Evidence Mounts For Water on Mars

by Marsha Freeman

The multi-year, multi-national effort that is under way to uncover the mysteries of the planet Mars made a great stride on March 1, when the initial results from NASA's Mars Odyssey spacecraft were released to the public during a briefing at NASA's Jet Propulsion Laboratory. After Odyssey had been collecting data for less than two weeks, the team of investigators responsible for the instruments on the spacecraft revealed that there is probably a substantial amount of water ice on Mars, in places that will be accessible for human use.

Scientists have known for decades that there is water ice on the surface of the poles of Mars, but much of that sublimes into the atmosphere during the Martian Summer. The new data indicates that there are concentrations of ice at 60° South latitude, which is far enough away from the frozen South Pole to be a resource for a landing party, and it is most likely permanently frozen into the soil, similar to permafrost on Earth.

There is no way that Odyssey can "see" ice on or near the surface of Mars from orbit, but it can measure the amount of hydrogen in the soil. There is no way to account for the presence of significant amounts of hydrogen, except that it is in the form of water ice.

Two of the methods being used now, to determine the elemental composition of the soil on Mars, were employed previously by the Lunar Prospector spacecraft. In 1998, investigators for that mission announced that its gamma-ray spectrometer and neutron spectrometer had found evidence of water ice at both the North and South Poles of the Moon. These results were dramatic and somewhat unexpected.

In the case of Mars, there is ample evidence that water was once plentiful, and even hints that at least small amounts came to the surface in the not-too-distant past. But the bodies of water that appear to have rested on the surface in millennia past, have disappeared. There is hope, and now some evidence, that a fair share resides in the soil, and perhaps even in underground aquifers.

The Signature of Hydrogen

Aboard Odyssey is a suite of three instruments, collectively known as the Gamma-Ray Spectrometer (GRS). Included in the GRS is the Gamma Ray Sensor, the Neutron Spectrometer, and the High-Energy Neutron Detector. As their names indicate, these instruments are detecting hydrogen (and other elements) indirectly, through its interaction with other particles.

When cosmic rays, which are very energetic and mostly protons, encounter an object such as Mars, they collide with the nuclei of the atoms that make up the surface of the planet. The collisions generate several other, secondary particles, in a process known as spallation.

These secondary particles are mainly neutrons and other protons, and, like the cosmic rays themselves, have very high velocities. They, in turn, undergo collisions, generating more particles, creating a cascade of protons and neutrons in the upper layers of the soil. When these secondary neutrons collide with the nuclei of other atoms, they lose energy, slow down, and eventually become thermalized, moving at speeds comparable to that of other atoms on the surface of Mars.

Once the neutrons are thermalized, other atoms, including hydrogen, can absorb them, and when they do, they immediately emit a gamma ray. The Gamma Ray Spectrometer on Odyssey measures these emitted gamma rays, and can discern those that are characteristic of an absorbing hydrogen atom.

The second method involves the Neutron Spectrometer and the High-Energy Neutron Detector. These two instruments detect neutrons and determine their energy levels. Hydrogen has an exceptional ability to moderate the velocity of neutrons, so where there is a high concentration of hydrogen present, the neutrons will be slowed to thermal velocities, and there will be relatively few fast (higher-energy) neutrons.

These instruments aboard Odyssey indicate that there is a significant amount of water ice—perhaps several percent—in the surface soil, and up to a meter underneath. Areas as far north as 60°S (90°S latitude being at the pole) showed this hydrogen concentration.

Stressing that Odyssey will be orbiting Mars for two years, Dr. Jim Gavin, lead NASA scientist for the multi-mission Mars Exploration Program, stated, "These preliminary Odyssey observations are the tip of the iceberg of the science results that are soon to come, so stay tuned."

Dr. Steve Saunders, Odyssey project scientist, stated, "Now we may actually see water rather than guessing where it is or was. And with the thermal images we are able to examine surface geology from a new perspective." He was referring to images taken by Odyssey's Thermal Emission Imaging System, which allows nighttime images to be taken in the infrared, measuring the amount of heat emitted by the soil, and by objects on the planet.

Because different materials on the surface cool at night at varying rates, Themis was able to image underground rocks, which retain their heat longer than the Martian soil. Themis will also be able to detect thermal anomolies coming from the Martian interior, such as possible dormant volcanoes that may still have hot springs, reworking our knowledge of the geology of Mars.