How Do Geochemical Markers in Hudson River Sediments Correlate with Environmental Changes and Catastrophes?

Background: High resolution XRF scanning shows apparent annual cycles in Mn within core LWB1-8, taken off Yonkers, NY. We confirmed the annual cycles with reconnaissance Cs dating. Unusual horizons appear to correlate with extreme floods (Fig.1). We also found peaks in Sr that may correspond to incursions of seawater from hurricanes and nor'easters, as inferred from pelagic tropical microfossils found in some layers within LWB1-8 and CD02-29A.

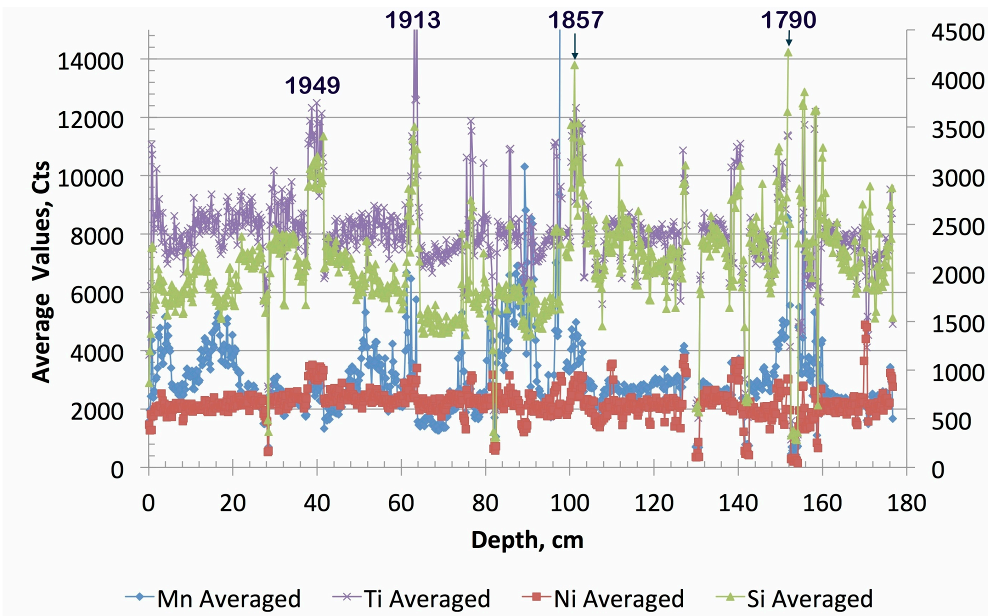

Fig. 1: ITRAX logging of Mn, Ti, Ni and Si in core LWB1-08. Extreme peaks in all four elements correlate with spring floods in 1949, 1913, 1857 and 1790. 1857 and 1913 represent the 1st and 2nd highest water levels ever recorded at Albany, N.Y.

Analysis Required: We will verify, calibrate and elucidate our geochemical stratigraphy of LWB1-8 by performing analyses of geochemistry (including heavy metals), mineralogy, grain size and fossil content along with SEM imaging and further dating. We will test the reproducibility of these marker horizons by using the same methods on core CD02-29, recovered from the Hudson off Manhattan, NY. We will also conduct local fieldwork to sample potential sources of sediment and metals.

Prerequisites: Intense interest in geology and environmental science. Strong interest in co-mentoring high school students from New York City.

Mentors: Dallas Abbott (dallashabbott@gmail.com) and Karin Block (kblock@ccny.cuny.edu)

Where Do the Birds Go? Investigating the Fall Migration of Arctic-boreal Breeding American Robins

