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Tectonic evolution of Sinus Iridum and northwestern Imbrium regions

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Tectonic features, including mare ridges and lobate scarps, visualize the permanent strains of the lunar crust, and show ancient stress field in the shallow part of the crust, which can further places constraint on global thermal history [1], orbital evolution [2] or basin-scale mascon loading [3, 4]. Their formation ages are clues to understand the origin of tectonic movements. The subsidence of mare basalts began to affect the lithosphere as soon as they were deposited, but global tectonics can affect it long after their deposition. Some of the lobate scarps were recently estimated to be younger than 0.1 Ga [5]. It was pointed out there are some mare ridges even on the youngest mare basalts. These young tectonic structures suggest their origins other than the mascon loading. However, the amount of contraction induced by mascon loading have not yet been elucidated. The formation age of each mare ridge is not well understood. In this study, we estimated the ages of mare ridges in northwestern Imbrium and Sinus Iridum regions.

By means of optical data taken by the cameras onboard SELENE, we estimated the depositional ages of mare units and constrained the formation ages of ridges. Mare basalt lavas were so inviscid that the lava field initially made level surfaces. Therefore, the ages of deformed and dammed mare units by tectonic structures help us to determine the upper and lower bound of formation ages of the structures. We defined geological units by spectral features. The absolute ages of the units were estimated by crater-size frequency distribution measurements, applicable to craters with diameters ranging from 0.25 to 1 km, where the production and chronology functions of Neukum and Ivanov [6, 7].

The prominent mare ridges in the study area are ENE-WSW trending ridge system, hereafter Ridge System A, and NE-SW trending ridge system, Ridge System B. They are located at just to the south of Promontorium Laplace. They are parts of the concentric ridge system of Mare Imbrium, suggesting that the ridges are results of mascon loading. The eastern part of Ridge System A branches into three relatively small ridges. There is a unit boundary runs along the southern foot of Ridge System A. Relatively Ti-poor basalt [8] makes up the ridge, and relatively Ti-rich one [8] lies on the plain at the foot of the ridge. This indicates that the unit was dammed by the ridge. Therefore, the upper and lower limits of ridge formation are determined by the ages of the deformed and dammed basalt units. As a result, we estimated the ages of nine units and constrained the ages of tectonic structures as follows. Western part of Ridge System A and northern part of Ridge System B were formed between 3.0 to 2.1 Ga and 3.3 to 2.1 Ga, respectively. However, Ridge System A partially reactivated and become higher after 2.1 Ga. The middle part of Ridge System B also partially reactivated after 2.1 Ga. The southern part of Ridge System B deforms the youngest basalt indicating it was formed after 2.1 Ga.

Most of mare ridges in the study area can not be explained by mascon loading, because the major subsidence by mare basalt was occurred before 3.0 Ga in Mare Imbrium. Accordingly, this area was tectonically active after the deposition of mare basalts.

We also report other young tectonic features, such as lobate scarps and arcuate rilles in the study area.

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