STRUCTURAL GEOLOGY and TECTONICS DIVISION *Newsletter*
Volume 13, Number 1 March 1994

CHAIRPERSON'S MESSAGE

Division activities at the annual meeting in Boston were quite successful. John Bartley became the new second vice chair, Ed Beutner moved up to first vice-chair and Art Goldstein is the new secretary-treasurer. We all thank the past secretary-treasurer, Don Secor, for keeping the Division running properly during his record tenure of six years. The papers at Division sessions were excellent, so interesting to me that I spent the meeting in these sessions and missed the exhibits. Thanks to Fred Chester and Ron Bruhn for organizing a really cutting-edge symposium on inferring paleoearthquakes from fault-rock fabrics. It appears that this seemingly intractable problem has some solutions. We can expect some significant publications from the speakers. Terry Engelder, with help from Mike Gross and Mark Fischer presented the Division's short course on fracture mechanics of rock. The course was highly praised by everyone I heard from; thanks guys.

As always, it was a pleasure to attend the Division's award ceremony to honor the recipients and to hear the citations and responses. As Darrel Cowan, in his citation of Ben Page for the Career Contribution Award, summarized Ben's significant publications, I was intrigued as I realized that my list would have been as long but different. Such a broad range of important contributions is an excellent qualification for this award. Mark Cloos cited Dan Worrall and Sig Snelson for the best paper award for their 1989 DNAG paper "Evolution of the northern Gulf of Mexico, with emphasis on Cenozoic growth faulting and the role of salt." This paper contains important new insights into regional salt tectonics as well as helps highlight a large region of very active tectonics that misses out on being a classic orogenic belt only because it is not forming mountains. Jed Mosenfelder of Stanford won the Student Research Award for his project titled "Emplacement history of the Oman ophiolite."

The technical sessions seemed generally well organized, but then, we of the management board did the organizing. Did you agree with our arrangement? You might be interested in how it was done. We frequently faced the question of whether a paper on, for example, Himalayan cleavage, should be grouped with cleavage or with the Himalayas. For the most part, if you checked the structure box, we tried to group your paper by structural type, whereas if you checked tectonics, you were grouped according to region. If everyone feels that they were in the correct session, then this interpretation of structure versus tectonics is useful and we will continue to do it. If there is a problem, what should we do? Should we ask on the abstract form whether you would like your paper grouped by subject or geography? Let us hear from you if we can improve the arrangement of sessions.

It was decided at the Boston meeting to continue making a 50 cent per member contribution to the International Association of Structural/Tectonic Geologists. This is a valuable investment in international cooperation. If you have sent your name, address, and areas of interest to Sue Treagus, then you have seen the primary product of the association, the directory of members. The Association currently has approximately 1000 members of whom about 20% are in the U.S.; Membership is free. The purpose of the association is to foster cooperation by increasing international communication and

the directory has already inspired the formation of new tectonic studies groups in Argentina and India. If you are not already in the directory or the supplement, you can reach Dr. Treagus at the Department of Geology, University of Manchester, Manchester, M13 9PL, U.K.

The membership has ratified the proposed bylaw change forming a four-member Short Course and Symposium Committee. Three members of this committee are appointed and the fourth is the current vice-chair of the Division. Members for 1994 are Rick Allmendinger (Chair), Jeff Karson, Tekla Harms and Board member John Bartley. They are charged with suggesting topics for short courses and symposia that can be discussed and approved by the Division at the annual meeting. With the help of this committee, we hope to begin planning farther ahead. This is now also a necessity, because the GSA has started requesting submission of short course proposals by October 1 of the year preceding the course, a deadline that occurs before our annual meeting. In order to be able to discuss and approve the proposals at the annual meeting, we are thus required to plan nearly two years ahead. This is probably a good idea but requires significantly more advance planning than has been traditional. The longer lead time may allow us to attempt some things we haven't been able to do in the past. Inasmuch as the short course is one of the Division's most important activities, it seems appropriate to consider the philosophy behind the courses and to discuss what, if any, new directions we might pursue.

The Division's short courses are chosen to be at the cutting edge of research or to survey a slightly more mature topic that is still too new to be in textbooks. The intended audience is college teachers and researchers who wish to be updated in a particular subspecialty. The short courses have done an excellent job of achieving these goals and we need to be sure they continue to do so. Because of the changes in the course proposal procedure, this is a good time to also consider expanding our offerings and broadening their scope. For example, we could design courses aimed at graduate students or aimed at those required by licensing laws to obtain continuing education. Courses fulfilling more general needs might be offered more than once, perhaps for years in a row. Courses that are designed for graduate students could become a valuable adjunct to graduate education. A possible model I have seen in action is the "Third Cycle" course offering by Swiss universities. A Third-Cycle course is organized by a group of universities for their collective graduate students and are on topics that are too specialized for the faculty at any one university or are outside the normal range of the curriculum. Representative topics in which I have participated are nappe tectonics and rock deformation. I highly recommend the concept to both students and faculty. Should the Division sponsor something like this and does anyone have topics to suggest? These days a fair number of Division members may be in environmental geology and may have a desire for continuing education related to their work. What sort of structural/tectonics courses would be useful? Subjects that come to mind are the identification of potentially active faults, criteria for field determination of fault offset, or the effect of structural discontinuities on fluid flow. We would like to hear from you if you think new types of courses would be useful and what subjects are important.

Plans are progressing well for the '94 meeting in Seattle. The Division has been enthusiastically backing the Active Tectonics Initiative at NSF and this will be reflected in the topics of both the symposium and the short course. Our symposium, titled "New

Frontiers in Active Tectonics," will be combined with that of the Geophysics Division and run for a full day. George Davis is the convenor for our Division and Bernard Minster for Geophysics. Four themes will be explored: tectonically active regions as laboratories for natural deformation; new and emerging technologies for measuring the rates and kinematics of deformation fields; fully integrating geology and geophysics to achieve a fundamental understanding of tectonic processes; and transferring basic scientific understanding to the mitigation of natural hazards. Our short course will be "GPS Geodesy and Active Tectonics," a two-day practical course taught by Michael Bevis and Charles Meertens. Global positioning system geodesy has recently been perfected to an accuracy of about 1 cm and can now be used to study individual active structures as well as regional deformation. The course will provide a hands-on overview of the essential technical and organizational aspects of GPS, how to obtain help from the experts at UNAVCO (Universities Navstar Consortium) and discussions of actual and potential structural and tectonic applications. Both the short course and the symposium are going to demonstrate the state of the art and the future potential of active tectonics research.
Richard H. Groshong, Jr.

[Please put photo 1 here]

In the interest of ready access, here are the addresses for the Board members this year:
Richard H. Groshong, Jr:
Department of Geology, Box 870338
The University of Alabama, Tuscaloosa, AL, 35487-0338
Phone: (205) 348-1882; Fax (205) 348-0818
John Bartley:
Department of Geology and Geophysics, University of Utah,
Salt Lake City, Utah, 84112
Phone: 801-581-7937
e-mail: jmbartle@cc.utah.edu
Ed Beutner:
Department of Geosciences, Franklin & Marshall College, PO Box 3003,
Lancaster, PA 17604-3003
Phone: 717-291-3814; Fax: 717-291-4186
email: e_beutner@acad.fandm.edu
Art Goldstein:
Department of Geology, Colgate University, Hamilton, NY 13346
Phone: 315-824-7203; Fax: 315-824-7831

NSF NEWS

The Active Tectonics initiative is moving along well. George Davis is doing a fine job of coordinating the preparation of a science plan for NSF and in explaining the initiative and its goals at various meetings (see below). His presentation at the Fall AGU was well attended. George and some of the other members of the science plan workshop will be attending GSA sectional meetings, to further advertise the initiative and get your input. Also, Darrel Cowan is planning a special session at the Annual GSA meeting in Seattle. NSF has reacted favorably to these developments and has even earmarked $500,000 this year to help launch the initiative. Much work lies ahead, however, before we can declare the initiative a success. Give George and the other members of the science plan workship your views either by calling them or stopping by at the GSA meetings. The science they are planning is very interesting, important, and has clear relevance to some of society's needs. The chances of success in getting the initiative approved and funded, not to mention actually producing scientific results, greatly depend on your active participation and guidance.

