LDEO Postdoctoral Symposium 2012

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

From the Office of the Director

Greetings! Welcome to the LDEO Postdoctoral Symposium. Since its founding in 1949, Lamont-Doherty has been a leader in the earth sciences. Our scientists were the first to map the seafloor and develop a computer model that could predict an El Nino weather event, the first to provide concrete proof for the theory of plate tectonics and to reveal the oceans' role in triggering abrupt climate change. We work to understand how the deep earth feeds global volcanism and triggers earthquakes; how the atmosphere changes when we add greenhouse gases and other pollutants; how the oceans transport great quantities of heat and control the ever-changing cycles of climate. When such fundamental earth processes occur catastrophically, as they have in recent years with the Indian Ocean tsunami and Hurricane Katrina, everyone is reminded that earth sciences play a central role in human survival.

With each year, our understanding of the earth improves. Yet, new discoveries await us. It is that next insight on the horizon that keeps our researchers excited to learn more about how and why earth changes as it does. Our diverse and vibrant community of postdoctoral scholars represents our youngest and newest talent, working towards our goal to develop and communicate new knowledge about the origin, evolution and future of the natural world. Our postdoctoral scholars are being trained by our more senior scientists to become future leaders in their respective fields, advancing our knowledge of the natural world even further.

We hope that this Postdoctoral Symposium provides you with an overview of the fundamental research carried out by our postdoctoral scholars.

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LDEO Postdoctoral Symposium Agenda

April 5, 2012

Comer Seminar Room 1st Floor

9:45 a.m. to 4:30 p.m

9:45 – 10:00	***Welcome Note:*** *Arthur Lerner-Lam, Interim Director, LDEO*
10:00 – 11:30	***Geochemistry Division*** *Presenters: Irene Schimmelpfennig, Gordon Bromley, Elizabeth Ferriss, Qiang Yang, Merry Yue Cai, Sharon Hoffman*
11:30 – 11:35	***Coffee break***
11:35 – 12:35	***Seismology, Geology and Techtonophysics Division*** *Presenters: Julia de Juan Verger, YoungHee Kim, Einat Lev, Cian Wilson*
12:35 – 1:15	***Lunch Break***
1:15 – 2:15	***Biology & Paleo Environment Division*** *Presenters: Laia Andreu-Hayles, Dario Martin-Benito, Jonathan Nichols, Beth Stauffer, Jessica Tierney*
2:15 – 2:45	***Ocean & Climate Physics Division*** *Presenters: Daehyun Kim, Karen Smith*
2:45 – 3:00	***Marine Geology & Geophysics Division*** *Presenter: Timothy Creyts*
3:00 – 4:30	***Poster Session over Coffee & Dessert*** *Presenters: Gordon Bromley, Merry Yue Cai, Nicole Davi, Julia de Juan Verger, David Ferguson, Leslie Hsu, YoungHee Kim, Einat Lev, Dario Martin-Benito, Christine McCarthy, Alessio Rovere, Irene Schimmelpfennig, Cian Wilson, Qiang Yang*

ORAL SESSION ABSTRACTS

Geochemistry Division

Gordon Bromley

Moraine records of tropical climate change: The development of cosmogenic surface-exposure methods has opened the door for dating a wide range of geologic phenomena, including glacial moraine records. We are employing He3 surface-exposure dating to resolve the timing of past glacial events in the tropical Andes, including the last glacial maximum, the late-glacial readvance, and Holocene advances. In conjunction with our palaeosnowline reconstructions on Andean peaks, these data are providing detailed insight into both the timing and magnitude of late Quaternary climate variability in high-altitude, low-latitude regions.

Merry Yue Cai

Subduction erosion as possible cause of ultra-potassic arc lavas in western Mexico: Despite clear geophysical evidence of subduction erosion at convergent plate boundaries, geochemical signature of this process has been largely elusive due to the similarity between eroded crustal material and subducted ocean sediments. I will present geochemical evidence that could link subduction erosion with occurrence of rare ultrapotassic arc lavas (lamprophyres) from the western Mexico Volcanic Belt. The lamprophyres show 5-10 fold enrichment in incompatible elements relative to contemporaneous normal arc lavas albeit little fractionation between LREE and MREE. Mantle source contribution of high degree partial melt of subducted ocean sediments could account for their trace element signature. However, the subducted ocean sediments in western Mexico are enriched in Fe-Mn oxides with strong negative Ce anomaly, unradiogenic Pb isotope ratio and seawater-like Sr-Nd-Hf isotope ratios which differ greatly from the composition of the lamprophyres. Thus, the sediments could not have been the main source for the anomalous chemical signature of the lamprophyres, whose Pb-Nd-Hf isotope signature resemble long-term incompatible element enriched lower continental crust. Geochemical modeling confirms that subduction erosion and subsequent high degree partial melting of the eroded lower crust material in the mantle wedge could generate the appropriate geochemical signature of the lamprophyres. Furthermore, the clustered occurrence of lamprophyres close to the trench and in western Mexico where arc-trench distance is unusually short suggests that the eroded crustal material likely stagnate in the mantle wedge close to the source (trench) due to their lower density than the ambient mantle.

Sharon Hoffmann

Synchronous 231Pa/230Th Holocene variability from the Mendeleev and Lomonosov Ridges at mid-depths: The Arctic Ocean contributes to global thermohaline circulation through export of intermediate and deep water through Fram Strait; however, the history of formation and circulation of Arctic waters at these depths is little known and presents a major challenge to paleoceanographers. Sedimentary measurements of the uranium-series radionuclides 231Pa and 230Th may provide a means of investigating the past dynamics of these deeper waters. We present 231Pa/230Th records from two well-dated box cores at mid-depths in the Arctic: PL-AR-94 BC 17 from 2255 m on the flank of the Mendeleev Ridge, Makarov Basin, and PL-94-AR BC 28 from 1990 m on the Lomonosov Ridge flank, Amundsen Basin. These records show synchronous millennial-scale variability through the Holocene, with peaks in 231Pa/230Th at 10.5, 7, and 5 ka, interspersed with low ratio values at 8, 6, and 4 ka. Indicators of surface ocean processes at these sites, such as particle fluxes do not show similar synchronous variation; nor do 231Pa/230Th records from shallower and deeper waters in the central Arctic. We therefore hypothesize that these millennial-scale variations in 231Pa/230Th ratios reflect paleoceanographic changes specific to mid-depth waters across Arctic subbasins, and that these common features may reflect a common source in the core flow of the Arctic Ocean Boundary Current between 1500 and 2500 m.

