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Could Life Exist on Mars? Answers May Lie in the Otherworldly Environment of a River in Spain

Understanding the Rio Tinto's extremophiles and the fingerprints they leave on the geologic record could provide important clues about how and where life might survive on the Red Planet.

by **Adam Voiland '05**

The Rio Tinto is a foul, oozing trickle of a river that muddles its way through mining country in southwestern Spain, has the pH of gastric juice, and is awash with pollution and heavy metals. The water ranges from a brilliant blood red to rusty wine that, in concert with the yellow, orange, and green rinds of color flanking the banks, make for a truly psychedelic and otherworldly scene.

Ancient Phoenician miners called the Rio Tinto *Ur-yero* or "River of Fire," and the Spanish *tinto* translates to "red." It's a fitting hue for a waterway that's a hotspot in the search for life on the Red Planet. Though people long assumed Rio Tinto was dead due to a dearth of visible life, scientists now know the water actually teems with odd microscopic organisms called extremophiles which thrive in conditions that would kill most organisms.

Linda Amaral Zettler of the Marine Biological Laboratory is one of the specialists working on the Rio Tinto project with Brown Associate Professor John Mustard.

Understanding extremophiles and the fingerprints they leave on the geologic record, scientists hope, will provide important clues about how and where life might survive on Mars.

Although extremophiles live in a range of environments, a subgroup known as acidophiles dominate the Rio Tinto. One species, *Acidithiobacillis ferrooxidan,* feeds on iron and thrives in the river's acid water; others live in some of the Earth's saltiest, hottest, most chemically abrasive cracks and crevices, ranging from deep-sea vents to the guts of volcanoes.

"They're actually taking advantage of the environment and not just hanging on by their fingernails," Associate Professsor of Geological Sciences John Mustard said of the extremophiles that live in the Rio Tinto.

Mustard, with geology postdoctoral student Aline Gendrin and graduate student Leah Hutchinson, spent five days at Rio Tinto last summer scouring rocks for chemical signatures of extremophile activity. *Ferrooxidans*, for example, help regulate the precipitation of distinct, seasonal, iron-rich bands along the river's banks, which over time have become easily identifiable iron terraces. Similar layers exist on Mars, but as yet scientists have no way of telling whether microbes were involved in their formation.

Ricardo Amils is one of the Spanish researchers

working with the Mustard team. He holds a beaker of the river's water.

The team's research is part of a project that includes collaborators at the Marine Biological Laboratory at Woods Hole and the Centro de Astrobiologia in Spain. The project aims to understand precisely how life impacts geological processes at Rio Tinto, an analogue for the Martian environment. Ultimately, their findings will help planners of missions to Mars search more effectively for evidence of life on the Red Planet.

The Rio Tinto may be a good analogue for Mars because the river is unusually acidic and also iron and sulfur rich.

"We know for a fact that Mars is iron rich and has boatloads of sulfur on the surface," Mustard said, referencing his work with the Mars Express orbiter, which is in the midst of mapping the mineralogical composition of the entire Martian crust. Meanwhile, Opportunity, a Martian rover operated by NASA, has discovered the presence of a sulfate called jarosite, a mineral scientists believe can only form in the presence of extremely acidic water.

In comparison to Earth, however, Mars is extremely cold and dry. At some levels this makes Mustard skeptical about the reliability of Rio Tinto as an analogue.

"The ideal thing would be that you could take the modern Rio Tinto and stick it on a shelf for three billion years so that it would dry out. Then you could go look at it without having it continually flushed with rainwater," he said.

Even so, the existence of critters like *ferrooxidans* at Rio Tinto, in conjunction with a flood of data coming back from Mars indicating that water used to be plentiful on the planet's surface, has made the Red Planet the best candidate for finding evidence of extraterrestrial life.

Brown graduate student Leah Hutchinson, left, with Mustard.

So how does a researcher seek clues to further develop the hypothesis? For Hutchinson, whose master's thesis focuses on understanding the interaction between biology and geology at Rio Tinto, it took plenty of muscle. She spent her time scrambling about the brightly colored banks of the Rio Tinto, hauling a bulky twelve-pound spectrometer around a twenty-by-twenty-foot grid for hours on end.

"It sort of felt like being pregnant," she said with a laugh, "or a popcorn seller at a baseball game."

Operator fatigue wasn't the only variable Mustard's team had to juggle to complete their spectroscopic mapping. By alternating frequently they managed to avoid turning anybody's arm muscles into putty, but it wasn't as easy to balance the spectrometer's finicky battery with the availability of sunlight, especially because their Spanish hosts tended to take long lunchtime siestas.

In the end, however, the team obtained all the data they need. Now Hutchinson is back at Brown preparing to dive into the countless hours of laboratory work and computer modeling that must occur before she'll be ready to publish her results.

Photos by Erik Zettler

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