DARK LAYERS AS LOCAL SOURCES FOR THE DARK INTRA-CRATER DUNES ON MARS.

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Introduction: The conventional assumption about the relationship between the dark mafic material and depressions is that the material is blown into as well as out of the craters [1,2]. Depressions may act as sediment traps into which the aeolian material is blown to accumulate on the depression floor. Once the material is deposited on a crater floor, it may also act as a source, meaning that material is blown out or deflated, frequently in the form of wind streaks [3]. In view of the aeolian character of transport and the huge number of traps, it might appear logical at first sight that the trapping function of craters should be the main mechanism that governs the accumulation of dark material. However, HRSC images show that the material is only blown out in most cases indicating that there might be an intra-crater source. We present morphological indications and mineralogical evidence for dark layers acting as local sources for the dark dune material on Mars.

Morphological indications: Central and western Arabia Terra present good examples for regions, which look completely 'clean' of dark material upwind of the craters. The material solely appears inside and downwind of these craters, forming visible dark dunes and wind streaks. Fig. 1a presents an example of that situation in western Arabia Terra. There, it seems that the material has its origin in the craters itself. Fig. 1b shows that the floor of the bigger crater is blotched by numerous smaller craters. It is noticeable that the dark material in this crater solely appears downwind of the smaller craters. The material seems to originate from a sediment source just beneath the crater floor, which was cut by the smaller craters. MOC narrow-angle images of small craters (Fig. 1c) reveal dark layers exposed in the crater walls. Such layers can be observed in many other craters. At Rabe Crater (Fig. 2), an intra-crater pit provides illuminating insights into the morphology of the dark layers, as previously described by [4]. HiRISE images disclose dark gully-like streaks extending down-wall, indicating erosion of these dark layers and a transport of dark material into the crater's interior (Fig. 2c and 2d) [4,5].

Mineralogical evidence: CRISM spectra of dark material emanating from a dark layer exposed in the wall of a crater at Terra Sirenum (Fig. 3) exhibit obvious signatures of olivine and pyroxene. Several dark dunes are deposited just down-slope of this crater

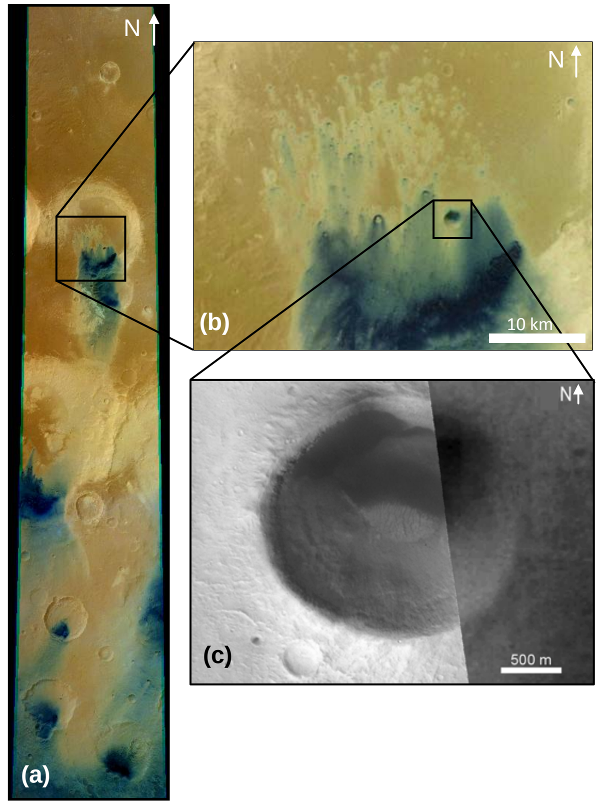

Fig. 1: Indication of craters acting as a local material source. (a): HRSC orbit 3397_0000 shows dark material deposits appearing in the craters and emanating from there. (b): Zoom into HRSC 3297_0000 showing a 62 km diameter crater near Mawrth Vallis (18.9°N, 345.5°E) and dark material emanating from smaller craters. (c): Subset of MOC R0701192 overlaid on HRSC showing a small crater comprising a dark layer exposed in the crater wall.

wall where dark material emerges from the dark layer. Spectral analyses of the dunes reveal an obvious pyroxene content. The lack of strong olivine signatures in the dunes of this crater could be an effect of a small grain size, which decreases the absorption band depth and makes it difficult to detect small olivine grains in mineral mixtures [6]. However, the concurrent mafic composition results establish a mineralogical association between the wall and the dune material. Previous analysis on the mineralogical composition of dark deposits in Martian craters by using OMEGA data revealed a similar mafic composition [7]. Accordingly, the dark layers may be supposed to be a local source of the intra-crater dune material (see also [5]).

