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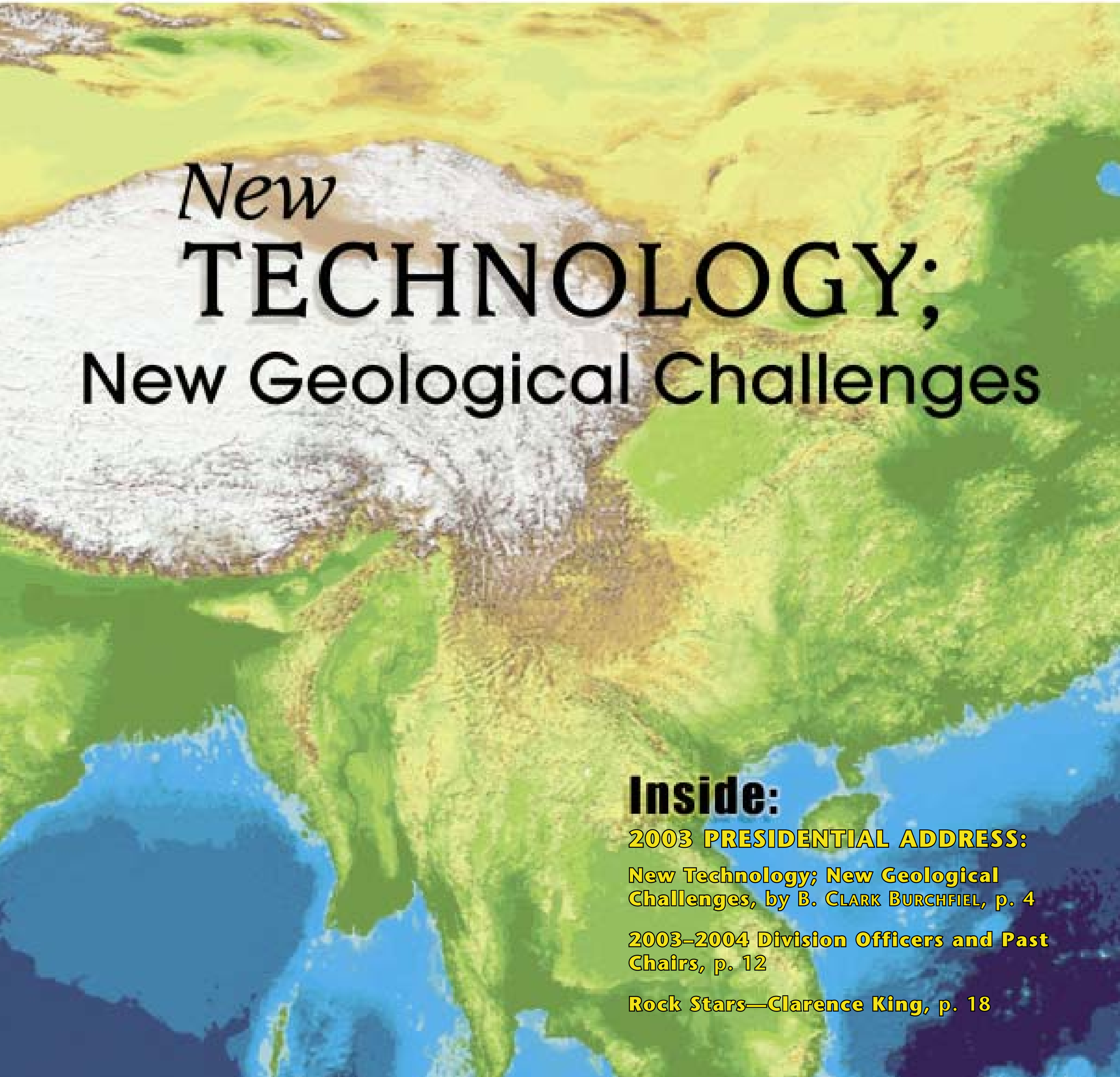

New TECHNOLOGY; New Geological Challenges

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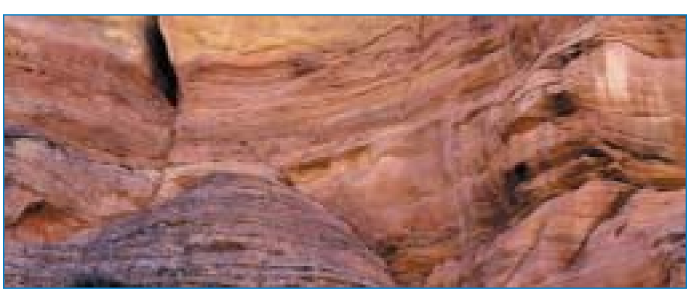

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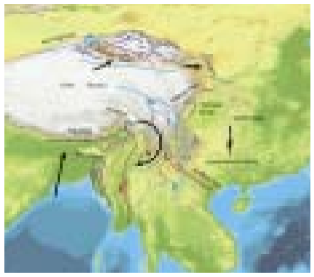

Cover: Generalized tectonic map of the eastern part of the Tibetan plateau and adjacent areas for late Cenozoic to Recent time.
See "2003 Presidential Address: New Technology; New Geological Challenges," by B.C. Burchfiel, p. 4-9.

SCIENCE ARTICLE

New Technology; New Geological Challenges

B.C. Burchfiel, *Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*

Figure 1. Looking west into the eastern part of the Tibetan plateau. This digital elevation model image shows the very different topography of the eastern margin of the plateau compared to the steep topographic fronts that form the northern and southern boundaries of the plateau.

New technologies applied to geoscience yield new scientific data that permit us to advance our understanding of geological processes. At the same time, new technologies often yield data that challenge the ways in which we interpret geological processes and force us to examine these processes in new and different ways. Here, I want to discuss some data that, as a field geologist, I only partially understand and that remain a topic of active investigation. This is really a work in progress, but potentially also has produced results that will force us to look at shallow crustal structures and their relationship to deeper lithospheric processes in new ways. The technology is Global Positioning Systems (GPS), and the data come largely from China, but similar problems of data analysis are known from other places.

During our cooperative field geological studies with the Chengdu Institute of Geology and Mineral Resources (CIGMR) from 1986 to about 1995, we developed a hypothesis for the late Cenozoic to Recent tectonic framework of the eastern Tibetan plateau. I must acknowledge here my long time colleague at CIGMR, Chen Zhiliang, with whom I have worked continuously for the past 17 years. The hypothesis contains interpretations that we believed to be new and unconventional. GPS studies were considered to be a new technology at that time, because their use was still finding new applications. It took only a few years of campaign GPS to produce preliminary results.

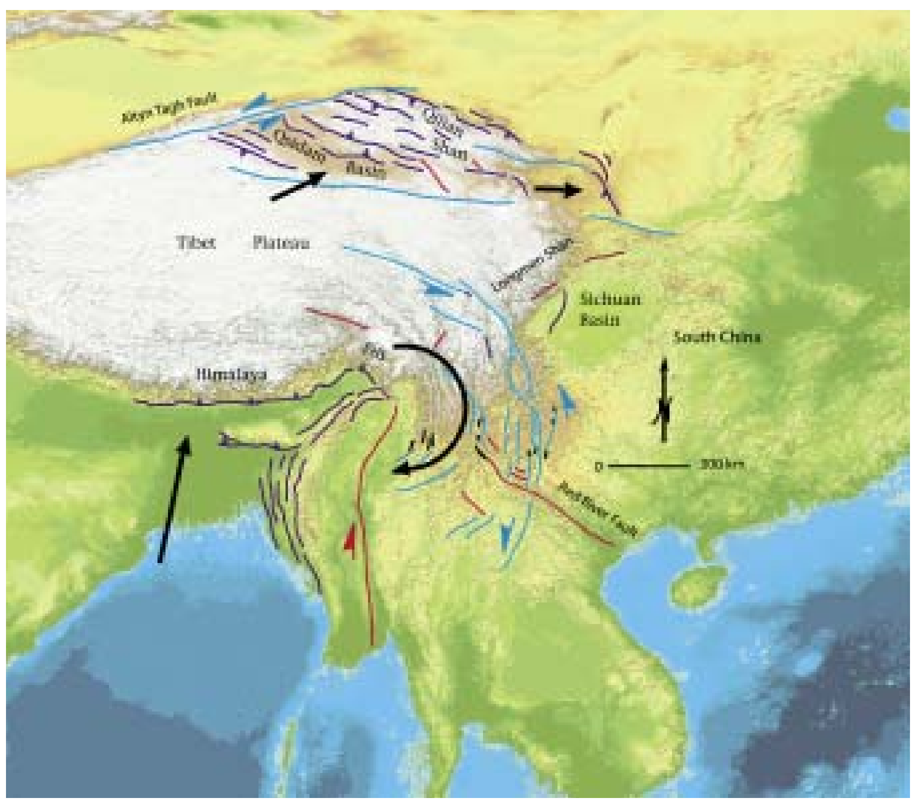

Figure 2. Generalized tectonic map of the eastern part of the Tibetan plateau and adjacent areas for late Cenozoic to Recent time. Black arrows show movement of crustal fragments relative to Eurasia for India and in the northeast part of the plateau, and relative to South China in the southeastern part of the plateau. Left-lateral strike-slip faults shown in blue, right-lateral strike-slip faults shown in red, shortening structures shown in purple, and extensional structures shown by short black lines. EHS—Eastern Himalayan syntaxis.

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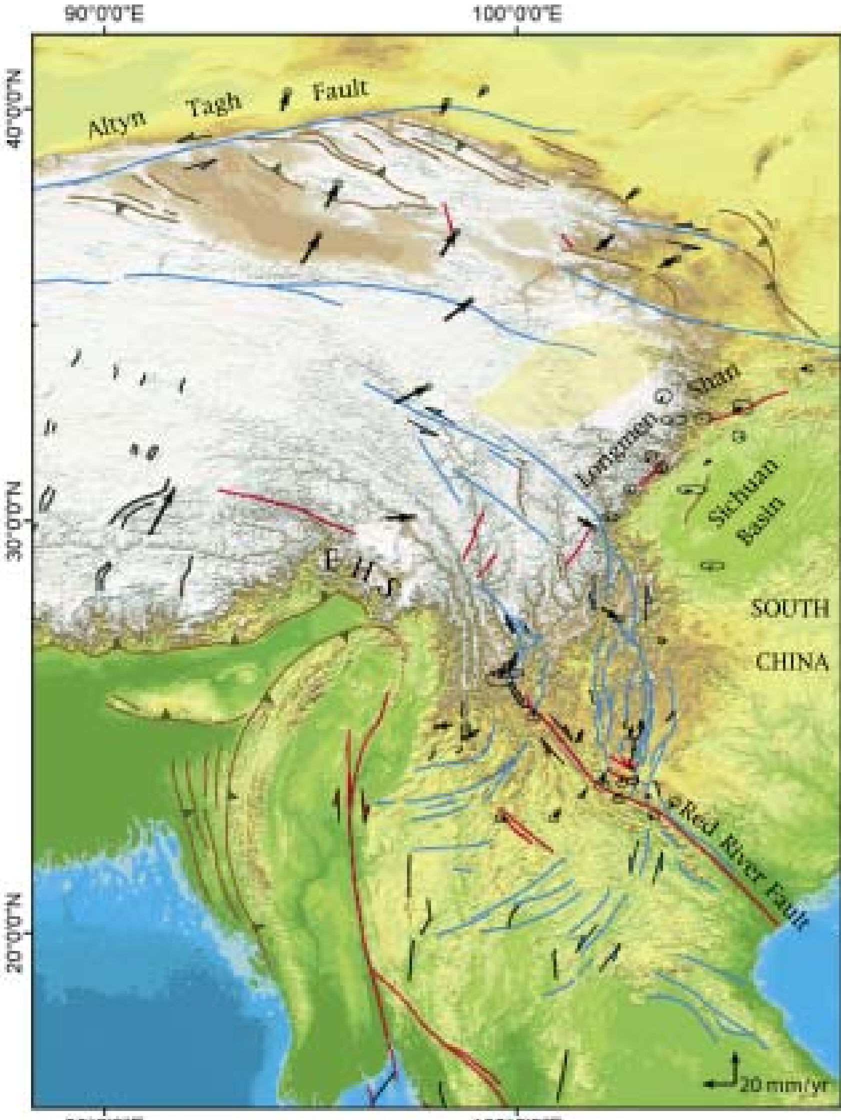

Figure 3. Global Positioning System (GPS) velocities within the eastern part of the Tibetan plateau and its adjacent foreland relative to South China superposed on tectonic map of Figure 2. The GPS velocities show that the Longmen Shan part of the Tibetan plateau moves with South China and that there is no shortening within error along the steep topographic front of the Longmen Shan. These GPS data indicate a velocity gradient west of the Longmen Shan that has no apparent surface structure related to it (region shown in yellow). Color code on structures are the same as in Figure 2. EHS—Eastern Himalayan Syntaxis.

