EAR TO THE GROUND

SUMMER 2012

The Division of Earth Sciences (EAR) is part of the Geosciences Directorate at the National Science Foundation.

IN THIS ISSUE

Echo Canyon Trail, AZ

Update from the Acting Division Director

The National Science Foundation has selected Dr. Wendy Harrison, as the new Division Director for the Division of Earth Sciences (biography in this issue). We are excited to welcome Wendy to the EAR family, and we are looking forward to her leadership.

EAR also welcomes two distinguished members of the hydrologic sciences community, Dr. Ni-Bin Chang and Dr. Shemin Ge (biographies also in this issue), who will join Dr. Tom Torgersen in the Hydrologic

Sciences (HS) program as program directors. Two program directors, Dr. Bill Leeman and Dr. Laura Toran are leaving EAR; Bill recently retired his post as program director for the Petrology and Geochemistry program, and Laura (HS) is rotating out of NSF. Both will be sorely missed, and we sincerely thank each of them for their exemplary service to EAR and NSF.

Dr. Tim Killeen has rotated out as the Assistant Director (AD) for the GEO Directorate effective last month. All of us at EAR appreciate the bold and determined leadership that Tim has provided GEO and NSF in the past four years. Dr. Marge Cavanaugh was designated as the Acting AD, while the search continues for a new GEO AD. Marge is a veteran of the GEO Directorate, and is a leader in the development of the SEES, OneNSF and educational initiatives. In the interim, I have also assumed the role of Acting Deputy Assistant Director for GEO.

Despite the fiscal challenges confronting the federal government, the EAR community has reasons to be upbeat in the coming years. For example, this issue of EAR to the Ground contains additional news items on recent solicitations and new initiatives at NSF that the EAR community can lead or participate in. EAR scientists are poised to have central roles in the Hazard, Coastal and Arctic SEES solicitations. A DCL on Sustainable Chemistry, another SEES program, likewise features key partnership roles for the geochemical community. A new solicitation for an expanded and refocused Critical Zone Observatory program and a DCL announcing a recompetition call for DOSECC were also released recently. EarthCube remains the most vibrant initiative in support of the NSF-wide CyberInfrastructure for the 21st Century, Big Data and Open Access initiatives. Finally, the eastward march of the EarthScope transportable array (TA) has now reached Atlantic states, with a plan for long-term siting and operation of a sizable fraction of the TA in their east coast location. Plans for the migration of the TA to Alaska are also underway.

On balance, the human capital of the EAR Division and the community it represents are just as dynamic as the science they look after. The study of Earth systems continues to be inspiring and relevant, and the multitude of new initiatives noted above will keep the level of excitement in the community very high for the next several years. That said, we have more frontiers to discover and investigate, and we always welcome your ideas and suggestions on yet uncharted zones and borders of our science that we must explore.

Jun Abrajano, Acting Division Director
Division of Earth Sciences

Introducing EAR's new Division Director

Dr. Wendy J. Harrison is a professor of geology and geological engineering at Colorado School of Mines and formerly Associate Provost and Dean of Undergraduate Studies and Faculty.

Harrison's research interests lie broadly in the field of geochemistry. She has tackled subjects as varied as experimental shock metamorphism in lunar materials, fundamental thermodynamics of trace element substitution in minerals at high pressure and temperature, the numerical simulation of paleohydrology and diagenesis in sedimentary basins and the contemporary hydro-geochemistry of wetlands, as well as more applied geochemical problems including artificial diagenesis induced by enhanced oil recovery technologies, buffering capacity of acid-impacted agricultural soils, and the formation of gas hydrates and their role in ocean CO2 sequestration. She has several contributions in the field of

geoscience education. Harrison joined CSM in 1988 as an assistant professor after 8 years as a senior research geologist at Exxon Production Research Company, Houston, Texas and 2 years as a National Research Council Fellow at NASA-Johnson Space Center. She received bachelor's and doctoral degrees in geology from Manchester University, U.K. and was awarded a predoctoral fellowship at the Carnegie Institution of Washington's Geophysical Laboratory.

