# Lamont-Doherty Earth Observatory
# 2017 Postdoctoral Symposium

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**Megan Newcombe, Lucia Gualtieri, Benjamin Gaglioti**

**Agenda page: Benjamin Gaglioti**

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# From the Office of the Director

Greetings! Welcome to the 2017 LDEO Postdoctoral Symposium. Since its founding in 1949, Lamont-Doherty has been a leader in the Earth sciences. Our scientists were among the first to map the seafloor and provide concrete proof for the theory of plate tectonics. We have collected deep-sea sediment cores in order to understand Earth's past climate, and have explored the ice caps on both the North and South Poles with sophisticated instruments. We were the first to predict an El Niño event and have illuminated 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 with dire consequences and with increasing frequency, as they have in recent years, we are all reminded that Earth sciences play a central role in human survival and adaptation.

Even as our understanding of Earth improves, new discoveries and findings await us. It is that next insight on the horizon, that next finding, that next groundbreaking result that drives our scientists to learn more about the Earth's processes. Our vibrant, creative, and diverse community of postdoctoral scientists 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 scientists, under the guidance of senior scientists, are poised to becoming tomorrow's scientific leaders, further advancing our knowledge of the natural world.

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

**Sean C. Solomon**
Director
Lamont-Doherty Earth Observatory

**Arthur Lerner-Lam**
Deputy Director
Lamont-Doherty Earth Observatory

**Kuheli Dutt**
Assistant Director
Academic Affairs & Diversity
Lamont-Doherty Earth Observatory

# Lamont-Doherty Earth Observatory

# 2017 Postdoctoral Symposium

## Wednesday, 12 April

Gary C. Comer Building

Seminar Room, 1st Floor

10:00 am to 4:00 pm

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|---|---|
| 10:00a - 10:05a | **Welcome**<br>Sean C. Solomon, Director |
| 10:05a - 11:35a | **Marine Geology & Geophysics Division**<br>Céline Grall, Samer Naif, Jean-Arthur Olive |
| | **Seismology, Geology and Tectonophysics**<br>Roger Fu, Lucia Gualtieri, Emily Hopper,<br>Julie Oppenheimer, Arthur Paté, Clément Perrin |
| 11:35a - 11:45a | ***Coffee Break*** |
| 11:45a - 12:30p | **Ocean and Climate Physics**<br>Katinka Bellomo, Gabriel Chiodo,<br>Louis Clément, Melissa Gervais |
| 12:30p - 1:30p | ***Lunch*** |
| 1:35p - 2:45p | **Biology and Paleo Environment**<br>Blake Dyer, Matthew Harke, Scott LaPoint, Gerald Rustic |
| | **Geochemistry Division**<br>Jennifer Lamp, Megan Newcombe |
| 2:45p - 4:00p | **Poster Session over Coffee and Dessert**<br>Chandranath Basak, Elizabeth Corbett, Kelsey Dyez,<br>Benjamin Gaglioti, Céline Grall, Karla Knudson,<br>Scott LaPoint, Francesco Muschitiello, Christian Otto<br>Gerald Rustic, Robert Skarbek |

# Marine Geology and Geophysics

## Balance of subsidence and sediment needs for the sustainability of the Ganges-Meghna-Brahmaputra Delta Plain during periods of sea-level rise

*Céline Grall, et al.*

Sustainable coastal management requires a good understanding of subsidence as a natural process, as well as the manner that human interventions modify it. We present a reconstruction of the Holocene relative sea-level history in the Ganges-Brahmaputra-Meghna Delta (GBMD, Bangladesh) based on hand-drilled stratigraphic wells, radiocarbon ages, and seismic reflection data (BanglaPIRE project). The reconstruction is precise enough to distinguish between the effects of eustasy and subsidence on the relative sea-level history. Results provide evidence of moderate Holocene subsidence, that gently increases seaward from 1 to ~4.5 mm/a. The subsidence associated with the sediment mechanical compaction is modelled and results suggest a moderate contribution of compaction that accounts for at least half of the total subsidence. This low compaction rate may be associated with the low clay and organic matter content of the sediment in GBMD, in contrast to other deltas, such as the Mississippi or the Mekong deltas, which are muddier and thus subsiding at a faster rate. We estimate the volume of sediment needed to offset, under natural conditions, both the subsidence and the 2 to 7 m of eustatic rise that is predicted for the next century. This study may provide critical information about the possible effect of upstream sediment starvation associated with proposed human interventions.

## The electrical conductivity origin of the asthenosphere

*Samer Naif*

The upper mantle is composed of rigid lithospheric plates that slide on ductile asthenosphere. The mechanism responsible for the viscosity reduction at the lithosphere-asthenosphere boundary is often attributed to temperature, mineral hydration, or partial melting. Since electrical conductivity is sensitive to all three parameters, magnetotelluric data can help to constrain which mechanism is ultimately controlling the rheology of the upper mantle. Previous studies have established multiple conflicting empirical models for the electrical conductivity of hydrous olivine. The model discrepancies have led to competing interpretations of either hydration or partial melting as the origin of the asthenosphere. Here, I demonstrate that when temperature and hydration are parameterized in a thermodynamically consistent framework, none of the existing hydrous olivine models can explain a subset of the MT observations of highly conductive asthenosphere without inducing dehydration melting.

## A recipe for smooth seafloor (just add water)

*Jean-Arthur Olive*

Smooth seafloor is an endmember type of ocean floor found at ultraslow spreading mid-ocean ridges, where altered mantle units are exposed by slip on large-offset detachment faults of alternating polarity, and very little igneous crust is emplaced. Recent seismological evidence suggests that the axial oceanic lithosphere underlying this type of seafloor is unusually thick and strong. This contradicts classical models of detachment fault formation, which usually require moderately weak axial lithosphere and intermediate rates of magmatic intrusions. To resolve this apparent paradox, we develop thermo-mechanical models of smooth seafloor formation that account for rheological weakening due to fluid-rock reactions. We find that reproducing smooth seafloor architecture and bathymetry requires moderate, yet pervasive alteration of the top 10-15 km of the lithosphere, and profound alteration of the detachment fault zones. These can be attributed to the formation of weak minerals such as serpentine and talc, respectively. Our models thus highlight the importance of lithosphere-hydrosphere interactions in shaping extensional plate boundaries in the absence of significant magmatic activity.

### The 2015 Taan Fjord, Alaska landslide: broadband seismic analysis and modeling

*Lucia Gualtieri*

In remote regions, many mass-wasting events would likely go unnoticed without networks of seismometers and satellite imagery. Mass-wasting events, such as landslides, generate seismic signals as the mobilized mass accelerates and decelerates, sliding along the ground. The combination of seismic monitoring and numerical modeling provides a way to detect, locate and infer the dynamics of such events, also in the absence of direct observations. In this talk, I will present a broadband analysis and modeling of the seismic signals generated by a massive landslide that occurred near Icy Bay (Alaska) on October 17th, 2015. This was the largest landslide in North America since the collapse of Mount St. Helens in 1980 and generated broadband seismic signals recorded worldwide. Using a recently developed tool for rapid computation of broadband synthetic seismograms, called Instaseis, we model the seismic signals between 5 and 200 s and we reconstruct the time-varying point force to characterize the landslide time history. We also compute the broadband spectrum of the seismic source associated with the landslide. From the inverted force history and an estimate of the final runout distance from satellite images, we deduce the runout trajectory and characteristics of the landslide, such as acceleration, velocity and displacement.

