**CHARACTERIZATION OF LAYERED DEPOSITS AT THE VALLES MARINERIS PLATEAU WITH MULTIPLE INSTRUMENTS.** I. B. Smith[1†]; C. E. Viviano-Beck[2]; M. Chojnacki[3]; Cathy Quantin[4]; N. E. Putzig[1]. [1]Southwest Research Institute, Boulder, CO; [2]Applied Physics Laboratory, Johns Hopkins University, Laurel, MD; [3]Lunar and Planetary Laboratory, AZ, [4]Université de Lyon No 1, Lyon, France. [†]Contact: isaac@boulder.swri.edu.

**Introduction:** Characterizing the nature of surface materials on Mars is essential for determining past and present climate. Critical to the effort is understanding mineralogical and physical properties, including their distribution and abundance. Whereas materials are spread non-uniformly over the Martian surface, many deposits exist in locations that are difficult to measure with one or more instruments, impeding full characterization. Furthermore, their vertical distribution is rarely known. In exceptional cases several orbiting instruments are able to train on a single deposit or multiple deposits in their entirety. We have located layered deposits (LDs) near the rim of Valles Marineris (VM) and neighboring chasmata (Figs. 1-5) where surface deposits may be characterized by optical imagery, spectroscopy, thermal measurements, and subsurface radar sounding.

Various observations suggest that some of these deposits were emplaced during wet periods while others were altered by flowing water after deposition [1-3]. The former presence of liquid water on the surface reveals that climatic conditions were once more favorable for geochemical processing and potential habitats. The varied distribution of this evidence, especially by longitude (corresponding to a range of ages from middle Noachian late Hesperian), provides constraints for climate modelers and future missions

**Objectives:** The VM plateau LD are ideally situated for ease of observation and characterization by a large suite of instruments and should provide a key to understanding similar deposits distributed across the planet. We seek to address the following fundamental questions: 1) What are the extent and volume of the sedimentary deposits near VM? 2) What mineralogical, geophysical, and thermophysical characteristics define the layered deposits? 3) What is the relevant history of water in the region?

**Methodology:** Our multidisciplinary approach is to gather and analyze the data from the Shallow Radar (SHARAD), High Resolution Science Experiment (HiRISE), Compact Reconnaissance Imaging Spectrometer (CRISM), thermal emission imaging system (THEMIS), Thermal Emission Spectrometer (TES) and High Resolution Stereo Color Imager (HRSC) to create detailed maps of a) subsurface structure using SHARAD, b) mineralogic information using CRISM, c) topographic information using DTMs from stereo pairs, d) thermophysical properties with THEMIS and TES, and e) geomorphology with HiRISE and HRSC.

**Observations:** Several LD had previously been detected based on morphology from optical based instruments (Fig 2). Here we extend the size of the known deposits beyond where surface outcrops are present and detect LD in new locations near to VM.

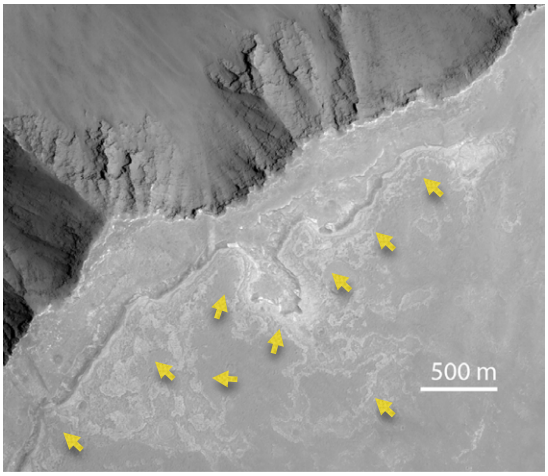



***Figure 1:*** *Light-toned Layered Deposits at Melas Chasma rim. HiRISE image PSP_05030_1685*

We also detect subsurface reflections beneath phylosillicate bearing deposits (Figs. 4 and 5f), a first for SHARAD. Constraining the geophysical properties of these types of mineral deposits along with spectral and surface expressions will increase our understanding of the water environment in the late Noachian.

