GEOLOGIC EVOLUTION OF THE RUNANGA-JÖRN BASIN, NORTHEAST HELLAS, MARS. C. M. Fortezzo and J. A. Skinner Jr., United States Geological Survey, Astrogeology Science Center, 2255 N. Gemini Dr, Flagstaff, AZ, cfortezzo@usgs.gov.

Introduction: On Earth, exposed sections of geologic strata within topographic and structural basins provide critical information about syn- and post-tectonic basin fill. The study of terrestrial basins relies heavily on local observations of meter- to decameter-scale bedding or bundles of layered deposits in order to augment and refine hypotheses regarding the basin and regional geologic history [1]. On Mars, the inverse applies: basin studies rely on regional observations to infer generalized basin settings (i.e., formation and extent) [3-5], which are refined through local observation afforded by high-resolution images [6, 7].

Recent satellite-based observations, including images from the Thermal Emission Imaging System (THEMIS) on Mars Odyssey and Context Camera (CTX) and High Resolution Imaging Science Experiment (HiRISE) on Mars Reconnaissance Orbiter (MRO), have provided unprecedented levels of context and detail on the areal distribution and internal characteristics of layered sequences within martian basins [2, 6, 7, 10-13]. These data can now be used to investigate outcrops of eroded, depression filling sediments on Mars, which in turn provide fundamental constraints on martian tectonism and climate change.

The widespread occurrence, varied internal architecture, and common aqueous mineral signatures of basin-related (non-polar) layered rocks and sediments on Mars are critically important for an improved understanding of water-based geologic processes and the search for life on that planet. For example, despite their pervasive occurrence, it remains unclear what materials occupy the many irregularly-shaped (principally non-crater) topographic basins within the martian highlands and if these materials implicate a regional to global stratigraphic sequence. However, our understanding is heavily reliant on the ability to effectively compare and contrast the geologic details of stratified sequences (such as periodicity of bedding [2] or facies gradations [7]), which in turn is reliant on the adequacy of technical methods to effectively extract and consistently convey critical geologic observations into geologic map products [14].

Here, we present the beginning stages of a study that leverages high-resolution images to comprehensively detail the geologic evolution of an under-characterized portion of the martian surface using contrasting map scales and “measured” stratigraphic sections. This ultimate goal of this work is to specifically assess the limitations of currently established photogeologic mapping methods by examining the effect of scale in portraying geologic relationships. Applying similar techniques to a terrestrial basin will allow exploration of the limitations of remote mapping techniques on Earth and Mars.

Runanga-Jörn Basin, Mars: The “Runanga-Jörn” basin is a roughly ovoid-shaped, 160 km long by 80 km wide depression adjacent to Runanga and Jörn craters on the northeast rim of Hellas basin (**Fig. 1A**). The easternmost margin of the basin is dissected by channels whose orientation implies drainage of the adjacent Noachian-age cratered plains from the north, east, and south. The basin surface occupies an elevation range from -2450 to -2700 m, with a very slight west-southwest slope (<0.1°). The westernmost margin of the basin is generally un-dissected except for a single groove-like channel that debouches into 171.5-km-diameter Terby crater (-28.0°N, 74.1°E). No through-flowing channel is readily apparent within the basin based on Viking, MOLA, or THEMIS data sets.

The THEMIS daytime IR images show characteristic scalloped depressions wherein layered sequences can be locally observed. A HiRISE stereo pair positioned over these depressions (PSP_006198_1525 and PSP_010839_1525, **Fig. 1B**) shows a complex sequence of bright and dark layered materials exposed within the margins of eroded buttes and mesas. Details of these deposits, as displayed in the high-resolution image, include: (1) dark-toned units with superposed channel-like forms (**Fig. 2A**), (2) medium-toned basal units with meter-scale columnar joints (**Fig. 2B**), (3) multiple asymmetric channel cross sections located within light-toned wall-rock (**Fig. 2C**), and (4) dark-toned capping strata and interbeds. Vertical and lateral variations in exposed materials suggest a level of detail commensurate with that required to discern not only the stratigraphic architecture of these rocks and sediments but also the geologic evolution of the Runanga-Jörn basin.

Implications: Based on our observations, one hypothesis is that the build up of highland regolith in this region was followed by a period of volcanism and depositon of the columnar jointed materials. The volcanic activity was followed by a build up of laminar strata, (perhaps as ash-fall from waning volcanism), eolian, and/or laminar flows that have been incised by low-slope channels, and (in some instances) braided, run-off. Channels occur in both vertical succession and with multiple lateral instances, indicating a long-lived system with a periodically recharged source region.

The intermittent burial of those streams likely by a mélange of impact, eolian, and volcanic materials, was followed much later by another episode of downcutting preserved as a wide trough with channel features on the floor of the valley. This final period of downcutting is what gives us insight into preserved history of the basin.

Other hypotheses for the evolution of the Runanga-Jörn basin will likely be formed and tested as the regional and local geologic histories of this area are advanced. We plan to test these hypotheses by mapping the regional and local geology at the 1:10,000- and 1:1,000-scales, respectively. We will also use stratigraphic columns to link units, where possible, and tie channel cross sections to each other. These will allow us to create fence diagrams and piece together the stratigraphy and fluvial history of the basin. Theses data will give us a better understanding of the depostional environment, local climate history, and geologic evolution of the region.