New Program Directors in Hydrologic Sciences

Dr. Ni-Bin Chang is a professor with Civil and Environmental Engineering Department and the Director of the Stormwater Management Academy, University of Central Florida. He received a BS in Civil Engineering from National Chiao-Tung University in Taiwan, and both an MS and PhD in Environmental Systems Engineering from Cornell University. He has been working with hydrological community for 20 years, focusing on hydroinfomatics, hydrological remote sensing, ecohydrology, biogeochemical cycle and low impact development (LID), and teleconnection pattern identification in climate change assessment. He was the associate editor of Water Resources Research (AGU) and Journal of Hydrologic Engineering (ASCE). He is now an editorial board member of Journal of Hydroinformatics.

Dr. Shemin Ge is a professor in the Department of Geological Sciences at the University of Colorado. She holds a BS in Geotechnical Engineering from the Wuhan University of Technology in China, an MS in the same from the University of British Columbia, and both an MA and PhD in Hydrogeology from The Johns Hopkins University. Her research focuses on understanding the role of groundwater dynamics in various geologic processes and applying groundwater knowledge to studying issues related to water resources, geohazard, geothermal energy. Currently, she studies the impact of climate change on water resources in high altitude headwater regions. As temperature fluctuations at land surface influence hydrologic properties of shallow aquifers, the exchange between shallow groundwater and surface waters can be enhanced or impeded. She also studies the interaction between groundwater and earthquakes, which includes deciphering earthquake-induced hydrologic responses for hydrologic properties and examining how pore pressures influence the timing and locality of seismicity.

Retiring Program Director in Petrology & Geochemistry

Bill Leeman is a geologist/geochemist principally interested in understanding magmatic processes and the formation of igneous rocks in diverse geologic and geographic settings (western US, Hawaii, Italy, Chile, Greenland, Mexico, New Zealand, etc.), with particular emphasis on volcanism associated with the Yellowstone hotspot, the Cascades volcanic arc, and the Pacific 'Ring of Fire'. Dr. Leeman graduated with B.A. (1967) and M.A. (1969) degrees from Rice University, and earned his Ph.D. from University of Oregon (1974). Following brief stints with the US Geological Survey and Oregon State University, he was a member of the Rice University Earth Science Department for some 26 years - with interludes as visiting scientist at the Open University (U.K.) and interim program director with the National Science Foundation (NSF). In 2005 he joined

the Earth Science Division at NSF. For the past seven years he co-directed the Petrology & Geochemistry Program in EAR, during which time he processed over 700 proposals of which about 30% were funded at some level. Also during that time, he retained status of Emeritus Professor at Rice University, was a Visiting Scientist with the Smithsonian Institution, published or coauthored some 27 research papers, and was coauthor on some 60 presentations at professional meetings. Upon retirement, he plans to move to Santa Fe, NM where he will enjoy the climate, scenery, and culture of the southwest and work on a backlog of research projects. Bill says: 'Being at NSF has been a pleasurable experience, both with regard to colleagues here and with the principal investigators with whom I have interacted.'

Celebrating EAR awardees

Several EAR PI's have been recognized for their outstanding accomplishments this year. We first congratulate two Tectonics awardees to receive GSA Awards at GSA Annual Meeting: **Katharine Huntington**, University of Washington, will receive the Young Scientist Award (Donath Medal), and **Kathleen Surpless**, Trinity University, will receive the Biggs Award for Excellence in Earth Science Teaching.

In addition, five EAR PI's have been nominated to the National Academy of Sciences: **Susan Brantley**, Pennsylvania State University; **Richard Carlson**, Carnegie Institution of Washington; **Patricia Dove**, Virginia Polytechnic Institute and State University; **Hiroo Kanamori**, California Institute of Technology; and **John Wahr**, University of Colorado. In addition, **Diane McKnight**, University of Colorado, has been nominated to the National Academy of Engineering. Congratulations, from everyone in the Division!

