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EarthScoping the Inner Workings of Magmatic Systems

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Pew Commission Defends Oceans Report

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Several fisheries groups and others have charged that a 4 June report by the Pew Oceans Commission presents recommendations for reform of U.S. ocean govenance that are ill-founded or unworkable.

However, Christophe Tulou, executive director of the independent commission, defended the report for using the best science available, and for presenting solutions to serious problems facing the oceans.

The report recommends sweeping changes in ocean governance and in coastal and fisheries management (*Eos*, 17 June 2003, p. 226). It calls for the protection of marine ecosystems to be a principal objective of U.S. marine fisheries policy.

Concerning Pew's call for governance reform, Terry Leitzell, president of the Marine Conservation Alliance, an Alaska commercial fisheries group, said, "The report insists on an impossibly ambitious solution to its catalog of ocean problems: sweeping agencies from five federal departments into a new Ocean Department; and a National Oceans Council parallel to the National Security Council. Implementation would take years, even with the obviously absent political will, stalling progress toward improvements in the current system."

John Connelly, president of the National Fisheries Institute, a trade association, said the report's claims of fisheries collapse "simply ignore a mass of positive scientific and industry data to the contrary."

Richard Pombo (R-Calif.), chairman of the Resources Committee in the U.S. House of Representatives, and another Pew critic, cited a 13 June report by the Mid-Atlantic Fishery Management Council that the 2003 summer flounder stocks have reached record levels. That group is one of eight regional councils established under the amended federal Magnuson-Stevens Fishery Conservation and Management Act of 1976.

"We will continue to see stock reports that disprove the conclusions in Pew's coffee table book on fisheries management," Pombo said.

He added that the fishery management council's findings are "a reality check amidst the doom-and-gloom scare tactics of radical environmentalists." He said that existing federal fisheries legislation works and that progress should not be cut off "with the illogical regulations and bureaucracy called for by Pew."

Several critics said a report by the National Oceanic and Atmospheric Administration, (NOAA), "Status of U.S. Fisheries Report to Congress" (for 2002), which was released on 13 May, presents contrary information to that presented by Pew. This report states, "A review of the past 5 years of fisheries management shows steady, incremental improvement in the status of America's fisheries."

However, the NOAA report also acknowledges that many valuable fish stocks remain overfished, and that a number of species that may not be considered valuable major fish stocks are not routinely assessed.

Pew's Tulou questioned NOAA's statement that America's fisheries have improved over the past 5 years. "This is like having given Enron $100 of your money, and finding its worth is now just $1. If the following week, its worth is $2, do they get credit for raising the value by 100%? No.

"What isn't helpful is for people to be told that our marine fisheries are in good shape or that our fisheries management is doing a good job—neither of which is true," he said.

Tulou added that the "doom-and-gloom" criticism about the Pew report focuses on only half of his commission's findings. "The other half is that science tells us that there are solutions to the problems facing us if we act quickly enough."

The Pew Oceans Commission included scientists, fisheries experts, elected officials, and representatives from industry and from the environmental community.

—RANDY SHOWSTACK, Staff Writer

MEETINGS

EarthScoping the Inner Workings of Magmatic Systems

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In the shadow of one of the world's great volcanic systems, an intensive 3-day workshop was undertaken to work toward developing a scientific plan for the magmatic systems component of the U.S. National Science Foundation's (NSF) EarthScope Initiative. This NSF-sponsored workshop was designed to provide direction to the EarthScope planning committee and the NSF in developing scientific, technical, deployment, and management decisions related to the magmatic systems component of EarthScope. The meeting featured a mixture of oral and poster scientific sessions, breakout group and plenary discussions, and a field trip to examine one of the targets of the EarthScope magmatic science research plan: Mount St. Helens.

The 60 participants represented a broad cross-section of the volcanology community, including geologists, geophysicists, geodesists, petrologists, and geochemists. Details on the meeting plan can be viewed at http://www.unavco.net/earthscope.asp.

