DIVISION OF Earth Sciences

GUIDE TO MULTI-USER FACILITIES

Instrumentation & Facilities Program
Division of Earth Sciences
National Science Foundation

Available at: http://www.nsf.gov/geo/ear/if/facil.jsp

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Division of Earth Sciences – Instrumentation & Facilities Program

INTRODUCTION

At the time of this writing, the *Instrumentation & Facilities Program* of the Division of Earth Sciences (EAR/IF) at NSF supports nineteen (19) national, multi-user facilities on behalf of the earth sciences research and education community. Although ranging widely in the scope and cost of their individual operations, all of the facilities share a common attribute. They provide to their respective basic research and education communities on a national or regional scale certain complex and expensive technical and logistical capabilities that would otherwise be impractical to make available to individual or small groups of investigators.

This ***GUIDE TO MULTI-USER FACILITIES*** is intended primarily as a service to the potential user who needs an introduction to the range of services available. In assembling the guide, each Director was asked to provide a description of their facility. Interested researchers are encouraged to contact the facility directly for further information.

All facilities described in this guide are reviewed on a regular basis by the *Instrumentation & Facilities Program* using the NSF merit review system. The ability of a facility to provide the basic research and education community efficient and timely access to its technical capabilities is one of the important criteria used by EAR/IF in reviewing performance. Comments on the performance of these facilities or on any other topic relevant to the material presented in this guide are welcome.

The reader of this guide should also explore research and education opportunities at other EAR-supported activities funded outside of the *Instrumentation & Facilities Program*. These include: the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (http://www.cuahsi.org/), the National Center for Earth Surface Dynamics (http://www.nced.umn.edu), Sustainability of Semi-Arid Hydrology and Riparian Areas (http://www.sahra.arizona.edu), the Southern California Earthquake Center (http://www.scec.org/), Computational Infrastructure for Geodynamics (http://www.geodynamics.org/), and EarthScope (http://www.earthscope.org). Access to many of these facilities may be requested in proposals submitted to the core science programs within the Division of Earth Sciences and the EarthScope Program (solicitations revised annually and available at the EAR website: http://www.nsf.gov/div/index.jsp?div=EAR).

Program Director:

Dr. David D. Lambert
Instrumentation & Facilities Program
Division of Earth Sciences, Suite 785
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230
Tel: (703) 292-8558
FAX: (703) 292-9025
E-mail: dlambert@nsf.gov

Program Director:

Mr. Russell C. Kelz
Instrumentation & Facilities Program
Division of Earth Sciences, Suite 785
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230
Tel: (703) 292-8558
FAX: (703) 292-9025
E-mail: rkelz@nsf.gov

WWW Home page URL: http://www.geo.nsf.gov/ear/if/facil.htm

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Incorporated Research Institutions for Seismology (IRIS)

Scientist in Charge:

David Simpson, President
IRIS
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
E-mail: simpson@iris.edu

Contact Person:

Leslie Linn
IRIS
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
E-mail: leslie@iris.edu

Facility Description:

IRIS (www.iris.edu) was formed in 1984 by twenty-six universities to provide a national focus for the development, deployment, and support of modern digital seismic instrumentation. Today, membership in this nonprofit consortium includes 114 U.S. research institutions as full members, 20 Educational Affiliates and more than 100 Foreign Affiliates. IRIS supports the research needs of Earth scientists in the U.S. and around the world. IRIS is funded primarily through two Cooperative Agreements from NSF: one for the core programs (PASSCAL, Global Seismographic Network, Data Management System, and Education and Outreach) and one for the USArray component of the EarthScope project. These programs are coordinated through Instrumentation Services (PASSCAL, GSN and USArray), Data Services, Education and Public Outreach and International Development Seismology.

PASSCAL

The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) provides portable instrumentation and support facilities for temporary deployments in studies of seismic sources and Earth structure. Data loggers developed to PASSCAL specifications form the core of the program. These data loggers are extremely flexible in their ability to respond to a variety of deployment schemes -- mobile arrays for recording of planned explosions; temporary deployments for aftershock studies; longer term deployments for observations of teleseismic events. Over 900 multi-channel and 550 single-channel recorders, associated sensors and support equipment are available. Over 60 individual experiments ranging from a few to more than 2500 instruments are supported annually. The PASSCAL Instrument Center at the New Mexico Institute of Technology in Socorro, NM is responsible for supporting field experiments; maintaining equipment; implementing improvements in hardware; and developing software for efficient data collection and initial processing. Data from PASSCAL experiments are distributed through the IRIS Data Management Center.

James Gridley, Program Manager - PASSCAL
PASSCAL Instrument Center
New Mexico Tech
100 East Road
Socorro, NM 87801
Tel: (505) 835-5070
FAX: (505) 835-5079
James.Gridley@iris.edu

GLOBAL SEISMOGRAPHIC NETWORK

The Global Seismographic Network (GSN) is the focused effort of the U.S. seismological research community to provide a permanent state-of-the-art, broadband, digital network of seismic instrumentation for research on the three-dimensional structure of the Earth and the study of earthquakes and other seismic sources. The GSN is a partnership between IRIS and the U.S. Geological Survey, cooperating under a Memorandum of Understanding. GSN stations are installed and operated by the U.S. Geological Survey Albuquerque Seismological Laboratory and by the IDA project at the University of California, San Diego. IRIS GSN global siting plans are coordinated with other international networks through the Federation of Digital Seismic

Networks (FDSN), of which IRIS is a founding member. Beginning in late 1986 with the installation of the first broadband seismometers, the GSN has seen steady progress toward its long-term goals, and serves as a fundamental resource in the study of earthquake dynamics and tomographic analyses of the elastic and anelastic structure of the Earth. There are now 154 GSN stations and affiliate arrays, of which more than 96% have real-time telemetry via satellite or the Internet.

Kent Anderson, Operations Manager and Acting Program Manager – GSN
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
kent@iris.edu

DATA MANAGEMENT SYSTEM

The IRIS Data Management System (DMS) is the primary conduit for data flow within IRIS and to the broad scientific community. The DMS acts as the archive for all data collected by the IRIS GSN, PASSCAL and EarthScope/USArray programs. The DMS also receives, archives and distributes data from a variety of other data sources, most notably the international Federation of Digital Seismographic Networks (FDSN). All broadband data from the GSN, PASSCAL, USArray and FDSN are available in a seamless fashion from the DMC in SEED format. Active source data are available in SEG-Y format. At the end of June 2010, the IRIS Data Management Center (DMC) had more than 118 terabytes (118×10^{12} bytes) of seismic waveform data in more than 8.4 million files. These data are stored on-line in a large disk-based mass storage system. Fully redundant copies of waveform data, database tables, and operating software are available at an active backup location in Boulder, Colorado. The IRIS DMS has sent more than 80 terabytes of data to the research community in 2010.

The core of the IRIS DMS is the IRIS Data Management Center (DMC) located in Seattle. Other nodes of the system include the IRIS/IDA Data Collection Center at UCSD, the IRIS/USGS DCC at Albuquerque and the DMC Host at the University of Washington. In addition to its role of archiving and distributing data, the IRIS DMS is responsible for quality control of IRIS generated data and has a well established mechanism in place to monitor and correct data problems as they are discovered.

The IRIS DMS has developed novel means of accessing data in near real time by supporting roughly ten different real time data communication protocols. The BUD system operated by the DMC receives nearly 12 terabytes of data per year in near real time. The SeedLink system allows all data received in real time to be redistributed in real time as well. Systems such as WILBER (via www.iris.edu), provide a convenient way for scientists to access data for significant events shortly after they occur. A complete database management system and associated user tools allow researchers to make complex requests for customized subsets of data stored in the IRIS archive.

The IRIS DMS is now generating many data products defined by the research community, drawing from the primary observational data managed at the DMC. Ground Motion Visualizations, the EARS system that automatically calculates receiver functions, synthetic waveform data generated at Princeton, tomographic models of the Earth through the Earth Model Collaboration effort, and a suite of event-based products are among the initial products being supported at the DMC.

Tim Ahern, Program Manager - DMS
1408 NE 45th Street Suite #201
Seattle, WA 98105
Tel: (206) 547-0393
FAX: (206) 547-1093
tim@iris.edu

EDUCATION AND PUBLIC OUTREACH

The seismological community recognizes the potential for coordinated Education and Outreach (EPO) activities in seismology to contribute significantly to the advancement of national awareness, interest, and understanding of science and mathematics. IRIS E&O Program activities are targeted at audiences ranging from K-16 students to the general public, and are focused on areas where IRIS is well-positioned to make substantive contributions stemming from its strong research and data resources. The EPO staff works in close collaboration with diverse allies, including IRIS members, K-12 teachers, undergraduate institutions, science museums, and other national and regional Earth science organizations. Current efforts include a Research Experiences for

Undergraduates program where students conduct research with seismologists throughout the US, a range of K-16 educator workshops, widely distributed teaching modules and associated tools, and an Educational Affiliate membership for undergraduate institutions desiring to improve their seismology instruction. The Seismographs in Schools program provides seismographs and software for viewing and interpreting seismograms as well as an online community where schools throughout the world share data and resources. Outreach to the general public is enhanced through a very successful Distinguished Lecture Program (in collaboration with the Seismological Society of America), permanent exhibits at major museums and "Active Earth" displays designed for installation at visitors centers, parks and universities. Improved access to and use of seismic data are facilitated via our website, along with other informational materials including Teachable Moment slide sets released shortly after major earthquakes, and educational animations and videos.

John Taber, Program Manager – EPO
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
taber@iris.edu

USARRAY – COMPONENT OF EARTHSCOPE

The EarthScope project brings a new suite of facilities for research on the structure and dynamics of the North American continent. The seismological resources of EarthScope/USArray are supported under a separate Cooperative Agreement through the NSF/EAR/EarthScope Program, but many components of USArray share facilities and resources with the other facilities of the IRIS Consortium. USArray consist of three major elements: a transportable array of 400 portable, unmanned three-component broadband seismometers deployed on a uniform grid that will systematically cover the US; a flexible array of 446 portable, three-component, short-period and broadband seismographs and 1700 single-channel high frequency recorders for active and passive source studies that will augment the transportable array, permitting a range of specific targets to be addressed in a focused manner; and contributions to a permanent array, coordinated as part of the U. S. Geological Survey's Advanced National Seismic System (ANSS), to provide a reference array spanning the contiguous United States and Alaska. Additional components of the USArray facility include an array of 27 magneto-telluric sensors embedded within the transportable and permanent arrays that will provide constraints on temperature and fluid content within the lithosphere. The goal of this layered design is to achieve imaging capabilities that flexibly span the continuous range of scales from whole Earth, through lithospheric and crustal, to local.

Bob Woodward - USArray Director
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
woodward@iris.edu

INTERNATIONAL DEVELOPMENT SEISMOLOGY

International Development Seismology (IDS) constitutes one of IRIS interfaces between its NSF-sponsored scientific mission and the imperative to ensure that scientific progress enables socially important outcomes. While IRIS has been international since its inception, the specific focus of this effort responds to the recognized importance of developing the partnerships, technical infrastructure, and human capacity required for effective international cooperation not only as an instrument to accelerate scientific progress through collaboration with technologically equal partners, but also as an essential element of various other modes of current U.S. foreign engagement, including foreign assistance and science diplomacy.

Although IDS activities are not directly discovery-oriented, they are designed to support engagement of IRIS member and foreign affiliate institutions in low and middle income countries and to serve as seeding efforts or pilot projects driven by the need to support the scientific inquiry, and targeted toward two complementary and synergistic goals.

The first goal is to promote strategies that support fundamental research and exploration through wide and reliable geographic coverage. These efforts are focused on leveraging U.S. investment in advancing scientific understanding of some of the most

complex tectonic systems on Earth by encouraging the sustained and active participation of low and middle income countries located in these territories in regional technological investment and capacity building.

The second is addressing the social responsibility of the IRIS community to facilitate the translation of new knowledge into societal benefits by contributing to sustainable development of low and middle income countries through the mitigation of population exposure to seismic hazard including broad education strategies of scientific and technical principles that impact on societal resilience through increased awareness, preparedness and accountability.

