Continued Implementation of a Regional Database of Crustal Geophysical Controls on Geothermal Resource Assessment, and a New Seismic Survey of the Northwesternmost Great Basin

A proposal for

DOE Geothermal Funding for Research to Increase Utilization of Geothermal Resources in the Western United States

To the

Great Basin Center for Geothermal Energy, University of Nevada, Reno

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Contents

Abstract

We propose to continue the assembly, testing, and dissemination of a three-dimensional reference model and databases of crustal thickness and seismic velocity for the Great Basin region of Nevada and surrounding States. This project is divided into two tasks; the main task proposed is to continue current research into crustal thicknesses and seismic velocities in the Great Basin. Funding only a portion of the total budget will allow this task to continue to support graduate student Michelle Heimgartner, \$38,613 for Year 1 and \$42,598 for Year 2. The remainder of the total budget would fund the secondary task, a fourth regional seismic-refraction experiment. This experiment will profile the very poorly known crust below the northwestern-most Great Basin, from Crater Lake, Oregon east-southeast toward Winnemucca, Nevada. A previous project has identified an association of geothermal systems in tectonically extending areas with areas of thinner crust. This correlation has assisted the regional assessment of geothermal resources, and identified areas for new exploration such as Buffalo Valley, Nevada. Much of the Great Basin is still not well characterized for crustal geophysical parameters, either due to lack of prior measurement, or to the existence of conflicting prior measurements from various techniques. Careful selection among data has discovered new regional crustal structures such as a Moho ridge following the Humboldt lineament.

Project Description

Objectives

We propose to continue the assembly, testing, and dissemination of a three-dimensional reference model of seismic velocity for the Great Basin region of Nevada, eastern California, southeast Oregon, southernmost Idaho, western Utah, and northwesternmost Arizona. This project is divided into two tasks:

The main task proposed is to continue current research into crustal thicknesses and seismic velocities in the Great Basin. Only a portion of the total Year 1 and Year 2 budgets requested here will be enough to allow Prof. Louie to continue to supervise and support UNR Geophysics graduate student Michelle Heimgartner in this task. The portion of the budget request for this main task is $38,613 ($10,128 matching) for Year 1 and $42,598 ($11,049 matching) for Year 2. If only this task can be funded, most of the objectives can still be met.

The remainder of the total budget is intended to fund the secondary task, a fourth GBCGE regional seismic-refraction experiment. This experiment will profile the very poorly known crust below the northwestern-most Great Basin, from Crater Lake, Oregon east-southeast toward Winnemucca, Nevada. Scouting for the experiment and completing GBCGE refraction facility upgrades in the first year, and fieldwork costs in the second year, increase both budgets to the total requested in the attached budget.

Relevance and Background

This research was begun three years ago in a prior GBCGE sub-project. Exploration for hidden resources requires a realistic three-dimensional crustal model to understand the deep sources of geothermal heat in the crust of the western Great Basin. Our crustal models have been contributed to the associated sub-projects assembling geographic databases of geothermal indicators. With the our more complete sampling of the crustal geophysical characteristics of geothermal resources in the Great Basin, these measures have contributed to quantitative analyses of the associations between different indicators. This project develops critical data toward the effective exploration for new geothermal resources.

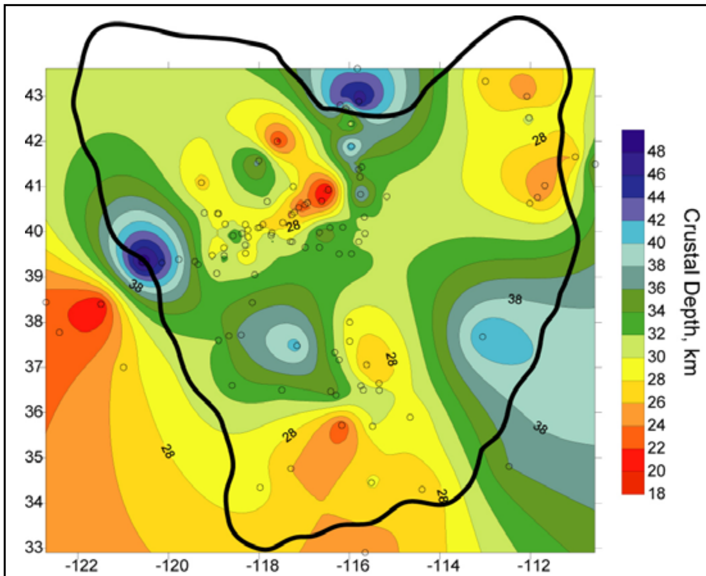

Fig. 1- Great Basin crustal-thickness model assembled by M. Heimgartner, showing data points used for this interpretation. Data include selected results of others, and our 2002 results from the northern Walker Lane.

