WELL-PRESERVED VOLCANIC TERRAINS IN MARS' TERRA CIMMERIA HIGHLANDS: J. C. Cowart[1] and A. D. Rogers[1], [1]Stony Brook University (255 Earth and Space Science Building, Stony Brook, NY, 11790-2100, justin.cowart@stonybrook.edu).

Introduction: Previous work characterizing bedrock plains found a cluster of seven large (> 50,000 km^2) bedrock exposures in the central Terra Cimmeria (TC) highlands region (**Fig. 1a**) [1]. These bedrock plains, located within Late Noachian intercrater basins [2], contain apparent volcanic surfaces. Here we summarize new observations of landforms within these bedrock plains and the surrounding highlands, which indicate widespread volcanic activity throughout TC and preserve evidence for possible lava-ice interaction.

Bedrock Plain Stratigraphy: TC bedrock plains commonly contain two spectral units in Mars Odyssey THEMIS band 8-7-5 decorrelation stretch imagery (highlighting variations in bulk silica content) (**Fig. 1b**). Unit 1 is most areally-extensive unit; THEMIS spectra of these surfaces show similar or slightly elevated silica content relative to surrounding highlands materials. Unit 1 typically has an intermediate-to-dark toned, erosionally-resistant surface in CTX imagery. Unit 2 occurs as a thin band near the boundary between bedrock plains and the surrounding highlands. In some locations, this unit fills highlands valley networks and has a dendritic outcrop pattern. THEMIS spectra show that Unit 2 is typically olivine-bearing. Unit 2 generally corresponds to light-toned surfaces with moderate to low crater retention and strongly developed erosional surfaces relative to Unit 1. Unit 2 is presumed to variably underlie Unit 1 in some bedrock plains; craters between 2.5 and 10 km typically produce DCS pink or purple ejecta deposits consistent with Unit 2. Craters in this size range typically contain fluidized ejecta suggesting the former presence of a volatile-rich subsurface materials [3].

Volcanic Landforms: All seven bedrock plains are associated with raised lobate landforms (RLLs) occurring exclusively within Unit 1 (**Fig.2b**). Further mapping has located additional RLLs extending southeast to the Sirenum Fossae fracture system (37 S, 173E). Margins of some RLLs appear to deflect around other RLLs, leading [1] to suggest these features were lava flows. However, well-preserved flow textures are not present, and individual RLL surfaces often show unusually large differences in erosional susceptibility. RLLs typically occur in the lowest elevation portions of intercrater basins. In a few moderately degraded RLLs, small polygonal ridge networks are present (**Fig. 2c**). Ridges may represent small dikes feeding lava flows, or basal injections of water-laden sediment from the underlying erosion surface. Ring-mold morphologies are observed in < 500 m craters located within some RLLs. It is unclear whether this is a true ring-mold texture arising from the presence of subsurface volatiles [4], or if this texture results from unusual preservation of a regional crater fill deposit.

One TC volcanic plain contains a 7 km diameter rimless crater, interpreted as a diatreme or maar by [1]. This crater is associated with a mantling deposit extending to its southeast (**Fig. 2a**). Small flat-topped domes and mounds have been previously described to the southeast of our study region, which were inter-

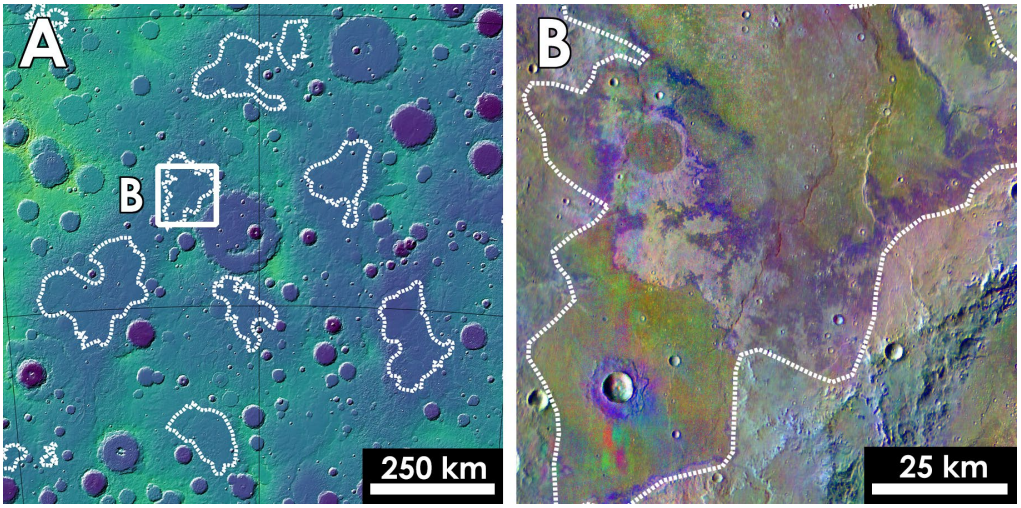

Figure 1. A) *MOLA/HRSC topography map centered on cluster of Terra Cimmeria bedrock plains with spectrally and texturally distinctive surfaces mapped by [Cowart et al.] (white outlines). B) THEMIS DCS 875 false color image showing relationship between Unit 1 (DCS yellow/green) and olivine-bearing Unit 2 (DCS purple). Note dendritic outcrop pattern of Unit 2 and DCS purple ejecta of 5 km crater at lower left.*

