GEOLOGY AND STRATIGRAPHY OF MARE TRANQUILLITATIS. David Rajmon[1,2], Arch M Reid[1,2] and Paul Spudis[2]
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Introduction: Mare Tranquillitatis occupies a pre-Nectarian impact basin (center: 7°N, 40°E; 800 km diameter) filled by ejecta from younger basins (Nectaris (oldest), Crisium, Serenitatis, and Imbrium (youngest)), which provide a brecciated, highlands-composition, basement to the lavas[1], multiple basalt flows ranging from about 3.8 b.y. to an (~ 3.4-3.3 b.y) Upper Imbrian age. [1]. Ti-rich Apollo 11 basalts [2], are a potential lunar oxygen resource, through ilmenite reduction by heated hydrogen [3]. Estimating the lava volume in Mare Tranquillitatis determines potential ilmenite reserves and also serves to constrain the thermal history of the Moon [4].

Method: Mosaics of Clementine images were made covering Mare Tranquillitatis, using the 415, 750, and 950 nm filters, and Fe and Ti concentration maps were generated [5]. High Fe contrasts between mare basalt and highland substrate allow identification of craters that have penetrated mare basalt. Excavation depths were estimated from diameters assuming an effective depth/diameter of the excavation cavity of 0.1 [6]. Average Fe concentrations in ejecta can be estimated from the iron map and the true color mosaic. A simple linear mixing model was used, using average highlands and fresh mare basalt as end members, to calculate fractions of excavated basalt and highland substrate. The fractions were fit back into a spherical cavity to estimate the pre-impact thickness of mare basalt for each crater (Table 1).

Results: The maria are relatively shallow (Table 1), in agreement with estimates from photogeology [7] and regolith petrology [8]. The area of Mare Tranquillitatis [1] is 31,000 ± 1,000 km^2 . The mean lava thickness (~ 400 m), determined for widely distributed craters, gives a total lava volume of ~12.4 ± 0.5 km^3. If all this is high-Ti basalt (modal ilmenite 15-20% [2]), the total ilmenite reserve of Mare Tranquillitatis is ~1.9 km^3.

These are rough estimates. All impact craters that penetrated the basalt layer are located near the basin margin. The morphology of Mare Tranquillitatis suggests that the western and southern part of the basin may be shallower than the eastern portions and thus our results may be an underestimate. The largest error comes from estimates of Fe concentration in ejecta; a 1% change in Fe content changes the estimated basalt thickness by ~ 30 %. This error is included in the Fe map itself plus another 1% error may be associated with our estimates of ejecta Fe content. Applicability of the assumed depth/diameter relation, appropriate for simple craters, remains uncertain for larger craters.

Implications: The lavas of Mare Tranquillitatis are extensive, but thin. Ilmenite reserves are considerable, 1.9 km^3 or over 10 billion metric tonnes. Use of this resource can be facilitated by mining the loose regolith. We are continuing the studies of Tranquillitatis to determine lava stratigraphy, including buried basalt units, and to refine estimates of lava volume and the distribution of lava thicknesses.

Table 1. Estimated basalt thickness at selected craters in Mare Tranquillitatis

Crater	Depth (m)	Mean Fe% in ejecta	Highland %	Basalt thickness (m)
Vitruvius	3,000	16	0.44	711
Ross	2,300	17	0.33	705
Maskelyne	2,300	16	0.44	545
Vitruvius A	1,800	15-16	0.44-0.56	320-426
Cauchy	1,300	16	0.44	308
Fabbro	1,100	17-18	0.22-0.33	337-434
Maraldi M	1,000	16-17	0.33-0.44	237-307
Maskelyne H	800	16-17	0.33-0.44	189-245
Lyell A	700	17	0.33	215
Average thickness of mare basalts (m)				396-433

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