SATELLITE DATA FUSION TO BETTER UNDERSTAND MARTIAN STRUCTURE AND VOLCANICS.
C. G. Hughes[1], [1]Dept Of Geosciences, EKU, Richmond KY USA christopher.hughes@eku.edu

Introduction: The Thermal Emission Imaging System (THEMIS) provides the highest spatial resolution (~100 m/pixel) Thermal Infrared (TIR) data of Mars' surface from orbit [1]. However, the utility of these data are limited by their spatial scale and can be improved by decreasing the pixel size. Super-resolution of this data, in conjunction with high resolution Visible/Near-Infrared (VNIR) data, can provide a new way to approach problems in structural and volcanic geology on the surface of Mars.

Super-Resolution. Data from VNIR instruments such as THEMIS VNIR at 36 or 18 m/pixel, CTX at 6 m/pixel [2], and HiRISE [3] at 30 cm/pixel show that there are significant surficial differences within the THEMIS TIR pixel size of 100 m. An improved spatial resolution of TIR data would enable better alignment and interpretation of results between these instruments. Such an algorithm has been developed and applied to Martian TIR data to investigate evolved lava compositions and chloride deposits [4, 5]. These data, at 9- to 36-fold improvement in resolution, can be used to better interpret Martian geology.

Super-resolved data can also be used in conjunction with even higher-resolution data from other instruments to better interpret the geologic relationships among units. Instruments such as CTX and HiRISE provide greater spatial detail about an area (Figure 1). These instruments have fewer bands, and collect data in a wavelength region that is less sensitive to changes in mineralogy. CTX data are collected as a single band in the VNIR. HiRISE data can be either greyscale (using the "red" band) or as color VNIR data. Figure 1 shows the spatial scale of surface features identifiable in these data.

Motivation: Examination of structural features and surface volcanic deposits with the combination of super-resolved TIR and high-resolution CTX and HiRISE data can provide additional insights into Mars' geologic setting and history. Previous workers have mapped Mars tectonic and structural features at a large scale [6, 7] and HiRISE data have been used to examine kilometer-scale features such as faults and folds [8]. However, it would be beneficial to understand the composition and competence of the beds being faulted or deformed within these structures. Super-resolved TIR data can provide this information, and aid our interpretation.

Mapping of volcanic flows on Mars was done with even the earliest satellite data [9]. Hypotheses had been put forward that the darker regions of Mars were lava fields even before the era of satellite exploration, based on telescopic observations [10]. With the advent of the modern Mars satellite program we can map volcanic fields over areas thousands of square kilometers in extent [11] down to individual ridges within a flow field [12]. The addition of TIR data enables the recognition of the composition and competence of individual flows [27], allowing workers to compare morphologies seen in Mars data to similar volcanic flows on Earth.

Location. Xanthe Terra is a highlands region located at the highland/lowland dichotomy boundary on Mars. It has a mix of rocks of various ages, including lava flows, exposed within it, and numerous Valles and Chasma provide views of the subsurface. Structurally, the region contains numerous wrinkle ridges, which may indicate subsurface faulting [14]. It is also located in close proximity to Valles Marineris, and the alignment of its structural features at a large scale may be driven by this proximity [16].

Specific Goals: Undergraduate students will use the JMars program [16] to map structural and volcanic features in Xanthe Terra, and to then use these maps with super-resolved TIR data to characterize these features. This will enable the scientific interpretation of these features, and allow us to gain insights into the geologic history of Xanthe Terra, and of Mars as a whole. Mapping will be done at an 8192 pixels per degree (PPD) scale to ensure that features as small as 1 kilometer are mapped and described. Metadata about these features, such as length, perimeter, composition from super-resolved TIR data, and location, will all be recorded in a database to allow comparison to similar efforts.

References: [1] P.R. Christensen et al. (2004) SSR 110, 85-130. [2] M.C. Malin et al.(2007) JGR 112. [3] A.S. McEwen et al.(2007) JGR 112. [4] C.G. Hughes and M.S. Ramsey (2010) Icarus 208, 704-720. [5] C.G. Hughes and M.S. Ramsey (2013) IJIDF 4, 52-74. [6] R.C. Anderson et al. (2001) JGR 106, 20563-20585. [7] R.C. Anderson et al. (2008) Icarus 195, 537-546. [8] C.H. Okubo (2010) Icarus 207, 210-225. [9] R. Greeley (1973) Geology 1, 175-180. [10] G.P. Kuiper (1957), The Astrophysical Journal 125, 307. [11] W.L. Jaeger et al. (2010) Icarus vol. 205, 230-243. [12] M.E. Banks et al. (2009) JGR. [13] D.A. Crown and M.S. Ramsey (2016) JVGR. [14] M. Golombek et al.(2001) JGR 106, 23811-23821. [15] S. Meresse et al. (2008) Icarus 194, 487-500. [16] P.R. Christensen et al., (2009) AGU Fall Meeting.

