

EarthScope Interpretive Workshop for the Basin and Range Province
University of Nevada – Reno
October 19-22, 2008

What?

EarthScope is a nationwide effort that applies the latest science and technology to explore the structure and evolution of the North American continent and understand processes that cause earthquakes and volcanic eruptions (www.earthscope.org). The western United States is a prime target area for EarthScope to investigate continental rifting processes that result in elevated topography, earthquakes, and volcanism. Interpretive professionals in the Basin and Range Province have the unique opportunity to engage the public on the relevance of EarthScope continental rifting discoveries as they are being made. This 3-day workshop combines presentations by EarthScope scientists and interpretive specialists to convey the story of how continental rifting processes result in the region's breathtaking landscape and geological processes. Participants will learn how to use EarthScope data and science results, and will develop and present actual interpretive programs during the workshop. The goal is to help interpreters create opportunities for the public to form their own intellectual and emotional connections to the dynamic landscape of the Basin and Range Province.

Sponsored by:

EarthScope National Office, Nevada Bureau of Mines and Geology, and University of Nevada–Reno.

Who should attend?

Interpretive professionals from the National Park Service, U. S. Forest Service, Bureau of Land Management, state parks, museums, state geological surveys, and other agencies that engage the public on geological features and processes in the Basin and Range Province. Participants do not have to be geologists, but they should have some knowledge of the geology and tectonics of the region and experience incorporating geological information into interpretive programs or exhibits. There is also room for a few K-12 Earth science teachers who interact with interpretive specialists in parks or museums.

Funding:

Participants' organizations provide travel costs to and from the workshop. The EarthScope National Office (ESNO), through a grant from the National Science Foundation to Oregon State University, provides food, lodging, materials, and field trip travel while at the workshop. CD's, printed handouts, and other workshop materials will be provided by the ESNO at no cost to participants.

Lodging:

Rooms have been booked at the Silver Legacy Resort and Casino in downtown Reno (www.silverlegacyreno.com). The ESNO will pay for double-occupancy rooms for participants. (Single rooms are available for those participants wishing to pay half the room rate – the ENSO will pay the other half).

Session Locations:

Workshop sessions will be held in the Silver Baron E Room at the Silver Legacy Resort and Casino, and at the Lawlor Events Center Silver/Blue Room on the campus of the University of Nevada–Reno (15-minute walk from the Silver Legacy).

Field Trip:

The morning field trip on Tuesday (Oct. 21) will depart from the Silver Legacy at 8:00 AM sharp. It will return before 1:00 PM to the Lawlor Events Center at the University of Nevada–Reno. A big-yellow ☺ school bus will be provided. The trip will include a two-mile (round trip) hike from the parking area to the top of Slide Mountain for a breathtaking view of Basin and Range landscape and a visit to an active GPS station.

Food:

All food will be provided by the ESNO from Sunday dinner through Wednesday lunch, including meals at the Silver Legacy and catering through the University of Nevada–Reno. The field trip will include a box lunch enjoyed at the top of Slide Mountain! Vegetarian and other food accommodations are available upon request.

Commitment:

Participants and instructors are required to attend the full three days of the workshop (from 6:00 PM Sunday, October 19 to 12:00 Noon Wednesday, October 22). Each participant and their supervisor must commit to providing follow-up training to their staff members on how EarthScope data, scientific results, and societal implications can be incorporated into interpretive programs at their site.

Instructors:

Dr. Jochen Braunmiller (Research Assoc., Oregon State Univ. and Science/Planning Specialist for EarthScope National Office).

Dr. Bill Hammond (Research Asst. Professor, University of Nevada–Reno and expert on GPS and continental dynamics).

Dr. Corné Kreemer (Research Asst. Professor, University of Nevada–Reno and expert on GPS and crustal deformation).

Dr. Bob Lillie (Professor of Geology at Oregon State University and EarthScope Education/Outreach Manager).

Allyson Mathis (Science and Education Outreach Coord. at Grand Canyon National Park and specialist on Interpretive Methods).

Dr. Ken Smith (Research Asst. Prof., University of Nevada–Reno and expert on seismicity of the Basin and Range Province).

