EROSION AND TERRAIN INVERSION IN NORTHEAST ARABIA TERRA. C. I. Fassett and J. W. Head, Dept. of Geological Sciences, Brown University, Providence, RI. 02912 (Caleb_Fassett@brown.edu).

Introduction: The northeast part of Arabia Terra directly west of Syrtis Major is marked by two widespread morphological units: dissected terrain (Npld) and etched terrain (Nple) [1]. In both of these units, but especially in the etched terrain, there is evidence for inverted topography, such as old craters and valleys that now lie above the surrounding plains. The formation of this inverted terrain requires infilling of formerly low-lying regions (gradation) and preferential removal of the former surrounding topography (erosion). Grant and Schultz [2] made a detailed examination of this region based on Viking data, with a focus on the timing of gradational and erosional episodes. Here, on the basis of new data, we reexamine the geological history of the etched and dissected units in northeast Arabia Terra, specifically focusing on a region from 45-55 °E and 5-25 °N, which is centered on the transition from the dissected unit (SW) to the etched unit (NE) (Fig. 1).

Regional/Unit Characteristics: Virtually the whole northeast Arabia Terra region has low thermal inertia ($I<200$ J/(K m^2 $s^{0.5}$)) [3, 4], which is consistent with widespread surface dust or lightly indurated fines, and minimal surface rock abundance. The regional slope is from the south to north, averaging 0.07°. Figure 1 shows a THEMIS IR daytime mosaic of the region, and the boundary between Npld and Nple.

Basement material in both the Nple and Npld is quite ancient. Counting all craters on Viking data (including the most degraded ones), Grant and Schultz [2] derived a common N5 age of 3.5 (cumulative $\log_{10}$ number of craters > 5 km in diameter per 10^6 km^2) for both units, with craters smaller than 20 km diverging from the expected production function. Based on their work, the crust in this region thus dates to the mid-early Noachian [5]. However, much of the surficial material has been substantially reworked subsequently.

Etched terrain (Nple). The etched unit is marked by the widespread (but not universal) presence of an eroded/eroding layered material (100-200 meters in thickness) which fills the interior of craters and valleys. In some locations, this fill material sits above its surroundings and terrain inversion has occured (Fig 2.). Locally, the fill material is cracked and/or pitted. In general, its surface age is much less than the etched terrain as a whole, based on the relatively infrequent superposition of pristine small craters on the etched/fill material; in Grant and Schultz's crater counts, this unit could be as young as the early Amazonian (N5 age 1.6-1.7), though continual (but perhaps declining) modification may have occured since its emplacement. As the etched terrain has been eroded, ancient underlying material is likely exposed. There are only a few valley networks in the etched region.

Dissected terrain (Npld). The dissected terrain is marked by widespread erosion by dendritic valley networks. At regional scale, valley networks appear similar to those in other portions of highlands [e.g., 6], and probably date to the Late Noachian like most highland valley networks (N5=2.7 [2]). In low elevation portions of the dissected units (predominately in degraded craters), crater fill material is present similar to what is observed in the etched terrain.

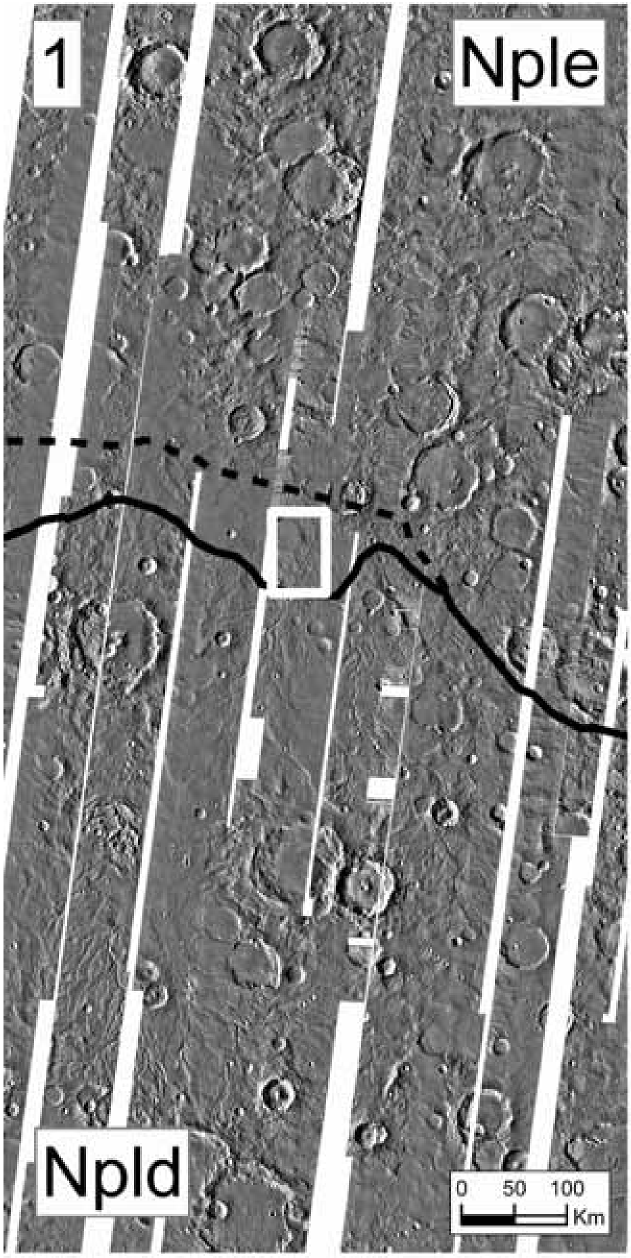
Transition: Given that the fill material, which is the most prominent characteristic of the etched terrain, extends into the dissected unit, it is tempting to think of the transition between these morphological units as gradational. However, new data illustrates that the transition between valleys and inverted valley forms is (at least locally) abrupt (see Fig 3.) Even more intriguingly, although valleys exhibit a graded profile (south to north) consistent with their erosion by surface water, the surface elevation of the inverted deposits that these valleys transition increases northward, counter to our expectations that these might mark the surface of old channel bed deposits (for example, like those in NE Holden (Eberswalde) crater, [8]).