Revision of the Continental Dynamics Program

Note that there will be no Continental Dynamics (CD) competition for FY 2013. This means that there will be **no proposals accepted to the November 15, 2012 deadline**. NSF intends to revise and expand the current CD solicitation, so please stay tuned for details. If you have any questions about this change, please contact Leonard Johnson at lejohnso@nsf.gov or 703. 292. 4749.

A New Critical Zone Observatory Program

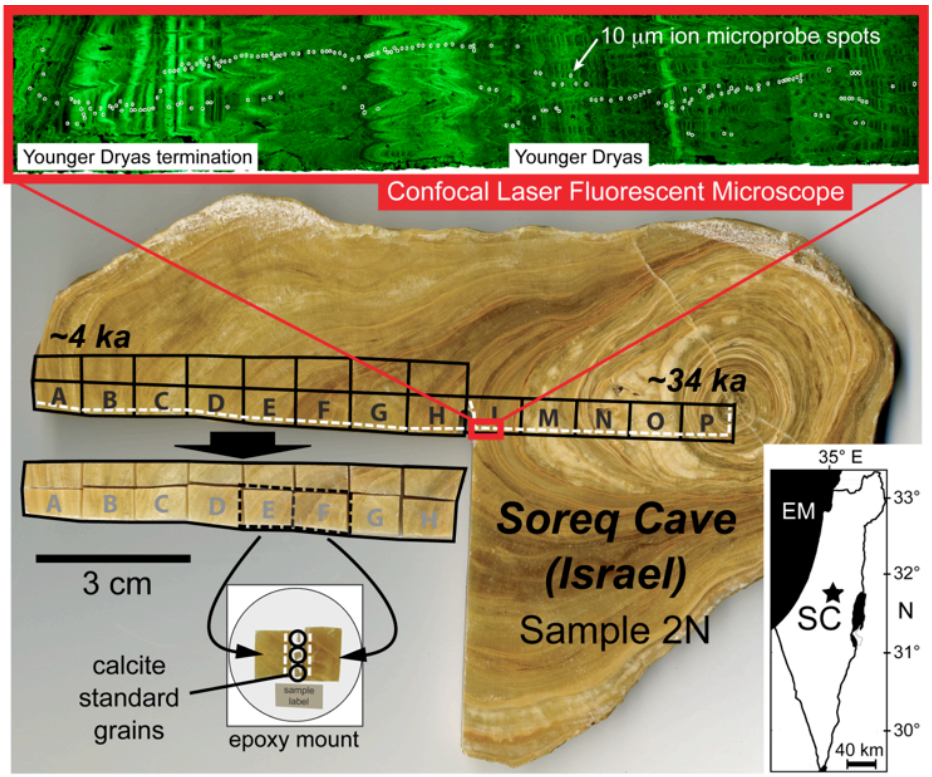
The National Science Foundation released a new solicitation for the Critical Zone Observatory (CZO) program. In contrast to the exploratory program commenced five years ago, the solicitation opens the opportunity to create a network of up to eight observatories that will be fully coordinated in terms of observations, data management, modeling, and educational and outreach activities. A centralized National CZO Network Office will be created along with the successful site awards.

There is likewise an emphatic shift in focus of the CZO program from one that utilized the societal implications of critical zone processes as a context for the research to one that envisions informing societal decisions as the direct goal of observations and interpretation.

The Earth's critical zone is the foundation of terrestrial ecosystem function, hence understanding and quantifying transformation of the critical zone are important for informing critical decisions on how humans can best mitigate, adapt or respond to slow or abrupt changes in terrestrial environments.

Instrumentation and Facilities Highlight: WiscSIMS

The Instrumentation & Facilities Program of the Division of Earth Sciences (EAR/IF) 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.