Dr. Brian Wernicke (Prof., Calif. Inst. of Technology and specialist on structure and tectonics of the Basin and Range Province).

Agenda: EarthScope Interpretive Workshop for the Basin and Range Province

Sunday, October 19, 2008

- 3:00 Instructors meet at Silver Legacy Resort and Casino to review workshop goals, agenda, and evaluation plan
- 6:00 Participants and instructors meet at Silver Legacy (Silver Baron E Room) for Fajita Bar dinner and overview**
- 7:00 Welcoming remarks and discussion of workshop goals and agenda. "Overview of the workshop" (Bob Lillie)
- 7:45 *Personal Introductions*
- 8:30 Adjourn

Monday, October 20, 2008

- 7:00 Breakfast at the Flavorz Buffet at the Silver Legacy
- 8:00 Convene at the Silver/Blue Room at the Lawlor Events Center at the University of Nevada–Reno**
- 8:00 "Overview of EarthScope: USArray and the Plate Boundary Observatory" (Bob Lillie)
- 8:30 *Brainstorming – Tangible and Intangible ideas for connecting EarthScope to the public*
- 8:45 "Plate tectonics and building the landscape of the western United States" (Brian Wernicke)
- 9:25 *Brainstorming – Connections for interpreting the landscape of the western U.S. to the public*
- 9:45 Break**
- 10:00 "USArray and other seismic measurements of continental rifting in the Basin and Range Province" (Ken Smith)
- 10:40 *Brainstorming – Connecting results of USArray to the public*
- 11:00 "GPS and other geodetic monitoring of the dynamic landscape of the Basin and Range Province using the Plate Boundary Observatory (PBO)" (Corné Kreemer)
- 11:40 *Brainstorming – Connecting results of PBO to the public*
- 12:00 Lunch in the meeting room**

- 1:00 *Participants present their posters, exhibits, and other materials on Basin/Range Geology*
- 2:00 *Brainstorming – How can we incorporate EarthScope into some of these exhibits?*
- 2:15 Break**
- 2:30 "Presenting EarthScope to the public in parks and museums: Interpretive themes and strategies for the Basin and Range Province" (Allyson Mathis)
- 3:10 *Brainstorming – Combining EarthScope and interpretive methods to connect visitors to the dynamic landscape of the Basin and Range Province.*
- 3:30 Developing site-specific interpretive programs based on today's presentations.**
 - Participants divide into five teams (each team has 4 to 6 participants and one instructor)
 - Discuss continental rifting topics and EarthScope materials to incorporate into programs and exhibits
 - Each team generates an outline with content, data needs, and a theme statement for their program
- 5:00 Adjourn**
- 6:30 Dinner at Bertha Miranda's Mexican Food Restaurant & Cantina, 336 Mill St (www.berthamirandas.com)**

Tuesday, October 21, 2008

- 7:00 Breakfast at the Flavorz Buffet at the Silver Legacy
- 8:00 *Field excursion. (Bus leaves from the Valet area of the Silver Legacy hotel/casino entrance).* (Bill Hammond)
 - Observe geological features and visit EarthScope instrument site.
 - Discuss landscape features and processes that can be presented to the public.
 - Relate each group's interpretive theme to EarthScope and continental rifting processes.
- 11:30 Box lunch at the top of Slide Mountain.**

- 1:00 Bus returns to University of Nevada–Reno (Silver/Blue Room at the Lawlor Events Center)**
- 1:00 "National Park Service Interpretation in the Intermountain Region." (Phil Zichterman)
- 1:15 "UNAVCO resources for scientists, educators, and the public: www.unavco.org" (Celia Schiffman)
- 1:30 "IRIS resources for scientists, educators, and the public: www.iris.edu" (Jenda Johnson)
- 1:55 "Active Earth kiosk overview and proposal process" (Jochen Braunmiller)
- 2:10 *Brainstorming – Incorporating EarthScope digital resources into interpretive programs and exhibits*
- 2:30 Break**
- 2:45 *Groups continue to develop 15-minute interpretive programs based on EarthScope continental rifting themes*
- 4:15 *First group presentation. (Theme statement, setting, audience – followed by actual program presentation)*
- 4:30 *Brainstorming about 1st presentation: Geology/EarthScope content and interpretive methods employed*
- 5:00 Adjourn**
- 6:30 Dinner at Silver Peak Restaurant, 135 N. Sierra St (www.silverpeakbrewery.com)**