Background: Arctic-Boreal regions (ABRs) of North America have been warming at a rate two to three times higher than the global average, with acute physical and biological responses. Many recent studies suggest that animal habitat throughout the ABR is undergoing profound change. Each of these changes alters wildlife habitat characteristics in unique ways - often overlapping and interacting with one another in time and space. In fact, in the last 20 years, some Inuit people have had to invent a name for the American Robin ("Koyapigaktoruk") as they expand into new habitat, yet little effort has been made to understand the ecological consequences of this heterogeneity in Arctic-Boreal environmental conditions. Long distance migratory animals such as robins must navigate through an increasingly complex and dynamic mosaic of environmental and land surface conditions, but how vulnerable or resistant their long-term persistence is to the increasing spatiotemporal heterogeneity is unknown. To contribute understanding, in Spring 2016 we equipped 30 American robins with mini-GPS tags, catching them as they migrated northward (spring migration) through the Canadian boreal forest. From this effort, we not only learned the timing and pathways taken by the birds on their way to annual ABR breeding grounds, but we are working to understand the role that ecological and environmental conditions played in controlling their migration behavior. In late Summer 2017, we plan to equip another 30 robins with mini-GPS tags to understand fall migratory behavior of ABR breeding robin populations, and also to determine their overwintering locations. Additionally, there are geographical patterns stored in the feathers of birds as carbon and hydrogen isotopes that vary with where the birds spent the winter eating and growing their feathers – "you are what you eat!". As such, we will collect tail feathers from these same 30 birds so that we can relate *exactly* where the bird migrated/overwintered (from our GPS locations) to the isotopic signals in their feathers which should reflect the latitude at which they overwintered the previous year.

Analysis Required: The primary goal of our fieldwork will be to capture and equip 30 robins with mini-GPS tags, and to collect a tail feather from each one of those birds. This project will require fieldwork in a boreal forest ecosystem in either northern Alaska or Canada (specific location TBD) in mid-August 2017. The fieldwork will last for approximately two weeks and will involve working directly with other project team members, including graduate students and field technicians with significant ornithological experience.

Prerequisites: None, apart from having experience and being comfortable/ enthusiastic working outdoors for several hours at a time regardless of weather conditions.

Mentors: Natalie Boelman (nboelman@ldeo.columbia.edu) and Ruthie Oliver (ryo2101@columbia.edu)

How Well Can Current Models for Ocean Dynamics and Ice-mass Loss Predict the Geographic Variability of Sea-level Change?

Background: Future mean sea-level rise will be driven largely by mass loss from Earth's major ice complexes as well as by ocean dynamics (including all the contributions to ocean dynamics, such as ocean currents, winds, and distribution of heat and freshwater in the ocean). Prediction of local and regional (i.e., geographically variable) sea-level rise depends critically on the spatial variability of all these physical processes as well as on the response of Earth's crust and mantle and its gravity field to the present and past redistribution of surface mass. We are in the process of investigating the suitability of the suites of numerical modeling experiments performed by the climate community for prediction of regional sea-level change, in particular, the CMIP5 experiments for ocean dynamics and the SeaRISE sensitivity experiments for Antarctic and Greenland ice evolution.

Analysis Required: The project will require statistical evaluation of suites of community predictive climate models and assessment of their accuracy by comparison to satellite observations and to other models that assimilate observations.
The project requires interaction with other members of the NASA Sea-Level Change Team (sealevel.nasa.gov).

Prerequisites: Familiarity with basic statistics would be useful. Experience with elementary computer coding, or willingness to learn, using any language (e.g., PERL, Python, Matlab) is necessary for data manipulation. Knowledge of basic physics (particularly mechanics, gravitation, and thermodynamics) is highly desirable.

Mentor: James Davis (jdavis@ldeo.columbia.edu)

Did the Agulhas Leakage Change over the Past 1.5 Million Years? Evidence from Terrigenous Sediment Sources from IODP Expedition 361 Cores

Background: The Agulhas Current is a major current flowing southward near the east coast of South Africa. A portion of it “leaks” into the Atlantic, bringing warm salty water from the Indian Ocean into the Atlantic circulation system. The extra salt is thought to have an important impact on the formation of North Atlantic Deep Water and the global ocean circulation. Therefore it is important to constrain how the “Agulhas Leakage” has changed through time. Our previous studies have shown that sediments eroded from Africa and carried by the Agulhas have distinct compositional “fingerprints” that actually “maps” the path of the Agulhas Current System. Moreover, the compositions of sediments from the last ice age indicate that the Agulhas Current was weaker at that time. We are currently involved with IODP Expedition 361, which recovered sediments that were deposited over the last 7 million years on the southeast African margin and in the Indian-Atlantic ocean gateway.

We seek a student to study the terrigenous sediment composition of samples from the last 1.5 million years from IODP EXP 361 site U1479 from the Cape Basin, in the path of eddies from the Agulhas Leakage. This work will complement parallel work on other EXP 361 sites being conducted at LDEO and elsewhere, as well as the concurrent studies by other interns and senior scientists of sediments collected from the Limpopo River cone, and from the mouths of various rivers along the eastern coast of South Africa. We expect all of the interns to work together. There will be energetic group discussions at LDEO and with our international collaborators during the internship and beyond.

