2001 GSA Presidential Address

Plate Boundaries to Politics: Pursuing Passions in Science

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INTRODUCTION

Our passion for science, for scientific discovery, is our common bond as geoscientists: searching for answers to the unknown, solving puzzles of the natural world, exploring the last frontier—scientific discovery. It is our passions that drive us to the far reaches of the globe to work under idyllic or harsh conditions, that keep us up late at night hunched over computers till we are bleary-eyed and so stiff we can hardly move, or arguing for hours over beer long since warm and forgotten. We come to GSA meetings to share the results of our scientific passions with friends, colleagues, students, and other geoscientists, but I submit that we need to broaden our audience to include public policy makers, the public, current and future educators, the media, and other scientists, as well as students and colleagues. Here, I discuss using our scientific passions in different forums and GSA's role, starting with politics and ending with plate boundaries.

PUBLIC POLICY

Thomas Jefferson once said, "Science is my passion; politics my duty." I find it inspiring that someone so well known for his political contributions fundamentally viewed himself as a scientist. Although we need not become president of the United States, now is a critical time for us as geoscientists to follow his lead and become politically aware and active. Numerous issues of importance to us have become political issues: evolution, natural-hazard planning, energy policy, climate change, environmental protection, research funding, and geoscience education, to name only a few. All of these and more have come up before Congress or state legislatures this past year. Regardless of your views on these issues, you have a stake in their outcome. The following examples are specific to the United States, but are also valid for other countries.

We have two primary reasons for being active. (1) We have knowledge that politicians need to make informed decisions: 50% of all bills that come before Congress have a scientific or technical component; 81% of U.S. policy goals include science and technology. Every day, members of Congress make decisions that impact the scientific community, yet few ever hear from scientists before voting. (2) Many of us depend on federal or state support for research funding or employment, either directly or indirectly. We have a vested interest in being politically active.

One common concern is scientific research funding. Opinion polls show that the public supports spending money on science; interest in science is at its all-time highest level (Fig. 1A and 1B). The public loves frontiers, recognizes the economic benefits of research, and approves of merit-based funding. People know that university-based (fundamental) research opens the door to other scientific developments that may be more directly useful to the average person. Public support for better science education also is high (Fig. 1C). The public recognizes the need for a next generation of highly skilled, well-trained scientists and engineers.

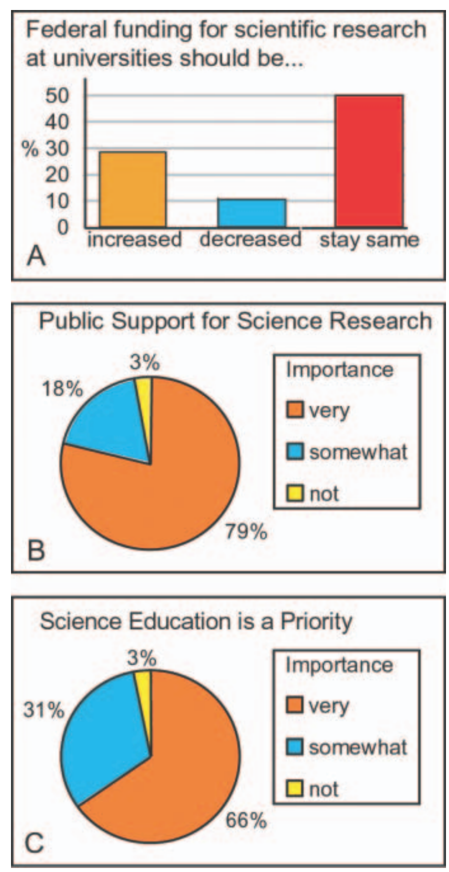


Figure 1. Results from public opinion polls. **A:** From Public Opinion Strategies, B. McInturff and E. Frontczak for The Science Coalition. **B, C:** From Research America, Aggregate 2000, Charlton Research Company.

This strong support, however, does not translate into letters, e-mails, and visits to Congress demanding increased funding! The National Institutes of Health budget has nearly doubled over the past five years because people have a personal stake in finding cures for diseases. One can strongly support university-based research funding, but it takes more than that to make people passionate enough to demand that funding be doubled over five years—that would bring us to the same level of funding we had in the 1960s. We should not feel guilty about asking for increased funding when there are so many other "real" needs in the United States; less than a nickel on every dollar goes into science and technology funding.

