# CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

## TRIP REPORT

**SUBJECT:** Annual Meeting of the Seismological Society of America
Administrative Item: 06002.01.332.502

**DATE/PLACE:** April 27–29, 2005
Lake Tahoe, Nevada

**AUTHOR:** Sarah H. Gonzalez and John A. Stamatakos

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### BACKGROUND AND PURPOSE OF TRIP:

The Seismological Society of America held its annual meeting at Lake Tahoe, Nevada on April 27–29, 2005. The meeting was hosted by the Nevada Seismological Laboratory of the University of Nevada at Reno. The Seismological Society of America is one of the leading professional societies and their annual meeting attracts a broad range of disciplines and interests.

The meeting consisted of 13 technical sessions given over the 3-day conference period:

- The September 28, 2004 $M_w$ 6 Parkfield Earthquake
- Nuclear Explosion Monitoring Research Developments
- Promoting Earthquake Safety
- ANSS and Real Time Seismology
- The December 26, 2004 $M_w$ 9 Indonesia Earthquake and Tsunami
- Recent Advances in Seismic Inversion
- Crustal Structure
- Predicting Ground Motions for Shallow Crustal Earthquakes
- Seismic Hazard of the Great Basin
- Walker Lane, Central Nevada Seismic Belt, and Eastern Sierra Nevada Margin
- Earthquake Source Physics
- Seismic Hazard
- Volcanoes and Earthquakes

Many of the sessions included presentations that directly relate to ongoing or recent seismological work at the Center for Nuclear Waste Regulatory Analyses (CNWRA). Especially relevant at this year's meeting was the William B. Joyner Memorial Lecture by Allin Cornell on advancements in "Quantifying the 'Seismology-Engineering' Interface." Dr. Cornell is one of the leading experts on probabilistic engineering design and is an often used consultant by the DOE to help them develop adequate technical bases for both pre-closure and post-closure seismic safety. A second highlight of the meeting was the special session devoted to the September 28, 2004 $M_w$ 6 Parkfield earthquake. This earthquake is the first event in which the near-field ground motion of a moderate earthquake has been well recorded.

## SUMMARY OF ACTIVITIES:

On April 27, 2005, we attended "The September 28, 2004 $M_w$ 6 Parkfield Earthquake," "Promoting Earthquake Safety," "ANSS and Real Time Seismology," and "The December 26, 2004 $M_w$ 9 Indonesia Earthquake and Tsunami" oral sessions.

On April 28, 2005 we attended the "Seismic Hazard of the Great Basin" and the "Walker Lane, Central Nevada Seismic Belt, and Eastern Sierra Nevada Margin" sessions. John Stamatakos gave a presentation entitled "Geological and Geophysical Evidence for the Nature and Style and Age of Faults in Crater Flat, Nevada." Sarah Gonzalez and John Stamatakos gave a poster presentation entitled "Evaluation of Site Response for the Surface Facilities Site at the Potential Yucca Mountain Repository, Nevada."

## SUMMARY OF PERTINENT POINTS:

The September 28, 2004 $M_w$ 6 Parkfield Earthquake. This session was dedicated to the recent $M_w$ 6 Parkfield earthquake. The ground motion instrumentation during the Parkfield earthquake included a total of 56 three-component strong motion accelerographs located within 20 km of the fault. A total of 50 stations were located within 10 km of the fault. These recordings provide a large amount of information on near-field ground motion and thus provide an excellent opportunity to study earthquake physics.

The 2004 Parkfield earthquake strong motion data set shows the near-field motion to be highly variable, including localized zones of high-amplitude shaking. Stations within about 2 km recorded accelerations well over 1 g and at one station the motion was beyond the recording capability of the instrument. The best estimate for the peak acceleration is over 2.7 g. Strong shaking near the termination end of the rupture was also observed, which is consistent with directivity focusing for rupture propagating northwest from the epicenter, but strong shaking to the south suggests at least a component of bilateral rupture. The SE to NW rupture direction, contradicts the "single-propagation–direction-hypothesis" which is based on numerical simulations and proposes that a material contrast across a fault will lead to unilateral rupture propagation in the slip direction of the less-rigid material. Although rupture behavior can easily be affected by material contrast, propagation direction is not predetermined.

