STRUCTURAL GEOLOGY AND TECTONICS DIVISION Newsletter

Volume 19, Number 1 **March 2000**

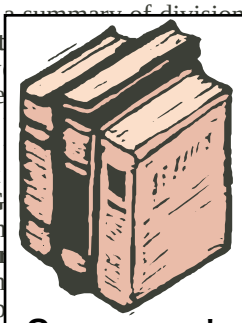
WORKSHOP REPORT
"Future Research and Growth Oppportunities in Tectonics and Earth Sciences"

Executive summary, October 1999

The academic community has increasingly become aware of sweeping changes in new long term initiatives by federal agencies, and is concerned about their impact on funding, graduate student training and community outreach. In response to these changes, and in an attempt to participate in defining some long term first order objectives for future research and growth opportunities in Tectonics, a number of faculty members with broad interests in geoscience, participated in a workshop at Denver this past October. In order to involve individuals with a background in evaluating new research ideas, participants at the work shop were mostly either past or

continued on page 3

Table of Contents



CHAIRPERSON'S MESSAGE

Greetings to all of you. I would like to start this column with a summary of division related news from the last few months. First, let me thank **St** excellent leadership of the division over the last year. Stev sabbatical last year, but put in an enormous amount of time de affect the SG&T membership. Thanks also go to **Vicki Hansen**, past chair. Both Steve and Vicki had large smiles on their faces the stage following the Division business meeting in Denver, but as I call on him frequently for advice. We welcomed **Laurel G** vice chair of the Division at the management board's lunchtim Minutes of this meeting are presented by secretary/treasurer **Char** in this newsletter. Laurel and I also attended the GSA Division heard about plans at GSA to have a 2001 Council member to rep the divisions, and about efforts underway at GSA to streng geoscience societies.

One of the societies of particular interest to SG&T memb Society of London; GSA is exploring joint publication possibilities, and will cosponsor a meeting with GSL in Edinburgh in 2001. A meeting on processes of fault-zone weakening is being cosponsored this year (London; March 7-9) by the Tectonic Studies Group of the GSL and our SG&T Division; I will be at the meeting to represent SG&T, and look forward to increased interactions between these two groups.

The Division's evening business meeting was well attended, and started off with presentations by **Clark Burchfiel**, **Karl Karlstrom**, and **Krishna Sinha** on issues related to the EarthScope initiative at NSF and efforts on the part of several former NSF Tectonics panelists to open a dialogue with NSF about future funding (see below). As usual, the most enjoyable part of the evening was the presentation of awards to several outstanding individuals. Student Research Awards were presented to **Rebecca Ghent** (Southern Methodist University) and **Christopher Zahm** (Colorado School of Mines) for their excellent GSA research proposals; the Division wishes them the best of luck during the remainder of their graduate careers, and looks forward to hearing about their work at future GSA meetings. This year's Best Paper Award went to **Susan H. Treagus** and **Richard J. Lisle** for their elegant 1997 paper "*Do Principal Surfaces of Stress and Strain Always Exist?*" (J. Structural Geol. **19**, 997-1010). Following the citation by **Steve Wojtal**, Sue graciously accepted the award on behalf of both authors, and pointed out that unfunded research can lead to award-winning papers! **Robert Hatcher** presented this year's Career Contribution Award to **Hans Laubscher** many of whose papers I pored over as a graduate student. In his acceptance, Dr. Laubscher reminisced about the serendipitous factors involved in his switch from botany to geology, and about the important influence that discussions with mathematicians, geophysicists, and engineers had on his thinking about tectonic problems.

I would like to thank all of those who helped in the selection of these awardees through their membership on Division committees: **Kip Hodges**, **Ron Bruhn**, and **Terry Engelder** on the Career Contribution Award Committee, and **Don Fisher, Sarah Roeske, Steve Wojtal**, **Joann Stock**, **Sandra Wyld**, and **Mike Williams** on the Best Paper Award Committee. New members of these committees for 2000 are **Margi Rusmore** (CCA comm.) and **Gary Axen** and **Susan Agar** (BPA comm.). I'd also like to thank **Martin Miller**, **Meghan Miller**, **Marcia Bjornerud**, and **Christian Teyssier** on the

Sarah Roeske, Steve Wojtal, **Joann Stock**, **Sandra Wyld**, and **Mike Williams** on the Best Paper Award Committee. New members of these committees for 2000 are **Margi Rusmore** (CCA comm.) and **Gary Axen** and **Susan Agar** (BPA comm.). I'd also like to thank **Martin Miller**, **Meghan Miller**, **Marcia Bjornerud**, and **Christian Teyssier** on the Short Course Committee for lining up three potential Division short courses for the 2000 GSA meeting in Reno. These proposed courses are: (1) Characterization and modeling of fluid flow in fault and fracture zones (Instructors: **Jim Evans**, **Jonathan Caine**, and **Craig Forster**); (2) Digital mapping methods (Instructors: **Kent Nielsen** and **Carlos Aiken**); and (3) Earthquake geology and paleoseismology (Instructors: **Charlie Rubin** and **Thomas Rockwell**). You'll be hearing more about these proposed courses in the next few months. New members of the short course committee for this year are **Andrew Meigs** and **Laurel Goodwin**.

One of the most important items of concern to members of SG&T is the pending **EarthScope** initiative at NSF. EarthScope is an effort to obtain major funding for equipment to support four research programs: USArray, a continental-scale array of seismometers to image the lithosphere and deep-earth structure beneath the US; San Andreas Fault Observatory at Depth, a deep borehole to determine the physical conditions associated with earthquake occurrence; Plate Boundary Observatory, a GPS network to measure real-time deformation along the Pacific margin; and InSAR, a dedicated satellite mission to image tectonically active regions of our continent. The EarthScope initiative is currently pending in the federal budget, but has advanced so quickly that many members of the SG&T community may be unaware of it or its potential impact on our science and funding over the next decade or more. If you are not familiar with EarthScope, I urge you to check out the following web sites:

http://www.earthscope.org
http://www.iris.iris.edu/USArray.html
http://pangea.Stanford.edu/~zoback/FZD

and to consider attending any workshops that you see announced. Better yet, SG&T members of should take the initiative in organizing workshops to focus on where we want to move in the future and how best to work with NSF to ensure adequate funding for our science. (We all witnessed the unfortunate fate of the Active Tectonics program at NSF; we can't afford to let this happen again). If EarthScope is funded, it will bring over $75 million in new funding into the earth sciences, largely in the form of new equipment. This can only be a good thing for the earth sciences in general. However, we need to be certain that the science component of this initiative includes the structural geology and tectonics community in an integral way by making our voices heard.

Special thanks go to **Krishna Sinha** and **Maria Luisa Crawford** for organizing a workshop at GSA of former NSF Tectonics panelists to discuss issues related to structural geology and tectonics funding at NSF. A report stemming from this workshop was submitted to Herman Zimmerman (director of EAR at NSF) in December and is included in this newsletter, along with a list of participants. One of the requests in this report was to develop a national geologic data repository to facilitate integration of field, petrologic, and geochronologic data with the seismologic data that will be obtained from experiments such as USArray. Although there was not complete agreement about every item in this report, those present at the workshop and many of the SG&T Division members who were involved in subsequent discussions agreed that the community needs to show a unified front in supporting the EarthScope initiative and in pushing for expanded earth science funding opportunities at NSF.

I recently read Alexander Winchell's "Walks and Talks in the Geological Field", published by the Chautauqua Literary and Scientific Circle in 1890 (at the time, Winchell was vice-president of GSA). The chapter on mountain building argues that shrinkage of the earth's interior due to cooling would cause folding of rocks near the surface of the earth, "just as the skin of an apple is wrinkled when the pulp within shrinks through the evaporation of juice". We have clearly come quite a distance in the 110 years since Winchell wrote this, and his words now seem a rather quaint description of a phenomenon that we generally explain within the paradigm of plate tectonics. I wonder, however, which of our own works will still be regarded as accurate descriptions or interpretations of geologic phenomena a hundred years in the future. Perhaps USArray will provide us with images that fundamentally change our views of crustal architecture and assembly. I try to teach my students that science is by its very nature progressive: we cannot advance without looking at old ideas with new eyes, and we should therefore be encouraging others with ideas and opinions different from our own to enter into a dialogue with us. In terms of our Division, I hope that this means forging a stronger alliance with those in allied disciplines such as active tectonics, geophysics, and petrology, and including the steering committee for EarthScope.

In closing, I would like to encourage each member of SG&T to recruit one new member for the division and/or to volunteer for a Division committee or position on the Management Board. Please remind your students that as members they are eligible for Division awards and partial scholarships for attendance at Division-sponsored fieldtrips and short courses. All members have the opportunity to help the SG&T community by serving on Division committees. Furthermore, the Division is responsible for scheduling hundreds of abstracts at the annual GSA meeting; if you've ever complained about the scheduling at GSA, you should do your part and get more involved in the Division! (**Christian Teyssier** and I scheduled 300 SG&T abstracts for the Denver meeting, and **Laurel Goodwin** and I will do the same for the Reno meeting).

Our strength as a GSA division comes from our numbers as well as the makeup of our membership. Please help to maintain this strength by recruiting new members, particularly among those who are just embarking upon their careers or who might be in a related field.

*-- **Jane Selverstone***

continued from page 1

present members of the expert panel for the Tectonics Program at NSF. A few others were invited on behalf of the SG&T Division of GSA, which provided the logistical support for the meeting. The participants represent expertise across a wide spectrum of research interests and academic institutions. Those with comments on the report should contact Krishna Sinha at pitlab@vt.edu.