Irene Schimmelpfennig

Glacier culminations in the Western Alps during the earliest and late Holocene link to the Greenland temperature record: The natural variability of Holocene climate defines the baseline to assess ongoing climate change, but it remains elusive in extra-polar latitudes. Greenland ice-core records indicate rapid warming superimposed by abrupt cold oscillations in the early Holocene, followed by a general cooling trend throughout the mid and late Holocene that culminated during the Little Ice Age (LIA). Here we use mountain glaciers in the Alps to reconstruct the regional Holocene climate evolution and to evaluate the link between mid-latitude and North Atlantic climate. Our precise in situ cosmogenic 10Be chronology from Tsidjiore Nouve Glacier, western Swiss Alps, indicates a glacier culmination during the earliest Holocene ~11.4 kyr ago, which we relate to the Preboreal Oscillation. Based on our data, no Holocene glacier advance of similar amplitude occurred before ~3.8-3.2 kyr ago. 10Be ages between 500 and 170 yr date LIA glacier maxima, while the youngest 10Be ages reflect the interruption of the LIA recession during the early 20th century. Integration with existing records implies a tight hemispheric climate link between glacier patterns in the Alps and Greenland temperature throughout the Holocene supporting the concept of a pervasive climate driver. The Intertropical Convergence Zone, responding to North Atlantic temperature changes, might have changed its course from southward to northward at the end of the LIA, and related warm air masses triggered the onset of the current glacier melt in the Alps.

Sundial in rose garden, Lamont Campus

Qiang Yang

Biogeochemical reactions in response to CO_2 leaking in a test well of bedrock aquifers in Newark Basin: Potential leakage of CO_2 from deep intervals used for geological sequestration to shallow aquifers can have important negative impacts on drinking water resources, thus it is very important to understand the biogeochemical response to elevated CO_2 plumes and develop diagnostic monitoring systems. An experimental injection, composed of one atmosphere partial pressure CO_2, was conducted in fracture zones in a sand and clay aquifer in the Newark Basin and incubated for three weeks. The geophysical logging of the borehole and tracer tests using bromide and SF_6 indicated a weak background ambient flow in the aquifer. Monitoring of groundwater parameters showed a decrease of pH from 8.2 to 6.1, in addition to silicate and carbonate dissolution, and the release of 16 trace metals, including iron, manganese, cobalt, zinc, nickel, and uranium. Changes in bacterial abundance and community diversity were also tracked in parallel with geochemical transitions. Lab incubation experiments have been conducted to compare the mineral dissolution and trace metal release rates, as well as the microbial community' response to 1 atm pCO_2 under anaerobic and aerobic conditions. This research will provide criteria for site selection for geological CO_2 sequestration, investigate the vulnerability of shallow aquifers to CO_2 leakage, and develop the diagnostic testing techniques to assess risk.

Seismology, Geology & Techtonophysics Division:

Julia de Juan Verger

Understanding sea-level variations in the Bay of Bengal: Sea level is affected by a wide variety of processes. Two important climate-related processes are ice-sheet mass redistribution and ocean water density variations due to temperature and salinity changes. Other major processes that cause surface redistribution of water include ocean circulation and mass transport, changes in terrestrial water storage, local precipitation, and surface loading. Sea level is also affected indirectly by the solid-Earth deformation due to present and past redistribution of mass, as well as changes in the gravity of the Earth. All of these processes result in a spatially and temporally variable sea-level response. I will report on the initial steps of a project aimed at understanding the response of sea level to the gravitational and mass-loading changes associated with the flooding that occurs annually in Bangladesh. Previous studies show that the effect of self-attraction and loading (SAL) on the annual cycle of sea level is at its maximum in the Bay of Bengal, associated with the flooding cycle in this region. Preliminary inspection of monthly mean sea level as measured by tide gauges reveals large variations in the annual cycle and at longer periods. Comparison with an ocean general circulation model (GECCO) shows a disagreement by a factor of 2 in the amplitude of the annual cycle with respect to tide-gauge variations. The project will combine tide-gauge and altimetry data, an ocean general circulation model and solid-Earth deformation models, and include the effect of SAL to better understand sea-level variations in this region.

Einat Lev

Investigating lava dynamics using man-made flows, video analysis and numerical models: Lava flows are abundant on Earth and other rocky planets and moons. Understanding lava flows is essential for interpreting ancient flow environments as well as for mitigating present day volcanic risk. Our investigation focuses on constraining the mechanical and thermal properties of lava, key factors in lava flow dynamics and how lava interacts with other materials. We perform experiments in which we melt up to 400 Kg of basalt, and create controlled lava flows. Our experimental facility, located at Syracuse University, supports a wide variety of flow geometries and bed materials, including: straight rectangular steel channels, unconfined sand slopes with or without obstacles, and ice channels, plates and caves. Detailed velocity fields are extracted from a high resolution video of the flow using Optical Flow algorithms. Infrared cameras and thermocouple arrays record temperatures. We then use analytical and numerical models to estimate rheological and thermal parameters from the observed velocities and temperatures.

YoungHee Kim

Imaging Alaska subduction megathrust zone: We image the subducted slab underneath a 450 km long transect of the Alaska subduction zone from the middle of the megathrust, where the great 1964 (magnitude 9.3) earthquake ruptured the largest, downdip past the end of the visible slab. The joint teleseismic migration of two array datasets (MOOS, Multidisciplinary Observations of Onshore Subduction, and BEAAR, Broadband Experiment Across the Alaska Range) and teleseismic receiver functions using the MOOS data reveal a shallow to nearly flat transition of the megathrust zone shown as a prominent low-velocity structure in southern Alaska. This very thin low-velocity channel (6-7 km thick with Vp/Vs of 2) dips at <5 degrees at the coast then subsequently dips ~20 degrees down to 130 km depth at approximately 200 km inland. The observed low-velocity features may be due to thick sediment input from the trench in combination of elevated pore fluid pressure in the channel. The crust below the low-velocity channel has the gabbroic velocities with a thickness of 11-12 km. Both velocities and thickness of the low-velocity channel gradually increase as the slab bends, which agrees with previously published receiver function results. The image of this thick low-velocity zone (20% reduction in shear wave velocities) gives an evidence of the exotic terrane subduction in central Alaska.