The first areas I will discuss come from the eastern Tibetan plateau. The topography of the eastern part of the plateau is very different from the northern and southern boundaries of the plateau, which have steep continuous topographic fronts (Fig. 1). The eastern part of the plateau has two areas of long continuous slopes with no definable topographic boundaries and is separated by the very steep topographic front of the Longmen Shan west of the Sichuan basin. Our tectonic hypothesis, developed largely by field studies, indicated that the tectonic framework of the eastern Tibetan plateau consisted of three regions of different late Cenozoic and active deformation (Fig. 2). In the northeast region, displacement along the sinistral east-northeast–striking Altyn Tagh fault is transferred to northeast-southwest–shortening in the Qilian Shan. Eastward, the shortening direction becomes more east-west where east-west–striking left-lateral strike-slip faults are transferred into north-south–shortening on north-south–trending structures. In the central region, the Longmen Shan rise to more than 6 km above the Sichuan basin, forming one of the steepest mountain fronts along any margin of the Tibetan plateau. Field studies show that this mountain front and the high plateau to the west were not formed by significant upper crustal shortening and that the eastern part of the plateau in this area moves with its foreland to the east at a slow rate (Burchfiel et al., l995; Chen et al., 2000). Finally, in the southwest region, there is no prominent topographic break that defines the eastern margin of the plateau. Here, the crust contains active, convex-east, left-lateral strike-slip faults, and the crust west of these faults rotates clockwise around the eastern Himalayan syntaxis relative to South China (Wang et al., 1998).

Our GPS studies in the eastern part of the Tibetan plateau have supported and modified our general tectonic interpretations (Chen et al., 2000) and have forced us to look for new structural interpretations. Here, I must acknowledge the outstanding work of our geodetic colleagues, Bob King of MIT, and Xuanyang Zhang of the Chengdu Institute. These GPS data are valid for time scales of years or decades, but our geological studies indicate that the present system has been active for at least the past 4–6 m.y. and perhaps longer in some places. What is of particular interest, and the focus of this presentation, are the implications of the combined GPS and geological data.

In the central Longmen Shan region, geology and GPS data, in a South China reference frame, indicate the coupled eastward movement of a segment of the plateau with South China and virtually no shortening to account for formation of a high plateau west of the topographic margin (Fig. 3). This was not at all the interpretation we initially proposed to test when we went into this area. Based largely on work by Royden (1996) we have developed the interpretation that eastward lower crustal flow, driven by gravitational potential energy of the central plateau, created the high topography of the eastern part of the Tibetan plateau by inflational thickening of the lower crust. A cross section through the southern Longmen Shan also shows the small magnitude of late

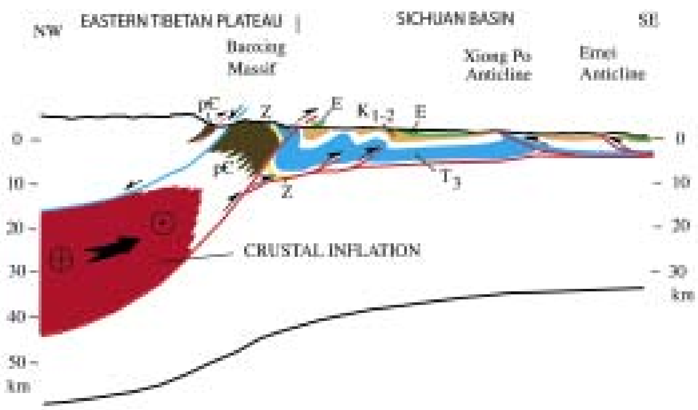

Figure 4. Generalized cross section from the Tibetan plateau across the very southern part of the Sichuan basin. Shows the interpretation of thickening of the crust below the plateau by lateral eastward crustal flow of ductile middle to lower crust causing thickening by crustal inflation. Eastward flow from the central part of the plateau encounters less ductile crust beneath the Sichuan basin and flows around the Sichuan basin forming the gently inclined plateau surface to the north and south of the Sichuan basin (see Figure 1).

Cenozoic shortening within and east of the Longmen Shan front (Fig. 4). The steep topographic front of the Longmen Shan results from resistance to eastward crustal flow because of a strong, less ductile crust underlying the adjacent Sichuan basin. The ductile lower crust appears to upwell at the plateau edge producing uncompensated local relief. Most of the lower crust flows laterally around the less ductile crust below the Sichuan basin to form broad areas with more gentle topographic gradients to the north and south (Clark and Royden, 2000) (Fig. 1). Recent work on mantle tomography by Lebedev and Nolet (2003) shows the Sichuan basin to be underlain by high velocity, presumably cold and less ductile lithosphere to depths of 150 km and possibly to more than 350 km.

But here is where the challenge comes in. If this interpretation is correct, there are few data from surface geology to provide direct evidence for the deformation occurring at depth or to analyze past changes in plateau elevation. We find evidence from the work of Kirby et al. (2002), and Clark (2003) that the eastern plateau was elevated in the past ~5–12 m.y., and our structural and geochronological studies along the steep Longmen Shan front have shown that the faults here have mainly vertical displacements during late Cenozoic time (Burchfiel et al., l995). However, if we were dealing with an older mountain system where data from topography, young or active structures, and GPS were not available, would we be able to identify such important tectonic processes and provinces?

The GPS data from the northeastern part of the plateau have also revealed an additional, previously unrecognized problem (Fig. 3). Where is the western boundary for the part of the Longmen Shan plateau that moves with South China? This was a question we never considered until the GPS data began to show the need for a possible western boundary within the eastern plateau. West of the Longmen Shan, preliminary GPS data show a boundary, trending approximately northeast, with ~8–15 mm/yr active right shear. Because this result was not anticipated, we did not design our network to constrain the location of this boundary. We have now densified the network in this area to define more clearly where this boundary may be, but the results are not yet available. These data also presented another challenge for the field geologist: there were no structures on any Chinese map, or evident from the topography or from satellite imagery, that would lead one to hypothesize the existence of such a boundary. It raises the questions of how much strain the continental crust can absorb without developing throughgoing structures and whether we would recognize such strain in the older geological record.

A related problem is present in the southeastern region of the plateau where the convex-east faults define crustal fragments that rotate clockwise around the eastern Himalayan syntaxis at ~10 mm/yr relative to South China, as described by Wang (1994), and verified by GPS measurements (King et al., l997; Chen et al., 2000). The left-lateral fault system that bounds this zone of rotating crustal fragments on the east is

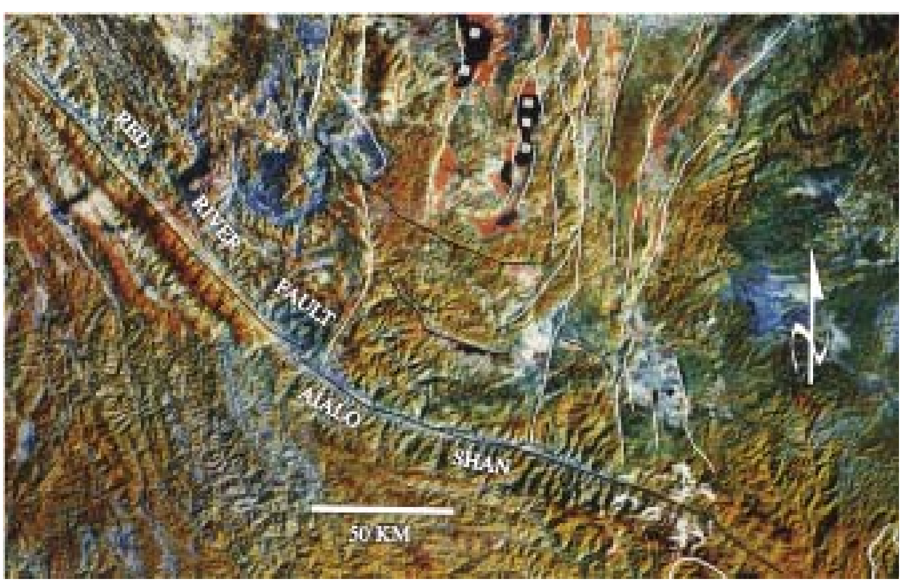

Figure 5. Landsat image of the central part of the Red River area where the left-lateral displacements on faults of the north-south striking Xianshuihe-Xiaojiang fault system, shown in white, die out, but the shear continues across the Red River fault (shown in black), Ailao Shan and structures farther south, bending the these features without being marked by prominent surface structures. Two prominent active right-lateral faults north of the Red River fault are also shown in black.

well defined, but to the southeast the fault splays into several branches that are marked by numerous extensional pull-apart basins (Wang et al., l998; Fig. 3). Total displacement on the fault system is ~60 km throughout. About 100 km north of the Red River, the total displacement is still ~60 km but occurs on numerous splays instead of a single fault as it does farther north. However, within ~100 km north of the Red River, left-slip displacements on these splays decreases southward, and only a few of these faults reach the northwest-trending right-lateral Red River fault (Wang et al., 1998); none of them displaces it as shown by the recent work of Schoenbohm et al. (2003). Yet, although these individual faults lose displacement to the south, the portion of the Red River fault that lies across the geographic limits of the north-south–striking left-lateral system displays a prominent left-lateral bend with ~60 km of apparent deflection (Fig. 5). In the Landsat image, not only is the Red River fault bent, but the Ailao Shan range and other tectonic units farther south are also bent. Still farther south, a series of northeast-striking left-lateral faults and a few northwest-striking right-lateral faults appear and become more prominent southward into Indochina (Fig. 2). It thus appears that the shear that is bounding the clockwise rotating crust within the southeastern part of the plateau continues across the Red River fault and into Indochina, but the character of this upper crustal deformation changes along strike from discrete faults, to a broad zone of lesser faults, to a broad shear zone without faults, and finally to a broad region of northeast-striking left-lateral faults with some conjugate right-lateral faults.