*Iceland*
*Lucia Gualtieri*

## Building and modification of the continental lithosphere: the history of the contiguous U.S. as told by MLDs and LABs

***Emily Hopper, et al.***

The lithosphere preserves a record of past and present tectonic processes in its internal structures and its boundary with the underlying asthenosphere. We use common conversion point stacked Sp converted waves recorded by EarthScope's Transportable Array, as well as other available broadband stations, to image such structures in the lithospheric mantle of the contiguous U.S. In the tectonically youngest western U.S., a shallow, sharp velocity gradient at the base of the lithosphere suggests a boundary defined by ponded melt. Beneath older, colder lithosphere where melt fractions are likely much lower, the velocity gradient at the base of such a layer should be a more diffuse, primarily thermal boundary. In the cratonic interior, the LAB is more gradual in depth, and is transparent to Sp waves with dominant periods of 10 s. Although seismic imaging only provides a snapshot of the lithosphere as it is today, preserved internal structures extend the utility of this imaging back into deep geological time. While the lithosphere often appears seismically transparent, metasomatism localised below a carbonated peridotite solidus explain a sub-horizontal mid-lithospheric discontinuity (MLD) sometimes observed at 70-100 km depth. This type of MLD appears strongest in lithosphere beneath ancient collisional zones, suggesting that it may record extensive tectonism in the deep past.

## Rise of large bubbles in a particle-rich suspension: an analogue for normal activity at Stromboli Volcano, Italy.

***Julie Oppenheimer, et al.***

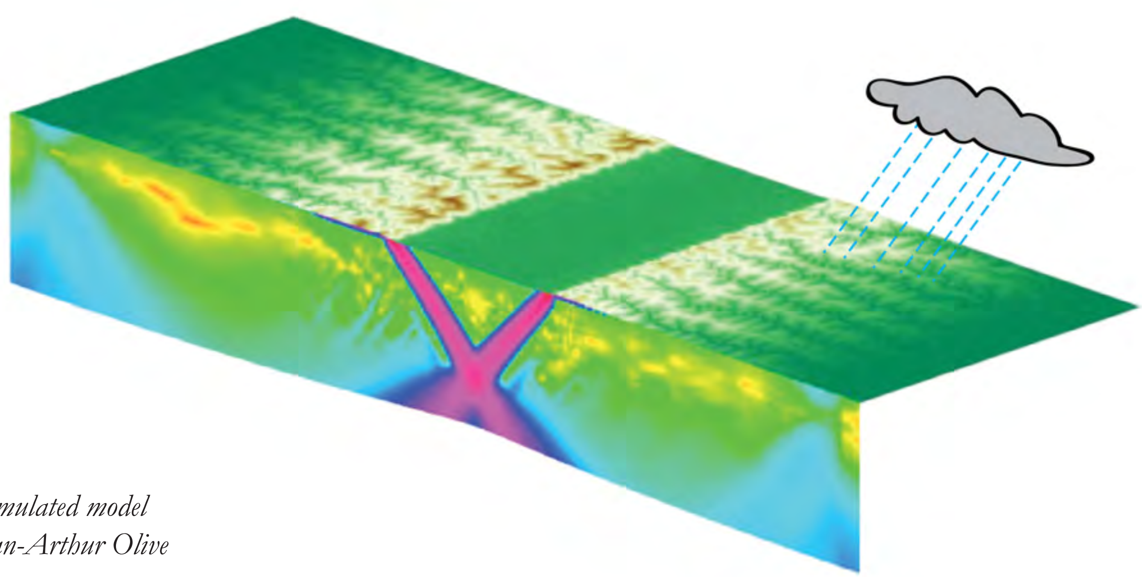
Normal activity at Stromboli is characterized by short (5 – 10 s), intermittent, pulsatory eruptions that generate picturesque fountains of glowing clasts. These eruptions are generally explained as large Taylor bubbles rising to the surface of a liquid-filled conduit. However, eruptions at Stromboli generate magma fragments that contain 45 – 55 vol% crystals on average, evidence of a crystal-rich layer near the surface. To explore how the presence of crystals influences bubble rise in Strombolian magma, we performed a series of analogue experiments where large bubbles rise in a vertical tube. The tube is filled with silicone oil surmounted by an oil-and-particle layer of varying thickness and particle content. The vertical pressure gradient in the tube is scaled by reducing the pressure at the liquid surface with a vacuum pump. When particle contents reached ~30 vol%, the presence of the cap caused significant bubble deformations, pressure variations in the liquid column and in emitted acoustic signals at burst. Particle-rich experiments also generated a very different surface display, with bubble burst on the side (rather than the centre) of the tube, and a pulsatory fountain of ejected clasts, reminiscent of those observed at Stromboli. We suggest that a "weak plug" model better represents Strombolian eruption dynamics.

## Listening to earthquakes: Results from auditory display and machine listening.
***Arthur Paté***

In this talk I will present our collaborative study with the Data Science Institute at Columbia. Inspired by the remarkable ability of the human auditory system to detect and interpret very fine spectral and temporal patterns, we are introducing "machine listening" to seismic data. "Unsupervised" machine learning algorithms are run on spectrograms instead of waveforms. Standard machine learning techniques are used to identify clusters among thousands of seismic signals recorded at the Geysers, CA. The clustering turns out to group earthquakes primarily based on occurrence time, showing a strong and unexpected correlation with the history of water injection into the reservoir. The next step is the use of "human listening" approaches to characterize the clustered signals: links with the rock fracture process are expected. Applications of these results are to inform "supervised" machine learning algorithms for a) the monitoring of human-induced earthquakes and of fracture networks produced by fluid injection, and b) contributing to the forecasting of earthquakes.

## Persistent fine-scale fault structures control rupture development in Parkfield, CA.
***Clément Perrin et al.***

We investigate the fine-scale geometry and structure of the San Andreas Fault (SAF) near Parkfield, CA, and their role in the development of the 1966 and 2004 ~M6 earthquakes. Large aftershocks are concentrated at both rupture tips, characterized by strong heterogeneities in the fault structure at the surface and at depth (change in the fault dip and local variations of the fault strike), and in good agreement with focal mechanisms, which show oblique normal and reverse faulting. We observe these variations during the interseismic periods before and after the 2004 event, suggesting that the structural heterogeneities persisted through at least two earthquake cycles. These heterogeneities act as barriers to rupture propagation of moderate size earthquakes at Parkfield, but also as stress concentrations where rupture initiates. Across fault distribution show a rapid decrease of event density away from the fault core. The damage zone is narrower in the Parkfield section than in the creeping section. We observe a similar but broader distribution during the interseismic periods. This implies that stress accumulates in a volume around the fault during interseismic periods, whereas coseismic deformation is more localized on the mature SAF.



*Simulated model*
*Jean-Arthur Olive*

# Ocean and Climate Physics

## Historical Forcings as Main Drivers of the Atlantic Multidecadal Oscillation

*Katinka Bellomo*

The Atlantic Multidecadal Oscillation (AMO) is the leading mode of climate variability in the North Atlantic affecting multi-decadal variability in rainfall, temperature and hurricanes. Previous studies suggest that internal variability, in particular the Atlantic Meridional Overturning Circulation (AMOC), drives the Atlantic Multidecadal Oscillation (AMO), while external radiative forcing only creates a steady increase in sea surface temperature (SST). This view was recently challenged and new evidence has emerged that aerosols and greenhouse gases could play a role in driving the AMO. Here we examine the drivers of the AMO using the Community Earth System Model (CESM) Large Ensemble and Last Millennium Ensemble. By computing the ensemble mean we isolate the radiatively forced component of the AMO, while we estimate the role of internal variability using the ensemble spread. We find that phase changes of the AMO over the years 1850-2005 cannot be explained in the absence of historical forcings. Further, we find that internal variability dominates North Atlantic SST at timescales shorter than 10-25 years, but at longer timescales the forced response is larger. Single forcing experiments show that greenhouse gases and tropospheric aerosols are the main drivers of the AMO in the latter part of the 20th century. Finally, we show that the forced spatial pattern of SST is not distinct from the internal variability pattern, which has implications for detection and attribution.