Crustal thickness and velocity are closely related to a region's thermal and tectonic history. Known geothermal resources in north-central Nevada are closely associated with thin crust and an uplifted Moho (fig. 1; Thelen et al., 2002; Savage and Sheehan, 2000; Ozalaybey et al., 1997; Fliedner et al., 1996; Humphreys and Dueker, 1994). The main task of this project is to continue the assembly of alternative velocity models for the entire Basin and Range (fig. 1). Sets of alternative models are enabling the search for crustal features, similar to those under known geothermal resources (Thelen et al., 2002), which may be closer to Southern California power markets.

The acquisition under the previous project of 20 Reftek RT-125 "Texan" seismic recorders will assist our effort, as a secondary task proposed here, to acquire a fourth 500-km-long refraction profile in the second project year. This experiment will profile the very poorly known crust below the northwestern-most Great Basin, from Crater Lake, Oregon east-southeast toward Winnemucca, Nevada. We will again borrow an additional 400 recorders from the IRIS/PASSCAL Instrument Center for each experiment, for the cost of shipping and batteries. The travel and personnel costs for this experiment make up the majority of the budget proposed for the second project year.

Texan Refraction Recorder Facility Upgrade— As part of the secondary task, we also propose for the first project year the completion of the upgrade of our 20-Texan recorder facility. Two years ago we proposed and received from the GBCGE $20,000 in funds to have Reftek upgrade our 20 recorders to a new, more robust design. The new design uses standard USB-2 connections to control the recorders and dump data from them. Our estimated cost of $1000 per Texan was based on some very early estimates, prior to the completion of the design, or its qualification with IRIS-PASSCAL. The upgrade could not be quoted by Reftek until January 2005, and their quote shows a cost of almost $2000 per Texan. Thus our current project lacks sufficient funds to complete the upgrade, and we include in the proposed project the additional $20,000 of upgrade cost.

The seismic velocity models resulting from this project consist of simplified rule-based representations of the lithosphere to 50 km depth, and of the region's most important geothermal areas and sedimentary basins. The models are specified in a form compatible with computer codes developed for SCEC, NSF-EarthScope, and a collaborating project on seismic hazards in southern Nevada funded by the Lawrence Livermore National Lab. The type of rule-based representations developed by the Southern California Earthquake Center (SCEC) are very appropriate to defining velocity on the spatial scales of this application, particularly for the western Great Basin (Louie, 2002). Crustal properties and thickness are known only at wide (100 km) spacing (fig. 1),

