VOL. 102 | NO. 4
APRIL 2021

Eos

SCIENCE NEWS BY AGU

FILLING IN THE MARGINS

This spring, GeoPRISMS leaves behind a legacy of research by shoreline-crossing scientists and the National Science Foundation.

Supercharged Lightning

An Asteroid Double Disaster

Sooty Stalagmite Records

AGU
ADVANCING EARTH AND SPACE SCIENCE

This Search for Alien Life Starts with Destroying Bacteria on Earth

Sometimes it takes a little destruction to unlock the secrets of the universe.

In a lab at Imperial College London, Tara Salter used high temperatures to destroy samples of bacteria and archaea, leaving behind molecular fragments. With this pyrolysis process, Salter attempted to simulate what might happen to molecules that smash into a spacecraft like bugs on a windshield.

Specifically, Salter simulated a spacecraft flying through the geyser-like plumes of the outer solar system's ocean moons. Scientists have observed plumes spouting from the icy shells of both Saturn's moon Enceladus and Jupiter's moon Europa—and they want to send spacecraft through those plumes to investigate what kinds of molecules are being ejected from the extraterrestrial oceans below.

Any molecule colliding with a spacecraft flying at speeds of several kilometers per second would be "smashed to smithereens," Salter said.

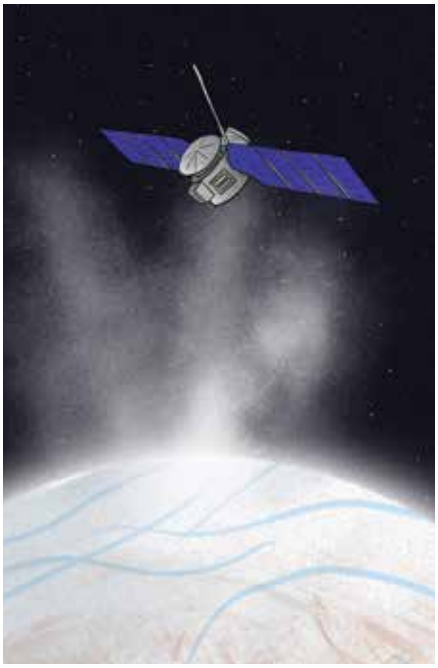
Even if microbes are part of plume ejecta, sampling spacecraft likely won't be able to observe entire organisms—just bits of them. "Being able to put back together the organism from detecting small parts is the big aim" of her research, Salter said. She hopes that her smashed-up bacteria samples, and the molecular fragments they leave behind, will help future scientists investigate the possibility of life on one of these ocean worlds.

Salter presented the research at AGU's Fall Meeting 2020 (bit.ly/life-on-icy-moons).

"Being able to put back together the organism from detecting small parts is the big aim."

Far-Away Oceans

Back in 2005, NASA's Cassini spacecraft made a spectacular discovery: Underneath many kilometers of ice on Saturn's moon Enceladus churned a vast ocean of liquid water. Cassini discovered this ocean almost by accident when it flew through geyser-like plumes of water vapor spewing from Enceladus's south pole. Cassini didn't discover just water molecules in the plume—there also seemed to be fragments of organic molecules clinging to the speeding grains of ice.



NASA's Europa Clipper, set to launch in 2024, will study Jupiter's icy moon Europa. Credit: JoAnna Wendel

But Cassini's instruments weren't designed to distinguish between large organic molecules, said Hunter Waite, a program director of mass spectrometry at the Southwest Research Institute in San Antonio.

Now that we know that a future spacecraft needs to be able to detect large, complex organics, NASA is prepared. The agency's next mission to the outer solar system, Europa Clipper, will study another moon that contains a liquid water ocean, Jupiter's satellite Europa. Numerous observations from the Galileo spacecraft and the Hubble Space Telescope indicate that like Enceladus, Europa sports plumes shooting from its surface. Whether those plumes originate in the moon's internal ocean or in a subsurface reservoir remains to be seen.

Europa Clipper's mass spectrometer will be able to detect and determine the composition of larger organic molecules, said Waite, who is also a coinvestigator on the instrument. That way, scientists will be able to study exactly what material is coming out of the plumes.

Flying Through Plumes...in the Lab

To simulate a spacecraft's flight through Europa's plumes, Salter heated specimens of extremophile bacteria in a special chamber to 650°C, which mimics the destructive force of smashing into a spacecraft. The heat destroys the molecules to some extent, and what's left is a smorgasbord of fragments. Salter then analyzed fragments with her lab's mass spectrometer and created a catalog.

"You can simplify a bacteria into proteins, carbohydrates, and lipids," among other things, Salter said. In her analysis, she found fragments of amino acids; fatty acid chains that make up lipids; and molecules containing oxygen, hydrogen, and carbon from the carbohydrates.

After analyzing the fragments, Salter created a library of molecular signatures—one she hopes to expand and share with fellow scientists.

"Work like this can help us unlock hidden gems in previous data sets like the measurements Cassini made of the Enceladus plume and will also help us inform future measurements by missions designed to search for life in these alien oceans," said Morgan Cable, a planetary scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif., who wasn't involved in the research.

However, "we also need to keep in mind that we might encounter only trace amounts of life, where that biosignature spectrum could be hidden underneath a strong abiotic signature," she said.

Salter has more plans for destruction. She wants to destroy bacteria cells using ultraviolet radiation—to mimic the surface of Europa—and to heat up the cells in the presence of water to see how water affects what molecules get left behind.

From the dust of pulverized bacteria, scientists hope to compile a complete library of molecular fragments that can help identify life on another world.

By **JoAnna Wendel** (@JoAnnaScience), Science Writer