GEOLOGIC MAPPING AND THE GRADATIONAL HISTORY OF SOUTHERN MARGARITIFER TERRA ON MARS. S. A. Wilson[1], J. A. Grant[1], D. L. Buczkowski[2], and C. M. Weitz[3]. [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, 6th at Independence SW, Washington, DC, USA (wilsons@si.edu). [2]JHU-APL, Laurel, Maryland, USA. [3]Planetary Science Institute, 1700 East Fort Lowell, Suite 106, Tucson, AZ 85719, USA.

Introduction: Southern Margaritifer Terra on Mars preserves a long record of aqueous processes (**Fig. 1**). The Noachian-Hesperian age [1] Uzboi-Ladon-Morava (ULM) outflow system dominates the regional drainage from Argyre to the northern plains [1-4]. Holden crater formed in the mid- to Late Hesperian [5] and blocked the northern end of Uzboi Vallis, thereby creating an enclosed basin that flooded and formed a large paleolake [6]. Alluvial fans in Holden and other craters were active as late as the Amazonian-Hesperian boundary [e.g., 7]. Finally, aqueous deposits related to the Hale impact may have modified Uzboi Vallis and its tributaries [8] as late as the early-to-middle Amazonian [9].

Preliminary geologic mapping in Mars Transverse Mercator (MTM) map quadrangles -20037, -25037, -30037 and -30032 on Mars encompasses Uzboi Vallis and terrain to the south, west and northwest of Holden crater (**Fig. 1)**. This 1:1M scale geologic map broadens the regional framework by constraining the timing, duration and the relative importance of aqueous and other geomorphic processes (**Fig. 2**).

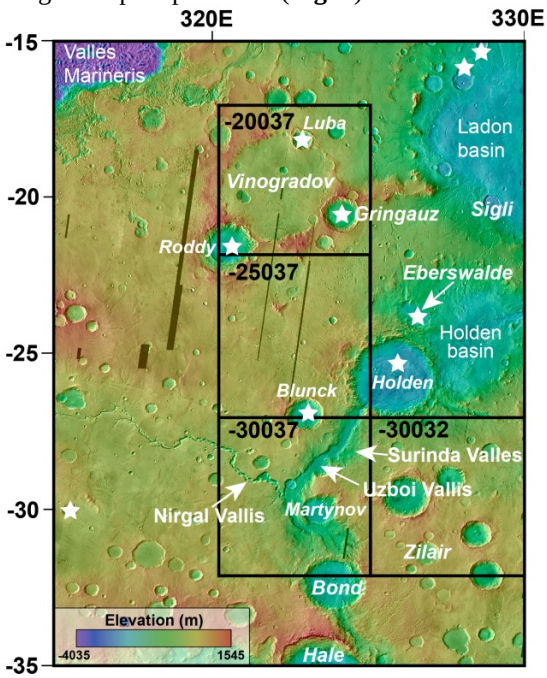

Figure 1. Map quads from 17.5°S-32.5°S, 320°E-325°E and 27.5°S-32.5°S, 325°E -330°E (black boxes) and major place names. Stars mark craters hosting alluvial fans [e.g., 15-16]. MOLA over THEMIS day IR.

Preliminary Description of Map Units (Fig. 2):

Plateau and Highland Materials. The oldest material in the map area are remnant high-standing bedrock promontories from the Ladon and Holden basin ring structures, mapped as Early to mid-Noachian Mountainous unit (*Nm*) [10]. A large outcrop of unit Nm occurs along the southern rim of Vinogradov crater near one intersection of the basin ring structures.

The Highland unit (*Nh*) is likely late Noachian to early Hesperian in age and occurs primarily in -30037 and -30032. This unit is heavily cratered, differentially mantled, contains older valley networks, grabens, a few wrinkle ridges, and lacks evidence of the phyllosilicate layer observed in the Terra unit (*HNt*) [11]. Unit Nh embays unit Nm and underlies all other units.

