



Distribution of hydrated minerals in the north polar region of Mars

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[1] The previous discovery of extensive deposits of hydrated minerals in Olympia Planum in the north polar region of Mars by the Mars Express OMEGA instrument raises important questions about the origin and subsequent redistribution of these hydrated minerals. Here we present a new map of the distribution of hydrated minerals within the north polar region of Mars by applying both standard and new spectral analysis techniques to near-infrared spectral data from OMEGA. Our results are in agreement with the previous OMEGA observations but also show more extensive detections of hydrated minerals throughout the circumpolar plains, as well as new detections of hydrated minerals on the surface of Planum Boreum and within the polar troughs. We find that while the circumpolar plains hydration signatures appear to be correlated with the dark dunes of the north polar erg, hydration signatures in Planum Boreum instead appear to be correlated with the north polar veneers and their sources within the polar layered deposits. By applying laboratory-derived empirical models of the dependence of gypsum spectra on grain size and abundance, we provide approximate abundance estimates for the hydrated minerals we have identified in Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA) and Compact Reconnaissance Imaging Spectrometer (CRISM) data. We find that the presence of hydrated minerals throughout the north polar region suggests (1) a complex cycle of sediment exchange between the Olympia Planum dunes and the other polar units; (2) an earlier origin for the hydrated minerals than originally postulated; and (3) the occurrence of significant water activity in this region during the Amazonian.

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1. Introduction

[2] The north polar region of Mars is situated at the lowest elevation within a basin that encompasses much of the northern hemisphere, making it an ideal place for the potential deposition of outflow channel fluids and sediments [Fishbaugh and Head, 2000; Tanaka, 2005; Tanaka et al., 2008]. Today, dark-toned sedimentary structures dominate the nonice regional geology. Dark-toned sediments make up the large, aeolian dune fields and sand sheets in the circumpolar plains (the north polar erg) between about 75°N and 85°N (Figure 1) [Tsoar et al., 1979; Thomas and Weitz, 1989; Lancaster and Greeley, 1990], while on Planum Boreum, dark-toned sediments are present within the polar layered deposits and on the surface as water ice-free, low-albedo surfaces, classified as the north polar veneers [e.g., Rodriguez et al., 2007; Tanaka, 2005; Malin and Edgett, 2001]. Evidence

in the region for large, aqueous outflows from the ice cap [Fishbaugh and Head, 2002], volatile-driven resurfacing [Tanaka et al., 2003; Wyatt et al., 2004], and water-equivalent hydrogen contents of the subsurface in excess of 30% by mass [Feldman et al., 2004] suggest that, in addition to aeolian processes, surface or groundwater may have played a role in the formation and modification of these deposits. Consequently, the composition, morphology, and current physical state of the dark-toned sedimentary deposits may give insight into surface deposition and modification processes in the north polar region, throughout, or even prior to, the Amazonian.

[3] Results from the Mars Express spacecraft's Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (MEx/OMEGA) near-IR imaging spectrometer investigation [Bibring et al., 2004] have indicated the presence of extended deposits of hydrated calcium sulfates in the Olympia Planum region [Langevin et al., 2005a], possibly implying an important role for surface or near-surface water in the alteration of the dune materials. Langevin et al. [2005a] proposed that the observed hydrated calcium sulfates are gypsum ($\text{CaSO}_4 \bullet 2\text{H}_2\text{O}$) on the basis of comparison with spectra taken by OMEGA during ground calibration. Gypsum can be formed in a variety of environments, but in general, gypsum formation requires a source of sulfur and H_2O (in the liquid or gas phase) interacting with Ca-bearing minerals. Langevin et al.

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