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 fifteen (15) 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

Table of Contents

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 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 more than one hundred U.S. institutions with more than 40 foreign affiliates. IRIS supports the research needs of Earth scientists in the U.S. and around the world. IRIS consists of core programs (PASSCAL, Global Seismographic Network, Data Management System, and Education and Outreach) and is responsible for the USArray component of the EarthScope project.

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 800 multi-channel and 550 single-channel recorders, associated sensors and support equipment are available. Individual experiments involving more than 500 PASSCAL instruments have been supported. The instrument center for maintenance of PASSCAL equipment is located at New Mexico Institute of Technology in Socorro, NM. Data from PASSCAL experiments are distributed through the IRIS Data Management Center. As the program moves towards acquisition of the eventual goal of 6000 channels, current emphasis is on supporting field experiments; maintaining equipment; implementing improvements in hardware; and developing software for efficient data collection and initial processing.

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

GLOBAL SEISMOGRAPHIC NETWORK

The Global Seismographic Network (GSN) is the focused effort of the U.S. seismological research community to provide a 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 138 GSN stations and affiliate arrays, of which more than 80% have real-time telemetry via satellite or the Internet.

Rhett Butler, Program Manager – GSN
Kent Anderson, Operations Manager – GSN
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
rhett@iris.edu
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 and IRIS PASSCAL programs. The DMS also receives, archives and distributes data from a variety of other data sources, most notably the Federation of Digital Broadband Seismographic Networks (FDSN). All broadband data, from the GSN, PASSCAL 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 August 2006, the IRIS Data Management Center (DMC) had more than 51 terabytes (57,000,000,000,000 bytes) of seismic waveform data in more than 4.7 million files. These data are now stored on-line in a large disk-based mass storage system. The IRIS DMS typically services close to 3000,000 requests for seismic data each year.

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, the DMC Host at the University of Washington, and the Waveform Quality Center at Harvard. Significant amounts of data are now received and distributed electronically. In 2006 we project that we will send more than 1 billion seismograms with a volume of more than 10 terabytes to the research community.

In addition to its role of archiving and distributing data, the IRIS DMS is responsible for all quality control of IRIS generated data and has a well established mechanism in place to monitor and correct data problems as they are discovered. At this time there is a mature system of automated quality review in place.

The IRIS DMS has developed novel means of accessing data in near real time through systems such as WILBER (via www.iris.edu), SPYDER® developed by the University of Washington and NRTS developed by the University of California at San Diego, and the LISS System developed by the USGS in Albuquerque. These systems provide researchers access to data within minutes of a seismic event of interest. 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.

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 OUTREACH

The seismological community recognizes the potential for coordinated Education and Outreach (E&O) 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 E&O 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 range of K-16 teacher workshops, widely distributed teaching modules and associated tools (including seismographs and software for viewing and interpreting seismograms), and an Educational Affiliate membership for undergraduate institutions. Outreach to the general public is enhanced through a distinguished lecture program, museum

exhibits, improved access to and use of seismic data via our website, and other informational materials.

John Taber, Program Manager – E&O
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 initiation of EarthScope 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 being implemented through the facilities of the IRIS Consortium and 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 411 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 a permanent array of 39 high-quality, three-component seismic stations, 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.

Rob Woolley, Project Manager - USArray
1200 New York Avenue, NW #800
Washington, DC 20005
Tel: (202) 682-2220
FAX: (202) 682-2444
woolley@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 http://www.iris.edu/about/publications.htm. To receive a hard copy of one of these publications, please send your name, institution, address, telephone, fax number and e-mail address to:

Teresa Saavedra
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 sending a request to leslie@iris.edu.

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

Consortium for Materials Properties Research in Earth Sciences (COMPRES)

Scientist in Charge:	***Contact Person:***
Robert C. Liebermann	Ann Lattimore
COMPRES	COMPRES
ESS Building	ESS Building
Stony Brook University	Stony Brook University
Stony Brook, NY 11794-2100	Stony Brook, NY 11794-2100
Tel: (631) 632-1968	Tel : (631) 632-8213
FAX: (631) 632-8140	FAX: (631) 632-8140
E-mail: Robert.Liebermann@stonybrook.edu	E-mail: Ann.Lattimore@notes.cc.sunysb.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. 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 the P-V-T equation of state, phase transformations, crystal structures, stress state and rheological properties, absorption, reflectance, P and S wave velocities, dilatometry, and kinetics.