Cian Wilson

Modeling the migration of fluids in subduction zones: Fluids play a major role in the formation of arc volcanism and the generation of continental crust. Progressive dehydration reactions in the downgoing slab release fluids to the hot overlying mantle wedge, causing flux melting and the migration of melts to the volcanic front. While the qualitative concept is well established, the quantitative details of fluid release and especially that of fluid migration and generation of hydrous melting in the wedge is still poorly understood. Here we present initial models of the fluid migration through the mantle wedge for subduction zones. We use an existing set of high resolution metamorphic models to predict the regions of water release from the sediments, upper and lower crust, and upper most mantle. We use this water flux as input for the fluid migration calculation based on new finite element models built on advanced computational libraries (FEniCS/PETSc) for efficient and flexible solution of coupled multi-physics problems. The first generation of one-way coupled models solves for the evolution of porosity and fluid-pressure throughout the slab and wedge given solid flow, viscosity and thermal fields from separate solutions to the incompressible Stokes and energy equations in the mantle wedge. These solid flow solutions are verified by comparing to previous benchmark studies and global suites of thermal subduction models. The fluid flow itself depends on both permeability and the rheology of the slab-wedge system as interaction with rheological variability can induce additional pressure gradients that affect the fluid flow pathways. Using idealized geometries we demonstrate the effects of this non-linearity on subduction zones.

Gary Comer Geochemistry Bldg, Lamont Campus

Biology & Paleo Environment Division

Laia Andreu-Hayles

Varying boreal forest response to Arctic environmental change: The 'divergence problem' in dendroclimatology has called into question the ability of tree-ring proxies at high latitudes to be used in paleoclimatic reconstructions. Here, we focus on tree-ring data from the Firth River site at treeline in northeastern Alaska. Both tree ring-width (TRW) and maximum latewood density (MXD) chronologies were developed to identify the nature of tree growth and density responses to climatic and environmental changes in white spruce (*Picea glauca*), a dominant Arctic treeline species. We found good agreement between the interannual fluctuations in the TRW chronology and summer temperatures from 1901 to 1950, but no significant relationships from 1951 to 2001. In contrast to the unstable climatic response in the TRW record, the July-August temperature signal in the MXD series was stable through the 20th century. Wider and denser rings were more frequent during the 20th century, particularly after 1950, than in previous centuries. Comparisons between tree-ring data and a satellite derived vegetation index suggest that tree-ring proxies correlate with vegetation productivity at the landscape level at different times of the growing season. This case study highlights some critical challenges for dendrochronology, including: (1) instability in the climate-growth relationships; (2) the assessment of tree growth; (3) linking tree-ring proxies with remote sensing data.

Marine Geology & Geophysics Division:

Timothy Creyts

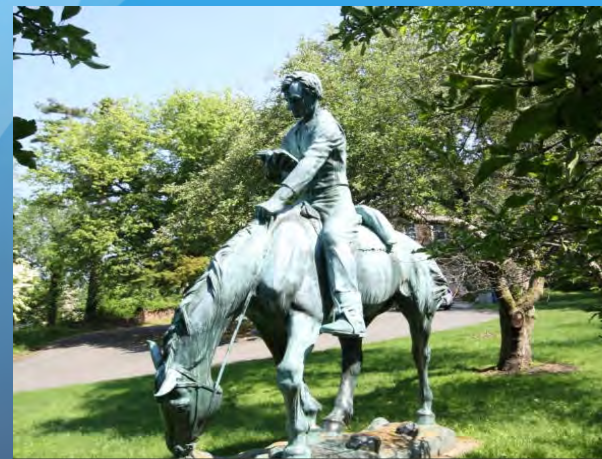
Caught in a trap: the effects of glacier hydrology on sediment transport and the erosion of mountain ranges: Erosion of mountain ranges proceeds rapidly where glaciers quarry bedrock. Evacuation of sediments through subglacial drainage networks depends crucially on the configuration of the glacier surface relative to the bed. Where glaciers cross overdeepenings, local closed depressions, the bed opposes the ice surface. If these overdeepenings are sufficiently steep, freezing of subglacial water via glaciohydraulic supercooling changes the efficiency of the basal drainage network. Based on local balances of heat and momentum, it has been proposed that freezing induced by glaciohydraulic supercooling causes a stabilizing feedback in glacier-bed erosion. Sediment transport, however, requires a connected subglacial hydrologic network that cannot be local. Here we present results of a dynamic, distributed model of coupled basal hydrology and sediment transport to show how overdeepenings evolve over the course of a melt season. In general, opposition of surface and bed slopes lowers gradients driving water flow and lessens sediment transport. These effects are realized readily for glaciers with a steeper hydrologic gradient driving flow. Glacier configurations for which glaciohydraulic supercooling occurs tend to evolve out of their freezing regime. Model results indicate that a stabilizing feedback can exist with respect to overdeepenings, but it likely is unrelated to freezing of the basal water network. We anticipate that our results will spur future work into feedbacks into subglacial sediment transport and limits to erosion by glaciers.

ORAL SESSION ABSTRACTS

Ocean & Climate Physics Division:

Daehyun Kim

ENSO sensitivity to cumulus entrainment in a coupled GCM: A series of 200-year long integrations is performed using GFDL CM2.1, by varying the Tokioka parameter, a minimum entrainment rate threshold in the cumulus parameterization. Changing the threshold alters both the tropical Pacific mean state and the ENSO variability. Increasing the Tokioka parameter causes a basin-wide cooling in the tropical Pacific, with the reduction of high cloud. The degree of cooling in the western part of the basin is bigger than that in the east. As a result, the east-west asymmetry in the tropical Pacific SST decreases with increasing the Tokioka parameter. Accompanied with the reduced east-west SST asymmetry are the increase of mean precipitation over the eastern Pacific and the eastward shift of the atmospheric responses to the ENSO-related SST forcing. The eastward shifted wind stress anomaly associated with ENSO leads to the stronger ENSO variability. In this way, the magnitude of ENSO simulated in this model increases with the Tokioka parameter. Implication of our results on the relationship between the tropical Pacific mean state and ENSO is discussed.



Abraham Lincoln statue near apple orchard, Lamont Campus

Karen Smith

Estimating the Influence of the Stratospheric Processes on the Antarctic Atmospheric Energy Budget: We discuss ongoing work to construct an atmospheric energy budget for the Southern Hemisphere polar region based on observations from the post-1979 period. Satellite measurements and atmospheric reanalyses are synthesized in order to describe the long-term means and variability of radiative, latent and sensible heating, as well as the atmospheric transport of moist static energy into the polar region. We compare estimates of the atmospheric transport of energy determined by direct calculation and as a budget residual. The largest difference occurs in the summer season, when the estimates can vary by over 30%. Decadal trends in energy budget components linked to stratospheric ozone depletion and increases in well-mixed greenhouse gases (GHG) are identified. Trends occur primarily in the summer season when changes in the Southern Hemisphere atmospheric circulation associated with ozone depletion are most pronounced. Comparisons are made between observed trends and general circulation model simulations with individually prescribed transient ozone and GHG forcings. Shorter term interannual variations in the energy budget associated with the El Niño-Southern Oscillation and Southern Annular Mode (SAM) are also examined. We find that large magnitude SAM events such as the sudden stratospheric warming (SSW) of 2002 can have a significant effect on the polar atmospheric energy budget. Similarly, robust differences in the Northern Hemisphere polar energy budget are found when winters with and without SSWs are compared.