Through this executive summary, we share with you the results of the workshop. Two clear and strong ideas emerged, that if implemented are likely to change the research culture of our community. These two initiatives have potential to greatly strengthen the EARTHSCOPE initiative by creating broader community involvement in data management and analysis, and by further focusing the scientific objectives of Earthscope by adding the "Time" and "Process" dimensions.

1. Creating an initiative that would establish a Geoscience Data Facility.

The aim would be to transform all aspects of tectonics and allied disciplines (field and laboratory based data) from an analog form to a digital database. We suggest that the implementation of such an initiative should include a clear recognition of the need to provide technical support to the academic community and address issues of proprietary data (especially student research). We recognize that the concept of a DIGITAL EARTH is already underway at many federal agencies, including NSF, and on behalf of the academic community, we support such an initiative. We also agreed that for a full impact of a digital earth on both the scientific community and the public at large, a world wide data base would be required, but we suggest starting with a U.S. based program to maximize the science benefit to the community within the immediate future. Since the bulk of the geological and tectonic data reside at State Surveys and Universities, we also suggest that resources be made available for both cataloging and digitizing such information. Digital formatting of data as varied as lineations recorded in rocks to compositions of plutons must be explored through the involvement of scientists who generate such data. This initiative will therefore need to involve an organized consortium of different disciplinary groups. It will be essential to provide a mechanism to integrate ongoing efforts of the federal and state agencies, and the oil, gas and mineral industries, which in many ways are already leading this effort. We envision a process of disciplinary workshops that will help define and direct this effort. The task of digital data management for the Earth Sciences is large, and clearly transcends the objectives of Earthscope. However, an alliance with Earthscope may help focus initial development of an Earth Science Information System. Our workshop participants, with their broad interests in geological sciences, are willing to help with the implementation of these workshops.

2. Maximize the science benefit to EARTHSCOPE through a parallel initiative in TECTONICS

After presentations by Clark Burchfiel and Karl Karlstrom on the impact of Earthscope on the geologic community, workshop participants agreed that we must urgently craft a comprehensive science plan to enhance research opportunities in tectonics allied with the goals of Earthscope. A new dimension in multidisciplinary research in earth science is already upon us, yet we continue to also see the value of single investigator projects. Earthscope seems to offer an opportunity to bring together a wide range of types and scales of research in the context of understanding the lithospheric evolution of North America. However, we agreed that the scientific agenda for use of this new facility will need new funding, will need to involve many subdisciplines and researchers, and will need to be based on open proposal competition.

In an effort to participate in creating a science plan that identifies scientific opportunities for all fields of geoscience as important adjuncts to Earthscope, we discussed ways that Earthscope might have the largest scientific impact. First, the frontiers of research in geosciences will always be dominated by questions related to processes that modify the earth, requiring the need to craft a " Process" dimension to Earthscope. Second, Earthscope needs a "Time " dimension that maximizes our understanding of earth history to help understand current and future changes in earth systems. To merge these two, we request that NSF consider an initiative on "Processes of Continental Construction through Time". A commitment of new resources could provide the community a window of opportunity to truly create a Digital Earth in 4-D (including time). Such an initiative would provide and allow the U.S.Array program within Earthscope, the opportunity to recast the traditional 3-D images into an evolutionary model for the construction of the lithosphere within North America. The obvious benefits are too many to list in this summary document, but there is little doubt that studies related to defining the architecture of continents must include the element of time and processes, as provided by either individual investigators or multidisciplinary projects within the geologic community. This "GEOLOGIC ARRAY" seems to be in accord with the goals (but perhaps not the funding structure) of the U.S.Array initiative. We would like to work closely with NSF to integrate our broader goals and methods with the Earthscope initiative. We see a need to have national and regional workshops to help define the scientific goals and plans as U.S. Array moves from region to region. We are willing to actively help in defining the strategic planning for such an initiative.

On behalf of the Tectonics community, we encourage the National Science Foundation to consider our suggestions in its strategic long term planning. Our recommendation is based on the unprecedented opportunity for the community to make critical links between tectonics past and present, with issues related to geologic hazards and resources. We need these links and new understanding to make appropriate policy decisions in the future. We are willing to provide the community support necessary for the successful implementation of projects that have the potential to reshape earth sciences for the near future.

Report submitted by members of the Workshop on Future Research and Growth Opportunities in Tectonics

A.K. Sinha *(Convenor),* ***M.L. Crawford*** *(Convenor)*
R.D. Hatcher, C. Burchfiel, K. Karlstrom, R. Dokka, J. Selverstone, M. Steiner, R. Van Schmus, M. Rusmore, J. Valley, D. Fisher, L. Goodwin, and D.Wiltschko

GSA Structural Geology and Tectonics Management Board Minutes

Denver, Colorado - October 26, 1999

Board members present: Vicki Hansen (past-Chair), Steve Marshak (Chair), Jane Selverstone (1st Vice Chair), Christian Teyssier (2nd Vice Chair), Laurel Goodwin (2nd Vice Chair-elect), Charlie Onasch (Secretary/Treasurer)
Guests: Krisha Sinha (former NSF panel member), Mary Hubbard, Barbara John (Co-editors, SG&T Newsletter)

1. Budget – The income was $9,000, expenses were $6,898.34 leaving a net income of $2,101.66. With the carryover from last year of $9,109.72, we have a net balance of $11,211.38. Discussion followed on how to better publicize the student grants for field trips and short courses that would help lower the large carryover.

2. Membership – the membership was up by 3 from last year giving a total of 1,504. The division continues to be the largest in GSA.

3. GSA Division Chairs Meeting (Jane and Laurel)

a. GSA recognizes the problem with the two-year dues option leaving out division dues for the second year. They will send a mailing correcting the problem.

b. GSA is joining with AGU to sponsor the Spring 2000 AGU meeting and the 2000 annual GSA meeting. GSA will also jointly sponsor the 2001 meeting in Edinburgh with the Geological Society of London.

c. GSA asked division chairs for nominees for the seat on the GSA council. One representative will be elected from all divisions combined.

d. GSA asked chairs to inform their membership about a rebate program with Barnesandnoble.com. If members link to the book sites through the GSA site, GSA will receive 7% of any purchases.

e. GSA wants more proposals for Pardee symposia, theme sessions, and topical sessions. They are due January 10, 2000.

f. The division was asked to recommend someone to serve as the Precambrian geology representative on the JTPC.

4. Committee of present and past NSF Tectonics panel members (Krishna Sinha) – Krishna explained the history of the committee and its purpose to develop a plan for future research directions in the tectonics community. The majority of the discussion centered on the recent EarthScope initiative, and how the tectonics community can take advantage of the resources and research opportunities. The importance of involving the entire geological community, not just tectonics, was stressed. The committee reached a consensus that they should propose a 10-year program that will provide the science framework for the EarthScope initiative. Krishna will draft a four-page paper that will ultimately go to NSF with the signatures of all panel members in each Geoscience program.

5. National Meeting – Discussion focused on how to generate more interest in the membership at national meetings. Possibilities include more Pardee symposia, linked sessions (meeting within a meeting), general call to membership for more suggestions for session topics, symposia, and field trips.

6. Short courses for 2000 meeting – Two short courses have bee proposed for next year's meeting – "Earthquake Science and Paleoseismology" (Charlie Rubin, Doug Yule, and Doug Rockwell) and "Fluid Flow and Fault Zones" (Jim Evans, Jonathan Caine, and Craig Foster).

Charlie Onasch
SG&T Secretary and Treasurer

RESOURCE BIN

* **Stereonet 6 (Beta)** by Rick Allmendinger is now available on his ftp site (see below) for free downloading (non-commercial use only). This version works only on PowerPC based computers running MacOS 8.1 or later, including MacOS 9. The program has a new interface, is much faster, and corrects a widely reported problem saving PICT files to disk in previous versions (which is actually an extension conflict). In addition, new functionality includes the ability to draw contour lines as continuous polygons rather than painted patterns, plots that can now be set to any size, the ability to plot a light gray grid in 2 or 10 degree increments as a back drop, increased resolution of the contouring grid, rose diagrams with variable petal sizes, etc. The old version will continue to be available at the same web site for those whose computers do not meet the above system requirements. Look for Stereonet 6 in the following directory:

ftp://www.geo.cornell.edu/pub/rwa/Stereonet/

* Scott Wilkerson notes a shareware program, ***'EarthBrowser'***. It is an application/screen saver for the Macintosh that features a spinning earth with the ability to post several things on it that are downloaded from the Internet: a "real-time" day/night shadow (updates every 5 minutes, not from Internet), cloud cover and weather (updates hourly), recent earthquakes (updates "many times a day as needed"), recent volcanic eruptions (updates "fairly often"), and a few other items as well. It is $19.95 for a single copy; site licenses are available too.

Their web page is: http://www.earthbrowser.com/

4

On January 16, 2000, NSF announced that Dr. Herman Zimmerman had been selected as the permanent Earth Sciences Division Director. Dr Zimmerman was instrumental in organizing efforts to prepare a new initiative called "Earthscope" while he was acting Division Director. That initiative has been discussed at several meetings, including last fall's GSA, but as it is a relatively new, fast moving, and potentially large initiative, interested structure and tectonics folk should try to keep informed about developments. One good way of doing so would be to call up the website (www.earthscope.org). As of this writing, the NSF Board has blessed it, but whether or not it will be in the President's request to Congress, and what Congress will do, will not be known for some time.

