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Formation and reactivation ages of a lunar mare ridge in northern Imbrium

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Mare ridges and lobate scarps are the manifestations of ancient or recent horizontal compression in the shallow part of the Moon. Regional and global stress fields have been controlled possibly by mascon loading (e.g., Solomon and Head, 1980) and/or global cooling, the latter of which is affected by the origin of the Moon (e.g., Prichard and Stevenson, 2000). On the other hand, mascon loading results in tectonic deformations immediately after the deposition of mare fills (Mohit and Phillips, 2006). Therefore, the timing of deformations is a clue to distinguish the mechanisms.

We constrained the formation age of a mare ridge in northern Mare Imbrium as follows. Mare basalts were so inviscid that their lava fields have level surfaces. And, lava flows would have been dammed by pre-existing mare ridges. Therefore, the depositional ages of the mare units—the one involved in the ridge and the other dammed by the ridge, indicate the range of the formation age of the ridge.

Using images taken by SELENE (Kaguya), we found such an ENE-WSW trending ridge in northern Imbrium with the height, width and length of 300–400 m, 30 km and $\sim$150 km, respectively. We defined spectrally distinctive two basaltic units in this area: Ti-poor basalt makes up the ridge, and relatively Ti-rich one lies on the plain at the foot of the ridge. Their boundary runs along the southern foot of the ridge. There are no fissures along the boundary that could have fed the Ti-rich basalt. Their model ages were estimated by crater-size frequency distribution measurements using craters of 250 m to 1 km in diameter. As a result, the Ti-poor and Ti-rich units gave the ages at 2.97 +0.16/–0.23 and 2.07 +0.17/–0.17 Ga, respectively, indicating the ridge was formed between $\sim$3.0 and $\sim$2.0 Ga.

The majority of mare basalts in mare Imbrium were deposited before $\sim$3.0 Ga (Solomon and Head, 1980), indicating that the ridge formation is explained as a latest event of the mascon loading. However, the unit boundary does not exactly trace a topographic contour along the ridge. A lower part of the ridge is covered by the younger unit that has been uplifted by $\sim$50 m from the level surface, indicating the reactivation of the part after $\sim$2 Ga. This later event is significantly younger than the major loading phase, suggesting that the event was not resulted from the loading but from other mechanisms including global cooling.

References

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