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Relationship between compositions and ages of lunar mare basalts

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Toward a systematic understanding of the formation and evolution of terrestrial planets, it is necessary to understand the early evolution of the Moon, an endmember of differentiated planetary bodies. However, the process of magma ocean solidification and the thermal and structural evolution of the mantle are still unknown.

Lunar mare basalts provide insight into horizontal and vertical compositional structure and the thermal history of the lunar mantle. In this study, we investigated titanium contents of mare basalts using high-resolution image data obtained by Kaguya Multi-band Imager. Our results show that mare basalts exhibit typical variations in titanium content, which may reflect differences in chemical composition of the magma source.

Previous studies with remote-sensing data have suggested that no simple relationship exists between titanium contents and ages of mare basalts. However, our new analysis indicates an obvious increase in mean titanium content at 2.3 Ga, implying that the mechanism for magma production changed at that time. The high-titanium basaltic eruption, which occurred at the late stage of mare volcanism, can be correlated with a peak of volcanic activity at ˜2 Ga revealed from crater counts for mare basalts. One possible explanation for the massive eruption of high titanium basalt is the development of hot super-plume rising into the mantle from the core-mantle boundary.

Keywords: Moon, lunar mare basalts, titanium content, lunar mantle, the Procellarum KREEP Terrane, mantle over turn