Wednesday, October 22, 2008

- 7:00 Breakfast in the MEETING ROOM the Silver Legacy (Silver Baron E Room)
- 8:00 Convene at the Silver Legacy (Silver Baron E Room)**
- 8:00 *Group presentations, each followed by brainstorming about content and interpretive methods.*
- 11:45 *Workshop evaluation.*
- 12:00 Adjourn and have lunch at the Flavorz Buffet at the Silver Legacy.**
 - Participants depart after lunch; organizers and instructors meet to discuss workshop and follow-up activities.

Description: EarthScope Interpretive Workshop for the Basin and Range Province

Purpose of Workshop

This is the second in a series of workshops organized by the EarthScope National Office (ESNO) to train interpreters¹ in parks and museums to incorporate EarthScope into programs that engage the public in landscape-forming processes and natural hazards. EarthScope employs advanced geophysical sensors and high-performance computing to measure signals generated by earthquakes and volcanic events. The program is deploying hundreds of seismometers and GPS devices, and drilling a borehole across the San Andreas Fault, to observe the inner-workings of the continent. Many of the instruments are permanently-based in the western United States. Other instruments are being gradually moved across the country from west to east over the next decade. The resulting EarthScope images provide a record of how the continent has evolved over millions of years, enabling scientists, students, and the public to appreciate how the North American continent deforms in ways that affect our lives.

One of the fundamental aspects of EarthScope is the integration of many types of observations to study the structure and evolution of the continent. Two challenges facing the EarthScope community include providing the public with access to timely EarthScope science and presenting complex data and related principles in language and formats accessible to varied audiences. This workshop will show how incorporating EarthScope data and scientific results into interpretive programs and exhibits can enhance the “sense of place” represented by the dynamic landscape of the Basin and Range Province. Presentations and activities will focus on engaging the public on not only how and why science is important, but also that it is understandable and meaningful. The workshop will bring together individuals from the scientific and interpretive communities to learn about EarthScope and develop interpretive programs on how geophysical instrumentation enhances our understanding of landscape formation and geological hazards in the region of continental rifting in the western United States.

EarthScope Primary Interpretive Themes

Workshops were held in 2003 and 2004 to develop a comprehensive interpretive plan involving EarthScope and the National Park Service (NPS; see www.ees.nmt.edu/RME/fall2004.html). The primary interpretive themes developed in the workshops are key ideas through which EarthScope’s nationally-significant values can be conveyed to the public. Two of the overall NPS/EarthScope themes are particularly applicable to interpretation in the Basin and Range Province:

- ***The EarthScope experiment – the most comprehensive exploration to date of the structure, dynamics, and geologic history of the North American continent – exemplifies the insatiable human drive to learn.***
- ***EarthScope encourages a feeling of national interconnectedness – a continental sense of place – by openly inviting communities to actively participate in the experiment, and by fostering an understanding that their local environment and culture interact with other components within the larger, dynamic Earth system.***

During the Basin and Range Workshop, participants will work with scientists to develop themes specific to parks and museums in the region. By the end of the workshop, groups will develop and present interpretive programs that provide opportunities for visitors to connect EarthScope data and science to the physical and cultural aspects of their site. Here’s an example of a theme that might link EarthScope observations to dynamic Earth processes in the region:

- ***The same earthquake and volcanic activity that threatens our lives also nourishes our spirits by creating the majestic mountains and valleys in the Basin and Range Province.***

Workshop Goals

EarthScope (www.earthscope.org) consists of three observatories: USArray, a system of seismometers managed by the Incorporated Research Institutions for Seismology (IRIS, www.iris.edu); Plate Boundary Observatory (PBO), an array of GPS, strainmeter, and other geodetic instruments managed by UNAVCO, Inc. (www.unavco.org); and San Andreas Fault Observatory at Depth (SAFOD), a deep drillhole managed by Stanford University (www.stanford.edu). The goals of the Basin and Range Province Interpretive Workshop are consistent with those of EarthScope and these collaborative institutions.

