard W. Szukalski
Benjamin R. Tanner
Christopher R. Tanner
Leif M. Tapanila
Nicole P. Tardif
Peter B. Tauscher
Jean Pierre Tchouankoue
Samuel R. Teeters
Joyashish Thakurta
Bradley J. Thomson
Steven J. Tice
Judy Tobin
Lawrence Todd
Samantha Tokash
Iulia Tomescu
Bruno Tomljenovic
Funda O. Toprak
Jaime Toro
Felix Sadrack Toteu
Peter H. Townsend
Amy Townsend-Small
John C. Tracy
Taylor Andrew Tribble
Kelli Trujillo
Laura E. Trunk
Jeffrey Trust
Katushiro Tsukimura
Ralph D. Tullberg
Alice Turkington
Julie Ann Turrentine
Patrick Unternehr
Harry Tapio Uosukainen
Robert James Urban
Benjamin Urlwin
Luis C. Valenzuela-Navarro
Brian Valukonis
Phoenix Vamvakias
Douwe J.J. van Hinsbergen
Peter van Keken
Christopher J. Van Treeck
John Vandecar
Beth Ann Vanden Berg
Sandy Vanderburgh
Carla Vandervoort
J. Patricio Varas
Brian Vauter
Maria Elena Vazquez
Gregory T. Ventura
Pieter Vermeesch
Phil R. Verrengia
Ela L. Viray
Jared W. Volpe
Stacy S. Wagner
Brent R. Waidman
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Lee-Anna M. Walker
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Tania C. Wallace
Rose Wallick
Katherine Walton-Day
Yi Wang
Yiming Wang
Paul Wangenstein
Kelley S. Ward
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Chad Warren
Shizuko Watanabe
Andrew Alexander G. Webb
Sarah Elizabeth Webb
David Michael Wedge
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Clifton W. Whitfield
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Richard D. Williams
Todd B. Williams
Andrea Marie Williamson
Stephen E. Williamson
Mark Wilson
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Cornelia Winguth
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James A. Woodhead
Ulrich G. Wortmann
Lori Wozniak
Gerald L. Wright
Nichole Wummel
Dimitris Xirouchakis
Oren Yagil
Qi Ye
Susan B. Yelton
David J. Young
Ronald E. Young
Zicheng Yu
Ziming Yue
Andrew J. Zachary
Michael James Zaleha
Lindsay Elizabeth Zanno
Matthias Zeitlhofler
Dawn A. Zemo
Dongxiao Zhang
Di Zhou
Leifeng Zhou
Yong Zhou
Mangzheng Zhu
Agostino Zuppetta

THE GEOLOGICAL SOCIETY OF AMERICA

New GSA Student Members

The following people affiliated with GSA as Student Associates between October 2001 and March 2002.

