

NEW MEASUREMENT OF MARTIAN IMPACT CRATER PRODUCTION FUNCTION SIZE DISTRIBUTION. W. K. Hartmann, Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719; hartmann@psi.edu .

Several authors have raised questions about the accuracy with which the Martian impact crater size-frequency distribution (SFD) is known or understood, especially at small diameters (D). Plescia [1] questioned whether observed SFDs fit proposed production function SFDs. McEwen et al. [2] and McEwen and Bierhaus [3] suggested observed SFD's are hopelessly confused by the presence of secondaries. I addressed some of these concerns in 2005 [4].

To address these issues further, I conducted new crater counts on a test area in east Amazonis Planitia (around 30°N, 100°W), suggested by Ken Tanaka and colleagues (private communication) as ideal for measuring the production function SFD. The area shows overlapping late Amazonian lava flows (Fig. 1). Careful counts were made on several adjacent MGS MOC, Odyssey THEMIS, Mars Express HRSC, and Viking mosaic images of various resolutions, giving SFD data over 3 orders of magnitude, $16 \text{ m} < D < 16,000 \text{ m}$. As seen in Fig. 2a, an exceptionally good fit is found to the isochron shape from 16 m to 1.4 km in my most recent, "2004" iteration of the isochron system [4]. (This is also, essentially, the Martian production SFD inferred by Neukum and Ivanov at $D < 500 \text{ m}$, which I grafted onto my independent estimate of the Martian SFD at larger D, derived from my lunar crater measurements.) The average crater retention age model age, inferred from the "2004" iteration, is roughly 100 Ma, interpreted as the approximate formation age of lavas in this region.

Plescia [1] is correct in noting that larger craters often don't fit same isochrons as younger ones, giving older ages, as I have also previously noted [4, 5]. Plescia portrayed this as a failure of the isochron system, but the explanation suggests valuable geologic information. The 12.5 m/pixel HRSC images reveal numerous examples where multi-kilometer craters were formed on now-buried surfaces, and their rims "stick up through" the younger flows. Thus, they give older ages when counted uncritically on low-res images, as seen in Fig. 2b.

I conclude that the production function SFD shape for Mars (by which I refer to primaries plus scattered distant secondaries) is better determined than implied in recent critiques [1-3]. Thus, the crater-count chronologic system, as adopted by various authors [6, 7] is on better footing than has been implied. Late Amazonian formations include ages of a few hundred

million years and less. In spite of various critiques, no alternative Martian timescale has yet been suggested.

References: [1] Plescia J. B. (2005) Lunar Planet Sci. Conf. XXXVI, Abstr. 2171. [2] McEwen A. S. et al. (2005) *Icarus*, 176, 351-381. [3] McEwen A. S., Bierhaus E. B. (2006) *Ann. Rev. Earth Planet. Sci.*, 34, 535-567. [4] Hartmann W. K. (2005) *Icarus*, 174, 294-320. [5] Hartmann W. K., Neukum, G. (2001) In *Chronology and Evolution of Mars* (Kallenbach R., Geiss J., Hartmann W. K., Eds.) U. Ariz. Press, Tucson, pp. 165-196; also *Space Sci. Rev.*, 96, 165-194. [6] Werner S. C. (2005) Berlin: Freie Universität Berlin; Göttingen: Cuvillier Verlag. [7] Quantin C., Allemand P., Mangold N., Delacourt C. (2004) *Icarus*, 172, 552-572.



Figure 1. Mars Express HRSC image at 12.5 m/pixel shows a 1.4 km crater where lavas have overlapped most of ejecta blanket from W, flowing around the crater without breaching the rim. An older flow on E side appears to have done the same thing. The crater thus formed on an older, now-buried surface. Nearby HRSC examples explain why sharp-rimmed craters at $D > 1.4 \text{ km}$ show older ages than isochron for smaller craters on top of the last flow. (HRSC 2987, courtesy Mars Express project, G. Neukum, S. Werner.)

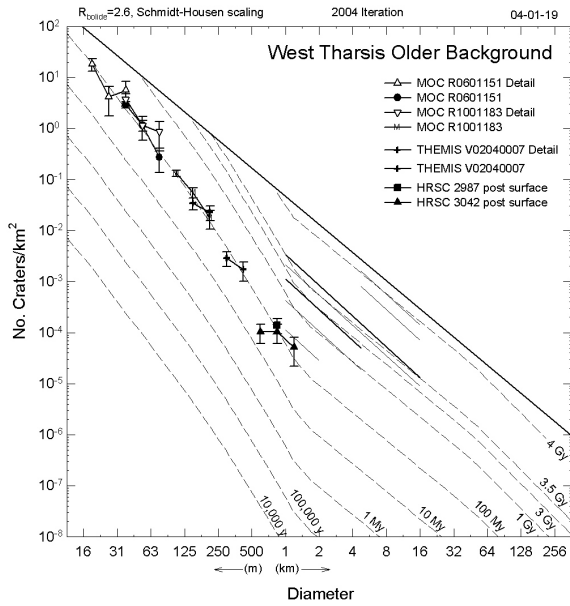


Figure 2a. Size frequency distribution (SFD) of craters superposed on sparsely cratered late Amazonian flows in eastern Amazonia Planitia. At $D = 16\text{-}707$ m, crater counts give an excellent fit to the isochron shape proposed in my latest “2004” isochron iteration [4]. Model age for these lavas is close to 100 Ma (bins with two craters).

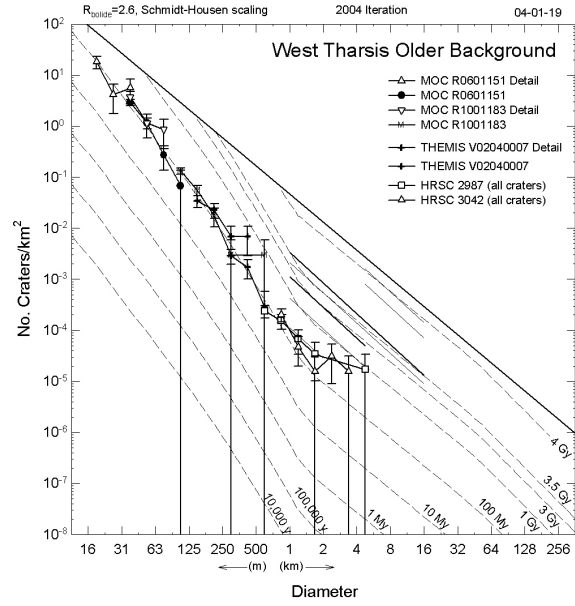


Figure 2b. When craters similar to Fig. 1 are counted on HRSC and Viking photos (open symbols at $D > 1.4$ km), the counts pick up an older population of larger craters formed on older, now-buried surfaces. (This includes bins with one crater.) Viking counts (not available at deadline time) exited curve along 1403 Gy isochron to $D = 16$ m.