Exhumed Evidence

The third day of the conference, including the field trip, featured observations and discussions of exhumed faults. Seismogenic faults at depth can be directly observed following tectonic uplift and erosion (e.g., the coastal outcrops near Portland). Mining and drilling can also expose ruptures in situ; the discussion included examples of both.

Drilling for the San Andreas Fault Observatory at Depth intersects seismic source zones near the recent Parkfield earthquake, and in Taiwan the Chelungpu-fault drilling project reveals evidence of large-slip behavior during the 1999 Chi-Chi earthquake. Similarly, deep-level gold mining operations in South Africa occasionally expose rupture zones of mining-induced earthquakes. Debate on the apparent scarcity of fault-generated pseudotachylytes focused on whether they were rarely generated or only rarely preserved in recognizable form.

Fault localization was another issue that featured prominently in the discussion during this long, intense day. The fault systems that had been observed in the field earlier that day involved total slips of several meters, distributed over zones at least a few meters wide. These examples of immature faults, their 300-million-year age notwithstanding, were shown to have slipped during one or a few earthquakes. By contrast, the Punchbowl fault in southern California shows 44 kilometers of slip localized to a zone less than a meter wide, an example of a mature fault.

Fault Strength

This question of whether energy budgets on mature and immature faults differ was pursued further during the final afternoon of the conference, when the strength of mature, active faults was debated. Although in situ stress measurements suggest that crustal strength is generally consistent with expectations based on laboratory friction measurements (Byerlee's law), many types of data and analyses suggest that major active faults, including plate boundaries, are considerably weaker.

The San Andreas fault is the best studied example of this, and for nearly 40 years the arguments concerning its strength have persisted. Determining the strength of the San Andreas fault, as well as other major active faults is critical to understanding earthquake energy changes. If the San Andreas is as strong as expected from laboratory results, then frictional energy losses are much larger than the other components in the energy budget. If the San Andreas fault is as weak as suggested by analysis of heat flow data, for example, then this component is much less prominent in the budget, at least for earthquakes that rupture mature, active faults.

The discussion involved observations and analyses of heat flow, in situ stresses measured at depth, stress direction indicators, hydrologic data, and exhumed-fault evidence of fault strength. Although this longstanding question was not resolved to everyone's satisfaction, the discussion sharpened the understanding of the remaining uncertainties.

One of the primary goals of this conference was to encourage Earth scientists in different disciplines to share their various perspectives concerning the physics of earthquake faulting. This goal was certainly achieved as indicated, for example, by the many comments from field geologists during the technical session on dynamic rupture models of earthquakes and, perhaps even more so, by the theoretical seismologists who were among the most enthusiastic participants crawling over the coastal outcrops to scrutinize the 300-million-year-old earthquakes.

An AGU monograph, to be published in December 2006, will describe the discussions, arguments, and main results of this conference in more detail.

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Young Scientist Network Holds Inaugural Workshop

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The vulnerability and sustainability of the global human-environment system is poised on a threshold of uncertainty in the near- and long-term future. The future of the planet may at least be partly in the hands of young scientists.

Because Earth system science has become increasingly integrative and the need for international communication is increasingly important, an international young scientist network was established in June 2005 as a key activity of the Analysis, Integration, and Modeling of the Earth System (AIMES) project of the International Geosphere-Biosphere Programme.

The goal of this network is to facilitate communication between young scientists who work on a wide range of biophysical and chemical climate models, those who work on models that include human decision making such as land use models or economic models, and scientists who analyze the observations that test these models.

The network will promote collaboration between the natural and social sciences and the discussion of the human-environment system as an integral component of Earth system models. An important element of the network is to encourage participants from developing countries to contribute their expertise in quickly changing and highly vulnerable environments and to enhance the human resources in important regions of the globe that will be needed for future science projects.

As a step toward fuller integration of Earth system science, the AIMES Young Scientist Network was inaugurated at a workshop in Breckenridge, Colo., in June 2005. (The former name of the network, the International Post-doctoral Network for Earth System Science, was changed following the workshop.)

Participating in the three-day meeting were 52 young scientists from 18 countries (Argentina, Australia, Bangladesh, Brazil, Canada, France, Germany, Ghana, India, Italy, Nigeria, Poland, Portugal, Russia, Switzerland, United Kingdom, United States, and Zimbabwe). Conference participants reflected the broad geographic composition of the network members.

While most participants are involved with the biological, chemical, and physical sciences, about one-fourth work on problems involving human decision making.

During the workshop, all participants presented a talk or poster on their research. In addition, two invited senior scientists gave introductory presentations on the two workshop topics. The first topic, on "*The end of nature? Human-Earth systems interactions*," was introduced by John Reilly of the Massachusetts Institute of Technology (MIT), Cambridge. The second topic, on "*Is there a scenario in the class? Different views of the future (multi-scaled approaches to Earth system modeling)*," was introduced by Ron Prinn of MIT.

The two workshop themes were well-reflected in participant presentations. One hot topic in the first session was how integrated assessment models were used by decision makers to understand scenarios that would achieve climate stabilization. Urbanization and urban development in the context of the global carbon cycle and climate change also were discussed.