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Laura Allen
Jeffrey S. Alley
John M. Alten
Douglas B. Amburn
Erika Amir-Denton
Arlene M. Anderson
Jonathan Antia
Sven Arndt
James D. Asher Jr.
Sara Elizabeth Austin
Bria M. Backhaus
Janet E. Bader
Clinton G. Bailey
Jake Bailey
Victoria N. Balfour
Eileen A. Ballerstein
John David Bannister
Kourtney N. Barto
Steven M. Bates
William Joseph Bates
Carl T. Bauer
Lisa A. Beale
Steven Joel Beardsley
Amanda L. Benedict
Marc A. Bieler
Sean J. Birt
Dana Bishop
Tara L. Blair
Margaret W. Blome
Madalyn S. Blondes
Francis Boccabella III
Robert J. Bodek Jr.
Angela Nicole Bond
Bradley Joseph Boring
Snejana Boscov-Parfitt
Karen E. Bossenbroek
Rabecka Ruth Bourke
Patrick Bourne
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Kevin M. Bradley
Sonia E. Bradley
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Matthew P. Brennan
Ryan Paul Bresnahan
James D. Bride
Thomas F. Bristow
Joe F. Brookshier
Michael Brown
Rob Jerome Brown
Jeffrey Bruesewitz
Kelly Bryan
Rebecca Budaj
Heather D. Burgess
Javier Burgos
Anna K. Burke
Laura L. Burnette
Jennifer A. Butler
Erika Buzzard
Bill Caddy
Douglas M. Campbell
Thomas J. Campbell
Nathan Cardoos
Holly A. Carlson
Polly M. Carter
Christopher F. Cassle
Ed Cavallerano
Brandon C. Chamberlin
Emily L. Chapp
Kimberly Ann Cheney
Lauren M. Chetel
Christin E. Cifelli
Paula K. Cint
Victoria A. Clancy
Daniel Coman Clark
Elke Clark
Robert H. Clark
David L. Cleary
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Ruth Coffey
James S. Cokinos
Jessica L. Conroy
Robyn C. Cook
Donald Coons
Stephen A. Cosaboon
Neal Brian Counts
Anne Covault
Brad Cramer
Scott K. Crane
Michelle R. Crist
Greg J. Crownover
Ryan W. Cummings
Stacy A. Curtis
Thomas Darrah
Michael J. DaSilva
Gregory A. Davis
Luke A. Davis
Marshall B. Davis
Krystle J. Day
Nicole A. Dean
Tonya Sue Del Sontro
Brad L. Deline
Asha Deosaran
Mitch J. Devries
Victor G. DeWolfe III
H. Jordan Diamond
Brad Didericksen
Aaron Fuller Diefendorf
Caleb E. Diehl
Erin N. DiMaggio
Jessica B. Dockendorff
Jessica Drees
Becky R. Dreibelbis
Allison Duchateau
Debra C. Ducotey
Laura K. Duncan
Sandy Duong
Matt E. Dupee
Kuwanna Dyer
Kevin C. Eagar
Richard D. Eagle
Ryan J. Earley
Sean P. Ellison
Raena England
Leah I. Englander
Travis Erny
Tzvetina V. Erohina
Joel J. Fassbinder
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Jonathan A. Faulkner
Paul R. Ferguson
Jennifer Marie Fimbres
Craig R. Fisher
Cheryl A. Foley
William R. Foniri
James E. Ford
Karolin M. Ford
Tom Fournier
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Justin C. Frieberg
Tiffany F. Friedel
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Jenna M. Hoffman
Adam J. Hollenbach
Christina M. Holtzinger
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Jennifer I. Kuykendall
Jennifer Kyle
Heather G. Lackey
Marshall Lake
Kenneth P. Lamkin
Elizabeth Landau
Gabe A. Landes
Levi C. Langevin
Christopher Lanteigne
Alexandra Larson
David B. Lasris
Jeffrey S. Latham
Ronald M. Latham II
Jeremy W. Laucks
C. Gordon Layfield
James A. Leavor II
Rachel J. Lee
Dennis Leikam
Gareth G. Leonard
Jill Leonard
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Phyllis K. Lewis
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Craig Maier

Amanda L. Malaney
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Kate Sowder
Demmy Spounias
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Jeffery D. Stepp
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Marie E. Walker
Benjamin Harvey Walls
Melinda K. Wamsley
Caroline N. Wannamaker
Gibran D. Washington
Matthew S. Wasson
Noah G. Weber
Aubrey Weese
Ethan Weikel
William J. Weiss
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Jennifer Weller
Zachary R. Wessel
Marissa K. Westerfield
Kelly A. Weyer
Sarah F. Whiting
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Bryce Willems
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Andrew Wilson
Laura Elizabeth Wilson
Sara Joy Wilson
Brent W. Wimmer
Nathan D. Winters
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Nicholas J. Wolfe
Amanda L. Wolters
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Brian P. Yurk
Stephen J. Zahniser
Andrew Zaprzal

