IMPACT CRATER MORPHOLOGY AS A GUIDE TO REGOLITH STRUCTURE AT TAURUS-LITTROW. H. H. Schmitt[1], [1]University of Wisconsin-Madison, P.O. Box 90730, Albuquerque, NM 87199, schmitt@engr.wisc.edu.

Introduction: Mapping of variables in primary crater morphology relative to crater size can be used as an initial guide to factors that will affect mining and processing of that material for lunar resources such as helium-3, hydrogen, oxygen and water. Although time did not permit the systematic mapping of craters during the Apollo 17 exploration of the Valley of Taurus Littrow, the writer was able to provide descriptions of the variety of crater morphologies present (1).

About 3.5 b.y. ago (2), the Valley of Taurus-Littrow and its surroundings had been blanketed with a dark, pyroclastic mantle (3,4). Orange and black varieties of this mantle were specifically sampled at Station 4, Shorty Crater (5) as well as being a significant component of most samples of the regolith (4). All of the craters investigated, observed, and described are younger than the period of pyroclastic mantling. Every later impact, however, re-mobilized the fine pyroclastic material as well as the developing regolith, partially mantling all nearby younger materials.

Crater Age: The primary process that visibly ages impact craters on the Moon is the impact of small and micro-meteors over time (6) and the associated deposition of nanophase iron on all particle surfaces (7). Micro-meteor impacts generally keep the surfaces of boulders clear of this debris.

Small-scale impact processing of the upper few centimeters of the lunar surface gradually degrades and/or buries the primary features of larger impact craters and their ejecta. Crater age Category One (C1) are ubiquitous in Taurus-Littrow [<1 m.y.?]. They consist of the youngest and statistically the smallest craters and are characterized by bright halos and irregular but coherent pools of impact glass on their floors and regolith breccia fragments scattered on their walls, rims and ejecta blankets. Category Two (C2) craters include several observed on the traverse from Challenger to Station 2 and Van Serg Crater at Station 9 [1.5-3.7 m.y. (8,9)]. Relative to C1 craters, the bright halo has faded in C2 craters. Category Three (C3) craters, such as Ballet Crater [2-5 m.y. (8,10)], the coherent masses of impact glass have disappeared but fragments of regolith breccia have been retained. Category Four (C4) craters, including Shorty Crater at Station 4 [10-19 m.y. (4,11)], are marked by the full degradation of visible regolith breccia fragments. If a C4 crater is large enough to have penetrated to bedrock, it will have visible bedrock fragments on their floors and in their walls and ejecta blankets.

Additional age categories can be defined for craters large enough to expose bedrock in their floors and/or have bedrock as part of their ejecta blankets. Category Five (C5) craters have no visible bedrock on their floors even though bedrock fragments are exposed in the walls and in their ejecta blankets. Examples of C5 craters are Camelot Crater at Station 5 [70-95 m.y. (4)], Emory Crater at Station 1 [~100 m.y. (12)]. Category Six (C6) craters, such as Horatio Crater, have bedrock fragments exposed only in their walls.

Regolith Depth: Fresh craters that penetrate the regolith have fragments of the underlying bedrock on their rims as well as exposing that bedrock on their floors. They can be used to map variations in the depth of the regolith.

Regolith Layering: Craters with continuous interior benches in their walls give an indication of a significant discontinuity in the physical properties of the regolith with depth. Generally, as apparently is the case with Van Serg Crater, a bench indicates a sharp increase in compaction or strength with depth. An extreme version of a bench crater, given the field name of "pit bottomed crater," may indicate a sharp decrease in compaction or strength with depth. Pit bottomed craters were only observed on the light mantle and may indicate better compaction near the top of the light mantle than lower down as might be expected in a fluidized avalanche deposit (5).

Buried Boulder Concentrations: Craters of insufficient size to penetrate the regolith to bedrock, but which have boulders in their ejecta blankets are indicative of a concentration of buried boulders, presumably ejecta from a larger crater. Radar scans, including look-ahead radar from a mining-processing machine, might be employed to fully map a buried boulder field.

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