AGES AND THICKNESSES OF MARE BASALTS IN MARE MOSCOVIENSE: RESULTS FROM SELENE (KAGUYA) TERRAIN CAMERA DATA. T. Morota[1], J. Haruyama[1], C. Honda[1], M. Ohtake[1], Y. Yokota[1], J. Kimura[1], T. Matsunaga[2], Y. Ogawa[2], N. Hirata[3], H. Demura[3], A. Iwasaki[4], H. Miyamoto[4], R. Nakamura[5], Y. Ishihara[6], and S. Sasaki[6], [1]ISAS/JAXA (morota@planeta.sci.isas.jaxa.jp), [2]NIES, [3]Univ. Aizu, [4]Univ. Tokyo, [5]AIST, [6]NAOJ.

1. Introduction

Mare Moscoviense fills a part of the 445 km-diameter Moscoviense basin (27N, 146E), which is in the northern hemisphere of the lunar farside. Clementine UVVIS data indicate that Mare Moscoviense is composed of three basaltic units [1]; (1) the oldest basaltic unit with low estimated FeO content in the southern part (Im), (2) a northwestern basaltic unit with low TiO_2 content (Iltm), and (3) an eastern unit with higher TiO_2 content (Ihtm) (Fig. 1). Using high-resolution image data (10 m/pixel) obtained by Japanese lunar explorer SELENE (Kaguya), Haruyama et al. [2] investigated crater densities of the northwestern and eastern units and reported that the ages are 3.5 (northwestern) and 2.6 Ga (eastern).

Here we report ages and thicknesses of mare basalts in Mare Moscoviense. We use images and digital terrain models (DTMs) obtained by SELENE Terrain Camera (TC) [3]. Figure 1 presents a TC mosaic image of Mare Moscoviense.

2. Technique

2.1. Age determination

Crater counting is a well established technique to derive relative and absolute ages of planetary surfaces. Based on the simple idea that older surfaces accumulate more craters, we can infer relative ages by measuring the crater size-frequency distribution (CSFD) with image data. The cratering chronology formulated by relating crater frequencies to the radiometric ages of Apollo and Luna samples enables us to convert the crater frequencies into absolute ages [e.g., 4, 5]. In this study, we use Neukum's cratering chronology [6].

2.2. Estimate of basalt thickness

Lava flow processes can be identified by their characteristic effects on crater size-frequency distributions (CSFDs) [e.g., 7, 8]; a resurfacing of a lava eruption preferentially covers smaller craters of the older unit while larger craters remain detectable. Continued impact cratering forms a new crater population on the younger flow unit. The selective covering of smaller craters results in characteristic deflections of the CSFD. Using the relationship between the crater diameter and rim height [9], the flow thickness can be estimated from the crater diameters where these deflections occur. This method is useful for estimating thicknesses of individual lava flows.

Another method of estimating thickness is to use the morphology of large, flooded craters. This method is used to place constraints on the total thickness of Mare Moscoviense. The rim height of the flooded crater provides information about the thickness of post-crater lava flow. When using this technique to estimate the total thickness of mare basalts, it must be determined that the crater formed before mare basalt eruption. Using craters that formed after the beginning of flooding gives underestimates [10, 11].

3. Results

3.1. Ages and thicknesses of individual units

We counted craters in four regions (Fig. 1), which are summarized in Fig. 2 as cumulative crater size-frequency distribution plots.

Highland unit in Moscoviense basin. From the observed CSFD, the age of Moscoviense basin is estimated to be ~4.1 Ga. According to the stratigraphy of Neukum & Ivanov [6], this is classified as a Nectarian system, which is consistent with the classification of Wilhelms [12].

Oldest unit in the southern part. The observed CSFD for this unit gives a model age of 3.9 Ga. There is no deflection in CSFD for craters < 3 km in diameter, implying that the mare basalt of this unit is thicker than 100 m.

Northwestern Unit. The age of this unit is estimated to be 3.5 Ga from the CSFD for $D < 1$ km [2]. We find a deflection at $D = 1.4$ km of the CSFD. From the diameter, the thickness of mare basalt in this unit is estimated to be ~50 m. The CSFD for craters > 1.4 km gives a model age of ~3.7 Ga for underlaid basalt. This does not correspond to the age of southern basalt, suggesting the existence of a lava flow that is not exposed at the surface.

Eastern unit. The age of this mare basalt was estimated to be 2.6 Ga [2]. Haruyama et al. [2] reported that the mare basalt in this unit is ~40 m thick based on the deflection of the CSFD occurring at D = 1.1 km. They consider that the basalt in the northwestern unit spread under that of the eastern unit because the CSFD in the larger diameter range gave a model age of 3.5 Ga,.