ANNOUNCEMENTS

MEETINGS CALENDAR

2002

August 21–23	Eighth International Symposium on Borehole Geophysics for Minerals, Geotechnical, and Groundwater Applications, Toronto, Ontario, Canada. Information: Carol La Delfe, Minerals and Geotechnical Logging Society, webmaster@mgls.org.
August 26–29	Chapman Conference on High-Latitude Ocean Processes, L'Estérel, Québec, Canada. Information: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, D.C. 20009, USA, (202) 462-6900, toll-free in North America 800-966-2481, fax: 202-328-0566, meetinginfo@agu.org, www.agu.org/meetings/cc02ecall.html.
September 9–13	Chapman Conference on Eco-hydrology of Semiarid Landscapes: Interactions and Processes, Taos, New Mexico. Information: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, D.C. 20009, USA, (202) 462-6900, toll-free in North America 800-966-2481, fax: 202-328-0566, meetinginfo@agu.org, http://agu.org/meetings/cc02dcall.html.
October 28–30	Coaltrans 2002, Berlin. Information: +44-20-7779-8945, fax +44-20-7779-8946, coaltrans@euromoneyplc.com, coaltransconferences.com.
November 10–14	American Society of Agronomy (ASA)–Crop Science Society of America (CSSA)–Soil Science Society of America (SSSA) Annual Meetings: Uniting Sciences: Solutions for the Global Community, Indianapolis, Indiana. Information: www.asa-cssa-sssa.org/anmeet/.
November 11–14	Chapman Conference on Continent-Ocean Interactions within the East Asian Marginal Seas, San Diego, California. Information: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, D.C. 20009, USA, (202) 462-6900, toll-free in North America 800-966-2481, fax: 202-328-0566, meetinginfo@agu.org, http://agu.org/meetings/cc02ccall.html.
December 6–10	AGU 2002 Fall Meeting, San Francisco, California. Information: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, D.C. 20009, USA, (202) 462-6900, toll-free in North America 800-966-2481, fax: 202-328-0566, meetinginfo@agu.org, http://www.agu.org/meetings/meetings.html. *(Abstract deadline: September 5, 2002)*

2003

February 3–9	8th International Congress on Pacific Neogene Stratigraphy, Chaing Mai, Thailand. Information: Prof. B. Ratanasthien, Dept. of Geological Sciences, Chiang Mai University, Chiang Mai 50200, Thailand, benjavun@geol.science.cmu.ac.th.
April 7–11	2003 EGS, AGU, and EUG Joint Assembly, Nice, France. Information: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, D.C. 20009, USA, (202) 462-6900, toll-free in North America 800-966-2481, fax: 202-328-0566, meetinginfo@agu.org, egs@copernicus.org, www.copernicus.org/egsagueug/. *(Abstract deadline: January 15, 2003)*
August 26–30	Present State and Future Evolution of Paleogene Stratigraphy: A Symposium of the International Subcommission on Paleogene Stratigraphy, Leuven, Belgium. Information: Noël Vandenberghe, Dept. Geografie-Geologie, Afd. Historische Geologie, KU Leuven, Redingestraat 16, B-3000 Leuven, Belgium, noel.vandenberghe@geo.kuleuven.be, www.uni-tuebingen.de/geo/isps/news.
November 2–6	American Society of Agronomy (ASA)–Crop Science Society of America (CSSA)–Soil Science Society of America (SSSA) Annual Meetings. Information: www.asa-cssa-sssa.org.

About People

The American Institute of Professional Geologists (AIPG) announced the following AIPG award recipients for 2002 (all are GSA Fellows): **Larry D. Woodfork**, Ben H. Parker Memorial Award; **Madhurendu B. Kumar,** Martin Van Couvering Award; **Thomas M. Berg,** John T. Galey, Sr. Memorial Public Service Award; **Michel T. Halbouty,** Honorary Membership; **John W. Rold,** Honorary Membership; and **Roy J. Shlemon,** Honorary Membership. The awards will be given at the AIPG–AEG (Association of Engineering Geologists) Annual Meeting, September 25–27, 2002, in Reno, Nevada. Background and descriptions for each award can be found on the AIPG Web site at www.aipg.org.