The Late Noachian to Early Hesperian Terra unit (*HNt*) is characterized by widespread, smooth to rolling, cratered and variably dissected surfaces between degraded impact craters [12]. In MTM -25037, unit HNt occurs beneath the continuous Holden ejecta (unit Hc_2) and was modified by secondary craters related to the impact. Unit HNt west of Uzboi Vallis consists of a ~10 m-thick, laterally continuous Fe/Mg-smectite phyllosilicate-bearing layer located a few meters below the surface cap material and stratigraphically above Al-phyllosilicates [13-14].

Crater and Channel-Fill Units. The Late Noachian to Early Hesperian Channel unit (*NHch*) are fluvially eroded surfaces related to the initial incision of Uzboi Vallis [12]. The floor of Uzboi Vallis is mapped as Early to Late Hesperian Etched unit (*He*), characterized by erosionally resistant material exposed where aeolian deflation has selectively removed light-toned layered material [12]. A similar appearing etched unit occurs on the floor of crater Gringauz and an unnamed crater near 29°S, 326.6°E (although these deposits will likely not be unit He in the final map). The floor of Nirgal Vallis is tentatively mapped as *NHch* but will likely change upon further investigation of its origin, age and relation to Uzboi.

The Late Hesperian to Early Amazonian Smooth unit (*AHs*) in the southern part of the map is a darker-toned deposit that is smooth at scales of 10s to 100s of m, typically bright in THEMIS day IR and has variable thickness. Channels and streamlined deposits are common close to Hale crater south of the map area [9] (**Fig. 1**). Unit AHs occurs in pre-existing valleys, topographic depressions and craters and forms locally as lobes with distinct margins [9]. Some flows deposited

lobes characterized by roughly parallel ridges oriented perpendicular to the presumed direction of flow. Aeolian bedforms and extensive cracks are common on lobe surfaces and layering is not evident [8]. The deposit embays secondary craters from Hale and thins with increasing distance from Hale. We interpret these to be aqueous deposits that are related to and immediately post-date the formation of crater Hale. Local aeolian erosion of the distal margins of the lobes implies a fine-grained component, perhaps produced by weathering [8].

The Late Hesperian to Early Amazonian Fan unit (*AHf*) consists of sloping or cone-shaped deposits that occur on the interior slopes of craters [12]. Distributary paleo-channel networks are preserved in negative or (more commonly) positive relief. Cone-shaped deposits derived from deeply dissected impact crater walls coalesced into fans in craters Luba, Roddy, Gringauz and Holden. The deposits appear bright in THEMIS nighttime IR. We interpret AHf as alluvial deposits composed primarily of gravel and fines [e.g. 7, 15] emplaced by fluvial sediment transport with little to no evident contribution from debris flows. At HiRISE scale, there is a low abundance of boulders.

Crater Units. The Noachian aged Crater 1 unit (Nc_1) is characterized by rim remnants of heavily modified craters with little to no preserved ejecta (e.g., craters Vinogradov, Roddy and Gringauz). The Late to Early Hesperian Crater 2 unit (Hc_2) are moderately degraded craters with relatively continuous ejecta (e.g., craters Holden and Luba). Late Hesperian to Late Amazonian Crater 3 Unit (Ac_3) are morphologically "fresh" craters with well-preserved ejecta, little rim modification and (or) infilling.

Surficial Deposits. The Hesperian to Amazonian (?) Mass movement unit (*Mm*) is a single to multi-lobed shaped deposit with distinct margins. It occurs in craters Roddy and Blunck and is interpreted to be landslides possibly triggered by nearby impacts.

The Late Amazonian aged Dune unit (*Ad*) after [12] are concentrations of typically dark-toned bedforms that are dark in THEMIS nighttime IR data and are interpreted to be aeolian dunes.