Olga A. Cabello - Director of International Development Seismology
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220 x 121
FAX: (202) 682-2444
olga.cabello@iris.edu

IRIS, SEISMOLOGY, AND THE PUBLIC INTEREST

While the advancement of science is the primary goal of IRIS, perhaps an equal achievement of the Consortium has been to demonstrate that national and international scientific communities can cooperate on programs that not only advance our understanding of the physical world, but also address the current needs of our society. IRIS works with federal, state and international agencies to enhance IRIS facilities into multi-use resources for applications in earthquake hazards, global earthquake monitoring and the international verification of nuclear test ban treaties. Many nations use IRIS GSN stations as their contribution to the International Seismic Monitoring System. Instruments from the IRIS PASSCAL Program are used by scientists funded with Department of Defense and Department of Energy research grants to characterize seismic wave propagation in areas of concern for treaty monitoring. IRIS also works in partnership with the U. S. Geological Survey, both in developing the IRIS GSN and the U. S. Advanced National Seismic System (ANSS), and in making the data from these stations available for use by the National Earthquake Information Center in their location and cataloging of national and global seismicity. Through the PASSCAL program, the RAMP initiative (Rapid Array Mobilization Program) provides portable instruments for use in the detailed study of aftershocks immediately following important earthquakes.

IRIS produces publications available to the scientific and educational communities. These include an Annual Report, an IRIS Newsletter, educational posters and "1-pagers", an on-line DMS Newsletter and numerous technical reports. Many publications, including the IRIS Newsletter, are available online at www.iris.edu/hq/publications.

Ray Willemann – Director of Planning
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
teresa@iris.edu

MEMBERSHIP IN THE IRIS CONSORTIUM

Educational and not-for-profit institutions chartered in the U.S., with a major commitment to research in seismology and related fields, may become Members of IRIS. Two and four year colleges and universities with a commitment to teaching undergraduate Earth science including seismology may become Educational Affiliates. Research institutions and other not-for-profit organizations both inside and outside the U.S. engaged in seismological research and development, which do not otherwise qualify for IRIS membership, may be elected Affiliates or Foreign Affiliates.

Additional information on membership can be obtained by completing the membership request form at http://www.iris.edu/hq/about_iris/membership/become_a_member..

WWW Home page URL: http://www.iris.edu

Consortium for Materials Properties Research in Earth Sciences (COMPRES)

Scientist in Charge:

Jay D. Bass
COMPRES
Geology Department, 1301 W Green St.
University of Illinois at Urbana-Champaign
Urbana, IL 61801
Tel:(217) 333-1018
FAX:(217) 244-4996
E-mail: jaybass@illinois.edu

Contact Person:

Chong-Hwey Fee
COMPRES
Geology Dept., 1301 W Green St.
University of Illinois
Urbana, IL 61801
Tel : (217) 333-6379
FAX: (217) 244-4996
E-mail: fee@illinois.edu

Facility Description:

The Consortium for Materials Properties Research in the Earth Sciences (COMPRES) has been established to promote research, technology development, and educational activities related to the behavior of materials at extreme pressure-temperature conditions typical of the deep Earth and other planetary bodies. Membership in this consortium includes more than 57 US institutions and 39 foreign affiliates. Over the past decade, a variety of sophisticated tools have been developed to study Earth materials at extreme conditions. Many of these technological developments have involved the exploitation of national X-ray synchrotron facilities. The mission of COMPRES includes providing access to these advanced facilities for the broader Earth science community, further development of technology, and educational outreach at a variety of levels (including professional workshops). Full information on how to request use of COMPRES facilities (including synchrotron beamtime), becoming a member of the consortium, submitting proposals for projects under COMPRES, or participating in other activities can be found on the COMPRES website (http://www.compres.us).

CENTRALIZED FACILITIES

COMPRES supports a variety of facilities for research at high pressures and temperatures, and experimentation on phases that exist under extreme P-T conditions. There is currently great demand for beamtime to perform high-pressure experiments at national synchrotron facilities. COMPRES is responding to help meet that demand by providing expanded access to synchrotron facilities for high-pressure research at the National Synchrotron Light Source (NSLS, Brookhaven, NY), and the Advanced Light Source (ALS, Lawrence Berkeley National Laboratory). Depending on the size of user team and their experience, support provided by COMPRES can include training in the use of equipment, assistance in performing experiments, and help with the analysis of data. Information and applications for beamtime can be obtained through the COMPRES website: http://www.compres.us. Much of the experimental capability involves diamond anvil cells (DAC) or large volume multi-anvil presses (LVP or MAC).

NSLS: Facilities include three experimental stations (*X17B2, X17B3* and *X17C*) on the superconducting wiggler beamline X17, and the infrared (IR) beamline (*U2A*). Equipment is available for high-pressure x-ray studies using multi-anvil presses and diamond cells, and IR studies with the DAC. The types of experiments that can be performed include measurements of the P-V-T equation of state, phase transformations, crystal structures, stress state and rheological properties, absorption, reflectance, P and S acoustic wave velocities, dilatometry, kinetics, and infra-red spectroscopy under a range of extreme P-T conditions.

X17C is dedicated to diamond-cell applications, using focused white radiation for energy dispersive X-ray diffraction (EDX) or a focused monochromatic beam for angle dispersive X-ray diffraction (ADX) experiments in the photon energy range 20 – 40 keV. The facility provides the following experimental capabilities:

- EDX and ADX for polycrystalline samples in diamond cells at temperatures to 1100K with resistance heating.
- Single-crystal x-ray diffraction up to 100 GPa, on samples as small as 1 micron.
- Ruby fluorescence spectroscopic system for pressure calibration.
- Off-line laser-heating equipment for temperatures up to 4000K at high pressure.

X17B3 is a dedicated DAC hutch with focused high-energy monochromatic beam up to 100keV and white radiation for ADX and EDX studies. The hutch is larger than X17C and provides complementary capabilities that are unfeasible in the restrictive

X17C space. X-ray studies of Earth materials can be performed at cryogenic temperatures (in liquid helium cryostat to 4K) and along the entire geotherm from the crust to the core using double-sided laser-heating equipment for high temperatures up to 4000K.

X17B2 is a dedicated hutch for studies using multi-anvil large-volume presses. The capabilities include:

- A DIA apparatus (SAM 85), capable of 10 GPa and 2000 K on cylindrical samples 2mm in length and 1 mm in diameter.
- A D-DIA apparatus for significant axial deformation (up to 50% shortening) of sample in biaxial compression.
- A "T-cup" two-stage (6-8 or Kawai-type) device, routinely capable of 20 GPa and 2000 K with smaller samples.
- Both white and monochromatic x-rays for ADX and EDX experiments.
- X-radiography experiments to measure sample length changes and absorption.
- Ultrasonic interferometry measurements of P and S velocities to P -T conditions representative of the transition zone.
- Ability to measure differential stress on samples, rheologic properties and yield strength.

U2A is an infrared facility dedicated to high-pressure spectroscopy and microspectroscopy studies, and in particular, using diamond and gem anvil cells. The capabilities include:

- Far- and mid-IR reflectivity and absorption measurements from kilobar to multimegabar pressures and temperatures in the range of 4-1000 K.
- Two Bruker FT-IR spectrometers (Vertex 80v and IFS/66v) for the spectral range 30-25,000 cm^{-1} and four IR microscopes including a Bruker Hyperion 2000 and IRscopeII microscope, a custom made vacuum microscope for far-IR absorption, and an integrated microscope system for both IR and Raman experiments at high pressure and variable temperature.
- Companion Raman, UV-visible absorption/reflectivity and ruby fluorescence capability with Ar-ion or Ti-sapphire, as well as DPSS lasers, cryostats, and furnaces.

West Coast Synchrotron Facilities: COMPRES-funded facilities for high-pressure x-ray experimentation are available to the geosciences community at beamline 12.2.2 of the Advanced Light Source at Lawrence Berkeley National Labs. This source is a superbend, 1.9 GeV, 500 mA source equipped with a Si(111) monochromator with an operational energy range between 6 and 40 keV, and is typically used for high-pressure powder diffraction or scattering studies with a focused x-ray beam (beam flux will be upgraded by a factor of six in a ring-wide upgrade in 2011). Potential users should contact Alastair MacDowell at aamacdowell@lbl.gov. A partial list of the present capabilities includes:

- X-ray diffraction on polycrystalline samples using diamond cells with high resolution CCDs, including both a MAR 345 and a Bruker P200 detector.
- Diamond cells available to users for x-ray diffraction or x-ray spectroscopic studies at both ambient temperatures and with resistance heating to 1100 K.
- Two-sided infrared laser heating coupled with spectroradiometric temperature determinations for diffraction at simultaneous pressure and temperature in high-pressure diamond cell samples. Temperatures to ~6000 K are accessible at high pressures, and this set-up is supplemented with high-quality sample imaging capabilities.
- On-site ruby fluorescence for pressure measurements, extensive sample preparation facilities and a high-quality micromachining laser mill for gasket preparation are all available to users on site. A high-pressure gas loading system, to ensure hydrostaticity at high pressures, is anticipated to be deployed in early 2011.

COLLABORATIVE RESEARCH AND DEVELOPMENT

In addition to supporting facilities, COMPRES promotes the development of new technology through Infrastructure Development projects. Current Infrastructure Development projects include multi-anvil cell assembly development and production, development of inelastic X-ray scattering techniques, gas loading facilities for diamond anvil cells, a community Mössbauer facility, the development of new toroidal (Paris-Edinburgh) high-pressure cells, and interfacing Brillouin scattering with x-ray diffraction. Submissions of new Infrastructure Development projects are encouraged; contact Pam Burnley (Pamela.Burnley@unlv.edu) or Jay Bass (jaybass@illinois.edu). COMPRES also cultivates and nurtures collaborative scientific projects that utilize the facilities it manages or which build on the infrastructure development projects it sponsors. These projects are typically multi-institutional initiatives and are submitted and reviewed by the existing Programs in the Division of Earth Sciences at the NSF. For additional information on such collaborative research programs, contact Jay Bass (jaybass@illinois.edu) or see the COMPRES website for additional details.

EDUCATION AND OUTREACH

COMPRES education and outreach promotes the scientific investigation of the Earth, its materials, and its processes among students, researchers and the general public. The education and outreach program includes:

- Distinguished Lecturer Series: COMPRES supports visits by distinguished lecturers from the COMPRES community to science departments within the US. Priority is given to colloquia at four-year undergraduate institutions, and non-COMPRES-member institutions. Visits are free of charge to the host institutions. See www.compres.us for more information.
- Developing and disseminating educational resources, including online information systems for educators and researchers. Efforts in this area include: 1) The *SERC:Teaching with Google Earth* collection - This web-based guide provides a comprehensive roadmap to help educators teach with Google Earth. The website (http://serc.carleton.edu/sp/library/google_earth/), which is hosted by the Science Education Resource Center (SERC) at Carleton College, presents techniques and examples of how Google Earth can be used to support a range of activities in Earth science education. 2) The *On the Cutting Edge: Understanding the Deep Earth* collection – COMPRES works with the NAGT project *On the Cutting Edge* to provide professional development materials related to the deep Earth. COMPRES helps to organize contributions of teaching material from the deep-Earth community for this collection (http://serc.carleton.edu/NAGTWorkshops/deepearth/index.html). The COMPRES representative for both these efforts is Glenn Richard (garichard@notes.cc.sunysb.edu).
- Promoting the dissemination and advancement of knowledge through topical workshops. We strongly encourage the participation of the entire Earth science community (particularly students and post-docs) in these efforts, and encourage proposals for new projects.

For more information on COMPRES E&O activities, see www.compres.us, or contact Jay Bass (jaybass@illinois.edu).

MEMBERSHIP IN THE COMPRES CONSORTIUM

Educational and not-for-profit US Institutions are eligible to become members. Other organizations and non-US institutions are eligible to be affiliated members with a non-voting representative. Detailed information on the application process is described on the COMPRES website (www.compres.us), or contact Jay Bass (jaybass@illinois.edu).