Meanwhile, a related idea has received attention. Dr Krishna Sinh coordinated a group at GSA that produced a report titled "Future research and growth opportunities in tectonics and earth sciences" that focused on establishing a geoscience data facility based on an open, GIS data system that serves all of the earth sciences including the earthscope needs. Still in the discussion stage, this has an exciting possibility to give the research community much greater and easier access to all sorts of data and data management techniques, but there are many issues that need to be sorted out. Clearly, input from everyone is needed, and there will be a number of workshops devoted to thinking this through. Stay tuned to this development; it may significantly improve our ability to utilize the huge and growing volume of data available to us.

'*Fastlane*' continues to develop, and the best way to keep up with the changes is to consult the NSF website for updates. It is a good idea to check this site (www.nsf.gov) before submitting proposals for the June 1 deadline.

The Tectonics program received 107 proposals for the December 1 deadline, up considerably from the 70 last time. As the program still is shorthanded (I'm it), it is even more important than usual for people to respond promptly when asked to reviewer proposals for us. I'm working on reading and assigning reviewers, but some requests for reviews are going to be sent out later than I'd like. Now that Dr. Zimmerman is the Earth Sciences Division Director, I expect that we will be able to offer a "rotatorship" in tectonics very soon. Please let us know if you or anyone you know might be attracted to a stint "inside the beltway".

The following awards were finalized since the last newsletter....Congratulations!

--Tom Wright
Program Director, Tectonics
Earth Sciences Division
National Science Foundation

Tectonics Awards for July 1, 1999 - January 1, 2000

Prop ID	P.I.	Institution	Title
9909559	Davis	SUNY Stony Brook	Theoretical and Modeling Studies of Strain Partitioning
9909568	Kohn	U of SC Columbia	Constraints on Miocene Uplift of the Central Cascade Range, Oregon
9909575	Willett	U of Washington	Collaborative Research: The Thermo-Kinematic Evolution of the Taiwan Mountain Belt
9944147	Williams	U of Massachusetts Amherst	Processes of Folding and Cleavage Development and the Use of Compositional Imaging in Fabric Analysis
9909638	Wiltschko	Texas A&M Research Fdn	Collaborative Research: The Thermo-Kinematic Evolution of the Taiwan Mountain Belt
9909120	Samson	Syracuse University	Paleogeography of the Carolina Terrane: Constraints from Detrital Zircon Ages
9909150	Patchett	U of Arizona	Nd Isotopes and Geochemistry of North American Cratonic Sequences: Constraints on Dynamic Topography
9909697	Boundy	Ball State University	RUI: Deep Crustal Earthquakes and Metamorphic Phase Transitions: Direct Observations from Exposed Fault Systems in Western Norway
9909699	Fisher	PA St U University Park	Collaborative Research: Active Out-of-Sequence Thrusting in the Fila Costena Thrust Belt, Pacific Costa Rica
9909210	Roden-Tice	SUNY Plattsburgh	Thermochronologic Evidence Linking the Adirondack and Connecticut Valley Regions of Post-Early Cretaceous Unroofing
9980535	Phillips	NM Inst of Mining & Tech	Cosmogenic Nuclides Applied to Fault-Scarp Dating

Tectonics Awards for July 1, 1999 - January 1, 2000 *(continued)*

Prop ID	P.I.	Institution	Title
9909231	Van der Voo	University of Michigan	The Main Tectonic Junction of Asia: A Paleomagnetic and Structural Study of Kazakhstan
9909260	Frost	University of Wyoming	Late Archean Crustal Evolution of the Southern Wyoming Province
9909293	Sahagian	U of New Hampshire	Lava Flow Vesicle Distributions as a Tool for Determining Paleo-Elevation: Application to Timing of Uplift of the Colorado Plateau and Adjacent Rocky Mountains
9980623	Bowring	MIT	Collaborative Research: Rates of Processes in the Mid-to Deep Crust of Arcs: A Case Study from the Cretaceous Cascades Arc
9944335	Wernicke	California Inst of Tech	Studies of Large-Magnitude Intracontinental Extensional Tectonism in the Basin and Range, California and Nevada
9980662	Miller	San Jose State Univ Fdn	Collaborative Research: Rates of Processes in the Mid-to Deep Crust of Arcs: A Case Study from the Cretaceous Cascades Arc
0040083	Hollister	Princeton University	Tectonometamorphic Evolution of the Greater Himalayan Sequence of Bhutan
9909375	Gardner	Trinity University	Collaborative Research: Active Out-of-Sequence Thrusting in the Fila Costena Thrust Belt, Pacific Costa Rica
9814373	Tucker	Washington University	Neoproterozoic Crust Formation and Terrane Suturing in the East African Orogen: Geological, Geochemical, and Geochronological Investigations in Madagascar
9909410	Wintsch	Indiana U Bloomington	Identifying Multiple Thermal Events in Polymetamorphic Rocks: Electron and Ion Microprobe Analysis of Complexly Zoned Titanite
9909421	Williams	U of Massachusetts Amherst	Timing of Proterozoic Tectonics in Southwestern North America: The Use of Microprobe Dating and Age Mapping for Constraining P-T-t-D Histories
9909453	Wernicke	California Inst of Tech	Timing of Incision of the Salmon River, West-Central Idaho, Using (U-Th)/He Analysis of Apatites
9909457	Hollister	Princeton University	Testing Models of Polyphase Tectonism in Northern New Mexico and Characterizing the ~1.4 Ga Tectonic Setting of the Southwest U.S.
9909459	Cameron	U of Cal Santa Cruz	Did Eastern Mexico and the Eastern Margin of Laurentia Collide during the Grenvillian Orogeny?
9909464	Fisher	PA St U University Park	Collaborative Research: The Thermo-Kinematic Evolution of the Taiwan Mountian Belt
9944018	Isacks	Cornell University-Endowed	Interferometric SAR Measurements of Seismic and Inter-Seismic Strain Near a Major Seismic Gap in the Peru-Chile Convergent Plate Boundary

Active Tectonics Awards for July 1, 1999 - January 1, 2000

Prop ID	P.I.	Institution	Title
9909638	Wiltschko	Texas A&M Research Fdn	Collaborative Research: The Thermo-Kinematic Evolution of the Taiwan Mountain Belt
9972915	Burgmann	U of Cal Berkeley	COLLABORATIVE RESEARCH: Structural, Kinematic, and Dynamic Segmentation of the Himalayan Frontal Fault System, NW India
9972955	Wesnousky	U of Nevada Reno	COLLABORATIVE RESEARCH: Structural, Kinematic, and Dynamic Segmentation of the Himalayan Frontal Fault System, NW India
9902730	Marshak	U of Ill Urbana-Champaign	Tectonics of the Aracuai/Ribeira Orogenic Tongue of Southeastern Brazil, and its Significance for the Paleo- and Neoproterozoic Assembly of West Gondwana
9814373	Tucker	Washington University	Neoproterozoic Crust Formation and Terrane Suturing in the East African Orogen: Geological, Geochemical, and Geochronological Investigations in Madagascar
9903081	Bilham	U of Colorado Boulder	COLLABORATIVE RESEARCH: Structural, Kinematic, and Dynamic Segmentation of the Himalayan Frontal Fault System, NW India
9903144	Rockwell	San Diego State Univ Fdn	COLLABORATIVE RESEARCH: Structural, Kinematic and Dynamic Segmentation of the Himalayan Frontal Fault System, NW India
9903200	Schweickert	U of Nevada Reno	Processes of Active Deformation and Slip Transfer Along the Sierra Nevada-Great Basin Boundary Zone in the Lake Tahoe Basin
9526506	Umhoefer	Northern Arizona Univ	RUI: COLLABORATIVE RESEARCH: Active Tectonics of a Young Oblique-Rifted Continental Margin, Loreto Area, Baja California Sur, Mexico
9909464	Fisher	PA St U University Park	Collaborative Research: The Thermo-Kinematic Evolution of the Taiwan Mountain Belt
9909575	Willett	U of Washington	Collaborative Research: The Thermo-Kinematic Evolution of the Taiwan Mountain Belt

MEMORIAL TO PERRY L. EHLIG

Dr. Perry L. Ehlig, professor emeritus of geology at California State University, Los Angles (CSULA) died unexpectedly December 26, 1999. He served the students of CSULA continuously since 1956. He retired in 1992, but continued to teach and guide theses voluntarily.

Perry was a real friend, colleague, mentor, and professor to many working geologists in southern California. His generosity to students and community was extraordinary. During his stints teaching the summer field course, he paid the students' tuition. Even I was a beneficiary of Perry's generosity when he paid over $1000 for whole-rock chemical analyses related to my M.S. thesis. He was insturmental in mitigating the Portuguese Bend and related landslides in southern California's Palos Verdes Peninsula, for the city of Rancho Palos Verdes, mostly *pro bono* since 1956. Where contractual agreements dictated that he be paid, Perry immediately signed the check over to a scholarship fund for students in the CSULA Geology department.

Perry contributed much to our understanding of the tectonic development of southern California, and to its landslide hazard and mitigation. He had over 40 scientific papers published that discussed the basement rock terranes of the Transverse Ranges, palinspastic reconstruction of the southern San Andreas fault, and the Portuguese Bend landslide.

Many of us will remember Perry for his unquestionable ability to beat everyone to the top of the mountain - and back down it again as well ! He made geology a wonderful adventure to us all. He will be greatly missed by everyone lucky enough to have known him, and most of all by his family.