EarthScope is a 10-year NSF Major Research Equipment Initiative consisting of four main components: the San Andreas Fault Observatory at Depth (SAFOD, a deep borehole), the U.S. Array (permanent and portable seismic instruments), the Plate Boundary Observatory (PBO, mainly deformation instruments), and Interferometric Synthetic Aperture Radar (InSAR, a satellite mission to study Earth deformation). The magmatic science component includes portions of the latter three elements of EarthScope. The Initiative is in the FY2003 budget of President George Bush, as well as those of the House and Senate; however, the final scope and budget have not yet been approved. The formal proposal to NSF was delivered in January 2003.

Scientific Issues

The workshop and its ultimate product—a magmatic systems science plan—were conceived to address a number of fundamental scientific issues associated with magmatic systems, including:

- Understanding the role played by volcanic systems in plate margin and intraplate geodynamics; and the effects of magmatic processes on crustal properties and motions;
- Documenting and understanding interactions among magmatic systems, regional crustal stress, faults, and large earthquakes;
- Characterizing magma plumbing systems from source to surface in four dimensions;
- Understanding the kinematics and dynamics of magma movements beneath plate-margin volcanoes of various types in a variety of tectonic settings;
- Understanding the dynamics of eruptive and intrusive processes; and
- Understanding the origins and interrelationships of seismicity, ground deformation, gas emission, and groundwater at volcanoes.

The meeting included plenary presentations on magmatic processes that sought to develop a broad, interdisciplinary view of magmatic systems in the broad range of tectonic settings that will fall under the EarthScope umbrella. These presentations included an opening session examining broad-scale magmatic processes, beginning with a provocative overview, "Common sense about magmatic systems," by John Eichelberger, followed by a series of focused presentations on magmatic processes ranging from lithospheric dynamics and the origin of magma to reservoir and conduit processes, final ascent/pre-eruption processes, magma/hydrothermal system interaction, and volcano-tectonic interactions.

A session on volcano monitoring techniques featured a series of short "bullet presentations" focusing on state-of-the-art technologies and critical scientific opportunities in volcano seismology, geodesy, gas studies, and geological

observations. A third session, "Synthesizing geological, geophysical, and geochemical observations," featured case studies that typified interdisciplinary studies of basaltic systems, stratovolcanoes, and silicic calderas.

A final session, "Development of an interdisciplinary science project," focused on technical and organizational issues facing a major scientific initiative and included presentations on data integration and source modeling, data visualization, data management, and education and outreach.

Much of the meeting's work was done in informal breakout sessions, with individual focus groups devoted to plate boundary processes and volcano-tectonic interactions (led by Wayne Thatcher, USGS); magmatic plumbing and structure/evolution of magmatic systems (John Eichelberger, University of Alaska-Fairbanks); and kinematics and dynamics of magma movement (Kathy Cashman, University of Oregon). Individual breakout sessions focused first on defining and refining scientific issues for EarthScope magmatic systems, then on developing appropriate deployment strategies to address those issues, and finally, on developing an action plan for the first year of EarthScope activities.

Workshop Recommendations

The following recommendations represent a further evolution of ideas pertaining to magmatic science, and are intended to be modest modifications to the EarthScope proposal. The hope is that they will significantly strengthen the scientific impact of the EarthScope Initiative.

1. Development of a seismic observation component for magmatic systems.

The participants viewed with great concern the absence of a seismic complement to the intensive geodetic observations planned for magmatic systems under PBO. The group concluded that seismic networks should be deployed in parallel with the long-term geodetic observing systems to take full advantage of the scientific potential for integrated geophysical observations of magmatic systems. Seismic observations are critical for adding constraints on physical and chemical properties of magma, on the locations and shapes of deforming bodies, and for studying interactions between magmatic and hydrothermal systems. A seismic system can be built around a framework of existing and planned instrumentation, from both within and outside EarthScope.

We recommend that the following resources be linked to allow development of composite seismic observation networks at targeted active magmatic systems: three-component borehole seismometers deployed as part of PBO borehole strain packages; existing and planned USGS seismic monitoring networks; existing regional seismic networks; and contributed instruments from the EarthScope pool.

2. Tiltmeter observations for magmatic systems.

The workshop considered the value of shallow-borehole tiltmeters as a component of the geodetic monitoring system on selected volcanoes. Because of their relative low cost, ease of installation, and applicability in areas that are logistically unfavorable to deep borehole strainmeter installations, the group felt that tiltmeters should be added to the instrumentation options for selected volcanic systems.