WWW Home page URL: http://www.compres.us

UNAVCO, A University Consortium for Geodesy

Scientist in Charge:

M. Meghan Miller, President
UNAVCO, Inc.
6350 Nautilus Drive
Boulder, CO 80301-5554
Tel: (303) 381-7514
FAX: (303) 381-7501
E-mail: meghan@unavco.org

Contact Person:

Charles Meertens, Facility Manager
UNAVCO Facility
6350 Nautilus Drive
Boulder, CO 80301-5554
Tel: (303) 381-7465
FAX: (303) 381-7451
E-mail: meertens@unavco.org

Facility Description:

UNAVCO is a non-profit membership-governed university consortium that facilitates geoscience research and education using geodesy. This academic community shares a collective vision to transform human understanding of the changing Earth by enabling the integration of innovative technologies, open geodetic observations, and research, from pole to pole.

The UNAVCO Facility supports geoscience investigations through community coordination, field engineering, data services, technology innovation, and instrument testing, acquisition, and deployment. Further, it maintains and enhances state-of-the-art global geodetic infrastructure that is developed and operated through international collaborations, including continuous GPS sites in NASA's Global GPS network, many of which contribute to the International GPS Service (IGS) global network. EarthScope provides integrated geophysical observations that result in community data sets sampling across the temporal spectrum of Earth deformation processes. In particular, the Plate Boundary Observatory (PBO) including GeoEarthScope provides unprecedented geodetic imaging of plate boundary deformation. Together, the UNAVCO Facility and PBO are committed to enabling efficient testing, adoption, and implementation of rapidly evolving geodetic technologies needed to support cutting edge geodynamics research. The UNAVCO community relies on the Education and Outreach program to support development of a forward-looking, diversified workforce that draws on and cultivates talent across the demographic spectrum of gender and ethnicity, across international boundaries, and across scientific disciplines, and to inform the public interest and to support the development of partnerships, collaborations, curricula, and student opportunities.

Services. UNAVCO-provided services to the scientific community include:

- UNAVCO manages a community pool of high accuracy portable GPS receiver systems that can be used for a range of applications. These complete systems – receivers, antennas, mounts, power and optional communications - can be deployed for days in episodic campaigns or for many months in more protracted deployments. Systems are also available for precision mapping applications.

- UNAVCO manages a community pool of Terrestrial Lidar Scanners suitable for precise geodetic imaging of Earth and ice surfaces. The Facility also provides engineering and data services to support investigator studies.

- UNAVCO acquires, archives, and/or distributes a number of community data sets including GPS, strainmeter, borehole seismometer, tilt meter, and geodetic imaging with radar and lidar, as part of EarthScope's Plate Boundary Observatory.

- UNAVCO provides administrative and logistical support for the WInSAR consortium of universities and research laboratories. With WInSAR, UNAVCO helps coordinate requests for satellite radar remote sensing data acquisition and for data purchase, aiding individual investigators by simplifying interactions with data providers and with government agencies funding science, including NASA, NSF, and the USGS. UNAVCO also provides an InSAR data archive.

- Engineering resources are available to provide classroom and in-the-field training, project design and implementation, field engineering, TLS or GPS network operations, and technology development for GPS, TLS and other applications.

- Data archiving and distribution are supported for GPS data collected by investigators in campaigns and continuous networks, of as part of community projects coordinated by UNAVCO such as EarthScope and Africa Array. GPS data

are available both via ftp and via a data-mining interface: http://facility.unavco.org/data/dai2/app/dai2.html. In a collaborative project, the UNAVCO Facility is developing web services capabilities to update Seamless Archive Centers (GSAC) for sharing of meta data with GPS archive at Scripps Oceanographic Institution (SOPAC) and Goddard Space Flight Center (CDDIS). This system will modernize seamless access by sharing of metadata, allowing users to obtain data without knowledge of the individual archive holdings or data structures.

- Contributed investigator science products are shared via the UNAVCO velocity and strain archives and a suite of advanced Internet mapping tools and related on-line resources that serve the science and education communities.

- UNAVCO's Education and Outreach (E&O) effort is built upon strategic partnerships with community investigators and other facilities. UNAVCO is committed to increasing the participation of underrepresented populations in science. The program portfolio includes short courses and workshops for professional development, research, and education, strategic support for investigators in developing broader impacts, in-residence programs for geodesy science community members and educators, professional development in geosciences for K-12 faculty, and RESESS student internships for diversity and workforce development. UNAVCO E&O Director: Shelley Olds, olds@unavco.org

- UNAVCO is principally organized to support NSF- and NASA-funded Earth science investigators and projects but it also provides keystone support for wider interdisciplinary geodetic applications at the international level. Many of the geodetic tools and techniques developed by the UNAVCO community are publicly accessible via the UNAVCO Web site.

EarthScope. Between 2003 and 2008, UNAVCO constructed and now maintains and operates the Plate Boundary Observatory (PBO) as a partner in EarthScope, together with the Incorporated Research Institutions for Seismology (IRIS) and Stanford University. Since the inception of operations and maintenance in 2008, UNAVCO oversees management of SAFOD.

Membership. UNAVCO Members are educational or nonprofit institutions chartered in the United States (US) or its Territories with a commitment to scholarly research involving the application of high precision geodesy to Earth science or related fields. Members must also be willing to make a clear and continuing commitment to active participation in governance and science activities. Associate Membership is available to organizations other than U.S. educational institutions, when those organizations share UNAVCO's mission and otherwise meet the qualifications for membership. To learn more about UNAVCO Membership, visit http://www.unavco.org/community/membership/membership.html

Governance. A Board of Directors is charged with UNAVCO oversight and governance, and is elected by designated representatives of UNAVCO member institutions. The Board works with the science community to promote a broad interdisciplinary research agenda based on applications of geodetic technology, to identify investigator needs for infrastructure support, to develop proposals to appropriate sponsors to maintain that infrastructure capability, and to ensure that UNAVCO and its activities provide high quality, cost-effective, and responsive support. UNAVCO also undertakes community-wide activities, including science planning, development and distribution of community data sets for geodesy, professional development for faculty and students, structured student internships for diversity, and related activities.

E-Mail List. UNAVCO distributes e-mail of interest to its community through an e-mail distribution list. Unav_all e-mail list: http://ls.unavco.org/mailman/listinfo/unav_all.

UNAVCO welcomes inquiries from prospective users of GPS and other geodetic techniques for either recognized or new science applications of these powerful tools.

WWW Home page URL: http://www.unavco.org

GeoSoilEnviroCARS Synchrotron Radiation Beamlines at the Advanced Photon Source (GSECARS)

Scientist in Charge:

Mark L. Rivers
Consortium for Advanced Radiation Sources
The University of Chicago
Building 434A
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439
Tel: (630) 252-0422
FAX: (630) 252-0436
E-mail: rivers@cars.uchicago.edu

Contact Person:

See Scientist in Charge

Facility Description:

GeoSoilEnviroCARS (GSECARS) is a national synchrotron radiation user facility for earth science research at the Advanced Photon Source (APS), Argonne National Laboratory. The APS is a 7 GeV storage ring producing extremely high brilliance X-ray beams using undulators, wigglers and bending magnets. The GSECARS sector, consisting of an undulator beamline and a bending magnet beamline, is operated by the Consortium for Advanced Radiation Sources, which is managed by the University of Chicago.

The principal synchrotron-based analytical techniques in demand by earth scientists are available at GSECARS including:

- X-ray diffraction and spectroscopy in the diamond-anvil cell using both monochromatic and energy-dispersive techniques, including double-sided laser heating apparatus. Online Brillouin spectroscopy is available on the bending magnet beamline.
- X-ray diffraction and imaging in the large-volume press using both monochromatic and energy-dispersive techniques, including a 250-ton press on the bending magnet beamline and a 1000-ton press on the undulator beamline.
- Powder diffraction, surface diffraction, and single-crystal micro-diffraction.
- X-ray absorption spectroscopy including micro-spectroscopy, with beam sizes near 1 μm, and surface studies.
- X-ray fluorescence microanalysis.
- Inelastic x-ray scattering with ~1eV resolution.
- 3-D computed microtomography.

Principal research areas include (1) speciation and microdistribution of metals and radionuclides in soils, (2) redox reactions and transport processes and kinetics of metals in soils, (3) sorption processes and reactions of metals at mineral-water interfaces, (4) role of biota in transport processes, (5) oxidation states of igneous systems, (6) metal partitioning and speciation in hydrothermal fluids, (7) crystal chemistry of rare, complex minerals, (8) dynamics of fluid transport in rocks, (9) equations-of-state of mantle phases, (10) rheology studies at high pressure, (11) determination of melting points and the densities and viscosities of melts, and (12) phase transitions and relationships in mantle minerals and candidate core materials.

A research environment is provided where users receive expert assistance in planning and conducting experiments, and with data analysis. This service-oriented mode of operation allows the facility to be accessible to the entire spectrum of synchrotron radiation users from novices to experienced investigators. There are currently no user fees.

Beam time at the GeoSoilEnviroCARS facility is available to all interested Earth scientists through the APS web-based proposal system (http://www.aps.anl.gov/Users/Scientific_Access/General_User/index.html). The APS web page (http://www.aps.anl.gov/Users/Calendars/GUP_Calendar.htm) contains announcements of proposal deadlines. The GSECARS Web page (htttp://www.gsecars.org) contains GSECARS staff contacts for experiment design information, descriptions of available instrumentation and capabilities, hardware and software tutorials, photographs of the facility, recent scientific results and a publication list. Since 2006 over 1400 beamtime proposals have been received, and over 680 visiting scientists have conducted experiments at GSECARS. Each year over 200 experiments are performed at GSECARS, with over 100 each on the undulator beamline and bending magnet beamlines.

In addition to the experimental stations, GeoSoilEnviroCARS has laboratories for sample preparation and characterization. For diamond-anvil cell experiments this includes off-line laser heating, Raman and ruby fluorescence spectroscopy, Brillouin spectroscopy, and a gas-loading facility. GSECARS provides office space with computer workstations for users. Convenient lodging for visitors is available on the Argonne Campus at the Argonne Guest House (http://www.aps.anl.gov/travel/anlghhome.html).

WWW Home page URL: http://www.gsecars.org

Purdue Rare Isotope Measurement Laboratory (PRIME Lab)

Scientist in Charge:

Marc Caffee
PRIME Lab
Purdue University
1396 Physics Building
West Lafayette, IN 47907-1396
Office Tel: (765) 494-2586
PRIME : (765) 494-5381
FAX: (765) 496-7228
Email : mcaffee@purdue.edu

Contact Person:

see Scientist in Charge

Facility Description:

Purdue Rare Isotope Measurement Laboratory (PRIME Lab) is a dedicated research and service facility for accelerator mass spectrometry (AMS). AMS is an ultra-sensitive analytical technique for measuring low-levels of long-lived radionuclides and rare trace elements. We routinely measure both man-made and cosmic-ray-produced radioisotopes such as ^{14}C (half-life 5730 years), ^{10}Be (1,380,000 years), ^{10}Be (730,000 years), ^{26}Al (300,000 years), ^{36}Cl (100,000 years) and ^{129}I (16,000,000 years) in natural samples having isotopic abundances down to 10^{-15}.

Although the instruments and detection methods are those of nuclear physics, research applications are concentrated in Earth and planetary sciences. Applications include measuring the exposure time and erosion rate of rocks on the Earth's surface in the range 5,000 to 1,000,000 years, dating and tracing of ground water, ^{129}I as an oceanographic tracer, measuring solar and atmospheric variability using ^{10}Be and ^{36}Cl in precipitation and ice cores, radiocarbon dating of archaeological artifacts, tracing the global carbon cycle with ^{14}C, determining terrestrial ages of meteorites recovered from the Antarctic ice sheet, and tracing of ^{14}C-labeled compounds, aluminum, and calcium in biological systems. We are also currently building a dedicated laboratory for in-situ ^{14}C analyses. Our publications, newsletters, and annual report are available on request.

PRIME Lab is an active teaching facility training graduate and undergraduate students in the departments of Physics, Chemistry, and Earth and Atmospheric Sciences. Every year several Purdue students obtain advanced degrees using AMS and over 100 external scientists and their students use PRIME Lab.

PRIME Lab is based on an upgraded FN (nominal 8 MV) tandem electrostatic accelerator. With higher energies than most accelerators dedicated to AMS, it has the capability to measure the full range of radionuclides including ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, and ^{129}I. The PRIME Lab is located within the Physics building on the Purdue campus and contains 31,000 sq. ft of floor space, housing offices for PRIME Lab staff and chemical preparation laboratories.

