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Toward a New Generation of Ice Sheet Models

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EOS

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EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

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Sandy Signs of a Tsunami's Onshore Depth and Speed

Tsunamis rank among the most devastating and unpredictable natural hazards to affect coastal areas. Just 3 years ago, in December 2004, the Indian Ocean tsunami caused more than 225,000 deaths. Like many extreme events, however, destructive tsunamis strike rarely enough that written records span too little time to quantify tsunami hazard and risk. Tsunami deposits preserved in the geologic record have been used to extend the record of tsunami occurrence but not the magnitude of past events. To quantify tsunami hazard further, we asked the following question: Can ancient deposits also provide guidance on the expectable water depths and speeds for future tsunamis?

It has been well documented in the past 20 years that tsunami deposits, both ancient and recent, act as natural recorders of tsunami waves [*Tappin*, 2007]. With reliable dating, such deposits enable us to quantify paleotsunami recurrence intervals. But characterizing both event frequency and magnitude is critical for assessing tsunami risk. Quantifying paleotsunami size by modeling onshore flow depth and speed from tsunami deposits would provide a key for determining the deadliness and destructiveness of past events. Ideally, such a key could also inform long-term hazard assessments based on tsunami source mechanisms (e.g., fault slip or submarine landslides) inverted from calculated paleotsunami wave characteristics.

Developing quantitative tools to estimate flow depth and speed from tsunami deposits requires interdisciplinary collaboration among the coastal geomorphology, sedimentary geology, sediment transport, hydrodynamics, remote-sensing, and seismology communities. This article presents a strategy for using "sedimentology benchmarks" to enhance this collaboration. Promising preliminary work, based on a tsunami sedimentology workshop held in spring 2007 in Friday Harbor, Wash., suggests that benchmarks will lead to an improved understanding of tsunami physical processes and to advances in our ability to quantify paleotsunami magnitudes by interpreting the geologic record.

The State of the Science

Tsunamis deliver highly energetic, sustained flows that can erode everything from large blocks to fine sediment and transport them up to thousands of meters across coastal plains. The long-period waves of a tsunami approach the shore at speeds of tens of kilometers per hour, causing nearshore water surface fluctuations with amplitudes of several to tens of meters. The leading wave—commonly related to the pattern of seafloor displacement in the source region—may arrive as either a receding trough or an advancing crest. The incoming waves commonly break offshore, where they form a bore or series of bores—relatively short breaking waveforms riding on the tsunami's longer wave. For example, in many videos of the 2004 Indian Ocean tsunami, the first tsunami wave rushes onto dry land much like a surging flood. Several additional large waves, with typical periods of tens of minutes, commonly follow, and onshore flooding typically lasts for hours.

While tsunami propagation models have been around for years and have been shown to be fairly accurate at predicting basin-scale travel times and deep-water wave amplitudes, models of tsunami inundation—where waves approach shore and flood the land—are less common and have not been adequately tested against field data. Recent inundation models consider wave evolution by simulating both linear and highly nonlinear processes of various length scales and timescales [*Liu et al.*, 2007]. Model predictions are particularly sensitive to effects of local bathymetry and coastal topography that cause tsunami runup to vary significantly, even in neighboring areas.

Inverse models of flow from tsunami deposits [see *Tappin*, 2007] and forward models of deposits from flow [*Gelfenbaum et al.*, 2007] are relatively new and still under development. These models exploit the dependence of sediment transport on the relationship between grain size (grain settling velocity) and flow shear stress. Deposition occurs where sediment transport converges or where deceleration permits sediment to fall out of suspension. Empirical relationships to infer deposit characteristics from flow velocities and, conversely, flow velocities from deposits have been derived from steady channel-flow experiments.

This suggests that it should be possible to combine tsunami hydrodynamics and knowledge of the sediment available for transport to predict the structure and texture of tsunami deposits—or to reconstruct tsunami flow histories from deposit characteristics. However, fundamental questions remain regarding tsunami turbulent flow structure and the applicability of existing sediment-transport models to a tsunami's timescale and initial dry-bed conditions.

Benchmark Strategy for Collaboration

Benchmarking tsunami sedimentology models entails developing test cases that can be treated using different approaches, allowing the model results to be compared and problems to be tackled in an efficient, coherent manner. Given the limitations of existing tsunami inundation and sediment transport models, two key challenges are well suited for such an approach: (1) closing the knowledge gap in linking modern events to their deposits with an improved understanding of tsunami sediment transport, and (2) adapting that relationship to interpret the geologic record.

Traditionally, benchmarks rely on analytical solutions or controlled experiments of known initial conditions with which to test and compare models or laboratory equipment. Our working definition of a benchmark is somewhat different for several reasons. First, there is no adequate analytical solution available for "tsunami sediment" problems, even for a case with simplified boundary conditions (e.g., planar beach topography) and homogeneous sediment. Second, while initial conditions of laboratory experiments can be specified in detail, comparing these small-scale experiments with nature is limited by scaling difficulties. Most important, while conventional benchmarks are used to rank models in well-established fields of study, tsunami sedimentology is at such an early stage that benchmarking serves instead to enhance collaboration in exploring physical processes and making improved model predictions. Such collaboration has already resulted from benchmark exercises designed to investigate the hydrodynamics on which tsunami runup models are based [*Yeh et al.*, 1996].

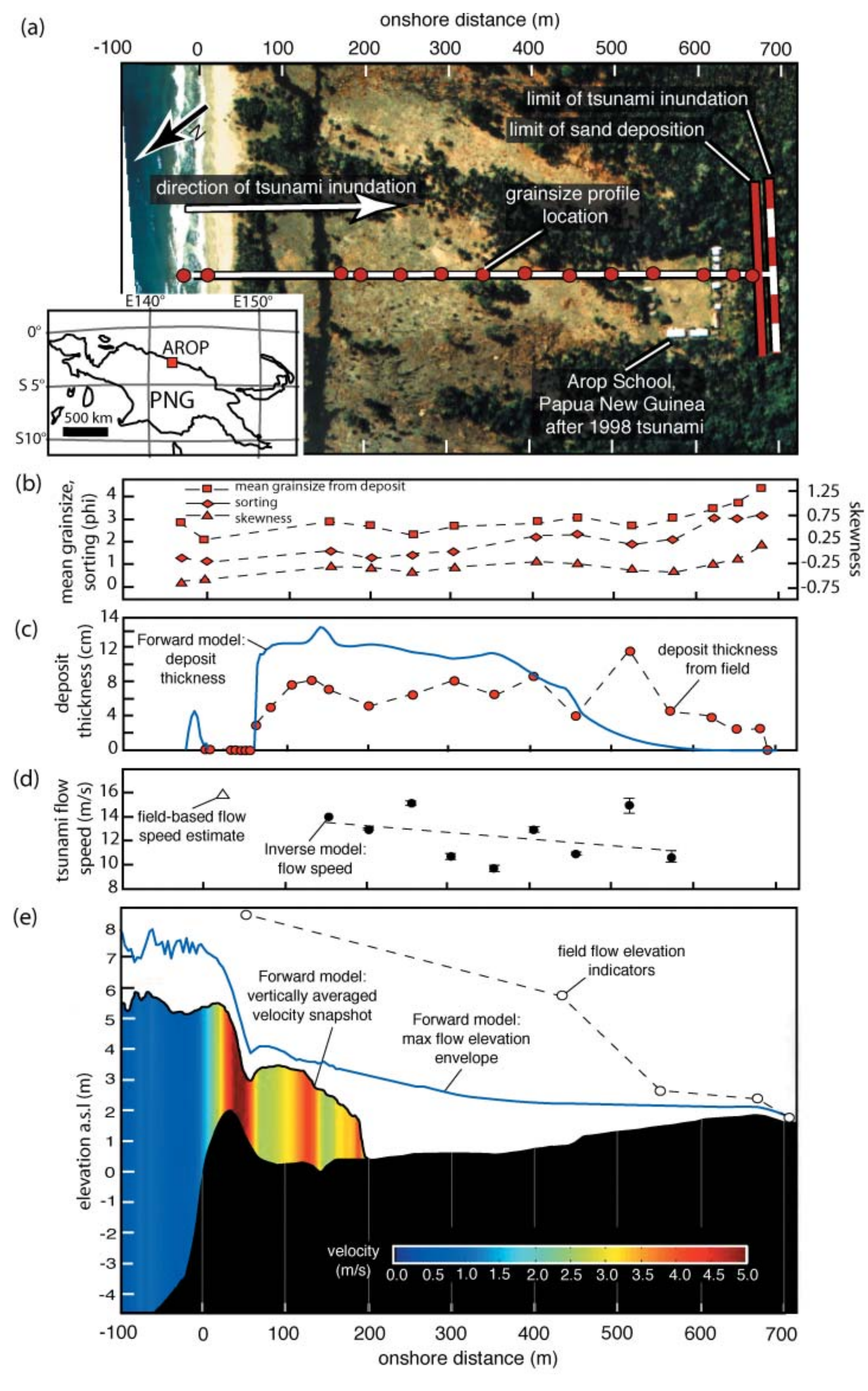

*Fig. 1. Flow depth and speed estimates for the 1998 Papua New Guinea tsunami. (a) Location and sample sites [*Gelfenbaum and Jaffe, *2003]. (b–e) Data collected from tsunami deposit (red symbols), field-based estimates of tsunami flow elevation (sum of flow depth and land elevation, white circles) and speed (white triangle), predictions using hydrodynamic model of* Lynett *[2007] with incorporated transport model following* Rakha et al. *[1997] (bold blue lines), and inverse model predictions of* Jaffe and Gelfenbaum *[2007] (black symbols).*

Benchmarking for tsunami sedimentology requires agreed-upon goals that promote interdisciplinary collaboration and development of appropriate data sets. For example, the community must identify key parameters to be estimated (e.g., wave height and speed) and set sensitivity study targets (e.g., effect of grain size on deposit thickness). These actions will ensure that the focus and scope of modeling studies are comparable. Identifying these parameters also helps to determine the minimum amount of information a benchmark data set must contain.

Proof of Concept

As a test of this approach, we performed pilot benchmark exercises on two data sets of tsunami deposits, one modern (1998 Papua New Guinea (PNG)) and the other ancient (buried; Mutnaya Bay, Kamchatka, Russia). Detailed treatment of the modern case (Figure 1) was aimed at linking modern events to their deposits and improving the understanding of tsunami sediment transport. The application of the models to the ancient case allowed us to evaluate how this understanding might be adapted to interpret the geologic record.

