GEOLOGIC HISTORY OF RUNANGA-JÖRN BASIN, NORTHEAST HELLAS, MARS: BASED ON MODELED CRATER AGES. C. M. Fortezzo and J. A. Skinner, Jr., Astrogeology Science Center, U.S. Geological Survey, 2255 N. Gemini Dr, Flagstaff, AZ, 86001 (cfortezzo@usgs.gov).

Introduction: Basins within the highland terrain of Mars include impact craters and topographic lows within the intra-crater plains (palus, *pl.* paludes). These basins collect materials from volcanic (flow, pyroclastic, and ash), sedimentary (e.g., fluvial, lacustrine, eolian, and mass movement), and impact processes. Recent rover missions have landed in these highland basins at Merdiani Planum and Gusev crater with the Mars Exploration Rovers A and B [e.g., 1], and Gale crater with the Mars Science Laboratory [e.g., 2]. Materials in these regions include those derived from volcanic, sedimentary, impact and eolian processes. Though these areas were chosen for both engineering requirements and potential science return, numerous other craters and paludes exist in the highlands. Many of these sites record a diverse history of geologic processes, and some of these deposits are exposed through post emplacement erosion.

Background: Of particular geologic interest is an improved understanding of the basin-related sequences that fill topographic lows within the cratered highlands. These regions have been mapped globally as a variety of geologic units, including Noachian to Hesperian units of the plateau and highland assemblage, Hesperian "ridge plains" units, and Hesperian to Amazonian crater fill units using Viking data [3-4], and late Noachian and early Hesperian highland and highland undivided (layered) materials using THEMIS daytime infrared data [5]. Though these units are pervasive based on regional to hemisphere-scale mapping, their internal architecture is only partly understood due not only to limited instances of material exhumation but also the limited areal extent and number of high-resolution images that transect these exposed strata.

Datasets: For describing the regional context, we used a portion of a mosaic of High Resolution Stereo Camera (HRSC) images (h0389_0000, h0411_0000, h6430_0000, 12.5 m/pixel), and stereo-derived digital terrain models (100 m/pixel) merged into a seamless product. To find sutable locations for and perform the crater counts, we used a patchwork of Context Camera (CTX, ~6 m/pixel) images partially covering the same area as the HRSC mosaic.

Data were overlain in Environmental Systems Research Institute™ (ESRI) ArcGIS® software package, which allowed for further analysis using a high-resolution digital terrain model created from a matched set of HiRISE images. We used an ArGIS add-on, CraterTools [6], to perform crater counts down to 100 m diameters on discrete surfaces of known areal extents. These data were exported into IDL-based CraterStats program to derive model ages based on established chronology and production functions [7-8].

Regional Physiography: The Runanga-Jörn basin (center at 27.4ºS, 78.2ºE) is located in Noachian- and Hesperian-age terrains on the northern margin of Hellas basin, west of Hadriaca Patera. This region is characterized by Noachian-age mountains, which rise >1500 m above adjacent basin-filling plains. These mountains are interpreted to be degraded vestiges of crustal blocks that were uplifted by the Hellas multi-ring impact [9]. The inter-montane regions are defined by a topographic and structural basin that are generally occupied by rugged and locally dissected Noachian-age cratered plains interpreted as predominantly impact-generated breccias derived from the ancient Martian crust [10].

The low-lying intercrater plains and the materials that occupy them broadly constitute the highland plateau assemblage, collectively (and variably) interpreted as undifferentiated sequences of impact breccias, lava flows, and sedimentary deposits derived from eolian and fluvial processes [4]. Erosion of these units in the vicinity of craters Runanga and Jörn has resulted in the exposure of layered materials both within the intercrater plains as well as in "smooth floor units" of adjacent impact craters [4].

Local Physiography: The Runanga-Jörn basin is roughly ovoid in planimetric shape and 160 km long by 90 km wide, with a total relief of ~4km (**Figure 1**). The high standing eastern and northern margins of the basin are fluvially dissected with orientations impling drainage of the adjacent Noachian cratered plains into the basin. The roughly circular nature of these margins and the alignment of massifs suggest the existence of several overlapping, ancient impact craters, which likely post-date the Hellas impact (though this will be examined in future work). Runanga and Jörn craters (41 km and 20 km diameters, respectively) dominate the northwest portion of the basin and ejecta from Jörn obscures a portion of the widespread basin surface materials. This 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 un-dissected except for a single groove-like channel that debouches into the 171.5-km-diameter Terby crater (-27.96N, 74.14E). There is no apparent channel connecting the inflow channels in the north and east with the channel into Terby, potentially indicating ponding within the local basin. Alternatively, these connecting channels could be buried by later infilling processes. The lower standing southern margin, relative to the northern and eastern margin, of the basin has plateaus, buttes, scarps, channels, and scalloped depressions adjacent to several high-relief massifs. The southern margin has ~1km of relief from the massifs to the bottom of the scalloped depression. Layered sequences are exposed in the scalloped depressions north of the massifs and these sequences are the focus of this study.