Chemistry operations are an integral part of PRIME lab, offering users not wishing to prepare their own samples the unique opportunity to have their samples physically and chemically prepared for AMS measurements. Separate laboratories allow us to analyze samples covering a wide range of specific activities. Analytical methods have been established for diverse sample matrices, such as rock, soil, sediment, and water, for all nuclides measured by AMS at PRIME Lab. Methods include physical pretreatment as well as chemical separation procedures. We also assist users in planning their sampling trips, to ensure maximum scientific quality. In-house training programs are available for users to learn to prepare their own samples. We also welcome visiting students and scientists. Arrangements are routinely made for visiting scientists to perform the mineral separation or chemical preparation steps themselves after receiving training from PRIME Lab staff.

Purdue University dedicated its tandem accelerator to accelerator mass spectrometry in 1989; external funding began in April 1990; and the first AMS measurements took place in early 1991. The internal upgrade of the accelerator, which included new acceleration tubes and a new charging system, took place from December 1993 through April 1994. We chemically prepare over 800 samples per year and perform AMS measurements on over 5000 samples per year. We are constantly striving to improve AMS methods and develop detection of new nuclides.

PRIME Lab facilities are available to the research community for measurements of the nuclides ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, and

^{129}I. Sample requirements, performance for each nuclide, and prices are available on our web site. Contact us if you have any questions.

WWW Home page URL: http://primelab.physics.purdue.edu

Institute for Rock Magnetism (IRM)

Scientist in Charge:

Bruce M. Moskowitz, Director
Department of Geology and Geophysics
University of Minnesota
310 Pillsbury Drive SE
Minneapolis, MN 55455-0219
Tel: (612) 624-1547
FAX: (612) 625-7502
E-mail: bmosk@umn.edu

Contact Person:

Mike Jackson, Laboratory Manager
Institute for Rock Magnetism
University of Minnesota
100 Union Street SE
Minneapolis, MN 55455-0128
Tel: (612) 624-5274
FAX: (612) 625-7502
E-mail: irm@tc.umn.edu or jacks057@umn.edu

Facility Description:

The Institute for Rock Magnetism (IRM) was established in the fall of 1990 to provide the Earth Science research community with access to state-of-the-art facilities and technical expertise for magnetic material characterization. Visiting scholars and resident researchers utilize the resources of the IRM to study contemporary topics in rock magnetism, paleomagnetism, and a broad range of interdisciplinary fields such as biomagnetism, paleoclimatology, archeology, planetary science, and nanomagnetism of iron oxides. More than 300 Visiting Fellowships have been awarded since 1990 for advanced experimental or characterization studies involving magnetic properties of natural materials or synthetic analogs.

The same physical principles that govern magnetic information storage in audio/video recording media and in computer disks also operate in geological recording media: rocks and sediments. The processes involved in natural magnetic recording are both complex and inefficient, and the characteristics of natural particulate storage media vary strongly with the mineral composition and grain size of the ferromagnetic particles. The recorded signal of geomagnetic field behavior through time is inevitably distorted by variations in these properties of the recording medium, and the signal is moreover subject to degradation and overprinting by stress, thermal perturbations and chemical alteration. High-fidelity geomagnetic signal recovery depends on separating out this geological "noise," which itself, of course, contains significant information about Earth processes that have affected the medium. Research at IRM thus aims at separate recovery of both the geomagnetic and geological signals in the magnetism of Earth materials as well as understanding the magnetic signatures in extraterrestrial materials.

The instrumentation at IRM enables measurement of the magnetic properties of materials, including AC and DC magnetic moments and Mössbauer spectra, over a wide range of temperatures (4.2 K - 1000 K) and magnetic fields (10^{-5} T - 5 T). In addition, magnetic domain structures may be imaged by various means, including the magneto-optic Kerr effect (MOKE) and magnetic force microscopy (MFM). A recently-built field-free room and newly-acquired magnetometer enable measurement of very weak moments ($\geq \sim 10^{-11}$ Am^2), characteristic of geological and biological materials. This system also allows for the automated measurement of intact sediment core sections.

Research goals have both fundamental and applied aspects. Fundamental rock-magnetic and mineral-magnetic studies are leading to a better understanding of the origin and geological stability of remanent magnetization in fine particles (10 nm - 100 μm) of magnetic oxides, sulfides, and other natural materials or synthetic analogues. Fundamental research is also leading to improved understanding of how measured magnetic properties depend on particle size, shape, stress, and other physical characteristics. This knowledge is simultaneously being applied throughout the geosciences with the development of sensitive magnetic proxies of chemical and grain-size changes caused by tectonic activities, and climatic and environmental change.

Areas of recent research by resident scientists and Visiting Fellows include magnetic phenomena in nanophase and poorly-ordered materials; magnetofossil occurrences and properties; synthesis and magnetic characterization of basaltic Martian-crust analogs; magnetic interactions and exchange in fine-scale hematite-ilmenite intergrowths; magnetic imaging of domain structures in experimentally shocked pyrrhotite, with the goal of understanding planetary magnetic anomalies; and magnetic signatures of climate-driven periodic variations in the physical and chemical characteristics (particle size distribution, mineral composition) of marine sediments and atmospheric mineral dust. Undergraduate seniors from the University of Minnesota and from small colleges and universities in the upper mid-west carry out senior thesis research under guidance from IRM faculty and staff. Each summer, the IRM additionally hosts several undergraduate interns from across the United States. Starting in 2011, the IRM now offers a biennial summer school for rock magnetism for US and international graduate students. Since 1992, eight biennial conferences have been held in Santa Fe, NM, organized by IRM to advance new interdisciplinary research utilizing

rock-magnetic techniques. Similar conferences organized jointly by the IRM and several European institutions were held in Erice, Sicily in 2002, and in Corsica, France in 2008, and have broadened perspectives and promoted international collaborations..

Interested scientists are encouraged to apply to become Visiting Fellows, in one of three categories: (1) Visiting Research Fellowships allow up to ten days use of the full set of *IRM* instruments for in-depth experimental or characterization studies; (2) U.S. Student Fellowships allow up to five days of more closely supervised studies aimed at integrating research and learning; (3). U-Channel Fellowships provide access to the IRM's new u-channel magnetometer system for detailed investigations of natural and/or artificial remanent magnetizations in continuous sediment cores or discrete samples. Applications are accepted twice a year for work to be done during the following half year, and are evaluated by an external Review and Advisory Committee (RAC), comprising experts from paleomagnetism, rock magnetism, solid-state physics and materials science. Proposals are due by October 30 for stays during the following January 1 to June 30 interval, and by April 30 for stays during the following July 1 to December 31. Shorter, less formal visits from other researchers are readily arranged through the laboratory manager. Visiting Fellows receive a substantial exemption from facility usage fees, and other academic researchers are charged at discounted rates.

The *IRM Quarterly* includes abstracts of current articles, news about IRM equipment, reports from Visiting Fellows, updates on meetings, and other relevant information. It reaches people on all continents. Contact the lab to be added to the mailing list. The IRM web site contains information on visiting IRM, and a collection of experimental data from a variety of magnetic minerals.

WWW Home page URL: http://www.irm.umn.edu

UCLA SIMS Laboratory (UCLASIMS)

Scientist in Charge:

T. Mark Harrison and Kevin D. McKeegan (Co-directors)
Department of Earth and Space Sciences
University of California, Los Angeles
2667A Geology Building
Los Angeles, CA 90095-1567
Tel: : (310) 825-7970 (TMH) (310) 825-3580 (KDM)
Lab: (310) 825-4328
FAX: (310) 825-2779
E-mail: tmh@argon.ess.ucla.edu
mckeegan@ess.ucla.edu

Contact Person:

Axel K. Schmitt
Department of Earth and Space Sciences
University of California, Los Angeles
3667B Geology Building
Los Angeles, CA 90095-1567
Tel: (310) 206-5760
Lab: (310) 825-4328
FAX: (310) 825-2779
E-mail: axel@argon.ess.ucla.edu

Facility Description:

The UCLA SIMS laboratory is supported by NSF's *Instrumentation & Facilities Program* to develop and maintain a national facility for *in situ* microscale isotopic analyses of geologic materials and to provide access to its special capabilities to the broader community to address important problems in earth and planetary science.

Since the inception of facility operations (1996), more than 300 scientists have undertaken projects in the UCLA SIMS lab. Facility productivity has averaged 23 papers per year – including 19 papers in Nature and Science – with a citation impact that is at least 250% higher than the average for publications in geochemistry and geophysics. The UCLA SIMS laboratory is an active teaching facility, training graduate and undergraduate students involved in the Earth and Space Sciences. Since 1995, over 72 completed Ph.D. and M.S. theses relied heavily upon data students collected using our facility. The UCLA SIMS student workshop, an annually event since the last 4 years, has attracted nearly 100 undergraduate and graduate students that were trained in geochemical SIMS applications during a week-long course. Two dozen post-doctoral students have also been trained in the laboratory and several of these now run SIMS laboratories at their home institutions.

The UCLA SIMS laboratory features a continuously upgraded CAMECA ims 1270 that uses both the standard Cs^+ (microbeam) and duoplasmatron (mainly O^-) primary ion sources. In addition, the instrument is equipped with a Ga^+ liquid metal source, a unique feature for a large magnet radius SIMS instrument. Lateral ion beam resolution of ~1 µm in diameter can routinely be achieved (~0.5 µm for Ga^+), although most isotopic analyses utilize beam diameters in the 10 to 30 µm range to quickly achieve desired precision. Like the SHRIMP ion probe, the 1270 routinely attains a mass resolving power (MRP) of up to 5,000 without significant loss of secondary ion intensity; this is necessary for isotopic analysis of certain trace elements at high sensitivity (e.g., Pb in zircon). Oxygen flooding of the sample chamber can further enhance yields for certain trace elements, and mitigate crystal-orientation dependent inter-element bias (e.g., for baddeleyite U-Pb geochronology). Dynamic mass range is 300 (H to UO_2). Like the smaller CAMECA instruments, the 1270 also functions as an ion microscope by direct ion imaging of the sample (with ~0.5 µm lateral resolution), which is a key component for achieving good (~nm scale) spatial resolution during depth-profiling (because it enables elimination of crater edge contributions). Isotopic and elemental variations can also be imaged via scanning ion imaging. For the analysis of negative secondary ions from electrically insulating samples (e.g., O isotope measurements in silicates or carbonates), a normal incidence electron flood gun provides charge compensation which is a prerequisite for high-precision oxygen isotope measurements. A five moveable collector ion detection system (equipped with electron multipliers and Faraday cups enabling a dynamic range of $>10^{10}$) is operational for several types of isotopic analyses. In some favorable cases, precision of isotopic ratios achieved in multicollector mode is comparable to that typical of other traditional high-precision mass spectrometric methods although with SIMS the spatial information regarding complex isotopic distributions in a sample is preserved. The multicollector enables precise and rapid isotopic analysis, and is routinely utilized by visitors to the facility, particularly for investigations of C, O, and S isotopes.

The facility offers access to peripheral instrumentation that is useful for pre- or post-analysis sample characterization. This includes a LEO 1430 VP Scanning Electron Microscope (SEM) which is equipped with a 4-quadrant backscattered electron detector (BSD), as well as an EDAX energy dispersive X-ray analysis (EDS) system and an Oxford "mini-CL"

cathodoluminescene detector. The "VP" option indicates that the SEM can operate under variable pressure mode, meaning that BSD, CL, and EDS analysis can be performed on uncoated samples. A contact-free surface mapper (ADE Phase Shift MicroXAM) is available for surface characterization and sputter pit analysis. Users also can access a range of optical microscopic imaging tools for documentation.

UCLA SIMS is currently available to the research community for *in situ* microscale isotopic analyses of geologic materials. Please contact us for additional information if you have questions.