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 uniaxial 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.
- A Bruker IFS/66v FT-IR spectrometer for the spectral range 10-25,000 cm^{-1} and three IR microscopes including a Bruker 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 lasers, cryostats, and furnaces.

West Coast Synchrotron Facilities: Facilities for high pressure x-ray and infrared experimentation are available beginning in summer of 2003. Beamline 11.3.1 at the Advanced Light Source will operate up to ~16 keV for high-pressure powder diffraction studies with a focused x-ray beam. ALS beamline 1.4.3 will be equipped for high-pressure infrared studies. Potential users should contact Simon Clark at smclark@lbl.gov. A partial list of the present capabilities include:

- ADX X-ray diffraction on polycrystalline samples using diamond cells, with a high resolution CCD detector.
- Diamond cells for XRD or IR studies at ambient temperature or resistance heating to 1100K.
- Pressure measurements by ruby fluorescence and sample preparation facilities.

Neutron Scattering: A number of facilities for neutron scattering exist within the US (http://www.crystal.vt.edu/compres/). COMPRES is actively promoting the use of these facilities for research on earth materials, especially at high pressures and temperatures. COMPRES can assist in utilizing these facilities through the general user programs by defraying expenses and arranging for technical support. COMPRES is also supporting educational initiatives to broaden the user base of earth scientists at neutron sources. Contact Nancy Ross (nross@vt.edu) for further information.

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, improved laser-heated diamond cells, pressure and temperature calibration, and interfacing Brillouin scattering with x-ray diffraction. Submissions of new Infrastructure Development projects are encouraged; contact Nancy Ross (nross@vt.edu). COMPRES also cultivates and nurtures collaborative scientific projects which 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. Three original projects initiated in 2002 are in the areas of elasticity, rheology, and development of new growth of larger diamonds for high-pressure experiments. For additional information on such collaborative research programs, contact Bob Liebermann (Robert.Liebermann@stonybrook.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: 1) Collaborations with EarthScope, IRIS, the Digital Library for Earth System Education and other organizations to cultivate a network of educators and scientists, 2) Developing and disseminating educational resources, including online information systems for educators and researchers, 3) Utilizing ongoing programs by local school systems to pilot specific programs and to evaluate their

effectiveness; and 4) Promoting the dissemination and advancement of knowledge through topical workshops. We strongly encourage the participation of the entire Earth science community in these efforts and proposals for new projects. The E&O coordinator is Glenn Richard (garichard@notes.cc.sunysb.edu).

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

UNAVCO, A Geodetic Consortium

Scientist in Charge:

Charles Meertens, Acting President
UNAVCO, Inc.
6350 Nautilus Drive
Boulder, CO 80301-5554
Tel: (303) 381-7514
FAX: (303) 381-7501
E-mail: meertens@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 consortium that supports and promotes Earth science by advancing high-precision geodetic and strain techniques such as the Global Positioning System (GPS), borehole strain and Interferometric Synthetic Aperture Radar (InSAR). UNAVCO provides planning and management for community activities. The precise positioning provided by GPS has become a powerful tool for studies of diverse Earth processes including plate tectonics, the earthquake cycle, mountain building, volcanism, plate rigidity and intraplate deformation, hydrology, ice dynamics, sea level change, and atmospheric dynamics, as well as contributing to many education and engineering activities, as summarized in http://www.unavco.org/research_science/brochure/brochure.html.

UNAVCO assists investigators in the use of GPS and related technology primarily through the capability and activities of its Facility in Boulder, Colorado. Supported investigators use space-based geodesy as a tool to solve earth science problems in geology, geophysics, glaciology and other fields. Support is also provided for investigators interested in advancing geodetic techniques. A growing group of researchers are interested in using or synthesizing the results of studies, in many cases conducted by others, for modeling and strain analysis. UNAVCO therefore provides higher order products derived from geodetic and strain techniques to allow investigators to focus on their scientific goals rather than on the technology.

To meet these diverse needs, UNAVCO assists NSF- and NASA-funded principal investigators with GPS equipment, engineering, technology development, training, technology transfer, data management, and archiving, depending on specific project needs. Another service provided by the Facility is the bulk purchase of GPS and ancillary equipment at significant discounts on behalf of the university research community. The UNAVCO Facility also provides technical and operational support to the permanent GPS stations in NASA's Global GPS network, many of which contribute to the International GPS Service (IGS) global network.

