PRELIMINARY ANALYSES OF BASALTIC DUNES IN THE KA'U DESERT, HAWAII AND IMPLICATIONS FOR UNDERSTANDING DUNES ON MARS. R. A. Craddock[1], A. D. Howard[2], D. Tirsch[3], and J.R. Zimbleman[1], [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, DC 20560 (craddockb@si.edu), [2]Department of Environemental Sciences, University of Virginia, Charlottesville, VA 22904 (alanh@virginia.edu), [3]German Aerospace Center, Institute of Planetary Research, Rutherfordstrasse 2, 12489, Berlin, Germany (Daniela.Tirsch@dlr.de).

Introduction: Dunes composed of volcaniclastic particles and derived from basaltic materials are the dominant eolian bedforms on both Mars and Venus. However, volcaniclastic dunes are rare on Earth, and basaltic dunes are even rarer. However, they are found in Hawaii, Iceland, New Zealand, and parts of the western United States [1]. Here we report our preliminary analyses of basaltic dunes located in the Ka'u Desert of Hawaii. The provenance of these dunes has been established as the Keanakako'i tephra deposit [2], which has accumulated over the last ~10,000 years due to period phreatic eruptions of Kilauea [e.g., 3]. The objectives of our study are to (1) determine if the dunes form predominately from local reworking of tephra that is emplaced during larger phreatic eruptions, such as the one that occurred in 1790 [4], or if the dunes form as material is eroded and stripped from the deposits located near the summit [5]; (2) determine how the grain size and composition of the dunes changes with transport distances, and (3) compare the characteristics of the dune materials to material that is transported downslope through emphermal fluvial processes. Our results will help us understand how basaltic dunes form on Venus and Mars and will provide a set of criteria for assessing dune provenance, distance to the source material (i.e., transport distance and maturity), and emplacement mechanism from lander and remote sensing data.

Dune Morphology: We have observed four different types of dunes in the Ka'u Desert. By far the most common types are climbing and falling dunes that occur in the lee and stoss sides of pahoehoe squeeze ups, cinder and spatter cones, and fault scarps. Perhaps the largest climbing dunes are located at the base of a small pali along the Mauna Iki Trail (Figure 1, 19° 21'07.60"N, 155° 18'28.84"W). Auger samples suggest that these dunes were constructed by local reworking of tephra that was erupted over time. The largest eolian features we observed were parabolic dunes that occur near the margins of the desert where there is generally more vegetation (Figure 2, 19° 18'16.91"N, 155° 18'57.81", see also [6]); however, it is possible the the rough surface of some lava flows have also acted as an anchor in creating these features. Occasionally we also observed some relict crecentric dunes and isolated sand sheets (Figure 3, 19° 19'27.17"N, 155° 21'50.75"). A final feature worth mentioning are coarse-grained ripples, that are often superposed on the larger dunes (Figure 4). These features are very similar to those commonly seen by the MER rovers [e.g., 7].

Sediment Characteristics: Typically dunes on the Earth are composed of quartz with small amounts of feldspar and even smaller amounts other minerals. In a general way it has been shown that as a dune is transported further from its source the ratio of quartz increases, the particle sizes decrease, and the particle shapes become more rounded [8]. Analyses of the physical and chemical characteristics of an eolian deposit can provide a variety of information about the protolith, transport distances and relative age of the dune. However, very little is know about volcaniclastic sediments. Is is possible to determine the sources for different dunes on Mars? Can we use multispectral data to determine where the older, more mature sand dunes may exist on Mars or estimate how far their source may be?

The first step in addressing this problem is to determine what kind of physical and chemical differences are created during the initial emplacement. That is to say, what are the differences that can be attributed directly from the downwind emplacement of the tephra as it is deposited? Determining this would have been difficult because all the existing tephra has been reworked by eolian and fluvial processes to some extent. Fortunately, however, Kilauea began a small phreatic eruption on March 19, 2008, and we set up several bins downwind of the caldera to collect samples of tephra. These represent the only samples that have been collected downwind during the current eruption, and it is clear there are physical and chemical differences in the tephra that can be attributed to simple emplacement (Figure 5).

The Keanakako'i tephra consists of four basic clasts: olive, pyroxene, lithic fragments, and vitric fragments. While many of the characteristics of these clasts overlap, it is possible that eolian processes would preferentially sort some clasts (e.g., the specific gravity of olivine ranges from 3.3 to 4.4 and pyroxenes range from 3.2 to 3.6), while others would physically breakdown faster as transport distances increase. We are in the process of evaluating this now.

