LUNAR ANALOGUE MISSION: OVERVIEW OF THE SITE SELECTION PROCESS AT MISTASTIN LAKE IMPACT STRUCTURE, LABRADOR, CANADA. B. Shankar[1], I. Antonenko[1], G. R. Osinski[1], M. M. Mader[1], L. Preston[1], M. Battler[1], M. Beauchamp[1], A. Chanou[1], L. Cupelli[1], R. Francis[1], C. Marion[1], E. McCullough[1], A. Pickersgill[1], T. Unrau[1], and D. Veillette[1], [1]Centre for Planetary Science and Exploration & Canadian Lunar Research Network, University of Western Ontario, London, ON, Canada. (bshanka2@uwo.ca)

Introduction: A Canadian Space Agency (CSA) funded lunar analogue mission has provided an opportunity to perform science in a simulated robotic precursor mission at the Mistastin Lake impact structure (55°53'N; 63°18'W) in Labrador, Canada (see [1] for overview). The Mistastin Lake impact structure is an exceptional lunar analogue. Excellent exposure combined with variable topography makes this location an ideal site for rover testing. A robotic precursor mission took place in late August- early September, 2010, with overall goals of robotic surveying and identifying sites of interest (SOIs) in order to meet the mission's scientific objectives to study:

- Ages and rates of impact bombardment on planetary bodies;
- Shock processes in lunar materials and terrestrial analogues;
- Impact ejecta emplacement processes; and
- Resources within lunar impact craters.

The Mission Control (MC) team, based at the University of Western Ontario (UWO), comprised a facilitator, note taker, and a group of scientists with various specialties. They reviewed acquired data, planned future targets, made scientific decisions and gave directions to the "rover" team. The field team, based out of Mistastin, Labrador, included four geologists who acted as the rover, surveying selected sites and collecting data. MC scientists had no prior physical knowledge of the field area which allowed an unbiased analysis of remote sensing data. Site selections were based solely on data commonly available to a lunar mission. Rover instruments included 3-D Light Detection and Ranging (LIDAR), Ground Penetrating Radar (GPR), standard digital SLR cameras, mobile Scene Modeler (mSM), and X-ray fluorescence XRF.

Site Selection Methods: Site selection was performed by the MC team. Sites were selected first at a regional level (selecting regions of interest – ROI's, landing sites), moving onto more localized sites (SOI's), and ultimately zooming in on a prime site of geologic interest (Fig. 1). This was accomplished using available georeferenced satellite data, air photos, and geophysical datasets together with rover acquired surface data. At the impact structure-wide scale, landing sites, regions and localized SOI were selected keeping crater material sampling in mind. Sites were prioritized based on location within the impact structure (identification of crater-scale features like crater rim, impact melt, ejecta materials) and logistical accessibility. Landing sites were selected based on close proximity to SOI's, exploration prospects, and accessibility, such as landing site opportunities, topography, lakes, etc.

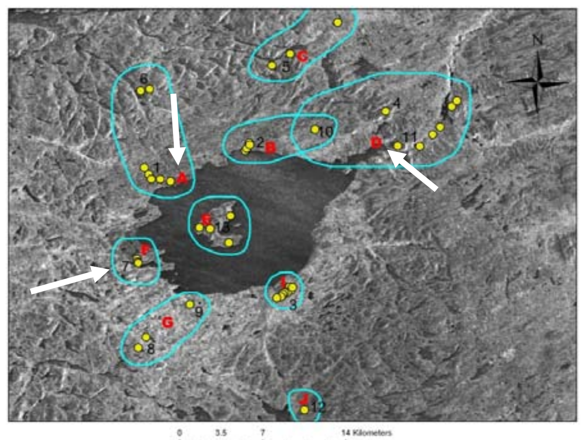

Figure 1: Radarsat1 image of Mistastin Lake impact structure and surrounding area, showing (1) SOI - yellow dots, (2) Regions of Interest, based on groupings of SOI's - black numbers, (3) Landing Sites - red letters (4) Landing Site Areas, outlined in blue, showing areas accessible from a single landing site. Arrows indicate rover deployment landing sites.

Site Selection Protocol: A general site survey was conducted using panoramic image data in order to 1) identify prime direction for rover traverse, 2) identify and prioritize several outcrop scale SOI's from surface data, and 3) select a primary target. Once data from a primary target was acquired, site surveying followed the same trend of identifying and prioritizing sub-outcrop scale SOI's to capture higher resolution imagery and geochemical data based on scientific interest (Fig. 2). At sub-outcrop scales, XRF sample spot selection were conducted using high resolution digital photos (selecting multiple sites to avoid spots for weathering and lichen coverage), LIDAR data was used in interpreting position and orientation of the rover. GPR transect profiles were captured along rover paths to examine the subsurface, identify structures, and aid in the identification of areas requiring further study (e.g. acquisition of higher resolution imagery, or XRF data). Logistical constraints including the ability to set up a satellite terminal for communication access were kept in mind during prioritization discussions.