**Discussion:** Investigations of Mars often focus on ancient climate and the duration/timing of surface water. This study attempts to address both. Because the reflections that SHARAD detects are spread over the length of VM, they represent different geologic periods. Western VM LD overlie Hesperian lava plains, indicating that liquid water ran over the surface at least as recently as the emplacement of those units [*2-4*]. On the other end of VM, Between Capri and Ganges Chasmata, Noachian-aged phyllosilicates indicative of a pedogenic (or soil forming) sequence have been mapped at the surface, providing evidence for much earlier water activity (Fig. 4) [*5-7*]. Our initial analysis of SHARAD reflections in VM points to a much older period than has ever been investigated with orbital radar, allowing us to use this instrument for a new type of characterization. This study will enhance our understanding of sedimentary processes at each relevant time and possibly constrain the nature of the aqueous environments in which the deposits were emplaced.

The LD have implications for what was happening elsewhere on Mars, where similar deposits are difficult to study with this suite of instruments. We aim to constrain the properties of those deposits by testing analog sites at VM, with the goal of instigating new lines of thought regarding layered deposits on Mars.

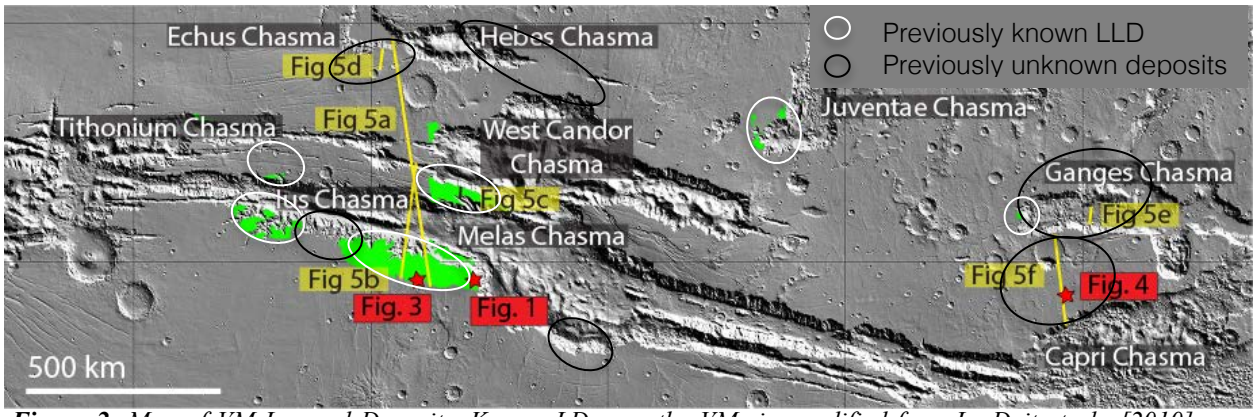



***Figure 2**: Map of VM Layered Deposits. Known LD near the VM rim modified from Le Deit et al., [2010] are shown in green. Stars (Figs. 1, 3, and 4) and yellow radar tracks (Fig. 5) indicate the locations of other images.*

**References:** [1] Le Deit, L., *et al.*, (2010), *Icarus*, 205(2), 684–703. [2] Mangold, N., *et al.*, (2004), *Science*, 305(5680), 78–81. [3] Mangold, N., *et al.*, (2008), *J. Geophys. Res. Planets*, 113(E8), E08009. [4] Quantin, C., *et al.*, (2005), *J. Geophys. Res.*, 110(E12), E12S19. [5] Ehlmann, B., *et al.*, (2012), *Space Sci. Rev.*, 174(1-4), 329–364. [6] Le Deit, L., *et al.*, (2012), *J. Geophys. Res.*, 117. [7] Carter, J., *et al.*, (2015), Icarus, 248, 373–382.

