Mars Surface Mineralogy

Doug W. Ming, Johnson Space Center
Richard V. Morris, Johnson Space Centers

The theme of the Mars Exploration Program is to "follow the water," which has important implications in the search for life, climate evolution, evolution of the martian surface and interior, and preparing for human exploration. The two Viking Landers discovered small amounts of water (1–2 wt.%) in the surface materials, however, it is not known how the water is incorporated into these materials. Recently, Mars Odyssey results showed that water in the form of ice may be very near the surface, about 20–30 cm below the surface, at high latitudes above 60 deg. Again, we do not know how the water is incorporated into these materials (ice, adsorbed water, structural water). Doug Ming, Dick Morris, and Vern Lauer are conducing research on the thermal and evolved gas behaviors of Mars analog materials, such as minerals and "soils."

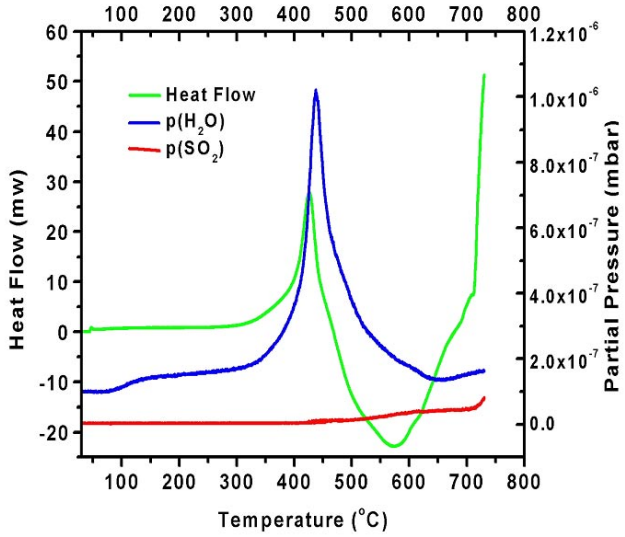
Our current research tasks are:

- To determine the thermal and evolved gas behaviors of Mars analog minerals at Earth-ambient and Mars-like surface pressures.
- To determine the thermal and evolved gas analysis of Mars analog "soils" from near the summit of Mauna Kea Volcano in Hawaii.
- To develop a thermal and evolved gas dataset in support of the Mars Exploration Program.

Results obtained from this proposed effort will provide important implications on the nature of water and other volatiles, such as carbon dioxide and sulfur dioxide, in martian surface materials and will provide viable geologic pathways for their formation. Thermal and evolved gas behaviors of Mars analog materials will also provide critical "feed forward" information on the possible mineralogy and chemistry of Mars surface "weathering" phases that will enhance the planning for instruments and investigations on future Mars robotic missions—Phoenix Mars Scout in 2007 and Mars Science Laboratory in 2009.

One way to understand the chemical and mineralogical composition of Mars and the processes that brought them to their current state is to study martian analog samples from other planetary bodies. Morris and Ming are conducting analog studies on samples from the Island of Hawaii and on samples from the Moon.

Based on studies of martian meteorites and direct analysis of martian surface materials by Viking and Pathfinder landed instruments, the surface of Mars is basaltic in composition. The Island of Hawaii also has a basaltic composition, and analysis and identification of primary, aqueous, and hydrothermal alteration phases found there provide a template for identification of those phases on Mars. Because the elemental and mineralogical composition of basaltic alteration products



Thermal behavior and evolved gas concentrations during heating of a Mars analog material.

Mars analog materials on Hawaii.

depends largely on the specific nature of alteration processes, the analog samples also provide information about the type and timing of alteration processes on Mars. Certain lunar samples have mineral assemblages that are more similar to martian meteorites than natural terrestrial samples, especially with respect to the mineral pigeonite. Because aqueous alteration has not taken place on the Moon, lunar samples are a "Mars without water" zero-point for martian alteration processes.