Measurement of Boron on Vera Rubin Ridge, Gale Crater

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Introduction

Boron (B) was discovered on Mars in calcium sulfate ($CaSO_4$) veins within Gale crater using the Laser Induced Breakdown Spectroscopy (LIBS) instrument onboard *Curiosity* rover's ChemCam suite [1,2]. B was found in the Yellowknife Bay, Stimson and lower Murray formations [1] (Fig. 3)

The $CaSO_4$ veins in Gale crater formed due to groundwater (GW) circulation through pre-existing sedimentary rocks [1,3]. These veins give insight to ancient fluid chemistry that could have supported life on Mars. New B observations are made near and on the resistant Vera Rubin Ridge (VRR) in upper Murray formation as shown in Fig. 3 c and d. These observations could have important implications for aqueous geochemistry and habitability of Mars.

On Earth, borates stabilize ribose, which forms the backbone of RNA [4]. On Mars, presence of B in veins formed by GW activity make them ideal targets for current and future astrobiological investigations.

Objectives

1. To systematically search for new B enriched areas on Mars.
2. To identify the cause of B enrichment on Mars with the help of terrestrial analogues.
3. To improve measurement of B using LIBS by developing new calibration standards in laboratory.

Methodology

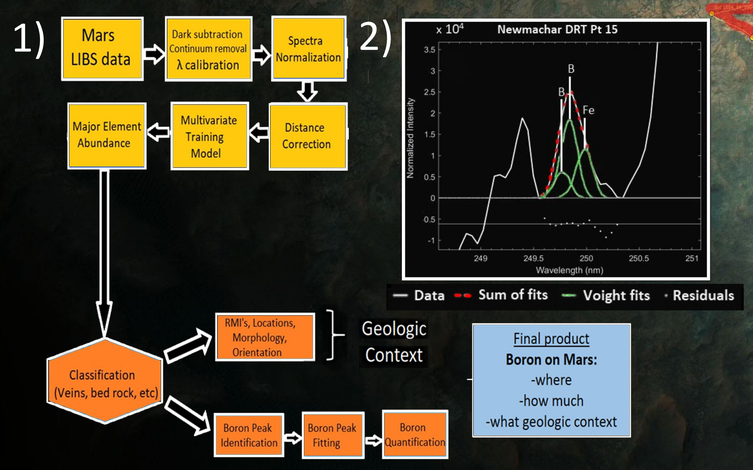
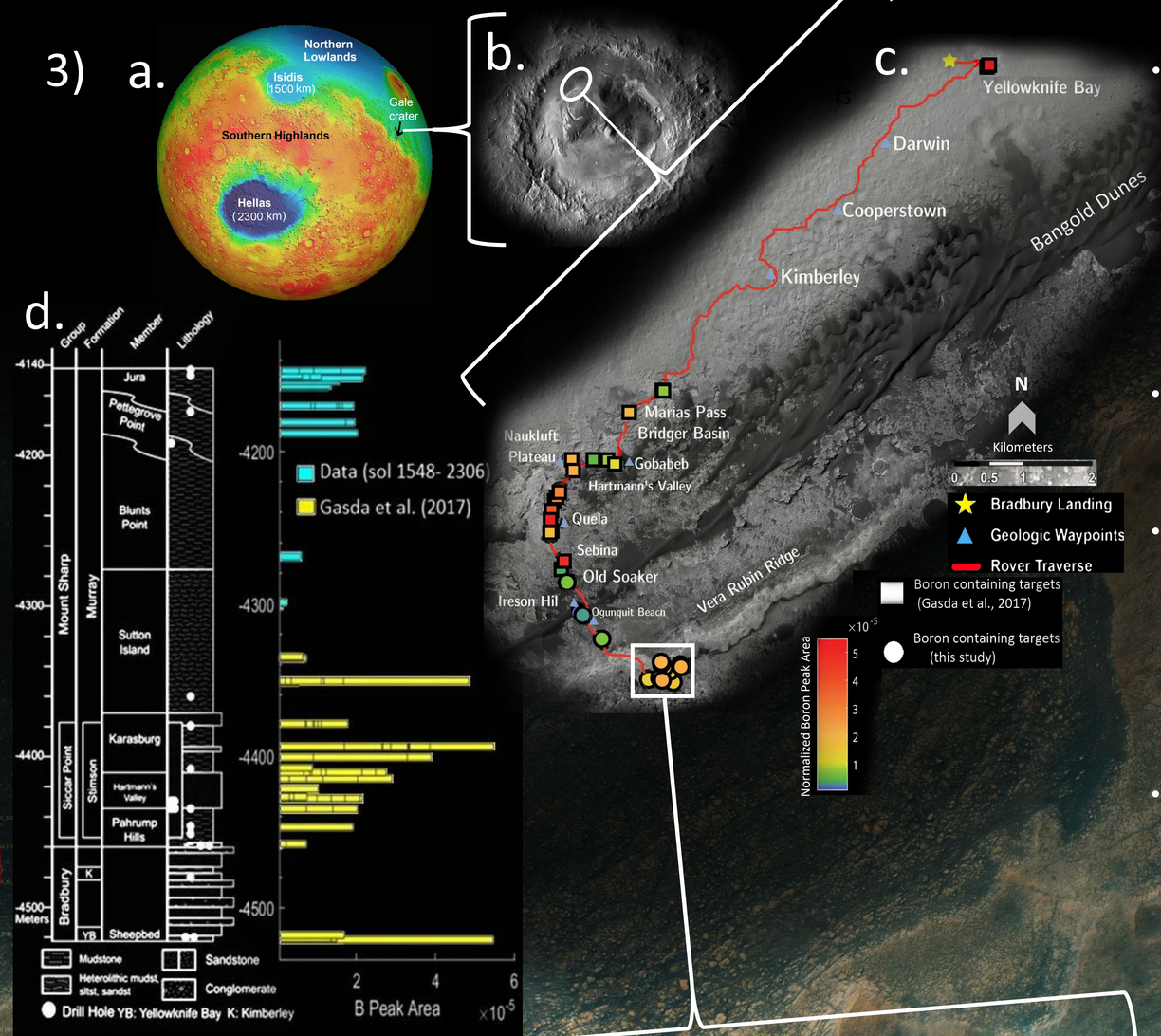