R. Forrest Hopson
Thousand Oaks, California

Geological Society of America
Structural Geology and Tectonics Division 1999 Best Paper Award

Susan H. Treagus & Richard J. Lisle

Citation by Steven Wojtal

It is a distinct pleasure to announce the winners of this year's Structure & Tectonics Division Best Paper Award - Sue Treagus and Richard Lisle for their 1997 *Journal of Structural Geology* paper entitled '**Do principal surfaces of stress and strain always exist ?**'

As you might gather from the rhetorical question that is the title of the paper, the answer is no, principal surfaces do not always exist. To clarify this statement, principal trajectories of stress or strain exist at all points in any continuous deformation, but there need not be families of continuous surfaces that are normal to these families of curving trajectories. Sue & Richard show that whether principal surfaces are definable or not depends on the geometric properties of the principal trajectories. Taking $\mathbf{v}$ to represent a principal trajectory vector field, continuous principal surfaces will exist only if the **abnormality A** -

$$\mathbf{A} = \mathbf{v} \bullet \text{curl } \mathbf{v} = 0$$

If the **abnormality** of the vector field is non-zero, then one cannot define principal surfaces. For this insight and to prove this assertion, Sue and Richard drew on previous work by Mandl (1987) and earlier work from the mechanics literature. For those who are less mathematically confident, and to generalize this approach to settings where we cannot define analytically the geometry of the principal trajectories, Sue and Richard presented an alternative way to test the properties of those trajectories – a geometric construction called the **continuity loop**.

The bulk of the paper is a thoughtful and thought-provoking examination of a series of common, general three-dimensional deformations. For example, they show that principal surfaces

- regularly exist in three dimensional inflation,
- exist in strain refraction across layers with varying viscosities only under certain restrictive conditions,
- exist in three dimensional general deformation zones only under restrictive conditions, and
- do not exist around fracture tips subjected to torsion.

They end the paper with brief but instructive discussion of natural examples of these general deformation types. Of particular interest is their discussion of criteria by which we might determine if fabric surfaces are, in fact, truly continuous surfaces.

The paper addresses an issue fundamental to all of us who study the deformation of earth materials. The range of topics it considers – fracturing, faulting, folding, cleavage formation, and deformation zones - is broad. For all of its reach, the paper is profoundly deep. The points made in this paper have fundamental implications for anyone analyzing and modeling any of these features in three dimensions. I recommend this paper to theoreticians and field geologists alike.

Response by Susan H. Treagus & Richard J. Lisle

(Read by Susan H. Treagus)

Thank you, Steve, for your tribute. We are both thrilled to receive this award in America from the Structure & Tectonics Division, and moved by the open-mindedness of your panelists in choosing a rather idiosyncratic paper by a couple of Brits. We feel truly honoured. Whatever the topic, we authors always wonder whether our papers will be read, or even noticed at all. While writing this one, our first joint effort, we began to realise that it *might* create some kind of reaction. Would it upset structural geologists who had, perhaps, imagined that principal surfaces of stress and strain could *always* be drawn in space? (As we had once assumed.) How widely should we paint the geological implications? Might there be a strong reaction (against) from the various groups working on fracture continuity? (In fact, no: there was more or less silence, except for a friend in this audience, who light-heartedly pronounced it "nonsense" - from our title alone. Thankfully, not the view of the whole Division!) We are overwhelmed by *this* reaction (an award),- and your enthusiastic citation, Steve.

Let me say something on how this paper came about. This was no routine research paper, the end product of funded research (a paper that *had* to be written to satisfy the HOD, NERC, NSF, etc.). Quite the contrary. Richard *did* have a nice piece of research (if I may say so) going on in 1994, with all the right credentials in today's academic environment: industry-sponsored, bringing money into his department, possible implications for the oil industry, etc. This concerned curvature of surfaces, and his rediscovery of an intriguing theorem from 1813 by Dupin. When applied to principal surfaces, this seemed to be saying that principal axes could be determined from the curvature geometry. Richard brought me in, hoping to unite these concepts with mine on stress and strain refraction in two and three dimensions. But even back then, there was something not quite adding up: we weren't clear what. In the meantime, Richard gave a talk about the Dupin theorem at the Leeds TSG meeting in December 1994. It was here that Peter Hudleston asked a perceptive but devastating question: Are you aware that there may not always be definable principal surfaces? - see Mandl, *JSG Brevia*, 1987. George Mandl's short paper on discontinuous fault zones presents proof that for some stress fields continuous smooth principal surfaces (and therefore fracture surfaces) cannot be defined. Peter Hudleston had actually edited that paper, but I should certainly have remembered it - if only for its rather rough ride to eventual publication. But we were probably not alone, in 1994, in not realising its importance. Peter's question, and Mandl's paper, were the two trigger events that partly unravelled Richard's curvature research, but paved the way for the paper we are talking about, today: a paper that actually required no substantial research grant or expensive equipment, just time, thought and paper!

So Richard and I joined forces properly, and spent a couple of years back and forth, chewing over various things, and what had already been written: Mandl's paper, Love in the 1920s, (not that kind of love), and back another 50 yrs to Boussinesq (1872). We grappled with vector mathematics, but we also tried to think of a simple geometric test. The *continuity loop* seemed too simple to be true, and the idea was inspired by figure 9 in Robin & Cruden (1994 - *JSG* again, we're afraid). We then wondered how bold to be in arm-waving the geological implications for fabrics and fractures.

We cannot claim to have 'invented' the idea that principal surfaces are undefinable for certain types of 3D deformations. What we have done, we hope, is to broadcast these concepts a little more widely to structural geologists. We hope the prominence you are giving to our paper, today, will lead a few more people back to Mandl's 1987 paper, and then to consider whatwe have written not only in terms of relevance to strain and fabric patters, but also to segmented fractures. And finally, without venturing too far into advertising, I would personally like to mention *JSG*. For many years this was my geological existence, and it provided me with professional companions who have become good friends. This family-like environment led to collaborations beyond editing into research, blossoming into occasional papers such as this one. Thank you GSA, from both of us, for making it this year's Best Paper Award.

Geological Society of America
Structural Geology and Tectonics Division 1999 Career Contribution Award

Hans Peter Laubscher

Citation by Robert D. Hatcher, Jr.

It is both a pleasure and an honor for me to present to you this millennium's last recipient of the GSA Structural Geology and Tectonics Division Career Contribution Award—Professor Hans Peter Laubscher. I have had the pleasure of knowing Hans for more than two decades; I first met him in 1978 at one of the Penrose Conferences we held at Helen, Georgia, in the southern Appalachians. Helen is billed as the "Swiss Alpine village of the Blue Ridge." We had several Swiss at that meeting and none were able to see any similarities. On a field trip following the conference, with numerous opportunities to sample southern cuisine, Hans learned that he did not like the southern delicacy called country ham—an obvious discriminating taste that we both share.

Hans was born near Basel, Switzerland, and was brought up with a love of the outdoors. He discovered geology as many of us do after he entered the University of Basel and decided that there could be no better profession for someone who loved the out of doors. He received all of his university education at the University of Basel, completing the Ph.D. there in 1947, and conducting his research in an area where the Jura Mountains and Rhine graben interacted with each other. From 1948 until 1958 he worked for what is now Mobil Oil Company in Venezuela as a field geologist, a seismic interpreter, and then as a staff geologist. Here was loosed a fertile mind in a tectonically interesting region, where he also was able to discuss his embryonic ideas on material balance with mathematicians and petroleum engineers. These ideas were brought out in his early papers, but were perhaps best developed in some of his late 1980s papers on 3D material balance in the Alpine lithosphere.

In 1958 he returned to the University of Basel to work as a young faculty member in the Institute of Geology and Paleontology, becoming professor and head of the institute in 1966, where he remained until his retirement in 1989. He was a visiting professor of geology at the University of Illinois (1963-64) and has been a consultant in petroleum exporation, seismic hazard assessment, and radioactive waste disposal. He has since his "retirement" worked with the Swiss Geological Survey in computer-assisted analysis and synthesis of previously mapped areas, which permits him to spend time in the field checking and remapping problem areas. Hans is a member of the GSA, the AGU, AAPG, SSA, and a number of European geological societies including the Geologische Vereinigung, the Swiss Geological Society, and the new European Union of Geoscientists, and has been a recipient of the highest awards and medals of several of these organizations.

We know Professor Laubscher's work in numerous papers on the Jura and Alps, particularly several that establish basement controls and influence on thin-skinned structure developed in the cover rocks. He has also published important papers on the Venezuelan Andes and the Rhine graben. His 1962 *Ecolgae Geologicae Helvetica* paper on Die Zweiphasenhypothese der Jurafaltung established him as one of the modern fathers of section balancing, and, in his 1988 GSA *Bulletin* paper, he extended balancing concepts to the third dimension of the Alpine lithosphere. He is also the father of the concept of the "tectonic lid," introducing that in a paper in a 1983 GSA Memoir.

Hans Laubscher is truly one of the great geologists of our time. It would be unfair to describe him as one of the "grand old men of geology;" it is better to think of him as one who has generated great ideas and we anticipate the appearance of his next great idea. If nothing else, perhaps we should anticipate an improvement on Hans' description of crustal balancing as being no more than "semiquantitative considerations of material balance." I present to you, our Society and Division, the 1999 recipient of the GSA SG & T Division Career Contribution Award: Hans Peter Laubscher, monumental scientist and honorable man.

Response by Hans Laubscher

Thank you, Bob, for your very generous words. Surely, nobody has been more surprised than I myself at learning to have been elected for this year's Career Contribution Award. After my retirement 10 years ago, I felt like fading out of international enterprises. I concentrated on remapping the Jura south of Basel, publishing little, and then mainly in German for local consumption.

There is a time in life when you expand, and then there is a time when you contract again. My drawers are full of unfinished work. I had to decide on priorities. For various reasons, the Jura maps made the top of the list. One of the reasons is that as a young man I had been an enthusiastic hiker, mountaineer, and admirer of nature generally. Botany was my first love.

