ACID ALTERATION OF BASALTIC SAND: FORMATION OF A MAJOR MARTIAN SURFACE TYPE.

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Introduction: The north polar sand sea of Mars is the type locality for the silca-rich TES Surface Type 2 (ST2) unit [1], but the nature of ST2 is not well constrained. Possible compositions for ST2 include high-Si volcanic glass, zeolites, and high-Si amorphous phases [1-4]. As no major volcanic edifices have been conclusively identified in the north polar region (NPR), it has been suggested that ST2 may form as a result of alteration of primary lithics. Indeed, recent studies have provided evidence for aqueous alteration of NPR deposits during the Amazonian [5-7]. Here we present new evidence from OMEGA near-IR spectra that ST2 contains iron-bearing glass and high-Si amorphous phases, likely formed via acidic aqueous alteration of typical martian olvine-rich basaltic sand.

Data: We have analyzed 0.37 to 2.5 μm OMEGA data north of 70°N from the first year of northern summer observations (L_s=90-125°). The spectra were atmospherically corrected [7], stereographically projected into a north polar mosaic, and smoothed with a boxcar smoothing algorithm.

Results: Fig. 1 shows a representative OMEGA spectrum from the unit that we have classifed as the most consistent with TES ST2. The spectrum has a wide and shallow absorption band centered near 1.1 μm, a broad reflectance maximum near 0.68 μm, and a concave continuum (steep and negative between 0.7 and 1.5 μm, but relatively flat beyond 1.5 μm).

A ~1.1 μm band with no band near 2 μm is consistent with iron bearing glass (*e.g.*, lunar volcanic glasses in [8]). The presence of this band indicates no more than minor (~5%) pyroxene, which typically obscures the presence of glass. Spectra with this band are present throughout the NPR, but are concentrated within particular sources in the polar layered deposits and Siton Undae (SU), the extensive dune field south of Chasma Boreale. SU also has some of the strongest values of the TES 465 index [1], which detects ST2.

While negative (blue) slopes due to thin ferric coatings are common on Mars, the concave slope we have observed in the NPR is unique, and is an excellent match for the spectra of thin (~3 μm), Si-rich alteration coatings on Hawaiian basaltic glass [9] (Fig. 1).

Discussion: Relatively thick (10's – 100's of μm) Si-rich rinds are common on Earth, and are thought to form via alteration of Si-rich surface particles [10]. The similarity of the SU spectra to those of the thinnest coatings of [9] implies that these coatings are uniformly thin and likely to form from minor surface alteration of the grains. In Hawaii, this process occurs due to contact with sulfuric acid (pH 3-4) rain. At these pH levels, Si, Al, and Ti are retained while lower valence cations are removed from the leached layer [9].

While these Si-coated, glassy deposits may be produced by alteration of glass-rich volcanic ash, leaching of typical martian olivine-rich basaltic sand may also explain the lack of other ferrous minerals that would otherwise obscure the glass absorption bands. In leaching experiments at low pH (<1) with olivine-rich basaltic sand, olivine is much more reactive than glass, and dissolves to leave amorphous-Si and sulfate coatings on intact glass sand grains [11].

Implications: If the Si-coated basaltic glass sand grains of SU are representative of the global ST2, then the acidic alteration that produced them may also be a widespread process. The association of strong ST2 signatures with high-latitude terrains [1] may indicate that the source of the water for alteration is related to the climatic shifts that occur during obliquity cycles. Additional evidence may be present at the Phoenix landing site. The translucent to opaque brown sand/silt particles observed by the Optical Microscope have been suggested to be altered volcanic glass, and rinds may have been observed on black, presumably ferrous sand particles [14].

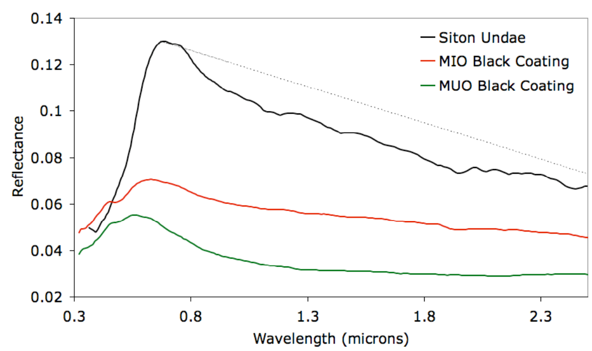

Figure 1: SU (72.1°N, 315.7°E) OMEGA spectrum compared with Si-rich coatings on Hawaiian basaltic glass [9]. Negative and concave cont. may represent a linear combination of ferric and Si-coatings.

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