

MARE DOMES IN MARE TRANQUILLITATIS: IDENTIFICATION, CHARACTERISTICS, AND IMPLICATIONS FOR THE OLDEST LUNAR VOLCANISM. L. Qiao¹, J. W. Head², L. Wilson³ and Z. Ling¹, ¹Shandong Univ., Weihai, Shandong, 264209, China (LeQiao.GEO@Gmail.com), ²Brown Univ., Providence, RI, 02912, USA, ³Lancaster Univ., Lancaster LA1 4YQ, UK.

Introduction: Mare domes, small (<~30 km diameter) and generally circular structures with convex-upward profiles [1], are among the most common endmember volcanic landforms on the Moon, serving as an indispensable part of mare volcanism investigation and providing an important window into the geological and thermal evolution of the Moon. Lunar mare domes are generally interpreted to be built up through multiple phases of flows erupted from a common pit crater source, dominated by accumulating low-effusion rate, cooling-limited flows (e.g., [2]), though other formation mechanisms have also been proposed, for instance, laccolithic intrusions [3]. Over 300 mare domes have been previously identified, using mainly telescope and orbital photographs [e.g., 1, 4-6]. However, due to the very gently-sloping topographic nature of lunar mare domes (generally <5°), many of them are not easily identified or are otherwise obscured, especially for areas where images obtained at very low Sun illumination (for example near terminator and in earthshine [7]) are not available.

Data and Method: Newly-obtained global lunar topographic data, like the Kaguya/SELENE-TC (Terrain Camera) + LRO-LOLA (Lunar Orbiter Laser Altimeter) merged topography (SLDEM2015) with ~60 m spatial sampling and ~3–4 m vertical altimetric accuracy [8], provide an unprecedented tool for identifying and characterizing low-amplitude gently-sloping mare domes. We initiated a global search campaign for mare domes, plotting their distribution, modes of occurrence, local and regional clustering, range of characteristics and associations. As the first step of this project, we focus on Mare Tranquillitatis, which has one of the greatest concentrations of mare domes (e.g., [1,6]). We employ the SLDEM2015 topography, with assistance from other multi-source topography and images to (1) evaluate each mare dome identification in previous investigations and (2) search for new mare dome features. We then characterize each catalogued mare dome further by examining the detailed surface morphology and structure.

Mare Dome in Mare Tranquillitatis. Three prior mare dome identification studies are re-visited as follows (Figure 1): (1) of the 36 domes identified by [1], all but one are re-confirmed; (2) among the 67 additional domes identified in [6], 54 are re-confirmed, five are poorly defined and eight are questionable; (3) of the seven additional domes detected by Wöhler et al.

[4,5,9], four are re-confirmed, two is poorly defined and one are questionable.

Newly-Identified Mare Domes. Using the new SLDEM2015 topography and other new data, we identify 96 new domes in Mare Tranquillitatis (Fig. 1), which brings the number of confirmed domes in this region to 189. We also find possible evidence for 87 additional mare domes (Fig. 1). These observations show that Mare Tranquillitatis contains one of the highest densities of mare domes among the entire lunar maria.

All these catalogued mare domes ($n=189$) ranges from 1.8 to 22.8 km in diameter (median value = 5.6 km) and from 21 to 540 m in height (median value = 53 m). The average topographic slopes (180-m-baseline) of the dome flanks are between 1.9 and 6.4° (median value = 2.7°), verifying they are indeed very gentle in topographic reliefs. Summit pit craters are identified on 145 of these domes (77%), whose diameters range from 0.3 to 3.3 km (median value = 0.8 km). Crater count dating has shown that Mare Tranquillitatis is one of the oldest maria on the Moon, with ~90% of mare units emplaced between 3.5 and 3.8 Ga ago [10], indicating that shield-building eruptions may be a prevalent volcanic eruption style in the earliest stage of lunar volcanism, a very important constraint on lunar thermal evolution history.

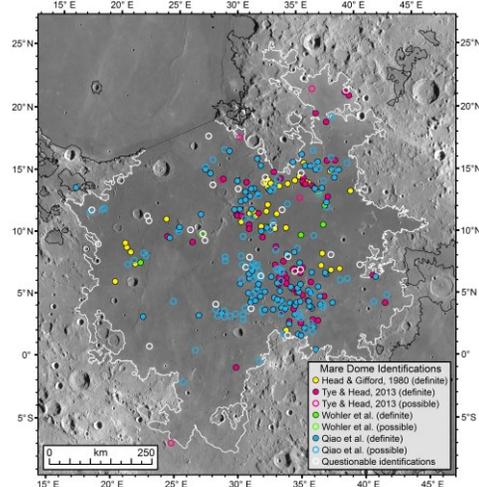


Fig. 1. Identifications of mare dome in Mare Tranquillitatis by prior and our studies.

References: [1] Head & Gifford (1980) *Moon and the Planets* 22, 235. [2] Head & Wilson (2017) *Icarus* 283, 176. [3] Wöhler et al. (2007) *Icarus* 204, 381. [4] Wöhler et al. (2006) *Icarus* 183, 237. [5] Wöhler et al. (2007) *Icarus* 189, 279. [6] Tye & Head (2013) *LPSC XLIV*, #1319. [7] Head & Lloyd (1973) *NASA SP-330*, 4-33. [8] Barker et al. (2016) *Icarus* 273, 346. [9] Pau et al. (2008) *LPSC XXXIX*, #1107. [10] Hiesinger et al. (2011) *GSA-SP 477*, 1.