While passing the final exams of my classical high school and wondering what I should do at the University, I read by chance about the adventures of a petroleum geologist in Borneo. Outdoors work, traveling, observing nature- a dream profession I had not known to exist. My decision was made. Decades ago Bill Brace told me that was the Boy Scout Approach to Geology.

In the course of my studies, and particularly when working on my dissertation, I also found that geology presented those challenges to powers of observation, of inference, of combination and last, but not least, of imagination a young mind craves.

In 1948, I began work for Mobil, then Socony-Vaccuum Oil Co., in Venezuela. My first assignment was that of a junior field geologist west of Lake Maracaibo, at that time still a wild jungle. The other members of the party were true professionals. We followed the rivers, making maps based on aerial photos and plane table measurements. I myself in addition collected plants and snake hides, which earned me the comment: "Hans, you are not a geologist, you are a naturalist".

It was not going unnoticed, however, that I also studied mathematical texts, and because in many other ways I was not the typical American Boy who easily fit into the party but a crazy Swiss, it was decided to put me into geophysics.

I worked for almost ten years in the Geophysics Department of Socony and after having missed the outdoors in the beginning, I began to like it more and more. I studied the physics of seismic wave propagation and similar things in my free time and found in the combination of clean physics and dirty geology a truly rewarding field of action.

It took, however, not too long for me to realize that the earth was hopelessly chaotic, and that it had to be simplified almost beyond recognition to make it tractable by physical theory. This was before the arrival of computers in the earth sciences, but the problem remains even in these times of massively parallel computing. In discussions with reservoir engineers, I realized that material balance was that fundamental quantity that most effectively constrained kinematic l reconstructions.

As to data and "facts", the lesson that most impressed me was the grading of geophysical data- good, passing or poor. We used only these three categories in an infinity of shades. And it was fun and frustration at the same time to realize how much subjective experience and intellectual temperament entered the game even at this early stage.

After ten years of oil finding in Venezuela, I returned to the University of Basel in Switzerland. I had acquired, by then, a wife and four children. The question of how to bring them up became more urgent by the day. I therefore accepted, after some reluctance, because I liked my job- an invitation by my old professor to join his staff with a view to succeeding him.

Basel is that Swiss city farthest away from the Alps in a geographical sense. Indeed people have maliciously noted that the Basel institute is the only one in Switzerland from which the Alps may not be seen. However, Basel has one great advantage. It lies at a point where contractional features such as the Jura join extensional ones such as the Rhine graben and its flanking elevations, the Vosges and the Black Forest. Working out the relationships of these apparently discrepant units presents quite a challenge, and for more than one hundred years people have been debating them. Fundamental data were lacking until quite recently: It is possible only now to correlate events, as Tertiary stratigraphy has been refined by the study of mouse teeth, and events outside datable sediments have been more and more closely pinpointed by geochronology. It turns out that Basel is in the midst of Alpine structures- they are all an expression of the Africa-Europa plate collision. But don't expect that everybody agrees.

When more than a hundred years ago the railroad connection between the northern and the southern foreland of the Alps was built, geologists from the Universities of the Upper Rhine graben began to discover the Southern Alps. Ever since, the Southern Alps have been a domain for research based in Basel. When I returned to Basel in 1958, I first met Daniel Bernoulli who was working on his thesis in the Southern Alps. After a stint with Shell in the Mediterranean ranges, he returned to Basel, and fruitful collaboration of almost two decades was the result. Daniel not only helped in unraveling what is now considered the complex Africa-Europa plate boundary zone. He, together with Hans Peter Luterbacher realized that the Mesozoic sediments drilled in the central Atlantic closely correlated with those in the Apennines. This was an important milestone in concretizing the Plate Tectonics concept.

Plate Tectonics had become an article of faith for me in 1963, even before the term had been coined and the concept formulated, after I had talked to Runcorn about the newest results in paleomagnetism on my way to Urbana, where I spent the academic year 1963/64 as a visitor, teaching geophysics. The ophiolites which I had pursued in the Zermatt Alps with my teacher and friend Peter Bearth in the late 1940s became the oceanic crust, of the Piemonte ocean separating the sediments of the African margin as seen in the Southern Alps from those of the European margin as seen in the Helvetic Alps. Today this seems almost self-evident, but in the 1960s, you had to find that Alpine geologist that did not sneer at such outlandish ideas.

Of course it turns out that this simple concept does not do full justice to the truly chaotic nature of the earth in general and the Africa-Europa boundary in particular. The work of the French in the Aegean basin revealed subduction roll-back with extreme crustal extension and block rotations at the splintered margins. This for me was a fundamental addition to the general concept of Plate Tectonics, similar to the metamorphic core complexes, the first glimpses of which I owe to Greg Davis. In 1976 he showed me those then puzzling outcrops on a marvelous field trip into the desert.

Subduction-related processes began to intrigue me from those early days on when Peter Bearth showed me the eclogitic pillow lavas in the Zermatt area, with their colorful red and green rims. The mechanisms and thermodynamics of deep subduction and later exhumation of surface rocks is still a fundamental issue in tectonics. As far as I see, the jury is still out on this.

In teaching quantitative tectonics I concentrated, after the most fundamental introduction into geodynamics, on aspects of material balance, first in the Jura and then in the Alps. One of the main challenges therein was the decision of how and how much to simplify the system.

From early on, kinematics in 3d seized my imagination. It was conceived as an exercise in material balance in 3d, and as a time series with changing configurations. Beginning in the Jura and expanding into the arc of the Western Alps and its join with the Apennines and then continuing into the Southern Alps and other areas of the Alpine-Mediterranean system, and finally into some features in the Americas, particularly the northwestern corner of South America.

I have contracted now and returned to mapping and 3D kinematics in the Jura, and my time is fully taken care of. For the rest, of the many exciting things that are going on in tectonics, I am a mere spectator, applauding here, and frowning there. New fascinating perspectives are opening all the time, and old absurdities continue to surface.

Let me end by expressing my gratitude to the many people who have helped me in my career. There was, of course, my mother, widowed when I was two years old, there are the teachers, colleagues, friends and students. There is in particular my wife who shared the career and burdened herself graciously with the not always easy life of a geologist's wife, and who enriched my own life with her sense of the beautiful and her own quest for truth. And last not least I am indebted to you of the Structural Geology and Tectonics division of GSA who have so generously honored this career with your reward.

Theme Session Summary

Faulting and Folding: Crossing the Divide between 2-D and 3-D

Conveners: M. Scott Wilkerson and John Byrd

This session was convened to provide a forum where researchers in various tectonic settings could meet and discuss recent advances in the depiction, restoration, and modeling of fault-related folds in three dimensions. Presenters in the Monday afternoon poster session and in the Tuesday oral session provided numerous examples of 3-D geometric, kinematic, and/or dynamic analyses of fault-related folds using 2-D/3-D seismic, detailed field mapping, physical modeling, and/or computer modeling.

The Monday afternoon poster session was well attended and highlighted a series of presentations on new techniques, concepts, applications and links between 2-D and 3-D structural analysis and modeling. **Meigs et al.** illustrated the contribution of growth strata geometry in constraining fold development, and the sensitivities and problems associated when data were projected without proper consideration of axial plunge. **Brewer and Thomas** used a series of cross sections to document variations in structural style, frontal-ramp terminations, and 3-D transfer geometries across the Bessemer Transverse Zone in the Appalachians. **Jusczuk et al.** showed how restoration of dip sections across the Ouachita Mountains produced a volume-surplus that implied oblique translation across the thrust belt, and how this was consistent with variations in structural style along-strike. **Thomas and Bayona** presented palinspastic map and cross-section restorations of a series of lateral thrust ramps utilizing points, lines, and planes of reference. **Willsey and Umhoefer** interpreted disparities in topography, detailed field mapping, clay model results, and a series of cross sections to decipher variations in "structural-activity" and geometry along the Loreto rift segment in Baja, California. **Ahlgren and Swanberg** investigated a "soft-link" between two oppositely-verging Laramide uplifts and correlated macro- and meso-scale strain data from the field with 3-D structural models. **Riedel and Cooke** studied the density and orientation of fractures and deformation bands around Sheep Mountain anticline, and concluded that mechanical stratigraphy and structural position control fracture patterns. **Maschmeyer et al.** interpreted changes in joint and shear fracture orientations around the nose of Sheep Mountain anticline as indications of rotation and uplift of strata associated with fault propagation. **Faulds** integrated detailed field mapping, structural analysis, and paleomagnetic data to demonstrate the 3-D relationship of extensional fault-related folds to overlap and dip reversals of normal faults; a relationship that is not clearly demonstrated from a purely 2-D analysis. **Lisle** exposed the disconnect between 2-D descriptors of fold geometry and natural non-cylindrical folds. He proposed adopting the concepts of the differential geometry of curved surfaces and the use of a curvature tensor to describe folded surfaces. **Yin and Groshong** elucidated the complexity and ambiguity of 2-D representations of salt-piercement structures in a series of robust 3-D kinematic models and balanced cross sections. **Hedlund et al.** demonstrated computer workstation techniques for interpretation of 2-D and 3-D seismic data and the implications on fault-related fold models. **Seitz and Weldon** documented multiple paleo-seismic events by applying line-length preservation and variable limb rotation techniques to restore meso-scale folds exposed in a trench-excavation across the San Andreas Fault. **Byrd** presented a kinematic model of symmetrical buckle folds with implications for growth stratal geometries and the onset of diapirism. **Ormand and Hudleston** illustrated results of physical-analogue experiments investigating variations in backthrust and tension fracture geometries associated with changes in lateral ramp geometries. **Ribeiro et al.** integrated field data and 3-D physical and geometrical models to evaluate thrust morphology. Their modeling tested four boundary conditions and led to the conclusion that detachment shape and friction were the principal controls on 3-D thrust-geometry. **Cristallini and Allmendinger** presented a pseudo-3-D trishear fault propagation fold model that allowed along-strike variations in model parameters, calculated volume and surface areas, and possessed an asymmetric tri-shear zone. **Strayer et al.** unfolded a series of "map-scale" anticlines with a variety of flattening methods by characterizing the surfaces as irregular triangulated meshes. Their technique reassembled the flattened surfaces with a least-squares best-fit, block packing method and included the ability of calculating surface strains. **Landau and Mueller** demonstrated a link between subsurface geometries and geomorphic indices to determine the location of fault tips beneath the active Los Lobos and San Emigdio folds in the southern San Joaquin Valley.

