ANALYSIS OF OLIVINE AND AUGITE BEARING MATERIALS AND ICE-RELATED FEATURES FOUND IN ASSOCIATION WITH DOMES ON THE NORTHERN PLAINS OF MARS. W.H. Farrand[1] M.D. Lane[2], B.R. Edwards[3]. [1]Space Science Institute, 4750 Walnut St. #205, Boulder, CO 80301, farrand@spacescience.org, [2]Planetary Science Institute, Tucson, AZ, [3]Dickinson College, Carlisle, PA.

Introduction: Domes and more oblong and irregularly shaped mounds occurring in western Arcadia and Utopia Planitiae regions on Mars have been previously described [1,2]. 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] the compositions of the domes were examined using CRISM hyperspectral data and evidence of mafic compositions were found. Here we build on the work from [2] and analyze the compositions of the olivine and augite found in association with these domes using a MGM band fitting methodology [3]. Also, HiRISE data have become available that show unique ice-related features occurring in association with these domes and these are also described.

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: Several CRISM FRT and HRL scenes from the western Arcadia region were analyzed. CRISM L spectrometer data were corrected to reflectance via the "volcano scan" approach contained in the CAT software [4]. The data were further smoothed with the CIRRUS tools also contained in CAT [5]. The data were additionally subjected to a flat-field correction utilizing a line-by-line average. Some spectra were also obtained from I/F S spectrometer data that had been subjected to the line-by-line flat field correction, but only the longer wavelengths of the S spectrometer data were used. Several HiRISE scenes were analyzed also using software provided as an ENVI add-on.

Results: **Fig. 1** shows a three band composite of CRISM S bands, a 530 nm band depth image and a 1000 nm band depth image derived from the S bands. High 530 nm band depth values are associated with the light-toned inner aureole surrounding these domes. High 1000 nm band depth values occur in association with the flanks of the domes and the apron of the largest dome.

The high 1000 nm band depth material was found to have the signature of olivine and high-Ca pyroxene (**Fig. 2**). An average of spectra from two overlapping scenes was subjected to MGM analysis with the results shown in **Table 1**. This spectrum could be modeled with 6 bands with an RMS error of 2.44×10^{-3}. The nominal high Ca pyroxene was modeled with bands centered at 0.996 and 2.23 μm. The olivine was modeled with bands centered at 0.83, 1.07, and 1.27 μm. In the nominal olivine bands, the 1.27 μm band was strongest with the 0.83 um band being marginally stronger than the 1.07 μm band. This set of band centers and relative strength of bands is consistent with a low Fo number (more fayalitic or Fe-rich) olivine based on relations observed in [6]. The 1.7 μm band is interpreted as an artifact of the line-by-line flat field correction.

Observation of "Brain Terrain" in Association with Domes: In examining concentric crater fill in [7] a type of ice-related material termed "brain terrain" was described. We find this material occurring in association with light-toned aureoles of some of the examined Arcadia domes (**Fig. 3**). We interpret the presence of this material as evidence of the build-up of ice in association with these domes, most likely in past high orbital obliquity excusions [8]. The evidence of ice also contributes to our interpretation of how these features were formed.

Origin Mechanism: We agree with [1] that many of these domes were likely originally formed as cryptodomes intruded into the near-subsurface. Although we cannot rule out more silica-rich compositions, we feel that the spectral data is more consistent with broadly basaltic compositions. We suggest the domes were intruded into permafrost or near-surface ice and that this interaction led to the formation of a chilled hyaloclastite carapace, inhibiting lateral extrusion of magma and leading to dome formation. Erosion, magmatic inflation, or both, led to the exposure of the domes. Erosion of the carapace material led to the formation of the dark-toned aprons that surround these domes. The positive relief domes likely acted as accumulation centers for ice during high obliquity excursions and the consequent formation of brain terrain textures around the domes.

References: [1] Rampey M. et al (2007) *JGR*, *112*, 2006JE002750. [2] Farrand W. et al. (2009) *LPS 40th*, #1268. [3] Sunshine J. et al. (1990) *JGR*, *95*, 6955. [4] Murchie S. et al. (2007) *JGR*, *112*, 2006JE002682. [5] Parente M. (2008) *LPS 40th*, #2528. [6] Sunshine J. and C. Pieters (1998) *JGR*, *103*, 13675. [7] Levy J. et al. (2009) *Icarus*, *202*, 462. [8] Fastook J. et al. (2009) *LPS 40th*, #1144.