* * * * *

Once again the Tectonics Program received level funding for this fiscal year at 6.6 million and the chances for a significant increase next year are dim. From its annual budget, the Tectonics Program funds proposals from both the June 1 and December 1 submission periods. There were 136 proposals in June 1993, with an aggregate request of $16,500,000. The December 1, 1993 deadline resulted in 140 proposals requesting a whopping $19,031,528. We'll let you do the sums! As was the case last year, approximately 40% of these proposals were re-submissions of ones recently reviewed. These facts and figures are not new, but they do underscore the need to aggressively pursue additional funding and to carefully examine how we can best use our limited resources. Your reviews are all-important in the assessment of scientific potential, competitive ranking, and funding levels of proposals. In these financially tight times, please continue to give straightforward reviews focused on the proposed research, and make an extra effort to avoid mixing scientific criticisms with policy matters and personality clashes. Before you lick the envelope (or punch the 'send' button), read your review from the Principal Investigator's perspective. Supportive or critical, it should give the PI something to work with, not present him or her with obstacles over which they have no control.

In the last two articles, we've discussed the problems caused by high volume, quickly re-submitted proposals, and possible ways to deal with them. An additional idea has surfaced: Do away with deadlines and have a once-a-year funding competition. This would remove the artificial revise-and-resubmit-by-a-certain-date treadmill and eliminate the artificial division of annual funds into two panel cycles. Any comments?

* * * * *

NSF has moved and there are some important changes in the requirements for Proposal Format (see next section). We are now in the northern Virginia suburbs instead of two blocks west of the White House on G Street. Hopefully the disruption and delays caused by the move have abated, and those of you who have occasion to contact us have the appropriate numbers, which are: Tectonics Program Earth Sciences

Division, Room 785 National Science Foundation 4201 Wilson Blvd. Arlington, VA 22230 Tel: (703) 306-1552 FAX: (703) 306-0382

* * * * *

The editors of GSA Bulletin, Art Sylvester and John Costa, published a comment in the December 1993 issue (vol. 105, number 12, p. 1516) that struck a chord with us. We thought that proposals that appeared to make every effort to hide the significance of the work, and that seemed to be written to even prevent understanding of what it was that the proposer wanted to do, were unique to our system. Now we are told that manuscripts sent to GSA have also been infected with this! We recommend that you read their comments, enjoy them, and try to respond to their plea. The following section is abstracted from a talk Carol Simpson gave recently on the same subject.

* * * * *

WHAT MAKES A SUCCESSFUL PROPOSAL?

1. Have a good idea
2. Give it some careful thought
3. Package it nicely
4. Sell it to reviewers

We can't advise you on how to have a good idea, or on how to think it through, but we can offer some advice on items 3 and 4.

A. Follow the NSF guidelines
B. Get the reviewer's attention
C. Formulate a reasonable work plan
E. Try to avoid 'sticker shock'

A. Follow the NSF Guidelines:

NSF has recently revised its' "Grants for Research and Education in Science and Engineering" (GRESE) application guide. Make sure you have access to a copy of the latest version - now called the NSF Grant Proposal Guide (GPG) NSF 94-2. Important points are:

п There is now a proposal forms kit available as part of the GPG, or as NSF 94-3, or you can get it electronically from the Foundation's Science and Technology Information System (STIS).

п The Project Description section is limited (unless modified by program announcement/ solicitation or approved in advance by the applicable NSF Assistant Director) to 15 pages, including text and all visual materials. Apparently, the exception in the previous version of the GRESE presented difficulties in defining visual materials, counting pages and keeping overall length limited. Font size is to be not less than 10 point.

п Appendices are not permitted (unless modified by program announcement/solicitation or approved in advance by applicable NSF Assistant Director).

п Biographical sketches are limited to 2 pages per investigator and should include: Vitae (only essential details); up to 5 publications closely related to proposed project; 5 other siginficant publications; collaborators within the past 48 months; the name of each investigator's own graduate and postgraduate advisors.

B. Get the reviewer's attention:

If you haven't got the interest and enthusiasm of the reader in the first paragraph, you're in for a long uphill battle. So, right up front in the Project Summary: i) say what the problem is; ii) say why it is significant, iii) specify the hypotheses to be tested; iv) specify the technique(s) that will test them; and v) say what you expect the outcome to be. Sounds obvious, but you'd be surprised how many proposals do not do this - instead they launch into a detailed discussion of the stratigraphy on either side of the Whydyacallit fault, follow this with vague references to, for example, 'mapping' and 'geochemistry,' and then finish with an even vaguer statement that the results will 'help constrain the tectonics of North America' (or wherever). Imagine you've got five minutes of time with your Dean who has to choose between funding your project or refurbishing the athletic center. Your research future is on the line. OK, so why is your project worth doing?

C. Keep the Reviewer's Attention:

You're off to a good start and the reviewer thinks there just may be a good idea here. The problem now is to expand in the Project Description on those initial claims to solve "the problem of life, the universe and everything," without leaving the reviewer full of nagging doubts that you can do the job successfully, or, worse yet, uninterested in whether you do or not. Easy to say, not so easy to do. In 15 pages or less, you must:

(a) show the exact nature and significance of the problem you want to solve:
(b) clearly and simply state the hypothesis (or hypotheses) that you intend to test;
(c) show that you have done your homework on all previous related work;
(d) succinctly describe the preliminary work you have done which leads you to believe that the problem can be solved;
(e) say what new work must be done to solve the problem, and bv whom;
(f) discuss the anticipated pitfalls and how these will be overcome;
(g) discuss the anticipated results (positive and negative) and how they will be used to test your hypotheses.

(a), (b) and (c) would normally fall into the Introduction section of the proposal, (d) into the Preliminary Results section, (e), (f) and (g) into the Proposed Research section. Of course, you can organize the 15-page Project Description part of your proposal on entirely different lines, but each of these categories should be addressed somewhere.

D. Formulate a Reasonable Work Plan:

Make sure that the reviewers sense you can actually do all the work you propose to do in the time available between classes, committee meetings, student supervision, proposal writing, manuscript preparation. For example: If you plan to make a couple of 70 km-long transects across a mountain range with no roads, or map a 400 km2 area on foot, make sure it really is feasible to cover that amount of ground in the 2 summer months field time you have allotted. If you intend to use thin sections, ask yourself if you can realistically examine carefully 500 sections in 2 summer months (10 a day for 5 days a week for 10 weeks...). If you need radiometric age determinations, geochemical analyses, palynological analysis, seismic profiles, how many will you need and from where? And don't put the whole Department onto one project unless everyone is necessary. If you have Co-PIs, Post Docs, Graduate Students, Undergraduates, Secretaries, Technicians... make sure that each is justified and that it is clear to reviewers that all these people are absolutely necessary to do this particular job. Avoid duplicative efforts or the appearance thereof.

E. Try to avoid 'sticker shock', i.e., keep the budget in line with the job:
Most reviewers get a little dismayed by very high budget lines - it's a fact of life that you can't avoid. So the best approach is to accept this and think of ways both to keep the budget as low as possible and to persuade reviewers (and NSF) that the money is going to be well invested. If you want to work in a remote, inaccessible spot, then it's probably going to cost more than if you want to work in your backyard. Either way, you will need to justify the cost of doing the work, including the expense of getting to the area, in the Project Description and include a detailed breakdown of the individual costs in the Budget Explanation. Similarly, if you really need expensive machine time, then make sure you budget enough of it to do the job - but also make sure you carefully justify both the necessity for the machine's use and the amount of time. Remember, it doesn't mean the project is more or less important if there is a large or small budget. What does matter is that the budget is appropriate for the significance of the scientific outcome.
To which program should you submit your proposal? The subject matter of most proposals falls squarely within one of the existing Programs. See NSF 93-66 for the latest Program Announcement for Earth Sciences Research at the NSF. Earth Sciences Project Support is for research proposals involving single or small groups of investigators. Individual Programs are:
Geology and Paleontology
Tectonics
Petrology and Geochemistry
Geophysics
Hydrologic Sciences
Education and Human Resources
Instrumentation and Facilities is for proposals requesting support for development or acquisition of research instrumentation. Continental Dynamics is for large, multi-investigator, multi-disciplinary research projects.
If the material in a proposal seems to fall in more than one category, first decide what is its major scientific problem. For example, a proposal that addresses a tectonics problem using geophysical methods should be sent to the Tectonics program, whereas a geophysics problem with secondary tectonic implications should go to Geophysics. If NSF officials feel your proposal would stand a better chance in a different program than the one you chose, it will be re-assigned to the more advantageous program. For some proposals, no single program is appropriate. In this case, NSF will assign your proposal for review to more than one program, or even more than one Division. Some related NSF Divisons and their programs:
Divison of Ocean Sciences (OCE)
Marine Geology & Geophysics
Chemical Oceanography
Ocean Drilling Program
Office of Polar Programs (OPP)
Polar Earth Sciences
Polar Glaciology
Division of Environmental Biology (DEB)
Systematic and Population Biology

