HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
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BASELINE SCIENTIFIC REQUIREMENTS FOR A LUNAR ROBOTIC PRECURSOR MISSION: LESSONS LEARNED FROM ANALOGUE MISSIONS AT THE MISTASTIN (KAMESTASTIN) LAKE IMPACT STRUCTURE, CANADA

Abstract

Sample return from the Moon and Mars is a high priority for scientific communities interested in testing theories about planetary formation and surface processes. Canada is situated to play a key role in this endeavour by contributing robotic assets. To prepare and test protocols for future lunar sample return missions, our team carried out two contingent analogue missions at the Mistastin (Kamestastin) Lake impact structure, Canada, as part of a campaign entitled Impacts: Lunar Sample Return (ILSR) funded by the Canadian Space Agency. This is the first multi-year Canadian lunar analogue program of its kind. This research will help to define scientific requirements for a robotic field reconnaissance mission as a precursor to a human sortie sample return mission.

The first analogue mission occurred in August and September 2010 and involved simulated robotic surveying of selected "landing sites" at the Mistastin Lake impact structure, which is an exceptional geological lunar analogue with anorthosite and preserved impact ejecta deposits. A second mission took place at the same location in 2011, which included simulated astronaut surface operations. A mission control team, based at the University of Western Ontario, 1900 km from the field site, oversaw operations.

Our study indicates that precursor reconnaissance missions provide surface geology visualization at resolutions and from viewpoints not achievable from orbit, including high resolution surface imagery on the scale of 10s of metres to kilometres. The datasets most used by mission control were:

1) 3D images of up to 360 extent generated from Optech ILRIS-3D LiDAR cloud point data that provided range and scale information up to 1 kilometre away;

2) Large panoramic digital camera images (e.g., 25 x 4Mp) allowing: a) Full context regional views including rock outcroppings and traversibility of the area (landscape overview from a topographic high); b) Side views of steep topography (allowing cross-sectional perspective of rock stratigraphy).

We suggest that reconnaissance mobility can be reduced relative to the mobility needed later for crew transport (i.e., crewrover). A rover with the ability to: 1) collect panoramic photographs and LiDAR scans, and 2) access low lying areas to view edges of steep topography and potentially reach high points would meet baseline needs. Such rovers are within the scope of a Canadian contribution to future planetary missions. Examples that are currently being prototyped in Canada range from the Mars Exploration Science Rover (MESR) and medium-scale Lunar Exploration Light Rovers down to the 30kg-class lunar microrover.