How Does Air Pollution Move Around New York City?

Background: Carbon dioxide (CO_2) and methane (CH_4) are important greenhouse gases. CO_2 has increased dramatically in recent years. CO2 is emitted from human-related combustion sources such as cars and power stations, as well as being taken up and emitted by natural sources such as trees and vegetation. Methane is emitted from different sources such as leaky natural gas lines, landfills and sewers, as well as natural sources such as wetlands. Within NYC our estimates of CO_2 and CH_4 emissions are calculated from inventories maintained by various state and federal agencies. However, recent studies have shown that inventory methods consistently underestimate CH_4 emissions and that fossil fuels are likely responsible for a large portion of the underestimate. Likewise, the uncertainty related to CO_2 inventories is not well defined. We are developing an urban network of gas sampling sites in order to calculate the total amount of CO_2 and CH_4 emitted within NYC. The basis of this method involves measurements of CO_2 and CH_4 in the atmosphere around the city at various locations. The optimal location of these sites will be determined by undertaking an atmospheric transport modeling study around New York City.

Anticipated tasks: The undergraduate intern will travel to various locations around NYC to sample a suite of trace gases in syringes followed by analysis by gas chromatography back in the laboratory. The intern will also use an existing dataset of re-analysis wind fields in a Lagrangian particle dispersion model to determine the surface influence of air reaching potential sampling locations in the urban network. This involves learning to use already developed tools and applying them to the specific problem.

Skills required: A lab science class is required. Coding experience in Python, R or Matlab, and/or experience working with different file formats and analyzing data is also an advantage but not essential. Communication skills are highly valued for thoroughly documenting codes and disseminating scientific findings.

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Martin Stute: martins@ldeo.columbia.edu, (845) 365-8704.

What Can the Distribution of Heavy Metals Tell Us about Sedimentary Environments and Benthic Habitats in Long Island Sound?

Background: As researchers participating in the Long Island Sound Mapping Project, we are working to characterize the benthic habitats in Long Island Sound. Knowledge of the type and distribution of benthic environments with respect to sedimentary environments and ecological communities is essential for successful management of these systems. Our role in the project is to identify and map the different physical and chemical environments and characterize depositional regimes within the study site. We do this through a combination of geophysical, geochemical and sedimentological approaches. This includes sonar surveys and a variety of physical/chemical measurements made on sediment samples. During the summer 2017 field season, we collected surface sediment grab samples in shallow areas of Eastern Long Island Sound. These are currently being processed and analyzed for grain size distribution and density, organic content, and bulk chemical composition. For the 2018 field season, we plan to acquire additional sediment grabs as well as sediment core samples from the deeper sections of Eastern Long Island Sound.

The sediment core samples, up to 2m long, can provide a record of deposition at a given site. In general, industrial activities in the 19th and 20th centuries introduced a variety of contaminants into the environment. As a result, this time period can be identified in the sedimentary record by elevated concentrations of lead and other metals (i.e., pollution chronology). Further, the distribution profile and inventory of a particular metal also allows one to infer information regarding the type of depositional environment, rate of sediment accumulation and level of disturbance. Traditionally, these types of measurement require a significant amount of analytical work; however, the acquisition of our new X-ray florescence (XRF) core scanner allows this type of data to be collected at high resolution in a fraction of the time.

Analysis Required: The student would have the opportunity to participate in field work on Long Island Sound. They would participate in analyzing selected sediment samples and/or acoustic data in the lab, e.g. using the XRF scanner, integrating the results and comparing those with existing data from other part of the Long Island Sound. Data analysis and integration will be done using Excel and GIS software.

Prerequisites: Confidence in working with Excel and potentially ArcGIS is preferred but not required.

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Where Do Dust and Sediments Come from during Dry Periods in the Eastern Mediterranean-Levant? Characterizing Dead Sea Sediment Sources

Background: Water is a scarce resource in the Middle East, and climate models predict a drier future in a warmer world. The Dead Sea watershed stretches between the Saharan-Arabian desert belt and the more temperate and wetter Mediterranean climate zones, and different paleoclimate proxies in sediments trace the changes in these zones through time. In the Dead Sea (Israel, Jordan, Palestine) salt, mainly halite, has precipitated during arid periods of interglacials. Characterizing past climate during drought intervals provides a means for understanding the climatic driving forces that are responsible for the increased aridity, which is forecasted for a future warmer world.

This project aims to identify changes in the Dead Sea sources through chemical and isotopic analyses of sediment samples. Changes in these compositions will be used to determine changes in the water and dust sources in the Middle East, providing an important past climate record of the last 200,000 years.

Work description: The project involves processing sediment samples from the Dead Sea Deep Drill Core (crushing, dissolving, chemical separation), and from rivers in Jordan, at the LDEO Ultraclean Chemistry Lab, and measuring them by mass spectrometry. The student will gain experience in sample digestion and chemical procedures in the Ultraclean Lab and will learn how to work with different mass spectrometers. The work also involves data processing using MS Excel and/or MatLab. The student will expand his/her knowledge about paleoclimate reconstruction, isotope geochemistry and Middle East climate.

Qualifications: Lab experience is preferred but is not necessary.