POSTER SESSION ABSTRACTS

Geochemistry Division

Gordon Bromley

Moraine records of tropical climate change: The development of cosmogenic surface-exposure methods has opened the door for dating a wide range of geologic phenomena, including glacial moraine records. We are employing He3 surface-exposure dating to resolve the timing of past glacial events in the tropical Andes, including the last glacial maximum, the late-glacial readvance, and Holocene advances. In conjunction with our palaeosnowline reconstructions on Andean peaks, these data are providing detailed insight into both the timing and magnitude of late Quaternary climate variability in high-altitude, low-latitude regions

Merry Yue Cai

Childhood, boyhood and youth – a biography of the Arctic mantle written by basalts from the ultra-slow spreading Gakkel Ridge: Mid-Ocean Ridge basalts from the ultra-slow spreading Gakkel Ridge comprise ~100 km long segments with coherent geochemical and isotopic affinities, created by melt depletion and refertilization of the sub-ridge mantle. Basalts just to the east of the sparsely magmatic zone where peridotite outcrops in the ridge axis (EVZ 1) show some of the highest MORB Hf and Nd isotope ratios on Earth. They plot significantly above the Nd-Hf mantle-crust array. Basalts further to the east (EVZ 2-3) show lower εNd and εHf values and plot closer to the mantle-crust array. In contrast to their high Hf-Nd isotope ratios (indicating severe incompatible element depletion), basalts from EVZ1 segment show strong enrichments in highly incompatible elements. We will propose two hypotheses to account for these discrepancies. In contrast to basalts from EVZ 1, with enriched trace elements but Hf-Nd isotopes indicating long-term incompatible depletion, a group of samples from segment EVZ 2 show the opposite characteristics, that is, depleted incompatible element signatures, but long-term trace element enrichment. These basalts seem to represent a second-round of melting of an enriched mantle component which lost its initial partial melts at depth in the garnet stability field. We attribute their occurrence to melt "diversion" via high angle fault scarps associated with ultra-slow ridges. The basalts of the Gakkel Ridge EVZ appear to record melt depletion-enrichment events that would likely be lost or "blurred" in basalts from faster spreading ridges, where melt pooling and mixing is more prominent under the ridge axis.

David Ferguson

Volcanism during late-stage continental break-up in Afar, Ethiopia: In Afar, late-stage continental break-up is characterized by the formation of en-echelon magmatic rift zones, thought to represent proto-mid ocean ridges (MOR's). A recent phase of active magmatic rifting (2005-2011) along one of these magmatic segments has demonstrated the importance of axial melt intrusion in accommodating Afro-Arabian extension during late-stage rift evolution. Although the present day surface morphology and recent rifting activity at this segment are reminiscent of a slow-spreading MOR it is unclear how these relate to melt generation in the sub-rift mantle and the process of segment formation. The isotopic (Sr, Nd and Pb) composition of lavas erupted along the segment and from off-axis vents are consistent with other recent lavas from Afar and suggests a significant component of enriched source material (the Afar plume). Major element constraints on melting depths suggests partial melting at pressure <3 GPa in upwelling mantle with a Tp of ~1380-1420°C. All the lavas are enriched in incompatible trace elements relative to MORB and show rare earth element fractionations consistent with initial melting in the garnet stability field. Systematic variations in trace element ratios between lavas erupted at the rift axis and those from off-axis vents ~20 km away suggest that axial lavas are derived from slightly greater extents (~1-2%) of partial melting compared to those erupted off-axis. This suggests that focused mantle upwellings, similar to those observed beneath MOR's, are forming beneath transitional rift segments in Afar.

Irene Schimmelpfennig

Calibration of the in situ cosmogenic 14C production rate in New Zealand's Southern Alps: In situ cosmogenic 14C (in situ 14C) analysis from quartz-bearing rocks is a novel isotopic tool useful for quantifying recent surface exposure histories (up to ~25 ka). It is particularly powerful when combined with longer-lived cosmogenic isotopes such as 10Be. Recent advances in the extraction of in situ 14C from quartz now permit the routine application of this method. However, only a few experiments to calibrate the production rate of in situ 14C in quartz have been published to date. Here, we present a new in situ 14C production rate estimate derived from a well-dated debris flow deposit in the Southern Alps, New Zealand, previously used to calibrate 10Be production rates. We derive a spallogenic production rate of 11.4 ± 0.9 atoms 14C (g quartz)-1 a-1 (based on a geomagnetic implementation of the Lal/Stone scaling scheme) and a 14C/10Be spallogenic production rate ratio of 3.0 ± 0.2. The results are comparable to production rates from previous calibrations in the northern hemisphere.

POSTER SESSION ABSTRACTS

Geochemistry Division

Qiang Yang

Bedrock geology, groundwater geochemistry, and hydrogeology controls on arsenic in private wells in the greater Augusta area, Maine, USA: Thirty-one percent of private well water samples collected in 2006 from fractured bedrock aquifers in thirteen towns of the Waterville-Augusta area, Maine were found to contain more than 10 µg/L of arsenic, the U.S. EPA and WHO standard for drinking water, with the highest occurrence rates in the Silurian calcareous meta-sedimentary rocks. Elevated arsenic concentrations were more frequently found in the samples with higher pH and more reducing conditions. A logistic regression model showed that bedrock geology, soil arsenic content, groundwater pH, dissolved oxygen, nitrate and sulfate concentrations played important roles on groundwater arsenic levels in the study area, which suggested a sulfidic source of groundwater arsenic, and a complex mobilization mechanism of oxidation of arsenic-rich sulfide, adsorption on iron minerals, and pH and redox dependent desorption with the dissolution of calcites along groundwater flow path. The association of groundwater arsenic exceedance rates with bedrock geology and control by groundwater geochemistry were verified by higher density sampling in four clusters in 2007 and expanded sampling in five additional towns in 2010. In individual wells, arsenic concentration in borehole water is determined by mixing of water with distinct arsenic concentrations from fractures at various depths with variable flow rates. The borehole water arsenic concentration reflects the weighted average of arsenic concentrations of fracture water, subjected to modification of redox reactions in the borehole. Arsenic oxidation, adsorption and precipitation with iron particles are very quick in the wells in response to pumping.

