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Mono Lake and Mars: The Extremophile Connection

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For Immediate Release

Meteorites, Mars, Mono Lake and microorganisms. These seemingly unrelated areas of scientific research are helping NASA scientists to look for evidence that Mars once supported life. What these four areas of research have in common is water – and following this “water trail” has led NASA scientists to Mono Lake. Located in California’s Eastern Sierra, Mono Lake is visited each year by thousands of people. One of the many scenic attractions that fascinate visitors to Mono Lake is the tufa towers that are formed under the lake’s surface by the chemical reactions of calcium in fresh water springs. Reacting with the carbonates that occur in Mono Lake’s salty, alkaline water, limestone tufa towers rise from the bottom of Mono Lake. It is these limestone formations, and the mud that they rise from, that have attracted NASA scientists.

13,000 years ago, a little piece of Mars crashed through Earth's atmosphere and landed in Antarctica, where it was later discovered by scientists in 1984. Thinking it was an ordinary meteorite, scientists tucked it safely away for 10 years inside a specimen drawer, waiting for the time when its secrets could be unlocked. That time came in 1994, when researchers discovered that the meteorite originated from Mars and contained carbonate globules. Similar carbonate globules can be found in the unusual tufa towers at Mono Lake.

Mono Lake has been around at least 760,000 years – enough time to have witnessed some impressive events in the natural history of the Mono Basin. Volcanic eruptions formed its two largest islands, catapulting pumice boulders onto its surface, and ice bergs floated on its saline water, calving off of huge Sierra glaciers advancing down to its shoreline during the last Ice Age. Evidence of these past events, visible today, has been extensively studied by scientists from around the world. But now it's the time of the "extremophile," tiny microorganisms that thrive in the known world's most hostile environments. Finding where these tiny bacteria live on the Earth's surface and comparing the data collected with similar surface features on Mars has enabled NASA's Mars Surveyor program to better understand where they might find evidence that extremophiles once lived in Mars' hostile environments.

In 1976, probes launched by NASA during the Viking program landed on Mars to analyze soil samples. It was theorized that water had once flowed freely on the surface of Mars, and with a past climate and atmosphere that was

less hostile, scientists hoped to find evidence that life had once existed on Mars. Though no conclusive evidence was found, researchers came away with the hope that by looking for and studying extremophiles on Earth a more comprehensive picture would develop as to where the next probes should look for evidence of life on Mars.

In August 1995, Mono Lake became the focus of project director Carol Stoker from NASA's Ames Research Center. Along with researchers from the Monterey Bay Aquarium Research Institute, the Navy Postgraduate School, and Stanford University, NASA converged on Mono Lake. Calcium carbonate precipitating out of water forms limestone and often traps microorganisms within the forming rocks, a process that occurs at Mono Lake with the building of tufa towers. The same process might have occurred on the surface of Mars, where lakes might have been formed in the basins that are similar to those found on Earth. By studying freshwater vents under the surface of Mono Lake, researchers hoped to gather information that microorganisms or "extremophiles" live and die in tufa and could become fossilized after the tufa formations become exposed due to shrinking lake levels.

Operating from a houseboat on Mono Lake, the research group operated a Telepresence Controlled Remotely Operated Vehicle (TROV) equipped with 1000 feet of cable, a state of the art high frequency sonar system, stereoscopic cameras, an acoustic positioning system, and a sample-grabbing arm. With a similar TROV planned for use on the Mars probe *Spirit*, working out the bugs was crucial. Visibility in Mono Lake's waters was limited to about one foot,

the murkiest the researchers had ever encountered, and the chemical composition of the water reduced the sonar range from 30 meters to only 2 meters. Tufa samples were taken from the bases of tufa towers, and were analyzed over the next few months to see how well they preserved microbes. The experience gained from these experiments contributed to the development of some of the virtual reality tools that are presently being used on Mars.

On January 2, 2004, the Mars probe *Spirit* landed in the Gusev Crater, an area that perhaps contained an ancient dried lakebed, and on January 25, the probe *Opportunity* landed on the opposite side of Mars in an area that contains gray hematite, a mineral that usually forms in the presence of water. NASA hopes to find evidence that water existed on the surface of Mars; a crucial link in finding signs that extremophiles once lived there. It's unlikely that any extremophiles are alive on the surface of Mars, but their fossils might be there. A good place to look would be inside evaporated mineral deposits or tufa-like towers. The possibility of finding evidence that extremophiles once existed on Mars is fascinating. Any form of life that could live in such a hostile environment would have developed survival skills unmatched by anything known before. But you don't have to go to the surface of the angry Red Planet to find them. They exist right here on Earth.

In September of 2000, Astrobiologist Richard Hoover of NASA's National Space Science and Technology Center in Huntsville, Alabama, visited Mono Lake with the hopes of finding extremophiles. Deep within the salty alkaline mud of Mono Lake, life-producing oxygen is non-existent. Noxious

sulfur fumes rise out of the disturbed muck, and it would seem that life could not possibly exist in these harsh conditions. Yet this is exactly where Dr. Hoover discovered three new species of living bacteria: *Spirochaeta americana*, *Tindallia californiensis*, and *Desulfonatronum thiodismutans*. Dr. Hoover explains “by studying microorganisms found in Earth’s extreme places, like Mono Lake, we begin to understand how life might exist on Mars or on other worlds.” The discovery of these new species of extremophiles, and the data collected in 1995’s TROV program hold intriguing possibilities that life might have existed on Mars. The tufa towers at Mono Lake contain the fossil remains of bacteria that lived under extreme conditions, and many visitors who first see the lake and its strange tufa formations often describe them as looking alien and Martian-like. Standing in the starlight among the tufa towers along the shores of Mono Lake, you can sometimes see the red planet called Mars, millions of miles away. It seems unbelievably far away. But reach out and touch a tufa tower anchored in the mud and you can almost feel a direct connection between Mono Lake and Mars. For more information on Mono Lake, you can contact the Mono Lake Committee at www.monolake.org or call 760-647-6595.

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Photo #1 – Tufa towers

Caption: Often described as otherworldly, these tufa towers, exposed by shrinking lake levels, attract thousands of visitors each year to Mono Lake.

Photo by Mono Lake Committee.

Photo #2 – Underwater tufa

Caption: These limestone tufa towers, surrounded by thousands of brine shrimp, are forming under the surface of Mono Lake. Microorganisms flourish on the surface of these towers and can become trapped in the limestone as the towers continue to grow. Photo by Mono Lake Committee.

Photo #3 – TROV on Mono Lake

Caption: From a research boat on Mono Lake, this TROV was submerged into the salty water to test a sample-grabbing robotic arm, used to collect pieces of limestone from the bases of tufa towers. Photo by Dave Marquart.

Photo #4 – Spirochaeta americana

Caption: NASA scientist Richard B. Hoover recently discovered three new microorganisms in the salty, alkaline mud of Mono Lake, including this extremophile named *Spirochaeta americana*. Photo courtesy of Richard Hoover.