UNAVCO works collaboratively with other research institutions in the areas of data processing, technology development, and data archiving. UNAVCO supports scientific interchange among investigators doing GPS-related science, both from UNAVCO members and from other institutions, via an annual community meeting, scientific working groups, and other forums.

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 semi-permanent networks depending on precision requirements. Systems are also available for precision mapping applications.

- Engineering resources are available to provide classroom and in-the-field training, project design and implementation, field engineering, GPS network operations, and technology development for GPS surveys or continuously operating permanent station network studies.

- Data archiving and distribution are supported for campaign and continuous GPS data, via ftp and an archive accessible via a relational database. The archive allows query by data location, date of collection, equipment used, principal investigator, and other "descriptors." The UNAVCO Facility, in conjunction with the Scripps Institution of Oceanography, and many other participants, developed a system of GPS Seamless Archive Centers (GSAC). This system provides a "seamless" access to multiple archive centers, 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 both the scientific and educational communities.

- UNAVCO has a growing Education and Outreach (E&O) effort that is built upon strategic collaborations and partnerships with other Facilities, the Digital Library for Earth System Education, GEON, and UNAVCO member institutions. UNAVCO is committed to increasing the participation of underrepresented populations in the scientific enterprise. **UNAVCO E&O Coordinator**: Susan Eriksson, eriksson@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 GPS applications at the international level. Many of the GPS tools and techniques developed by the UNAVCO community are publicly available via the UNAVCO Web site.

EarthScope. UNAVCO is a principal participant in constructing EarthScope, an NSF Major Research Equipment and Facilities Construction (MREFC) project. UNAVCO's partners in this project are the Incorporated Research Institutions for Seismology (IRIS) and Stanford University.

Membership. UNAVCO Members are educational or nonprofit institutions chartered in the United States (US) or its Territories who are willing to make a clear and continuing commitment to active participation in the activities of the organization. Associate Memberships are available to non-US institutions that otherwise meet the qualifications for membership. If your organization meets these qualifications, please consider membership in UNAVCO.
UNAVCO Membership: http://www.unavco.org/community/membership/membership.html

Governance. UNAVCO is governed by a Board of Directors elected by member institution representatives. The Board works with the research 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 associated activities provide high quality, cost-effective, and responsive support.

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 related technology for either recognized or new applications of these exciting 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
- 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 a web-based proposal system (http://www.aps.anl.gov/user/beamtime/get_beam.html). The GSECARS web page (http://www.gsecars.org) contains announcements of proposal deadlines, 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. Over 1100 beamtime proposals have been received since implementation of the web-based beamtime proposal system in 2001. Over 680 visiting scientists have conducted experiments on the GSECARS sector since

1997. In FY2006 there were 108 experiments performed on the undulator beamline and 102 experiments on the bending magnet beamline.

In addition to the experimental stations, GeoSoilEnviroCARS has laboratories for sample preparation and characterization, and 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
E-mail: mcaffee@physics.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 are using the accelerator to measure both man-made and cosmic-ray-produced radioisotopes such as ^{14}C (half-life 5730 years), ^{10}Be (1,500,000 years), ^{26}Al (730,000 years), ^{36}Cl (300,000 years), ^{41}Ca (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 the Earth and planetary sciences. Applications include measuring the exposure time and erosion rate of rocks on the surface of the Earth 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. 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 building on the Purdue campus contains 31,000 sq. ft of floor space with 14 offices and 16 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.

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 300 samples per year and perform AMS measurements on over 3000 samples per year. We continually work to improve AMS methods and develop detection of new nuclides.