Seismology, Geology & Techtonophysics Division:

Julia de Juan Verger et al

Modulation of flow by ocean tides at Helheim Glacier, East Greenland: We collected simultaneous high-rate GPS observations at several locations distributed along and across Helheim Glacier, East Greenland, for various periods of time during the summer seasons of 2006-2008. The fast temporal sampling rate and high precision of our GPS observations allow us to study details of the flow behavior of this large tidewater glacier. We observe spatio-temporal variation in sub-daily deviations from mean flow, such as the glacier response to ocean tides over daily, monthly, and seasonal timescales. Here we characterize the tidal signals observed in the GPS time series and analyze the floating conditions and tidal flow modulations at Helheim Glacier during this period. We find that the flow velocity of Helheim Glacier is modulated by ocean tides in a region covering both sides of the grounding line. An admittance analysis of the tidal signal shows that, in both the vertical and horizontal components, the amplitude of the tidal response decreases exponentially with distance up the glacier, and that the glacier response lags the tide by ~1-3 hours. Moreover, we observe transitory increases in the amplitude of the tidally-driven flow response coinciding with glacial earthquake events, which are associated with large losses of mass at the calving front and step-like increases in flow speed. These observations contribute to understanding the interaction between ocean tides and outlet glacier dynamics.

YoungHee Kim

Seismic imaging of the Cocos plate subduction zone system in central Mexico: Broadband data from the Meso-America Subduction Experiment line in central Mexico were used to image the subducted Cocos plate and the overriding continental lithosphere using a generalized radon transform based migration. Our images provide insight into the process of subducting relatively young oceanic lithosphere and its complex geometry beneath continental North America. The converted and reverberated phase image shows complete horizontal tectonic underplating of the Cocos plate beneath the North American plate, with a clear image of a 7-8 km thick low-velocity oceanic crust which dips at 15-20 degrees at Acapulco then flattens approximately 300 km from the Middle America Trench. A low-pressure mineral phase such as talc is considered a prime candidate for anomalously low shear speeds in the flat upper oceanic crust. Especially near the coast, long-term slow-slip events likely coincide with a near-lithostatic semiductile talc rich zone. Farther inland the slab then appears to abruptly change from nearly horizontal to a steeply dipping geometry of approximately 75 degrees underneath the Trans-Mexican Volcanic Belt (TMVB). Where the slab bends underneath the TMVB, the migrated image depicts the transition from subducted oceanic Moho to continental Moho, neither of which were clearly resolved in previous seismic images. The deeper seismic structure beneath the TMVB shows a prominent negative discontinuity at ~65-75 km within the upper mantle. This feature, which spans horizontally beneath the arc, may delineate the top of a layer of ponded partial melt, which has migrated southwards as the slab has rolled back since the end of the Miocene.

Springtime, Lamont Campus

Einat Lev

Investigating lava dynamics using man-made flows, video analysis and numerical models: Lava flows are abundant on Earth and other rocky planets and moons. Understanding lava flows is essential for interpreting ancient flow environments as well as for mitigating present day volcanic risk. Our investigation focuses on constraining the mechanical and thermal properties of lava, key factors in lava flow dynamics and how lava interacts with other materials. We perform experiments in which we melt up to 400 Kg of basalt, and create controlled lava flows. Our experimental facility, located at Syracuse University, supports a wide variety of flow geometries and bed materials, including: straight rectangular steel channels, unconfined sand slopes with or without obstacles, and ice channels, plates and caves. Detailed velocity fields are extracted from a high resolution video of the flow using Optical Flow algorithms. Infrared cameras and thermocouple arrays record temperatures. We then use analytical and numerical models to estimate rheological and thermal parameters from the observed velocities and temperatures.

Christine McCarthy

Developing models of flow for tidewater glaciers: I will be using a new, custom-fabricated cryo-friction apparatus to conduct laboratory experiments of ice sliding on rock. The unique aspect of the experiment is that I will try to simulate the role of tides in glacier flow by applying a periodic normal (resistive) stress and a constant vertical load and then measure the resulting rate of displacement. We will also try to mimic calving events by rapidly dropping the median normal stress (while keeping the periodicity). Strike-slip events in ice sheets have been observed to coincide with diurnal tides but the sensitivity to the tidal resistive force changes after a calving event in an unexpected, nonlinear way that then recovers with time. With these experiments I hope to provide some explanation for this behavior and work with glaciologists at LDEO to develop models of flow for tidewater glaciers.

POSTER SESSION ABSTRACTS

Seismology, Geology & Techtonophysics Division:

Cian Wilson et al

Numerical validation of Fluidity: an adaptive unstructured mesh geodynamics model: Fluidity is a finite element-finite volume fluid dynamics model. Several features of the model make it attractive for use in geodynamics. In particular, unstructured, simplex meshes allow the computational resolution to vary rapidly across the domain of the numerical simulation. Combined with dynamic mesh adaptivity, where the mesh is periodically optimised to the current conditions, this allows significant savings in computational cost to be achieved over traditional chessboard-like structured mesh simulations. In this study we extend Fluidity (using the Portable, Extensible Toolkit for Scientific Computation [PETSc, 2]) to Stokes flow problems relevant to geodynamics. However, due to the assumptions inherent in all models, it is necessary to properly verify and validate the code before applying it to any large-scale geodynamic problems. In recent years this has been made easier by the publication of a series of 'community benchmarks' for geodynamics modeling. We use the experimental results of Vatteville et al. to validate Fluidity against laboratory measurements. This test case is also used to highlight the computational advantages of using adaptive, unstructured meshes – significantly reducing the number of nodes required to match a fixed mesh simulation. However, adapting the mesh also poses numerical challenges. These are discussed in relation to a benchmark taken from van Keken et al. where the material conservation, boundedness and mixing properties of the discretisation are affected by the mesh optimisation and interpolation process. We demonstrate the use of a minimally dissipative, conservative and bounded interpolation algorithm that ensures that adaptive remeshing preserves the desired properties of the selected discretisation.