Orland et al. (2012, Geochimica et Cosmochimica Acta) employed oxygen isotope analysis of a stalactite from Soreq Cave at the WiscSIMS National Ion Microprobe Facility to document the most detailed climate record, to date, of low-latitude seasonality since the last glacial maximum. The lower panel shows a polished cross section of sample 2N, cut into cubes for analysis, and a map indicating the location of Soreq Cave (SC) in Israel and the Eastern Mediterranean (EM). The upper panel shows the abrupt end of the Younger Dryas cold period (11.6 ka), imaged by Confocal Laser Fluorescent Microscope; each green/black couplet is an annual growth band. The ion microprobe data from 10 µm spots (white circles) show systematic changes in δ18O across single annual growth bands, which are interpreted as a proxy for seasonality. These results indicate that before 15 ka, regional seasonality was less severe than the distinct wet/dry seasonal cycles that existed throughout the Holocene. Detailed analysis of the Younger Dryas termination shows that abrupt warming caused rapid environmental change on a decadal timescale in the Eastern Mediterranean region.

EAR to the Ground is continuing to highlight some of these facilities, to make the community aware of the incredible capabilities sponsored by EAR/IF. You can download the newly-updated guide to multi-user facilities here.

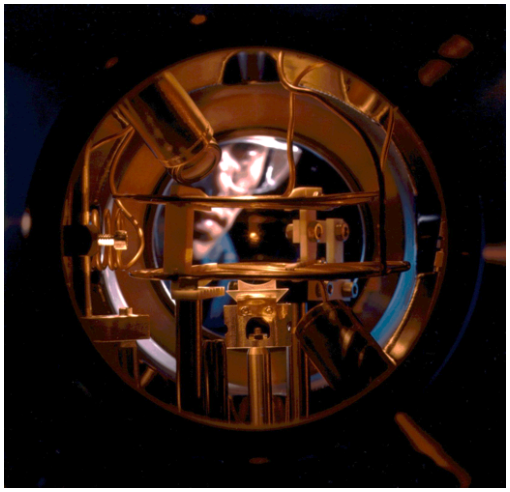
In this issue, we bring you a highlight from the WiscSIMS National Ion Microprobe Facility. This lab houses the first CAMECA IMS-1280. This is a large radius multi-collector ion microprobe incorporating many improvements over earlier instruments, several of which are designed to enhance precision of 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 δ18O and δ17O in well-polished silicates is typically better than ±0.3‰ (2 SD, spot-to-spot) with 10μm diameter beam (Kita et al. 2009 Chem. Geol. 264:43-57; Valley and Kita 2009 MAC Short Course 41:19-63).

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. 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.

Atom Trap Trace Analyses (ATTA) and radiokrypton

The Atom Trap Trace Analyses (ATTA) is a laser-based atom counting method that is now reaching sensitivity of one in 10^{15} and is being actively developed at Argonne National Laboratory in Chicago for the analyses of long-lived noble gas isotopes in the environment. The idea of cooling atoms and trapping them with laser light was pioneered by now Secretary of Energy, Steven Chu for which he was co-recipient of the 1997 Noble Prize in Physics. At room temperature, atoms and molecules move at speeds of about 4,000 km/hr and it is nearly impossible to study these atoms as they disappear too quickly from the area being observed. By lowering their temperature to a few microkelvin (approaching absolute zero, -273°C), atoms move at speeds of less than 1 km/hr. Dr. Chu and co-workers developed methods using laser light to cool gases into the microkelvin range and keep the chilled atoms floating in atom traps for analyses.



Magneto-Optical Trap of Sodium at NIST. Photo credit: Mark Helfer, NIST. Provided by Z.-T. Lu, Physics Division, Argonne National Laboratory