Individual Roles

We must bring our passion for science to public policy makers and we must make the public passionate about science so they will do so as well. What can one scientist do? Amazingly enough, congressmen listen to constituents, especially when they go home to their states or districts. Most make themselves available through town meetings or at local offices. When a scientist expresses his or her concerns about a specific issue, it makes a major impression. After all, you are a voter, and you obviously care about the issue. Visits to congressmen in Washington, D.C., or to a legislator in a state capital are effective, but local visits are said to have the most impact. The saying "All politics is local" is true. Also, one letter does matter if it is about a science issue. For social security, abortion, or other major hot-button issues, one letter doesn't make much difference. But for science issues, Congress and the president receive so few that one or two can make a significant difference.

Other helpful actions include writing a thank-you letter to your congressman when you receive a National Science Foundation or other federal agency grant. The letter should describe briefly what you were funded to study and how the research will help with science education, and, most important, it should thank him or her for past support of science research funding. Apparently, this is effective and appreciated. Or, invite politicians and the press to a photo opportunity, such as a new lab opening or special symposium. The public approves of science, and such opportunities provide a noncontroversial venue for the politician to look good.

We also need to work together with other scientists toward common goals. If scientists present a unified message, such as across-the-board increases in research funding, we will all win. We, as a profession, are very well respected. But we must remember that we all lose when we argue amongst ourselves to see who will get the biggest piece of the pie. Within the geosciences, we need to take a broad, united approach as well. We tend to be individualistic in our approach to science, and we do not actively support large cooperative projects, such as EarthScope. We should consider what is best for the advancement of the geosciences at large. Working together to tackle large fundamental problems is critical to making major progress. Plus, it is these large research projects that increase the overall awareness of the significance of the earth sciences, which in turn generates more funding overall.

What are our reasons for not being involved in politics? A recent poll by Sigma Xi indicates that we don't have time (74%), don't know how (50%), don't think it makes a difference (47%), and don't want to do it (41%). However, few of us don't care (25%) and even fewer think others are doing it well (15%). Thus, following Thomas Jefferson's lead, it is up to us to do our duty both for society and for ourselves.

GSA's Role

GSA is launching a public-policy list server (subscriber only) to provide you with information so that you know what the issues are, who to contact, and when contact would be timely. Help with effective ways to communicate will also be available. In 2002, GSA will start a public-policy speaker lecture series to try to

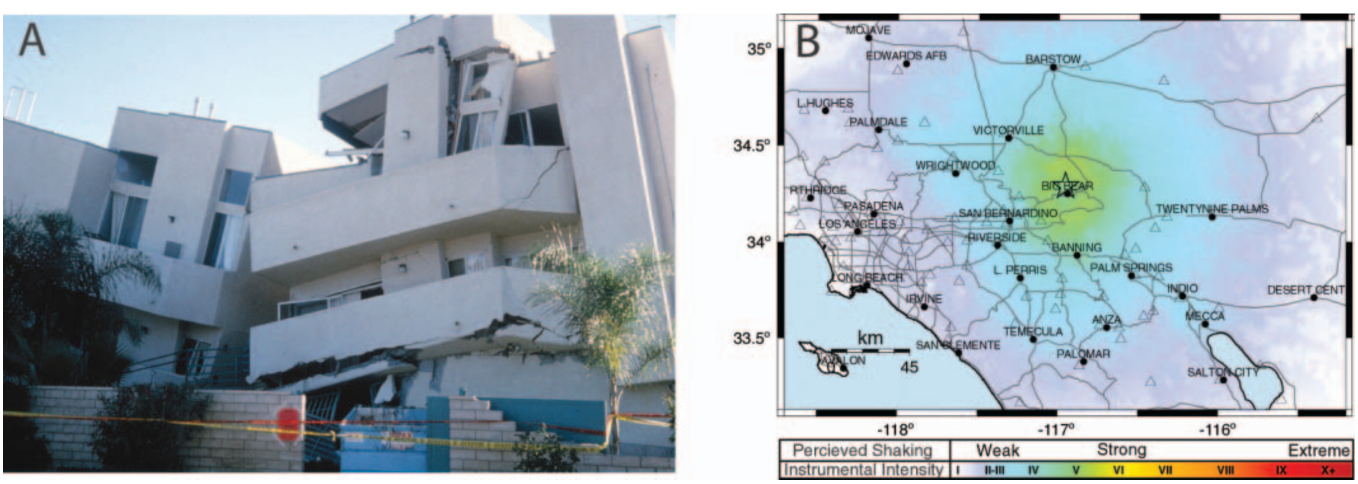


Figure 2. Earth science research addresses scientific problems and societal issues; understanding geologic processes is important for the public. **A:** Apartment building damaged during Northridge, California, 1994 earthquake. Photograph by Greg Davis. **B:** Shake maps produced from strong motion detectors are available within 5 minutes of an earthquake. These detectors provide seismologists with important scientific data and engineers with valuable intensity maps. In a major earthquake, such maps will be invaluable to emergency services dispatchers, fire, search and rescue teams, and utility companies. Big Bear Lake, California, February 10, 2001, earthquake; M 5.1. Green—most intense shaking. From TriNet Shake Map, Southern California Seismic Network.

encourage more young people to consider careers in public policy. Congressional staff members are young, and we want to increase the number of geoscientists on Capitol Hill.