Models were used to estimate tsunami characteristics such as flow depth, flow speed, number of waves, and where possible, tsunami source for each benchmark. The data sets included grain-size distributions, deposit thickness, topographic profiles, and bathymetry. In the case of the modern deposit, additional information (from field estimates and eyewitness accounts) on the tsunami was available [*Gelfenbaum and Jaffe*, 2003]. Paleotsunami modeling efforts were complicated by incomplete deposit preservation, lack of flow depth or inundation limit indicators, and poorly constrained pre-tsunami topography at Mutnaya Bay.

Forward modeling of tsunami inundation was based on high-resolution bathymetry and topography collected along the sample

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transect for each benchmark. For the PNG case (Figure 1), further model constraints were provided by tsunami inundation limits and flow-depth indicators identified in the field and by the number of waves reported by eyewitnesses. Modeled and measured deposit thicknesses were comparable (Figure 1c). The modeled, vertically averaged velocity and flow depth snapshot (Figure 1e) shows flow accelerations and decelerations as the wave cascades over a topographic high, illustrating the complexity of flow-topography interactions.

Estimates of maximum flow speed from inverse modeling were based on assumptions of steady and uniform flow and on observed grain-size distributions and deposit thicknesses. The inverse model estimates for the PNG benchmark (Figure 1d) are consistent with independent field estimates of flow speed (calculated using Bernoulli's principle and water level data on buildings left standing after the tsunami). These estimates are of the same order of magnitude, but they exceed the flow speeds predicted by the forward model. Discrepancies between models may be due to missing processes (such as not accounting for momentum extracted from the flow by dense vegetation), other simplifying assumptions (such as no particle reentrainment), or poorly characterized initial conditions.

Results of the PNG case highlight the potential of using detailed data from a modern tsunami and its deposit for benchmarking inverse models. For forward models, however, a limitation of this type of benchmark is that initial conditions are poorly known for natural tsunamis. A better benchmark for forward modeling would be a detailed laboratory experiment data set with well-defined initial conditions. Whereas treating a paleotsunami deposit benchmark would be a valuable step toward interpreting the geologic record for hazard assessment, problems with preservation limit available information for ancient cases like Mutnaya Bay. Nature is not simple, but initial benchmark cases should be.

On the basis of our pilot study, we developed a preliminary list of requirements for future tsunami sedimentology benchmarks (see http://tsunami.orst.edu/sedimentology). This list is a work in progress, and we ask interested scientists to comment on it by prioritizing parameters to which their own approaches are most sensitive. For example, what are the minimum bathymetric resolution, deposit-sampling density, and grain-size detail required to test your model? Answers to these questions will vary over a broad range depending on model techniques, assumptions, and goals. Responses will help to guide data gathering, experimental design, and field campaigns and will define objectives for the next generation of tsunami sedimentology benchmark experiments.

Acknowledgments

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Toward a New Generation of Ice Sheet Models

Large ice sheets, such as those presently covering Greenland and Antarctica, are important in driving changes of global climate and sea level. Yet numerical models developed to predict climate change and ice sheet–driven sea level fluctuations have substantial limitations: Poorly represented physical processes in the ice sheet component likely lead to an underestimation of sea level rise forced by a warming climate.

The resultant uncertainty in sea level projections, and the implications for climate policy, have been widely discussed since the publication of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) [*IPCC*, 2007]. The assessment report notes that current models do not include "the full effects of changes in ice sheet flow, because a basis in published literature is lacking." The report also notes that the understanding of rapid dynamical changes in ice flow "is too limited to assess their likelihood or provide a best estimate or an upper bound for sea level rise."

Credible predictions of ice sheet evolution and sea level change will require a new generation of ice sheet models (ISMs) coupled to atmosphere-ocean general circulation models (AOGCMs). Although the development of these new tools is ongoing, credibility (i.e., physically justifiable model assumptions) demands institutional support and the sustained efforts of researchers working on numerical algorithm development, software engineering, and the analysis of model output.

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Perhaps more important, developing these tools will require collaboration with glaciologists, climate modelers, and end users to implement physically sound ice dynamics while working within the constraints of AOGCMs. A concerted effort to develop a new generation of ISMs should be pursued concurrently with observational efforts and glaciological process studies; yet progress is hampered by a lack of cross-disciplinary and cross-institutional coordination (and resources) focused on this goal.

Current Status

The comprehensive continental-scale ice sheet models used to predict global sea level change have not been substantially modified in the past decade. The models are based primarily on the assumption that gravitational driving stresses are balanced locally by basal traction, resulting in flow dominated by vertical shear (i.e., that the horizontal transmission of stress is unimportant) [e.g., *Huybrechts et al.*, 2004]. This assumption is appropriate where creep is the dominant ice flow process and where the effects of subglacial meltwater can be neglected. These ISMs have been partially coupled to AOGCMs (developed at leading centers in the United States and around the world), using surface fields such as air temperature and precipitation, to develop the projections of sea level change that have been used in the IPCC's Third and Fourth Assessments.

Why Scientists and Policy Makers Are Dissatisfied

In the past decade, our knowledge of ice sheet dynamics has improved dramatically, due to the application of satellite techniques such as radar altimetry and interferometry, together with airborne and surface observations (reviewed by *Shepherd and Wingham* [2007]). New, unexpected observations include the thinning and acceleration of Greenland outlet glaciers, rapid ice shelf melting and increased discharge in the grounded drainage basins of the Amundsen Sea embayment, West Antarctica, and the acceleration of many upstream glaciers following the collapse of the Larsen B ice shelf on the Antarctic Peninsula. In addition to the present-day evidence of rapid flow, paleoclimate records suggest that sea level rise during deglaciations may have occurred, at least episodically, at rates not attainable by current ice sheet models.

However, ice sheet simulations assessed by the IPCC cannot reproduce these observations because the simulations fail to fully account for ice shelves, subglacial processes, and changes in stress underlying these events. Additionally, observed changes in ice volume and discharge occur rapidly enough to modify ice sheet boundary conditions. The implicit assumption in current stand-alone ice sheet models—disparate atmospheric, oceanic, ice shelf, and ice sheet timescales—is invalid if this behavior is widespread. Without coupling these components in a climate model, we cannot assess the spatial and temporal extent of these potentially important feedbacks.

Underlying Problems

Continental-scale ice sheet models have the least skill where the influences of meltwater production and flow, ice shelf buttressing, and subglacial sediment deformation are prominent. These processes can interact to accelerate discharge near ice sheet margins. Current computer-based projections of ice sheet response to a warming climate are thus almost certainly biased against delivering fast responses, in turn underestimating the rate of sea level rise.

Key processes that should be incorporated into models to make reliable predictions of future ice sheet change include the following:

- interaction of ice sheets with the ocean, requiring models of regional oceanic circulation, melting and freezing in subshelf cavities, a better representation of continental shelf processes, and coupling to the global ocean;
- grounding line migration, requiring improved numerical algorithms (e.g., high-resolution with adaptive grids) and coupled models of inland and ice shelf flow;
- production and flow of water at the surface and within and beneath the ice;
- ice streaming, whose modeling requires higher-order flow physics, a basal processes submodel, and a nested mesh approach; and
- iceberg calving, which is important in ice shelf collapse as well as outlet glacier dynamics and which requires the application of fracture mechanics.

Insights From AOGCMs

Incorporating physically accurate stand-alone ISMs into an AOGCM requires awareness of overall design constraints, including

- conservation of heat and freshwater. AOGCM-ready ISMs will need to include a complete surface energy balance and hydrologic accounting (e.g., the disposition of basal and surface melt).
- a time-dependent boundary. Incorporating this capability will necessitate a coincident change in ocean models, whose lateral boundaries need to be able to migrate as the ice sheet grows or shrinks in response to climate forcing.
- acceptance of the large-scale nature of AOGCMs, which will not be able to provide or accept fluxes at the scale of individual ice streams or small ice shelves. The next generation of ISMs must resolve key small-scale flow features, either with statistical techniques (perhaps based on off-line high-resolution studies scaled up to the AOGCM grid scale), a uniform reduction of the grid spacing (≤5 kilometers), and/or by selective resolution using nested or unstructured grids.

Additionally, there are several lessons learned over the history of global coupled climate modeling, under way at many institutions since the 1960s, which should be applied to the model-coupling process.

- Model building is a highly interactive process. A distributed mode of model building, where component development takes place at differing institutions, can work, but it increases the need for enhanced, sustained communication.
- The development of new components should occur in close coordination with the rest of the model physics, since their interactions are crucial. The idea that a component can be developed in isolation, and then simply "plugged into" the model, is fraught with difficulties.
- Clarity of purpose is essential. The specific goal for which a model is developed must always be clear, including the definition of what would constitute "success" of the model.
- Model development usually takes longer than anticipated.

Recommendations

Ice sheet models currently used in conjunction with AOGCMs are process-poor, even when compared with our imperfect understanding of ice sheet dynamics. The computational demands of ice models are modest; a substantial increase in their complexity would not affect the ability of a coupled ISM-AOGCM to perform millennial-scale climate experiments. Success in constraining ice sheet response to climate forcing is thus limited (at least in part) by the validation of physically sound ice sheet models and their incorporation into AOGCMs. Model development should occur concurrently with ongoing and proposed observational programs, and with studies of physical processes controlling ice sheet dynamics, to improve the chances that models will be able to reproduce reality in a timely manner.

We therefore recommend increased support for ice sheet modeling at facilities developing comprehensive state-of-the-art AOGCMs. A key aspect of any such effort

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should include stronger links between government labs and researchers in the university community in order to maintain optimal allocation of tasks and resources. We encourage the development of different ice sheet dynamical cores and process parameterizations by various modeling groups. At the same time, we recommend the use of a shared modular software framework to avoid duplication of labor. Modularity will simplify the AOGCM-ISM coupling interface and allow meaningful intercomparisons, a large step forward toward the integration of ISMs into the modeling efforts in the climate community.

Acknowledgments

This report summarizes the conclusions and recommendations of a 1-day workshop on ice sheet modeling held at the NOAA Geophysical Fluid Dynamics Laboratory on 8 January 2007, sponsored by NOAA and by the Program in Science, Technology, and Environmental Policy of the Woodrow Wilson School of Public and International Affairs at Princeton University, N. J.