The most likely sites for tiltmeter installations are basaltic and andesitic systems in the Alaska and Cascades target areas. These systems will be of immense value when deployed close to the magmatic source areas. They record short-term (< ~1 wk) deformation with greater temporal resolution than the global positioning system (GPS); and by substituting a larger number of tiltmeters for a small subset of the requested borehole strainmeters, we get increased spatial resolution. This type of data is crucial for understanding the dynamics of magma movement, especially when it is close to the surface and the details of the propagation can only be observed very close to the event.

3. Additional borehole observations.

The participants recognized the value of water-pressure and temperature sensors as a component of the borehole strainmeter package. These observing systems are particularly valuable for investigating volcano-tectonic interactions, magmatic-hydrothermal system interactions, and determination of hydrologic changes that may influence deformation measurements. The relatively low cost of acquisition and installation of these systems, combined with the scientific value of these measurements, lead us to the recommendation that they be installed at all borehole strain sites.

4. Development of an integrated, rapid-deployment volcano monitoring system (the "Hotfoot" array).

The group recognized that great scientific value emerges from observations of transient magmatic events, and that many of these events will occur either in areas not initially designated as targeted areas for the magmatic systems component of EarthScope or that the patterns of deformation will require spatial densification of existing EarthScope observing systems. The group recommended as a high priority that a suite of instruments be set aside for observation during significant magmatic, tectonic, or seismic events. Such deployments have great value for scientific and natural hazard mitigation goals and public relations value for EarthScope. Plans for such emergency deployments must be developed in advance of magmatic crises, and a well-established structure for management of such deployments must be set in place.

Deployments should be closely integrated with temporary observing networks that will be deployed by the USGS Volcano Hazards Program and the Volcano Disaster Assistance Program (VDAP) to mitigate volcanic hazards.

Critical components of this Hotfoot array would include lower-cost, expendable instruments for installation in high-risk areas (for example, L1 GPS instruments, short-period vertical seismometers), a quickly installed monumentation system, and an integrated telemetry system to allow for remote recording. Proposed components of this system include 3 broadband seismic systems, 8 to 10 short-period seismic systems, 3 dual-frequency GPS systems, 10 to 20 L1 GPS systems, and 5 to 8 tiltmeters. The system should also be designed to allow for integration of other observing systems, such as video, acoustic, or gas monitoring modules. Because of the applicability of such systems for a variety of scientific targets, the array could be used for transient events, including seismic events, slope failures, volcanic events, and transient tectonic events.

5. Baseline study of selected magmatic systems.

One of the critical concerns that emerged from discussions on transient magmatic activity is the need to acquire baseline geodetic observations against which deformation during magmatic crises can be evaluated. In coordination with the USGS Volcano Hazards Program, EarthScope should ensure that baseline geodetic and seismic observations are made at each of the targeted volcanoes as well as at other potential sites of magmatic activity. An infrastructure component of this recommendation includes permanent geodetic monumentation, allowing for rapid installation and re-occupation during magmatic crises.

6. Involvement of volcanological community in Geo-PBO.

There was widespread recognition that the study of magmatic systems depends on close collaboration among geophysicists, geochemists, petrologists, and volcanic stratigraphers, and the success of the magmatic systems component of EarthScope depends in large part on the support for broader volcanological endeavors. We recognize that the tools being developed as part of the 'Geo-PBO' effort will be of benefit to volcano geologists, and that such tools should be extended to the volcano geology community. In turn, refined volcanological methods have important implications for geochronological work in tectonic settings, and the Geo-PBO effort offers a useful tool for investigating volcano-tectonic interactions.

All told, most participants felt that the meeting was successful in developing a cogent scientific plan for EarthScope. What are the next steps? First, recommendations were submitted to UNAVCO and IRIS for the major instrumentation proposal. Second, a workshop White Paper currently in preparation will summarize a wide range of ideas on how the new EarthScope instruments can give unprecedented data and insights into active magmatic processes.

The Workshop on Active Magmatic Systems was held 30 October–3 November 2002, in Vancouver, Washington.

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