Life on Mars?

Samples taken by the Perseverance rover show the presence of organic material.

By Robert Perkins

As NASA's Mars Perseverance rover explores Jezero Crater on the Red Planet, scientists at Caltech will help humanity discover whether the samples it collects hold signs of ancient extraterrestrial life.

The rover is currently traversing the remnant of a delta where, about 3.7 billion years ago (when liquid water still flowed on the Martian surface), an ancient river terminated in a lake. On September 15, 2022, the Perseverance team announced that the rover had detected organic compounds in a location called Wildcat Ridge. While the compounds can be produced abiotically, some could be biosignatures.

"In the distant past, the sand, mud, and salts that now make up the Wildcat Ridge sample were deposited under conditions where life could potentially have thrived," said Ken Farley, the W. M. Keck Foundation Professor of Geochemistry and Perseverance project scientist. "The fact the organic matter was found in such a sedimentary rock—known for preserving fossils of ancient life here on Earth—is important. However, further conclusions will have to wait until it's returned to Earth for in-depth study as part of the agency's Mars Sample Return campaign."

The rover had previously made the notable yet surprising discovery of igneous rocks in the base of Jezero Crater. Igneous rocks, such as the basalt that makes up island chains like Hawai'i, are cooled flows of magma that have solidified underground or emerged during volcanic eruptions. Sedimentary rocks, on the other hand, are the result of rocks that eroded into fine grains and cemented together into a single rock through heat, pressure, and chemical processes.

"The finding of igneous rocks in the floor of the crater says that Jezero is more complex than the model of a lake basin that is filling with sediments over time with the delta being the last landform," says Bethany Ehlmann, professor of planetary science and associate director of the Keck Institute for Space Studies. "It says that the region has had a rich geological history that has had both igneous and sedimentary processes."

The fortuitous (and forward-thinking) large concentration of geochemists at Caltech preparing to analyze Martian samples mirrors a similar situation two generations earlier, when Caltech was home to some of the first geologists, geophysicists, and geochemists to analyze lunar samples brought home by the Apollo astronauts.

"Planetary geology was essentially invented at Caltech," says John Grotzinger, the Harold Brown Professor of Geology and Ted and Ginger Jenkins Leadership Chair of the Division of Geological and Planetary Sciences. "The close proximity to JPL, and Caltech's small size, allowed close collaborations between scientists in the GPS division and the PMA [Physics, Mathematics and Astronomy] division with the engineers at JPL." The new Caltech Center for Comparative Planetary Evolution seeks to stimulate current and future collaborations of the type needed by the Perseverance rover team to identify attractive targets that may contain biosignatures.

Even if the organic material does not turn out to be evidence of life, the analysis of Jezero Crater will be a firm step toward learning more about the evolution of our closest planetary neighbor. And there may still be connections to Earth. While life may not have emerged on Mars, it is possible that there may be a record of key precursor steps. The returned samples can be examined for complex organic molecules that represent those initial steps, and these may help us fill in the missing links in the story of how life started on Earth.