Newsletter

Center for

GeoHazards Studies

Spring 2017

Special points of interest:

STUDENTS:

Interested in becoming more involved?

E-mail David Hyman at davidhym@buffalo.edu to learn about the student committee.

Inside this issue:

The Center for Geohazards is jointy sponsored at UB by the College of Arts and Sciences and by the School of Engineering and Applied Sciences.

Letter from the Director

Dear members and stakeholders of the UB Center for Geohazards Studies,

This academic year finds the Center rapidly advancing on several fronts:

Student engagement and support via the CGS Graduate Student Research Grant program. Last year's two recipients, Andrew Harp and David Hyman, provide synopses of their research using the grants. The current call for proposals can be accessed through our website (geohazards.buffalo.edu). I emphasize that *any graduate student in any UB department* who is doing any type of work related to natural hazards is encouraged to submit a proposal.

Hazard-SEES Project. This is a UB-led, $2.8 million grant that seeks to integrate geophysics, geology, statistical mathematics, and social sciences in order to advance our understanding of volcanic hazards and our ability to communicate about the hazards with stakeholder populations and decision makers. The research centers on two case studies: Kīlauea volcano on the Island of Hawaii, which has been continuously erupting for more than 30 years, and Long Valley in eastern California, which is a "supervolcano" system that has been showing signs of unrest during the same 30 year period but has not erupted. These case studies give two end-members on how scientists and populations deal with long-term, persistent hazards. The study involves researchers at University of Hawaii, Berkeley, Eastern Tennessee State University, and Duke and Marquette Universities, all working closely with partners at the U.S. Geological Survey.

Geohazards Seminar Series. We are hosted Dr. Giday WoldeGabriel, a leading researcher on the interaction of environment and human evolution in the East Africa region, and who is working to improve that region's understanding of and planning for potential volcanic disasters.

Geohazards Field Station. Lead scientist Ingo Sonder has developed a unique-in-the-world experimental apparatus to study processes that occur when hot magma interacts with water. We know from Nature that this can lead to highly dangerous explosive eruptions that can cause damage on the ground and that can be a significant hazard to aviation (for example, the 2010 eruption of Eyjafjallajökull in Iceland, which shut down all air traffic in western Europe). Cutting edge laboratory experiments by postdoc Pranabendu Moitra are providing fundamental new data on high-temperature heat transfer between rock (molten or solid) and water. An additional apparatus is being constructed that will enable research on the initiation of hazardous pyroclastic flows. The Field Station is planning to host an open workshop on multidisciplinary experimental research on geohazards during the next year.

Annual conference/workshop. In March the Center will host the 47th Annual International Arctic Workshop, which will bring leading researchers to UB to discuss recent and future advances in our understanding of the Arctic's response to changing climate and the resulting hazards. More information is included in this newsletter, and please see our website if you are interested in learning more about this event.

Cyberinfrastructure. Center researchers continue to lead development of a global online collaboration platform for volcano research and hazards mitigation. The platform, vhub.org, is approaching 4000 registered members with approximately 15,000 users (including non-registered) accessing its resources per month, from around the world. Vhub.org is one way that we are having global impact on geohazards research.

Greg Valentine, Director

Student Research Award Recipient - Andrew Harp

Magma pathways in stratovolcanoes

Understanding the propagation of magma within volcanoes is important for both eruption forecasting and hazard mitigation. Direct measurements of active intravolcanic intrusions are difficult due to their location within the edifice, therefore, we often must rely on eroded volcanoes where exhumed intrusions such as dikes are available for direct study. Thanks in part to the support by the Center for Geohazards Studies Student Research Grant, my field assistant Nicole Leach and I completed a two-week field season at the eroded Oligocene age Summer Coon stratovolcano in south-central Colorado. There, we collected oriented samples from the margins of 80 mafic radial dikes. The goal was to use flow fabrics of high aspect minerals analyzed in thin sections to infer the emplacement direction of each dike. Of the 80 mafic dikes sampled, 40 possess clear fabrics of plagioclase crystals where the mean orientation could be measured with confidence. There are three distinct crystal fabric populations: 14 dikes plunge away from the center of the volcano 10-55° from horizontal, the flow fabrics of 5 dikes are at high angles from horizontal, ranging from 75-90°, and 21 dikes plunge toward the center of the volcano 5-70° from horizontal. Results indicate a majority of mafic radial dikes successfully analyzed at Summer Coon volcano were emplaced by a combination of vertical and horizontal propagation. Additionally, emplacement directions plunge both towards and away from the center of the volcano which likely reflects variability in the local stress field related to the weight of the edifice combined with pressurization of a basement reservoir.

