**EarthScope Workshop for Interpretive Professionals in the Yellowstone-Snake River Plain-Teton Region**
Teton Science Schools (TSS), Jackson, Wyoming (www.tetonscience.org), September 9-12, 2010

TSS Campus Map: www.tetonscience.org/data/contentfiles/file/downloads/pdf/tss_jackson_campus_map.pdf
EarthScope Interpretive Workshops: www.earthscope.org/eno/parks
This workshop: www.earthscope.org/workshops/yellowstone

**What?** The greater Yellowstone region is a prime target area to investigate plate-tectonic processes that result in earthquakes, volcanism, and the dramatic topography along an active hotspot track and continental rift zone. Interpretive professionals in state and national parks, forests, museums, and other sites have the unique opportunity to engage the public on the scientific and societal implications of exciting discoveries as they are being made. EarthScope presents a 4-day[1] workshop that features presentations by prominent scientists and National Park Service professionals to help convey the story of the breathtaking landscape and geological hazards of this geologically active region. Participants will learn how to use basic geologic and EarthScope information and science results, and will develop and present actual interpretive programs and exhibits during the workshop. Access to digitally-archived and real-time, web-accessible geologic information will provide a key source of information for such programs. 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 Yellowstone Hotspot, Snake River Plain, Tetons, and northern Basin and Range Province.

**Sponsored by:** EarthScope National Office at Oregon State University. EarthScope (www.earthscope.org) is funded by the National Science Foundation (NSF).

**Who should attend?** Interpretive professionals from the National Park Service, U. S. Forest Service, Bureau of Land Management, state parks, state geological surveys, community museums, and other individuals who engage the public on geological processes in the greater Yellowstone-Snake River Plain-Teton region of Wyoming, Idaho, Montana, and Utah. Participants do not have to be geologists or geophysicists, but they should have some knowledge of Earth science and experience incorporating geological information into interpretive programs or exhibits. We also welcome applications from K-12 Earth science teachers who interact with interpretive specialists in parks or museums, as well as from college faculty teaching geology field camps or informal education programs in the region.

**Funding**: Participants or their organizations provide travel costs to and from the workshop. The NSF EarthScope science program, through the EarthScope National Office (ESNO) provides food, lodging, materials, and field trip travel while at the workshop. DVDs, printed handouts, and other workshop materials will be provided by ESNO at no cost to participants.

**Lodging:** Rooms have been reserved at the Jackson, Wyoming Campus of the Teton Science School, where most of the workshop will be held (www.tetonscience.org/index.cfm?id=lodging). The EarthScope National Office will pay double occupancy rates for participants. Single rooms are available for participants who wish to pay ½ of the single room cost (ESNO pays the other half).

**Commitment:** Participants and instructors must commit to all four days of the workshop (from 1:00 PM Thursday, Sept. 9 to 12:00 Noon Sunday, Sept. 12). 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 and exhibits.

**Instructors:**
Bob Lillie (Professor of Geology at Oregon State Univ., Certified Interpretive Trainer, and EarthScope Education/Outreach Manager)
Bob Smith (Professor of Geophysics at Univ. Utah, livelong Yellowstone-Teton researcher, and EarthScope Distinguished Lecturer)
David James (Senior Staff Scientist, Carnegie Institution, and expert on USArray investigations of the Yellowstone hotspot track)
Mike Jackson (Scientist with UNAVCO, Inc. and Director of the Plate Boundary Observatory)
Cheryl Jaworowski (Geologist at Yellowstone National Park)
Patrick McQuillan (Education and Outreach Specialist, Incorporated Research Institutions for Seismology)
Shelley Olds (Science Education Specialist at UNAVCO, Inc.)
Doug Owen (Park Geologist & Education Specialist at Craters of the Moon National Monument and Preserve)
Suzette J. Payne (Seismologist at the Idaho National Laboratory)
Christine Puskas (Post Doctoral Fellow, University of Utah and specialist on GPS and ground deformation in the Yellowstone region)
John Shervais (Professor and Head, Department of Geology at Utah State University)

**Teaching Assistants:**
Jamie Farrell (PhD student at the University of Utah, researching the seismology and geodynamics of Yellowstone)
Ben Lillie (Particle physicist and science writer and storyteller for The Story Collider in New York City).