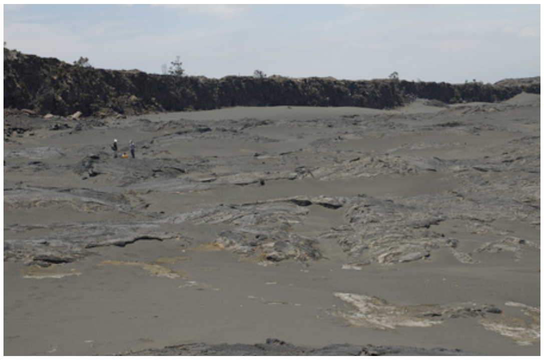

Figure 1. A series of climbing dunes along Mauna Iki Trail. The largest occur at the base of a ~20 m high pali (background).

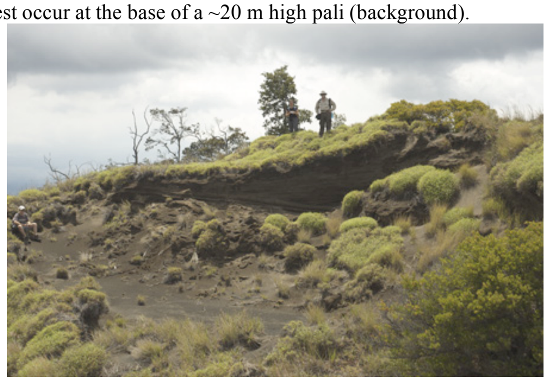

Figure 2. A ~10 m high parabolic dune located off the Halina Pali Road. The cross bedding in this dune is evident.

Figure 3. An isolated sand sheet located at the top of an a'a flow along the Ka'u Desert Trail. These materials create a falling dune on the edge of the flow (see Figure 1 in [6]).

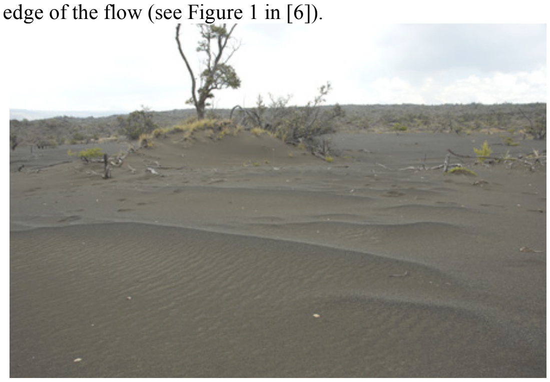

Figure 4. Coarse-grained ripples are commonly seen on the surfaces of the larger dunes.

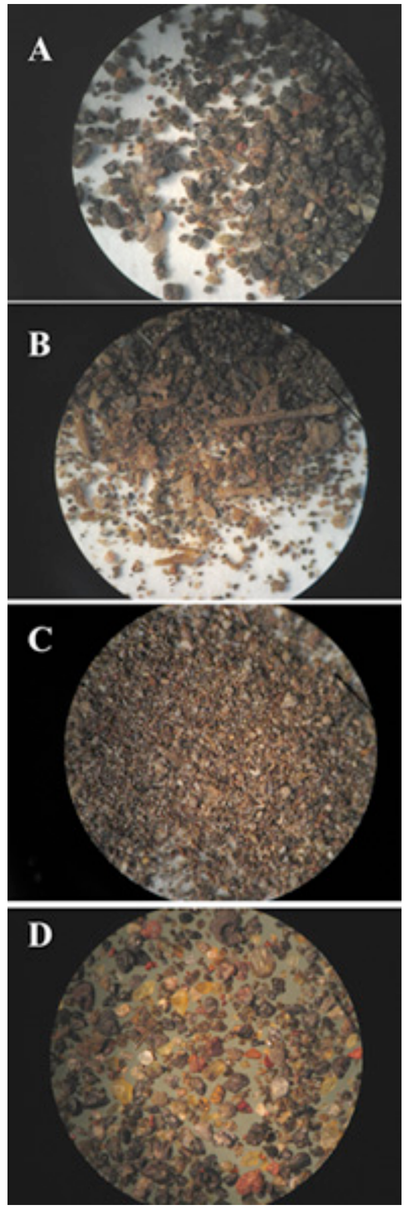

Figure 5. Microscopic images of tephra samples collected from the current phreatic eruption at Kilauea. The magnification is 20x with a field of view of 9.3 mm. (A) Sample collected near the crest of Halemaumau. (B) Sample collected downwind ~2.5 km. Larger fragments are from insects. (C) Sample collected downwind ~6.2 km. (D) Typical sand sample found ~6.2 km from the caldera.

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