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Size frequency distribution of small craters on the Moon

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Abstract

Thanks to the Lunar Reconnaissance Orbiter Camera (LROC) data, we are now able to observe the small size craters (<30 m) to define the size frequency distribution (SFD) in these diameter bins on the Moon. We worked on one of the youngest surface of the Moon: Tycho crater that has been estimated to be 109±4 My old. We report that the crater size distribution of impacts smaller than 30 m in diameter refined the shape of the known isochrons for diameter ranging from 30 m to 1 km. Our preliminary results suggest a younger model age and also suggest that the target properties may play a role in this range of crater size.

1. Introduction

The crater size distribution on planetary surfaces has been largely studied especially on the Moon and Mars [1]. The lunar crater size distributions have been calibrated to absolute ages from returned samples and a crater chronology has been proposed [2], [3] and [4]. This crater count chronology is commonly used to assess relative and absolute ages of geological processes on planets. However, the crater count chronology was defined for crater diameter only down to 1 km due to the resolution of the image coverage at time of crater chronology compilation. The Lunar Reconnaissance Orbiter Camera (LROC) onboard Lunar Reconnaissance Orbiter (LRO) provides for the first time very high-resolution images down to 50 cm per pixel. These images allow us to observe the size frequency distribution of small craters on the Moon. The aim of this study is to assess the crater size frequency distribution of small craters (<100m) on the Moon. In order to avoid the crater saturation in this range of diameter, we had to work on the rare young lunar surfaces. We worked on a Copernican-aged crater, Tycho. The age of this impact crater has been estimated at 109±4 My although this age has been debated [4].

2. Dataset and method

We construct a Geographic Information System (GIS) to combine global lunar data set released to public by the United States Geological Survey (USGS). We then geo-processed and included to the GIS, wide angle LROC images N°117554677 and N°117575036 that are down to 60 m per pixel as context for LROC narrow angle images (LROC NA, 50 cm per pixels). We then geoprojected and integrated to the GIS the following LROC NA images: M119923147, M122291425, M129363095, M119943483 and M135250778. We selected boxes of around 70 000 m² on both inner melt ponds and first row of impact ejecta to study the crater size distribution. We counted craters down to 3 m in diameter. We used incremental representation of crater size vs crater density from [5], but our background isochron curves are only preliminary, fitting curvature from Neukum data [3] at D < 200m to Hartmann lunar data. This kind of incremental diagram is more sensitive to slope variation of the distribution than cumulative plots.

3. Results

3.1 Size frequency distribution

The crater size distribution over the melt ponds of Tycho crater is presented in figure 1. The slope of the size frequency distribution of small craters (<30m) is quite similar than the SFD of craters from 30 m to 1 km (Figure 1).

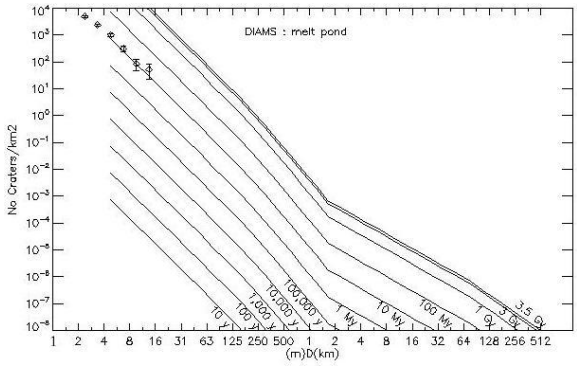

Figure 1: Craters size distribution over a melt pond on LROC NA image N° M122291425. The counted surface is ~70 000 m².

The crater size distribution follow the preliminary-estimated 10 My isochron. The result is reproduced with all crater counts in the melt ponds. These preliminary results suggest that the SFD for the smallest craters (<30m) is an extension of the known SFD for small craters (<1km), and that the model age may be less than widely quoted 109±4 My age.

3.2 Differences between melt pond and ejecta crater counts

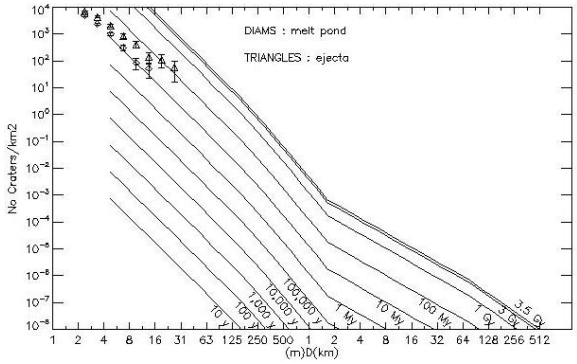

Figure 2: Comparison of craters size distribution on the melt pond (image LROC NA N°M122291425) and on the ejecta (image LROC NA N°M119943483). For both counts, the counted surface is ~70 000 m².

At the largest sizes (16m <D> 33m), the crater densities on the ejecta are almost one order in magnitude higher than on the melt ponds (Figure 2). The crater size distribution on the ejecta is close to the 80-100 My isochrons while the melt ponds follow the 10 My isochron. This difference has already been reported by [6] who reported an age from crater count of 36.7±6 My on the melts floor and an age of 110±15 My on the ejecta of Tycho. The difference may be explained by different scenarios: these surfaces might have a distinct age, or the ejecta has been exposed to Tycho secondary cratering, or both surfaces have properties different enough to induce a difference in the crater size and hence apparent crater density at these small sizes of impacts.

4. Conclusions

During this preliminary study we began to define the size frequency distribution of small craters on the Moon. We suggest that the Hartmann and Neukum isochrons can be refined for the smallest craters. We also suggest that at this range of crater size, target properties may have an effect on the crater density.

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