

GEOLOGIC MAPPING OF THE SCHRÖDINGER BASIN AREA, LUNAR SOUTH POLE. L.E. Van Arsdall¹ and S.C. Mest², ¹Department of Geology and Environmental Geosciences, College of Charleston, 66 George St., Charleston, SC 29424-0001 (levanars@edisto.cofc.edu); ²Planetary Science Institute, 1700 E. Ft. Lowell, Suite 106, Tucson, AZ 85719-2395 (mest@psi.edu).

Introduction: In this study we use high resolution Clementine images and topographic data to map the geology and geomorphology, and examine crater size-frequency distributions of a 90 degree quadrangle near the lunar south pole. This area, located on the lunar far side, contains two multi-ring impact basins of similar size - the Amundsen-Ganswindt Basin and the younger Schrödinger Basin.

The south pole is of interest because of the postulated occurrence of perennial ice in permanently shadowed areas, which could be a useful resource for future manned missions to the Moon. Our scientific motivation concerns characterization of polar landscapes, which could then be supplied to mission planners that could be integrated into analyses to assess potential landing sites. This study is part of a larger effort to map the north and south polar regions out to 70° [1].

Previous Work: Wilhelms et al. [2] provide the most detailed mapping effort of this area, which is Lunar Orbiter-based and mapped at 1:5,000,000 scale. Since Wilhelms, there have been few systematic mapping endeavors of the polar regions. Previous mapping of Schrödinger's floor [3], based on preliminary Clementine data, showed more detail than the Wilhelms map. Our goal is to update the lunar map resource by utilizing the most recent and most complete datasets available, including Clementine and Lunar Prospector.

Background: This study covers a 90 degree quadrant (90-180°) on the lunar far-side extending from the south pole to 70° S latitude. This area includes two multi-ring impact basins; here the Imbrian-aged Schrödinger basin (D=312 km; 76 °S, 134 °E) intersects the rim of the Pre-Nectarian-aged Amundsen-Ganswindt (D=175 km; 81°S, 120°E) [4]. Both basins are located within the South Pole-Aitken Basin, one of the oldest, deepest, and largest of the lunar basins [5].

Principles of Lunar Stratigraphy: It is assumed that older surfaces have more craters, smaller craters are more frequent than large craters, and crater counts correlate to surface age if no other resurfacing processes are at work [6]. Morphologically, older craters appear shallow and smooth because of erosion, collapse and impact gardening, whereas younger craters tend to have sharp rims and show less signs of degradation.

One problem addressed by proponents of the crater production function relates to the incorporation of secondary craters into the crater count dataset, primarily by misidentification. 'Secondary craters' form by the impact of secondary materials from nearby impact

events [7]. There has been a long-standing controversy about the relative abundance of primaries and secondaries on the Moon [e.g., 8]. It has been hypothesized that a very large population of secondaries may be present on the lunar surface [9] and arguably, enough of them would skew the statistics. Additionally, because secondary craters are generated within the gravitational field of a primary body and are therefore densely clustered occurrences, they carry a caveat: two surfaces of equal age may differ in density significantly enough to invalidate assumptions about age [8]. Morphological constraints at best provide a sense of crater scaling schema, however they are far from objective.

Methodology: This project utilized ArcGIS (v. 9.2) as a base for mapping. A mosaic of Clementine images, obtained from the U.S.G.S., containing more than one hundred stereographically projected UV-VIS 750-nm images (100 m/pixel), was used as the base to characterize geologic units from surface textures and albedos, identify unit contacts, and identify impact craters with diameters greater than 2 km. The convenience of GIS software for mapping of this scale (~1:1,000,000) is that multiple layers - units, structures, contacts, spectral, and shaded relief - can be georeferenced to display different characteristics about a zone of interest while, at the same time, large scale trends can be observed.

Results: Here we describe the geologic materials identified in the map area and we present a regional crater size-frequency distribution for the entire map area.

Geologic materials: Seventeen units have been identified in this map area and are organized into the following groups: Highland Materials, Crater Materials, and Schrödinger Materials.