The discussions highlighted difficulties in quantifying uncertainties, particularly in the context of the human/natural environment system and the consequences to the policy and assessment communities. Participants noted that greater involvement of scientists with a background in the social sciences is needed to help deal with these important issues.

The second session was devoted to using a hierarchy of models to examine the complexities of the coupled biogeochemical-climate system. Presentations ranged from studies of processes at local sites, to regional modeling studies and meta-analyses of global climate change experiments. One focus of the session presented was the aspect of physical coupling between land, ocean, and atmosphere and the biogeochemical interactions. Discussions underlined the importance, when linking biophysical and climate system science, of applying a wide range of modeling tools, such as simple conceptual models, models of intermediate complexity, and full three-dimensional general circulation models.

Overall, the presentations addressed integrative questions of a coupled human and natural science system. However, the focus of most of the presentations was on the development, improvement, and application of the various models of the human and natural environmental processes themselves rather than on the coupled carbon climate system.

Participants also discussed the future of the AIMES network and how this network should operate. Overall, there was enthusiasm for the idea of a network that would link together young scientists involved in Earth system science. Participants agreed to have future workshops on an annual or biannual basis that would serve as a place to present recent research highlights and to discuss more general topics relevant to young scientists. Such topics could include discussions led by senior scientists about potential career paths, and how to present research to the general public.

Participants proposed that the next network workshop should be held in 2006 in the United Kingdom, jointly organized with the U.K. Natural Environment Research Council's Quantifying and Understanding the Earth System program. However, a firm decision has not yet been made. Some participants also volunteered to organize smaller social or working meetings at existing larger conferences such as the AGU Fall Meeting or the European Geophysical Union assembly.

Participants also suggested that the network organize or cosponsor tutorials on specific topics to broaden the researchers' knowledge. These topics can either address scientific questions such as the use of data assimilation in Earth sciences or the social skills of young scientists (such as improving communication skills). Additionally, participants discussed how the network could reach more social scientists, for example, by advertising the network at conferences and meetings, such as the Open Science Conference of the International Human Dimensions Programme on Global Environmental Change. The expertise of social scientists is required in order to fully integrate the effects of humans into Earth system science.

The Advanced Study Program at the National Center for Atmospheric Research (NCAR), which cosponsored this workshop, has established a Web site to facilitate communication among the young scientists (http://www.asp.ucar.edu/ess/). The private part of the site includes short participant biographies and features an open forum to improve collaborations, discuss emerging topics in Earth system science, and link together on subprojects. Workshop participants also discussed the possibility of developing formal links between this network and existing networks or institutions. A link with the Australian Earth System Science Network has since been established. Links with other institutions still need to be developed. The participants also discussed ways to expand the membership of the network.

Outside the formal agenda, small groups from different disciplines and even different continents formed as participants interacted through scientific discussions and social networking while hiking, biking, or sightseeing.

The inaugural workshop of the AIMES Young Scientist Network was held on 23–25 June 2005 in Breckenridge, Colo. More information is available at: http://www.asp.ucar.edu/ess.html. The workshop was supported by the U.S. National Science Foundation, AIMES, and the Advanced Study Program and the Societal-Environmental Research and Education Laboratory, both at NCAR, as well as by the home institutions of many of the participants.

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About AGU

AGU Fall Meeting Mentors for Students Sought

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Science mentors are sought for the Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science Initiative (MS PHD's) Professional Development Program. MS PHD's, begun in 2004, is a joint NASA-U.S. National Science Foundation funded program that provides early career mentoring, professional development, and networking for minority undergraduate and graduate students pursuing degrees in the Earth and space sciences.

AGU is one of several major sponsoring societies for this five-year effort to provide participating students with increased exposure to, interaction with, and engagement in the Earth system science community, in order to help them achieve their academic and professional goals.

In the MS PHD's program, cohorts of 25–30 students are selected each year from communities traditionally underrepresented in the geosciences (e.g., African-American, Hispanic, Native American) to become part of a virtual scientific community of senior and junior professionals who interact over a three-year period. In the first year, students are assigned peer mentors—Earth and space scientists from underrepresented groups, and science mentors—science professionals from the student's discipline of interest.

Mentors and "mentees" meet for the first time at the AGU Fall Meeting, where they participate in several community-building activities. The science mentors also provide instruction to the students on how to effectively capitalize on the many resources and opportunities available during the Fall Meeting.

In the second year, students attend an annual meeting of a scientific society that is more closely aligned with their research interests (e.g., American Meteorological Society, American Society of Limnology and Oceanography, Ecological Society of America). A special convocation at the U.S. National Academies in the third year provides a capstone event to the program. More than 75 minority scientists will have participated by the end of the five year program.

Scientists willing to volunteer as science mentors are sought for the second cohort of MS PHD's students, who will begin the program at the 2005 AGU Fall Meeting in San Francisco (5–9 December 2005). For more information or to volunteer, contact Jozan Powell (College of Marine Science, University of South Florida) at +1 813-317-4270 or msphds@marine.usf.edu.

Additional details about the 2005 MS PHD'S Professional Development Program can be found at http://www.msphds.usf.edu/app-opp.html.

—JILL KARSTEN, Director, AGU Education and Career Services, Washington, D.C.