Analysis Required: This project will require sediment preparation and 40Ar* and other geochemical analysis (major and trace elements and perhaps radiogenic isotopes if time allows) of samples from IODP Site U1479. Lab work will require 20 hrs/week. Some interaction with high school interns is likely.

Prerequisites: None, although some coursework or background in geology, paleoclimate or isotope geochemistry is a plus.

Mentors: Allison Franzese (afranzese@hostos.cuny.edu), Sidney Hemming: (sidney@ldeo.columbia.edu), Steve Goldstein, (steveg@ldeo.columbia.edu) and Merry Cai (merrycai@gmail.com)

Plastic Microbeads in the Waters Around New York - How Widespread and How Toxic?

Background: Microbeads (Fig. 1) are synthetic polymer particles that have found extensive use as a replacement for natural exfoliating materials in personal care products and abrasives in cleaning supplies. They typically range between 5μm and 1 mm and are made of polymers such as polyethylene, nylon etc. that are not easily degraded and are potentially toxic to marine life. Microbeads enter the aquatic environment primarily through effluent release from wastewater treatment plants because their small size allows them to escape capture by filter screening in sewage treatment plants. Recent studies have shown that microbeads are capable of concentrating a wide variety of toxic organic compounds found in waste treatment plants, and can therefore serve as efficient vectors for dispersal of pollutants. However efforts to assess their ecological risks have been frustrated by their small size and lack of adequate techniques to quantify their distribution in seawater. By some rough estimates, New York alone washes 19 tons of microbeads down the drain each year but actual microbead concentrations in the coastal waters of New York have not been assessed for want of a quick and reliable method for their detection. Here we propose an interdisciplinary study focused on mapping the distribution of microbeads and evaluating their toxicity for lower trophic organisms. Our plan is to focus on water bodies around New York, the Hudson River and Long Island Sound. Our central hypothesis is that microbeads are more widespread than previously recognized and represent a significant threat for commercially harvested bivalves and human health. Students will take part in field sample collections around New York, for mapping and determination of hot spots of microbeads and for assessments of the organic compounds associated with microbeads. This study will also permit students to undertake exposure/response experiments to examine the toxicity of naturally occurring microbeads on lower trophic level organisms.

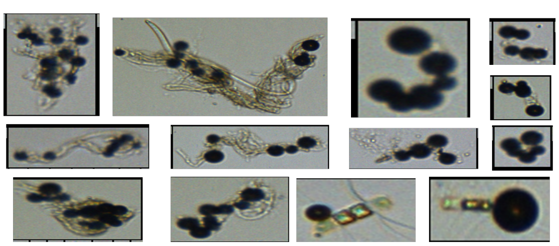

Fig.1: Diversity of microbeads found in seawater samples

Analysis Required: field sampling in water bodies around New York, The rest of the summer will be spent preparing samples for analysis and laboratory experiments.

Prerequisites: None, although knowledge of organic chemistry is a plus.

Mentors: Joaquim I. Goes (jig@ldeo.columbia.edu) and Beizhan Yan (yanbz@ldeo.columbia.edu)

Geochemical “Fingerprints” of the Agulhas Current: Are They Changed by South African Rivers?

Background: The Agulhas Current is a major current flowing southward near the east coast of South Africa. A portion of it “leaks” into the Atlantic, bringing warm salty water from the Indian Ocean into the Atlantic circulation system. The extra salt is thought to have an important impact on the formation of North Atlantic Deep Water and the global ocean circulation. Therefore it is important to constrain how the “Agulhas Leakage” has changed through time. Our previous studies have shown that sediments eroded from Africa and carried by the Agulhas have *distinct compositional “fingerprints”* that actually “maps” the path of the Agulhas Current System (!). Moreover, the compositions of sediments from the last ice age indicate that the Agulhas Current was weaker at that time. However, there are important open questions. Do the compositional changes really reflect a weaker Agulhas Current? Or were the ice age sediments coming from different African sources, carrying different geochemical fingerprints?