- ***Build networks of scientists and interpreters.*** EarthScope scientists will present overviews of their research and work with participants to develop interpretive programs on continental rifting in the western United States.
- ***Produce interpretive programs and exhibits targeting specific audiences.*** Teams of participants will work with the scientists to develop region-specific interpretive materials on earthquakes, volcanoes, and landscape development targeting visitors to parks and museums in the Basin and Range Province.
- ***Collaborate with EarthScope organizations to produce and disseminate data and products to interpretive professionals.*** The workshop will foster collaboration between interpreters and IRIS, UNAVCO, the U. S. Geological Survey, and other organizations to expand the EarthScope education and outreach network. Workshop products will be disseminated via print materials and the EarthScope, UNAVCO, and IRIS education and outreach web pages.
- ***Target diverse audiences to engage in interpretive programs and exhibits.*** Diverse backgrounds, learning styles and gender equity will be built explicitly into interpretive programs.

¹ The term “informal educator” is commonly used in museums, while parks typically use “interpreter.” Other terms such as “resource educator” are used by various organizations. The term “interpreter” in this document is meant to encompass all the professionals who engage the public in informal education.

Interpretive Program Development

Participants and instructors will work in teams to assemble EarthScope and other content for interpretive programs focused on continental rifting in the Basin and Range Province. Here are examples of three topics for interpretive programs that might be developed during the workshop.

1. **Plate Tectonics and its bearing on Earthquakes, Volcanoes, and Landscape Development.** Because of EarthScope's goal to study North America in an integrative way, interpretive programs should not "stand alone" as individual topics, but should feed into an integrative approach. This Basin and Range EarthScope program might be the "big picture" program that provides the plate-tectonic context for other programs. Interpretive opportunities will also be developed by incorporating connections of the landscape and its formation processes to the region's biology, ecology, culture, and history.
2. **Earthquakes.** EarthScope is advancing understanding of how and why earthquakes occur by measuring small-to-moderate sized earthquakes in the region, imaging the deep structure of the crust and mantle by studying how seismic waves from distant earthquakes travel to USArray seismometers, and mapping the movement of Earth's surface with PBO strainmeters and GPS instruments. EarthScope instrumentation has been in the news recently because it provides crucial information on the 2007 Utah mine collapse, and the 2008 Wells, Nevada Earthquake and earthquake swarms in the Reno area. One group could develop a program emphasizing how advancement in knowledge about continental rifting earthquakes and other seismic events impacts the safety, economy, history, and other aspects of society in the Basin and Range Province and beyond.
3. **Volcanoes.** Ground deformation in volcanic systems measured by GPS has important implications for regional tectonics, magma recharge, and volcanic hazard mitigation. Integrating GPS observations from PBO stations and seismic data from USArray and other networks in the Basin and Range Province helps us advance the science of volcano monitoring, understand factors responsible for continental rifting volcanism, and make for a safer environment for life and leisure.

Programs might be done as skits, perhaps as one participant acting as an interpretive ranger and the others as designated audience members. Before each presentation, a group spokesperson will be asked to share the following:

1. What is the setting for the presentation?
2. Who is the audience?
3. What might be a theme statement for the program?

Remember that **an effective interpretive program creates opportunities for an audience to form their own intellectual and emotional connections to the meanings inherent in a resource.** After the 10-15 minute presentation, the workshop participants and instructors will discuss and brainstorm about:

- a) Was the information presented accurate and germane? Did it include some solid geology and EarthScope content?
- b) How effective were the interpretive techniques employed in reaching the designated audience? What were opportunities for intellectual connections? For emotional connections?
- c) As a result of the program, would the audience be more knowledgeable about the dynamic landscape of the Basin and Range Province? About EarthScope and its meanings? About Earth science in general?

