CANMOON ANALOGUE MISSION POST-OPERATION TRIALS: ROVER TRAVERSE VS. ASTRONAUT TRAVERSE IN LANZAROTE, CANARY ISLANDS, SPAIN. K. Kubanek[1], E. A. Cloutis[1], D. M. Applin[1], N. N. Turenne[1], A. E. Parkinson[1], J. C. Kuik[1], S. A. Connell[1], E. A. Stanish[1], J. L. Mollerup[2]. [1]Department of Geography, University of Winnipeg, 515 Portage Avenue, Winnipeg, MB, Canada. [2]Physics and Astronomy Department, Western Washington University, 516 High Street, Bellingham, WA, USA. (kubanek.krista@gmail.com)

Introduction: The Canadian Space Agency (CSA) places importance on doing fieldwork for the advancement of science and technology for planetary exploration. This goal is particularly applied under the Lunar Exploration Analogue Deployment (LEAD) in order to test technologies, develop mission operations architectures, and provide training for young professionals through various field tests and analogue missions. The CanMoon lunar sample return analogue mission was a joint collaboration between the University of Winnipeg and Western University.

The purpose of the analogue mission was to attempt to accurately simulate the communication between an Earth-based mission control station and a scientific rover operating on the lunar surface [1]. The simulated lunar rover mission ran for three weeks in total during the month of August 2019. This included two weeks of ground control for the planning and science teams stationed in London, Ontario, and the field team stationed at the field site in Lanzarote for the full three-week duration. Several group members from each university travelled to the analogue site for an additional week for further post-operations data gathering, additional trials, and sample triage. The University of Winnipeg post-operation team had multiple objectives, one of them focusing on the differences between a traverse path that was operated by a rover compared to one that was operated by an astronaut team. For a full overview of the 2019 CanMoon analogue mission see Osinski et al. (this conference) [2].

Site Descriptions: Dating to the 1700s, Lanzarote hosts several geologically young basaltic lava flows [3]. For the CanMoon mission, two different field sites were chosen as lunar analogue terrains. The first site visited during the mission, called Janubio, was located on the western side of the island and consisted of many xenoliths, levees, and flow ridges. The second site, called Nuevo Ortiz, was also located on the western side of the island near a large cinder cone.

The European Space Agency (ESA), including the PANGEA astronaut training simulation, have been using these well preserved volcanic deposits as lunar analogue sites for past missions [4,5].

Mission Overview: The primary scientific goals for the CanMoon post-operations team were to collect a new suite of samples, apart from those collected during the CanMoon analogue mission, that met the following scientific objectives: 1. Detect varying concentrations of opaque minerals, 2. Detect presence of hydration, 3. Identify differences in geology. With these objectives acting as the framework for our team, two different scenarios were performed at each of the two sites being utilized by the CanMoon mission. The first scenario followed the pathway that the rover took during the CanMoon operations. The second scenario that the team executed acted as independent astronauts. No longer confined to the rover traverse path, the astronaut team was able to explore areas of the site that a rover would be unable to reach. This freedom allowed the astronaut team to identify Regions of Interest (ROIs) and Targets of Interest (TOIs) that better fulfilled the mission objectives with respect to sample triage. Each TOI was also documented using pictures, GPS coordinates, and written descriptions that validated the choice of the TOI. In addition to the documentation of each TOI, team members had the ability to utilize the instruments used during the CanMoon mission operations, which included a Laser-Induced Breakdown Spectroscopy (LIBS) system, a visible near infrared (VNIR) spectrometer, and a Raman spectrometer. The spin-off of these post-operation activities will help in furthering our knowledge on the limitations and differences between remotely-operated rovers equipped with spectroscopy instruments, and in-situ astronauts with the same.

Results: Visiting the analogue site in person after seeing the imagery from the mission operations put the areas into enhanced context. However, all scales within the sites were different from the imagery seen, but not to the point of unfamiliarity. While in the role of the rover, the astronaut team quickly became aware of how many sample opportunities were missed and not identified within the rover traverse pathway during mission operations. The rover was not able to identify a substantial amount of areas that satisfied the mission objectives, which were visible in all directions while standing there in person on the same tracks as the rover. In addition, sun angles casting a shadow on certain areas of the site depending on the time of day, poor spatial resolution of the RGB images, and the different spectral contrast of the images also made it difficult to identify TOIs from the panoramic images taken by the rover.

While the astronaut team walked through the rover pathway, they demonstrated the need for better imaging and a more in-depth approach to the rover images. While in the role of the astronaut, the science teams allocated a portion of their TOIs to darker rocks in hopes of finding enhanced opaque abundances with the instrumentation. They also selected a portion of the TOIs to “rusty” or “glassy” rocks in hopes of finding evidence of volatiles as well as anything out of the ordinary to identify differences in geology. In addition, the teams allocated some of their TOIs to understanding the baseline geology and the in-situ geology of each analogue site.

Figure 1: Sample collected during an astronaut traverse on day 2 at Janubio site from astronaut traverse 1, once broken open the rock was identified as a xenolith.

The astronaut teams were able to manipulate samples using their hands and tools to verify if a sample fulfilled any of the mission objectives. Sample A.1.S.20 was found to have contrasting mineralogy and evidence of volatiles as seen by the red inclusions inside the xenoliths once broken open (Fig. 1). For additional information on the Science Interpretation team and a thorough analysis of both in-simulation and post-mission data analysis see Hill et al. [6].

Lessons Learned: The human eye was able to detect much more than what was detected by analysis of the rover imagery in response to our mission objectives. Having astronauts walk freely in the designated field sites allowed for greater science to be done. There was a greater field of view and clearer understanding of the scale of each analogue site, ROI, and TOI. Imaging received from the rover during mission operations provided less detail, as many potential areas of interest were overlooked. Having astronauts present at a landing site allows for the influence of human presence that becomes diluted through low-context imaging. For future sample return missions it may be the most beneficial to include both geological training for astronauts, as well as providing enhanced context imaging cameras on a rover. This pairing could result in a deeper overall understanding of the site of interest, providing more quality data and sample suites for scientific knowledge.

Furthermore, astronauts have greater mobility than the rover and access to more tools, as the rover has physical limitations, due to its size and mobility limitations. The rover cannot maneuver around objects to get to hard to reach places, whereas an astronaut’s accessibility allows for the discoveries of samples that can better meet the mission’s science objectives.

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