SIZE DISTRIBUTION OF LUNAR BASINS. Charles J. Byrne, Image Again, 39 Brandywine Way, Middletown, NJ 07748, charles.byrne@verizon.net.

Introduction: Even a cursory examination of the near side and far side of the Moon reveals an obvious difference; dark mare material has flooded the large basins on the near side, particularly north of 35 degrees South latitude. This has been found to be due to the crust being thinner there. However, a more careful examination of multi-ringed basins reveals a difference in the relative sizes of near side and far side basins (measured by their main rings). This paper looks beyond the flooding by mare material to examine the distribution of basins by size and position. A list of 45 multi-ringed basins, with estimates of the location of their centers and the diameter of their rings, was given by Spudis in [1]. The list is similar to that of Wilhelms [2]. Although these data could be reviewed in the light of the altimetry and remote sensing measurements of the Clementine and Lunar Prospector spacecraft missions, this list, published before those missions, is used as the source data for this paper. The estimate of the diameter of the main ring of each basin is taken as the measure of its size. The mean main ring diameter of the basins is 581 km, with a standard deviation of 371 km.

Basin size and arc distance from center: As a first step in the analysis of the distribution of basins, the arc distances of their centers from the center of the Moon as we see it (0 degrees latitude and 0 degrees longitude) were examined (see Figure 1). The basins that are less than 95 degrees from the center of the Moon are systematically larger than the basins between 95 and 180 degrees, with the exception of the South Pole – Aiken basin, which is much larger than any other basin.

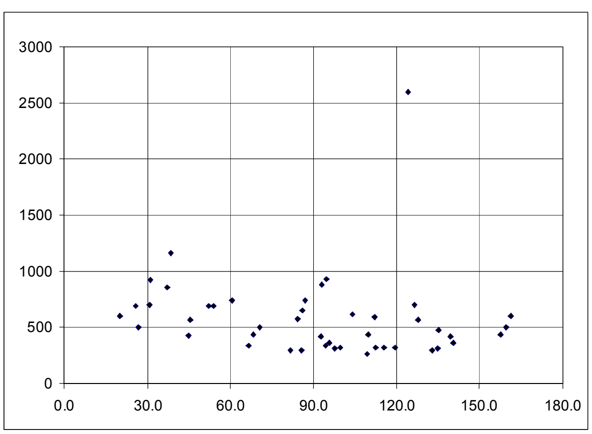

Figure 1: Basin main ring diameters (km) are plotted against the arc distance of the basin centers from the center of the near side of the Moon.

The South Pole – Aiken Basin, an enormous far side basin, is exceptional. It not only is extremely large (its deviation from the mean is 5.4 times the standard deviation of all basins in the list) but also appears older than the other basins because of the degradation of its rings [2]. For these reasons, the impactor of the South Pole – Aiken Basin is not likely to be from the same population as those of the other basins: accordingly, this basin is excluded from the following statistical analysis.

Histograms of basin sizes: The next step in the examination of basin distributions is to compare histograms of the diameters of near side basins with those of far side basins.

Figure 2 shows important differences in these histograms. Far side basins show a distribution of exponentially falling frequency with diameter (as is typical of crater size distributions) but near side basins show a complex distribution with two peaks. The distribution of smaller near side basins is similar to that of that of far side basns, while larger near side basins have a similarly shaped distribution, but displaced. The 650 km peak diameter of the larger near side basins is about 1.8 times the 350 km peak diameter of both far side and smaller near side basins.

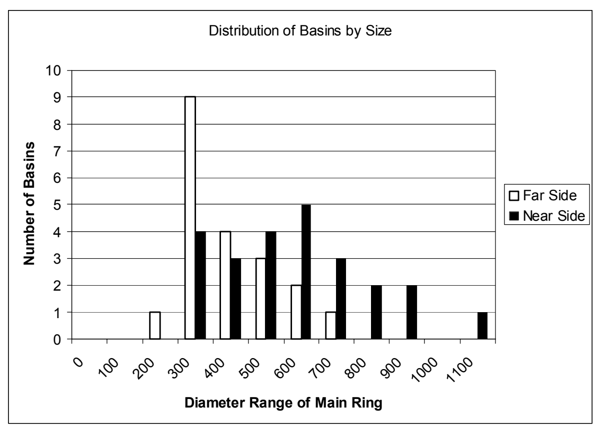

Figure 2: Histogram of numbers of basins of the near and far sides with main ring diameters in 100 km ranges.

Location of large and small basins: When the locations of the centers of all basins are plotted (Figure 3), the smaller near side basins, those whose main ring diameters are less than 500 km, are found to form a distiinct cluster to the southwest of the center of the Moon. The larger near side basins (those with diameters of 500 km or more) occur in a compact area, with the Orientale Basin the only exception.