3.2. Total Thickness of Mare Moscoviense

We measured rim heights of 10 large flooded craters (> 5 km in diameter). We obtained lava thickness from the decrease of rim height, since the original rim height can be estimated from the crater diameter. From the results, the basalts covering these craters are estimated to be ~600 m thick at most (Fig. 3). It is not clear whether these craters formed before the beginning of mare eruption or not. Therefore, the thickness is the lower limit of the total thickness of mare basalts in Mare Moscociense. On the other hand, we presume that the total thickness is less than 1 km, because the crater density of the flooded craters is roughly as high as the density of large craters in the highland unit of Moscoviense basin, suggesting that most large post-Moscoviense basin craters survive the subsequent mare flooding.

References

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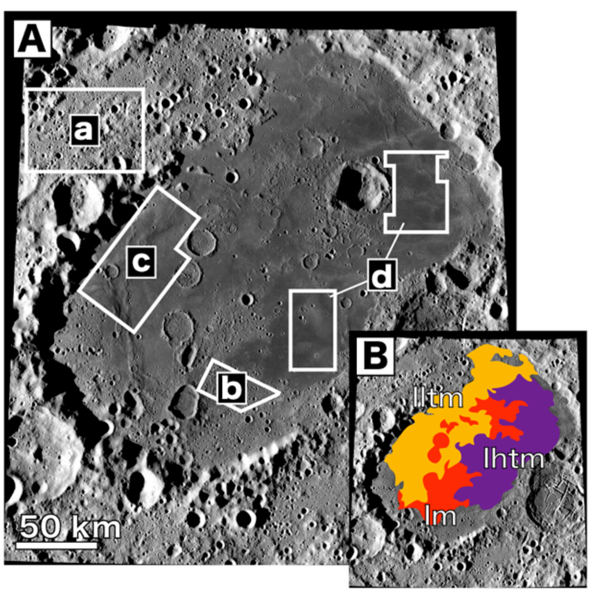

Figure 1. (A) TC mosaic image of Mare Moscoviense. Counting areas are indicated by white lines; (a) Highland unit in Moscoviense basin. (b) Oldest unit in the southern part. (c) Northwestern Unit. (d) Eastern unit. (B) Mare basalt unit map [1]. Transverse Mercator Map Projection.

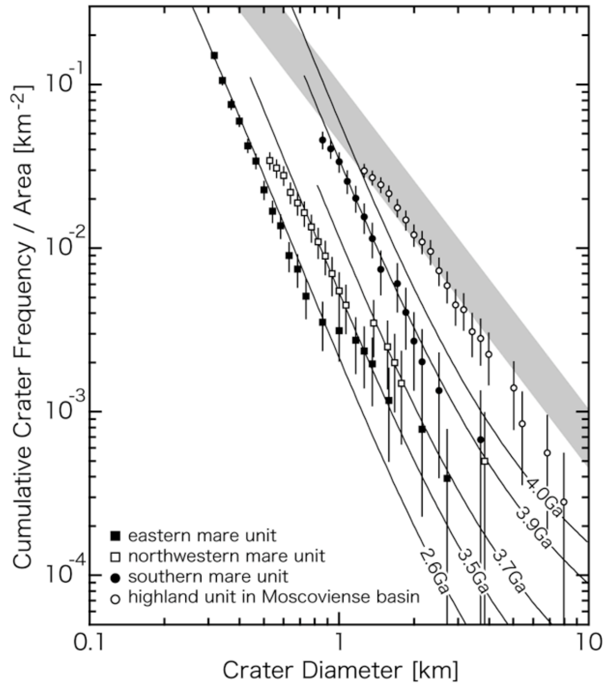

Figure 2. Cumulative crater size-frequency distributions. Solid curves indicate the standard lunar size distribution [6]. Error bars are calculated by log $(N \pm N^{1/2})/A$, where N is the cumulative number of craters and A is the counted area. Gray zone indicates the saturation equilibrium level corresponding to 3 to 7 % of the geometric saturation. The data of the eastern unit are from Haruyama et al. [2].

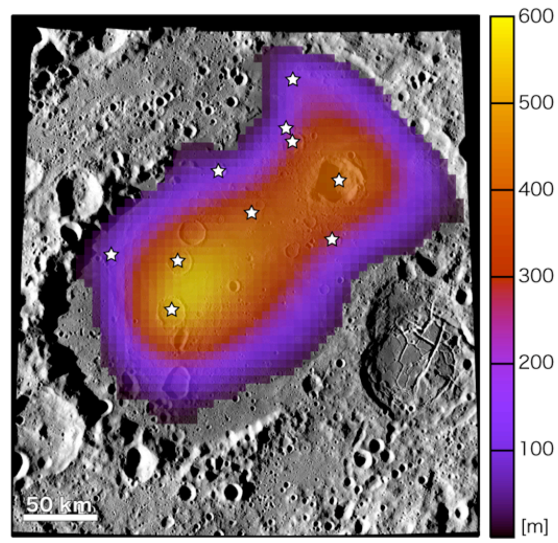

Figure 3. Thickness of Mare Moscoviense. White stars indicate locations of the flooded craters used for thickness estimate.