Our most recent GPS results confirm this interpretation of the active deformation in the region (Fig. 3), and our geological studies suggest that this pattern of deformation is at least 4–6 m.y. old (Wang et al., 1998). The challenge presented by these data is to understand how the crust accommodates the broadly distributed shear that bends the Red River fault and adjacent rocks without discrete faults, obvious fractures, or other structures that absorb the deformation. It is in the deflected segment that the Red River fault shows its most prominent active right-slip. Thus, the counterclockwise rotation within the north-south shear zone increases right-lateral slip on the northwest-trending Red River fault and forms a discrete crustal boundary within a zone of the crust that otherwise behaves as if it is affected by a uniform homogenous shear. From surface geology, it has been proposed that the Red River fault is a major active right-lateral strike-slip fault in the tectonic scheme of southern China, but our studies show that most of the right-lateral activity may be related to counterclockwise rotation within the north-south–trending shear zone. Field geology and GPS data are in agreement with this interpretation, but the processes of how crustal bending is accommodated remains unresolved. Thus, the challenge for field geology is whether such relationships would be recognized in older orogens. Perhaps if the proper rocks are present within such regions, paleomagnetic studies might be useful to determine how the rotation was accomplished. A further question is presented. What would these structures look like at depth in more deeply eroded orogens?

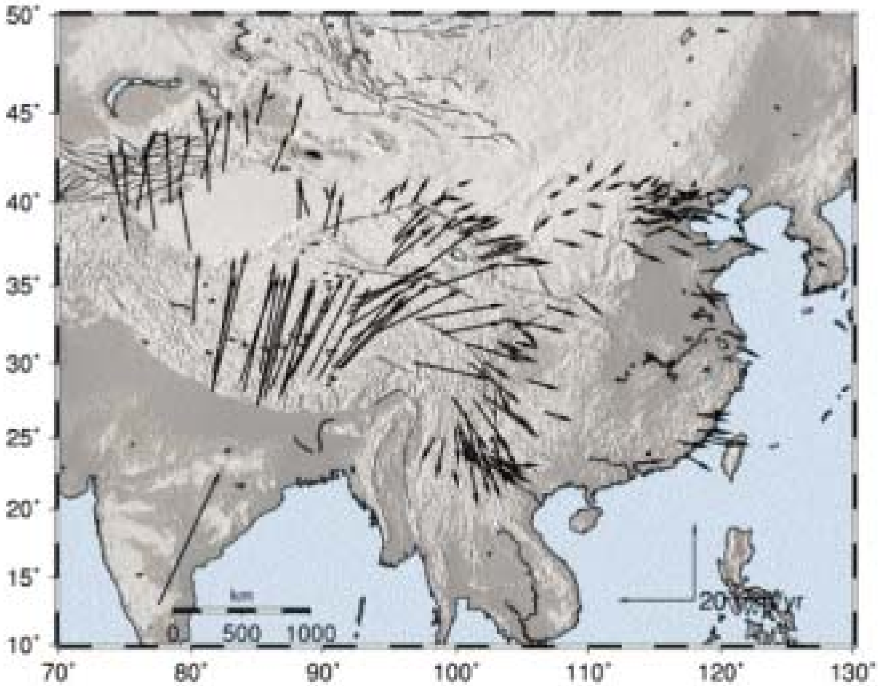

Figure 6. Compilation of Global Positioning System data for China and Nepal in a Eurasian reference frame. Shows the general ESE movement at about the same velocity of the eastern part of the Tibetan plateau (Longmen Shan area) and the clockwise rotating crustal fragment in the SE part of the plateau along with eastern China. Data from Abdrakhmatov et al. (1996), Chen et al. (2000), T. Herring (2003, personal commun.), Shen et al. (2000), and Wang et al. (2001).

If the results of tectonic and GPS analyses are viewed more broadly, additional challenges present themselves. When the GPS results are viewed in a fixed Eurasian frame of reference, all of the eastern part of China, including the Longmen Shan part of eastern Tibet, moves east-southeast about a pole of rotation far from eastern China (Fig. 6). Our preliminary interpretation is that the rotation of the crust around the eastern Himalayan syntaxis is driven by the northward indentation of India into Eurasia and gradients in gravitational potential energy from the central high Tibetan plateau. However, to the south, crustal motions are increasingly influenced by pull from the IndoBurman subduction zone and extensional structures within the upper crust become progressively more abundant. We suggest that such movements indicate that upper crustal structures and motions observed are decoupled from deeper lithospheric motions. The east-southeast motion of South China relative to Eurasia may be the result of deeper lithospheric motion, and the upper crustal structures are carried along with the deeper lithosphere. Tests of these

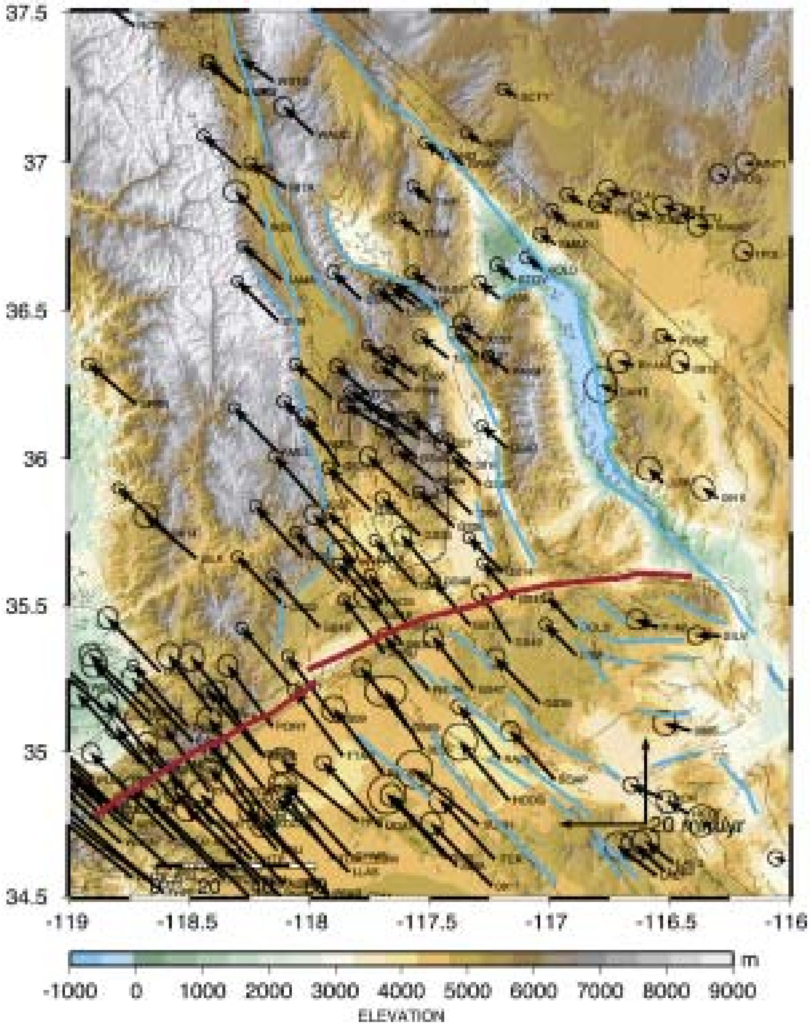

Figure 7. Global Positioning System velocity field relative to North America in southern Nevada and southeastern California (S.C. McClusky, 2003, personal commun.). Garlock fault shown in red; some of the major active NNW-striking right-lateral faults shown in blue.

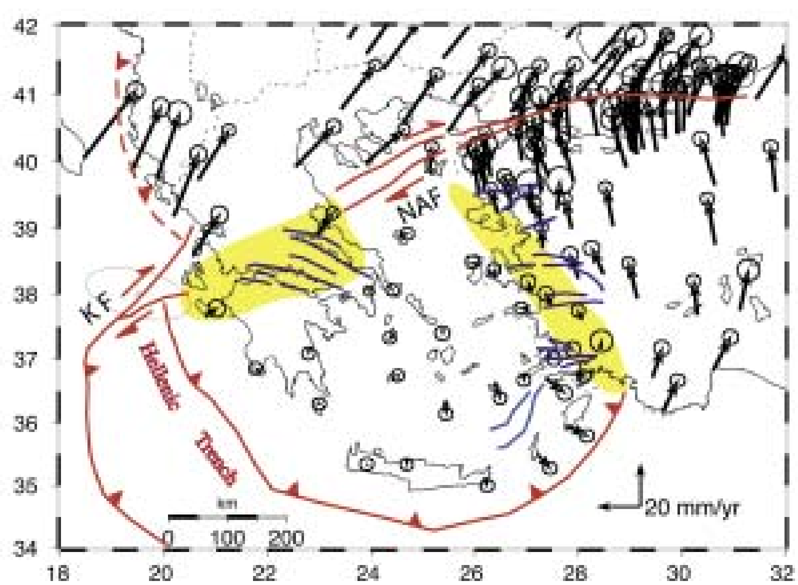

Figure 8. Global Positioning System (GPS) velocities plotted relative to minimized velocities in the area of the Aegean Sea. Hellenic trench and right-lateral Kefalonia (KF) and North Anatolian fault (NAF) zones shown in red. Yellow areas are diffuse boundaries defined by GPS velocity gradients. Blue lines are normal faults.

interpretations are possible and are in progress now by an aerial broadband seismic network we have deployed with our Chinese colleagues in southeast Tibet and its southeastern foreland. When viewed within the Eurasian reference frame, the east-southeast motion is toward the complex Pacific–southeast Asian plate boundary and may be driven to some degree by the dynamics of that boundary. At this scale, the entire complex region of offshore southeast Asia, a site of extensional oceanic and continental basins and irregular subduction zones, is as large as or larger than the region of intercontinental convergence north of the India-Eurasia collision zone. These two regions probably define different but interconnected regions of "push" and "pull." The boundary between them is complex, is very diffuse, and lies on-land within southeast Asia.

The challenge that faces us from the use of new GPS technology includes addressing the following problems. First, in the region of southeastern Tibet, we can determine the rates and directions of crustal movements, but we have difficulty in explaining how upper crustal deformation is accommodated by local areas of continuous shear strain without mappable structures. Second, what does the deeper crustal structure look like in such areas? Third, without GPS data, it would be difficult to determine that the local upper crustal domains are moving east-southeast, decoupled from deeper lithospheric motion.

Problems such as the ones I have covered here take many different expressions. Similar shear and bending of fault traces and adjacent crustal rocks are known from other areas. For example, the north-northwest–trending right-shear that passes through the eastern Mojave and east of the Sierra Nevada in the western United States is bending the eastern part of the east-striking left-lateral Garlock fault (Miller et al., 2001) at about ~11 mm/yr of right shear as shown in the compilation of GPS velocities by McClusky et al., (2001; Fig. 7). The bending here is much like that of the Red River fault region in that most of the north-northwest–striking right-slip faults, except for the southern Death Valley fault zone, do not cut the Garlock fault. Here, paleomagnetic studies have been very useful in defining how the deformation has been accommodated (see, for example, Schermer et al., 1996), but the mechanism of crustal shear remains unclear.

A different surface expression of upper crustal shear occurs in Greece and western Turkey. Recent GPS data by McClusky et al. (2000) have defined the crustal velocities in the eastern Mediterranean region. The GPS velocities in the Aegean Sea region are all about the same within error and indicate that the Aegean Sea crust moves as a single small crustal fragment without significant internal deformation (Fig. 8). Its boundaries on the northwest and northeast are expressed differently: on the west by a zone of horizontal shear and extension within the Greek mainland and in the east by a zone of mixed horizontal shear and extension as shown by the GPS velocity gradients. The North Anatolian fault zone bounds the Aegean crust in the north and is a well-defined fault zone in the northern Aegean Sea and along its apparent western continuation in the Kefalonia fault zone in the Ionian Sea. Right-shear along this fault system is ~25 mm/yr, but where it crosses the Greek mainland, there is no single continuous fault system. Instead, major west-northwest to east-west–trending en echelon grabens, such as the Corinth graben, form a belt ~100 km wide and trend at an oblique angle to the projection of the main shear zone (McKenzie, l978; Goldsworthy et al., 2003). The eastern boundary of the Aegean crust lies in western Turkey in a northwest-trending belt of east-west–trending grabens, but no through-going zone of transtensional left-lateral shear is present. A recent interpretation by Dimitris Papanikolaou and Leigh Royden (2003, personal commun.), based on geological mapping in Peloponnesus, suggests that movement of the Aegean as a single crustal fragment is young, probably Pliocene-Quaternary, and disrupts a long Cenozoic history of more typical back-arc extension above a subducting slab. The challenge for field geology here is to determine how surface structures in this part of Greece and Turkey would have been recognized as the expression of a major through-going shear without GPS and seismic data. Geologists mapping these surface structures might have struggled with the importance of these complex structures without a good regional framework within which to work. The expression of these structures at depth where they cross the Greek and Turkish mainlands remains a tectonic problem to be investigated.