## On the importance of ozone feedbacks in the climate system

*Gabriel Chiodo*

Due to computational constraints, an interactive ozone chemistry is commonly neglected in state-of-the-art climate models involved in future climate projections. The impact of this simplification on the modeled response to external forcings is still unclear. Inter-model differences in the treatment of the coupling between stratospheric ozone and circulation could be partly responsible for some of the existing spread in future projections. By carrying out model simulations from the Community Earth System Model (CESM), we carefully quantify the effect of coupling the stratospheric ozone chemistry onto the model's sensitivity to solar and anthropogenic greenhouse gases. We accomplish this by using a version of the model, which allows coupling and de-coupling stratospheric ozone chemistry, without altering the dynamical core and physical parameterizations. This model offers the unprecedented opportunity of assessing the importance of the stratospheric chemistry feedbacks, an their importance for the determination of climate sensitivity. We show that the inclusion of a coupled stratospheric chemistry significantly reduces the model response to both greenhouse gases and solar forcing, albeit through two different mechanisms. According to our findings, stratospheric ozone responses yield an important, and yet undocumented, negative feedback in the climate system.

## Turbulent Mixing in a Deep Fracture Zone on the Mid-Atlantic Ridge
***Louis Clément***

Mid-Ocean Ridge fracture zones channel bottom waters in the eastern Brazil Basin in regions of intensified deep mixing. The mechanisms responsible for the deep turbulent mixing inside the numerous mid-ocean fracture zones, whether affected by the local or the non-local canyon topography, are still subject to debate. To discriminate those mechanisms and to discern the canyon mean flow, two moorings sampled a deep canyon over and away from a sill/contraction. A 2-layer exchange flow, accelerated at the sill, transports 0.04–0.10 Sv up-canyon in the deep layer. At the sill, the dissipation rate of turbulent kinetic energy (ε) increases as measured from microstructure profilers, and as inferred from a parameterization of vertical kinetic energy. Cross-sill density and microstructure transects reveal an overflow potentially hydraulically controlled and modulated by fortnightly tides. During spring to neap tides, ε varies from 10^-9 W/kg to 10^-10 W/kg below 3500 m around the 2-layer interface. The detection of temperature overturns during tidal flow reversal, which almost fully opposes the deep up-canyon mean flow, confirms the canyon mid-depth enhancement of epsilon. The internal tide energy flux, particularly enhanced at the sill, compares with the lower-layer energy loss across the sill. Throughout the canyon away from the sill, near-inertial waves with downward propagating energy predominate the internal wave characteristics. The present study underlines the intricate pattern of the deep turbulent mixing affected by the mean flow, internal tides, and near-inertial waves.

## Impacts of the North Atlantic Warming Hole on Atmospheric Circulation
***Melissa Gervais***

Recent studies have documented the development of warming deficit in North Atlantic sea surface temperatures both in observations and in future climate simulations. To investigate the potential dynamical response of atmospheric circulations to this “North Atlantic warming hole”, I conduct a series of Community Atmosphere Model 5 (CAM5) large-ensemble experiments for the mid-21st century with prescribed SSTs and sea ice that are adjusted so as to either remove or enhance the warming hole. Analysis of the impacts of the warming hole on atmospheric circulation and variability will be presented.


*Canoes in the Piermont Marsh*
*Elizabeth Corbett*

# Biology and Paleo Environment

## Combining neural networks, photogrammetry, and carbonate sedimentology to investigate sea level during the last interglacial

*Blake Dyer*

In the last interglacial period (MIS 5e), global mean sea level was potentially as high as 9 meters relative to today, and greenhouse gases were similar to pre-industrial levels. Combined, these estimates suggest that current sea level may be primed for sudden and drastic change. However, the exact elevation of global sea level during MIS 5e, and the rates of change during that interglacial are complicated by incomplete chronologies in the geologic record and uncertainties in local isostatic or tectonic adjustment of these records since deposition. The Bahamian archipelago consists of several isolated, shallow carbonate platforms that are tectonically stable and may record a relatively straightforward history of past interglacial sea level. The rocky islands on the eastern margins of the platforms are composed of carbonate sediments arranged in coast-parallel and V-shaped coast-perpendicular ridges as high as 20-30 meters above modern sea level. There is a lack of scientific consensus as to the origin and depositional timing of these sediments. Many of these rocks contain aeolian depositional features such as the inverse grading of ripple sets, and the orientation of V-shaped ridges is consistent with modern high speed wind patterns. Moreover, the elevation of ridges is consistent across the archipelago, suggesting deposition occurred after the expected last interglacial glacial isostatic adjustments.

## Conserved Diatom Responses To Resources In The Oligotrophic Ocean

*Matthew Harke*

Primary production in the oligotrophic ocean is carried out by a complex diversity of organisms including the large (>5 μm) eukaryotic phytoplankton that contribute to carbon export. Here I examined how resource availability shapes these eukaryotic phytoplankton assemblages and how taxa respond to resource changes in the oligotrophic ocean during a field study near Station ALOHA in the North Pacific Subtropical Gyre (NPSG). Metatranscriptomic analyses were used to profile the in situ eukaryotic phytoplankton community and track the response of the community to shifts in resource ratios in incubation experiments. Changes in resources drove shifts in apparent community composition relative to the in situ samples, with diatoms consistently displaying increased abundance in response to nitrogen. Cylindrotheca sp. was the dominant diatom in the incubations and displayed a conserved transcriptional response to treatments with added nitrogen. For example, nitrate transporters decreased in transcript abundance in all treatments with added nitrate. The patterns observed in this study mirror prior investigations in this region and suggest a stable community response to shifts in resource ratios. The apparent predictability of this response may aid efforts to model phytoplankton community dynamics and patterns of primary production in the NPSG.

## Functional ecology of carnivores: behavioral and morphological responses to dynamic environments

***Scott LaPoint***

My research efforts aim to better understand how individuals, populations, and species respond to their dynamic environments. I will introduce you to the field and analytical techniques I employ, and how I combine my main research interests (i.e., animal behavior and movement ecology) with my side research interest (i.e., skull morphology) to quantify functional ecological responses in wild animals. I'll describe how we've used skull metrics, generalized additive models, diet studies, and spatial models to suggest some small carnivore species can respond to seasonally limited prey availability (one example) and also newly available (due to reductions in larger predators) larger, more profitable prey species (second example). Next, I will introduce you to my work in movement ecology, where using spatial, temporal, and motion data collected via GPS tracking devices, we've quantified carnivore behaviors to understand how they survive within an urban landscape. I'll end with a brief introduction to my current work: quantifying migratory behavioral responses of golden eagles to climate change.

## Insolation, Ice, and Individual Foraminifera: ENSO response to changing climate boundary conditions

***Gerald Rustic***

The El Niño Southern Oscillation (ENSO) dominates inter-annual climate variability but its relationship to global climate on longer timescales (centuries and beyond) is not well constrained. The response of ENSO to changing climatic boundary conditions remains an outstanding and fundamental question. We investigate how ENSO behavior is influenced by changes in insolation and glacial state, as well as changes in the tropical Pacific east-west temperature gradient. Using trace metal ratios from individual foraminifera found in central Pacific Line Islands sediments, we reconstructed tropical Pacific variability and ENSO activity at key intervals including the mid-Holocene, Last Glacial Maximum, and previous glacial and interglacial periods (MIS 5d/e, MIS6). We find that intervals with reduced insolation generally exhibit lower ENSO activity, with the magnitude of ENSO change at least partially dependent on additional climatic factors. We explore the influence of these climate factors and outline approaches to better understanding ENSO response to these climatic influences.

