GEOLOGIC MAPPING OF THE MARIUS QUADRANGLE, THE MOON. Tracy K.P. Gregg[1] and Aileen Yingst[2], [1]Department of Geology, 876 Natural Sciences Complex, University at Buffalo, Buffalo, NY 14260, (tgregg@geology.buffalo.edu), [2]Natural and Applied Sciences, University of Wisconsin-Green Bay, Green Bay, WI 54311-7001 (yingsta@uwgb.edu).

Introduction: We will construct a 1:2,500,000-scale map of Lunar Quadrangle 10 (hereinafter called "LQ10" and/or the "Marius Quadrangle") to address outstanding questions about the Moon's volcanologic history and the role of impact basins in lunar geologic evolution. The selected quadrangle contains Aristarchus plateau and the Marius hills (informal names), Reiner Gamma, and Hevelius crater. By generating a geologic map of this region, we can constrain the temporal (and possibly genetic) relations between these features, revealing more information about the Moon's chemical and thermal evolution. Although many of these individual sites have been investigated using Lunar Orbiter, Clementine, Lunar Prospector and Galileo data, no single investigation has yet attempted to constrain the stratigraphic and geologic relationships between these features. Furthermore, we will be able to compare our unit boundaries on the eastern boundary of the proposed map area with those already mapped in the Copernicus Quadrangle [1-3].

Outstanding Questions to be Answered through Geologic Mapping: Geologic mapping of the Marius Quadrangle would provide insight to the following questions [4].

1) What are the origin, evolution, and distribution of mare volcanism?

The Marius Quadrangle contains superlatives of lunar volcanism. Aristarchus plateau contains the widest sinuous rille on the Moon, Vallis Schröteri [5], and the highest concentration of sinuous rilles on the Moon [5-7]. The Marius hills represent the largest concentration of domes and cones yet found on the Moon [8]. Surrounding these features are the maria of Oceanus Procellarum, containing some of the youngest examples of lunar volcanism [7, 9–11]. Any model for mare volcanism must take into account the range of volcanic behavior displayed within the Marius Quadrangle, and geologic mapping will provide clues as to how these volcanic features are related in space and time. Furthermore, the Procellarum KREEP terrain [12-14] is roughly centered within the proposed map area. It is unlikely to be mere coincidence that the high abundance of heat-producing thorium [12] is concentrated in this region of nonpareil volcanism on the Moon [cf. 14]. However, the precise relation between the Procellarum KREEP terrain and the surficial geology must be examined in detail to constrain cause and effect. A geologic map of LQ10 will directly address this outstanding question.

2) What were the timing and effects of the major basin-forming impacts on lunar crustal stratigraphy?

Orientale basin is one of the youngest impact basins on the Moon [5], and much of its structure is not flooded by younger maria. The western portion of LQ10 is dominated by highlands that are modified by Orientale impact ejecta [5,15]. The boundary between the ejecta-covered highlands and the Procellarum maria has an interesting topographic expression (Fig. 2), revealing that the lavas are quite thin where they embay the highlands, and that the underlying ejecta patterns locally control the lava emplacement. Examining the Orientale ejecta, its distribution and composition, could reveal important information about ejecta emplacement and basin excavation. Mustard and Head [16] identified abundant cryptomaria identified in the region affected by Orientale ejecta, indicative of volcanism within Oceanus Procellarum prior to the Orientale impact. Furthermore, they state that the relation between geomorphology and composition is not always clear-cut on the Moon. It has been proposed [5,17,18] that Oceanus Procellarum is the site of an ancient impact basin. However, there is not a general consensus about the existence of such a basin [5,10,11,19,20]. Generating a geologic map, including structural features and mare thickness, would provide additional data to constrain the presence of such a basin. As noted below, the most up-to-date lunar topographic data [21] will be used to characterize the current expression of impact craters and their deposits.

3) What are the Moon's important resources, where are they concentrated, and how can they be accessed?

How "important resources" are precisely defined would shape the answer to this question. Here, we define "important resources" as those that would assist the human presence on the Moon. Oxygen is obviously a vital resource, and most proposals to extract oxygen from lunar materials require a source of FeO [22-24]. Ilmenite ($FeTiO_2$) has been identified on the Moon, and is the most likely source for abundant TiO_2 and FeO. Recently, the Hubble Telescope imaged the Apollo 17 landing site and Aristarchus crater, and ilmenite was identified as a likely component in both locations [http://www.nasa.gov/vision/universe/solarsystem/hubble_moon.html]. Volcanic glass could be a viable FeO source [25]. McEwen et al. [26] identified ~200 km^3 of pyroclastic deposits (i.e., iron-bearing volcanic glass) mantling the Aristarchus plateau; similar deposits are found on the Marius hills [8]. By analogy with materials collected at the Apollo 17 landing site, these pyroclastics were likely generated by the fragmentation of lava by magmatic volatiles [cf. 27,28], and so their surficial distribution is related to their subsurface distribution. Identifying and mapping pyroclastic deposits within the Marius Quadrangle will provide information about the distribution of these materials through space and time. Constraining the timing, volumes, and distributions of pyroclastic deposits within the map area further constrains the volatile history, and provides insight as to the volatile abundance through time—and possibly identifies additional resources for lunar development.

Mapping Progress: Although funding has been approved, it has not yet been received. The PIs will meet this summer to begin test-mapping subregions in July, 2008.