[1] *Two full days and two ½ days.*

# Agenda: EarthScope Yellowstone-Snake River Plain-Teton Workshop

## Thursday, September 9, 2010

**10:30 AM–1:00 PM**

**Room check-in at the Welcome Center at the Teton Science Schools (TSS). (Lunch on your own; note there are several good eateries nearby in the town of Jackson)**

12:00 Noon Instructors meet at the TSS Education Center to review workshop goals, agenda, and evaluation plan

**The Big Picture -**

**1:00** **Participants and instructors meet in the Education Center at the Jackson, Wyoming Campus of the Teton Science School (www.tetonscience.org/index.cfm?id=campuses_jackson).** Welcoming. (Emily Curran, Bob Lillie, Bob Smith)

1:10 Workshop overview. "Plate tectonics and the landscapes of our National Parks: Building the foundations of 'America's Best Idea'" (Bob Lillie)

1:40 ***Personal Introductions***

2:00 "The dynamic landscape of the western United States: Geodynamics and evolution of the Yellowstone Hotspot and its track along the Snake River Plain from seismic and GPS imaging" (Bob Smith)

2:40 ***Brainstorming – Educating the public on the landscape of the region***

**3:00** **Break (TSS Dining Lodge, directly across from the Education Center)**

3:15 "Overview of EarthScope: Seismometers of the USArray and GPS instruments of the Plate Boundary Observatory" (Bob Lillie)

3:30 "USArray and related seismic studies of the western U.S., Snake River Plan-Newberry-High Lava Plains subduction and hotspot imaging, and northern Basin and Range Province" (David James).

4:00 "Plate Boundary Observatory measurements of the dynamic landscape in the western U.S. and Yellowstone-Teton-Snake River Plain region" (Mike Jackson)

4:30 ***Brainstorming – Tangible and Intangible ideas for connecting seismic and GPS studies to the public***

4:45 "IRIS Active Earth Display: Overview and design of module for parks and visitor centers in the Yellowstone-Snake River Plain-Teton region" (Patrick McQuillan)

**5:00** **Announcements and Adjourn**

Evening:

**5:00–6:30** **Continued room check-in at the Welcome Center at the Teton Science Schools**

**6:30** **Dinner at TSS Dining Lodge (directly across from the Education Center)**

**Designing Interpretive Programs -**

7:00 "Presenting EarthScope and other geological and geophysical observations to the public in parks and museums: Interpretive themes and strategies for the Yellowstone-Snake River Plain-Teton region" (Bob Lillie)

7:30 ***Brainstorming – Developing site-specific interpretive themes incorporating workshop content***

**Form Groups:** Begin work to develop site-specific interpretive programs that incorporate EarthScope and other geophysical observations in the Yellowstone-Snake River Plain-Teton region

- Participants divide into five teams (each team has 4 to 6 participants and one scientist)
- Discuss hotspot and continental rifting topics and EarthScope materials to incorporate into an interpretive program
- Each team will come up with a skit by defining an audience, formulating tangible/intangible connections, and developing a theme statement and strategy for presentation of their program
- 15-minute programs will be presented and discussed on Sunday

**8:00** **Adjourn**

## Friday, September 10, 2010

Morning:

**6:30** **Meet at TSS Dining Lodge. (Take box breakfasts and lunches along on bus)**

**7:00** **Depart on bus from Teton Science Schools**

**Field excursion to Yellowstone and Grand Teton national parks** (Led by Bob Smith, Cheryl Jaworowski, Mike Jackson, Dave Mencin)

- ***Discuss landscape features and processes that can be presented to the public***
- ***Relate each group's interpretive theme to EarthScope and other geophysical monitoring of the region***
- ***Stops include:***
  - ***Views of Grand Teton National Park***
  - ***Seismic, GPS, and borehole strainmeter instruments at Grant Village***
  - ***New Old Faithful Visitor Center and walk at Geyser Hill***
  - ***Geological exhibits at Canyon Visitor Center***
  - ***Artist Point and Grand Canyon of the Yellowstone River***

Evening:

**6:30** **Return to Teton Science Schools**

**7:00** **Dinner at TSS Dining Lodge**

## Saturday, September 11, 2010

Morning:

**7:30 Breakfast at TSS Dining Lodge**

**Snake River Plain and Surrounding Basin and Range Province -**

8:00 "Plume tails: Geologic and volcanic history of the Snake River Plain" (John Shervais)
8:30 "GPS measurements of the eastern Snake River Plain and surrounding Basin and Range Province" (Suzette Payne)
9:00 "Interpreting geology to the public at Craters of the Moon National Monument" (Doug Owen)
9:30 "Interpreting geology to the public in Grand Teton National Park" (Ann Mattson and Andrew Langford)
9:45 ***Brainstorming – Tangible and Intangible ideas for connecting the landscape of the Snake River Plain and surrounding Basin and Range Province to the public***
**10:00 Break (TSS Dining Lodge)**

**Yellowstone -**

10:15 "GPS ground motion studies in Yellowstone National Park and the surrounding region" (Christine Puskas)
10:45 "Past, Present, and Future of the Yellowstone Supervolcano" (Bob Smith)
11:00 "Yellowstone National Park: Hydrothermal studies and LiDAR imaging of tectonic geomorphology" (Cheryl Jaworowski)
11:30 "Societal knowledge and safety management for earthquake and volcano hazards of the Yellowstone-Snake River Plain-Teton system" (Bob Smith)
11:45 ***Brainstorming – Tangible and Intangible ideas for connecting Yellowstone to the public***
**12:00 Lunch (TSS Dining Lodge)**

Afternoon:

**Incorporating Web-Based Resources into Interpretive Programs and Exhibits -**

1:00 "Using EarthScope data into interpretive programs and exhibits: www.unavco.org; www.iris.edu; www.earthscope.org" (Shelley Olds and Patrick McQuillan)
1:45 "Web-accessible resources for interpretive programs and exhibits in the Yellowstone-Teton-Snake River Plain region" (Bob Smith)
2:15 ***Participants present their posters, exhibits, and other materials on geology related to the Yellowstone-Snake River Plain-Teton region***
**3:15 Break (TSS Dining Lodge)**
3:30 ***Groups continue to develop 15-minute interpretive programs based on themes involving EarthScope and the dynamic landscape of the Yellowstone-Snake River Plain-Teton region***
**5:00 Adjourn**

Evening:

**6:00 Dinner at Bob Smith's Home (carpool; 15 miles from Teton Science School; catered by Bubba's Barbecue)**

## Sunday, September 12, 2010

Morning:

**7:30 Breakfast at TSS Dining Lodge**

**Interpretive Presentations -**

8:00 ***Group presentations, each involving:***
- ***Theme statement, setting, audience – followed by 10-15 minute program presentation***
- ***Brainstorming about geology and EarthScope content, and interpretive methods employed***

**10:00 Break (TSS Dining Lodge)**
10:15 ***Continue group presentations***
11:45 ***Workshop evaluation***
**12:00 Lunch and adjourn (TSS Dining Lodge)**
- Participants depart after lunch
- Organizers and instructors meet briefly to discuss workshop and follow-up activities

## Campus Map: Teton Science Schools

http://www.tetonscience.org/data/contentfiles/file/downloads/pdf/tss_jackson_campus_map.pdf

**Description:**
**EarthScope Yellowstone-Snake River Plain-Teton Workshop**

Purpose of Workshop

This is the 5th in a series of workshops organized by the EarthScope National Office (ESNO) to train interpreters[2] in parks and museums to incorporate EarthScope observations and science results into programs that engage the public in landscape-forming processes and natural hazards (www.earthscope.org/eno/parks). EarthScope employs advanced geophysical sensors and high-performance computing to measure signals generated by earthquakes and volcanic events. This National Science Foundation (NSF) program is deploying hundreds of seismometers, GPS receivers and borehole strainmeters, 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 3-D images from EarthScope and related projects provide a view 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 (and real-time) science results and presenting complex data and related principles in language and formats accessible to varied audiences. This workshop will show how incorporating fundamental science and EarthScope data into interpretive programs and exhibits can enhance the "sense of place" represented by the dynamic landscape of the greater Yellowstone region. 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 similar geophysical programs. They will work together to develop interpretive programs focused on how society benefits from the increased knowledge of earthquake and volcanic hazards in the region.

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 Yellowstone-Snake River Plain-Teton region:

- ***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 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 observations to the physical and cultural aspects of their site. Here's an example of a "Beauty and the Beast" theme that might link EarthScope science to dynamic Earth processes in the region:

- ***The same earthquake and volcanic activity that threatens our lives also nourishes our spirits by forming the dramatic landscape of the greater Yellowstone-Teton region.***

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 the San Andreas Fault Observatory at Depth (SAFOD), a deep drillhole originally managed by Stanford University (www.stanford.edu) and now UNAVCO. The goals of the Greater Yellowstone Interpretive Workshop are consistent with those of EarthScope.

- ***Build networks of informed scientists and interpreters.*** EarthScope scientists will develop linkages with scientists and interpreters of common interests. Scientists will present overviews of their research and work with participants to develop interpretive programs on active tectonics and geological hazards of the Yellowstone-Snake River Plain-Teton region.

[2] *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.*

- ***Produce interpretive programs and displays targeting specific audiences***. Teams of participants will work with the scientists to develop interpretive materials on earthquakes, volcanoes, and landscape development targeting visitors to parks and museums in the region.
- ***Understand and be able to convey to the public the basic physics of geological processes.*** Participants will learn how to use analogy, scale and computer models, computer-generated animations, time-dependent maps, and other tools in their interpretive programs and exhibits.
- ***Collaborate with a variety of organizations to produce and disseminate data and products to interpretive professionals, including web-based information.*** The workshop will foster collaboration between interpreters and EarthScope, IRIS, UNAVCO, USGS, and other organizations to expand education and outreach networks. Workshop products will be disseminated via print materials and the EarthScope and other websites.
- ***Target diverse audiences to engage in interpretive programs and exhibits.*** Diverse backgrounds, learning styles and gender equity will be built explicitly into interpretive programs.

Interpretive Program Development

Participants and scientists will work in teams to assemble EarthScope and other content for interpretive programs focused on hotspot and continental rifting processes in the Wyoming-Idaho-Montana region. Here are examples of three topics for interpretive programs that might be developed during the workshop.