AGI Releases Geoscience Department Status Report

The American Geological Institute (AGI) has released the *2001 Report on the Status of Academic Geoscience Departments,* which describes and analyzes enrollments, employment trends of recent graduates, faculty demographics, and other department characteristics at degree-granting geoscience departments in the United States.

The report is the result of AGI's comprehensive survey of more than 700 geoscience departments in the United States in 2001. "Close inspection of the findings presented in the *2001 Report* reveals many of the factors—and uncertainties—that have a bearing on the future of the geoscience profession," commented AGI Executive Director Marcus E. Milling.

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The *2001 Report* focuses on geoscience enrollments and degrees granted, employment trends of recent graduates, faculty ranks, faculty teaching specialties, geoscience theses and dissertation topics, research funding support, and geoscience employment by employer category, age, and gender.

The free12-page report is available online in PDF format at www.agiweb.org/career/rsad2001.pdf. Also available for free (at http://guide.agiweb.org) are AGI's two companion online publications, the *Guide to Geoscience Departments* and the *Guide to Geoscience Careers and Employers.*

Fulbright Scholar Grants Offered

The Fulbright Scholar Program is offering nine lecturing, research, and lecturing-research awards in geology for the 2003–2004 academic year. Awards for both faculty and professionals range from two months to an academic year.

While many awards specify project and host institution, there are a number of open "any field" awards that allow candidates to propose their own project and determine their host institution affiliation. Foreign language skills are needed in some countries, but most Fulbright lecturing assignments are in English.

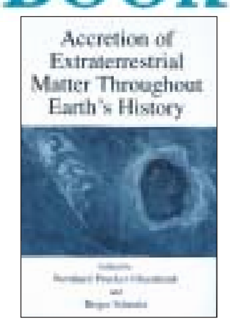
Application deadline for 2003–2004 award: August 1 for Fulbright traditional lecturing and research grants worldwide. For information, visit www.cies.org, or contact: The Council for International Exchange of Scholars, 3007 Tilden Street, N.W., Suite 5L, Washington, D.C. 20008, (202) 686-7877, apprequest@cies.iie.org.

National Academy of Sciences Call for Nominations

The National Academy of Sciences is accepting nominations for the Mary Clark Thompson Medal, a $15,000 prize given every three years to recognize important service to geology and paleontology. There are no age or nationality restrictions.

Nominations will be accepted through September 6, 2002. For more information, contact: National Academy of Sciences, Awards Program, Room 146, 2001 Wisconsin Avenue, NW, Washington, D.C. 20007, (202) 334-1602, fax 202-334-1255, awards@nas.edu, http://nas.edu/nas/awards.

BOOK REVIEW



Accretion of Extraterrestrial Matter Throughout Earth's History

B. Peucker-Ehrenbrink and B. Schmitz, *Kluwer Academic/Plenum Publishers, 2001, 492 p., $110.00, hardcover.*

Good morning. This is your wakeup call. Have you realized that you live on a planet careening through the debris generated by an ongoing 4.5-billion-year-old demolition derby? Did you know that during the 8 hours you slept, about 40 tons of material accumulated on your planet, much (but not all) of it too small to see? Not worth much thought? Relax. Sleep as soundly as a dinosaur...

Geologists have a fondness for processes that proceed at measurable rates, and for extrapolating these to reveal their historical influence on our planet. It's only recently that we've treated accretion as one of these processes, and our increased awareness of the sometimes not-so-gentle rain of extraterrestrial material encountering Earth has been of great benefit. Large impact events, once lionized by mainstream geologists as baneful and improbable catastrophes, are now used as powerful stratigraphic tools. Smaller objects (meteorites) that survive an encounter with our planet have become our most important source of information on the materials that make up the solar system and its earliest history. And even smaller objects, some nanometers across, may influence the composition and climate of our planet in dramatic ways. In their book, Peucker-Ehrenbrink and Schmitz have done a good job of portraying the importance and constant influence of ongoing accretion, with various authors covering topics that range across nearly 50 orders of magnitude of mass and distance.

