The Near Side Megabasin of the Moon. Charles J. Byrne, Image Again, 39 Brandywine Way, Middletown, NJ 07748, charles.byrne@verizon.net.

Introduction: A very old, very large basin has been found to underlie the region of large maria on the near side of the Moon. The strong differences between the near and far sides of the Moon have led to searches for such a basin in the past [1], [2], [3]. The Topogrd1 elevation database [4] from the Clementine mission was used to locate the basin. Its central depression covers more than half the Moon, including nearly all of the near side. The ejecta of this basin forms the highlands of the far side. The center of this feature is at 7 degrees North latitude and 21 degrees East longitude, with a radius of 3050 km (101 degrees of arc). A model of this Near Side Megabasin and its ejecta field, together with a model of the South Pole – Aitken Basin, account for over half of the standard deviation of the topography of the entire. Moon.

Ejecta of large basins: The ejecta of basins of moderate size such as Orientale can be approximated as if they impacted a flat Moon: curvature of the spherical Moon can be neglected for the rounded rim and for the ejecta blanket within about twice the basin radius. A correction can be made for the far field ejecta by assuming it was all launched from a single radius within the basin. However, for basins of the size of the South Pole – Aitken Basin or more it is important to consider the trajectories of ejecta launched from each radius within the basin, considering the profile of velocity as a function of the internal radius. The model should account for ejected material that escapes the Moon, for focussing of the ejecta at the antipode of the basin center, and for ejecta that passes the antipode and forms a second deposited layer. Such a model was constructed, starting with an empirical "flat Moon" model derived from examination of selected basins, using Clementine elevation data [5]. This model is based on Topogrd2, the quarter-degree model [4] from Clementine.

Velocity profile: A velocity profile was estimated from the "flat Moon" model. The ejecta profile depends on the radial ejection profiles of volume per angle of azimuth, the launch angle, and the launch velocity [7]. The volume rate and launch angle were assumed to be constant and the velocity profile was adjusted to produce the ejecta profile of the "flat Mooon" model (see Figure 1).

Orbital and spherical effects: The equations of motion of the ejecta thrown into orbit were used to determine the external radius as a function of the internal radius of launch. The depth of the deposit was determined by dividing the incremental volume of the launched material by the derivative of the external radius as a function of the radius of ejection (to account for the spreading out of ejecta). The spherical shape of the Moon was further taken into account by multiplying the depth by the ratio of the ejection radius to the radius of the circle of deposition (a function of the arc distance from the center of the basin).

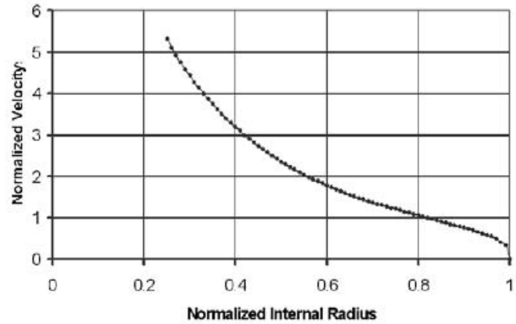

Figure 1: Velocity profile that produces the typical depth profile of basin ejecta [5. To find the velocity for a particular basin, multiply the normalized velocity by the square root of the radius of the basin.

Radial profiles of the Near Side Megabasin: The depth profile for the Near Side is shown in Figure 2, along with the measured profile from Topogrd1. There are several points of interest in these profiles.

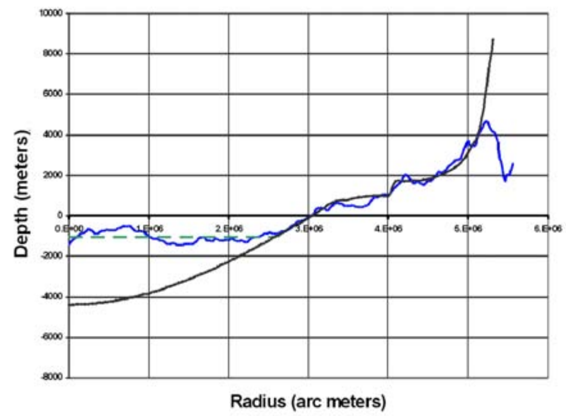

Figure 2: The radial profile of the model of the Near Side Megabasin is shown along with the measured profile. The profiles run from the center of the basin to the antipode.

The model of the Near Side Megabasin includes a level of mare fill that is appropriate to the measured data. Some of this fill may have occurred before the formation of later basins, but of course the flooding was completed later. The antipode deposit is obscured by the Korolev Basin. Considerable ejecta from the Near Side Megabasin has landed beyond the antipode and formed a second layer of deposit overlying the first. A circular scarp is formed at the end of this deposit where the launch velocity comes to exceed the escape velocity. The angle of launch is important in establishing the radius of this scarp, and is found to be 50 degrees from the horizontal in order to match the measured profile.

The estimated depth at the center of the Near Side Megabasin immediately after impact was assigned so that the slope of the edge of the basin matches the "flat Moon" model and the depth of the ejecta profile matches the measured depth.

The topography of the Moon: A very strong test of the models of the two large basins is to examine how they have influenced the topography of the entire Moon.