Divison of Biological & Critical Systems (BCS)
Earthquake Hazard Mitigation
Natural & Man-Made Hazard Mitigation
Divison of International Programs

* * * * *

The following awards were made by NSF from the Tectonics Program for the period July 1993 to January 1994 ... Congratulations!
-Tom Wright and Carol Simpson-

P.I. NAME INSTITUTION TITLE

Bickford, Marion Syracuse University COLLABORATIVE RESEARCH: Timing and Correlation of Tectonic Events in Grenville-Aged Province Trans-Pecos, Texas

Chamberlain, C. Page Dartmouth College Crustal Scale Fluid Flow during Continental Collision in the Southern Alps, New Zealand

Crawford, Maria L. Bryn Mawr College COLLABORATIVE RESEARCH: Structural and Geochronologic- al study of Coast Mountain Orogen near Portland Canal, SE Alaska and Coastal British Columbia

Dallmeyer, David University of Georgia Tectonothermal Evolution of the Research Foundation Internal Alpine-Carpathian Orogen: Implications for Collisional Tectonics

Gehrels, George University of Arizona COLLABORATIVE RESEARCH: Structural and Geochronological study of Coast Mountain Orogen near Portland Canal, SE Alaska and Coastal British Columbia

Hodges, Kip MIT COLLABORATIVE RESEARCH: Thermal and Mechanical Modeling of Himalayan Geology

Jacobson, Carl Iowa State University Structural and Metamorphic Evolution of the Chocolate Mountains Thrust, Southeasternmost California

Molina-Garza, Roberto S. Univ. of New Mexico Paleomagnetic Investigation in Northwest Mexico: Further Evaluation of the Mojave-Sonora Megashear Hypothesis

Opdyke, Neil University of Florida A Paleomagnetic Study of the Middle and Late Triassic of the Yangtze and Simao Terranes

Soegaard, Kristian University of Texas COLLABORATIVE RESEARCH:
at Dallas Timing and Correlation of Tectonic
Events in Grenville-Aged Province,
Trans-Pecos, Texas

---

*As a consequence of NSF's move to the new building, many of the Tectonics Program's recommendations for awards for this period were not finalized at the time of writing. By the time you read this we hope that the backlog will be gone. We will include the remainder of this period's awards in the next *Newsletter*.

Division 1993 Best Paper Award
Citation by Mark Cloos

The Structural Geology and Tectonics Division has chosen the 1989 paper by Dan Worrall and Sig Snelson entitled **"Evolution of the northern Gulf of Mexico, with emphasis on Cenozoic growth faulting and the role of salt"** for its 1993 Best Paper Award. The paper was published in the GSA DNAG Volume A, The Geology of North America (p. 97-138).

This paper is a monumental contribution for it completely changes our understanding of the tectonics of major salt provinces. All structural geology textbooks have some discussion of salt diapirs. Many of the cited examples are from the Gulf of Mexico Basin. The classic picture of salt tectonics in almost all texts is the vertical diapiric rise of 5-10 km with only limited horizontal salt flowage associated with withdrawal to fill the diapir. Classic vertical salt diapirism certainly occurs, but Worrall and Snelson and their colleagues at Shell concluded that it is really a minor part of the salt tectonics story for the Gulf of Mexico Basin.

The paper has several parts. It opens with a review of the geologic evolution of the Gulf of Mexico region. This is followed with a section on the history of observations and ideas concerning growth faults and salt behavior. Worrall and Snelson then show, with reflection seismic profiles and palinspastic cross sections constrained with well data, that the dominant effect of salt flowage in the Gulf of Mexico is not a vertical diapiric rise but instead the seaward flowage of salt nappes for more than 80 km! The salt flowage system they describe is truly of orogenic proportions. The submerged system extends for a width of 400+ km with extensional growth faulting in the updip limit near the coast and a contractional fold-and-thrust belt in the deep Gulf. The fact that this salt-based, detached orogenic system dwarfs the Swiss Alps is nicely illustrated in their Figure 20. Moreover, they are able to use palinspastic reconstructions of the growth faulted region to show that 40+ km of extension has occurred since the early Miocene and that the rate of extension is coupled to the rate of sedimentation. Thus, sediment loading acts to drive the salt seaward, much like cookie dough beneath a rolling pin. This is also an exciting paper for anyone interested in basin analysis for the dynamic coupling between sedimentation and tectonics is clear and profound. The new ideas and figures concerning the tectonics of salt provinces must be incorporated in the next generation of structural geology textbooks.

Dan and Sig, we congratulate you on your award, and if you will please step forward, Jan Tullis, our Division Chair, will make the presentation.

[Please Put Photo 2 Here]

Response by Dan Worrall

Sig Snelson and I are honored and thrilled to receive this award from the Structure and Tectonics Division, and thank our friend Mark Cloos for his very kind words. As you probably know, Mark spearheaded the effort in this Division a few years ago to assemble a symposium on the topic of salt tectonics, so that some of the exciting new work by many geologists in this field could be seen by a wider audience.

The work reported in this paper occurred over many years both at Shell research and at our offshore Gulf of Mexico exploration office in New Orleans. We were hardly alone in this effort, and I'd !ike to mention and thank a few of the many people who helped guide us.

By the late 1970's, the offshore Gulf of Mexico basin had become a major focus arena for Shell and for other exploration organizations, but a difficult one to understand structurally. Regional cross sections were rare because it was hard to correlate for great distances across the huge growth faults. No one really knew what the geometry at depth of these great faults was, or what forces (gravity tectonics, shale diapirism, etc.) controlled tnem. Three people were instrumental in providing a framework for a study of these faults. Bert Bally, who was at our research lab at the time, had the insight from his earlier work in the Canadian Rockies that perhaps palinspastic reconstructions of regional cross sections might help. My co-author Sig Snelson headed a research group of structural geologists in a section where such work was encouraged. Dick Nicholas, who was Chief Geologist of our New Orleans office at that time, offered the assistance of our New Orleans office. !t was in this very fertile environment that our growth fault tectonics effort began in 1978.

At first, drawing reconstructions through literally hundreds of fault blocks, and correcting for significant compaction effects seemed a daunting task. Help came from the chance lunchtime meeting in 1979 of a computer hacker named Mike Virnig, who had an incredible gift for computer graphics. With a few napkins and a pencil, we soon had the framework for one of the first palinspastic reconstruction programs for extensional faults.

The compilation of the regional cross sections was a lengthy task that utilized the hard work of scores of previous interpreters in Shell and the industry. Arthur Christensen and the late Joe Broussard were especially instrumental in teaching me about the spectacularly listric Corsair fault system. Shell Offshore provided the opportunity to shoot a long regional research line in deep water, a rare occurrence in the 1970's; only a few visionaries at that time could imagine that within a decade our company and others would be scouring the seemingly hostile deep water region for giant fields, and luckily they helped us along.

It became obvious quickly from the reconstructions that there were major geometric problems at depth beneath the Gulf coastal plain and continental shelf, and that large amounts of material had moved out of the plane of the sections. Previous workers had shown that much of the present day slope was underlain by salt. The idea that salt could be moving laterally at a regional scale was first voiced by Chuck Humphris of Chevron. Our in-house palinspastic reconstructions were convincing tests of the hypothesis, but were very controversial at first. Many lively debates took place over the next few years in our company, and I'm sure in other quarters as well. Good deep seismic data over the structurally complex continental slope to back up the palinspastic predictions became available to us in the early to mid 1980's. Allen Scardina of Shell first showed me a seismic line that at last documented the concept of a regional allochthonous nappe of salt; this seismic line is in our paper.

Each new seismic line in this region shows ever more complexity in the system, and asks new questions. Scaled regional cross sections and serial palinspastic reconstructions are often the only way to make inroads into these sorts of structures, and these take time. We thank Shell Oil for providing this time and for providing the continued environment for this type of work to flourish. Ever more elegant understandings of Gulf structures have continued to emerge from the minds of people like Fred Diegel, Dave Schuster, Charlie Harvie, Bill Dirks, and Scott Sumner, and from many more in other parts of industry and academia. I must also thank Bert Bally, who invited Sig and I to prepare a paper for the GSI's Decade of North American Geology project, and Martin Jackson of the Texas Bureau of Economic Geology, who provided some verv insightful reviewer's comments and an invitation to present it at an AAPG salt symposium. Once again, thanks to all involved in the nomination and selection process; it is an extremely pleasant honor to receive this award!