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NEWS

In Brief

Protecting Louisiana's coasts With numerous wetlands restoration and protection projects slated for Louisiana, a well-developed implementation strategy that can address a number of uncertainties is important for the success of these projects, according to a 14 December report by the U.S. Government Accountability Office (GAO). GAO specifically urged maintaining the collaborative process that is used by Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program agencies, with scientists, engineers, and others working together to plan and design restoration projects. The report also noted the need to address such other issues as having an integrated monitoring system to determine whether goals and objectives are met as well as to understand that projects can encounter significant setbacks due to storms and hurricanes, landscape and structural causes, and spiraling project costs. Louisiana state officials anticipate the state could receive about $8.5 billion over the next 10 years for coastal restoration and protection. Nearly 40% of all coastal wetlands in the lower 48 U.S. states are located in Louisiana. For more information, visit the Web site: http://www.gao.gov/new.items/d08130.pdf.

En route to comet Hartley 2 NASA has given the go-ahead for the Deep Impact spacecraft to fly to comet Hartley 2 after the original target, comet Boethin, could not be found despite extensive searching. The spacecraft, which successfully guided an impactor into comet Tempel 1 in July 2005, will fly by comet Hartley 2 on 11 October 2010 as part of a two-part extended mission known as EPOXI. During the first part of the mission—Extrasolar Planet Observation and Characterization—a large telescope on the spacecraft will observe and study several previously discovered extrasolar planetary systems. During the second part of the mission—the Deep Impact Extended Investigation—the spacecraft will fly to within 1000 kilometers of the 0.8-kilometer-wide comet and study it with two telescopes and an infrared spectrometer. "Hartley 2 is scientifically just as interesting as comet Boethin because both have relatively small, active nuclei," said Michael A'Hearn, principal investigator for EPOXI at the University of Maryland at College Park. Scientists speculate that comet Boethin may have broken up into pieces too small for detection. For more information, visit the Web sites: http://www.nasa.gov/deepimpact and http://www.nasa.gov/epoxi.

—RANDY SHOWSTACK, Staff Writer

GEOPHYSICISTS

In Memoriam

John Ellis, 76, 10 August 2007, Atmospheric Sciences, 1958
Richard Ewing, 61, 5 December 2007, Hydrology, 2006
Stanley M. Flatté, 66, 4 November 2007, Ocean Sciences, 1985
Stanley N. Davis, 83, 18 November 2007, Fellow, Hydrology, 1953

Honors

Mary M. Glackin has been appointed deputy undersecretary of commerce for oceans and atmosphere of the U.S. National Oceanic and Atmospheric Administration. In this capacity, she serves as NOAA's chief operating officer, responsible for the day-to-day management of the agency's operations, and functions as a key advisor to the NOAA administrator on all program and policy issues. Among Glackin's previous positions, from June through September 2007 she served as acting assistant administrator for weather services and director of NOAA's National Weather Service.

Stanley A. Morain and the Gravity Recovery and Climate Experiment (GRACE) mission team received the William T. Pecora Award at a 10 December ceremony at the AGU Fall Meeting. NASA and the U.S. Department of the Interior present individual and group Pecora Awards annually to honor outstanding contributions in the field of remote sensing and its application to understanding Earth. The award was established in 1974 to honor the memory of William T. Pecora, former director of the U.S. Geological Survey and undersecretary of the Interior Department. Morain, professor of geography and director of the Earth Data Analysis Center at the University of New Mexico, Albuquerque, has collaborated internationally to create remote sensing applications that benefit society in the areas of agriculture, transportation, and public health. GRACE is a collaborative endeavor involving the Center for Space Research at the University of Texas at Austin; NASA's Jet Propulsion Laboratory, Pasadena, Calif.; the German Space Agency; and Germany's National Research Center for Geosciences, Potsdam.

MEETINGS

Studying Geohazards With Ocean Cores

Addressing Geologic Hazards Through Ocean Drilling: An IODP International Workshop; Portland, Oregon, 27–30 August 2007

How can Integrated Ocean Drilling Program (IODP) drilling contribute to the understanding of highly hazardous geologic events, such as great earthquakes, submarine landslides, and volcano collapses, all of which can generate devastating tsunamis and threaten huge parts of Earth's coasts? Eighty-nine participants from 18 countries grappled with this topic for 4 days near Portland, Oreg., in late August and spawned a number of working groups focused on generating proposals to gain such understanding.

Ideas included potential scientific targets and locations for drilling, proposed observatories to study active and potentially precursory processes, in situ measurement techniques, and methodologies for interpreting sedimentary records. A common theme was the unique opportunity afforded by IODP drilling to study active processes relevant to geohazards, especially at known points within the deformation cycle. The meeting also led to proposed additions to the IODP initial science plan.

Meeting participants discussed how geohazards can be evaluated through drilling in several ways. One way is to understand the preconditioning for failure and the changes in physical properties that can trigger an event. Preconditioning includes diagenetic and mineralogic changes that affect strength and rheology, as well as reservoir-seal variability, smear zones on fault surfaces, injected sands, and gas content. Triggering mechanisms include earthquakes, wave and tide action, rapid sedimentation, magmatic overpressuring, destabilization of hydrates, groundwater seepage, and glaciation. The development of excess fluid pressures is common to many of these mechanisms.

A second way to understand the risk associated with geohazards is to develop a careful understanding of their frequency and spatial distribution, which can be established through drilling and dating the events. For example, conference sessions reviewed studies of earthquake recurrence in the Pacific Northwest region resulting from careful dating of turbidite sequences along the Cascadia margin, and such studies should be expanded to many other settings.

The combination of drilling and ocean observatories (seafloor and subseafloor) is important for understanding the processes responsible for slope and volcano failure and earthquake rupture, and also for documenting the changes in movement, rate, and physical properties associated with failure. A number of examples that were discussed at the meeting underscored the potential devastation that such events could have on coastal populations, reminiscent of the consequences of the 2004 Sumatra earthquake and tsunami. Collapse of Mount Etna, an active volcano on the coast of Sicily, could threaten much of the Mediterranean coastline, and failure of one of the large Hawaiian volcanoes could affect huge portions of the Pacific coastline. A repeat of known landslides, such as the Grand Banks slide in 1929 or the Storegga slide of ~8100 years ago, would also be devastating for the North Atlantic region. Large bolide impacts, fortunately very rare, could change the world as we know it.

Further details from this workshop can be found at http://www.iodp.org/geohazards/. See also J. Morgan and E. Silver (Addressing Geologic Hazards Through Ocean Drilling Workshop, *MARGINS Newsl., 19,* 5–6, 2007).

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Effect of Human Activities on the Atmosphere

Detecting the Atmospheric Response to the Changing Face of the Earth: A Focus on Human-Caused Regional Climate Forcings, Land-Cover/ Land-Use Change, and Data Monitoring; Boulder, Colorado, 27–29 August 2007

Human activities continue to significantly modify the environment. The impacts of these changes are highlighted, for example, in local-, regional-, and global-scale trends in modern atmospheric temperature records and other relevant atmospheric indicators. Studies using both modeled and observed data have documented these impacts. Thus, it is essential that we detect these changes accurately to better understand the impacts on climate and provide improved assessment of the predictability of future climate.

Therefore, the objectives of this National Science Foundation–funded workshop were twofold. First, the workshop highlighted land-use/land-cover and ecosystem change and subsequent impacts on weather and climate. Participants discussed both long-term systematic change (e.g., agricultural land-use change, deforestation) and short-term abrupt change (e.g., rapid small-scale urbanization). Second, the workshop addressed new observing systems and issues associated with using the national data archive to monitor climate changes. Temperature is one key indicator of impacts of land-use/ land-cover change, and hence this workshop featured issues related to temperature observation and associated bias. However, biases associated with precipitation were also discussed.

Papers were organized under three sessions to discuss recent developments, including (1) observations of land-surface/ ecosystems function changes and their interactions with weather and climate; (2) modeling effects of land-use/land-cover change and ecological processes on weather and climate; and (3) monitoring and quantifying land-use/land-cover change and ecological processes and their impacts on observational data including multidecadal surface air temperature trends and associated bias.

Participants discussed impacts of croplands on climate, land-use changes on temperature change, urbanization on precipitation, deforestation and soil moisture changes on the monsoon and monsoon depressions, vegetation change and subsequent modification of the effect of plant biophysical properties on climate, impacts of man-made lakes on weather, and model representation of land use. Several papers also discussed the role of station histories in identifying land-use change; the important role the Climate Reference Network (CRN) can play in detecting the impacts of land-use change on climate; the effects of land use on precipitation measurement and bias correction; biases associated with United States Historical Climatology Network (USHCN) data and its use in land-change studies; and challenges associated with determining impacts of land-use change on the Tibetan Plateau.

More than 50 papers were presented, and the participants represented Australia, Canada, China, Colombia, India, Netherlands, Turkey, and the United States. A total of 16 graduate students and postdoctoral researchers were supported through travel grants from the NSF. A number of recommendations were made including a call for more accurate land-use/land-cover data for modeling and for better understanding of the interactions between changed land surface and the atmosphere; more studies on the impacts of wetlands, man-made lakes, agricultural land uses, and urbanization on weather and climate; the monitoring of soil moisture; and the use of the CRN in conjunction with land-use/land-cover change studies and assessment of data quality in other networks. Details of the recommendations will be published in the form of several journal papers. Participants also recommended publishing a journal special issue. Papers presented at the workshop can be found at http://cires.colorado.edu/science/groups/pielke/links/Detect/ and http://kyclim.wku.edu/.

—REZAUL MAHMOOD, Department of Geography and Geology and Kentucky Climate Center, Western Kentucky University, Bowling Green; E-mail: rezaul.mahmood@wku.edu; ROGER PIELKE SR., Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder; and KENNETH G. HUBBARD, High Plains Regional Climate Center, University of Nebraska at Lincoln.

Sediment Fluxes and Budgets in High-Latitude and High-Altitude Cold Environments

Sediment Budgets in Cold Environments (SEDIBUD) Second Workshop; Abisko, Sweden, 15–19 September 2007

Amplified climate change and ecological sensitivity of polar and cold regions have been highlighted as key global environmental issues. Projected climate change in cold regions is expected to alter melt season duration and intensity, along with total precipitation and the balance between snowfall and rainfall. Similarly, changes to the reduced extent of permafrost and increased active layer depth are also expected. These effects will undoubtedly change surface water environments in cold regions and alter the flux of sediment, nutrients, and solutes, but the absence of data and analysis to understand the sensitivity of the surface water environment is acute in cold regions.

