Abstract (#2414)

We make quantitative estimates of the maximum total number of large terrestrial impact craters that might have survived until the current era. Our estimates of crater survival are made using the age of the Earth’s crust and the expected flux of large extraterrestrial bodies striking the Earth. We neglect other effects such as weathering and burial, which tend to preferentially erase smaller craters. Thus, our results represent the maximum number of craters we expect to persist. We find that, over the past 3.5 Gyr, at least 49±7 craters larger than 85 km in diameter should have formed, but only 8±3 could have survived until today. This suggests that the six terrestrial craters larger than 85 km in diameter, which have already been discovered, represent most, if not all, of the large craters in existence on Earth today. The strong bias toward younger ages makes our results quite insensitive to past changes in the impactor flux.

Results

• Two bombardment scenarios
  - Constant flux over 3.5 Gy⁵
    - 49±7 craters larger than 85 km diameter produced in last 3.5 Gy [Fig 2]
    - 8±3 of these survive to current era [Fig 3]
  - Steadily decreasing flux over past 3.5 Gy⁶
    - 113±11 craters larger than 85 km diameter produced in last 3.5 Gy [Fig 2]
    - 11±3 of these survive to current era [Fig 3]

• 6 terrestrial craters larger than 85 km diameter have been found [Fig 3]
  - Within error estimates of both models, which overestimate the number of surviving craters
  - Suggests that most, if not all, very large craters on Earth have been found

• Below ~85 km diameter, the number of observed craters is deficient when compared to model estimates [Fig 4]
  - Result of size dependent weathering, burial, and observational bias

References


Method

Age of Earth’s Crust
+ Bombardment Rate
+ Crater Scaling

# of Surviving Large Craters

Figure 1 - Maximum Probability of Crater Survival on Earth

- Based on isotopically determined⁷ crustal ages combined with ages for Earth’s ocean basins⁸
- Considers only tectonic recycling/production of crust
- A crater ‘survives’ if it formed in crust that is still existant
- Neglects additional effects such as weathering and burial
- Overestimates the number of surviving craters
- Assumes:
  - Thickness of continental crust is constant over time
  - Any given impact will strike a random point on Earth

Figure 2 - Total Number of Expected Craters Larger than 85 km Diameter Produced on Earth

- Why 85 km?
  - Craters with diameters of 85 km or larger will take ~3 Gyr to completely erode⁹, similar to the timescale of this study
  - Crater scaling⁰ used to translate impactor diameter to final crater diameter
  - 7.4 km diameter impactor -> 85 km diameter crater
  - 2 bombardment scenarios
    - Constant flux based on NEO observations¹
      - 49±7 total craters produced
    - Decreasing flux based on dynamics¹
      - 113±11 total craters produced

Figure 3 - Maximum Number of Surviving Terrestrial Craters Larger than 85 km Diameter

- Convolve probability of survival (Fig 1) with production curve (Fig 2) to estimate the number of surviving large craters
- Constant flux⁶
  - 8±3 surviving craters
  - Decreasing flux⁶
  - 11±3 surviving craters
- Number of observed large craters⁸ lies within error estimates for both models
- Suggests that we have found most, if not all, craters larger than 85 km diameter on Earth today

Figure 4 - Size Frequency Distribution of Surviving Terrestrial Craters

- Similar analysis as for Fig 3, but with scaling for all final crater sizes
- Departure from power law similar to previous work⁹