DARK DUNES IN KA'U DESERT (HAWAII) AS TERRESTRIAL ANALOGS TO DARK DUNES ON MARS.
D. Tirsch[1], R.A. Craddock[2], and R. Jaumann[1,3] [1]German Aerospace Center, Institute of Planetary Research, Rutherfordstrasse 2, 12489, Berlin, Germany. (Daniela.Tirsch@dlr.de); [2]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington D.C.; [3]Institute of Geological Sciences, Free University Berlin, Berlin, Germany.

Introduction: Dark basaltic dunes represent the majority of Martian eolian bedforms. However, on Earth there are only few places where basaltic dunes can be found, including New Zealand, Iceland, the western USA, Peru, and Hawaii [1]. Is has been suggested that the Marian dunes sands are volcanic in origin because their mineralogical composition consists of pyroxene and olivine [e.g. 2, 3, 4]. The dark dunes in Ka'u Desert on the Big Island of Hawaii are located on the western flank of Kilauea volcano. The dark sands are derived from volcanic ash and reworked pyroclastic material [e.g. 1, 5, 6]. Thus, the Hawaiian dark sand dunes are an adequate analog to Martian dunes, particularly for testing the hypothesis of volcanic origin and to determine basic spectral characteristics that may be associated with differences in grain size and chemistry indicative of maturity and transport distances.

Methods: Samples of different dark dunes in Ka'u Desert were collected during a field trip in summer 2009. Several samples were taken from a large, dark vegetated parabolic dune (Fig. 1) and a 10 m high falling dune (Fig. 2). The sand samples have a grayish-dark color and are of fine-grained sand sizes. This grain size differs from that of the Martian dunes, which is in the coarse-grained sand size range [e.g. 7]. We measured the samples with an ASD field spectrometer [8] in a laboratory. For each sample, we took 10 reflection spectra from 0.5 to 2.5 µm each consisting of 50 single measurements and created an average spectrum, which best reflects the mineralogical composition. We compared the terrestrial spectra with typical OMEGA [9] and CRISM [10] near-infrared spectra of different Martian dark dune fields and with dark material emanating from a dark layer exposed in a crater wall [cf. 4].

Fig. 1: Vegetated dark dune in Ka'u Desert, located off the Footprints Trail at 19°21' 17.52"N, 155°21'51.59"W.

Fig. 2: 10 m high dark vegetated dune in Ka'u Desert located off the Ka'u Desert Trail at 19°19'29"N, 155°21'51.15"W.

Results: Fig. 3 presents a comparison between spectra of Martian and terrestrial dark dunes. The Martian spectrum reflects the basaltic composition of the dark dunes. The spectra show a deep broad absorption band at 1 µm and a shallower band around 2.2 µm indicative of a mixture of olivine and pyroxene. The terrestrial spectra (sample 1, 6) strongly reflect the olivine content of the dark sands as indicated by the deep broad absorption band at 1 µm (cf. Fig. 5). Fig. 4 presents further examples of Martian dark material as derived by the CRISM spectrometer in an intra-crater dune and dark material emanating from a dark layer exposed at a crater wall [cf. 4]. The dune spectrum reflects the typical mixture of pyroxene and olivine whereas the wall spectrum is dominated by olivine absorption features only. The terrestrial spectra correlate very well with the Martian spectra in terms of olivine absorption features. However, the pyroxene absorption is less obvious. Nevertheless, a slight absorption around 2.2 µm, which is typical for high-calcium pyroxenes such as diopside (cf. Fig. 5), is recognizable in each of the terrestrial spectra we acquired. This shallow absorption might partially be caused by the difference in grain sizes which influences the depth of absorption features [e.g. 11]. Moreover, the sands of the Ka'u Desert dunes might comprise a higher amount of olivine compared to the Martian dark dune sands which masks the absorptions of other minerals. Since this research is in its initial phase, further analyses are needed to answer these questions. Nevertheless, the dark material that emanates from a dark layer on Mars (green curve in Fig. 4) shows a good correlation to the terrestrial spectra showing a similar olivine dominated signature.

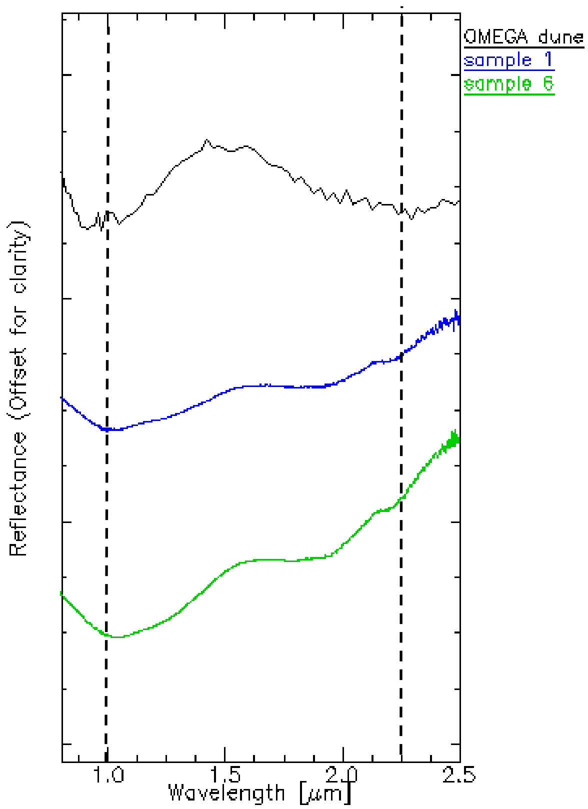

Fig. 3: Spectral comparison of Martian dark material (OMEGA dune) and terrestrial dark dune sands (sample 1, 6).