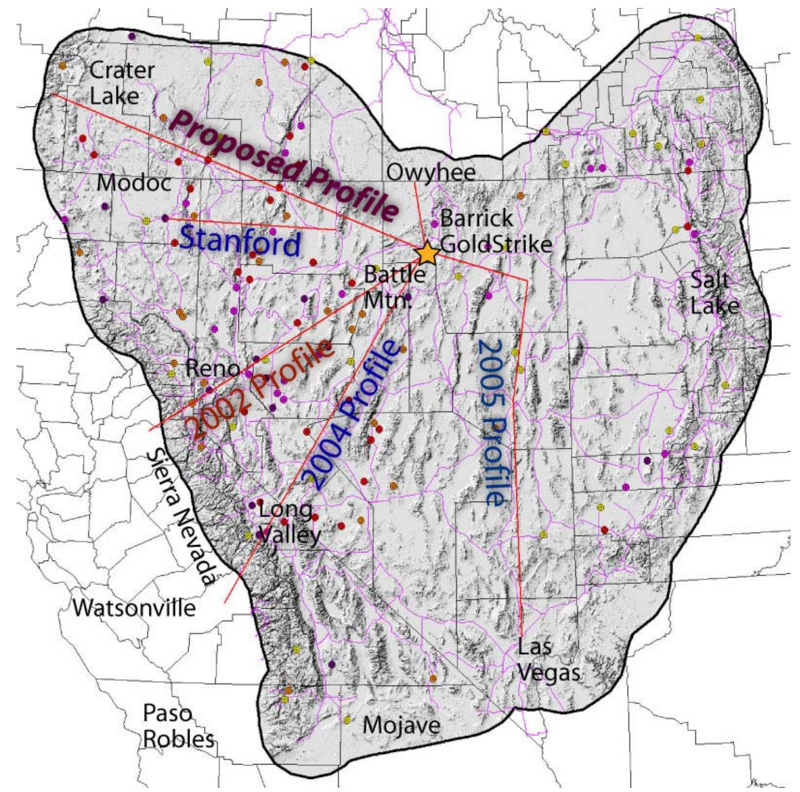

Fig. 2- Physiographic map of the Great Basin, with completed, planned, and proposed regional seismic-refraction experiments. Dots show geothermal wells, with warmer colors for higher temperatures.

but the structure of the urban basins (Abbott and Louie, 2000) and some geothermal regions (e.g., Coso, Dixie Valley) is known at some detail (0.2 km spacing).

Project Plan and Schedule

Velocity information will continue to be compiled from sources in the literature, results of previous and cooperating, on-going seismic experiments and earthquake-monitoring projects, and data donated from mining and petroleum companies. Figure 2 shows that our previous Northern Walker Lane survey was aligned along a northeasterly trend of extensional geothermal fields termed the "Humboldt lineament," and that we found a striking feature of the northeast end of this zone to be a crustal thickness of only 19 km (Louie et al., 2004). To better define the limits of this thin crust, we collected a second profile in August 2004, and plan a third for August 2005 (fig. 2). All profiles will originate at the mine near Battle Mountain, Nev. (fig. 1) that proved to have daily blasting work that we could record to long distances with Texan arrays in the previous project (Louie et al., 2004). Mine blasts could be identified in the 2002 and 2004 recordings to 400-km distances, producing the new crustal velocity results included in fig. 1.

In year 2 of the proposed project, if fully funded, we will extend a new profile from these large daily blasts in Barrick's GoldStrike mine (often >40,000 kg ANFO) west-northwest to Crater Lake, Oregon. We will obtain a reverse shot from a quarry in the Rogue River area, with a subcontract to Prof. Cathy Snelson at UNLV. The reversal may be augmented by earthquake activity in the Crater Lake and Newberry Volcano areas. The 2002 and 2004 projects recorded several magnitude 1-4 earthquakes to 600-km distances from Bridgeport, Watsonville, Long Valley, Paso Robles, and Lake Nacimiento, Calif.

Unlike the 2002 and 2004 surveys, the 2005 survey will cross a region of no known geothermal production (figure 2). We seek to validate the correlations of crustal geophysical properties against the occurrence of economic geothermal resources with additional data coverage. The survey results are being embedded in a 3-d crust over a variable-depth Moho, by graduate student Michelle Heimgartner under the previous project, and have been contributed to the associated projects, to assemble geographic databases of geothermal indicators.

Aside from the secondary objective of the new refraction survey, most of the proposed effort will be to assemble alternative, test velocity models of several types and at several scales, by selecting among and interpreting prior results at different depths. This work will continue through both project years, and will be the M.S. thesis research of Michelle Heimgartner.

Testing of Alternative Velocity Models— During both project years we will be proposing and testing alternative velocity models. The models will be based on data selection from our database of others' results, and on the results of our regional seismic refraction transects. By constructing a 3-d model, we will be able to make tests against both the 2-d analyses of refraction data and the 1-d analyses of receiver function data. The 2-d and 1-d interpretation and modeling techniques previously used by others can give misleading results in the presence of significant 3-d structure. We will be able to test whether a 3-d model developed by throwing away some data may in the end be able to match that data.

To project synthetic data in 3-d from our trial models, we will make use of software and cluster computer facilities in our Collaboratory for Computational Geosciences (CCoG; www.seismo.unr.edu/ccog). This facility is already in use generating refraction travel times, synthetic seismograms, and synthetic receiver functions from complex 3-d geophysical models.

The alternative models that pass these tests will be made available to GBCGE collaborators at UNR. As our initial models already have been used to improve regional statistics on the occurrence of geothermal power resources, we expect the new sets of alternative models to add significant detail to the regional analyses. Further, the models' fitness evaluations to the seismic data will allow them to be incorporated into a probabilistic approach, helping to generate exploration risk estimates.