Mentors: Yael Kiro ykiro@ldeo.columbia.edu, (845) 365-8916
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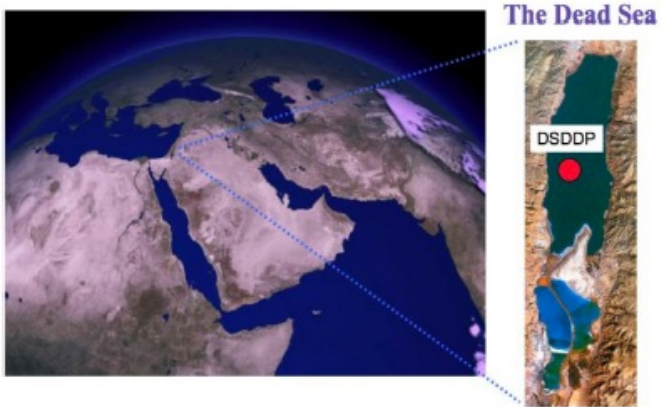
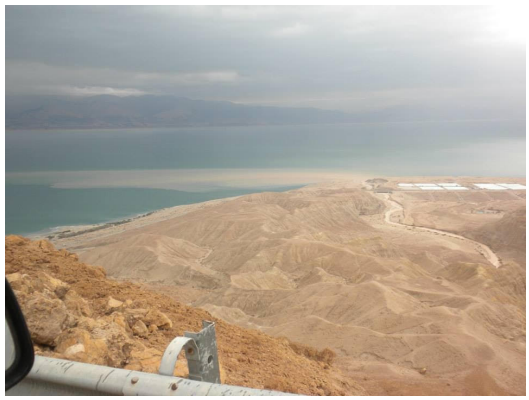


The Dead Sea basin is located within two major climate systems: the Saharan–Arabian and the Mediterranean. The figure shows the location of the Dead Sea Deep Drilling Project (DSDDP) site at the center of the modern salt lake, at a water depth of 300 m.



A flood entering the Dead Sea creating a plume of fresh water and sediment.

Do Pulses in Effusion Promote Lava Dome Collapse?

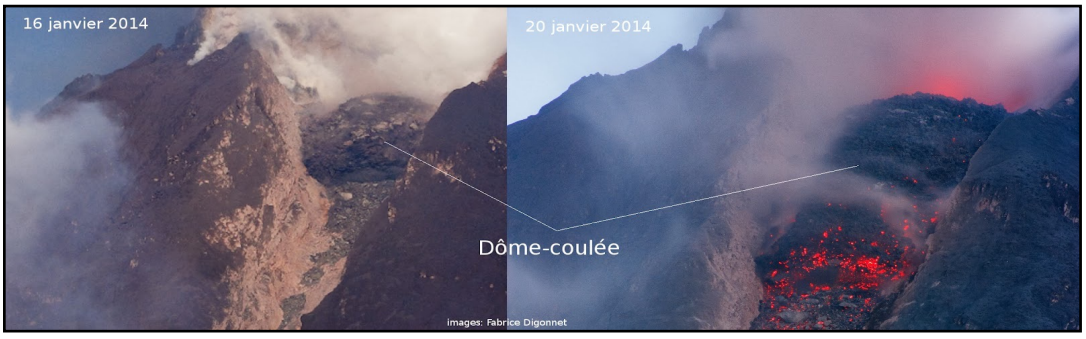
Background: Lava domes are formed when the erupting lava is too viscous to flow freely, yet there is not enough gas in the magma to drive an explosion. Lava domes are frequently unstable, and in their collapse form hazardous pyroclastic flows. In recent years, lava domes collapses and the resulting pyroclastic flows caused great damage at Unzen, Japan (1991), Merapi, Indonesia (1994), Soufriere Hills Volcano, Montserrat (1997), which caused over 100 deaths, and currently at Sinabung, Indonesia. In order to provide prediction tools for dome hazards, it is important to understand what controls the stability of lava domes.

The stability of a dome depends on many factors, both internal, including the distribution of vesicularity, temperature, and crystallinity, and external, such as the underlying topography and the rate at which lava is extruded at the vent. However, most models of lava dome evolution do not account for many of the complexities necessary for accurately capturing natural dome dynamics.

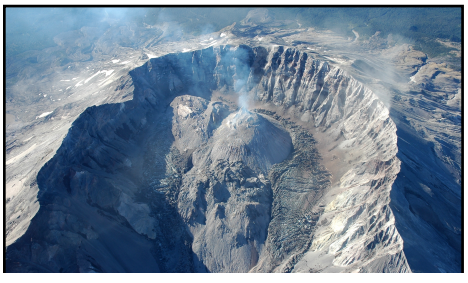
Intern project: We will address questions regarding dome evolution and stability using *experiments in the Fluid Mechanics lab*. The intern will lead a team of 2-3 high-school students in preparing and characterizing mixtures of liquids (syrup/wax), solids (e.g., clay, micro-beads) and gas bubbles. Next, the team will create domes by "erupting" the mixtures at different flux rates using a new, programmable pump. The team will document the evolution of the domes using an array of cameras and will create 3D reconstructions of the dome surface to capture pre- and post-collapse structures. Results will then be compared with natural dome collapse events (see Figures). The project directly meshes with active theoretical and fieldwork currently taking place by group members.

