CLASSIFYING LEVEES AT THE OLYMPUS MONS USING MACHINE LEARNING FOR SAFE SPACECRAFT DEPLOYMENT SITE IDENTIFICATION J. C. Johnson[1,2,3], P. A. Johnson[1,3], and A. A. Mardon[2,3], [1]Faculty of Engineering, University of Alberta (email: jcj2@ualberta.ca), [2]Faculty of Medicine and Dentistry, University of Alberta (email: paj1@ualberta.ca) [3]Antarctic Institute of Canada (103, 11919-82 Str. NW, Edmonton, Alberta CANADA T5B 2W4; email: aamardon@yahoo.ca)

Introduction: Observed telescopically as early as the 19th century, the Olympus Mons teems with scientific and hobbyist interest. The Olympus Mons is a Martian shield volcano that is currently the tallest planetary mountain and second-largest volcano in the solar system discovered. Unfortunately, it is an unlikely site for deployment of probes due to low atmospheric density and higher dust concentrations that impede rock sample collection. [1]

However, images from the *Mars Global Surveyor* and the *HiRISE* have depicted lava flows of varying ages located at the base of the Olympus Mons. It has been previously described that older flow has lava caves with levees. Here, we suggest that pinpointing the edges of levees can provide more accurate estimations for Martian rover landing sites to be deployed. [2]

This abstract briefly details the importance of collecting field data in this region, particularly focusing on its value in elucidating water on Mars and as a plausible sign of life, both ancient and present. It also suggests the adoption of a classification system to detect Martian levees using polarimetric Synthetic Aperture Radar (polSAR) data analysis.

Fluvial Channelized Flow Controversy: Ancient channelized flows have been observed in all inner planets and some satellites of the solar system. In 1972, the discovery of what are now-known as fluvial channels or levees on Mars became the subject of heated debate, particularly in regards to the contribution of water in molding these structures. However, the newfound understandings of the fluvial nature of these levees have spawned a new onslaught of theories with respect to the origin, mechanism, and presence of oceanic bodies and hydrological processes. [3]

Importance of Characterizing Levees: Since lava tubes or levees were first identified on the Red Planet, there has been curiosity towards sampling cave minerals due to the potential for unraveling historical or current interplays between water and subsurface regolith. Drawing further, perhaps it can provide some of the first moves towards Martian habitability.

Akin to the Mauna Kea in the Hawaiian Islands on Earth, Olympus Mons is the consequence of numerous basaltic lava flows from volcanic vents. [4] Research in terrestrial analogues has indicated the presence of small mineralized nodes called coralloid speleothems in these tubes which have a postulated link with biofilm that forms in caves. As a plausible source/sink of microbial diversity and associated geomicrobiological interactions, the mineralization can provide an important historic time bank for Mars. [5]

Use of polSAR in Terrestrial Classification Methods and Transfer to Martian Classification Methods: polSAR data analysis has had a myriad of terrestrial applications, including but not limited to terrain and land use classification. Marapareddy *et al* [6] have described the use of polSAR in detecting anomalies on terrestrial levees. They report the high spatial resolution and soil penetration capabilities as important elements in identifying regions of interest.

Typically, SAR imagery relies on algorithms that must be extensively optimized for reliably modeling the images statistically. [7] However, fundamental to statistical modeling is an in-depth recognition of the terrain scattering mechanism. If we can train a machine learning algorithm to optimize edge detection of Martian levees, it could provide us a way to provide space agencies with the pinpointed longitudinal and latitudinal points for landing future spacecrafts.

Conclusion: Understanding that older flows are relatively less volatile and safer areas for unmanned probes to explore, the authors propose a mechanism for targeting sites of landing that has the potential to reap exciting developments to current understandings of Martian geomorphology. Note that this geomorphological identification is merely one of many considerations in site selection. Amongst these considerations are climatology, gravity, and radiative stresses on Mars.

References:

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