CANMOON SCIENCE INTERPRETATION TEAM: INSIGHTS INTO VOLCANIC FLOWS IN LANZAROTE, SPAIN. P. J. A. Hill1,2, S. L. Simpson1, T. Xie1, Z. R. Morse1, L. E. Sacks1, G. R. Osinski1, E. A. Cloutis3, C. M. Caudill1, P. Christoffersen1, C. L. Marion1, J. D. Newman1, E. A. Pilles1 and L. L. Tornabene1
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Introduction: CanMoon was a two-week lunar sample return analogue mission conducted in August 2019 (see Marion et al. [1] for an overview). There were 4 primary science objectives:
1. Determine the diversity of rocks at the landing site;
2. Identify and collect the most volatile-rich rocks;
3. Explore for crustal and mantle material;
4. Identify and collect the best samples for age dating.

The science team was divided in the tactical team and interpretation team. In this abstract, we summarize the results from the data collected by the scientific instruments during the mission. The interpretations that led the science team to sample specific features of interest will be explored. An overview of the science tactical team is highlighted by Morse et al. [2].

Imagery Data: 4 types of imaging systems were available to the team: panorama camera, zoom camera, remote macro imager (RMI), and real time camera (RTC). Though the hazard camera was primarily utilized for navigational purposes as the rover was moving from waypoint to waypoint, it provided the team geographical context as they explored the landing site. The panorama camera, zoom camera, and RMI provided the important textural information of features of interest (FOIs) on various scales. Within the panoramic images, larger geologic context of the flow fields was gained and targets for the geochemical and mineralogical instrument suites were chosen.

Here the more altered surface on the top of the rock is clearly seen.

Mineralogical Data: A handheld Raman spectrometer (785 nm laser) and a handheld visible-near infrared (VIS-NIR) spectrometer were used as complimentary techniques to determining the mineralogy at the landing site. From the aforementioned targeted zoomed images, numerous inclusions of material were chosen as targets within the different lithologies. Raman spectroscopy was particularly useful for the identification of mineral phases within the xenoliths. The two diagnostic peaks around 817 and 850 cm\(^{-1}\) indicated that the green mineral is olivine. Magnetite was also identified with a Raman peak around 670 cm\(^{-1}\) from the red oxidization inner surface of large vesicles on the surface of the sample TinkerBell. Additionally, a red crusted rock named Kaa was analyzed and shows good peaks for hematite at 290, 405 and 605 cm\(^{-1}\). These Raman results are in good agreement with VIS-NIR data. In addition to corroborating olivine xenolith findings, the handheld VIS-NIR spectrometer also provided additional information regarding texture and chemical bonding in the rocks. The spectra from several rocks matched spectra resembling glassy basalts and scoria from JPL and USGS spectral libraries. The VIS-NIR spectrometer was also critical for the evaluation and identification of volatile-rich material with absorptions features around 1.4 and 1.9 µm. Observed 2.21 µm features were indicative of Si- or Al-OH bonding (Fig 2); typically, the broad shape of these features suggested a silica-rich glassy material.

Fig. 1: Overview of the different types of imagery used by the science team. A) An image captured by the RTC while the rover was moving. B) Example of an olivine rich xenolith captured by the RMI. C) Targeted zoom images of rocks of interest were taken throughout the mission to identify potential targets for further analysis and potentially sampling. D) The Science Interpretation Team would stretch the contrast and saturation of the images to highlight certain features.

Fig. 2: VIS-NIR spectra that indicated hydration and volatile material within a rock (Doc 3). Further processing of the data indicated the potential for minerals with Si-OH or Al-OH bonding due to the absorption feature at 2.21µm.
**Geochemical Data:** A handheld laser-induced breakdown spectroscopy (LIBS) instrument was utilized to investigate the major oxide compositions of FOIs. For each spot of interest, three measurements were taken and the average value for the measurements were used as representative measurement of the rock. 21 measurements were taken on 7 spots of interest. Figure 3 plots the individual measurement as well as the mean for all spots of interest, except for Doc 2 which was interpreted to be sedimentary in origin was is excluded from all plots utilized in the characterization of igneous rocks.

**Samples Acquired:** Seven samples (Fig. 4) were collected over the two-week mission (six rocks samples; one regolith scoop). The team criteria for sample selection required at least one of the science objectives be met; however, in most cases at least two objectives were satisfied with each sample. Pre- and post-imagery identified if sampling was successfully.

**Discussion:** Upon landing in the landing site, panorama and zoomed imagery quickly led the team to identify numerous vesicular, xenolith-bearing, glassy basalts at the landing site. The abundance of basalt was expected as pre-mission remote sensing [3] had led to identification of numerous volcanic features and basaltic flows.

To characterize the geologic setting of the basalts, the team relied on the geochemical and mineralogical instruments. As seen in Figure 3, though the LIBS instrument did display a wide range of composition, the interpretation team concluded that it indicated an intra-plate mantle plume as indicated by the general tholeitic trend, presence of alkaline rocks, and abundance of Mg-rich olivines xenoliths.

Volatile material was identified through the VIS-NIR instruments evidence for OH bonding (Fig. 2) and was consequently sampled. To address the age dating objective, the team utilized the K_2O content (wt%) as a vector for K-Ar dating and sampled lithologies that would give a complete geologic history of the site (i.e. both xenoliths and basaltic material). Though all of the samples fulfill the mission objectives 1 and 4, an regolith scoop was also acquired to specifically understand surficial processes and increase the lithological diversity collected.

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