WATER OUTSIDE THE SHADOWS: EVIDENCE FOR HYDROTECTONICS AT NORTHERN LUNAR LATITUDES?

T. Marshall Eubanks[1], W. Paul Blase[1], Rosario A. Gerhardt[2], Manasvi Lingam[3], Scott D. King[4]
[1]Space Initiatives Inc, Princeton, WV, USA [2]School of Materials Science & Engineering, Georgia Institute of Technology, Atlanta, GA, USA [3]Department of Aerospace, Physics & Space Science, Florida Institute of Technology, Melbourne, FL, USA [4]Department of Geosciences, Virginia Tech, Blacksburg, VA
; tme@space-initiatives.com;

Introduction: Space Initiatives Inc (SII) is conducting a survey of northern lunar latitudes to find scientifically and programmatically interesting sites for the deployment of its "Mote" penetrator arrays [1]. Here, we report on apparently recent surface deformations in Philolaus crater, one of these potential landing sites.

Tectonic Intrusions in Philolaus Crater: The lava plains on the eastern floor of Philolaus Crater exhibit many signs of geologically recent ground deformations, including rilles and possible skylights [2]. Figures 1–3 show details of one interesting region, which appears to contain intrusional domes or diapirs with boulder fields on their summits, clear evidence of geologically recent activity [3]. Philolaus Crater is in or near a region of lunar surface moonquakes observed by Apollo seismology[4], and it is thus possible that the Philolaus activity continues to the present.

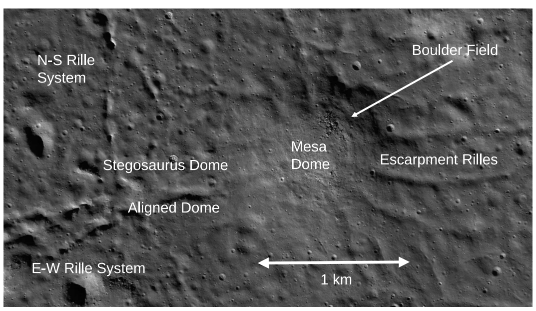

Figure 1: Part of the eastern floor of Philolaus crater. The large "Mesa" feature has a flat summit $\sim$100 m above the crater floor, surrounded by a series of radial rilles in the summit escarpment. From LROC NAC image M1206273917LC; North is at the top.

Water Driven Tectonics: The Philolaus domes may be diapirs driven by subsurface water. Hydrotectonics requires much less internal heating than igneous tectonics, but it does require subsurface water. While it is commonly assumed that water will largely be confined to permanently shadowed regions (PSRs), neutron scatterometry data indicates that hydrogen (and thus presumably free or bound water water) is present at relatively high latitudes ($|\phi| >\sim 70°$), outside of the PSR regions at the poles [5].

If the surface changes in Philolaus reflect hydrotectonics then in the vacuum lunar environment there should be an enhanced leakage of water at the surface. While the structures discussed here are too small to be resolved by orbital neutron scatterometry, they provide good locations for mapping of water emissions by in ground dielectric spectroscopy [6].

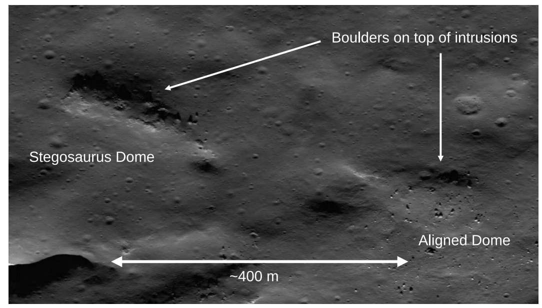

Figure 2: Closer view of the two small domes in Figure 1. With their surface boulders, these aligned features appear to be very geologically young. From LROC NAC image M137752358LC. North is at the top.

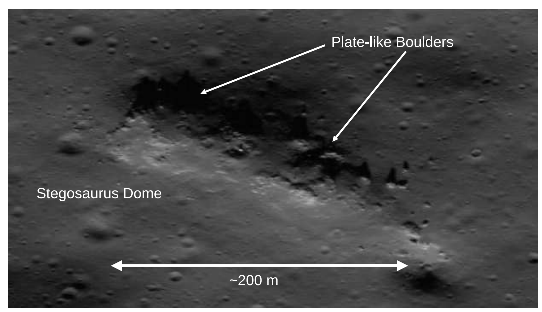

Figure 3: The "Stegosaurus" Dome" at 31° 2' 13.45" W & 72° 30' 32.44" N. This intrusional feature exhibits numerous protruding boulders, while there are otherwise few boulders in the immediate vicinity down to the resolution limit of 0.46 m/pixel. From LROC NAC image M155445584RC; North is at the top.

References: [1] T. M. Eubanks, et al. (2021) in *2021 Annual Meeting of the Lunar Exploration Analysis Group* vol. 2635 of *LPI Contributions* 5036. [2] P. Lee (2018) in *49th Annual Lunar and Planetary Science Conference* Lunar and Planetary Science Conference 2982. [3] P. S. Kumar, et al. (2019) *Geophys Res Lett* 46(14):7972 doi. [4] T. R. Watters, et al. (2019) *Nature Geoscience* 12:411 doi. [5] T. A. Livengood, et al. (2022) in *Lunar Polar Volatiles Conference* vol. 2703 of *LPI Contributions* 5021. [6] R. A. Gerhardt (2022) *IEEE Instrum Meas Mag* 25(4):14 doi.