IRIS "Active Earth" Kiosk

The Active Earth interpretive kiosk (www.iris.edu/about/ENO/aed.htm) has been developed by the Incorporated Research Institutions for Seismology. IRIS is the organization that deploys and maintains the seismic instrumentation for EarthScope. The kiosk includes a computer and touch-screen, and has basic modules on seismology (sample display at: www.iris.edu/activeearth/index.phtml?code=AGU2007). This material is designed to be complemented by modules focused on the region of the visitor center or museum hosting the kiosk. Funds are available to supply two or three sites participating in the workshop with their own "Active Earth" kiosk. The value of a kiosk, complete with computer, monitor, speakers, other electronic equipment, and housing with personalized logos, ranges from \$3500 to \$6000, depending on options chosen. After the workshop, participants will be invited to submit proposals outlining how they would use the kiosk to complement their overall interpretive program, and how they plan to maintain it. Sites will also be required to outline how they will help the EarthScope National Office, IRIS, and UNAVCO to develop content and interpretive strategies for a Basin and Range module for the kiosk.

Biographical Information: EarthScope Interpretive Workshop for the Basin and Range Province

Dr. Jochen Braunmiller is a Research Associate with the EarthScope National Office at Oregon State University. He specializes in science coordination and planning and is a co-editor of the EarthScope onSite Newsletter. Dr. Braunmiller received M.S. and Ph.D. degrees in geophysics from Oregon State University. Subsequently, he joined the research faculty at ETH Zurich, Switzerland, where he worked on earthquake quantification, earthquake source parameters, and deep Alpine structure, led a successful broadband seismic field experiment, taught graduate-level seismology classes, and advised M.S. and Ph.D. students (graduating 2 Ph.D. students). His research interests include earthquake source processes, Earth structure, and seismotectonic problems. He has worked on extensional tectonic problems determining the co-seismic rupture geometry of large continental normal faults, including earthquakes in the Aegean region of Europe and investigating the rupture processes of the Klamath Falls, Oregon earthquake sequence in the northwest corner of the Basin and Range Province.

Dr. William C. Hammond has been a Research Assistant Professor at the University of Nevada, Reno since 2004, working in the Nevada Bureau of Mines and Geology. He uses space geodetic methods to study motions of the Earth's surface that are related to the processes that result in earthquakes, build mountains, and provide information about the dynamics of the lithosphere. Before coming to Reno he worked in the Earthquake Hazards Team of the U.S. Geological Survey, in Menlo Park, CA where he first became involved with studying continental-scale deformation of the western U.S. using the Global Positioning

System (GPS). Since that time Dr. Hammond has spent much of his professional life working in the Nevada Geodetic Laboratory studying the patterns and rates of deformation of the Basin and Range, and how GPS measurements can provide information about the potential for future earthquakes. He is an investigator on various projects for the National Science Foundation (including EarthScope), Department of Energy, NASA and the National Earthquake Hazard Reduction Program. Dr. Hammond was born and raised in northern California, attended the University of California, Berkeley as an undergraduate major in mathematics, and obtained his Ph.D. in geophysics from the University of Oregon in 2000. Dr. Hammond now lives in Truckee, California with his wife and 3 young children. He likes to ride his bike up steep trails and take his family on outdoor adventures.

Dr. Corné Kreemer has been a Research Assistant Professor at the Nevada Bureau of Mines and Geology since 2005, where he conducts research centered on using GPS data to learn more about plate motions, crustal deformation, and earthquakes. He also regularly teaches guest lectures at the Department of Geological Sciences and Engineering at the University of Nevada–Reno. Dr. Kreemer was born and raised in the Netherlands where he studied Geophysics at the University of Utrecht and earned his Doctorandus (M.S. equivalent) degree in 1997. He obtained his Ph.D. degree at Stony Brook University in 2001, where he created a numerical global model of plate motions and crustal deformation based on geodetic, geologic and seismicologic data. From 2001 to 2004 he lived in Paris and Aix en Provence, France, where he worked with Xavier Le Pichon, one of the founding scientists of the theory of plate tectonics. In 2004 he came to Reno to be closer to the subject of his research interests. Dr. Kreemer has published close to 20 articles and he has participated in various outreach activities concerning GPS and crustal deformation. In his free time he enjoys hiking and cycling in the Sierra Nevada Mountains and Great Basin.

