3D RECONSTRUCTION OF THE GEOLOGIC RECORD PRESERVED IN AMAZONIS PLANITIA USING SHARAD. G. A. Morgan[1], B. A. Campbell[1], L. M. Carter[2], J. J. Plaut[3] and N. E. Putzig[4] [1]Center for Earth and Planetary Studies, Smithsonian Institution, MRC 315, PO Box 37012, Washington, DC 20013-7012, morganga@si.edu, [2]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA, [3]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109. [4]Southwest Research Institute, 1050 Walnut Street, Suite 300, Boulder, CO 80302

Introduction: The Hesperian basement of Amazonis Planitia has acted as a natural repository for geologic materials and offers a rich assemblage of morphological units that have arisen from potential marine/lacustrine, fluvial, volcanic, aeolian and glacial processes [see 1]. The lowest unit in the region's stratigraphic column, the Vastitas Borealis Formation, is interpreted to be sedimentary in nature, possibly deposited in an oceanic body of water [2-4]. Younger sedimentary and volcanic deposits overlie this, and the majority of Amazonis Planitia has experienced compressional tectonic deformation evident in chains of wrinkle ridges. The mouth of the Marte Vallis outflow channel is situated along the western boundary of Amazonis Planitia and provided a conduit for additional sedimentary and volcanic deposits originating in Elysium Planitia. To the east, the plains are bounded by blocky material that forms the Olympus Mons aureole deposits. The most recent chapter in the region's history has been the emplacement of an ice-rich mantle at latitudes > 30° [5].

The majority of current understanding of this region comes from geologic mapping based on image and topographic data collected since the 1970s [e.g. 1-2]. SHARAD sounder data provides two additional perspectives to further refine understanding of geologic history: 1) 3D mapping of the subsurface and 2) mapping of decameter-scale near-surface roughness.

3D Mapping: Subsurface SHARAD reflections arising from interfaces between units with different dielectric properties provide direct information regarding tomographic structure. SHARAD data can also be used to derive compositional information pertaining to the dielectric and loss properties of the materials bounded by these reflectors. Campbell et al. [6] conducted a survey of SHARAD tracks crossing Amazonis to identify and map subsurface reflectors. This study identified an interface interpreted to be the basement of the Vastitas Borealis Formation far to the south of where the unit can be identified on the surface. A conformal relationship between the surface topography of a wrinkle ridge and the underlying reflector tomography suggests the Vastitas Borealis Formation sediments were deposited prior to the tectonic activity, demonstrating the potential of SHARAD data to extend mapping efforts into the third dimension and to place further constraints on the sequence of geologic events.

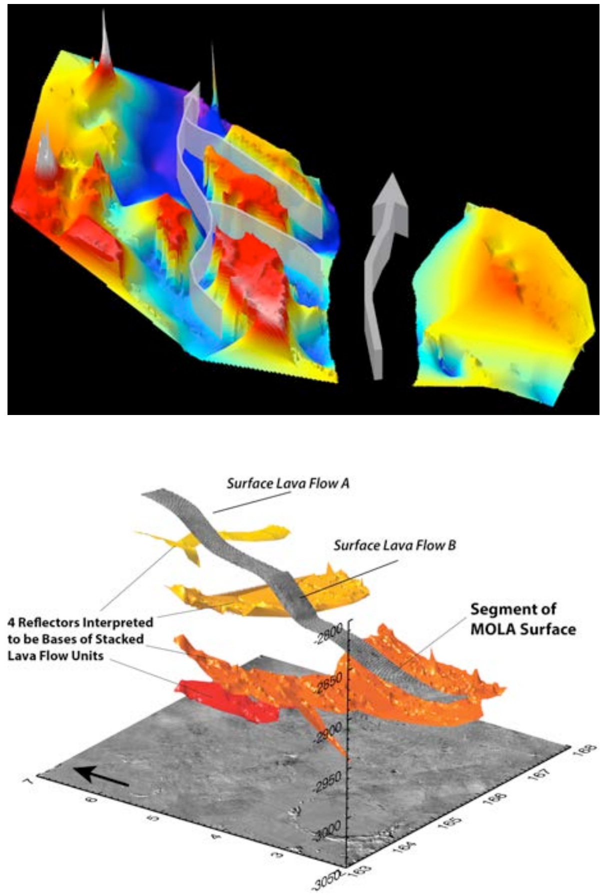

Fig. 1 *Examples of SHARAD 3D reconstructions of subsurface structures, demonstrating the versatility of SHARAD data to investigate a range of buried landforms. (Above) Buried Marte Vallis channels, arrows indicate direction of flow [7]. (Below), Stack of buried lava flows in Central Elysium Planitia [8].*

We will present results of subsurface mapping using six years of additional SHARAD data acquired since the original [6] study. Applying visualization techniques developed for SHARAD studies of Elysium Planitia [7-8], we will display full 3D renderings of all identified subsurface interfaces and place them within the context of the regional geologic history derived from surface mapping (Fig. 1). A secondary focus will be to identify the full influence of Marte Vallis preserved in the subsurface to constrain the links between Elysium and Amazonis Planitiae. Where possible we will present a dielectric loss analysis of the subsurface units identified.

