COMMUNITY USER WORKSHOP ON PLANETARY LIBS (CHEMCAM) DATA

Past and Current ChemCam Results

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The ChemCam team has exceeded our highest expectations at Gale crater!
Hydrated soil and dust

With the very first laser shot on Mars we discovered that the soil and even the wind-blewn dust is hydrated. The SAM instrument quantified the amounts, but ChemCam has shown the ubiquity of water in the soils and has helped constrain the mineral component in the soil containing the water.


Multiple components in soils

ChemCam provides the first microbeam analysis of soils, showing for the first time that all soils we have analyzed so far consist of multiple components including contributions from the local rock types. We can correlate these components with characteristic grain sizes.


Felsic rock and pebble compositions

In the very first week ChemCam yielded the first high-silicon rock compositions. These compositions have been found not only in float rocks, but in the pebbles comprising the first conglomerates, and in the coarse soil grains. These were reported in the first Science papers and have been discussed in several papers since. The implication is that the igneous volcanism of Mars is much more varied, including much more evolved magmas, than previously thought.

Ross-1 = felsic composition
First Mars fluorine chemistry

Fluorine could not be previously analyzed on Mars, as XRF-type instruments cannot observe elements with atomic masses lighter than sodium. ChemCam has now made multiple observations of fluorine, which is relatively abundant in SNC meteorites. Its presence implies lower magma melting temperatures, and it is often present as an element within alteration minerals.

Quantitative analysis

- Forni O. et al., First detection of fluorine on Mars: implications for Gale crater’s geochemistry LPSC Friday Room 4 11:15 AM.
First manganese-rich minerals

The production of manganese-rich minerals requires a highly oxidizing environment, which currently does not exist on Mars. The discovery by ChemCam of a number of Mn-rich minerals has powerful implications for the paleo-atmosphere of Mars.

Caribou Sandstone with High-Mn Mineral

- Lanza N. et al., Manganese trends with depth on rock surfaces in Gale crater, LPSC Wed. Room 4, 9:45 AM.
First Li, Rb, Sr, and Ba on Mars

LIBS is highly sensitive to the alkali and alkaline-earth elements, so much so that our detection limit for lithium is ~5 ppm. These elements have generally never been seen on Mars before and they each have implications for Mars geochemistry. Lithium is a strong indicator of alteration; Rb, Sr, and Ba each tend to be sequestered in different minerals: Rb in anorthoclase, Sr in albite and more so in anorthite, etc. The global Rb/K ratio has important implications for planetary origins.

Rock surface alteration of mobile elements

On the Bathurst_Inlet sample all five ChemCam observations showed surface depletions in mobile elements, grading from the most mobile element (Li) to the less mobile elements (e.g., Si, Ti). The gradient was consistent among all observed elements, definitively showing relatively recent rock surface alteration.


Li trends with depth for 5 points on Bathurst_Inlet
Fe-rich cements in sediments

The micro-beam LIBS technique allows us to probe small areas, looking for interstitial material. In the first Science paper on conglomerates we reported that one observation point showed the beam profiling through a Fe-rich hydrated phase which we interpret to be an iron-rich cement binding the conglomerate clasts. We have evidence for this cement in the Rocknest rocks as well.

Ca-sulfate veins, variable hydration

ChemCam was the first to observe and confirm the composition of the calcium sulfate veins in the Yellowknife Bay units. We were also able to show that the veins were variably hydrated, confirmed by the Mastcam 1 micron band.

Mg ridge transect

ChemCam is providing fine-scale geochemical constraints within the Yellowknife Bay formation: Mg and Li variations are correlated at the site of the raised ridge. Elevated Mg (but not Li) likely represents the outer layer of the cement, exposed on the dipping surface. ChemCam analyses of isopachous cements within early diagenetic raised ridges indicate the presence of a Mg-Fe-Cl rich phase (or assemblage).


Chemostratigraphy of Yellowknife Bay sediments

ChemCam used > 30,000 shots and > 100 of super-high resolution images to characterize the Yellowknife Bay sediments far more comprehensively than with any other instrument. Using large aggregates of observations provides high confidence in the relative differences in these units. In the Shaler outcrop alone, only ChemCam was able to cover the whole area, as the rover was not allowed to drive up the outcrop for arm-deployed sampling.

High-resolution reflectance spectroscopy

While the spectral range only covers the 0.4-0.9 micron range, spectral features consistent with hematite, pyroxenes/olivine, and calcium sulfate have been observed.

Observations of ~5 km distant dunes and ridges also exhibit features consistent with hematite and pyroxene/olivine.

Atmospheric H$_2$O, O$_2$ abundances

Water and O$_2$ adsorption bands will provide the highest precision local ground-based measurements.

Preliminary fit: 7.9±0.7 precip. μm H$_2$O; 960±22 ppm O$_2$; 90.8±3.76% CO$_2$

- Mcconnachie T. H. et al., ChemCam passive-mode sky observations, in preparation
Other ChemCam related publications (submitted or in press)

1. - 14. Cited in presentation


For More Information

• ChemCam papers, abstracts, and posters can be accessed at:
  http://www.msl-chemcam.com
    – Go to the ChemCam tab and select Publications

• Today’s presentations can be found at:
Many ChemCam team members have posters at LPSC report on the current studies under way.

- Feel free to stop by and talk to the authors if you want more information.
ChemCam capabilities and instrument status
Instrument Status
ChemCam is doing great!

As of SOL: 517
# sequences: 666
# working SOLs: 252
# Mars targets: 452
# LIBS points: 3162
# Images: 1585
Variety of fine scale textures

Pointing_test (sol 100)  Athole_point (sol 302)  Beachrock (sol 126)  John_Klein_RP3 (sol 165)

Denham (sol 326)  Fabricius_Cliffs (sol 322)  Cumberland (sol 187)  Selwyn (sol 157)
High res. Color images

Drill Tailings sol 183

Assisting rover operations

(Drill bit, sol 172)

(Wheel inspection, sol 520)
Fine pointing
Fine scale survey of large areas

Comprehensive analysis of the Shaler unit. At each location, several points (5 -10 typically) are sampled by 30 laser shots each.