WWW Home page URL: http://sims.ess.ucla.edu

Arizona State University SIMS Laboratories

Scientist in Charge:

Richard L. Hervig
School of Earth and Space Exploration
Arizona State University
550 E. Tyler Mall
Tempe, AZ 85287-1404
Tel: Office (480) 965-8427
6fLab: (480) 727-7282
3fLab: (480) 965-3107
FAX: (480) 965-5081
E-mail: hervig@asu.edu

Contact Persons:

Lynda Williams
School of Earth and Space Exploration
Arizona State University
550 E. Tyler Mall
Tempe, AZ 85287-1404
Tel: Office (480) 965-0829
Lab: (480) 727-7282

FAX: (480) 965-5081
E-mail: lynda.williams@asu.edu

Facility Description:

The Arizona State University secondary ion mass spectrometer (SIMS) laboratories are supported by NSF's *Instrumentation & Facilities Program* to maintain a national facility for the microanalysis of geologic materials. There are multiple emphases at these laboratories: 1) the analysis of light elements and their isotopic ratios (hydrogen to sulfur), 2) training visitors in the use of these instruments, and 3) developing new analytical techniques to match the needs of geochemical researchers.

The instruments available are a Cameca ims 3f and Cameca ims 6f SIMS. The older 3f instrument is well suited to isotopic microanalyses of trace levels of lithium and boron, sulfur isotope ratios in sulfides, relatively low-precision oxygen isotope microanalysis, and selected lithophile trace element analysis. Geochemical problems requiring mass resolving powers ($M/\Delta M$) < ~3000 are suitable to the 3f. The newer 6f SIMS can be used for the same analyses as the 3f, but excels at analysis of volatile elements, including trace hydrogen, carbon, and halogen microanalysis in minerals and glasses. The 6f also maintains high transmission at mass resolving powers up to ~6000. Both instruments can be used for depth profile analyses (e.g., in characterizing diffusion profiles) with depth resolution on the order of 50 nm. Both SIMS allow analyses with Cs+ or oxygen primary ion beams (O_2^+, O^-, O_2^-), and both instruments have a normal incidence electron gun for those approaches requiring charge neutralization (e.g., oxygen isotope analyses of insulating phases). The Cameca SIMS instruments can be used to obtain elemental maps of sample surfaces via direct ion imaging with <1 μm lateral resolution, and in the case of the 6f, can be operated in scanning ion imaging mode.

Please contact us for access to or questions about the ASU SIMS laboratories

WWW Home page URL: http://sims.asu.edu

University of Texas High-Resolution X-Ray Computed Tomography Facility (UTCT)

Scientist in Charge:

Richard A. Ketcham
Department of Geological Sciences
University of Texas at Austin
Austin TX 78712
Tel: (512) 471-6942
FAX: (512) 471-9425
E-mail: ketcham@mail.utexas.edu

Contact Person:

Jessica Maisano, Facility Manager
Department of Geological Sciences
University of Texas at Austin
Austin TX 78712
Tel: (512) 471-0260
FAX: (512) 471-9425
E-mail : maisano@mail.utexas.edu

Facility Description:

The high-resolution X-ray computed tomography (CT) facility at the University of Texas at Austin makes top-quality X-ray tomographic imaging capabilities available to the scientific community. Our principal focus is on research applications in the earth sciences. The facility combines a variety of tomographic scanning systems with a digital image-analysis laboratory to provide data analysis and visualization.

High-resolution X-ray CT is a completely non-destructive technique for visualizing and measuring features in the interior of opaque solid objects, and for obtaining information on their 3-D geometries and properties. It is useful for a wide range of materials, including rock, bone, ceramic, metal, and soft tissue. High-resolution X-ray CT differs from conventional medical CAT-scanning in its ability to resolve details as small as a few micrometers in size, even when imaging objects made of high-density materials. Examples of tomographic imagery are maintained on the facility's website.

Applications include internal inspection of rocks, fossils, artifacts, organisms, organic tissues, and man-made materials; quantitative textural analysis of crystalline rocks; porosity/permeability assessment; description of 3-D fracture patterns in aquifer and reservoir rocks; quantification of fabric strength, anisotropy and orientation in network materials such as trabecular bone and foams; determination of physical heterogeneity and flow properties of sediment columns; and any physical, morphological, or textural analysis that formerly required tedious physical serial sectioning combined with photography or drafting to document or measure features.

The facility hosts a range of tomographic instruments to enable imaging across a wide range of sample sizes and data resolutions. Our ACTIS instrument hosts two subsystems in a single radiation-safe enclosure. The high-energy subsystem utilizes a 450-kV X-ray source and a linear detector array optimized for imaging relatively large (~7-30 cm diameter; up to 1.5m high) and massive (up to 50 kg) objects at resolutions in the 100's of µm. The microfocal subsystem utilizes a 225-kV X-ray source capable of a focal spot size as low as 5 µm, and an image intensifier area detector capable of multi-slice and cone-beam acquisition. It is optimized for imaging smaller objects from ~5-80 mm in diameter and achieves resolutions in the 10's of µm. Our newest instrument, an Xradia MicroXCT scanner, is optimized for imaging small objects (< 5 mm) at ultra-high (0.1-5 µm) resolution.

The facility also features a multi-platform computer lab for visualization and quantitative analysis of tomographic data sets, which visiting researchers are encouraged to use. Available software includes both commercial visualization packages and programs developed in-house for specialized processing and analysis.

The facility is strongly oriented toward serving external investigators. More than two thirds of the imaging done is for outside users. Investigators working on NSF-EAR-funded projects receive priority scheduling and a reduction in user fees to 50% of normal rates. Full information on the facility's capabilities, costs, procedures for access, and answers to FAQs are available on the facility's website.

WWW Home page URL: http://www.ctlab.geo.utexas.edu/

National Center for Airborne Laser Mapping (NCALM)

Contact person:

Bill Dietrich
Department of Earth and Planetary Science
University of California
Berkeley, CA 94720-4767
Tel: (510) 642-2633
Fax: (510) 643-9980
E-mail: bill@eps.berkeley.edu

Contact person:

Ramesh L. Shrestha
University of Houston
NCALM
Dept. of Civil & Environmental Engineering
3605 Cullen Blvd., Room 2011
Houston, TX 77204-5059
Tel: (832) 842-8882
Fax: (713) 743-0186
E-mail: rlshrestha@uh.edu

Facility Description:

The National Center for Airborne Laser Mapping (NCALM) supports and promotes the application of Airborne Laser Swath Mapping (ALSM) technology in the scientific community. The Center is operated jointly by the Department of Civil & Environmental Engineering, College of Engineering, University of Houston (UH) and the Department of Earth and Planetary Science, University of California-Berkeley (UCB). NCALM uses the Gemini LiDAR system based at the UH Geosensing Science and Engineering Research Center.

The ALSM observations are analyzed both at UF and UCB, and made available to the PIs through an archiving and distribution center at UCB - building upon the Berkeley Seismological Laboratory (BSL) Northern California Earthquake Data Center system. Both the UH and UCB groups contribute to software development that increases the processing speed and data accuracy. NSF-supported researchers should contact UH during proposal preparation to obtain guidance on cost estimates, scheduling and related issues. Once funded, PIs and their students participate in all phases of the research.

CENTER OBJECTIVES

Primary goals of NCALM are to:

- Make airborne laser swath mapping (ALSM) widely available at affordable cost to the national research community.
- Advance both the technology and the scientific discoveries made possible as a consequence of ALSM.
- Track and evaluate other geosensing and remote sensing technologies that complement ALSM, and develop methods for multi-sensor data collection and fusion.
- Provide a training ground for students to meet the rapidly growing needs of industry and academia.

NCALM MANAGEMENT AND GOVERNANCE

NCALM is managed, overseen and governed by a nine-member Steering Committee (SC), including one elected Chair, from universities across the United States. The SC meets twice a year, once in Texas and once at Berkeley (the latter in association with the Annual meeting of the American Geophysical Union). The SC provides guidance and review on the following issues:

- Analysis scheduling and prioritizing projects
- Cost effective management of the Center
- Information dissemination
- Opportunities and necessities for technological upgrades
- Liaison and coordination with major NSF programs (PBO, CUAHSI, UNAVCO, etc.) and other Federal agencies (NASA, FEMA, etc.)

INFRASTRUCTURE

The NCALM instrumentation is used to collect data in areas selected through the competitive NSF proposal review process. The major component of the system is a Gemini LiDAR near infra-red sensor (NIR) head combined with a Waveform Digitizer. The Gemini provides up to 4 discrete returns stops for each laser pulse up to as many as 167,000 pulses per second and simultaneously digitized waveforms for as many as 70,000 per second of the returning pulses of laser light. The discrete and waveform data contain complementary information on the density and distribution of vegetation and the "bare earth" terrain below surface vegetation. The new waveform digitizer eliminates the dead time between returns and provides, in the place of 4 discrete returns, an intensity profile of the return signal. These intensity profiles will enable us to better detect and map the forest canopy, brush, and structures hidden by the vegetation. The system is mounted in a small twin-engine (Cessna 337) aircraft and the laser pulses are directed towards the ground by a scanning mirror. The round trip travel time of the laser light allows researchers to compute the precise three dimensional locations of the points on the ground. The result is a set of latitudes, longitudes and heights of many millions of points on the ground. Research-grade ALSM data can be used to produce a highly-accurate, three-dimensional, digital topographical map of a large area of land surface.

NCALM has recently added a green laser sensor, referred to as the Aquarius sensor to their instrumentation. The 70 khz green laser sensor head has a vertical accuracy of 5-10 cm and a point density of 5-10 per square meter. This new sensor will be able to map through shallow water working with the electronics rack of the Gemini system, and will enable NCALM to provide researchers bathymetric data from the bottoms of lakes, streams and coastal waters.

OUTREACH

The NCALM budget includes funding for "seed" projects. The fund is used for small demonstration projects for PIs who need ALSM data sets in different areas of research in the geosciences. The seed funds also provide support for educational and visiting fellowships and/or student programs. The motivation for such seed projects is to have PIs start their preliminary scientific research and subsequently develop larger NSF proposals to make scientific discoveries using observations and data sets from ALSM technology.

WWW Home page URL: http://www.ncalm.ufl.edu/

Amino Acid Geochronology Laboratory (AAGL)

Scientist in Charge:

Darrell Kaufman, Director
School of Earth Sciences & Environmental Sustainability
Northern Arizona University
Flagstaff, AZ 86011-4099
Tel: (928) 523-7192
Fax: (928) 523-9220
E-mail: Darrell.Kaufman@nau.edu

Contact Person:

Katherine Sides, Laboratory Manager
SESES
Northern Arizona University
Flagstaff, AZ 86011-4099
Tel: (928) 523-7834
Fax: (928) 523-9220
E-mail: Katherine.Sides@nau.edu

Facility Description:

The Amino Acid Geochronology Laboratory (AAGL) at Northern Arizona University is dedicated to estimating the ages of Quaternary deposits by analyzing the extent of racemization in amino acids preserved within carbonate fossils. In addition, the AAGL investigates the processes, rates, and temperature sensitivity of amino acid diagenesis in fossils to refine the method for geochronology and paleothermometry.

Amino acid geochronology is applicable to a wide range of fossils types (mollusks, ostracodes, foraminifera, egg shells), stratigraphic problems (correlations, reworking, unconformities), depositional environments (marine, lacustrine, fluvial), and time scales (decades to millions of years). The method is best suited as a relative-dating tool, or as a calibrated-dating method in conjunction with other dating techniques. It is particularly useful for fossiliferous deposits beyond the range of ^{14}C dating (older than about 40,000 years), for which there are few alternative geochronological tools available. The technique is inexpensive, rapid, and can be applied to fossils as small as a single ostracode or foraminifera tests. The technique is based primarily on the extent of amino acid racemization (AAR), the inter-conversion of amino acids from one chiral form (L - *laevo* amino acids, which are the building blocks of proteins) to a mixture of L- and D- (*dextro*) forms. The extent of racemization is measured by the ratio of D/L isomers and increases as a function of time and temperature.

The AAGL maintains two high performance liquid chromatographs (HPLC) for separating and detecting DL amino acids. The ion-exchange HPLC separates isoleucine and alloisoleucine, which measures the extent of epimerization (racemization) in this amino acid. Reverse-phase HPLC separates D and L forms of several amino acids, most reliably: aspartic acid, glutamic acid, serine, alanine, and valine. The reverse-phase procedure is capable of highly reproducible (better than 5% precision for D/L ratios of most amino acids) stereoisomeric separations of amino acids with sub-picomole detection, sufficient for analysis of single microfossils.

