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Curiosity Rover's CheMin Instrument Investigates Mineralogy of Gale Crater and Implications for Diagenesis

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The Mars Science Laboratory rover *Curiosity* employs a suite of instruments to investigate past or present habitability of Mars, as observed at Gale crater and particularly in the lower strata of the crater's central mound, informally named Mount Sharp. The X-ray diffractometer on board, CheMin, is used to assess the quantitative mineralogy of scooped soil samples and drilled rock powders. Methods of modeling diffraction peak positions and intensities to evaluate the abundances of minerals include Rietveld refinement and FULLPAT (full-pattern fitting). Each of the samples analyzed by CheMin contains X-ray amorphous material. The amorphous component chemistry is resolved by subtracting the chemistry of the crystalline composition, as determined by X-ray diffraction data, from the bulk sample chemistry, as determined by the Alpha Particle X-ray Spectrometer (APXS). Diffraction results have been obtained on five samples thus far to include Rocknest, John Klein, Cumberland, Windjana and Confidence Hills. Soil samples collected at Rocknest, an aeolian bedform in Gale crater, were the first to be analyzed *in situ* by CheMin. The Rocknest mineral assemblage is basaltic (plagioclase, Fe-forsterite, augite, pigeonite) and contains amorphous material that is compositionally similar to palagonitic volcanic soils found on Earth, with the addition of sulfur and chlorine. The four drill analyses are characteristic of deposition in a variety of fluviolacustrine environments and exhibit evidence of low-temperature diagenesis. Both John Klein and Cumberland are part of the Sheepbed mudstone at Yellowknife Bay, where the first drilled samples were acquired as well as the first evidence of a habitable environment on Mars. Drilled three meters apart from each other, the two samples reveal basaltic minerals similar to those at Rocknest, as well as phyllosilicates, Fe-oxides/hydroxides, Ca-sulfates, Fe-sulfides, and amorphous materials. The nature and hydration of interlayer cations within the phyllosilicates differs between the two samples, which implies localized diagenesis. The Windjana sandstone at the Kimberley location differs from the Sheepbed mudstone in that it contains more pyroxene and magnetite and abundant K-feldspar, as well as phyllosilicates and amorphous material. These phases may represent potassium-rich basaltic provenance or aqueous alteration by potassium-bearing fluids. While the Confidence Hills sample is still in the preliminary stages of evaluation, major crystalline phases observed in this fine-grained sedimentary rock include plagioclase, pyroxene, K-feldspar and phyllosilicates; hematite, rare in all previous samples, is notably abundant and jarosite is present. The findings suggest localized mobilization of iron-bearing fluids and acidic conditions. The more oxidized assemblage of Confidence Hills marks the transition into the lower strata of Mount Sharp.