MORPHOMETRIC AND COMPOSITIONAL ANALYSIS OF A SMALL MOUND OF POTENTIALLY EVOLVED VOLCANIC MATERIAL SOUTHWEST OF WEBB U IN MARE FECUNDITATIS. C. V. Fogerty[1], R. N. Watkins[1,2], C. Lauber[3], and B. L. Jolliff[1] [1]Department of Earth & Planetary Sciences, Campus Box 1169, Washington University in St. Louis, One Brookings Dr., St. Louis, MO 63130; [2]Planetary Science Institute, Tucson, AZ; [3]Lockheed Martin, Houston, TX. [bjolliff@wustl.edu]

Introduction: A small heart-shaped mound (HM) occurs in northeastern Mare Fecunditatis centered at 55.64 °E longitude and 0.93 °N latitude, measuring about 9 km in diameter at its base and 3.3 km (E-W) × 4.4 km (N-S) at its summit (Fig. 1a). The HM is located 30 km southwest of Webb U crater and about 50 km northwest of the Luna 16 site (Fig. 1b). The structure rises 250 to 400 m above the surrounding mare (Fig. 1c), with side slopes ranging from 6 to 20 degrees, steeper near the summit and shallower where slopes transition to the debris apron. Of interest is that HM sits near the center of a small Th enhancement (Fig. 1d), suggestive of an unusual composition. The feature has only 1/3 the area of a half-degree Lunar Prospector gamma-ray pixel, thus its Th content could be greater than 3 ppm (data from [1]). A similar but smaller mound occurs 16 km to the south (Fig. 1b). The smaller mound measures 6×7 km at its base and 1×1.5 km at its summit, which is very flat, but tilted slightly east to west. Similar to the larger mound, its side slopes are steep near the summit, but shallower where they transition from down-slope erosion to accumulation on the debris apron.

