Megaregolith Evolution and Cratering Cataclysm Models
(Lunar Cataclysm: A Misconception? 27 Years Later)

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Accepted by *Meteoritics & Planetary Science*

Abstract: The hypothesis of a lunar cataclysmic cratering episode between 3.8 and 3.9 Gy ago lacks proof. Its strongest form proposes no cratering before about 4.0 Gy, followed by catastrophic formation of most lunar craters and basins in < 200 My. The premise that "zero impact melts implies zero impacts" is disproved by asteroid data, where early collisions clearly occurred but early impact melts are scarce. Plausible cataclysm models imply that any cataclysm should have affected the whole inner solar system, but available lunar and asteroid impact melt and impact age resetting data (Apollo/Luna samples and lunar meteorites) show a narrow, strong 3.8-3.9 Gy spike in ages only in the region sampled by Apollo/Luna. Reported lunar meteorite data do not show the peak. Asteroid data show a broader, milder peak, spreading from about 4.2 to 3.5 Gy. These data suggest either that the spike in Apollo impact melt ages is associated with unique lunar front side events, or that the lunar meteorites data represent different kinds of events than the Apollo/Luna data. Here we develop an alternate "megaregolith evolution" hypothesis to explain these data. In this hypothesis, early impact melts are absent not because there were no impacts, but because they were destroyed by high early impact rates. The model estimates survival halflives of lunar impact melts prior to 4.1 Gy at < 100 My, but after a certain time $T_{critical}$, ~ 4.0 Gy, they lengthened and impact melts began to survive to the present. The age distribution differences among impact melts and plutonic rocks are controlled by, and hold clues to, the history of regolith evolution and the relative typical depths of sample sequestration of impact melts vs. plutonic rocks, both among lunar and asteroidal samples. Both the "zero cratering, then cataclysm" hypothesis and the "megaregolith evolution" hypothesis require further testing, especially with lunar meteorite impact melt studies.