Synthesis: Two primary questions that we seek to answer about NE Arabia Terra are: (I) What is the nature of the fill material? (II) What mechanism accomplished such widespread erosion (and inversion?)

We know that the fill material had to be (1) extensive but not universal (discontinuous); (2) preferentially deposited in prexisting low topography; and (3) more resistant to erosion than surrounding material. The hypotheses that we are currently testing include ashfall/tuff, distal ejecta, surface volcanics, and sediment emplacement. We are also focusing on the possible role of volatiles.

Our working hypothesis, following Grant and Schultz [2] and earlier workers [e.g. 1], is that the mechanism for etching/terrain inversion/exhumation was likely aeolian. A major question that remains regarding this hypothesis is the scale and breadth of the erosion needed – up to hundreds of meters of material must be removed over a region of several hundred thousand square kilometers. Though it is conceivable that this erosion may have been taking place over most of Mars' geological history, this would still require average erosion rates several orders of magnitude higher (~25 nm/year) than those typical over Mars history [9, 10].

References: [1] Greeley, R. and Guest, J.E. (1987) *Geologic Map of the Eastern Equatorial Region of Mars*, I-1802-B. [2] Grant, J.A., and Schultz, P.A. (1990) *Icarus, 84,* 166-195. [3] Putzig, N.E. et al., (2005) *Icarus, 173*, 325-341. [4] Christensen, P.R. (1986) *JGR, 91,* 3533-3545. [5] Hartmann, W.K. and Neukum, G. (2001) *Space Sci. Rev., 96,* 165-194. [6] Carr, M. H. (1996) *Water on Mars*. [7] Irwin, R.P. et al. (2005) *Geology, 33*, 489–492. [8] Malin, M.C. & Edgett, K.S. (2003) *Science, 302*, 1931-1934. [9] Golombek, M.P. and Bridges, N.T. (2000) *JGR, 105,* 1841-1853. [10] Golombek, M.P. et al. (2005) *LPSC XXXVI,* abs. no. 1539.



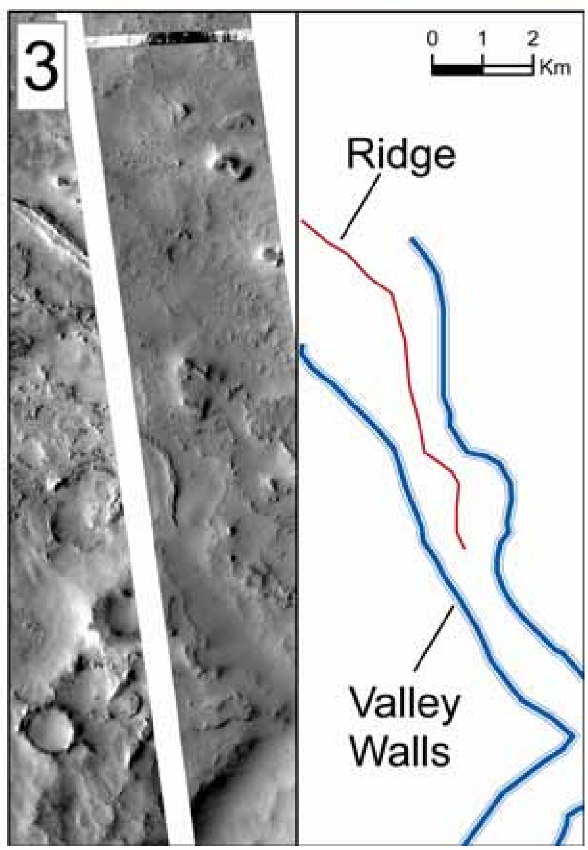


Figure 1. THEMIS IR mosaic of the NE Arabia Terra region (45-55°E, 5-25°N). The dotted line represents the boundary between Npld and Nple as mapped by Greeley and Guest [1]; the solid line marks where we would place the boundary on the basis of new data. The white box marks the location of Figure 2.

Figure 2. MOLA false color superposed on THEMIS IR daytime mosaic. Both a ~30-km-diameter crater and the valleys connected to it are now inverted; the fill material must have been more resistant to erosion than what once surrounded it.

Figure 3 (right). Example of the transition from typical highland valley networks to unusual inverted forms (MOC images R10-00363 & R20-001681 of valley at 50°9'E, 15°30 N; see also region around 46°45'E 10°12').