

## MEETING SUMMARY

### Scientific Earthquake Studies Advisory Committee (SESAC)

January 26, 2010

Reston, Virginia

#### Meeting Participants

##### SESAC Members

Mark Zoback, *Chair*, Stanford University, Stanford CA

Stu Nishenko, Pacific Gas & Electric, San Francisco CA

John Parrish, California Geological Survey, Sacramento CA

*Ellen Rathje, University of Texas, Austin TX (by phone)*

Garry Rogers, Geological Survey of Canada, Victoria BC

Ralph Archuleta, University of California at Santa Barbara and Chair, Advanced National Seismic System Steering Committee

##### USGS Staff

David Applegate, Earthquake Hazards Program (EHP), Reston VA

Mike Blanpied, EHP, Reston VA

John Filson, NEHRP office at National Institute of Standards and Technology

Linda Gundersen, Chief Scientist for Geology, Reston VA

Elizabeth Lemersal, EHP, Reston VA

Jill McCarthy, Geologic Hazards Science Center, Golden CO

Marcia McNutt, Director, Reston VA

Tom Brocher, Earthquake Science Center, Menlo Park CA

##### Guests

Jeff Freymueller, University of Alaska Fairbanks

Robert Lee, DOI Office of Inspector General

Arom Nadjmabadi, DOI Office of Inspector General

Susan Newman, Seismological Society of America

Bob Woodward, IRIS

#### Welcome and Introductions

After introductions, the meeting began with a review of the summary and action items of the last meeting. Stu Nishenko updated the group on the ongoing National Research Council study on future priorities for the four-agency National Earthquake Hazards Reduction Program (NEHRP). The study was commissioned by NEHRP lead agency National Institute of Standards and Technology (NIST). The panel recently held a workshop in Irvine CA and is currently in writing phase. They hope to have the report ready for review by NEHRP agencies in the near future.

## **Update on Earthquake Hazards Program and Geologic Discipline Planning**

Applegate made initial remarks on recent program activities and the state of program finances. He discussed the guidance provided to the program through the planning process for NEHRP, the bureau science strategy, and interagency priorities set through the National Science and Technology Council's Subcommittee on Disaster Reduction. USGS Chief Scientist for Geology Linda Gundersen discussed the Geologic Discipline's strategic plan, which will be out soon.

### **Perspective from USGS Director Marcia McNutt**

USGS Director Marcia McNutt began her remarks by noting that the timing for this meeting could not be better as the initial response phase of the Haiti earthquake was transitioning to the recovery phase. She expressed her appreciation for the service that committee members give to this panel and wanted the committee to know that she values their advice, especially given the great expertise assembled. She emphasized that the Secretary of the Interior and the Obama Administration care about science. She spends much of her time downtown interacting with the Secretary and other agency directors on science matters -- they are sponges for the science and very supportive. She has to balance her dual jobs as USGS Director and science advisor to the Secretary since USGS does not make policy recommendations or have management authority. She wants to help ensure that the Interior Department uses science correctly; science is not for the faint of heart. The Secretary will make decisions based on many factors, but if he is going to say that he made a particular decision for science reasons, then the science had better be there to support the decision.

Much is being done to raise the visibility of science in the Interior Department. For the very first time in the Department's history, science is a high-level strategic goal along with the more typical land and resource management goals. USGS science is at the highest level. Whenever USGS has an exciting science result to report, the Secretary gets right of first refusal to personally announce that result, which he often does, taking ownership of announcement. This provides more visibility for USGS science.

In terms of the USGS earthquake program, Salazar has picked up on levee issues in California, and the Haiti earthquake got his attention. Overall, however, the deficit is a huge looming problem, which will pose a major challenge for strengthening investments.

Ralph Archuleta began the discussion period by asking whether the Haiti disaster could spur fully funding the USGS Advanced National Seismic System (ANSS) so that new instruments are put in place before they become obsolete. McNutt noted that percent completion of ANSS is tracked as a high-level USGS goal. She will be the best PR person for why the current rate will not get us there. She also noted that early warning is an end goal of ANSS development.