A false color display of the Moon's current elevation as it is today is shown in Figure 3. Note that the large scale features are the area of maria on the near side, a band of high elevation on the far side, and the obvious South Pole – Aitken Basin. Also shown in Figure 3 are the boundaries of the South Pole – Aitken Basin and the Near Side Megabasin. These two boundaries outline the large-scale structures of the topography.

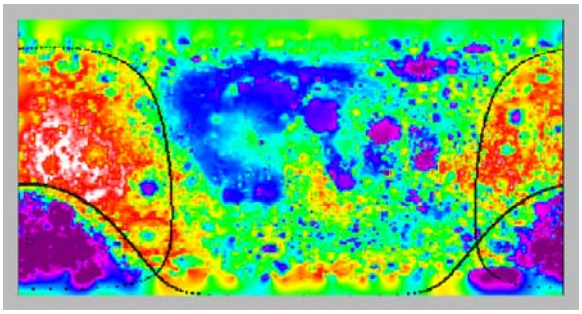

Figure 3: Elevation Mercator map of the Moon from Topogrd1: the equatorial near side is in the center. White is high, purple is low, with the spectral colors in between. The black outlines are the boundaries of the central depressions of the South Pole - Aitken Basin and the Near Side Megabasin. These boundaries are circles, distorted by the Mercator projection. The depression of the Near Side Megabasin covers the central part of the map and includes both poles. Its ejecta produces the far side highlands.

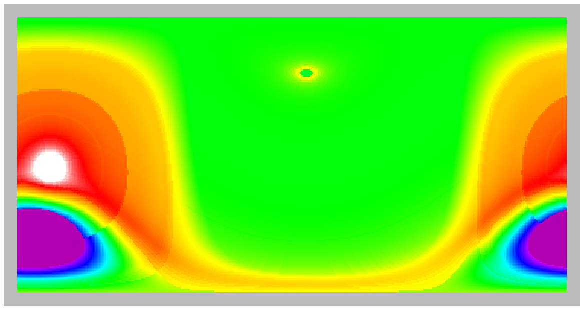

Figure 4: The models of the Near Side Megabasin and the South Pole – Aitken Basin are shown to the same scale as Figure 3. The Near Side Megabasin is shown filled with mare material, at today's average level.

The Near Side Megabasin, which probably came first, has carved out the area that has become the region of maria on the near side. The ejecta formed a circular plateau on the far side surrounding what is now the Korolev Basin. The antipode peak either formed the Korolev Basin or, was subsequently obliterated by the Korolev impact.

South Pole – Aitken Basin: The South Pole – Aitken Basin came later and carved a large notch in the far side plateau, adding its rim to the top of the plateau. Its antipode deposit was later submerged by Mare Frigoris. The center of this basin is at 54 South latitude and 171 West longitude, with a radius of 1100 km.

Quantitative results: The standard deviation of the elevation data of Topogrd1 is 2661 meters. After subtracting the models from Topogrd1 the standard deviation of the residual, which includes the topography of all subsequent events as well as inaccuracies in the models, is 1260 meters. This result confirms the reality of the Near Side Megabasin and the validity of both models. Figure 5 displays the residual small scale topography. The remaining features are largely recognizable as familiar maria, basins, and craters.

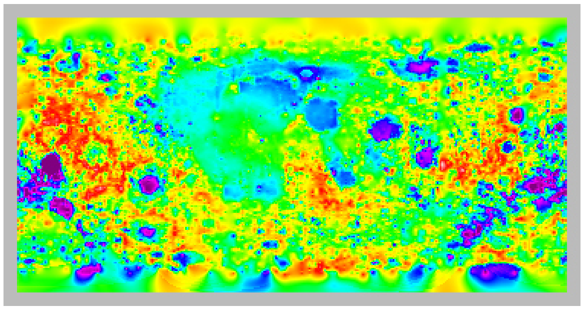

Figure 5: This map shows the residual topography after the models of the two large basins are subtracted from the topography shown in Figure 3. The familiar named features of the Moon can be easily identified.

Potential improvements in the models: Each of the two large basins is slightly elliptical. The South Pole – Aitken Basin has its long axis in the North - South direction [6] while the Near Side Megabasin has its long axis in the East-West direction. Introduction of an elliptical model would reduce the residual standard deviation.. Estimates of the thickness of crust [8] should be examined for correlation with the Near Side Megabasin.

References: [1] Cadogan, P.H., 1974, Oldest and Largest Lunar Basin? Nature, v. 250, No. 5464. [2] Whitaker, E.A. 1981, The Lunar Procellarum Basin, Multi-Ring Basins, LPSCP 12, Pt. A. [3] Byrne, C.J., 2005, Size Distribution of Lunar Basins, LPSC 2006, Abstract 1200. [4] Zuber, M.T., et al., 2004, Topogrd1 and Topogrd2, web site of the University of Washington at St. Louis, http://wufs.wustl.edu/geodata/clem1-gravity-topo-vl/. [5] Byrne, C. J., 2006, Radial Profiles of Lunar Basins, submitted to LPSC 2006. [6] Garrick-Bethell, I, Ellipses of the South Pole – Aitken Basin, LPSC 2004, Abstract 1515. [7] Housen, K.R. et al., 1983, Crater Ejecta Scaling Laws, JGR, 88. [8] Neumann, G.A. et al., 1996, The Lunar Crust, JGR 101.