Phoenix Lander Will Dig for Ice At North Polar Region of Mars

by Marsha Freeman

The polar regions of the Earth are the least hospitable on this planet; the same is true for Mars. Springtime temperatures there vary between –100°F (–38°C) and –28°F (–2°C) at Mars' equivalent to our Arctic Circle. Frozen soil is mixed with ice, similar to permafrost. During Winter, carbon dioxide and water vapor condense from the atmosphere, covering the surface with frost.

All previous spacecraft that have been successfully sent to Mars have landed near the equator, in a more benign environment, and within easier reach of the Earth. Why, then, send a spacecraft to the North Pole?

Since the earliest observations of Mars were made with Earth-based telescopes, it has been known that there are caps of frozen volatiles at the North and South Poles of the planet. They are composed of water ice and frozen carbon dioxide. These are the most dynamic regions of the planet, and the character of the poles changes, as the seasons change over the course of a Mars year, or 687 Earth-days.

Investigating the history of water on Mars will open an important window into the history of the geology, climate, chemistry, and any past or present life, on the planet. The discovery of life in extreme environments on Earth, including in lakes under the ice of Antarctica, has energized the search for evidence of life on Mars. By doing these first *in situ* experiments in the Martian soil and ice, data from the Phoenix lander, launched on Aug. 4, will create fresh insight into the development of Mars, and the Solar System, as a whole.

NASA/JPL-Caltech/IA/Lockheed Martin

The Phoenix lander, which stands 2.2 meters tall, supports an array of laboratory instruments to see, touch, "taste," and even listen to Mars. Its job is to investigate the current and past history of the North Polar region.

Should large caches of water ice be verified to exist just under the surface in polar regions, which make up 25% of the area of Mars, it would be possible to extract, melt, and use it as a resource for human explorers.

Until recently, it appeared that the only way a spacecraft would be able to directly study samples of ice on Mars might be to land on one of the perilous polar caps. But, in early 2002, data from NASA's Mars Odyssey orbiter contained evidence that a relatively flat arctic plain, comparable in latitude to Greenland or northern Alaska on Earth, contains high concentrations of water ice mixed with soil, just inches below the surface. Scientists began to sift through imaging data from Odyssey and Mars Global Surveyor, covering 65-72° North latitude, looking for possible landing sites.

Their first choice was an area between 120-140° East longitude. But high-resolution images from NASA's Mars Reconnaissance Orbiter last year, showed that this region was characterized by clustered boulder fields. The search continued.

Nighttime infrared imaging provided information about rock size in the region, by observing the rate of heat loss in the rocks after sundown. An arctic region further east was found, with fewer rocks. The favored site is at 68.35° North latitude, in a shallow valley called Vastitas Borealis Marginal. Phoenix is scheduled to land there on May 25, 2008.

Is Mars Fit To Support Life?

The scientific objectives of the Phoenix missions are: to study the history of water on different time scales; to determine if the soil could support life; and to study Martian weather at the dynamic poles.

Billions of years ago, when Mars was warmer and wetter, the shallow plain where Phoenix will land may have been a sea. Tens of thousands to a few million years ago, the ice that is near the surface today might have periodically thawed, during warmer climatic periods. Dramatic climate changes on Mars are a result of the changes in the tilt of the planet's axis, from 10°, to the current 25°, to up to 40°. In addition, the ellipticity of the orbit of Mars changes on a 50,000-year cycle, dramatically changing its distance from the Sun. The arctic ground also "breathes" every day and each season, creating melting/freezing cycles at the poles, raising and lowering the ice table.

Phoenix will investigate the history of water at the pole, over these time scales. A 7.7-foot-long robotic arm will scrape the surface, uncovering historic ice and soil layers down to 20 inches, and will deliver tiny samples to miniature laboratories on the lander. A meteorological station will monitor changes in the water at the poles, moment-to-moment.