Marine Geology & Geophysics Division

Leslie Hsu

Maximizing data holdings and data documentation with a hierarchical system for sample-based geochemical data: Sample-based measurements in geochemistry are highly diverse, due to the large variety of sample types, measured properties, and idiosyncratic analytical procedures. To ensure the utility of sample-based data for re-use, it must be associated with a high quality and quantity of descriptive, discipline-specific metadata. The required detail makes it challenging to aggregate large sets of data from different investigators and disciplines. One solution is to build data systems with several tiers of intricacy, where the less detailed tiers are geared toward discovery and interoperability, and the more detailed tiers have higher value for data analysis. Geoinformatics for Geochemistry (http://www.geoinfogeochem.org) builds and maintains three tiers of sample based data systems, from a simple data catalog (Geochemical Resource Library), to a substantially richer data model for the EarthChem Portal (EarthChem XML), and finally to detailed discipline-specific data models for petrologic, sedimentary, hydrothermal spring, and geochronological samples. The data catalog contains the sample data values plus metadata only about the dataset itself and therefore can accommodate the widest diversity of data holdings. The second level includes measured data values from the sample, basic information about the analytical method, and metadata about the samples such as geospatial information and sample type. The third level includes detailed data quality documentation and more specific information about the scientific context of the sample. The three tiers are linked by unique sample identifiers. This flexible, tiered, model provides a solution for aggregating large quantities of data and serving the largest user group of both disciplinary novices and experts.

Biology & Paleo Environment Division

Nicole Davi

Understanding Climate-Induced Disaster in Mongolia: Identifying Mechanisms, Change and Vulnerability: Mongolia is a remote, semiarid country heavily dependent on herding and animal resources. This makes it especially vulnerable to climatic extremes. Over the past decade, Mongolia has undergone four major climate-induced disasters that resulted in massive livestock losses. The climatological events responsible for this widespread mortality are commonly called 'dzud', defined as severe summer drought followed by a very harsh winter. The frequency and severity of dzuds may now be on the rise because of global warming, coupled with shifts in land-use. Yet, despite the great cost to Mongolia's people and its economy, we know little about the causes, mechanisms and long-term variability of dzud events. Over the next two years, Davi will build on dissertation research that reconstructed drought variability across Mongolia, to 1) identify and quantify spatial and temporal changes that have already occurred in the landscape (e.g. vegetation abundance, drought stress and desertification) using remotely sensed (MODIS & Landsat) and recorded meteorological data and develop spatiotemporal vegetation phenology maps from this analysis; 2) evaluate spatial coherence of dzud and other extreme events using several drought indices and extend our understanding of drought and spatial coherence by incorporating a network of climate sensitive tree-ring data, and develop vulnerability maps; 3) identify the large-scale modes of variability during known events and evaluate if there are patterns or commonalities; 4) model and reconstruct dzud and extreme events using knowledge from objective 1, 2 and 3, as well as historical, meteorological, satellite, and paleoclimatic data.

Monell building, Lamont Campus

Alessio Rovere

Pleistocene sea levels in the Mediterranean: how, when, where? The elevation of any marker of paleo relative sea level (RSL) observed in the field is the result of eustatic, glacio-idro-isostatic and tectonic processes. In the classic approach, RSL marker elevation is measured, and the marker is dated through either direct or indirect techniques. Often, the difference between the height of the marker and the position of the eustatic-isostatic sea level of the highstand to which it has been chronologically attributed is divided by the highstand age, providing an indicative amount of uplift/subsidence rate of a coastal area. This assumes importance form the point of view of adaptation policies to future sea level rise.In the Mediterranean, the most studied RSL markers are those pertaining to Late Pleistocene (MISs 5 and 7) and Holocene. In this work we present the most striking evidence of past RSLs which are been collected, categorized and organized in a coherent spatial database across the Mediterranean basin by INQUA MEDFLOOD project, to improve modelling of future coastal flooding.

Meet Our Postdoctoral Scholars

Biology & Paleo Environment Division

Laia Andreu-Hayles
Email: lah@ldeo.columbia.edu
Research: My research interest is to understand the interactions between forests and climate applying dendrochronological techniques, using these relationships: (1) to study ecological processes such as forest response to climate; (2) to estimate climatic conditions before the existence of instrumental records (paleoclimatology). My research is mainly focussed in the Iberian Peninsula and Alaska, but recently we have started a pilot study in Colombia, South America

Craig Aumack
Email: aumackcr@gmail.com
Research: My long term research interests focus on the physiological, biochemical, and ecological adaptations of both macro- and microalgae to their environments as well as their influences on overall community structure. Currently, I am looking at the algal sea ice community in the high Arctic with emphases on community composition throughout the ice column, the internal chemical environment, and contributions, upon export, to the underlying communities.

Nicole Davi
Email: ndavi@ldeo.columbia.edu
Research: I use tree-rings to reconstruct climate. For the past several years I have focused on reconstruct drought/streamflow in Mongolia. I am also interested in science education and have been teaching teachers about climate change at The American Museum of Natural History.

Dario Martin Benito
Email: dmbenito@ldeo.columbia.edu
Research: My research interests focus on the effect of climate and other environmental factors on trees and forest ecosystems by using dendrochronology and tree growth modelling. Currently I am working on past environmental and ecological changes in tropical Asian, Mediterranean, and Eastern North American forests.

Jonathan Nichols
Email: jnichols@ldeo.columbia.edu
Research: I am primarily interested in understanding and reconstructing the changes in the hydrological cycle and carbon cycle throughout the Holocene in the arctic and subarctic. I work primarily with the sediments of peatlands, important terrestrial carbon sinks, measuring the stable hydrogen and carbon isotope ratios and abundances of organic molecules.

Meet Our Postdoctoral Scholars

Biology & Paleo Environment Division

Alessio Rovere
Email: rovere@ldeo.columbia.edu
Research: My research has focused on different issues related to earth and environmental sciences, with particular emphasis on physical geography of coastal environments. Being a scientific scuba diver, some of my works are on underwater coastal geomorphology. In particular I study Pleistocene and Holocene sea level changes by means of geomorphological, sedimentological and archaeological markers

Beth Stauffer
Email: stauffer@ldeo.columbia.edu
Research: Marine environmental biology. The roles of physical, behavioral, and physiological processes in the initiation and maintenance of algal blooms in marine and aquatic environments as well as the use of networked and autonomous sensing to investigate freshwater and marine phytoplankton community dynamics.

Jessica Tierney
Email: tierney@ldeo.columbia.edu
Research: My research concerns the reconstruction of past climate change using organic 'biomarkers' - the molecular remains of algae and higher plants - in marine and lacustrine sediments. A primary focus of my research is reconstructing the hydrological cycle in the tropics via use of the stable hydrogen isotopic composition of terrestrial higher plant leaf waxes.

Geochemistry Division

Gordon Bromley
Email: gbromley@ldeo.columbia.edu
Research: I am utilising glacier records from the tropical Andes to reconstruct patterns of Quaternary and Holocene climate change at low latitudes. My research relies on cosmogenic surface-exposure methods to date past glacial events and so I am devoting much of my postdoc to learning and developing the geochemistry behind these techniques.