Dr. Robert J. Lillie has been a Professor of Geology at Oregon State University since 1984, where he teaches courses in physical geology, oceanography, tectonics, geophysics, geological writing, and public interpretation. He is author of *“Parks and Plates: The Geology of Our National Parks, Monuments, and Seashores”* (W. W. Norton and Company, 2005) and is a Certified Interpretive Trainer (CIT) through the National Association for Interpretation (NAI). In 2007 he became the Manager of Education and Outreach for EarthScope. Dr. Lillie was born and raised in the Cajun Country of Louisiana. He has a B.S. in geology from the University of Louisiana – Lafayette, and an M.S. in geophysics from Oregon State University. He worked three years in oil exploration in the Rocky Mountains before earning a Ph.D. in geophysics from Cornell University, where he processed and interpreted deep-crustal seismic reflection data with the COCORP project. Dr. Lillie’s research is focused on the crustal structure and tectonic evolution of mountain ranges formed by the collision of continents, including the Himalayas in India and Pakistan and the Carpathians in Central Europe. He is also author of *“Whole Earth Geophysics: An Introductory Textbook for Geologists and Geophysicists”* (Prentice Hall, 1999), used in college courses in the U. S. and other countries. Since 1994 Dr. Lillie has collaborated with the National Park Service (NPS) on educating the public in geology. He has been a seasonal interpretive ranger at Crater Lake and Yellowstone national parks and John Day Fossil Beds National Monument, and he and his graduate students have written and illustrated geology training manuals for several NPS sites. Dr. Lillie has presented seasonal training on geology at many parks, as well as workshops at annual NAI meetings. At the 2005 Geological Society of America meeting, Dr. Lillie was presented an award from the NSP Geological Resources Division for “outstanding contributions in engaging the National Parks staff and visitors in geoscience.” Dr. Lillie has done numerous bicycle tours of the U.S., Ireland, the Alps, Central Europe, and Scandinavia, and he is an accomplished photographer and Cajun cook.

Allyson Mathis is the Science and Education Outreach Coordinator for the Division of Science and Resource Management at Grand Canyon National Park. She grew up in Florida and received a B.S. in Geology from the University of North Carolina, Chapel Hill, and M.S. in geology from Oregon State University. Her M.S. thesis work focused on the volcanic history of the Basin and Range Province in southeastern Oregon. She has worked for the National Park Service (NPS) since 1991 as an interpretive ranger at Canyonlands and Capitol Reef National Parks in Utah, Capulin Volcano National Monument in New Mexico, and Grand Canyon National Park in Arizona. She is an NPS interpretive trainer and has presented many training sessions on interpretive methods and techniques to convey geological features and processes to the public.

Dr. Kenneth D. Smith is a research seismologist at the Nevada Seismological Laboratory of the University of Nevada–Reno. His researches focuses on seismicity and seismotectonics of the Great Basin; seismicity and tectonics of the Reno-Carson City-Lake Tahoe and Yucca Mountain areas; and earthquake source processes. Dr. Smith is involved with the EarthScope USArray Observatory and he was instrumental in establishing a real-time seismic network for K-12 Science Education in Nevada.

Dr. Brian Wernicke is the Chandler Family Professor of Geology at the California Institute of Technology. He received a B.S. degree in Geological Sciences from the University of Southern California in 1978 and a PhD from the Massachusetts Institute of Technology in 1982. He was on the faculty at Syracuse University and Harvard University before coming to Cal Tech in 1992. Dr. Wernicke’s research is on the tectonic evolution of the continental lithosphere through judicious combination of field observation and geophysical and geochemical methods; physical processes governing the large-scale structural evolution of mountain belts, especially extension of the continental crust and processes in the deep lithosphere; and GPS geodesy and neotectonics, especially earthquakes and slow episodic deformations revealed through comparison of geodetic and geologic measurements.

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