PRIME Lab is currently available to the research community for measurements of the nuclides ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, and ^{129}I. In addition, we can determine carbon and chloride concentrations using isotope dilution. 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

NSF – University of Arizona Accelerator Mass Spectrometer (AMS) Laboratory

Scientist in Charge:

A.J. Timothy Jull
NSF-Arizona AMS Laboratory
University of Arizona
Tucson, AZ 85721
Tel: (520) 621-6816
FAX: (520) 621-9619
E-mail: jull@email.arizona.edu

Contact Person:

M. De Martino
NSF-Arizona AMS Facility
Physics Bldg. 1118 East Fourth Street
P.O. Box 210081
University of Arizona
Tucson, AZ 85721-0081
Tel: (520) 621-6810
FAX: (520) 621-9619
E-mail: ams@physics.arizona.edu

Facility Description:

The NSF - University of Arizona Accelerator Mass Spectrometer (AMS) laboratory is a national facility dedicated to radioisotope research. The purpose of the facility is to provide radioisotope measurements for a broad range of scientific and historical studies. The facility is financed by the National Science Foundation and by funds received from user charges.

The AMS laboratory is primarily devoted to radiocarbon measurements. Samples are submitted by scientists from around the world. A typical sample is pretreated, converted to CO_2, and reduced to graphite. The ratio of $^{14}C/^{13}C$ in the graphite is measured in the accelerator and used to calculate a radiocarbon age. A conventional stable isotope mass spectrometer is available to provide $\delta^{13}C$ measurements. These $\delta^{13}C$ measurements will be provided for all samples except some sediments, and this information is used to correct the ^{14}C ages to $\delta^{13}C$ of -25 ‰, as by convention, before reporting them.

For samples younger than a few thousand years, the $^{14}C/^{13}C$ ratio is measured with a standard deviation of about 0.5%. This precision yields an uncertainty in the radiocarbon age of approximately ± 40 years. Published tree-ring calibration curves are used to determine calendar ages. The uncertainty in the calendar age is generally larger than the uncertainty in the radiocarbon age, and depends on the location of the calculated age in the calibration curve. For samples with ages greater than about 11,000 years, only radiocarbon ages are quoted. For special cases, better precision can be achieved by analyzing several targets made from the same material. This improves the standard deviation of the averaged result by a factor of sqrt(n), where n is the number of independent analyses. The best precision obtained to date is 0.2%. The maximum radiocarbon age that can be measured at the facility is about 48,000 years B.P.

The AMS facility is also equipped to provide ^{10}Be measurements. Beryllium oxide targets are used in the accelerator to measure the ^{10}Be content of samples. For samples with ratios of $^{10}Be/^{9}Be = 10^{-13}$, ^{10}Be rates of about 3.5 counts per minute can be obtained.

The laboratory facilities have been expanded with the addition of a second AMS instrument. We expect that this addition will improve the reliability of the operation of the laboratory, and allow the analysis of additional cosmogenic isotopes.

For current sample size requirements and fees, see our web page or contact the laboratory directly.

WWW Home page URL: http://www.physics.arizona.edu/ams

Institute for Rock Magnetism (IRM)

Scientist in Charge:

Subir K. Banerjee, Director
Department of Geology and Geophysics
University of Minnesota
310 Pillsbury Drive SE
Minneapolis, MN 55455-0219
Tel: (612) 624-5722
FAX: (612) 625-3819
E-mail: banerjee@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 no-cost 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 and paleoclimate records.

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.

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). 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.

Recent and current in-house research projects include magnetic phenomena in nanophase and poorly-ordered materials [*e.g.*, Banerjee, *Phys. Earth Planet. Int.., 154*, 210-221, 2006], magnetofossil occurrences and properties [*e.g.*, Housen and Moskowitz, *J. Geophys. Res. B*, *111*, doi:10.1029/2005JG000068, 2006.], and fundamental properties and magnetization processes in remanence-carrying minerals [*e.g.*, Carter-Stiglitz et al, *J. Geophys. Res. B*, in press, 2006.]. Examples of recent research by Visiting Fellows include investigations of the origin of stable magnetic memory in relatively large multidomain particles, using low-temperature measurements; and studies of climate-driven periodic variations in the physical and chemical characteristics (particle size distribution, mineral composition) of marine sediments, using suites of field- and temperature-dependent magnetic measurements. Undergraduate seniors from small colleges and universities in the upper mid-west carry out senior thesis research under guidance from IRM faculty and staff. Since 1992, seven biennial conferences have been held in Santa Fe, NM, organized by IRM to advance new interdisciplinary research utilizing rock-magnetic techniques. A conference organized jointly by the IRM and the European Community's MAG-NET research consortium was held in Erice, Sicily in 2002.