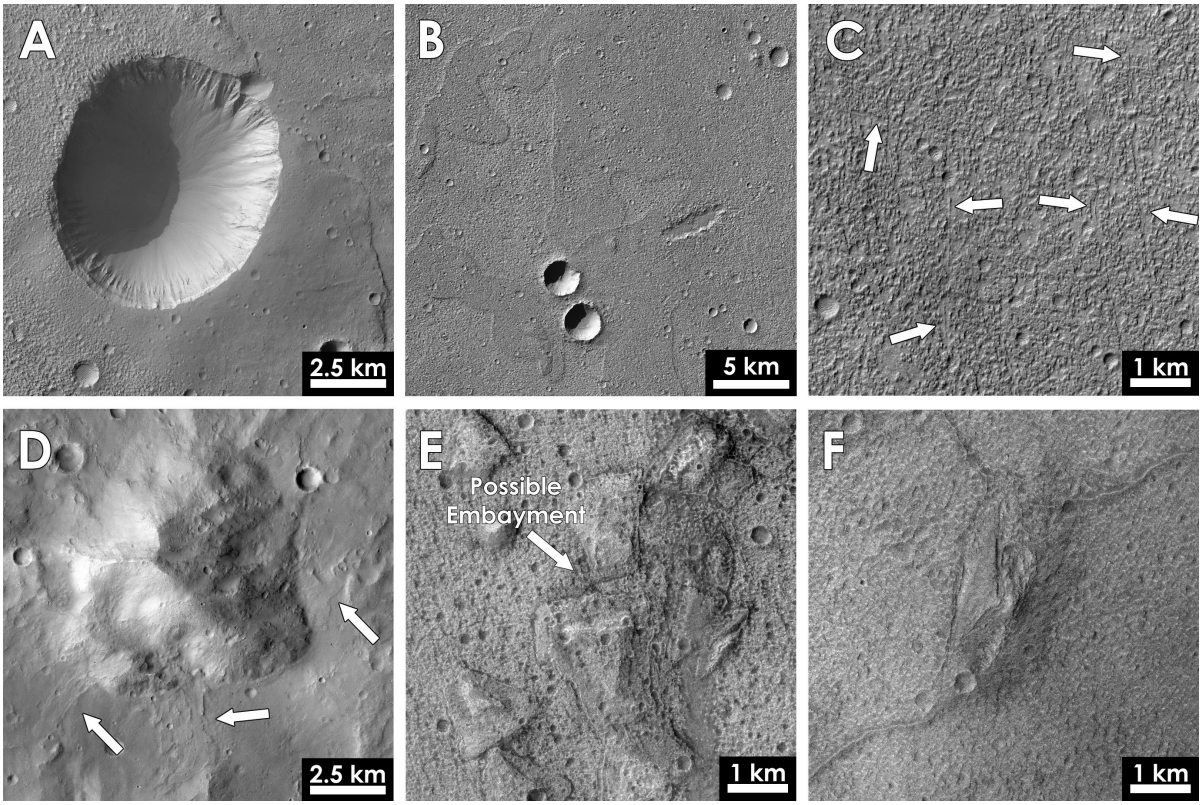

Figure 2) *Landforms in Terra Cimmeria. A) 7 km diameter rimless crater associated with mantling deposit, interpreted as a maar and tephra deposit (34S, 149E). B) Raised lobate landforms located within an intercrater bedrock plain. Note that some lobes appear to deflect around other lobes (34S, 147E). C) Small-scale polygonal ridge networks located within a moderately degraded raised lobate landform (30S, 149E). D) 8 km wide massif associated with possible lava flows (arrows) (32S, 165E) . E) Mound cluster located within an intercrater bedrock plain. Note stair-stepped appearance of mound cluster and possible embayment relationship with bedrock plains surface (34S, 147E). F) Mound located in intracrater plain unit, associated with dark ridges interpreted as dikes (bottom left, top center, top right) (31S, 162E).*

preted as products of andesitic eruptions [5]. We have mapped several additional probable volcanic structures in the region. These include two probable shield volcanoes and several small volcanic massifs. One massif, which measures 8 km across and is ~800 m in height, is associated with flow-like deposits (**Fig.2d**).

Mound Clusters: Unit 1 commonly contains mound clusters, with individual mounds measuring between 1-2 km in diameter. Mounds appear to be flat-topped, but larger mounds commonly exhibit a stair-stepped geometry (**Fig. 2e**). The stratigraphic position of mound clusters within bedrock plains material is unclear, but in one bedrock plain they appear to be partially embayed a raised lobate landform. The distinctive slope-break morphology resembles volcanic structures created by underwater or intraglacial eruptions with a subaerial phase.

In one location, a mound is associated with large dark ridges (**Fig. 2f**). These ridges appear to have a structural control and are interpreted as dikes. The associated mound and mound summit fissure occur along strike of the ridges, and likely formed above the bedrock surface. This suggests very shallow dike emplacement, possibly within an englacial environment.

Significance: Volcanic landforms in Terra Cimmeria are unusually well-preserved. Crater counting of these bedrock plains indicates an age of ~3.6 Ga [7]. Other volcanic plains (Syrtis Major Planum, Hesperia Planum) of similar age have developed thick regolith mantles. The good preservation of volcanic surfaces, presence of fluidized ejecta, and possible indications of lava-ice interactions suggests that preservation was aided by the former presence of mantling by a volatile-rich regolith or ice sheets.

References: [1] Cowart J.C et al. (2020) *JGR:Planets*, 124(12), 3181-3204. [2] Tanaka K. L. et al. (2014) *USGS Map #3292 pamplet.* [3] Barlow N.G. and Perez C.B. (2003) *JGR: Planets*, 103(E8), 5085. [4] Kress, A.M and Head, J.W. (2008), *GRL*, 35(23). [5] Brož, P. et al. (2015), *EPSL*, 415, 200-212. [6] Rogers A.D. et al., *9th International Conference on Mars, Abstract #6378.*