A SIMULATED ROVER EXPLORATION OF A MARS ANALOGUE SITE: GYPSUMVILLE/LAKE ST. MARTIN, MANITOBA, CANADA

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Introduction:

A major driver of Mars exploration is the search for past or present life [e.g.,1]. An important contributor to this effort is exploiting terrestrial analogue sites that have some geological and/or astrobiological relevance to Mars. These sites can be used for various purposes, such as: developing expertise in rover operations (e.g., [2, 3]; assessing performance and utility of scientific instruments for Mars landed missions; and testing instruments in Mars-like environments.

We undertook a rover-like investigation at the Gypsumville, MB, Canada Mars analogue site [4, 5] in the summer of 2018. Our goals were to:

- Assess target selection and sample triage, based on a combination of imagery taken at different scales and with inputs from various Mars rover-relevant analytical instruments;
- Assess the scientific importance of targets selected by an off-site science team via a post-deployment site visit by the team, and more detailed and comprehensive analysis of samples in the laboratory;
- Determine how future deployments could be improved to better inform Mars rover operations and instrument selection.

Site Description:

The Gypsumville site is located ~200 km north of Winnipeg, MB, Canada. The main feature of interest is the ~20 km diameter impact structure (Lake St. Martin – LSM) [4, 5], which includes a central uplift of shocked granitic materials, granitic and carbonate impact melts, post-impact deposits of evaporites (largely gypsum), and extensive slumping, reworking and cementation of impact-affected materials by surface or ground water, forming poorly sorted and partially lithified sediments (termed “red beds”).

Two areas of exposed red beds within an aggregate pit were selected as “landing sites” (LS1 and 2) – both with minimal vegetation and some topographic expression. LS1 had ~ 3 m high exposures of red beds, including faces where layering is observed, to older, more scree-covered slopes. LS2 was characterized by spoil piles of red bed blocks. The aggregate pit is located approximately equidistant between the crater rim and central peak, contains reworked materials from both rim and peak, and has been partially cemented by gypsum-rich groundwater or from an adjacent sea [5].

Field Campaign:

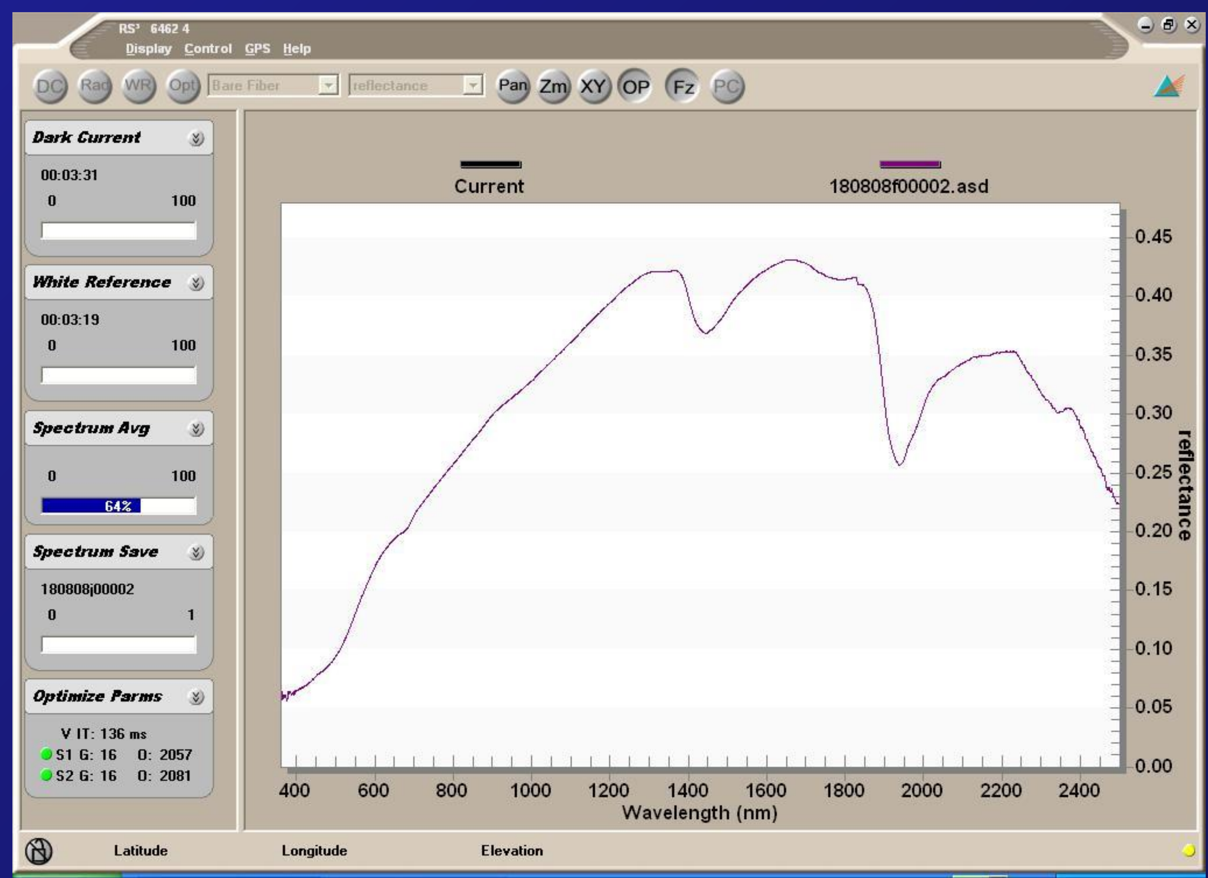
A 3-day field campaign was undertaken involving an off-site science team and an on-site team (for instrument deployment). The field campaign involved various activities to simulate a rover-based exploration of an impact structure in the context of a “fast motion” deployment.

