The Near Side Megabasin: topography and crustal thickness. Charles J. Byrne, Image Again**,** 39 Brandywine Way, Middletown, NJ 07748, charles.byrne@verizon.net.

Introduction: The Near Side Megabasin of the Moon was proposed [2, 4, 5] on the basis of comparing the topography of the Moon to a generalized model of an impact basin that was large in respect to its target body [3, 8, 10). Subsequently, consideration of a geophysical model of crustal thickness has resulted in a realization that the Near Side Megabasin has undergone full isostatic compensation. As a result, the estimated vertical dimensions of the initial apparent basin and its ejecta have been increased by a factor of 6.0 [4, 5, 7]. This brings the topographic and crustal thickness evidence in agreement with the proposed model of the Near Side Megabasin. The South Pole-Aitken Basin has also undergone isostatic compensation.

Current Topography: The current topography of the Moon is shown in Figure 1. A model [1, 2, 4, 8] of the current topography is shown in Figure 2.

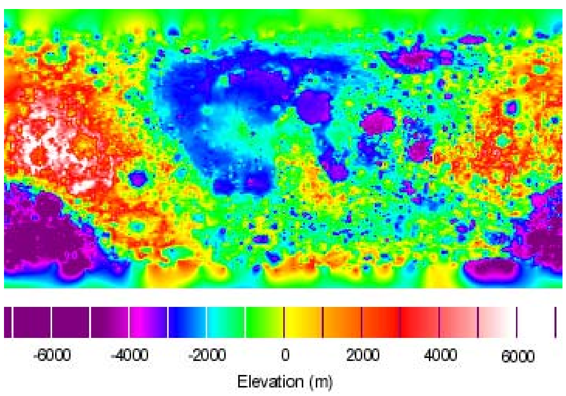

Figure 1: Digital elevation map (geographic coordinates), based on Clementine LIDAR data [12, 13].

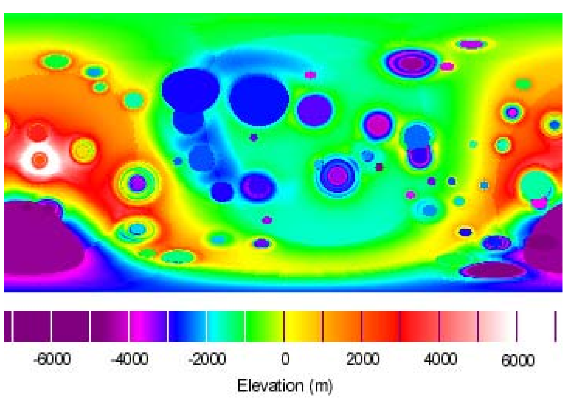

Figure 2: Model of the current topography of the Moon. Models [2, 4, 5, 8] of the proposed Near Side Megabasin, the South Pole-Aitken Basin, and 50 smaller basins and large craters, combined by superposition.

The large scale shape of the Moon is dominated by the bowl of the Near Side Megabasin, the smaller bowl of the South Pole-Aitken Basin, and a mound on the far side.

It is proposed that the current large-scale topography is the result of the two megabasins, the Near Side Megabasin and the South Pole Megabasin, having undergone isostatic compensation since their initial post-impact cofiguration. Both megabasins have flat floors similar to the maria flooding smaller basins. However, remote sensing establishes that these floors are formed of crustal material, possibly melted by the energy of impact [9].

The parameters of the two megabasins are shown in Tables 1 and 2 [2, 4, 5].

Table 1: Parameters of the Near Side Megabasin

Latitude	8.5° N	Longitude	22° E
Major axis r.	3320 km	Minor axis r.	3013 km
Eccentricity	0.42	Orientation	53° W of N
Current depth	3.5 km	Initial depth	21.0 km
Launch angle	50° from hor.		

Table 2: Parameters of the South Pole-Aitken Basin

Latitude	54.2° S[6]	Longitude	168.7° W[6]
Major axis r.	1440 km	Minor axis r.	1042 km
Eccentricity	0.69[6]	Orientation[6]	7.5° W of N[6]
Current depth	6.8 km	Initial depth	40.8 km
Launch angle	42° from hor.		

Crustal Thickness: The gravity field of the Moon is determined by tracking the orbits of spacecraft. Variations in topography or density cause corresponding variations in the gravity field. Indeed, such variations are found over relatively recent basins and mare flows within them (the mascons, for example).