A working group of the International Association of Geomorphologists (IAG) has been formed to address this key knowledge gap through the Sediment Budgets in Cold Regions (SEDIBUD) program. SEDIBUD represents a continuation of the previous European Science Foundation SEDIFLUX (Sedimentary Source-to-Sink Fluxes in Cold Environments) program. The central research question of the working group is to assess the contemporary particulate and dissolved fluxes in cold climates. SEDIBUD has expanded to an international group of researchers with field research sites located in polar and alpine regions in the Northern and Southern hemispheres. Research carried out at each site varies by program, logistics, and available resources, but typically represents interdisciplinary collaborations of geomorphologists, hydrologists, ecologists, and permafrost scientists and glaciologists with different levels of detail.

SEDIBUD has developed a key set of primary research data requirements intended to incorporate results from these varied projects and allow analysis across the network. Sites will report annual climate conditions as well as total discharge and particulate and dissolved fluxes. To support these efforts, the first edition of the SEDIFLUX/ SEDIBUD manual (http://www.ngu.no/FileArchive/237/2007_053.pdf) has been produced to establish common methods and data standards. Ongoing revision will continue to improve the manual to facilitate intercomparison of research results.

SEDIBUD currently has identified 37 sites with a goal to extend the network to at least 40 sites that cover the widest range of cold environments possible. Additionally, it is expected that collaboration within the group will act as a catalyst to develop new sites in underrepresented regions. Close coordination and collaboration with a number of International Polar Year (IPY) research programs, including International Tundra Experiment (ITEX), Circumpolar Active Layer Monitoring (CALM), and Arctic Coastal Dynamics (ACD/ACCO Net), will provide further opportunities for collaborative research to address broader polar environmental research issues.

Researchers met for the second SEDIBUD workshop at Abisko, Sweden, to present ongoing research efforts and discuss research goals and the field methods detailed in the SEDIFLUX/SEDIBUD manual. This successful workshop brought together 22 participants from 12 countries and built on the first SEDIBUD workshop in Trondheim, Norway (2006), and previous SEDIFLUX meetings in Durham, UK (2005), Clermont-Ferrand, France (2005), and Saudarkrokur, Iceland (2004).

The third SEDIBUD workshop will take place 9–13 September 2008 at the Niwot Ridge Field Station, Boulder, Colo. Interested researchers are encouraged to attend and participate in this growing international initiative. For more information on the SEDIBUD program, see http://www.geomorph.org/wg/wgsb.html or contact Achim A. Beylich (chair, Trondheim, achim.beylich@NGU.NO) or Scott Lamoureux (vice-chair, Kingston, scott.lamoureux@queensu.ca).

—SCOTT LAMOUREUX, Department of Geography, Queen's University, Kingston, Ontario, Canada; ACHIM BEYLICH, Norwegian Geological Survey, Trondheim, Norway; ARMELLE DECAULNE, Centre National de la Recherche Scientifique/GEOLAB, Clermont-Ferrand, France.

MEETING ANNOUNCEMENTS

■ 10–12 February 2008 **Teaching With New Geoscience Tools: Visualizations, Models, and Online Data**, Tempe, Arizona, USA. Sponsors: National Association of Geoscience Teachers (NAGT); National Science Foundation; Science Education Resource Center; others. (C. Manduca; Tel.: +1-507-646-7096; E-mail: cmanduca@carleton.edu; Web site: http://serc.carleton.edu/NAGTWorkshops/tools08/index.html)

This workshop will bring together geoscientists and educators to examine how they use new research tools in undergraduate education. Abstract deadline is 29 December.

■ 10–11 March 2008 **2008 Annual Student Meeting of the Remote Sensing and Photogrammetry Society (RSPSoc)**, Lyndhurst, New Forest, United Kingdom. Sponsors: RSPSoc; Intergraph; Leica Geosystems; others. (T. Thomson; E-mail: thomson@ge.ucl.ac.uk; Web site: http://www.rspsoc.org/events/info/annual-student-meeting-2008/)

This event provides a platform for young researchers to present their work from all sectors of remote sensing and photogrammetry. Topics include polar, forestry, geomorphology, vegetation, and operational remote sensing.

■ 3–4 April 2008 **First World Coal-to-Liquids Conference**, Paris, France. Sponsors: Axens; World Coal Institute; IFP Group Technologies; others. (Conference Secretariat, MCI, 24, rue Chauchat, Paris, France 75009; Tel.: +33-0-153-85-8274; Fax: +33-0-153-85-8283; E-mail: wctl2008info@mci-group.com; Web site: http://www.world-ctl2008.com/index.html)

The conference will focus on recent information related to this industry on geostrategy, technology, economics, and the environments. Session topics include energy supply and demand, environmental concerns, and associated industries.

■ 4–7 April 2008 **2008 Western Alaskan Interdisciplinary Science Conference and Forum**, Dillingham, Alaska, USA. Sponsors: Western Alaska Interdisciplinary Science Association; University of Alaska Fairbanks (UAF). (T. Radenbaugh, University of Alaska Fairbanks, Bristol Bay Campus, Fairbanks, Alaska, USA; Tel.: +1-800-478-5109; E-mail: bftar@uaf.edu; Web site: http://www.uaf.edu/waisc/)

The conference, whose theme is "Weathering change, monitoring uncertainty," will highlight regional scientific efforts that provide a more interdisciplinary approach to scientific inquiry and resource management. Session topics include subsistence and traditional ecological knowledge; solid and liquid waste disposal; ecosystem health; mining in western Alaska; and water quality. Abstract deadline is 30 January 2008.

■ 5–10 April 2008 **45th Annual Meeting of the Clay Minerals Society: Clays of Demeter**, New Orleans, Louisiana, USA. Sponsors: Clay Minerals Society; American Chemical Society (ACS). (B. Ross, Cottey College, Nevada, MO 64772, USA; Tel.: +1-417-667-8181; E-mail: bross@cottey.edu; Web site: http://www.clays.org/home/HomeAnnualMeeting.html)

At this joint meeting with the Geochemistry Division of the ACS, technical sessions focus on clay minerals and biomolecules, clay minerals and health, clay membranes in the subsurface, and the impact of Hurricane Katrina from an environmental and petrochemical perspective.

■ 5–7 May 2008 **40th International Liège Colloquium on Ocean Dynamics**, Liège, Belgium. Sponsor: NATO. (Conference Secretariat; Web site: http://modb.oce.ulg.ac.be/backup/colloquium/NATO-RussiaARW/2008.html)

This colloquium is being held in association with the NATO-Russia Advanced Research Workshop.

■ 5–8 May 2008 **Seventh Annual Conference on Carbon Capture and Sequestration**, Pittsburgh, Pennsylvania, USA. Sponsors: National Energy Technology Laboratory; Monitor Exchange; U.S. Department of Energy. (Conference Administrator; Tel.: +1-202-296-2814 ext. 109; Fax: +1-202-296-2805; E-mail: carbonsq@exchangemonitor.com; Web site: http://www.carbonsq.com/index.htm)

The conference will focus on carbon capture, separation, and sequestration technologies, providing a forum for the exchange of information on developing capacity within the public and private sectors to move the technology base forward. Topics include sequestration of carbon emissions in geologic formations, potential commercial approaches to supporting reduction of carbon intensity, and methods for reporting CO_2 emissions. Abstract deadline is 12 February 2008.

■ 8–10 May 2008 **NATO-Russian Advanced Research Workshop: Influence of Climatic Change on Arctic and Subarctic Changing Conditions**, Liège, Belgium. Sponsor: NATO. (Conference Secretariat; Web site: http://modb.oce.ulg.ac.be/backup/colloquium/NATO-RussiaARW/2008.html)

The workshop includes presentations and discussions on topics including the ongoing transformation of the Arctic ecosystem, impacts on sub-Arctic and temperate seas, and the issue of sovereignty and security in the Arctic.

About AGU

AGU Council and Other Union Leaders Meet in San Francisco

On 9 December, the chairs of the focus groups met with Union officers to discuss common concerns, in particular, ways to assure that all members can participate fully in AGU activities regardless of their primary scientific affiliation with the Union. The chairs of the policy committees joined the others and discussed programmatic priorities for the coming 6–12 months.

At the Council Forum later that day, the full Council and the focus group chairs discussed the items to be considered for Council action on 14 December. During the Forum, Executive Director Fred Spilhaus reported on the surveys he had been asked to conduct related to AGU's practice of not publishing the actual election counts. Those who had run for office in the past—both winners and losers—and a random sample of members had been queried. The current practice was supported, especially if it would mean that members were less likely to stand for election. Forty scientific society executives had also been queried about how their societies deal with election results; about three quarters of them follow practices similar to those of AGU.

At the Council meeting on Friday, AGU President Tim Killeen reported that the mayor had issued a proclamation declaring 14 December 2007 "American Geophysical Union Day" in San Francisco. This action was taken in recognition of the 40 years of support the AGU membership has given to the city, which is greatly appreciated.

Council also adopted a new vision statement as follows: "Our vision is a worldwide scientific community that advances, through unselfish cooperation in research, an understanding of Earth and space that is used for the benefit of humanity." A revised mission statement and a statement of strengths, weaknesses, opportunities, threats, and challenges were also adopted. These will be the foundations for updating AGU's strategic plan over the next few months with input of the policy committees and section and focus group officers. President-elect Tim Grove chairs this effort.

On the recommendation of the Publications Committee, Council authorized transferring $750,000 from the Electronic Publishing Development Fund to the Perpetual Care Trust Fund. These monies had originally been set aside in preparation for the transition to electronic publishing. The committee pointed out the importance of protecting the asset created when all of AGU's back issues of journals and books were digitized. The trust fund will provide monies to protect these files and to help migrate them forward when technology changes.

AGU is now the largest of the 10 member societies of the American Institute of Physics and is entitled to seven seats on the governing board. Tim Grove was elected and Tim Cohn was reelected for a term ending 2011; Jaime Fucugauchi was elected to complete the unexpired term of Lou Lanzerotti, who is the incoming chair of the AIP board.

