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Compositional Overview of Curiosity's Traverse to Yellowknife Bay

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Abstract

ChemCam has observed more than one hundred rock and soil targets and the APXS has analyzed more than two dozen targets over the course of the first 180 sols on Mars. This presentation gives an overview of the compositional and textural variations along the traverse from the Bradbury landing site to Yellowknife Bay (sol 180), where the first drill sampling was done by the rover arm.

1. Instrument Descriptions

The ChemCam remote sensing instrument suite on board the Curiosity rover employs the first laser-induced breakdown spectroscopy (LIBS) instrument on another planet and also includes the Remote Micro-Imager (RMI) [1,2]. The LIBS uses laser pulses of 14 mJ focused to a small spot to produce plasmas which emit light at wavelengths characteristic of the elements present. The LIBS can do rapid analyses within 7 m of the rover, providing semi-quantitative abundances of the major elements, and a number of minor and trace elements including hydrogen [3]. Passive spectroscopy is done in the range of 240-850 nm [4]. The RMI is capable of resolving to 50 µrad [5] making it the highest resolution remote imager on the rover.

In normal operation ChemCam takes RMI images for context before and after making LIBS observations. The latter consist of a linescan of 5-20 points or a 2D raster of 9-25 points. For each observation point approximately 30 lasers shots are used, with a spectrum taken for each shot to determine the homogeneity of the sample as the beam profiles into the rock or soil. Between 150 and 1000 spectra are typically collected for each target. The ChemCam LIBS instrument acts as a microprobe with its 350-550 µm spot size.

The APXS instrument is improved from the MER version by adding Peltier cooling, shortening the sample-to-detector distance by discarding the alpha channel, and increasing the strength of the x-ray source, thus facilitating analyses as short as 10 minutes [6].

2. Compositions Along the Traverse

At the Bradbury landing site the surface was covered with gravel that included rounded pebbles; several conglomerate outcrops were encountered. Scattered float of igneous rocks displayed a wide variety of grain sizes from very coarse grained (> 1 cm) to millimeter size grains. Compositions and visual clues indicate the presence of abundant alkali feldspars and suggested an overall composition higher in SiO2, alkalis, and aluminium than seen elsewhere on Mars. A single rock analyzed by APXS from this region, Jake Matijevic (Fig. 1), appears very similar in chemistry and mineralogy to terrestrial Mugearites [7]. Alkali and silica-rich compositions existed among the pebbles and in the one conglomerate analyzed for composition, Link [8].

After traversing ~400 m to the east toward a junction of three surface units (Hummocky; Light-toned Fractured; Cratered Surface; Fig. 1), Curiosity encountered apparent bedrock which was sampled on a fine-grained rock, Bathurst, found to contain 3.0% K_2O but low in sodium [6,9]. In close proximity

ChemCam and APXS sampled a collection of apparent sedimentary rocks at an aeolian drift named Rocknest. These rocks had FeO abundances into the upper 20% range and displayed a variety of textures, some with faint layering, supported by slight compositional variations along the face of the rocks. Calcium-rich salts appeared to occur in some of the layering [10,11]. These rocks may represent the top of a stratigraphic sequence that Curiosity explored down into Yellowknife Bay. As Curiosity crossed into this region the thermal inertia recorded by the REMS instrument showed a clear change [12], indicating that Curiosity had entered the region of higher thermal inertia seen by TES from orbit [13].

On its way into Yellowknife Bay Curiosity passed an outcrop of platy rocks named Shaler. From there the rover passed into lower units of Yellowknife Bay, inspecting a portion of the opposing side of the "bay" (Gillespie Lake) before settling along a lower portion of the sequence between Gillespie Lake and where it entered the lowest region below Shaler. An outstanding feature of this region is the abundant Ca-sulfate veins that intruded these rocks [14], seen first at Crest and Sheepbed on sols 125-126. More details will be given on the compositions at Yellowknife Bay in the presentation.

3. Discussion

Curiosity sampled striking compositional diversity within ~0.5 km distance of the landing site including a variety of both igneous and sedimentary rocks. Many details are left be revealed as the mission progresses. These include an understanding of the Fe-rich nature of Rocknest rocks, thought to be the topmost portion of the local sedimentary stratigraphy; sediments of the crater moat zone must ultimately be interpreted in comparison with the extensive stratigraphic section of the crater mound. In addition, many questions still surround the igneous samples encountered near Bradbury. What is the complete range of compositional igneous rock types at Gale? What source regions do they sample, and how extensive are they? What are the implications for the primitive crust of Mars' southern highlands?

References

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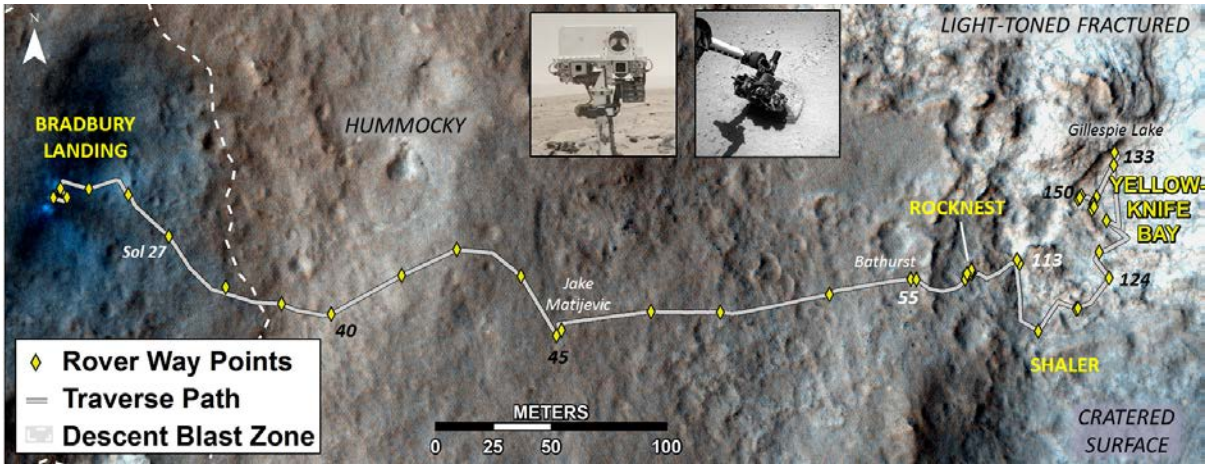

Fig. 1. MSL mission traverse path from Bradbury Landing, across the Hummocky Unit to Rocknest, where this unit meets the Light-toned Fractured Unit and the Cratered Surface Unit. From there the rover descended to Yellowknife Bay, where it remained through sol 280. Insets: ChemCam and APXS.