EDUCATION AND OUTREACH

Education, defined in the broadest sense as education of the public, current and future educators, the media, public-policy makers, students, and other scientists, is another important forum for our scientific passions. Two primary reasons to be involved are that (1) earth science research can provide answers to major scientific and societal problems; and (2) an understanding of geologic processes helps the average citizen make informed decisions with respect to their daily lives and about scientific political issues (Fig. 2). As geoscientists, we need to learn to communicate our passion for and excitement about our science to others.

Most scientists, however, prefer to concentrate on research or professional activities and spending time on outreach or K–12 education is not even a consideration. And nearly all of us shy away from any contact with the press or public officials. We didn't get into science to do these things, and our time is precious. If we had wanted to interact with the public or politicians, we would have chosen a different profession.

We are concerned, however, when shopping malls are built on environmentally sensitive aquifers or hospitals on active faults. We are appalled when we find out what our own children are being taught—or not being taught, as is usually the case—at school. When the National Science Foundation's funding for fundamental research is cut, we hope the public and public officials will recognize that such cuts are detrimental to society and the economy. When lawmakers or voters make uninformed decisions regarding global warming, evolution, or flooding along the Mississippi, we wish someone would do something. It is up to us to educate the public. Once we do this, we will find influencing public policy makers much easier. We have the potential to make a major impact.

Individual Roles

We need to take every opportunity offered to educate the public through teaching current and future educators, through outreach initiatives, and through effective use of the media.

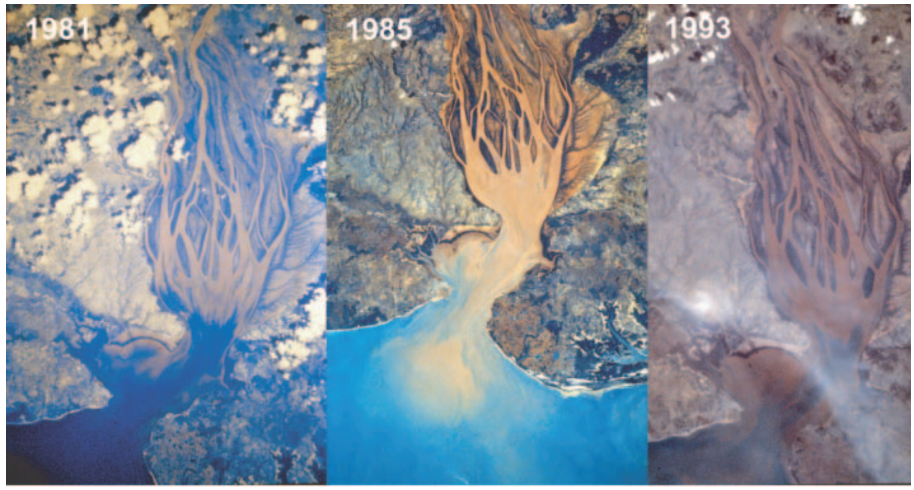


Figure 3. Betsiboka delta, Madagascar in 1981, 1985, 1993, showing increase in sediment supply to the delta. Over this period of time, 93% of the island was deforested. Space shuttle photographs, courtesy of NASA.

For those of us in academia, the easiest forum is a general course for nonmajors. I never had any interest in teaching nonscientists but was inspired to do so by Pete Palmer and GSA's SAGE (Science Awareness through Geoscience Education) program. About eight years ago, Gary Kocurek and I designed a course on everything a layperson needs to know to understand the world they live in and to make informed decisions. Called "Earth, Wind & Fire," it has reached more than 4,000 students. The course is different than most, and I present it here as a model of what we need to teach the general population.