Merry (Yue) Cai
Email: cai@ldeo.columbia.edu
Research: I use geochemical proxies to reconstruct processes that shape the Earth. The main proxies I use are Nd-Hf-Pb-Sr isotopes, which are long-lived radiogenic isotope systems. I am currently investigating the interaction between Earth's mantle and crust at both convergent plate boundary (Mexican Volcanic Belt) and divergent plate boundaries (the Arctic Gakkel Ridge).

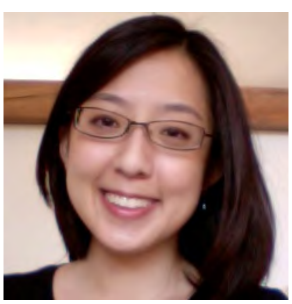
Meet Our Postdoctoral Scholars

Geochemistry Division

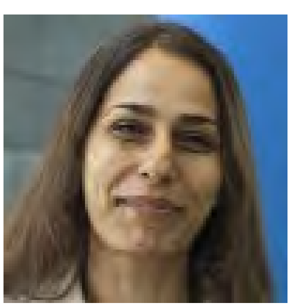
David Ferguson
Email: davef@ldeo.columbia.edu
Research: In the areas of volcanology and igneous petrology. I am interested in the processes associated with the generation and eruption of magma, particularly the links between volcanism, tectonics and climate. Current projects include volcanism during late-stage continental break-up in Afar, Ethiopia, post-glacial volcanism in southern Chile and the dynamics of explosive eruptions at Kilauea.

Elizabeth Ferriss
Email: ferriss@ldeo.columbia.edu
Research: I am a mineralogist interested primarily in the incorporation and behavior of impurities and trace elements. My current project is to determine how water diffuses through clinopyroxene and apply that information to understanding magma ascent rates and mantle composition. In the past, I have worked on projects related to nuclear waste management and Ti incorporation in zircon.

Sharon Hoffmann
Email: sharonh@ldeo.columbia.edu
Research: I study changes in Arctic ocean circulation and chemistry over the last 35,000 years, through the change from glacial to interglacial conditions, using the uranium-series radionuclides 231Pa and 230Th in seafloor sediments. I am also working to reconstruct variability in El Nino and the Southern Oscillation during the Holocene period.



Victoria Lee
Email: vlee@ldeo.columbia.edu
Research: I am working on the application and development of a geochemical method for determining sediment ages and transport times (the "uranium-series comminution age method", applicable to Quaternary fine-grained detrital material). I am currently investigating how marine paleoclimate proxy records may be affected by deep-sea sediment transport. My other work includes fluvial and glacial sediments, and chemical weathering.

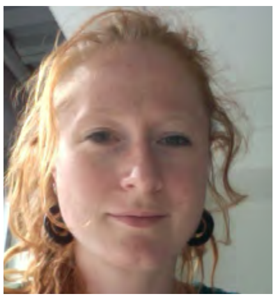


Zohra Mokeddem
Email: mokeddem@ldeo.columbia.edu
Research: The main focus of my project is the reconstruction of paleoclimate changes during the last interglacial peak warmth (120,000-114,000 years ago) using deep North Atlantic sediments. The broader goal of this study is to understand the environmental context in which similar warm period comparable to the current one ended without any anthropogenic influence.

Meet Our Postdoctoral Scholars

Geochemistry Division

Philipp Ruprecht
Email: ruprecht@ldeo.columbia.edu
Research: I am one of the few true volcanologists on campus. I work on time scales of magmatic processes and how those processes lead up to volcanic eruptions. I use primarily geochemical tools, such as crystal zonation, volatile measurements and geothermobarometry to identify the action in the volcanic plumbing system!

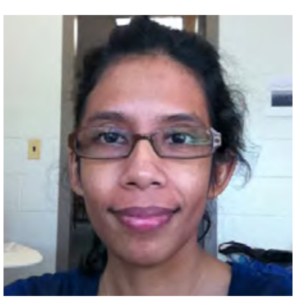


Irene Schimmelpfennig
Email: schimmel@ldeo.columbia.edu
Research: I am studying mountain glacier fluctuations throughout the current warm period "Holocene", the last 11,500 years, using the cosmogenic nuclides Be-10 and C-14 to date moraine deposits and proglacial bedrock. My main study area are currently the Swiss Alps. I am also interested in refining the cosmogenic nuclide dating method, with focus on production rate calibrations of the *in-situ* nuclides ^{36}Cl and ^{14}C

Qiang Yang
Email: qyang@ldeo.columbia.edu
Research: My current project is to examine the biogeochemical reactions of shallow aquifer water in response to CO2 leaking from geological sequestration, and to provide the criteria of parameters that can be used to monitor the groundwater quality in CO2 leaking scenarios.

Marine Geology & Geophysics Division

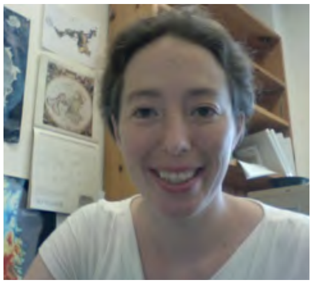
Timothy Creyts
Email: tcreyts@ldeo.columbia.edu
Research: I work on the fluid dynamics earth processes. In particular, I examine subglacial water movement and flowing ice and try to understand how these fluid systems behave. My research also contextualizes glaciers and ice sheets in the climate system.



Indrani Das
Email: indrani@ldeo.columbia.edu
Research: I use lidar and satellite data to study ice surface processes over East Antarctica. At present working on wind-ice surface-bed rock interaction over Dome A, East Antarctica

Meet Our Postdoctoral Scholars

Marine Geology & Geophysics Division



Kirsty Tinto
Email: tinto@ldeo.columbia.edu
Research: I'm working on aerogravity and magnetic data from Antarctica and Greenland collected with Operation IceBridge. I invert the potential field data for bathymetry and geology and investigate how these influence glacier flow.

Leslie Hsu
Email: lhsu@ldeo.columbia.edu
Research: At Lamont as part of the Integrated Earth Data Applications (IEDA) group, I am working on geoinformatics projects which preserve, search, and manage geochemical and earth surface data. My background is in experimental geomorphology and active tectonics.

Ocean & Climate Physics Division

Daehyun Kim
Email: dkim@ldeo.columbia.edu
Research: I am doing the atmospheric modeling, with focus on the representation of cumulus convection in the model, and simulations of the Madden-Julian oscillation. I'll be attending a field experiment soon to observe tropical and MJO-related clouds in the central Indian Ocean.

