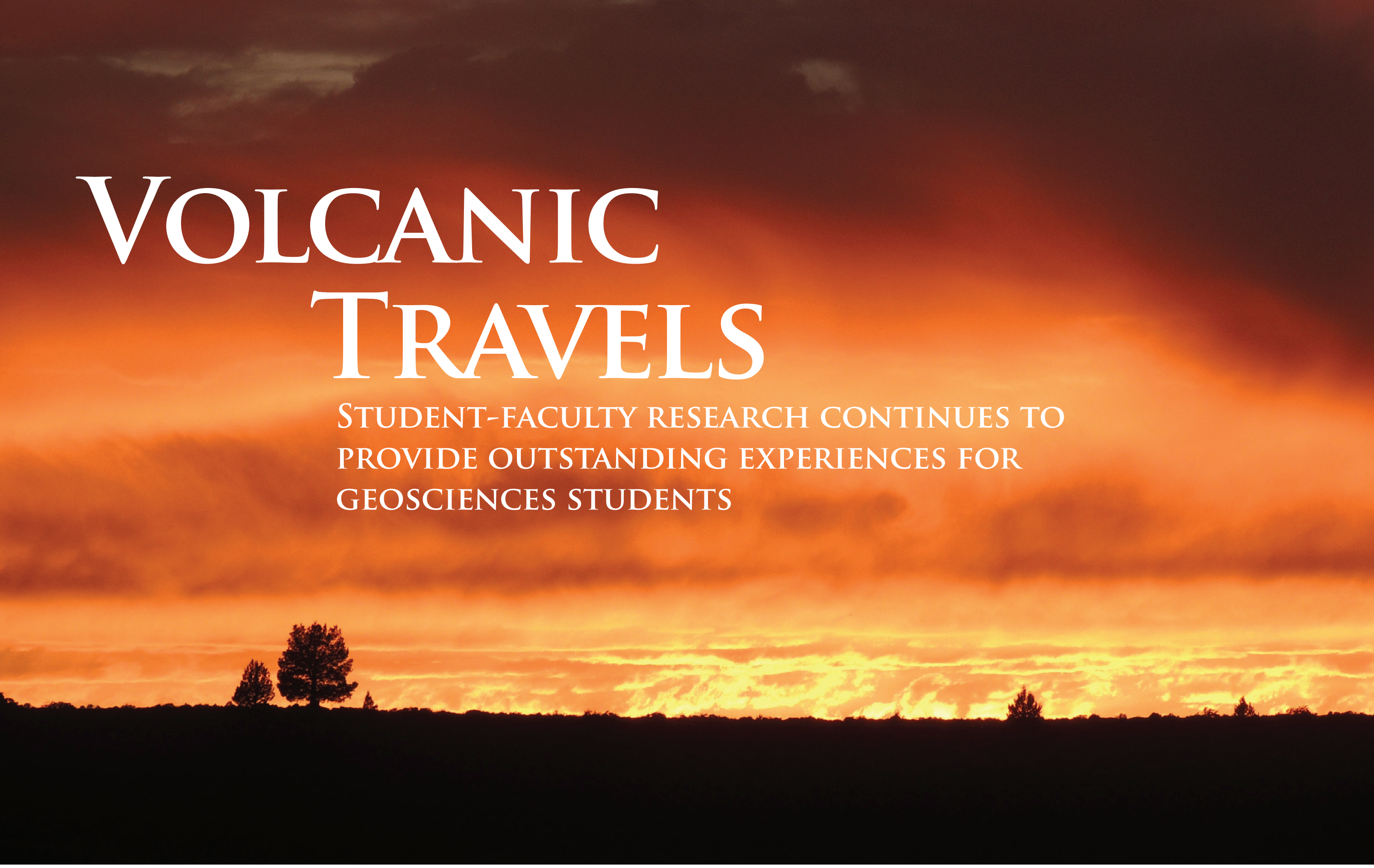

Volcanic Travels

Student-faculty research continues to provide outstanding experiences for geosciences students

During late July and early August 2014, two environmental geoscience students and I traveled to Oregon for field and lab studies that contribute to three ongoing research projects relating to volcanic eruptions and earthquakes in the western U.S. Field experiences like this and related research back at Concord are incredibly valuable for our students. They build on classroom learning and make participating students much more competitive upon graduation. Many times, this has been the difference that has helped our students get into funded graduate programs and good jobs. But beyond that, field studies, while sometimes intense and grueling, can also be a lot of fun. And these projects can take students to visit great places that they might otherwise never see.

All geoscience studies also have a sense of place, and going into the field typically provides that connection to place as well as context from the geological surroundings. When samples are taken back to the lab for further study, that field context continues to inform and guide the interpretation of laboratory results.