THEME SESSION SUMMARY

The Tuesday morning oral session began with a nice review of 2-D structural analysis tools and a look at recent advances in 3-D seismic interpretation, visualization, and restoration by **Charles Kluth**. Kluth's paper was followed by papers by **Griffiths et al.** and **Ratliff et al.**, that looked at new techniques for constructing and restoring 2-D cross sections and 3-D surfaces. **Griffiths et al.** showed the audience how to construct a slip system with a triangulated mesh that could restore 3-D surfaces to a target surface geometry. **Ratliff et al.** sought to break free from the standard techniques of surface projection with a "complex geometry" algorithm that utilized multiple layers and a mix of deformation models to more accurately model the change in folding styles dictated by mechanical contrasts in lithologies in natural structures. We then saw a series of papers that utilized physical modeling to simulate natural structures. **Dixon and Spratt** demonstrated that complex geometries develop as two thrust faults propagate toward each other. Specifically, lateral ramps or tear faults were unstable in their models suggesting that these features may not be very common in laterally uniform strata, but rather may require a significant heterogeneity in the strata to form and be preserved in the rock record. **Aydemir and Dixon** examined 2-D bed-

continued from page 11

ding strain in physical models by using x-rays to pinpoint galena markers before and after deformation. They saw that systematic variations in the bedding plane strain depended on structural position along the fold and on proximity to the fault. **Venkat-Ramani and Tikoff** investigated strains associated with transtensional folding. They showed how model transtensional folds developed and evolved and demonstrated why one cannot infer the maximum shortening direction from the orientation of the axial planes of the transtensional folds. **Le Calvez and Vendeville** illustrated the development and interaction between faults in and around normal fault relay zones. An important control on the resultant fault geometries in their models was fault spacing relative to overburden thickness. **Medwedeff and Krantz** used physical and kinematic models to simulate deformation over a 3-D listric extensional ramp. Their analog models employed a weak fault zone relative to the strength of the hanging-wall strata. They saw non-parallel displacements that bent towards the strike of the oblique ramp segment and were able to quantitatively describe the deformation using an "oblique-inclined shear" model. **Alkmim et al.** used physical and computer models to simulate the Neoproterozoic Dom Bosco thrust system. They show how curved faults can be developed in strata with laterally varying thicknesses. **Wilkerson and Apotria** used pseudo-3-D computer models to show that criteria commonly cited as evidence for lateral ramps at contractional fault-related fold terminations were not unique. They also suggested ways of constraining interpretations of the mechanism that causes such fold terminations. **Burbank et al.** studied excellent exposures of growth strata above two folds in Spain in order to back out their spatial and temporal development. They showed that the folds grew laterally at about 1 mm/yr and were uplifted at nearly an order of magnitude less. **Richards et al.** utilized paleomagnetism to help constrain restoration of the Bolivian orocline. Their work suggested that the deformation was more complex than simple oroclinal bending and may actually reflect fault-bounded blocks that have experienced rotation along previously unrecognized strike-slip faults. **Spratt and Dixon** finished the morning session by demonstrating how sharp lithofacies boundaries influenced 3-D fault-related fold geometries in the Canadian Rocky Mountains. Fault-bend folds predominated where lower Paleozoic carbonate rocks were reefal, whereas tighter fault-propagation and detachment folds were more common where lower Paleozoic rocks were shaley.

Carena and Suppe started out the Tuesday afternoon oral session with a talk on integrating focal mechanisms, surface geology, seismic and well data, and fault-related fold modeling to generate 3-D structural models of the source region of the 1994 Northridge and 1971 San Fernando earthquakes. They were followed by two talks that related 3-D fold geometry to fracture orientations. **Fischer and Wilkerson** created evolutionary pseudo-3-D models using a trishear algorithm and calculated curvature on the surfaces at different stages of fold growth. They showed how parts of the fold experienced different bending strains during fold development and related this to interpretations of fracture orientation and crosscutting relationships. **Gross and Eyal** looked at fracture sets in the Halukim anticline in Israel and related fracture development to fold development. The main through-going fractures in the structure turned out to not be single planes, but rather to be several cross joint segments connected into a single surface. **Spencer et al.** showed a 3-D finite element model that mapped stress trajectories based on well and seismic data. They showed some of the issues associated with conducting 3-D finite element modeling in segmented fields with complex boundary conditions. **Rose and Law** illustrated a new technique that looked at micro-scale deformation to help determine if hinge-plane migration had occurred or not. The last three talks focused on applying 3-D construction and visualization techniques to better understand specific areas. **Mitra and Leslie** used 3-D seismic data and 3-D modeling to unravel the complex inversion history of the Rhourde El Baguel structure in Algeria. They reinterpreted the structure to be a compressive fold related to two reverse faults that cut a pre-existing normal fault. **Groshong et al.** used 3-D visualization tools to develop a model of the Gilbertown graben system in Alabama. In particular, they showed the complex relationships between the boundary normal faults and how some faults in the displacement-transfer zones were soft-linked, whereas others were hard-linked. **Corbett** finished up the session by showing a new interpretation of the Kakap Block, Natuna Sea, Indonesia. Using a new high-resolution 3-D seismic dataset, he showed stratigraphic features across the main fault system that clearly had not experienced significant strike-slip offset. He used these features to reinterpret the structure as an inverted feature, rather than a flower structure.

Special Issue - Journal of Structural Geology

Fault-Related Folds: The Transition from Two Dimensions to Three Dimensions

Based on a theme session at the 1999 Geological Society of America annual meeting entitled "Faulting and Folding: Crossing the Divide between 2-D and 3-D", we invite papers for a Special Issue of the Journal of Structural Geology. The Special Issue will provide a forum for papers that highlight recent advances in the depiction, restoration, and modeling of fault-related folds in three dimensions in both contractional and extensional settings.

Topics for papers of this Special Issue should address (1) new techniques and/or issues for the 3-D representation, reconstruction and/or forward-modeling of fault-related folds; or (2) carefully documented natural examples or experimental models of zones of complex 3-D deformation within fault-related folds, such as terminations, displacement transfer zones, or cross-strike discontinuities. Ultimately, papers should shed insight into the three-dimensional geometric, kinematic, and/or dynamic analysis of natural structures; either through the use of 2-D/3-D seismic, detailed field mapping, physical modeling, and/or computer modeling.

The submission deadline for manuscripts will be April 1st, 2000, and will be adhered to strictly. All manuscripts should be written to comply with the Journal of Structural Geology's stated guidelines (at the end of each issue), and will be peer reviewed. Reviewing of manuscripts will be twofold: for science, in the normal way of reviewing for JSG; and to ensure that the collection of papers falls within the declared theme of the Special Issue. Papers that do not effectively address one of the topics will not be considered appropriate for this thematic issue, but may be suitable for a regular issue. The Special Issue must follow a strict schedule for reviewing, revising, editing, and proofreading of manuscripts to meet a desired early 2001 publication date. Contributors will be expected to meet all aspects of the schedule.

Papers also should make use of the Journal's electronic annex capabilities, in which complex graphics can now be stored in a JSG-related web site, and present visualizations that are not easily presented on the printed page.

12

JSG Special Issue continued

The General Editor for this issue is Dr. James P. Evans, with Special Editors Dr. M. Scott Wilkerson, Dr. Mark P. Fischer (fischer@geol.niu.edu), and Dr. Theodore G. Apotria (ted.g.apotria@exxon.sprint.com, apotria@wt.net (for attachments)

ALL manuscripts (three copies) should be submitted to Dr. M. Scott Wilkerson at the Department of Geology & Geography, DePauw University, 602 South College Avenue, Greencastle, IN 46135, mswilke@depauw.edu address listed below. If possible, please notify him in advance of your intention to submit a manuscript to the Special Issue.

General Editor:
Dr. James P. Evans
Department of Geology
Utah State University
4506 Old Main Hill
Logan, UT USA 84322-4506
(435) 797-3544
(435) 797-1588 (fax)
jsg@cc.usu.edu

UPS and other packages to: Room 205 Geology Bldg.

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Student members of SG & T are eligible to apply for grants to suppliment the cost of field trips and short-courses. Join the Division now to be a part of these tremendous learning opportunities.

What's Happening at the Journal of Structural Geology?
…An update on recent developments.

As you all know, the Journal of Structural Geology passed from the capable editorial hands of Sue Treagus to the equally capable, but different, editorial hands of Jim Evans (and assistant Amy Hochberg) just two years ago. Changes are inevitable under new leadership, and in this case there has been a very obvious change – in page size. There have been more subtle changes also, however, and the purpose of this brief note is to alert the community to these developments, as well as to invite participation in this period of transition.

