EVIDENCE OF MAFIC VOLCANIC COMPOSITIONS ASSOCIATED WITH DOMES IN ARCADIA AND UTOPIA PLANITIAE, MARS.
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Introduction: Domes and more oblong and irregularly shaped mounds have been described from the Arcadia and Utopia Planitiae regions on Mars [1,2,3]. In [1] it was suggested that the domes in Arcadia were volcanic domes and they were compared to terrestrial volcanic domes with silica contents generally higher than have been associated with known volcanic products on Mars. In [2] it was posited that these domes, and similar features just to the west of Utopia Planitia, might be more comparable to tephra mounds similar to those formed by sub-ice volcanism on Earth. In [3] these domes were compared to relatively rare basaltic volcanic domes. Here we analyze spectral evidence from the CRISM, THEMIS, and TES sensors to examine possible mineral spectroscopic evidence that could illuminate the nature of these features.

Locations and Description of Domes: The domes in Arcadia Planitia mostly lie between 34 and 46˚ N latitude and 167 to 180˚ E longitude, and those in western Utopia Planitia primarily between 38 and 45°N and 76 to 86°E. As described in [1], these domes and more irregularly shaped hills consist of features with a central mound, an apron, and often an irregularly toned aureole surrounding the apron. Their heights average around 160 m with diameters averaging around 1.5 km. Some domes, described in [1] as "blisters", lack the apron and aureole and appear to be upraised plains material.

Data: THEMIS data were examined as decorrelation stretch (DCS) composites (radiance and emissivity). CRISM FRT scenes have been collected over several of these domes. CRISM data were converted to apparent surface reflectance using a "volcano scan" approach [4]. Currently we are also working on utilizing a look-up table correction from DISORT radiative transfer modeling [5].

Multi- and Hyperspectral Analysis: THEMIS multispectral daytime IR data indicate differences in the spectra of domes and aprons compared to the background plains; these features can also display differences among each other (**Fig. 1**). In **Fig. 1**, the dome marked "1" appears yellow in the band 8,7,5 DCS composite while that marked "2" appears purple. Domes that appear yellow in the 8,7,5 combination appear yellow green in a band 9,6,4 combination and red to magenta in a band 6,4,2 DCS combination.

CRISM FRT's 8EE5, 9700, and 9A7D (the latter two being a paired observation) cover domes in the Arcadia region. The domes and aprons covered in these scenes show high "ISLOPE1" values [6] which indicates a negative spectral slope from 1.8 to 2.35 μm. This can also be mapped out as a spectral endmember using linear spectral mixture analysis (SMA) [7] as is shown in **Fig. 2**. Flanks of several of the domes also display a high 1 μm band depth value as calculated from the CRISM "S" spectrometer bands. These flanks also display a prominent 2 μm band and comparison to library spectra (**Fig. 3**) indicates a close match with augite (a high Ca pyroxene).

Discussion: In both the FRT 8EE5 and 9700/9A7D scenes, the augite-rich parts of the domes occur on relatively steep south-facing slopes. A possible explanation for this is that these could be the parts of the dome which have not been covered by high orbital obliquity snow cover (which would tend to form on north-facing slopes) and thus are less weathered.

HiRISE imagery of these domes, and similar features west of Utopia Planitia, show that the domes are covered by blocks up to 8 m or more in diameter and that the aprons very often display polygonal fracture patterns (**Fig 4**). We interpret the association of a mafic rock forming mineral, augite, along with low albedo relative to the surrounding plains as consistent with a basaltic composition for these domes. Some type of H_2O-magma interaction may be indicated by the polygonal fracturing of the aprons, which could be interpreted as desiccation fracturing.

We have found a possible terrestrial analog to these domes in the description of the Low Head dome on King George Island in the South Shetland Islands of Antarctica [8]. The Low Head dome was erupted subaqueously and the constituent basaltic magma was interpreted as being highly crystallized and largely degassed prior to extrusion leading to the formation of a dome. The Low Head dome consists of a central mass of columnar basalt blanketed by fractured basalt and basaltic breccia. While we have not observed columnar jointing, we have only a small number of HiRISE images collected over these features and such jointing might be covered by overburden. The description of the Low Head dome as being covered by fractured basalt and basaltic breccia is consistent with the rubbly exteriors observed in the HiRISE images.

We interpret the Arcadia and Utopia Planitiae domes as having formed, like the Low Head dome, from magmas that were largely crystallized and degassed prior to eruption. We also find it likely that they erupted through permafrost which further cooled the magma. Melting of the surrounding permafrost, adjacent to the central domes, led to the formation of hydrated surfaces which later were desiccated and formed the polygonal fracturing observed on many of the aprons.

