

## **APPENDIX C**

### **Detailed Regional Resource Area Mapping in Nevada Using Natural and Mining Seismic Sources and the New USArray Seismic Network**

Glenn Biasi, Leiph Preston, Ileana Tibuleac  
**Great Basin Center for Geothermal Energy**

#### **Abstract**

The Earthscope Transportable Array (TA) seismic network is new in Nevada and the Great Basin. Over 200 high quality stations have already been installed on a grid with ~70 km spacing, with funding for a total of 400. It is the first network with the spatial coverage and data quality to develop uniform, high-resolution seismic images of the crust and shallow mantle of the entire Great Basin. TA stations will be removed after two years, and relocated farther east, so this proposal is also timely. This work will contribute to geothermal resource assessment in the Great Basin by providing uniform, high-resolution regional maps of seismic properties in the crust and shallow mantle for correlation with other observables including geothermally significant structures and trends.

In a two year effort we propose to develop surface and body-wave seismic images of Nevada and the Great Basin using earthquake and mining blast sources and Earthscope Transportable Array stations. We will use two complimentary tomographic methods. P- and S-body-wave arrival times will image the mid- to deep crust and shallow mantle with a block size of 10 km or smaller. Surface waves will image the shallow to deep crust, with depth sensitivity depending on wave frequency. Results will be integrated with previous seismic data compilations by Louie et al. funded by the GBCGE. Body and surface-wave maps will be interpreted for temperature and crustal variations after correlation and removal of known effects of lithology and structure using GBCGE GIS facilities and in coordination with GBCGE scientists.

**Introduction:** Seismic waves at local and regional distances directly probe the physical and thermal state of the crust and shallow mantle. However, because of its scale, a systematic investigation of the Great Basin with dedicated instrumentation would be difficult and expensive. Despite that, just such an experiment is under way in the Great Basin, funded by the National Science Foundation through the EarthScope initiative ([www.earthscope.org](http://www.earthscope.org)). By analogy with a research telescope, EarthScope is a major equipment investment to explore the geologic history and deep interior of the United States. Of most significance for geothermal resource exploration, Earthscope includes a moveable 400-station seismic network called the Transportable Array (TA). Over 200 of these stations are now installed, mostly in California, Washington, Oregon, western Idaho, and most of Nevada (Figure 1). Utah and southern Idaho should be installed later this year. It is the highest density seismic array of its size ever deployed in the U.S. Individual stations will be occupied for only two years, after which they will be redeployed farther east. The network will “roll” in this manner across the continental United States. The TA presents an extraordinary opportunity for geothermal research in the Great Basin.

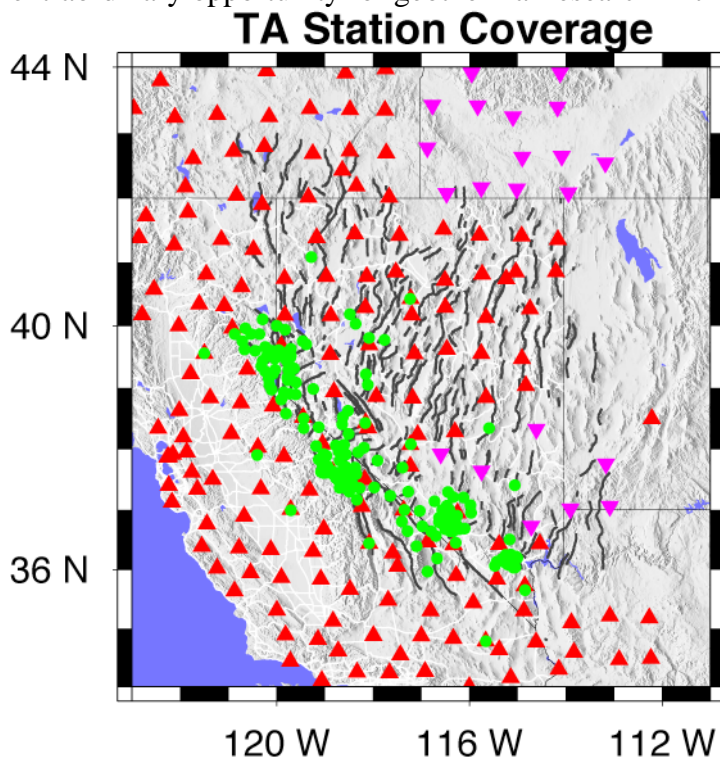


Figure 1. Red triangles are the USArray Transportable Array stations operating as of early December 2006. Stations installed in the past two months are inverted triangles. Utah, southern Idaho, and easternmost Nevada will be covered in 2007. The permanent seismic network (green circles) cannot match the TA for coverage or data quality.