In Earth, Wind & Fire, we concentrate on human interactions—the effects of geologic processes on humans and of humans on geologic processes. Hence, we cover a combination of natural hazards (volcanoes, earthquakes, landslides, flooding, coastal erosion; see Fig. 2), aquifers and hydrology, plate tectonics, evolution, environmental geology, and energy and mineral resources. We also cover climate and climate change, showing the complex interactions between the atmosphere, hydrosphere, biosphere, and geosphere. For example, when we discuss desertification, we point out its natural and human causes, how crop growth and changes in soil moisture affect local weather, how government policies contribute to desertification, and, most important, how it affects people. When we discuss deforestation, we include the effects on the atmosphere and local and long-term climate, but also the interplay with weathering and soil formation and the effects in terms of landslides and soil erosion (Fig. 3). The course is all process oriented, but geared specifically to the human element, with a reasonable dose of mitigation, prevention, prediction, and policy thrown in for good measure. We try to present a balanced approach to all these issues. Teaching a course like this is also something that all of us in academia can and should do. Trust me—it can be fun!

Your research can interest the public. Volunteer to talk to a local group such as a Rotary club or church group; give a university-sponsored outreach talk, or speak at a local school. Explain your ideas at a level that your neighbor, a teenager, or a freshman class will understand. All of the topics I listed above are of genuine interest to the average person. Talk to your neighbors, the parents of your children's friends—everyone you meet. Let people know what you do. Most people in the United States say they have never met a scientist! What do we do when we aren't at work, become invisible? Worried about the teaching of evolution? Teach children at Sunday school, the place where the ambiguities between belief and science arise. Apply your knowledge and passion wherever you can to educate.

Talking to the media is very important. The earth sciences are probably the easiest sell to the public because of the striking and newsworthy effects of geologic processes on people. The top news stories of the year generally have a geologic origin. Working with the media, we could capitalize on these to educate people on the importance of understanding geologic processes. Think how interested people are to read any news stories about space; astronomers and physicists capture the public's imagination with stories about black holes, the nature of the unidentified matter that makes up most of the universe, how fast galaxies are moving, and the implications for the origin of the universe. People would be just as fascinated about new discoveries related to seafloor spreading and magmatism and new discoveries from studies of hydrothermal vents that may help explain the origin of life and Earth's early atmosphere.

As scientists, we have problems talking to the media, the public, and public policy makers because we get caught up in uncertainties and incomplete data. By being too careful about what we say, we come off as being uncertain and are ignored. We can get around this problem by using probabilities, a concept that most of the public understands. Geoscientists have an additional problem; we think on such long time scales. If a geoscientist is asked about global warming, they may say Earth will compensate. The media pick this up, but they miss the point of how long it will take—that on a human time scale, the wait is not one we could live with.

GSA's Role

Our society should take an active leadership role in helping its members become more effective in these endeavors. Through workshops and meetings, we can be exposed to successful methods others have used to make an impact in teaching or outreach, stimulating us to do the same or to find new approaches. GSA can help us learn how and when to talk to the media. It can make sure that papers published and presented at meetings get good news coverage. GSA can also run education and outreach programs that accomplish multiple objectives we as individuals cannot achieve. GeoCorps America, which puts geologists in National Parks and National Forests, is an example of such a program.

As GSA members, we can serve as volunteers at varying levels of time commitment on outreach and education programs—just as we do for publications or meetings. And those of us who don't have the time or inclination but who understand the need can contribute financially to our society to help ensure that effective programs have adequate funding. When you get charitable solicitations to help find cures for various diseases, think about the size of the