In older orogens, can connections be made between broad regional shear, locally complex structure, and surficially discontinuous shear zones without the availability of GPS data? My answer is "yes," but only if we systematically study the upper crustal expressions and mode of deformation of modern shear zones of the type discussed here. It is also necessary to know what the deeper crustal expressions of these zones of active shear might be, so that structures related to such shear in older, more deeply eroded orogens can be recognized. Such data will come from combined geodetic, geological, geophysical, and paleomagnetic studies. Conversely, field studies of former deep crustal shear zones that are now exposed in older orogens can supply insights into active deep crustal processes discerned primarily by GPS-related investigations of the type described here.

We all know that GPS has become an increasingly important tool for a wide variety of geological research. My point here is that it is an extremely important tool for the field geologist as well. It yields a new type of data that needs to be integrated with field studies to solve not only local, but also regional problems. It is a new technology that presents us with new and significant geological challenges.

ACKNOWLEDGMENTS

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Ed. note: GSA has strategic goals of advancing the dissemination of geoscience knowledge and contributing to increased diversity of the profession. One means by which we can accomplish both is by encouraging and supporting new and more effective ways of communicating science at the K–12 level. We are pleased to share with all our members the following report submitted by GSA's Committee on Minorities and Women in the Geosciences. Congratulations to the Department of Geosciences at San Francisco State University on this innovative program!

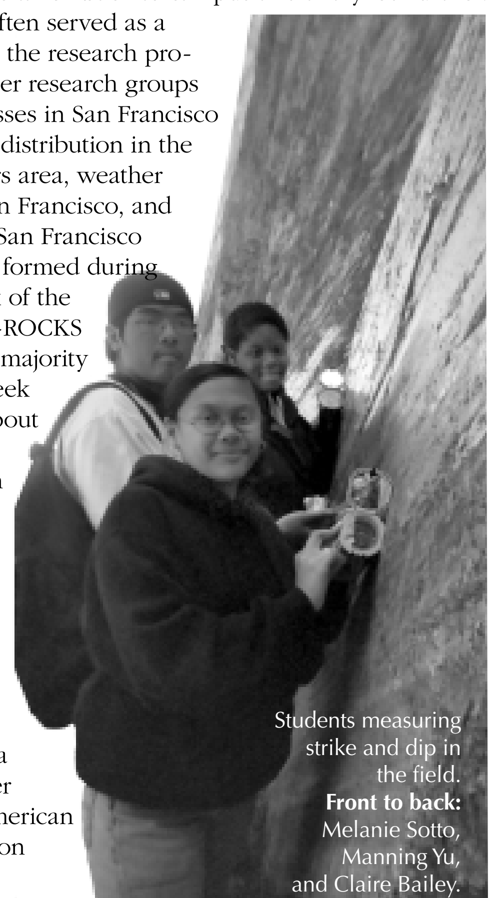
SF–ROCKS: Reaching out to Communities and Kids with Science in San Francisco

Lisa D. White, Karen Grove, David Dempsey, Oswaldo Garcia, Matthew J. La Force, Raymond Pestrong, Jennifer Davis, and Mary K. Snow

The Department of Geosciences at San Francisco State University (SFSU) received a five-year grant from the National Science Foundation's "Opportunities to Enhance Diversity in the Geosciences" program (OEDG) in September 2001 to introduce diverse groups of high school students to the earth sciences. Partnering with high schools in the San Francisco Unified School District, the collaborative SF-ROCKS (Reaching out to Communities and Kids with Science in San Francisco) program aims to increase the number of traditionally underrepresented students who enter college as geoscience majors. Working with high schools predominantly in the ethnically diverse southeastern region of San Francisco, SF-ROCKS has developed curricula designed to enhance ninth grade integrated science courses (http://sf-rocks.sfsu.edu). Fifteen lesson plans were developed by the SF-ROCKS faculty at SFSU in consultation with integrated science teachers from the Phillip and Sala Burton High School, the first SF-ROCKS high school. The lesson plans are tied to the California State Science Standards and largely focus on the unique watershed environments that surround each of the schools (four different high schools are now part of the SF-ROCKS consortium) allowing students to learn how earth science concepts apply to their own neighborhoods. Teachers can use the lesson plans in any order, but they are most logically grouped into three unit sequences: (1) Watersheds; (2) Rocks, Plate Tectonics, and Geologic Maps; and (3) Weather and the Rain Gauge Project. Instead of replacing the existing course of study in integrated science, SF-ROCKS applies a model that complements the curriculum and builds on the strengths of the teachers and the geologic settings of the schools.

During the 2002–2003 academic year at Burton High School, more than 300 ninth grade students became engaged in the SF-ROCKS program curriculum using the many different inquiry-driven and active-learning modules embedded in the lesson plans. Undergraduate students from SFSU and the City College of San Francisco serve as mentors to the ninth grade students and assist the teachers in the classroom. Fourteen students from these classes were selected to participate in a two-week summer research institute at SFSU. The goal of the summer institute is to provide meaningful experiences in science through supervised research projects that focus on the geology and meteorology of the greater San Francisco Bay Area. Most of these students were exposed to life on a college campus for the first time and clearly benefited from interactions with professors and undergraduate students.

Summer institute activities introduce the scientific method, scientific inquiry, and data collection using a variety of techniques from basic computer software applications to sediment grain size investigations. Field trips provided additional opportunities to explore the scientific method and review geoscience topics the students had learned about through the SF-ROCKS lesson plans. Emphasis was placed on watersheds, coastal and beach processes, earthquakes, and plate tectonics. Students hiked local creeks and beaches, cruised the San Francisco Bay in a research vessel, surveyed the S.F. Bay Model, pet a manta ray at the Monterey bay Aquarium, and took a "toxic tour" of the Bayview–Hunter's Point neighborhood in San Francisco. Field trips also helped students make connections to other disciplines of science, such as biology, chemistry, and physics. Students observed, took notes, collected samples, and, as a result, were very engaged with science. On most trips, sediment and water samples collected by the students were taken back to campus and analyzed further. These samples often served as a starting point for the research projects of the smaller research groups (sediment processes in San Francisco Bay, earthquake distribution in the California geysers area, weather forecasting in San Francisco, and water quality in San Francisco watersheds) that formed during the second week of the institute. The SF-ROCKS students spent a majority of the second week learning more about these specific topics and began the data collection processes for their research. The culmination of the students' research was an opportunity to present their data locally in a poster session at the American Geophysical Union meeting in December 2003.



Students measuring strike and dip in the field. **Front to back:** Melanie Sotto, Manning Yu, and Claire Bailey.

Report:
The Fifth Hutton Symposium

Takashi Nakajima and Shunso Ishihara, Geological Survey of Japan

The Fifth Hutton Symposium on granites and related rocks was held September 2–6, 2003, at Aichi University, Toyohashi City, Japan. The Hutton Symposium is an international conference on granites held in every fourth year in different continents. It commenced in 1987 in Edinburgh, UK, followed by conferences in 1991 (Canberra, Australia), 1995 (Maryland, USA), and 1999 (Clermont-Ferrand, France).

The Fifth Hutton Symposium was the first one held in an active modern arc. The session themes were selected taking this tectonic setting into account. More than 200 participants came from 25 countries. The symposium opened with special sessions, including invited talks by S. Ishihara, J. Blundy, and B.W. Chappell. In total, 62 oral presentations and 118 poster presentations were given in ten sessions: (A-1) UHT and UHP Metamorphism, Melting Processes under Extreme Conditions; (A-2) Anatexis and Melt Segregation in Lower Crust; (B-1) Processes in Granitic Magma Chambers; (B-2) Links between Volcanic and Plutonic Processes; (C-1) Juvenile Granitoids in Subduction Setting; (C-2) Granitoids with Intra-crustal Reworking Processes; (C-3) Tectonic Controls on Generation and Intrusion of Granitoid Magmas; (C-4) New Insights into the Asian Granites; (D-1) Behavior of Metals and Volatiles during Magmatic Processes; and (D-2) Granitoid-Series and Metallogenesis. A full program is available upon request from hutton-v@m.aist.go.jp.

We prepared four pre-symposium field excursions (A1, Quaternary and Pleistocene Granites in Northern Japan Alps; A2, Cretaceous Plutonometamorphic Complex of the Ryoke and San-yo Zones in the Iwakuni-Yanai Area; A3, Ilmenite-Series Granitoids and Felsic/Mafic Magma Interaction in Cretaceous Inner Zone Batholith; and A4, Miocene Granites and the Hishikari Gold Deposits in Kyushu) and one post-symposium excursion (B1, Crustal Section and Anatexis of Lower Crust in the Hidaka Metamorphic Belt, Hokkaido). Furthermore, four mid-symposium day trips were organized for the delegates.

The proceedings volume will be published in Transactions of the Royal Society of Edinburgh and also in a GSA Special Paper in mid-to-late 2004. The next Hutton Symposium will be held in 2007 in South Africa.

Meeting Wrap-Up

Geoscience Horizons:
Seattle 2003

GSA Annual Meeting & Exposition
November 2–5, 2003

Registration for the 2003 Annual Meeting in Seattle was the second highest of any GSA Annual Meeting. Almost 6,600 people attended technical sessions, field trips, and short courses, visited the GSA Bookstore and the Exhibit Hall, and took advantage of the GSA Employment Services. For a first-person account of meeting activities from a non-traditional perspective, see "Post-Seattle Reflections on a Different Kind of GSA," on page 16.

