NEW CANDIDATE PITS AND CAVES AT HIGH LATITUDES ON THE NEAR SIDE OF THE MOON.

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Summary: 35 new candidate pits are identified in Anaxagoras and Philolaus, two high-latitude impact structures on the near side of the Moon.

Introduction: Since the discovery in 2009 of the Marius Hills Pit (Haruyama et al. 2009), a.k.a. the “Haruyama Cavern”, over 300 hundred pits have been identified on the Moon (Wagner & Robinson 2014, Robinson & Wagner 2018). Lunar pits are small (10 to 150 m across), steep-walled, negative relief features (topographic depressions), surrounded by funnel-shaped outer slopes and, unlike impact craters, no raised rim. They are interpreted as collapse features resulting from the fall of the roof of shallow (a few meters deep) subsurface voids, generally lava cavities. Although pits on the Moon are found in mare basalt, impact melt deposits, and highland terrain of the >300 pits known, all but 16 are in impact melts (Robinson & Wagner 2018). Many pits are likely lava tube skylights, providing access to underground networks of tunnel-shaped caves, including possibly complex subsurface plumbing systems.

Most pits identified to date have been found between 50-degrees latitude North and South (Wagner & Robinson 2014), a concentration that reflects a bias due to limitations in the ability of the software used in identifying pits to recognize them at higher latitudes. Higher latitude pits no longer have significant portions of their floors lit differentially by sunlight throughout the lunar day, so they become difficult to recognize by the automated process used. Recently however a “manual” search for pits was conducted from both lunar poles toward lower latitudes and resulted in the identification of candidate pits on the impact melt floor of Philolaus Crater, a 70 km-wide impact structure of Copernican age (<1.1 Ga) located at 72.1°N, 32.4°W, on the lunar nearside (Lee 2018a,b,c). Such high latitude candidate pits are of special interest because their shadowed darkness would be as cold as the Permanently Shadowed Regions (PSRs) at the lunar poles, cold enough to cold-trap a wide variety of volatiles. Thus, in addition to potentially offering natural shelters on the Moon, like all caves do, the circumpolar candidate pits in Philolaus, if confirmed, might offer volatile resources away from the lunar poles themselves (Lee 2018ab,b,c).

In this study, we expanded the systematic search for high latitude pits on the Moon to other areas on the floor of Philolaus, and to other impact melt floor sections in craters in the general vicinity of Philolaus (Fig.1).

Methods: Like previous studies searching for pits (Wagner & Robinson 2014, Robinson & Wagner 2018, Lee 2018a,b,c), we used imaging data collected by the NASA Lunar Reconnaissance Orbiter (LRO) Narrow Angle Camera (NAC). Following the approach of Lee (2018a,b,c), we conducted a “manual” search for pits on the impact melt floors of four large and relatively fresh craters: Philolaus, Anaxagoras (73.48°N, 10.17°W), Carpenter (69.4°N, 50.9°W) and Scoresby (77.7°N, 14.1°E). Anaxagoras and Carpenter, like Philolaus, are Copernican in age. Scoresby while older still presents relatively smooth impact melt floor sections. Shadowed depressions were identified as candidate pits using the same set of criteria as used by Lee (2018a,b,c): i) depression straddles a discontinuous sinuous rille; ii) depression is approximately as wide as the associated rille; iii) absence of a raised rim, iv) presence of outer funnel-shaped slopes, v) shows local brightening contiguous to the shadowed zone.

Results & Discussion: We report identifying a total of ~35 new candidate pits, 20 of which are in Anaxagoras (Fig.2),

Figure 1: Location of studied craters (Polar projection).

Figure 2: Nested view of candidate pits in Anaxagoras.
and 15 in Philolaus (Fig. 3).

Figure 3: Nested view of candidate pits in Philolaus.

bringing the total in the latter to 18 if the three main candidate pits previously reported in Philolaus (Lee 2018 a,b,c) are included. No shadowed depressions meeting all of the above criteria were identified in Carpenter or Scoresby, although the present search results remain preliminary. The new candidate pits found in Anaxagoras represent the highest latitude candidate pits identified on the Moon to date. The candidate pits in the northernmost part of the northern section of the impact melt floor of Anaxagoras are at 73°48’ N, ~492 km from the lunar North Pole. These pits are interpreted as skylights associated with networks of partially collapsed underground impact melt lava tubes. The candidate lava tubes, if confirmed, would represent not only natural shelters against the radiation, micrometeoritic bombardment, and wide temperature swings affecting the lunar surface, but also permanently shadowed locations cold enough to cold-trap volatiles such as H2O ice, a potentially important resource for future human exploration. The presence of volatiles inside high latitude caves would also be scientifically important, as it would inform us about the origin and evolution of volatiles on the Moon and on other terrestrial planets.

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