A series of possible sources of sediments into the Agulhas Current during the ice age are rivers along the eastern coast of South Africa – for example, the deep gorges cut by these rivers show that they contained much more water in the past compared to today. In summer 2016 we collected a set of sediments from South African rivers between Durban (very near the headwaters of the fully constituted Agulhas Current) and Port Elizabeth (near the tip of South Africa, where the Agulhas Current “Retroflects” eastward into the Indian Ocean but still leaks” into the Atlantic), and we seek a student to work on them. This work will complement the concurrent study by other interns and senior scientists of sediments collected during 2016 by IODP Expedition 361 along the path of the Agulhas Current, to follow its history over the past few million years. We expect all of the interns to work together. There will be energetic group discussions at LDEO and with our international collaborators during the internship and beyond.

Analysis Required: This project will require sample preparation and 40Ar* and other geochemical analysis (major and trace elements and radiogenic isotopes if time allows). Lab work will require 20 hrs./week. Some interaction with high school interns is likely.

Prerequisites: None, although some coursework or background in geology, paleoclimate or isotope geochemistry is a plus.

Mentors: Steve Goldstein (steveg@ldeo.columbia.edu), Allison Franzese (AFRANZESE@hostos.cuny.edu), Sidney Hemming (sidney@ldeo.columbia.edu), and Merry Cai (merrycai@gmail.com)

Who’s Hanging Out in the Hudson River? “Shedding Light” on the Persistence of Waterborne Microbial Contamination

Background: In accordance with EPA determined standards, water quality is often assessed by the load of fecal indicating bacteria (FIB) in water samples. The classification FIB is used because these bacteria “indicate” potential sewage contamination, which can contain many other human and animal pathogens. Despite a common source, FIB and their co-occurring pathogens may have significantly different traits, which could cause them to respond differently to various environmental factors, like light exposure, turbidity, and temperature. If, under some conditions, FIB abundance did not approximate the abundance of co-occurring pathogens, water quality measurements would have to be adjusted to detect higher pathogen load without relying on FIB as the indicator. This project will focus on the effect of one particularly important environmental factor: sunlight. Previous studies demonstrate that FIB are highly sensitive to light, showing significant rates of degradation when exposed to sunlight. Are other sewage-associated bacteria similarly light sensitive? By exploring how sunlight degrades other bacteria that co-occur with FIB, the student will determine which bacteria can be approximated by FIB because of their similar light sensitivity and which respond differently. Results from this study will be crucial for understanding how FIB’s key traits affect their persistence in natural waterways and how these traits compare to those of co-occurring pathogens. Through exploration of the reliability of current water quality measurements under different environmental conditions, the student will work at the intersection of basic microbial ecology and applications for public health.

Analysis Required: This project will require fieldwork for obtaining water samples from the Hudson River. Additionally, the student will conduct laboratory-based experiments that utilize basic microbiological techniques (e.g. culturing, environmental-perturbation simulation, flow-cytometry) and then analyze their data.

Prerequisites: Some knowledge/experience of microbiology and statistics would be helpful

Mentor: Andy Juhl (andyjuhl@ldeo.columbia.edu)

Where Did Dust Come from during Cold Times in Europe? Identifying Dust Sources Using Chemical and Isotopic Tracers.

Background: Dust has an important role in climate and paleoclimate reconstruction. It affects climate by affecting solar radiation and is affected by wind transport and change in atmospheric circulation. At present, there is almost no dust deposition over Europe; however, past glacial periods and cold intervals during interglacials were characterized by deposition of loess (wind-blown sediment deposits). This reflects different atmospheric dynamics from today. Understanding the sources of these sediments will provide clues about the different environmental and climate conditions during cold intervals in the past. This project focuses on very interesting cycles of soil and wind-blown sediments deposited during the end of the last interglacial in Dolni Vistonice in the Czech Republic. These cycles reflect millennial scale fluctuations between relatively warm-wet intervals and cold-dry intervals. The wind-blown intervals are coeval with dust in Greenland ice cores and cold events in the North Atlantic, highlighting the global significance of these events. Chemical compositions (major and trace elements) and radiogenic isotopes (Pb, Nd, Sr) provide a means to identify sources of sediments. The aim of this project is to find possible sources to the different wind-blown sediments during the last interglacial, compare them to glacial sediments and other dust records, and characterize possible mechanisms that lead to the observed sediment composition.

