CRATER-COUNTING EVIDENCE AGAINST THE LATE HEAVY BOMBARDMENT HYPOTHESIS.

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Terrestrial life probably originated 3.8 or 4 billion years ago, after a 0.6 to 0.8 Gyr long period of impact frustration [1,2]. The day was much shorter, the Moon was much closer and tides were much higher. The surface of the Moon is old enough and well-preserved enough to serve as a bombardometer, i.e., the oldest part of the cratering record on the Moon is a measure of the impacts that were frustrating life ~ 4 billion years ago. If we are to understand the environment in which life arose on Earth, we need to be able to read the oldest part of the cratering record on the Moon. The nearside equatorial basins of the Moon have been approximately dated by rocks returned during the Apollo era. Their ages cluster around ~3.85 Gya. This clustering has produced the idea of a Late Heavy Bombardment (LHB) from ~3.75 to ~ 3.95 Gya [4,5]. Whether or not such a spike in the bombardment rate occurred during this interval has been a contentious issue for more than 20 years.

We review the arguments for and against a Late Heavy Bombardment of the Moon in the interval from ~3.75 to 3.95 Gya and present an analysis of the largest and earliest lunar impacts [3]. Our preliminary analysis of the ages (given current uncertainties) and cumulative impact diameter of lunar basins does not support the LHB. Our analysis does not indicate a pronounced spike in the bombardment rate at 3.85 +/- 0.1 Ga. Corrections to our analysis to compensate for (i) saturation effects in the oldest craters, (ii) the inclusion of an estimated ~14 pre-Al Khwarizmi/King obliterated basins to the analysis and (iii) an iterative approach to determining the impact rate, all support the idea that the highest lunar impact rate pre-dates the LHB date of 3.85 +/- 0.1 Ga. The decrease in the number of lunar meteorites with ages older than ~4 Ga is probably best explained as a selection effect of lunar meteorites (and glass spherules) sampling the current surface of the Moon, not sampling the largely buried, older than 4 Ga surface. The evidence for a pre-South-Pole-Aitken or pre-4 Ga heavy bombardment has probably been buried by its own, and subsequent impact blankets.

Our analysis does not support the LHB hypothesis as articulated by Ryder [4,5], nor do we find the data from impact breccias, glass spherules or lunar meteorites supportive of the LHB. We highlight the importance of dating South Pole Aitken and the other earliest impact basins to convert a relative basin chronology into an absolute chronology of the impact history of the Moon and Earth.

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