Summary and discussion: Multi-ringed basins appear to be distributed in two groups. Large basins, those with main ring diameters of 500 km or more, are in an area of the near side within 95 degrees of the center of the Moon, excluding a region to the south-west. The only exxceptions are the South Pole – Aiken Basin, the oldest of basin, and the Orientale Basin, the youngest basin.

How could this separation have come about? Three possible explanations come to mind:

1. The impactors that formed these basins could have come from two distributions, with the ones striking the near side area being systematically larger
2. The impactors could have come from the same size distribution, but struck the near side with greater kinetic energy.
3. The crust and mantle characteristics of the near side area of larger basins could be different from those of the rest of the Moon.

It is difficult to see how the first possible explanation could occur, unless the large impactors struck essentially simultaneously. Yet sample returns establish age differences for large basins that are in a range of 100 milllion years. The Moon would have been struck in many different areas over such a range.

The second explanation could have come about if the Moon were in a highly elliptical orbit. A swarm of Earth-crossing impactors could have been accelerated by Earth's gravity, so that the near side of the Moon, facing Earth at perigee, could have been struck with more energetic impactors. However, it is unlikely that such a highly elliptical orbit could have been maintained over the interval between the estimated time of the Moon's impact with Earth and the time (established by analysis of rock samples) of the fomation of large basins [3].

That leaves the third explanation. The thinner near side crust alone would not explain the formation of larger basins: the mantle is denser than the crust and would presumably resist excavation of a large transient crater. However, if the near side area were a fully or partially molten magma, the hypervelocity energy released by an impactor would not have to contribute the heat of fusion and so would distribute its energy over a larger volume. Initially, the temperature of the wave front would be above the vaporization temperature, but then it would fall below that point and simply raise the temperature of the melt (and also impart kinetic energy).

References: [1] Spudis, Paul D. (1993*), The Geology of Multi-Ring Impact Basins*, CUP. [2] Wilhelms, Don E. et al., The Geologic History of the Moon, USGS Prof. Paper 1348, US Gov. Printing Office. [3] Melosh, H. J. , November 2004, personal communication.

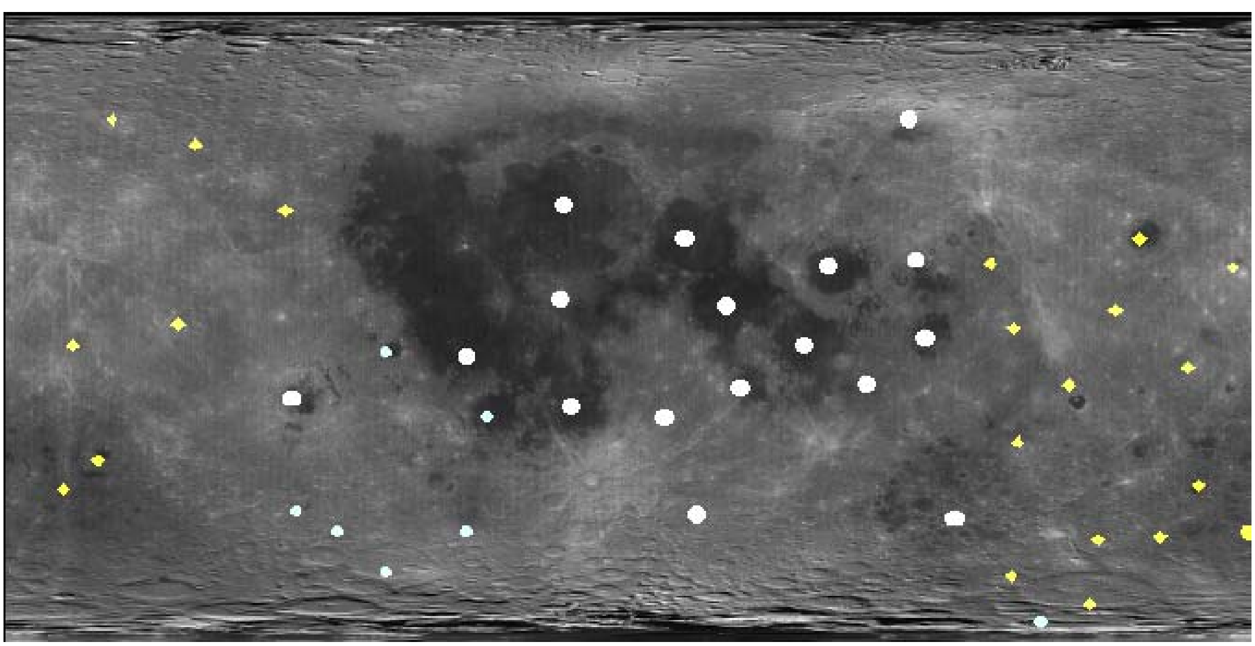

Figure 3: Centers of far side basins (yellow), larger near side basins (white), and smaller near side basins (light blue). The Mercator base map was constructed by NRL from Clementine albedo data.