Analysis Required: The project involves processing sediment samples in the LDEO clean chemistry lab (4 weeks) and measuring them by ICP-OES and ICP-MS in order to determine isotopic compositions in the interglacial and glacial sediment samples from Dolni Vestonice, Czech Republic (2.5 weeks). The remainder of the time will be spent processing the data, combining them with other existing data, and interpreting the paleoclimate implications.

Mentors: Yael Kiro (ykiro@ldeo.columbia.edu), Wallace Broecker (broecker@ldeo.columbia.edu), Merry (Yue) Cai (cai@ldeo.columbia.edu) and Prof. Steven Goldstein (steveg@ldeo.columbia.edu)

Do You Pine for a Better Understanding of Past Climate? Linking Tree-ring Stable Isotopes and Environmental Histories

Background: Trees are wonderful, long-lived organisms that record environmental information in their annual growth bands (tree rings). The widths of annual tree rings have told us about some variations in climate over the past millennium across Mongolia, a region of semi-arid Asia experiencing extreme, recent climatic change. However, tree rings contain more information than meets the eye. Measuring stable carbon and oxygen isotopes in tree-ring cellulose can tell us about the physiology of these trees, and in some cases, provide more climatic and environmental information than tree-ring width. In this project, we will evaluate the potential of using stable isotopes to provide a more comprehensive climate history of central Mongolia. Tree-ring stable isotope measurements from a new site will be compared to a new collection of written, historical climate records from nearby China. The climatic information gained from stable isotopes, in addition to classical ring-width measurements, could be used to answer some important questions. For example, do stable isotopes provide different seasonal or spatial climate information relative to tree-ring width? How has temperature and precipitation changed in the region during the pre-industrial and modern periods? Have major volcanic events influenced temperatures or precipitation patterns in high-latitude Asia? Does inferred past climate from tree-ring data match Chinese records of past climate? The student will gain invaluable laboratory and data analysis skills.

Analysis Required: Tree-ring samples from Mongolia are already available at the Lamont tree-ring lab. The student will be responsible for conducting laboratory work, including cellulose extraction in the wet laboratory, under the guidance of the mentors. In the process, the student will learn basic methods on processing tree-ring data.

Prerequisites: None, but laboratory experience is ideal

Mentors: Caroline Leland (cleland@ldeo.columbia.edu) and Laia Andreu-Hayles (lah@ldeo.columbia.edu)

What are the Geophysical Signatures of Mantle Upwellings beneath the US East Coast?

Background: Recent seismic imaging has identified several places beneath the US east coast where the mantle is upwelling and hot mantle rocks are being moved to shallower depths. The occurrence of upwelling beneath oceanic spreading centers such as the Mid Atlantic Ridge and hot spots such as Yellowstone is well known and believed to be the source of their volcanoes, seismicity and other distinctive features. The upwelling beneath the US east coast is a bit of a surprise, though simulations of mantle convection show that it may be caused by the sharp edge of a continent, which perturbs the mantle flow field. The heat brought up by upwelling, and the magma produced by it, can have profound effects on the shallower parts of the earth. The buoyancy of hot material can cause uplift, changes in shorelines, and accelerated erosion. The heat can increase the geothermal gradient, leading to metamorphism and geothermal activity. Thermal expansion can perturb the earth's isostatic balance, causing abnormally high elevations, and flex the lithosphere, causing stress field changes that make earthquakes either more or less likely. The lower viscosity of upwelling mantle, compared to normal mantle, will cause it to respond differently to external forces, such as glacial unloading at the end of the Ice Age. Whether any of these geophysical signatures of upwelling are present in the US east coast is unknown, because the upwelling was identified just in the last year or so.

Analysis Required: The student will assemble and map out previously published geophysical parameters such as heat flow, uplift, earthquakes, mineral springs, etc. for the US east coast, and assess whether their geographical patterns have any correspondence to the location of the upwellings. Second, the student will chose two or three of the more promising parameters for in-depth studies that will include quantitative modeling. The purpose of the modeling will be to establish that observed spatial relationships could plausibly be caused by the mantle upwelling.

Prerequisites: The student needs to have a willingness to read about the previously published geophysical measurements made in eastern North America, to extract data from them, to collate them and map them out. They should have some familiarity with geological and geophysical concepts and nomenclature and with "physics-style" units of measurement. Quantitative modeling will be performed using software provided by the mentors that runs under the MATLAB software environment. MATLAB training will be provided. Some experience with working with computer models will be helpful, as will enthusiasm for diving into them and understanding what they can (and cannot) do.

