ON THE SOURCES OF DARK DUNE SANDS ON MARS. D. Tirsch[1] and R. Jaumann[1,2], [1]Institute of Planetary Research, German Aerospace Center (DLR), Rutherfordstrasse 2, 12489 Berlin, Germany, (Daniela.Tirsch@dlr.de); [2]Institute of Geological Sciences, Freie Universität Berlin, Berlin, Germany.

Introduction and Background: Dark aeolian sediments can be observed almost all over Mars. They are preferably deposited as aeolian dunes on the floor of impact craters and in the north polar erg, but also as thin sand sheets and wind streaks in topographically unconfined places. The sediments are enriched in pyroxene and olivine pointing to a basaltic origin of the dune sands [1, 6]. Hypotheses of material origin include volcaniclastic sediments and volcanic ash [e.g. 1, 2], impact melts [3], and local geologic units, e.g. the Planum Boreum cavi unit [4] or the Medusae Fossae Formation [5].

In previous works [e.g. 6, 7] we have shown that the material seems to have its local source inside the depressions in the form of dark sedimentary layers exposed at crater walls or beneath crater floors – it is not blown into the craters as widely assumed. Similar intra-crater sources have also been described in Noachis Terra [8] and Amazonis Planitia [9].

In this work we present further examples of dark material emerging from local intra-crater sources and provide further spectral evidence for a mineralogical correlation between emerging material and the dune sands. The results will help to refine our view of these aeolian deposits on Mars.

Data and Methods: For feature identification HRSC nadir (12.5 m/px), CTX (6 m/px), and HiRISE (up to 0.25 m/px) image data were examined and provide a database from regional to local scale. Topographical information was gained from HRSC DTMs (up to 50 m/px). CRISM datasets with a spatial resolution of up to 18 m/px were used for the mineralogical analysis of the dark sediments.

Results and Discussion: We found numerous locations (e.g. western Arabia Terra, Noachis Terra, Terra Sirenum) where dark aeolian material emerges from distinct dark layers and is deposited as basaltic dunes nearby. The layers can be exposed at impact crater walls (Fig. 1, 2), along the scarps of channels and plateaus or are located beneath the floors of larger craters, which are blotched by smaller impacts. In the latter case the dark material emerges from these small impact craters, cutting the subsurface dark layer (Fig. 3). It is unlikely that the aeolian material has been blown into these small craters earlier because there are numerous similar craters nearby comprising no dark sand at all. These "clean" craters did not cut the subsurface layer because it is heavily degraded and fragmented. Hence it can take place that craters comprising dark sand and

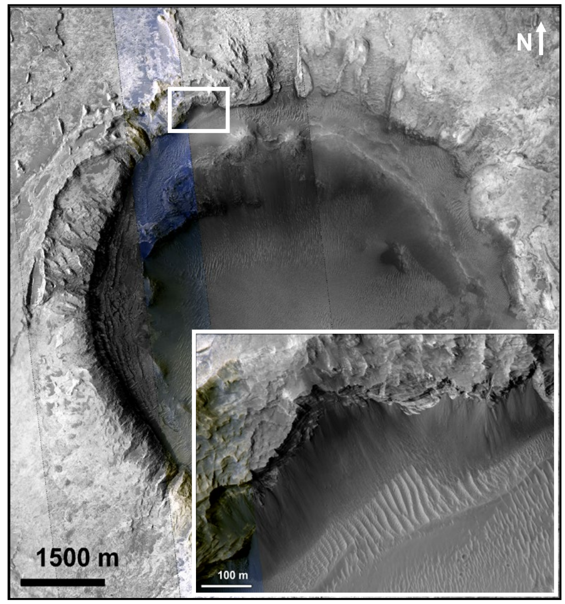

Fig. 1: A 7.8 km crater near Meridiani Planum showing layered structures and dark aeolian sediments emerging from a dark layer exposed in the crater wall. White box indicates location of inset (color and red image of HiRISE observation ESP_011277_1825 superimposed onto CTX P12_005647_1814_XI_01N002W, image center is at 2.5°S; 2.2°E).

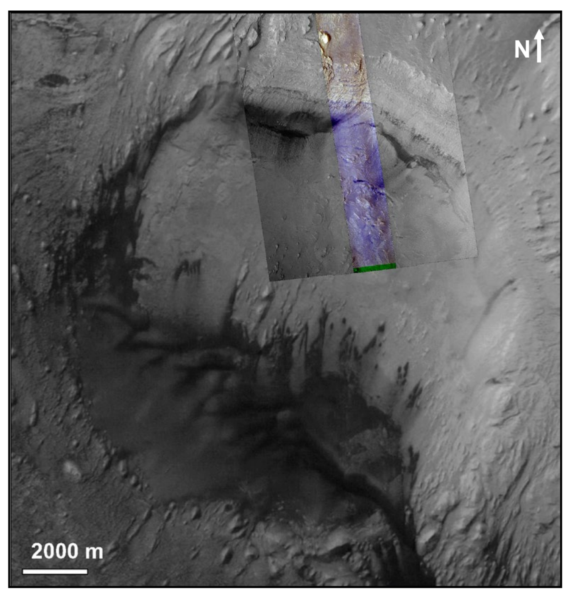

Fig. 2: A 14.3 km crater south of Crommelin crater featuring a dark sedimentary layer exposed at the northern wall and material transport going down-wall. (HiRISE ESP_012385_1825 color and red images on top of HRSC H3253_0002 nadir, image center is at 9.66°S; 2.55°W).

craters lacking dark sand occur right next to each other (Fig. 3, 4). Following our analysis no other regional sources could be identified. Sand transport pathways usually go from the layers to the dunes or start downwind of the dune deposits (Fig. 2, 3).

