AUTHIGENESIS/DIAGENESIS OF THE MURRAY FORMATION MUDSTONE IN GALE CRATER, MARS

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The Mars Science Laboratory rover Curiosity has been exploring sedimentary deposits in Gale crater since August, 2012. The rover has traversed up section through ~150 m of sedimentary rocks deposited in fluvial, deltaic, and lacustrine environments (Bradbury group and overlying Mount Sharp group). The Murray formation lies at the base of the Mt. Sharp group and has been interpreted to be a finely laminated mudstone likely deposited in a subaqueous lacustrine environment. Four drill samples from several elevations in the Murray fm have been acquired by the rover's sampling system and delivered to the CheMin XRD instrument. The lower section of the Murray fm contains 2:1 phyllosilicate(s), hematite, jarosite, XRD amorphous materials, and primary basaltic minerals. Further up section, the Murray fm contains magnetite, cristobalite, tridymite, abundant Si-rich XRD amorphous materials along with plagioclase and K-feldspars. Murray formation materials appear to have been altered under an open hydrologic system based on the bulk chemistry of these materials measured by the Alpha Particle X-ray Spectrometer (APXS). The 2:1 phyllosilicate only occurs in the lowermost section of the Murray fm and may be detrital or formed during authigenesis of Murray fm materials, similar to the Fe-saponite and magnetite detected in a mudstone in the Yellowknife Bay fm near Curiosity's landing site (stratigraphically at the base of the Bradbury group). The occurrence of jarosite and hematite in the lower section indicates an acidic diagenetic event. These phases may have formed via several acidic alteration mechanisms, including (1) oxidative weathering of mafic igneous rocks containing sulfides; (2) sulfuric acid weathering of Fe-bearing phases; and (3) near-neutral pH subsurface solutions rich in Fe^{2+} that were rapidly oxidized to Fe^{3+}, which produced excess acidity. The transition from abundant hematite in the lowermost Murray fm to magnetite moving up section may indicate changes in lake chemistry, i.e., variable redox conditions, possibly during authigenesis or subsequent diagenetic events. Tridymite, a high temperature mineral, (and possibly cristobalite) is detrital, potentially deposited in a lake from a distal silicic volcanic rock source or from crustal materials present prior to the Gale Crater impact event. Abundant Si-rich XRD amorphous materials in the upper sections of the Murray fm may be detrital or an aqueous alteration product of primary igneous phases and phyllosilicates. Curiosity's science team is still deciphering the authigenesis and diagenetic events that formed the Murray fm. The mineralogy and geochemistry of the formation suggest a complicated history with several (many?) episodes of aqueous alteration under a variety of environmental conditions.