References: [1] Allen P.A. and J.R. Allen (1990) *Blackwell Sci., 451 pp;* [2] Lewis, K.W., et al. (2008) *JGR, 113*; [3] Mcgill, G.E. (1996) *JGR, 94*. [4] Schultz, P.H., et al. (1982) *JGR 87*; [5] Skinner, J.A. Jr. and K.L. Tanaka (2007) *Icarus*, 186-1; [6] Wilson, S.A., et al. (2007) *JGR*, 112; [7] Ansan, V., et al. (2011) *Icarus*, 211-1; [8] Scott, D.H. and K.L. Tanaka (1986) *USGS SIM I-1802-A*; [9] Greeley, R. and J.E. Guest (1987) *USGS SIM I-1802-B*; [10] Hynek, B. and R. Phillips (2008) *Geology*, 29-5; [11] Pondrelli, M., et al. (2008) *Icarus*, 197-2; [12] Wray, J.J., et al. (2009) *Geology*, 37; [13] Fuenten, F., et al. (2010) *Earth & Planet. Sci. Let.*, 294-3-4; [14] Tanaka, K.L., et al (2009) *Planet. Space Sci.*, 57-5-6.

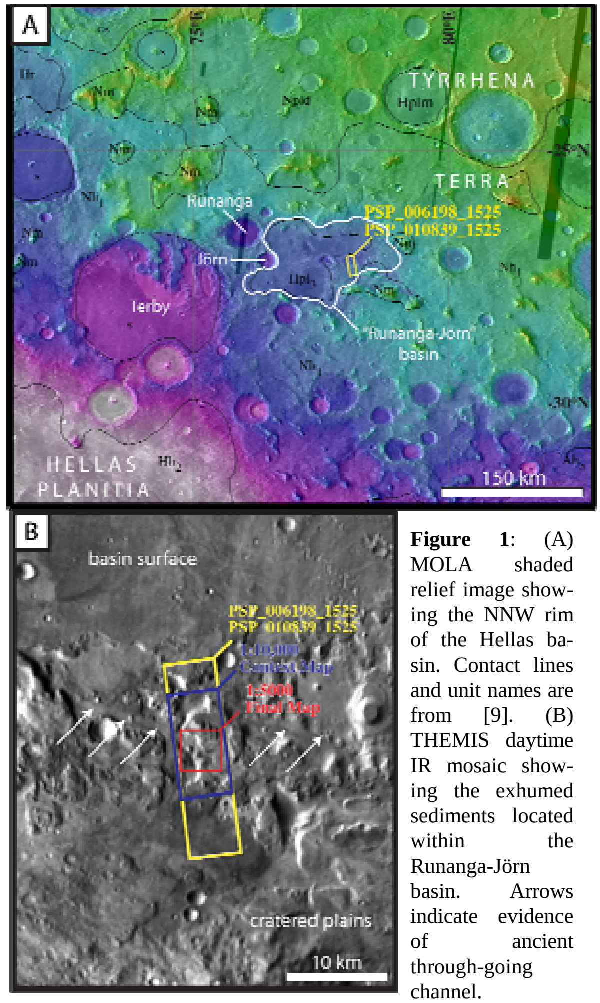

Figure 1: (A) MOLA shaded relief image showing the NNW rim of the Hellas basin. Contact lines and unit names are from [9]. (B) THEMIS daytime IR mosaic showing the exhumed sediments located within the Runanga-Jörn basin. Arrows indicate evidence of ancient through-going channel.

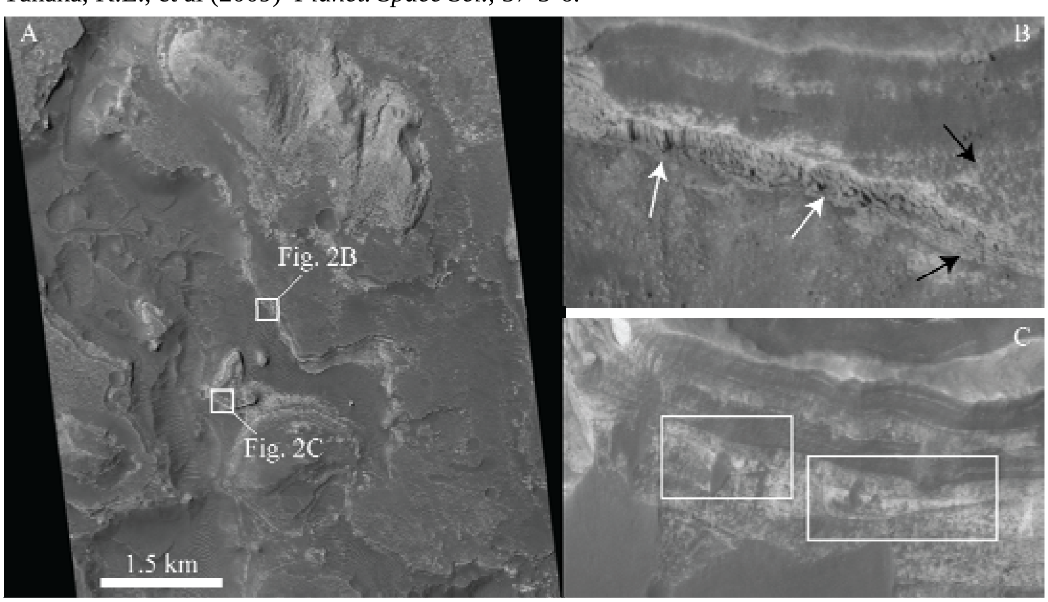

Figure 2. Excerpts of HiRISE image number PSP_006198_1525. (A) Central portion of image showing mesas and plateaus and intervening dark material. (B) Basal sequence of apparent columnar joints, whose texture and tone suggest an origin as welded volcanic ash. (C) Middle to upper sequences showing cross-sections of fluvial channels.