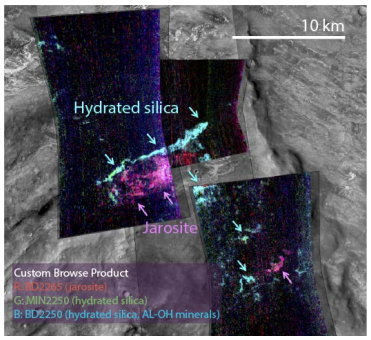
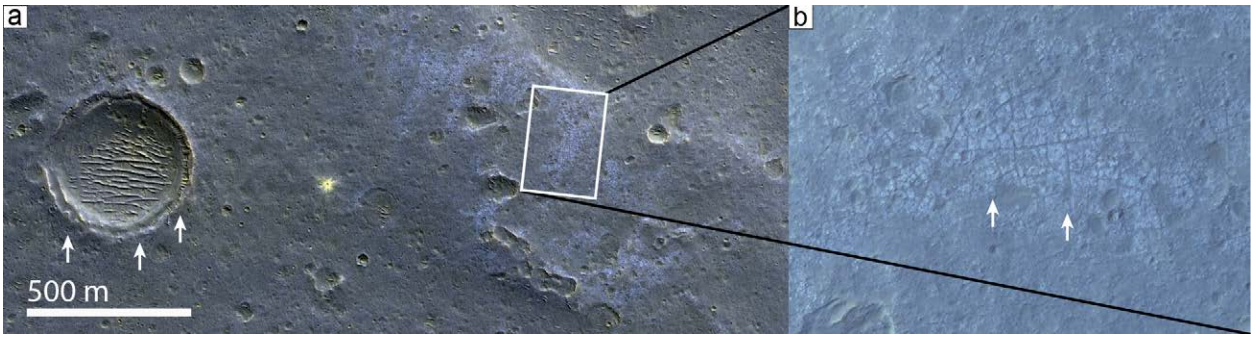



***Figure 3:** Custom CRISM product overlain highlighting hydrated silica (cyan) and jarosite (magenta) deposits. HRL00007F68, FRT00021F7F, and HRL000044AC.*

***Figure 4:** a) HiRISE image ESP_037203_1680 showing layered deposits between Ganges and Capri Chasmata corresponding to radar reflections in Fig. 5f. b) Capri deposits may correspond to mapped Noachian age clays [Carter et al., 2015]. Terraced crater and surface cracks reveal layering from sedimentation.*



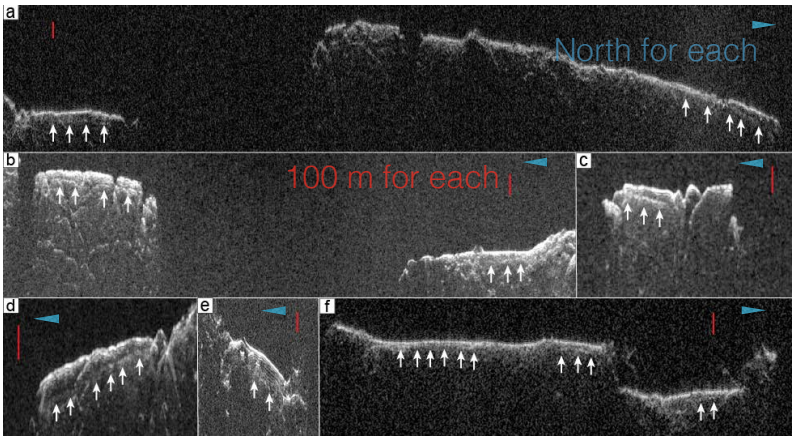




***Figure 5 (left):** SHARAD radargrams with arrows highlighting reflections near VM rim. Radar represents an new means of characterizing the LD, some of which had not been detected previously: (a) 3649201: deposits at Melas Chasma (left) and undescribed deposits at Echus Chasma (right) (b) 3763301: LD reflectors at Candor Plateau and Melas Chasma; (c) 3678901: LD reflections at Candor Plateau; (d)1749501: LD at Echus Chasma; (e) 2623901: multiple reflectors beneath a sand sheet inside of Ganges Chasma; (f) 3649101: a clay deposit near Ganges Chasma (Fig 4).*