LUNAR GEOLOGIC MAPPING: A PRELIMINARY MAP OF A PORTION OF THE LQ-10 ("MARIUS") QUADRANGLE. T.K.P. Gregg[1] and R.A. Yingst[2] [1],Department of Geology, 411 Cooke Hall, University at Buffalo, Buffalo, NY 14260; tgregg@buffalo.edu;[2] Planetary Science Institute, 1700 E. Ft. Lowell St., Suite 106, Tucson, AZ 85719; yingst@psi.edu.

Introduction: Since the first lunar mapping program ended in the 1970s, new topographical, multispectral, elemental and albedo imaging datasets have become available (e.g., Clementine, Lunar Prospector, Galileo). Lunar science has also advanced within the intervening time period. A new systematic lunar geologic mapping effort endeavors to build on the success of earlier mapping programs by fully integrating the many disparate datasets using GIS software and bringing to bear the most current understanding of lunar geologic history [1-3]. As part of this program, we report on a 1:2,500,000-scale preliminary map of a subset of Lunar Quadrangle 10 ("LQ-10" or the "Marius Quadrangle," see Figures 1 and 2), and discuss the first-order science results. By generating a geologic map of this region, we can constrain the stratigraphic and geologic relationships between features, revealing information about the Moon's chemical and thermal evolution [4].

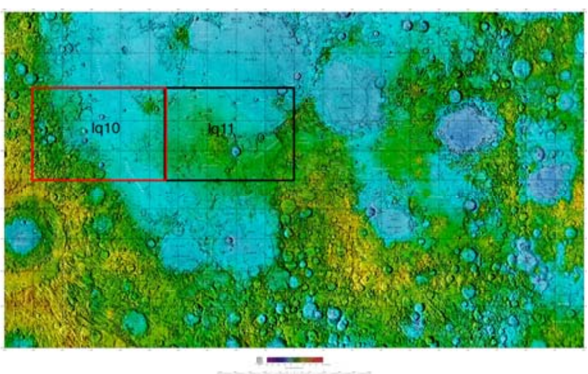

Figure 1. Location of LQ-10 (red box) on a topographic map of the lunar nearside [5]. LQ-11 (in black) is the "Copernicus Quadrangle," also being mapped [1, 2].

Science Rationale: In constructing a geologic map of LQ-10, we address the following science questions.

1) What are the origin, evolution, and distribution of mare volcanism? LQ-10 displays a wide variety of volcanic constructs, some of them unique to the Moon. LQ-10 contains the domes and cones of the Marius hills [6]; a high concentration of sinuous rilles within Aristarchus plateau [7-9]; young lava flows within Oceanus Procellarum [9-12]; and the approximate center of the Procellarum KREEP terrane [13-15]. LQ-10 is thus a prime testbed for hypotheses of lunar volcanic history, as any model must provide an explanation for each unique aspect of this region. Mapping reveals and characterizes relationships between disparate structures and units; these relationships contribute to understanding and constraining cause and effect of volcanic processes.

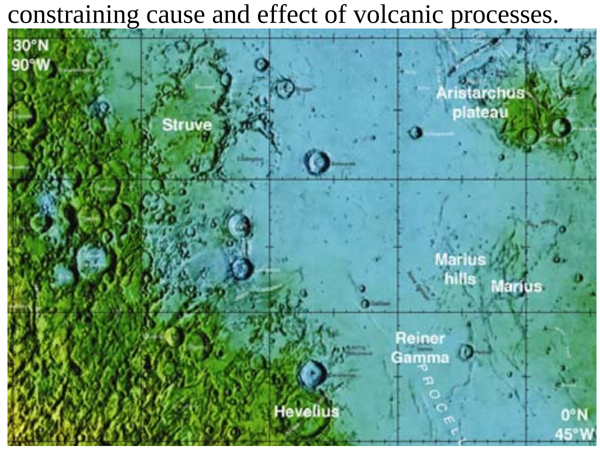

Figure 2. Topography and geography of LQ-10 [5].

2) What were the timing and effects of the major basin-forming impacts on lunar crustal stratigraphy? The western portion of LQ-10 is dominated by highlands modified by Orientale impact ejecta [7,16], whereas the boundary between the ejecta-covered highlands and the Procellarum maria intersects the quadrangle from northwest to southeast. The lavas appear to be thin where they embay the highlands, so that the underlying ejecta patterns locally control the lava emplacement [4]. Additionally, Mustard and Head [17] identified abundant cryptomaria in the region, affected by Orientale ejecta, indicative of volcanism within Oceanus Procellarum prior to the Orientale impact. LQ-10 thus contains connecting or intersecting examples of ancient highlands crust, mare material (surface and otherwise), basin material (including the proposed Oceanus Procellarum basin [7,18,19]) and impact ejecta. Identifying the spatial and stratigraphic relationships between these different units may reveal important information about the interplay between many crucial processes such as volcanic activity, ejecta emplacement, weathering and mixing. This is vital for our understanding of volcanic activity, as modeling volcanic processes requires a full inventory of volcanic material.

3) What are the Moon's important resources, where are they concentrated, and how can they be accessed? Ilmenite ($FeTiO_2$) is an excellent candidate source for lunar resources such as TiO_2 and FeO. Pyroclastics (iron-bearing volcanic glass) are likely to be important in this regard [20], and have been identified mantling the Aristarchus plateau [21]. Similar deposits are found on the Marius hills [6].