## Cosmogenic in situ $^{14}C$ in quartz: Applications to late-Quaternary glaciation on Svalbard

*Jennifer L. Lamp*

Deglaciation histories of the Polar Regions provide important insights into ice-sheet and climate dynamics, but cosmogenic nuclide surface exposure studies from these cold and arid areas based on stable ($^{3}He$ and $^{21}Ne$) or long-lived ($^{10}Be$ and $^{26}Al$) isotopes are frequently hampered by the problem of nuclide inheritance from prior exposure periods. In these situations, in situ cosmogenic $^{14}C$ is a useful tool for elucidating Holocene and late-Pleistocene glacial histories: due to its short half-life, $^{14}C$ is essentially reset during periods of significant glaciation lasting longer than ~30,000 years, and therefore does not suffer from the same inheritance complication of longer lived nuclides. Here I discuss the in situ $^{14}C$ extraction procedure from quartz at LDEO, and present the results of two multi-nuclide studies on Svalbard using $^{14}C$, $^{10}Be$, and $^{26}Al$. Our $^{14}C$ measurements show that nunataks in northwestern Svalbard have likely remained ice-free since at least the late-Pleistocene, and strengthen the conclusions of $^{26}Al/^{10}Be$ nuclide studies which imply that these peaks exhibit extremely low erosion rates. Additionally, $^{14}C$ measurements on Torbjornsenfjellet in southwestern Spitsbergen constrain fast deglaciation near the end of the LGM – a conclusion that is unable to be reached based solely on $^{10}Be$ and $^{26}Al$ measurements that are influenced by isotopic inheritance.

## Syneruptive thermal histories of magmas erupted by arc and ocean island volcanoes

*Megan Newcombe*

I am constraining syneruptive pressure-temperature-time paths of magmas using a combination of short-timescale cooling and decompression chronometers. Recent work has shown that the thermal histories of crystals in the last few seconds to hours of eruption can be constrained using concentration gradients of MgO inside olivine-hosted melt inclusions, produced in response to syneruptive cooling and crystallization of olivine on the melt inclusion walls (Newcombe et al. 2014). I have applied this technique to the study of melt inclusions erupted by arc and ocean island volcanoes, including the subplinean 1974 eruption of Fuego volcano; the 1977 fire-fountain eruption of Seguam volcano; and episode 1 of the 1959 Kilauea Iki fire-fountain eruption. Preliminary results indicate that melt inclusions from the Seguam and Kilauea Iki fire-fountain eruptions experience approximately isothermal ascent prior to fragmentation and rapid quenching. Melt inclusions from the subplinean eruption of Fuego volcano record ~30 °C of cooling per kbar of decompression, consistent with adiabatic ascent of magma containing ~60 % vapor (calculated using the Conflow model of Mastin 2002).

### Shifts in vegetation affect the quality of dissolved organic carbon and quantity of greenhouse gases produced in a tidal, brackish marsh along the Hudson River Estuary, NY
***J. Elizabeth Corbett, et al.***

To further investigate the carbon dynamics in tidal marshes, samples were collected and analyzed from Piermont Marsh, a brackish, tidal wetland along the Hudson River Estuary a few miles north of New York City. Sampling sites were determined by vegetation and location. Plant root analysis done on core taken from sites dominated by different vegetation site indicated that live Phragmites australis roots existed down deeper and with greater live root density than sites dominated by native plants. The amount of greenhouse gases both produced and released by the marsh were measured with concentration and stable isotope values of $CO_2$ and $CH_4$. Isotope-mass balance equations were used to determine the amount of $CO_2$ produced from methanogenesis ($CO_{2\text{-meth}}$) and the amount of $CH_4$ lost to the atmosphere. Methanogenesis occured mostly at depths below 100 cm while sulfate reduction occurred above 100 cm in the marsh pore water. Almost all of the methane was lost from the subsurface of the marsh with little evidence of methane oxidation. Interior marsh sites dominated by introduced Phragmites australis had the greatest amount of $CO_{2\text{-meth}}$ (49.8 ± 10.9 mM) followed by sites dominated by native mixed vegetation (Spartina patens, Schoenoplectus americanus, and Eleocharis parvula) (43.8 ± 10.4 mM) and lastly the mudflat location dominated by native Eleocharis (19.3 ± 8.9 mM). These findings were possibly due to the influence of labile substrates from Phragmites plant roots and the wetter conditions of the marsh interior. Optical analyses and FT-ICR-MS results showed Phragmites DOC to be more reactive than DOC from native vegetation. This research provides a deeper understanding on carbon production and release in tidal marshes, determines how much respiration is from methanogenesis, and investigates how the invasion of Phragmites australis has altered the biogeochemistry of the marsh environment.

### Developing winter-sensitive paleoclimate records in southeast Alaska
***Benjamin Gaglioti, et al.***

Recent shifts in winter climate have greatly impacted water resources, glaciers, and fisheries in the North Pacific region. We have a limited understanding of the long-term climate dynamics in winter partly because most high-latitude climate proxies only capture the growing season. Here we explore the potential for winter-sensitive paleoclimate records to serve as different perspectives on ocean-atmospheric variability during the Little Ice Age and Medieval Warm Period in Southeast Alaska. These include: (1) an annual record of water isotopes in trees that use snowmelt as source water; (2) winter-sensitive tree-ring-width records; and (3) geomorphic evidence for the intensity of storminess and snow avalanches. This work is ongoing, and it will be complemented by a study that determines how past winter climate variability affected forest dieback and glacier dynamics in the temperate rainforest of southeast Alaska.

## Golden eagle migratory behaviors and arctic warming
### *Scott LaPoint, et al.*

Many avian species migrate thousands of kilometers to the arctic-boreal regions of North America to nest and raise offspring. Their success though is affected by their ability to arrive and depart optimally; arriving too early could find a landscape covered in snow, arriving too late could mean chicks are ill prepared to depart. This could become more challenging as the region's climate becomes more variable and warms at a rate above the global average, raising serious conservation and evolutionary questions for this ecosystem. We are addressing these questions with the advancements in movement ecology (e.g., biotelemetry tools, data management systems, and spatio-temporal modeling) by quantifying golden eagle (Aquila chrysaetos) migration paths, phenology, and behaviors during the previous 24 years. Early summaries of our growing data set of ~500k locations of adult, migratory golden eagles (and an additional 5mil locations from five other arctic species) suggest that: (a) the onset and cessation of migration can be identified via spatio-temporal models, (b) the northward migration appears to begin earlier in recent years, (c) the duration of the northward migration is rather consistent, and (d) individuals appear to re-use migratory routes over time.

## Impact of North Atlantic circulation on atmospheric CO2 during the last deglaciation
### *Francesco Muschitiello*

Understanding the impact of ocean circulation on the global atmospheric $CO_2$ budget is of paramount importance for anticipating the consequences of projected future changes in Atlantic Meridional Overturning Circulation (AMOC). In particular, the efficiency of the AMOC can impact atmospheric $CO_2$ through changes in vertical carbon export mediated by variations in North Atlantic deep-water convection. However, the causal relationship between North Atlantic Ocean circulation, and atmospheric $CO_2$ is poorly understood. Here we present new high-resolution planktic $^{14}C$ data from an exceptionally well-dated marine core from the Nordic Seas spanning the last deglaciation ( 15,000-10,000 years BP). By precisely synchronizing terrestrial, marine and ice-core records, we document for the first time a large and rapid atmospheric $CO_2$ drawdown a few centuries prior to Greenland Stadial 1. Using transient climate simulations from a fully coupled climate-biosphere model, we show that surface freshening in the North Atlantic and consequent AMOC weakening can have a major impact on the global atmospheric $CO_2$ budget. Furthermore, our data help clarifying the timing and magnitude of the deglacial $CO_2$ signal recorded in Antarctic ice cores. We conclude that the global $CO_2$ budget is more sensitive to perturbations in North Atlantic circulation than previously thought, which has significance in the future debate of the AMOC response to anthropogenic warming.

## Measurement of trace metal ratios in individual foraminifera using OES
### *Gerald Rustic*

Trace metal ratios (Mg/Ca) measured in multiple, individually analyzed foraminifera have been used to provide new dimensions to paleoclimate reconstructions, but such measurements are difficult due to the small size of the target species. Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) has been used to make such measurements on individuals, but calibration and comparison with standard solution chemistry results has been limited due the low concentrations of target trace metals from single specimens. We have developed techniques for measuring trace metal ratios, including Mg/Ca, from individual foraminifera using Optical Emission Spectrometry - Inductively Coupled Mass Spectrometry (OES-ICPMS) and solution chemistry techniques. We directly compare LA-ICPMS and OES-ICPMS methods through paired, same-shell measurements of Mg/Ca. We find that same-shell Mg/Ca ratios from the two methods are well correlated ($r^2 = 0.92$). Importantly, we find that material lost during sample preparation and cleaning can alter Mg/Ca ratios, reducing inter-method correlation. These findings further expand the ability of the paleoclimate community to generate single-specimen trace metal data.

