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Recent sedimentological studies of the Murray and Stimson formations and their implications for Gale crater evolution, Mars

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The Mars Science Laboratory (MSL) Curiosity rover has been exploring sedimentary rocks on the lower north slope of Aeolis Mons since August 2014. Previous work has demonstrated a succession of sedimentary rock types deposited dominantly in river-delta settings (Bradbury group), and interfingering/overlying contemporaneous/younger lake settings (Murray formation, Mt. Sharp group). The Murray formation is unconformably overlain by the Stimson formation, an ancient aeolian sand lithology. Here, we describe the MSL team's most recent sedimentological findings regarding the Murray and Stimson formations. The Murray formation is of the order of 200 meters thick and formed dominantly of mudstones. The mudstone facies, originally identified at the Pahrump Hills field site, show abundant fine-scale planar laminations throughout the Murray formation succession and is interpreted to record deposition in an ancient lake system in Gale crater. Since leaving the Naukluft Plateau (Stimson formation rocks) and driving south-southeastwards and progressive stratigraphically upwards through the Murray succession, we have recognised a variety of additional facies have been recognized that indicate variability in the overall palaeoenvironmental setting. These facies include (1) cross-bedded siltstones to very fine-grained sandstones with metre-scale troughs that might represent aeolian sedimentation; (2) a heterolithic mudstone-sandstone facies with laminated fine-grained strata, cm-scale ripple cross-laminations in siltstone or very fine sandstone, and dm-scale cross-stratified siltstone and very fine grained sandstone. The palaeoenvironmental setting for the second facies remains under discussion. Our results show that Gale crater hosted lakes systems for millions to tens of millions of years, perhaps punctuated by drier intervals.

Murray strata are unconformably overlain by the Stimson formation. Stimson outcrops are typically characterized by cross-bedded sandstones with cross-sets ranging between 40-80 cm thick (Fig. 2). Within the sets, cross-strata comprise repetitive laminations that are a few millimeters thick and typically sub-parallel. Cross-laminations downlap onto the underlying bounding surface with an asymptotic profile and are truncated at their top by an overlying bounding surface. Palaeocurrent analysis based on measurements of 117 foreset azimuths indicate a wind regime that drove dune migration towards the northeast. Cross sets are separated by erosional bounding surfaces, which are interpreted to represent interdune surfaces, which were formed by migrating dunes as they climbed over the stoss slope of a preceding dune, eroding its stoss and upper part of the lee slope. From analysis of the sedimentary architecture, and comparison with terrestrial aeolian strata, we interpret the Stimson formation to represent sands deposited in a dry-aeolian dune system. In summary, sedimentary observations by the Curiosity rover record a diverse range of palaeoenvironments and a rich geological history in strata preserved in lower Aeolis Mons.