Notes from Mineralogy lecture on the chemistry and structure of various minerals (pyroxenes and amphiboles) that could crystallize from slowly cooling basalt magma. The different minerals reflect the changing conditions (temperature and composition) in a magma chamber deep in the earth's crust.

PHOTO BY RYAN FILLOON

Andrew Wulff and several undergraduate students take a break from sampling lava flows to plan the next traverse, under the imposing edifice of Volcan Cerro Azul in the Chilean Andes.

SITTING ON TOP OF THE WORLD

BY TOMMY NEWTON

PHOTO BY LADONNA HARMON

Wulff uses a polarizing microscope to identify different minerals and textures in lava samples from the Chilean Andes. Digital photomicrographs can then be used as "maps" for further investigations using the SEM and electron microprobe.

SOMEHOW IT SEEMS FITTING THAT MINERALOGIST ANDREW WULFF WOULD BE SITTING IN AN OFFICE ON TOP OF THE HILL. AFTER ALL, THE WELL-TRAVELED VOLCANO RESEARCHER HAS SPENT MUCH OF HIS CAREER SITTING ON TOP OF THE WORLD.

Dr. Wulff, an assistant professor in Western Kentucky University's Department of Geography and Geology, has been studying volcanoes since working at Crater Lake National Park after his sophomore year in college. His doctoral work at the University of Massachusetts gave him necessary analytical training and experience, and he continued that research at Whittier College in California, where he served as chairman of the Geology Department, and at the University of Iowa before coming to Western in the fall of 2002.

His work has focused on unraveling the eruptive history of several large volcanic complexes in the Andes Mountains in Chile, but he also conducts research on volcanoes in Java along with his numerous other geologic interests.

Dr. Wulff seeks projects that can involve undergraduate students to teach them research skills and to expose them to different cultures. "That kind of involvement is what makes the academic experience special," he said. "Once students leave here, unless they get an extraordinary job, they're not going to have the time or the resources to explore a new part of the world in this way, with the same measure of freedom."

Or to make a difference in the lives of people living in the shadow of a volcano.

PHOTO BY RYAN FILLOON

Wulff poses on the edge of the vent at Volcan Quizapu, site of two of the largest historical eruptions in South America. The volcano Descabezado Grande looms behind.

The Descabezado Grande-Cerro Azul (DGCA) volcanic complex in the Chilean Andes was the site of two of the largest eruptions in South American history, the last one in the 1930s, but a billion-dollar hydroelectric plant is being built within ten kilometers of the volcanoes.

"That seems foolish and it is," Dr. Wulff said. "They didn't make any exceptions for the fact they were building the plant under these big volcanoes — simply because the last big eruptions were sixty years ago. This hydroelectric plant is projected to be responsible for one-quarter of Chile's electrical power, and in five minutes, an eruption could knock it out."

That's where Dr. Wulff's research has an impact for the government, geologists, and people of Chile.

"When we're looking at volcanoes in the Andes, we have a rare opportunity because the rates of both uplift and erosion are quite high, exposing parts of volcanoes that normally you can't see," said Dr. Wulff, who received his bachelor's degree at Oberlin College and his master's at the University of Maryland. For example, one large sector collapse (landslide) removed the south side of Volcan Cerro Azul, revealing the layers of lava flows and ash flows that built up the mountain.

In the regions exposed by erosion of these half-million-year-old volcanoes, Dr. Wulff is able to sample the lavas that poured out of the vents and built up the volcano, flow upon flow. "Sampling each flow allows us to evaluate the separate cycles of eruptive activity. By looking at the mineral compositions and whole-rock chemistry of the ancient lavas, we can tell something about how the volcano has behaved over time. This means we can make more accurate predictions of what will happen in the future," he said.

Two of his WKU undergraduate students are working with Chilean lava samples to determine whether the volcanic complex is currently in a period of rapid growth or slower growth. "By compiling all these eruptive events into a composite history, we can get a good idea of how this complex behaves, and we can model individual eruptive episodes. That's a different approach from what most others are doing."

Dr. Wulff expects to complete research at the DGCA complex in two to three years then continue his work a little farther to the north in the Andes.

"Traditionally volcanologists have thought that every volcano was a separate entity and they weren't related in any way. This is unsatisfying because it suggests that there are no large-scale controls on volcanic behavior," he said. "We're finding out that the comprehensive sampling we're doing is reaping benefits in terms of identifying some of these controls and by allowing us to compare eruptive histories."

The area where he conducted his doctoral research is about twenty kilometers from his current research site and he's finding similar lavas and results. "We're starting to think that every volcano is not a mountain unto

PHOTO BY LADONNA HARMON

Samples of lava flows from a volcanic complex in Chile are cut into slabs and made into thin sections for microscope investigations. Portions of each sample are crushed, powdered, and melted for analysis of major and trace element composition, for isotope analysis, and age determinations.

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itself. There really are larger scale tectonic factors that may similarly influence entire segments of a volcanic arc," he said. After we identify these large-scale factors, we can study them closely and then consider other areas that might be influenced by the same factors."

That means the research under way in Chile may provide clues to volcanic activity in the Cascade Mountains of the northwest United States where Mount St. Helens erupted two decades ago. "If there are long-term, large-scale factors that control eruptions, our work in the Andes may provide us with a predictive tool for volcanic activity in other regions, such as the Cascades. Perhaps Mount St. Helens was telling us that the entire region is very active, and that we need to monitor the other volcanoes closely also," he said.

A recent increase in large geyser eruptions and in the temperature of soils and groundwater in Yellowstone National Park could even be related to what's happening in the Cascades, Dr. Wulff said.