2003 Meeting Statistics

Total attendance:	6,597
Abstracts submitted:	3,833
Number of technical sessions (including oral and poster sessions):	263
Number of short courses and field trips:	20
Number of exhibit booths:	203
Number of exhibiting companies:	149
Employment Service	
Number of interviews scheduled:	290
Number of applicants on-site:	130+
Number of employers using the on-site service:	30
Positions advertised included 36 in academics as well as many in consulting and petroleum.	
Number of new members signed up:	400

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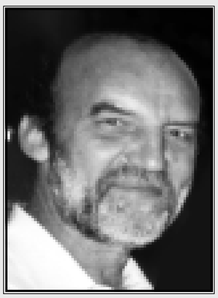
2003 MEDALS & AWARDS

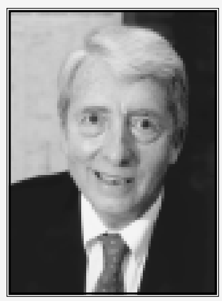


Dennis V. Kent

ARTHUR L. DAY MEDAL
Presented to Dennis V. Kent
Neil D. Opdyke, Citationist

Sharon Mosher

GSA DISTINGUISHED SERVICE AWARD
Presented to Sharon Mosher
B. Clark Burchfiel, Citationist



Peter R. Vail

PENROSE MEDAL
Presented to Peter R. Vail
Robert M. Mitchum, Citationist

Julia A. Jackson

GSA PUBLIC SERVICE AWARD
Presented to Julia A. Jackson
Samuel S. Adams, Citationist

Michael Manga

YOUNG SCIENTIST AWARD
(Donath Medal)
Presented to Michael Manga
Katharine V. Cashman, Citationist

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Antonio Carlos Rocha-Campos
Universidade de São Paulo, Brazil

Constantino Mpodozis
SIPETROL S.A., Chile

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The Geological Society of America
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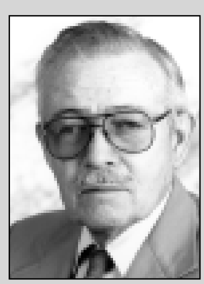
LAURENCE L. SLOSS AWARD
Presented to Robert J. Weimer
John W. Robinson, Citationist

Michael R. Waters



C. Vance Haynes Jr.

KIRK BRYAN AWARD
Presented to Michael R. Waters and C. Vance Haynes Jr.
Lee Nordt, Citationist

Steven E. Ingebritsen

O.E. MEINZER AWARD
Presented to Steven E. Ingebritsen
Stuart Rojstaczer, Citationist

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RIP RAPP ARCHAEOLOGICAL GEOLOGY AWARD
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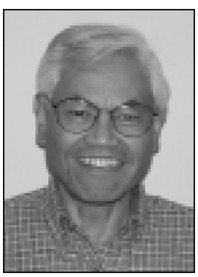
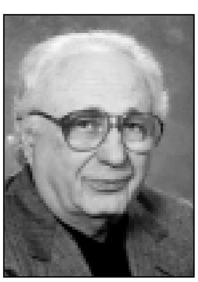
E. Arthur Bettis III, Citationist



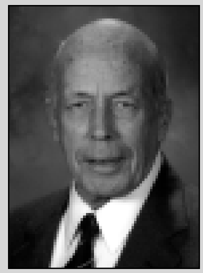
Romeo M. Flores

GILBERT H. CADY AWARD
Presented to Romeo M. Flores
Tim A. Moore, Citationist



Ellis L. Krinitzsky

E.B. BURWELL, JR., AWARD
Presented to Ellis L. Krinitzsky
Allen W. Hatheway, Citationist



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INTERNATIONAL DIVISION DISTINGUISHED CAREER AWARD
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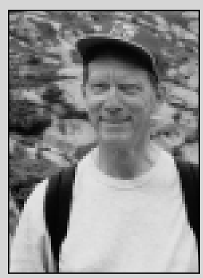
John A. Reinemund
Maurice J. Terman, George Gryc, and
Richard J. Calnan, Citationists



Gregory A. Davis

STRUCTURAL GEOLOGY & TECTONICS CAREER CONTRIBUTION AWARD
Presented to Gregory A. Davis
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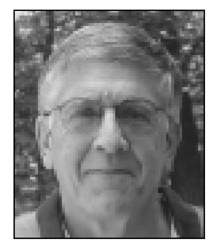

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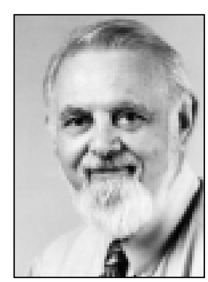
G.K. GILBERT AWARD
Presented to Roger J. Phillips
Raymond E. Arvidson, Citationist



Ellis L. Yochelson

HISTORY OF GEOLOGY AWARD
Presented to Ellis L. Yochelson
Michele Aldrich, Citationist

COMMENTARY

Post-Seattle Reflections on a Different Kind of GSA

Lisa Greer, *Geology Department, Washington and Lee University, Lexington, Virginia 24450, greerl@wlu.edu*

I always enjoy the annual GSA meeting. I find it stimulating, reinvigorating, and productive—a time and a place where ideas and motivation are born. This year was no different… and yet entirely different at the same time.

I met with colleagues, set deadlines, and roughed out two publications with co-authors. I outlined a proposal with colleagues and students from two universities, and I sketched out three abstracts with fellow researchers for an upcoming meeting in Japan. I met with longtime and new geo-friends and watched proudly as my student co-author, Lila Gerald, presented her first poster at a national meeting. I coerced a promise of course materials and field trip itineraries from two fellow professors, and I attended some very good talks and benefited from many great poster sessions. Overall, this ranked highly as one of my most fruitful and productive GSA meetings.

And yet this trip was entirely different from all past GSA ventures, because I was accompanied by my 6-month-old daughter, Maya.

I hesitated only briefly about bringing Maya to Seattle. It is a long trip, which coincided with my husband giving an invited talk at a meeting in Florida. I wondered, is it worth the effort? Will I accomplish anything at this meeting? What will people think about my "professionalism"?

Much to my delight, I believe Maya contributed greatly to the success and productivity of this meeting. Because of her, I met or made contact with many people I might never have met otherwise. Some people just made the effort to make eye contact or smile. Others made it a point to tell me how important they think it is to show younger colleagues that family and career are not mutually exclusive, particularly for those of us 30-something women who are starting families and teaching/research careers at the same time.

In addition, I have been heartily blessed with an easy and good-natured child. She is already adept at amusing herself. I was able to have lengthy, intelligent conversations with colleagues, particularly those who aren't easily distracted by peripheral movement, while Maya played with "crinkle-star" and "squeaky-spiral."

Now I am not entirely naïve. Having Maya with me did pose a few challenges.

As I write this on the plane ride home (Maya is finally taking a nap), I am tired. Very tired. Maya didn't understand the concept of a time change (prepared to greet the day at 5 a.m., Seattle time) and didn't have any desire to miss out on the fun (staying up way past her bedtime). But then again, I am *always* tired at the end of a GSA meeting.

I certainly missed my share of talks this year. At 6 months, Maya has "opinions" about presentations. If you heard her commentary during your presentation (as we made a hasty and polite retreat), I beg you to consider it a compliment. She usually liked what she saw. Yet the one upside to missing talks was ample time for posters—something I often miss as I rush from one session to another.

I owe this overwhelmingly positive GSA experience to a great many people. I owe thanks to my friends Beth and Pete, who brought their child, Oliver, to the Denver GSA meeting last year. Had I not seen them then, it might not have seemed a given that Maya could join me this year. I also owe a debt to my new family-friendly geology department at Washington and Lee University, where I began a new tenure-track position in August. I am grateful for the myriad kindnesses of strangers in Seattle. Doors were opened, smiles exchanged, and supportive comments granted. I especially appreciate colleagues like my good friend, Al, who could look at me and speak intelligently about our science, and yet when appropriate, acknowledge that I had a wonderful marvel at my side.

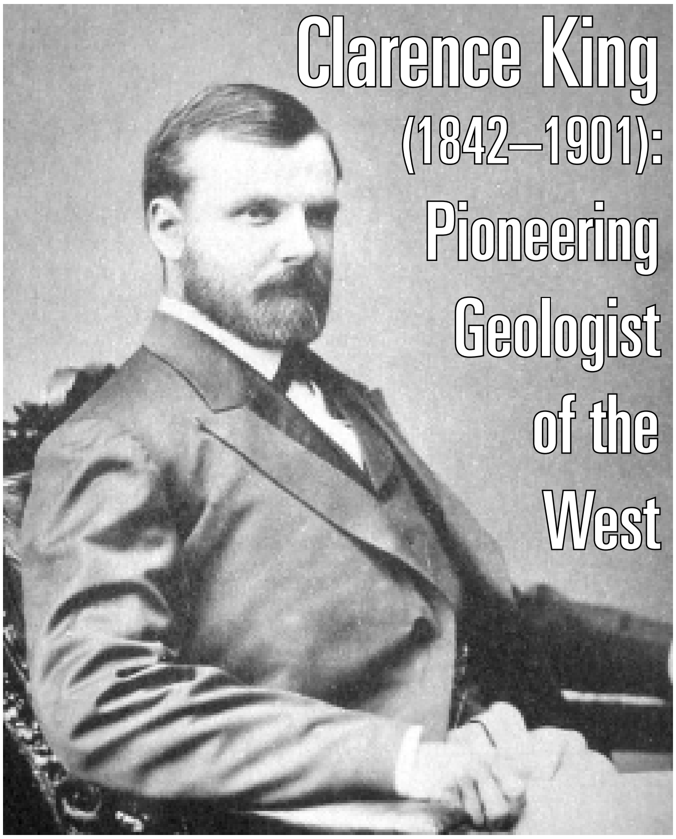
I am perhaps most grateful to the women who have done this (or similar adventures) before. I spoke with Cindy about the logistics of bringing a child in the field as she held Maya at the annual Association for Women Geologists (AWG) breakfast. I heard stories about teaching with babies in backpacks and playpens. And while I had to miss much of the presentation for the AWG Outstanding Educator Award to nurse in the hallway, I so sincerely appreciated the closing remarks by this year's award recipient, Patricia Kelley, who stated that "you can have a career and a family."

I see that Maya is waking up now and we are almost home. As I look at her I am reminded of the person I must be most thankful to for the success of this trip. I must thank Maya for being such a fabulous, cheerful, easy-going, and wondrous kid. I thank her for making this meeting something different…and something very very good.

I hesitated to write this down, but I decided it might be worth it to let those of you in similar shoes know that next year, I will be eager to meet you and support your choice to integrate family and career. I am quite confident that many others will be eager to support you as well!

ROCK STARS

Clarence King (1842–1901): Pioneering Geologist of the West



by ***K.R. Aalto,*** *Department of Geology, Humboldt State University, Arcata, CA 95521, kra1@humboldt.edu*

Introduction

Clarence King is well known for his organization of one of the principal post–Civil War geological surveys of the American West, the *Geological Exploration of the Fortieth Parallel.* The fact that, at the age of 25, he was given complete command of a five-year mapping project from the Sierra Nevada across the Rocky Mountains attests to a remarkably charismatic personality. His survey volume, *Systematic Geology,* ranks as one of the great scientific works of the late nineteenth century.

Young Clarence King

Clarence King was born in 1842 to a prosperous and religious Rhode Island family. In spite of the untimely death of his father in 1848 and economic adversity, King's mother devoted herself to his education, initially emphasizing literature, art, and music. She relocated first to New Haven and then to Hartford to assure good schooling. Later, she encouraged Clarence's interests in natural history, reading to him from Hitchcock's *Geology* after he expressed an interest in fossils. Following his mother's remarriage, King's stepfather financed an undergraduate education at Yale, where King enrolled in the newly established Sheffield Scientific School. He excelled in geology under Professors George Brush and James D. Dana and was graduated in 1862 in the first Sheffield class. During the winter following his graduation, he attended lectures in glaciology by Louis Agassiz at Harvard. King also socialized in the New York City art community, which spawned an interest in art and elegant living.

In 1863, Josiah Whitney's geological exploration of California and the accounts of Mount Shasta by William Brewer, Whitney's chief assistant, called King west. He traveled via wagon train and on horseback, visiting rip-roaring mining towns and experiencing harrowing encounters with unsavory miners. These experiences are recalled in King's *Mountaineering in the Sierra Nevada,* regarded by S.F. Emmons in 1902 (p. 236) "... as far the best book of its kind that had ever been written." Once in California, King convinced Whitney to allow him to serve as a volunteer on the new California Geological Survey. During three years with Whitney, he made many Sierran first ascents and named summits such as "Dana," "Brewer," "Lyell," and "Whitney," as well as "King." Although they did not always agree, Whitney considered King a competent employee. While in California, King conceived of organizing a more extensive survey of the American West, which would connect Whitney's survey with the Hayden survey 800 miles to the east, along the route of the transcontinental railroad.

Fortieth Parallel Survey

Though young, King convinced Congress to fund geologic mapping of some 100,000 square miles of desert, with King in charge. His success derived in part from endorsements by Brewer, Dana, and Agassiz directed toward the powerful bureaucrat, Secretary of War Edwin Stanton; from King's prior naming of a Sierran peak in honor of California's statesman John Conness; as well as from King's skill in social settings. Moreover, he adroitly stressed the potential economic benefit of the survey for the discovery of more precious metals deposits like Nevada's fabulous Comstock Lode.

