DEFINING ANALYTICAL STRATEGIES FOR MARS SAMPLE RETURN WITH ANALOGUE MISSIONS.

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Introduction: One of the highest priority goals for the international planetary science community is Mars Sample Return (MSR) [1],[2]. The top three science objectives identified by MEPAG [2] are:

1) Identify habitable environments;
2) Assess the potential for preservation;
3) Determination of biosignatures

Successful selection of a habitable environment, acquisition of samples with a high probability of biosignature preservation, and detection and characterization of putative Martian biosignatures, will require a rigorous integrated analytical pipeline across instrumental platforms and observational scales. Analogue environments and full-scale analogue missions provide context for implementation and assessment of such technologies and methodologies.

Over the past two years, we have conducted simulated Mars Sample Return missions. In November 2015, the Canadian Space Agency (CSA), MacDonald Dettwiler and Associates Ltd. (MDA), and the Centre for Planetary Science and Exploration (CPSX) at the University of Western Ontario designed and conducted one of the highest fidelity MSR mission simulations to date [3]. The 2015 “CanMars” deployment (#CanMars on Twitter) involved over 50 participants from 6 Canadian institutions organized into operational teams using a suite of integrated instruments onboard the CSA Mars Exploration Science Rover (MESR), built by MDA. The deployment site, near Hanksville, Utah, in the area known informally as Kissing Camel Ridge, was chosen based on an extensive assessment of its suitability from both scientific and engineering perspectives. The landing site region consists of a variety of clastic and chemical precipitates comprising potential samples corresponding to the three highest priority MSR sample suites: sedimentary, hydrothermal, and low temperature[2].

Defining Science Analysis Needs for MSR: The primary focus for continued work with the CanMars team is the science analysis needs for MSR and on the development of systematic protocols to be performed on samples selected and returned from a MSR mission, and an analytical pipeline specifically designed to achieve the 3 main MSR science Objectives. We assume that the Mars 2020 (M2020) will commence the MSR mission sequence with adaptive caching of samples. The overall Aim, broken into 4 goals (below) is to determine the optimum approaches (methodology) and requirements (instrumentation) during deployment (science operations and sample acquisition on Mars) and subsequent laboratory investigations (after the sample has been returned to a sample receiving facility on Earth). The 4 main goals are to:

1) Determine the optimal approach to using the M2020 instruments to select a sample site;
2) Determine what measurements need to be taken with the M2020 instruments in order to adequately characterize the sample in preparation for eventual Earth-based analysis including potential sample prioritization and down selection;
3) Determine the extent that autonomous geological feature detection be used to identify potential sampling sites faster;
4) Determine how best to optimize the detection of organic molecules and other potential biosignatures.

Rover-based instrumentation: The instrument suite includes a number of technologies that when combined will complement and simulate the NASA Mara 2020 payload instruments including: 532 nm Raman spectrometer, visable-near infrared (VIS-NIR) spectroscopy, X-Ray Diffraction/Fluorescence and laser-induced breakdown spectroscopy (LIBS). Three integrated camera systems: a high-resolution, multispectral, stereoscopic mast-mounted panoramic camera (PanCam), a high-resolution zoom-enabled camera (ZoomCam), and a three dimensional exploration multispectral microscope imager (TEMMI).

Laboratory-based methods will be used to assess the fidelity of field analyses and develop an optimized scalar-integrated analytical pipeline: spatially correlated 532, 785, and 980 nm Raman spectroscopy, inductively coupled plasma mass-spectrometry, micro-X-ray diffraction, micro-X-ray fluorescence, optical petrography, electron beam based techniques (including scanning electron microscopy, transmission electron microscopy and electron microprobe analyses, Fourier transform infrared spectroscopy, confocal Raman, and synchrotron beam based spectroscopy.

References: [1] The Global Exploration Strategy: The Framework for Coordination. [2] The MEPAG Next Decade Science Analysis Group. (2008) Astrobiology 8: 489–535. [3] Osinski et al. (2015) LPS XLVII abstract # 2616.