

GEOLOGIC MAPPING OF THE LUNAR SOUTH POLE, QUADRANGLE LQ-30: VOLCANIC HISTORY AND STRATIGRAPHY OF SCHRÖDINGER BASIN. S.C. Mest^{1,2}, D.C. Berman¹, and N.E. Petro²,
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Introduction: In this study we use recent images and topographic data to map the geology and geomorphology of the lunar South Pole quadrangle (LQ-30) at 1:2.5M scale [1-4] in accordance with the Lunar Geologic Mapping Program. Mapping of LQ-30 began during Mest's postdoctoral appointment and has continued under the PG&G Program, from which funding became available in February 2009. Preliminary mapping and analyses have been done using base materials compiled by Mest, but properly mosaicked and spatially registered base materials are being compiled by the USGS and should be received by the end of June 2009.

The overall objective of this research is to constrain the geologic evolution of the lunar South Pole (LQ-30: 60°-90°S, 0°-±180°) with specific emphasis on evaluation of a) the regional effects of basin formation on the structure and composition of the crust and b) the spatial distribution of ejecta, in particular resulting from formation of the South Pole-Aitken (SPA) basin and other large basins. Key scientific objectives include: 1) Constraining the geologic history of the lunar South Pole and examining the spatial and temporal variability of geologic processes within the map area. 2) Constraining the vertical and lateral structure of the lunar regolith and crust, assessing the distribution of impact-generated materials, and determining the timing and effects of major basin-forming impacts on crustal structure and stratigraphy in the map area. And 3) assessing the distribution of resources (e.g., H, Fe, Th) and their relationships with surface materials.

Methodology: This project utilizes ArcGIS (v. 9.2) to prepare map layers (e.g., image mosaics, topography, spectral maps) and conduct the mapping, which follows the work of [5] in their mapping of the Copernicus Quadrangle (LQ-11). The Clementine UV-VIS 750-nm mosaic (100 m/pixel) is being used as the primary base to characterize geologic units from surface textures and albedos, identify unit contacts, and identify impact craters with diameters greater than 2 km; other mosaics and images (e.g., Lunar Orbiter, Clementine NIR) are being used as well.

Previous Work: Wilhelms et al. [6] provides the most detailed mapping effort of the lunar South Pole to date, which is Lunar Orbiter-based and mapped at 1:5M scale. Recent mapping of Shackleton crater [7] using Arecibo radar and SMART-1 AMIE images found that Shackleton formed ~3.6 bya, nearly 300 my older than previous estimates [6,8]. Our goal is to update the lunar map resource by incorporating the most recent and most complete datasets available.

Regional Geology: LQ-30 exhibits ~16 km of relief. The near side consists predominantly of cratered highlands, is more heavily cratered and displays higher elevations than the far side. This difference is due to the overwhelming presence of the South Pole-Aitken impact basin (discussed below), which encompasses nearly all of the far side map area.

Impact features in LQ-30 display morphologies ranging from simple to complex craters, to central peak-ring, peak-ring and multi-ring basins [6,8,9]. LQ-30 hosts all or part of 46 impact features greater than 100 km in diameter that would have significantly affected the structure of the crust and redistributed large amounts of material across the surface.

South Pole-Aitken Basin: SPA is the largest (D=2600 km) and oldest (pre-Nectarian) impact basin identified on the moon [6,8,10]. The basin's rim is defined by discontinuous mountain rings [6] and it exhibits nearly 18 km of relief. Models suggest that SPA formed by an oblique impact that excavated material from the upper crust [11,12] to the lower crust or upper mantle [13,14]. Galileo and Clementine multispectral data show enrichment in mafic materials within SPA [15-19], and LP-GRS data show enhancements in both Fe and Th within the basin relative to the surrounding highlands [20-23]. Although the exposed materials within SPA have likely been altered by billions of years of geologic processes (impacts, space weathering, etc.) or buried by local mare and pyroclastic deposits, the materials exposed within SPA could be used as a proxy for estimating the composition of the lower crust/upper mantle.

Other Impact Features: All or parts of 46 large (D>100 km) impacts occur within the map area. Most (30) were identified in previous studies [6,8] using Lunar Orbiter data. Preliminary mapping found four unnamed craters with diameters between 100 and 200 km [1], and recent work by Frey [24,25] identified 12 lunar basins with diameters ≥300 km. The presence of these basins not only affects the calculation of crater size-frequency distributions, which has implications for surface age, but the impact events would have significantly affected structural patterns within the upper crust and they would have distributed ejecta throughout the map area.

