Mass Spectrometer for Mars Phoenix Lander

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The Phoenix Mars Scout Mission is the first of the PI directed low cost missions to Mars. It was selected by NASA for the August 2007 launch opportunity. This mission is a lander that will advance the NASA theme for studying the planets, called "Follow the Water". The landing site for Phoenix will be near 70 degrees north, in the region that the Mars Odyssey orbiter neutron spectrometer has observed a large excess of hydrogen. Interpretation of that data suggests a large quantity of water ice exists just below the surface, possibly in the range of 10 to 20 cm down. One of the lander instruments is an arm with a scoop that can dig a trench up to a meter deep in the surface of Mars to look for water ice and water bearing minerals. Selected samples from the trench are brought to the Thermal Evolved Gas Analyzer (TEGA) that consists of, a), a set of 8 small ovens that can heat the samples, first to melt any ice contained in them, then heat the residue to1000 degrees C to decompose the minerals, and, b), a small mass spectrometer that analyzes the effluents from the ovens to determine the presence of water and identify evolved gases, possibly hydrocarbons, as well as define the mineralogical composition of soil samples. Isotopic ratios of the principal elements in the samples will be determined and compared to the isotopic ratios of the atmospheric gases, also measured by the mass spectrometer. A gas enrichment cell is included that takes samples of the atmosphere, removes the active gases, carbon dioxide and nitrogen, thereby enriching the abundances of the noble gases by 1 ½ orders of magnitude in order to improve the accuracy of their isotopic ratio measurements. Humidity of the atmosphere will also be measured. The oven section of the TEGA instrument was developed by the Lunar and Planetary Laboratory of the University of Arizona. The mass spectrometer, developed by the University of Texas at Dallas, is a magnetic sector instrument having 4 mass channels that cover the range from 1 to 140 Da. Four electron energies ranging from 90 to 23 eV are available to vary the cracking patterns of complex molecules. Ions are detected by ceramic electron multipliers that feed pulses to a preamp-counter that has a dynamic range of 6 decades. Two electron emission current levels extend the dynamic range to 7 decades. Data storage is in the central electronics module for periodic transmittal to earth via Mars orbiting spacecraft relay. Operation of the MS is controlled via daily commands from earth. Modes include full sweeps of the mass range and hop modes wherein 7 closely spaced (in delta M) count accumulations are taken running over the top of a selected peak. A curve fit routine determines the peak amplitude. This mode is used for isotopic ratio determination by hopping between 2 or 3 mass peaks multiple times. Calibrations have been done with Mars analogs and simulated atmosphere gas mixtures.