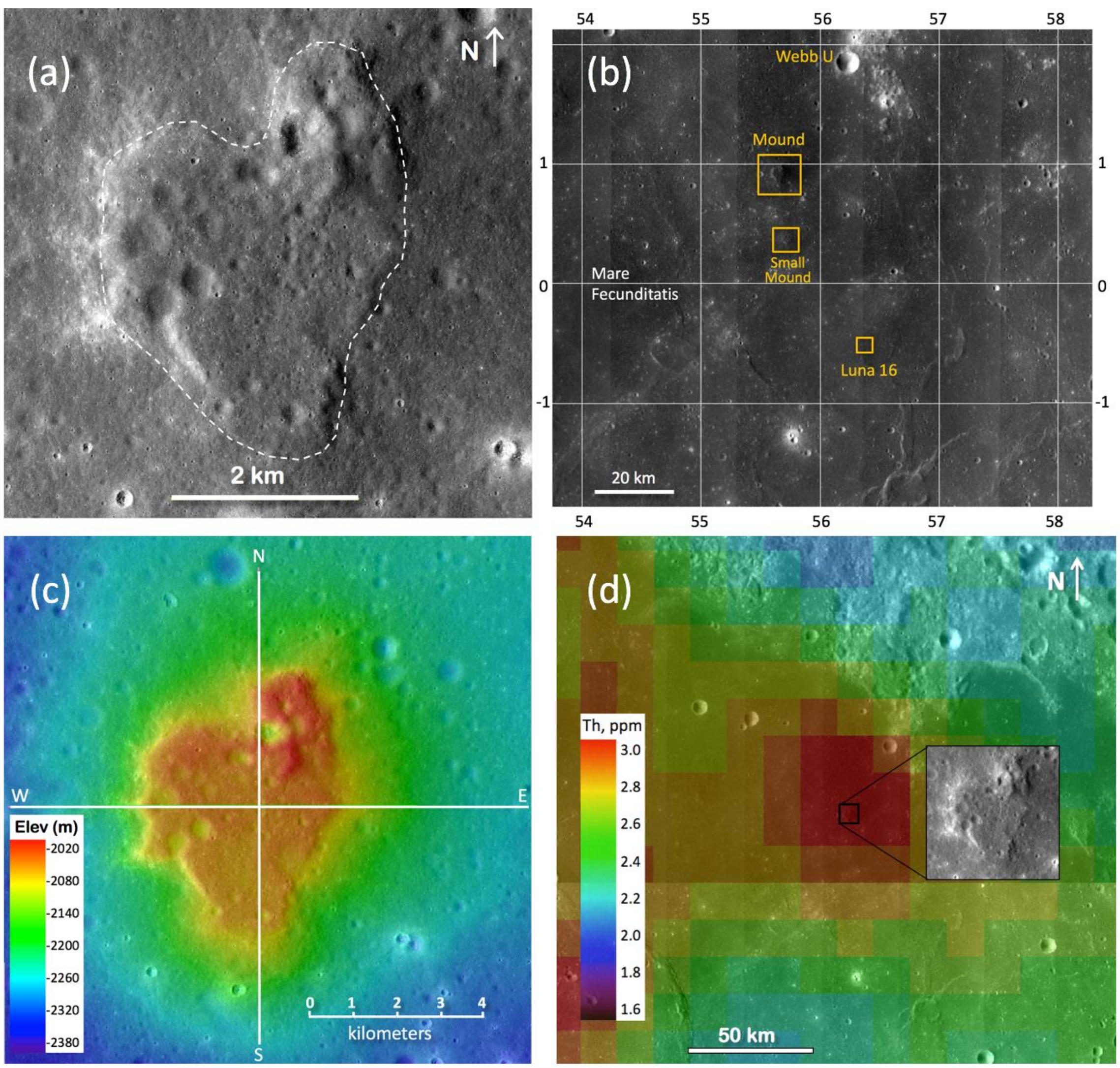

Figure 1: (a) Mound located at 55.64°E Lon. and 0.93°N Lat., NAC image M1175048303, L & R mosaic. Mound surrounded by basalts of Mare Fecunditatis. (b) WAC 100 mpp morphology base map showing locations of mound, Webb U crater, and the Luna 16 site. (c) NAC DTM. (d) Lunar Prospector gamma-ray Th, half-degree per pixel [1].

Understanding the distribution of Th on the Moon and the geologic features that correspond to local enhancements are important because Th is an indicator of KREEP-rich materials. Moreover, such morphologies and Th enhancements on the Moon are in some cases associated with felsic volcanics [2]. The Fecunditatis HM, however, has FeO and TiO_2 concentrations similar to surrounding mare and appears unremarkable in its Diviner Christiansen Feature spectral character, which is commonly diagnostic for felsic volcanics [3], thus it is not a silicic volcanic construct. In this abstract, we investigate the morphometry and composition to characterize the mound and constrain its origin.

Methods: NAC images that cover the feature and were suitable for geometric stereo were obtained and processed using ISIS3 [4] and a DTM was produced from these NAC images [5]. The NAC images used for geometric stereo were M1175048303 and M11750-41195. N-S and E-W elevation profiles and ten side-slope profiles were constructed to assess slopes and mound morphology. Compositions were examined using LP-GRS Th data at half-degree per pixel [1], Clementine FeO and TiO_2, and LROC WAC TiO_2 [6].

Composition: Other than the local Th enhancement, there is no indication that the mound compositions differ from surrounding mare basalts. Clementine FeO values in this part of Mare Fecunditatis are ~18-20 wt.%, and the mound may represent a slight local high at ~20 wt.%. In Clementine and LROC WAC TiO_2, the mound occurs in an area of elevated TiO_2 (5-8 wt.% as measured using WAC data [6]). The Luna 16 site is located along the southeastern edge of this local high, but Luna 16 regolith contained only about 3.4% TiO_2 [7,8]. Small basalt fragments sampled by Luna 16, however, had TiO_2 ranging 2-6 wt.% [7,9-13], thus hinting at a regional source of more TiO_2-rich components. Among the basalt fragments, Th concentrations are generally <2 ppm [8,13,14]) as is the soil [8]. The LP-GRS Th value is ~2 ppm at the Luna 16 site. If the local Th enhancement is in fact associated with HM, then it does not appear that Luna 16 samples contained basalts similar to the HM material.