In broad terms, the 22 chapters cover delivery mechanisms for dust from various solar-system sources; interactions of dust-sized particles with Earth; their effect on atmospheric and sediment chemistry, and their possible effect on climate; the recovery and recognition of accreted materials and their use in determining influx rates; and the longer term record of accretion found within terrestrial and lunar deposits. Speaking as someone who works on a few disparate parts of this incredible spectrum, I can say this book serves a wonderful purpose; it brings together topics that are all clearly related yet rarely discussed in a unified manner.

The book is not without its flaws, most of which I will attribute to the editors' desire to be inclusive. A few of the chapters focus on pet theories, obviously dear to the authors but less obviously embraced by the larger planetary community. Experienced readers will recognize these; hopefully, novices will not be misled. Some confusion also comes from a general lack of uniformity among the chapters; various authors use different baseline references as starting points, which leads to a few apparent (but not fatal) conflicts between interpretations. There are also a fair number of obvious proofreading mistakes, such as incomplete sentences and misspellings. But all in all, this is an exceptionally useful book, gathering together topics that have too often been treated in isolation.

Ralph Harvey
Case Western Reserve University, Cleveland, Ohio

George Sharp: A New Foundation Trustee


George Sharp

George C. Sharp has accepted a five-year appointment to the Foundation's Board of Trustees. Born in 1944, Sharp grew up in Portland, Oregon. He received B.S. degrees in geology (1967) and math (1968) and an M.S. degree in geology (1969)—all from Oregon State University. He served as an exploration geologist with the Shell Oil Company from 1969 to 1973 in Denver, Colorado, and in Midland and Houston, Texas. Sharp moved to the Tenneco Oil Company where he served from 1973 to 1977 as the Rocky Mountain Division geologist while managing geologic oil and gas exploration for the company in the Rocky Mountains. In 1977, he joined the Weyerhaeuser Company in Tacoma, Washington, where he was director of mineral resources until he retired after 25 years. Sharp managed all aspects of mining, oil, and gas, and geologic hazards, including exploration, development, production, and sales and acquisitions for approximately 7 million net mineral acres of Weyerhaeuser timberlands in the United States and Canada.

In addition to his membership in and activities on behalf of GSA, Sharp is a member of the American Association of Petroleum Geologists (AAPG) and is currently a trustee for the AAPG Foundation. He has served on the board of directors of the Northwest Mining Association and Northwest Energy Association, and is a member of the Rocky Mountain Association of Geologists, the Rocky Mountain Mineral Law Foundation, and the American Association of Mineral Owners. Sharp is registered as a professional geologist in Arkansas and Oregon.

Once again we have attracted a person to the Foundation's Board of Trustees who has a remarkable record of service and experience. The Foundation and Society are very fortunate to be served by someone with Sharp's stature, energy, and dedication.

Most memorable early geologic experience

Thanks to the invitation of Dr. Philip H. Abelson, I could learn geochronology at the Carnegie Institution in Washington—this was the basis for my later work.

—Emilie Jager

CLASSIFIED ADVERTISING

Ads (or cancellations) must reach the GSA Advertising office one month prior. Contact Advertising Department, (303) 357-1053, 1-800-472-1988, ext. 1053, fax 303-357-1070, acrawford@geosociety.org. Please include address, phone number, and e-mail address with all correspondence.

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Situations Wanted

Ph.D. in geology/paleontology w/ 5+ years exper in science research, oil industry, grad & undergrad teaching. Field experience in W. America, Europe, Greenland. Bilingual, published. Want to again be a geologist in USA. Willing to relocate. Contact @ (352) 278-3481.