Decameter-scale roughness: Campbell et al. [9] developed a technique exploiting the time delay behavior of SHARAD echoes to provide quantitative information related to the RMS slope (roughness) of the surface. Calculating the ratio of power integrated over a range of incidence angles to the peak power provides an estimate of surface roughness on horizontal scales relevant to the SHARAD center wavelength (15 m) and mostly independent of Fresnel reflectivity. This provides a measure of roughness that is complementary to MOLA pulse width [10] and baseline [4] roughness datasets.

We will present SHARAD roughness maps of Amazonis Planitia (Fig. 2) to further characterize the surface, and to aid in the identification of additional units. This technique has already been demonstrated to be much more sensitive to aeolian landforms NW of Olympus Mons relative to MOLA baseline roughness maps [see 9: Fig. 8].

A major result of the MOLA point-to-point roughness map was the recognition of the global effect of ice-rich mantles at mid- to high latitudes [4]. The SHARAD roughness parameter is also sensitive to the effects of these deposits (Fig. 2), and we will compare the two datasets to assess how the mantling process has influenced the surface of Amazonis Planitia, with implications for regional ice accumulation and sublimation.

References: [1] Tanaka et al., U. S. Geol. Surv. Sci. Invest. Map, 2888, 2005. [2] Tanaka & Scott, U. S. Geol. Surv. Misc. Invest. Map, I-1802-C, 1987. [3] Clifford & Parker, Icarus, doi:10.1006/icar. 2001.6671, 2001 [4] Kreslavsky, M.A., and J.W. Head, JGR, 105, 26,695- 26,711, 2000. [5] Head, et al., Nature, 426,797–802, 2003 [6] Campbell et al., JGR, doi:10.1029/2008JE003177, 2008. [7] Morgan et al., Science, 340, 607, 2013 [8] Morgan et al., LPSC 45, 2377, 2014. [9] Campbell et al., JGR, 118, 436, 2013. [10] Neumann et al., GRL 30 #11, 1561, 2003.

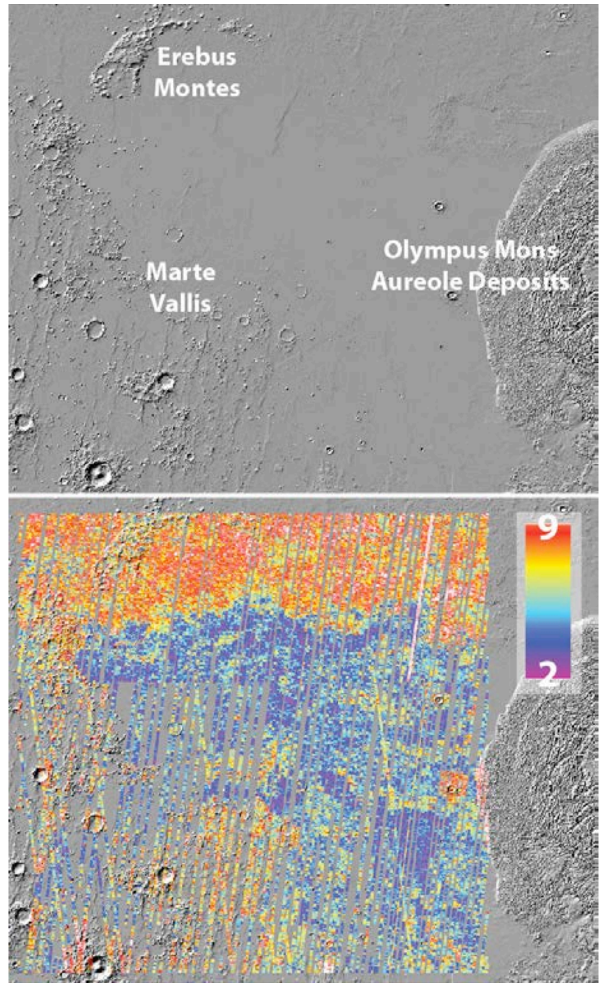

Fig. 2 Amazonis Planitia and corresponding SHARAD roughness map (below). Note the boundary between the smooth volcanic units and the rough southern boundary of the latitude dependant mantle.