The geophysical databases include data from the following sources:

Upper mantle— The tomographic image of Humphreys and Dueker (1994) provides a starting framework for mantle velocity in the western Great Basin.

Pn velocities— Thompson et al. (1989) review regional constraints on Pn velocities. Our continued research on our profiles across the northern and central Sierra and Walker Lane (fig. 2) will provide some of the constraints already available for the southern Sierra and Death Valley from Fliedner et al. (1996).

Crustal thickness— Mooney and Braile (1989) and Kaban and Mooney (2001) reviewed all available constraints on Moho depth for the western Great Basin. For the central Great Basin receiver-function analyses are available from Ozalaybey et al. (1997), but these are constrained to >30 km thicknesses to some extent from 1960s recording of nuclear tests.

Much of our data-selection work, and generation of alternative models and hypotheses, will center around the great discrepancies in crustal thicknesses from teleseismic receiver functions versus seismic refraction surveys. In the Battle Mountain, Nevada area our 2002 refraction results show a crust 15 km thinner than found from surrounding receiver-function measurements (Louie et al., 2004; fig. 1). Refraction experiments in the 1980s found crustal thicknesses as low as 22 km in the eastern Great Basin (Mooney and Braile, 1989), so our 19 km depths from our results near Battle Mountain are not unprecedented.

Middle & lower crustal velocities— Mooney and Braile (1989), Thompson et al. (1989), and Fliedner et al. (1996) provide reviews of crustal velocity information that form a basis for a 3-d crustal velocity model. Our survey results (fig. 1; Louie et al., 2004) have been integrated with the pre-existing data, again by the process of selection and the hypothesis of a trial model. Ozalaybey et al. (1997) constrained crustal velocity profiles at several locations in the central Great Basin, establishing low-velocity zones exist at very few.

Upper crust—In addition to crustal thickness, much of the work reviewed by Kaban and Mooney (2001) constrains P velocities well to 5-10 km depth. Additional constraints are reviewed by Thompson et al. (1989) and Fliedner et al. (1996); many of them come from long COCORP surveys extending from the northern Sierra to the Ruby Mountains, and in the Death Valley region (figure 1). We will continue to compile all available information from reflection stacking velocity analyses, and seek to examine copies of commercial spec surveys, abundant in eastern Nevada.

Basin depths and velocities— Honjas et al. (1997), Chavez-Perez et al. (1998) and Abbott et al. (2001) estimated basin depths and velocities for Death Valley and Dixie Valley from the first-arrival times recorded in reflection surveys. Jachens and Moring (1990) summarize relations between density and depth in Nevada basins from oil-well logs, mostly from Railroad Valley in southern Nevada. Langenheim et al. (2001) and Abbott and Louie (2000) used these relations together with some borehole and seismic data to detail the depths and density profiles of Nevada's urban basins in Las Vegas, Reno, and Carson (fig. 2).

We are in the third year of a LLNL-sponsored project to characterize the Las Vegas basin (Concha-Dimas et al., 2002), and parallel efforts to characterize the Reno basin. USGS-funded work by UNLV colleagues on this project has resulted in detailed basin structure and geotechnical characterization. All of this has been integrated with the results of this project into a rule-based model code available on the Internet at http://www.seismo.unr.edu/geothermal .

Student Involvement

UNR Geophysics M.S. student Michelle Heimgartner began her studies in the fall of 2004, and expects to graduate in December 2006. She is currently supported by our previous GBCGE project, which will run out of funds in September 2005. If this project is funded, Heimgartner will conduct the regional geophysical-model development, testing, and analysis. Even with partial funding, of this main task only, this project can support her for her Master's degree studies.

Full funding of this project will allow a large number of graduate and undergraduate students to become temporarily engaged with this research. UNR students will make up the field crew deploying the NW-Great Basin refraction experiment, and some of them will remain engaged during survey planning, data archiving, and initial analysis. Eighteen students worked on the 2004 experiment; sixteen from UNR and two from UNLV.

Deliverables and Milestones

If a deliverable has (M) denoted it is part of the main task and can be completed with partial funding. With (S) denoted, it is unique to the secondary task and can only be completed with full funding of this proposal.