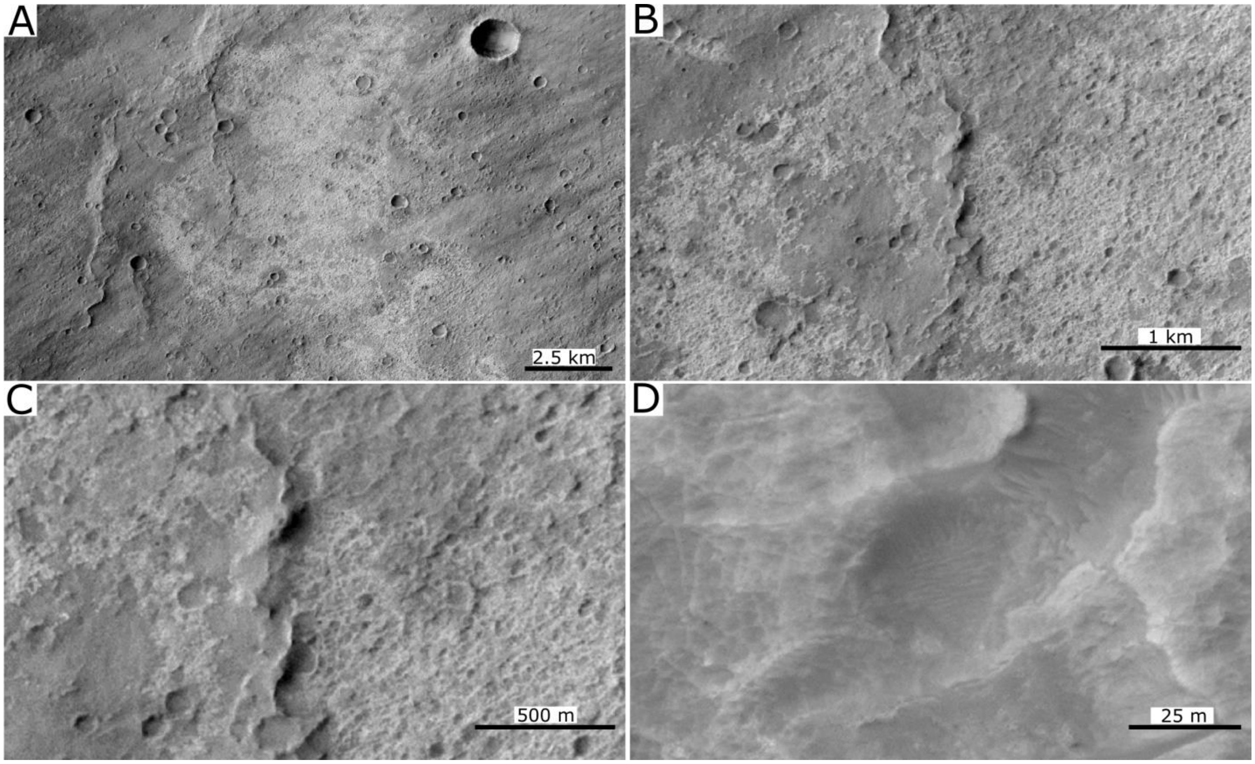

Figure 1. CTX and HiRISE data demonstrating data resolution. (A) is a CTX image, at 4096 pixels per degree (PPD), (B) is a CTX image at 16384 PPD, showing the details over one of the wrinkle ridges visible towards the west of the light-toned unit. (C) is a HiRISE image over the center area of (B), at 32,768 PPD. (D) is a demonstration of the spatial resolution of HiRISE: this figure is at 524,228 PPD.

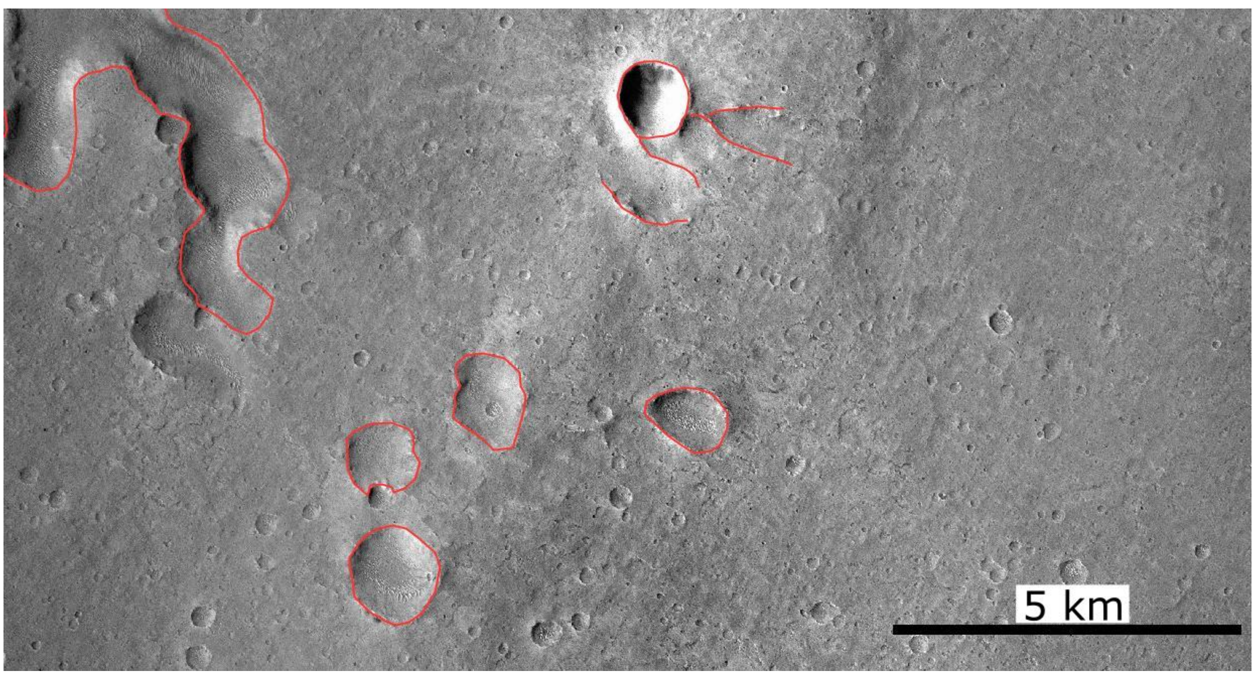

Figure 2. CTX image with mapped features shown. In this figure, several depressions and associated ridges have been outlined. These features are near Windfall Crater, in Xanthe Terra