1. ***Plate Tectonics and its bearing on Earthquakes, Volcanic Activity, and Landscape Development.*** Because of the EarthScope goal to study the deformation of western North America in an integrative way, interpretive programs should not "stand alone" as individual topics, but should feed into an integrative approach. This presentation 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, history, and economy.
2. ***Earthquakes.*** EarthScope and other programs are 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 arrays of seismometers, and mapping the movement of Earth's surface with strainmeters and GPS instruments. One group could develop a program emphasizing how advancement in knowledge about earthquake locations and processes impacts the safety, economy, history, and other aspects of society in the Yellowstone region and beyond.
3. ***Volcanoes.*** Seismic monitoring and contemporary ground motions measured by GPS have 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 Yellowstone-Snake River Plain region helps us advance the science of volcano monitoring, understand factors responsible for hotspot and continental rifting volcanism, and make for a safer environment for life and leisure.

IRIS Active Earth Display

The Active Earth Display is an interpretive kiosk (www.iris.edu/about/ENO/aed.htm) 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 may be available to supply two or three sites participating in the workshop with their own Active Earth Display. 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 may 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. Selected sites would be required to outline how they will help EarthScope, IRIS, and UNAVCO develop content and interpretive strategies for a Yellowstone Hotspot module for the kiosk.

Earth Science Literacy Document

Many of the "Big Ideas" discussed in the workshop are part of a document on "Earth Science Literacy" recently developed by the National Science Foundation. A copy of the brochure is in the workshop binder, and can be downloaded at www.earthscienceliteracy.org/document.html.

**Bios of Instructors and Teaching Assistants:**
**EarthScope Yellowstone-Snake River Plain-Teton Workshop**

**Instructors:**

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 NPS 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.

Dr. Robert B. Smith is a Research Professor and Professor Emeriti of Geophysics at the University of Utah, specializing in seismology and tectonophyics of active tectonics and volcanism. He is a Fellow of two societies, the American Geophysical Union (AGU) and the Geological Society of America (GSA). Dr. Smith has supervised 67 graduate students of which 27 have focused on Yellowstone and Teton research and he has published over 200 scientific papers. He has served as a Visiting Scientist at Columbia University, the Swiss Federal Institute of Technology, and Cambridge University. Dr. Smith served as the Exchange Scientist with the British Antarctic Survey in 1963 and received the Antarctic Medal. He served as President of the Seismology Section of AGU. Dr. Smith has served on numerous science committees, most recently: 1) helping form the NSF EarthScope program and served as the first chair of the EarthScope Science and Education Committee; 2) served on the USGS Scientific Earthquake Studies Advisory Committee; and 3) chair of the Science committee of the Southern California Earthquake Center. He received several awards: the 2005 Hamilton Scholar Award for his geologic career research; the 2006 Yellowstone Career Research Award, Department of Interior; the 2007, Hintze Award for a career of science; the 2008, National Park Service, Yellowstone National Park, Award for Contributions to the Geophysics and Geologic Understanding of Yellowstone; and the 2009 National Park Service Directors Award for Natural Resource Research. In 2008 he was honored to present his career research on Yellowstone in Washington, DC before Senate and House science and technology committees. He has conducted research in the Yellowstone-Teton region for 50+ years, beginning with field studies working as a student on the 1959 M7.5 Hebgen Lake, Montana, earthquake. Dr. Smith leads a world-recognized research team of students, post docs and staff that has focused on studies of the evolution of the Teton fault and origin of the Yellowstone hotspot. He is a Coordinating Scientist of the Yellowstone Volcano Observatory where he directs the Yellowstone seismic and GPS network. Smith is the senior author of the very popular science book, "Windows Into The Earth, The Geologic Story of Yellowstone and Grand Teton National Parks", Oxford University Press, 2000. Bob has assisted with training for NPS interpreters for 40+ years and has provided his illustrations, maps of real-time data, etc. for all the new Yellowstone and Grand Teton National Park Visitor and Educational Centers. Dr. Smith is on the Board of Directors of Teton Science Schools, on the Board of Directors of the Grand Teton National Park Foundation, a consultant to Grand Teton and Yellowstone National Parks, and is a very popular field trip leader and lecturer in the Teton-Yellowstone area. Of Swiss decent growing up in Jackson, Wyoming and Logan, Utah, he has been in the outdoors all his life and skied competitively in college. Some of his more notable adventures include: 1) installing "super secret" seismographs for nuclear monitoring around Europe as an Air Force geo-physicist, 1962-1963, 2) served as the American Exchange Scientist to the British Antarctic Survey where he survived a near death fall into one of its deep crevices on the Antarctic Plateau; 3) skied the Haute Route of the Swiss Alps; 4) Skied Mt. Blanc, France - 12,000 feet in one run, and keeping just ahead of big avalanches; and 5) conducted fault studies in Spain and Greece, staying just out of reach of the Spanish Civil Guard and Greek Antiquity police (1976). Dr. Smith has experienced most of Yellowstone, Teton and Wind River Range backcountry and is still skiing deep powder.