References: [1] Gaddis, L.R., J. Skinner, Jr., K. Tanaka, B.R. Hawke, P. Spudis, B. Bussey, C. Pieters and D. Lawrence, 2006a, *LPSC 37th*, Abstract #2135. [2] Gaddis, L.R., J. Skinner, Jr., T. Hare, K. Tanaka, B.R. Hawke, P. Spudis, B. Bussey, C. Pieters and D. Lawrence, 2006b, *USGS Open-File Report 2006-1263*. [3] Skinner, J.A., Jr., L.R. Gaddis and K.L. Tanaka, 2006, *USGS Open-File Report 2006-1263*. [4] Joliff, B.L., 2006, *Rev. Min. Chem. 60*:v-xv. [5] Wilhelms, D.E., 1987, *USGS Prof. Paper 1348*. [6] Guest, J.E. and J.B. Murray, 1976, *J. Geol. Soc. London 132(3)*:251. [7] Whitford-Stark, J.L. and J.W. Head, 1977, *Proc. Lun. Planet. Sci. 8th*:2705. [8] Weitz, C.M. and J.W. Head, 1999, *J. Geophys. Res. 104(E8)*:18,933. [9] Whitford-Stark, J.L. and J.W. Head, 1980, *Proc. Conf. Multi-ringed basins*, pp. 105. [10] Hiesinger, H., J.W. Head, U. Wolf, R. Jaumann and G. Neukum, 2003, *J. Geophys. Res. 108(E7):*5065. [11] Hiesinger, H. and J.W. Head, 2006, *Rev. Min. Geochem. 60*:1. [12] Haskin, L.A., J.J. Gillis, R.L. Korotev and B.L. Jolliff, 2000, *J. Geophys. Res. 105(E8)*:20,403-20,415. [13] Jolliff, B.L., J.J. Gillis, L.A. Haskin, R.L. Korotev and M.A. Wieczorek, 2000, *J. Geophys. Res. 105(2)*:4197. [14] Wieczorek, M.A. and R.J. Phillips, 2000, *J. Geophys. Res. 105(E8):*20,417. [15] Scott, D.H., J.F. McCauley and M.N. West, 1977, *USGS Misc. Invest. Ser. I-1034*. [16] Mustard, J.M. and J.W. Head, 1996, *J. Geophys. Res. 101(E8):*18,913. [17] Wilhelms, D.E. and J.F. McCauley, 1971, *USGS Misc. Invest. Series I-70*3. [18] Feldman, W.C., O. Gasnault, S. Maurice, D.J. Lawrence, R.C. Elphie, P.G. Lucey and A.B. Binder, 2002, *J. Geophys. Res. 107(3*):1. [19] Spudis, P.D., 1993, Cambridge University Press, 263 pp. [20] Spudis, P.D. and P.H. Schultz, 1976, *NASA Tech. Mem. 88-383:203*. [21] Archinal, B.A., M.R. Rosiek, R.L. Kirk and B.L. Redding, 2006, *USGS Open-File Report 2006-1367*. [22] Coombs, C.R., B.R. Hawke and C.C. Allen, 1998, *Proc. 6th Int. Conf. Exposition Eng. Const. Ops,* 608. [23] Rosenberg, S.D., 1998, *Proc. 6th Int. Conf. Exposition Eng. Const. Ops*, 622. [24] Duke, M.R., L.R. Gaddis, G.J. Taylor and H.H. Schmidt, 2006, *Rev. Min. Geochem. 60*:597. [25] Hawke, B.R., C.R. Coombs and B. Clarke, 1990, *PLPSC 20th*:249. [26] McEwen, A.S., M.S. Robinson, E.M. Eliason, P.G. Lucey, T.C. Duxbury and P.D. Spudis, 1994, *Science 266*:1858. [27] Wilson, L. and J.W. Head, 1981, *J. Geophys. Res. 86(4)*:2971. [28] Wilson, L. and J.W. Head, 2003, *Geophys. Res. Lett. 30(12*):1605.

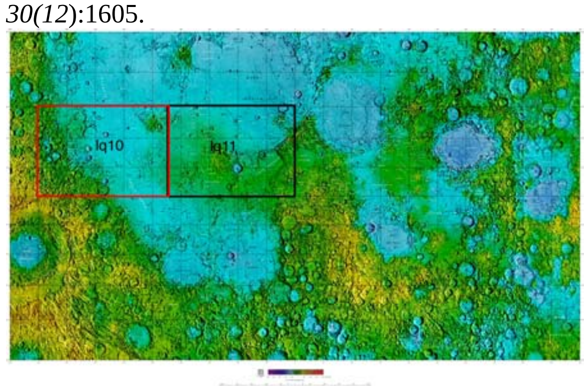

Figure 1. Location of Lunar Quadrangle 10 outlined in red in this topographic map of the lunar near side [Archinal et al., 2006]. Lunar Quadrangle 11, outlined in black, is currently being mapped at 1:2.5 million by Gaddis and others [1, 2].

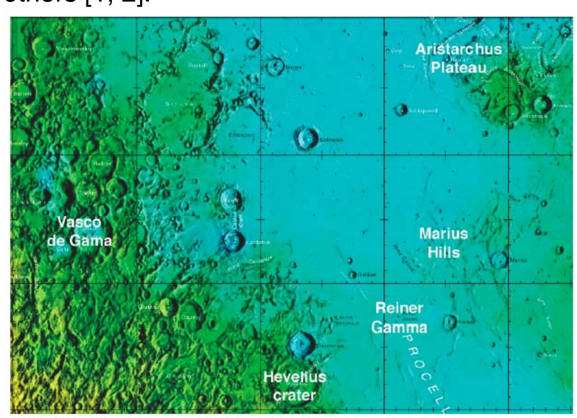

Figure 2. Topography and geography of the map area (LQ10), with major geographic features labeled. Topographic color scale is the same as in Fig. 1.