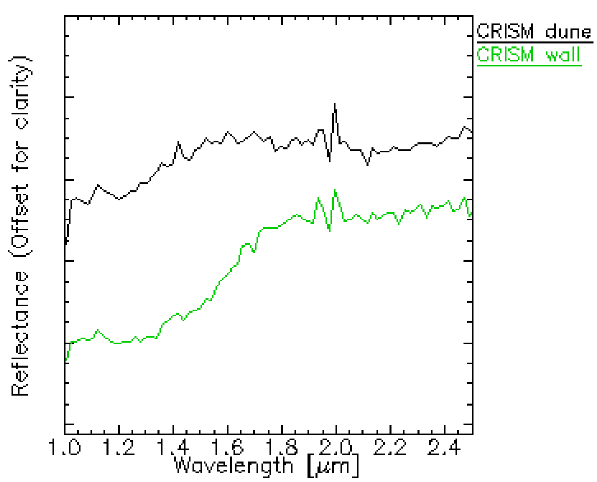

Fig. 4: CRISM spectra of dark material of a dune (black curve) and dark material emanating of a dark layer exposed at a crater wall (green curve).

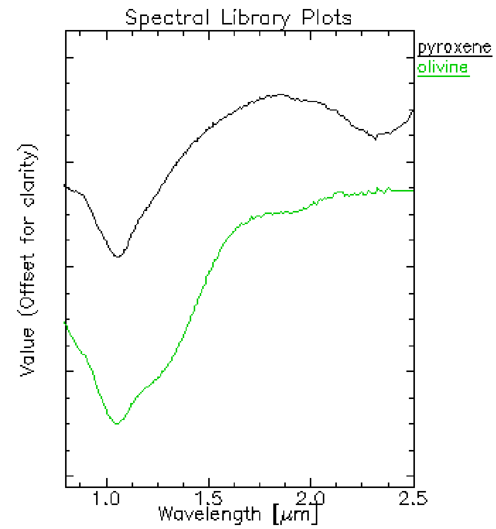

Fig. 5: Laboratory spectra of pyroxene and olivine.

Conclusions: The overall spectral shape of the terrestrial spectra reflects a basaltic composition of the sands fairly similar to that of Martian dunes, dominated by olivine. These rock-forming minerals form as the lava cools, and are commonly found in basaltic volcanic ash. The correlation in mineralogical composition of terrestrial and Martian dunes hints to a similar origin of the dark sands on Mars and Earth. The sources of the Ka'u Desert dune sands are ashes erupted from the volcanoes in the vicinity and lava disintegration particles [e.g. 1, 5, 6]. A similar volcanic ash origin for Martian dunes has been suggested by [4], who found dark layers of fine-grained materials exposed in impact craters and a material transport to the dark intra-crater dune fields. Based on the mineralogical similarities and the morphological evidence, the source of the dark material on Mars are probably layers of volcanic ash [4]. Our initial initial analyses of the Ka'u Desert's dark dune sands support these findings.

Acknowledgement: This research has been partly supported by the Helmholtz Association through the research alliance 'Planetary Evolution and Life' and NASA's Mars Fundamental Research Program, Grant NNX09AC27G (Smithsonian Institution).

References:

[1] Edgett, K.S. and Lancaster, N. (1993) *J. Arid Eniron 25,* 217-297.[2] Hoefen, T.M. et al. (2003) *Science*, *302*, 627-630. [3] Bandfield, J. (2002) *JGR,107,* 10.1029/2001JE001510. [4] Tirsch, D. (2009) *LPSC XL ,abst. #1004.* [5] Stearns, H.T. (1925), *Bull. Volcan.*, 2, doi: 10.1007/BF02719505. [6] Powers, H.A., (1948) *Pacific Sci., 2,* 278-292. [7] Edgett, K.S. and P. R. Christensen (1991), *JGR*, *96* (E5), 22,762-722,776. [8] ASD (2000) FieldSpec® Pro User's Guide, Analytical Spectral Devices, Boulder, CO, USA. [9] Bibring, J.-P. et al. (2004), *ESA Special Publication*, *1240*, 37-49.
[10] Murchie, S.L. et al. (2004), *Proceedings of the SPIE*, *5660*, 66-77. [11] Poulet, F.et al. (2007), *JGR*, *112*, doi: 10.1029/2006JE002840.