Earth-based Geophysical Investigation of the Near Subsurface Structures for Future in situ Resource Utilization on the Moon

Supervisor: Dr. Doyeon Kim (doyeon.kim@imperial.ac.uk)
Co-supervisor: Dr. Ian Bastow
External supervisor: Assoc. Prof. Nick Schmerr (University of Maryland)

Project Description

Planetary crusts host promising geological resources, such as lava tubes and void spaces, ice deposits, regolith, and magma-tectonic systems. For example, Lava tubes and void spaces have been discovered on the Moon, which have the potential to serve as habitats for future crewed missions, offering protection for astronauts against the perils of space. The lunar regolith, covering the Moon's surface, not only can serve as a construction material but also poses challenges and risks for both human and robotic activities. Additionally, magma-tectonic systems can play a crucial role in concentrating and trapping valuable volatiles, unique rock formations, and ore minerals. Therefore, detecting and quantitatively characterizing these target structures enable in-situ resource utilization (ISRU) on the Moon and is a pre-requisite for future exploration.

As a part of NASA's Geophysical Exploration of the Dynamics and Evolution of the Solar System (GEODES) SSERVI, the GEODES science team has been collecting various geophysical datasets using seismology, GPR, gravity, magnetics, and electromagnetic sounding from planetary analog environments appropriate for developing exploration strategies for upcoming lunar science missions. Analog field expeditions have been carried out since 2020 to the present day and some of these locations include the San Francisco Volcanic Field in Flagstaff, Arizona, the Lava Beds National Monument in Northern California, and Eastern Snake River Plain, Idaho, USA. These selected field sites are identified as analogs to lunar terrains because each host all of the aforementioned ISRU targets and provide an unique opportunity for application of multiple geophysical methods.

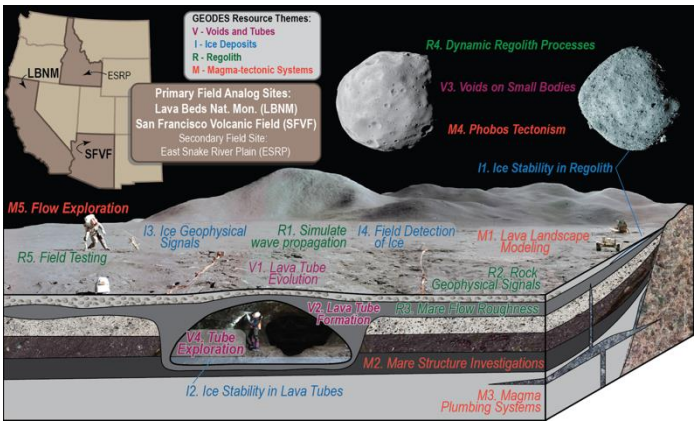

Figure 1: Analog geophysical investigations on Earth-based geological ISRU targets pursued by the GEODES participating institutions (Schmerr et al., 2019)

The aim of this project is to take advantage of the new collection of datasets from the Earth-based analogs and develop an integrated geophysical approach that can maximize the utility of available techniques that can bridge different scales or sensitivities across complementary material properties. This project would provide a crucial opportunity to (a) validate existing models of near-surface structure in Earth-based analog geologic settings, (b) determine the optimal scales of measurements to characterizing the subsurface

imaging targets, and (c) identify the observational overlap between outcrop-scale and orbital geophysical measurements. (d) Ultimately, our effort will inform capabilities and field strategies in future geophysical explorations of planetary bodies including upcoming lunar science missions.

The successful candidate will join, and be supported by, a vibrant and dynamic research group and would potentially collaborate with the GEODES participating scientists. The candidate will also have opportunities to participate future GEODES field expeditions and to develop their career and profile by presenting at international conferences and publishing in high impact journals. Candidates for PhD positions should have a good mathematical background and a degree in an appropriate field such as earth science, physics, mathematics, computer science or engineering.