AN INQUIRY ABOUT EVIDENCE FOR THE LATE HEAVY BOMBARDMENT. C.R. Chapman[1], B.A. Cohen[2], and D.H. Grinspoon[1]. [1]SwRI., #426, 1050 Walnut St., Boulder CO 80302, cchapman@boulder.swri.edu; [2]Hawaii Inst. of Geophys. and Planetology, Univ. of Hawaii at Manoa, Honolulu HI 96822.

Introduction: Tera et al. [1] first proposed a "terminal cataclysm" or Late Heavy Bombardment (LHB) based on an apparent spike in lunar rock resetting ages; the LHB has more recently been advocated on the basis of a spike in ages of lunar impact melts, or at least an absence of secure impact melt ages prior to 4 Ga [2-5]. Dates for lunar impact basins [6] from Nectaris (3.90-3.92 Ga) to Orientale (3.82 Ga) define an especially abrupt post-spike decline or cessation of bombardment by large projectiles (half-life ~50 Myr).

The last few years have seen remarkable developments in dynamical modelling of small solar system bodies, which have resulted in several scenarios [7-9] that might explain the LHB. In order to define the relevant dynamical parameters (e.g. rise-times and decay-times of the spikes) that might distinguish between proposed impactor populations (e.g. outer solar system planetesimals, Jupiter Trojans, main-belt asteroids, remnant planetesimal populations from the terrestrial planets, circum-terrestrial remnants of the Moon's formation) and the dynamical processes that caused a spike in terrestrial bombardment rates (e.g. formation of Uranus/Neptune, ejection of a fifth terrestrial planet, collisional break-up of a large asteroid), it is prudent to revisit the original analyses that have defined the LHB.

Discussion: It has been presumed, and supported by equivocal data or models, that the lunar LHB is also expressed in the cratering records of Mercury, Mars, and even the Galilean satellites, as well as in resetting ages of some OC and HED meteorites and one Martian meteorite (ALH84001). Most of these presumptions are plausible but not robust. For example, histograms of meteorite resetting ages differ sharply from those for lunar rocks.

Questions remain about the basis for a lunar LHB. The sharp cessation of basin formation depends on best-guess associations of lunar samples with often distant basins, whose relative stratigraphy is fairly well-established but whose associations with the rocks typically depend on geological models from the 1960s/70s -- when the missions were planned and the returned samples were under analysis -- which demand reinterpretation from a modern perspective.

Histograms of impact melt crystallization ages (including melt clasts from lunar meteorites) and of inferred resetting ages, are not in accord with each other or with the inferred sharp end of basin-bombardment. We are inclined to regard these discrepancies not as disproving that a cataclysm happened but rather as being the result of non-uniform sampling. Issues of collection biases need to be evaluated, but we suspect a prime sampling bias may be due to megaregolith development processes, which may preferentially hide, destroy, or reset older reset samples and exaggerate effects of the most recent basins (e.g. Imbrium [10]) and which certainly must differ between the Moon and smaller asteroids. An apparent total absence of early (pre-Nectarian) melts has been taken as potent evidence for a cataclysm, which greatly augmented the average impact rate between crustal solidification and the formation of Nectaris; this inference needs to be tested statistically in the light of physically realistic models for basin formation and megaregolith evolution.

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