King's proposed survey required preparation of suitable topographic base maps at a scale of 4 miles to the inch and a contour interval of 300 feet. The Hayden, Powell, Wheeler, and later surveys adopted his example in making topographical maps the basis for portraying geology. Despite bouts of illness, which affected the entire survey party, and the need to replace some of his staff, the survey field work, begun in 1867, was completed in 1872. Throughout, King demonstrated a gift for buoying flagging morale. Survey results were published in seven volumes as the *Geological Exploration of the Fortieth Parallel,* with two accompanying atlases. King arranged that *Mining Industry* (v. 3, 1870) appear first in order to demonstrate the utility of his survey. *Descriptive Geology* (v. 2, 1877) and King's own *Systematic Geology* (v. 1, 1878) appeared shortly thereafter. A major coup was to persuade the world leader in the new petrographic study of rocks, Ferdinand Zirkel, to prepare *Microscopical Petrography* (v. 6, 1876). Other volumes reviewed aspects of paleontology, botany, and ornithology. Of *Systematic Geology,* G.K. Gilbert stated, "Few American geologists have undertaken as wide a range of theoretic and economic studies and none have acquitted themselves with greater credit" (Wilkins, 1988, p. 227).

Later Career

King led efforts to found a national geological survey to oversee exploration of the West, and, in 1879, with endorsements from the foremost geologists of the day, he was appointed first director of the U.S. Geological Survey (USGS). He set the highest standards and focused survey endeavors on mineral exploration, mapping, and experimental petrology. He also established a physical laboratory to investigate the effects of pressure and temperature upon the melting point of rocks. King had accepted the directorship with the understanding that he would serve only to launch the USGS. In 1881, having placed the organization on a firm footing, he arranged transfer of the directorship to his handpicked successor, John Wesley Powell.

With extravagant interests in art collecting, literature, travel, and elegant living, King now hoped to use his geological talents to acquire a fortune in mining. He traveled throughout the continent but met with little success. In 1872, King's exposure of a major diamond fraud made him a sought-after expert witness in mining disputes, providing him with supplemental income. However, a worldwide economic depression, technical difficulties associated with several promising mining prospects, and lack of ready capital forced King to borrow heavily from friends. His health began to fail due to recurrent spinal inflammation, and he suffered bouts of depression. He largely withdrew from the scientific world and concentrated on mineral exploration and his life as a clubman in New York City. As a scientist, aesthete, and highly regarded raconteur, King moved in the highest social circles of New York and Washington. His reputation was such that King was received at Court in England on a triumphal grand tour of Europe from 1882 to 1884, during which he spent far in excess of his income collecting art. He was an intimate friend of both President Lincoln's former secretary, John Hay, and political historian Henry Adams, who viewed King as "...the best and brightest man of his generation, with talents immeasurably beyond any of his contemporaries..." (Adams, 1918, p. 388).

To recuperate from one of his ever more frequent bouts of illness and a nervous breakdown, King went to Cuba in 1894, where he reveled in both geology and interaction with the natives. (Adams [1919] reflected on his love of exotic culture and the adventurous aspect of consorting with Cuban rebels intent on overthrowing Spanish colonial rule.) King's long-term common-law marriage in 1888 to an uneducated black woman, Ada, 20 years his junior, was known only to Adams and Hay, who upon King's death provided a stipend for support of Ada and their five children. Clarence King died of tuberculosis in Arizona on December 24, 1901, at the age of 59.

King's Geology in the Context of his Era

When viewed in the context of his times, the interpretations that King presented in *Systematic Geology* and later papers reflect superb critical thinking. By recognizing several unconformity-bound depositional sequences, he established a framework for orogenic history that has remained largely unchanged. In evaluating King's geology, one should realize that conventional wisdom of the time held all coarsely crystalline rocks to be Archean and that Archean topography greatly influenced Phanerozoic structural development of a region; Archean faults and mountain ranges were lines of weakness where later orographic movements would express themselves. These ideas reflected the influential teachings of his Yale mentor, Dana.

King clearly described the effects of terminal Paleozoic orogenesis, based in part upon the appearance of western-derived siliciclastic sediments, and correctly delineated major structural effects of both the Sevier and Laramide orogenies. King appreciated the change of tectonic style within the Great Basin during the Cenozoic, a transition marked by a shift from chiefly east-west crustal shortening to extension. He noted the transition from predominately rhyolitic to basaltic volcanism during the Neogene, and he mapped the extent of Pleistocene glaciation in many ranges, as well as that of both pluvial lakes Lahontan (which he named) and Bonneville.

King was convinced that Lyellian uniformitarianism, a theory of gradualism and constancy of processes, could not explain the geologic evolution of the region surveyed, especially late Cenozoic effusive volcanism and the magnitude of glacial drainages. These views led King to be classed as a catastrophist. However, he was in good company with most late nineteenth century geologists in calling for greater variations of both rates and intensities of processes than Charles Lyell preached. King also believed that evolution did not proceed at a steady pace. Blending catastrophe and "adaptivity," he proposed that the former was an integral part of the cause of change. Destruction of biological equilibrium engendered by catastrophic change contributed to rapid morphological change among what he termed "plastic species" (King, 1877, p. 468–469). King in essence proposed a blending of Darwin's ideas on natural selection with the variable rate of change of geological processes. Employing data on rock fusion gathered at the USGS Physical Laboratory, King (1893) attempted to advance to new precision Kelvin's estimate of Earth's age deduced from terrestrial refrigeration, determining a maximum age of 24 Ma. Given this young age, insufficient time remained to construct a Lyellian geologic record of the Fortieth Parallel area.

Under King's sound leadership, the USGS became a successful government agency, and by personal example, he put an end to internecine warfare among geologists mapping the American West. He demonstrated the utility of allying science, government, and industry, perhaps his greatest contribution to our science.

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"Rock Stars" is produced by the GSA History of Geology Division. Editorial Committee: Kennard Bork, Robert Dott (editor of this profile), Robert Ginsburg, Gerard Middleton, Peter von Bitter, and E.L. (Jerry) Winterer.

UPCOMING DEADLINES

Nominations for the **John C. Frye Environmental Geology Award*** are due March 31, 2004. Nominations for the following national awards are due April 30, 2004: **William T. Pecora Award, National Medal of Science, Vannevar Bush Award,** and **Alan T. Waterman Award.** Details and nomination procedures for these awards are posted at http://www.geosociety.org/aboutus/awards/. You may also contact Diane Lorenz, (303) 357-1028, awards@geosociety.org, Grants, Awards, and Medals, P.O. Box 9140, Boulder, CO 80301-9140, or see the October 2003 issue of *GSA Today*.

Applications for the GSA Coal Geology Division's **Antoinette Lierman Medlin Scholarship in Coal Geology*** are due February 15, 2004, to Romeo Flores, U.S. Geological Survey, Box 25046, MS 939, Denver Federal Center, Denver, CO 80225, USA.; fax: 303-236-0459, rflores@dncrds0.cr.usgs.gov. For details, see the December 2003 issue of *GSA Today* or visit www.geosociety.org/grants/grantinf3.htm.

For details on the following awards, see the January 2004 issue of *GSA Today* or visit www.geosociety.org/sectdiv/divisions.htm.

- **Don J. Easterbrook Distinguished Scientist Award,*** Quaternary Geology and Geomorphology Division: Nominations due by April 1, 2004, to Ellen Wohl, ellenw@cnr.colostate.edu, Colorado State University, Dept. of Earth Resources, Fort Collins, CO 80523-1482.
- **Farouk El-Baz Award for Desert Research**,* Quaternary Geology and Geomorphology Division: Nominations due by April 1, 2004, to Alan Gillespie, alan@ess.washington.edu, Dept. of Earth & Space Sciences, PO Box 351310, University of Washington, WA 98195-1310.
- **Laurence L. Sloss Award for Sedimentary Geology**,* Sedimentary Geology Division: Nominations due by March 1, 2004, to Paul Karl Link, Treasurer, Sedimentary Geology, via e-mail (with attachments) to linkpaul@isu.edu.
- **Gilbert H. Cady Award**,* Coal Geology Division: Nominations due by February 28, 2004, to Cortland F. Eble, Kentucky Geological Survey, University of Kentucky, Lexington, KY 40506-0107; (859) 257-5500; fax 859-257-1147; eble@uky.edu.

*Funds supporting these awards are administered by the GSA Foundation.

Call for Nominations: Thirteenth Annual Biggs Award

for Excellence in Earth Science Teaching for Beginning Professors

The Biggs Award was established by GSA to reward and encourage teaching excellence in beginning professors of earth science at the college level.

Eligibility

Earth science instructors and faculty from all academic institutions engaged in undergraduate education who have been teaching full-time for 10 years or fewer. (Part-time teaching is not counted in the 10 years.)

Award Amount

An award of $750 is made possible as a result of support from the Donald and Carolyn Biggs Fund (maintained by the GSA Foundation), the GSA Geoscience Education Division, and GSA's Education, and Outreach Programs. In addition, this award also includes up to $500 in travel funds to attend the award presentation at the GSA annual meeting.

Deadline and Nomination Information

Nomination forms for the 2004 Biggs Earth Science Teaching Award are posted at www.geosociety.org/aboutus/awards/biggs.htm. Or, contact Diane Lorenz, (303) 357-1028, dlorenz@geosociety.org. Nominations must be received by May 1, 2004.

Mail nomination packets to:

Diane Lorenz
Program Officer, Grants, Awards, and Medals
GSA
P.O. Box 9140
Boulder, CO 80301-9140

Students:
Mark your Calendars!
Shlemon Mentor Programs for 2004

Students: If you have career-related questions, plan to attend a Shlemon Mentor Program at a 2004 GSA Section Meeting to chat one-on-one with practicing geoscientists. These volunteers will answer your questions and share insights about how to get a job after graduation. When programs are scheduled for multiple days, each day's program will offer a different set of mentors. These programs are made possible by the Roy J. Shlemon Fund, administered by the GSA Foundation.

FREE LUNCHES will be served (to students only) at the following Shlemon Mentor Programs at the spring GSA Section Meetings. Stop by the GSA registration desk to get the location of the luncheon.

South-Central Section Meeting

Mon. and Tues., March 15–16
11:30 a.m.–1 p.m.
College Station, Texas

Northeastern–Southeastern Sections Joint Meeting

Thurs. and Fri., March 25–26
11:30 a.m.–1 p.m.
Tyson's Corner, Virginia

North-Central Section Meeting

Mon. and Tues, April 1–2
11:30 a.m.–1 p.m.
St. Louis, Missouri

Cordilleran–Rocky Mountain Sections Joint Meeting

Mon. and Tues., May 3–4
11:30 a.m.–1 p.m.
Boise, Idaho

Students will receive a **FREE LUNCH** ticket along with their registration badge to attend each Shlemon Program. However, space is limited. First come, first served.