Response by Sigmund Snelson

Along with Dan, I would like to express my thanks and appreciation to all of those people who directly and indirectly made this paper and its publication possible, and our special thanks to the selection committee in recognizing the paper's significance in a revised picture of this hemisphere's richest hydrocarbon resource. In the last few years, I am happy to report, more of the exciting story from this research effort at Shell has been released and presented at the Dallas GSA and New Orleans AAPG connections and most recently at last month's AAPG Hedberg Salt Tectonic Research Conference in Bath, England co-covened by Martin Jackson, David Roberts, and myself. From this research conference I can report that there has been a remarkable convergence of ideas on salt styles and mechanisms in the Gulf of Mexico, and a much wider use of palinspastic analysis in the unraveling of complex salt systems.

Tradition, I believe, now allows me to digress a bit, perhaps philosophize, and mention a few people. My former Ph.D. professor and friend Peter Misch would be very proud on hearing of this award even though it was from work in the Gulf of Mexico, which by Peter's defnition would be considered "overburden" too far below sillimanite-grade to be of importance. He would have been shocked to learn that his beloved Swiss Alps, which he taught me and other University of Washington graduates about, could in terms of scale be potentially engulfed by a phenomenal allochthonous salt complex, let alone one here in our own backyard.

Such a feature could not have been discovered without the seismic tool which I have seen resolve many structural controversies over my 33 year career in industry. For example, it is now hard to remember that there was a time when we were arguing over thin- vs. thick-skinned tectonics in the Appalachians a well as other foldbelts. In 1972, though, I remember giving a paper at a GSA Penrose Conference and also at the first Eastem Section AAPG Meeting ambiguously entitled something like "Seismic data bearing on the tectonic style of the Appalachians," a paper which received the A. I. Levorsen Memorial Award. I can remember the face of my friend John Rogers of Yale, a key proponent of thin-skinned tectonics, who at that time had not had the opportunity to see our data. John was watching from the front row. First there was anticipation and then a smile emerged as extensive seismic data and cross-section were shown which depicted a clearly uninvolved basement.

Over the years, I, as well as other colleagues from Shell have had other opportunities - many at GSA Penrose Conferences -- to show interpretations with seismic data documenting the structural style at depth in a wide variety of provinces. A few examples: low angle normal faulting in the Basin and Range and the Rio Grande Rift provinces; low-angle basement-involved thrusting on the flanks of many Rocky Mountain ranges; and recently at the Reno GSA, an exciting line across the Great Valley-Franciscan boundary along the west flank of the Sacramento Basin.

But, the transfer of information is a two-way street and we in industry owe a great debt to the academic community, the USGS, and other state surveys who have shared their ideas freely with us. I can recall many, many examples: the second Penrose Conference at Asilomar, Califomia over 25 years ago where Tanya Atwater blew our minds with her elegant explanation of how the San Andreas fault could terminate into a transform fault and a subduction zone. These were new terms and there was excitement in the air as John Dewey and Jack Bird beautifully explained how plate tectonics explained mountain building in the Appalachians. Later Warren Hamilton of the U.S.G.S. published his impressive and masterful synthesis of the Western U.S.

We in industry were stimulated by these and many other papers coming from academia at that time. All of these ideas came at an opportune time for me, who had the wonderful job of heading up a research team in Ventura, California, charged with gaining a better understanding of the structural evolution of the Western States. I still have fond memories of Greg Davis sharing his thoughts with us as he hiked us through his Klamath terrain and Bill Dickinson doing the same in his thesis area along the west side of the Great Valley. Of our group's many studies, there is one this group may recall: a study by Art Sylvester and Bob Smith in the Mecca Hills adjacent to the San Andreas fault on the east flank of the Salton Basin. It was published in the AAPG Bulletin, and is work that Art, over the years, has generously shared with many geologists and students during countless field trips.

The Ventura project was preceded with another once-in-a-lifetime opportunity: I had to map in the northern Brook Range, from Canada to the Chukchi Sea for over five field seasons. Again, this was a two-way street: I enjoyed many hours trading ideas with USGS geologists, including Irv Tallieur, a pioneer on the North Slope. It was in Alaska in 1960 that I first met Bert Bally, then working for Shell Canada. He was up there to check out my interpretations of large-scale thrusting. At that time Bert's classic paper with Gordy and Stewart on the Canadian Rockies was still a company manuscript but it was

an inspiration to many of us, teaching us the power of regional palinspastic analysis. Dan and I would probably not be here today had not Bert requested that we write up our Gulf work for publication in the DNAG volume.
In closing, I would like to say how enjoyable it has been to work with Dan on the Gulf study, as well as on other equally stimulating projects. He is a fine scientist. Lastly, both of would again like to express our appreciation to the GSA Structural Geology and Tectonics Division for this award; and would also like to thank all of you for coming this evening and sharing this special honor with us.

UPDATE ON THE ACTIVE TECTONICS INITIATIVE

Following their workshop in Boulder, Colorado, in October, the Active Tectonics Planning Committee drafted a detailed outline of the basic science plan that is to be submitted to the National Science Foundation in early summer, 1994. A brief report on the workshop and an early form of the outline were presented to the Structure and Tectonics Division of the GSA in late October in Boston. During November, a preliminary executive summary of the basic science plan was developed; the outline was strengthened and developed in greater detail and writing assignments were made. At the December meeting of AGU in San Francisco, a special Union Session on Active Tectonics was held. Bob Smith convened the full day session, which proved to be a standing-room only affair during its entirety. As co-chair of the morning session, I led off with an overview of the purpose and status of the Active Tectonics initiative. A number of members of the Planning Committee -- Mark Brandon, Gene Humphreys, Kerry Sieh, Mike Bevis, Bob Smith -- presented technical papers, and they, along with the other invited speakers (see EOS, AGU Fall Meeting, 1993), captured the breadth and scientific excitement of the advances being made in the basic science of Active Tectonics.
Winter activities related to the Active Tectonics initiative are focused on the completion of a first draft of the basic science plan. This preliminary draft will be completed in late February or early March, at which time there will be announcements both in GSA Today and EOS describing how members of the scientific community can get a copy -- via E-mail -- for review and input. Receiving informed, substantive input from the Structure-Tectonics community as a whole is an essential step in the process of preparing the final version of the basic science plan. We will need your input!!! Spring activities are intended to further this objective. In particular, at each of the GSA Sectional Meetings throughout the country, there will be an ACTIVE TECTONICS poster session. The Planning Committee will be represented at each of the sessions. Hard-copy of the draft version of the science plan will be on hand. We trust that the poster itself will generate interest, discussion, and input re/ the draft plan.
Following the Spring Sectional Meetings, and guided by the input recieved via E-Mail and through firsthand conversations at the meetings themselves, the final version will be prepared, completed, and submitted to NSF. Already Active Tectonics has been designated a "SPECIAL EMPHASIS AREA" within Earth Sciences-NSF, and already there is a starting budget behind it ($500K). One purpose of the basic science plan is to provide a vision in regards to the scientific value and opportunity associated with Active

Tectonics research. The primary scientific objective of the initiative is to achieve greater comprehensive understanding of the tectonic processes (all scales, and the linkages from one scale to another) that are contributing to the ongoing, contemporary deformation of the Earth's outer layers. The means is through studying processes that are ongoing here and now in actively deforming regions, illuminated by fuller intellectual integration between complementary, sometimes disparate fields, supported by new and emerging tools and technologies, and informed through the geologic record.

Active Tectonics research proposals may well be marked by a number of distinctive characteristics, but above all by high potential for meaningful integration of multiple disciplines; demonstrated capability of measuring dynamic-earth properties that are directly relevant to understanding specific tectonic processes; clever designation of an actively deforming region or subregion where certain dynamic activities can be observed/measured; ability to integrate models of new understanding of active tectonic processes into tectonic synthesis; and potential for transfer to societal outreach in such arenas as hazards, resources, and environment and global change.

Next Fall at GSA Seattle there will be a special symposium on FRONTIERS IN INTEGRATED ACTIVE TECTONICS RESEARCH. Bernard Minster and I are the convenors of this session, which is jointly sponsored by the Structure and Tectonics Division and the Geophysics Division of the GSA. We hope to provide a series of illustrative teameffort approaches, involving different disciplines, state-of-the-art technology, "bridging" between the geologic record and the actively (de)forming record, as well as societal/public policy implications.

Actively Yours,

George H. Davis and the Members of the Planning Team: Mike Bevis, Ron Blom, Mark Brandon, William Bull, Darrel Cowan, Roy Dokka, Jon Fink, Gene Humphreys, Arch Johnston, Thorne Lay, Larry Mayer, Marcia McNutt, Bernard Minster, Kerry Sieh, Robert Smith, John Sutter, Jan Tullis, Robert Yeats, and Mary Lou Zoback.

