BURIAL, EXHUMATION, METAMORPHISM AND OTHER DASTARDLY DEEDS EXPOSED AT THE HESPERIAN/NOACHIAN BOUNDARY IN THE SOUTHERN NILI FOSSAE REGION. R.P. Harvey[1] and J. Griswold[1,2], [1]Dept. of Geology, Case Western Reserve University, Cleveland OH 44106 (rph@case.edu), [2]Lake Erie College of Osteopathic Medicine, Erie PA 16509

Introduction: The best place on Mars to examine the boundary between Noachian and Hesperian surfaces is at the southern boundary of the Nili Fossae region. Here younger Hesperian Syrtis Major lavas have been emplaced conformably over the older Noachian terrain. In this region this important boundary in the geological history of Mars is relatively free of young aeolian deposits, exposing dramatic mineralogical and physical distinctions between mafic-to-ultramafic Syrtis lavas and the phyllosilicate-rich Nili Fossae terrain that document the distinction between an earlier "wet" Mars and the drier Mars that followed.

The richness of secondary minerals exhibited by this region of Nili Fossae has been well-documented and is under increasing observation [e.g. 1]. What the exposed Nili surface represents in geological terms is less well understood; is it a relatively unmodified surface reflecting Noachian processes, or has it been significantly altered by later interactions with Syrtis lavas? To address this question we have conducted a preliminary survey of the Hesperian /Noachian border between 70° and 80° E longitude and 15° and 20° latitude. Our results suggest that Syrtis lavas buried a significant portion of southeast Nili Fossae and that these flows were later removed, providing interesting implications for what the local mineralogy and geomorphology actually records.

Syrtis Lavas: Syrtis Major Planum is one of several 1000-km-scale volcanic constructs in the circum-Hellas region of Mars [e.g. 2]. At the border with Nili Fossae individual flows are long, thick and low-slope, with prominent straight and unroofed channels, suggesting low viscosity, high effusivity and ultramafic to mafic compositions [e.g. 3]. The top surfaces of flows show scarce evidence of fluvial erosion and flow margins are generally rounded with modest landsliding and talus development.

Burial: One flow in particular (hereafter called I-80) offers significant insight into the relationship between Syrtis flows and the pre-existing eastern Nili surface (Fig 1). I-80 originates within a broad lava plain that fed flows into the largest of the Nili "Fos-

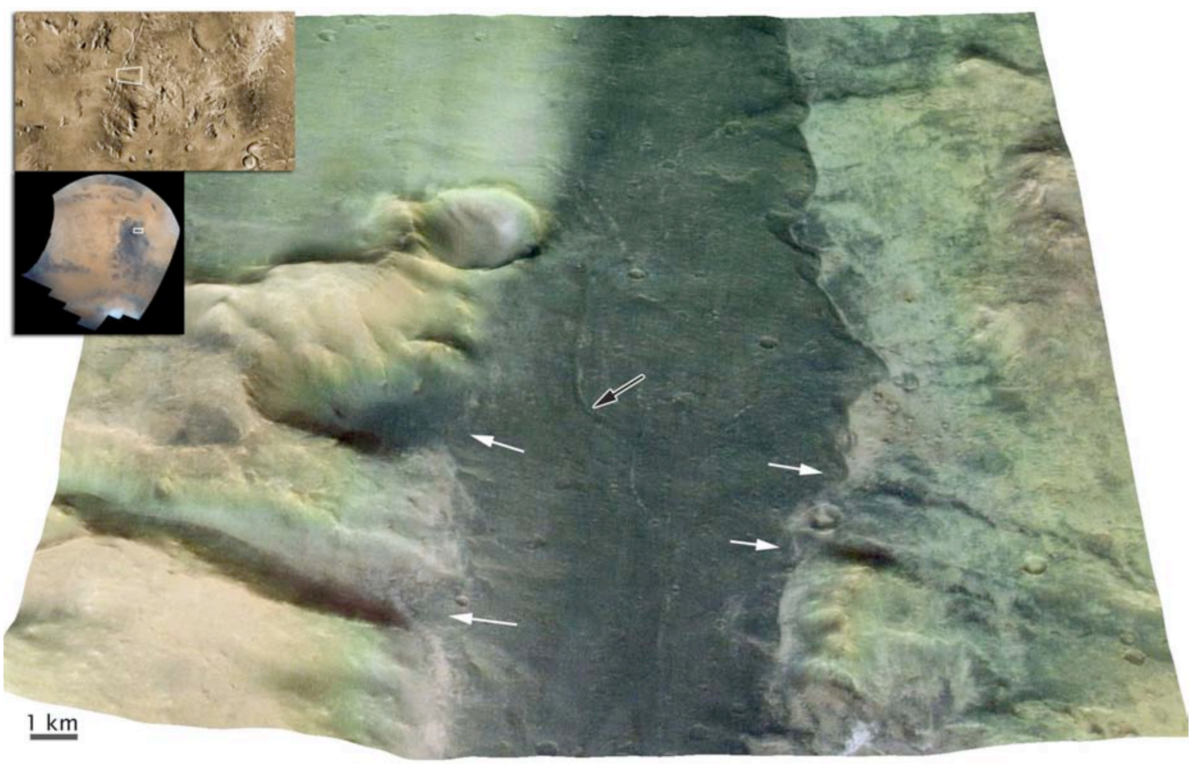

Figure 1. HRSC perspective view of the western end of the informally named I-80 flow originating from Syrtis Major, looking eastward (vertical exaggeration 1.5x). Colors are a mix of the "mars-like" and elevation channels available from the HRSC data explorer. White arrows show flow intrusions into fossae and other depressions; the black arrow shows the well-developed channel. Context images show location of southern Nili Fossae region in hemispheric view and HRSC footprint on THEMIS IR mosaic

sae"; while most of this lava flowed north and west, I-80 flows almost due eastward and is quickly constrained within a gently sloping valley. At its western end, the I-80 flow slopes gently and uniformly (~0.8°) eastward, exhibiting clear conformable margins against a typical Noachian terrain, and flowing into local depressions. MOLA data suggests that flow margins rise about 70 m above the local surface where unconstrained by valley walls. The Noachian surface in this region is moderately well-dissected with prexisting fluvial channels that flow down into and are cross-cut by the I-80 flow. These observations suggest that at its western end, the I-80 flow took the path of least resistance, flowing down a pre-existing fluvial valley, and is cleanly superimposed on a well-preserved Noachian surface, with later erosional events doing little to confound the local sequence of events.