Council also adopted four position statements. Each had been revised to bring it up to date in light of current scientific knowledge. The statement on the Comprehensive Nuclear Test Ban Treaty is a joint statement of AGU and the Seismological Society of America, the two research societies most able to provide scientific expertise to U.S. policy makers on this topic. The statement, "Biological Evolution and the History of the Earth Are Foundations of Science," is the most recent version of the statement related to teaching evolution, which, when adopted in 1981, was AGU's first position statement.

The other two position statements deal with meeting challenges of natural hazards and with human impact on climate. The full text of all statements will be published in *Eos* and posted on AGU's Web page in the near future.

Other actions taken by Council included adopting a statement of commendation to Spilhaus for his 40 years of service to the Union, approving the 2008 budget, and authorizing four new section and focus group awards. Members will have the opportunity to nominate colleagues for these new recognitions.

The Council meeting was the last event at the 2008 Fall Meeting, which once again broke attendance records with more than 14,600 participants.

—Judy C. Holoviak, Director of Publications

Book Review

Biogeochemistry of Estuaries

Thomas S. Bianchi
Oxford University Press; xiv + 706 pp.; ISBN 0-19-516082-7; 2006; $124.50

Whether you are interested in material flux from the continents to the oceans or whether the oysters set down in front of you at a waterfront restaurant may have come from polluted waters, we know estuaries are important places. However, anyone attempting to summarize and synthesize the long and rich literature of estuarine research is presented with a daunting task. This is because beyond the concept of an estuary being the transition zone where "fresh water meets seawater," the exact definition of an estuary is not uniformly agreed upon by scientists in this field. Also, estuaries—regardless of how they are defined—tend to be highly heterogeneous, in both space and time. Against this backdrop, Thomas Bianchi's *Biogeochemistry of Estuaries* successfully tackles its subject matter and is an exciting addition to the field of estuarine research.

The way the author discusses topics should make this an excellent textbook for an upper level class in estuarine biogeochemistry. Assuming only some basic knowledge of chemistry and physics, Bianchi presents the material in a manner that makes it accessible to advanced undergraduates or beginning graduate students across a broad range of scientific disciplines. At the same time, because the material is presented with sufficient detail and scientific rigor, the book also should be useful to researchers who are more versed in different aspects of the study of estuaries. Such individuals likely will find this book to be a valuable contribution to their personal—and their institution's—libraries. Individuals involved in related fields such as oceanography or aquatic chemistry also will find much that is interesting and relevant to them in this book.

The book contains 16 chapters divided among seven sections. Each chapter concludes with a summary series of concise statements that lay out the major points in the chapter. Overall, I found this approach to be a great way to end the chapters. In particular, in a few places where bigger concepts got lost among a chapter's details, the summary helped me get back on track.

After an introductory chapter that briefly defines the subject of the book, the first of the book's seven sections contains chapters that describe the geomorphology (physical structure) of estuaries and examine estuarine hydrodynamics (e.g., circulation, mixing, and salt balance). The next section describes the chemistry of estuarine waters, while the third section discusses estuarine sediments and the use of radioisotopes to quantify the rates of estuarine processes.

The fourth section presents a thorough discussion on organic matter sources and cycling, which in many ways sets the stage for the material presented in later chapters. The next section contains several chapters on nutrient and trace metal cycling in estuaries. These chapters generally do an excellent job examining these topics, although I found the chapter on trace metals a bit too general, particularly in comparison with the depth of the discussions in the other chapters in this section. The sixth section is a single chapter on anthropogenic inputs to estuaries. The chapter's examination of the biogeochemical impacts of human populations on estuaries builds on information presented in previous chapters.

The last section is a single chapter examining the global impact of estuaries. The chapter moves beyond traditional ideas and concepts about the linkages between estuaries and the coastal ocean by examining river-dominated ocean margins—such as the Mississippi and Amazon rivers—and groundwater inputs to the coastal ocean. Although the discussions here are somewhat short, in part because these are relatively new areas of research, a good overview of these topics is presented.

The book is thoroughly referenced, containing by my estimation almost 3000 references. Thus, the book provides interested individuals a superb map to the important works in specific areas of research discussed in the book. The book also contains an extensive glossary of key terms used in the book, as well as a series of relevant tables. All of these will be useful to readers, regardless of their level of expertise.

Overall, *Biogeochemistry of Estuaries* is well written and does a superb job of synthesizing information that heretofore was scattered across a wide range of books and/or journals. The book represents a major contribution to the field of estuarine science and should be of interest to students as well as those with more expertise in this field.

—David J. Burdige, Old Dominion University, Norfolk, Va.

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applicants' specific interests may include but are not limited to quantitative physical and/or chemical analysis of surface and groundwater flow in porous and/or fractured media; solute or contaminant transport and water quality models; impacts of global and local environmental change on surface and/or groundwater resources, and surface-subsurface linkages; groundwater remediation; biosphere-lithosphere exchange processes and their impact on the hydrological cycle. Demonstrated experience with field studies and data collection is an asset. We are particularly interested in applicants whose research will benefit from, as well as contribute to, our department's growing strengths in low temperature geochemistry, stable and radioisotope biogeochemistry, and global environmental change.

Memorial University has one of the largest and most diverse Earth Science departments in Canada. With 30 faculty members including 3 Canada Research Chairs, over 15 staff members, and leading-edge teaching and research facilities, the department is able to offer high quality undergraduate and graduate degree programs. The successful candidate will have access to modern analytical facilities listed at (www.mun.ca/earthsciences/facilities/). In addition, Memorial University's CREAIT (www.mun.ca/creait/maf/ICPMS.php) network is accessible to all faculty and offers additional analytical and experimental facilities, many overseen by faculty in the Department of Earth Sciences. Other research and teaching resources available at Memorial University include the Ocean Sciences Centre, the Bonne Bay Marine Station in Gros Morne National Park, the Labrador Institute, and the Harlow Campus outside London, England.

Applicants must possess a Ph.D. and should preferably have post-doctoral experience. The successful candidate is expected to maintain a vigorous research program, sustain a strong record of peer-reviewed publication and external funding, advise and mentor undergraduate and graduate students, and contribute energetically to the teaching mission of the department, including courses in hydrogeology. In addition to its own M.Sc. and Ph.D. programs in earth science, the Department of Earth Science participates in Memorial's interdisciplinary graduate program in environmental science (www.mun.ca/science/envs/).

Applications must be received by February 15th, 2008. Candidates should submit a letter of application with the names and addresses (including email) of three referees, current curriculum vitae, and a statement of planned research program and teaching interests to: Dr. John M. Hanchar, Head, Department of Earth Sciences, Memorial University of Newfoundland, St. John's, NL, Canada A1B 3X5, or, preferably, e-mail applications in PDF format to: head@esd.mun.ca. Additional information is available at www.mun.ca/earthsciences/about/ or by contacting Dr. John M. Hanchar at head@esd.mun.ca or by telephone at 709-737-2334.

Memorial University is the largest university in Atlantic Canada. As the province's only university, Memorial plays an integral role in the educational life of Newfoundland and Labrador. Offering a diverse set of undergraduate and graduate programs to almost 18,000 students, Memorial provides a distinctive and stimulating environment for learning in St. John's (http://www.stjohns.ca/index.jsp), a very safe, friendly city with great historical charm, a vibrant cultural life, and easy access to a wide range of outdoor activities.

Memorial University is committed to employment equity and encourages applications from qualified women and men, visible minorities, aboriginal people and persons with disabilities. All qualified candidates are encouraged to apply; however, Canadian citizens and permanent residents will be given priority. Partners of candidates for positions are invited to include their resume for possible matching with other job opportunities and candidates eligible for NSERC University Faculty Awards are encouraged to apply.

Ocean Sciences

Assistant or Associate Professor (Marine Chemistry). The Graduate School of Oceanography (GSO) of the University of Rhode Island invites applications from outstanding scientists for a calendar-year, tenure-track position with 8 months of salary support per year. We are particularly interested in marine chemists who address interdisciplinary topics in oceanography, and focus on biogeochemical processes. The successful candidate will be expected to develop and maintain an externally funded, vigorous research program and an education program that complements the existing strengths at GSO and in affiliated departments. Visit our website at www.uri.edu/human_resources for full requirements. To apply send via e-mail or regular post, send a letter of application, curriculum vitae, statements of teaching philosophy and research interests, and the names and addresses of four (4) references to: MarineChemistSearch@gso.uri.edu, or to: John King, Search Chair, refer to Req #EOS12026. Review of applications will begin on January 14, 2008 and continue until position is filled. UNIVERSITY OF RHODE ISLAND, P.O. Box G, Kingston, RI 02881. URI is an AA/EOD employer and values diversity and also is an NSF ADVANCE institutional transformation university, working to advance the careers of women faculty, especially in the science and engineering disciplines.

Scientific Researchers positions at NURC, a NATO Research Centre. NURC conducts research in support of NATO's operational and transformation requirements, focusing on the undersea domain and on solutions to maritime security problems. NURC is seeking junior and senior scientific researchers in the following disciplines: - Operational Oceanography - Simulation and Modeling - Mine Countermeasures - Mathematics - Physics - Engineering Underwater Vehicles, Networks & Sensors.

Please visit http://www.nurc.nato.int/employment/index.htm for details.

Solid Earth Geophysics

Computational Geoscientist Position. Stanford University's School of Earth Sciences invites applications for a senior tenure-track faculty appointment at either the Associate or Full Professor level in the area of computational geosciences. We welcome applicants with strong skills in computational theory and practice, as well as a working familiarity with numerical methods for large-scale problems, parallelization paradigms, and modern computer systems. The successful applicant will have research experience or interests in applications to Earth and environmental problems, including but not limited to one or more of the following areas: energy, water, other natural resources, atmospheres, oceans, fluid dynamics, geodynamics, geomechanics, hazards, seismology, electromagnetics, inversion, optimization, and imaging of the earth surface and interior.

Experience with large geoscience datasets is desirable.

Strong interest in or experience with research collaboration and teaching across earth and environmental science disciplines is highly desirable. We expect the successful applicant to lead development and growth of the Stanford Center for Computational Earth and Environmental Science. The Center, with its shared high productivity computing resources, seeks to expand research and educational opportunities in computational geosciences. This appointment will be with one (or jointly with two) of the four departments in the School of Earth Sciences: Energy Resources Engineering, Geological and Environmental Sciences, Geophysics, and Environmental Earth System Science (proposed). Further information about the School of Earth Sciences and this search can be found at http://pangea.stanford.edu/.