EDITOR'S COMMENT

We are continuing our efforts to provide you with a fun yet informative *Newsletter* and wish to thank those of you who have sent in materials for publication in the *Newsletter*. We particularly wish to thank Tom Wright and Carol Simpson for their continued efforts in writing the NSF NEWS column. However, we remain surprised by the small percentage of the Division membership who have responded. We need your help. The editors need information about career changes by you or others for the HAVE YOU HEARD? column. Our column on SYMPOSIA AND THEME SESSION SUMMARIES is rather short because we only received one summary. We have also been stymied in our STRUCTURE AND TECTONICS OVERSEAS column because of unkept promises to submit materials. Wouldn't it be great to hear more about Symposia and theme sessions, what our overseas colleagues are doing, or how funding is obtained in other countries? Talk to your colleagues and get them to write us. Please send us your letters, comments, or information for our various columns (e.g., Have You Heard?, The Resource Bin, Meeting Announcements, Grant Deadlines, Symposia/Theme Session Summaries, etc.). We also welcome suggestions for other types of material that you would find useful in future Newsletters. Call us, write to us, send us e-mail, or fax messages, use the Pony Express. But DO SOMETHING. If you don't talk to us, that's

just more time we have to talk to each other. The deadline for inclusion of materials in the next issue is July 1, 1992. Please send lengthy items on a Mac floppy if possible. Greg Davis: Phone - (213) 740-6726, Fax: (213) 740-8801; e-mail: davis@coda.usc.edu; Scott Paterson: Phone- (213) 740-6103, e-mail - Scott@coda.usc.edu.

HAVE YOU HEARD ... ?

Itнs quiet out there folks. Not a lot to pass on to you about members of the Division, despite our efforts to glean items from across the country. Youнd think there was an employment recession on, or something like one....

Faculty appointments -- only a few that weнve heard of. *Tekla Harms* has joined the faculty at Amherst College and, on the opposite coast, *Joseph Hull* has been appointed Professor of Geology at Seattle Central Community College. A much-sought-after faculty position at the University of Texas, Austin, has now been filled by *Jim Connelly* (a recent Ph.D. from Memorial University, Newfoundland), whose specialties are U/Pb geochronology and structural geology of the Grenville orogen. *Elizabeth McClellan* (Ph.D., '93, Tennessee) has been successful in receiving a one-year appointment at Western Kentucky University in Bowling Green. Filling another short-term position -- this one at Middlebury College -- is *Kim Hannula* (Ph.D., Stanford). *Allen Dennis*, Univ. South Carolina-Aiken, has been promoted from Instructor to the tenure-track rank of Assistant Prof.

Out west, *Hugh Hurlow* (Ph.D., Washington) is in the midst of a one year sabbatical replacement at the University of Montana, and over in nearby Pocatello, *Joe Reese* (soon-to-be-Ph.D. at Texas) has just filled a sabbatical leave slot at Idaho State U. *Jeff Unruh* has been appointed as an Asst. Research Geologist in the Geology Department at U.C. Davis. Incidentally, *Eldridge Moores* of that department was elected to Fellowship in the American Association for the Advancement of Science not long ago. *David Ferrill* (Ph.D. Alabama, л91) has taken a structural geology position in the Center for Nuclear Waste Regulatory Analyses at the Southwest Research Institute in San Antonio; heнll be studying the regional structure of the Yucca Mtn. waste site. Advance Resources International in Denver has just hired *Tom Hoak* (Ph.D., л94, UT-Austin) for tectonic basin analysis. Post-doc news? A bit. *Allen McGrew* (Ph.D., л92, Wyoming) is now at Leeds University in the second year of a NSF Post-doctoral Fellowship, and his former classmate *Karl Mueller* (Ph.D., л92) is at Princeton, post-docнing with *John Suppe*.

From various Canadian sources we have learned of a number of awards worth mentioning. The GACнs Structural Geology and Tectonics Division has given its 1993 Best Paper Award to *Sean Willet, C. Beaumont*, and *P. Fullsack*, all of Dalhousie U., for their paper мMechanical models for the tectonics of doubly vergent compressional orogenso (Geology, 21, 371-374). *Jeroen van Gool* of Memorial University won the Divisionнs Best Thesis Award for his dissertation entitled мThe Grenville Front foreland fold-and-thrust Belt in SW Labrador: Mid-crustal structural and metamorphic configuration of a Proterozoic orogenic thrust wedge.o The 1993 Canadian Governor Generalнs Gold Medal for outstanding achievement in graduate research has been won by *Shoufa Lin*, who is currently a post-doc at the GSC and a former student of Paul *Williams* at the Univ. of New Brunswick.

Bob Hatcher, 1993 GSA President, has passed the pick to *Bill Dickinson*, another Division member, who will lead us through '94. Gordon Eaton, current director of the Lamont-Doherty Earth Observatory has been nominated by President Clinton to be the twelth Director of the U.S. Geological Survey. Although not a Division member, USGS geologist *Bruce мBiffo Read*, a pioneer in Alaskan field mapping (Brooks Range) and an expert on tin deposits has passed away.

Having run out of people stuff, letнs talk science! Have you heard how rapidly dikes can develop above magma chambers? Modeling of a 1991 fissure eruption of Hekla volcano in Iceland by a team from the Carnegie Institution of Washington and the Icelandic Meteorological Office produced some interesting results (reported in *EOS* last year, **74**, 540-1). The team concluded that a roughly spheroidal magma chamber, with a diameter of 5 km and its top at 4 km depth, lay centered below the fissure-to-be. Primarily from an analysis of subsurface strainmeters, the team concluded that dike propagation (and magma movement) from the roof of the chamber to the surface took only 30 minutes, although the dike continued to extend laterally for another 90 minutes. The dikeнs final dimensions were calculated to be about 4 km long and 0.85 m wide -- consistent with observed thicknesses of other dikes in the area.

Question: what are you supposed to do when you find yourself on top of such a propagating dike and fissure system? Answer: youнre going to be glad you read this column. The U. S. Government in an article entitled мWhat to do when a volcano eruptso (*Earthquake Information Bulletin*, 1980, **12**, 161) offers sage advice, from which the following verbatim excerpts are extracted. (1) мMost important, donнt panic -- keep calmo; (2) мIf volcanic ash begins to fall, stay indoorso; (3) мWhen air is full of ash, keep your eyes closed as much as possibleo; and (4), my favorite, мDURING AN ERUPTION MOVE AWAY FROM A VOLCANO, NOT TOWARD ITo (their caps, not mine!). Future visitors to Hekla are advised to cut out this paragraph from their *Newsletter* and carry it with them at all times.

It wasnнt volcanic eruptions that the people of southern California were concerned about last January (although the news has been so bad from here lately that an eruption probably wouldnнt attract much attention). The disastrous Northridge earthquake has dominated the news and our thoughts for weeks. So here, from inside the thrust belt, are some personal perspectives -- some serious and others not so serious.

This correspondent (GD) used to think that earthquakes are fun and exciting. I donнt think that they are fun anymore. I used to tell my friends and students -- with braggadocio -- that I wanted to be in LA when the oft-predicted мBIG ONEo (with a magnitude of 8 or so) visits us. I no longer feel that way. I realize now that this former good-natured attitude toward earthquakes stemmed solely from my good fortune over the years to have been safely distant from the epicenters of past Californian tremors. I had been in Seattle during the 1971 Sylmar event, had flown out of San Francisco airport just four hours before Loma Prieta, and even the Landers earthquake -- the largest on the planet in 1992 -- had produce intensities in my San Fernando Valley neighborhood of only V or VI. Earthquakes were fun, exciting, and made great lecture material for my courses.

January 17th changed that perspective. At 4:31 AM, I and several million of my closest neighbors awoke to the most frightening event of most of our lives. Jarred from deep sleep, I knew instantly that the demonic shaking of my Valley condo was earthquake-

induced and I knew it was going to be bad ... very bad. In total city-wide darkness, my three-story building shook and flexed and rolled with a ferocity so unimagineable to me that I knew it would fail. A horrendously loud and ugly cacophony -- the dissonant, overprinted sounds of furniture toppling, glass breaking, wood flexing, screams coming from an adjacent condo, and car alarms blaring -- accompanied the intense lurching and vibration of the building around me. With a flashlight from my bedside in hand I ran down my swaying stairs to save from falling a living room cabinet filled with prized art glass. It was not a smart thing to do, but it was what I had focused on in the midst of a situation over which I had no other control whatsoever. Quickly, but not as abruptly as they had started, the shaking and noises lessened, then ceased. With heart pounding I stood in the almost quiet darkness beside the rescued cabinet and surveyed my littered, tumbled living room. I remember my wonderment then -- a feeling that continues to this day three weeks later -- that my home was still standing and that structurally it had survived essentially undamaged. Just two blocks away and also ten miles from the earthquakeнs epicenter, a major freeway interchange had suffered heavy damage and come near to collapse. Four blocks distant a large apartment complex was to be condemned before the day was over. I had been lucky.

