THE MARS ODYSSEY MISSION, TWO MARS YEARS OF OBSERVATIONS. D. A. Senske, J. J. Plaut and the Mars Odyssey Science Teams, Jet Propulsion Laboratory/California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA, 91109, dsenske@jpl.nasa.gov.

Introduction: In August of 2006, Mars Odyssey will complete its first extended mission. Since science data collection commenced in February of 2002, observations will have spanned over two Mars years. The results from the THEMIS, GRS and MARIE/MRME investigations continue to significantly advance the understanding of Mars and its environment.

The overarching objectives of the Odyssey Mission are fourfold:
- Generate a global picture of the abundance and distribution of elements making up the surface of Mars
- Generate a global picture of the surface mineralogy, geomorphology and thermophysical properties of Mars
- Provide an understanding of the distribution of water ice via the proxy of measuring the distribution and abundance of hydrogen
- Provide an understanding of the Martian radiation environment and its variability as a function of time

The first extended mission has expanded on these goals, by (1) Significantly enhancing the data sets already acquired in the prime mission by extending temporal and spatial coverage; (2) Enabling new types of observations through operating the instruments and the spacecraft in new and innovative ways; (3) Providing operational support for critical phases of future missions, such as communications relay, landing site characterization, and atmospheric monitoring for aerobraking; (4) Involving additional students and scientists in data collection and analysis; and (5) Establishing Odyssey’s role as a long-term asset in the scientific and operational infrastructure at Mars.

THEMIS Results: The THEMIS instrument provides thermal infrared (IR) multispectral observations in 9 wavelength bands at a ground sample of 100-m/pixel and visual images in up to five colors at a ground sample of 18-m/pixel. Daytime infrared mapping is now at 97% coverage while 85% of the surface has been observed at least twice in nighttime infrared for thermal change detection. Visible mapping is now at 39% coverage with 17% of the surface having been imaged at a resolution of 18-m/pixel. These data sets provide a basis for broad geologic analyses. Compositional mapping has demonstrated the presence of a wide diversity of igneous materials whose range in composition is comparable to that found on the Earth. Volcanic processes have produced compositions from low-silica basalts to high-silica dacite in the Syrtis Major caldera [1]. The existence of dacite demonstrates that highly evolved lavas have been produced, at least locally. In addition, quartz-bearing granitoid rocks have also been discovered in two 30-km-diameter craters on the northern flank of the Syrtis Major volcanic construct [2].

A major result from the infrared data is the discovery that the physical and compositional properties of layered rock units can vary. This suggests temporal changes in the process or environments that formed the different units [3]. Specific examples of these thermally distinct units can be found in Terra Meridiani [4,5].

During both the prime and first extended mission, dedicated campaigns to image the Polar Regions in both the visible and IR have been performed. These data, collected during the spring/summer season, provide a basis to monitor interannual variations with specific emphasis on the CO₂ frost cycle.

GRS Suite Results: The GRS suite is made up of the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS) and the High Energy Neutron Detector (HEND). The primary objective of the GRS instrument is the map the distribution of key rock forming elements. Data currently gathered is sufficient to map H, Si, Fe, Cl, K and Th. These elements have allowed the assessment of the abundance of water—Water Equivalent Hydrogen (WEH; also measured by the Neutron Spectrometer) [6], the distribution of important rock forming elements [7] and an evaluation of the early differentiation and evolution of the bulk elemental composition of Mars [8].
In the extended mission, detailed maps of WEH derived from the NS are being analyzed in association with morphologic data to better understand the relation between the geology and hydrogen anomalies--especially in the martian equatorial region.

Study of the Mars surface-atmosphere interactions are being performed by the entire GRS suite. These data provide a means to monitor the CO$_2$ cycle, facilitating assessment of variations between Mars years. In addition, data from the Gamma Ray instrument show an enrichment of the Argon over the poles during the winter [9].

**MRME Results**: in October of 2003, a Solar Particle Event (SPE) permanently disabled the MARIE instrument. Subsequently, proxies for MARIE charged particle data from the GRS suite (GRS and HEND) have been used to extend the radiation monitoring capability of Odyssey without MARIE. Although, neither of these instruments can provide the detailed spectral information that MARIE could, both can be used to monitor the overall rate of Galactic Cosmic Rays (GCR), and hence to observe the flux modulation as the solar cycle progresses. Both are also useful as rate monitors during SPEs.

**Plans for Odyssey’s Second Extended Mission**: Preparations are now underway for a second Odyssey extended mission. For the THEMIS investigation, this period of science activity will include, filling gaps in the IR and visible maps (facilitated in part by a new mode of spacecraft operation where Odyssey is rolled off of nadir); implementing a new data summation mode in which global, continuous, atmospheric monitoring data can be collected; and exercising a new operating mode to perform autonomous onboard data analysis. For the GRS suite, extension to a third winter season will provide an opportunity to monitor the buildup and decay of both polar caps under differing weather patterns and dust conditions. Comparison with predictions of frost build up by different Mars Global Circulation Models (MGCMs) will allow refinements of these models and provide a better understanding of the many assumed physical parameters that are required by these codes. The continued monitoring of the Mars radiation environment via the MRME investigation will provide information on long-term patterns over the entire solar cycle.

Near the end of the second extended mission, it is planned to begin moving the local solar time from its current 5:00 P.M orbit to a near 3:00 P.M. orbit. This will allow the collection of high quality THEMIS IR data for mineralogical mapping.

**Conclusions**: Significant spacecraft resources will remain after completion of both the first and second extended missions. Thus, continued operations and science operations may be possible for an extended period of time. As such, the Odyssey Project Science Group (PSG) has formulated a strategic plan, encompassing science objectives that can take full advantage of the spacecraft capability for years to come.