**Background:** The contrast of TA coverage with that of previous studies in the Great Basin is substantial. Broad-scale (~100 km or more) measurements of crustal thicknesses and upper mantle velocities have been reported based on receiver functions, Pn or surface waves [e.g., Hearn *et al.*, 1991; Hearn and Rosca, 1994; Priestly *et al.*, 1980; Ozalaybey *et al.*, 1997]. These measurements indicate an average crustal thickness of ~30 km for the state, with a range from ~25 km under the Battle Mountain Heat Flow High [Stauber and Boore, 1978; Priestly *et al.*, 1980] to ~38 km under east central NV [Ozalaybey *et al.*, 1997; Gilbert and Sheehan, 2004]. Upper mantle P-wave velocities from these studies average  $\sim 7.8 \pm 0.2$  km/s, and show intriguing associations with faults and regions of high shear strain [Biasi and Humphreys, 1992; Humphreys and Dueker, 1994; Biasi, 2005]. Surface wave studies [e.g., Priestly and Brune, 1982] indicate that at least some parts of the state may possess an upper mantle high shear velocity lid ~30 km thick. More detailed studies have focused on specific areas within the state: along ~40°N latitude with the PASSCAL and COCORP reflection/refraction lines [e.g., Catchings and Mooney, 1991; Knuepfer *et al.*, 1987; Benz *et al.*, 1990; Hauser *et al.*, 1987], the Ruby Mountains and the Nevada Test Site. These studies report

generally flat or gently dipping Moho and locally, highly reflective lower crust interpreted as the brittle-ductile transition [Catchings and Mooney, 1991]. Crustal velocities derived from these studies broadly show low-velocity basins (<5 km/s) and higher velocity ranges (5-6 km/s) down to ~10 km depth. Below this depth the structure was imaged as nearly 1-D with velocities increasing to upper 6 km/s range at the bottom of the crust and jumping to upper 7 km/s below the Moho. These models, however, are very smooth and were constructed from stitching together 1-D models and forward modeling. Louie *et al.* [2004], Louie *et al.*, [2006], and Heimgartner *et al.*, [2006] have constructed fully 2-D velocity models of the crust and upper mantle along refraction lines west and southwest from central Nevada, but the resolution of the models are on the order of 50 km or more. A more complete review and synthesis has been provided through GBCGE research and reports by cooperating scientist Louie.

### TA Ray Coverage

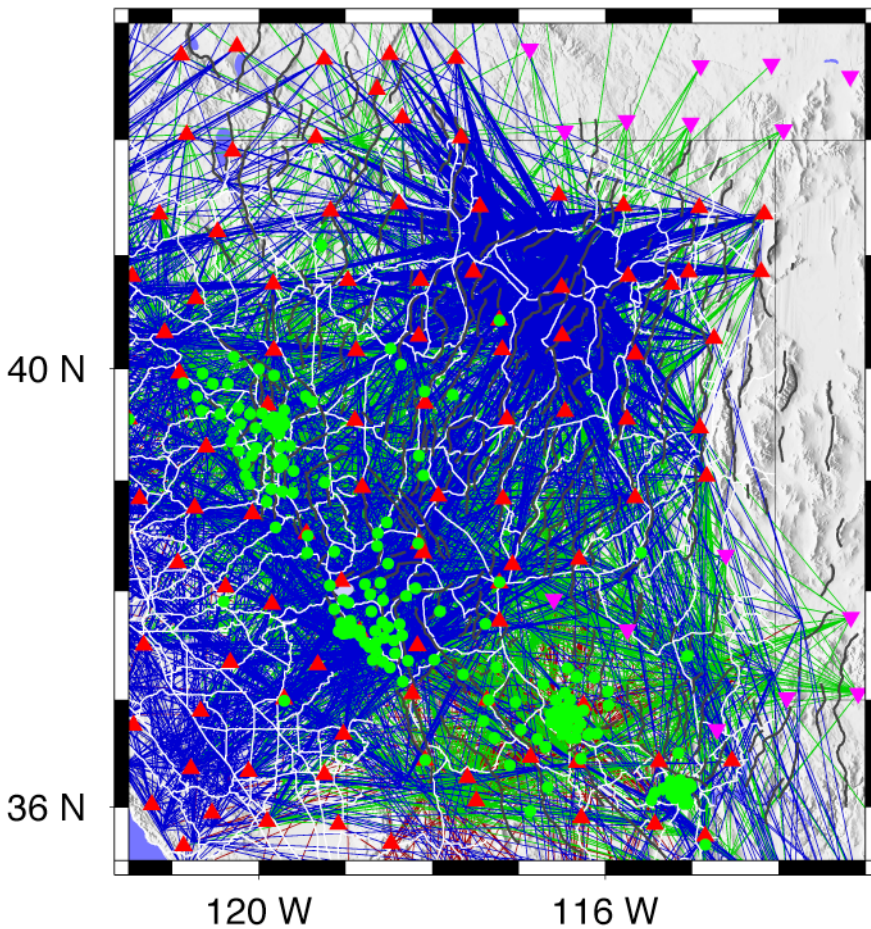


Figure 2: Current and anticipated ray coverage to the TA station. Station symbols as from Figure 1. Dense source coverage near 41N, 117W is due to mine blasts. See text for other details.

**Data Availability:** Figure 2 illustrates the increase in measurement density available for geothermal research through the Transportable Array. Lines on this figure are seismic paths for the 6 months from August 2006 through January 2007 recorded by NSL. From this period only earthquakes and mining blasts recorded by 10 or more stations (8100 rays) are shown. New paths covered because of the TA stations are shown in dark blue. Green lines are projected additional data for the coming year based on last year’s NSL catalog of M>3 earthquakes (4100 rays). We expect between 12,000 and 25,000 new seismic

measurements per year. Northern and central Nevada is especially well covered. Line density is a rough proxy for resolution. For most of the central Great Basin resolving blocks of 10 km or smaller is clearly feasible.

We propose to image seismic velocity using both body waves – compressional and shear waves – and surface waves. Body waves travel faster and deeper in the crust – 12 to 25 km for stations spaced at 70 km, and only sample the shallow crust in a limited cone near the stations.