*Ancient Forest*
*Benjamin Gaglioti*

## The influence of nepheloid layers on global model simulations of 231Pa and 230Th.
***Chandranath Basak, et al.***

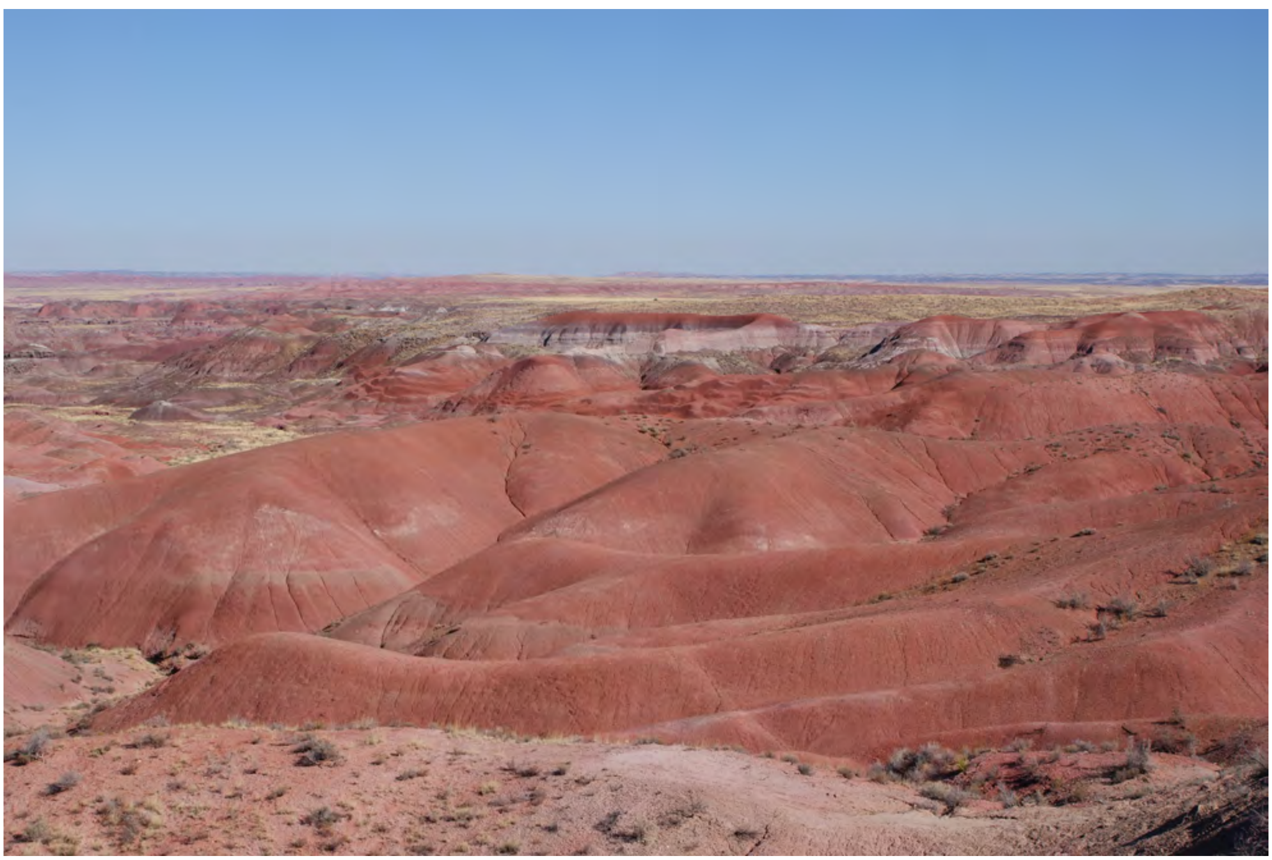
$^{231}$Pa and $^{230}$Th in the ocean are produced at a constant ratio by Uranium decay but adsorption onto particles removes these tracers differentially. This fractionation process makes it possible to use the elemental $^{231}$Pa/$^{230}$Th ratio as a paleoceanography proxy, frequently used for deriving the strength of Atlantic Meridional Overturning Circulation. The removal process, however, is further complicated by the abundance and composition of the available particle types. Understanding how dissolved tracers interact with the particle field in the ocean is key to better understand the biogeochemical cycling of these particle-reactive elements and their use as a flux tracer in present and past oceans. We here present simulations of the $^{231}$Pa/$^{230}$Th ratio using the Transport Matrix Method (TMM, Khatiwala, 2007), focusing especially on the role of the nepheloid layer in controlling the distribution of these radiotracers. The model simulates each tracer separately, with advective-diffusive transport based on the ECCO ocean state estimate (Stammer et al., 2004). Sources include production by Uranium decay and dust dissolution. Radioactive decay and importantly, reversible scavenging and sedimentation are the main sinks that control the removal of the radiotracers. Similar to previous studies, we consider particle fields consisting of calcium carbonate, opal, particle organic matter, and dust. A novelty is that we explicitly consider the influence of an additional bottom particle layer (nepheloid). Simulations that include a nepheloid layer produce vertical profiles that better fit the observed distribution of $^{230}$Th and $^{231}$Pa. Specifically, observational data in the South Atlantic and eastern South Pacific indicate a mid-depth inflection (for both Pa and Th), a feature that can only be obtained if a nepheloid layer is included in the simulation. Our simulations reinforce the idea that nepheloid layers play an important role in Pa and Th cycling in the ocean (Deng et al., 2014; Hayes et al., 2015).

## Deglacial surface ocean pH: implications for foraminifer assemblages and the carbon cycle
***Kelsey Dyez***

The physical characteristics of the ocean environment (temperature, pH, salinity, etc) place constraints for organisms living in seawater. While many studies have focused on temperature as the primary factor determining the composition of planktic foraminifera communities, ocean pH changes could also change species density under future ocean acidification. This project studies the respective effects of ocean warming and acidification on planktic foraminifera, collected from a global suite of sediment cores covering the time from the last ice age (colder and more alkaline seawater conditions) into the current warm period (warmer and more acidic seawater conditions). Some sites do indeed indicate little variation in ocean acidity, but large changes in temperature and foraminiferal species composition. If this trend is corroborated, it would suggest that warming is more important for ecosystem changes than acidification, at least over the slow rate of acidification and warming from the last ice age to the preindustrial. By reconstructing deglacial pH, we can also derive a signal of how much carbon ($CO_2$) may be entering (or exiting) the surface ocean into the atmosphere. These signals will then allow for a characterization of changes in the ocean-atmosphere $CO_2$ flux and can help to constrain the mechanisms behind carbon storage in the deep ocean.

## Constraining North Pacific Intermediate Water circulation from 0-1.2 Ma
***Karla Knudson***

North Pacific Intermediate Water (NPIW) is the primary water mass associated with Pacific meridional overturning circulation. While the relationship between Atlantic meridional overturning circulation and climate has been extensively studied, a lack of suitable Pacific sediment cores has limited our ability to reconstruct past changes in North Pacific climate and NPIW past the last glacial cycle. Our future work will investigate changes in NPIW, using one-of-a-kind North Pacific region samples from Integrated Ocean Drilling Program Site U1342 to generate records of Nd isotopes as "water mass tracers" over the past 1.2 Myr. Site U1342 is located at a sensitive depth (818 m) for detecting changes in NPIW, and it is the only available North Pacific site that offers long, continuous core recovery, relatively high sedimentation rates, excellent foraminifera preservation, and a well-constrained age model. Previous studies at Site U1342 using non-quantitative circulation proxies provide evidence for enhanced NPIW formation during extreme glacials associated with the closure of the Bering Strait and suggest that NPIW was formed locally within the Bering Sea. Our proposed work, which builds on the potential importance of these results, will apply more robust and potentially quantitative circulation proxies to constrain NPIW variability.