References: [**1**] Grant, JA, 1987, NASA Tech. Memo. 89871, 1-268 [**2**] Grant, JA., TJ Parker, 2002, *JGR*, *107*, doi:10.1029/2001JE001678 [**3**] Parker, TJ, 1985, M.S. Thesis, Cal. State Univ. [**4**] Saunders SR, 1979, USGS Map I-1144 [**5**] Irwin, RP, JA Grant, 2013, USGS Map I-3209 [**6**] Grant, J.A. et al., 2011, *Icarus*, *212*, doi:10.1016/j.icarus.2010.11. 024 **[7]** Grant, JA and SA Wilson (2011), *GRL*, 38, L08201, doi:10.1029/2011GL046844. [**8**] Wilson SA et al., (2013), *Abs. Ann. Mtg. Planet. Geol. Mappers*, Washington, DC. **[9]** Jones et al. (2011), *Icarus*, doi:10.1016/j.icarus.2010.10.014. **[10]** Shultz et al. (1982), *JGR*, 87, 9803-9820. [**11**] Wilson SA et al., (2014), *Abs. Ann. Mtg. Planet. Geol. Mappers*, Flagstaff, AZ. **[12]** Irwin, RP III and JA Grant (2013), *USGS Map* 3209 **[13]** Buczkowski, DL et al. (2010), *LPSC*, Abst. 1458 **[14]** Buczkowski, DL et al. (2013), *LPSC*, Abst. 2331 **[15]** Moore, JM and AD Moore (2005), *JGR*, 110, doi:10.1029/2005 JE002352. **[16]** Wilson et al. (2013), *LPSC* Abst. 2710.

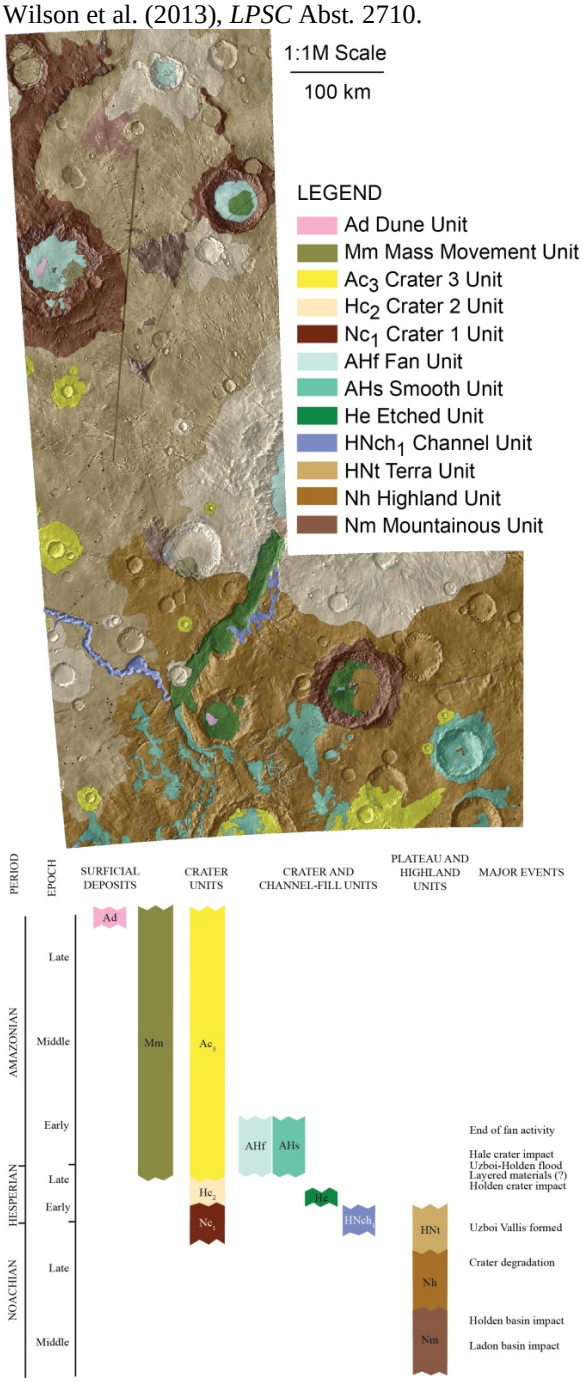

Figure 2: Preliminary geologic map at 1:1M scale (top) and correlation of map units (COMU, bottom).