Unfortunately this leaves most of the volume between the stations unsampled except in the mid-to lower crust. On the other hand, surface waves sample from the free surface down to some depth that depends on their frequency. The lower the frequency, the deeper they sample. In typical Great Basin geologic conditions, surface waves at 5-second period sample to a depth of a few to perhaps 10 km. At 10 second periods they sample to a depth of 10-20 km. Thus maps of surface wave velocity as a function of frequency provide an indication of seismic velocity as a function of depth. By using both surface and body waves together most of the crust can be sampled.

**Body Wave Inversion:** For the body wave portion of this proposal, we will use the tomographic inversion code of *Preston et al.* [2003] to invert travel times of P and S waves. This code is an iterative non-linear inversion procedure that simultaneously solves for optimal earthquake locations and 3-D P- and S-wave velocity structure. Full 3-D ray-tracing and travel-time calculations are implemented through the Vidale-Hole algorithm [Vidale, 1990; Hole and Zelt, 1995].

*Figure 3: Example P-wave tomographic image of velocity structure at ~2 km depth (sea level) in the Yucca Mountain region over shaded topography. Yucca Mountain is shown in the center of the plot. Contours are 0.5 km/s intervals; black dots are relocated earthquakes within 1 km of this depth section. Ray coverage for this map is exceptional; resolution of 5-10 km is anticipated from the proposed work.*

