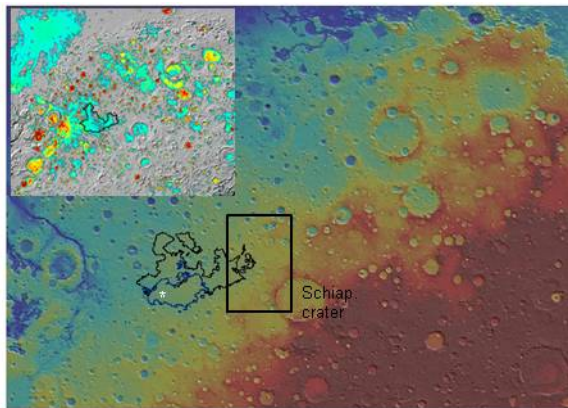


**DISTRIBUTION OF HYDRATED SULFATES ACROSS ARABIA TERRA USING CRISM DATA: IMPLICATIONS FOR MARTIAN HYDROLOGY.** S. M. Wiseman<sup>1</sup>, J. C. Andrews-Hanna<sup>2</sup>, R. E. Arvidson<sup>3</sup>, J. F. Mustard<sup>1</sup>, K. J. Zabusky<sup>2</sup>, <sup>1</sup>Department of Geological Sciences, Brown University, Providence, RI, sandra\_wiseman@brown.edu, <sup>2</sup>Department of Geophysics, Colorado School of Mines, Golden, CO, <sup>3</sup>Department of Earth and Planetary Sciences, Washington University, Saint Louis, MO.

**Introduction:** Hydrologic modeling relevant to late Noachian through Hesperian conditions on Mars predicts that Arabia Terra was a region of enhanced groundwater upwelling that resulted in a shallow water table that intersected the surface at topographic lows [1]. Arabia Terra is situated between the highlands and lowlands and would have received sustained ground water flux as a result of its unique topography (Fig. 1). The most well preserved deposit explained by the Andrews-Hanna hydrologic model is the late Noachian/Early Hesperian sulfate rich Meridiani Planum unit investigated by the MER rover Opportunity (Fig. 1). Analyses of MER data revealed that the Meridiani Planum sediments likely formed as reworked aeolian sands originally formed in a sabka environment and cemented by a rising ground water table [2,3].



**Figure 1.** MOLA colorized shaded relief map of Arabia Terra (20°S to 45°N, 30°W to 60°E). The Meridiani Planum hematite-bearing unit is outlined in blue and etched terrain is outlined in black. The star indicates the MER Opportunity rover landing site. Inset shows predicted evaporate thickness map from [1].

There is also widespread geomorphic evidence for sedimentary deposits across Arabia Terra e.g., [4]. These deposits have variable layer thicknesses, erosional morphologies, and thermal inertias and have been attributed to a variety of formation mechanisms [5,6,7,8]. Deposits formed in a ground water regime can range from relatively pure evaporitic salts to weakly cemented aeolian deposits that were infiltrated and cemented by small amounts of ground water and are consistent with the range of morphologies observed in Arabia Terra. Mapping the current distribution of se-

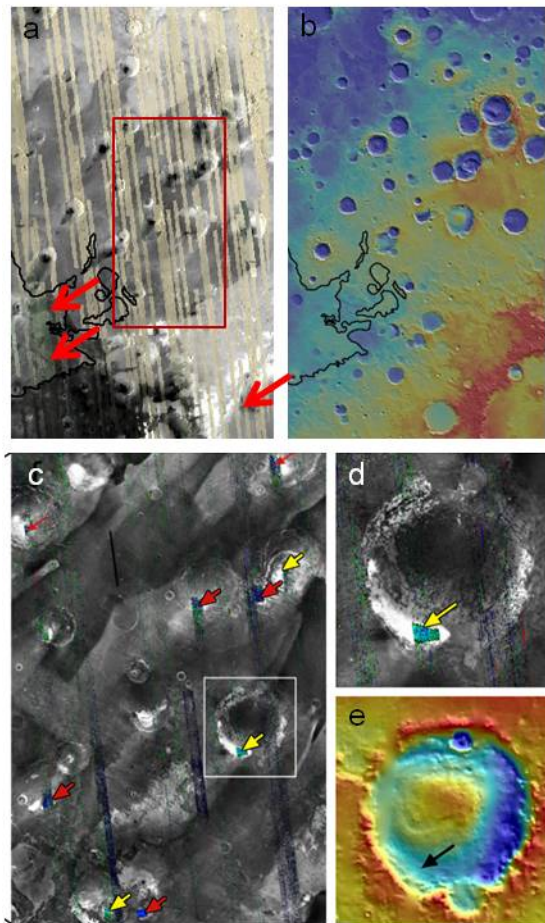
dimentary deposits based on geomorphology as well as extrapolating their initial extent is presented in [9].

Here, we use 20 to 200 m/pixel CRISM images to map the distribution of deposits across Arabia Terra that exhibit spectral evidence for hydrated phases, particularly hydrated sulfate phases consistent with an evaporitic origin. We focus on these deposits as the presence of hydrated sulfates indicates that ground water supplies were sufficient to allow evaporitic concentration of dissolved solutes at the surface. Therefore, these deposits are proxies for past ground water activity. Initial results are presented for the area between Sinus Meridiani and Schiaparelli crater.