Exhumation: In contrast, the eastern end of the I-80 flow appears to have been subjected to severe erosion, creating a highly dissected terrain. The flow terminates in sharp alcoves and crenulations, with continous talus slopes down to the characteristic blocky and lighter Nili surface (Fig 2) . Discontinuous mesas and buttes capped with I-80 lavas continue eastwards out into Nili Fossae. Small craters are infrequent on the lower surfaces, while dunes of dark Syrtis-lava-derived materials are relatively common. Unlike the well-preserved Noachian surfaces to the west, fluvial channels are rare and poorly developed in southeast Nili Fossae: major channels are visible further north but show poor tributary development.

Metamorphism: In many places the terminations and remnants of the I-80 flow can be seen to lie immediately above a bright, resistant and polygonally-patterned unit that probably represents the original Nili Fossae surface after being over-run and cooked by the I-80 flow. The patterning is similar to that seen on terrestrial exhumed surfaces, while the significant low-grade thermal metamorphism that would accompany burial typically leads to diagenetic lithification of any unconsolidated materials [e.g. 4].

Implications: Physical evidence of burial and metamorphism in southeast Nili Fossae suggests zeolite to greenstone grade metamorphism of a presumed mafic protolith rich in plagioclase and pyroxene. Although uncertainties about the protolith and presence, absence or composition of fluids makes the resulting mineralogy speculative, laumontite, chlorite-smectite, hematite, titanite, calcite, silica and pumpellyite are all likely products in the less-metamorphosed materials; prehnite, epidote and heulandite are all likely in more intensely metamorphsed materials. This "zoo" of mineral species goes significantly beyond what is commonly identified in weathered martian terrains; but many have already been detected [1] at Nili Fossae and can offer significant new constraints on regional geological history.

References: [1] Ehlmann et al. (2009) *JGR Planets* 114, E00D08. [2] [4] Hiesinger and Head (2004) *JGR Planets* **109**, E01004 [3] Rampey and Harvey (2008) Icarus 196,49-62 [4] Waichel et al. (2007) *J. Volc. Geotherm.* 171, 59-72.

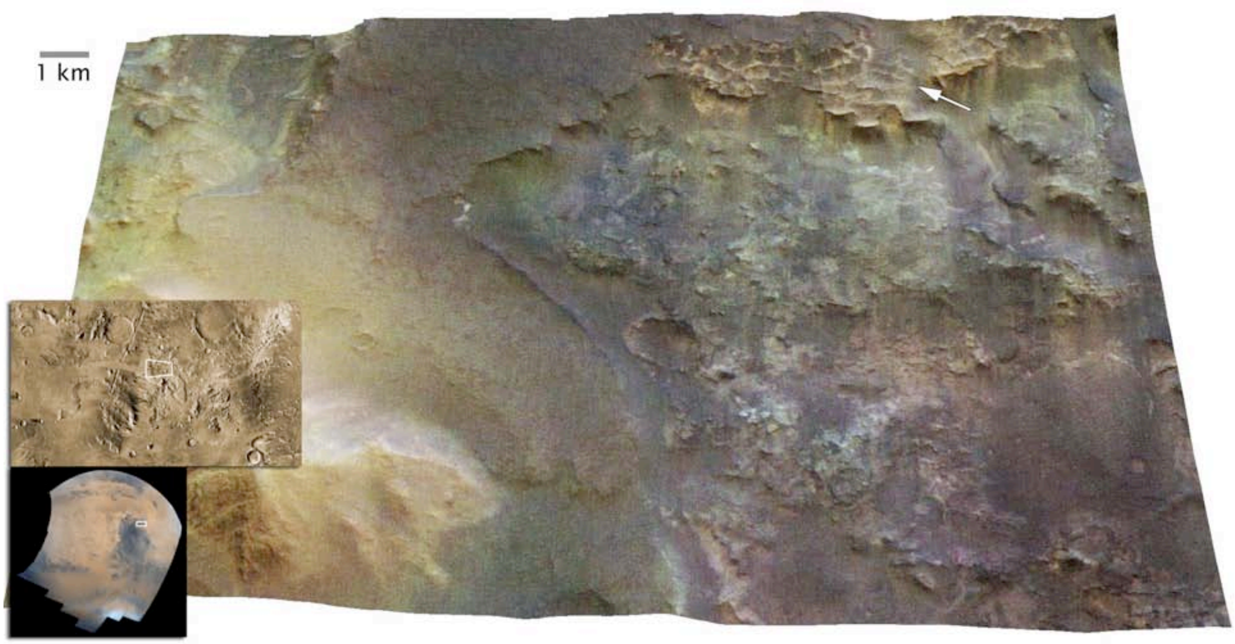

Figure 2: HRSC perspective view of the eastern end of the I-80 flow, looking westward (vertical exaggeration 1.5x). Colors and context images as in Fig. 1. The flow terminates in steep cliffs and alcoves several 100 m tall with fully developed talus slopes, and can be seen to immediately overlie bright, polygonally-jointed subsurface (arrow).