Prerequisites: Experience using MatLab is a plus. Laboratory experience also a plus.

Project mentor: Einat Lev (einatlev@ldeo.columbia.edu)



Evolution of the dome at Sinabung in dome-flow between 16 and 20 January 2014. Images: Fabrice Digonnet



What Moves First: Arsenic or Carbon in Vietnamese Groundwater?

Background: In Vietnam geogenic arsenic is naturally released from the sediment to the groundwater in shallow aquifers. At the same time the country is rapidly developing with rural areas becoming urban. This development includes the installation of water supply systems that that have dramatically increased the amount of groundwater abstraction. This pumping has changed groundwater flow patterns and areas of arsenic contamination. It has been observed that arsenic is now present in once pristine aquifers. Low arsenic aquifers are becoming contaminated. But it is not clear if the arsenic is moving with the groundwater or if carbon is moving with the groundwater causing arsenic release into pristine aquifers. Analysis of RNA has the potential to help us understand arsenic and carbon dynamics in these newly contaminated aquifers. We have collected filters for RNA work from an aquifer that has recently become arsenic contaminated. The goal of the work will be to extract RNA from the filters for molecular and radiocarbon analysis. You will be involved in all aspects of the sample preparation and analysis.

Analysis Required: The project will require you to use geochemical and biological methods in the lab. We will teach you all the methods you need, you just need to be willing to learn.

Prerequisites: None. But chemistry and biology labs are a plus along with experience with Excel.

Mentor: Brian J. Mailloux bmaillou@barnard.edu 212-854-7956

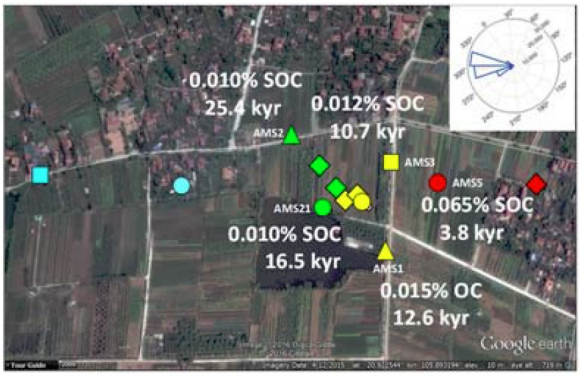


Figure 1. Field Site in Vietnam. Groundwater is moving towards the Northwest from wells with high arsenic (red) to areas of low arsenic (yellow->green->blue). Age of sediment is shown when available and analysis will enable us to match RNA ages to the age of the sediment or water.

Are We Eating Microplastics through Marine Foods?

Background: Microplastics including microbeads 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 5 μm 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. They 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 microplastics are capable of adsorbing a wide variety of toxic organic compounds found in waste treatment plants, for example PCBs and polycyclic aromatic hydrocarbons (PAHs, carcinogens), and can therefore serve as efficient vectors for dispersal of pollutants. Microplastics have been found in mussels, fishes and shrimps around the world, providing a possible pathway for affecting human health.

Analysis Required: This project will analyze abundance and type of microplastics in scallops collected from the Atlantic Ocean by our collaborators from NOAA. We also plan to collect water and plankton samples from waters around NYC through our collaboration with Riverkeeper. Lab work will also include the analysis of certain organic pollutants in scallop tissues and microplastics found in the scallops. Lab work will require an average of 30 hrs/wk, with the rest of the time being focused on data analysis and literature review.

Prerequisites: General chemistry and lab courses are required. Organic chemistry with interests in biological and environmental issues would be a plus.

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Is Biking and Breathing in New York City Bad for Your Heart? A Validation and Health Study on Whether There Is a Cardiovascular Hit for Biking in Close Proximity to Traffic

Background: There is overwhelming evidence that exercise is good for you, but should we be avoiding exercise in close proximity to traffic emissions? The overall goals of this project include, 1) validation of a new personal level approach to assessing potential inhaled dose of particulate air pollution, and 2) assessment of this approach for cardiovascular impacts of short-term exposures during biking exercise.

Analysis Required: This project will require preparation of environmental and physiological monitors for the field study of bikers who regularly commute to work. Field work in NYC will include deploying the monitors. Analytical work will include measurement and analysis of spatial and temporal variability in black carbon, fine particulate matter, activity level, GPS coordinates, volumetric breathing rate, blood pressure, and heart rate.

A research assistant will be a great addition to the current team to ensure the accomplishment of recruiting a large number of subjects, simultaneous deployment of several monitors, and data collection.

The research assistant will benefit from working with colleague undergraduate, graduate students and senior research scientists in enhancing project management skills and specific technical skills such as data cleaning and spatial and temporal analysis of air pollution data. This project can help the student research assistant to improve the understanding of air pollution and environmental public health research.

Prerequisites: Knowledge of GIS and a programming/data analysis language such as R is a big plus.

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Steven Chillrud: chilli@ldeo.columbia.edu, 845-365-8893.