Dr. Michael Jackson is the Director of the EarthScope Plate Boundary Observatory, which is a broad, integrated geodetic network designed to study the four-dimensional strain field resulting from active deformation across the North American plate boundary (www.earthscope.org/observatories/pbo). Dr. Jackson is also responsible for the operations and maintenance of the San Andreas Fault Observatory at Depth (SAFOD), a deep borehole drilled across the San Andreas Fault (http://www.earthscope.org/observatories/safod). He specializes in the geodesy, paleoseismology, and physics of tectonically active parts of the Earth with an emphasis on the installation, operations, and management of remote, geographically distributed instrumentation networks. Dr. Jackson manages a staff of 40 people at UNAVCO, an NSF and NASA funded, non-profit, membership-governed consortium that facilitates geoscience research and education. As part of his duties as an NSF Major Equipment and Facilities Construction Project Manager, he provides advice to the National Science Foundation feasibility of large facility projects and provides ongoing guidance to NSF during the construction and operations phases. Dr. Jackson was the chair of the Ocean Observatories Initiatives Preliminary Design Review panel, a member of the NEON Conceptual Design and Preliminary Design review panels and is a past-member of the USGS National Volcano Early Warning System (NVEWS) advisory panel. Dr. Jackson is an avid telemark skier, sailor, mountain and road biker, rock climber, published photographer, and a closet banjo player.

Dr. David E. James is a senior staff scientist at the Department of Terrestrial Magnetism, Carnegie Institution of Washington, DC. He has spent his career studying the structure, composition, evolution, and formation of continental lithosphere. His early studies (beginning in the late 60s, as plate tectonics was just taking off) led to a plate tectonic synthesis for the formation of the Andean mountain range, showing how subduction processes drive mountain building. In the course of those studies he spent many months doing fieldwork in the High Andes of Peru, Bolivia, Chile, and Colombia. For the past two decades or more his work has involved using dense arrays of portable seismic instruments for seismic imagery to investigate how continents that formed in the early Earth differ from continental masses (such as the Pacific Northwest) that formed in much more recent geologic time. Dr. James has led large-scale portable-array field experiments in southern Africa (to image the deep, cold keels of ancient continental nuclei), in Brazil (to study how the Paraná mantle plume interacted with the Brazilian Shield), in Venezuela (to investigate the interface between the Caribbean and South American plates), in the Galapagos and the Azores (to study oceanic hotspots), as well as in the U.S. and Canada. Dr. James is currently a Principle Investigator on the High Lava Plains Project of central/eastern Oregon, western Idaho, and northern Nevada. And important component of that project includes using EarthScope Transportable Array seismic data for high resolution imaging across the Pacific Northwest. Dr. James' investigations over the past year have specifically focused on detailed seismic imaging of the deep Earth beneath the Snake River Plain and Yellowstone (SRP/Y), particularly as it relates to the evolving tectonics of the western United States. The curious relationship of the SRP/Y hotspot to subduction-related structures, deep-mantle plumes, slab gaps, trench jumps, and the High Lava Plains hotspot track remains one of his immediate scientific preoccupations. Dr. James is a Fellow of the American Geophysical Union and the Royal Astronomical Society and a member of the Seismological Society of America (SSA), the Geological Society of America and the Society of Exploration Geophysicists. He is the editor of the Encyclopedia of Solid Earth Geophysics and served as a 2003-2004 Distinguished IRIS/SSA Lecturer in seismology. Dr. James has a second home in Driggs, Idaho. He is a competitive cyclist, active in backpacking, kayaking, and skiing, and an avid outdoor photographer.

Dr. Cheryl Jaworowski is a geologist at Yellowstone National Park and specializes in Quaternary geology, remote sensing, digital mapping, and science education. Since 2004, she has provided timely geologic information and on-site assessments to resources managers, law enforcement rangers, interpretive rangers, and maintenance personnel at Yellowstone National Park. On-site geologic assessments during 2007 and 2008 also included providing geologic assessments of cuttings within 7 boreholes for UNAVCO/PBO and EarthScope personnel. Beginning in 2005, she has collaborated with researchers at Utah State University, University of Montana, Montana State University, and the U.S. Geological Survey to investigate the use of thermal infrared remote sensing and satellite imagery for monitoring Yellowstone's geothermal resources. Integration of thermal infrared imagery, LiDAR, and other geologic information provides a new way to visualize Yellowstone's hydrothermal systems. Prior to working at Yellowstone National Park, she taught introductory geology, physical geography, and GIS courses at Laramie County Community College from 2000-2003. Postdoctoral and graduate work at the University of Wyoming included the following areas of interest and investigation: compilation of information for a Quaternary geologic map of Wyoming including Yellowstone National Park, fractures affecting deep hydrocarbon reservoirs in Wyoming basins, tectonic effects of the Yellowstone hotspot on the glacial-fluvial sequence in the western Wind River Basin, Lava Creek tephra, and mapping active Quaternary faults.