Crater Statistics: The main focus of this study is to establish model ages of the representative surfaces in the region in advance of more detailed stratigraphic studies. This will assist with bracketing the timing of the fluvial activity in the region. The fluvial features themselves are not useful for crater statistics, and their corresponding deposits are difficult to distinguish from other deposits in the region. We have identified areas that could help to bracket the ages (numbers correspond to **Figure 2** and **Table 1**): (1) northern inner flank materials, (2) eastern flank materials, (3-5) northern to western basin floor materials, (6 and 7) higher-standing flank materials, and (8) cap rock materials where a set of channels are assumed to originate.

The crater statistics indicate that materials have been deposited here since the Early to Middle Noachian, especially near the high standing regions (Areas 1, 2, and 7). These materials may be related to the formation of the basin or may be deposits from adjacent ancient impacts. The modeled ages within the Hesperian (Areas 3 and 4) are related to deposits that have preserved channel forms and provide good brackets for a maximum age range for fluvial activity. The youngest ages, near the Hesperian Amazonian boundary represent the last widespread geologic event besides recent eolian processes in the region.

Future Work: We plan to create two geologic/geomorphologic maps in the Ranunga-Jörn basin: (1) a regional map of the area, and (2) a local, HiRISE scale map of the exposed strata on the southern basin margin. Additional crater ages will be modeled on significant surfaces with distinct material properties and sufficient craters. This work is being used as a mapping analog with a terrestrial basin in Verde Valley, Arizona to develop protocols and investigate limitations for remotely mapping basins.

References: [1] Squyres, S.W., et al. (2003) *J. Geophys. Res.*, 108. [2] Milliken, R.E., et al. (2010) *Geophys. Res. Letters*, 37. [3] Scott, D.H. and K.L. Tanaka (1986) *USGS SIM I-1802-A*. [4] Greeley, R. and J.E. Guest (1987) *USGS SIM I-1802-B*. [5] Tanaka, K.L., et al. (*in review*) Mars Global Geologic Map. [6] Kniessl, T., et al. (2011) *Plant. Space Sci.*, 59(11-12). [7] Michael, G.G. and G. Neukum (2010) *Planet. Sci. Letters*, 294(3-4). [8] Platz, T., et al. (*in review*) *Icarus*. [9] Schultz, P.H., et al. (1982) *JGR 87*. [10] Leonard, G.J. and Tanaka, K.L. (2001) *USGS SIM I-2694*.

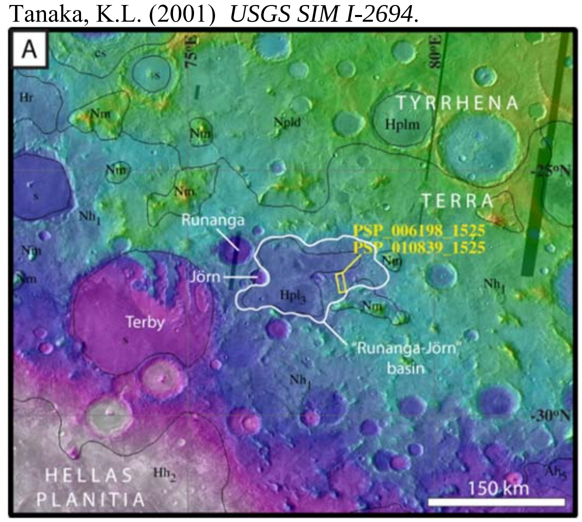

Figure 1: MOLA shaded relief image showing the NNW rim of the Hellas basin. Contact lines and unit names are from [9]. The Runanga-Jörn basin is located within an intercrater basin, adjacent to uplifted crustal massifs. The elevation ranges from ~9700 m (yellow) to ~-6450 m (white).

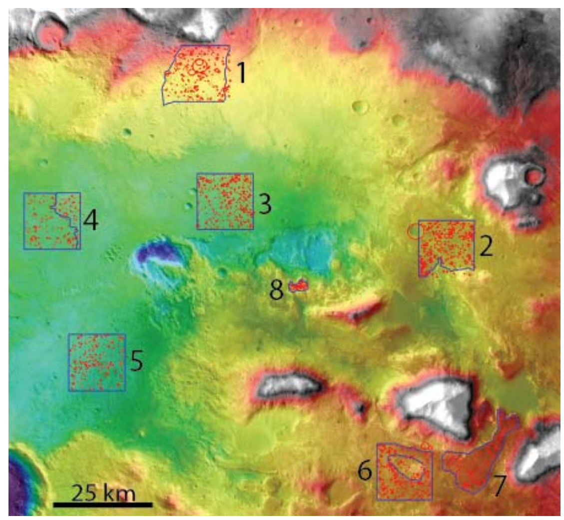

Figure 2: HRSC color shaded relief overlying HRSC images showing Runanga-Jörn basin. Blue boxes identify the exents of the areas counted. The red circles represent the craters counted. The numbers correspond to those in Table 1. The elevation ranges from ~250 m (white grey) to ~-3,750 m (blue indigo).

Table 1. Modeled Crater ages for locations in Figure 1

Count ID	Age (Ga)	Resurfacing (Ga)
1	4.06±0.10	3.39±0.18
2	3.89±0.05	3.69±0.03
3	3.38±0.08	NA
4	3.45±0.20	NA
5	3.38±0.28	2.34±0.38
6	3.69±0.06	3.46±0.05
7	3.97±0.14	3.45±0.07
8	3.73±0.21	NA