As an NSF-supported multi-user facility, the AAGL will analyze samples and interpret data at reduced cost to NSF-funded researchers. The facility's highest priority is to analyze samples collected by scientists seeking to apply AAR for a variety of purposes. The lab is presently offering ~1500 analyses per year at a reduced fee ($20 per sample, about one-third the standard rate) to laboratory users. The AAGL is committed to expanding the use of the technique and increasing the number of experienced users. The facility will train new users in laboratory procedures; funds are available for students, postdoctoral, and other researchers to travel to Flagstaff, AZ to learn to analyze samples and interpret results.

WWW Home page URL: http://jan.ucc.nau.edu/~dsk5/AAGL

Drilling, Observation and Sampling of the Earth's Continental Crust, Inc. (DOSECC)

Scientist in Charge:

Dennis L. Nielson, President
DOSECC, Inc.
675 S. Arapeen Dr., Suite 201
Salt Lake City, UT 84108
Tel: (801) 585-6855
FAX: (801) 585-9386
E-mail: dnielson@dosecc.org

Contact Person:

David M. Zur, Education and Outreach Manager
DOSEC, Inc.
675 S. Arapeen Dr., Suite 201
Salt Lake City, UT 84108
Tel : (801) 585-2150
Fax : (801) 585-9386
E-mail : dzur@dosecc.org

Facility Description:

DOSECC is a not-for-profit corporation whose mission is to provide leadership and technical support in subsurface sampling and monitoring to address topics of scientific and societal importance. DOSECC was formed in 1984 and currently has 53 member organizations, principally universities. Our goals are as follows:

- Facilitate and support cost-effective scientific drilling projects
- Link science and drilling technology
- Design, build and operate drilling systems
- Promote technology transfer and education
- Represent U.S. interests in the international scientific drilling community

The requirements of scientific drilling are often different than those of the commercial sector. Scientific projects focus on sample quality, collection of fluids and gasses and installation of instrumentation. This emphasis often requires specialized drilling equipment.

EQUIPMENT

DOSECC operates the following major pieces of equipment for the scientific community:

1. The ***Deep Lake Drilling System (DLDS)*** was designed and built specifically for sampling sediments from the world's deep lakes. Designed to drill 1400 meters (4593 feet), the DLDS enables scientists worldwide to delve deeper into past climate changes and biological evolution. The DLDS platform made its maiden voyage on Lake Van, Turkey in July 2010.

2. The ***GLAD800*** (Global Lake Drilling to 800 m) is an integrated system that was developed to collect long cores in modern lakes. The system has a barge made up of standard shipping containers that is anchored to maintain position whole drilling. The system utilizes drilling tools that we have also developed to accommodate different drilling conditions. The GLAD800 was developed using funding from the International Continental Scientific Drilling Program (ICDP). It has been used to collect core from seven lakes around the world.

3. The ***GLAD200*** (Global Lake Drilling to 200 m) system is a smaller version of the GLAD800 and can collect continuous core to a depth of 200 m. It has been used to collect core from four lakes.

4. DOSECC's suite of ***soft sediment sampling tools*** enables collection of long cores of unconsolidated lake and marine sediments.

5. The ***DOSECC Hybrid Coring System*** **(DHCS)** is a coring rig that is capable of collecting continuous core to a depth of approximately 6,000 m. The rig attaches to a rotary drilling rig that is used for setting casing, tripping pipe and other applications that require heavy lifting capabilities.

6. The ***AHC800*** (Active Heave Compensated to 800 m) is a rig that DOSECC has built for the Office of Naval Research. It can operate from a variety of research vessels and has been tested on two cruises on the *R/V Knorr*. The

rig senses and then compensates for the heave of a vessel and was designed to collect core along the continental shelves.

7. A portable ***Dynamic Positioning*** **(DP)** system is available to attach to vessels of opportunity that are being used to drill in deep lakes or shallow marine settings. The DP system was funded by the NSF and ICDP.

8. A small man-portable ***Winkie drill*** is available for use on projects where shallow cores are needed.

9. A ***fleet of 5 drilling rigs*** are also available for scientific drilling projects.

SCIENTIFIC DRILLING PLANNING AND BUDGETING

DOSECC will plan and develop budgets for scientific drilling projects. Drilling projects may require review of the drilling plans as well as environmental and personnel protection issues before the project can be submitted to NSF, so sufficient time must be allowed for the review process prior to the submittal deadline. We recommend that DOSECC be contacted at least six months prior to proposal submission.

DOSECC will prepare drilling budgets that will then be submitted to the NSF as a Supplementary Document attached to the Principal Investigator's proposal. The cost of drilling should not be included in the proposing institution's budget. If approved for funding by NSF, the drilling costs of the project will be supported directly through DOSECC.

EDUCATION AND OUTREACH

DOSECC sponsors Grants in Scientific Drilling to promote research on samples and data from scientific drilling projects. These grants are offered on an annual basis and are open to graduate and undergraduate students as well as primary and secondary school teachers.

DOSECC holds an annual Workshop on Scientific Drilling that provides a forum for the discussion of drilling and associated scientific studies. DOSECC also sponsors workshops that define and organize drilling projects, promote new research directions or technological innovations, and support scientific drilling infrastructure.

GOVERNANCE

An eleven-member Board of Directors is elected from the member representatives and provides policy guidance for the corporation. Elections are held at the annual meeting of the corporation.

MEMBERSHIP

Educational institutions with a major program in Earth Sciences, state geological surveys and water resources departments, national laboratories, government agencies, professional geosciences-related societies, continental scientific drilling organizations of other nations, and not-for-profit corporations or for-profit corporations with an interest in continental scientific drilling may be elected as Members with the consent of three-quarters of the entire Board of Directors.

WWW Home page URL: http://www.dosecc.org

Arizona LaserChron Center (ALCC)

Scientist in Charge:

George Gehrels, Director
Department of Geosciences
University of Arizona
Tucson, Arizona 85721
Tel: (520) 349-4702
FAX: (520) 621-2672
E-mail: ggehrels@email.arizona.edu

Contact Person:

Mark Pecha
Department of Geosciences
University of Arizona
Tucson, AZ 85721
Tel : (520) 419-8934
FAX : (520) 621-2672
E-mail: mpecha@email.arizona.edu

Facility Description:

The Arizona LaserChron Center is an NSF-supported multi-user facility that generates U-Th-Pb geochronologic information by Laser Ablation-ICP Mass Spectrometry (LA-ICPMS). Our primary goals are as follows:

- Maintain a facility that generates U-Th-Pb ages and Hf isotope ratios of the best precision and accuracy available from a Laser-Ablation Multicollector ICP Mass Spectrometer.
- Provide opportunities for NSF-supported researchers to use our instruments and expertise to address geologic problems.
- Push the development of new applications of laser ablation ICP mass spectrometry.
- Provide opportunities for researchers and students to learn the theory and analytical techniques of U-Th-Pb geochronology while acquiring geochronologic information.

The Arizona LaserChron Center utilizes a multicollector ICP mass spectrometer (from Nu Instruments) coupled with a 193 nm Excimer laser (from Photon Machines). This instrument is capable of generating U-Th-Pb ages rapidly (~40 per hour), with a precision of 1-2% (2-sigma), utilizing a beam size of 6 to 60 microns. This rapid throughput is optimal for applications that require large data sets (e.g., detrital zircon provenance studies), and allows for a cost of only $4 per age determination for NSF-supported users. During a typical 24 hour analytical session it is possible to generate ~700 ages, which would be sufficient for analysis of ~15 igneous rock samples or 7 detrital zircon samples.

The spatial resolution enabled by laser ablation also provides a powerful tool for unraveling complex growth/disturbance histories commonly encountered in igneous and metamorphic terranes. Such studies are facilitated by the use of back-scatter and cathode luminescence images acquired with a dedicated Hitachi 3400N SEM (equipped with Gatan Chroma CL and Oxford EDS/EBSD detectors). We are able to routinely conduct U-Th-Pb age determinations on zircon, titanite, apatite, and monazite. Efforts to develop analytical methods for analysis of rutile and baddeleyite are ongoing.

The center presently generates ~50,000 U-Th-Pb ages in support of ~100 separate projects per year. Most of these projects are conducted in close collaboration with LaserChron staff members, who are commonly involved in all aspects of the research (including project design, sample collection, data acquisition, and data interpretation). We find that this helps ensure that the data are acquired and interpreted correctly. Likewise, we encourage researchers to visit the facility and conduct their own analyses so that they fully understand the strengths and limitations of the geochronologic information. This also takes advantage of the spatial resolution and instantaneous age determination of the LA-ICPMS, which allows an operator to adjust the analytical strategies real-time depending on project goals and complexities encountered.

We particularly encourage students and researchers with limited geochronologic experience to use the facility, as spatial resolution coupled with real-time age calculation provides a powerful tool for learning the theory and techniques of U-Th-Pb geochronology. To facilitate student involvement, funds are available to subsidize student visits to the LaserChron center.

WWW Home page URL: http://www.geo.arizona.edu/alc/

The University of Wisconsin SIMS Lab (Wisc-SIMS)

Scientist in Charge:

John W. Valley, Professor
Department of Geology & Geophysics
University of Wisconsin
Madison, Wisconsin 53106
Tel: (608) 263-5659
Lab: (608) 265-9528
FAX: (608) 262-0693
E-mail: valley@geology.wisc.edu

Contact Person:

Noriko Kita, Lab Director
Department of Geology & Geophysics
University of Wisconsin
Madison, Wisconsin 53106
Tel: (608) 262-7118
Lab: (608) 265-9528
FAX: (608) 262-0693
E-mail: noriko@geology.wisc.edu

Facility Description:

The University of Wisconsin SIMS lab (WiscSIMS) was installed in 2005 and became a National Facility for Stable Isotope Geochemistry in 2008 with support from NSF. The primary goal of WiscSIMS is to provide experienced and inexperienced SIMS users with the highest possible analytical precision and accuracy for in situ analysis of stable isotope ratios at the scale of 1 to 10 micrometers. These unique ion microprobe capabilities permit analyses in thin section or polished mount to be correlated with textures and information from optics, imaging, or other forms of instrumental analysis. In combination, such data can potentially provide fundamental new levels of understanding for samples of Geological, Planetary, or Biological interest. The advantages are especially great for samples that are zoned, precious, or very small, which cannot be analyzed by other means. Since 2006, over 130 scientists from 60 universities and institutes have worked with WiscSIMS.

The WiscSIMS lab houses the first CAMECA ims 1280. The ims 1280 is a large radius multi-collector ion microprobe incorporating many improvements over earlier instruments, several of which are designed to enhance precision of isotope ratio analysis, including: better focusing of the primary and secondary beam, continuous monitoring of primary beam current during analysis, better control of external magnetic fields in the sample chamber and mass spectrometer, NMR control of analyzer magnet, six sample airlock for changing samples, oil-free rough pumping for cleaner vacuum, all digital electronics, and PC computer control. The detector assembly includes a total of 10 electron multiplier and Faraday Cup detectors with five moveable trolleys for simultaneous analysis of a wide range of isotope systems. Both alkali metal (Cs^+) and duoplasmatron (O^-, O^+) sources are available. Spot sizes as small as 250 nm are possible (with Cs), but more generally, a spot of 3 to 10 μm diameter by 1 μm deep is used to increase sample size (~1ng/analysis) and optimize precision. Precision for $\delta^{18}O$ and $\delta^{17}O$ in well-polished silicates is typically better than ±0.3‰ (2 SD, spot-to-spot) with 10_m diameter beam (Kita et al. 2009 Chem. Geol. 264:43-57; Valley and Kita 2009 MAC Short Course 41:19-63).

As of September 2011, the lab has experience with analysis of Li, C, O, Mg, Si, S, and Fe isotope ratios. Best results come from well-prepared samples that are vacuum stable; have a smooth, flat, low-relief surface; and are 25.4 mm in diameter and <5 mm thick (max. 12 mm). Surface relief is minimized by careful polishing and is measured at nm-scale by white light profilometer. Other materials are possible. Accurate analysis requires well characterized, homogeneous standards with similar chemistry and crystal structure to samples. For oxygen isotope ratios, WiscSIMS has many silicate, carbonate, and oxide standards. Other standards exist or are being developed. Potential users should enquire about standard availability.

