LANDER DETECTION AND IDENTIFICATION OF HYDROTHERMAL DEPOSITS. M. L. Urquhart$^1$ and V. Gulick$^2$. $^1$NRC/NASA Ames, MS 239-20, Moffett Field, CA 94035 (murquhart@mail.arc.nasa.gov), $^2$SETI Inst./NASA Ames, MS 239-20, Moffett Field, CA 94035 (vgulick@mail.arc.nasa.gov).

**Introduction:** The role of hydrothermal activity on Mars in altering crustal materials and sequestering volatiles is a critical component in understanding the interactions between the atmosphere, surface, and hydrosphere of Mars. In turn, these interactions are key elements in understanding the martian climate history, surface geology, and potential for past life on Mars. Identification of hydrothermal deposits at the surface of Mars, especially within a region in which the geologic context is clear (e.g. a volcanic region such as a Apollinarius Patera), would provide valuable information about the geologic history of the planet, and would be indicative of a potential site for the search for evidence of life on Mars.

Specific hydrothermal mineral assemblages will be dependent on the environmental conditions under which the country rock was altered. Mini-TES, however, has the capacity to identify a wide range of alteration products, and Mössbauer Spectrometer will be able to identify both altered and unaltered iron-bearing bearing minerals, and will yield information on the environment in which iron oxidation has occurred. The instruments on the 2003 rover will have the capability to identify hydrothermal deposits present at the surface of the landing site, potentially yielding information about the nature of the environment in which hydrothermal alteration occurred.

**Environments of interest:** Sites where hydrothermally produced minerals may be present at the surface range from volcanic regions and impacts craters to sites of ground water outflow channels and smaller water-carved features such as gulleys. In some terrestrial environments where the bulk of hydrothermal activity occurs in the subsurface, the surface expression of alteration products such as carbonates may be minimal in comparison with the overall extent of the region hydrothermal activity. Such is the case of Yellowstone's Mammoth Hot Springs [1]. The release of ground water may also carry alteration products onto the surface, or exposed rock may contain veins of altered minerals. Hydrothermal deposits may be located at sites where their presence was not detected from orbit.

**Identification of hydrothermal vs. other aqueous alteration products:** Mini-TES will be able to identify a wide variety of alteration products including carbonates, salts such as sulfates and phosphates, silicates, oxides, and hydroxides. Some minerals resulting from water-rock interactions, such as carbonates, may be produced by both hydrothermal activity and surface aqueous environments such as paleolakes. However, other minerals such as large-grain hematite and quartz [2] are indicative of hydrothermal activity, and can be identified by Mini-TES. The Microscopic Imager may provide contextual information about the minerals within individual rocks, such as the presence of mineral veins indicating water circulation. The Mössbauer Spectrometer can distinguish between individual iron minerals that form in different environments. The data gathered by these instruments will not only have the potential to distinguish between mineral assemblages of...
DETECTION OF HYDROTHERMAL DEPOSITS: M. L. Urquhart and V. C. Gulick

...a hydrothermal or surface aqueous origin, but may also give valuable information about the environments under which hydrothermal alteration occurred.

**Future Work:** We are beginning an investigation of the mineralogies which could be produced by hydrothermal activity on Mars in a variety of environments including volcanic and impact produced hydrothermal systems. Our investigation will include both a comparison of potential Mars environments with terrestrial analogs and a theoretical approach. We will build upon the work of Griffith and Shock [2] who used an aqueous geochemical equilibrium model, EQ3/6, [3] to determine alteration products from a parent rock such as basalt for a range of environmental conditions, each representing a single alteration event. We will use these altered mineralogy as starting points for the same geochemical model, with a new set of environmental conditions. This will serve to simulate changes in the environment within a hydrothermal system. We will examine the effect of different environments and multiple changes in the environment on resulting mineralogies in order to predict mineral assemblages which may be present on the martian surface as well as in the subsurface.

**Application:** Examining the effect of changing environmental conditions on types of Mars hydrothermal deposits will aid in the search for mineral evidence of long-term or vigorous hydrothermal activity, and potentially the search for evidence of life on Mars. The identification of large-grained hematite by the Thermal Emission Spectrometer (TES) [4], a common terrestrial hydrothermal alteration product shows that hydrothermal deposits are present on Mars. Hydrothermal systems provide environments in which life may have existed under Mars conditions [5]. If the identification of hydrothermal deposits indicative of long term hydrothermal activity can be located by the 2003 rover or its successors on future Mars missions, then NASA can make a closer examination of the region containing the deposits in its mission to search for evidence of ancient life on Mars.