Detecting life on Mars with a single shot

Idaho National Laboratory research podcast by Roberta Kwok

NARRATION: If you want to enter the lab of scientist Jill Scott, you'll have to answer some questions first.

JILL: Do you have a pacemaker?

ROBERTA: No.

JILL: Do you have any metal plates in your body from surgeries?

ROBERTA: Uh, no.

JILL: Any credit cards, analogue watches, cell phone, pager or anything that you think would be affected by a magnetic field?

ROBERTA: Yeah, I do.

JILL: Okay, well, we need to set those aside here before we go back into the lab.

NARRATION: Scott is a scientist at Idaho National Laboratory, or INL. She's working with researchers at the University of Montana-Missoula on a tantalizing problem: how to find life on Mars. To answer that question, Scott's INL team has built an instrument about the size of a city bus. It's 25 feet long, 6 feet high, and stretches from one end of her lab to the other. The instrument contains a giant magnet, which is why Scott doesn't want anyone with a pacemaker getting near it. Along with the magnet, there's an obstacle course of wires, tubes and other unidentified electronic objects.

JILL: What we really have here is a laser on the side of the wall. It comes over here through a laser scanner system that moves the laser light around, which then goes down through a superconducting magnet -- which you can think of as kind of like an MRI type of magnet -- into a lens. It goes into a vacuum chamber where our cell and sample are sitting. We're working on a NASA project to determine how well we can see biosignatures in heterogeneous geomatrices, i.e., rocks and minerals.

NARRATION: The instrument can detect tiny traces of cells on the surface of rocks. That's exactly what NASA needs to do if it's going to find life on Mars. Scott's instrument is too big to send into space, but it could help analyze any Martian mineral samples that NASA brings back to

Earth. And unlike other chemical analysis methods, INL's technique uses very small amounts of sample and is still highly sensitive. That’s important, Scott says, because any signs of life that do exist are likely to be few and far between.

JILL: Well, if life were abundant on Mars, we'd probably have already seen it because they have some fantastic cameras and other instrumentation that they've looked at. So it's not going to be obvious, which means you've got to have instrumentation that can see minute traces of what's probably left over. In other words, some microbes probably crawled around on Mars, died and decayed and turned into little bitty particles, and we have to be able to find those little bitty particles.

NARRATION: Here's how the instrument works. First, Scott points a laser at the rock sample to blast mineral fragments off the surface. If any biomolecules from old cells are present, they’ll react with the mineral fragments to create charged particles. Those particles are then trapped by the magnet so the team can look for chemical signatures that might be unique to the biomolecules.

The technique is unusual because it doesn’t require much sample preparation. With other detection methods, scientists usually have to crush the rock or mix it with a synthetic material in order to see the biomolecules. These steps can use up large amounts of sample and increase the risk of contamination.

JILL: We wanted to see how well you could do this with no sample prep, minimum damage to a sample. For instance, if they brought special samples back from Mars, you don’t want to destroy them while you try to search for signs of life in them. So we wanted a simple, straightforward, shoot-it, detect-it type technique.

NARRATION: There’s one catch: The technique doesn’t work well for all minerals. So the team has been testing a variety of rock samples collected from Earth to see which ones perform the best.

One of the most promising is a white mineral called thenardite. Scientists believe they've spotted traces of it on the surface of Mars. And thenardite is left behind when lakes dry up, which makes it a natural place to look for signs of life.

DOC: The thenardite and the other sulfate minerals that are on Mars are suggested to form in evaporitic environments, meaning water. And that’s what NASA pushes: Follow the water and you’ll find the life.

NARRATION: That’s Doc Richardson, one of Scott’s collaborators at the University of Montana. He led the team’s latest study, which found that INL’s instrument could detect biomolecules in thenardite at levels of 3 parts per trillion. That’s the equivalent of a few drops of water in 20 Olympic-sized swimming pools.

Richardson is particularly intrigued by thenardite because it’s also found in Craters of the Moon, a national monument in Idaho. Craters of the Moon is covered in volcanic basalt rock that has a similar chemistry to rocks on Mars.

DOC: The high iron content and some other elemental compositions and such make it extremely, extremely comparable to the basalts found on Mars. So just that link between Craters of the Moon and Mars is phenomenal, and it's wonderful that we have it so close to the INL.

NARRATION: The thenardite forms in caves that run underground, so the team gets to take some interesting expeditions to find it.

DOC: Being the geologist I am, you know, I get to put on my hard hat and my rock hammer and, you know, go caving. What it is, is you'll be in these caves, and the caves can range from maybe 30 feet to caves that are miles and miles deep under Craters of the Moon. The field research down there is wonderful because you just get to go play in caves and hop around basalt.

NARRATION: Richardson believes that thenardite found in basalt environments could be created by bacteria. That could make thenardite an even more promising place to look for microbial leftovers.

By figuring out which minerals are most likely to show signs of life, the team can help NASA decide which samples to collect on Mars. And if scientists do find evidence of Martian microbes one day, it could have implications far beyond the Red Planet.

JILL: I think it also tells us a lot about how life can happen and what types of environments it can live in and what potentially could happen to the Earth in the future, as well as what's happened to the Earth in the past. So it has the chance to answer a lot of questions about the origin of life, as well as the questions of "Are we alone? Is there any chance that we're not alone here in the universe?" So people are interested in it because it does impact how you think about -- what's the meaning of life?

NARRATION: I'm Roberta Kwok with Idaho National Laboratory. For more information about this project, read our news release at the inl.gov newsroom.