Stanford University is an equal opportunity employer and is committed to increasing the diversity of its faculty. It welcomes nominations of and applications from women and minority groups, as well as others who would bring additional dimensions to the university's research, teaching and service missions.

Please apply online in electronic format (.pdf only) with the following application material: cover letter, curriculum vitae, a statement outlining research and teaching experience and interests, and the names and addresses of four referees, at http://pangea.stanford.edu/about/jobs.php addressed to Computational Geosciences Search Committee.

Applications received by January 31, 2008 will receive full consideration, though the position will remain open until the appropriate applicant is identified.

Interdisciplinary/Other

Bateman Postdoctoral Fellowships in Geosciences at Yale University. The Department of Geology and Geophysics at Yale University (www.geology.yale.edu) announces an annual competition for one or more Bateman Postdoctoral Fellowships. We welcome applicants with research interests across the full range of disciplines within the Earth Sciences, including studies of the solid earth, oceans, atmosphere, climate dynamics, geochemistry, paleoclimatology, and the evolution of life. Each of these Postdoctoral Associate positions is awarded for two years, providing a stipend ($48,000/yr) and base research funds ($5,000/yr), plus health care benefits and expenses for relocation. Applicants should contact a sponsor in the Department to identify potential research projects, and then submit a short (2-3 page) statement of research interests and proposed research, a curriculum vita, and list of publications. Applicants should also arrange for three reference letters to be sent directly to the Department. The deadline for receipt of all application materials is January 2, 2008, and decisions will be announced by February 29, 2008. Successful candidates are expected to begin their program at Yale between July 1 and December 31, 2008.

Application materials and reference letters should be sent by email (bateman.fellowship@geology.yale.edu) or by post:

Bateman Postdoctoral Fellowship, Yale University, Department of Geology and Geophysics, PO Box 208109, New Haven, CT 06520-8109. Yale University is an equal opportunity/affirmative action employer; applications from women and minority scientists are strongly encouraged.

Dickinson College, Visiting Assistant Professor. The Dickinson College Geology Department invites applications for a one-year position as a Visiting Assistant Professor to begin Fall 2008. Teaching excellence in the liberal arts tradition and broad interests in geosciences beyond their specialty, along with a strong commitment to field studies, are the critical characteristics of a successful candidate. Exact teaching responsibilities will depend on the background of the candidate but should be integrative with the current faculty's expertise in mineralogy/petrology, geochemistry, climate change, structure/tectonics, and geomorphology. Demonstrated success in student-faculty undergraduate research is highly desirable. Completion or near completion of a Ph.D. in the earth sciences is required. Applications, including a cover letter describing teaching and research interests, curriculum vitae, and addresses for three referees, should be sent to Dr. Jeff Niemitz, Department of Geology, Dickinson College, P.O. Box 1773, Carlisle, PA 17013-2896. Review of applications will begin on 1 March 2008. Our curriculum emphasizes project-based learning with a strong field component. This is greatly facilitated by our location in the folded Appalachians, at the northern terminus of the Blue Ridge, near the Triassic rift basins. The department has excellent analytical (GFAAS, SEM-EDS, XRD, XRF, TOC, digital 3-component seismometer, and well field for hydrogeologic investigations) and computing facilities including a GIS lab. More information can be found on the college and department Web pages at www.dickinson.edu/departments/geol. Dickinson College is a highly selective private liberal arts college in south-central PA within easy drive of the New York-Washington, D.C., metro corridor. Dickinson is committed to diversity, and we encourage candidates who will contribute to meeting that goal to apply. Applications and nominations for women and minorities are strongly encouraged.

Ecological Toxicologist, NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI. NOAA's Great Lakes Environmental Research Laboratory (GLERL) seeks an enthusiastic scientist with experience in environmental/ecological toxicology, chemistry, or biogeochemistry to pursue research towards understanding the impact of contaminants on Great Lakes and coastal ecosystems, and to apply this understanding to management and restoration problems. The incumbent will be expected to develop predictive models to address contaminant concerns in the Great Lakes and coastal ecosystems, to collaborate with other scientists at GLERL and outside GLERL (e.g., other federal laboratories, universities, private industry), and to build active research programs emphasizing collaborative and inter-disciplinary approaches. It is desirable that the incumbent have a PhD in environmental/ecological toxicology, chemistry, biology, biogeochemistry or related field; and strong quantitative skills. The individual will be expected to present results in peer-reviewed publications and scientific presentations and to submit research proposals to supplement their research programs.

This is a full time permanent Federal position (GS-12) with a starting salary of at least $68,423. Qualifications will be judged in part based on both numbers of peer reviewed publications and a track record for obtaining grants. Closing date is midnight January 7, 2008.

Detailed job information and application instructions can be found at: http://www.usajobs.opm.gov/, reference vacancy number OAR-GLERL-2008-0007. Position is open to all U.S. citizens and Federal status applicants. Further information can be obtained from Doran.Mason@noaa.gov. In addition to making a formal application on line, please send a courtesy CV to Dr. Doran Mason either electronically or by mail to Great Lakes Environmental Research Laboratory, 2205 Commonwealth Blvd. Ann Arbor, MI 48105. Further information on NOAA GLERL, can be found at www.glerl.noaa.gov.

The U.S. Department of Commerce is an Equal Opportunity Employer.

Electronics Engineer Position. The Geophysical Laboratory, Carnegie Institution of Washington, seeks applications for an electronics engineer who will be in charge of the Lab's electronics department. The primary responsibility includes operation of electron microprobe and scanning electron microscopes. This includes training and providing assistance to new and visiting users, performing routine maintenance, sample preparation, providing analytical support, and collaborating with staff and students. Other responsibilities are to assist staff scientists to solve electronics problems and to maintain smooth operation of various scientific instrumentation at the Lab. The Laboratory supports world-class facilities in high-pressure research; organic, stable isotope and biogeochemistry; mineral physics and petrology; and astrobiology. See http://www.gl.ciw.edu/ for a listing of its research programs and facilities.

Applicant must have a bachelor's degree in engineering, applied science, or equivalent and four years of experience. Candidates with experience in microbeam analysis are encouraged to apply. Experience in using computerized control systems, electronic measuring equipment, test instrumentation and data acquisition systems as it applies to Laboratory apparatus is desirable. Completed applications (including CV and names of two references) should be submitted to Russell J. Hemley, Director, Geophysical Laboratory, 5251 Broad Branch Road, NW, Washington, DC 20015-1305, USA, or email the applications to dappleby@ciw.edu indicating "electronics engineer position" in the subject line. The position is available immediately; applications will be reviewed until an appropriate candidate is hired.

The Geophysical Laboratory is an equal opportunity employer.

Geoscience Teaching Faculty - University of Nevada Las Vegas. The Department of Geoscience (http://geoscience.unlv.edu/) at UNLV invites applications for a full time, 9-month, non-tenure track faculty member (Faculty in Residence) to begin Fall 2008. Primary responsibilities are teaching of introductory level courses for non-science majors and potentially one or more upper division courses for undergraduate majors. The successful applicant will have the opportunity to develop and implement innovative geoscience courses and to seek external funding for educational activities and research in geoscience and geoscience education. Additional responsibilities include education and outreach to the community. The Department seeks a dynamic and enthusiastic individual with a commitment to undergraduate education. A minimum requirement is a Ph.D. degree in geoscience or sub-discipline of geoscience. Salary is commensurate with qualifications and experience. Please submit curriculum vitae and statement of teaching interests/philosophy, and contact information for five referees to Dr. David K. Kreamer (kreamer@nevada.edu), Chair - Faculty in Residence Search Committee, via on-line application at https://hrsearch.unlv.edu. For assistance with UNLV's on-line applicant portal, contact Jen Feldmann at (702) 895-3886 or hrsearch@unlv.edu. Application review will begin on January 22, 2008 and will continue until the position is filled. UNLV is an Affirmative Action/Equal Opportunity educator and employer committed to excellence through diversity; women and minorities are encouraged to apply.

Interdepartmental Postdoctoral Fellowship in Geosciences at Yale University. The Department of Geology and Geophysics at Yale University (www.geology.yale.edu) seeks applicants for a postdoctoral fellowship in research that links geosciences (studies of the solid earth, oceans, atmosphere, climate, and the evolution of life) with other sciences, including, for example, astronomy and astrophysics; environmental studies; physics; chemistry; biology; engineering; anthropology; medical science and public health; economics and political science.

This Postdoctoral Associate position is awarded for two years, contingent on satisfactory progress, and provides a stipend ($48,000/yr) and base research funds ($5,000/yr), plus health care benefits and expenses for relocation.

The Interdepartmental Postdoctoral Fellowship will have at least two faculty collaborators: the primary sponsor will be from Geology and Geophysics, while others are from one or more other Yale departments. Interested candidates should first contact a faculty member in Geology and Geophysics to define a research theme and to identify other appropriate faculty collaborators.

Applicants should submit a curriculum vita, a list of publications, an interdisciplinary research proposal (2-3 pages, in which the Yale collaborators are identified), and a brief letter of endorsement from each of the Yale faculty collaborators. Applicants should also arrange for three reference letters to be sent directly to the Department. The deadline for receipt of all application materials is January 2, 2008, and decisions will be announced by February 29, 2008. Successful candidates are expected to begin their program at Yale between July 1 and December 31, 2008.

nature

Climate Scientist

Nature, the international weekly journal of science, seeks a **Climate Scientist** to join a team of editors dedicated to publishing the world's best original research in the Earth & Environmental Sciences in Nature. He or she will play a key role in determining how these fields are represented - through the selection and preparation of manuscripts for publication and by acting as Nature's interface with the relevant research communities. It is a demanding and intellectually stimulating position, and calls for a keen interest in the practice and communication of science.

The ideal candidate will have research experience in climate science, but highly qualified candidates from other areas of the Earth sciences should not be deterred from applying. Applicants should hold or expect shortly to receive a PhD or equivalent degree.

The job is based in Nature's modern London offices but will involve international travel to meetings and laboratories.