Cooperative efforts with magnetics groups from nearby companies (Seagate Technology and Web Research) lead to the productive exchange of ideas and provide fertile ground for the development of new technology.

Interested scientists are encouraged to apply to become Visiting Fellows or Visiting Students. Applications are accepted twice a year for work to be done during the following half year. 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. To help defray travel costs, we offer a limited number of grants for up to $750 each as seed money to researchers who submit outstanding proposals. (There are no funds available for per diem personal expenses.) Shorter, less formal visits from other researchers are readily arranged through the laboratory manager. There are no fees for use of IRM facilities.

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:

Kevin McKeegan
Department of Earth and Space Sciences
University of California, Los Angeles
2667A Geology Building
Los Angeles, CA 90095-1567
Tel: (310) 825-3580
Lab: (310) 825-4328
FAX: (310) 825-2779
E-mail: mckeegan@ess.ucla.edu

Contact Person:

Marty Grove
Department of Earth and Space Sciences
University of California, Los Angeles
3667B Geology Building
Los Angeles, CA 90095-1567
Tel: (310) 794-5457
Lab: (310) 825-4328
FAX: (310) 825-2779
E-mail: marty@argon.ess.ucla.edu

Facility Description:

The UCLA SIMS laboratory has been supported since 1992 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 unique capabilities to the broader community to address important problems in earth and planetary science. Over the last two decades, the ion microprobe has become one of the most potent tools for isotope geochemistry and cosmochemistry due to its ability to reveal isotopic and elemental heterogeneity at the micro-scale. Since the inception of facility operations (1996), more than 200 scientists have undertaken projects in the UCLA SIMS lab.

The UCLA SIMS laboratory is an active teaching facility training graduate and undergraduate students involved in the Earth and Space Sciences. Since 1995, over 40 completed Ph.D. and M.S. theses relied heavily upon data students collected using our facility. Two dozen post-doctoral students have also been trained in the laboratory and three of these now run SIMS laboratories at their home institutions.

The UCLA SIMS laboratory features a CAMECA ims 1270 that uses both the standard Cs+ (microbeam) and duoplasmatron primary ion sources. While either source is capable of producing ion beams as small as 1 µm diameter, 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 a zircon). 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). 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. This is the only method that has been demonstrated to work routinely for high-precision oxygen isotope measurements. A five moveable collector ion detection system 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 new types of scientific investigations, and has been increasingly utilized by visitors to the facility, particularly for investigations of C, O, and S isotopes.

UCLASIMS 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:

See Scientist in Charge

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:

William D. Carlson
Department of Geological Sciences
University of Texas at Austin
Austin TX 78712
Tel: (512) 471-4770
FAX: (512) 471-9425
E-mail: wcarlson@mail.utexas.edu

Contact Person:

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

Facility Description:

The high-resolution X-ray computed tomography 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 custom-designed tomographic scanning system with a digital image-analysis laboratory to provide data analysis and v

High-resolution X-ray CT (computed tomography) is a completely non-destructive technique for visualizing and measuring features in the interior of opaque solid objects, and for obtaining digital 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 tens of 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, and organic tissues; quantitative textural analysis of crystalline rocks; porosity/permeability assessment; description of 3-D fracture patterns in aquifer and reservoir rocks; 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 centerpiece of the facility is a tomographic scanner designed for three modes of operation: high-energy and high-resolution computed tomography; real-time microradiography; and digital radiography. For high-penetration tomography of large and dense objects, a 420-kV X-ray source is employed, with either a solid-state linear array detector, or a high-resolution radiographic line scanner detector. For micro-tomography of smaller objects, a 225-kV microfocal X-ray source with image intensifier is employed.

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 graphics 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-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/

Facility for Electromagnetic Study of the Continents (EMSOC)

Scientist in Charge:

Phil Wannamaker
University of Utah
Energy and Geoscience Institute
423 Wakara Way, Suite 300
Salt Lake City, UT 84108-1210
Tel: (801) 581-3547
FAX: (801) 585-3540
E-mail: pewanna@egi.utah.edu

Contact Person:

Stephen Park
University of California, Riverside
Department of Earth Sciences
Riverside, CA 92521
Tel : (951) 827-4501
FAX : (951) 827-4324
E-mail : skpark@ucr.edu

Facility Description:

The EMSOC facility provides equipment for inductively sensing the electrical conductivity structure of the Earth's interior. Electrical conductivity is related to temperature and the presence and connectivity of fluids or other interstitial conductive material such as graphite that are difficult or impossible to sense by other means.