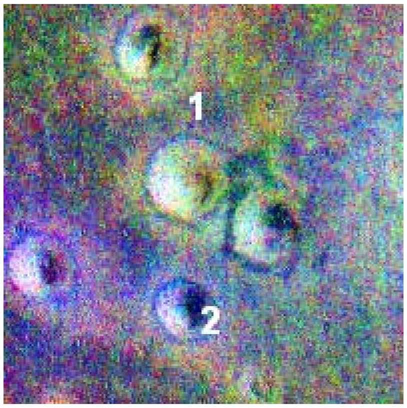

Fig. 1. THEMIS scene I13462008 band 8, 7, 5 DCS composite.

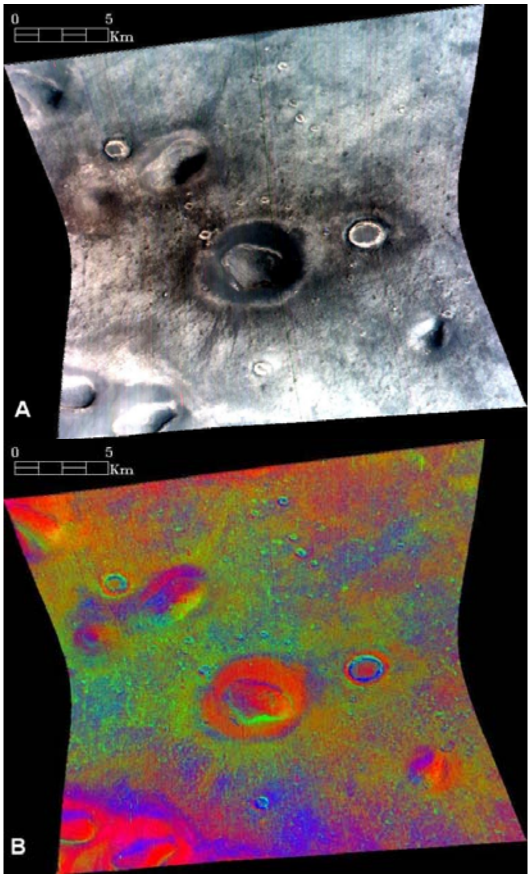

Fig. 2. CRISM FRT 8EE5 **A**. Composite of bands centered at 2.5, 1.5, and 1.08 μm. **B**. Composite of SMA fraction images; R = negative IR slope, G = augite rich, B = positive IR slope.

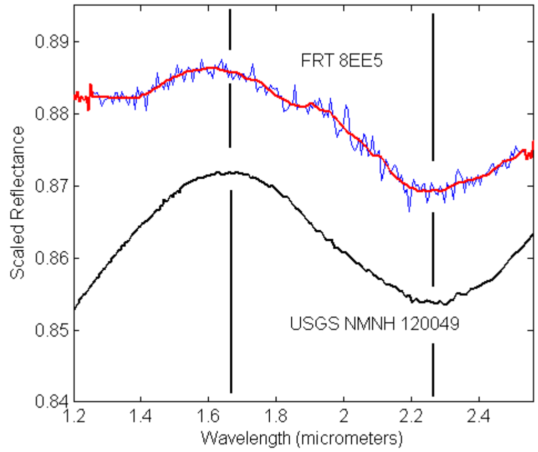

Fig. 3. Atmospherically corrected spectrum from FRT 8EE5in blue with red smoothed version overlaid. Augite spectrum for sample NMHN 120049 in black. Note match to 2.26 μm band minimum and approximately the same relative reflectance maximum at 1.65 μm.

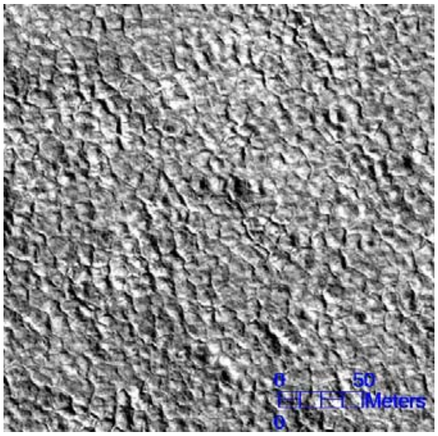

Fig. 4. Polygonal fracturing on apron to the northeast of dome covered in HiRISE scene PSP_006893_2190.

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