*Painted desert in Petrified Forest National Park*
*Natalia Zakharova*

## Interaction of blind foldbelt and fluvial system in Bangladesh: Avulsion of the Meghna River

*Céline Grall, et al.*

The eastern part of the Ganges-Brahmaputra-Meghna Delta (GBMD) is underlain by the blind megathrust of the IndoBurma subduction zone, but the paleoseismologic history of this region is unknown. Earthquakes and associated co-seismic uplift can drive channel migration and river avulsion. In this context, we are investigating the history of a 100 km long sinuous abandoned channel and associated flood plain of the Meghna River with the aim to determine if an historical earthquake could have been responsible of the complex Holocene channel history of this fluvial system. We use hand drilled stratigraphic logs and OSL dating method to show that the channel onset during the mid-Holocene (~7.2 ± 0.2 ka) has been abandoned during the late Holocene (~3.7 ± 0.5 ka). Nearby, additional evidence of uplift is provided by oxidized terraces of Holocene age. Numerical models have been carried out to evaluate the hypothesis that the co-seismic uplift associated with an earthquake can trigger the channel abandon. We explore different reasonable earthquake magnitudes and fault geometries to shows that the co-seismic uplift associated with a potential earthquake is sufficient to trigger the channel abandonment.

## Stratigraphic model of the Sea of Marmara as a useful framework to study the activity of the submerged section of the North Anatolian Fault system

*Céline Grall, et al.*

The submerged section of the North Anatolian Fault in the Sea of Marmara, which corresponds to the dextral plate boundary between Eurasia and Anatolia, poses strong hazard for earthquakes and consequent submarine landslides and tsunamis in the vicinity of the highly populated region of Istanbul. Yet, estimations of geological fault slip rates remain scarce, as no borehole data is available in this region. In such a context, developing a seismic stratigraphic model in order to provide a time frame for the fault offsets observed on the broad multi-channel seismic reflection dataset available in this region is critical. In an international joint effort, we have been able to develop a regional stratigraphic model from the shelves to the deep, quickly subsiding basins. This model is based on both seismic observations and core-seismic data correlation. Remarkably, earthquake related events such as submarine mass-movement and mud volcanism are stacked at stratigraphic boundaries, suggesting a close interplay between environmental factors and seismotectonic processes. This age model can be directly used to interpret observed fault offset and allow us to document the activity of the main plate boundary faults and a notable secondary fault system observed on the southern shelf of the Sea of Marmara.

# POSTER SESSION
# Ocean and Climate Physics

### Propagation Dynamics of Disaster-Induced Production Losses in the Global Economic Network
***Christian Otto, et al.***

Risks of extreme weather events like floods, heat-waves, and storms are likely to increase under global warming. Since world markets are highly interlinked and local economies extensively rely on global supply and value added chains, local extreme weather events can have global repercussions. Accordingly, comprehensive climate risk assessment and cost estimation should take these interactions into account. Here, we present the dynamic agent-based loss propagation model acclimate. It describes the immediate response of the global supply network to local disasters as well as its recovery dynamics in the disaster aftermath. The model accounts for price dynamics and can thus base the decision rationale of the economic agents on clear and simple optimization principles. Furthermore, price effects like demand surge can be analyzed, which become important for large scale disasters. In our analysis, we introduce the economic amplification ratio measuring the importance of indirect losses with respect to total losses and study its dependence upon the severity of the disaster and inventory size. Moreover, we discuss global changes in purchasing power that can be induced by local disasters.

# Seismology, Geology and Tectonophysics

### Reaction-Induced Uni-axial Compaction and Expansion During Gypsum Formation
***Robert Skarbek, et al.***

Deformation and cracking caused by reaction-driven volume increase is an important process in many geological settings. The interaction of brittle rocks with reactive fluids can change permeability and reactive surface area, leading to a large variety of feedbacks. The conditions controlling these processes are poorly understood. We conducted uni-axial deformation experiments to study the effects of confining pressure on deformation during the formation of gypsum from bassanite $CaSO_4 \cdot (1/2)H_2O + (3/2)H_2O = CaSO_4 \cdot 2H_2O$. We cold-pressed basanite powder to form cylinders ~2.5 cm in height and 1.2 cm in diameter. Samples were confined in steel, and compressed with a static axial load of 0.1 to 5 MPa. Water was allowed to infiltrate the initially unsaturated samples through the bottom face across a micro-porous frit. The height of the sample was recorded during the experiment, and serves as a measure of volume change induced by the hydration reaction. The samples exhibit a change from monotonic expansion at 0.1 MPa, to monotonic compaction at 5 MPa axial load. At 1 MPa axial load, samples exhibit alternating phases of compaction and expansion, resulting in net compaction. We explain this behavior with a 1-D poroelastic model of unsaturated flow that includes a hydration reaction, and allows for creep in the product phase (gypsum).

# Meet our Postdoctoral Scientists

**Chandranath Basak**
*Research*: I am working on a project where I use biogeochemical models in order to understand the chemical behavior of particle reactive elements in modern Ocean. I also use radiogenic stable isotopes (Sr, Nd, Pb) to reconstruct past deep ocean circulation changes as well as study the distribution of trace elements and their isotopes in the modern global ocean.
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**Paul M. Betka**
*Research*: I am a field-based structural geologist. Currently, I investigate the structure of the IndoBurman ranges which is one of the planets's most densely populated accretionary prisms and potential source of a >8 Mw earthquake. I integrate field mapping, detrital geo- and thermochronology and structural analysis to understand the long-term geologic evolution of the IndoBurman forearc. Prior to joining Lamont, I was a field geologist for the Alaska Division of Geological and Geophysical Surveys.
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*Division*: Marine Geology and Geophysics

**Katinka Bellomo**
*Research:* My research focuses on understanding the air-sea interactions driving internal modes of climate variability, such as the Atlantic Multidecadal Oscillation and the Pacific Decadal Variability, which have social and environmental impacts over land (e.g., rainfall, temperature, hurricanes) and persist for several years. My research tools include hierarchical models with increasing degrees of complexity between the atmosphere, ocean, and topography, as well as surface and satellite observations.
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**Gabriel Chiodo**
*Research*: My research focuses on interactions between atmospheric chemistry and climate, with particular emphasis on stratospheric ozone. I aim to quantify the feedbacks induced by ozone chemistry in the climate response to external forcings, such as anthropogenic greenhouse gases and solar activity. To this end I run ensembles and hierarchies of global climate models. I am currently investigating how the representation of stratospheric ozone chemistry in global models can impact their future climate projections in the Southern Hemisphere.
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**Louis Clément**
*Research*: My research interests are primarily in observational physical oceanography. I am currently working on understanding the various processes which can contribute to the turbulence in a fracture zone canyon, adjacent to the Mid-Atlantic Ridge, and to the upwelling branch of the overturning circulation in the South Atlantic. I previously worked on the effect of eddies on the meridional overturning circulation in the North Atlantic and also on the generation of internal waves by decaying eddies at the western boundary.
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**Naftali Cohen**
*Research*: I am an atmospheric dynamicist. My research focuses on high-impact weather events in monsoon regions as well as the global-scale flow in the atmosphere and how it might change in the future.
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*Division*: Ocean and Climate Physics