One study of repeating earthquakes identified reductions in seismic velocity coincident with the 2004 Parkfield earthquake. This reduction in seismic velocity is interpreted to be evidence of microcracking induced by the strong shaking in the earthquake (nonlinear strong ground motion). This study is particularly relevant to Yucca Mountain where there is a large amount of uncertainty regarding the placement of upper limits on ground motion.

William B. Joyner Memorial Lecture. In this lecture, Dr. Cornell focused on the problems associated with developing and scaling hazard-consistent input time histories for engineering evaluations from ground motion levels predicted by probabilistic seismic hazard curves. The issue is important, because most engineering applications require sets of input time histories that match ground motion levels from the hazard curve with relatively small annual exceedence probabilities. Because these low-probability ground motions are rare, there are relatively few actual earthquake records that can be used directly. Instead, seismologists and engineers must scale existing records upwards to develop requisite hazard consistent ground motions. However, Dr. Cornell showed the scaled time histories often yield additional uncertainty that

often results in an overly conservative analysis. Dr. Cornell recommended that uncertainty should also be one of the criteria for seismologists to use to select appropriate time histories. This issue is important to Yucca Mountain studies because the DOE is trying to develop hazard-consistent time histories for analyses of the drip shields and waste packages. In the past few years, the issues of overly conservative input ground motions for these studies have been the topic of extended discussion between the NRC, DOE, and the Nuclear Waste Technical Review Board.

Seismic Hazard of the Great Basin. In this session papers focused on recent advances in the seismic hazard and ground motion assessments of the Great Basin, which includes Yucca Mountain. Papers were presented on the detailed shallow crustal studies of the Las Vegas and Reno basins that control the site response of those areas. The new geophysical data from these cities shows that both areas would potentially experience relatively large amplifications of Basin and Range earthquake ground motions because of the deep and soft soil, alluvium, and lacustrian sediments accumulated in these basins.

Recent Geodetic data, including Global Positioning Satellite (GPS) data, was also discussed. GPS data continue to predict larger crustal strains (and thus more frequent earthquakes) compared to earthquake activity predicted by paleoseismic and structural studies. Several reasons have been proposed to explain this apparent "strain gap." These include residual and unaccounted for GPS strain from past earthquakes, distributed strain on non-seismogenic features (e.g., small faults and fractures), decade-scale strain transients that are too short-lived to amass significant displacement over the hundred to thousand year earthquake cycle, and increased crustal extension reflecting a recent shift in the tectonic plate boundary from the San Andreas fault to the western Basin and Range.

In this session, Dr. Stamatakos presented a summary of the structural and tectonic studies of Crater Flat Basin and Bare Mountain. Data from Crater Flat show that the major episode of slip on the Bare Mountain fault and antithetic faults at Yucca Mountain occurred mainly within an approximately 500,000 year period in the Miocene. Since then, the fault activity of these faults has slowed by about two orders of magnitude. This style of fault activity may be typical for the basin and range, in which the loci of active deformation migrates from basin to basin rather than a uniform extension of the entire Basin and Range crust.

Sarah Gonzalez and John Stamatakos presented an evaluation of site response for the surface facilities site at the potential repository in Yucca Mountain, Nevada during the Seismic Hazard of the Great Basin poster session. This poster presented a comparison of the DOE 1D site response results with CNWRA preliminary results. Our approach was slightly different from the DOE approach in that we considered lithology when we developed velocity, density, and layer thickness profiles as inputs to the site response model. This is in contrast to the DOE approach, which relied on a site-wide stochastic sampling of the data. CNWRA preliminary results are similar to DOE results. However, DOE results are slightly overpredicted at low frequencies (less than 2 Hz).

Meeting abstracts are provided in the March/April 2005 issue of Seismological Research Letters (Volume76, Number 2).

**CONCLUSIONS:**

The 2005 Seismological Society of America Annual meeting proved to be a successful and productive event. CNWRA staff gained valuable information from numerous technical sessions that bear directly and indirectly on the CNWRA work for the NRC.

**PROBLEMS ENCOUNTERED:**

None.

**PENDING ACTIONS:**

None.

**RECOMMENDATIONS:**

Attendance at professional society meetings is an integral component of staff professional development. In addition to maintaining an up-to-date understanding of our technical disciplines, this activity ensures that CNWRA staff continue to be visible participants in the scientific and engineering community.

**SIGNATURES:**

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5/24/2005
Date

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5/24/2005
Date

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5/31/2005
Date