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Sensitive laser instrument could aid search for life on Mars

UPDATE: Listen to a podcast about this research or read the transcript.

IDAHO FALLS -- Minuscule traces of cells can be detected in a mineral likely present on Mars, a new study shows. The results, obtained using a technique developed at the U.S. Department of Energy's Idaho National Laboratory, could help mission scientists choose Martian surface samples with the most promise for yielding signs of life.

INL's instrument blasts off tiny bits of mineral and looks for chemical signatures of molecules commonly found in cells. While other methods require extensive sample handling, this analysis relies on a "point-and-shoot" laser technique that preserves more of the rock and reduces contamination risk. In the current online issue of the peer-reviewed *Geomicrobiology Journal* , the researchers report they could detect biomolecules at concentrations as low as 3 parts per trillion.

High sensitivity is crucial for NASA's search for life on Mars, says INL scientist Jill Scott, whose team collaborated with researchers at the University of Montana-Missoula on the study.

"The worst-case scenario is a false negative," Scott says. "If you're just missing stuff, that would be devastating."

While other techniques also have achieved parts-per-trillion sensitivity, they often require scientists to first extract the organic cell remnants from the mineral. This type of preparation can use up large amounts of sample and potentially introduce contamination.

INL's method is based on a technique called laser desorption mass spectroscopy. By focusing a laser beam on a spot less than one-hundredth the width of a pencil point, the researchers can knock microscopic fragments off the mineral. Those fragments react with organic molecules to form detectable charged particles called ions. The team can then study the ion patterns for signatures that might be specific to biomolecules.

Typically, this method would require the organic molecules to be embedded in a synthetic matrix that encourages ion formation. But the INL team simply relies on the rock to act as the matrix, eliminating the need for sample preparation.

"We thought, what can the rock do for you?" Scott says. "You don't want to damage the sample more than you have to. You'd like to just shoot it directly."

With funding from NASA's Astrobiology program, the researchers have done previous studies showing that minerals like halite and jarosite yield distinct ion patterns when organic molecules are present. This time, they tried thenardite, a compound thought to be part of the Martian surface. Because thenardite is left behind when lakes dry up, its presence could signify the past existence of water -- and hence life.

The team tested thenardite samples taken from the evaporated Searles Lake bed in California. They also created artificial thenardite samples that contained traces of stearic acid, which is left behind by dead cells, and glycine, the simplest amino acid used by organisms on Earth. In all cases, the researchers found a distinct ion pattern that did not appear for thenardite alone, suggesting they had detected a signature for the biomolecules.

The team also measured the sensitivity of its instrument for the first time. By testing more and more dilute artificial samples, they found they could detect the stearic acid signature at levels as low as 3 parts per trillion. In fact, the signatures became even more distinct as concentration dropped, presumably because more ion-producing matrix surrounded each biomolecule.

While the instrument is too big to send into space, it could potentially be used for analysis if NASA brings Martian samples back to Earth. The INL study also could help determine which samples should be collected, based on how likely they are to show signs of life. Thenardite and jarosite look the most promising, Scott says, while hematite -- an iron-based compound common on the Martian surface -- has yielded poor results so far.

"The wider the variety of minerals we test, the larger the suite we can target on Mars," says collaborator Nancy Hinman, a geochemist at the University of Montana-Missoula.

The team's next step is to improve the laser on its machine. Right now, the instrument is ionizing only about 10 percent of the available biomolecules in the sample. If the remaining biomolecules could be ionized with a better laser, Scott says, the detection level could increase tenfold.

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Read the *Geomicrobiology Journal* paper here.
Read more about INL's science & engineering capabilities.
Read more about NASA's astrobiology and Mars exploration programs.

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