Starting in the late 1990's, scientists led by Zheng-Tian Lu in the Physics Division at Argonne National Laboratory in Chicago developed the ATTA method to analyze ^{85}Kr and ^{81}Kr. Loosi and Oeschger (EPSL 1969) proposed ^{81}Kr as the ideal tracer for dating water and ice in the range of 10^5 to 10^6 years which is beyond the range of ^{14}C-dating. ^{81}Kr, which is produced in the upper atmosphere by cosmic-ray spallation and neutron activation of stable krypton, is uniformly distributed in the atmosphere and subsurface sinks and sources are likely negligible. Human activities also have a negligible effect on ^{81}Kr because ^{81}Br shields ^{81}Kr from the decay of neutron-rich fission products. These characteristics are extremely favorable for applying ^{81}Kr dating to natural. However, ^{85}Kr is a fission product of ^{235}U and ^{239}Pu and is released into the atmosphere predominantly by nuclear fuel reprocessing activities. For natural fluid dating, there is a need to measure both ^{85}Kr and ^{81}Kr in the same water sample because ^{85}Kr serves as a tracer for recent water contributions, which allows old groundwater ages to be appropriately interpreted. These techniques have been used to date water from the Great Artesian Basin in Australia (Collon et al., 2000 EPSL; Lehmann et al., 2003 EPSL)

and in the Nubian aquifer in western Egypt (Sturchio et al., GRL 2004), though both required large quantities of water. The most recent vintage of the ATTA group of instruments at Argonne (ATTA-3) has significantly improved performance compared to earlier versions: it can measure both ^{81}Kr/Kr and ^{85}Kr/Kr ratios, it has been independently calibrated using Low Level Decay Counting (LLC) and its counting rate has been improved by an order of magnitude reducing the required water or ice samples also by a factor of 10 (Jiang et al., GCA 2012).

The excitement about ATTA-3 and recent technological developments was conveyed in the June 21-22, 2012 Workshop on Tracer Applications of Noble Gas Radionuclides held at Argonne Lab and sponsored by Argonne, the National Science Foundation (EAR/Hydrology, OCE/Chemical Oceanography and OPP/Arctic Sciences) and the University of Chicago. European and Asian groups presented parallel efforts of ATTA developments with subsequent discussions resulting in new ideas of improving the efficiency of the method. Several presentations covered new and exciting applications of the technique that are either already underway or will be executed in the near future uses such as: (1) tracing the time scales of fluid residence and migration in the crust, (2) using ^{81}Kr and ^{85}Kr in groundwater hydrology, (3) using ^{39}Ar to date deep and abyssal waters in the Atlantic Ocean, and (4) dating of ancient glacial ice using ^{81}Kr. The presentations are available online. Currently the required sample size for ATTA-3 radio-Krypton dating is about 5-10 micro-l of Kr or 100-200 kg of water or 40-80 kg of ice. The Argonne ATTA-3 is capable of analyzing about 120 samples per year. Development of optical Kr production is under investigation and if successful would further boost the efficiency by another two orders of magnitude.

The ATTA experiment is another example of how a novel idea in one discipline – in this case physics - can lead to the development of cutting-edge instrumentation that is now driving transformative research in another discipline. Applications of ATTA for ^{81}Kr, ^{85}Kr and ^{39}Ar dating techniques are expected to lead to new discoveries in basic earth, ocean and atmospheric sciences as well as applied research with relevance to societal issues such as groundwater and energy resources, carbon sequestration and climate change.

Arctic Science, Engineering, and Education for Sustainability (ArcSEES)

We mentioned this in the last issue, but want to remind the community that several NSF directorates, US, and foreign agencies have come together to support research that aims to better understand the resiliency of the Arctic system and also provide possible science and engineering-based solutions to the challenges and opportunities that current changes in the Arctic pose to northern residents and the globe. A joint solicitation (NSF 12-553) has recently been released for ArcSEES (Arctic Science, Engineering, and Education for Sustainability) which brings the combined resources of the National Science Foundation, Bureau of Ocean Energy Management, Environmental Protection Agency, US Fish and Wildlife Service, US Geological Survey, and Centre National de la Recherche Scientifique in France to bear on the complex, non-linear and often inter-dependent changes in the: (1) living and natural environment, (2) built environment, (3) natural resource development, and (4) governance of the high north. Proposers are encouraged to draw on the breadth of disciplinary and community knowledge available to conduct research in one or more of the thematic areas. All proposals must be submitted by the September 14, 2012 deadline. Please send specific questions via e-mail to arcsees@nsf.gov.

