GEOLOGIC MAPPING AND STUDIES OF DIVERSE DEPOSITS AT NOCTIS LABYRINTHUS, MARS.
Catherine M. Weitz[1], Dan Berman[1], Alexis Rodriguez[1], and Janice L. Bishop[2], [1]Planetary Science Institute, 1700 E Fort Lowell, Suite 106, Tucson, AZ 85719 (weitz@psi.edu); [2]SETI Institute, 189 Bernardo Ave., Mountain View, CA 94043.

Introduction: Noctis Labyrinthus consists of a network of intersecting linear troughs and pits along the eastern Tharsis rise that connect eastward to the continuous chasmata of Valles Marineris. The pits and troughs may have formed due to withdrawal of magmatic reservoirs at depth [1], or by collapse over conduits developed as a consequence of groundwater flow along pre-existing fault systems [2,3]. The age of the Noctis Labyrinthus depressions is thought to be Late Hesperian to Early Amazonian based upon disruption of the lava plains along the plateaus [2,4]. Consequently, sediments deposited within the depressions represent this age or younger materials.

Mapping Investigation: We are mapping the western portion of Noctis Labyrinthus (-6 to -14°N, -99.5 to -95.0°W), which includes some of the most diverse mineralogies identified on Mars using CRISM data [5-8]. Thus far across the Noctis Labyrinthus region, the following minerals have been identified: several kinds of sulfates (monohydrated (kieserite, szomolnokite) and polyhydrated sulfates, jarosite, and Ca-sulfates (gypsum, bassanite)), clays (Fe/Mg-phyllosilicates and Al-phyllosilicates), a doublet absorption between 2.2-2.3 μm, and hydrated silica/opal (Figure 3). The role of water, both in the formation of the Noctis depressions and the hydrated deposits found within them, is a focus of this investigation. The diverse range of sulfates and phyllosilicates identified within the depressions of Noctis Labyrinthus either resulted from localized aqueous activity [7,8] and/or may have been part of a broader synoptically driven period of late activity during the Late Hesperian to Amazonian [e.g., 9-12].

Previous research on similar phyllosilicates and sulfates elsewhere on Mars suggested that Fe/Mg-smectites were emplaced in the older Noachian time under neutral pH conditions, followed by a global transition to more acidic conditions that led to deposition of sulfates in the Hesperian [13,14]. In contrast, we have thus far found the opposite progression in at least two of the troughs of Noctis, where acidic clays and sulfates underlie younger Fe/Mg-smectites. Therefore, our current observations indicate these troughs apparently underwent localized aqueous conditions that are inverted relative to the global chemistry of Mars, making them potentially habitable zones for life during the Late Hesperian to Early Amazonian when drier conditions dominated the surface.

While the majority of light-toned and hydrated deposits at Noctis are observed within the depressions, there are also examples of these deposits along the central Noctis Labyrinthus plateau (Fig. 2) [5]. These plateau deposits are included in our mapping region. The morphologies of many of these deposits resemble those seen along the plateaus of Valles Marineris, which have been interpreted as fluvial deposits and/or volcanic ash (i.e., 15,16).

Constraints from geologic mapping and morphologic and stratigraphic analyses will be key contributions toward deciphering the geologic diversity and history of this portion of Noctis Labyrinthus, with specific implications regarding the role and history of water. In particular, the timing, duration, nature, and spatial extent of the influence of water-related processes in the region is a focus on this study. An understanding of the history of deformation and collapse within this region will also be key to deciphering the timing of sedimentary deposition and aqueous alteration.

Mapping Progress: We are using THEMIS daytime IR as a basemap, with a 1:500,000 publication scale. We have been working in the first year of our grant on mapping linear features. Numerous structural features, including grabens and scarps, are found throughout the mapping region. Several volcanic cones have also been identified. In addition to the light-toned hydrated deposits, other floor deposits include mass wasting and landslide materials, which have been identified in many of the Noctis depressions. Once we have completed mapping of linear features, we will begin to map geologic units and measure crater counts to determine ages of the units and decipher the geologic history of the region.

References: [1] Mege D. et al. (2003) *J. Geophys. Res*., 108(E5), doi:10.1029/2002JE001852; [2] Tanaka K.L. and P.A. Davis (1988) *J. Geophys. Res. 93*, 14893-14917; [3] Witbeck et al., (1991) USGS Map I-2010, scale 1:2,000,000; [4] Tanaka K.L. et al. (2014) Geologic Map of Mars, *USGS Map* 3292; [5] Weitz C.M. and J.L. Bishop (2014) *Mars 8th Conference*, Abstract 1222; [6] Weitz C.M. and J.L. Bishop (2013) *Planet. Space Sci*., doi:10.1016/j.pss.2013.08.007; [7] Weitz C.M. et al. (2011) *Geology*, 39;899-902, doi: 10.1130/G32045.1; [8] Thollot P. et al. (2012) *J. Geophys. Res*., 117, E00J06, doi:10.1029/2011JE004028; [9] Moore J.M. and A.D. Howard (2005) *J. Geophys. Res., 110*, E04005, doi:10.1029/2005JE002352; [10] Fassett C.I. and J.W. Head (2008) *Geophys. Res. Letts*., *32*, L14201, doi:10.1029/2005GL023456; [11] Grant J.A. and S.A. Wil-

son, (2011) *Geophys. Res. Letts.*, 38, L08201, doi:10.1029/2011GL046844; [13] Bibring J.P. et al. (2006) *Science 312*, 400-404, DOI: 10.1126/science.1122659; [14] Murchie S.L. et al., (2009) *J. Geophys. Res., 114*, E00D07, doi:10.1029/2009JE00334; [15] Weitz C.M. et al. (2009) *Icarus*, doi:10.1016/j.icarus.2009.04.017; [16] Le Deit L. et al. (2010) *Icarus*, *208*(2), 684-703.