Positions Open

WASHINGTON AND LEE UNIVERSITY

Tenure track position starting fall 2003. The Geology Department at Washington and Lee University seeks applicants in any specialty complementing our current faculty, with teaching interests in Sed/Strat and Historical Geology. W&L is a nationally ranked, highly selective liberal arts college. Our department (geology.wlu.edu) is a member of the Keck Geology Consortium and is ideally situated for field studies in the Valley and Ridge of southwestern Virginia. We seek a colleague who is dedicated to diverse teaching approaches, interested in making the most of our field setting, committed to collaborative undergraduate research, and enthusiastic about teaching intensive major/non-major field geology courses during spring term. A resume, statements of teaching interests/experience and research interests, and 3 letters of reference should be sent by Sept. 1, 2002 to David Harbor (harbord@wlu.edu), Geology Department, Washington and Lee University, Lexington, VA 24450. We encourage women and minority candidates to apply.

STATE GEOLOGIST OF ALABAMA

The President of The University of Alabama, the appointing authority, invites nominations and applications for the position of State Geologist of Alabama. In addition to proven administrative ability, candidates should have an educational background in geology or closely related earth science disciplines and substantial experience in some phase of geology and petroleum exploration and/or production. Because the Geological Survey of Alabama has a significant research emphasis, preference will be given to candidates with a Ph.D. in geology or a closely related earth science discipline.

The State Geologist is Director of the Geological Survey and also serves as State Oil and Gas Supervisor and Secretary of the State Oil and Gas Board. The total current combined budget is approximately $6 million with a staff of 86.

The salary is negotiable. Nominations and letters of application (including resumes) should be sent before August 1, 2002, to: Charles D. Haynes, Chairman, Search Committee for State Geologist, P.O. Box 870205, Tuscaloosa, AL 35487-0205, or e-mail to: stategeologistsearch@gsa.state.al.us.

Electronic correspondence is preferred but not required.

For more details on this position, visit the Web sites at http://www.gsa.state.al.us or http://www.ogb.state.al.us.

The Geological Survey/State Oil and Gas Board of Alabama is an Affirmative Action/Equal Opportunity Employer.

TECTONIC GEODESY
UNIVERSITY OF CALIFORNIA AT SANTA BARBARA

The Department of Geological Sciences at the University of California at Santa Barbara invites applications for a tenure-track position at the assistant professor level in Tectonic Geodesy for an appointment to begin July 1, 2003. We seek a broadly trained geoscientist who utilizes geodesy (primarily GPS and interferometry) for creative research in the fields of quantitative crustal deformation, plate tectonics, and/or surface processes. Individuals with additional expertise in numerical modeling or field geology are especially encouraged to apply. The successful applicant should complement departmental strengths in structural geology, tectonics, seismology, and surface processes. The appointee to this position will teach both undergraduate and graduate courses and is expected to maintain a vigorous, externally funded research program.

A Ph.D. is required at the time of appointment. The deadline for applications is September 1, 2002. Applicants should submit a letter of application, curriculum vita, and description of teaching and research objectives and accomplishments. Applicants should request that three referees send letters of evaluation directly to the search committee by the September deadline. Applicants should also provide the names, e-mail addresses, and contact information of those referees. All materials should be sent to: Geodesy Search Committee, Department of Geological Sciences, University of California, Santa Barbara, CA 93106-9630.

UCSB is an Equal Opportunity/Affirmative Action employer.

ENVIRONMENTAL GEOLOGIST,
LANDER UNIVERSITY

Environmental Geologist: Assistant Professor—August 2002. Teach physical and environmental geology, environmental/physical science, and hydrogeology; coordinate undergraduate ES degree program and direct undergraduate research. This is a one-year position. Person hired may apply for tenure-track position available August 2003. Screening will begin July 1, 2002. Application information and complete job description may be obtained at http://lander.edu/science/jobs.html AA/EOE.

Opportunities for Students

Attention students! Looking for a job or an internship? Then join us in Houston for the 5th Annual National AAPG/SEG Student Expo on October 20–21, 2002! The Expo is a great opportunity for students to meet with representatives from oil and gas and environmental companies, some of which recruit only at the Expo. Students will have the chance to showcase their research in a poster session and network with potential employers. Successful job searches result from the Expo every year. And use this occasion to explore Houston, a vibrant city, an oil capital, and home to the largest geoscientist population in the world! Contact Kerri Donathan at AAPG for more information (donathan@aapg.org).

