SEDIMENTOLOGY AND STRATIGRAPHY OF THE MURRAY FORMATION, GALE CRATER, MARS.

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Introduction: Gale crater is located on fluvially dissected, cratered, highlands bedrock astride the dichotomy boundary on Mars. Sedimentary rocks in Gale were deposited, buried, lithified, exhumed, and eroded before 3.3-3.1 Ga and comprise a 5 km high mountain (Aeolis Mons) [1]. One of the critical objectives of the Mars Science Laboratory (MSL) mission is to determine whether the strata preserved in Gale crater record a paleoenvironmental record capable of supporting past life. Since arrival at the Bradbury landing site, the Curiosity rover has amassed textural and compositional evidence for persistent liquid water from both coarse- and fine-grained sedimentary rocks. A diverse rock package dominated by mudstones termed the Murray formation makes up the lowermost stratal package exposed on the northern slope of Aeolis Mons; it has been interpreted to interfinger with the fluvio-deltaic strata of the Bradbury group [1]. Curiosity has gained approximately 400 m of elevation, which roughly corresponds to stratigraphic thickness because the layers are approximately subhorizontal. For more than 1000 sols, the Curiosity rover has been exploring the Murray formation (Fig. 1), a unit dominated by laminated, fine-grained, clastic rocks, but which has a variety of grain sizes and structures. This abstract represents a progress report on the sedimentology and stratigraphy of part of the Murray formation.

Stratigraphy and Sedimentology: Rocks comprising the Murray formation (> 300 m thick) are presently divided into five members representing three major facies associations (Fig. 1). We have identified five members (with approximate thicknesses in parentheses) in ascending order: Pahrump Hills (25 m), Hartmann's Valley (25 m), Karasburg (37 m), Sutton Island (98 m), Vera Rubin Ridge (> 100 m). Thus far, there has been no compelling stratigraphic or mapping reason to place an upper boundary on the Vera Rubin Ridge (VRR) member or Murray formation. Contact relationships between members are difficult to ascertain, but mostly considered to be conformable. As previously documented [1], contacts with the Bradbury group are considered transitional with interfingering facies.

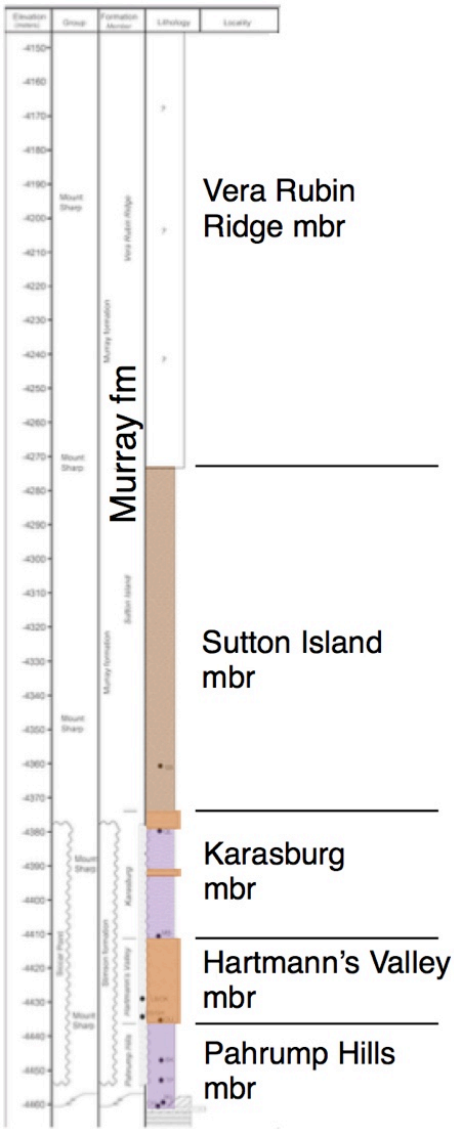

Figure 1. *Stratigraphic column of the Murray formation showing elevation, formation and member divisions, and facies groupings.*

Facies 1 is typified by thinly laminated, gray-colored, fine-grained rocks; these are best preserved in the Pahrump Hills member (Fig. 1). A variant on this facies is similarly laminated, but being more purple in color and containing distinct patches of cm-scale concretions. This variant is best developed in the Karasburg member (Fig. 1). Persistent fine lamination, coupled with an absence of desiccation cracks, suggests deposition from suspension in a lake with a generally stable level. Facies 2 forms an ~25 m thick interval exhibiting meter-scale trough cross-bedding with steep foresets. These are consistent with curved-crested dune bedforms resulting from bedload sediment transport. While the fine grain size points to an aeolian setting, such structures are also produced in fluvial settings [2]. This facies is best observed in the Hartmann's Valley member (Fig. 1). Facies 3 comprises a package of heterolithic mudstone and sandstone. Identifiable in Mastcam and Mars Hand Lens Imager images are maroon-colored, finely laminated mudstone, cm-scale ripple cross-laminated sandstone, and dm-scale cross-stratified sandstone. Supporting evidence for sandstone lenses in the Murray comes from the ChemCam Laser Induced Breakdown Spectroscopy grain size proxy [3]. Concretions occur commonly [4] and obscure primary lamination where abundant. Locally abundant, younger, sulfate veins occur both transecting and parallel to primary layering. Facies 3 also shows distinctive, small-scale polygonal fractures that resemble desiccation cracks [5]. Their presence, with locally developed possibly contemporaneous gypsum precipitates, suggests deposition in lake and lake-margin environments dominated by suspension fallout with less common traction deposition. This facies is best exemplified by the Sutton Island member (Fig. 1). The Vera Rubin Ridge member (Fig. 1) is still under active interrogation by Curiosity [6], so interpretations are provisional. The majority of the VRR member is fine-grained and thinly laminated, consistent with deposition from fallout from suspension in a low-energy lacustrine environment as with Facies 1. The lower part of the VRR member is cross-cut by abundant calcium sulfate veins, and mm-scale nodules are observed throughout the ridge. In the upper part of the VRR member, m-scale inclined strata in isolated outcrops hints at possible aeolian or subaqueous transport similar to Facies 2.

The broad facies arrangement of the Murray formation and Bradbury group along the >17 km traverse by Curiosity since 2012 is consistent with progradation of fluvial deposits from the crater margin to a lake setting that occupied part of the crater interior. Overall, the facies types and architecture are consistent with a lake basin that has abundant fluvial input and relatively stable lake levels, where water and sediment load generally exceeded overall evaporation, similar to overfilled lake basins recognized on Earth [7].

References:

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