DIVERSE VOLCANISM AND VOLCANOTECTONICS ASSOCIATED WITH THE ERIDANIA BASIN ON MARS. J. R. Michalski[1-2], A. D. Rogers[3], C. S. Edwards[4], A. Cowart[5], L. Xiao[6] [1]Dept of Earth Sciences, University of Hong Kong, Hong Kong, China, [2]Laboratory for Space Research, University of Hong Kong, [3]Stony Brook University, [4]Northern Arizona University, [5]Planetary Science Institute, [6]China University of Geosciences

Introduction: This work explores the geology and volcanology of the Eridania basin and surrounding terrains in Terra Cimmeria and Terra Sirenum (~180 E, 30S). This region contains the strongest signature of remnant crustal magnetism on the planet [1], a high potassium anomaly [2], and volcanically and structurally complex Hesperian-Noachian (>3 Ga) crust [3-7]. In addition, the region contains the largest example of an ancient martian sea approximately 3x the size of the modern Caspian Sea on Earth [8]. Though the region is recognized for having some volcanic vents and structures [3-8], provenance of olivine-rich flood lavas or the widespread (1.8 x 10^6 km^2) or the voluminous (~10^6 km^3) "Electris" suite of airfall deposits remains enigmatic [9]. This work describes a diverse suite of volcanic structures, and associations of those volcanoes with tectonic structures resulting in complex volcanotectonics. The diverse volcanism is associated with felsic volcanic compositions which are collectively unlike any other suite of recognized deposits or volcanic region on Mars.

Volcanic morphology and morphometrics: We classified >60 volcanic structures into four categories based on their morphologies and morphometric characteristics: 1) volcanic domes; 2) stratovolcanoes; 3) pyroclastic shields; and 4) caldera complexes (Fig. 1). Volcanic domes are characterized by their smaller size (average diameter, d, = 14 km), low height (average height, h = 0.8 km), viscous flow features, lobate plan view, sharp edges or escarpments and high average height-diameter ratio (h/d) of 0.056 (Fig. 1). Stratovolcanoes have some similar features to domes such as steep escarpments and some lobate flow features elevated on the structure, but overall have a shallow, conical morphology and often contain summit or flank craters, sometimes structurally linked through faults and fractures. They are typically 40-80 km diameter and are the tallest of the structures described here with heights reaching 2-3 km above the surrounding terrain with moderate h/d (0.036) (Fig. 1). Pyroclastic shields are large features approximately 100 km diameter with low heights (~1.1 km) and low corresponding h/d (.011). They are quasi-circular in plan-view and contain a summit or near-summit crater. A striking and important characteristic of the pyroclastic shields is that they contain dense valley networks eroded into their flanks, which we propose is a reflection of the susceptibility to erosion of their pyroclastic rock. Caldera complexes are unique because they are destructional volcanic features not constructional ones [10], hence their negative average h/d value (-0.015).

The martian volcanic structures discovered here follow the same trend as comparable classes of volcanoes on Earth, but they are shifted to larger diameter and therefore have lower h/d values (Fig.1). This can be explained in the context of Mars's lower gravity environment (38% of Earth), resulting not only in more explosive volcanism but dispersal of pyroclasts further from the vents resulting lower profiles.

Composition of volcanic materials: Thermal infrared remote sensing of the Eridania region demonstrates a diversity of compositions among the volcanic materials. Decorrelation stretched (DCS) Thermal Emission Imaging System (THEMIS) images show mafic to ultramafic surfaces as purple-blue and more felsic surfaces a yellow (Fig. 2a), linking qualitative compositional variation to morphological context. Surface composition is quantitatively constrained by fitting a spline curve to the atmospherically corrected surface emissivity spectra (Fig. 2b) thereby providing a central wavelength of the Si-O stretching absorption in silicates [11], which is correlated with SiO_2% (Fig. 2c). THEMIS spline fits suggest that the felsic volcaniclastic surfaces and volcanic domes have 64-69% SiO_2 (Fig. 2b-c) but it bears noting that the presence of basaltic sand on the felsic surfaces could serve to make the silica content appear lower than it is in the primary rock (Fig. 2). Further, the silica correlation is different for crystalline materials than for pure glasses and if the felsic volcanic materials contain a large glass component, the silica content is likely higher. High silica content in the same surfaces is supported by high values of the Thermal Emission Spectrometer silica index, which independently measures Si-O bending absorptions in the region.

Conclusions: The wide range of volcanic styles evident in the Eridania region suggests that similar structures including domes, stratovolcanoes, small pyroclastic shields and calderas could be much more widespread in the ancient martian crust than is currently recognized [12]. Evidence for diverse volcanic compositions in highland terranes also challenges the long-held paradigm that Mars is purely a basaltic world and potentially the idea that it is a one-plate planet. Further, Eridania contains a wide range of subaqueous and coastal volcanoes analogous to the hypothesized geology of the Eoarchean or Mesoarchean Earth. The chemically and physically diverse settings present in this region of Mars provide the closest analog to both seafloor and land-based hydrothermal origin of life scenarios proposed for the Earth [13].