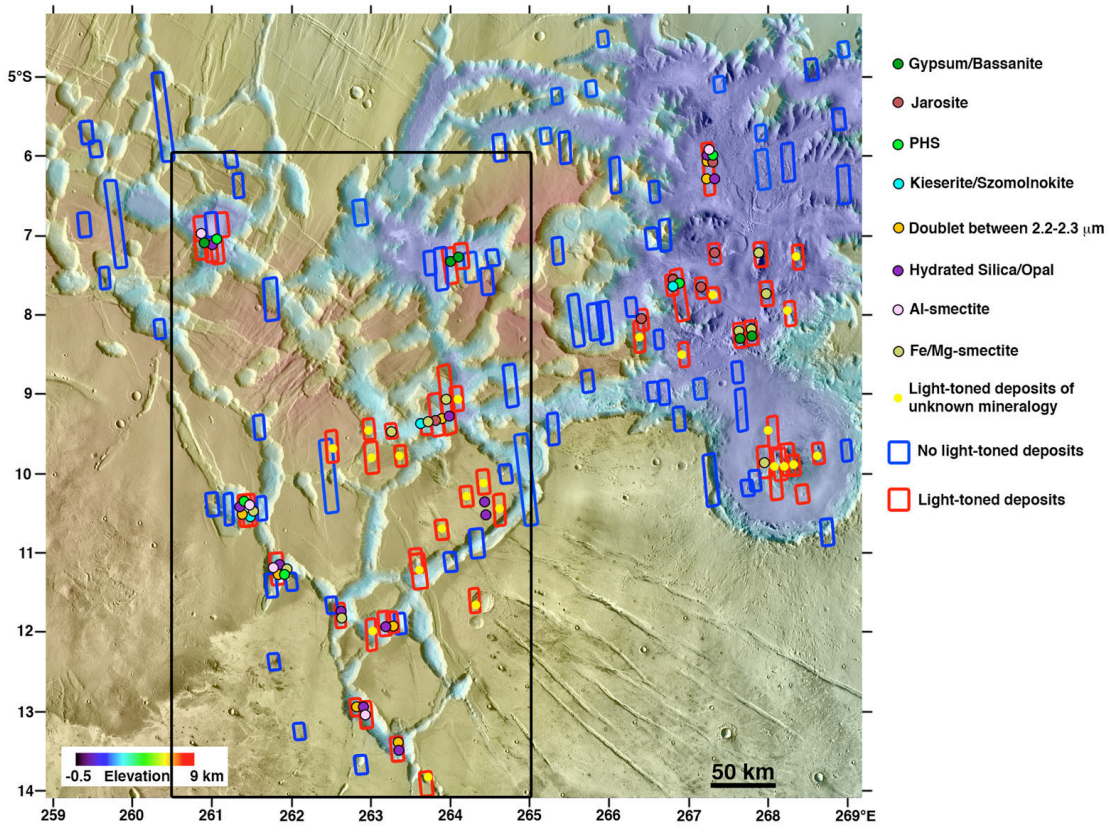

Figure 1. THEMIS daytime infrared mosaic with MOLA topography overlain in color for the Noctis Labyrinthus region. HiRISE images are outlined by red and blue rectangles whereas minerals interpreted from CRISM spectra are noted by colored circles. Mapping region is outlined by large black box. (Figure from [5]).

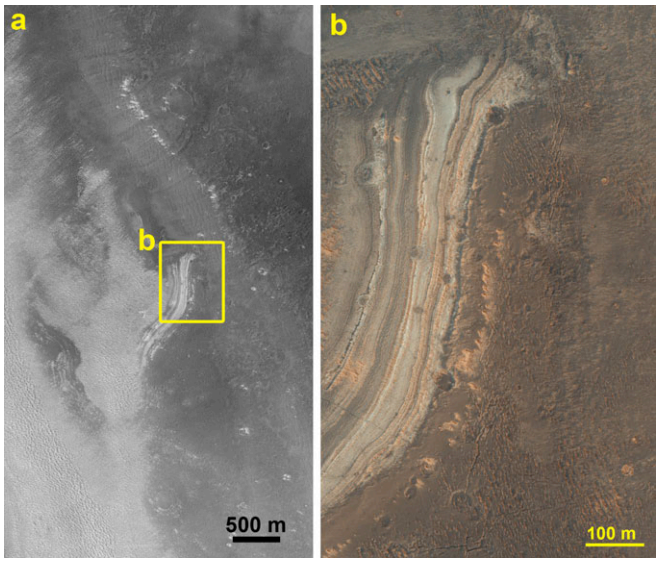

Figure 2. (a) Portion of HiRISE image showing light-toned layered deposits within a fracture along the Noctis plateau. Yellow box indicates location of blowup show in b. (b) Enhanced HiRISE color image showing color and thickness variations within the deposit. The deposit lacks hydration features in CRISM data but appears morphologically similar to deposits visible along the Valles Marienris plateau to the east of our study region [15].