

REMOTE X-RAY DIFFRACTION OF PLANETARY BODIES: WHAT IS MARS REALLY MADE OF?

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Since before the time of Italian Giovanni Schiaparelli (1877), who published a map showing Mars *canali*, mankind has sought to learn the mineralogical makeup of planetary bodies. Virtually all of our knowledge of Earth's neighbors (apart from our Moon and Mars) has been obtained remotely via spectroscopic or photographic methods. Not unlike Percival Lowell, who suggested in 1895 that martian canals had been constructed by an intelligent race tapping melting polar ice for water to irrigate equatorial crops, understanding the *mineralogy* of other planetary bodies has often required imagination. We now have considerable chemical and spectroscopic data for the surface of Mars, but these do not provide unambiguous mineralogic information. Indeed, considerable speculation and discussion continue about the mineralogy of the martian surface. Orbital data show the widespread occurrence of common basaltic or andesitic minerals, but it has proven more difficult to unravel Mars' alteration mineralogy. Spectroscopic and chemical data obtained by the martian landers have provided tantalizing suggestions of a secondary minerals, such as phyllosilicates and evaporite minerals, but there are few relatively unambiguous mineralogical identifications, including jarosite, $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$ (based on Mössbauer spectroscopy), gypsum, and a variety of less well-constrained sulfates and silicates. CheMin is a miniature XRD/XRF instrument designed for mineralogical analyses on extraterrestrial bodies (e.g., planets, moons, asteroids and cometary nuclei). CheMin uses a Co X-ray tube in transmission mode with a 2-D CCD detector capable of spatial and energy resolution of X-ray photons. Sample preparation requires only crushing to $<150 \mu\text{m}$ due to a unique sample movement technique applied during analysis for enhanced particle statistics. The instrument has been lab and field tested and was used to obtain in situ XRD and XRF analyses in Death Valley and in the Arctic. The mineralogy of rock and soil samples was identified in the field, with analysis times as short as 15 min, and data were analyzed on-site, including Rietveld refinements to compute the quantitative compositions of mineral mixtures. CheMin is scheduled to fly on the 2009 Mars Science Laboratory landed mission to Mars, where it will perform mineralogical and elemental analyses of rocks, sediments, and regoliths to provide the first definitive mineralogical data for Mars, including assessing the possible role of water in mineral formation and searching for indicators of past habitable environments.