"The idea is, if we can figure out what's happening in the Andes where everything is remarkably well-exposed, then we can take those models and bring them home to the Cascades, Alaska, Japan, and other subduction-related volcanic regions."

A view into the crater of Villarrica volcano in Southern Chile shows a pool of lava.

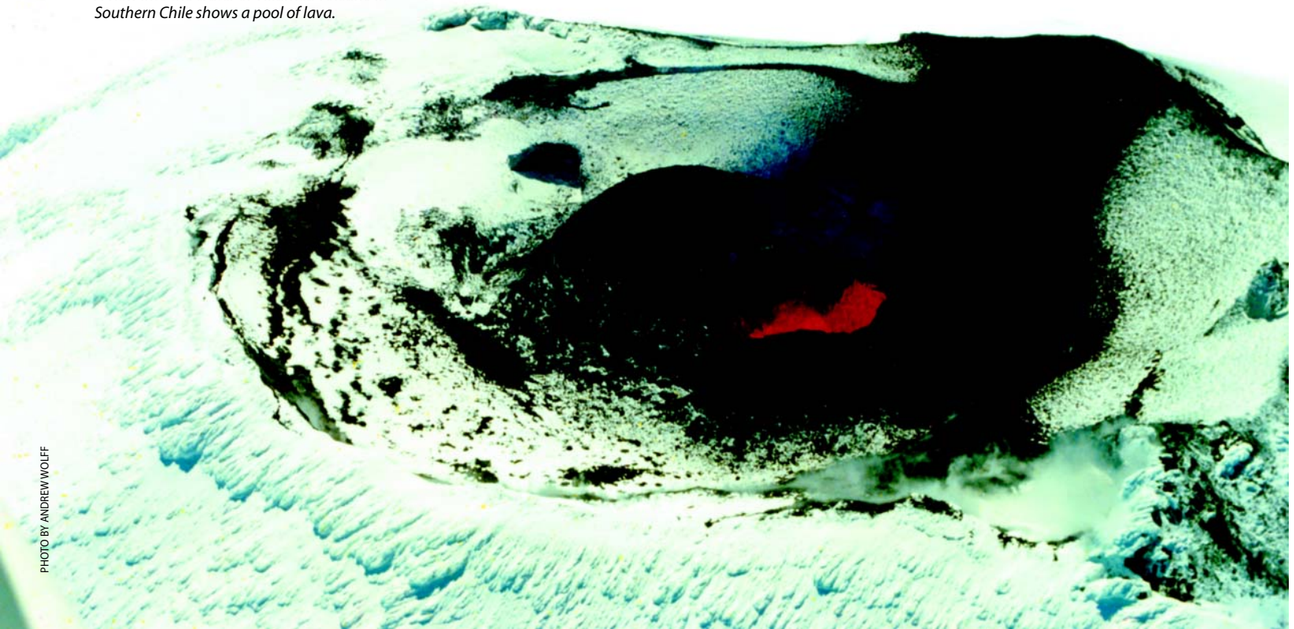

PHOTO BY ANDREW WOLFF

He's also bringing his expertise on volcanoes and other geologic issues — mineralogy, petrology, and medical geology — into the classroom. Wulff's geology background includes working with a urologist to study the mineralogical composition of kidney stones, studying sediments in Chesapeake Bay, studying the distribution and health effects of radon in Maryland and Pennsylvania, and working for the Maryland Geological Survey and for a gold exploration firm in Utah and Idaho.

PHOTO BY ANDREW WOLFF

A minor eruption of Villarrica volcano shows lava flowing down the snow-covered slope.

He is continuing his research of radon, an issue for Southcentral Kentucky's karst region; the medical implications of breathing airborne mineral and chemical particulates; the connection between geology and archaeology, a key feature of his research on human migration in Java; and his work on the geochemistry of chert and obsidian artifacts, which reveal clues about migration patterns and trading routes of Native Americans.

"That's what is fun for me, where geology impacts all these other things," he said. "The idea is that we can get students here to understand that geology really has a global impact on other subjects of study. If you're in economics, you need to know who has the gold and the resources. The study of history is the study of geographical and geologic boundaries. Who has the resources? Who is living on the hill and who is living in the swamp? Literature and the arts have so many rich references to Earth and the processes that form it. And, from the standpoint of understanding geopolitics, students need to have some understanding of the 'geo' part."

"Western's Department of Geography and Geology is well-positioned to have a significant impact on research and on student achievement," he said. Undergraduate students have the opportunity to work alongside faculty mentors, to participate in regional and national conferences and to operate analytical equipment like a scanning electron microscope or an X-ray diffractometer. For example, two geology majors just presented their research at a national meeting of the Geological Society of America in Seattle.

"Those are skills that make them employable, but it also means that they have a depth of understanding of material that students at other schools simply are not going to get," Dr. Wulff said. "As we get deluged with data and information from all directions, it is becoming increasingly important to understand experientially such aspects as sample preparation techniques, causes of analytical error, and biases in the manipulation of data."

The scientific method, he said, is designed to train people to make sense of the unknown. "When you get a science degree, you should be equipped in a different way to handle something entirely unknown to you," he said. "You should have discovered a discipline that allows you to systematically explore the unfamiliar and the familiar in the world around you. The analytical and observational skills that students develop working on these types of projects will make them much more comfortable and creative when working on a project here at home.

"There are no volcanoes in Kentucky, but there is no shortage of geologic issues for people in our region. The idea is that when you get students involved in research they may not do that research for the rest of their lives, but they're going to use these new skills. We encourage them to change from students to scientists."