Interpretations: Given the broad spatial response function of the LP-GRS [1], it seems plausible that the location of HM at the center of a local enhancement is not coincidental. Alternatively, the high-Ti basalts in this area might simply be somewhat enriched in Th compared to low-Ti basalts elsewhere in Fecunditatis. Both the HM and the smaller mound to the south are ancient features, likely formed toward the end of the time of the Fecunditatis basalt eruptions (~3.4 Ga [15]). The steep side slopes are not consistent with high FeO, low-viscosity lava. Their flat tops distinguish these mounds from other volcanic domes. The tilt of the flat summit of the smaller mound is consistent with regional mare slopes in this part of Fecunditatis. Perhaps the mounds formed instead as small pop-up mesas over late, shallow intrusions. The HM may have experienced outflow from a vent on its west side and local doming and perhaps surface eruption on its northeastern lobe; impacts into this lobe may have distributed ejecta with high-Th basalt locally. Although fundamentally basaltic and high in FeO, these basalts were late-stage and may have had elevated KREEP contents, similar to Apollo 11 high-K basalts [16].

Acknowledgements: We are grateful to NASA for continued support of LRO, the LRO Project and Ops team at GSFC, and LROC Operations Team at ASU.

References: [1] Lawrence, D. et al. (2003) *J. Geophys. Res.* 108, 5102. [2] Glotch et al. (2010) Science 329, 1510-1513. [3] Greenhagen et al. (2010) Science 329, 1507-1509. [4] Anderson et al. (2004) Lunar Planet. Sci. 35, #2039. [5] Henriksen et al. (2017) Icarus 283, 122-137. [6] Sato et al. (2017) *Icarus* 296, 216-238. [7] Vinogradov (1971) *Proc. Lunar Sci. Conf.* 2nd, 1-16. [8] Laul et al. (1981) *Proc. Lunar Planet. Sci.* 12b, 389-407. [9] Albee et al. (1972) *EPSL* 13, 353-367. [10] Grieve (1972) *EPSL* 13, 225-232. [11] Keil et al. (1972) *EPSL* 13, 243-256. [12] Kurat et al. (1976) Proc. 7th Lunar Sci. Conf., pp. 1301-1321. [13] Cimbalnikova et al. (1977) Soviet-American Conf. on Cosmochemistry of the Moon and Planets, 263-275. [14] Korotev et al. (1990) *Lunar Planet. Sci.* 21, #1338. [15] Papanastassiou and Wasserburg (1972) *EPSL* 13 368-374. [16] Papike et al. (1998) RiM 36, Ch 5.

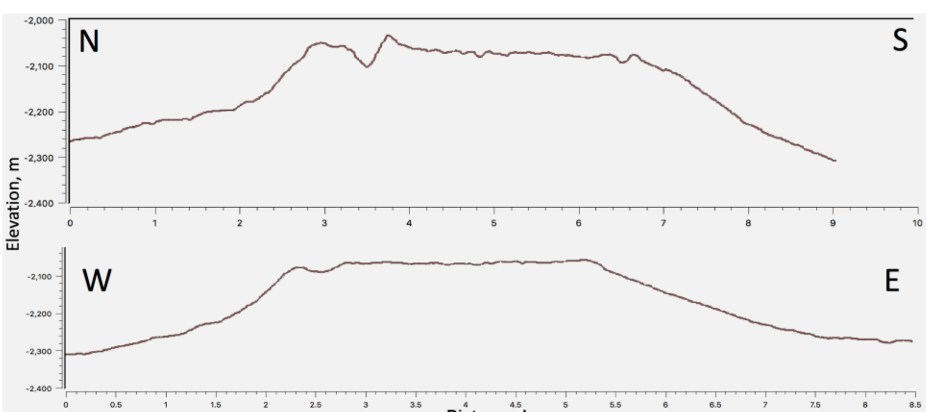

Figure 2. NAC DTM elevation profiles of HM, (top) N-S, and (bottom) W-E (see Fig. 1c for locations).