Use of associated instrumentation at nominal cost can be arranged in support of projects at WiscSIMS including: an Hitachi S3400N Variable Pressure Scanning Electron Microscope with capability for imaging uncoated samples, HKL Electron Back Scatter Diffraction (EBSD), Gatan color-filtered CL, Thermo EDS, and BSE detectors; a CAMECA SX-51 electron microprobe with 5 crystal spectrometers, EDS, CL, and BSE; and a ZYGO NewView 6300 white light optical profilometer.

For more information about the capabilities of WiscSIMS and applying to use the facility, please consult our web site (below) and contact John Valley or Noriko Kita (above).

WWW Home page URL: http://www.geology.wisc.edu/~wiscsims/

Center for Transformative Environmental Sensing Programs (CTEMPs)

Scientist in Charge/Contact person:

Scott W. Tyler
Dept. of Geologic Science and Engineering
Laxalt Mineral Resources
University of Nevada, Reno
Reno, Nevada
Tel: (775) 784-6250
E-mail: styler@unr.edu

Scientist in Charge/Contact person:

John S. Selker
Dept. of Biological and Ecological Engineering
210 Gilmore Hall
Oregon State University
Corvallis, Oregon 97331
Tel : (541) 737-6304
E-mail: selkerj@engr.orst.edu

Facility Description:

The Centers for Transformative Environmental Monitoring Programs (CTEMPs), jointly operated by Oregon State University and the University of Nevada, Reno are a multi-user facility providing field-deployable high-precision fiber-optic temperature measurement systems and wireless self-organizing multi-parameter sensor stations. Fiber-optic temperature sensing relies on Raman backscatter to infer temperatures along optical fibers deployed in a wide variety of environmental settings. Typical applications of distributed temperature sensing (DTS) include borehole monitoring, stream environment monitoring, ocean and lake circulation, and soil heat flux. Unlike traditional sensors, DTS systems provide continuous temperature measurements at spatial resolutions as small as 0.25m, yet extending for kilometers. Measurements can be made at frequencies as high as 1 Hz, thus providing the user with a very high spatial and temporal density of temperature measurements. CTEMPs provides short and intermediate term access to five field-deployable fiber optic Distributed Temperature Sensing (DTS) systems which can be shipped directly to project sites. Use fees are very low, and experiment design, installation, and data analysis is supported by a staff of scientists. Instruments are available now, obtained rapidly through an online request form. All non-commercial projects for discovery and education are welcome.

CTEMPs is operating as an instrumentation node of the Hydrologic Measurement Facility of the Consortium of Universities for the Advancement of Hydrologic Sciences, Inc. (CUAHSI) and in the first two years of operation (2009-2011) supported over 25 research projects. These projects covered a wide range of topics, including river restoration, aquifer storage and recovery, snow hydrology, geomechanics, oceanography and ecological research. Systems have been deployed across the US, as well as deployments in the Arctic, Costa Rican rainforest, Antarctica and Europe. DTS systems are available to the Earth science community and they can be configured for a wide variety of environmental measurements, data storage/data transmission protocols, and operating conditions. CTEMPs also provides as part of the field-deployable systems, wireless autonomous meteorological stations to augment the thermal data collection, as well as advice, guidance, and logistical services to the user community. CTEMPs users have access to instrumentation as well as technical support for experiment design, field deployment, and data interpretation.

CTEMPs also provides a program of no-cost instrument leasing to young investigators and students through its Pilot Program. The Pilot Program provides instruments and services at no cost to innovative projects proposed by these investigators. The CTEMPs Pilot Program call for proposals is quarterly and in its first two calls, supported 4 new projects. Each proposal is first reviewed by the CTEMPs PI's to insure only that the proposed effort is consistent with the instrumentation capabilities of the Centers. The proposals are then reviewed by the independent CTEMPs Advisory Board for final approval or recommendation for revision.

CTEMPs in-house instrumentation includes DTS systems capable of operating in a wide range of settings to address diverse experimental needs. CTEMPs DTS instrumentation includes units which may operate in harsh environments (-40 to 60 ^{o}C), and the sensing cable may span temperatures from -100 C to temperatures exceeding 200 ^{o}C. Instruments are typically run on solar power systems, provided by CTEMPs, or can be run on generators or line power, as needed. The instruments have a range of capabilities, with spatial resolutions from 0.25 m to 2.0 m, and temporal resolution from as low as 1 s to 15 s, and precision from 0.01 to 1 ^{o}C. CTEMPs instruments are focused on measurements over the <5 km range, though instruments capable of reading cables up to 10 km are available as well. For field installation, the Centers maintains a stock of over 30 km of field deployable optical fiber designed for a variety of environments, including deep borehole (high pressure), expanded spatial resolution, high temperature environments and high traffic sites. Both at Nevada and Oregon, a full set of optical fiber testing, fabrication and repair tools are maintained and available either as a service to the user, or for loan during field deployment.

CTEMPs also provides programs focused on developing and advancing the field of distributed environmental sensing for the research community. CTEMPs, working with industry partners, has developed extended resolution (spatial and temporal) DTS systems available to address the most demanding applications of this technology. Additionally, CTEMPs is testing a suite of other sensing systems, including fiber optic distributed strain and acoustic sensing, and a spectrum of low-cost and high precision point-sensors suitable for traditional and wireless networked sensing systems.

CTEMPs conducts a range of hands-on training courses. Primarily, CTEMPs puts on regularly-scheduled one-day intensive trainings on DTS methods including an annual short course preceding the Fall AGU meeting. These have very low registration fees, and include both theory and hands-on use of DTS. These short-courses are designed to help potential users assess the suitability of the DTS tool for their projects. For investigators who have decided to move forward with the application of DTS in their research, CTEMPs conducts multi-day, in-depth trainings, which cover all aspects of DTS theory, experimental design, installation and operation, calibration, and data analysis.

Complete information on how to request use of CTEMPs instrumentation, submitting proposals for projects under CTEMPs and access to training and training materials can be found on the CTEMPs website (www.ctemps.org). CTEMPs training videos on the set-up and operation of DTS systems can be found on YouTube at: http://www.youtube.com/user/ctempsdts

WWW Home page URL: http://www.CTEMPs.org

International Seismological Centre (ISC)

Scientist in Charge:

Dmitry A. Storchak
International Seismological Centre
Pipers Lane
Thatcham
Berkshire
RG19 4NS
United Kingdom
Tel: +44 (0)1635 861022
Fax: +44 (0)1635 872351
E-mail: dmitry@isc.ac.uk

Contact Person:

Maureen Aspinwall
International Seismological Centre
Pipers Lane
Thatcham
Berkshire
RG19 4NS
United Kingdom
Tel: +44 (0)1635 861022
Fax: +44 (0)1635 872351
E-mail: admin@isc.ac.uk

Facility Description:

The ISC is an international non-governmental non-profit organization that was set up in 1964 with the help of the UNESCO and IASPEI to compile and distribute the ISC Bulletin – the most definitive and complete summary of world seismicity. In addition to the NSF, the ISC is funded by 56 research and operational institutions and agencies around the world, with major contributions coming from the US, UK, Japan, Russia, China, India, Canada, Germany, France and Italy. The ISC operates from its own building in the UK and collects seismic bulletin data electronically from 126 seismic networks, data centers and observatories worldwide.

Soon after earthquakes or other seismic events occur, preliminary seismic bulletins from networks are received electronically in a large variety of formats and parsed into the ISC database. Data for the same natural events are merged and made freely available from the ISC website as part of the *automatic preliminary* ISC Bulletin. One after the other, preliminary reports from networks are deleted from the ISC database in favor of the revised reports. Once all revised bulletins from networks are available (approximately two years after event occurrence), the ISC runs its own procedure of re-computing parameters of seismic events based on the wealth of all seismic recordings made worldwide and its own location algorithm that uses standard velocity model. The *final* ISC Bulletin is thoroughly reviewed and revised by a team of professional seismologists and made freely available via web and ftp-sites.

OBJECTIVES

- Collection, automatic merging and association of reported bulletin data from networks and data centres around the world, including NEIC, EMSC, USArray, JMA etc;
- Manual Review of hypocentres, phase readings, and related data for events simultaneously reported by several networks approximately of magnitude 3.5 and above;
- Distribution of the ISC Bulletin, both reviewed and un-reviewed, by means of the web-search, ftp, CD-ROMs and the printed ISC Bulletin Summary.
- Maintenance and development of the International Seismograph Station Registry jointly with WDC for Seismology, Denver (USGS) and in coordination with FDSN;
- Maintenance of the IASPEI Collection of Reference Events (GT0-5);
- Update and distribution of the EHB bulletin data collection

MANAGEMENT AND GOVERNANCE

The ISC is governed by the ISC Governing Council (GC) that comprises representatives of all 57 funding agencies, including NSF. The Governing Council meets every two years and makes fundamental decisions on scientific, operational and financial issues. In addition, the GC elects an Executive Committee (EC) that meets once a year, hears the ISC Director's report and

plans and makes recommendations on further development, operation and funding of the ISC between the meetings of the GC. In addition to elected members, the EC includes representatives of both IASPEI and the host institution – Oxford University.

INFRASTRUCTURE

The ISC operates from its own building that it maintains from its own resources. In order to fulfill its mission, the ISC runs a network of web, file and database servers connected with workstations used by 17 members of staff. Internet connection is used to receive original data from networks and also to distribute ISC data to users. Internet connection is maintained via a dedicated high-speed internet link in addition to a number of broad-band channels. The ISC database is also mirrored at two separate servers maintained remotely at both IRIS DMC and ERI/University of Tokyo. Another mirror is maintained for the use by the CTBTO Preparatory Commission and the National Data Centers. All three mirrored database servers are used to operate additional remote ISC web and ftp sites in US, Japan and Austria to provide uninterrupted access to the ISC data.

BROADER IMPACT and OUTREACH

The broader impact of the ISC operations is through basic and applied research based on the Bulletin, ultimately including mitigation of earthquake disasters through planning reliant on realistic seismic hazard analysis and monitoring of the Comprehensive Test Ban Treaty. The ISC Bulletin is the principal data source for some 100 research papers each year, and many more papers depend on the ISC data to select events or stations to be studied, or to establish the seismotectonic setting. The types of studies for which the ISC data are virtually indispensable include seismotectonics, seismic tomography, seismic hazard analysis, earthquake physics, earthquake prediction, and explosion monitoring.

Members of the ISC staff maintain high visibility in professional scientific organizations and often take part or lead in setting up international standards of scientific data measurement and exchange.

The ISC serves as a unique valuable tool for education in geophysics, routinely provides training to young seismologists from developing countries and broadens opportunities by enabling participation to all citizen, men and women, of many different nationalities. The ISC often answers queries from the media and members of the public following destructive earthquakes or tsunamis.

WWW Home page URL: http://www.isc.ac.uk/ or http://colossus.iris.washington.edu/

LacCore: National Lacustrine Core Facility

Scientist in Charge:

Emi Ito
Department of Earth Sciences
University of Minnesota
Minneapolis, MN 55455
Tel: (612) 624-7881
Fax: (612) 625-3819
E-mail: eito@umn.edu

Contact Person:

Amy Myrbo, Anders Noren, Kristina Brady
University of Minnesota
500 Pillsbury Dr SE
Minneapolis, MN 55455
Tel: (612) 626-7889
Fax: (612) 626-7750
E-mail: laccore@umn.edu

Facility Description:

LacCore, the National Lacustrine Core Facility, centered on the Minneapolis campus of the University of Minnesota, supports the paleolimnological and broader terrestrial paleorecord community for studies that contribute to our understanding of past climates, ecological systems, and biogeochemical dynamics on the continents through detailed sedimentological analysis and archival services for lacustrine cores and samples from other terrestrial water bodies. LacCore operates as an open facility to allow community access to specialized field equipment, and laboratory instrumentation and staff expertise for initial core description (ICD) methods including: core splitting; non-destructive multi-sensor core logging; digital linescan core photography; X-ray computed tomography (CT scans); preparation and/or analysis of subsamples for palynology; imaging and elemental characterization through scanning electron microscopy and energy-dispersive X-ray spectroscopy (SEM/EDS); grain size; carbon coulometry; sulfur coulometry; phase identification via X-ray diffraction (XRD); biogenic silica; charcoal; thin sectioning; stable isotopic analysis; and optical petrography/smear slide analysis. The Large Lakes Observatory at the University of Minnesota-Duluth campus is a node of LacCore and provides X-ray fluorescence (XRF) core scanning and digital X-radiographic imaging services for rapid down-core elemental analysis. LacCore provides ambient, refrigerated, and frozen core storage and permanent curation services, and as the National Lacustrine Core Repository curates the world's largest and most diverse collection of lacustrine cores. Samples from the collection are carefully appropriated for the ongoing efforts of researchers, museums, and other educational institutions. LacCore maintains and continually develops a broad array of specialized field equipment available for rental or purchase, for accessing lacustrine environments and collecting highest-quality cores of maximum length; and serves as the scientific, logistical, and curatorial interface in lacustrine and other continental scientific drilling operations. LacCore staff members are responsible for capture, curation, and dissemination of lake core metadata and the routine transmission of all data to the NOAA National Geophysical Data Center. LacCore collaborates with programmers developing cutting-edge software for core description, data visualization, data discovery, and remote collaboration. LacCore is a training ground for several hundred researchers annually, particularly graduate and undergraduate students, in coring and core analysis techniques. LacCore funding was renewed for five years in June 2010.