As the new chair of the National Earthquake Prediction Evaluation Council (NEPEC), Terry Tullis described the council's responsibility to stay on top of the current state of understanding in order to provide advice to the Director on predictions that are made. He

added that earthquake prediction has gotten a bad name, but that we are now entering a stage when we can make true scientific evaluations of prediction methodologies thanks to efforts like the Southern California Earthquake Center (SCEC) Collaboratory for Scientific Earthquake Predictability. It appears that some earthquakes are predictable, but the only way to figure that out is to do evaluations in a vigorous way. It is too early to say whether predictions can be made that would make a societal difference. To get there will require continuity of funding.

McNutt asked whether the USGS role should primarily be evaluation or as a research funder and welcomed a recommendation on what role was appropriate in the future. Research efforts in this arena will only be successful if there is broad-based support from the National Science Foundation (NSF) and NASA. Otherwise, USGS would be missing a lot of opportunities. It would be worth having a discussion with NSF and NASA leadership regarding opportunities for an interagency program.

Nishenko asked how the professional societies can help USGS maintain or increase support for earthquake activities. McNutt responded that Washington reacts to crises. What has been interesting about Haiti is that the reaction has been almost as though it is a domestic earthquake; this was as close as it could come to being a US earthquake without actually being one. We should highlight what hazards are in the US. This earthquake occurred on a known fault that had produced large earthquakes more than a century ago. Buildings collapsed because of poor standards. If we look around the US, where are places at risk for a disaster like this -- where is our Port au Prince where we could have something like this happen? There are many US cities where buildings have not been built to withstand magnitude-7 quakes. She emphasized that the committee can help USGS make this case.

John Parrish pointed out the potential for trillion dollar impacts of a west coast catastrophic earthquake, emphasizing that USGS needs a two-pronged focus. Early warning does not protect the buildings from collapse; translating seismic hazard assessments into building codes must remain a priority.

Archuleta observed that there was not a single seismic instrument in Haiti, the nearest being in the Dominican Republic. Monitoring is necessary in order to be able to assess the hazard, emphasizing the value of having instruments in the ground. There are places in the US where instrument density is fairly low, so we do not know what activity we would see with lower detection thresholds. Zoback added that Memphis could be a beneficiary of this recognition. He encouraged USGS to develop a two-pager on possible supplemental investments looking not only at Haiti but more broadly at other Caribbean nations so they can develop their own mitigation programs;

There was a comment from the audience about the importance of delivering information before damaging earthquakes, not just informing the response. Haiti was cited as an example where nothing was done that we would like to have done. Engineers would like to be getting recordings of very large earthquakes in subduction setting prior to a domestic event happening. It was noted that Alaska has lots of earthquakes -- are we doing a good enough job of highlighting that sort of pathway to hazard mitigation.

Ellen Rathje noted that the science and engineering response to the Haiti earthquake was greatly aided by the fast pace of making imagery available. As a result, the teams being deployed were the most prepared they have ever been.

Nishenko pointed out that Haiti underscores the value of developing an aftershock early warning capability. Jill McCarthy noted that to do so we will have to start from scratch. Applegate pointed out that the Los Angeles fire department is a potential partner since they are one of the urban search and rescue teams deployed to Haiti and have been working closely with USGS on the ShakeOut activities. It might be possible to develop a portable system that could be deployed as part of urban search and rescue efforts. It was suggested that the value of an aftershock warning capability might be most valuable for a New Madrid type event where there will be more lead time before shaking is felt in urban areas. Garry Rogers noted that the time available for early warning is particularly long for subduction-zone earthquakes.

Rathje gave an overview of the planned Geo-engineering Extreme Events Reconnaissance (GEER) team activities in Haiti, which she will lead. Liquefaction appears to be focused on man-made ground at the port. The team will try to help understand why the port failed so it is not reconstructed in a way that it will happen again. They need to look at geology to understand the distribution so are bringing handheld cone penetrometer that works on a drop-hammer to get some subsurface information. They are also bringing portable surface wave shear wave velocity equipment to investigate site effects. Post-earthquake investigations in Haiti face a number of unique challenges.

A question was raised whether the pathways are there to get the scientific findings that can inform reconstruction on a short-term basis to the right people or will those pathways have to be built.

McNutt stated that we need to think about what the messaging should be after earthquake disasters. In talking about the threat of the Bay Delta levees failing, is it better to rebuild to stronger seismic standards or to develop a system to bypass the delta entirely in order to have a more earthquake-resistant water delivery system. When talking about earthquake risk on the east coast, early warning does not get around economic collapse of large cities. Stronger building codes do.

