Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PPS25-15 Room:201B Time:May 23 14:15-14:30

Deformation of lunar maria inferred from Kaguya geodetic data

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Spatial and temporal scales of deformation on the Moon are important keys for understandings of the lunar evolution, particularly of its thermal evolution. The aim of this study is to understand the history of large-scale deformation of lunar maria using latest version of Kaguya topography and gravity field data (i.e., LALT 1/16 degree grid data Ver. 2.0 and SGM150j [1]).

The viscosity of lunar mare basaltic magma is extremely low compared to terrestrial magma [e.g., 2]. Consequently, surface topography of thick maria may be parallel to selenoid, the lunar geoid, at the time of the eruption of mare basaltic lava. Thus, the difference between present-day topography and selenoid may indicate deformation occurred after the eruption of lava. In order to extract information of large-scale deformation, we first calculate the slope of surface topography respect to selenoid for mare basalt units, whose the model age is determined based on crater chronology [e.g., 3]. We found that the slope is not zero for most of units (confidence interval of 99%). This result suggests that large-scale deformation occurred after the eruption of lava. We also find that the absolute value of the slope for younger units (i.e., $<$=2.5 Ga) is smaller than that for older units (i.e., $>$2.5 Ga). This result may reflect the history of large-scale deformation for billions of years.

In order to investigate larger deformation for maria, we fit a sphere to topography of maria. An elevation profile directly below an orbit of Apollo 17 (Revolution 16) indicates that several mare units share a common "circle" [4]. This circle may be a first-order approximation of selenoid at the time of eruption of mare lava. Since the center of maria is not coincide with the present-day center of mass (COM), results shown by [4] may indicate extremely-large-scale deformation, such as a displacement of the COM. However, further investigations are necessary because the analysis has conducted only for a single along-track elevation profile. In this study, we use LALT topography data and fit a sphere (instead of a circle used by [4]) to topography of maria. We found that the center of maria is not coincide with the COM even if we consider the effect of tidal deformation. This result suggests that extremely-large-scale deformation had occurred on the Moon after the time of major mare volcanism.

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Keywords: Moon, Mare, Selenoid, Geoid, Large-scale deformation