DEO Mark K. Reagan

To all alumni and friends of the Department of Earth and Environmental Sciences (formerly Geoscience), I would like to thank you for your support over my term as Department Executive Officer. Your strong support has been a primary factor in the success of our Department. This is my last year as DEO before taking leave to conduct research. Part of this research leave will be spent in the western Pacific as co-chief scientist for IODP expedition 352, where I will spend two months on the RV JOIDES Resolution drilling into the Bonin fore-arc to investigate the causes and consequences of subduction initiation.

Yes, the Department has a new name. The Board of Regents instituted it this year after a unanimous Geoscience faculty vote and strong support from other UI system-wide organizations. We believe that the new name better reflects the diversity of our research and teaching specialties now that the Department has grown to 17 faculty and houses both Geoscience and Environmental Science majors.

Another dramatic change that has occurred over the past year is a major renovation to Trowbridge Hall (see photo). Our venerable building now has all new windows, which have really brightened up the place. Next on tap is a renovation of our HVAC system and the laboratory space for the new Electron Microprobe laboratory. The Electron Microprobe, which is being purchased with funds from a National Science Foundation Major Research Instrumentation grant (PIs: Ingrid Uksitns Peate, David Peate, Jane Gilotti, and Nancy Budd) is scheduled to be delivered early December. We also recently installed a new cathodoluminescence detector on our scanning electron microscope, which is used for fine scale imaging minerals such as zircon before dating by U-Pb techniques.

Besides the MRI grant cited above, the Department has several active NSF grants covering a diverse array of topics ranging from subduction to paleoenvironments to vertebrate and invertebrate evolution. Art Bettis and Adam Ward are principal investigators for a recently awarded NSF Critical Zone Observatory grant to study the Mississippi River system.

Our recent faculty hires in sedimentary geology (Emily Finzel and Bradley Cramer) are settled in to their new offices and labs. They already have dramatically upgraded our educational offerings in this area, and have contributed to the department in myriad other ways. The last long-term deficiency in the tenure-track faculty of the department is in the area of geophysics. I am happy to announce that we
Geochemical Research

David Peate
As a geochemist, my research involves applying basic chemical principles and chemical data to address problems in Earth and environmental science, which requires the availability of suitable analytical equipment. Therefore, establishing new state-of-the-art instrumentation facilities has been an important effort by faculty in the Earth & Environmental Sciences Department over the last few years. Since 2009, this has led to three successful instrumentation proposals funded by the National Science Foundation (NSF) with matching funds from University of Iowa sources (a combined investment of...
almost $1.8 million dollars). Bill McClelland was the lead PI on the proposal for a CL (cathodoluminescence) detector for the SEM (scanning electron microscope). Ingrid Uktins Peate was the lead PI on the proposal for an electron microprobe (to be installed in late 2013). I was the lead PI on the proposal for an ICP-MS (inductively-coupled-plasma mass spectrometer) and laser ablation unit. The ICP-MS laboratory was established in Nov 2009. The Thermo X-series II ICP-MS allows concentrations of a wide range of elements to be measured in solutions (digested samples, natural waters) with detection limits of parts per trillion (pg/g or 10^{-12} g/g), and a 213 nm UV laser adds the capability of in-situ analysis of trace element contents in solid materials at a spatial resolution of 5-100 µm. I have set up a metal-free clean laboratory facility for the preparation of samples for elemental and Sr-Nd-Pb-Hf-U-Th-Ra isotopic analysis. This lab, together with the ICP-MS and laser instruments, forms the core of a trace element analysis facility that I direct, and it represents a key resource for faculty and student research and teaching in the Earth & Environmental Sciences Department as well as the broader University of Iowa community and beyond. The ICP-MS lab is widely used by researchers and students from the Earth & Environmental Sciences Department and the Environmental Engineering & Science program, as well as in Anthropology, Chemistry, the College of Public Health, the College of Medicine, and the Center for Biocatalysis and Bioprocessing.

My research is in igneous petrogenesis – understanding the origins of volcanic rocks. I use high precision measurements of the elemental and isotopic composition of rocks and minerals to determine how melt is generated and to understand the processes that affect the melt as it is transported through the Earth’s crust to be erupted at volcanoes. I had an NSF-funded project (2006-2010) that supported a post-doctoral researcher (Michael Rowe) and a graduate student (Jay Thompson) to study the plumbing system of small-volume mafic monogenetic eruptions, using olivine-hosted melt inclusions compositions and whole rock data. Our study of Paricutín (Mexico) showed that compositional variations over the course of the eruption are related to mixing between two independent magma batches rather than coupled assimilation – fractional crystallization of a single magma batch as described in most textbooks. Our study of Dotsero maar (Colorado) highlighted the importance of shallow assimilation of local basement sandstone. I am continuing to work on the origins and environmental impact of large igneous provinces, and I recently co-authored a paper on "The largest volcanic eruptions on Earth" that re-evaluated the immense volumetric extent of individual basaltic and silicic eruptions in large igneous provinces.

