GEOLOGICAL MAP OF THE NECTARIS BASIN AND ITS DEPOSITS. M. C. Smith[1] and P. D. Spudis[2], [1]Department of Earth and Planetary Sciences, University of Tennessee, 1412 Circle Dr., Knoxville, TN 37916, [2]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058.

Introduction: Geological maps are an efficient way to visually convey the geometric and relative age relations of units in a concise manner. These maps are made in order to understand the three-dimensional make up, processes, and crustal structure on any given terrestrial planetary body. The purpose of this project is to update the geological map of the Nectaris basin in light of new data and to unravel its stratigraphy and relation to the overlying Imbrium basin [1].

The Nectarian System, which begins with the impact that created the Nectaris basin (860 km diameter), was only proposed as a new lunar time-stratigraphic unit in 1975 [2]. Although several different absolute ages for this impact have been proposed [e.g., 3-5], no direct evidence for a specific age of Nectaris has been recovered. The Apollo 16 mission, attempting to sample material older than the Imbrium impact, returned rock samples that could, arguably, have been derived mostly from the Imbrium basin impact [1]. If we could identify Nectaris ejecta at the Apollo 16 landing site on the basis of geological or compositional affinity to such deposits elsewhere on the Moon, we would derive a better understanding of early lunar geologic history as well as address the existence or absence of a “cataclysm” in early lunar history.

A new geologic map of the Nectaris basin based upon images from the wide-angle Lunar Reconnaissance Orbiter Camera (LROC) would provide better insight into the geologic units present and possibly aid in selecting a location(s) for future sample retrieval. Current geologic maps of the Moon are both outdated and inconsistent in their labeling and designation of units [7-12]. The geologic map that encompasses the majority of the Nectaris basin deposits [7] was created prior to the definition of the Nectarian System as a lunar time-stratigraphic unit [2] and therefore does not specifically delineate Nectarian-age units. This new map seeks to identify and map all Nectaris basin units, including their stratigraphic relationship, areal extent, and relative age. Additionally, we hope to use this map as a template in which to determine the compositional properties of Nectaris basin ejecta as well as to interpret the samples from the Apollo 16 landing site.

Methods: A special orthographic Nectaris-centered (16°S, 34°E) base map was prepared from the LROC Wide Angle Camera (WAC). Geological units were defined and mapped by surface morphology, albedo, and relative preservation. Units were distinguished and mapped using the standard methods of planetary geological mapping, including truncation of older units by younger ones, superposition and overall crater density [13]. Descriptions and labels of units were adopted and modified from previous maps where applicable [7-12]. In many cases, the Lunar Orbiter and Apollo photographs were analyzed in order to gain more insight into the reasoning behind the original geologic interpretations. Comparison of the images from Lunar Orbiter and LROC allowed for more accurate interpretations of the terrain and the geologic contacts. All craters larger than 10 km in diameter and their associated continuous ejecta blankets were mapped.

The map has been rendered in ArcMap (ArcGIS 10.0) using an “Equirectangular Moon” projection and draped over a Nectaris-centered shaded-relief image derived from the global LROC WAC digital terrain model [14] with the same projection. A color-scheme for geological units was chosen to parallel the traditional photogeologic convention for lunar units [7-12]. The map layout, including correlation and unit description sections, was modeled after the most recent lunar geologic maps [1, 7-12].

Results: Units were identified and labeled ranging in age from the pre-Nectarian to the Copernican. The labeling of uncertain or unclassifiable materials as “undifferentiated” was minimal and avoided if possible. Many geologic units originally mapped as Imbrian in age appear from the new image data to be Nectarian, as evidenced by the superposition of Imbrian ejecta on Nectarian materials.

Several locations of potential Nectaris basin impact melt-sheet remnants were identified; relatively smooth plains units lying between Nectaris basin massifs and other terra are prime candidates. Typical structures of melt-sheet remnants, such as the folding, flow features, and cooling fractures seen in the Orientale basin impact melt sheet [7] are not readily apparent at Nectaris, probably because of its advanced degradational state.

Discussion: The Nectaris basin ejecta blanket (units Ntp and Nj) is manifested primarily through exposures to the south and southeast. Additional remnants of a Nectaris basin ejecta blanket (unit Nh) may be found to the west, encompassing the Apollo 16 landing site. Although this unit differs texturally from the south and southeast locations, it may be indicative of structural variations in the target rock or the superposition of Imbrium basin structure. Unit Ihp, a hilly and pitted material, spans across the Nectaris basin, loosely forming a fan shape, radial to Imbrium basin. It can be observed blanketing the rims of Nectarian and older craters, but not Imbrian age craters. Similarly, the Nectarian equivalent, unit

Ntp, is found to blanket only the rims of pre-Nectarian craters.

