GEOLOGIC MAPPING IN SOUTHERN MARGARITIFER TERRA ON MARS AND THE EVOLUTION OF NIRGAL VALLIS. S. A. Wilson[1], J. A. Grant[1], and D. L. Buczkowski[2], [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, 6th at Independence SW, Washington, DC (wilsons@si.edu), [2]Johns Hopkins University, Applied Physics Laboratory, Laurel, MD.

Introduction: Geologic mapping in Mars Transverse Mercator (MTM) quadrangles -20037, -25037, -30037 and -30032 encompasses Uzboi Vallis and terrain west of Holden and Ladon basins in southern Margaritifer Terra (**Fig. 1A**). This region preserves a long record of aqueous activity, and mapping helps to constrain the timing, source, duration and relative importance of aqueous versus other geomorphic processes (**Fig. 1B**).

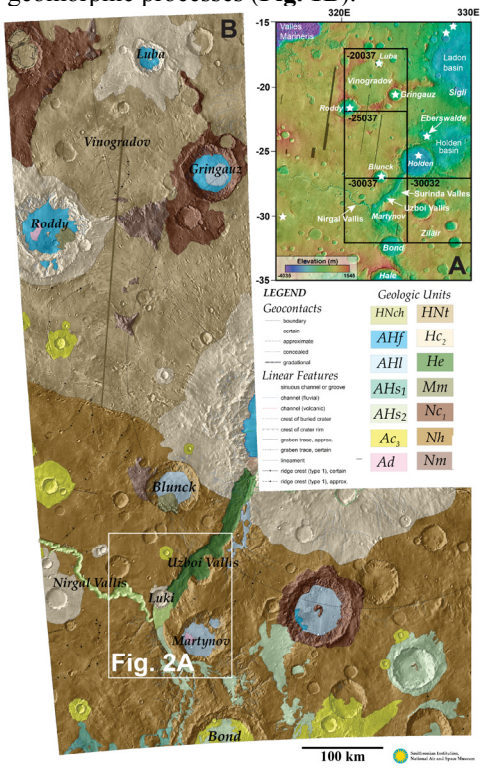

Fig. 1. A) Map quads cover 17.5°S-32.5°S, 320°E-325°E and 27.5°S-32.5°S, 325°E-330°E (black boxes). Stars mark craters with alluvial fans [1-2]. MOLA over THEMIS IR. **B**) Preliminary geologic map, 1:1M scale. Box shows location of Fig. 2A.

Background: The Noachian-Hesperian age [1] Uzboi-Ladon-Morava outflow system dominates the regional drainage from Argyre to the northern plains [3-7]. Holden crater formed in the mid to Late Hesperian [7] and blocked the northern end of Uzboi Vallis, creating an enclosed basin within Uzboi that flooded and formed a large paleolake [8]. Nirgal Vallis is a 670 km-long [9] east-west trending valley network that debouches into Uzboi along its western flank south of crater Luki (**Figs. 1 and 2A**). Despite being Uzboi's largest tributary, one of the outstanding questions regarding the geologic history of this region is the age, timing and duration of fluvial activity within Nirgal Vallis [8]. Furthermore, it was unclear whether discharge from Nirgal contributed to the relatively short-lived lake in Uzboi or if fluvial activity in Nirgal terminated prior to the filling and draining of the Uzboi basin [8]. Hence, the nature of a deposit on the floor of Uzboi Valles at the mouth of Nirgal helps constrain possible sources of water for Lake Uzboi [8] and furthers our understanding of the aqueous history of this region that extended into the Late Hesperian.

Observations and Results: The deposit at the mouth of Nirgal Vallis consists of a fairly small (~40 km^3), symmetric fan-shaped deposit (**Fig. 2A**) that is stratigraphically on top of a larger (~200 km^3) mound of light-toned material. The lower mound is offset downstream toward Holden crater (**Fig. 2B**) [11] and is incised by a few shallow and poorly integrated channels [6]. The total estimated volume of the deposit at the mouth of Nirgal (upper fan-shaped material and underlying mound) is significantly less (~240 km^3) than the approximate volume of material removed from Nirgal Vallis (~1600 km^3) [10-11].

