

**LHB WAS CAUSED BY MARS-CROSSERS, AND IT WAS NOT ALL THAT HEAVY.** Matija Čuk<sup>1,2</sup>, <sup>1</sup>SETI Institute, Carl Sagan Center, 189 N Bernardo Ave, Mountain View, CA 94043, <sup>2</sup>Harvard University, Department of Earth and Planetary Sciences, 20 Oxford St, Cambridge, MA 02138.

**Abstract:** The Moon has suffered intense impact bombardment ending at 3.85 Gyr ago, and this bombardment probably affected all of the inner Solar System. Basin magnetization signatures and lunar crater size-distributions indicate that the last episode of bombardment at about 3.85 Gyr ago was less extensive than previously thought. We explore the contribution of the primordial Mars-crosser population to early lunar bombardment. We find that Mars-crosser population initially decays with a 80-Myr half-life, with the long tail of survivors clustering on temporarily non-Mars-crossing orbits between 1.8 and 2 AU. These survivors decay with half-life of about 600 Myr and are progenitors of the extant Hungaria asteroid group in the same region. We estimate the primordial Mars-crosser population contained about 0.01-0.02 Earth masses. Such initial population is consistent with no lunar basins forming after 3.8 Gya and the amount of mass in the Hungaria group. As they survive longer and in greater numbers than other primordial populations, Mars-crossers are the best candidate for forming the majority of lunar craters and basins, including most of the Nectarian system. However, this remnant population cannot produce Imbrium and Orientale basins, which formed too late and are too large to be part of a smooth bombardment. We propose that the Imbrian basins and craters formed in a discrete event, consistent with the basin magnetization signatures and crater size-distributions. This late "impactor shower" would be triggered by a collisional disruption of a Vesta-sized body from this primordial Mars-crossing population [1] that was still comparable to the present-day asteroid belt a 3.9 Gya. This tidal disruption lead to a short-lived spike in bombardment by non-chondritic impactors with a non-asteroidal size-frequency distribution, in agreement with available evidence. This body ("Wetherill's object") also uniquely matches the constraints for the parent body of mesosiderite meteorites. We propose that the present-day sources of mesosiderites are multi-km-sized asteroids residing in the Hungaria group, that have been implanted there soon after the original disruption of their parent 3.9 Gyr ago.

**References:** [1] Wetherill G. W. (1975) *LPSC Proceedings*, 6, 1539–1561.

**Further information:** The preprint of the detailed paper (under review for *Icarus*) can be found at:  
[www.fas.harvard.edu/~cuk/papers/chronology.pdf](http://www.fas.harvard.edu/~cuk/papers/chronology.pdf)