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Retention time of crater ray materials on the Moon

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Abstract

We investigated the retention time of crater ray materials around smaller lunar craters with multiband images and high-resolution images acquired by Kaguya / MI and TC, respectively. We surveyed rayed craters using OMAT (Optical Maturity) parameter developed by [1]. We surveyed craters larger than 300 m in diameter in lunar highland and Mare Humorum. Previous research suggested that rayed craters larger than 5 km in diameter show 750 Myr of retention time using Clementine UVVIS data [2]. However, our results suggest that the retention time of crater ray materials with lunar smaller craters on highland and mare show 2-3 Gyr and 250 Myr, respectively.

1. Introduction

Surfaces of astronomical objects are scarred with numerous impact craterings. Much of fresh material (ejecta) ejected from the impact cratering was deposited in the area surrounding the crater during its impact cratering. These ejecta blanket reveals bright ray because of the immature ejecta shortly after the impact cratering. Adjacent to the crater rim, the ejecta typically form a thicker, continuous layer and shows brighter feature. At larger distances from the crater rim, the ejecta may occur as discontinuous clumps of materials. Lunar crater rays disappear over time, and it's suggested that these are the reason why space weathering that is the process of surface materials altered by exposure to solar wind, cosmic rays, and micro-meteorite bombardments and impact gardening that is the mixing process of surface and subsurface materials [3].

Wilhelms [3] described that the presence of crater rays is considered as the marker to define the Copernican - Eratosthenian boundary, and the immature rays, which had been formed by impact cratering in the Copernican, disappear within about 1.1 Gyr. So, it is important to estimate the crater rays retention time for the well-understanding of lunar geologic history. The purpose of this research is to investigate crater ray retention time of lunar craters using high-resolution data from Multiband Imager (MI) and Terrain Camera (TC) onboard Kaguya. In previous research, the retention time of crater ray materials on lunar highland is longer than results of [2] and [3]. The reason of longer time scale on lunar highland is supposed that space-weathering depending on the FeO content of lunar surface differ in lunar highland and mare. So, we examine the retention time of crater ray materials on Mare Humorum.

2. Method

This study made crater and its ray detection, independently. Our crater detection is done by visual inspection using the TC images that is suitable for examination of morphology because of low sun-elevation, and its ray detection using the MI images that is suitable for spectral analysis because of its small phase angle. Besides, we utilized optical index representing the degree of space weathering because disappearance of rays is strongly related to space weathering. Therefore, it is possible to survey rayed craters more confidently. Optical index representing the degree of space weathering is named as optical maturity parameter (OMAT, [1]). We identified craters larger than 300 m in diameter by using TC images. After that, using MI images, average OMAT profiles with circumferential direction are estimated to be with the distance in diameters from each crater center. For fresh craters with bright visible rays, the OMAT value is very high at the crater rim and decreases before it blends in to the background. Crater rays should have higher OMAT value than calculated average background OMAT value (0.15). We defined rayed craters based on the following criteria: OMAT value at the crater rim is larger than 0.15 and OMAT value profile decreases with the distance from crater rim.

3. Result

Figure 1 shows the size-frequency distribution of the detected craters in the analysis areas with isochrones

for 250 Ma, 1 Ga, 2 Ga, and 3 Ga surface age, calculated using the crater production function given by [4]. The size-frequency distribution of rayed craters on Mare Humorum (blue squares) is plotted at the 250 Ma isochron. This means that the retention time of crater ray materials on mare with high FeO contents is 250 Myr, which is lower than that of previous research ([2], [3]). So, the retention time of crater ray materials depends on the degree of space weathering.

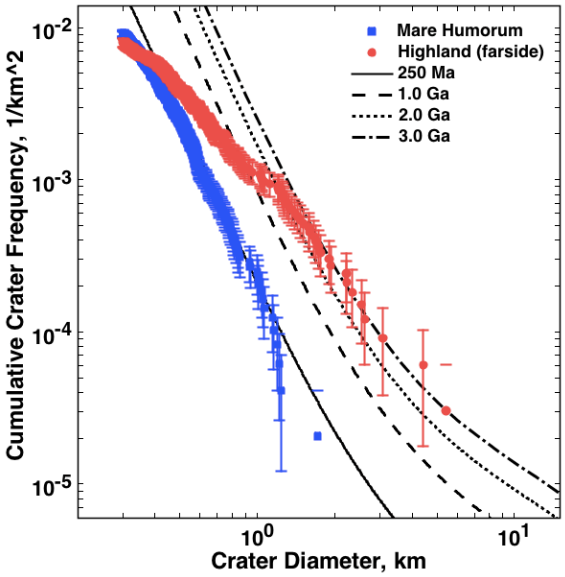

Figure 1: Comparison between crater size-frequency distributions of rayed craters on lunar highland and Mare Humorum.

6. Summary and Conclusions

We suggest that a strong possibility that retention time of crater ray materials on mare is substantially shorter than 1 Gyr reported by previous researches, and is highly depending on the degree of space weathering.

References

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