**J. Elizabeth Corbett**
*Research*: I investigate greenhouse gas emissions and subsurface production from various types of wetland environments. I do this with isotope-mass balance calculations to determine the amount of $CO_2$ produced from methanogenesis, the amount of methane produced in the subsurface before loss, and the percent of methanogenesis that escapes to the atmosphere. I use these calculated amounts to compare various types of global wetlands and sites containing different types of vegetation to assess which environments may contribute the most to global climate change.
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**Blake Dyer**
*Research*: My research goal is to better understand how sediments record the Earth-system response to changing boundary conditions. The information stored in the sedimentary rock record offers a broad range of past environmental variability that serves as a powerful baseline to differentiate naturally occurring change from human induced change and can reveal feedbacks that may become critically important in predicting future climate change. I investigate this sedimentary record by merging modern data.
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**Kelsey A. Dyez**
*Research*: I work on Pleistocene and Holocene climate/ocean change from a geochemical perspective. By building records of past temperature, salinity, paleo pH and $pCO_2$ from various locations across the planet, we can address the natural mechanisms of past climate change. The tools I use include the trace element and isotopic composition of surface-dwelling marine plankton. At Lamont I am involved in a project reconstructing $pCO_2$ in the Pleistocene, and deglacial pH from the Last Glacial Maximum to present.
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**Will F. J. Fortin**
*Research*: My research focus is in building robust methods to extract detailed subsurface properties from seismic reflection data. Currently, I am developing and applying seismic inversion techniques to: (1) examine $CO_2$ storage potential off the US east coast, and (2) determine gas hydrate response properties and concentrations in the Gulf of Mexico.
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**Roger R. Fu**
*Research*: I am primarily a paleomagnetist working on the measurement and interpretation of magnetism in deep time samples such as meteorites and terrestrial zircons. At Lamont I have been working to understand anomalous plate motions in the late Jurassic and to test the hypothesis of true polar wander occurring during this time.
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*Division*: Seismology, Geology and Tectonophysics

**Benjamin Gaglioti**
*Research:* I study high latitude landscapes and climate change over the late Quaternary period. I use a variety of tools to quantify climate forcing (tree rings, stable isotopes, sedimentology), and then determine how landscape patterns and processes have responded to these changes (biogeography, permafrost thaw, glaciers, and wildfire). I am presently working on developing tree ring records to understand North Pacific climate change over the Common Era.
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**Melissa Gervais**
*Research*: My current research is focused on understanding how the development of a warming deficit in North Atlantic sea surface temperatures may impact atmospheric circulation in future climate simulations. To study this problem, I am conducting a series of large-ensemble atmosphere-only global climate model simulations with adjustments to the SST field over the North Atlantic so as to either remove or enhance the warming hole.
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**Céline Grall**
*Research*: I am a geodynamicist, working on the tectono-sedimentary processes in coastal regions and underwater sedimentary basins. My current research is split in two topics: (1) determining the relative sea-level history and constraining associated subsidence rates and driving forces, (2) determining the slip rates of active faults. My analysis is primarily based on core and seismic reflection data, compaction and thermal modeling.
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*Division*: Marine Geology and Geophysics

**Sjoerd Groeskamp**
Research: How do tracers move from the surface of the ocean to the interior (and back)? A part of the answer is: through mixing. A large part of my research involves understanding and estimating the magnitude of ocean mixing processes, from the smallest to the largest scales. This will help us to more accurately represent these processes in ocean models and improve climate predictions.
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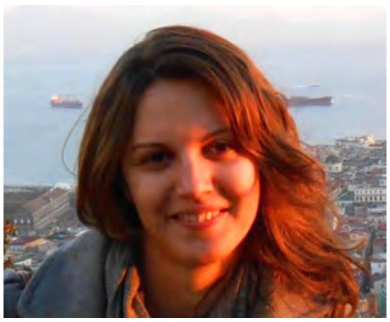

**Lucia Gualtieri**
*Research*: My research is broadly motivated by the willing of using Seismology to develop a theoretical understanding of the generation mechanisms of a variety of environmental processes. In particular, I use analytical and numerical seismic models to study mass-wasting events, ocean and atmospheric activity. This gives me the opportunity to investigate the coupling between different Earth systems, such as the atmosphere, the ocean and the solid Earth.
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**Matthew J. Harke**
*Research*: My research uses modern molecular microbiology techniques and bioinformatic tools to assess the genetic underpinnings that drive the proliferation of microbes in response to changing environmental conditions in both marine and freshwater ecosystems. I have combined these molecular observations with physiological and experimental approaches to understand how environmental conditions shape microbial succession and how microbial succession may shape ecosystem dynamics.
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**Gwenn M. M. Hennon**
*Research*: Gwenn is interested in the mechanisms of phytoplankton acclimation and adaptation to climate change. She received her Ph.D. in Biological Oceanography in 2015 from the University of Washington. Her current research utilizes gene expression to uncover how phytoplankton shift carbon concentrating mechanisms and interactions with their microbial partners in response to elevated CO2.
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**Emily Hopper**
*Research*: I received my PhD from Brown University, where I worked on the seismic structure of the crust and lithospheric mantle across the U.S. from common-conversion-point stacks of receiver functions recorded by the EarthScope array. I am now working in the seismology division at Lamont, looking at crust and uppermost mantle structure in the Pacific and East Africa.
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Division: Seismology, Geology and Tectonophysics

**Karla Knudson**
*Research:* I investigate the relationship between past climate changes, ocean circulation, marine biological productivity, the ocean-atmosphere carbon pump, nutrient cycling, and other environmental conditions. My research combines multi-proxy geochemical and sedimentological analyses, including measurements of oxygen, carbon, nitrogen, and neodymium isotopes, to create paleoceanographic records over a range of timescales.
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**Jennifer Lamp**
*Research*: I am a geomorphologist focusing primarily on (1) sub-meter scale processes active in the Arctic and Antarctic, and (2) the theory and application of cosmogenic nuclide techniques, particularly *in situ* $^{14}C$. My interests include examining mechanisms such as rock weathering and the sublimation of debris-covered glaciers using a combination of experimental, numerical, and *in situ* monitoring techniques, and applying cosmogenic nuclide methods to elucidate the glacial history of Svalbard and the McMurdo Dry Valleys of Antarctica.
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**Scott LaPoint**
*Research*: My research combines field-derived data, e.g., from camera traps or biotelemetry, with spatial models to better understand how wildlife responds to their dynamic environments. This has included studies around the world in animal behavior, movement ecology, and skull morphology. I currently investigate golden eagle migratory behavior as a respond to climate change.
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**Francesco Muschitiello**
*Research*: My research interest lies in understanding the mechanisms behind rapid transitions in the climate system to create predictability for future climate change. I am particularly focused on the study of the exact sequence of events occurring across rapid climate shifts of the past in order to discern cause-effect relationships between the different components of the global climate system (atmosphere, oceans, ice sheets and the carbon cycle). My research involves the use of paleo-climate records from marine and lake sediment cores using a variety of inorganic and organic geochemical proxies, with a special focus on stable isotopic tracers.
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**Samer Naif**
*Research*: I analyze passive and active source electromagnetic data to map the electrical conductivity structure of the crust and upper mantle at plate margins. I use the electrical constraints to investigate the role of fluids and partial melts on various tectonic processes, such as megathrust earthquakes and arc magmatism.
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*Division*: Marine Geology and Geophysics

**Megan Newcombe**
*Research*: I am trying to understand the controls on volcano explosivity. I use short-timescale diffusion chronometers to study syneruptive magma ascent and cooling at arc and ocean island volcanoes.
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**Jean-Arthur Olive**
*Research*: My research focuses on the evolution of rift systems, with particular emphasis on tectonic, hydrothermal and magmatic interactions at mid-ocean ridges. I combine numerical and analytical modeling to investigate the dynamics of long-term normal fault growth, hydrothermal circulation, and the thermo-mechanical behavior of the lithosphere.
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**Julie Oppenheimer**
*Research*: I study the dynamics of volcanic eruptions using analogue materials. My research focuses on mechanical interactions between bubbles and crystals in suspension, and specifically on how these interactions affect gas migration and eruption style. I run three-phase experiments with analogue materials for melt (silicone oil, sugar syrup), crystals (glass beads, crushed plastic, sugar), and exsolved gas (air, CO2), which I then relate to case studies in volcanology.
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**Christian Otto**
*Research:* In my research, I study, on the one hand, the impacts of local climate extremes on the global economy. Thereby, I focus on cascading indirect losses arising from supply chain interruptions. On the other hands, I analyze the main drivers of food price volatility on global markets challenging food security.
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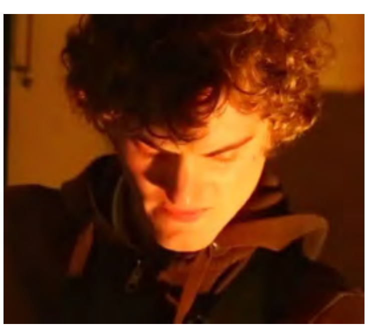