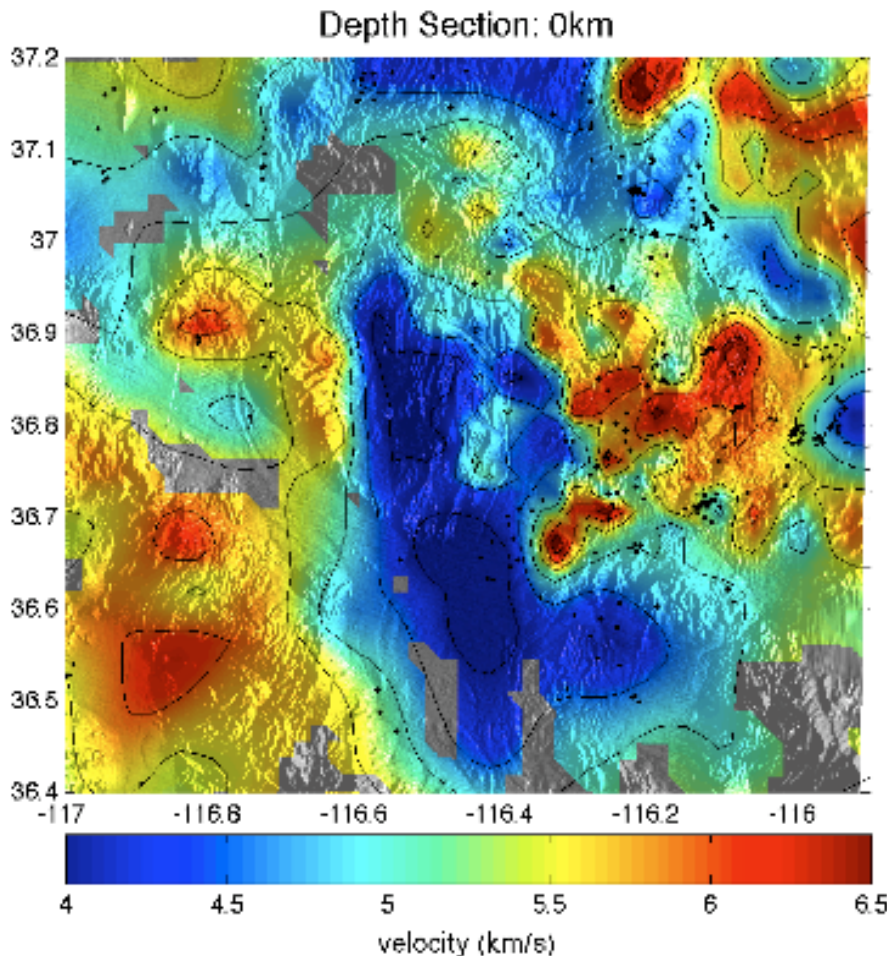


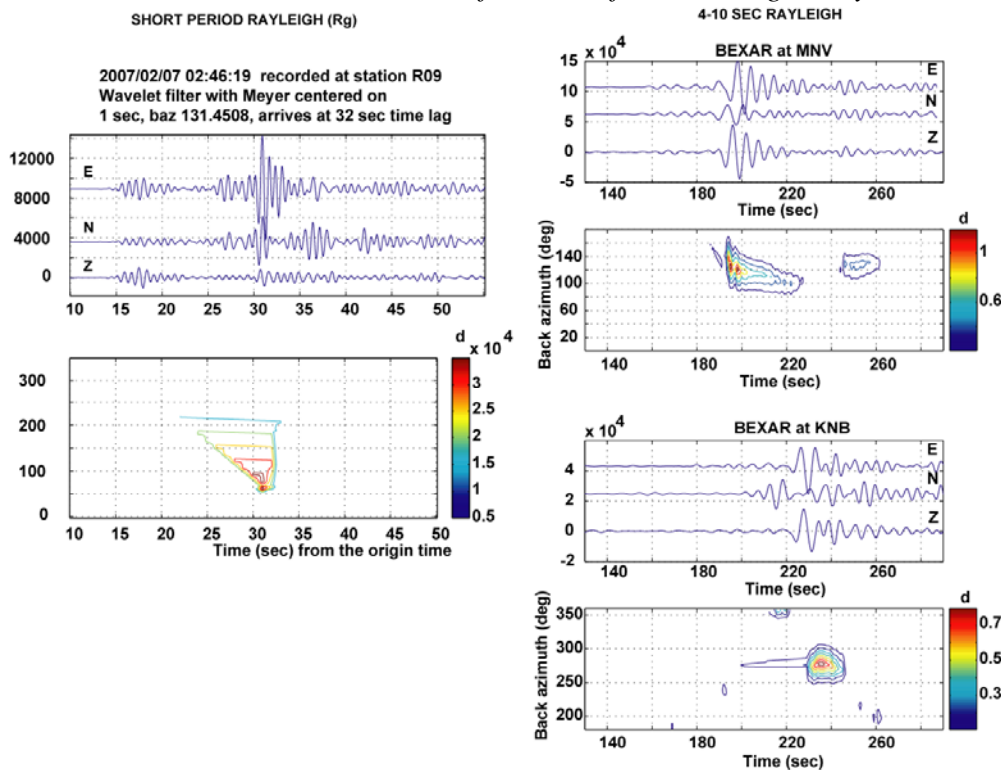
Figure 3 shows the P-wave velocity structure we have obtained for the Yucca Mountain region at a depth of about 1.5 km (or 0 km relative to sea level) [Preston et al., 2005]. We propose to invert travel times from both natural and previously compiled active (e.g., mine blasts, refraction experiments) sources. Active sources can provide premier constraint on velocities since their source locations and origin times are known. Our model region will consist of the entire state of NV and borderlands into OR, CA, AZ, UT, and ID to ensure maximum coverage even on the edges of the state. We hope to achieve ~5-10 km

horizontal resolution in the best sampled areas with poorer resolution elsewhere. Resolution with shear waves is expected to be lower because many of the central and eastern Nevada sources are mine blasts that do not generate usable shear waves.

**Surface Wave Inversion.** Rayleigh surface waves are dispersive, meaning that their velocity depends on frequency. Thus, the velocity with which energy travels, or group velocity, in a Rayleigh wave is a crustal thickness indicator. Our goal is to develop group velocity tomographic models for periods between 1 and 22 sec using travel time and back azimuth measurements. We propose three steps:

1) *Fundamental mode Rayleigh wave detection and picking.* Our database will include all shallow events with detectable Rayleigh waves, from 30 km to 1700 km epicentral distance. To confidently identify Rayleigh arrivals we will use a detector based on a method by Chael (1997) and Tibuleac and Britton (2006). We will modify the algorithm to account for Love-Rayleigh interference, which is usually the reason Raleigh signals cannot be extracted. Examples of  $R_g$  and regional Rayleigh wave detection are shown in Figure 4. Specific filtering techniques are required for  $R_g$  and for longer period Rayleigh phases (Herrmann and Ammon, 2002). Mine blasts are best sources for Raleigh waves, so we anticipate the best resolution in north-central Nevada.

Figure 4. Left:  $R_g$  phase detected at USArray station R09A from an ML 2.7 earthquake on February 7, 2007. The earthquake was 91 km from the station. The  $R_g$  phase arrives at 32 sec time lag, with a back-azimuth deviation of 10 deg. The lower left plot shows time variation of the estimated back azimuth. Waveforms are filtered using a Meyer wavelet centered on 1 sec period.



Right plots show results of Rayleigh wave detection of nuclear explosion BEXAR at the MNV, KNB and LAC seismic stations. Waveforms are filtered using a zero-phase Butterworth filter between 0.05 and 0.2 Hz. Back-azimuth deviations are smaller at longer periods.

2) *Rayleigh wave tomography.* We will use a method developed by Barmin et al., (2001). Initially

we will assume that the Rayleigh paths are straight, then in the second year, incorporate the detected back azimuth deviations into the tomographic inversion. The resolution will depend on the fraction of events producing useable Raleigh waves.

3) *Higher mode analysis.* Higher mode Raleigh waves were reported by Priestley and Brune (1980) to directly reflect crustal thickness. They arrive after direct S and before the fundamental mode Raleigh wave. We propose to explore the usefulness of this phase for constraining the tomographic model and crustal properties.

**Scaling Seismic Anomalies For Geothermal Application:** Humphreys and Dueker (1994b) provide an extensive review of the physical state of the mantle and its impact on crustal evolution based seismic and other geophysical measurements. Our interpretations of crustal velocity anomalies will begin with Christensen and Wepfer (1989). They tabulate pressure and temperature derivatives of compressional velocity for a range of crustal lithologies. They note that pressure increases and temperature decreases approximately offset each other for 25-40 C/km geotherms, but velocity inversion can occur with higher heat flows. Thus inversions may be detectable by anomalous Raleigh wave dispersion. Fountain and Christensen (1989) tabulate velocity vs. petrology, density, and Poisson's ratio for common lithologies. Comparison of velocity anomalies with mapped and suspected rock types from the GBCGE GIS database may identify regions where velocity anomalies are not explained by petrology, and thus more likely to be due to anomalous temperatures.