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WORKSHOP ANNOUNCEMENT

Setting Priorities in Solid Earth Sciences

October 26, 2002
Denver, Colorado
Application Deadline:
August 1, 2002

An NSF-sponsored, one-day workshop will be held in Denver, Colorado, on Saturday October 26, 2002 (the day before the Annual Meeting of the Geological Society of America). This workshop is envisioned as the first step in developing an integrated approach to research, education, and facilities development in the Solid Earth Sciences as the central core of geology. The primary goal of the workshop is to promote an integrated and coherent approach to planning for the future of the Solid Earth Sciences across the sub-disciplines in the Solid Earth Sciences and among the synergistic activities of research, education and outreach. An additional outcome of the Workshop will be to formalize a group to promote the Solid Earth Sciences, which will need to have an appropriate representative executive committee.

Support from the National Science Foundation will assist with travel and other expenses for 50–100 participants to attend the Workshop. The participants will be selected from the pool of applicants to ensure balance, both across the Solid Earth Sciences and among research, education and outreach. Individuals interested in participating in this workshop should send an application by August 1, 2002, to Mike Brown (mbrown@geol.umd.edu) or Basil Tikoff (basil@geology.wisc.edu). Applications are to be e-submissions; a one-page abstract (Times New Roman, 12 point font, Title upper case/bold for headings) about priorities in the Solid Earth Sciences and the area(s) in which the applicant can best contribute. All applicants will be informed of the outcome of their application by August 30, 2002.

Call for Applications and Nominations for

GSA BULLETIN EDITOR

The GSA *Bulletin* seeks a co-editor, beginning January 1, 2003. The new editor will replace the editor whose term ends in 2002 and will serve a four-year term. A phased transition should begin in autumn of 2002.

GSA will provide a half-time assistant, pay the costs of maintaining an editorial office, and reimburse journal-related travel expense. Discretionary funds are also available.

The GSA *Bulletin* has a 114-year history of excellence in publication of definitive works related to all aspects of geoscience. Part of GSA's mission is to bring together different earth sciences in a forum for scientific inquiry and discussion, and the *Bulletin* editors are charged with continuing this tradition while helping Society staff find the best ways to provide comprehensive manuscripts in the electronic environment.