Karen Smith
Email: ksmith@ldeo.columbia.edu
Research: I am an atmospheric scientist interested in better understanding climate variability on seasonal to decadal time scales. I observational data analysis and simple and complex computer models to study the variability of the large-scale circulation of the mid- and high latitudes. I am currently studying the influence of stratospheric ozone depletion and recovery on the coupled variability of the Antarctic atmosphere-cryosphere system.

Seismology, Geology & Techtonophysics Division

Julia de Juan Verger
Email: dejuan@ldeo.columbia.edu
Research: I use geodetic measurements to study glacier dynamics, regional sea level, and crustal deformation. I utilize scientific data sets/ models such as Global Positioning System (GPS) measurements, tide-gauge records, and ocean tides and circulation models. I use high-rate, high-precision GPS observations to study spatio-temporal variations from mean flow at Helheim Glacier, East Greenland.

Meet Our Postdoctoral Scholars

Seismology Geology & Techtonophysics Division

YoungHee Kim
Email: ykim@ldeo.columbia.edu
Research: Research: My research objectives are to develop a better quantitative understanding of physical processes operating in tectonically active zones through the range of topics such as seismology, tectonics, geodynamics, and mineral physics. My main study areas are Alaska and Papua New Guinea, and I am currently trying to understand the nature of tectonic processes via seismic imaging.

Einat Lev
Email: einatlev@ldeo.columbia.edu
Research: I am a geodynamicist and a physical volcanologist. I use numerical models, laboratory experiments, video analysis and field data to study the dynamics of lava flows. Additionally, I work on mantle dynamics, subduction zones in particular. Themes I focus on are rheology, viscous flow, fabric and anisotropy. I am also interested in ice and glaciology.

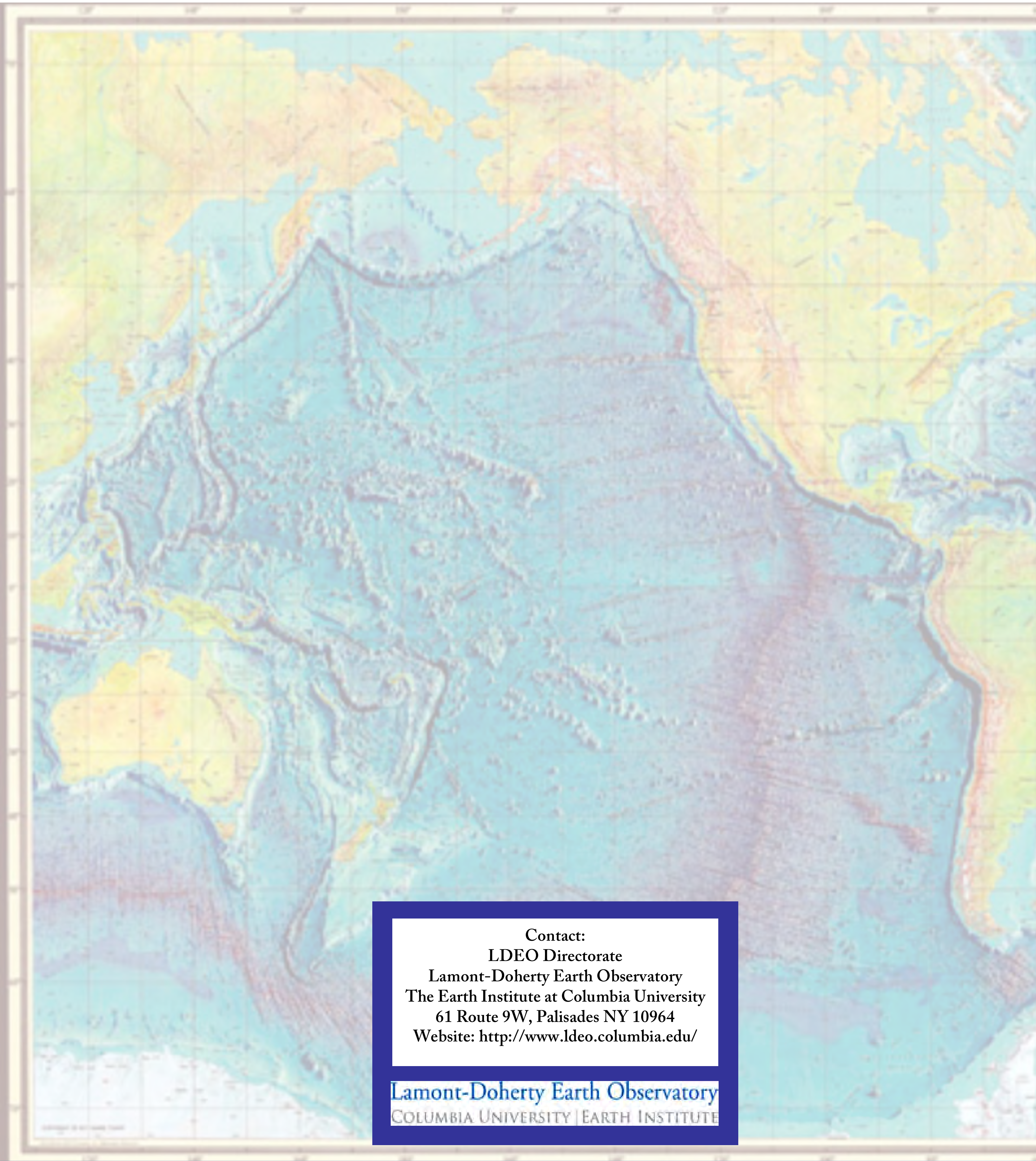
Christine McCarthy
Email: mccarthy@ldeo.columbia.edu
Research: My research explores the mechanical properties of ice and rock at various length and timescales. Here at Lamont I will be conducting dynamic ice friction experiments to examine the influence of tides on the flow speeds of tidewater glaciers. I will also look at how various industrial contaminant affect the viscosity of polycrystalline ice.

Lei Wang
Email: leiwang@ldeo.columbia.edu
Research: I work on spaceborne gravimetry using contemporary orbiting satellites, such as Gravity Recovery And Climate Experiment (GRACE) and Gravity field and steady-state Ocean Circulation Explorer (GOCE). I also work on interpretations of gravity changes associated with mass redistribution phenomena in the earth system, particularly the coseismic and postseismic gravity changes due to great subduction earthquakes.

Cian Wilson
Email: cwilson@ldeo.columbia.edu
Research: I develop (and use) numerical models for fluid- and geo- dynamics. My current project is focused on modeling fluid migration in subduction zones but I'm also involved in work with landslide-generated tsunami, high Rayleigh number flows, plume ascent rates in non-linear rheologies and numerical algorithms for free surfaces

Flagpole, Lamont Campus

All pictures of Lamont Campus taken by Bill Menke, DEES



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