### **Proposed Work:**

- (1) Formally begin data collection at NSL of useful events for all Great Basin stations. (Biasi)
- (2) Mine IRIS archive for Great Basin events that were not saved at NSL. (Biasi, student)
- (3) Develop and QC body-wave data (student, Preston)
- (4) Develop tuned detector for quarry and mine blasts (Tibuleac)
- (5) Presentation at GRC Annual Meeting of data quality and coverage (co-PI's)
- (6) Preliminary body-wave inversion for Nevada for AGU Meeting (Preston, Biasi)
- (7) Develop Love-wave filtering-based Raleigh detector (Tibuleac)
- (7) P- and S-wave tomographic images of Nevada (Preston)
- (8) Straight-ray surface-wave tomographic images (Tibuleac)
- (9) Incorporate images into previous seismic integrations and existing geophysical constraints into the images. (Louie)
- (10) Develop temperature and constrained lithologic interpretations for surface and body-wave maps (Biasi).
- (11) Annual, quarterly reports to DOE (Biasi)
- (12) Develop full Great Basin grids for tomographic models (co-PI's)
- (13) Develop dispersion and azimuth-anomaly tomographic inversion method for surface waves (Tibuleac)
- (14) Body-wave and surface wave tomographic images (Preston)
- (15) Final integration with physical property scalings, existing data, and develop web-publication summary, summarization for GBCGE GIS application (co-PI's)
- (16) Present findings in meetings, workshops, quarterly reports, and journals (co-PI's)

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**Glenn P. Biasi**  
**Research Associate Professor**  
**Nevada Seismological Laboratory**  
**University of Nevada, Reno**

February 2007

**Education:**

Ph.D., Geological Sciences, 1994, University of Oregon, Eugene, OR  
M.S., Geological Sciences, 1988, University of California Riverside, Riverside, CA  
M.S., Systems Management, 1980, University of Southern California  
B.A., Applied Mechanics and Engineering Science, 1976, University of California San Diego

**Affiliations:**

Geological Society of America (1986- )    Society of Exploration Geophysicists (1985- )  
American Geophysical Union (1985- )    Seismological Society of America (1991- )

**Recent Career Experience:**

Acting Assistant Seismic Network Manager, Nevada Seismological Laboratory, 10/2005-11/2006  
Research Assistant Professor, Seismological Laboratory, University of Nevada Reno, 1997-2006  
Postdoctoral Researcher, 1994-7, Yucca Mountain Project, University of Nevada Reno

**Current Research:**

Tomographic imaging; broadband measurements of mantle structure and physical properties; site effects and related parametric estimates from local earthquakes; Bayesian applications in paleoseismology and conditional probabilities of ground rupture.

**Recent Publications (peer reviewed since 2000):**

- Scharer, K. M., Weldon, Ray J. II, Fumal, T. E., and **Biasi, G. P.** (in press). Paleoearthquakes on the southern San Andreas Fault, Wrightwood CA, 3000 to 1500 BC, *Bulletin of the Seismological Society of America*.
- Biasi, G.P.** and R.J. Weldon (2006). Estimating surface rupture length and magnitude of paleoearthquakes from point measurements of rupture displacement, *Bulletin of the Seismological Society of America*, 96, 1612-1623.
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### **Active and Recent Grants and Contracts:**

- Western Great Basin Seismic Network Operations (USGS), 2/2007-1/2010, \$412K for 2/2007-1/2008; P.I., co-PI K. Smith
- Support for USArray operations in the Great Basin (NSF IRIS), 5/2005-2/2007, \$440K, co-PI w. K. D. Smith.
- Time-Space Probability of San Andreas Fault Earthquake Ruptures, Southern California Earthquake Center), 2/2005-1/2007, \$15K, P.I.
- Modeling strategy for southern San Andreas earthquake ruptures (Southern California Earthquake Center), 2/2004-1/2007, \$17K, P.I.
- Joint UNR-UC Berkeley proposal to CALTRANS (seismic monitoring) (U.C. Berkeley CALTRANS pass-through), 2/2004-1/2007, \$27K, P.I.

*Leiph A. Preston*

**EDUCATION:**

**B.Sc. Physics**            Physics, Purdue University, West Lafayette, Indiana, 1997  
**Ph.D. Geophysics**        Seismology, University of Washington, Seattle, Washington. 2003  
**Postdoctoral Seismology**    University of Nevada Reno, Reno, Nevada, 2003-present

**EMPLOYMENT:**

University of Nevada Reno Seismological Laboratory MS/174, Reno, Nevada 89557  
*October 2003 – present:* Post-Doctoral researcher

**SELECTED PUBLICATIONS:**

Creager, K.C., L. Preston, R.S. Crosson, T. van Wagoner, A. Trehu, and SHIPS working group, 3-D reflection image of the subducting Juan de Fuca plate, in *The Cascadia Subduction Zone and Related Subduction Systems-Seismic Structure, Intraslab Earthquakes and Processes, and Earthquake Hazards*, Stephen Kirby, Kelin Wang, and Susan Dunlop, eds.: U.S. Geological Survey Open-File Report 02-328, on 1 CD-ROM, and Geological Survey of Canada Open File 4350, 37-41, 2002.