After McNutt left, Applegate returned to an overview of the Earthquake Hazards Program activities. He discussed the upcoming NEHRP reauthorization issue of switching responsibility for coordination of post-earthquake investigations from USGS to NIST. A question was raised about NIST's ability to take on the lead. It was noted that NIST has been an honest broker as lead agency. The committee recognizes the challenge that a small NIST faces and need for more support.

Increased FEMA interaction was also discussed. Archuleta noted the effectiveness of scenario-based information to encouraging interaction and that this is only possible because of fundamental research and finding ways to make that real.

## **New Madrid Bicentennial**

USGS is ramping up for the 200<sup>th</sup> anniversary of the New Madrid earthquakes, which presents an incredible teachable moment, but one that is complicated by several factors. There are many different groups with which coordination is needed. The affected area includes four FEMA regions and eight states. Public awareness is lower so a different outreach challenge compared to California. The final challenge is that the existence and nature of the hazard is being challenged publicly on the horizon. USGS has participated in FEMA catastrophic planning efforts including regional workshops; worked with our partners at the University of Memphis Center for Earthquake Research and Information (CERI) to be boots on the ground as well as the Central US Earthquake Consortium (CUSEC) state geologists, who are a key resource to exploit to handle all the demands. With limited staff in the region, USGS is taking a train the trainer approach. Until a new regional coordinator in place, USGS does not have a permanent lead for the Central US. USGS is trying to be creative in using expertise across the program to help out. The coordinator position has three functions – external coordination to partners and research community, internal project, and management. The apparent USGS presence is increased through co-location with CERI, and working groups are being used to focus research response in critical areas. The internal project is led by Rob Williams working with Oliver, and Jill McCarthy is leading USGS participation in the bicentennial planning committee.

Questions were raised about the challenge of recruiting for a position in Memphis. The need for an office is based on recognition that having some presence on the ground is important due to the extent of local communications, which is hard to do remotely. The post-bicentennial needs will change. Rodgers noted that there is a need to focus on more than New Madrid in the central US.

Susan Newman, executive director of the Seismological Society of America, noted that the SSA annual meeting in April 2011 would be in Memphis, kicking off a year's discussion culminating in the February 2012 National Earthquake Conference. They still do not have a program committee and are working on how to involve all the different very emotional factions in a program that does the topic justice. SSA would like to work with USGS on a public forum.

Archuleta expressed concern that the lack of a senior person in Memphis will cause all the effort leading to the bicentennial to lose momentum afterwards. McCarthy noted that in the Geologic Hazards Science Center's staffing plan, there is a commitment to Memphis and hope to grow there, recognizing the merit in having a regional office to keep the message going. Tullis noted the challenge for individuals to focus their career on low-probability events, suggesting the need to make the role for the whole eastern US. Zoback noted that nuclear power plant siting represents an important opportunity for strengthening earthquake research in the Central and Eastern US. Nishenko noted that in the NRC report's 20-year look at the landscape, there was a recognition that earthquake scenarios are a way to bring the message home, but determining cost is a challenge.

***Action Item: Provide a better sense of cost for scenarios and commemoration activities;***

Bob Woodward of the IRIS Consortium noted that the EarthScope USArray project's Transportable Array will have 400 stations in the region centered around New Madrid, and IRIS is happy to try to identify opportunities to leverage the Survey's bicentennial activities. It is a chance to tie in the academic community. There is a possibility for the 2011 EarthScope national meeting to take place in the region.

**Status of Science Centers Supported by the Earthquake Hazards Program**

Tom Brocher provided an overview of the Earthquake Science Center. The committee received a copy of the center's strategic plan developed by senior scientists. Future directions include Sacramento delta seismic vulnerability, multi-hazard demonstration projects in Southern California and Pacific Northwest, opportunities for getting involved in induced seismicity associated with energy development (geothermal and CO<sub>2</sub> sequestration), and seismic risk to critical structures in partnership with the USNRC. Fifty percent of the staff is retirement-eligible, but researchers do not tend to retire at point of eligibility, so only 10 percent retirement likely. A buyout was offered with only one taker. There is a recognized need to restore the research capacity in the Pasadena office. Deployments of lower-cost NetQuake sensors are taking place very successfully in the Bay Area, southern California and Pacific Northwest. The Committee expressed concern hearing the structure of matrix management and explored whether this interfered with the effective management of the Survey's earthquake activities.