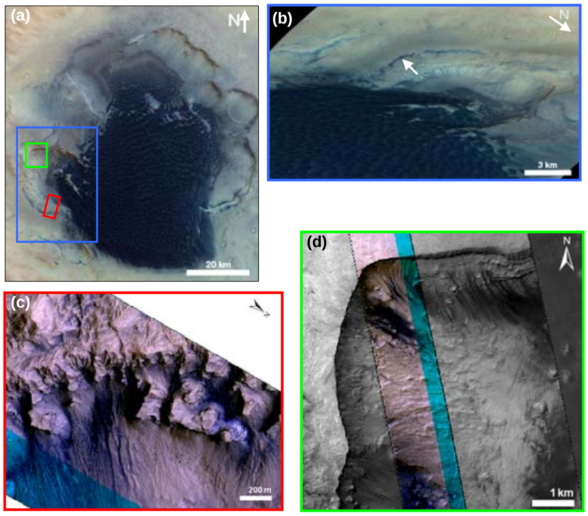

*Figure 2: Dark layers exposed in the walls of a pit within Rabe Crater. **(a)** Plan view of Rabe Crater (43.9°S, 34.8°E; HRSC color composite 2441_0000), rectangles indicate the positions of Fig. b, c, and d, identifiable by their outline colors. **(b)** Perspective view of the intra-crater pit, same HRSC orbit as Fig. a. **(c)** + **(d)** Dark material emanating from dark layers exposed in the pit wall (subsets of HiRISE color image PSP 005646_13460, in d: overlaid on red channel of the same image).*

Conclusions: Spectral analyses of the dark layers exposed in crater walls confirm the suggestion that the dark wall material and the dune material are of similar mineralogical composition. The dark layers acting as local sources for the dark intra-crater material on Mars appear in two different morphological crater-layer-relationships. The layer is either exposed on the crater wall (situation A in Fig. 4) or is located just beneath the floor of a larger impact crater (situation B in Fig. 4), which does not reach the depth of the layer. Subsequently smaller impacts on the larger crater floor cut the dark layer and result in the exposure and mobilization of the material, which is than blown out of the craters.

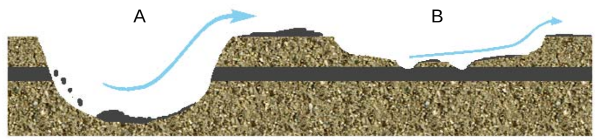

Fig.4: Crater-Layer-Relationships. Sketch of two possible cases of exposure of dark material layers indicated by multiple image data (see text for discussion).

References: [1] Christensen R.P. (1983), *Icarus*, *56*, 496-518. [2] Jaumann et al. (2006), *LPSC XXXVII*, Abstract #1735. [3] Thomas et al. (1981), *Icarus*, *45*, 124-153. [4] Fenton L.K. (2005), *JGR*, *110*, E11004. [5] Tirsch et al. (2007), *LPSC XXXVIII*, Abstract #1569. [6] Poulet et al. (2007), *JGR*, 112, doi:10.1029/2006JE002840. [7] Tirsch et al. (2008), *LPSC XXXIX*, Abstract #1693.

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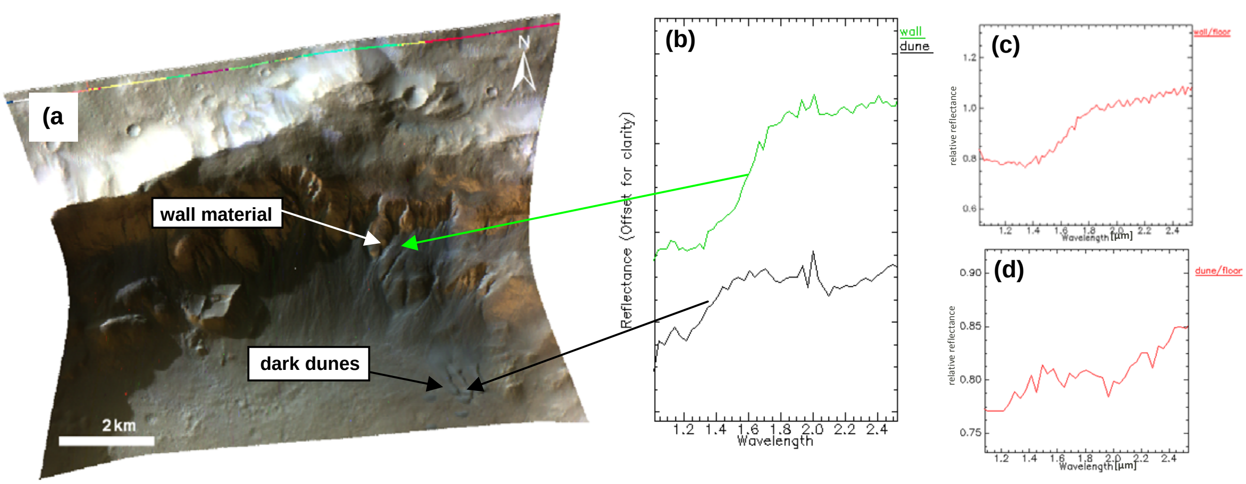

*Figure 3: CRISM spectral analysis of dark material emanating from a dark layer exposed in a crater wall. Reflection spectra of dark material emanating from the crater wall show a similar mafic composition as the dune material. **(a)** CRISM observation showing the wall of a crater in Terra Sirenum (39.3°S, 196.0°E). Green and blue arrows marks the locations where the wall and dune spectra of Fig. b were taken (CRISM FRT00003266). **(b)** Reflection spectra of wall (green curve) and dune material (black curve). The wall material curve exhibits pyroxene as well as strong olivine absorption, whereas the dune material spectrum (black curve) shows a pyroxene signature only. **(c)** CRISM spectral ratio of wall material and crater floor emphasizing the olivine signature of the dark wall material. **(d)** CRISM spectral ratio of dune material and crater floor emphasizing the pyroxene signature of the dark dune material (see text for discussion).*