The Thermal and Evolved-Gas Analyzer (TEGA) will heat pinch-sized samples of subsurface soil, revealing the transition points from solid to gas, which vary by element. The gases will be examined by a mass spectrometer to identify their chemical composition. TEGA will measure the different isotopes of carbon, oxygen, hydrogen, and other elements. Isotopic ratios can change over time, through processes that act preferentially on lighter or heavier isotopes of elements, which can reveal the age of the water ice found in the soil.

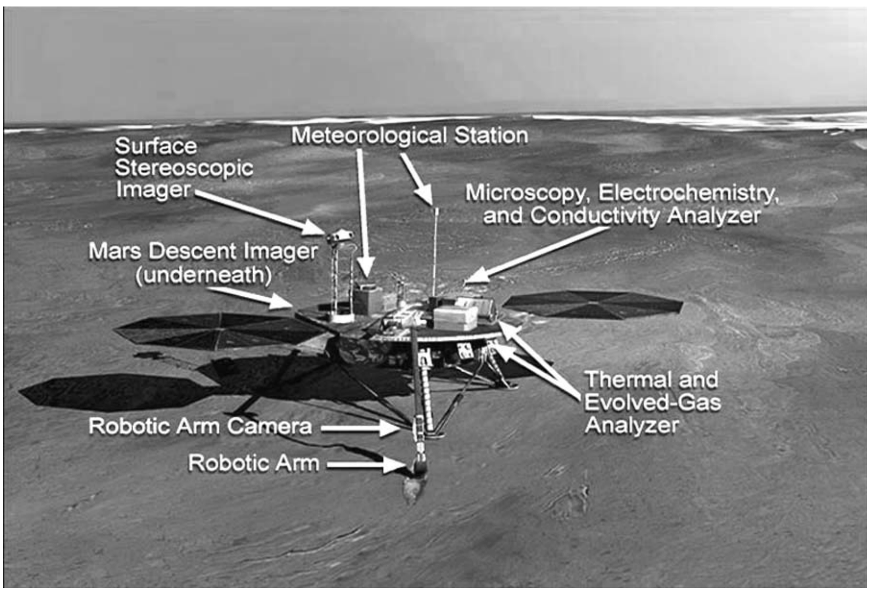
Phoneix is not designed to search for life on Mars, but for the footprints that living organisms may have left behind. TEGA will examine up to eight samples of Martian soil, to look for organic, or carbon, molecules. Other instruments will also characterize the soil, the way a farmer might, which will not only aid in discovering Mars' history, but its fitness to support life in the future.

A wet chemistry laboratory will mix water with the soil samples, into a soupy consistency, and reveal the pH of the soil. Sensors will gauge concentrations of ions that form water-soluble salts, such as chlorides, bromides, and magnesium.

An optical microscope, which will be able to image features 1/100 the width of a human hair, will reveal the shapes and size distributions of soil particles, which tell scientists about the conditions the material has been exposed to, including the action of water. The Surface Stereo Imager, mounted on the mast of Phoenix, will provide high-resolution color, stereo images of the terrain, providing the context for *in situ* data.

Technology used in commercial soil-moisture gauges for irrigation systems, has been adapted to examine the electrical and thermal conductivity of the soil. Heat conductivity measurements will indicate the presence of ice in the soil, and electrical conductivity measurements are a sensitive indicator of soil moisture.

The primary mission for Phoenix is intended to last 90 days. As the season on Mars changes from Summer to Fall, and the temperature drops, carbon dioxide will condense from the atmosphere, encasing the lander in frost. The Martian Winter Sun will provide decreasing amount of energy for the spacecraft's solar panels, which will also become covered with dust. Scientists expect, however, that the three-month mission will be more than enough time to reveal more of the past and current history of the Red Planet.



NASA/JPL-Caltech/University of Arizona

This artist's concept depicts the Phoenix Mars lander just before touchdown near the North Pole, on May 25, 2008. It will be the first powered landing, using on-board engines, since the Viking mission in 1976.