THE PAHRUMP SUCCESSION IN GALE CRATER – A POTENTIALLY EVAPORITE BEARING LACUSTRINE MUDSTONE WITH RESEMBLANCE TO EARTH ANALOGS. J. Schieber1, D. Sumner2, D. Bish1, K. Stack3, M. Minitti4, A. Yingst5, K. Edgett6, M. Malin6, J. Grotzinger3, and the MSL Science Team, 1Dept. Geol. Sci., Indiana Univ., 1001 E 10th Str., Bloomington, IN 47405. jschiebe@indiana.edu; 2 Dept. Geol. Sci., UC Davis; 3California Institute of Technology, Pasadena, CA; 4Arizona State University, Tempe, AZ, 5Planetary Science Institute, Tucson, AZ, 6Malin Space Science Systems, San Diego, CA.

Introduction: The mission objective of Mars Science Lab (MSL)/Curiosity is the identification of habitable environments in the Gale Crater landing site on Mars. A potentially habitable setting has already been described from Yellowknife Bay near the landing site [1], and an abundance of likely fluvial sandy and conglomeratic strata have been encountered since the rover started to drive towards the Murray Buttes target area [2]. At Pahrump, strata whose mineralogy is consistent with orbital data and are likely the lowermost exposed parts of the Mt. Sharp succession, were examined in detail because they are of fine-grained appearance and show significant stratigraphic variability (Fig. 1). Resistant intervals and laminae within that succession are characterized by concentrations of crystals or crystal pseudomorphs and associated secondary cementation. These crystal enriched intervals share morphological similarities with lacustrine and restricted marine evaporate successions studied on Earth.

Mudstone Matrix: Exploring the approximately 9 meter thick succession, the “brush” (DRT) was employed multiple times to enable close-up examination of rock features with MAHLI. Brushing removed the rusty surface dust and coloration of the bedrock (Fig. 2), and exposed a fine grained rock matrix of mostly gray color, although reddish tints occur locally.

Figure 1: Partial stratigraphic column of the Pahrump succession from Katie Stack that shows a mudstone dominated succession with more resistant weathering ledges.

Figure 2: The Pelona brush spot at Shoemaker (Fig.1). Shows the gray (reduced) color of the bedrock, as well as parallel laminae that are marked by more erosion resistant crystals and near the bottom and top of the image more resistant spots that appears “hardened” by additional (secondary) cementation.

In several places the DRT grooved the rock surface in a similar fashion as a steel brush grooves a clay-rich soft mudstone on Earth, suggesting a comparatively soft material bonded by compacted clay minerals. This assumption was confirmed by Chemin analysis at Confidence Hills with more than 10% of a 10Å phyllosili-
cate, possibly illite or collapsed smetite, and jarosite in the mudstone matrix.

MAHLI examination of brushed surfaces in multiple locations shows that the largest visible grains in the soft matrix material are smaller than 62 µm and that the majority of the surface was composed of particles that could not be resolved by MAHLI in closest approach. They must therefore be substantially smaller than 62 µm and thus qualify as a bona fide mudstone by Earth criteria.

**Likely Evaporites:** In many of the brush spots and MAHLI closeups the mudstone matrix contains mm-size crystals or crystal pseudomorphs that contrast with the surrounding matrix by color and hardness. Most commonly these crystals have rhombic outlines, Jarosite shows comparable crystal morphologies. In resistant ledges they tend to form depressions, whereas in softer (uncemented) matrix they often project above the surface. Crystals can be scattered through the matrix (Book Cliffs, Fig. 3), or they may be concentrated along specific laminae (Fig. 2).

![Figure 3: Jail Canyon, Book Cliffs, view perpendicular to bedding. Holes are sites of former crystals in a more erosion resistant (cemented) matrix.](image)

In addition to these mm-size crystals or crystal pseudomorphs that are ubiquitous throughout the succession, we also find that certain intervals contain unique features like dendritic crystal clusters (Confidence Hills) or rounded oblate concretions (“potatoes”, at Pink Cliffs), possible formed by Mg Sulfates (based on APXS analysis), that are not repeated elsewhere in the succession.

**Discussion & Conclusion:** Lath-shaped crystals like those seen in Fig. 3 show a striking resemblance to the morphology of gypsum crystals in the deposits of arid region saline mudflats and ephemeral lakes [3]. CheMin data, however, do not show presence of Ca-sulfate minerals. Jarosite was the only evaporite mineral seen by X-ray diffraction. Other features, like the mm-scale parallel laminae marked by crystal concentrations (Fig. 2) could mark evaporitic cyclicity within alternating shrinking and expanding lake basins, where wet periods are marked by clay dominated laminae and dry periods by crystal rich laminae [4]. Whether jarosite indeed forms crystal-rich laminae like seen in Fig. 2 will need to be verified with further Chemin analysis from these intervals. Close textural analogs for such laminae occur for example in the Eocene Green River Formation of Wyoming [5]. Alternatively, the parallel laminae could also reflect episodic settling of crystals from a deeper water body that becomes supersaturated with a given mineral. A possible Earth analog, at least from a mechanistic perspective, would be the Permian Castile Formation (Delaware Basin, Texas) where this style of lamination has been interpreted as annual varves in a restricted marginal marine basin [6]. Stratigraphically restricted features, like crystal clusters and concretions, may reflect diagenetic overprints that reflect changing sources of water supply over time, as well as different intensities of evaporation and lake restriction. Because we can draw upon extensive research on possible Earth analogs, the evaporitic Pahrump successions holds considerable promise to decipher the sedimentary and geochemical history of a long-lived body of Martian surface water.

**References:**