Using Mineralogy to Interpret Martian Geologic History

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The surface mineralogy of Mars is key to interpreting the planet's geologic history and constraining when and where Mars may have been habitable to microbial life. Orbital mineralogical data from infrared spectrometers collected over the last two decades have demonstrated that Mars is more than a basaltic planet. Thermal infrared (TIR) emission spectrometers have identified regional variations in igneous minerals, iron oxides, and chloride salts, showing evidence for magmatic evolution and aqueous alteration. Orbital visible/shortwave infrared reflectance spectra provide detailed information about the aqueous history of Mars through the identification of clay minerals, sulfates, carbonates, zeolites, and amorphous materials in ancient ~3-4-billion-year-old terrains. Mineralogical data from rovers allow us to better characterize mineral formation mechanisms by identifying mineral assemblages and placing them in geologic context using outcrop- to grain-scale images. TIR and Mössbauer data from the Mars Exploration Rovers helped identify an ancient dune-interdune playa environment with multiple episodes of groundwater at Meridiani Planum and volcanism-induced hydrothermalism at Gusev crater. The CheMin X-ray diffractometer on the Mars Science Laboratory *Curiosity* rover in Gale crater is the first fully quantitative mineralogical instrument sent to another planetary surface. CheMin data allow the quantification of minerals and X-ray amorphous materials with a mineral detection limit of <1 wt.% and provide crystal chemistry of major phases from refined unit-cell parameters. CheMin has revealed local mineralogical changes in ancient sedimentary rocks not seen from orbit and helped identify habitable environments. Throughout the 600+ m of vertical stratigraphy studied so far, changes in clay mineralogy, Fe-oxides/oxyhydroxides, sulfates, and carbonates demonstrate a long history of surface and groundwater at Gale crater with variable salinity, pH, Eh, and temperature. Recent CheMin data document a decrease in clay minerals and an increase in sulfate minerals in younger strata that corresponds with a change from fluvio-lacustrine to eolian depositional environments, potentially documenting a change to a drier climate across the planet.

Session T153. Mineral Informatics and the Evolution of Earth, Planets, and Life: In Honor of MSA Awardee, Shaunna M. Morrison
Description: Mineral data are critical to understanding Solar System history. This session will explore powerful methods of data analysis and visualization in the quest to explore the origins and evolution of Earth, other planets, and life.
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