Mentors: Bill Menke (menke@ldeo.columbia.edu) and Dallas Abbott (dallashabbott@gmail.com)

How is the Recently-Identified Mantle Upwelling beneath New England Affecting Its Lithosphere?

Background: Recent seismic imaging has identified several places beneath the US east coast, including southern New England, where the mantle is upwelling and hot mantle rocks are being uplifted to shallower depths. The occurrence of upwelling beneath oceanic spreading centers such as the Mid Atlantic Ridge and hot spots such as Yellowstone is well known and believed to be the source of their volcanism, seismicity and other distinctive phenomena. The upwelling beneath the US east coast is a bit of a surprise, though simulations of mantle convection show that it may be induced by mantle flow across the sharp edge of a continent. The heat brought up by this upwelling and the magma (if any) produced by it are likely to be having a profound effects on the lithosphere above. It may be eroding the lithosphere away, or chemically altering it, or even thickening it by consequent underplating of solidified magma. The seismic imaging performed so far is too low-resolution to discern among these hypotheses.

Analysis Required: This is a seismological data analysis project that will address the question of whether the lithosphere above the upwelling in southern New England is different from adjacent areas and interpret the significance of these differences. The student will use seismic waves from nearby (North American) earthquakes to probe the region just below the crust-mantle boundary (Moho) and to map out its physical properties. Any spatial patterns that are detected will then be interpreted in terms of the processes enumerated above.

Prerequisites: The student needs to have a willingness to work with many, many seismograms -wiggly lines displayed on a computer screen – and a knack for spotting salient features within them. The data analysis presumes some familiarity with basic physical quantities (such as velocity, density, frequency, etc.), so some prior coursework in elementary physics is required. Data analysis will be performed using software provided by the mentor that runs under the MATLAB software environment, and while training will be provided, some prior exposure to analyzing numerical data would be helpful.

Mentor: Bill Menke (menke@ldeo.columbia.edu)

What Are the Timing, Periodicity and Sources of Pleistocene Ice Rafted Detritus Deposits in ODP Leg 113 Site 693 in the Southeast Weddell Sea?

Background: It is important to understand how glaciation in East Antarctica has varied on glacial/interglacial timescales and through time in the Pleistocene and Pliocene. Recent work from our group at LDEO has demonstrated a wide range of geological ages within the continental sources surrounding the Weddell Sea (Pierce et al., 2014, Earth Science Reviews) that suggests we may be able to probe the processes related to waxing and waning of the ice streams draining from East Antarctica into the Weddell Sea by constraining the sources of ice rafted detritus. Other recently published work has suggested significant changes in ice volume on millennial timescales, with implied sources from East Antarctica through the last deglaciation (Weber et al., 2014, Nature), and through the last 6 million years from James Ross Island (e.g., Smellie et al., 2008, Paleo-Paleo-Paleo). A recent discovery of that core 2 from Site 693 that contains (relatively) abundant planktonic foraminifera and peaks in ice rafted detritus (senior thesis from Wesleyan University) presents the possibility to 1) place time constraints on the interval, estimated to be approximately 1 million years ago based on shipboard observations, with strontium isotope composition of the foraminifera, 2) test for cyclicity with stable isotopes and possibly trace element compositions of the foraminifera, and 3) test for variability in the sources of ice rafted detritus by dating the individual hornblende and biotite grains with 40Ar/39Ar.

Analysis Required: This project will require sediment preparation and hornblende and biotite picking for $^{40}Ar/^{39}Ar$ analyses and foraminifera picking and processing for strontium isotope analyses. Lab work will require 20 hrs./week. Some interaction with high school interns likely.

Prerequisites: None, although some coursework or background in geology and chemistry is a plus. Strong interest in co-mentoring science-interested high school students.

Mentors: Suzanne O’Connell, (soconnell@wesleyan.edu), Sidney Hemming (sidney@ldeo.columbia.edu), Mike Kaplan (mkaplan@ldeo.columbia.edu) and Merry Cai (merrycai@gmail.com)

Do Plant-wax Biomarkers Capture Past Global Climate Gradients?

