

The Amorphous Composition of Three Mudstone Samples from Gale Crater: Implications for Weathering and Diagenetic Processes on Mars

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The Mars Science Laboratory rover, Curiosity, is exploring the lowermost formation of Gale crater's central mound. Within this formation, three samples named Marimba, Quela, and Sebina have been analyzed by the CheMin X-ray diffractometer and the Alpha Particle X-ray Spectrometer (APXS) to determine mineralogy and bulk elemental chemistry, respectively. Marimba and Quela were also analyzed by the SAM (Sample Analysis at Mars) instrument to characterize the type and abundance of volatile phases detected in evolved gas analyses (EGA). CheMin data show similar proportions of plagioclase, hematite, and Ca-sulfates along with a mixture of di- and trioctahedral smectites at abundances of ~28, ~16, and ~18 wt% for Marimba, Quela, and Sebina. Approximately 50 wt% of each mudstone is comprised of X-ray amorphous and trace crystalline phases present below the CheMin detection limit (~1 wt%). APXS measurements reveal a distinct bulk elemental chemistry that cannot be attributed to the clay mineral variation alone indicating a variable amorphous phase assemblage exists among the three mudstones. To explore the amorphous component, the calculated amorphous composition and SAM EGA results are used to identify amorphous phases unique to each mudstone. For example, the amorphous fraction of Marimba has twice the FeO wt% compared to Quela and Sebina yet, SAM EGA data show no evidence for Fe-sulfates. These data imply that Fe must reside in alternate Fe-bearing amorphous phases (e.g., nanophase iron oxides, ferrihydrite, etc.). Constraining the composition, abundances, and proposed identity of the amorphous fraction provides an opportunity to speculate on the past physical, chemical, and/or diagenetic processes which produced such phases in addition to sediment sources, lake chemistry, and the broader geologic history of Gale crater.