EPSC Abstracts
Vol. 6, EPSC-DPS2011-1146-1, 2011
EPSC-DPS Joint Meeting 2011

Retention time of crater ray materials on the lunar highland

C. Honda (1), S. Suzuki (1), N. Hirata (1), T. Morota (2), H. Demura (1), M. Ohtake (3), J. Haruyama (3) and N. Asada (1)
(1) Univ. of Aizu, Aizuwakamatsu, Japan, (2) National Astronomical Observatory of Japan, Mitaka, Japan, (3) Japan Aerospace exploration agency, Sagamihara, Japan (chonda@u-aizu.ac.jp / Fax: +81-242-37-2748)

Abstract

We investigate 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. In our research, we surveyed rayed craters using OMAT (Optical Maturity) parameter developed by [1]. We surveyed craters from 300 m to 10 km in diameter in lunar highland. The craters larger than 1 km in diameter are plotted above the 750 Ma isochron which was estimated by [2]. However, the distribution cannot be fitted by a single isochron, this might suggest that the retention time of crater ray materials is longer than 750 Myr.

1. Introduction

Surfaces of astronomical objects are scarred with numerous impact craterings. Much of fresh material (ejecta) ejected from the impact cratering is deposited in the area surrounding the crater during the formation of impact crater. These ejecta blanket reveals bright ray because the ejecta shortly after the impact cratering are immature (fresh). Adjacent to the crater rim, the ejecta typically forms a thick, 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 is suggested that these are the reason why space weathering that is the process of surface materials modified 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 persistence of immature rays is less than about 1.1 Ga. Copernican is one of the lunar geological timescale and runs from approximately 1.1 Ga to the present day. This is defined by impact craters having bright immature rays. It is important to estimate the crater rays retention time for the well-understanding of lunar geology. 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.

2. Method

This study investigates crater detection and ray detection, independently. Crater detection is done by visual inspection using the TC images which has low sun-elevation, and ray detection using the MI images which has small phase angle. Besides, we calculate and use optical index representing the degree of space weathering because disappearance of rays is strongly related to space weathering. Therefore, it is possible to detect rayed craters more confidently. Optical index representing the degree of space weathering is named optical maturity parameter (OMAT). We identified craters larger than 300 m in diameter in 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 steeply over a large number of crater diameters before it blends in to the background. Rayed craters should be higher than calculated average background OMAT value (0.14). 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 ares with isochrones for 750 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 is deviated from the 750 Ma isochron. The craters larger than 1.3 km in diameter are plotted by the isochrons of between 2 Ga and 3 Ga. The slope of the distribution for craters between 800 m and 1.3 km in diameter is not steep, and for the craters smaller than 800 m is a little steep. The distribution for the craters of less than 800 m in diameter falls beneath the 750 Ma isochron. This supports an idea that the retention time of rays depends on the crater diameter [2]. Smaller craters would show shorter ray retention times. This result larger than 1 km in diameter is inconsistent with [2], then, we should conduct precise inspection of rayed craters.

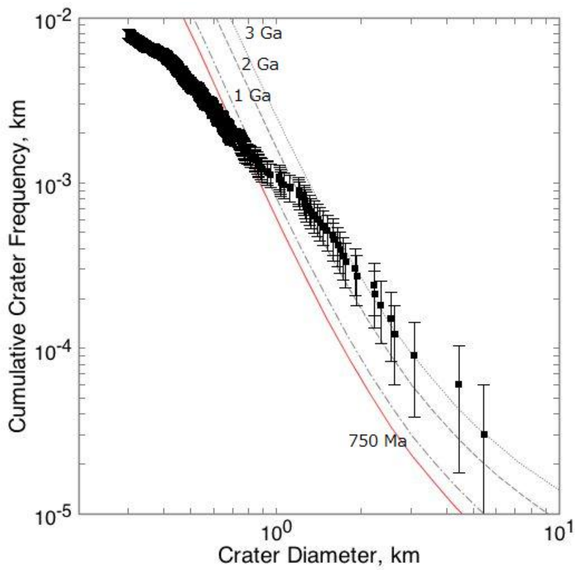

Figure 1: Crater size-frequency distribution of rayed craters on the lunar highland.

6. Summary and Conclusions

We suggest that a strong possibility that retention time of crater ray materials is substantially longer than 750 Myr reported by previous research, and is highly depending on crater size.

References

[1] Lucey, P. G., Blewett, D. T., Taylor, G. J. and Hawke, B. R.: Imaging of lunar surface maturity, Journal of Geophysical Research, vol. 105, 20377-20386, 2000.

[2] Werner, S. C. and Medvedev, S.: The Lunar rayed-crater population - Characteristics of the spatial distribution and ray retention, Earth and Planetary Science Letters, vol. 295, 147-158, 2010.

[3] Wilhelms, D. E., McCauley, J. F. and Trask, N. J.: The geologic history of the moon, U. S. Geological Survey, 1987.

[4] Neukum, G., Ivanov, B. A. and Hartmann, W. K.: Cratering Records in the Inner Solar System in Relation to the Lunar Reference System, Space Science Reviews, vol. 96, 55-86, 2001.