Highland Materials are believed to predate or coincide with formation of the Amundsen-Ganswindt and Schrödinger Basin-forming events and are thus likely some of the oldest materials in this area. *Rugged basin material* forms elevated terrain and sequences of ridges and depressions and was interpreted to be part of South Pole-Aitken Basin [2]. *Dark and Light plains materials* form smooth intercrater surfaces interpreted to be relict lowland and highland materials, respectively.

Crater Materials are found throughout the map area and include material emplaced by impact events or by subsequent mass wasting of impact materials (includes *Outer crater material*, *Bright inter-crater material*, and *Rough inter-crater material*); many of these deposits are gradational, making identification of their parent crater difficult. Other members of this group include materials that mantle craters (*Rough mantling*

material) or are found along the walls (*Hummocky crater material*) or floors of craters (*Crater fill material*).

Schrödinger Materials are the most interesting and, with the exception of Schrödinger's *Wall*, *Rim* and *Basin-massif Materials*, appear to form some of the youngest deposits in this area. Most of the deposits on Schrödinger's floor (*Dark materials a and b*, *Smooth floor material*, and *Bright floor material*) form relatively smooth surfaces degraded to varying amounts and display lobate edges. *Dark material b* contains a well-preserved ovoidal depression interpreted to be the source of pyroclastic eruptions within the basin [3]; *Dark material a* (identified in this study) is overlain by *Dark material b* and may be similar material from a prior eruption. *Rough material* occurs as broad flat expanses in low-relief areas of the basin. Based on albedos and surface textures, as well as the abundance of intersecting fissures and wrinkle ridges throughout Schrödinger, our interpretations for these materials are in agreement with previous authors [e.g., 2,3] in that the Schrödinger floor materials are indicative of effusive fissure eruptions followed by later-stage pyroclastic eruptions centered at the ovoidal depression.

Crater Size-Frequency Distributions: For this area we have identified all impact craters with diameters greater than 2 km. In this study we are principally interested in statistical representations of the entire population as a standard for age-dating of discrete units. However, classifying by crater type - either primary or secondary - can have a significant effect on our results. The effect is considered to be noteworthy because an overwhelming number of secondary craters steepen the SFD curve [8]; however a secondary advantage to this error is that ascertaining the slope gradient (or 'crossover diameter') is often used to derive unit-specific age-constraints. Where high-resolution image data allowed, craters were classified as either secondary or primary. Secondary craters were identified by their tendency to be found in clusters, chains, and their amorphous shape, whereas primaries were identified by their pristine, symmetrical, and singular occurrence. The classification as primary or secondary is treated here as a statistical experiment to determine if any meaningful correlations exist between secondary versus primary distribution and unit ages. For the purposes of overall age determination however, our approach will use both primaries and secondaries to derive SFDs.

The use of SFDs represents an approximation of lunar chronology based on the crater production function [10,11]. We use the term approximation because most lunar surfaces have an interrelated history of crater accumulation and degradation [e.g., 12]. The principle of using SFDs as a proxy for relative age where superposition relationships are inadequate has long been established [e.g., 7,11-15]. We analyze our results using the cumulative [16,17] form of SFD. The cumulative SFD is represented by the number of craters (N)

within a diameter bin size equal or greater than D where D equals a specific diameter. The SFD of craters is normally an inverse power-law function with the number of craters increasing as diameter decreases [8].

Conclusions: This mapping effort is upgrading the lunar map record for the polar regions and here we present the map of the Schrödinger Basin area. We have mapped at higher resolution with ArcGIS software to produce a more detailed, more accurate, and more informative map than its predecessors. Contacts have been mapped in increased detail and in places, revised. Verifiable tone and texture, the key factors in map unit description and identification, are more readily discernible than maps created by [2]. This has the capacity to be used in mission planning. Our hope is that future missions will be able to use our results as a staging ground for potential moon-landings.

Ongoing Work: This research will continue to refine geologic contacts located within this map area. Once mapping is concluded, crater size-frequency distributions will be calculated for each unit identified to place them in stratigraphic context.

Acknowledgements: I wish to thank Dr. Scott Mest, Dr. Noah Petro, and Dr. Herbert Frey for their helpful suggestions, support, and encouragement, and Mablene Burrell and Adrienne Byrd for their excellence in program leadership. This work was supported by the NASA USRP at Goddard Space Flight Center's Planetary Geodynamics Laboratory.

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