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Smith, K.D., D. von Seggern, G. Blewitt, L. Preston, J.G. Anderson, B.P. Wernicke, and J.L. Davis, Moving mountains and lower crustal earthquakes at Lake Tahoe, California: Evidence for 30km deep magma injection, *Science*, 305, 1277-1280, 2004.

van Wagoner, T.M., R. S. Crosson, K.C. Creager, , G. Medema, L. Preston, N. P. Symons, and T.M. Brocher. Crustal Structure and relocated earthquakes in the Puget Lowland, Washington, from high-resolution seismic tomography, *J. Geophys. Res.*, 107, doi:10.1029/2001JB000710, 2003.

von Seggern, D., K.D. Smith, and L. Preston, Seismic spatial-temporal character and effects of a deep (25-30 km) magma intrusion below north Lake Tahoe, California-Nevada, Bull. Seis. Soc. Am., accepted for publication.

### **SYNERGISTIC ACTIVITIES:**

Developed a methodology for inverting travel times from first and reflected arrivals from active and earthquake sources for velocity structure, earthquake locations, and reflector geometry.

Developed a Matlab program that determines focal mechanisms for (small) earthquakes from the first motions and P, SV, and SH amplitudes that is highly controllable by the user. It may effectively be used as both a teaching and research tool depending on parameters supplied by the user.

### **COLLABORATORS AND AFFILIATIONS:**

Collaborators: John Anderson (U. Nevada Reno), Geoff Blewitt (UNR), Thomas Brocher (USGS), Ken Creager (U. Washington), Robert Crosson (UW), James Davis (Harvard-Smithsonian Center for Astrophysics), Shawn Larson ((Lawrence Livermore NL), Guy Medema (UW), Steve Myers (LLNL), Thomas Pratt (USGS), Ken Smith (UNR), Neill Symons (Sandia NL), Anne Trehu (Oregon State U.), Thomas vanWagoner (Chevron Inc.), David vonSeggern (UNR), Brian Wernicke (California Institute of Technology).

Graduate and Postdoctoral Advisors: Graduate: Kenneth Creager (University of Washington);

Postdoctoral: Ken Smith (University of Nevada Reno).

Thesis Advisor and Postdoctoral Sponsor: None.

### **INTERESTS:**

Earthquake and seismic tomographic structure research in the Great Basin. Includes stress fields derived from small earthquake focal mechanisms, modeling structure with full 3D waveform simulations (E3D) and tomography and earthquake relocations. Experience in subduction zone environment studies in Washington State using tomographic inversion for structure, earthquake locations, and wide-angle reflections from subducting Juan de Fuca slab. Development of computer software for UNIX for tomographic inversion and visualization. Proficiency includes Matlab, perl, C, C++, java, seismic unix, sac. Develop software that interacts with CSS3.0 database.

## **Biographical Sketch of John N. Louie**

Nevada Seismological Laboratory  
(775) 784-4219; fax (775) 784-1833; louie@seismo.unr.edu

### **Professional Experience**

**Professor of Seismology**, Seismological Laboratory and Department of Geological Sciences and Engineering, The University of Nevada, Reno; since July 2006; Assoc. since 1992. Responsibilities include undergraduate and graduate instruction, supervision of M.S. and Ph.D. degree candidates, and conducting a research program in seismology.

**Assistant Professor of Geosciences**, The Pennsylvania State University, University Park, Penna.; Sept. 1987 to Jan. 1992.

### **Selected Recent Graduate Theses Directed**

M.S. Thesis in Hydrogeology by Matthew Clark on "Hydrologic and geophysical investigation of a fault as a hydrologic barrier in Reno, Nevada" defended on 26 Oct. 2005.

Ph.D. Thesis in Geophysics by Robert E. Abbott on "Geophysical constraints on seismic hazard and tectonics in the western Basin and Range" defended on 23 Aug. 2001.

Ph.D. Thesis in Geophysics by Abu M. Asad on "Linearized and nonlinear travel time tomography for upper crustal velocity structure of the western Great Basin" defended on 23 Jan. 1998.

M.S. Thesis in Hydrogeology by Ken Mela on "Interpretation of stochastic hydrogeologic properties from seismic data" defended on 14 Nov. 1997.

### **Selected Recent Sponsored Research**

*Collaborative research with CGS: Improving hazard maps and NGA models with  $V_s$  measurements at 25 CISN stations in San Bernardino and Riverside*, sponsored by the U.S. Geological Survey, 1/2007 – 12/2007 for \$50,000.

*Developing a Wellington community earthquake hazard modeling environment*, Fulbright Senior Scholar Award to New Zealand, US Dept. of State, 2/2006-7/2006, sabbatical support.

*Improving next-generation attenuation models with shear-velocity measurements at all TriNet and strong-motion stations in LA*, sponsored by the U.S. Geological Survey under contract 05HQGR0078, 2/2005 – 1/2006 for \$54,000.

*3-D Evaluation of Ground-Shaking Potential in the Las Vegas Basin*, sponsored by the U.S. Dept. of Energy/Lawrence Livermore National Laboratory 5/2002 - 9/2005 for \$330,000 between 2 PIs.

*Assembly of a crustal seismic velocity database for the Western Great Basin*, sponsored by the U.S. Dept. of Energy/Great Basin Center for Geothermal Energy 4/2002-9/2006 for \$302,668.

*Improving southern California seismic hazard models with a 45-km shear-velocity profile along the San Gabriel River*, sponsored by the U.S. Geological Survey under contract 03HQGR0068, 2/1/2003 - 1/31/2004 for \$52,000 between 2 PIs.

*Evolution of the Sierra Nevada - Basin and Range boundary — tephrochronologic and gravity constraints on the record in Neogene basin deposits*, sponsored by the National Science Foundation 6/2000-5/2002 for \$55,182 between 3 PIs.