**Sinus Meridiani:** The regional slope at Meridiani, which is located near the southern margin of Arabia Terra (Fig. 1), resulted in sustained groundwater upwelling that was not restricted to topographic depressions. Three major sedimentary units occur in Sinus Meridiani. The stratigraphically lowest unit, termed 'etched terrain' unconformably overlies cratered terrain and consists of high thermal inertia, light toned, layered rocks that exhibit wide spread hydration features in VNIR spectra [10, 11]. Etched terrain is overlain by the sulfate- and hematite-bearing rock unit explored by the Opportunity rover. This unit, termed the 'hematite-bearing plains' is several hundred meters thick. Carter counts indicate a late Noachian/Early Hesperian age. A unit with distinctive monohydrated and polyhydrated sulfate spectral signatures occurs in a 120 km long valley in northern Meridiani [11,12]. High resolution mapping using MRO data show that the hydrated sulfate exposures in the valley were unconformably deposited after significant differential erosion of the etched terrain and formed contemporaneously or subsequent to the hematite-bearing plains [11]. In addition to the hydrated sulfate unit in the valley, small exposures of monohydrated and polyhydrated sulfates are observed on eroded surfaces of the etched terrain and within a few locations in the hematite-bearing plains [11]. These deposits cross unit boundaries and may record the most recent aqueous processes in Sinus Meridiani.

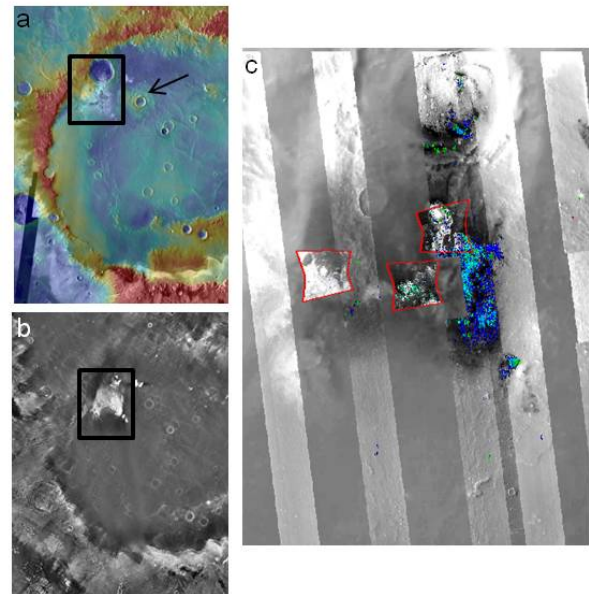
**Hydrated Sulfates in Arabia Terra:** Although much of Arabia Terra is covered with dust that obscures the spectral signature of underlying deposits, erosional windows are present in some locations. In the region between Sinus Meridiani and Schiaparelli crater, hydrated materials occur in local topographic

lows and are associated with high thermal inertia exposures (Fig. 2). Many of these areas contain dark toned basaltic sand, indicating aeolian activity. Hydrated sulfates detected in the crater shown in Fig. 2 d, e occur on the crater floor adjacent to a partially exhumed mound. The hydrated sulfate deposits likely formed on the crater floor, were buried, and subsequently exhumed to produce their current configuration.



**Figure 2.** a) MOC WA mosaic of the region outlined in Fig 1. with CRISM MSP (200 m/pixel) coverage overlain. Large hydrated deposits in Meridiani and Schaparelli crater are indicated with red arrows. b) MOLA colorized shaded relief map. c) CRISM parameter map (R=D2100, G=D2400, B=D1900) for the region outlined in red in part a. Blue indicates hydrated deposits (red arrows) and cyan indicates polyhydrated sulfates (yellow arrows). d-e) Zoom in of crater outlined with the white box in part c.

Hydrated sulfate deposits also occur in association with high thermal inertia material in the northwestern portion of Schiaparelli crater (Fig. 3). A pedestal crater located to the east of these deposits that stands 200 m above the current surface of the crater floor indicates that deposits in Schiaparelli crater were original more extensive and have experienced substantial erosion.



**Figure 3.** a-b) MOLA colorized shaded relief and THEMIS nighttime IR map showing Schiaparelli crater. c) Zoom in on the area outlined in part b with CRISM MSP and FRT coverage and parameter map overlain (R=D2100, G=D2400, B=D1900). Hydrated deposits appear blue and polyhydrated sulfates cyan.

**Implications:** The detection of hydrated sulfates preserved in Sinus Meridiani, Schiaparelli crater, and the intervening region is consistent with hydrologic model predictions. The deposits at Meridiani are not singular in nature but are consistent with sustained and widespread ground water-related processes. The hydrated sulfate detections in Arabia Terra are typically associated with highly eroded material, which indicates that the deposits were originally more extensive. Mapping the now isolated exposures across Arabia Terra will allow for the reconstruction of their original extent, comparison to hydrologic model predictions, and eventual reconstruction of paleoenvironmental conditions.

**References:** [1] Andrews-Hanna et al (2010) *JGR*, 115, doi:10.1029/2009JE003485. [2] R.E. Arvidson et al. (2006) *JGR*, 111, doi:10.1029/13602006JE002728. [3] J. Grotzinger et al. (2005) *EPSL*, 240. [4] K. I. Fassett and J. W. Head (2007) *JGR*, 112, doi:10.1029. [5]. P. H. Schultz and A. B. Lutz (1988), *Icarus*, 73, 91-141. [6]. M. G. Chapman and K. L. Tanaka (2002) *Icarus*, 155, 324-339. [7] K. S. Edgett and T. J. Parker (1997) *GRL*, 24, 2897-2900. [8] R. M. McCollom and B. M. Hynek (2005) *Nature*, 438, 1129-1131. [9]. [10]. R. E. Arvidson et al (2003), *JGR*, 108, doi:10.1029/2002JE 001982. [11] Wiseman et al. (2010), *JGR*, 115, doi:10.1029/2009JE003354. [12] J.L. Griffes et al. (2007) *JGR*, 112.