The Northridge earthquake. 25-30 seconds duration. 57 deaths. 9300 injuries. 10,000 jobs lost. 5700 mobile homes knocked off their foundations and another 240 burned when ruptured gas lines were ignited. 13,000 buildings destroyed or severely damaged. 22,000 dwelling units ordered vacated. 51,600 residences damaged to some extent. 55,000 persons left homeless, at least temporarily. 304,000 people seeking financial aid. More than 10 billions of dollars of damage, and several million bruised states of mind -- mine being one.

The мBIG ONEo? Still wanna be here when it comes Greg? -- all two or three minutes of it?

Thanks, but Iнll pass. Earthquakes just arenнt fun anymore. And now I know, the big ones never were .....

* * * * *

..... but, as with all such dire events there can be found a lighter side (with thanks to Steve Harveyнs column in the *LA Times* for some of the anectodal material).

Sign on the front of a condemned San Fernando Valley apartment house: "The fat lady has sung." Quote from a radio traffic announcer after the earthquake: мThe traffic is stopped, but the freeways are moving.o A pre-earthquake мFor Saleo sign on a damaged home in Northridge is joined by a hand-lettered notice: мSome Assembly Required.o And, to the south in heavily battered Sherman Oaks, a barber shop announces itнs open for business with this notice: мShake and a haircut, two bricks!o That same Sherman Oaks community is shown on a *TIME* magazine map of the earthquake-affected area (1/31) as lying some 10 miles south of its pre-quake location. I knew the earthquake was big, but ..... !!! Other relocations: now that Cal Tech and USGS scientists have decided that the earthquakeнs epicenter actually lies in the community of Reseda, just south of Northridge, some Resedans want the мNorthridgeo quake renamed in honor of their town. Talk about civic pride! No name changes, say the seismologists, who argue that most of the deep part of the causative fault (whichever one it is) lies below Northridge. They are being charged by some Resedan activists as

favoring the Northridge moniker because Northridge, unlike Reseda, is an up-scale community (about a 6.8 on the up-scale seems right). I would guess that those Resedans who are trying to sell their homes and move to Nebraska (or other flatland locales) are more than happy to disclaim the prestige of having a disastrous earthquake named after their community. [Actually ..... мNorthridgeo really does sound better!]

Itнs one thing to argue about the name of the earthquake, but its a scientifically more serious matter to identify which fault produced it. Because the fault is a blind thrust -- i.e. one that did not break through to the earthнs surface -- its exact identity is in doubt. At various times in the two weeks following the quake, various seismologists and geologists tentatively identified the culprit structure as the Oak Ridge fault, the Devonshire fault, the Frew fault, the Elysian Park fault, and the Pico thrust. The public and the press became increasingly puzzled by the series of conflicting interpretations. In exasperation, Cal Tech seismologist Egil Hauksson is quoted in the Valley *Daily News* (1/28) as saying in response to a reporterнs question about the name of the fault, мWe have discussed this at length. We donнt see a reason to name it. What weнre dealing with here is a whole system of thrust faults that stretches 150 miles along the base of the Transverse mountain ranges. Itнs impossible to name them all.o Aw come on guys, give the public a break and name the damn thing! Even if you call it мRalpho, or maybe мTriciao (which sounds a bit gentler). After all, we name hurricanes and tornadoes, and weнre not much fond of them either. Give it a name! For our collective peace of mind, we demand it!

It is common in the media to refer to major unanticipated events that threaten societal well-being as giving us a мwake-up callo for some kind of subsequent needed action. A мwake-up callo is exactly what Mom Nature has been doing to us in the greater LA area over the past four decades. Not only did Ralph and the Northridge quake awake us at 4:31 AM, but since 1952 we have been awakened at 4:58 (Landers, л92), 4:52 (Arvin-Tehachapi, 1952), 6:00 (Sylmar, 1971), 7:42 (Whittier (л87), 7:43 (Sierra Madre, л91), and at 8:00 (Big Bear, л92). Whatнs more, the three largest of this group (Arvin-Tehachapi, M = 7.7; Landers, 7.5; Northridge = 6.8) all alarmed us in the half-hour period between 4:30 and 5:00 AM. Surely, thereнs something here for the seismologists to ponder! Actually they have, and their conclusion is that thereнs no conclusion to be drawn -- itнsjust coincidence. After all, the 1933 Long Beach earthquake happened at 5:54 .... PM. Hmmmm, I'm not convinced.

Weird damage effects: the Anheuser-Busch company reports that the Northridge (aka мResedao) quake destroyed 400,000 cases of beer at their Valley plant and warehouse. Thats 9,600,00 bottles of brew! Think of all the foam! Were the brewery workers who cleaned up the fumey mess мbuschedo at the end of their day? This was also not a kind event for librarians. Nearly 1,000,000 volumes toppled to the floor at the various libraries of UCLA -- 600,000 books at the Research Library alone! 350,000 volumes filled the aisles of the Santa Monica public library. Only 150,000 books will need reshelving in the Burbank city library. Incidentally, in my neighborhood, books on bookshelves oriented east and west toppled; those with north-south orientations generally didnнt. Valley librarians take note!

In defense of Mom Nature and her motives: evangelist Pat Robertson has hinted that perhaps the Northridge earthquake is Godнs way of teaching the sinful people of southern California a lesson. Not likely, says one reader of the *LA Times*: мThe fault-

riddled earth under Southern California would have shaken whether we were here or not.o Amen! Pat, get real! In closing, letнs keep earthquake dangers in perspective. The same *Times* reader (above) proposes her candidate for this monthнs bumper sticker: мEarthquakes Donнt Kill People, Man-Made Objects Do!o As for living in LA-LA-land, a cartoon by Brookins from the *Richland Times-Dispatch* says it all. A couple, she with cat in lap and he with beer in hand, sit beside their television set amidst the rubble of their former home. мGang warfare,o she says, мriots, high taxes, traffic gridlock, pollution, droughts, wildfires, mudslides, earthquakes! ... Why donнt we just LEAVE California?! ...o мWhat?!,o he answers, мand give up the good life?!o
[editorнs note: she forgot floods and unemployment.]

HANTAAN VIRUS ALERT

We all remember the outbreak last May of a severe respiratory disease that took the lives of l6 people in the Four Corners region of New Mexico. That disease was quickly identified by the Center for Disease Control as being caused by a species of hantavirus, a family of rodent-borne viruses known to infect thousands of east Asians with hemorrhagic kidney disease each year. Although a hantavirus had been found in U.S. rodents by NIH researchers in 1982, it was was not thought to cause human disease. The American virus is now known to be carried by the common deer mouse *Peromyscus maniculatus* , a resident of nearly all of the U.S. except the Southeast; a different rodent, perhaps the cotton mouse (*P. gossypinus*), may be responsible for Hantaan virus deaths in Florida and Louisiana. Cases of hantaviral disease probably related to *P. maniculatus* have been reported widely outside of the Four Corners area (where 30% of tested mice were found to be infected by the virus): Texas, California, Arizona, Idaho, Nevada, the Dakotas, and Montana. New cases are being documented in other areas and no part of the country should, at present, be considered exempt from the disease. The American species of Hantaan virus produces rapid and severe respiratory distress after initial flu-like symptoms of fever and muscle aches. The mortality rate for infected persons appears to be very high, and it is likely that many past cases of unexplained respiratory failure may be attributable to the virus. There is much to be learned about the virus(es) and their host animals.

The Hantaan virus is shed to the environment in rodent feces, urine, and saliva. Persons become ill after coming in direct or close contact with the deer mouse or by breathing dust contaminated with the rodent's excrement or saliva. The USC Safety Department in a Health and Safety Information Bulletin advises the following precautions for persons finding themselves in mouse-infested areas (unfortunately, most outdoor areas where geologists do their fieldwork):

1) Avoid contact with rodents, rodent nests, feces, or contaminated material.
2) Do not use buildings or enclosed shelters that are infested with rodents. If you must use these buildings, maintain ventilation by opening doors and windows for at least 30 minutes.
3) If possible, do not sleep on the bare ground.
4) Pitch tents in daylight to ensure the area is free of rodent infestation
5) Keep food in rodent-proof containers.
6) Clean your area after eating and properly dispose of garbage.