Because the surficial distribution of pyroclastics is related to their subsurface distribution, identifying and mapping pyroclastic deposits within LQ-10 will provide information about the distribution of these materials through space and time.

Mapping Procedure: We began by each individually mapping a subquadrangle of LQ-10, and comparing our preliminary results to identify differences in interpretation and mapping style; other teams of planetary mappers have successfully used this method when mapping large areas [5,22,23]. We each created a map of the region between 6.5° - 17.5°N and 281° - 291°E (Figure 3). This area was selected because it contains multiple, and representative, terrains and geologic contacts: maria, highlands, and fresh and degraded impact craters are observed. Clementine data (at all available wavelengths and band ratios) and Lunar Orbiter data were both used to interpret this sub-quad; however, both mappers used Lunar Orbiter images as the primary base map. Unit descriptions, boundaries and interpretations were compared, and differences noted. Special attention was paid to procedures in regions where craters have excavated material spectrally different from the surface material. We presented these results at the Lunar and Planetary Science Conference [23], and concluded that our mapping styles are similar and compatible.

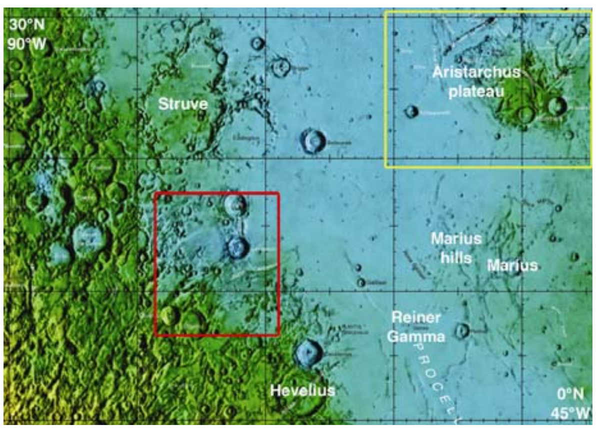

Figure 3. LQ-10, showing the area (red box) chosen for preliminary mapping and the region (yellow box) that is the subject of M.S. candidate Lough's research.

We subsequently divided LQ-10 into 4 equal quadrangles (NE, NW, SE and SW), with an additional map area around Aristarchus plateau that will receive special attention from Ms. Trevi Lough, an M.S. candidate under Gregg's advisement (Figure 3). Gregg will map the NE and SW quadrangles; Yingst will focus on the NW and SE quadrangles. We plan to meet at the upcoming Fall Geological Society of America Meeting to compare our units, and confirm areas for further scrutiny. Ms. Lough is unraveling the stratigraphy of the Aristarchus plateau as part of her M.S. thesis, and her goal is to finish this work by the Fall semester of 2010. Yingst and Gregg will incorporate Lough's results into the final map, which we plan to submit for review in approximately 12 – 18 months.

References: [1] Gaddis, L.R., et al. (2006) *LPSC XXXVII*, Abstract #2135. [2] Gaddis, L.R., et al. (2006) *USGS Open-File Report 2006-1263*. [3] Skinner, J.A., et al. (2006) *USGS Open-File Report 2006-1263*. [4] Gregg, T.K.P., and Yingst, R.A. (2008) *NASA/CP-2008-215469*. [5] Dohm, J.M. et al. (2007) *USGS Open-File Report 2007-1333*. [6] Weitz, C.M. and Head, J.W. (1999) *J. Geophys. Res. 104*, 18,933. [7] Wilhelms, D.E. (1987) *USGS Prof. Paper 1348*. [8] Guest, G.E. and Murray, J.B. (1976) *J. Geol. Soc. London 132*, 251. [9] Whitford-Stark, J.L. and Head, J.W. (1977), *Proc. Lun. Planet. Sci. VIII*, 2705. [10] Whitford- Stark, J.L. and Head, J.W. (1980) *Proc. Conf. Multi-ringed basins*, pp. 105. [11] Hiesinger, H., et al. (2003) *J. Geophys. Res. 108*, 5065. [12] Hiesinger, H. and Head, J.W. (2006) *Rev. Min. Geochem. 60*, 1. [13] Haskin, L.A., et al. (2000) *J. Geophys. Res. 105*, 20,403-20,415. [14] Jolliff, B.L., et al. (2000) *J. Geophys. Res. 105*, 4197. [15] Wieczorek, M.A. and Phillips, R.J. (2000) *J. Geophys. Res. 105*, 20,417. [16] Scott, D.H., et al. (1977) *USGS Misc. Invest. Ser. I-1034*. [17] Mustard, J.M. and Head, J.W. (1996) *J. Geophys. Res. 101*, 18,913. [18] Wilhelms, D.E. and McCauley, J.F. (1971) *USGS Misc. Invest. Series I-70*3. [19] Feldman, W.C., et al. (2002) *J. Geophys. Res. 107(3*), 1. [20] Hawke, B.R., et al. (1990) *PLPSC XX*, 249. [21] McEwen, A.S., et al. (1994) *Science*, *266*, 1858. [22] Tanaka, K.L. et al. (2007) *USGS Open-File Report 2007-1333*. [23] Williams, D.A. et al. (2007) *USGS Open-File Report 2007-1333*. [23] Yingst, R.A. and T.K.P. Gregg (2009), *Lun. Planet. Sci. Conf. 40*, Abstract #1319.