Results: Here we describe preliminary mapping results obtained for the Schrödinger basin. The Schrödinger basin (76 °S, 134 °E), located on the lunar far-side and just inside SPA, is a 2-3 km-deep multi-ring basin consisting of a 312-km-diameter outer ring and a ~160-km-diameter peak ring. Schrödinger is believed to be

Imbrian in age [6,26] and is likely one of the last major basin-forming impact events on the Moon, only slightly older than the Orientale impact, which emplaced secondary craters on Schrödinger's floor [26].

Structures: The predominant structures visible on the floor of Schrödinger basin are fractures that formed concentric and radial to the basin rim. The fractures dissect both peak ring and plains materials. They are only a few kilometers wide, and most fractures are tens of kilometers long.

Schrödinger Floor Materials: Nine primary units have been identified that compose the Schrödinger basin, and are organized into two groups: Plains Materials, and "Volcanic" Materials.

The Plains Materials cover most of Schrödinger's floor. These deposits show surfaces ranging from smooth to rugged, display lobate edges, and embay Schrödinger's peak ring and rim materials. *Schrödinger rugged plains material* (unit srp) appears to be stratigraphically the oldest plains material on the basin floor. Most exposures of the rugged plains are found outside of the peak ring and form heavily cratered knobby plateaus and massifs of moderately high albedo. Orientale secondaries are found within this unit in the eastern and southern parts of the basin [26]. *Schrödinger smooth plains material* (unit ssp) is found just inside the peak ring and embays the rugged plains where in contact. The smooth plains displays moderate to high albedo and contains fewer craters than the rugged plains. Antoniadi secondaries are found primarily within this unit in the eastern part of the basin, but a few have been identified in the rugged, mottled, and hummocky plains [26]. *Schrödinger mottled plains material* (unit smp) is found primarily in the center of the basin, but two small exposures are found among the massifs in the western and northeastern parts of the peak ring. The mottled plains display an overall smooth surface that is lower in albedo than the smooth plains, and slightly less cratered. *Schrödinger hummocky plains material* (unit shp) occupies much of the floor along the northern and western walls, and in the south where the peak ring is the most discontinuous. Hummocky plains displays moderately cratered, low albedo surfaces with gently rolling topography. These plains materials are interpreted to consist of impact melt from the time of basin formation and/or volcanic plains.

The *Schrödinger knobby plains material* (unit skp) forms two fairly high albedo deposits along the southern basin wall. These plains exhibit clusters of rounded and elongated knobs; elongation and some clusters appear to trend approximately north-south. Fissures within this unit appear subdued relative to those that bisect other plains units. This deposit is interpreted to be ejecta from Ganswindt crater, located on Schrödinger's rim, and/or the younger Amundsen crater ~150 km to the south.

"Volcanic" Materials are concentrated in the northern and eastern parts of the basin within the peak ring. Four patches of *Schrödinger dark plains material* (sdp) are found on the basin floor, three are located around the deposits of dark material and the fourth, and largest exposure, is located along the northern part of the peak ring. These deposits display smooth relatively featureless low albedo surfaces. In Clementine UVVIS color ratio maps, these units are distinct from the surrounding plains and appear mafic in composition. These deposits display no clear contact with adjacent materials, suggesting these materials get extremely thin toward their edges. Within the northern deposit, a long (a few 10s of kilometers) sinuous rille emerges from the mottled plains and terminates within the dark plains. The morphology of these plains, their spectral appearance, and the presence of this rille suggest these plains are composed of very fluid basaltic lavas [4].

The eastern part of Schrödinger contains a well-preserved ovoidal depression surrounded by dark materials. The depression has been interpreted as a "maar"-type crater [26], which is referred to here as a "pit crater." This pit crater has been identified as the source of pyroclastic eruptions [26,27]; this study has identified at least two distinct deposits surrounding the pit - *Schrödinger dark material 2* (sdm2) and *Schrödinger dark material 1* (sdm1) - suggesting at least two eruptive events [2-4]. The younger deposit (sdm2) shows a smooth surface and makes up the pit crater's flank; this deposit superposes the more heavily-cratered older deposit (sdm1).

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