2004 GSA Section Meetings

South-Central Section

March 15–16, 2004
Texas A&M University, College Station, Texas
Information: Christopher Mathewson, Texas A&M University, Department of Geology & Geophysics, 3115 TAMU, College Station, TX 77843-3115, (979) 845-2488, mathewson@geo.tamu.edu

Northeastern–Southeastern Sections Joint Meeting

March 25–27, 2004
Hilton McLean Tyson's Corner, Washington, D.C.
Information: George Stephens, George Washington University, Department of Earth & Environmental Sciences, 2029 G St., NW, Washington, D.C. 20052-0001, (202) 994-6189, geoice@gwu.edu; Rick Diecchio, George Mason University, Department of Environmental Science & Policy, MS 572, 4400 University Dr., Fairfax, VA 22030-4444, (703) 993-1208, rdiecchi@gmu.edu

North-Central Section

April 1–2, 2004
Millennium Hotel, St. Louis, Missouri
Information: Joachim O. Dorsch, Saint Louis University, Department of Earth & Atmospheric Science, 3507 Laclede Ave., St. Louis, MO 63103-2010, (314) 977-3124, dorsch@eas.slu.edu

Rocky Mountain–Cordilleran Sections Joint Meeting

May 3–5, 2004
Boise Centre on the Grove, Boise, Idaho
Information: C.J. Northrup, Boise State University, Department of Geosciences, 1910 University Dr., Boise, ID 83725, (208) 426-1009, cjnorth@boisestate.edu

www.geosociety.org/sectdiv/sections.htm

GSA Foundation Update

Donna L. Russell, *Director of Operations*

History of Geology Division Receives Bequest

William Brice, *Secretary/Treasurer, History of Geology Division*

At the GSA Annual Meeting in Seattle, the announcement was made at the History of Geology Division/HESS reception that the Division has received a bequest of $86,000 from the estate of Mary Rabbitt, recipient of the History of Geology Award in 1984 and a GSA Fellow, who died August 8, 2002, at age 87. Mary Priscilla Collins was born and raised in the Boston area and chose geology as her major at Radcliffe. At that time, Radcliffe women were forbidden to attend any Harvard classes, so Esper Larsen allowed Mary to sit in his office with the door open to hear his petrology lectures across the hall. She received her B.A. (magna cum laude) in 1937, and, shortly afterward, in the *Bulletin of the Seismological Society of America*, she published her first paper, about earthquakes in New England.

Mary then returned to Radcliffe as a teaching fellow with Kirtley Mather and then as an assistant seismologist with Don Leet at Harvard's Seismograph Station. During World War II, she worked on normal and nuclear explosion seismology. In November of 1947, she married John Charles "Jack" Rabbitt who completed his Ph.D. at Harvard that same year. In 1948, Jack became head of the U.S. Geological Survey Geochemistry and Petrology Branch's Trace Elements Section. The next year, Mary joined the USGS also as geophysicist-in-charge of the Geophysics Branch's Abstracts Unit, the section responsible for publication of Geophysical Abstracts. From 1950 to 1957, she was the assistant chief of that branch.

After the death of her husband in 1957, Mary succeeded him at the USGS as the Geology Division's staff assistant for publications. In 1966, the USGS Director, William Pecora, appointed Mary as geologist and as his staff assistant, and it was he who encouraged Mary that, "when you have time..." have a look at the history of the USGS. She did, indeed, "have time," for in 1954, the 75th anniversary of the USGS, she and her husband, Jack, published a brief account of that history in *Science*. Mary later expanded this history, and in 1979, published a brief history of the USGS. Later, for the 100th anniversary of his Colorado River exploration, she did a brief analysis of the life and work of Powell, which was published in 1995 as John Wesley Powell's exploration of the Colorado River. After her retirement in 1978, Mary prepared an assessment and history of the public lands, government mapping policies, and the development of mineral resources in the United States from its founding to 1939. The first volume of this four-volume work was issued on March 2, 1979, as part of the Centennial Celebration of the USGS. Other volumes came out in 1980 and 1987. Volume four of this series was still in preparation at the time of her death, and Clifford

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Nelson, a friend and colleague at USGS, undertook the task of completing this final volume.

In addition to receiving the History of Geology Award in 1984, Mary also received the Distinguished Service Award from the Department of the Interior. She is survived by Patricia M. Ieradi, a niece, and two nephews, John A. Collins III and Michael Collins. (Note: Biographical information taken from the memorial in the December 2002 *Geotimes* and an August 30, 2002, news release from the USGS, both by Cliff Nelson.)

Mary Rabbitt was a longtime supporter of the history of geology and this bequest demonstrates the depth of her support and commitment. The Division will honor her memory by using the income from the bequest to expand and enhance its programs in the history of geology.

Most memorable early geologic experience:
Deducing replacement mechanisms of growth of orthoclase crystals in Papoose Flat pluton, Inyo Range, California, and scaling to crustal replacement of country rocks by granite

—F.W. Dickson

GeoVentures™ 2004

Photo by Ivo Lucchitta.

Want to find out about all our latest GeoVenture trips?
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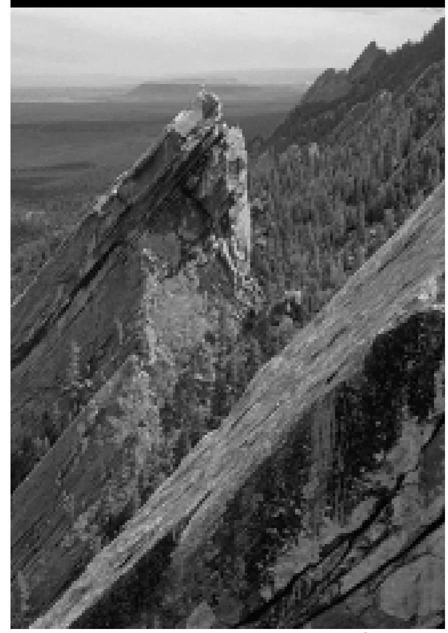

Flatirons, Boulder, Colorado.
Photo by John Karachewski.

GeoTrip Rio Colorado: A Geologic Exploration of the Colorado River and Its Grand Canyon—Lee's Ferry to Diamond Creek

April 22–29, 2004 (8 days, 7 nights)

Scientific Leader: Ivo Lucchitta, U.S. Geological Survey (emeritus), Flagstaff, Arizona. Ivo has been in, through, and around the Grand Canyon since 1963, when he started his Ph.D. dissertation in the upper Lake Mead area under the tutelage of Eddie McKee. His interests include continental extension (from the perspective of Colorado Plateau–Basin and Range interface); uplift of the Colorado Plateau; history of Grand Canyon and Colorado River; and Cenozoic/Quaternary geology, geomorphology, and processes, especially as applied to southwestern drainage systems.

Description

Even though the stately succession of strata that form the imposing walls of the Grand Canyon will by no means be ignored, the geologic focus of the trip will be more on processes operating within the Canyon, its Quaternary geology and geomorphology, and the interrelation between the activities of the Colorado River and those of humans, including thorny subjects of current interest and unexpected insights into the activities of prehistoric Puebloan farmers.

Non-geologists on the trip will be treated to many talks presented in non-technical language and designed to make them aware of the wonderful stories Earth has to tell. The purpose of the trip is to learn, travel through some of the most remarkable scenery on Earth, enjoy good companionship, and have fun.

Fees and Payment: $2,875 for GSA members; $2,975 for nonmember spouses; $3,125 for nonmembers. A $300 deposit is due with your reservation and is refundable through February 15, less a $50 processing fee. The total balance is due February 15. Minimum: 14. We are holding 14 spaces. Any additional spaces will be based on availability. If you would like to participate in this trip, we recommend that you register today. **Included:** Guidebooks to the river; geologic guide; ground transportation from Las Vegas to and from the river; waterproof bags for clothes; life jacket; camping gear, including a two-person tent, sleeping bag and pad, and eating utensils; all river meals; and soft drinks on the river. **Not included:** Airfare to and from Las Vegas; nights and meals in Las Vegas; alcoholic beverages.

To register for this trip, please fill out and return the registration form on page 26.

GeoClass

Two Billion Years in Two Days—A Front Range Geology Primer GeoClass

June 25–28, 2004

Boulder, Colorado,
Best Western Boulder Inn
Scientific leader: Alan Lester, University of Colorado, Boulder. Lester, a recipient of multiple teaching awards at the University of Colorado, is a research associate and senior instructor in the Department of Geological Sciences. His research interests include Laramide magmatism, Front Range kimberlite emplacement, and Eocene sedimentary rocks of southwest Wyoming.

Description

Experience three days of scenic geology excursions along the eastern margin of the Front Range, south-central Rocky Mountains, Colorado. Situated at the foot of the Front Range, Boulder is a picturesque and convenient vantage point from which to launch explorations. In Boulder, home of the University of Colorado, participants, spouses, and family will find ample opportunities for dining and shopping. Our excursions, although geological in focus, will also be wonderful opportunities for bird and wildlife watching.

The western backdrop for Boulder features the spectacular tilted (late Paleozoic) sedimentary rocks of the Flatirons and the uplifted crystalline basement along the Continental Divide. In this GeoClass, designed for those with relatively little prior background in Front Range geology, we examine the nearly two-billion-year history of Boulder's geologically fascinating "backyard." On Saturday, we'll take a short hike along the Mesa Trail in the Boulder Mountain Parks, searching for clues with which to interpret the ancient depositional environments of this layered and tilted sequence of Paleozoic and Mesozoic sedimentary rocks. The trail is gentle and takes us through pine forests with wonderful views of the Flatirons and the city below. On Sunday, we'll journey to the Indian Peaks Wilderness, near Nederland, Colorado, to view both the Precambrian basement rocks and intrusions associated with the northeast portion of the Colorado Mineral Belt. Here we will take a four-mile round-trip hike (with minimal altitude gain, but at nearly 10,000 feet above sea level) through meadows with alpine flowers, along rushing streams, and into a region of glacial lakes. We will consider the mechanisms for crust formation during the Precambrian, mountain building and magmatism during the Laramide phase of Rocky Mountain uplift, and the evidence for late Pleistocene glaciation.

Fees and Payment: $650 for GSA members; $700 for spouses; $750 for nonmembers. A $200 deposit is due with your reservation and is refundable through May 1, less a $20 processing fee. Total balance is due May 1. Minimum: 12; maximum: 22. **Included:** Classroom programs and materials; field trip transportation; lodging for three nights (single occupancy or doubles for couples); breakfast on Saturday, Sunday, and Monday; boxed lunch on Saturday and Sunday, welcoming and farewell events. **Not included:** Transportation to and from Boulder, Colorado, transportation during hours outside field trips, alcoholic beverages, and other expenses not specifically included.

To register for this trip, please fill out and return the registration form on page 26.

GeoTrip Iceland: A Student Only GeoTrip

July 11–25, 2004

Scientific Leader: James Reynolds, Brevard College, Brevard, North Carolina. Jim is a magnetostratigrapher with interests in Neogene volcanism and foreland basins who has been leading international field trips since 1996.

Description

Designed for students only, this GeoTrip will visit the classic geological localities of Iceland on a low-frills budget. Participants will camp and prepare meals in a group kitchen tent. Eighty kilometers of hikes will take us through spectacular volcanic and glacial scenery.

The trip begins in Baltimore and will fly to Reykjavík to make a 12-day loop around the country, starting at Thingvellir, Gullfoss waterfall, and Geysir geothermal area, near the capital. Next, we'll head to Myvatn, in northeastern Iceland, where we will hike through Krafla caldera and investigate other volcanic areas. Then, after passing steep table mountains to get to Askja caldera, we'll swim in the acidic water of the 1912 Viti crater within the caldera. Several days will be spent in southeastern Iceland around the Vatnajokull ice sheet, visiting the valley glaciers descending from the large icecap. Hikes at Skaftafjell National Park lead to spectacular overlooks of the ice. We'll continue across southern Iceland to the Lakigigar craters from the 1783 eruptions and proceed to the hot springs at Landmannalauger where a slowly cooling obsidian flow heats the water. Upon returning to Reykjavík, we'll have a free day and night in the city with the final stop at the Blue Lagoon on our way to the airport.

