Investigations using Laboratory Testbeds to Interpret Flight Instrument Datasets from Mars Robotic Missions.

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The Astromaterials Research and Exploration Science Directorate at the NASA Johnson Space Center (JSC) has laboratory instrumentation that mimic the capabilities of corresponding flight instruments to enable interpretation of datasets returned from Mars robotic missions. The lab instruments have been and continue to be applied to datasets for the Mössbauer Spectrometer (MB) on the Mars Exploration Rovers (MER), the Thermal & Evolved Gas Analyzer (TEGA) on the Mars Phoenix Scout, the CRISM instrument on the Mars Reconnaissance Orbiter Missions and will be applied to datasets for the Sample Analysis at Mars (SAM), Chemistry and Mineralogy (CheMin) and Chemistry & Camera (ChemCam) instruments onboard the Mars Science Laboratory (MSL). The laboratory instruments can analyze analog samples at costs that are substantially lower than engineering models of flight instruments, but their success to enable interpretation of flight data depends on how closely their capabilities mimic those of the flight instrument.

The JSC lab MB instruments are equivalent to the MER instruments except without flight qualified components and no reference channel Co-57 source. Data from analog samples were critical for identification of Mg-Fe carbonate at Gusev crater. Fiber-optic VNIR spectrometers are used to obtain CRISM-like spectral data over the range 350-2500 nm, and data for Fe-phyllosilicates show irreversible behavior in the electronic transition region upon dessication. The MB and VNIR instruments can be operated within chambers where, for example, the absolute H_2O concentration can be measured and controlled.

Phoenix's TEGA consisted of a calorimeter coupled to a mass spectrometer (MS). The JSC laboratory testbed instrument consisted of a differential scanning calorimeter (DSC) coupled to a MS configured to operate under total pressure (12 mbar), heating rate (20 °C/min), and purge gas composition (N_2) analogous to the flight TEGA. TEGA detected CO_2 release at both low (400-680 °C) and high (725-820 °C) temperature and an endothermic reaction in concert with the high temperature release. The high-temperature thermal decomposition is consistent with calcite, dolomite, or ankerite, (3–6 wt.%) or any combination of these phase based upon laboratory testbed experiments. Recent laboratory experiments suggest that the low temperature CO_2 release was caused by a reaction between calcium carbonate and hydrated magnesium perchlorate; although, CO_2 release by the oxidation of organic materials and Fe-/Mg-rich carbonates cannot be ruled out.

MSL landed in Gale crater on August 5, 2012. Although numerous analog samples have been analyzed on the JSC laboratory testbeds, no SAM, CheMin, or ChemCam analyses have been acquired by MSL to date. The JSC SAM laboratory testbed consists of a thermal analyzer coupled with a MS configured to operate under total pressure (30 mbar), heating rate (35 °C/min), and purge gas composition (He) analogous to the flight SAM. The CheMin and ChemCam laboratory testbeds were developed and built by inXitu, Inc. and Los Alamos National Laboratory, respectively, to acquire datasets relevant to the MSL CheMin and ChemCam flight instruments.