This summer's travels began with Savannah Ballengee and Addison Hostetler taking a flight to Portland, Oregon. I met them at the airport, and after a couple of hours drive, we arrived at the Marine Geology Repository or core lab at Oregon State University in Corvallis for the first phase of the trip. The core lab is a major research facility that houses more than 6,000 sediment cores and other samples. Most of these originated from ocean drilling projects going back decades, but some lake cores are housed there as well.

Our objective was to examine some sediment cores taken from a place called Carp Lake, located downwind from Mt. St. Helens in Washington State. In 2012 I made my first visit to the core lab to collect samples from parts of the Carp Lake cores that had been previously studied by others to reconstruct past environments going back thousands of years. That paleoenvironmental study, published in 2000, is a key reference that provides important context for archaeology research across the region. Besides being great archives of environmental history, lakes are also great at preserving records of past volcanic eruptions in the form of layers of volcanic ash. This provides information on the volcanic history as well as the potential for future activity. The volcanic ash, also known to geologists as tephra, provides the basis for my interest in Carp Lake, in particular the outstanding record of

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Desert field work

explosive eruptions of Mt. St. Helens preserved there.

That earlier study of volcanic ash samples from Carp Lake led to multiple conference presentations by Teye Kalteyer, then a Concord geology student, and myself reporting on what is probably the single best record of the early eruptive history of Mt. St. Helens. It also involved three other students. Teye spent numerous hours chemically fingerprinting the volcanic ash layers for this project using Concord's electron microprobe, and that experience really paid off. Teye is now in graduate school in Maine working on grant-funded research on volcanic ash in Antarctica. Her research experience at Concord is a key reason why she was able to land that funded graduate school position. This earlier work left about a third of the archived Carp Lake cores unstudied, however. So, a return trip to the core lab was needed.

Sediment cores are typically taken by pushing a hollow tube or pipe down into the bottom of a lake or the sea. In the case of the Carp Lake cores we are studying, steel pipe was used. The core was taken in 1994 and had been sitting unopened in cold storage ever since. We had the privilege, or perhaps challenge, of cutting open tens of feet of steel pipe lengthwise. This required a jig, a circular saw, and a hardened-tip blade, several blades actually. After three repeat trips to a local hardware store for additional blades and three days of work, we finally had all of the core cut open, described, photographed, and sampled. The sequence of layers in the core and known location of the lake provide the geologic context for further analysis of the samples collected back in the lab at Concord.

For the next phase of our travels, we headed up into the volcanic chain that comprises the Cascade Range mountains. We spent the first night camped in National Forest just outside the small town of Sisters with volcanic peaks all around. We were here because I was following a hunch. There is a deposit of fine ash to sandy pumice known as the Wono tephra that is widespread in south-central Oregon down into California and Nevada, but its source is unknown. It isn't the only one. Some ancient lakes in eastern Oregon contain scores of volcanic ash layers. At one place, Summer Lake, two-thirds of the ash layers can't be traced back to their source volcanoes. No one has yet found the corresponding deposits near any of the Cascade volcanoes. My hunch is that the area around Three Sisters volcanoes in the middle of the Oregon part of the Cascades could be the source of Wono and some of the others. This area is known to be one of the most active parts of the entire Cascade Range, and it contains many unstudied deposits of ash and pumice tephra.

So, we spent two days driving gravel and dirt roads, stopping at

Digging a trench through layers from multiple explosive eruptions road cuts, and looking for pumice. On private timberland where we had permission to dig, we hand-dug trenches to uncover and sample layers from multiple eruptions. We also stopped at many places on Deschutes National Forest land, recording locations, taking photographs, and taking samples of loose pumice. This preliminary data will be key to obtaining permission for more detailed work, including trenching, in the National Forest.

This is a beautiful place to work, surrounded by pine trees and views of volcanoes. By chance, we happened across an old volcanic vent, a place where lava came up out of the ground and flowed out across the landscape long ago. We also found signs of wildlife: a toad, wolf tracks, and a great flock of nighthawks performing mating calls and displays. After dark, there were city lights of Bend in the distance and directly above was the Milky Way.

One day we passed through recently burned forest where surviving plants were just beginning to re-sprout and then descended into a canyon. There, thick layers of white, pink, yellow, brown, and gray dramatically lined the canyon walls, and large boulders stood out on the canyon floor. These colorful layers are remains of great pyroclastic flows that swept across the landscape leaving stacks of pumice and ash known as the Tumalo tuff, Columbia Canal pumice, and Shevlin Park tuff.

Left: Fossil shell layer loaded with gastropods (snails). Right: Coarse pumice that fell from the sky during a major eruption.