Fees and Payment: $2100 for GSA student members; $2200 for nonmembers. $200 deposit is due with your reservation and is refundable (less $75) through May 1. Balance is due May 1. *Firm* minimum number of participants: 21. **Included:** Ground transportation, all meals, classroom programs and materials, guidebook, and map. **Not included:** Roundtrip airfare to Iceland from Baltimore, airfare to and from Baltimore, camping equipment (tent and sleeping bag), alcoholic beverages, and other expenses not specifically included.

To register for this trip, please contact Sandy Doss, Holbrook Educational Tours at sdoss@holbrooktravel.com, 1-888-890-0632.

GeoTrip Geological Excursion to Central and Northern Mongolia

July 24–August 11, 2004

Scientific co-leaders: Gregory S. Holden, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, Colorado. Greg has 26 years of teaching experience in petrology and field geology and has led five previous GSA GeoHostels. He will provide general geological background to complement the local expertise of the Mongolian trip leaders. Greg led a student field trip to Mongolia with B. Tumenbayar and Ch. Minjin in 2001. If you would like to discuss the trip further, please contact Greg at gholden@mines.edu, (303) 273-3855. **Ch. Minjin,** Mongolian Technical University, is well published and an internationally recognized expert on the stratigraphy and paleontology of Mongolia. **B. Tumenbayar,** Mongolian Academy of Sciences and BEMM Consulting, is a mineralogist and active consulting exploration geologist. Tumenbayar's firm, BEMM Consulting,

GeoVentures™ 2004 for GSA Members and Friends

For complete details on GeoVentures or for full itineraries, contact Edna Collis, Program Officer, 1-800-472-1988, ext. 1034, fax 303-357-1072, ecollis@geosociety.org. Participants must be 18 or older and in good health. Any physical condition requiring special attention, diet, or treatment must be reported in writing when reservations are made. We'll do our best to accommodate special needs, including dietary requirements and physical disabilities. Deposits and payments are refundable less a processing fee, up to the cutoff date. Termination by an individual during a trip in progress for any reason will not result in a refund, and no refund will be made for unused parts of trips. For details on accommodations and occupancies, see trip descriptions or contact Edna Collis.

The Govi at Mushagai. Photo by Lisa R. Lytle.

which has provided logistical support for numerous international geological field trips and for exploration efforts by international minerals companies, will be responsible for all logistical support in Mongolia. His company has an experienced staff of coordinators, cooks and drivers, many of whom speak English well. **J. Byamba,** Mongolian State University.

Description

Central Mongolia is a high, dissected plateau with numerous peaks over 3000 meters, well above timberline. Thick birch and larch forests cover the high slopes above valleys carpeted with grass and flowers of the Central Asian steppe. Big, fish-filled rivers flow north, ultimately into Siberia's famous Lake Baikal and on to the Arctic Ocean.

The steppe supports horses, camels, and yaks, herded by nomads living in gers, their traditional round tents. Wolves and snow leopards still roam the more remote areas.

This GeoTrip provides a unique opportunity to explore the geology, flora, fauna and culture of this amazing country in the company of two expert guides from the Mongolian Technical University and the Mongolian State University. The 19-day trip, including two travel days, begins in Ulaan Baator, the capital and only major city in Mongolia, then proceeds west across the north slopes of the Khangai Mountains, with opportunities to examine the often highly deformed Paleozoic metamorphic and sedimentary basement and Mesozoic intrusive rocks that underlie the mountains. We'll visit a Cenozoic volcanic area and the famous Kuvsugul Lake, which is similar in style, size, and origin to Lake Baikal. We will visit phosphorite, placer gold, and porphyry copper deposits. On several nights, we'll camp near monasteries and will have ample occasions to meet and get to know local people. We'll have time to hike, climb peaks, and fish on an individual or group basis.

Travel will be via Russian 4-wheel-drive minivans and jeeps and, since hotels are rare, we'll camp most nights. Participants will bring their own tents and sleeping bags. Meals will be traditional Mongolian fare, cooked by an experienced, local expedition staff. This will not be an easy trip, and participants need to be ready for some rough rides and rough weather in a very remote area. For those who love geology and have always wanted to see central Asia, this will be an adventure of a lifetime, a chance to see the magnificent unfenced landscape, and an opportunity to meet the wonderful people of Mongolia.

Fees and Payment: $2,700 for GSA members; $2,800 for spouses; $2,950 for nonmembers. $200 deposit is due with your reservation and is refundable (less $100) through May 15. Balance is due May 15. Minimum number of participants: 12; maximum: 20. *Most nights will be spent camping. Participants must supply their own mountain tent, good quality sleeping bag, and foam pad.* **Included:** Four nights in ger hotels, all meals, field trip transportation, local guides, and guidebook and program materials. **Not included:** Roundtrip airfare to Ulaan Baator from San Francisco, airfare to and from San Francisco, alcoholic beverages, and other expenses not specifically included.

To register for this trip, please fill out and return the registration form at bottom of this page.

K–12 Teacher GeoVentures

There are four specialist trips for K–12 teachers running next summer. These trips are to Hawaii, Iceland, South Dakota, and New Mexico. For more information, see **www.geosociety.org/geoVentures/.**

REGISTER TODAY!

Send a deposit to hold your reservation; please pay by check or credit card. You will receive further information soon.

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Guest Name

GSA Member #

	DEPOSIT PER PERSON	NO. OF PERSONS	TOTAL PAID DEPOSIT
GRAND CANYON	$300	____	$_________
BOULDER	$200	____	$_________
MONGOLIA	$200	____	$_________
DILLON, MONTANA	$200	____	$_________
	TOTAL DEPOSIT		$_________

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GeoHostel Geology of the Northern Margin of the Yellowstone Hot Spot, Southwest Montana

June 19–24, 2004, 5 days, 6 nights.
GuestHouse Inn Suites, Dillon, Montana

Scientific Coleaders: Robert C. Thomas and **Sheila M. Roberts**, The University of Montana—Western. Rob Thomas is a professor of geology in the Department of Environmental Sciences at Western, where he teaches his courses in the natural lab of southwest Montana. Western is the experiential learning campus of the University of Montana and is the first public university in the U.S. to offer semester courses one at a time. Thomas utilizes these field-based courses to incorporate undergraduate students as partners in his research. For example, he and his students have worked on sedimentary basins along the northern margin of the Yellowstone hot spot for the past ten years. Sheila Roberts has been a professor of geology and chemistry in the Department of Environmental Sciences at Western for nine years. By utilizing the department's field-based program, Roberts has incorporated all levels of undergraduate students in her research. Her master's thesis was on Permian rocks in southwest Montana (The University of Montana—Missoula). She teaches regional geology at Western and has edited many publications about western Montana, including the 2000 Rocky Mountain Regional GSA guidebook. Roberts' current research is extremely diverse, and includes aspects of Pleistocene climate change in southwestern Montana, the geology of the Lewis and Clark Trail in Montana, weathering rates of marble tombstones regionally, and the chemistry of natural waters in Beaverhead County.

Description

Extensional tectonism along the northern margin of the Yellowstone hot spot has exposed some of the most diverse and interesting geology in North America. The pre–hot spot geology includes Precambrian metamorphic rocks, Proterozoic sedimentary rocks of the Belt Supergroup, Paleozoic epeiric sea deposits, Mesozoic foreland basin deposits and associated compressional structures and igneous rocks. The early Tertiary records the beginning of a complex history of regional uplift and basin subsidence as a result of extensional tectonism. By mid-Miocene time, regional extension and sedimentation were influenced by the Yellowstone hot spot. Our trip will focus primarily on the geology influenced by the hot spot, including Tertiary extensional tectonism, sedimentation and volcanism, mountain-front geomorphology, Quaternary glaciation, recent seismicity and hot springs activity. We will base our geological exploration from the small (pop. 5,000) intermountain town of Dillon, Montana. This college town provides the ideal blend of old-west charm and modern conveniences, making it an ideal location for the GeoVenture of a lifetime!

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Southwest Montana. Photo by Rob Thomas.

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For more information, contact Cindy Lonergan at clonergan@usgs.gov or (703) 648-7472.

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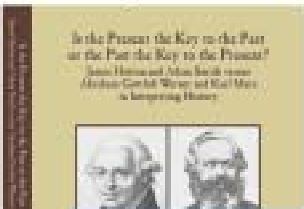

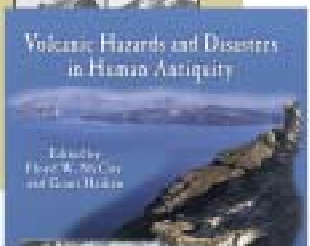

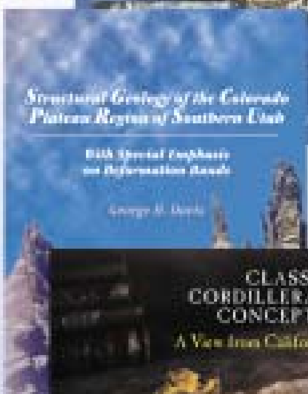

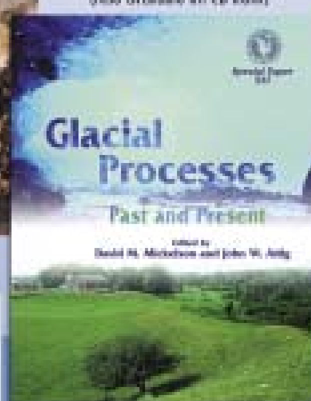

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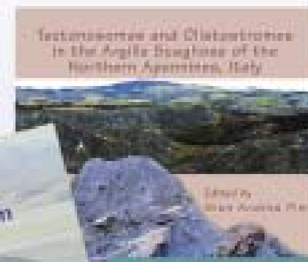

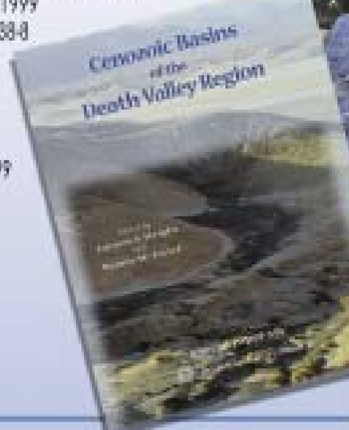

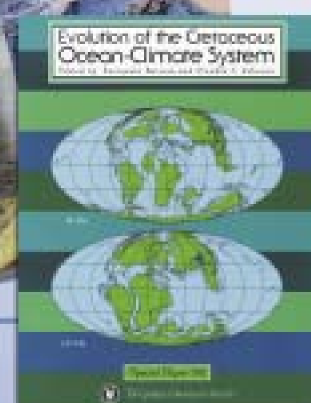

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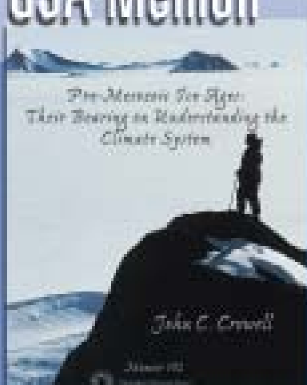

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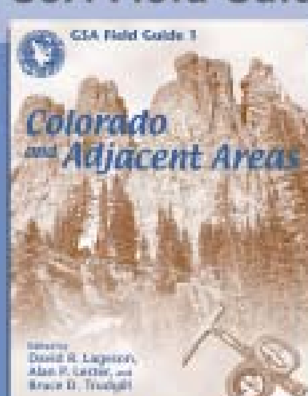

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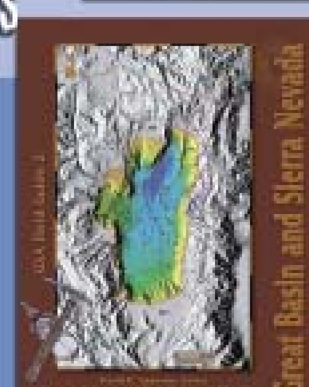

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