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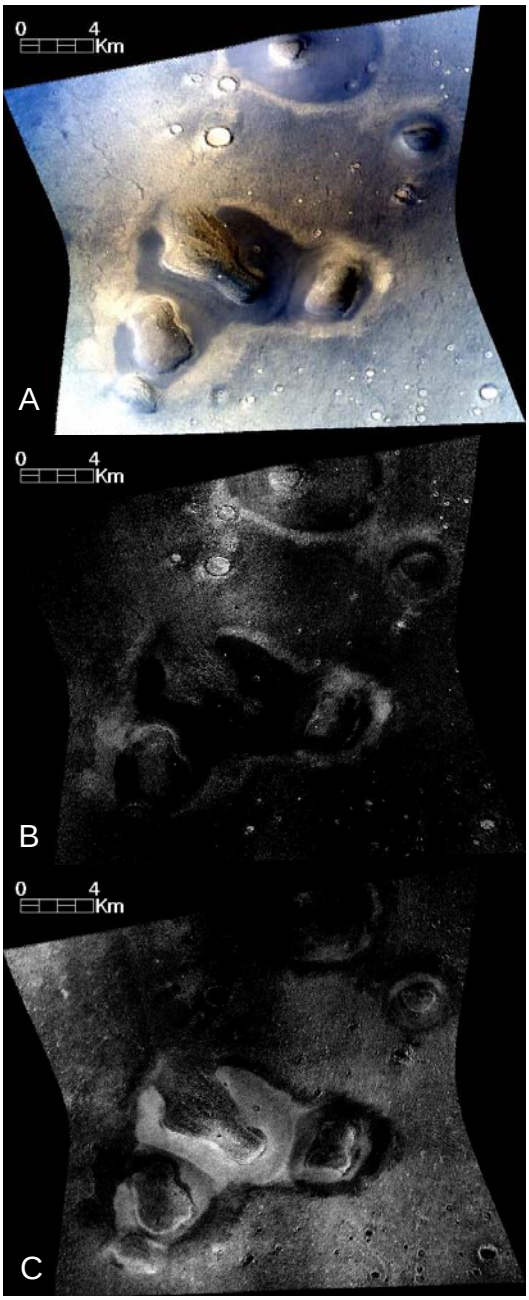

Figure 1. A. Composite of 0.71. 0.6, and 0.53 mm bands. **B**. 530 nm band depth. **C**. 1000 nm band depth.

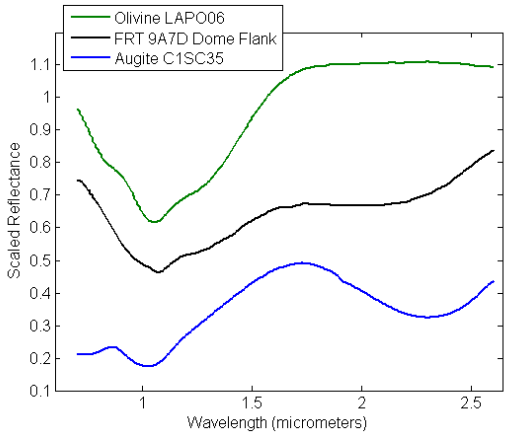

Figure 2. Comparison of smoothed FRT 9A7D flank spectrum with library olivine and augite.

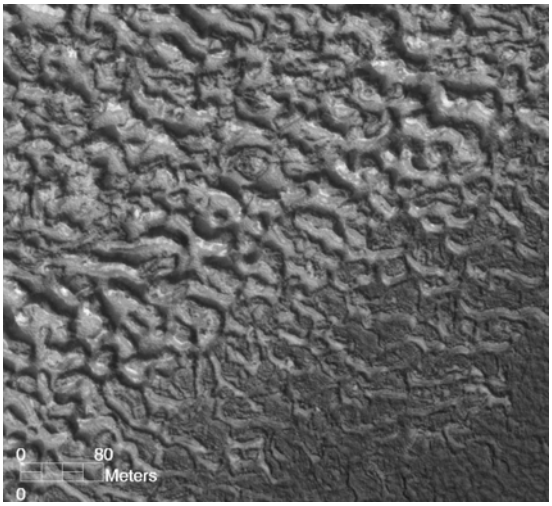

Figure 3. "Brain terrain occurring in association with light-toned aureole around dome.

Table 1. MGM band parameters for average of dome flank materials from FRT 9700 & 9A7D

Band	*Mineral*	*Center (nm)*	*FWHM (nm)*	*Strength*
1	Olv	831.31	233.79	-0.14
2	CPX	996.08	274.69	-0.32
3	Olv	1067.66	268.71	-0.13
4	Olv	1271.28	405.74	-0.38
5	--	1694.31	636.00	-0.25
6	CPX	2271.79	537.44	-0.14