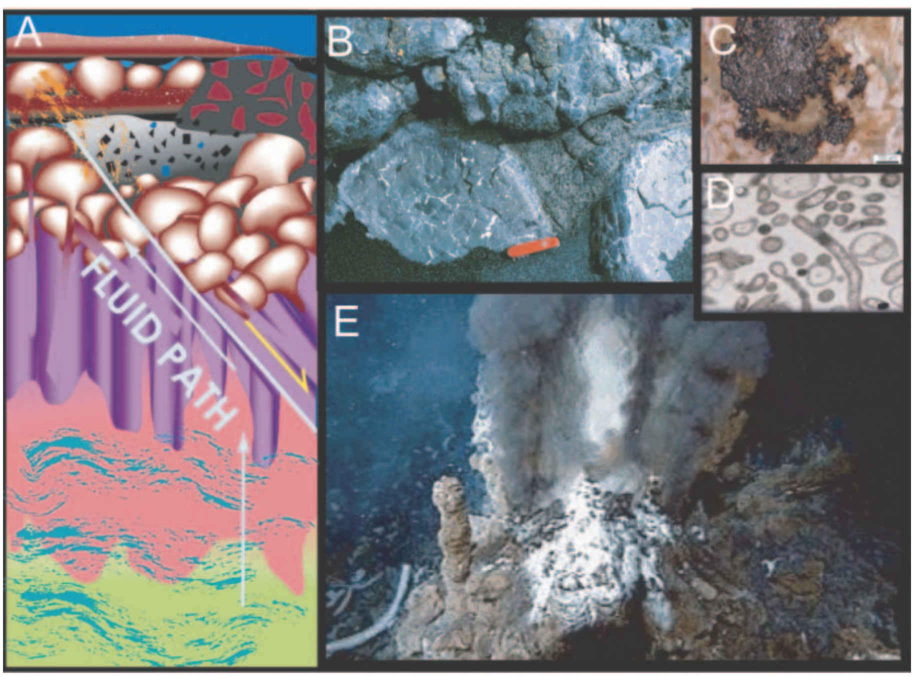


Figure 4. Oceanic spreading centers where processes of the geosphere, hydrosphere and biosphere become linked. **A:** Cross section of oceanic crust from peridotite to sediments, showing faulting of pillow lavas and sheeted dikes and localization of fluid flow that leads to hydrothermal vents. Drawing by Karah Wertz (Wertz et al., 2000). **B:** Pillow lavas. **C:** Massive sulphides (scale bar 100 µm). B,C from Macquarie Island. **D:** Chemosynthetic microbes form around high-temperature hydrothermal vents. **E:** Sulphide-rich hydrothermal vents. (D, E from NOAA Vents Program, NeMo [New Millennium Observatory]).

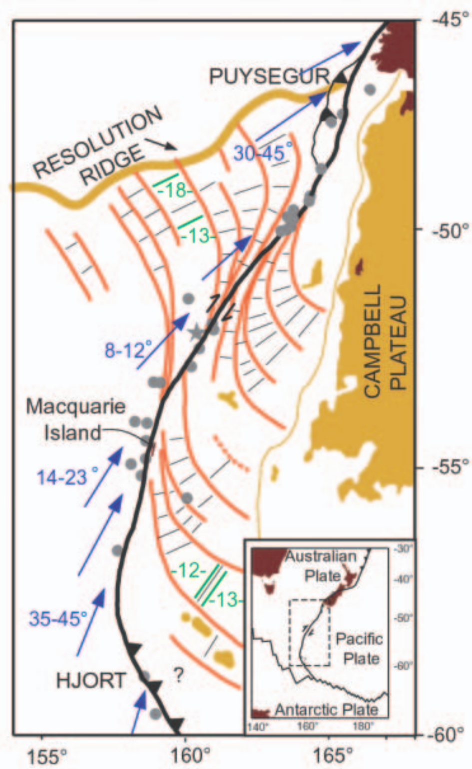


Figure 5. Present-day Pacific-Australian, dextral, transform plate boundary is also a relict spreading center. Current-day plate motion vectors (blue arrows, angles) show obliquity of motion; magnetic anomalies (green lines) young toward the boundary; fracture zones (red lines) become asymptotic to the current plate boundary; abyssal hill faults or spreading fabric (black lines) remain orthogonal to the fracture zones approaching the boundary. Gray dots—earthquake epicenters. Fracture zones and spreading fabric record oblique spreading between the rifted margins (Campbell Plateau and the Resolution Ridge). For location, see inset (dashed box). From Massell et al., 2000.

