USING TEMPERATURE CONSTRAINTS TO IDENTIFY POTENTIALLY TRAVERSABLE PERMANENTLY SHADOWED REGIONS AT THE LUNAR SOUTH POLE. G. D. Tolometti[1], V. T. Bickel[2,3], E. C. Czaplinski[4], H. M. Sargeant[5], and D. A. Kring[6,7]. [1]Department of Earth Sciences, University of Western Ontario, London, Ontario, Canada. [2]Department Planets & Comets, MPS, Göttingen, Germany, [3]Department of Earth Sciences, ETH Zurich, Zurich, Switzerland, [4]Arkansas Center for Space and Planetary Sciences, University of Arkansas, USA, [5]School of Physical Sciences, The Open University, Milton Keynes, UK, [6]Center for Lunar Science and Exploration, Lunar and Planetary Institute, USRA, Houston, TX, USA, [7]NASA Solar System Exploration Research Virtual Institute, Houston, TX, USA. (gtolomet@uwo.ca).

Introduction: Evidence of water ice in permanently shadowed regions (PSRs) near the lunar poles is attracting robotic and human missions to the Moon. To facilitate those missions, the mechanical properties of PSR regolith must be assessed to ensure rovers and/or crews can traverse them. A previous study of boulder tracks in PSRs between 70 to 76 ° S [1] suggest those PSRs were just as traversable as highlands and mare terrain. Here we utilize Lunar Reconnaissance Orbiter (LRO) DIVINER annual maximum and average temperature data to identify PSRs closer to the poles with similar thermal conditions to those previously found trafficable.

Bearing capacity of PSRs: The key mechanical property in those regions is bearing capacity, which is a measure of the ability of soil to bear a load. Boulder tracks were used to evaluate bearing capacity in lunar highlands, mare, and pyroclastic regolith [2] and in PSRs [1]. The bearing capacities of the PSRs studied by [1] were similar to those recorded in sunlit regions of the Moon at depths of ~0.28-1 m. Although PSR regolith is potentially more porous than highland and mare regolith (e.g., [3]), the boulder tracks suggest that has not significantly reduced the bearing strength in PSRs at the observed depths, potentially because water ice forms a rigid matrix structure between grains.

Temperature effects on regolith properties: Water ice is thought to have accumulated in PSRs over hundreds of millions of years [4]. Water can thermally migrate through regolith where it remains trapped [5], therefore temperature conditions strongly influence the distribution of water ice in regolith. Therefore, the mechanical properties of regolith, including bearing capacity, is strongly influenced by temperature conditions.

Mapping traversable PSRs: The PSRs analyzed by [1] are characterized by annual maximum and average temperatures between 160-200 K and 90-130 K respectively at their centers. We applied these temperature criteria to a map of south polar PSRs [6] to identify PSRs that thermally mimic the PSRs analyzed by [1] at their centers, as well as throughout their perimeter. Mapping was performed from 60°-90°S, where PSR candidates were discarded if they were smaller than ~0.15 km^2, limited by the spatial resolution of the used DIVINER products and PSR map. We identified 372 potentially traversable PSRs at the south pole.

Distribution of PSRs: The selected PSRs are distributed evenly across the south polar region and are found in a wide range of sizes (<1 km^2 to >100 km^2). Some are in areas of interest for future exploration missions, such as Schrödinger basin (Fig. 1). From a trafficability (bearing capacity) point of view, traverses into PSR's within Schrödinger basin and many other regions of interest might be feasible.

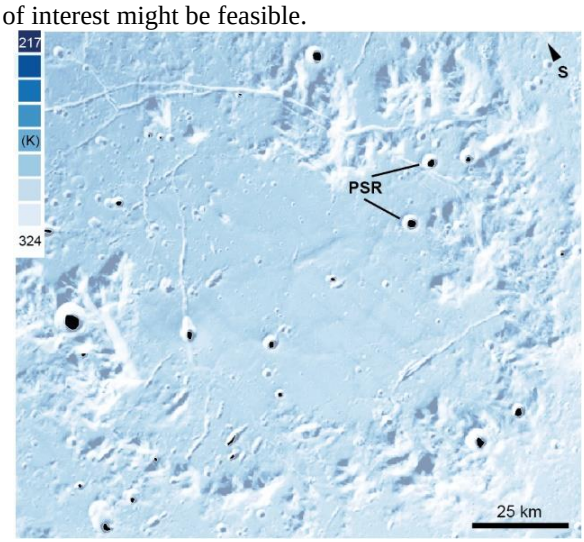

Fig. 1 Annual max. temperature map within Schrödinger basin. Black polygons represent PSRs that meet the mapping requirements.

Conclusions: The temperature conditions of select PSRs that were deemed traversable have been used to identify 372 south polar PSRs which may have similar regolith properties.

References: [1] Sargeant et al. (2020) *JGR: Planets*, *125*(2). [2] Bickel et al. (2019) *JGR: Planets*, *124*(5), 1296-1314. [3] Gladstone et al. (2012) *JGR: Planets*, 117. [4] Siegler et al. (2018) *Lunar Polar Volatiles* #5038. [5] Schorghofer & Taylor (2007) *JGR*, 112. [6] McGovern et al. (2013) *Icarus*, 223(1), 566-581. [7] Morse et al. (2019) LPSC L, Abstract #2886, [8] Steenstra et al. (2016) Adv. In Space, Res., 58(6), 1050-1065.

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