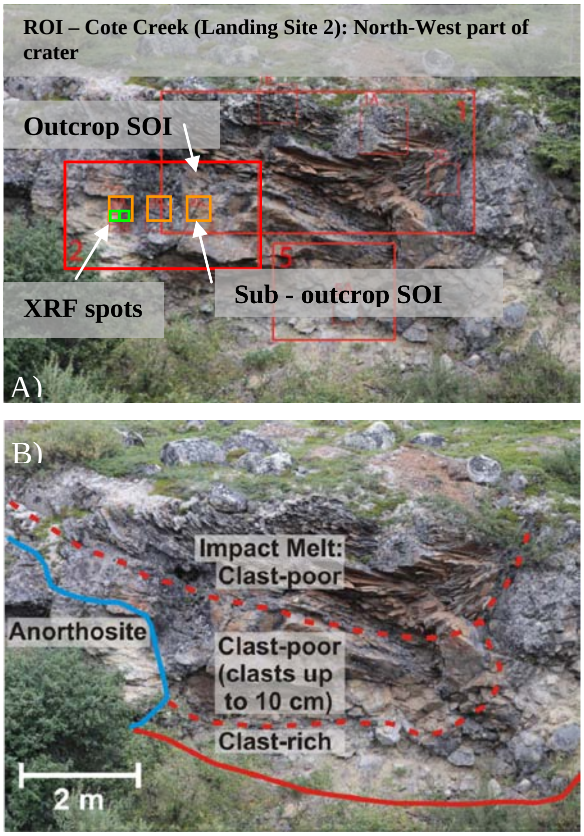

Figure 2: A) Example of MC selected SOI's shown at multiple scales. Structural features and geological contacts are identifiable at this scale. B) Ground truthing of the site by rover team confirms presence of a geological contact.

Results and Discussion: Three landing sites were selected for the rover team to survey during the 2010 field deployment (Fig. 1). These sites were chosen to sample materials that would enable the team to meet the scientific objectives.

Maps and remote sensing data proved most useful in the selection of scientifically interesting target sites at all scales. MC was able to interpret geological information from the site selection process including geological and structural features. At an outcrop scale, for example, the MC team was able to differentiate geological units and potential contact sites using available imagery and select SOI's at both the outcrop and sub outcrop scales (Fig. 2A). Ground truthing by the rover team confirmed this geological interpretation independently (Fig. 2B) [2].

SOI selection was driven by scientific interest but was constrained by accessibility and topography. Due to limitations in communication, interruptions due to weather with the rover, and slow data transfer rates, MC had to accommodate and request several scales of SOI's scales to minimize repetition of requests to the rover (Fig 2A).

Panoramic scale images were too small to identify crater-scale features, and the resolution was too low to identify features on the meter scale or less, therefore interpretation came with much uncertainty. 3D stereo camera data show the topography of rock outcrops. More sampling sites could be identified through closer inspection of high resolution photographic data, and through the analysis of XRF trace element spectra. However, due to time limitations, XRF data was left for processing and analyses after the deployment and had no impact in making decisions in the field.

Given the resolution of the data at the outcrop scale, it was not possible to differentiate the scientific value of the sites at this stage, therefore prioritization relied heavily on logistical considerations. With higher resolution data collection, prioritization of sites became easier as these data products allowed us to inspect and understand the layout of the topography and geology of each SOI. Scientific rationalization began to play a larger role and consensus was achieved quickly.

Lessons Learned: 1) It was essential for team members with particular instrument experience to process incoming data each time. 2) Instrument data capture is dependent on robot constraints therefore it is important to be flexible and know all limitations of the rover, in order to maximize data collection efficiency. 3) LIDAR and panoramic data must be collected first along with context images as they are critical in accurately determining the location of the rover and terrain orientation. 4) mSM is useful in capturing close-ups of outcrop topography. 5) Instruments such as a multispectral sensor on the rover could further enhance the site selection process, provide remote mineralogical information, and provide scientific rational for prioritization at outcrop and sub-outcrop scales.

References: [1] Marion C. et al. (2011) LPSC XXXXII (this meeting). [2] Mader M. et al. (2011) LPSC XXXXII (this meeting).

Acknowledgements: Funding from the Canadian Space Agency (CSA) is gratefully acknowledged. Genevieve Dubreuil-Laniel, Timothy Haltigin, David Gingras, Luminita Ilincalgnat, and Eric Martin, all from the CSA, are thanked for their support throughout. Ho-Kong (MDA), and C. Shaver (UWO) are thanked for their efforts in the field.