The facility presently consists of twenty five long period (10-30,000 s) magnetotelluric (MT) systems and 2 wideband (.002 to 500 s) MT systems. Together, these systems are suitable for targets ranging from the near surface (tens of meters) to the upper mantle (~400 km depth). They are owned respectively by the University of Washington (UW), the University of California at Riverside (UCR), and the University of Utah (UU).

The fifteen-channel, wideband MT system of UCR is commercially manufactured and is suitable for either continuous tensor MT profiling (an electromagnetic equivalent of seismic reflection profiling) or simultaneous multi-site MT using GPS synchronization. The commercial system at UCR is reaching the end of its useful life and an alternative system is currently being evaluated. The second existing wideband system has been developed by UU. While also functioning similarly to the commercial units, the latter addresses additional research situations, such as deployment on ice sheets or radio telemetry, which are not currently possible commercially. This system is currently being rebuilt to allow simultaneous multi-band acquisition, GPS synchronization, and higher bandwidth and telemetry rates. Five additional long-period instruments are to be purchased.

EMSOC also provides one copy of a commercial MT interpretation package to each member institution and offers a training seminar annually. The software can be installed under Windows and uses a dongle for licensing. Inquiries about the software or training should be addressed to the Contact Person.

Although the MT equipment is owned by the grantee institutions above, its use is open to the U.S. academic community. Users are expected to pay for expendables (e.g., batteries, wire, electrodes), shipping, insurance and training. Users are required to be trained and to archive data according to the IRIS Data Management System under rules similar to those governing PASSCAL seismic data.

The Facility is governed by the EMSOC Facility Steering Committee (EFSC). This committee presently consists of three representatives from the three grantee institutions and three representatives from other academic institutions. The EFSC sets policy, oversees operations, allocates equipment use through an open application process and organizes training opportunities. All actual equipment use is coordinated by the Contact Person to whom inquiries regarding equipment availability should be addressed.

WWW Home page URL: http://emsoc.ucr.edu/emsoc/index.html

National Center for Airborne Laser Mapping (NCALM)

Scientist in Charge:

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
365 Weil Hall, P.O. Box 116580
The GEM Center
Dept. of Civil & Coastal Engr.
University of Florida
Gainesville, FL 32611-6580
Tel: (352) 392-4999
Fax: (352) 392-5032
E-mail: rshre@ce.ufl.edu

Facility Description:

NCALM is a National Center for Airborne Laser Mapping which 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 & Coastal Engineering, College of Engineering, University of Florida (UF) and the Department of Earth and Planetary Science, University of California-Berkeley (UCB). NCALM uses the ALSM system jointly owned by UF and Florida International University (FIU), based at the UF Geosensing Engineering and Mapping (GEM) Research Center, UF. NCALM was renewed for three years starting August 1, 2005.

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 UF and UCB groups contribute to software development that increases the processing speed and data accuracy. NSF-supported researchers should contact UF 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:

1. Make airborne laser swath mapping (ALSM) widely available at affordable cost to the national research community.
2. Advance both the technology and the scientific discoveries made possible as a consequence of ALSM.
3. Track and evaluate other geosensing and remote sensing technologies that complement ALSM, and develop methods for multi-sensor data collection and fusion.
4. 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 Florida 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:

1. Analysis scheduling and prioritizing projects
2. Cost effective management of the Center
3. Information dissemination
4. Opportunities and necessities for technological upgrades
5. Liaison and coordination with major NSF programs (PBO, CUAHSI, MARGINS, 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 laser that emits 33,000 pulses per second. The laser is mounted in a small twin-engine (Cessna 337) aircraft and the laser pulses are directed towards the ground by a scanning mirror. Each pulse illuminates an area, or footprint, of about one foot in diameter and the light is scattered back to a sensor in the aircraft. The round trip travel time of the laser light allows researches 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.