LACCORE MISSION

LacCore is mandated to help researchers collect the best possible sediment core samples and data, and to preserve cores and data for use by future generations of geoscientists. The Facility provides five types of services to external users in support of these goals:

1. Direct or assist field operations and logistics and/or provide rental field equipment;
2. Provide instrumentation, expertise, and training to visitors conducting initial core description;
3. Curate cores and other samples; manage and disseminate data and metadata; provide samples of cores stored at LacCore; connect researchers seeking samples with PIs who store cores at other institutions;
4. Perform subsample analyses; prepare and submit samples to other labs on behalf of researchers;
5. Sell standard equipment and supplies.

LACCORE GOVERNANCE

LacCore is governed by a six-member External Advisory Group (EAG), including one Chair and one *ex officio* member, from US institutions. The EAG provides guidance remotely as needed, and meets occasionally to discuss and guide major transitions in facility operations. The EAG provides guidance on the following issues:

1. Facility policies, especially those applicable to data and sample access
2. Identification and prioritization of upgrades in facility infrastructure
3. Evaluation of requests for curated sediment samples as needed
4. Selection of LacCore Visiting Graduate Student Fellows
5. Liaison and coordination with NSF

INFRASTRUCTURE

LacCore infrastructure consists of field, laboratory, curatorial, and information technology resources. Physical space includes ~2700 square feet of laboratory space, 3800 square feet of sample repository space, and 4500 square feet of storage for equipment and supplies.

The extensive public pool of coring devices for rental or purchase provides suitable equipment at low cost for nearly all coring environments and protocols. Site survey equipment includes a ground-penetrating radar (GPR) system for sub-bottom profiling of lake sediments or dry land. Vehicles include a 4WD truck, and several watercraft: two 19-foot Carolina Skiff boats (for 5m x 5m Kullenberg piston coring platform with 6.5m tower and moonpool), pontoon boat with moonpool (2.5m x 5m), two 18-foot row/motorboats, cataraft with moonpool (2.5m x 4m), two canoes, two kayaks. Shipping large equipment, and field storage and climate-controlled transport of sediment cores is accomplished through a set of intermodal shipping containers, including a 20-foot, climate-controlled container with electrical generator, and 20-foot and 40-foot standard ("dry") containers.

Major laboratory instrumentation includes a Geotek MSCL-S standard multi-sensor core logger, for whole or split core logging for magnetic susceptibility (both loop and high-resolution point sensors), gamma density, acoustic velocity, non-contact electrical resistivity, and natural gamma radiation; a Geotek MSCL-XYZ multisensor core logger, for sequential logging of up to nine split core sections for high-resolution magnetic susceptibility and color spectrophotometry; a Geotek MSCL-CIS digital linescan camera, for core scans of up to 40 pixels/mm resolution; a DMT CoreScan Colour digital linescan camera; a Hitachi TM-1000 benchtop SEM with TM-SDD EDS attachment for rapid imaging and elemental analysis; a Horiba LA-920 laser diffraction particle size analyzer; an ITRAX XRF core scanner for elemental scans and X-radiographic imaging, housed at the Large Lakes Observatory, University of Minnesota-Duluth; UIC CM150 carbon coulometer (TIC/TOC/TC) and CM320 sulfur coulometer (TS); two Leica DM2500P petrographic microscopes with DFC 420 5.0 megapixel camera for smear slide analyses; several reflected/refracted binocular microscopes for picking; specialized microscopes for pollen and diatom analyses. Associated labs in the Department of Earth Sciences host the NSI X5000 industrial X-ray computed tomography scanner, Rigaku MiniFlex X-ray diffractometer, and 2G DC-SQUID U-channel magnetometer.

LacCore maintains 35 PCs, including high-end graphics processing workstations and multipanel core visualization workstations. Data are stored on a high-capacity server with RAID5 disk failure redundancy and automated nightly backup to an identical offsite server.

OUTREACH

LacCore staff are continually engaged in education and outreach at a range of educational levels, including routine facility tours, class field and lab projects, Research Experiences for Undergraduates (REU) projects, and a large-scale ongoing collaborative project with NSF-OEDG funding aimed at study of the paleoenvironments of wild rice lakes in northern Minnesota with tribal college students and teachers from the Fond du Lac Band of Lake Superior Chippewa and Fond du Lac Tribal and Community College.

WWW Home page URL: http://www.laccore.org/

OpenTopography

Scientists in Charge:

Chaitanya Baru
San Diego Supercomputer Center
University of California
La Jolla, CA 92093-0505
Tel: (858) 534-5035
Fax: (858) 534-5077
E-mail: cbaru@ucsd.edu

Ramon Arrowsmith
School of Earth and Space Exploration
Arizona State University
E-mail : ramon.arrowsmith@asu.edu

Contact Person:

Christopher Crosby
San Diego Supercomputer Center
University of California
La Jolla, CA 92093-0505
Tel: (858) 822-5458
Fax: (858) 534-5077
E-mail: ccrosby@sdsc.edu

Facility Description:

OpenTopography facilitates on-line, community access to high resolution (meter to sub-meter scale), Earth science-oriented, topography data, and related tools and resources. The facility collaborates with a wide range of partners to centralize access to data through metadata registration and hosting of lidar point cloud data and derived products (including various digital elevation models and Google Earth-oriented browse images). In addition to data hosting, OpenTopography provides high-performance processing services co-located with data to streamline user access to these scientific data. OpenTopography harnesses advanced cyberinfrastructure to provide Web service-based discovery, access, processing, and analysis capabilities that are scalable, extensible, and innovative. OpenTopography serves as a community hub for information exchange and education about high resolution topography.

The OpenTopography Facility is based at the San Diego Supercomputer Center at the University of California, San Diego, with Education and Outreach activities coordinated by Prof. Ramon Arrowsmith, School of Earth and Space Exploration, Arizona State University. Web-based lidar data access ad processing were initially prototyped as the *GEON LiDAR Workflow (GLW),* as a proof of concept for use of cyberinfrastructure in the Earth sciences, as part of the NSF Information and Technology Research (ITR) program-funded Geoscience Network (GEON) project. Based on the success of the GLW prototype, the OpenTopography facility was proposed and the facility is currently in its first round of funding.

CENTER OBJECTIVES

The mission of the OpenTopography Facility is to democratize access to high-resolution (meter to sub-meter scale), Earth science-oriented, topography data acquired with lidar and other technologies by providing co-located data hosting and associated on demand processing services. The facility objectives are to:

- Harness cutting-edge cyberinfrastructure to provide innovative, scalable, online and on-demand Web services-based data access, processing, and analysis capabilities.
- Promote discovery of data and software tools through community populated metadata catalogs.
- Partner with public domain data holders to leverage OpenTopography infrastructure for data discovery, hosting and processing.
- Provide professional training and expert guidance in data management, processing, and analysis.
- Foster interaction and knowledge exchange in the Earth science LiDAR user community.

OPENTOPOGRAPHY MANAGEMENT AND GOVERNANCE

The activites of OpenTopography are overseen by a six-member Advisory Committee (AC), including one elected Chair, from universities and geoscience organizations across the United States. The AC meets once a year, alternating at ASU and SDSC. The AC provides guidance and review on the following issues:

1. Liaison and coordination with major NSF and other data acquisition groups and data providers, including individual PIs.
2. Types of downstream processing to be supported
3. Information dissemination regarding activities of the facility as well as for new collaborations
4. Feedback on the online capabilities of the portal / website.

INFRASTRUCTURE

OpenTopography hosts advanced cyberinfrastructure capabilities for storage, processing, and access to point cloud LiDAR data and variety of derived products. The facility currently has access to over 50TB of storage and a large compute server for storage and processing of data. Other servers host the OpenTopography portal and website and provide post-processing services. In addition, pre-computed data products, such as pre-computed, tiled DEMs, are stored in the SDSC Cloud, which has a usable storage capacity of 1PB (5.5PB of raw disk). OpenTopography also has access to NSF's latest supercomputer, Gordon, which is designed to support data-intensive applications, for large-scale processing of data. The net impact of this cyberinfrastructure is that users of the facility are not restricted in their data access and processing activities due to lack of storage and computational resources.

OUTREACH

The OpenTopography budget includes funding for education and training activities. This fund is used to offer training workshops at various venues, e.g. GSA, AGU, and UNAVCO and SCEC meetings and stand alone events. The goal of these sessions is to educate attendees on the use of high-resolution topographic data and tools, and to introduce them to the resources and services available at OpenTopography. The meetings also serve as a venue for obtaining feedback from the OpenTopography user community. Education and outreach efforts have also resulted in the production of videos to introduce users to the facility, which is available at the site and via YouTube. OpenTopography also actively interacts with our user community via Facebook and Twitter.

WWW Home page URL: http://www.opentopography.org

Global Centroid-Moment-Tensor Project

Scientists in Charge/Contact persons:

Göran Ekström and Meredith Nettles
Lamont-Doherty Earth Observatory of Columbia University
61 Route 9W
Palisades, NY 10964
Tel: (845)365-8427, (845)365-8613
E-mail: ekstrom@ldeo.columbia.edu, nettles@ldeo.columbia.edu

Facility Description :

The goal of the Global Centroid-Moment-Tensor Project (GCMT Project) is to analyze and quantify all large earthquakes occurring worldwide using seismic data, and to provide the most comprehensive record of global seismic strain release available. The GCMT Project is overseen by Principal Investigator Göran Ekström and Co-Principal Investigator Meredith Nettles at the Lamont-Doherty Earth Observatory (LDEO) of Columbia University. The project was founded by Adam Dziewonski at Harvard University and operated there as the Harvard CMT Project from 1982-2006, led first by Prof. Dziewonski and later by Prof. Ekström. During the summer of 2006, the main activities of the project moved with Prof. Ekström to LDEO. The GCMT Project has been funded by NSF since its inception. Since 2008, funding for the GCMT Project has come from the EAR I&F Program, and the project is now operated as a national, multi-user facility.

FACILITY OBJECTIVES

The major objectives and activities of the GCMT Project are

1. Systematic determination of moment tensors for earthquakes with magnitude M>5 globally, and archiving of the results in the GCMT catalog.
2. Rapid determination of moment tensors for earthquakes with M>5.5 globally, and quick dissemination of the results ('quick CMTs').
3. Curation and distribution of the CMT catalog, which contains moment-tensor results for the period 1976 to the present, currently more than 35,000 earthquakes.
4. Routine detection and location of seismic sources using surface waves.
5. Investigation and reporting of the quality of seismic waveforms from the Global Seismographic Network and other seismic networks.
6. Systematic analysis of earthquake sequences of special importance.

DISSEMINATION OF RESULTS

We maintain the internet domain and web site www.globalcmt.org for the purpose of dissemination of results from the GCMT Project. The web site provides an easy-to-use interactive search tool for the GCMT catalog, as well as ftp download of the catalog in a well-defined format. Rapid results – quick CMTs – from the GCMT Project are disseminated via e-mail to several hundred recipients worldwide, and are redistributed by the United States Geological Survey, the European-Mediterranean Seismological Center, IRIS, and others.

WWW Home page URL: www.globalcmt.org