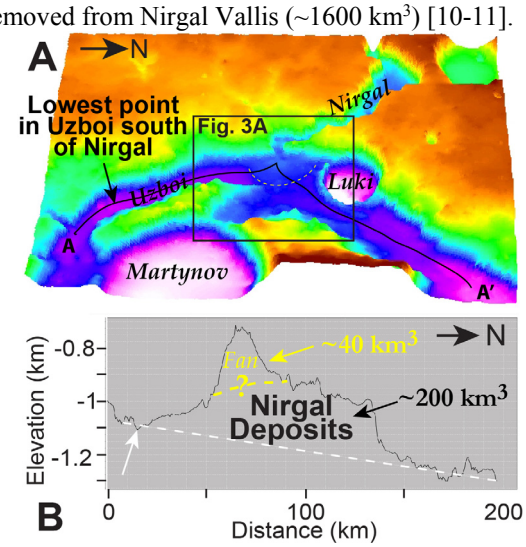

Fig. 2. A) Perspective eastward-looking view of deposit in Uzboi at confluence of Nirgal Vallis, dashed line indicates symmetric upper fan deposit at mouth of Nirgal (MOLA 8x VE, scene elevation ranges from 1060 to -1764 m, see Fig. 1B). For scale, crater Luki is D~20 km. Transect corresponds to profile in (B). **B**) Profile on Uzboi floor in (A), arrow indicates low point in Uzboi south of Nirgal. Dashed line projects Uzboi floor beneath Nirgal deposits.

Nature of the upper fan-shaped deposit at mouth of Nirgal Vallis (**Fig. 3A**): Proximal to the mouth of

Nirgal, the fan surface appears degraded, consisting of light-toned material that incorporates meter-scale blocks and lacks obvious layering [11]. Preliminary analysis of one relatively noise-free CRISM FRT (**Fig. 3B**) indicates the presence of olivine, small outcrops of low-calcium pyroxene and possible aluminum phyllosilicates. The distal fan surface ~15 km southeast of the confluence of Nirgal and Uzboi has hints of layering and may incorporate different rock types (**Fig. 3C**). The southern margin of the deposit (**Fig. 3D**) exposes light-toned horizontal layers near the fan surface [10-11] (**Fig. 3E**) and layers near the base dip ~5° to the SE **(Fig. 3F**).

Discussion: The net difference in volume between the Nirgal deposits in Uzboi relative to the volume of material eroded from Nirgal Vallis suggests most of the material eroded by Nirgal debouched into Uzboi when there was active flow through the system, thereby resulting in much of the sediment being transported downstream. The bulk of the deposit that is offset downstream beneath the fan-shaped deposit (**Fig. 2B**) suggests the majority of the incision of Nirgal likely pre-dated deposition into Lake Uzboi. The roughly symmetrical fan-shaped deposit at the mouth of Nirgal Vallis today, however, may be indicative of deposition into Lake Uzboi, an environment consistent with the form of the deposit and associated gently dipping layers (**Fig. 3**). If correct, this implies that late fluvial activity in Nirgal was concurrent with Lake Uzboi and (or) was related to water draining out of Uzboi as the lake drained northward into Holden.

References: [**1**] Moore, Howard 2005 *JGR*, doi:10.10 29/2005JE002352 **[2]** Wilson et al. 2013 *LPSC* Abst. 2710 [**3**] Grant 1987 NASA Memo 89871, 1-268 [**4**] Grant, Parker 2002 *JGR*, doi:10.1029/20 01JE001678 [**5**] Parker TJ 1985 Thesis, Cal. State [**6**] Saunders SR 1979 USGS Map I-1144 [**7**] Irwin, Grant 2013 USGS Map I-3209 [**8**] Grant et al. 2011 *Icarus*, doi:1 0.1016/j.icarus.20 10.11.024 [**9**] Reiss, D. et al. 2004 *JGR* doi:10.1029/2004JE002251 [**10**] Wilson, Grant 2016 *LPSC* Abst. 2505 [**11**] Wilson, Grant 2016 *PMM* Abst. 7034 [**12**] Kneissl et al. 2010 *LPSC* Abst. 1640.

Fig. 3. A) Upper fan deposit at mouth of Nirgal (dashed line, see Fig. 2A). **B)** Mosaic of CRISM Map-projected Targeted Reduced Data Record (MTRDR) images FRT 1B5F2 (upper) and 16554 (lower), see Fig. 3A. The MTRDRs are map-projected and standardize CRISM-measured spectral radiance to what they would be for each scene if viewed entirely at nadir, with normal illumination, without atmospheric gas absorptions, by an artifact-free instrument with a single optical path and full spectral range detector. Spectral parameter images overlie corrected I/F imagery to show the location of olivine (OLINDEX: red), low-calcium pyroxene (LCPINDEX: green) and Fe/Mg phyllosilicates (D2300: blue). **C)** Degraded fan surface with color and textural variations may suggest different rock types; arrows indicate possible layering. HiRISE PSP_ 003565_1495. **D)** 3-D view of southern margin of Nirgal deposit ~15 km from the mouth of Nirgal (5X VE). HiRISE DTM ESP_042082_1495 (image ~6 km across). **E)** Light-toned, fine-grained layers along fan surface. **F)** Strike and dip (blue symbols) of layers exposed near the base of fan deposit dip ~5° to the SE (from LayerTools software [12] in ArcGIS).