Patrick McQuillan is the Education and Outreach Specialist for the Incorporated Research Institutions for Seismology (IRIS). His responsibilities include managing informal education programs including museum exhibits such as the Active Earth Display, developing visualizations and K-12 lesson plans, presenting professional development and outreach programs, and managing the IRIS Distinguished Lectureship Speaker Series. Patrick has BS and MA degrees in Physics and Museum Education from the College of William and Mary. He has over twenty years experience managing and developing informal science education programs in museums and planetariums. Several of the planetarium programs he wrote and produced are used in museums around the world. As Education Manager for the Challenger Center for Space Science Education, he managed the production of the educational curriculum for the Next Generation Challenger Learning Center. The curriculum included over 80 hands-on, inquiry based science activities utilizing actual scientific equipment and real data. The video created for the curriculum included over one hour of animations at four-times-High-Definition resolution of solar system locations that are still the highest resolution animations using actual science data that exist for solar system objects. He is currently working on Active Earth Display content modules for the Cascadia Subduction Zone, Basin and Range Province, EarthScope, and PoleNet. In his spare time he is a NASA Solar System Ambassador and is creating content for the IYA 365 Days of Astronomy Podcasts project.

Shelley Olds is a member of the Education and Outreach team at UNAVCO. She develops free educational materials for high school and college science courses, provides professional development opportunities for college faculty and K-12 teachers, and manages the web content for UNAVCO. Shelley has over ten years experience leading science education and professional development projects. She holds an MA in Instructional Systems Development and a BS in Geology and Geophysics. She was the education lead on the DLESE Teaching Box project to facilitate collaborations between educators, scientists, designers, and technologists to develop classroom-ready instructional units that model scientific inquiry. Shelley has worked in the NASA Earth Science Directorate's Education office to coordinate education programs and support the Destination Earth website redesign. She also has many years of experience as a field geologist in environmental consulting to investigate Superfund and RCRA sites, develop remediation designs and implement remedial action plans.

Douglass Owen received degrees in geology and education from Kent State University and taught junior high science for 8 years in Ohio piloting Earth Science at its inception. Next he worked as a research geologist with the USGS for 16 years-- 6 years mostly doing high-resolution seismic work on the gulf coast followed by 10 years working on radionuclide studies and wetland research out of Denver. He was the USGS representative and expert consultant to the North American Regional Consultation on the World Biodiversity Strategy and Action Plan for the Earth Summit in Rio, for which he received a commendation. He was the USGS representative and expert consultant on both the Technical and Steering Committees of the Colorado Riparian Task Force, the USGS representative to the Colorado Ecosystem Partnership, and was an expert consultant to the EPA, SCS, DOE, NPS, Army Corps of Engineers, Colorado Natural Areas Program, and others. After a reduction in force he joined the NPS in 1996. For 13 years he served as lead interpreter and collateral duty park geologist at Craters of the Moon. He helped write and do the analysis for the parks new Environmental Impact Statement and General Management

Plan. In late 2009 his time as geologist was greatly increased when he was promoted to halftime Park Geologist and halftime Education Specialist for Craters of the Moon.

Suzette J. Payne is a seismologist who has worked for the Idaho National Laboratory (INL) for over 25 years in the areas of earthquake monitoring, seismic hazard analyses, and crustal deformation of the Snake River Plain and surrounding Basin and Range Province. She received geophysics degrees from the University of Utah for her B.S. and Boise State University for her M.S. She is currently completing a Ph.D. in geology from University of Idaho. Her dissertation research uses GPS measurements to understand how crustal deformation rates in the Snake River Plain differ from rates in the surrounding Basin and Range regions. Results of this research suggest an unrecognized region of right-lateral shear to accommodate these differences. She manages the INL Seismic Monitoring Program, which includes 27 seismic stations, 30 strong motion accelerographs, and 15 GPS sites to monitor earthquake activity in southeast Idaho. She is leading an effort to evaluate previous INL probabilistic seismic hazard analyses that will result in recommendations of approaches for future seismic analyses. She recently compiled and evaluated volcanic earthquakes to understand maximum magnitudes of dike-induced earthquakes and associated processes, which was published in the 2009 book edition of Paleoseismology.

Dr. Christine M. Puskas is at Post Doctoral Fellow at the University of Utah, where she studies ground deformation of Yellowstone and the Wasatch Front from GPS measurements, and western U.S. Geodynamics. She received a B.S. in geology from the University of Illinois at Champaign-Urbana and moved west to obtain an M.S. and PhD from the University of Utah. Dr. Puskas has participated in several GPS campaigns in the Yellowstone-Snake River Plain and Wasatch region, helping to document changes during the uplift to subsidence to uplift cycle in the Yellowstone caldera. Her primary research interests are in ground deformation and forces driving deformation, and in the rheology and strength of the lithosphere. As part of this research she has done field work in Yellowstone, using campaign GPS to measure ground deformation of an active caldera and the nearby major fault zones of the Hebgen Lake fault and Teton fault. Dr. Puskas has compiled data from Yellowstone, along with other GPS studies in the western U.S., to analyze the deformation of the Intermountain West and examine the distribution of deformation from a continuum and microplate perspective. She has modeled tectonic stresses for this region that result from variations in mass in the lithosphere. Presently Dr. Puskas is focusing on processing data from permanent GPS networks in Yellowstone and Utah.

