

## **X-RAYS ON MARS: HOW A HANDFUL OF PHOTONS IS HELPING REVOLUTIONIZE OUR UNDERSTANDING OF THE RED PLANET**

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As one of the most mysterious and intriguing bodies in our solar system, Mars has been the object of more spacecraft missions than any other planet. Questions of its geological and climate history are of great interest to planetary scientists of many disciplines, not the least of which include astrobiologists investigating the possibility of present and past habitats for life. Geochemical investigations have been at the forefront of many of these missions. With the Viking landers in the 1970's, the Pathfinder in the 1990's, and now the Mars Exploration Rovers, a steady stream of x-ray fluorescence analyzers have been sent to five different locations on the surface. Moessbauer spectrometers are also on the rovers, and a germanium-crystal gamma ray spectrometer is currently operating in orbit around Mars. In 2009, the Mars Science Laboratory rover will include both x-ray fluorescence and for the first time, x-ray diffraction instrumentation. These analytical techniques, all based upon the use of energetic photons, have pioneered new geochemical and mineralogical discoveries, many quite unexpected.

Opportunity Rover is currently exploring spectacular Victoria crater, seeking a path down into its interior where magnificent layered outcrops hold open the promise for deepening our understanding of the history and development of this sedimentary structure which involved acidic waters in its ancient past and produced hematite-rich natural spherules ("blueberries"). Spirit Rover is exploring the Columbia Hills in a former crater lake, discovering an almost bewildering array of geochemical variety in rock types and their trace elements. More than a dozen different iron minerals have also been discovered, as well as a surprising abundance of sulfate and silica soils.

Without the use of energetic photons for analysis, many of these samples would have remained of questionable composition and the evidences for the former presence of liquid water would have remained controversial or unknown.