7) Carry bottled water for drinking, cooking, and washing.
8) Do not enter caves, buildings, or other spaces infested with rodents without wearing a mask to prevent the inhalation of virus from the dust particles
If you have been doing fieldwork in areas where you have seen evidence of rodent habitation and you develop flu-like systems or shortness of breath, **don't delay in seeking medical attention**. The hantaviral disease can quickly produce edema in the lungs and total respiratory collapse leading to death. Present treatment of the disease is limited, often involving putting the infected person on a respirator. No vaccine against the disease is available, although at least one hantavirus vaccine is currently being tested.

SYMPOSIA OR THEME SESSION SUMMARIES

What Can We Learn From Structures In Plutons?

The significance of a large number of diverse structural, petrographic and geochemical features found within plutons, and their bearing on our understanding of magma emplacement, were the central topics of discussion at a well attended theme session entitled "Pluton Interiors: Structure and Dynamics" at the October 1993 GSA AGM in Boston. A number of important themes emerged from the 22 papers that were given. What do fabric and compositional zoning patterns tell us about the roles of diapiric and fracture transport mechanisms in the assembly of plutons? How does regional and local extension facilitate the emplacement of magma and what can we look for to evaluate it? What can we glean about magma flow from preferred orientations of minerals, elliptical enclaves and schlieren? How can we use information on syn- and postcrystallization histories to understand the textural evolution of magmatic rocks?

Field-based studies indicate that many potential mechanisms may operate during the assembly of large, elliptical felsic plutons. B. John & J. Blundy's work on the Adamello Massif and R. Rector's analysis of the Long Potrero Pluton suggest that the concentric zoning and structural patterns in these intrusions resulted from combinations of both diapiric/forceful emplacement mechanisms as well as passive stoping. More complex spatial compositional variations in the Lee Vining Diorite are considered by T. McCarthy & T. Furman to have their origins in petrological processes at depth and that this pluton was assembled by injection of a number of "colonies" of different composition. Two adjacent, almost identical foliation "cells" mapped in the Yakushima pluton by R. Anma, together with the geometry of its wall-rock structure, were taken to indicate a diapiric emplacement mechanism. These observations contrasted with those of A. Cruden, P. Launeau & O. Tobisch who used the anisotropy of magnetic susceptibility technique to determine magnetic foliations and lineations in the Dinkey Creek pluton. They found that lineation trajectories converge toward a number of linear zones that can be interpreted as dyke-like feeder structures.

It is clear that more theoretical and experimental work is required to fully understand the complex structural and compositional patterns displayed by plutons. R. Weinberg presented theoretical solutions to the problem of diapiric ascent in which both the ascending material and the surrounding wall-rock behave with a non-Newtonian rheology. He showed that diapiric ascent is much faster than in the Newtonian case and that the resulting strain-rate variations in the diapir and wallrock may result in the strain patterns observed in and around some natural plutons. The conditions under which

large magma chambers can undergo thermal convection were studied by G. Jacobs, M. Naney & N. Dunbar who measured changes in the temperature field within a cooling, artificial, 5 m3 magma chamber. An important observation for fabric studies is that the vigour of convection appeared to decrease near the liquidus and that it ceased when the melt contained 25 crystals.

The influence of regional deformation on pluton emplacement, and specifically how, and the evidence for, local extension in "space creation," is becoming an important issue in tectonics. S. Paterson & K. Fowler argued that emplacement into extensional environments must be incremental in nature and that plutons emplaced this way should show corresponding internal features, such as sheeting. Evidence for sheetlike assembly in a compressional environment was provided by P. Simony & D. Halwas who showed that the Kinnaird pluton is made up of multiple horizontal sheets, possibly emplaced by roof lifting. Examples of intrusions made up of vertical sheets are the Jackass Lakes pluton (B. McNulty & W. Tong) and the Colombourg pluton (E. Chown & R. Daigneault) which was emplaced syn-kinematically between two dextral strike-slip faults. A more complex interplay between regional deformation, emplacement and fabric development was reported by E. Kirby & K. Karlstrom from the Sandia pluton, interpreted to have been emplaced in a transpressional regime, and in the Odenwald Metamorphic complex (A. Krogh) where plutons have intruded into a strike-slip fault zone. Both studies are examples of how detailed observations of meso- and microstructures, to determine the physical state and P-T conditions of the materials during fabric formation, as well as documentation of brittle features such as dykes and veins can be integrated to determine the interactions between local and regional strain fields during pluton emplacement.

The significance and interpretation of a number of "magmatic" structures within plutons was discussed in 6 presentations. Results of mathematical modelling of how grains interact during flow of a crystal-laden suspension were presented by C. Teyssier, B. Tikoff & M de Saint Blanquat. This type of work, coupled with observations of natural textures, provides insights into how plutons deform in both magmatic-, solid- and transitional-states and how collisions between grains lead to imbricate structures, a potential kinematic indicator. A different modelling approach was taken by W. Means & Y. Park who studied the deformation of a thiocyanate "analogue" magma. The presence of even small amounts of melt allows large strains to be accumulated by contact melting and grain-boundary sliding mechanisms, without the development of a strong preferred orientation. Conversely, segmentation of dendritic crystals may result in strong local fabrics, without strain. These results force us to re-evaluate conventional notions about fabric development in deforming magmas. Using examples from the Main Donegal granite, S. Yuan & S. Paterson questioned the interpretation of magmatic foliations and lineations as flow planes and lines. They argued that the only unequivocal paleo-flow planes in magmatic rocks are features like intrusive contacts and igneous layering, whereas foliations and lineations are often imposed, post- or synemplacement, strain features.

Elliptical microgranular enclaves are often interpreted as products of incomplete mixing (mingling) between magmas. J. Reid & R. Vernon compared mafic-felsic interactions in a volcanic and a plutonic environment. The short lived, rapidly cooled volcanic flow shows complete mixing at the hand sample scale, but mingling at the microscale. The

plutonic rocks are mingled at the outcrop scale, suggesting that many textures may be erased by thorough stirring and slow cooling. The use of enclaves as strain markers was evaluated by O. Tobisch, A. Cruden & M. O'Keefe by examining the finite strain and magnetic fabrics of enclave populations in the Dinkey Creek pluton. Enclaves with serrated boundaries were probably introduced late in the crystallization history of the host and give a reasonable estimate of its magmatic strain state. Enclaves with smooth boundaries are interpreted to have been incorporated, strained and quenched at earlier stages and behaved only as rigid markers during the final increments of flow. An intriguing type of schlieren structure was described by D. Murray, J. Reid & O. Hermes from the Tuolumne Intrusive Suite and the Mount Givens granodiorite. These "ladder dykes" are interpreted as planar channels or scours in a partially to fully crystallized substrate within the magma chamber. They become progressively filled by relatively dense minerals as magma flows through and over the channel, resulting in rhythmic graded bedding, which can potentially be used as a magmatic way-up and paleocurrent indicator.

Syn- and post-crystallization textures provide important additional information on the history of intrusive bodies. For example, the potential of using crystal size distribution theory for understanding the crystal growth process in magmas was illustrated by R. Resmini & B. Marsh. Coupling this type of CSD data with kinematic studies should be an important area for future understanding of fabric forming mechanisms in plutonic rocks. The effects of late-stage fluid migration in the Capitan pluton were discussed by N. Dunbar, A. Campbell & P. Candela. They showed that volatile exsolution during, or dissolution after, crystallization can profoundly modify the texture and chemistry of a pluton, and that planar pathways of fluid-flow can have an external, tectonic control.

Many aspects of "The Granite Problem" are still with us after more than 200 years of research. One theme that became apparent from this special session was that considerable advances are being, and can be made by the integration of structural, petrological and geophysical approaches. Such new and fresh observations, coupled with modelling studies indicate that we (hopefully) have another 200 years of exciting research to be done in the field of "granitology".