Dr. John W. Shervais is Professor of Geology and Department Head at Utah State University, specializing in igneous petrology, geochemistry, and volcanology. He earned a BSc in Geology from San Jose State University and PhD from UC Santa Barbara, where he received a Regent's Fellowship, and carried out post-doctoral research at the Swiss Federal Institute of Technology (ETH) in Zürich, Switzerland, as a NATO post-doctoral fellow. Dr. Shervais is a Fellow of the Geological Society of America and served as Department Head in Geology at USU from 2000-2010. He has worked throughout the world, including Europe (Alps, Caucasus, Pyrenees) and south Asia (Pakistan Himalaya, Oman), and the continental United States (Appalachians, California, Oregon, Utah, and Idaho). Much of his work has focused on oceanic crust formation (ophiolites), mantle petrology, accretionary tectonics, and ancient island arcs, with brief forays into Paleoproterozoic crust formation, high-pressure metamorphism, and incision rates of rivers. He was a NASA PI from 1986-2000 and published extensively on lunar petrology. He first worked in the Snake River Plain in 1969 as a field assistant with the US Geological Survey, and has since carried out detailed mapping and geochemical studies with his graduate students and colleagues. Dr. Shervais is currently lead PI and Project Director for HOTSPOT: the Snake River Scientific Drilling Project – an international effort involving over 40 scientists from 6 countries. This project seeks to reveal the volcanic history of the Yellowstone hotspot as it migrated beneath the lithosphere of North American, collecting over two and half miles of core from deep drill holes at three strategic locations across the Snake River Plain. Dr Shervais is (*was*) an accomplished alpinist, with new technical climbing routes in the Alps, Canada, and Yosemite.

**Teaching Assistants:**

Jamie Farrell is a PhD student at the University of Utah where he studies the seismicity and geodynamics of the Yellowstone volcanic region. He received a B.S. in geology from Utah State University and an M.S. in geophysics from the University of Utah. His research interests are in seismology, tectonophysics, and geodynamics of the Yellowstone Hotspot. His current research projects include: 1) using seismic waves to decipher the crustal structure of the Yellowstone region; 2) seismicity and volcanic hazards of Yellowstone; 3) Yellowstone earthquake swarms; and 4) time-spatial seismicity patterns of the Yellowstone system characterized by the b-value. Jamie has participated in many seismic, GPS, and gravity field campaigns in Yellowstone, has led/participated in numerous geologic/geophysical field trips through Yellowstone and given lectures on the Yellowstone hotspot to various organizations.

Dr. Benjamin H. Lillie is a storyteller, writer, producer, and theoretical high-energy particle physicist. After receiving a BA degree from Reed College, he earned a PhD in particle physics from Stanford University in 2005, where he studied experimental signatures of extra dimensions. He then served as a Research Associate at the University of Chicago and Argonne National Laboratory, where he worked on searches for new physics at the Large Hadron Collider, and the proposed International Linear Collider. In 2008 Dr. Lillie left the ivory tower for the wilds of New York's theater district, where he writes and produces shows about science. He is a Moth StorySLAM winner, and hosts the monthly science storytelling show, The Story Collider, where guests are invited to share true, personal stories of the times in their lives when science has been important, inspiring, or simply absurd. He has also written and performed "Elliptical Orbits", a one-man play about cosmology and dating, and is writing the book for a musical about science.

**Instructor Contact Information:**
**EarthScope Yellowstone-Snake River Plain-Teton Workshop**

Bob Lillie
EarthScope Education and Outreach Manager
Professor of Geology, Department of Geosciences
Oregon State University, Wilkinson Room 104, Corvallis, OR, 97331-5506
Phone: (541)-737-1242; Cell: (541)-231-2247; E-mail: lillier@geo.oregonstate.edu

Bob Smith
Professor, Department of Geology and Geophysics, University of Utah
115 South 1460 East, Sutton Bldg. 242, Salt Lake City, UT 84112-0111
Phone: 801-581-7129; E-mail: robert.b.smith@utah.edu

Mike Jackson
Director, Plate Boundary Observatory
UNAVCO, Inc., 6350 Nautilus Dr., Boulder, CO 80301
Phone: (303)-381-7554; Cell: (303)-888-0718; E-mail: jackson@unavco.org

David James
Senior Staff Scientist, Department of Terrestrial Magnetism
Carnegie Institution of Washington, 5241 Broad Branch Rd. NW, Washington, DC, 20015
Phone: (202)-478-8838; E-mail: james@dtm.ciw.edu

Cheryl Jaworowski
Geologist, Yellowstone National Park,
Yellowstone Center for Resources, Building 27, Yellowstone National Park, WY, 82190
Phone: (307)-344-2208; E-mail: Cheryl_Jaworowski@nps.gov