Let's start with the bottom line – JSG's impact factor is climbing! And it's easier than ever to take advantage of this trend, as you can now submit electronic files for review. Once your paper has been approved for publication, you can expect a higher quality product - photos are being reproduced by a new technique. Sounds like a sales pitch, right? And what about the community participation part?

The 20th anniversary edition has generated a lot of discussion and positive comments, leading to consideration of how JSG can keep the momentum going. There is a perception among the editors and editorial board that the journal could serve as a useful avenue for professional debate as well as the more conventional venue for publication of current research. JSG therefore will welcome the occasional provocative 'Question' paper in the future. The idea is not to replace the present format, but instead to provide a platform for ongoing discussion of critical scientific issues.

Do you have an idea for additional improvements in the journal? Pass it on…the members of the structural community who serve JSG also serve you (this could get me in trouble!). Help us to continue to strengthen an already excellent journal.

Shameless sales pitch and plea for participation submitted by Laurel Goodwin, member of the Editorial Board, Journal of Structural Geology.

Based on a very informal get together at the annual GSA meeting, Dave Barbeau (University of Arizona) and others have started an *ad hoc* group, informally referred to as the "Friends of the Ancestral Rocky Mountains", for the purpose of promoting discussions and exchange of information related to various aspects of the Late Paleozoic deformation in western North America. They plan to meet at the GSA annual meeting each year, and probably elsewhere as well. **Chuck Kluth** (cklu@chevron.com) is the keeper of the e-mail mailing list. Anyone who is interested in Late Paleozoic features in the western North America and is "friendly" can receive e-mail updates from the "Friends of the ARM" by contacting Chuck.

FUTURE MEETINGS, CONFERENCES, AND COURSES

[Notices of future events of interest to Division members are welcomed by the editors]

2000

March 8-9: The Nature and Tectonic Significance of Fault Zone Weakening: Geological Society, Burlington House, London. http://www.geosociety.org/graphics/strat_header.jpg E-mail: menzies @gl.rhbnc.ac.uk

March 27–31 Penrose Conference: Volcanic Rifted Margins, Royal Holloway, University of London

April 9-12: Seismological Society of America, San Diego, Calif. E-mail: ssay2k@ucsd.edu

April 16-19 American Association of Petroleum Geologists annual meeting, New Orleans, La. (AAPG, 1444 So. Boulder Ave., P.O. Box 979, Tulsa, Okla. 74101-0979. Phone: 918/560-2639. Fax: 918/560-2626)

April 17-20 Geoscience 2000, University of Manchester; http://www.geolsoc.org.uk; Note special session: Fluids in the crust: making space and filling space.

Aprril 25-29 European Geophysical Society XXV General Assembly, France; http://www.copernicus.org/EGS/EGS.html

May 7-11 Salt Symposium, The Hague, The Netherlands. E-mail: Salt.2000@inter.NL.net)

May 15–18 Geology and Ore Deposits 2000 The Great Basin and Beyond, Reno/Sparks, Nevada. Information: GSN Symposium Editor, phone (775) 323-3500, fax 775-323-3599.

May 29-June 2 GeoCanada 2000, Calgary, Alberta; http://www.geocanada200.com

May 30-June 3 AGU Spring Meeting, Washington, DC.; http://www.agu.org/meetings

June 4-8 Penrose Conference: Great Cascadia Earthquake Tricentennial, Seaside, Ore. (Lois J. Elms, LJElms@aol.com)

June 7-9 Grand Canyon/Colorado River Geology Symposium, Grand Canyon National Park. E-Mail: young@geneseo.edu

June 27-30 Western Pacific Geophysics Meeting, Tokyo, Japan: http://www.agu.org/meetings

July 18-23 International Association of Volcanology & Chemistry of the Earth Interior (IAVCEI), Bandung, Indonesia; http://www.vsi.dpe.go.id/iavcei.html

July 31-August 3 Pacific Rocks 2000: Rock around the Rim, The Fourth North American Rock Mechanics Symposium, University of Washington; www.armarocks.org

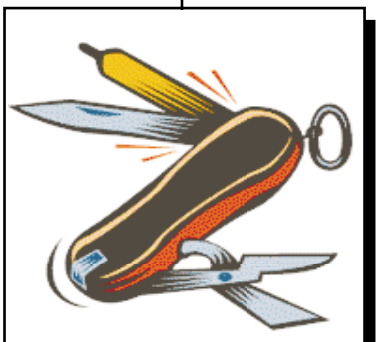
August 6-17 31st International Geological Congress, Rio de Janeiro, BRAZIL; http://www.31igc.org/

September 17-22 National Earthquake Hazards Conference, Seattle, Wash.; http://www.wsspc.org

September 17–24 Penrose Conference: The Iapetus Ocean — Its Birth, Life, and death: The Wilson Cycle: Edinburgh, Scotland (Lois J. Elms, LJElms@aol.com)

November 13-16 Geological Society of America Annual Meeting Reno, NV; http://www.geosociety.org/meetings/index.htm

December 15-19 AGU Fall Meeting, San Francisco, Calif.; http://www.agu.org/meetings



FUTURE MEETINGS, CONFERENCES, & COURSES

GeoCanada 2000 Conference
'Price Symposium' and field trips

GeoCanada 2000 will be the largest geological conference held in Canada in the year 2000. Part of this conference will be a special symposium held to honour Ray Price, in recognition of his official retirement (last year) from Queen's University. The symposium will focus on tectonics and structural geology, with particular emphasis on the Rocky Mountain Thrust and Fold Belt of western Canada, a major cornerstone of Dr. Price's research for the past four decades.

The main topics of the Price Symposium will include: 1) the Cordilleran Thrust Belt, with emphasis on multidisciplinary work; 2) other orogenic belts, with the goal of comparing and contrasting these regions to western Canada; and 3) theoretical and physical modeling of thrust belts and foreland basins. There will be a strong emphasis on poster sessions. It is anticipated that some of the special functions associated with the symposium will be held amongst the posters to stimulate more discussion about the material presented in poster form. There will be a post-conference field trip associated with the symposium, as well as others of interest at the meeting (see below).

ALONG STRIKE VARIATIONS IN THE SOUTHERN CANADIAN ROCKIES

(Post-conference fieldtrip in conjunction with the Ray Price Symposium)

Field trip Leaders:
Raymond A. Price, Queen's University, Kingston, ON
Marian J. Warren, PanCanadian Petroleum Limited, Calgary AB
Paul R. Price, Paramount Resources, Calgary AB

Three transects of the Canadian Rockies are used to illustrate new insights on the nature and evolution of a 600 km-long segment of the Cordilleran foreland thrust and fold belt. The Yellowhead Pass transect, from Hinton, AB, through Jasper National Park, to the Rocky Mountain trench at Valemont, BC, crosses a structural culmination exposing the deeper levels of the Cordilleran miogeocline. The Kickinghorse Pass transect, from Cochrane, AB, through Banff National Park, to the Rocky Mountain trench at Golden, BC, crosses higher, younger parts of the miogeocline. It is connected to the Yellowhead Pass transect, by the Columbia Icefields highway (Hwy 93), which follows the Main Ranges between Lake Louise and

which follows the Main Ranges between Lake Louise and Jasper. The Crowsnest Pass transect, from Pincher Creek and Waterton National Park, AB, into the Purcell Mountains near Cranbrook, BC, lies south of a cross-strike discontinuity, across which there is a 200-km right-hand shift in the edge of the miogeocline. It is connected to the Kickinghorse Pass transect by Highway 95, which follows the Rocky Mountain trench between Golden and Cranbrook, and provides access to the cross-strike discontinuity and to some of the along-strike changes within the miogeocline. The route from Pincher Creek to Calgary focuses on along-strike variations in the southern Foothills and Front Ranges. Most stops are roadside; no strenuous physical activity is required.

Duration: 6 days, departing Calgary am June 3rd, and returning to Calgary pm June 8th.

Number of participants: minimum - 35, maximum - 52. If oversubscribed, foreign visitors will be given first preference.

The registration fee is Cdn$900. It includes transportation by chartered bus, accommodation in shared twin-bedded rooms for 5 nights (Hinton, Valemont, Golden, Cranbrook, and Waterton Park), 6 days' box and liquid refreshments, 5 breakfasts and 5 dinners, and a guidebook. It does not cover the cost of personal expenses incurred in motels or hotels, nor personal accident and/or travel insurance. For single accommodation, add $200.

Additional cost for an optional regional overflight, from Calgary, on the morning of June 9th is $350.

PLUTONS AND TECTONICS; COMPRESSION, EXTENSION AND THE VALHALLA CORE COMPLEX IN SOUTHEASTERN BRITISH COLUMBIA
(Premeeting field trip #9)

Field Trip Leaders:
Sharon Carr, Carleton University, OT
Phillip Simony, University of Calgary, AB

The main themes of the trip are pluton emplacement, the relationship between plutonism, thermal history and compressional and extensional shear zones, and the evolution of the Cordilleran core complexes. On the first day, we travel from Calgary to Revelstoke across the spectacularly exposed Rocky Mountain thrust belt and the metamorphic-plutonic core zone. We present a tectonic overview and examine the linkages between the core complexes and the thrust belt. Days 2 and 3 will focus on Valhalla Complex in the scenic Slocan Valley-Castlegar area. We will examine major shear zones and granitic sheets and the superposition of multiple plutonic, thermal, and ductile deformation events. On the fourth day, we will travel eastward from the plutonic core in Quesnel Terrane, across the thrust belt following the Crowsnest Pass route. Although most outcrops are readily accessible near the road, at least one hike is involved each day.