Background: Over the past 23 million years, vegetation and fauna on earth have changed dramatically from the poles to the equator due to large-scale changes in the climate system. One of the most profound changes on land was the spread of grassland ecosystems in the tropics and subtropics, which gave rise to many new species of grazing mammals. The possible role of temperature and rainfall patterns in driving this revolution in terrestrial ecosystems remains unclear. This project aims to develop a long-term, broad record of temperature and rainfall history from the poles to the equator from 23 million years to present to begin to assess their role in global vegetation change.

One way to assess changes in global temperature and rainfall is to reconstruct changes in the hydrogen isotopic gradient of rainfall between the equatorial and polar regions. This gradient is largely due to the effect of equator-pole temperature gradients as well as rainfall amount. Here we will reconstruct the hydrogen isotopic composition of rainfall in the past by measuring the hydrogen isotopic composition of terrestrial plant biomarkers (molecular fossils) preserved in marine sediments. These biomarkers contain hydrogen atoms derived from rainwater, where low isotope ratios are indicative of cold climates values and higher ratios are indicative of warmer climates. Terrestrial biomarkers are transported offshore by winds and currents and preserved in deep-sea marine sediments.

This project will use marine sediments recovered by the International Ocean Discovery Program (IODP) over the past 40 years to build new hydrogen isotope records from the Neogene to present. The biomarker hydrogen isotope data will be used to assess changes in temperature and rainfall amount across periods of vegetation change. Other biomarker compounds, plant-wax distributions, and their carbon isotope ratios will be integrated into the analysis.

Analysis Required: The majority of the summer will be spent preparing (cleaning, freeze drying, and extracting) marine sediment samples and analyzing them by gas chromatograph-mass spectrometry and stable isotope ratio mass spectrometry. Lab work will require 20-40 hrs./wk.

Prerequisites: None, although knowledge of organic chemistry and stable isotope geochemistry are a plus. Neatness and attention to detail are essential.

Mentors: Pratigya Polissar (polissar@ldeo.columbia.edu), Kevin Uno (kevinuno@ldeo.columbia.edu), Sam Phelps (sphelps@ldeo.columbia.edu), and Peter deMenocal (peter@ldeo.columbia.edu)

Where Can We Store Lots of CO_2? A Study of Geologic Carbon Storage Offshore Washington & British Columbia

Background: Cutting carbon dioxide (CO_2) emissions and lowering its concentrations in the atmosphere is one of the greatest challenges of this century. Geologic storage of CO_2 – by injecting it into porous rock formations where it will be trapped as nontoxic carbonate minerals – may be an important key to reducing manmade greenhouse gas emissions and the impacts of climate change. One critical challenge for CO_2 storage is identifying where to put it. We are investigating offshore carbon storage in sub-seafloor basalt – the world's most common volcanic rock – offshore from Washington State and British Columbia in the Cascadia Basin, where more than 100 times the annual U.S. CO_2 emissions could safely be stored. Sub-seafloor basalts have enormous storage capacity and they are distant from human activities. If proven to be feasible, geologic carbon sequestration may become a critical component of solving the most important environmental problem of our time and with significantly higher public acceptance than some other approaches.

Before we can carry out an experiment to test offshore CO_2 storage in basalt, we have to understand those basalt formations in much more detail then we could possibly describe from a single field study or geologic survey. The CarbonSAFE project aims to compile data and expertise to develop a plan for a large-scale carbon storage project in the Cascadia Basin, which has been the focus area for many different types and scales of geologic, geophysical, and hydrologic studies. We need to begin by assembling the available data that has been collected in the area and assessing how valuable these data might be for understanding the sub-seafloor basalt formations.

Analysis Required: This project will involve compiling and assessing existing geophysical, geological, geographical, and core data from the Cascadia Basin region (offshore WA+BC), primarily from IODP research programs, Ocean Networks Canada, and the Ocean Observatories Initiative, and producing tables, plots, and maps of the assembled data. An intern can expect to gain experience handling seismic images & data, well logging data, core images & data, as well as bathymetric and oceanographic data.

Prerequisites: Experience with spreadsheets or other database software is needed. Experience with geographic information system (GIS) software or other data visualization tools would be helpful.

Mentors: Angela Slagle (aslagle@ldeo.columbia.edu) and Dave Goldberg (goldberg@ldeo.columbia.edu)