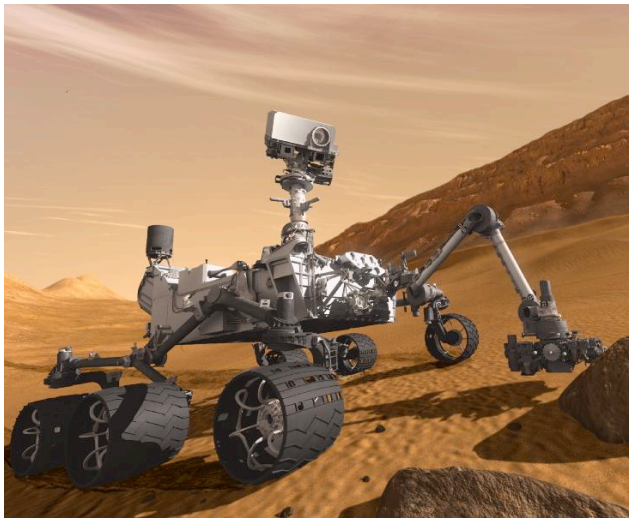
NASAfacts

Mars Science Laboratory - CheMin Instrument



This artist concept features NASA's Mars Science Laboratory rover, Curiosity, a mobile robot for investigating Mars' past or present potential to sustain microbial life. Image credit: NASA/JPL-Caltech.

Mission Overview

The Mars Science Laboratory (MSL) mission's rover, Curiosity, will assess whether Mars ever was, or is still today, an environment able to support microbial life. In other words, its mission is to determine the planet's "habitability." The Curiosity rover is part of NASA's Mars Exploration Program, a long-term effort of robotic exploration of the Red Planet.

To determine the habitability of Mars, the rover will carry the biggest, most advanced suite of instruments for scientific studies ever sent to the Martian surface. Curiosity will analyze samples scooped from the soil and drilled from rocks. The record of the planet's climate and geology is essentially "written in the rocks and soil"—in their formation, structure, and chemical composition.

An X-ray diffraction and fluorescence instrument called CheMin will also examine samples gathered by the robotic arm. It is designed to identify and quantify the minerals in rocks and soils, and to measure bulk composition. The principal investigator is David Blake of NASA's Ames Research Center, Moffett Field, Calif.

Science Objectives

An important science goal of the MSL mission is to identify and characterize past or present habitable environments as recorded in sediments and rocks. CheMin, short for "Chemistry and Mineralogy," is a definitive mineralogy instrument that will identify and quantify the minerals present in rocks and soil.

Different minerals are linked to certain kinds of environments. Examples of minerals found on Mars so far, include olivine, pyroxenes, hematite, goethite and magnetite. Scientists will use CheMin to search for mineral clues indicative of a past Martian environment that could have supported life.

By determining the mineralogy of rocks and soils, CheMin will assess the involvement of water in their formation, deposition, or alteration. In addition, CheMin data will be useful in the search for potential mineral biosignatures, energy sources for life or indicators of past habitable environments. CheMin can unequivocally identify and quantify minerals above its detection limits in complex natural samples such as basalts, multi-component evaporite systems, and soils.

CheMin Principal Investigator David Blake of NASA's Ames Research Center is seen here collecting data from a CheMin cousin called Terra. Image credit: NASA.

Instrument Description

CheMin is a powder X-ray Diffraction (XRD) instrument that also has X-ray Fluorescence (XRF) capabilities. CheMin is part of the analytical laboratory of Curiosity, which is located inside the main body of the rover.

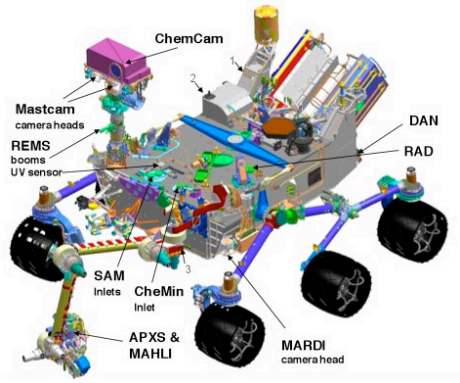


Diagram showing where MSL instruments are located. Image Credit: NASA/JPL-Caltech

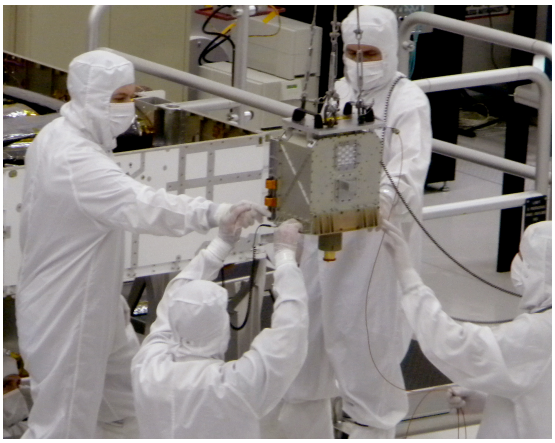
CheMin has the capability to analyze as many as a few dozen samples during the nominal prime mission, but if the mission lasts longer, CheMin is capable of analyzing many more, because its sample cells are reusable. Each analysis may take up to 10 hours of analysis time, spread out over two or more Martian nights, although some samples may provide acceptable results in a single Martian day.

Measurement Description

To prepare rock samples for analysis, the rover will be able to drill into rocks, collect the resulting fine powder, sift it, and deliver it to a sample holder. It will use a scoop for collecting soil. CheMin will then direct a beam of X-rays as fine as a human hair through the powdered material. X-rays, like visible light, are a form of electromagnetic radiation. They have a much shorter wavelength that cannot be seen with the naked eye. When the X-ray beam interacts with the rock or soil sample, some of the X-rays will be absorbed by atoms in the sample and re-emitted or fluoresced at energies that are characteristic of the particular atoms present.

In X-ray diffraction, some X-rays bounce away at the same angle from the internal crystal structure in the sample. When this happens, they mutually reinforce each other and produce a distinctive signal. Scientists can measure the angle at which X-rays are diffracted toward the detector and use that to identify minerals. For example, if the mineral halite (common table salt, or NaCl), were placed in CheMin, the instrument would produce a specific diffraction pattern that would identify the structure of halite.

Because all minerals diffract X-rays in a characteristic pattern and all elements emit X-rays with a unique set of energy levels, scientists will use the information from X-ray diffraction to identify the crystalline structure of materials the rover encounters on Mars. A charge-coupled device (CCD) will collect both diffraction and fluorescence information.



Members of NASA's Mars Science Laboratory team carefully steer the hoisted CheMin instrument during its June 15, 2010, installation into the mission's Mars rover, Curiosity. Image Credit: NASA/JPL-Caltech.

For more information about CheMin, visit: http://www.nasa.gov/msl