CO-LOCATED GEOPHYSICAL SURVEYS OVER A LAVA TUBE AS AN ANALOG FOR LUNAR CAVES.
J. A. Richardson1, E. Bell2,3, S. Esmaeili3, S. Jazayeri4, S. Kruse5, P. Whelley2,3, W.B. Garry1, N. Schmerr2, K. Young3, N. McCall1,6, L. Wike2. 1NASA Goddard Space Flight Center, Greenbelt, MD (jacob.richardson@nasa.gov), 2University of Maryland, College Park, MD, 3University of South Florida, Tampa, FL, 4Titan Advanced Energy Solutions, Boston, MA, 5University of Texas Austin, Austin, TX.

Introduction: Caves and void spaces are plentiful on the Moon and other planetary bodies. On the Moon, pits potentially leading to caves are seen visually [1] and potentially with orbital geophysics [2,3]. These caves are high priority targets for crewed exploration as they can be used for shelter and accessing ancient, pristine geologic surfaces [4]. Detection and characterization of caves before ingress by crews or robots will determine the feasibility and suitability of their exploration. We have used geophysical surveys at an analogous site in northern California to test different methods of detecting and measuring lava tubes from above.

Methodology: In 2017 and 2018, multiple geophysical survey techniques were employed in an effort to detect lava tube caves in Lava Beds National Monument (LBNM). The largest cave of interest, Skull Cave, has a diameter of 20 m [5-8], about one-quarter to one-half the diameter of a previously mapped lunar pits [1].

Geophysical methods at Skull Cave included Ground Penetrating Radar (GPR) [7], microgravity, and active seismic surveys [8]. Surveys with these methodologies were collected along a single transect, shown in Fig. 1 along with other methods. A total field magnetic survey was also collected over the entire surface above Skull Cave [5,6], with which the magnetic anomaly over the common transect was extracted. For ground reference, terrestrial laser scanning surveys were collected within and outside of the cave.

Results: All methods are able to detect the presence of this subsurface cave, though tube geometry reconstruction (e.g., identifying the cave floor and walls) can vary by survey and inversion methodology. While smaller or deeper caves might evade detection with geophysics, lunar pit depths and diameters indicate that extant tubes should be readily detected with radar [7] and magnetic methods [5,6]; the latter if emplaced contemporaneously with a magnetic field.


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Fig. 1: Map of Skull Cave, LBNM, CA and geophysical observation locations. Example co-located data over and within Skull Cave shown below.