Figure. 1) ChemCam data processing scheme [5]. Top two rows represent steps applied to all LIBS data. Bottom row represents steps applied specifically for B characterization. **B can be detected only in $CaSO_4$ veins due to their low Fe content. Fe interferes with B in LIBS data preventing measurement of B in Fe rich bed rocks.**

Figure. 2) Example of LIBS spectra with B and Fe line fits [1] for $CaSO_4$ vein target, Newmachar (sol 1965).

Results



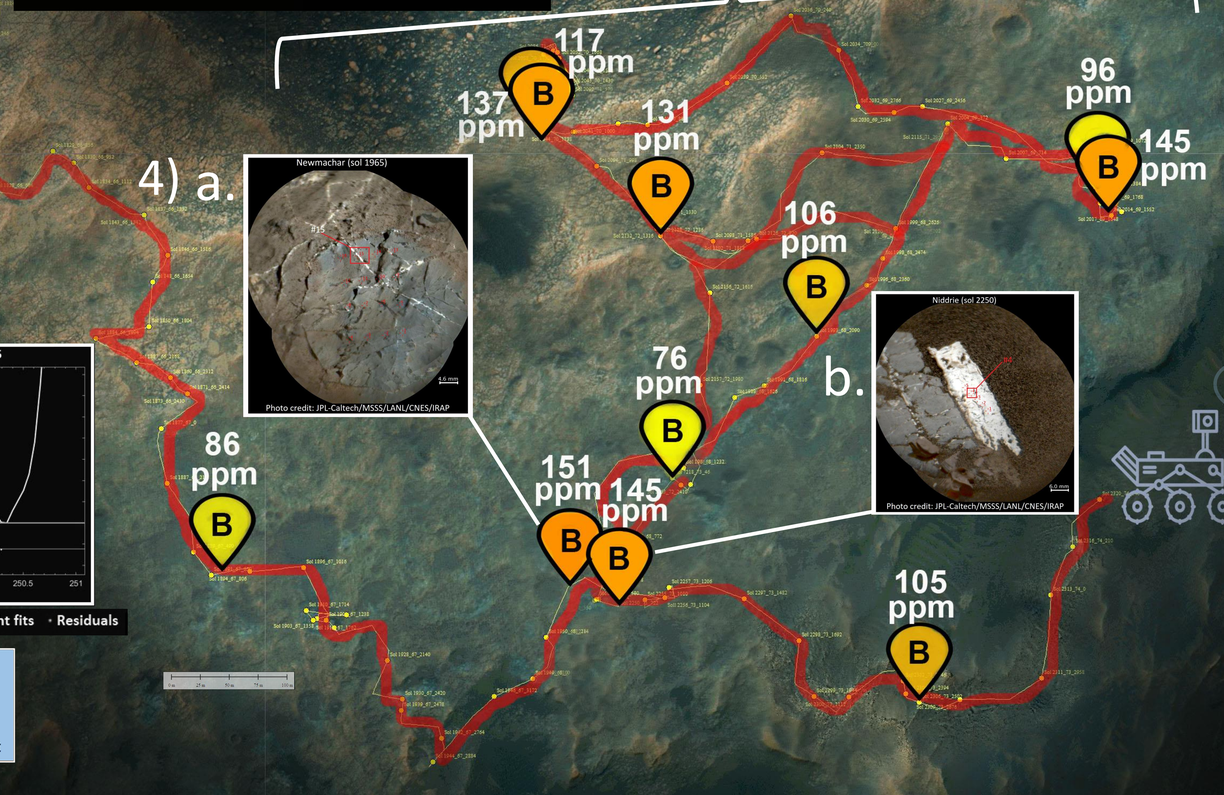


Figure. 3) a. Position of Gale crater on Mars [6]; b. Position of the rover and its traverse in the crater [7]; c. Rover traverse map showing locations of B detections. Colors on the filled squares [1] and circles (this study) represent normalized B peak area according to the color bar.; d. Gale crater stratigraphic column [8] with normalized B peak area for each boron detection plotted as bars versus elevation.

Figure. 4) Expanded map of Vera Rubin Ridge showing positions and concentrations of B detection; inset boxes (a and b): colorized RMI labeled with point observations for targets a. Newmachar (sol 1965) and b. Niddrie (sol 2250).

Discussion

- **Lower B for new data compared to [1] (Fig 3. d) and gaps in B detections. These may correspond to GW mobilization or variation of clay content and B adsorption.**