(1) April 2005: GRC Meeting abstract, on analysis of 2004 experiment. (M)

(2) September 30, 2005: a brief report will be delivered to the GBCGE outlining the success of the August 2005 refraction experiment. (M)

(3) October 30, 2005: a paper will be submitted to a refereed journal outlining the 2004 survey results and their integration with pre-existing data, and evidence for limits on the area of thin crust below Battle Mtn. (M)

(4) December 2005: presentation at the American Geophysical Union Fall Meeting on results from the 2004 experiment. (M)

(5) April 2006: a brief report will be delivered to the GBCGE showing trial regional geophysical models, and their 3-d tests against the database. (M)

(6) September 2006: a brief report will be delivered to the GBCGE on the level of success with recording the fourth survey from Crater Lake to Barrick GoldStrike. (S)

(7) At the completion of the project: technical papers detailing the features of the assembled crustal seismic velocity model, and their implications for the distribution of geothermal resources throughout the western Great Baisn, will be submitted for publication in peer-reviewed scientific journals. In addition, a web site accessing the updated database and all new results will be available, and a complete copy delivered to the GBCGE on CD-Rs or DVD-R disc. The Reftek recorders will continue to be maintained for use by UCCSN geophysicists.

(8) Quarterly DOE Reports: will be completed as required by the PI.

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Biographical Sketch of John N. Louie

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Professional Experience

Associate Professor of Seismology, Seismological Laboratory and Department of Geological Sciences, The University of Nevada, Reno; since January 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.

Recent Graduate Theses Directed

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.

Ph.D. Thesis in Geophysics by Sergio Chavez-Perez on ``Enhanced imaging of fault zones in southern California from seismic reflection studies'' defended on 4 Aug. 1997.

M.S. Thesis in Geophysics by Zakir Kanbur on ``Seismic reflection study of Upheaval Dome, Canyonlands National Park, Utah'' defended on 17 July 1997.

Selected Recent Sponsored Research

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 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 - 7/2005 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 2/1/2003 - 1/31/2004 for $52,000 between 2 PIs.

Establishment of a Center for Computational Geosciences, sponsored by the Nevada Applied Research Initiative and Optim LLC 5/2002 - 5/2003 for $50,000.

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. 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. (On line at www.seismo.unr.edu/hazsurv)

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Ken Mela and John N. Louie, 2001, Correlation length and fractal dimension interpretation from seismic data using variograms and power spectra: *Geophysics, 66,* 1372-1378.

Other Important Publications

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 and J. N. Louie, 2000, Depth to bedrock using gravimetry in the Reno and Carson City, Nevada area basins: *Geophysics, 65,* 340-350.

A. M. Asad, S. K. Pullammanappallil, A. Anooshehpoor, and J. N. Louie, 1999, Inversion of traveltime data for earthquake locations and three-dimensional velocity structure in the Eureka Valley area, eastern California: *Bull. Seismol. Soc. Amer., 89,* 796-810.

S. Chavez-Perez and J. N. Louie, 1998, Crustal imaging in southern California using earthquake sequences: *Tectonophysics, 286* (March 15), 223-236.

S. Chavez-Perez, J. N. Louie, and S. K. Pullammanappallil, 1998, Seismic depth imaging of normal faulting in the southern Death Valley basin: *Geophysics, 63,* 223-230.

Synergistic Activities

JRG, an open-source, menu-driven seismic processing package: www.seismo.unr.edu/jrg .

ModelAssembler, velocity gridding for the Great Basin: www.seismo.unr.edu/geothermal .

Applied Geophysics course with 1-week field camp and on-line exercises: www.seismo.unr.edu/ftp/pub/louie/class/492-syll.html .

Service on IRIS Standing Committee managing the PASSCAL national facility, Dec. 2000–Dec. 2003.

Recent Collaborators: Barbara Luke, Cathy Snelson (UNLV); Arthur Rodgers, Shawn Larsen (LLNL); Stephen Bannister, Stuart Henrys, Bill Stephenson (GNS); John Anderson, James Brune, Steve Wesnousky, Raj Siddharthan (UNR). **Graduate Advisor:** Robert W. Clayton. **Graduate Students Advised:** Jizeng Qin (M.S. 1989), Michael Matthewson, Raymond Laird, 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.