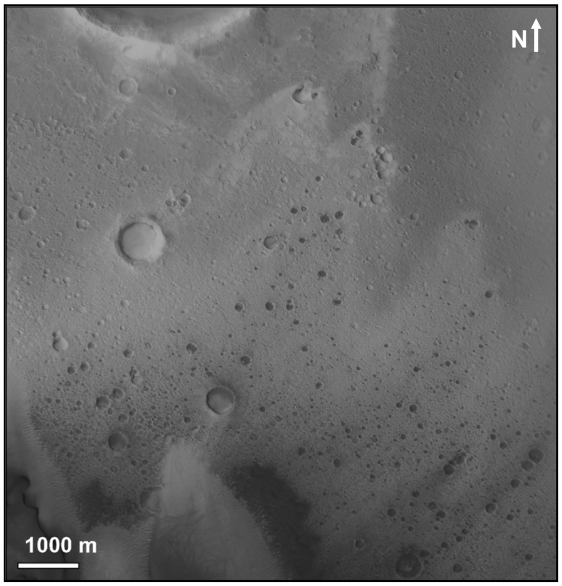

Fig. 3: Close-up of Trouvelot's crater floor, blotched by numerous smaller craters exposing dark aeolian sediments (CTX mosaic, image center is at 13.35°S; 16.17°W).

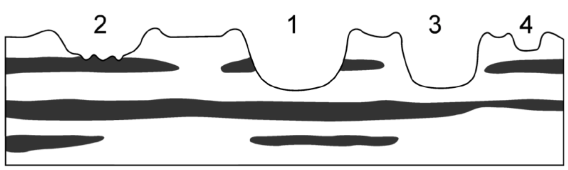

Fig. 4: Crater-Layer-Relationships. 1) Crater cuts dark layer completely, exposing a dark layer at the crater wall. 2) Crater cuts top of dark layer, exposing the dark layer at the crater floor. 3) Impact did not hit dark layer. 4) Impact did not reach the depth of dark layer. [6]

CRISM I/F observations show that the mineralogical composition of the emerging dark material correlates well with the dark dunes and sand sheets. Figure 5 shows rationed spectra of dark sediment emerging from small impact craters and dark dunes deposited on the floor of a crater NW of Crommelin crater. Both spectra show the typical broad absorption bands at 1 µm and around 2 µm indicating a mixture of olivine and pyroxene as it is typical for the dark sediments on Mars [6]. A similar correlation was also observed between wall and dune material [6].

Conclusions: The fact that the source material of the dark basaltic dunes is deposited as distinct geologic layers in many cases weakens the source hypotheses of impact melts because these permanently ongoing processes would not result in a discrete layer unit but produce material which is permanently mixed with bed rock material or regolith. The geologic setting rather points to single (or multiple) distinct source events such as volcanic eruptions producing thick ash layers, which are subsequently buried by regolith and reactivated by impact erosion. The Planum Boreum cavi unit could be the result of ash transport and deposition to the north poplar region as it is a sandy, even, and cross-bedded layer sequence, as typical for aeolian deposits. If the Medusae Fossae Formation hosts similar sedimentary layers acting as a local source for the dunes deposited there, need to be analyzed in detail.

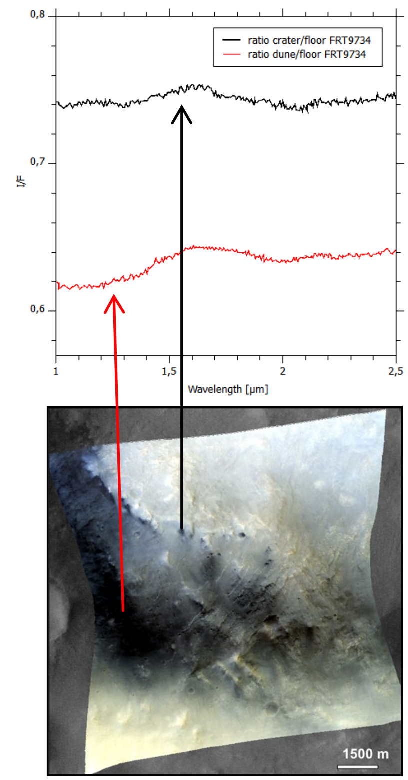

Fig. 5: Rationed near-infrared spectra of material emerging from a dark layer and dune forming material (CRISM FRT00009734_07_if165l_trr3, lower image is VIS RGB, north is to the top).

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References: [1] Tirsch D. et al. (2012) *Earth Surf. Process. Landforms, 37, 434-448*. [2] Edgett, K.S. and Lancaster N. (1993) *J. Arid. Env*. 25(3), 271-297. [3] Schultz P.H. and Mustard J.F. (2004) *JGR*, 109, doi: 10.1029/2002JE002025. [4] Tanaka K.L. and Hayward R.K. (2008) *LPI Contrib*. 1403, 69-70. [5] Burr D.M. et al. (2011) *LPSC XXVII,* Abstract #1582. [6] Tirsch D. (2011) JGR, 116, doi: 10.1029/2009JE003562. [7] Tirsch D. (2009) *LPSC XL*, Abstract 1004. [8] Fenton L.K. (2005) *JGR* 110, doi:10.1029/2005JE002436. [9] Stockstill-Cahill K.R. (2008) *JGR,* 113, doi: 10.1029/2007JE003036.