Applicants should send a CV (including their class of degree and a brief account of their research and other relevant experience), a concise discussion of which recent developments in the Earth sciences they have found particularly exciting (stating why) and a brief covering letter, quoting reference number NPG/LON/780 to Kerrie Willsher, Personnel, Macmillan Publishers at londonpersonnel@macmillan.co.uk

Closing date: 23 January 2008

nature publishing group npg

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Application materials and reference letters should be sent by email (interdepartmental .fellowship@geology.yale.edu) or by post: Interdepartmental Postdoctoral Fellowship, Yale University, Department of Geology and Geophysics, PO Box 208109, New Haven, CT 06520-8109. Yale University is an equal opportunity/affirmative action employer; applications from women and minority scientists are strongly encouraged.

Physical-Biological Modeler, NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI. NOAA's Great Lakes Environmental Research Laboratory (GLERL) seeks an enthusiastic scientist with experience in numerical modeling to examine physical-biological coupling in Great Lakes ecosystems. The candidate will be expected to develop coupled numerical models of Great Lakes ecology and physical dynamics, with particular emphasis on ecosystem forecasting. Some examples include episodes of hypolimnetic hypoxia, harmful algal blooms, and fish production and recruitment. The approach would involve coupling multiple state-variable ecological models with 3-d hydrodynamic, hydrologic, and/or sediment dynamics models. The incumbent will be expected to develop predictive models, to collaborate with other scientists at GLERL and other federal laboratories, universities, and private industry, and to build active research programs emphasizing collaborative and inter-disciplinary approaches. It is desirable that the incumbent have a PhD in physical sciences, biological sciences, or related field; and strong quantitative skills. Excellent communication skills are required to present results in peer-reviewed publications, scientific meetings, and to submit research proposals to supplement their research programs.

This is a full time permanent Federal position (GS-12) with a starting salary of at least $68,423. Qualifications will be judged in part based on both numbers of peer reviewed publications and a track record for obtaining grants. Closing date is midnight January 7, 2008.

Detailed job information and application instructions can be found at: http://www.usajobs .opm.gov/, reference vacancy number OAR-GLERL-2008-0005. Position is open to all U.S. citizens and Federal status applicants. Further information can be obtained from Doran.Mason@noaa.gov. In addition to making a formal application on line, please send a courtesy CV to Dr. Doran Mason either electronically or by mail to Great Lakes Environmental Research Laboratory, 2205 Commonwealth Blvd. Ann Arbor, MI 48105. Further information on NOAA GLERL, can be found at www.glerl.noaa.gov.

The U.S. Department of Commerce is an Equal Opportunity Employer.

T C Chamberlin Postdoctoral Fellowships in Geophysical Sciences, The University of Chicago. The Department of the Geophysical Sciences at The University of Chicago invites applications for the inaugural T.C. Chamberlin Postdoctoral Fellowships. We are interested in outstanding scientists who probe the fundamental nature of Earth and other planetary bodies, their physics, biology, chemistry, and history, and who have a desire to participate in the broad intellectual life of the Department and the University. Start date is negotiable, but our target is 1 July 2008. The initial term of the Fellowships will be one year, renewable for a second year. Salary will be $50,000 per annum, plus benefits. Consideration of applications will begin 7 January 2008. Please email a CV, statement of research interests, and names and contact information for at least three references, to: Michael Foote, Chairman, Department of the Geophysical Sciences, University of Chicago (foote@geosci.uchicago.edu). The University of Chicago is an equal opportunity/affirmative action employer.

The Department of Geological Engineering and Sciences at Michigan Tech seeks applications for a Tenure-track Appointment at the Assistant Professor Level. A Ph.D. in engineering or science is required. Candidates with demonstrated achievements commensurate with appointment at Associate or Full Professor will also be considered. The ideal candidate would conduct research in quantitative and/or engineering aspects of natural hazards, such as modeling, monitoring, forecasting, mitigation, or communication and response. However, we will consider outstanding applicants who can either complement our department's strengths (remote sensing, volcanology, hydrology, petroleum geology, and geophysics) or can help expand our department into new directions that show promise of future development. Applicants will be evaluated based on their ability to obtain outside funding, publish scholarly research, and succeed in teaching.

Michigan Tech has a total student population of about 6300 and is located in Michigan's Upper Peninsula, a pristine area on the south shore of Lake Superior. The department is committed to a strong educational focus and values basic and applied interdisciplinary research. Undergraduate and graduate programs are offered in Geology, Geological Engineering and Applied Geophysics. Interested candidates can learn more about the department faculty, research, and educational programs at www.geo.mtu.edu.

Applicants should send a single PDF document containing a detailed curriculum vitae, a statement of research capabilities and interests, a statement of teaching experience and interests, and the names and complete contact information for at least three professional references.

Applications should be e-mailed to geosearch @mtu.edu. Candidates who also identify themselves as interested in a broader Michigan Technological University faculty hiring initiative in Sustainability are invited to send a separate application as described at www.mtu.edu/sfhi.

Applications received by February 15, 2008 will receive the fullest attention. Michigan Tech University is an equal opportunity educational institution/equal opportunity employer.

The Houghton College Department of Physics and Earth Science invites applications for a Full-time, Tenure-track, Faculty Appointment beginning the fall semester of 2008. The position requires a Ph.D. in an earth science-related field (examples might include climatology or geophysics) with a strong background in physics. Academic rank will be determined based on previous teaching experience. Responsibilities include teaching earth systems science classes, as well as introductory geology, astronomy and physics. Courses in computational science are also possible for candidates with the appropriate background. The successful candidate must possess outstanding creative, interpersonal and leadership skills, provide evidence of teaching excellence, and have a strong commitment to evangelical Christian faith. Preference will be given to applicants that can actively involve undergraduates in research. www.houghton.edu.

Women and minorities are encouraged to apply. Send letter of application, curriculum vitae, and three professional references to Dr. Mark Yuly, Chair, Department of Physics and Earth Science, Houghton College, Houghton, NY 14744 or email mark.yuly@houghton.edu.

Two Postdoctoral Positions. Harvard University invites applications for two postdoctoral positions in terrestrial ecosystem modeling in the laboratory of Paul Moorcroft. The successful candidate will be involved in collaborative research projects relating to the effects of anthropogenic climate change on the composition, structure and functioning of temperate and tropical ecosystems.

Candidates should have a strong background in ecosystem ecology or a related field. Applicants with previous experience with terrestrial ecosystem or land surface models or the application of remote sensing to the study of terrestrial ecosystems are strongly preferred. Candidates should email their CV, a summary of research interests, and the names of three references to Paul Moorcroft (paul_moorcroft@harvard.edu). Harvard University is an equal opportunity/affirmative action employer.

Water Quality and Risk to Human Health. The Department of Earth Sciences and the Center for Earth and Environmental Science at Indiana University Purdue University Indianapolis (IUPUI) is seeking candidates for a tenure-track position to support a new program in water resources research and public health. This position is part of a university-supported initiative in water resources research, and will be a key component of a newly proposed interdisciplinary PhD program in Applied Earth Sciences. We are interested in candidates with research interests in the field of water quality and risk to human health.

Specific areas of interest may include aquatic toxicology/biology, cyanobacteria toxicology and limnology, organic geochemistry, and biogeochemical transport modeling. The successful candidates will be part of a team of environmental geoscientists and toxicologists working on cutting-edge detection and health impact studies. Candidates are expected to develop an independent research program, supported by close interactions with researchers in the basic sciences and in the multiple health-science programs on campus relating to qualitative and quantitative assessments of exposures to water-borne chemical or biological agents and partnering to assess the associated health effects.

Candidates should have a Ph.D., strong research records, an interest in multidisciplinary research and commitment to undergraduate and graduate education.

We will begin reviewing applications on Jan. 15, 2008, but will continue accepting applications until the position is filled. The expected start date is August, 2008, but this is negotiable.

IUPUI is Indiana's urban research and academic health sciences campus, and the focal point of IU's Life Sciences Initiative.

Interested candidates should send a curriculum vita, statements of research and teaching interests, and the names of at least three referees to:

Chair, Search and Screen Committee
Department of Earth Science/Center for Earth and Environmental Science
IUPUI
723 West Michigan Street
Indianapolis, IN 46202

Electron submissions may be sent to: ltedesco @iupui.edu.

IUPUI is an equal opportunity, affirmative-action employer.

STUDENT OPPORTUNITIES

Funded Graduate Student Opportunity in Coastal Hydrodynamics. Teaching and Research assistantships are available to support a graduate student at Washington State University's Vancouver campus. Student will work with advisor Steve Henderson (http://www.vancouver .wsu.edu/fac/steve_henderson/index.html) to understand water flows and morphodynamics in a tidal inlet. The ideal candidate will have a strong background in physics or mathematics. A background in Oceanography is not essential. Thesis work may include field measurements of

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(Interdisciplinary Scientist/Engineer – GS14/15)

U.S. Environmental Protection Agency
Office of Research and Development
Athens, Georgia

EPA's Office of Research and Development (ORD) seeks a nationally-recognized multimedia modeler for a federal position in Athens, Georgia. This person will provide scientific leadership in the mathematical development and regulatory-based application of integrated multimedia fate and transport models and computer-based technologies for human and ecological exposure and risk assessment. The person filling this position will work within a multi-disciplinary team structure to advance a new, dynamic paradigm in multi-media, multi-pathway, multi-receptor, multi-scale and multi-pollutant exposure and risk assessment modeling.

This position is located within the Ecosystems Research Division (ERD) of the National Exposure Research Laboratory. ERD conducts field and laboratory studies on the behavior of contaminants, nutrients, and biota in environmental systems and develops mathematical models to assess the response of aquatic systems, watersheds and landscapes to stresses from natural and anthropogenic sources. ERD is committed to developing modeling-based approaches that require interdisciplinary solutions and collaboration across EPA, other Federal Agencies, academicians, and non-governmental groups.

The preferred candidate will have a Ph.D. or equivalent degree in environmental or chemical engineering, hydrology, ecology, mathematics or a closely related field. Qualified applicants should possess (1) extensive experience in mathematical modeling, algorithm development and proficiency in a variety of computer programming languages and architectures, including GIS; (2) a demonstrated ability to lead innovative research teams that have informed real world decisions; and, (3) a history of significant publications in internationally-recognized journals.

This is an interdisciplinary position that can be filled at the GS-14 or GS-15 level as either a Physical Scientist or Mathematician. Applications will be accepted November 5, 2007, through January 4, 2008. For qualification and application details, visit www.usajobs.gov. **Applicants must be U.S. citizens.**

Additional information may be found at www.epa.gov/athens.