Lineated material (unit NpNl) to the northwest of Nectaris basin is likely to be caused by the Imbrium impact. Nectarian, or even pre-Nectarian, crater remnants are scoured by troughs that are radial to Imbrium. These troughs may be caused by low-altitude, high velocity Imbrium basin ejecta ripping through older terrain.

Much of the north, northeast, east, and to some extent, far western regions surrounding the Nectaris basin display minimal evidence of its creation. Nectarian plains material (Np), a unit consisting of hillier and more heavily cratered material than its Imbrian equivalent, can still be found on the crater floors of many Nectarian and pre-Nectarian age craters and in a larger area southwest of the crater Theophilus.

Nectarian-age crater chains and clusters occur southeast of the Nectaris basin within the Janssen Formation (Nj). These chains (Nbc) are radial to the Nectarian-age basin from which they originated and were probably caused by low angle secondary ejecta from the basin-forming impact. In most cases, the chains are partially buried by superposed Imbrian or younger material.

Several sites containing possible Nectaris basin impact melt have been identified. Impact melt samples will provide the most valuable samples from which the actual age of the Nectaris impact event could be determined. Establishing this date is critical to our understanding of lunar history [1] and would solidify the time of the beginning of the Nectarian period. The ideal candidate sites generally consist of moderate to heavily cratered, higher albedo plains material situated among rugged Nectaris basin material. In some cases, the potential melt sites are perched on uplifted basin rock and occupy local topographic lows. Although in some cases these areas are located adjacent to maria, they are brighter and more heavily cratered and thus they are readily differentiated from maria.

Summary: We have produced an updated, finely detailed geologic map of the Nectaris basin and its surrounding terrain (Fig.1) by studying and mapping from the high-resolution images of the LROC WAC global basemap and Lunar Orbiter photographs. Several units previously considered “undifferentiated” were classified and assigned stratigraphic positions. Sites that may contain Nectaris basin impact melt were identified and recorded. These sites could prove to be desirable targets for future lunar missions, since melt samples could directly determine the absolute age of the Nectaris basin-forming impact. A companion paper to this effort describes the use of the new geological map to ascertain the composition of Nectaris basin deposits [15].

References: [1] Wilhelms D.E. (1987) USGS Prof. Paper 1347. [2] Stuart-Alexander D. and Wilhelms D.E. (1975) JRUSGS 3, 53. [3] James O.B. (1981) PLPSC 12B, 209. [4] Spudis P.D. (1984) PLPSC 15, JGR 89, C95. [5] Stoffler D. et al (1985) PLPSC 15, JGR 89, C449. [6] Wilhelms D.E. (1993) To A Rocky Moon. Univ. Arizona Press [7] Wilhelms D.E. and McCaulet J.F. (1971) USGS Map I-703 [8] Scott D.H. et al. (1977) USGS Map I-1034 [9] Wilhelms D.E. and El-Baz F. (1977) USGS Map I-948 [10] Stuart-Alexander D.E. (1978) USGS Map I-1047. [11] Lucchitta B.K. (1978) USGS Map I-1062. [12] Wilhelms D.E. et al. (1979) USGS Map I-1162. [13] Wilhelms D.E. (1972) USGS Astrogeol. 55. [14] Scholten F. et al. (2012) JGR 117, doi:10.1029/2011JE003926. [15] Spudis P. and Smith M. (20134) this vol.

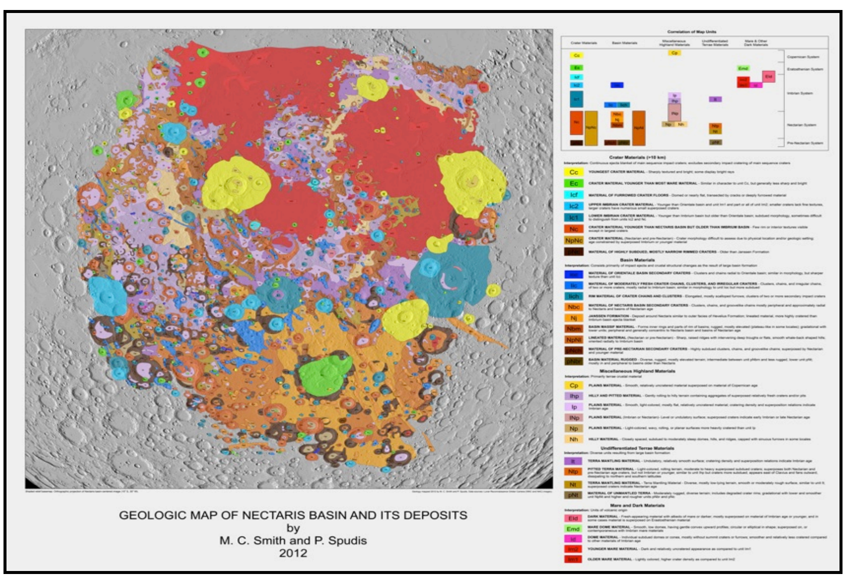

Figure 1: Geological map of Nectaris basin and its deposits