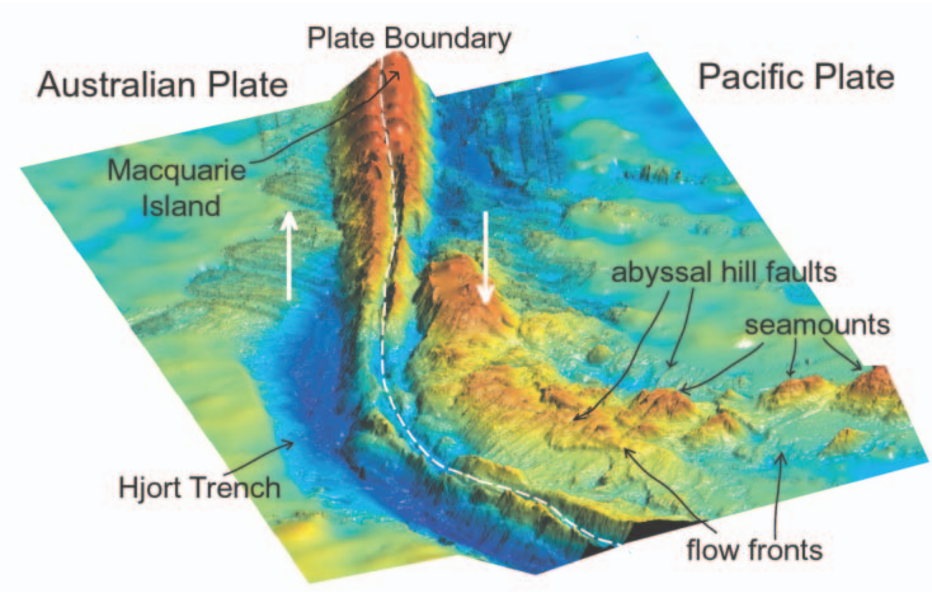


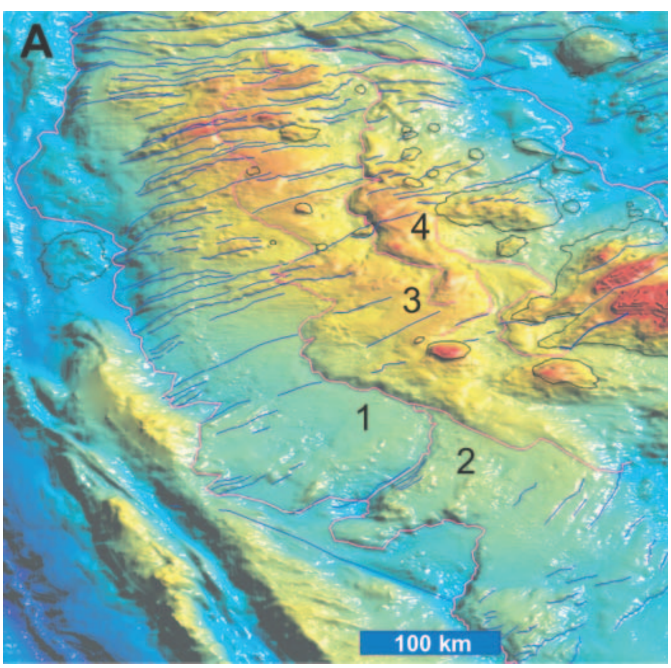
Figure 6. Pacific-Australian plate boundary south of New Zealand; 3-D seafloor bathymetry. Present-day dextral transform plate boundary is located in valley in center of ridge. Abyssal hill faults are at a high angle to plate boundary as a result of oblique spreading on relict spreading center (see Fig. 5). Note that abyssal hill faults near plate boundary cut volcanic flow fronts and seamounts (volcanoes), whereas farther from boundary (right) flows and volcanoes cover faults and are not dissected. Image merges bathymetry predicted from gravity (Smith and Sandwell, 1997) with detailed bathymetry from shipboard cruises. (Southern third of data collected by Australian Geological Survey Organisation from R/V *L'Alantate* 2000 cruise (Bernardel et al., 2000); northern two thirds of data collected by R/V *Rig Seismic* cruise 124 in 1994 (Massell et al., 2000); note ship tracks in northern data. Imaging courtesy of Geoscience Australia (Bernardel and Symonds, 2001; Meckel et al., 2001).

National Institutes for Health budget (over $20 billion for 2001), and give where your passion lies.

GSA is an ideal society to work with the public, media, educators, and public policy makers. It covers the broad range of geologic disciplines and represents both pure and applied scientists. Our members are both the exploiters and the environmentalists. But as geoscientists, we all know that exploration for mineral and energy resources is important and necessary, and we also understand the effects of this exploration and the need to protect the environment. So we as a society are uniquely poised to explain how to achieve this balanced need to the world.

INTERDISCIPLINARY SCIENCE

The joy of discovery is undoubtedly the greatest reward for pursuing our scientific passions. I have personally always had a passion for science. As a child, I started out by trying to make agates in my basement with a torn-up bicycle, an electrical motor, and a chemistry set. In graduate school, my passion was deformation by pressure solution—long before it