With our work in the Cascades completed, it was time to head out into the desert country located in the rain shadow east of the Cascades. We headed south from Bend on Highway 97, passing the broad shield of Newberry Volcano, one of the largest in North America. Just past the town of La Pine, we turned southeast onto Highway 31. A sign declared that we were entering the Oregon Outback. Soon, another gave us additional perspective: Reno 350 miles. No other town was listed. This is sparsely populated, high desert country with sagebrush, faulted mountains, ancient lavas, and the remains of ice age lakes.

That night we shared camp with an archaeology field school from the University of Oregon led by Dr. Dennis Jenkins. There, in the Fort Rock basin on the dry bed of an ice age lake, the sky put on a great show. Aided by scattered thunderstorms and lingering smoke from distant fires, the setting sun turned the sky brilliant yellow, orange, and red. We saw a rainbow and dark rain streaking downward from the scattered clouds, but none reached the ground. In this country, summer rains often evaporate in mid-air.

The following morning we were in for another treat, the Connley Caves. Dr. Jenkins took us on a tour of the Connley Cave site, discussing the decades of studies there, showing us the current excavations, and illustrating key findings. Connley Cave along with Fort Rock cave 10 miles to the north and Paisley caves 40 miles to the south, are key archaeological sites in this part of the world and among the oldest in North America. They have yielded key information about some of the earliest people on the continent,

Connley Cave archaeological site with University of Oregon field school.

Connley Cave archaeological site with University of Oregon field school.

including their DNA.

In the middle of the Connley cave excavation is a thick layer of tephra known as the Mazama ash. When this fell about 7,600 years ago, it was a world transformed. Imagine being a seasonal resident of that cave and having all of the land you can see in every direction covered in ash or pumice inches to feet thick. Imagine trying to survive. The visible extent of the layer spans multiple states and into Canada. Traces are known in Greenland. It was produced during the collapse of a large volcano, Mount Mazama, to leave a great depression, a caldera, where the summit once stood. That caldera is filled with the second-deepest lake in North America, Crater Lake, the namesake of a national park.

After a couple of hours at Connley caves, Jack Swisher, a resident of this Oregon Outback, took us to see some much older layers of tephra at a place called Summer Lake where another great ice age lake once stood. To reach the eastern part of the lake basin, Jack, on his motorbike, led us miles down a dusty dirt road and then on a hike across the desert. This was our first full day out in the desert heat. We were probably struck more by the extreme dryness of the air than by the mid-90s heat itself. On our trek, we found thick layers of fossil snail shells, hot spring mineral deposits, excellent exposures of a large fault at the edge of the basin, and several unstudied layers of tephra, some of which must record sizable eruptions judging from the coarse size of their pumice.

We spent much of the next four days walking dry stream gulleys in the desert near Summer Lake, less a half-day side trip to Newberry volcano. Our main reasons for traveling here during the last part of our trip are to study a series of potentially active earthquake faults that cut the eastern floor of this ice age lake basin and to study the tephra layers present there. Colleagues traveled out to meet us at Summer Lake and see the field site. The first, from the University of California at Berkeley is a geochronologist, someone who specializes in figuring out the ages of rocks, including tephras. The others came from the University at Buffalo in New York and the University of Oregon to talk about potential collaborations to study the faults and volcanic eruptions.

Thanks to uplift along the faults, the eastern part of the Summer Lake basin has surface exposures of what could be some of the oldest lake sediments in the region. Besides recording past eruptions, the tephra layers in the lake sediments are useful markers for deciphering the history of fault movements and fluctuations in the level of the lake. Several tephra layers are also found together with a key fossil site here which contains a rich deposit of fish bones. Although, at this point, we don't really know how old all these sediments are, the tephra layers may help. One of the thickest tephra layers at the fossil site is rich in feldspar, one of the best materials for argon dating. A sample of that feldspar has already been sent off to Berkeley for dating. In a few months we should have an answer to the question: How old is all of this stuff?

Now that we are all back at Concord, Addison has been at work getting the samples from Summer Lake ready for chemical fingerprinting on the electron microprobe. Once Savannah finishes a project on tephra from ocean sediments in the Aegean Sea near Greece, she will start work on some of the other samples that we collected. That still leaves plenty of research samples for other students too.

Our experiences in the field went far beyond anything one would get in a classroom, whether it be the research itself or just visiting new and different places. I am sure that the payoff will continue for many years to come. For Savannah, this was her "first time on a plane, first archaeological site, first desert, and first real-life volcano." For Addison, "climbing on top of a lava vent was one of the coolest things I've ever done." This Washington-Oregon research is far from finished. There are always new opportunities and new questions. There are always more interesting and fun field studies to do. And, there are always new students who can benefit from the experience. C