Andrew G. Harp
PhD Candidate

Andrew Harp preparing to sample an intrusion in the eroded Summer Coon volcano (southern Colorado).

Student Research Award Recipient - David Hyman

Pressurization-Induced Failure of a Deforming Porous Medium: Implications for Lava Dome Collapse

Periods of lava dome growth commonly consist of one or more cycles of dome growth, collapse, and explosive destruction. This scenario has played out repeatedly over the last two decades of eruptions at Volcán Popocatépetl, Mexico, where nearly continuous cycles of dome growth and destruction have coincided with very high gas flux out of the dome. While this cyclic behavior has been remarkably regular, producing a well-defined probability distribution of maximum dome volumes, the o--nset of the explosive breakup phase has proved mostly unpredictable, showing only rare precursory activity. Clearly, new theory is required to explain how and when such a system evolves to a critical state, and furthermore, what are the conditions necessary to generate the so-called "survival distribution" of maximal extruded dome volumes at Popocatépetl? By modeling an active lava dome as a viscous, permeable medium, we are able to rigorously study the physics of dome pressurization, degassing, and explosion.

With funds provided from the Center for GeoHazard Studies, I completed a geophysical field campaign at Volcán Popocatépetl, Mexico, in April 2016. Alongside collaborators including Marcus Bursik (UB) and Gabriel Paulín (UNAM), and with help from CENAPRED scientists, the five day campaign consisted of collecting thermal infrared imagery of the degassing plume above the dome as well as one excursion onto the flank of the volcano to investigate some ejected dome blocks and one day collecting ash from an eruption two weeks before our visit. The first product of the field campaign was a rich time series of thermal images of the degassing, with which we developed a thermal flux balance method to estimate the mass flow rate of gas (mainly water vapor) leaving the dome. Performing a time series analysis we were able to conclude that dome degassing is oscillatory over hour to day timescales. This ash-less 'puffing' gives us an indication that the mass flux through the dome is much more variable than bimonthly COSPEC measurements of volcanic gases suggest.

David Hyman with Volcán Popocatépetl emitting a puff of gases in the background.

To examine how an oscillatory flux pressurizes the dome, we developed a simple mathematical model that yields diffusive wave profiles through the dome, which in turn lead to periodic reductions in the stress required to fracture the dome and induce explosion. The results and analysis of this field campaign were presented at the American Geophysical Union 2016 Fall Meeting, and are currently being prepared for journal publication. This simplified mathematical model will serve as the basis for a numerical model that is currently in development to explore effects of variable porosity on the evolving state of pre-explosion criticality and will incorporate data from the samples collected at Popocatépetl as well as from Mono Craters, California.

I am very grateful for the support of the Center for Geohazards Studies, as the data collected in Mexico will play a central role in my PhD dissertation.

David M. Hyman , PhD candidate

Research Update - Ingo Sonder

Experiment preparation. Melt is poured into the experiment container (left). The container is then moved on tracks to the water injection position (partially visible on the right).

Experiments on explosive Magma-Water Interaction. Ongoing experiments at the Rock Melting Facility investigate explosive magma-water interaction. Focused are initial conditions of an explosive event: Timing, water amount, and geometry settings of water pre-mixes are tested. About 25–30 L magma analog is produced by melting about 60 kg of natural basaltic rock material (no further ingredients), and poured into a robust, insulated container. Water is then injected into the lower third part of the melt body, using a custom built injection system that controls water pressure and speed. A trigger setup was implemented that aims to start the explosion: A 4.54 kg (10 lbs) hammer mounted outside of the melt container is aligned with an impact baffle which has direct melt contact and can transfer the hammers impact momentum to the melt as a pressure pulse. Hammer release and water injection are controlled electronically and timed precisely. Currently we optimize conditions for high explosivity, and try to reproduce effects such as spontaneous explosions that start without a trigger event.