Jill McCarthy discussed staffing issues with the Geologic Hazards Science Center. The big shift for the team has been changing IT needs for software development, web development, system management. One cannot build a product like the Prompt Assessment of Global Earthquakes for Response (PAGER) and maintain it unless there are IT people making it stable. That heavily affects staffing decisions. Half the team is new in the past eight years, and McCarthy is pleased with the talent they have been able to draw to Golden, and she feels that they have good leaders at all levels. It is a challenge to find the right balance between permanent and non-permanent staff. New hires and recruitments are focused on IT needs and network operations as well as postdoctoral opportunities. Archuleta asked about succession planning for operational scientist leaders, and McCarthy responded that we are trying. She is concerned that research staff has dwindled in number; even though still strong impact, they are below 30% of the center now.

**National Earthquake Prediction Evaluation Council**

Terry Tullis discussed recent NEPEC activities. The council is looking ahead at three different geographical regions and three different subjects. The regions are California, the Pacific Northwest and Central US; subjects are aftershock models and short-term probability models, keeping eye on the SCEC Collaboratory for the Study of Earthquake Predictability, and encouraging a SCEC-NASA joint workshop on thermal anomalies and other precursory phenomena.

NEPEC most recently held a joint meeting with the California Earthquake Prediction Evaluation Council in Pasadena. They looked at the oversight role for the third-generation Unified California Earthquake Rupture Forecast (UCERF3) and are considering a joint subcommittee to review the process, making sure that the plans are well aligned with the time constraints so that there will be a solid model at the end that will be useful for public policy.

For the other regional/topical issues, the plan is to organize subcommittees that would include non-NEPEC members. There is no equivalent to CEPEC in the Pacific Northwest so one question is how to coordinate subduction-zone issues such that NEPEC in a position to provide quick guidance to the Director in the event of a newsworthy development. Zoback noted that in the past, NEPEC worked out scenarios about what information would be provided should a given scenario take place, for example a sudden change in episodic tremor and slip. The suggestion was made for a NEPEC letter to USGS suggesting that such scenarios be thought through, making it possible to have buy-in up front. John Filson noted the importance of meeting in the region and having discussions with the local people.

A key challenge for the Central US is the controversy generated by Seth Stein and others over whether the probabilities feeding into the national seismic hazard maps are properly constructed. NEPEC is considering whether to have an external review committee, perhaps not a NEPEC-sponsored committee since NEPEC would be perceived as being in the pocket of the USGS. It might be better to be independently convened. There is a need to provide scientific background for decisionmakers;

Zoback noted that the USNRC is engaged in these issues right now. They have to deal with a degree of uncertainty, and the stakes are higher than for building codes. His intuition is that USGS should not be the sponsor. Archuleta noted the need to reach the people who are building things; USNRC is in that position.

The committee had a discussion of induced seismicity. There was strong agreement on the committee that the USGS has an important role to play on this subject and that USGS is in a much better position than other government agencies to carry out an assessment of induced seismicity. The issue was raised whether NEPEC has a role. It was noted that CO2 sequestration is likely to get more traction with increasing focus on global warming. Bill Leith noted that most USGS work in this area has been outside funded project-level work. In order to make an estimate of the induced earthquake hazard, there is a need to know injection volumes and other proprietary information, which might prove difficult.

Zoback pointed out that the Department of Energy (DOE) has turned to the American Rock Mechanics Association (ARMA) to advise them on seismic issues. He had raised the question of where was the USGS. This topic represents a huge need, and the expertise is in USGS, which needs to organize itself around what the questions are going to be. He asked why DOE did not come to USGS.

Parrish noted that there are large ramifications to this issue. In the case of the Geysers in northern California, the induced seismicity affects a senior community that raised the

issue of injection and earthquakes and questioned whether geothermal was going to be a good idea as a secondary source of energy, putting a damper on its development there and potentially having much wider impact.

