ANALYSES OF A LARGE CLIMBING DUNE IN THE KA'U DESERT, HAWAII AND IMPLICATIONS FOR UNDERSTANDING DARK DUNES ON MARS.
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Introduction: It is well known that the chemical and physical characteristics of a sedimentary deposit can provide valuable clues about transport processes, the distance traveled, and the provenance of the deposit. These traditional sedimentological concepts are now being applied to our interpretation of Martian surface materials [e.g., 1]. However, our current understanding of these concepts is based on sediments derived from the terrestrial continental crust, which is typically felsic (e.g., granite) in composition. The Martian surface is composed primarily of mafic material, or basalt, which generates much different sedimentary particles as it weathers. Instead of quartz, feldspar, and heavy minerals commonly found in most terrestrial sedimentary deposits, basaltic sediments are typically composed of varying amounts of olivine, pyroxene, plagioclase, and vitric and lithic fragments. Both the durability and specific gravities of particles derived from basalt are different from particles derived from granite. Here we present the results of our initial analyses of basaltic dunes and sedimentary deposits found in the Ka'u Desert of Hawaii. This area is unique in that both eolian and fluvial sediment pathways occur in the same area, thus allowing a direct comparison of particles transported by different processes over identical distances (~20 km). It is also a relatively simple field site that is easily accessible and will provide definitive results.

Objectives. While common features on Mars, dunes consisting of basaltic sediments are rare on Earth. The objectives of our study are to (1) determine the emplacement history of basaltic dunes located in the Ka'u Desert of Hawaii in order to assess the extent to which sediments have been transported and reworked, (2) determine the changes in physical and chemical characteristics of basaltic sediments derived from the Keanakako'i tephra deposit as they are transported by eolian processes, and to (3) acquire the visible to near-infrared (VNIR) spectra of terrestrial basaltic sediments in order to better interpret remote sensing data from Mars.

Ka'u Climbing Dune: The first step in the process was to analyze a large climbing dune located along the Kalanaokuaiki Pali fault scarp at 19° 20' 39" N, 155° 18' 26" W. This dune is ~6-7 m high and ~500 m long (Fig. 1). Its surface is dominated by coarse-grained basaltic sand composed primarily of lithic and vitric fragments, olivine, feldspar, and pyroxene (Fig. 2). Augering reveals that this basaltic sand occurs to depths of ~3 meters (Fig. 3) although a thin (<15 cm) clay-rich interbed also occurs at variable depths within this unit (Fig. 4). Cross-bedding is well developed throughout most of this deposit, suggesting that it has aggraded over time from eolian activity (Fig. 3). Below ~3 m depths the dune is composed of vitric-rich sand (Fig. 5). Our preliminary analyses show that many of these particles are fragile (e.g., consisting of glass rods), which may indicate that these vitric materials were emplaced in situ following large phreatic eruptions at Kilauea. Both main units within the dune correspond to the general stratigraphy recognized in the Keanakako'i tephra.

Placing the dune stratigraphy into a temporal context is complicated. Age-dating techniques such as optically stimulated luminescence (OSL) or thermal luminescence (TL) are typically applied to quartz sand, but there has been some success in applying TL to age-dating feldspar [2]. An additional technique is obsidian hydration analyses (OHA), which often used in age-dating archeological artifacts [3]. However, OHA been applied successfully to age dating both tephras [4] and fluvial deposits [5]. While saltation can remove parts of the hydration rind, a large fraction usually remain and careful analyses can potentially reveal how many times a grain has been remobilized [4]. We are currently investigating both TL and OHA as methods for age-dating the stratigraphy within the Kalanaokuaiki Pali climbing dune. We will also present some chemical analyses of the materials within this climbing dune, and determine the physical characteristics of the particles within each unit. These results will be compared to samples of basaltic materials transported by fluvial and periglacial processes.

Summary: Continued studies will document the physical and chemical changes that take place in basaltic sediments as they are transported by wind and water over increasing distances. Results from our study will improve our understanding of traditional sedimentological concepts when applying them to the Martian surface.

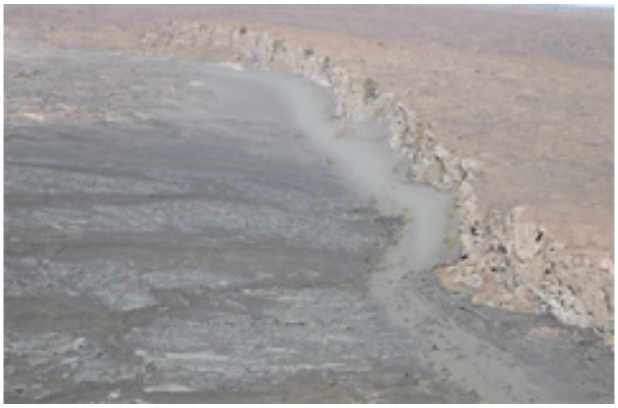

Figure 1. An aerial view of the Kalanaokuaiki Pali climbing dune. The brighter surface is a function of the sun angle and the fact that particles were salting across the dune surface while the photograph was taken. The dune is ~500 m long and 7 m high.

Figure 2. The dune surface is dominated by coarse-grained basaltic sand composed primarily of lithic and vitric fragments, olivine, feldspar, and pyroxene.

Figure 3. Digging and augering reveals that this basaltic sand occurs to depths of ~3 meters. Cross-bedding is well developed throughout most of this deposit, suggesting that it has aggraded over time from eolian activity.

Figure 4. A thin (<15 cm) clay-rich interbed also occurs at variable depths within the upper coarse-grained unit. Near the margin of the dune and against the pali there is a accumulation of lapilli-rich ash that may be the source of this clay, suggesting that some primary volcanic tephra may be interbedded with the eolian sand.

Figure 5. Below ~3 m depths the dune is composed of vitric-rich sand. Note the lighter colored droppings circled in the photograph. The augering pole provides some indication of the depth these materials were obtained.

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