The CheMin XRD on the Mars Science Laboratory rover *Curiosity*: Construction, operation, and quantitative mineralogical results from the surface of Mars.

David Blake

The Mars Science Laboratory mission was launched from Cape Canaveral, Florida on Nov. 26, 2011 and landed in Gale crater, Mars on Aug. 6, 2012. MSL's mission is to identify and characterize ancient "habitable" environments on Mars. MSL's precision landing system placed the *Curiosity* rover within 2 km of the center of its 20 X 6 km landing ellipse, next to Gale's central mound, a 5,000 meter high pile of laminated sediment which may contain 1 billion years of Mars history. Curiosity carries with it a full suite of analytical instruments, including the CheMin X-ray diffractometer, the first XRD flown in space.

CheMin is essentially a transmission X-ray pinhole camera. A fine-focus Co source and collimator transmits a 50μm beam through a powdered sample held between X-ray transparent plastic windows. The sample holder is shaken by a piezoelectric actuator such that the powder flows like a liquid, each grain passing in random orientation through the beam over time. Forward-diffracted and fluoresced X-ray photons from the sample are detected by an X-ray sensitive Charge Coupled Device (CCD) operated in single photon counting mode. When operated in this way, both the x,y position and the energy of each photon are detected. The resulting energy-selected Co Kα Debye-Scherrer pattern is used to determine the identities and amounts of minerals present via Rietveld refinement, and a histogram of all X-ray events constitutes an X-ray fluorescence analysis of the sample.

The key role that definitive mineralogy plays in understanding the Martian surface is a consequence of the fact that minerals are thermodynamic phases, having known and specific ranges of temperature, pressure and composition within which they are stable. More than simple compositional analysis, definitive mineralogical analysis can provide information about pressure/temperature conditions of formation, past climate, water activity and the like. Definitive mineralogical analyses are necessary to establish the origin or provenance of a sample. The search for evidence of extant or extinct life on Mars will initially be a search for evidence of present or past conditions supportive of life (e.g., evidence of water), not for life itself.

Results of the first 1,000 sols (Mars days) will be discussed, including the discovery of the first habitable environment on Mars.