Duration: May 25 - May 28, 2000, starting and ending at the University of Calgary.

Number of participants: 20 Participants

Estimated Cost (CDN)$495; includes three nights shared accommodation (one night at a ranch B&B and two nights at a lodge), four days travel by van, lunches, snacks, drinks, and guidebook. Some evening meals are not covered.

See GEO2000 - http://www.geocanada2000.com/ frameset.html

Mary and I have now done a full volume of the newsletter, and hope that time will move faster as we go around again. Please continue to send in your news and information as this is a good way to communicate with a large group of interested people.

A note to reiterate is that of Tom Wright's (NSF -Program Director, Tectonics) asking for interested parties to contact him regarding a possible "rotatorship" (see p. 5).

The March newsletter is again too early to contain much information about new academic hires, but a few have happened since the last issue. **Steve Harlan**, PhD from University of New Mexico, started a teaching position at George Mason University in January. Mark Anders (Lamont) writes that his recent Ph.D. student, **Nancye Dawers** has accepted an assistant professorship at Tulane University. **Scott Johnson** (postdoc with Ron Vernon and working with Scott Patterson's USC group in Baja) accepted the University of Maine, Orono job. On the mid-continent, **Jane Gilotti** is now the structure professor at University of Iowa. **Geoff Batt,** will start a faculty position in September, 2000, in the Department of Geology at Royal Holloway, University of London. Geoff completing his Ph.D. in 1997 at Australian National University (Jean Braun and Ian McDougall supervisors). He then spent three years in a post-doc with Mark Brandon at Yale University. At Royal Holloway, Geoff will have a new Ar-Ar lab to support his research in thermochronometry and tectonics. **Jonathan Lewis** (Ph.D., U Conn, Tim Byrne) finished his Ph.D., and was awarded an NSF Postdoctoral Fellowship to work on active convergent margins. He's currently at U.C. Davis working with Rob Twiss using a numerical adaptation of micropolar continuum theory to invert focal mechanisms for 3-D strain geometries in forearcs, specifically the Cascadia and Hikurangi margins.

In industry, Tim **Wawrzyniec** completed his Ph.D. with Jane Selverstone and John Geissman (U New Mexico), and took a

continued on page 16

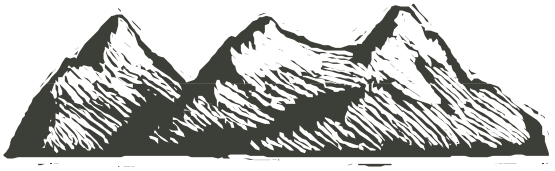
continued from page 15

position with Vastar Resources, Inc., in Houston. **Charlie Brankman** finished his MS thesis under Atilla Aydin (Stanford) and is now working with William Lettis Associates, Inc. at their Walnut Creek, CA, office.

Miscellaneous news includes word that **Brian Wernicke** has agreed to serve as Editor for Tectonics. Thanks Brian for taking on this job, and keeping the US side alive. **Stewart Wills** (Lamont Ph.D., Mark Anders) has just excepted an associate editorship at Science. Good luck to both of you. **Steve Marshak** notes with some trepidation that he will become department Head at the University of Illinois (March 6, 2000). **Greg Davis** sends the following - " Just back from a month's honeymoon in China :-)". Congratulations, Greg!

--Barbara John

The 2000 GSA Annual Meeting (*'Summit 2000'*) will be held November 13-16 in Reno, Nevada. The following is a *preliminary* list of Pardee Keynote sessions and Topical Sessions (Stratigraphy, Structure, Tectonics, and Volcanology) that might be of interest to SG&T members. Note that all Topical Sessions will be a mixture of invited and contributed talks. Consider contributing to one of these Topical Sessions or to a general structure/tectonics session. Watch *GSA Today* for the call for abstracts and more details of the meeting. Preregistration for field trips and the meeting begins in June.



GSA ANNUAL MEETING, RENO
'*SUMMIT 2000*'

Kinematics vs. Mechanics: Are only one or both useful rationales for understanding rock deformation?, Oral
Primary advocate/Convenor: William M. Dunne

Reconstructing Miocene and younger extension across the northern Basin and Range Province, Oral and Poster
Primary advocate/Convenor: Elizabeth L. Miller

Structure and Tectonics of Planets and Satellites, oral
Primary advocate/Convenor: Richard A. Schultz

Rates of Magmatic and Host Rock Processes in Arcs, oral and poster
Primary advocate/Convenor: Robert B. Miller

The Antler Foreland Basin System, oral
Primary advocate/Convenor: Katherine A. Giles

The Late Paleozoic Tectonics of Central and Western North America-The Ancestral Rocky Mountains-Insights into Intraplate Deformation, oral and poster
Primary advocate/Convenor: Charles F. Kluth

Evolution of the East African and Related Orogens, and the Assembly of Gondwana, oral
Primary advocate/Convenor: Timothy M. Kusky

The Walker Lane: An Evolving Transform Plate Boundary, oral and poster
Primary advocate/Convenor: James E. Faulds

MEXICO: Four Centuries of Geological Exploration, oral
Primary advocate/Convenor: Dr. Claudio Bartolini

Neotectonic Microplates of the Pacific-North America Boundary, oral and poster
Primary advocate/Convenor: Francis C. Monastero

Paleomagnetic applications to geologic problems, oral
Primary advocate/Convenor: Richard D. Elmore

New Developments in the Mesozoic Tectonic Evolution of the North American Cordillera, oral and poster
Primary advocate/Convenor: Sandra J. Wyld

Xenolith-Based Studies of the Physical and Chemical Evolution of the Deep North American Lithosphere, oral
Primary advocate/Convenor: G. Lang Farmer

Cenozoic Basin and Range tectonics and geophysical constraints, oral
Primary advocate/Convenor: John N. Louie

Interpreting the Morphology of Mafic and Ultramafic Lava Flows, oral
Primary advocate/Convenor: Laszlo Keszthelyi

Global Stratotype Section and Point (GSSP) for Middle Ordovician Series: biostratigraphy and candidate sections, Oral
Primary advocate/Convenor: Stan Finney

Carbonate Allostratigraphy and Sequence Stratigraphy, Poster
Primary advocate/Convenor: Ernest A. Mancini

Lake basins as archives of continental tectonics and climate Oral
Primary advocate/Convenor: Alan R. Carroll

Recent Results on the Causes and Consequences of Oceanic Island Volcanism: Where are we going next?, oral
Primary advocate/Convenor: Michael O. Garcia

Eruption or intrusion ? Volatiles, magmas and porphyry copper deposits, oral
Primary advocate/Convenor: Katharine V. Cashman

Pardee Keynote Symposia. Listed below are the Pardee symposia scheduled this year of potential interest to SG &T members. All sessions are oral.

Lamont and Plate Tectonics: History of Geology Division Millennium Symposium: Lamont 1949-1999
Primary advocate/Convenor: Dr. Gerald M. Friedman

A New Age of Planetary Exploration: Sample Returns, In Situ Geological Analysis, and Human Missions to Other Worlds
Primary advocate/Convenor: Ralph Harvey

Geology in the New Millenium: Resource Collapse, Environmental Catastrophe, or Technological Fix ?
Primary advocate/Convenor: Stephen L. Gillett

Nuclear Waste Disposal: "BRIDGING THE GAP BETWEEN SCIENCE AND POLICY"
Primary advocate/Convenor: Jane C. S. Long

GREAT SCIENCE IN THE GREAT BASIN
Primary advocate/Convenor: Benita L. Murchey

Living with Uncertainty: Scientific, Political and Societal Perspectives
Primary advocate/Convenor: Christine Turner

1999-2000 Structural Geology and Tectonics Division

Chair
Jane E. Selverstone
Dept. of Earth & Planetary Sciences
200 Yale Blvd. NE
University of New Mexico
Albuquerque, NM 87131-1116
ph: 505-277-6528; fax: 505-277-8843
selver@unm.edu

First Vice Chair
Christian P. Teyssier
Dept. of Geology & Geophysics
108 Pillsbury Hall
310 Pillsbury Drive SE
University of Minnesota
Minneapolis, MN 55455-0219
ph: 612-624-6801; fax: 612-625-3819
teyssier@tc.umn.edu

Second Vice Chair
Laurel B. Goodwin
New Mexico Institute of Mining and Technology
Department of Earth and Environmental Sciences
801 Leroy Place
Socorro, NM 87801-4796
ph: (505) 835-5178; fax: (505) 835-6436
lgoodwin@nmt.edu

Secretary-Treasurer
Charles M. Onasch
Department of Geology
Bowling Green State University
Bowling Green, OH 43403
ph: (419) 372-7197; fax: (419) 372-7205
conasch@bgnet.bgsu.edu

Past Chair
Stephen Marshak
Department of Geology
University of Illinois
1301 West Green St.
Urbana, IL 61801
ph: 217-333-7705; fax: 217-244-4996
smarshak@uiuc.edu

This newsletter is published biannually by the Structural Geology & Tectonics Division of GSA.

If you have any suggestions, ideas, professional and technical opinions, announcements, career changes, not-for profit offerings, and/or industry news, please send them to us! The deadline for inclusion of materials in the next issue will be June 15, 2000. Please send lengthy

Newsletter Co-Editors

Barbara John
Department of Geology and Geophysics
University of Wyoming
Laramie, Wyoming
ph: 307-766-4232; fax: 307-766-6679
bjohn@uwyo.edu

Mary Hubbard
Department of Geology
Kansas State University
Manhatten, Kansas
ph: 785-532-2241; fax: 785-532-5159
mhub@ksu.edu