The Rock Melting Facility is open to external researchers, who are interested in conducting their own experimental research. Melt temperatures can be adjusted between 1200 ºC and 1350 ºC. The facility provides tools to direct melt flow, and transport the melt at such temperatures. For more information contact facility maintainer Ingo Sonder (ingomark@buffalo.edu).

Research Update - Pranabendu Moitra

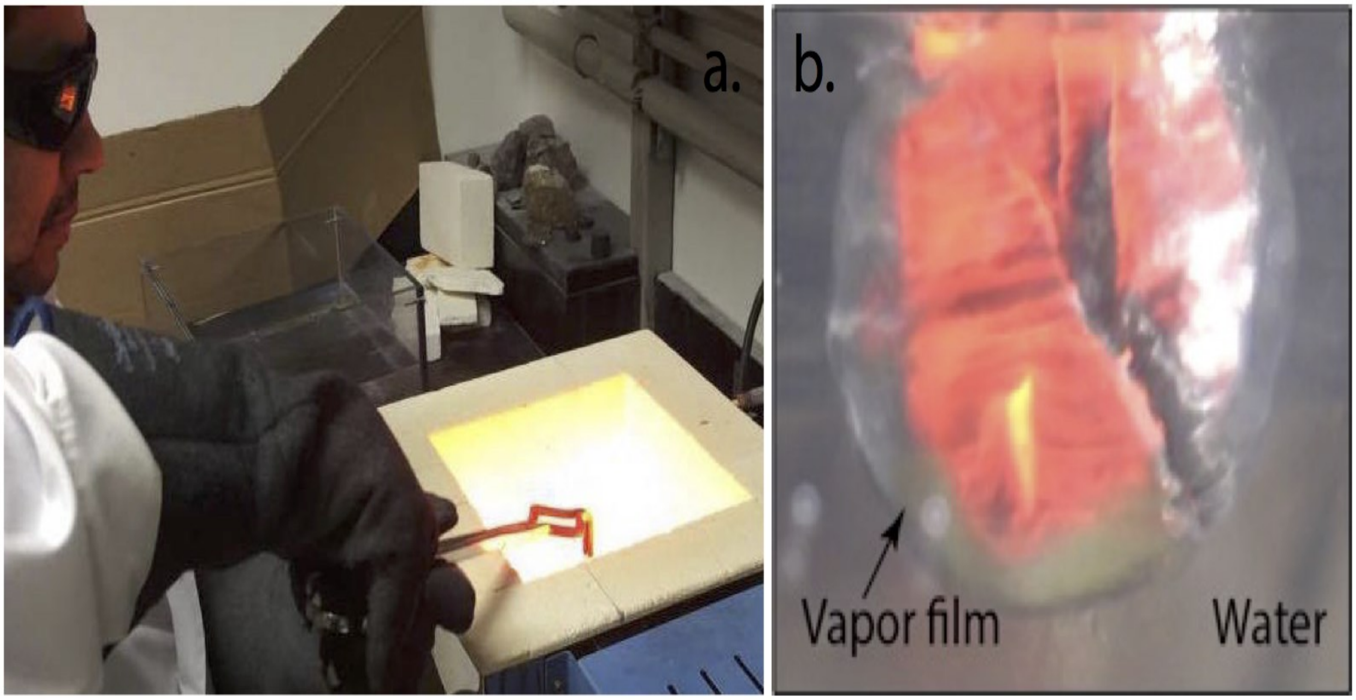

Figure 1 (**a**) Sample is heated to 1120 ºC in the furnace, purged with inert argon gas, and then, is submerged in a plexiglass tank filled with distilled water. Experiments are performed with a range of water temperatures (0 -100 ºC). During experiments, the temperatures of the sample and the water bath are recorded using thermocouples, while the videos of the experiments are taken using high-speed cameras (up to 1000 frames per second). (**b**) The snapshot of experimental video reveals the existence of vapor film surrounding the hot, glowing sample. A fracture in the submerged sample is also visible.