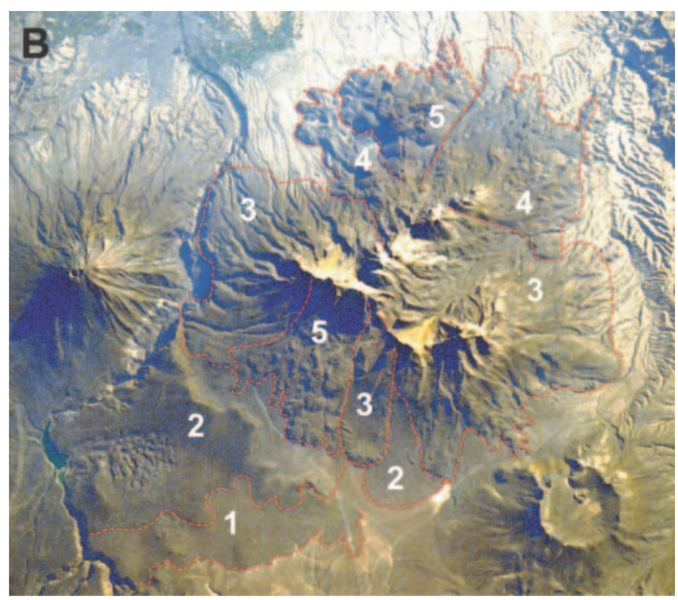


Figure 7. A: Three-dimensional seafloor bathymetry from near plate boundary (from Figure 6). Some flow fronts (red dashed lines) are cut by abyssal hill faults (blue dashed lines) whereas others cover the faults, indicating a synchronicity between volcanism and faulting. Note seamount (volcano) on far right is cut by abyssal hill faults. Numbers indicate volcanic stratigraphy with 1 being the oldest. (Meckel et al., 2001.) **B:** Volcanoes and flows from Peruvian Andes in Arequipa area. Flows show stratigraphy (numbers) similar to those observed on the seafloor. Red dashed lines—flow fronts. Space shuttle photograph STS 026-040-0-56; courtesy of NASA.

was acceptable in the United States—then on to the Alleghany Orogeny in New England when the possibility was just a twinkle in a few graduate students' eyes. Years later, my passion became polyphase folding, ductile deformation mechanisms and recrystallization processes, shear zones, and the effects of fluid flow on deformation, with several forays into brittle deformation. A common thread throughout it all was an underlying passion for strain analysis. Lately, my passion has been Grenville orogenesis along the southern margin of Laurentia, and my most recent passion is ephemeral plate boundaries.

The more I have done, the more I have realized the need to be proficient in many fields and the need for multidisciplinary research. Working in polydeformed granulite facies terranes, one needs geochemistry, geochronology, isotope geology, structural geology, and petrology of all types, and one still needs to be able to recognize sedimentary structures, depositional environments, paleoclimates, and weathering.

More important, however, is the need for interdisciplinary research, working at the interfaces between disciplines, and for cross-disciplinary research, using approaches of one discipline to tackle problems in another. I believe interdisciplinary and cross-disciplinary science have the most potential for major breakthroughs in the future. We need to explore the scientific boundaries between disciplines, both within the geosciences and without. The linkages among biological, chemical, physical, and geologic processes are becoming increasingly clear and critical to our understanding of earth processes.

The example I will use is plate boundaries, my most recent personal passion. Oceanic spreading centers are where the mantle, lithosphere, hydrosphere, and biosphere meet and processes become intertwined. Spreading rates control the structures that form ridge and abyssal hill morphology, types and shapes of magma reservoirs and chambers, and types of structures observed at transform-ridge intersections. Mantle chemistry affects that of the forming lithosphere, which affects the chemistry of the hydrothermal vent fluids. This in turn affects the biologic activity, particularly of microbes, which contributes to differences in mineralization around vents and evolution of life (Fig. 4). These upwellings affect the chemistry of the oceans and thus atmosphere and may even cause weather patterns such as the El Niño effect. Our understanding of the complex interrelationships between each of these processes has grown tremendously and highlights the need for interdisciplinary research to understand the complex interactions in these and other earth systems.

My own experience has shown me the importance of using techniques and experience from one discipline to tackle problems in another. I have been working with Mike Coffin, a geophysicist, on the dextral transform plate boundary between the Pacific and Australian plates south of New Zealand that is also a relict spreading center (Fig. 5). The seafloor contains a complete record of a transition from normal spreading to oblique spreading to transform faulting over the past 40 m.y. (Massell et al., 2000). Looking at the pattern of abyssal hill faults and fracture zones, a geophysicist immediately sees oblique spreading, whereas a structural geologist sees a giant shear zone (Fig. 5). Having spent much of my career looking at strain in shear zones, I couldn't resist doing an incremental strain analysis, if only for pure intellectual curiosity. Much to everyone's surprise, preliminary analysis shows that there is a direct relationship between the cessation of magmatism and the incremental strain history, implying a genetic relationship. This discovery has led me to propose a testable model to explain how magmatism shuts off during oblique spreading, a model that would not have arisen from more conventional approaches.

Working on this boundary has also shown me the importance of having a field perspective when looking at marine geophysical data for the seafloor. Farther south, the plate boundary curves significantly and parallels the Hjort trench, which may be undergoing incipient subduction (Fig. 6). Using marine geophysical data and new three-dimensional visualization techniques, we can explore these submarine features to better understand these transient plate boundaries. Volcanoes and lobate flow fronts, preserving a volcanic stratigraphy, are strikingly similar to those seen on land from the air (Fig. 7). Abyssal hill faults, related to earlier seafloor spreading, dissect the flows and volcanoes, similar to flows offset by rift-related faults in the East African rift zone. Some faults truncate flow fronts, and elsewhere, flows cover the faults, suggesting a synchronicity of the two processes (Fig. 7A). Away from the restraining bend along the present-day transform boundary, these features aren't faulted (Fig. 6). Such observations suggest that rather than being related to incipient subduction, or to off-axis volcanism during seafloor spreading, the volcanism is related to reactivated abyssal hill faults during transform motion in a restraining bend (Meckel et al., 2001).