However, the large-scale variations in the gravity field are much smaller than the topography would indicate. This has led geophysicists [11, 12] to infer that the thickness of the crust has varied to compensate for the topography: high elevations correspond to thicker crust.

The ratio between variations in elevations and crustal thickness depends on the assumed densities of crust and mantle and possible variations in density within those layers. The assumed density profiles are subject to many constraints. A recent study has chosen uniform densities of the mantle (3.361g/cm^3) and crust (2.8 g/cm^3) [7], modified by a small high-density core and infusions of high-density mare material. The resulting model of crustal thickness has three components: an average thickness, variations corresponding to the large-scale topography, and small-scale variations due to partial isotopic compensation of the later impacts and mare formations.

The density assumptions [7] establish a ratio of 6.0 between crustal thickness variations and topography, for full Airy isostatic compensation.

The average thickness would correspond to that of the pristine crust, if it were not for crustal material ejected into escape velocities by impacts, dominated by the escaped ejecta from the two megabasins.

A simple method of estimating the thickness of the pristine crust is to note that the crust in the region outside of the cavities of the two megabasins consists of three layers: the pristine crust and the ejecta from each of the two megabasins. Very little mare material is in this region. Therefore, by matching the impact models to the crustal thickness model there, the thickness of the pristine crust can be estimated.

Figure 3 shows the estimate of current topography that is obtained by assuming a pristine crustal thickness of 47 km and reducing the variations of the crustal thickness model by a factor of 6.0.

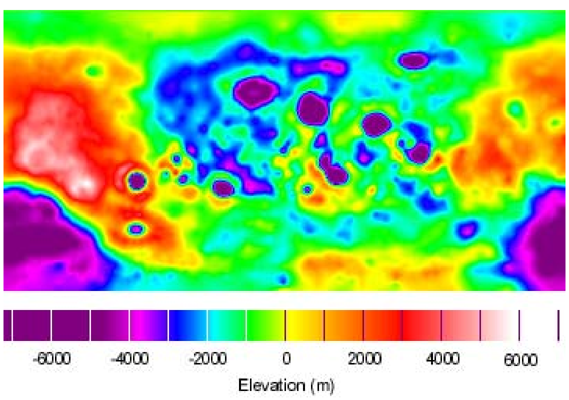

Figure 3: An estimate of large-scale current topography derived from a crustal thickness model [7].

Comparing Figures 1, 2, and 3 clearly shows a high degree of agreement among current topography, impact models, and the topography implied by the crustal thickness model.

A check on the estimated thickness of the pristine crust can be made by considering the volumes ejected to escape by the two megabasins. The current average thickness of the crust is related to the thickness of the pristine crust by:

$$(p-t) \cdot (4 \cdot \pi \cdot R_m^2) = V_e$$

where p is the thickness of the pristine crust (assumed to be uniform), t is the average thickness of the current crust, and V_e is the volume of the escaped material. R_m is the radius of the Moon.

The model [7] has an average crustal thickness of 43 km, 4 km less than the 47 km estimated thickness of the pristine crust, so the volume of escaped material is $152 \cdot 10^6$ km^3.

The escaped volumes of the megabasin models [4] are $130 \cdot 10^6$ km^3 (Near Side Megabasin) and $25 \cdot 10^6$ km^3 (South Pole-Aitken Basin) for a total of $155 \cdot 10^6$ km^3, in reasonable agreement with the $152 \cdot 10^6$ km^3 derived above.

Conclusions: Accounting for isostatic compensation implies that the initial vertical parameters of the two megabasins (depth of their cavity and depth of their ejecta fields) were a factor of 6.0 greater than the values for the current topology.

The thickness of the pristine crust had been approximately uniform before the impacts that formed the two megabasins, and was about 4 km greater than the current average crust, which is estimated to be 43 km [7]. This much crust was lost by being ejected from the two megabasins at greater than escape velocity.

A single-layer model of the crust is adequate to explain the data for the region outside of the cavities of the two megabasins. There, the primitive crust is overlain by crustal ejecta. Further evidence may lead to vertical variation such as greater porosity in the upper layers. Within the cavities of the giant basins, there is evidence for both vertical and lateral variation in the crust.

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References:

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