The quantification of magma-to-water heat transfer rate is key to understand and improve the hazard analyses of hydromagmatic and submarine eruptions, and is vital to understand other geological processes, such as geothermal and hydrothermal processes. Current models, on magma-to-water heat flux, assume a turbulently convective water regime or use heat flux parameters from nuclear engineering studies on metal-to-water heat flux. The absence of experimental validation and quantification of magma-water interaction dynamics is a significant gap in our ability to model hydromagmatic fragmentation.

In this study, I perform laboratory experiments with hot spherical samples of basaltic magma (1120 ºC) submerged in water (Figure 1) at a certain temperature (0 - 100 ºC). The change in magma and the water temperatures during the experiments, and the videos of the experiments are recorded. With decreasing magma temperature, transition from vapor film- to transition- to nucleate-boiling to free convection of water is observed. By solving the heat equation in spherical coordinate, the heat transfer rate at the magma-water interface is calculated. This is an ongoing project and is the first study that directly and systematically quantifies magma- to-water heat flux.

The Center for Geohazards team associated with this project includes Dr. Greg Valentine, Dr. Ingo Sonder and I. This ongoing research, in addition to its stand-alone merit, will support the large-scale experimental research at the Geohazards Field Station, which is being developed as a user facility for research in volcanology and other geological hazards.

Upcoming Events - 2017 Artic Workshop

The Center for GeoHazards Studies and the Department of Geology are honored to host the 47th International Arctic Workshop from March 23-25, 2017, at the University at Buffalo's North Campus. This long-running, internationally renowned conference focuses on Arctic climate change with this year's theme on "Polar Climate and Sea Level: Past, Present and Future." The Arctic Workshop is open to anyone interested in Arctic and Antarctic climate and hazards research within disciplines spanning the natural and social sciences, including geology, environmental geochemistry, geomorphology, hydrology, oceanography, ecology, archeology, and glaciology. Topical sessions will focus on the Greenland Ice Sheet, hazards of polar change, and the climate history of the North Atlantic region among many more.

The Arctic Workshop is known for fostering a relaxed and student-friendly atmosphere where professionals, graduate and undergraduate students can network and present their latest research. We are proud to announce that registration for student presenters is free this year, and registration for non-presenting students is at a discounted price. The Center for GeoHazards Studies and the Department of Geology look forward to welcoming an esteemed group of climate and research scientists from around the world to the University at Buffalo!

For additional information and the conference schedule please refer to our website: https://geohazards.buffalo.edu/aw2017/about/

UNIVERSITY AT BUFFALO

Center for Geohazards Studies
University at Buffalo
126 Cooke Hall
Buffalo, NY 14260-3050

Phone: 716-645-4858
Fax: 716-645-3999
E-mail: geohaz@buffalo.edu

geohazards.buffalo.edu

Send your research updates to Barb Catalano (bac6@buffalo.edu) to be included in the next newsletter or e-blast!

Center for GeoHazards Studies

Have changes to your employment, research interests, or contact information? Let us know at [geohaz@buffalo.edu.](mailto:geohaz@buffalo.edu)

Center for GeoHazards Studies

The ***Center for GeoHazards Studies*** seeks to decrease harmful societal effects of natural phenomena such as volcanic eruptions, landslides, mudflows, and avalanches through research, service, and education. Our team of scientists and engineers works together with social scientists, urban planners and public health researchers to evaluate the broader harmful impact of hazardous natural phenomena. One of our principal goals is to integrate analyses of various hazards with predictions of their effects on human infrastructure and ecosystems in order to evaluate approaches that could lead to a reduction of injury and death. Hazards that are affected or triggered by changes in climate are included within the Center's scope.

Special thanks to:

Advisory Committee Members:

Amjad Aref, *Civil,Structural and Environmental Engineering*
Marcus Bursik, Geology Department
Estelle Chaussard, Geology Department
Beata Csatho, Department of Geology
Amit Goyal, Research and Economic Development
Abani Patra, Mechanical And Aerospace Engineering
Bruce Pitman, Materials, Design and Innovation
Chris Renschler, Geography Department
Michael Sheridan, Geology Department
Ingo Sonder, Center for Geohazards Studies
Janet Yang, Communications Department
Jun Zhuang, Industrial and System Engineering

Student Representative*:*
David Hyman, Geology Department

Sponsors:
College of Arts and Sciences
School of Engineering and Applied Sciences