Applying a field-based approach to a "virtual" field area is just the beginning. Where the boundary makes an abrupt change in strike, a sliver of oceanic crust was uplifted in situ (Macquarie Island; Figs. 5 and 6). This gives us the best of both worlds and allows us to use field data to ground truth the marine geophysical data and to combine the two data sets for an integrated picture of the evolution of this complex ephemeral plate boundary. This work is just one of many possible examples of cross-disciplinary research, illustrating the benefits of bringing the perspective of one discipline to another.

Individual Roles

We as individual scientists need to bring diverse scientific disciplines to bear on fundamental problems and work together with our colleagues to tackle problems with many different approaches and techniques. We need to broaden our horizons and consider problems outside the narrow confines of our past work. Serendipity will always be a major source of scientific advancement, but combined efforts are critical to making major progress. Geoscientists also need to forge better working relationships with fellow scientists. Many of the problems we are addressing are the same and require input from other scientific disciplines. Also, if we are insular in our science, our results will be unrecognized and unused by the larger scientific community.

GSA's Role

GSA is an ideal geoscience society to promote interdisciplinary science. It encompasses a broad range of disciplines, which encourages research at the interfaces between these disciplines as well as cross-disciplinary and multidisciplinary approaches to research. Another of GSA's strengths is its strong ties to the field, even for studies with a theoretical or laboratory focus. A fundamental part of our science involves testing our ideas and models with the reality exposed in the field. What we observe there often forces us to search for new explanations to old questions and inspires us to ask new ones. The final results of the processes we study—regardless of our methods—are revealed in the world's geology.

As geoscientists, we should pursue our scientific passions to their fullest but broaden our audience to include public policy makers, the public, current and future educators, the media, and other scientists, as well as students and colleagues. We can turn our passions for science into progress for both science and the public.

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POSITION ANNOUNCEMENT

EDUCATION & OUTREACH DIRECTOR
The Geological Society of America

SCIENCE
STEWARDSHIP
SERVICE

The Geological Society of America (GSA) seeks an Education and Outreach Director to lead the Society's efforts to promote excellent geoscience education, in its broadest sense, to students, educators, GSA members, the public, the media, and public policy makers. GSA is a scientific society serving 17,000 members worldwide and is headquartered in Boulder, Colorado.

The Director will ensure that efforts in GSA Education and Outreach have a national impact on the visibility of geosciences and the excellence of geoscience programs at all educational levels. The Education and Outreach Director will be expected to develop and manage programs in support of GSA's goal of promoting geoscience in the service of society. It is expected that new programs will be self supporting through appropriate grants or other outside resources. The Director will work with GSA Council and staff, as well as with the GSA Education Committee, the National Association of Geoscience Teachers, and with members, associated societies, and other organizations to ensure coordination so that GSA Education and Outreach programs and efforts are an integrated part of a national strategy to raise the level of geoscience awareness and visibility and to improve the quality of education in the geosciences at all levels.

Candidates for this position should hold an advanced degree in geoscience, a related discipline, or science education and should have a record of scholarly and professional accomplishments in geoscience education. We are particularly interested in candidates who have, in addition, demonstrated interest and achievement in promotion of geoscience awareness with policy makers, or through the media. Leading candidates will be able to demonstrate, through recent achievements, that their contributions have effected durable and fundamental change in at least one of these areas. Preferred candidates will also have experience in strategic and financial planning, program development and implementation, budget management, and documented success in team leadership and membership. The successful candidate will be committed to applying his or her professional energy in serving the overall mission of GSA.

The Education and Outreach Director will report to the GSA Executive Director. Salary will be commensurate with experience, and includes a highly competitive benefits package, including matching contributions to a 403(b) after 6 months of employment. GSA is an equal opportunity employer and compliant with the Americans with Disabilities Act. The anticipated start date for this position is August 2002.

Applicants should send their curriculum vitae, a statement of interest and qualifications, one or more reprints or other samples of professional writing relevant to the described position, and the names and contact information of three professional references to the address below. Review of applications will begin March 1, 2002, and will continue until the position is filled.

Chair, Education and Outreach Director Search Committee

c/o Jack Hess, Executive Director

The Geological Society of America
PO Box 9140
Boulder, Colorado 80301