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Education

University of Nevada, Reno, Reno, NV

- Pursing a Masters in Geophysics

Whitman College, Walla Walla, WA

- Degree, B.A. in Geology 2004

University of Indiana

- Advanced Field Course in Tobacco Root Mountains, Summer 2004

National Outdoor Leadership School, Talkeetna Mountains, Alaska

Publication

2004, Heimgartner, Michelle N., Winter, John D., and Carson, Robert J. “Siliceous Cobbles in a Grande Ronde Basalt Flow at Oregon Butte, Blue Mountains, Washington.” Geological Society of America *Abstracts with Programs*, Vol. 36, No. 4, p. 90

Professional Experience

2003-2004, *Army Corps of Engineers*, Walla Walla, WA

- Student Aid in the Office of Council

2000-2001, *Kleinfelder*, Fresno, CA

- Geotechnical and Materials Laboratory Technician

2002-2003, *America Reads Program*, Walla Walla, WA

- English and Math Tutor for Elementary School Children

Objectives and Benefits of Previous GBCGE Project

(8) Assembly of a crustal seismic velocity database for the western Great Basin
PI: John N. Louie
Project Period: March 2002 – September 2005

The objective of this previous sub-project, completing its third year, is to assemble a three-dimensional reference model of crustal seismic velocity for the western Great Basin region of Nevada and eastern California. The seismic velocity model consists of simplified rule-based representations of region's crust to 50 km depth, and more detailed characterization of geothermal areas and sedimentary basins. The model has been contributed to the associated sub-projects assembling geographic databases of geothermal indicators. With the resulting more complete sampling of the crustal geophysical characteristics of geothermal resources in the Great Basin, these measures have contributed to quantitative analyses of the associations between different indicators. Under the Center's goal "(1) Geothermal Resource Assessment and Exploration: B. Identification and Characterization of New Potential Geothermal Resource Targets," this project contributes critical data toward the effective exploration for new geothermal resources.

This project has undertaken two major seismic-refraction recording campaigns, in May 2002 and August 2004 (fig. 1). A third field campaign is planned for August 2005, after which all funds allocated to this previous project will have been expended. Large blasts were recorded from the Barrick GoldStrike and other mines, including one in Watsonville, Calif. Several magnitude 1-2 earthquakes in California were also recorded by both experiments, providing important refraction reversals.

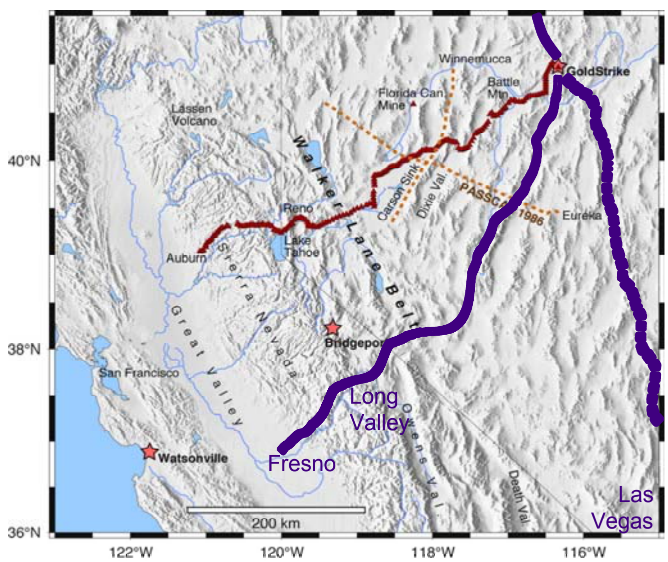

Fig. 1- Map showing regional seismic-refraction transects completed by this project in 2002 (red), 2004 (purple), and planned for Aug. 2005 (dotted).

We performed acoustic and elastic modeling of the seismic refraction data recorded in May 2002 across northwestern Nevada and eastern California. The modeling, carried out on the cluster facilities of the Collaboratory for Computational Geosciences (www.seismo.unr.edu/ccog) at UNR, substantiates our interpretations of only 20 km crustal thickness below the geothermal fields near Battle Mountain, and a deep root for the northern Sierra where there are no economic geothermal fields (fig. 2). Statistical tests by M. Coolbaugh of the GBCGE support this association of geothermal resources originating in extensional tectonics with areas of thin crust, newly mapped by our experiments. Buffalo Valley, near Battle Mtn., Nevada, is one such area of newly revealed thin crust that has been targeted by the GBCGE for intensive exploration. We have published a paper on our 2002 results in the journal *Tectonophysics*:

John N. Louie, Weston Thelen, Shane B. Smith, Jim B. Scott, Matthew Clark, and Satish Pullammanappallil, 2004, The northern Walker Lane refraction experiment: Pn arrivals and the northern Sierra Nevada root: *Tectonophysics, 388*, no. 1-4, 253-269. (Available on line at www.seismo.unr.edu/geothermal/walker.html)

New graduate student Michelle Heimgartner has primary responsibility for interpretation and modeling of the 2004 transect data. We plan to work again with Dr. Satish Pullammanappallil of Optim LLC, to provide commercial-quality velocity tomography to this project. Heimgartner has submitted an abstract on our 2004 results for presentation at the April 2005 Seismological Society of America annual meeting at Lake Tahoe. Displays of some of the records as well as explanations of both the 2002 and 2004 survey results are available through the sub-project's web site at *www.seismo.unr.edu/geothermal*.

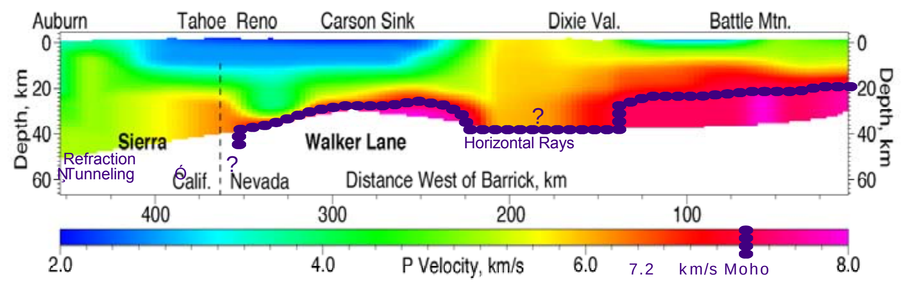

Fig. 2- Northern Walker Lane crustal cross section, a result of the 2002 experiment from Louie et al. (2004).

This sub-project has worked in close concert with another project, sponsored by LLNL, which has developed a prototype velocity model assembler code. Model assembler code and an updated velocity database are available now on the web.

Graduate student Michelle Heimgartner has completed the assembly of previous crustal geophysical information for the entire Great Basin. We interpreted a trial crustal-thickness model (fig. 3), following seismic refraction measurements where they were in conflict with other techniques such as teleseismic receiver functions. The model suggests a Moho ridge following the Humboldt lineament. The trial map, velocity models and other geophysical images and databases are available in our 11/5/2004 presentation at the Great Basin Geothermal Conf. (http://quake.seismo.unr.edu/ftp/pub/louie/geothermal/Louie-gbcge0411.html). We are continuing the construction of trial Great Basin crustal models, and getting comments from the geothermal industry and other colleagues on the utility of the web site.

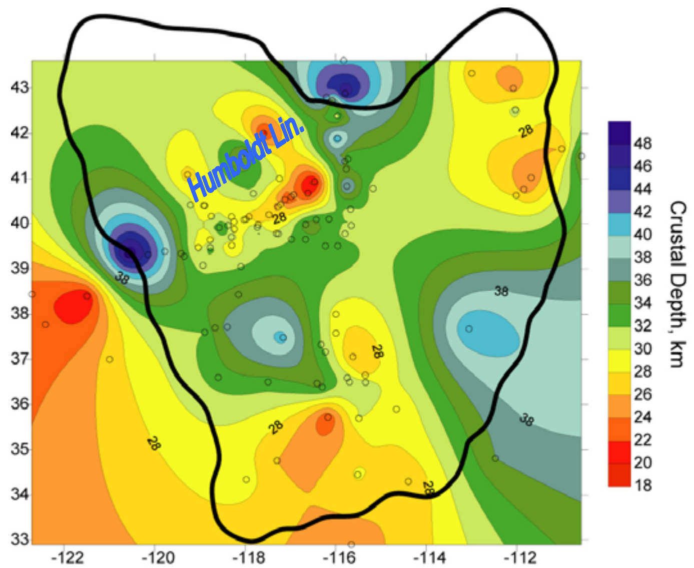

Fig. 3- Great Basin crustal-thickness model assembled by M. Heimgartner, showing data points used for this interpretation. Data include selected results of others, and our 2002 results from the northern Walker Lane.

Five UNR graduate students and several undergraduates have been partly supported by this project, increasing technical workforce skills in regional geothermal assessment.