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SELENE lunar mission reveals the formation history of the Marius Hills Plateau, the largest lunar volcanic complexes

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Lunar volcanic activity played a significant role in the geological evolution of the Moon. The Marius Hills Plateau (13.5N, 306E) of the Oceanus Procellarum is one of the largest volcanic complexes on the nearside of the Moon, presenting records of igneous activities such as numerous dome-like structures, rilles, cones, and lava flows [1]. To estimate the precise formation ages of the Marius Hills Plateau and understand the past lunar volcanism, we used the data from the Terrain Camera (TC) and the Multiband Imager (MI) installed on the Selenological and Engineering Explorer (SELENE).

The TC is a push-broom stereo-camera with two slant telescopes, +15 degrees forward looking and -15 degrees backward looking. It acquired 10 m spatial resolution image data from the SELENE nominal altitude of 100 km. The stereo pair images are used to produce digital terrain models (DTMs) with an elevational resolution of 20 m or better [2]. The MI is a multi-spectral imager with four and five color bands with 20 m (visible) and 62 m (near-infrared) spatial resolutions from the SELENE nominal altitude. The band assignments are 415 nm, 750 nm, 900 nm, 950 nm, and 1000 nm in the visible range and 1000 nm, 1050 nm, 1250 nm, and 1550 nm in the near-infrared range [2]. Based on the TC and MI data, we first morphologically and spectrally classified distinct basaltic lava flows on the Marius Hills Plateau as different geological units. We then estimated the crater retention ages of each geological unit using the TC data.

Crater counting is a well-established technique for deriving the model ages of planetary surfaces. We can infer the relative and absolute ages by measuring the Crater Size-Frequency Distribution (CSFD) with image data based on the simple idea that older surfaces accumulate more craters [3]. We counted craters and measured their diameters using the TC data and estimated the age based on CSFD measurements for each unit on the Marius Hills Plateau. We used the polynomial production function and the cratering chronology model proposed by Neukum and Ivanov (1994) [4] to obtain the absolute model age from the CSFD measurement [5]. Volcanic craters such as the top of the dome-like structures or cones may affect the counting results, so we eliminated what can be clearly distinguished from impact craters in the TC data.

The Marius Hills Plateau can be classified into about sixty geological units based on the MI color-composite maps. There are twice as many geological units on the Marius Hills Plateau than previously proposed by [6].

The measured crater retention age of each unit indicated that the youngest Marius Hills Plateau formation is ˜3.3 Ga, corresponding to the Early Imbrian Model Age, while some geological units exhibit greatest ages of ˜3.8 Ga. The Marius Hills Plateau is thus older than previously estimated. In our study, no classified geological unit exhibited young ages of 0.7?1.5 Ga, corresponding to the Late Eratosthenian Model Age and the Early Copernican Model Age reported by [7].

We found that almost all geological units of the high-calcium pyroxene plateau are significantly older than those of the olivine-rich basaltic lava areas, consistent with [8]. However, we note that some geological units of the high-calcium pyroxene plateau are apparently younger than those of the olivine-rich basaltic lava areas. The Marius Hills Plateau formation history is thus complex [9].

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