A TWO-BASIN MODEL FOR MARE TRANQUILLITATIS. R.A. De Hon, Department of Geography, Texas State University, San Marcos, TX <dehon@txstate.edu>

Summary: Mare Tranquillitatis lacks the structure and gravity signature of a typical multi-ringed basin. Its configuration is best described as two overlapping basins.

Introduction: Mare Tranquillitatis is an irregular-shaped mare on the eastern hemisphere of the earth-facing side of the moon (centered on 0.68 N, 23.43 E; extending from 20.4 N-4.4 S, 15.0-45.9 E). It has irregular margins and lacks a well-defined, multiple-ringed structure. The irregular topography in and near the basin results from the intersection and overlap of features of surrounding Serenitatis, Crisium, Fecunditatis, Nectaris and Asperitatis basins. Tranquillitatis is divided into eastern and western basins by subtle differences in topography and superposed features (Fig. 1). The mare surface is slightly higher in the east, sloping to the west [1]. The 3.8-3.6 by mare lavas are Late Imbrian age [2, 3, 4]`. Mare Tranquillitatis is a blue mare which corresponds to high Ti abundance [5]. Highest Ti values are found western Tranquillitatis and slightly lower values in the eastern basin [4]. Craters Ritter and Sabine are located near the southwest margin; Argo and Ross occur on the western interior of the basin; and Plinius is near the junction with Serenitatis. Maskelyne occurs in the southcentral part of the basin. No craters greater than 10 km occur on the eastern basin. Partially-buried craters are found around the edges of the mare; within the western half of the mare; and on a broad shelf in the southeast. Rilles in western Tranqillitatis are largely confined to the mare edge. The Cauchy Rilles cross the central part of eastern Tranqillitatis with NW-SE trends. At least 20 domes are scattered across the surface west and north of Cauchy Rilles. Mare ridges stretch across western Tranquillitatis with a NNE trend, and a few with a NW trend. The 75 km diameter ghost ring is part of this trend and probably marks a completely buried crater rim crest. Mare domes are scattered near the north end of the Cauchy Rilles and along the southern margin of the eastern basin.

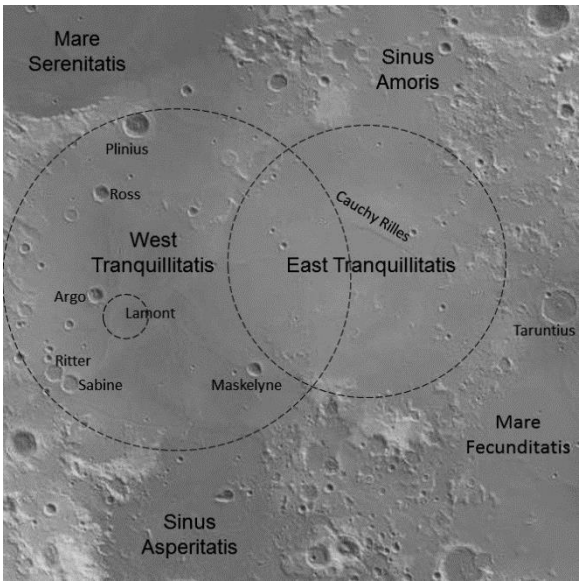

Figure 1. Division of Mare Tranquillitatis as two overlapping circular basins.

Isopach map and basin floor configuration: Isopach maps based on partially-buried crater [6,7] with local thick lenses occurring in the western part of the mare are associated with the Lamont Ring; in Sinus Asperitatis; northwest of the Cauchy Rilles; and Sinus Amoris. A sparsity of buried craters in the eastern portion of the basin leads to a large uncertainty to the thickness of the mare lavas in that region. Although isopachus contouring projects moderate thickness-values in this region, the thickness is unmeasured. Surfaces without partially-buried craters often overlie areas of thick basalt that have completely obliterated

underlying craters [4, 7]. A thick basalt lense in this region cannot be ruled out.

As the surface is relatively level, the isopach map roughly echoes the configuration of the sub-basalt topography. The floor slopes to the west. Lamont overlies the lowest part of the western basin. A thick region near the north end of Cauchy Rilles is not associated with any wrinkle ridges or massifs. Sinus Asperitatis, which is probably a pre-Necturian impact basin, forms a deep trough connecting east Tranquillitatis with the Nectaris basin. Sinus Amoris forms a deep embayment on the northern rim of the eastern basin.

Grail gravity anomalies: Tranquilllitatis is a non-mascon basin [8, 9]. It displays a broad positive anomaly associated with Lamont (which has a Bouguer maximum of 200 mgal and extremely high lithostatic stresses of 285 bar [9]); a pair of anomalies in the northern part of the basin in the region of mare domes; and a large positive associated with Sinus Asperitatis [10]. Taken together these anamolies and the northern-most Fecundatitis positive form a ring of positive gravity around the east Tranquilitatis basin. East Tranquilitatis—with a slight negative gravity anomaly—is more or less in isostatic balance. These anomalies are crudely coincident with thick lenses of basalt in each of these areas. Gravity highs are also associated with Sinus Asperatatis, but not with Sinus Amoris. The thick lense in the northeast is probably associated with uncompensated lava fill in buried craters [9].

Discussion: Tranquillitatis basin is often referred to as a pre-Nectarian impact basin, but it lacks many of the signature characteristics—a large mascon and concentric rings. The overprint of adjacent basins may have destroyed a Tranquillitatis ring system, but it should be apparent on the west side of the basin in the Cayley plains area that is beyond the raised rings of adjacent basins. Early basins in this region would be Filled with ejecta from the younger, surrounding impact basins.

Surface topography is compatible with a two-basin model in which the West Tranquillitatis basin is the larger and the older of the two. The Lamont ring, which may be a 75 km diameter crater or the peak ring of a 150 km double ring structure, formed much later than the basin.

The East Tranquillitatis basin probably has a deep inner basin associated with the featureless basalts in the center of the basin. The interior of this feature could consist of thick lavas that are in isostatic equilibrium. Mare domes probably are formed over a shallow shelf surrounding the deep inner basin.

References:

[1] Smith, D. E.*, et al. (*2010*)* Geophys. Res. Lett.*,* **37***,* L18204*.* [2] Schaeffer, O.A., et al. (1970) *Science,* ***170*** (3954), 161-162. [3] Hiesinger, H., et al.(2000) *Journal of Geophysical Research: Planets,* ***105*** (E12), 29239-29275. [4] Staid, M.I., et al. (1996) J. *Geophys. Res-All Series,* ***101***, 23-213. [5] Rajmon, D., et al. (1999) *Meteoritics and Planetary Science Supplement,* ***34***, 96. [6] De Hon, R.A. (1974) *Lunar and Planetary Science Conference Proceedings* ***5th*****,** 53-59. [7] DeHon, R.A. and Waskom, J.D. (1976) *Lunar and Planetary Science Conference Proceedings* ***7th***, 2729-2746. [8] Muller, J.M. and Sjogren W.L. (1968) *Science,* ***161*** (3842) 680-684). [9] Zuber, M.T., et al. (2013) *Science,* ***339*** (6120), 668-671. [10] Janle, P. (1981) *Moon and the Planets,* ***24****,* 441.