ASSOCIATIONS OF ICE AND MAGMA IN THE FORMATION OF DOMES IN WESTERN ARCADIA PLANITIA. W.H. Farrand[1] , J.W. Rice, Jr.[2]. [1]Space Science Institute, 4750 Walnut St., #205, Boulder, CO 80301, farrand@spacescience.org, [2]Planetary Science Institute, Tucson, AZ.

Introduction: Domes in western Arcadia Planitia, and a smaller number of similar features in southern Utopia Planitia, were described in [1] as being cryptodomes, formed in the subsurface, and as having morphologic features consistent with compositions more silica-rich than typical basaltic martian volcanics. Further study of these features in [2] using THEMIS data from its 4:30 PM LST orbit, and a handful of CRISM scenes suggested that they could be basaltic in composition, but with features indicating magma-ice interactions. Since the publication of [2], more CRISM scenes over the western Arcadia domes have become available and Mars Odyssey has shifted to a 3:00 PM LST orbit. The latter change means warmer surface temperatures for THEMIS scenes and the chance to more fully assess if the domes and their surroundings have silica-stretching minima more consistent with basalt or a more silicic composition.

Dome Features: The western Arcadia domes, as well as those in Utopia Planitia (which were not examined in this study) are recognized by several defining characteristics (**Fig. 1**). They consist of a central core, sometimes in a hemispherical dome shape, but also often in more irregular shapes, that are typically 1 to 2 km in approximate diameter. Surrounding the domes are shallowly sloping dark-toned aprons. The aprons sometimes are surrounded by light-toned aureoles. As was pointed out in [1], there are in this region domes that lack the dark-toned aprons and light-toned aureoles and appear more as upraised bumps in the plains. The domes are typically high in thermal inertia relative to the plains (TI units on the order of 200 to 300 $Jm^{-2}K^{-1}s^{-½}$ as determined using the JMARS utility [3]) while the dark-toned aprons are low in thermal inertia relative to the plains (TI units of approximately 150 300 $Jm^{-2}K^{-1}s^{-½}$).

CRISM-determined Spectral Features: In standard spectral parameter images derived from CRISM S and L detector data [4], the tops of the domes are generally indistinct with regards to the surrounding plains; however, the flanks can have elevated BD1000VIS spectral parameter values, indicating the presence of a crystal field band near 1 μm, and high values in the HCPINDEX and LCPINDEX parameters indicating the presence of a high and/or low Ca pyroxene. The aprons and parts of some domes have high values in the ISLOPE1 parameter, potentially indicating ferric

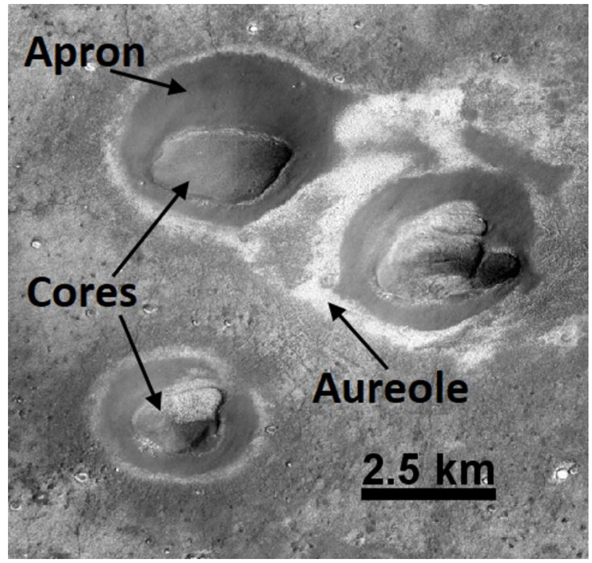

Fig. 1. CTX view of western Arcadia domes at 39.1° N, 172.6° E.

oxide coatings. In [2], the presence of olivine was suggested. In the current study, we find elevated values of the revised OLINDEX3 parameter on the flanks of some domes indicating olivine's presence for those sites. Spectral parameters that would indicate the presence of alteration materials, e.g., sulfates and/or phyllosilicates are generally not elevated in association with the domes or their aprons. However, a parameter indicating the possible presence of zeolites or sulfates, the difference of reflectance at 2240 nm and 2540 nm (R2240-R2540), is elevated in association with some of the aprons. The BD3000 parameter is elevated in association with the light-toned aureoles. As was noted in [2], HiRISE imagery of the light-toned aureoles show morphology nearly identical to the "brain terrain" described by [5] for ice-filled craters; thus ice is inferred as being a component of the light-toned aureoles.