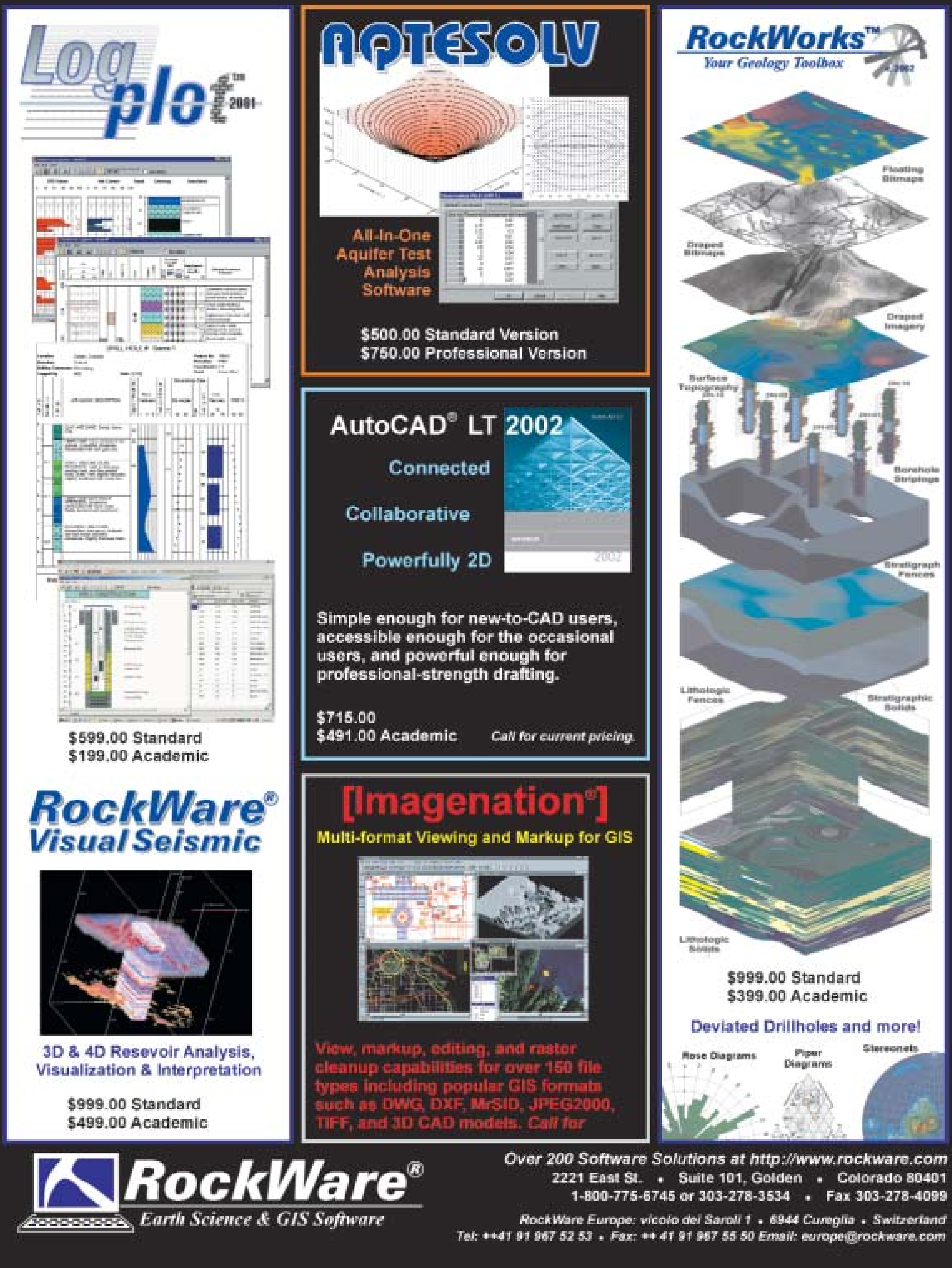
Editor Duties

1. Continue to maintain excellence of journal content through active solicitation of diverse and definitive manuscripts.
2. Support GSA's efforts to process and publish Bulletin manuscripts on the internet.
3. Ensure stringent peer review and expeditious processing of manuscripts.
4. Make final acceptance or rejection decisions after consideration of recommendations of reviewers and Associate Editors.
5. Correspond with authors regarding revisions and expeditious return of final manuscripts. Maintain active correspondence with current and potential contributors.
6. Select and maintain an active board of Associate Editors.
7. Report to the Committee on Publications on manuscript topic trends and issues specific to the *Bulletin*.

Editor Qualities

1. Broad personal background and active research in the geological sciences. Broad knowledge of geological research activities of scientists both nationally and internationally.
2. Interest in electronic publishing and in maximizing *Bulletin* content for print and electronic media.
3. Willingness to try new techniques to enhance author and reader satisfaction.
4. Excellent organizational skills and ability to manage significant manuscript flow to ensure timely publication of papers. Ability to supervise editorial assistant to ensure that schedules are maintained.
5. Ability to remain tactful and helpful to authors, yet create and maintain stringent acceptance and rejection policies.
6. Willingness and capability to coordinate working schedules with a co-editor.
7. Willingness to invest about one day per week on *Bulletin*-related activities.
8. Objectivity and scientific maturity.

If you are interested in this opportunity to help guide the *Bulletin*, one of the premier geoscience journals, submit a resume and a brief letter describing relevant qualifications, experience, and objectives. If you are nominating someone, include a letter of nomination and the nominee's written permission and resume. Send nominations and applications to Jon Olsen, Director of Publications, Geological Society of America, P.O. Box 9140, Boulder, CO 80301 by August 31, 2002.



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