### **Graduate Education**

California Institute of Technology, Pasadena, California. Degrees: Ph.D. Geophysics, June, 1987; M.S. Geophysics, June, 1983.

### **Relevant Publications**

- J. N. Louie, W. Thelen, S. B. Smith, J. B. Scott, M. Clark, 2004, The northern Walker Lane refraction experiment: Pn arrivals and the northern Sierra Nevada root: *Tectonophysics*, 388, no. 1-4, 253-269.
- J. B. Scott, M. Clark, T. Rennie, A. Pancha, H. Park and J. N. Louie, 2004, A shallow shear-velocity transect across the Reno, Nevada area basin: *Bull. Seismol. Soc. Amer.*, 94, no. 6 (Dec.), 2222-2228.
- J. N. Louie, S. Chavez-Perez, S. Henrys, and S. Bannister, 2002, Multimode migration of scattered and converted waves for the structure of the Hikurangi slab interface, New Zealand: *Tectonophysics*, 355 (1-4), 227-246.
- R. E. Abbott, J. N. Louie, S. J. Caskey, and S. Pullammanappallil, 2001, Geophysical confirmation of low-angle normal slip on the historically active Dixie Valley fault, Nevada: *Jour. Geophys. Res.*, 106, 4169-4181.
- R. E. Abbott and J. N. Louie, 2000, Depth to bedrock using gravimetry in the Reno and Carson City, Nevada area basins: *Geophysics*, 65, 340-350.

### **Other Important Publications**

- W. A. Thelen, M. Clark, C. T. Lopez, C. Loughner, H. Park, J. B. Scott, S. B. Smith, B. Greschke, and J. N. Louie, 2006, A transect of 200 shallow shear velocity profiles across the Los Angeles Basin: *Bull. Seismol. Soc. Amer.*, 96, no. 3 (June), pp. 1055-1067, doi: 10.1785/0120040093.
- J. B. Scott, T. Rasmussen, B. Luke, W. Taylor, J. L. Wagoner, S. B. Smith, and J. N. Louie, 2006, Shallow shear velocity and seismic microzonation of the urban Las Vegas, Nevada basin: *Bull. Seismol. Soc. Amer.*, 96, no. 3 (June), pp. 1068-1077, doi: 10.1785/0120050044.
- W. J. Stephenson, J. N. Louie, S. Pullammanappallil, R. A. Williams, and J. K. Odum, 2005, Blind shear-wave velocity comparison of ReMi and MASW results with boreholes to 200 m in Santa Clara Valley: Implications for earthquake ground motion assessment: *Bull. Seismol. Soc. Amer.*, 95, no. 6 (Dec.), 2506-2516.
- A. Pancha, J. G. Anderson, J. N. Louie, A. Anooshehpour, and G. Biasi, 2004, Data and simulation of ground motion for Reno, Nevada: presented at *13th World Conf. on Earthquake Engineering*, Vancouver, B.C., Aug. 1-6, paper no. 3452.
- J. N. Louie, 2001, Faster, better: shear-wave velocity to 100 meters depth from refraction microtremor arrays: *Bull. Seismol. Soc. Amer.*, 91, no. 2 (April), 347-364.

### **Synergistic Activities**

- JRG, an open-source, menu-driven seismic processing package: [www.seismo.unr.edu/jrg](http://www.seismo.unr.edu/jrg) .
- ModelAssembler, velocity gridding for Great Basin seismic models: [www.seismo.unr.edu/ma](http://www.seismo.unr.edu/ma) .
- Applied Geophysics course with 1-week field camp and on-line exercises: [www.seismo.unr.edu/ftp/pub/louie/class/492-syll.html](http://www.seismo.unr.edu/ftp/pub/louie/class/492-syll.html) .
- Service on IRIS Standing Committee, managing the PASSCAL national facility, 2001–2003.

**Recent Collaborators:** Barbara Luke, Cathy Snelson (UNLV); Arthur Rodgers, Shawn Larsen (LLNL); Stephen Bannister, Stuart Henrys, W. R. Stephenson (GNS); W. J. Stephenson (USGS).

**Graduate Advisor:** Robert W. Clayton.

**Graduate Students Advised:** Satish K. Pullammanappallil (Ph.D. 1994), Deborah Dann, Abu Asad (Ph.D. 1998), William Honjas (M.S. 1993), Serdar Ozalaybey (Ph.D. 1996), Sergio Chavez-Perez (Ph.D. 1997), Ken Mela (M.S. 1997), Zakir Kanbur (M.S. 1997), Li Li, Robert E. Abbott (Ph.D. 2001), Matthew Clark, James Scott, Shane B. Smith, Aline Concha-Dimas (Ph.D. 2004), Aasha Pancha, Michelle Heimgartner, Donghong Pei.

ILEANA MADALINA TIBULEAC

Research Associate Professor

Address: Seismology, MS/174, University of Nevada at Reno, Reno, NV 89557

e-mail address: ileana@seismo.unr.edu

## EDUCATION

Ph.D. in Geophysics, SOUTHERN METHODIST UNIVERSITY Dallas, TX.,

15 May 1999, overall GPA: 3.827/4.0 scale.

Thesis: Array Measurements of P and PcP Slowness Residuals with Implications for Lateral Heterogeneity in the Lower Mantle beneath the Caribbean Sea and Other Geophysical Studies  
Master of Science in Nuclear Physics, BUCHAREST UNIVERSITY, ROMANIA, Overall GPA: 9.80/10.0 scale. Thesis: Thorium Utilization in Nuclear Plants

Bachelor of Science in Physics, BUCHAREST UNIVERSITY, ROMANIA.