Offsite team: The off-site team was tasked with initially identifying regions of interest (ROIs) within each LS on the basis of panoramic color imagery, and then targets of interest (TOIs) within each ROI which were imaged at higher resolution and characterized in the field by reflectance and Raman spectroscopy. These data were all used to rank the TOIs for science value/sample return. They were provided with a basic structural (but not geological) map of the site showing location of the LSs.

Image dimensions and scales, respectively, were: (1) LSs: 10s of meters; few cm; ROIs: few meters, sub-cm; TOIs: few decimeters, sub-mm.

A few rules were imposed on the science team:

- a maximum of 20 high priority targets (i.e., deemed important enough for sample return);
- a “no going back rule: i.e., if a TOI in a subsequent ROI was found to be more scientifically valuable than a previously identified high priority TOI sample in a previous ROI, the first sample’s priority could not be downgraded. This was done to reflect the “reality” of sample acquisition;
- the “ROI rule”: detailed data for the TOIs within a single ROI could be compared with each other for prioritization prior to moving to another ROI. This was implemented to reflect the ability of a rover to linger within an ROI.



L1-R4-T1

Figure 2: “Screen shot of reflectance spectrum of sample acquired in the field (ASD spectrometer).

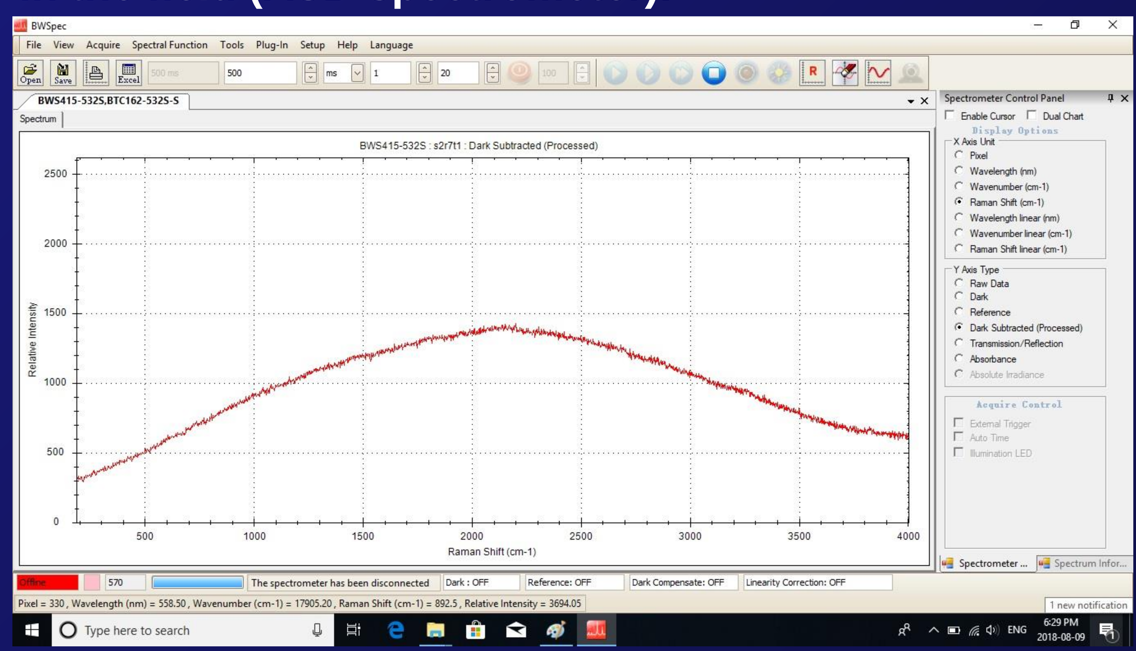


Figure 3: “Screen shot of Raman spectrum of sample acquired in the field (iRaman spectrometer).

Figure 1: Panorama of landing site 1 with regions of interest identified from this image superimposed.

Lessons learned:

This study helps inform future field and planetary rover campaigns. Lessons learned include:

- Slow downlink-uplink between the field and off-site teams impeded quantitative spectral analysis.
- Related to this, we were unable to confidently identify small differences in absorption band positions, which may be indicative of mineralogical variations.
- Data analysis would have benefited from the availability of spectral libraries and easy-to-apply and rapid spectral analysis tools.
- The use of imagery at the three different scales (LS, ROIs, TOIs) affected sample prioritization.
- Target selection and geological interpretation was hampered by the lack of scale for the imagery.

Summary and conclusions:

- Field-based rover-relevant deployments provide invaluable operational experience, help to identify potential pitfalls and issues, and inform best practices for future deployments.

Figure 4: Field-acquired image of target of interest for triage and prioritization.

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