OUTREACH

The three-year NCALM renewal 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 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
Department of Geology
Northern Arizona University
Flagstaff, AZ 86011-4099
Tel: (928) 523-7192
Fax: (928) 523-9220
E-mail: Darrell.Kaufman@nau.edu

Contact Person:

Jordon Bright, Laboratory Manager
Department of Geology
Northern Arizona University
Flagstaff, AZ 86011-4099
Tel: (928) 523-7834
Fax: (928) 523-9220
E-mail: Jordon.Bright@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, bone, egg shells, and teeth), 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. The technique is based primarily on the extent of amino acid racemization (AAR), the interconversion 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 liquid chromatographs (LC) for separating and detecting DL amino acids. The ion-exchange LC separates isoleucine and alloisoleucine, which measures the extent of epimerization (racemization) in this amino acid. Reverse-phase LC separates D and L forms of several amino acids, most reliably: aspartic acid, glutamic acid, serine, alanine, and valine. The reverse phase LC 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 a National Shared Facility, the AAGL will analyze samples and interpret data at reduced cost to collaborating researchers. The facility's highest priority is to analyze samples collected by NSF scientists seeking to apply AAR for a variety of purposes. The lab is presently offering ~1500 analyses per year at a nominal fee ($5 per sample, about one-tenth the standard rate). A primary goal of these analyses is to cross-check the results of amino acid geochronology with results of other geochronological methods. The facility will also work with collaborating researchers to design and conduct a variety of experiments aimed at improving the accuracy and applicability of the technique. In particular, the AGGL solicits material from other amino acid geochronologists to heat for long durations in its calibrated ovens.

The AAGL offers to train new users in laboratory procedures related to amino acid geochronology. Funds are presently available to travel to Flagstaff, AZ to learn to analyze samples and interpret results. The AAGL also seeks to coordinate with other amino acid geochronology laboratories, including: distributing inter-laboratory standards, sharing reverse-phase columns, and compiling extended data sets on AAR. Other amino acid geochronologists are encouraged to contact the AAGL with suggestions for improving coordination, increasing the exposure of amino acid geochronology, or using the shared facility in other ways.

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:

See Scientist in Charge

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 52 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.

An eleven-member Board of Directors is elected from the member representatives and provides policy guidance for the corporation. The member representatives also elect DOSECC's Science Planning, Technology Planning and Education and Outreach Committees. Elections are held at the annual meeting of the corporation.

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

1. 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.

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 different 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. It has collected core from the Great Salt Lake and Bear Lake in Utah, Lake Titicaca in Bolivia and Lake Bosumtwi in Ghana. The GLAD200 system is a smaller version of the GLAD800 and can collect continuous core to a depth of 200 m.

3. 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.

4. 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.

SCIENTIFIC DRILLING PLANNING AND BUDGETING

DOSECC will plan and develop budgets for scientific drilling projects. Please be aware that 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. 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 Internships in Scientific Drilling to promote research on samples and data from scientific drilling projects. These internships are offered on an annual basis and are open to graduate and undergraduate students as well as 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.

MEMBERSHIP IN DOSECC

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) 621-6026
FAX: (520) 621-2672
E-mail: ggehrels@geo.arizona.edu

Contact Person:

See Scientist in Charge

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 goal is to provide the Earth Science community with a facility that will:

- Determine U-Th-Pb ages with the highest precision and accuracy possible by LA-ICPMS
- Generate U-Th-Pb ages in an efficient and cost-effective manner
- Determine ages of zircon, monazite, and sphene using established techniques
- Develop new analytical techniques that take advantage of the spatial resolution and rapid throughput of LA-ICPMS
- Serve as a powerful tool for learning the theory and techniques of U-Th-Pb geochronology

The Arizona LaserChron Center utilizes a multicollector ICP mass spectrometer (from GV Instruments) coupled with a 193 nm DUV Excimer laser (from New Wave Research/Lambda Physik). 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 10 to 50 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 ~20 igneous rock samples or ~5 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, which can be acquired with a Cameca CamScan Series II SEM housed within the Department of Geosciences. We are presently able to routinely conduct U-Th-Pb age determinations on zircon, sphene, monazite, and monazite inclusions in garnet grains. Efforts to develop analytical methods for analysis of apatite, rutile, and xenotime are ongoing.

The center presently generates ~50,000 U-Th-Pb ages in support of ~50 separate projects per year. Most of these projects are conducted in close collaboration with LaserChron staff personnel, who are 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. We also encourage use of the instrument in a classroom setting as it can be operated remotely with simultaneous displays of laser excavation and age determination.

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