# Geology Goes to Mars

### UI researchers examine volcanic minerals from the Northwest to understand the red planet's history

From molten rock, a new land-scape is born. Lava flows and cools, hardening into pools and pillars of basalt. Ash drifts and settles.

Time passes. Rain falls.

Weather transforms the ash first, dissolving and morphing it into allophane — nanoscopic balls of silicon, aluminum, oxygen and hydrogen.

The basalt changes too. Water seeps into cracks and bubbles in the rock, setting off chemical reactions that create clay minerals like nontronite, made of sandwiched sheets of silicon and iron woven with oxygen.

This process began in the Columbia River Basin about 18 million years ago, when rampant volcanic activity across Idaho, Washington and Oregon flooded the region with layers of lava.

But it also happened much longer ago on Mars.

## Finding Minerals on Mars

Rocks from Mars aren't exactly easy to come by. All we have are tiny, precious samples that were blasted off Mars' surface by meteorite impacts and flung to our planet. The small fleet of rovers inhabiting Mars are limited in where they can explore and what they can test. The next planned robotic mission is slated to return samples to Earth, but still can't replicate the ingenuity and nimbleness of a human scientist.

So to understand the geologic forces that shaped the red planet, scientists gather clues from Earth.At the University of Idaho, geologist and soil scientist Leslie Baker and her students study clay and allophane from the Columbia River Basin to reveal what Mars was like billions of years ago.

Satellites orbiting Mars measure the infrared energy emitting from the planet's surface, which scientists then translate into information about the composition of the minerals below. These satellites have found 4 billion-year-old rocks containing clay minerals at the bottoms of deep Martian canyons, and 2 billion-year-old deposits containing allophane.

"It means there had to be liquid water," explained Baker, the chair of the geology and geography departments in the College of Science.

The rocks containing allophane don't show signs of more advanced weathering processes, indicating Mars was either cold or not particularly wet around 2 billion years ago.

But for nontronite to form, 4 billion-year-old Mars must have been warmer and wetter, with an abundance of liquid water and atmospheric conditions similar to Earth's — but that's a "very stretchy set of conditions," Baker said.

"Like Hawaii? Like Iceland? That's still very much a question," Baker said. "We're using the field examples here from the Columbia River Basalts to try to narrow those conditions down."

The techniques Baker has honed and passed along to her students are already opening up our ability to under-stand the history of Mars. As space exploration evolves, she expects their skills will become even more valuable.

Someday, a robotic or crewed mission will bring home Martian rocks to study. But the time, effort and money required to get them will make those rocks worth millions of dollars.

"They're going to be very, very precious and very limited in amount, so we'll need to know how to work with them efficiently, and we need to know the best possible set of techniques to get all the information we can," Baker said.

"Here, we have the expertise."

UI geologist and soil scientist Leslie Baker

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## Building Skills on Earth

UI researchers' Mars mineral expertise lies at the intersection of soil science and geology. Space is naturally interdisciplinary, and Baker's experience in both fields has allowed her to bring new ideas and methods to planetary science.

"It seems like all the different interesting questions are on the boundaries between fields these days," she said.

In 2009, Baker and Daniel Strawn, a soil science professor in the College of Agricultural and Life Sciences, were working on another project involving nontronite and went to Garfield, Washington, just 24 miles from Moscow, to collect more samples. As they climbed a bank along the highway to scrape out the clay, they started talking about nontronite's special properties.

"We just were observing it's so unique, such a neat mineral," Strawn said. "We had all kinds of questions at that moment of 'Why is this forming here?'"

Baker began collecting other nontronite samples to investigate why it only occurred in certain parts of the Columbia River Basin. Over the years, she's collected and begun to analyze hundreds of clay samples from across the region. In

January 2017, she published some of her research in a special issue of American Mineralogist dedicated to explaining how to use Earth evidence to understand Mars geology, and expects other findings to come out soon.

In 2016, first-year physics student Archana Dahal from Dharan, Nepal, joined Baker's research team. Dahal, who was inspired to pursue planetary science after reading the works of Carl Sagan, spent her first semester of college preparing clay samples for analysis, and was eager to spend spring 2017 gathering minerals on the Palouse and learning field research skills.

"Science is not only in a lab, it's in life," Dahal said. Around the same time Baker started studying nontronite's importance to Mars, she helped UI's allophane science make the leap across the solar system, too.

UI researchers have examined allophane's role in agricultural and forest soils for years. While helping a soil science graduate student synthesize the mineral to compare to samples found in Craters of the Moon National Monument, Baker kept running into references about allophane on Mars.

"It turned out the planetary science community was very interested in allophane, but they didn't know how to synthesize it," she said.

Baker contacted Janice Bishop, a researcher at the SETI Institute and NASA's Ames Research Center in the Bay Area of California. Bishop is one of the world's leading experts in analyzing infrared data from satellites to study clay minerals, and she was eager to tap in to UI researchers' abilities.

With funding from the NASA Idaho Space Grant Consortium from 2010 to 2012, Baker and her students made varieties of allophane for Bishop and other NASA scientists. By examining the lab-made minerals' infrared signatures, scientists can know with confidence what the satellites are finding on Mars.

Continued funding from NASA has allowed the allophane research to advance. Tom Jeute, a UI geology graduate student who works with Baker, spent 2016 synthesizing samples of allophane, opal and other minerals for Bishop and collaborators at NASA's Johnson Space Center to study. This spring, he and Baker visited Stanford University's synchrotron, an incredibly powerful X-ray tool that allowed the UI researchers to examine their samples down to the level of measuring the distance between individual atoms.

Jeute said he enjoys the research because it helps him not only understand the history of Earth, but also make a connection to space.

"When I was young I always wanted to be an astronaut. When I started doing geology, I started realizing, 'Oh, a lot of astronauts are geologists,'" he said. "That's how we learn about planets."

*Article by Tara Roberts, University Communications and Marketing*

UI geologist Lesie Baker and student Archana Dahal, a first-year physics major, prepare mineral samples in Baker's lab.