SusChEM: Sustainable Chemistry, Engineering, and Materials

Do you have ideas for how your research in the earth sciences might apply to the development of sustainable technologies? If so, check out the new NSF Dear Colleague Letter about the Sustainable

Chemistry, Engineering, and Materials (SusChEM) initiative. The Division of Earth Sciences is participating in this new initiative starting in Fall 2013. Proposals dealing with harvesting of elements and geological processes pertinent to the development or fate of technological materials can be submitted to the relevant EAR program. Ties with industry, national laboratories, or other organizations are encouraged. Contact Deborah Aruguete, EAR liaison for the SusChEM initiative, at daruguet@nsf.gov for more information.

Call for AGU Abstracts

EAR PO's are involved in several AGU Fall Meeting sessions this year, and we encourage your abstract submissions - the deadline is August 8.

ED024: Improving Student Retention in the Geosciences
The current attrition rate in many college STEM degree programs is 50% or higher. While there is great interest in improving the retention of students who enter college intending to major in STEM, we are still exploring effective and sustainable approaches that might be used to meet these goals. The need to assess and disseminate information about successful programs is a high priority in light of national goals for STEM education and funding opportunities. This session will include descriptions of programs that have documented success of improving the retention rate of students majoring in STEM degrees.

Conveners: Michelle K Hall, National Science Foundation; Lina C Patino, National Science Foundation; Jill L Karsten, National Science Foundation; Elizabeth Lynch Rom, National Science Foundation
Session Topic: Education (ED)
Co-Sponsors: Atmospheric Sciences (AS); Earth and Planetary Surface Processes (EP); Ocean Sciences (OS)

GC052. Toward a Sustainable Human Future
Today's society is faced with critical adjustments to our changing environment, reconciling social, economic and environmental expectations, while deriving technological and social solutions to enable the sustenance of cultures and communities, from the regional to global scale. This grand challenge is the motivation for the emerging field of sustainability science and forms the foundation for the NSF's Science, Engineering and Education for Sustainability (SEES) initiative. The session will bring together interdisciplinary research teams that address key topics, including fresh and ocean water challenges, air quality, coastal vulnerability, cyber-enabled sustainability, climate modeling, sustainable resources and materials, hazards, and ecosystem changes.

Conveners: Ben van der Pluijm, University of Michigan; Jessica Robin, National Science Foundation; Nancy Grimm, Arizona State University
Session Topic: Global Environmental Change (GC)
Co-Sponsors: Biogeosciences (B); Public Affairs (PA); Societal Impacts and Policy Sciences (SI)

Upcoming NSF Proposal Announcement Deadlines and Target Dates

You can find the full list of active GEO funding opportunities on the Directorate for Geosciences website, but here are some programs particular interest to the EAR community:

ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers
12-584 - Letter of Intent, September 5; Full Proposal, November 8

Partnership for Innovation: Accelerating Innovation Research (PFI: AIR)
12-571 - Letter of Intent, September 12; Full Proposal, November 13

Innovation Corps Program (I-Corps)
11-560 - July 1-September 15 (window)

Arctic SEES (ArcSEES)
12-553 - September 14

Cooperative Studies of the Earth's Deep Interior (CSEDI)
11-548 - September 24

EarthScope: SAFOD Management Office (SMO)
12-574 - September 24

Industry/University Cooperative Research Centers Program (I/UCRC)
12-516 - September 28

Alliances for Graduate Education and the Professoriate (AGEP)
12-554 - October 30

@NSF_EAR : Earth Science news from the Division and beyond
@NSF : News and highlights from all directorates at NSF
@EarthScopeInfo : News, updates, and fun facts from the EarthScope Office
@GeoPRISMS : News and updates from the GeoPRISMS Office

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This newsletter is designed to share information about NSF s Division of Earth Sciences. If you have comments or questions, please contact Dr. Jennifer Wade at jwade@nsf.gov

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