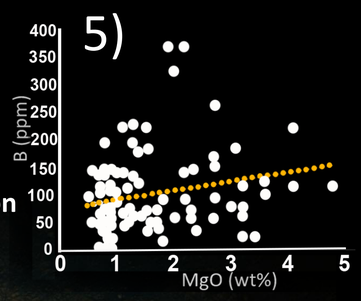


Figure. 5) Plot of MgO wt% v/s B conc.

- **Frequent B on VRR may be because of reduced adsorption of B due to lower clay content at Jura member [9].**
- **MgO wt% and B shows weak +ve correlation (Fig.5). Dehydration and alteration cause loss of Mg^{2+} cations from clay minerals into solution [10,11]. Correlation may indicate B and MgO were concentrated in remnant brine and eventually in GW as Gale lake evaporated. No similar relationship observed with other soluble elements like Na or K.**
- **Other possible causes of B enrichment:**
  - Change in fluid origin interacting with GW.
  - Increased proximity of rover to sulfate unit (sulfate unit may be a significant source of evaporites like borates)

Future Work

To understand behavior of B with respect to other evaporites, terrestrial analogue studies will be performed in borate and sulfate-rich playas of Death Valley, California.

Acknowledgment for field funding: NATIONAL GEOGRAPHIC

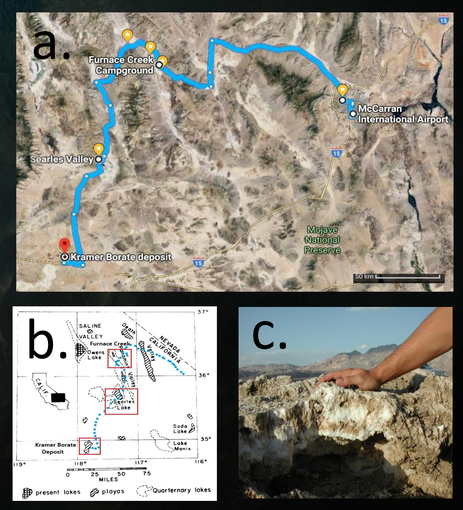


Figure. 6) a. Traverse map for upcoming field work in Southern California; b. Borate deposits aimed to be sampled [12]; c. Gypsum deposit in Death Valley [13]

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