A GLOBAL VIEW ON THE MINERALOGICAL COMPOSITION OF DARK DUNES ON MARS

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Introduction: The Martian fine-grained dark material is analyzed by focusing on a global selection of about 70 impact craters. These craters are of interest because the aeolian transported material is frequently trapped in these craters and accumulates on their floors into huge dune fields such as barchan or transverse dunes. For this study we selected multiple occurrences of intra-crater dark material including single dunes, huge dune fields, and thin sand sheets.

In previous works we analyzed the dark dunes regarding their surface condition by using THEMIS night-time brightness temperature and TES thermal inertia. These investigations revealed that a portion of the dark dunes have supposed consolidated surfaces, while other dune surfaces consist of loose material [1]. Here we examine whether the mineralogical composition of consolidated dunes differs from the one of the unconsolidated dune surfaces. Furthermore we want to know if there is any correlation between the mineralogical composition of the dark dunes and their geographical location.

Analysis: The mineralogical composition of the dark material was examined by using near infrared spectra from the OMEGA spectrometer [2] on MarsExpress. For every location, we analyzed at least two different OMEGA orbits. These data were corrected for solar irradiance and atmospheric absorptions. The mineral detection was done using an IDL routine that applies a rationing technique on the geometrically and atmospherically corrected OMEGA data. The applied rationing technique was developed and described in detail by [3]. The spectral parameters used for the mineral detection were also derived from [3]. They include the typical absorption features for every mineral of interest. Using these different spectral criteria, the distribution of high- and low-calcium pyroxenes, olivine (forsterite and fayalite) and hydrated minerals are studied. This technique provides the corresponding absorption depths for every type of mineral as shown in figure 1 and 2 exemplary for pyroxene and olivine in Reuyl and Dawes crater, respectively.

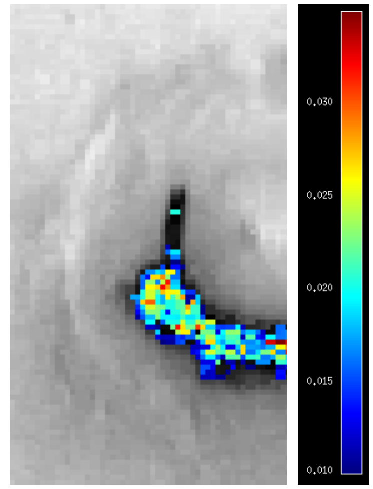

Fig. 1: Mapping of pyroxene in Reuyl crater (OMEGA orbit 2436_3) inferred from the depth of the 2-µm band.

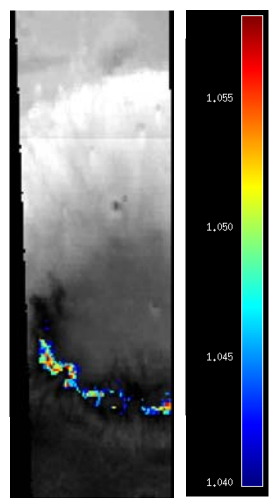

Fig. 2: Mapping of olivine (forsterite) in Dawes crater (OMEGA orbit 2386_4) inferred from the 1-µm band.

Results: The global mineralogical distribution of the dark dunes is shown in figure 3. As already known from multiple former studies [e.g. 4, 5] the analysis yields a higher content of mafic unoxidized minerals such as pyroxenes and olivine. Most of the dark intra-crater deposits show strong pyroxene absorptions. The minor part has olivine absorptions, whereas forsterite occurs in most cases. Until this point, no mineralogical difference between unconsolidated and consolidated dunes could be identified. There is also no correlation between the mineralogical composition and the geographical location recognizable. The presence of pyroxene and olivine indicates that these unoxidized materials were not affected by aqueous weathering. Thus, mechanical weathering could be the major process that caused the comminution of the material [6].In some places, we confirm the report of [7] that a portion of the dark material shows absorption features of hydrated minerals indicating that the material has partly underlain a chemical alteration process. The hydration might have been caused by the supply of water, e.g. by melting H_2O-frost layers. There is no obvious correlation between hydrated minerals and consolidated dune surfaces. However, it is notable that the detection of hydrated minerals concentrates in craters located in Arabia Terra which are described by [8]. Although there is no correlation between the detected mineralogical composition and the dune surface induration, it can not be excluded that the surface consolidation might correlate to any other minerals which could not be detected by OMEGA.