CRISM L detector spectra of high BD1000VIS, and R2240-R2540 regions are shown in **Fig. 2**. The band minimum in the high BD1000VIS material at a wavelength greater than 1 μm is more consistent with a high rather than a low Ca pyroxene. Also, the broadened band is indicative of the presence of an iron-rich olivine. The presence of a shallow band just longwards of 2.5 μm in the apron and flank material with high R2240-R2540 values is potential evidence of an alteration mineral such as a sulfate or zeolite although further analysis is required to determine the most likely

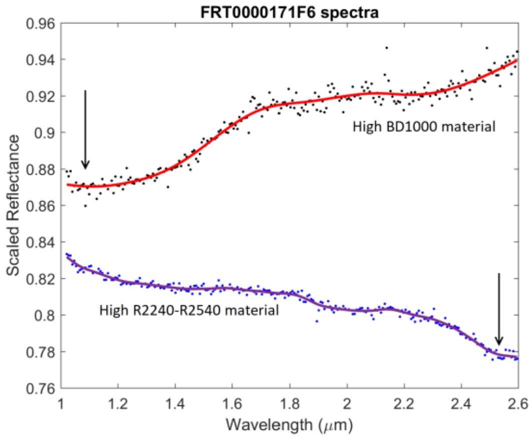

Fig. 2. CRISM spectra extracted from FRT000171F6. Arrow on left indicates band minimum of BD1000 material. Arrow on right indicates band near 2.5 μm of high R2240-R2540 material.

mineral or mineral group causing this feature.

THEMIS Multispectral Data: As was noted in [2] the domes and their aprons stand out in THEMIS decorrelation stretch (DCS) images, such as band 8, 7, and 5 composites. In this band combination, the domes and aprons appear in a yellow color relative to the blue-purple of the surrounding plains. The DCS images are derived from the THEMIS radiance data and thus can be influenced by surface temperature. A more accurate gauge of actual compositional differences is provided by emissivity data. Emissivity data (obtained from the ASU THMPROC web site) shows that the domes and aprons are generally indistinguishable from the background plains. However, in some scenes, there are yellow regions in the band 8-7-5 composites of emissivity data (**Fig. 3**) associated with the lower flanks and aprons of some domes indicating a spectral character distinct from the surrounding plains. While spectra of the yellow regions indicated in **Fig. 3** have a emissivity minimum at a shorter wavelength than those of the surrounding plains, the difference is minor and still consistent with a basaltic composition although that of a basaltic andesite to andesite is not excluded.

Conclusions: While work on this project is ongoing, preliminary results indicate the presence of a high Ca pyroxene and olivine on the flanks of some domes, ice associated with the bright aureoles, and a potential hydrous alteration mineral on some apron, and possibly flank, materials. The lack of a strong multispectral color difference in the thermal infrared THEMIS data of the cores of the domes, and only subtle indications of spectral differences in the emissivity of the flanks and aprons of some domes relative to the plains, does not indicate silica-rich compositions for these features although marginally more silica-rich materials such as basaltic andesite to andesite is still a possibility.

Also, the sloping, but otherwise spectrally featureless, apron and core summit materials is consistent with a glass, or devitrified glass (e.g., tachylyte) type of material as was suggested in [2]. This characteristic, in association with the presence of ice in the light-toned aureole features and possible presence of some hydrous alteration mineral in some locations (indicated by the shallow 2.5 μm band) are consistent with intrusion of the domes into ice-rich materials causing the production of glasses and mild alteration.

References: [1] Rampey, M.L. et al. (2007) J. Geophys. Res. 112, E06011. doi:10.1029/2006JE002750. [2] Farrand, W.H. et al. (2011) *Icarus*, 211, 139-156. [3] Dickenshied, S., et al. (2015*) 2nd Planetary Data Workshop*, #7013. [4] Viviano-Beck, C.E., et al. (2014) *J. Geophys. Res*., 119, 1403–1431, doi:10.1002/2014JE004627. [5] Levy, J.S. et al. (2009) *Icarus*, 202, 462-476.

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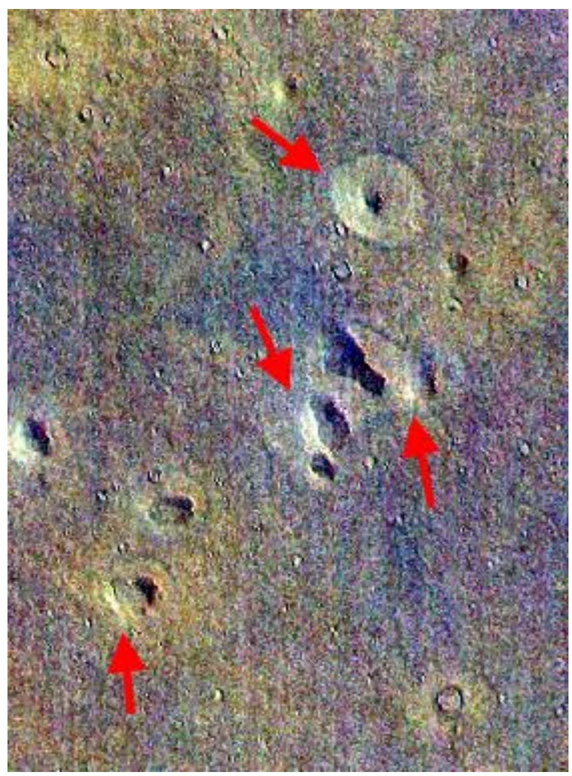

Fig. 3. Composite of emissivity bands 8, 7, and 5 (11.79, 11.04, and 9.35 μm) from THEMIS scene I46407013. Arrows indicate dome flanks and aprons with multispectral character distinct from that of the surrounding plains.