## PROFESSIONAL EXPERIENCE

UNIVERSITY OF NEVADA, April 2006 - present

WESTON GEOPHYSICAL CORPORATION, Feb. 2002 - 2006

Research Interests include:

### NUCLEAR MONITORING RESEARCH

Developing automatic secondary seismic phase detectors (Lg, Rg) using wavelet transforms and other signal processing methods. Principal investigator on a SBIR phase I awarded between July - Dec 2002. Applying array processing methods to event location and discrimination studies.

### LOWER MANTLE HETEROGENEITY

Continuing studies on the extent of the lower mantle heterogeneity beneath the Caribbean Sea using new sets of data.

PRINCETON UNIVERSITY Research Associate, 2001 - 2002

### LOWER MANTLE HETEROGENEITY

Analyzed and interpreted P wave amplitudes as observed in the past ten years with the new, global digital broadband seismic networks. The study was original because we used new data sources, and also because it concluded that focusing and defocusing in the mantle is an important factor for compressional wave amplitude variation, and this effect is underestimated by current tomographic models.

SOUTHERN METHODIST UNIVERSITY Post doctoral Fellow, 15 May 1999 - February 1<sup>st</sup>, 2000.

## SEISMIC ARRAY CALIBRATION

I was part of a team that calibrated the TXAR (Lajitas, Texas), NVAR (Mina, Nevada) and ILAR (Eilson, Alaska) seismic arrays. I assessed the location capability at NVAR for events near

the Nevada Test Site. I quantified the effect of elevation, geology and source azimuth on array locations and signal/noise level at search site.

SOUTHERN METHODIST UNIVERSITY Research Assistant, 1994-1999.

I have developed a new automatic method for timing Lg arrivals using wavelet transforms to decompose the Lg signal into its components localized both in time and scale (inverse frequency).

Together with my colleague Rebecca Ghent, I have applied signal processing techniques and wavelet transforms to digital Magellan SAR data from Venus to determine dominant wavelengths in various types of ribbon terrain.

#### SELECTED PUBLICATIONS

Tibuleac, I.M. and J. M. Britton (2006), An automated short-period surface-wave detection algorithm, *Bulletin of the Seismological Society of America*, 96, 334-343.

Lindquist, K. G., Tibuleac, I. M. and R. A. Hansen, (2006), A Semi-Automatic Calibration Method Applied to a Small-aperture Alaskan Seismic Array, accepted at BSSA.

Tibuleac, I. M., G. Nolet, C. Mychaelson and I. Koulakov, (2003), P wave amplitudes in a 3 D Earth, *Geophys. J. Int.*, 155, 1-10.

Anderson, D., E. T. Herrin, V. L. Teplitz and I. M. Tibuleac,(2003), Unexplained Sets of Seismographic Station Reports and A Set Consistent with a Quark Nugget Passage, in press, *Bull. Seis. Soc. Am*, <http://www.geology.smu.edu/~dpa-www/sqm/index.html>

Tibuleac, I. M., E. T. Herrin, James Britton, R. G. Shymway and A. C. Rosca, (2003), Automatic of secondary phase arrivals using wavelet transforms, in press at *Seis. Res. Lett.*

Bonner, J. L., Harkrider, D., Herrin, E. T., S. Rusell, R. Shumway, I.M. Tibuleac and D. Reiter, (2002) Evaluation of short-period, near-regional Ms scales for the Nevada Test Site, in press at *Bull. Seis. Soc. Am.*

Ghent, R. R. and I. M. Tibuleac, (2002), Ribbon spacing in Venusian tessera: Implications for layer thickness and thermal state, *Geophys. Res. Lett.*, 29, No. 20, 2000, 61-1-4.

Tibuleac, I. M, E.T. Herrin and Petru Negraru, (2001), Calibration Studies at NVAR, *Seis. Res. Lett.*, 72, 754.

Tibuleac, I. M. and E.T. Herrin, (2000), Location Capability at NVAR (Mina,Nevada) Seismic Array for Events on the Nevada Test Site, *Seismological Research Letters*, 72, 97 - 107

Tibuleac, I. M. and E.T. Herrin, (1999), Lower Mantle Heterogeneity Beneath the Caribbean Sea, *Science*, 285, 1711 - 1715.

Tibuleac, I. M. and E.T. Herrin, (1999), "An Automatic Method for Determination of Lg Arrival Times Using Wavelet Methods", *Seis. Res. Lett.*, 70, 577 - 595.

Tibuleac, I. M. and Herrin, E, (1997), Calibration Studies at TXAR, *Seis. Res. Lett.*, 68, 353-365.

#### Selected Technical Reports

Bonner J., Sarah Deering, Tao Liu, Swanson J. and Ileana Tibuleac, Seismic and acoustic data observations at TXAR, January 1997.

E.T., Herrin, E., Burlacu, V., Tibuleac, I. M., Hayward, C., Bonner, J., Golden, P., and Sorrels, G., (1995), Seismo-Acoustic Synergy, in Herrin, E., Golden, P., and Robertson, E., Eds., Design, Evaluation, and Construction of TEXESS and LUXESS, and research in mini-array technology and use of data from single stations and sparse networks: phase V, SMU Scientific Report No. 5, 41-71.