Outlook: In some crater walls, there are dark layers recognizable which have the same false color as the dark material inside and thus, might be of the same composition. Unfortunately, OMEGA's spatial resolution limits the possibility to analyze very small-scale morphological features. Thus, for the mineralogical analysis of the dark layers exposed at the crater walls CRISM data with a higher spatial resolution (of up to ~18 m/px [9]) shall be considered in further works. If these layers show the same mineralogical composition as the material inside of the crater, this could be evidence that the layers might be a local source for the intra-crater dune fields.

References: [1] Tirsch, D., et al. (2007), *LPSC XXXVIII*, Abstract #1596. [2] Bibring, J.P., et al. (2004), *ESA SP 1240*, 37-49. [3] Poulet, F., et al. (2007), *JGR 112*, doi: 10.1029/2006JE002840. [4] Bandfield, J.L. (2002), *JGR 107*, doi: 10.1029/2001JE001510. [5] Bibring, J.-P. (2001), *SSR 96*, 293-316. [6] Jaumann, R. (2006), *LPSC XXXVII*, Abstract #1735. [7] Poulet, F. (2005), *Nature 438*, 623-627. [8] Edgett, K.S. (2002), *JGR 107*, doi: 10.1029/2001JE001587. [9] Murchie, S. (2003), *6th Int. Conf. on Mars*, Abstract #3062.

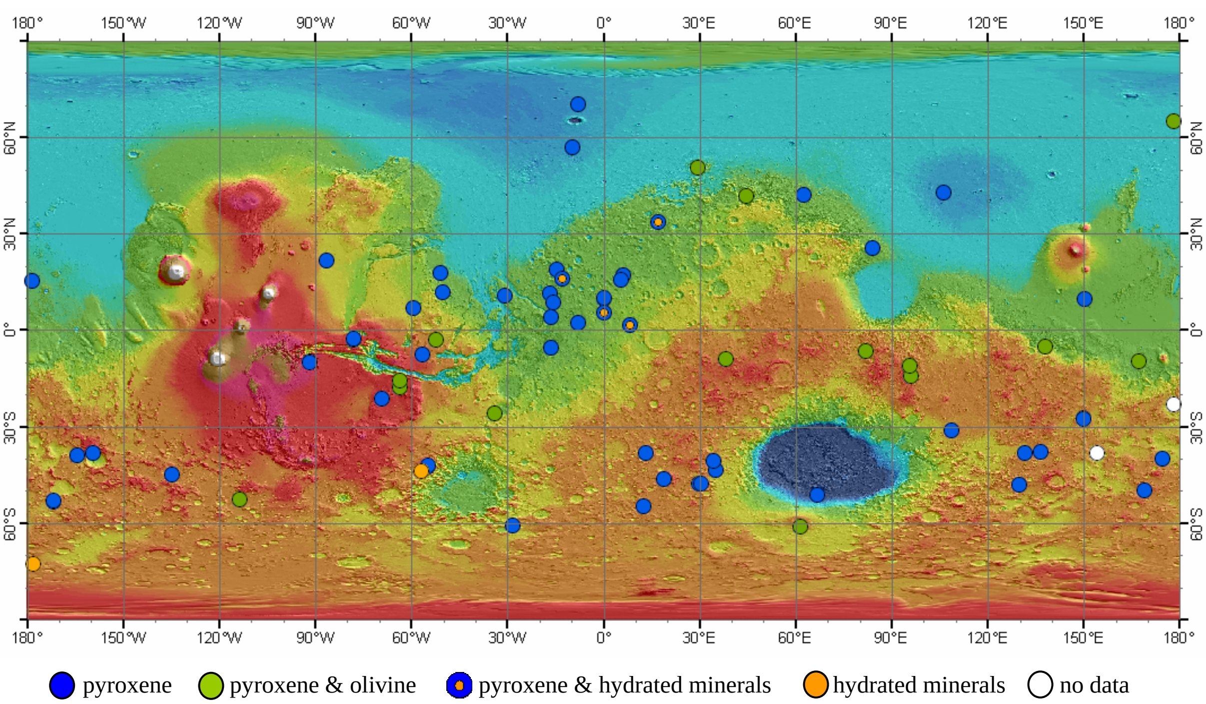

Fig. 3: Global distribution of studied craters with their associated composition.