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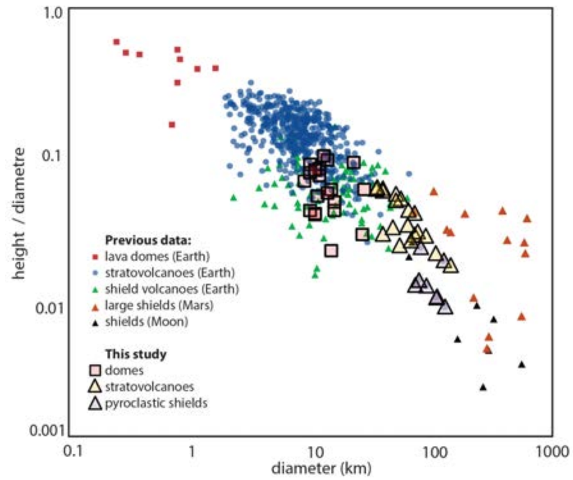

Figure 1: Morphometric data for volcanic structures. Data for volcanic domes, stratovolcanoes and pyroclastic shields in the Eridania region described in this study are compared to similar measurements for structures on the Earth, Moon and Mars. Diametre and height/diameter ratios are shown for rhyolitic/dacitic domes, stratovolcanoes and shield volcanoes on Earth, large shields on Mars, and large shields on the Moon.

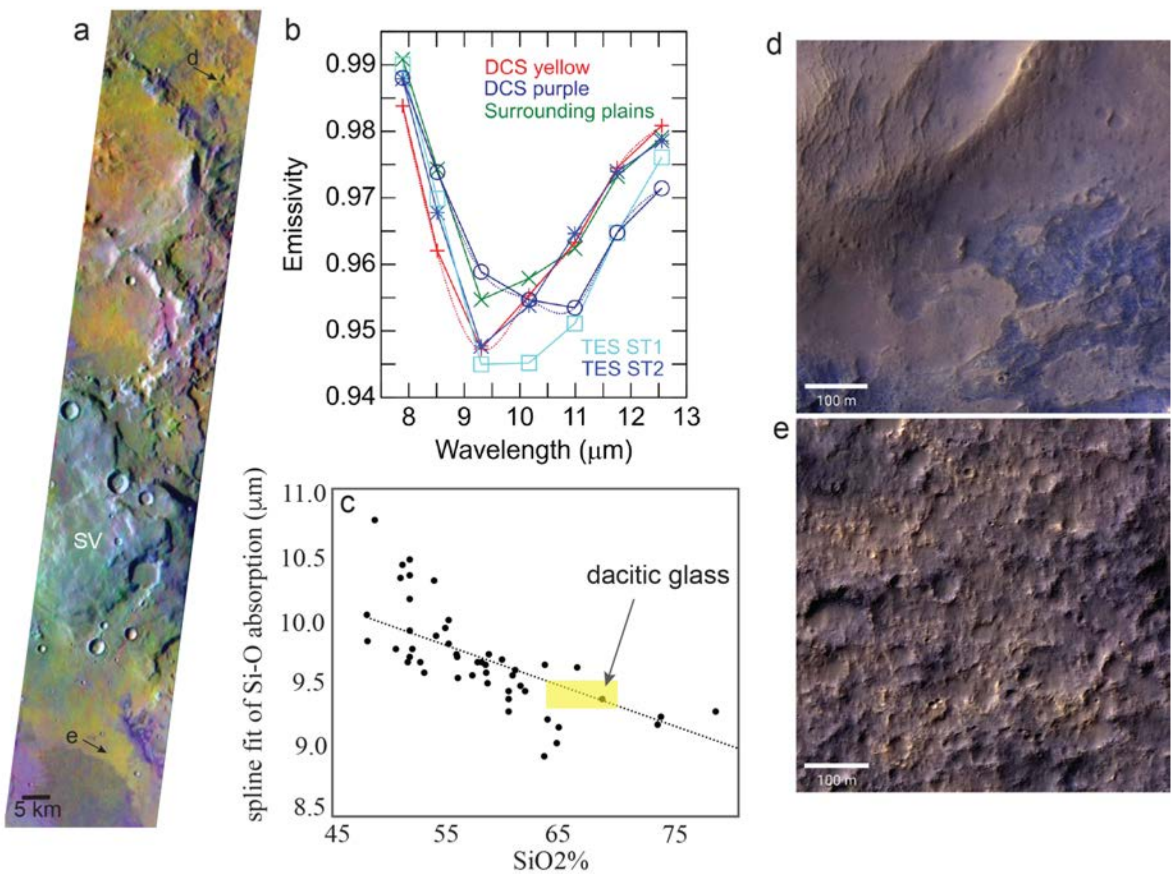

Figure 2: Infrared and image data showing felsic volcanic materials in the Eridania region. A THEMIS DCS image shows felsic materials as yellow and mafic material as purple surrounding a stratovolcano located at 170.3E, 35S (a). Surface emissivity spectra of the yellow and purple surfaces are compared to global average TES surface type 1 (ST1) and surface type 2 (ST2) (b). Spline fits to the THEMIS data shown in "b" correspond to 9.36-9.5 µm for the yellow, felsic surfaces and 10.74 for the purple, and when compared to a plot of the spline fits for laboratory rocks and glasses, these values suggest a composition of ~64-69% HiRISE data show that the felsic material is buff to pink colored images. Locations of HiRISE IRB images are indicated with arrows in "a."