Iceland remains an important research area. I recently published two manuscripts that used high-precision of recent Icelandic lavas to investigate the scale of compositional heterogeneity and showed that the main rift zones are tapping mantle of different composition in the north and south of the island. My research is now focused on the alkaline magmatism of the Snaefellsnes flank zone, away from the plate boundary. High-precision measurements of transition metals (e.g. Fe, Mn, Co, Zn) in lavas and olivine crystals can be used to infer the mineralogy of mantle sources: a preliminary
Geochemical Research (Cont’d)

data set on lava Fe/Mn variations (Nick Lamkey: undergraduate research project) suggests that pyroxenite is not an important component of the mantle beneath Iceland. I am extending this study to include a wider sample set of lavas and olivines, and measurement of other transition metals. I am also working to develop a better understanding of plumbing systems beneath the Snæfellsnes off-axis zone, from melt aggregation to magma ascent, mixing and cooling, and how this contrasts with the main rift zones, using compositional data on whole rocks, olivine-hosted melt inclusions, and minerals. I have a new MS student (Dave Burney) who will be using glass and clinopyroxene compositions to constrain crystallization depths for a alkaline sub-glacial Snæfellsnes eruption.

I am also collaborating with Ingrid Ukstins Peate on a project to study the formation of small (< 1 km) impact craters, using samples from Monturaqui crater (Chile). Post-doctoral researcher Chungwan Lim used the SEM to study textural and compositional variations in the impact melt, while MS student Dan Cukierski focused on compositional variations in FeNi droplets within the melt and used X-ray Tomography (with the help of Tom Foster) to define the size distribution of droplets for the first time.

As director of the ICP-MS trace element analysis facility, I have found it stimulating to be involved in a diverse range of projects that might be outside of my expertise in igneous petrogenesis but that all involve acquisition and interpretation of elemental and isotopic data. These include:

1. **Water chemistry**: I am working with colleagues from the Iowa Geological and Water Survey and from Grinnell College (IA) on several water resource issues both in Iowa (origin of soft water from the Manson impact crater; flow paths in the Jordan aquifer) and in Namibia (project on springs for the ‘Save the Rhino’ trust).

2. **Nanoscience**: I am collaborating with colleagues from Environmental Engineering on a project to look at the extent of gold nanoparticle uptake in plants, and I have been assisting other researchers from the College of Public Health, Chemistry, and Environmental Engineering to obtain ICP-MS trace element data on a variety of nanoparticle experiments.

3. **Geoarchaeology**: I am collaborating with Anna Waterman (Mount Mercy University, IA) to use strontium isotopes to investigate human migration patterns in the Late Neolithic of Iberia. 4. **Sedimentary geochemistry**: I am working with Umran Dogan (KFUPM, Saudi Arabia) on a Saudi-funded project on chemosтратigraphy of Ordovician sandstones that are an important gas reservoir rock. Hallie Sims and I have obtained some promising reconnaissance data that suggest that trace elements might be used to fingerprint ‘coal balls’ from particular coal seams. 5. **Environmental impact of volcanism**: MS student Jaime Ricci analyzed trace elements in Oligocene carbonates from an Indian Ocean ODP core in the Indian Ocean and showed a distinct compositional shift that is coincident with the inferred onset of mafic volcanism in the Afro-Arabian large igneous province. I also provided ICP-MS analyses of ash samples and leachates from the 2010 Eyjafjallajökull eruption in Iceland for a study of the medical effects of ash inhalation in collaboration with colleagues from The Carver College of Medicine and Chemistry.
Luan Heywood

The three weeks I spent in Montana this summer attending the University of Iowa’s Field Analysis advanced field camp in Dillon and Sun River Canyon, Montana were three weeks I’d been looking forward to all year.

We started off with two weeks in Dillon. Majestic Dillon, Montana, whose streets I’d never expected I’d miss, but I did! In this advanced field course, we focused on structurally complex areas around Dillon and learned new stratigraphy. We saw some marvelous rocks: my favorites were the silicified breccias and the bomb beds southwest of town.

For our final week, we traveled to Sun River Canyon, where we spent a week observing geology in the Rocky Mountain Front. It was extremely interesting to see the regional variation in the Paleozoic and Mesozoic stratigraphy that we had learned in Dillon, as well as the large-scale structural geology of the area. Sun River Canyon was one of the most beautiful places I have ever been. While we didn’t see any bears, the big limestone blocks were very impressive.

In comparison to other field courses I have taken at the University, Field Analysis stood out in its rigor. Whereas last year in Field Methods, it felt like I mostly devoted my energy to holding onto my hat and coloring in my map, this year we focused on structural interpretations, developing field hypotheses and testing them. We worked mainly with Drs. McClelland and Gilotti, whose expertise in tectonics and structural geology proved to be very helpful as we learned to think innovatively and concoct interpretations to explain our observations of the complex geology of the area. Needless to say, many interpretations were thrown around in the field or at the campfire, some of our geological interpretations stuck and some were quickly discarded, but it all contributed to a great learning experience.

Overall in Field Analysis, we saw some great rocks and some world-class outcrops. Other field camps may travel more widely and camp, but since we don’t, we are able to focus our efforts more exclusively on becoming skilled in field geology. In this course, we gain all the tools needed to become expert field geologists—the rest is only practice.
For more information about private support for the Department of Geoscience, contact the UI Foundation at the address or phone number listed below. Your inquiry will be treated confidentially.

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