INTRODUCTION: The primary target for the Mars Science Laboratory (MSL) rover investigation in Gale Crater is the 5 km thick stack of layers that make up the central mound of the crater, known officially as Aeolis Mons and informally as Mt. Sharp [1,2]. Previous near-infrared spectral investigations using the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) have shown that the northwest portion of the mound that MSL will investigate in situ exhibits diverse mineralogy, including smectites, sulfates, and iron oxides, which may indicate changing climates and/or aqueous environments on early Mars [3]. However, to date, no comprehensive map of the mineralogy of the rest of the mound has been published. Here we present new mineral maps of Mt. Sharp derived from CRISM data, and use these new results to constrain hypotheses for the origin of the layers and modes of aqueous alteration in Gale Crater.

METHODS: Mineral maps were created from CRISM cubes at the TRR3 calibration level and processed to estimated Lambert albedo using the CRISM Analysis Toolkit (CAT) for ENVI, including the standard volcano-scan atmospheric correction [4]. In order to suppress systematic noise, residual atmospheric effects, and dust, spectrally neutral reference spectra were calculated for each column of each cube, and then all spectra were divided by the corresponding reference spectrum for their column. “Neutral” spectra have low or null values for standard CRISM spectral parameters [5] (typically LCPINDEX<0.01, HCPINDEX<0.05, OLINDEX2<0.06, BD1900<0.005, BD2290<0.005, D2300<0.005, SINDE<0.02, and BD2500<0.01). Parameters were then recalculated on ratio spectra. To verify mineral detections based on spectral parameters, local band minima locations were found in the regions of 0.8-0.98, 2.0-2.2, and 2.16-2.35 µm relative to linear continua between those endpoints. Spectral units were defined based on parameters and band minima. Spectral maps were projected and co-registered to HiRISE imagery and digital elevation models in ArcGIS.

SPECTRAL UNITS: Spectral units from our work are consistent with previous investigations [3,6] (Table 1), including Fe/Mg-smectites, both poly- and monohydrated sulfates (PHS/MHS), iron oxides, high-Ca pyroxene (HCP), and a ferrous phase with a strong red spectral slope between 1.1-1.8 µm. Our unit distributions within the previously mapped MSL future traverse area in the NW mound agree well with previous results (Fig. 2). All units that we have so far identified elsewhere in the mound are similar to the units in the NW, although not all units are present in each location.

LATERAL CONTINUITY OF UNITS: Here we focus on two CRISM images from the NW and SW portions of the mound (Fig. 1). The mineral strigraphy of the NW mound is generally Fe/Mg-smectites overlain by the ferrous phase and the hematite ridge (Fig. 2), which is overlain by PHS with scattered MHS signatures [3,6]. In the SW mound, perspective views of our mineral maps appear to show two separate packets of smectites overlain by the ferrous phase, separated in elevation by a cliff with MHS signatures (Fig. 3). The sulfate straitigraphy in the SW is also more complex, with both clear PHS and MHS layers occurring throughout the cube, that may or may not be interbedded. Additional mapping will be required to fully understand the strait-
graphy in the SW mound and how it relates to the NW mound, but these preliminary results suggest that the mound units may not be entirely laterally continuous. If this is the case, then the formation of the mound may be more complicated than implied by the NW mound.

**Evidence for redox reactions:** An enigmatic spectral unit found in both the NW and SW mound is the ferrous iron signature found above and overlapping onto the smectite unit. This signature is consistent with olivine [3], but also with other ferrous phases. Similar signatures have been identified at Mawrth Vallis, and there are interpreted as indicating a reduced-iron-bearing alteration phase [7]. Ferrous clays (e.g., chlorite, celadonite, Fe-rich illites) exhibit this slope, however, the ferrous phases at Mawrth and the Gale mound do not exhibit clay absorption bands. Instead, the signature is more consistent with poorly-crystalline ferrous alteration phases, like the “green rust” that gives reducing soils their green to grey color [8]. Thus, we hypothesize that the ferrous signature in the mound is indicative of reducing alteration conditions.

This hypothesis also may explain the origin of the hematite ridge in the NW mound. The ridge is closely associated with the ferrous unit, which is located in a topographic bench (Fig 2) that is either immediately stratigraphically above or at the same level as the ridge, and both are underlain by the Fe/Mg-smectites. Previous studies suggested that the ridge may have formed when an Fe2+-bearing fluid encountered an oxidizing environment [6], and the presence of ferrous alteration phases supports this interpretation. In this scenario, the reducing fluids were created by long-term oxygen limited alteration of Fe-bearing minerals in the near-surface. Downward movement of these fluids may have been limited by the underlying clay layer, forcing lateral flow. On emergence at the surface (sub-aerial or sub-aqueous), the iron was oxidized by photochemical or other redox reactions. On Earth, similar processes form hematite ironpans on slopes surrounding poorly-drained hilltops [9], as well as ancient banded iron formations in shallow coastal waters [10].

**HCP in the upper mound:** Multiple origin scenarios have been postulated for the origin of the regularly-bedded layers in the upper mound, including deposition of ice-dust or dust mantles, pyroclastic, and aeolian processes [e.g., 2, 3, 11-13]. One key observation that may help to constrain these hypotheses is the presence of HCP throughout the upper mound, in the form of dark sediments in topographic lows, likely sourced from local erosion. These sediments are then transported into aeolian bedforms on the crater floor, suggesting some fraction is sand-sized. The presence of mafic sand throughout the upper mound is inconsistent with origins related to atmospheric dust. Furthermore, the high albedo of the bulk upper mound suggests that the bulk material is fine grained, implying a mixture of sand and finer grains. This mixture is most likely inconsistent with most aeolian deposition scenarios. However, similar mixtures of bright fines and dark sand/granules are observed during erosion of pyroclastic deposits like ignimbrites [14], possibly supporting a primarily volcaniclastic origin for the upper strata.

**References:**


**Figure 2:** Mineral units at the NW mound - PHS (blue), ferrous (green) and Fe/Mg-smectites (pink) over HiRISE image PSP_009149_1750_RED and HiRISE elevation. The horizontal and vertical extents shown are 5.44km and 1.22km.

**Figure 3:** Mineral units at the SW mound - ferrous (green) and Fe/Mg-smectites (pink) over HRSC elevation (2X exaggeration) and HiRISE image ESP_017931_1745_MIRB. The horizontal and vertical extents shown are 8.78km and 1.32km. North is to