Patrick McQuillan
Education & Outreach Specialist
Incorporated Research Institutions for Seismology (IRIS)
1200 New York Ave. NW, Washington, DC, 20005
Phone: (202)-682-2220 (ext. 126); E-mail: mcquillan@iris.edu

Shelley Olds
Education & Outreach Specialist, UNAVCO, Inc.
6350 Nautilus Drive, Boulder, CO 80301-5554
Phone: (303)-381-7496; E-mail: olds@unavco.org

Doug Owen
Park Geologist & Education Specialist
Craters of the Moon National Monument and Preserve
P.O. Box 29, Arco, ID 83213
Phone: (208)-527-1331; E-mail: Doug_Owen@nps.gov

Suzette Payne
Seismologist, Idaho National Laboratory
P.O. Box 1625, Idaho Falls, ID, 83415-2203
Phone: (866)-526-4293; E-mail: Suzette.Payne@inl.gov

Christine Puskas
Professor, Department of Geology and Geophysics, University of Utah
115 South 1460 East, Sutton Bldg. 282, Salt Lake City, UT 84112-0111
Phone: (801)-581-7856; E-mail: c.puskas@utah.edu

John Shervais
Professor and Head, Department of Geology
Utah State University, Logan, Utah 84322
Phone: (435)-797-1274; E-mail: shervais@cc.usu.edu

## Workshop Funding, Lodging, and Food

Through a grant from the National Science Foundation, the EarthScope National Office (ESNO) pays shared-lodging, meals, workshop materials, and field trip costs for all participants. **Participants must arrange and pay their own travel to and from the workshop.**

Lodging (www.tetonscience.org/index.cfm?id=campuses_jackson):
Rooms are reserved at the workshop site (**Jackson Campus** of the Teton Science Schools). ESNO pays double occupancy rates for participants. Single rooms are available for participants who wish to pay ½ of the single room cost (ESNO will pay the other half). **Either way, you do not need to book your own reservations.**

On applying online for the workshop, please indicate the nights you'll need lodging (Sept. 9, 10, 11) and if you wish a single room. **ESNO will make the reservations for you and pay the hotel directly. Those requesting single rooms will pay their half of the room cost on checkout.**

**If arriving on Sept. 9 you can check in to the Welcome Center at the Teton Science Schools from 10:30 AM to 1:00 PM (before the workshop starts), or from 5:00 to 6:30 PM (after the initial workshop sessions).**

**Note that you're responsible for your own lunch on Sept. 9. There are several good eateries nearby in the town of Jackson.**

Teton Science School lodging (www.tetonscience.org/index.cfm?id=lodging):

Teton Science Schools
700 Coyote Canyon Road
Jackson, WY, 83001
Phone: (307)-733-1313; Fax: (307)-733-7560; Web: www.tetonscience.org

Food:
All breakfasts, lunches (including during the field trip) and dinners during the workshop will be provided by ESNO. All on-campus meals and snacks will be in the Dining Lodge (directly across from the Education Center).

Breakfasts, Lunches, and Snacks. ESNO will provide free coffee/tea/soft drinks/snacks and lunches at the workshop site and field trip. **We'll have take-along lunches on the bus on Friday so that the bus can leave at 7:00 AM sharp. Please arrive at the bus no later than 6:45 AM.** Continental breakfast starts at 7:30 AM at the workshop site on Saturday and Sunday.

Dinners.
Dinners served at the Teton Science Schools at 6:30 PM on Thursday and 7:00 PM on Friday. On Saturday, carpool to Bob Smith's home for barbeque starting at 6:00 PM (1335 Middle Meadow Rd, Jackson, Wyoming; 15 miles from the Teton Science School). ESNO will pay for food and non-alcoholic beverages. (Participants and instructors pay for and bring their own drinks if they wish to have alcohol). Catered by Bubba's Barbecue (vegetarian options available).

Further Information:

Bob Lillie
EarthScope Education and Outreach Manager
Professor of Geology and Certified Interpretive Trainer
Department of Geosciences, Oregon State University, Wilkinson Room 104, Corvallis, OR, 97331-5506
Phone: (541)-737-1242; Fax: (541)-737-1200; E-mail: lillier@geo.oregonstate.edu

Bob Smith
Professor, Department of Geology and Geophysics, University of Utah
115 South 1460 East, Sutton Bldg. 242
Salt Lake City, UT 84112-0111
Phone: 801-581-7129; E-mail: robert.b.smith@utah.edu

Charlotte Goddard
EarthScope National Office
Oregon State University, 104 Ocean Admin, Corvallis, OR, 97331
Phone: (541)-737-9658; Fax: (541)-737-2064
E-mail: cgoddard@coas.oregonstate.edu

Emily Curran
Jackson Campus Administrative Coordinator
Teton Science Schools
700 Coyote Canyon Road, Jackson, WY, 83001
Phone: (307)-734-3789; Fax: (307)-734-3715; E-mail: Emily.Curran@tetonscience.org

TSS Campus Map: www.tetonscience.org/data/contentfiles/file/downloads/pdf/tss_jackson_campus_map.pdf