WHAT REALLY HAPPENED TO EARTH'S OLDER CRATERS? W. F. Bottke1, S. Mazrouei2, R. R. Ghent1,2, A. H. Parker1, T. M. Gernon3. 1Southwest Research Institute and NASA’s SSERVI-ISET Team, Boulder, CO (bottke@boulder.swri.edu) 2Dept. Earth Sciences, University of Toronto, Toronto, ON, Canada. 3Planetary Science Institute, Tucson, AZ. 4Ocean and Earth Science, University of Southampton, Southampton, UK.

Summary. The crater records of Earth and the Moon are surprisingly similar. Both show big increases in impacts starting ~250 Ma. Terrestrial craters older than 650 Ma were erased by “Snowball Earth.”

Introduction. Most assume the Earth’s crater record is heavily biased, with erosion/tectonics preferentially destroying older craters. This matches expectations, but is it true? To test this idea, we compared Earth’s crater record, where nearly all \( D \geq 20 \) km craters formed < 650 Ma [1], to the Moon’s, where we applied a new method to date all \( D \geq 10 \) km lunar craters younger than 1 Ga [2].

Our lunar crater ages were computed using LRO-Diviner temperature data [2]. Large lunar rocks have high thermal inertia and remain warm through the night relative to the regolith. Analysis shows young craters with numerous meter-sized fragments are easy to pick out from older craters with eroded fragments. Moreover, an inverse relationship between rock abundance and crater age exists, as measured from craters with known ages (e.g., Tycho, Copernicus). Using this rock abundance-age function, we computed ages for 111 rocky craters with \( D \geq 10 \) km that formed between 80°N and 80°S over the last 1 Gyr (Fig. 1).

Earth/Moon Results. The age distribution of lunar and terrestrial craters is shown in Fig. 2 (see also Figs. 1 & 3). Our analysis yielded several surprising results.

1. The production rate of \( D \geq 10 \) km lunar craters increased by a factor of 2.2 [-0.9, +4.4; 95% confidence limits] over the past 250 Myr compared to the previous 750 Myr.

2. Both age and size distributions of \( D \geq 20 \) km lunar and terrestrial craters < 650 Ma have similar shapes (ages shown in Fig. 2). This implies that crater erasure is limited on stable terrestrial terrains; in an average sense, for a given region, the Earth either keeps or loses all of its \( D \geq 20 \) craters at the same rate, independent of size. It also implies the observed deficit of large terrestrial craters between 250-650 Ma in Fig. 2 is not preservation bias but rather reflects a distinctly lower impact flux.

3. Our results suggest the NEO population was considerably lower ~250-1000 Ma. Consequently, Chicxulub-type impacts also occurred less frequently in this interval, with implications for our biosphere.

Where Are Craters Older Than 650 Ma? There is a sharp cut-off of nearly all terrestrial craters at ~650 Ma [1]. Given the low cratonic erosion rates for < 650 Ma [3], our work predicts that similar conditions further back in time would have allowed most Precambrian craters to survive. So, where are all the old craters?

Intriguingly, the paucity of Precambrian craters is coincident with major episodes of globally-extensive Cryogenian glaciation (i.e., Snowball Earth). Pervasive subglacial erosion at ~650–720 Ma is thought to have removed kilometers of material from all continents [4], enough to erase most existing impact craters.