'Extreme analytical chemistry' will help unravel Mars' mysteries

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Sam Kounaves spends his time unraveling fundamental questions in planetary science by applying "extreme analytical chemistry" to the harshest environments imaginable: Places like Death Valley, Antarctica – and now Mars.

The Tufts professor is a co-investigator on NASA's Phoenix Mars Lander Mission currently scheduled for launch on August 4. Kounaves will be leading the chemical analysis of Martian soil and ice after the Lander craft touches down on Mars in May 2008.

It's a fitting challenge for someone who grew up with dreams of being an astronaut going to Mars, and fascinated by science. Kounaves is one of only two dozen investigators on the project that is tapping resources from universities and companies around the world.

Watery Clues to Life

Those who seek clues to life always "follow the water." So, Phoenix is designed to study the history of water and search for complex organic molecules in the ice-rich soil of the Martian arctic. Kounaves will spearhead the chemical interpretation of the inorganic and electrochemical analyses of the soil-ice constituents, their relationship to past and present Martian geochemistry, and the potential of the Martian environment to support microbial life.

"We will also try to decipher the climatic history of Mars via the chemical record left in the soil," he says. That history, he says, may hold vital clues and lessons for climate change on Earth.

Phoenix incorporates some of the most sophisticated advanced technology ever sent to Mars, according to NASA. A robotic arm will dig through the soil to the water-ice layer underneath, and deliver soil and ice samples to the mission's experiments. On the Lander deck, miniature ovens and a mass spectrometer will chemically analyze trace matter, the wet chemistry laboratory (WCL) will characterize the soil and ice chemistry, imaging systems will provide an unprecedented view of Mars, and a meteorological station will study the atmosphere and clouds.

Kounaves' team is focused on the WCL, which includes four teacup-size beakers that will receive soil-ice samples. He and his researchers – most of them Tufts students – have developed sampling and analytical methodologies to ensure reliable chemistry and geochemical analysis. In addition, his group was responsible for delivering, as flight ready hardware, the tiny crucibles that hold the chemical reagents that will be mixed with soil-ice samples, and a sensor array originally developed at Tufts for analysis of metal ions in water. The concentrations and forms of inorganic and organic molecules are among the signatures of life that the Phoenix team is looking for.

"We're basically explorers," Kounaves notes, "just like the explorers of centuries past. Usually an analytical chemist would receive samples and be asked to analyze them. With this project, we are also involved with the overwhelming challenge of getting to the sample, insuring we conduct a scientifically valid chemical analysis, and doing good science."

The biggest surprise so far" "That, for all the differences, Mars is so earth-like." For example, polar ice caps, permafrost, climate, and

perhaps liquid water exist on both planets. "Scientists have been able to find microbes in Antarctica and miles underground where it was thought impossible for any life to exist," he muses. "If life on Earth can exist in such severe places, perhaps it may have started and still exist on Mars."

"Are We Alone in the Universe?"

Kounaves and Research Associate Suzanne Young will be at Cape Canaveral, Fla., for Phoenix's launch. Growing up, Young took apart everything she could lay her hands on, including the oven. She still loves playing with the big toys and asking the big questions—like "Are we alone in the universe"".

In the Tufts lab, she points out students who are conducting tests to ensure that sensors in the WCL will withstand everything that Mars can dish out. Procedures that would be simple on Earth become Herculean under frigid Martian conditions that would crack similar sensors used on Earth. Notable is a tank labeled "Mini Mars," which mimics the atmospheric pressure on Mars; "Tank o' Mars replicates the planet's alien atmosphere—more than 95 percent carbon dioxide, with smatterings of nitrogen and argon.

At the beginning of this year, the Tufts team produced the tiny crucibles, containing salts or acids, that the Lander will carry 423 million miles to Mars. Each crucible is about 3.5 by 7 mm, made of stainless steel and Teflon-coated so it slides easily in the dispenser mechanism. "It's amazing that stuff we touched will be on Mars," says Young.

Student Scientists Make Big Contributions

The group's accomplishments are all the more impressive because, unlike most of the mission teams, it's comprised almost entirely of

students, including Tufts undergraduates.

Jason Kapit is a three-year Phoenix team member who is working on his M.S. in mechanical engineering from Tufts after graduating with a degree in engineering physics in 2006. "What students get to do at Tufts is pretty cool," he says. "This is a research university but small enough for anyone to get involved in exciting projects." So passionate is he about the project that on spring break 2007 he went to Denver to see the actual Phoenix Lander at Lockheed Martin. "It was like Christmas morning for me. I was so excited the night before, I couldn't sleep."

Shake and Bake, Rock and Roll

As launch day drew closer, the team was busy tweaking experiments. Everything needs to pass muster under the severe shake and bake and rock 'n roll conditions of launch, landing and the Red Planet itself.

The Lander will operate about three months after it touches down on Mars, providing plenty of live data for the project team to analyze and interpret. But Kounaves and Young are looking at the mission through a much longer lens. "Space exploration ultimately will be essential to our survival as a species," says Young. "Eventually, we're going to have to move on from Planet Earth."

The 2007 Phoenix Mars Mission is the first in NASA's "Scout Program." The Phoenix was one of 30 proposals submitted to NASA in 2002. Kounaves was a member of the winning proposal, selected in August 2003, and initially funded by NASA for $325 million. He is currently the principal investigator or co-principal investigator on three other NASA-supported research projects, including one to try to understand how to definitively detect microbial life on planets.

"There is nothing more intellectually satisfying as an educator and

scientist," says Kounaves, "than being on the cutting edge of discovery, of using the scientific method to expand human awareness of who we are, where we came from, and perhaps where we can go."

Source: Tufts University