**Arthur Paté**
*Research*: I am an acoustician and I worked on vibration measurements, sound processing and sound perception. My current research project uses machine learning ("machine listening") and auditory display methods to explore, mine and understand large databases of seismic data.
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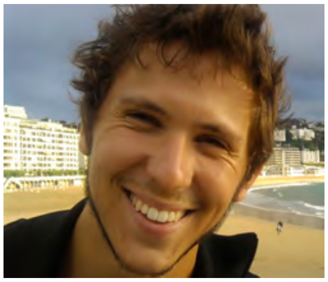

**Clément Perrin**
*Research*: My research focuses on understanding 3D fault structures and their role in the rupture process of large earthquakes. I'm working mainly on earthquakes occuring in California, using high-resolution data at surface (topographic data, satellite images) and at depth (earthquake catalogs).
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**Gerald Rustic**
*Research*: I study climate variability on human time scales and the relationship of short-term climate variability, specifically the El Nino Southern Oscillation (ENSO), to large scale climate change. Using the geochemical signatures from foraminifera found in deep sea sediments, I look to reconstruct past ENSO conditions and identify connections with the background state of the Tropical Pacific ocean, global ice volume, and changes in insolation. These patterns provide clues to help us better understand ENSO's behavior under future climate conditions.
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**Jack Scheff**
*Research*: I study the impacts of future, present, and deep-past global climate and $CO_2$ change on all aspects of the terrestrial water cycle, including precipitation, evapotranspiration, soil moisture, runoff / water resources, and vegetation water stress. I also have a strong interest in the impact of climate change on the general circulation of the atmosphere, again in both the future and the past. My tools include climate models, large global datasets, and theory.
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**Deepti Singh**
*Research*: My research is centered on the intersection of physical climate and human vulnerability, to assess climate risks to society. I combine climate dynamics with statistical approaches to examine the influence of historical and future climate forcings on the characteristics of climate extremes and their associated physical processes on a range of spatio-temporal scales. Overall, my work aims to improve our understanding of the societal risks in a changing physical climate to inform policy, risk-management, and adaptation strategies.
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**Rob Skarbek**
*Research*: I use theoretical, numerical, and experimental methods to study the mechanics of geophysical systems. Currently, I am preforming experiments in the LDEO Rock Mechanics Lab to study the effects of hydration reactions on fluid flow and cracking. In the past I have studied the mechanics of slow slip events, accretionary prisms, and landslides.
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**Nathan Steiger**
*Research*: My work engages the fundamental problem of understanding the historical variability of the climate system and its relevance to human societies. In particular, I seek to understand the physical mechanisms of severe droughts as well as Arctic and Antarctic climate variability.
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**Natalia V. Zakharova**
*Research*: My research focuses on reservoir characterization and risk assessment for $CO_2$ geologic storage. I am particularly interested in developing better understanding of fractured media, and evaluating induced seismicity risks from underground fluid injections. I use borehole geophysical data for petrophysical, geochemical and geomechanical analysis, and integrate them with core and large-scale geophysical surveys to characterize geologic formations across multiple scales.
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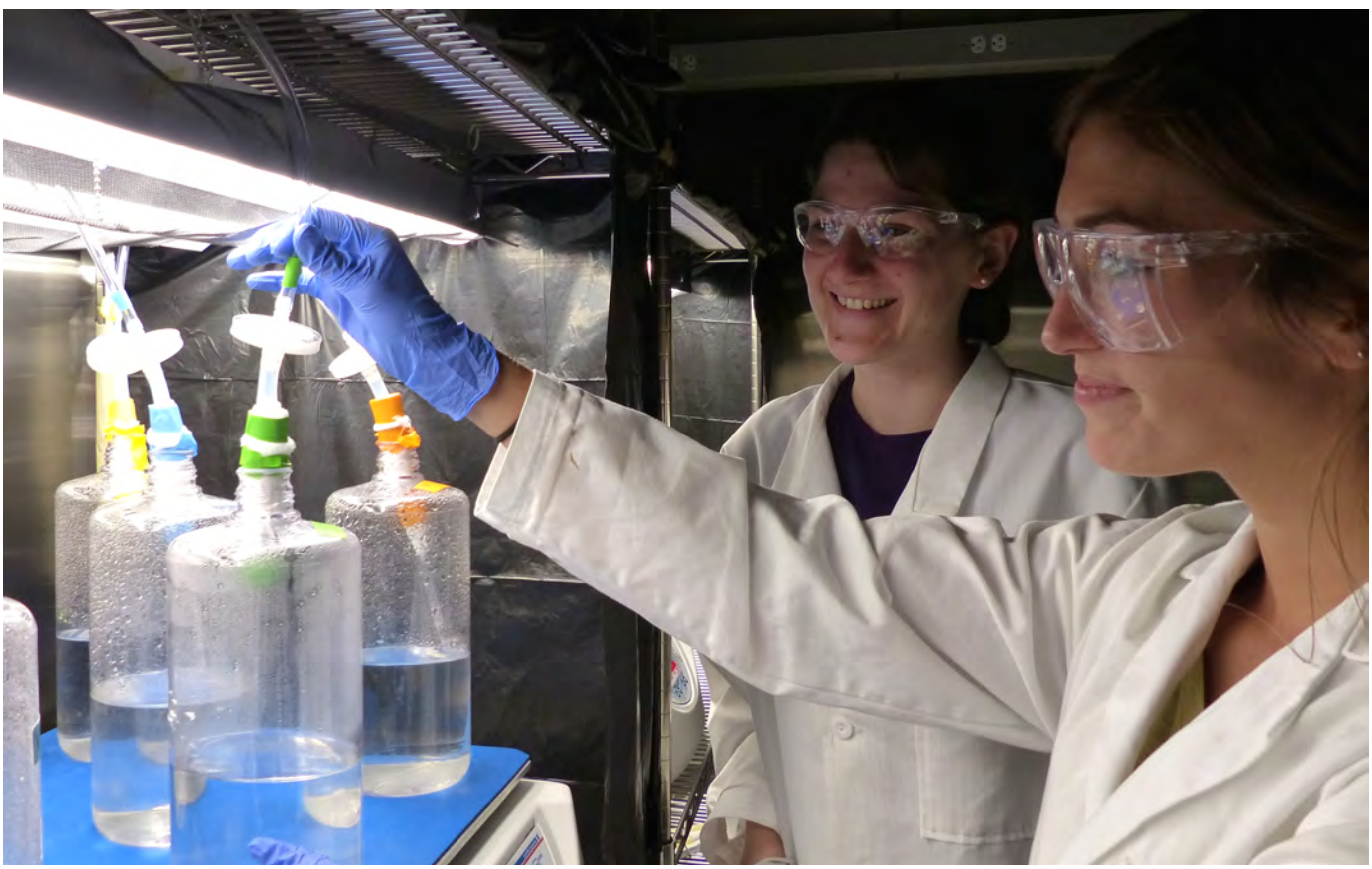
*Division*: Marine/ Large Programs



*Postdoc Gwenn Hennon (left) in her lab*

# NOTES

# NOTES

Facing page: Coring a mountain hemlock tree
Benjamin Gaglioti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