Zoback added that shale gas and carbon capture and storage both have induced seismicity issues, which can be managed with proper procedures, but DOE needs technical help with the kind of skill sets that are in USGS. These sites will need to be licensed and considerable litigation can be expected. The Waxman-Markey climate change bill in the House contains \$50 billion for carbon capture and storage. McCarthy noted that the bulk of this expertise is in the Earthquake Science Center. She also indicated that advice was welcome on the relative priority this should be given in reference to rest of earthquake program.

***ACTION ITEM: Topic for next SESAC meeting;***

### **Recovery Act Seismic and Geodetic Monitoring Upgrades**

Bill Leith provided the committee with a summary of progress in implementing the \$30 million in American Recovery and Reinvestment Act (ARRA) funding that the USGS is investing in earthquake monitoring. Cooperative agreements have been initiated with university partners maintaining seismic and geodetic networks. Procurement of sensors has been a challenge but is moving ahead. Work is continuing on lidar data purchases for the Central US and other high-hazard areas. The USGS work is overseen by an internal Recovery Act board. The ARRA drill has created an opportunity to think more fully about how USGS interacts with cooperators. In particular, it has shifted how we approach the research-focused geodetic networks. There will be a meeting of geodetic network cooperators tied to the UNAVCO meeting to address these issues.

Leith discussed how the ARRA investments were being targeted to complement earthquake early warning (EEW) activities in California. Around the world, EEW system investments have been made foremost by the Japanese but in a number of other countries as well. EEW has a direct link to USGS legal responsibility delegated under the Stafford Act to issue warnings. The USGS has been supporting R&D algorithm testing with California Integrated Seismic Network (CISN) partners and SCEC for the past three years. Now a new cooperative agreement has started to prototype development and identify test users. Recovery Act funding is being used to upgrade CISN data-loggers to reduce latency -- every high data latency data-logger is being replaced with short-latency ones. Up to a minute or more of warning is possible in California, for example for an earthquake on the southern San Andreas relative to Los Angeles. Improved sensor density and real-time performance of ANSS will enable warning systems to be implemented, but it will require robust and redundant communications and denser seismic networks. There will always be a range of warning times, for example limited to no warning for urban areas adjacent to Hayward Fault.

The early warning ShakeAlert could be provided for certain users for certain earthquakes. Alarms can be programmed into strong-motion sensor for damage evaluation, one of which could be an early warning. Algorithms have been tested for central processing and



on-site detection. The algorithm testing made considerable progress in reducing magnitude uncertainty, leading to the second phase prototype development and test user identification.

Zoback suggested having private industry implement once the USGS and its partners have established viability, such implementation being more dicey at this stage without proof of concept. Having implementation by private companies could mean that they would work with clients then create a business arrangement with client doing the decision-making. Leith noted that the Japanese Meteorological Agency issues warnings and operates network but anybody can develop a product using that. USGS has received inquiries from security system companies.

For the second phase cooperative agreement with CISN and SCEC, the Year 1 milestone is to identify and partner with potential users to make sure that what is being developed is useable. In Year 2, it is integration of current algorithms, developing a hybrid system and developing warning products. In Year 3, it is delivery of automated warning products to selected users in a test mode and prepare design-level specifications for prototype system in California, a full cost and deployment proposal and a cost-benefit analysis.

Rodgers expressed concern that real-time GPS does not seem to be a factor. Leith noted that USGS is looking into zipper arrays that could capture relative displacements across faults, but when all sensors moving, there is the question to what such movements are relative.

Freymueller noted that at a recent IRIS/UNAVCO joint meeting, there was a demonstration of how GPS can complement what one can get from seismic, generating displacement proportional to slip. For subduction zone, once S-wave gets to station, one has the displacement, so this is potentially great for tsunami warning.

Nishenko commented that in terms of identifying users, it is important to identify public policy implications and ramifications. The Bay Area Rapid Transit system is a low-cost, high-impact situation: Slowing the train down is not a big problem or cost. By contrast, utilities shutting down someone's power (for example home health care recipients) would be a different situation. Liability issues deserve investigation and attention on how to move around the problem to be able to use it for other institutions.

### **Next Meeting**

The committee's next meeting will take place in a May-June timeframe in Pasadena.

Before adjourning, the committee made assignments with deadline for getting bi-annual report to the Director.

The meeting adjourned at 4pm.