The U.S. EPA is an Equal Opportunity Employer

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tidal currents, data analysis, and theoretical flow modeling. The Vancouver area offers outstanding outdoor recreational opportunities, and ready access to the adjacent city of Portland, Oregon. For further information contact Dr. Stephen Henderson (steve_henderson@wsu.edu). First consideration will be given to applications received before 1/3/08.

Graduate Research Assistantships, Department of Civil, Construction and Environmental Engineering, North Carolina State University, Raleigh, NC. Fully funded PhD and/or MSc assistantships are available for highly qualified applicants interested in water wave mechanics, coastal hydrodynamics and morphodynamics. The students will conduct quantitative research, which involves both theoretical and numerical modeling, as well as incorporating observations into numerical models (e.g. data assimilations), to improve the understanding of surf zone dynamics, in particular the complex interactions among waves, currents and coastal morphology. Assistantships include an annual stipend of $21600 (rate for academic year 2008/2009), health insurance and tuition waiver. Candidates with academic/research background in Coastal/Civil/Mechanical Engineering, Oceanography, Applied Mathematics or any other engineering/science fields with strong interests in fluid mechanics are encouraged to apply. Please send your CV to jie_yu@ncsu.edu, or contact Dr. Jie Yu at this email address for more information.

Graduate Student Opportunities, Ore Deposits Geochemistry/Igneous Geochemistry/ Environmental Geochemistry, Memorial University of Newfoundland. Funded M.Sc. and Ph.D. opportunities are currently available in the Dept. of Earth Sciences.

Project opportunities in Ore Deposits Geochemistry include, 1) Trace element and stable isotope distributions within the Voisey's Bay Cu-Ni Deposit as a guide to understanding possibly episodic processes of ore deposition and upgrading. This project could also incorporate a component of Fluid Dynamics Modelling of the magmatic system, and synthesis of these models with field observations, 2) Recognition of Olympic Dam (IOCG) type mineral deposition environments in the Proterozoic terranes of Canada - including integrated mineralogical, fluid inclusion and stable isotope approaches. Projects in Igneous Geochemistry are available to students interested in addressing volatile phase behaviour in magmatic and volcanic systems through the study of trace element and stable isotope variations in melt inclusions. Opportunities also exist in Environmental Geochemistry. Specifically, the microanalysis of Marine Biomineralization - especially coldwater corals and fish otoliths - and its application to paleotemperature proxies, monitoring of ecological disturbance and population studies.

St. John's is a vibrant coastal city (www.stjohns.ca), and capital of Newfoundland (www.newfoundlandlabrador.com). Memorial (www.mun.ca) is the largest university in Atlantic Canada, with over 17,000 students. Graduate students will join a large, diversified Earth Sciences department (www.mun.ca/earthsciences), with a wide spectrum of modern research facilities. All projects will utilize the advanced analytical instrumentation within the Microanalysis Facility of the INCO Innovation Centre (www.mun.ca/creait/maf/) - including SIMS, LA-ICP-MS, and MLA-EDS.

Admissions requirements may be viewed at: http://www.mun.ca/sgs/prospective/. Applications are strongly encouraged by February 1st, 2008 - to facilitate full enrollment for Fall 2008. For further information contact: Prof. Graham Layne (gdlayne@mun.ca).

MS Student to Assess Thermal Infrared Remote Sensing to Improve Wildfire Inputs to Regional Air Quality Models. The Department of Forest Resources, University of Idaho (www.cnr.uidaho.edu/measurements), invites applications for graduate study in fire science/remote sensing research. With 16 faculty, 20 graduate students, at least 30 undergraduate students currently working in fire, and a 30-year history of fire education; our fire program is nationally and internationally distinctive as a leader in wildland fire research.

We are seeking a highly motivated student to evaluate thermal remote sensing methods to improve the estimation of smoke emissions from wildfires. Applicants should be familiar with remote sensing/GIS and natural resources/environmental science applications. Experience in wildfire behavior is advantageous. Applications should be submitted to Dr Alistair Smith (alistair@uidaho.edu). Applications should include a clear statement of goals, b) a CV, and c) names of three references. The assistantship will be available starting January 1, 2008.

PhD and MS Opportunities in Earth and Environmental Sciences - University of Illinois at Chicago. The Department of Earth and Environmental Sciences, University of Illinois at Chicago, invites applications for graduate admission in Fall 2008. We are seeking students interested in Geobiology (including Geomicrobiology and Paleontology), Geochemistry (including Aqueous, Environmental, Isotopic, and Organic), Global Change (including Quaternary geomorphology, geochronology, paleoclimatology), Hydrology/Limnology, Geophysics, Mineralogy, and Planetary Science. Financial support is available to successful applicants through Research and Teaching Assistantships, and NSF-IGERT fellowships (www.uic.edu/depts/bios/leap/). Our research involves a variety of field investigations (e.g. Antarctica, Asia, Egypt, Yellowstone) and uses state-of-the-art laboratory instrumentation within the department, elsewhere at UIC, and at nearby facilities such Argonne National Laboratory. We are located in a vibrant, growing urban neighborhood, with convenient access to all that the great city of Chicago has to offer. Application deadline is February 1. For more information and application procedures, visit www.uic.edu/depts/geos/ or contact Dr. Kathryn Nagyat klnagy@uic.edu.

Research & Discover Undergraduate Summer Internships and Graduate Fellowships in Earth System Science. Join some of the nation's top scientists at the Institute for the Study of Earth, Oceans, and Space (EOS) in research through the UNH-Goddard Joint Center for the Earth Sciences. As a Research & Discover awardee, you will be involved in ground-breaking research conducted jointly at University of New Hampshire and the NASA-Goddard Space Flight Center. Our geo-science and environmental science research is among the most frequently cited in the country. Our scientists are engaged in:
- Investigating the effects of human activities on the Earth, including the causes and effects of global climate change and deforestation;
- Analyzing samples of snow, ice, and the atmosphere to study climate and chemical changes;
- Exploring chemical, physical, and biological oceanography;
- Studying dynamic processes in the Earth system using remote sensing, GIS, computer models, and other state-of-the-art tools.

All awards include a competitive stipend. Applications are due March 3, 2008. For more information, visit http://www.eos.unh.edu/ResearchAndDiscover/.

University at Buffalo: Interdisciplinary Graduate Study in Ecosystem Restoration. We invite applications to the Ecosystem Restoration through Interdisciplinary Exchange (ERIE) initiative, a collection of academic programs designed to advance the science, engineering, and policy of ecosystem restoration. Generous student support packages are available for qualified applicants, including PhD traineeships through the NSF IGERT program (US citizens or permanent residents). Interested applicants should apply to one of the seven participating graduate programs in Biology, Chemistry, Civil (environmental) Engineering, Geography, Geology, Philosophy, and (Native) American Studies. For more information contact Prof. Alan J. Rabideau (rabideau@buffalo.edu) or visit http://www.erie.buffalo.edu.

RSMAS

Tenure-Track positions in Geochemistry and Geophysics/Seismology Division of Marine Geology and Geophysics

The Division of Marine Geology and Geophysics at the University of Miami's Rosenstiel School of Marine and Atmospheric Science is looking to fill two tenure track positions in the fields of Geochemistry and Solid Earth Geophysics. These positions are supported by an endowment from Martha Weeks and are nine month appointments.

Geochemistry: Although the precise area of geochemical expertise is open, we are looking for to complement existing expertise in the fields of trace element and stable isotope geochemistry, paleoceanography, and mantle geochemistry. Such areas might include, but are not limited to, radiogenic isotopes, isotope geochemistry of elements not analyzed in the gaseous phase, organic geochemistry, and biogeochemistry. Applicants are expected to interact with other faculty in the division and school, particularly in the areas of sedimentology, global change, geochemical cycling, environmental applications, and paleoceaongraphy.

Geophysics: We are looking for candidates with interests including, but not limited to, earthquake source mechanics, local and global seismic tomography, seismotectonics, crustal structure, volcano seismology, and any other aspect of observational and/or computational geophysics. Applicants are expected to interact with other faculty in the Division and School, and contribute to existing research in active tectonics, crustal deformation and volcanic processes including projects in the Earthscope region, Central America and South America. Facilities include a planned high-performance computing facility and an existing satellite ground station.

Marine Geology and Geophysics is a Division of the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS), one of the premier Earth science research institutions in the nation. For details of existing faculty and research interests please visit our web site at http://www.rsmas.miami.edu. We are especially interested in applicants who can build strong, interdisciplinary research programs with other components of the school. We anticipate filling these positions at either the Assistant or Associate Professor Level. Send CV, names of four referees, and statement of interest to: Chair Marine Geology and Geophysics, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149.

Application deadline: Initial examination of applicants will take place after January 1, 2008 although the positions will remain open until suitable applicants are identified.

The University is a private independent university and an equal opportunity and affirmative action employer.

Assistant, Associate and/or Senior Scientists

The Department of Applied Ocean Physics and Engineering at the Woods Hole Oceanographic Institution (WHOI) invites applications for full-time tenure track faculty positions in areas including:

- **Coastal Fluid Dynamics and Nearshore Processes**
- **Ocean Acoustics, Wave Propagation, Scattering and Signal Processing**
- **Underwater Vehicles**
- **Coupled Biological and Physical Processes**
- **Air/Sea Interaction and Marine Meteorology**
- **Ocean Sensor Development**

We seek exceptional candidates from the mathematical, physical, biological and engineering sciences to complement our existing observational and theoretical strengths. Target research topics this year include: Autonomous Underwater Vehicle and glider technologies for chemical, acoustic, and other sensing applications; coastal, estuarine and nearshore modeling and data analysis and assimilation; signal processing and geophysical inverse methods.

Candidates are expected to develop their own independent externally funded and nationally and internationally recognized research and education programs. Faculty members have the option of advising graduate students and teaching courses through the MIT-WHOI Joint Program in Oceanography and Oceanographic Engineering.

Sea Duty is expected at this level. Ph.D. and experience commensurate to rank required.

Education and experience will dictate position level. The selection process will begin **January 15, 2008.**

For more information or to apply, please visit http://jobs.whoi.edu.

WHOI is an Affirmative Action/ Equal Opportunity Employer M/F/D/V. Applications are reviewed confidentially.

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

Woods Hole Oceanographic Institution