Alexander R. Cruden Othmar T. Tobisch
Dept. of Geology, University of Toronto and Earth Science Board
Mississauga, Ontario L5L IC6 University of California
Santa Cruz, CA 95064

1994-GRANT APPLICATION DEADLINES (Subject to Change)

National Science Foundation (Earth Sciences) ..... June 1
National Science Foundation (Ocean Sciences) ..... May 1

Petroleum Research Fund ..... July 31
USGS National Earthquakes Hazard Reduction Program ..... April 15
NASA (Planetary Geology, Geophysics) ..... April 22

Society of the Sigma Xi (student grants) ..... May 1

ANNOUNCEMENTS

1994 Annual GSA Meeting, Seattle October 24-27

The Seattle meeting will feature a program of interest to all Division members. The keynote symposium will address "The Birth and Death of a Plate" -- the geological and geophysical conditions attending the creation of oceanic lithosphere and its modification during subduction. The Division symposium highlights "New Frontiers in Active Tectonics Science" You will want to attend proposed theme sessions on: the seismic character and tectonics of the Cascadia subduction zone; relationships between diagenesis and deformation; tectonics and landforms around the Pacific Rim; active collision in Taiwan; the geologic development of Japan; rheological and structural evolution of contractional orogenic belts; the Baja B.C. controversy; teaching structural geology -- these are just a sample! The Division short course will teach you about the Global Positioning System (GPS) and its geological applications. Look for the April issue of GSA TODAY for a complete summary of the technical program and field trips. Cheers, Darrel Cowan

Paleoseismology Workshop, Tomales Bay, California, September

Task Group II-3 of the International Lithosphere Commission and the U.S. Geological Survey will hold a workshop on paleoseismology in September (18-22) at the Marconi Conference Center at Marshall, on Tomales Bay north of San Francisco. Among the issues to be addressed are: (1) recognition of paleoearthquakes in the geologic record; (2) Quaternary dating techniques applicable to the precise dating of paleoearthquakes and the estimation of fault slip rates; (3) models of earthquake occurrence and fault behavior. Persons interested in participating should write a letter of application to Robert S. Yeats, Geosciences, OSU, Corvallis, OR 97331 (e-mail: yeatsr@bcc.orst.edu) or to Carol Prentice, MS 977, USGS, 345 Middlefield Rd., Menlo Park, CA 94025 (e-mail: cprentice@isdmnl.wr.usgs.gov). Letters of invitation will be issued in the spring.

Geology of Wyoming: Geological Survey of Wyoming Memoir No. 5

Art Snoke would like to spread the word that the long-awaited "Geology of Wyoming" has now been published. This 2 volume set, edited by Snoke, Jim Steidtmann, and Sheila Roberts is dedicated to those pioneers of Wyoming geology, Don Blackstone, Jr., and J. David Love. Its contents: An overview by Snoke on the geologic history of Wyoming within the tectonic framework of the North American Cordillera; 3 papers on aspects of Archean and Proterozoic history; 2 on Paleozoic history; 4 on Mesozoic sedimentation and tectonics; 10 contributions on Cenozoic geology; and 7 topical papers with emphasis on economic geology. The volume (plus maps in pocket) can be ordered, prepaid, through: Dept. of Geology and Geophysics, University of Wyoming, Laramie, WY 82071-3006 (phone 307-766-3386). The price: $75 plus postage ($5, Wyo. + 5% sales tax; $10 other US; $20, International including Canada). Credit cards not accepted.

FUTURE MEETINGS, CONFERENCES, AND COURSES
[Notices of future events of interest to Division members are welcomed by the editors]

1994
April 21-26: Triple junction interactions at convergent plate margins (Penrose Conference): Eureka, CA [contact: Lois Elms, 4881 Evening Sun Lane, Colorado Springs, CO 80917; phone (719) 597-9201; fax (719) 591-4852].
April 25-30: VII international syposium on the observation of the continental crust through drilling (with pre- and post-conference field trips to California, Creede caldera and San Juan volcanic field, Colorado, and the Newark Basin): Santa Fe, New Mexico [contact: Earl Hoskins, DOSECC, College of Geosciences & Maritime Studies, Texas A&M, College Station, TX 77843-3148; phone (409) 845-3651; fax (409) 845-0056]. Tentative themes of special interest include "Active tectonic processes," "Thermal regimes," and "Evolution of continental lithosphere." Abst. deadline: Jan. 15. Sign-up deadline for pre- and post-meeting field trips: Oct. 1. Registration fees: $450 after March 1; student fee, $50.
May 9-12: Geologic remote sensing tenth thematic conference: San Antonio, TX [see *GSA Today*, December, 1993].
June 1-3: lst North American rock mechanics symposium (international conference with pre- and post-meeting field trips to the Superconducting Super Collider site): Austin, TX [sponsors: U.S. Natl. Comm. on Rock Mechanics, Sociedad Mexicana de Mecanica de Rocas, and the Canadian Rock Mechanics Assoc.; contact: Priscilla Nelson, phone (512) 471-5664, or Stephen Laubach, fax (512) 471-0140, or write to: NARM Symposium, Continuing Education Studies, Cockrell Hall 10.324, Univ. Texas, Austin, TX 78712].
June 6-7: Weddell Sea tectonics and Gondwana breakup (meeting): Cambridge, U.K. [sponsor: British Antarctic Survey; contact: Edward King, B.A.S., High Cross, Madingley Rd., Cambridge, CB3 0ET, UK; phone 44-22-361188; fax 44-22-362616]. Aim of meeting is to bring together those working on tectonic problems related to the breakup of Gondwana in the Weddell sea sector.
July 10-14: Earthquake engineering (meeting): Chicago [Earthquake Engineering Research Institute, Suite 320, 499 14th St., Oakland, CA 94612-1902; phone (510) 451-0905; fax (510) 451-5411, or contact: Claudia Cook, Newmark Civil Engineering Laboratory, Univ. of Illinois, 205 N. Mathews, Urbana, IL 61801-2397; phone (217) 333-0498].
July 25-29: 11th International Conference on Basement Tectonics: Potsdam, Germany [contact: Onno Oncken, GeoForschungZentrum, Telegrafenberg, D-O-1561 Potsdam, Germany; phone, 49-331-310601; fax, 49-331-310306]. Some major topics: continental scale features of basement rocks of Phanerozoic cratons; correlations of geological and geophysical data from basement rocks; mechanism and processes of tectonic decoupling of crustal layers; the role of basement exhumation in the evolution of orogenic belts.
August 29-Sept. 1: Proterozoic crustal and metallogenic evolution: Windhoek, Namibia [see *GSA Today*, December, 1993].
Sept. 5-9: International conference on Arctic margins: Magadan, Russia [see *GSA Today*, December, 1993].

Sept. 11-15: First international airborne remote sensing conference and exhibition: Strasbourg, France [see *GSA Today*, December, 1993].
Sept. 12-16: International volcanological congress: Ankara, Turkey [contact: Ayla Tankut, Dept. of Geological Engineering, Middle East Technical Univ., 06531, Ankara; phone 90-4-210-1000, exts. 2682, 2679; fax 90-4-210-1263].
Sept. 13-17: Precambrian crustal evolution in the North Atlantic regions (international symposium): Nottingham, U.K. [sponsor: ICGP Project 275; contact: T. S. Brewer, Dept. of Mineral Resources Engineering, Univ. of Nottingham, University Park, Nottingham NG7 2RD, UK; phone +44-602-514111; fax +44-602-678495].
Sept. 18-22: Workshop on paleoseismicity: Marshall, California [sponsors: International Lithosphere Commission and U. S. Geological Survey; see announcement elsewhere in this *Newsletter*].
Sept. 26-30: 12th Australian Geological Convention: Perth, Australia [see *GSA Today*, December, 1993].
Oct. 24-27: Annual GSA meeting: Seattle, Washington. Call GSA Meetings Department, (800) 472-1988 or (303) 447-2020 for information.
Nov. 15-17: Geology and resources of the eastern frontal belt, Ouachita Mtns., and SE Arkoma Basin, OK (one-day workshop and papers; two-day field trip): Poteau Oklahoma [sponsor: Oklahoma Geological Survey; contact Neil Suneson, O.G.S., Sarkeys Energy Cntr., Rm. N-131, 100 E. Boyd St., Norman, OK 73019-0628].

1995
April 10-13: Geology and ore deposits of the North American Cordillera (symposium and field trips): Reno/Sparks, Nev. [sponsors: Geol. Soc. of Nevada, U.S.G.S; contact: Geol. Society of Nevada, P. O. Box 12021, Reno, NV 89510; phone, (702) 323-4569, fax (702) 784-1766. The symposium will focus on the metallogeny of the American Cordillera from the Precambrian to the present, and the role that depositional, tectonic, and magmatic events have played in the formation of ore deposits of the region. Abstract deadline: April 1, 1994; accepted paper deadline: Oct. 1.
August 28-Sept. 1: Tectonics and metallogeny of early Precambrian orogenic belts (international meeting): Montreal, Canada [contact: John Percival, Geol. Survey of Canada, 601 Booth St., Ottawa, Ontarion K1A 0E8; fax (613) 995-9273, or John Ludden, Univ. du Quйbec a Montrйal, Quebec, H3C 3J7; fax (514) 343-5782].

Photo Captions
For photo 1
Darrel Cowan (left) presenting Career Achievement Award to Ben Page.
For photo 2
Mark Cloos (right) presenting Best Paper Award to Dan Worrall (center) and Sig Snelson.