Lunar radar sounder observations of subsurface layers under the nearside maria of the Moon

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The Lunar Radar Sounder (LRS) on-board the Kaguya (SELENE) spacecraft started the lunar surface and subsurface soundings since November 2007 in order to understand the origin and evolution of the Moon. Kaguya is in circular orbit with an altitude of 100 km and an inclination of 90 degrees. Orbital period is about 2 hours. The LRS system transmits a radar signal modulated from 4 MHz to 6MHz with a pulse width of 200 microseconds and a peak power of about 800 Watts. The range resolution of LRS is 75 m in free space.The pulse repetition frequency of pulse transmission is 20Hz (Ono and Oya, 2000; Ono et al., 2008). After the operation for 10 month, the radar sounder observation covered almost whole area of the lunar surface.

Based on the observations performed by Apollo Lunar Sounder Experiment (ALSE), it was reported that there are two reflectors at depths of ˜1km and ˜2km, or apparent depths of ˜3km and ˜6km, in Mare Serenitatis. Therefore, we have checked LRS data obtained in Mare Serenitatis. However, we could not find such reflectors in the LRS data. Instead, we have discovered prominent reflectors lying at the apparent depths of a few hundred meters. Because the range resolution of ALSE was ˜400 m, or ˜1200 m in free space, it could not distinguish shallow reflectors as found by LRS. We also found that most of neaside maria have subsurface stratifications at depths of several hundred meters as seen in Mare Selenitatis. It suggests that there were common geologic processes in the nearside maria of the Moon.

We found outcrops of some reflectors at the surface of Serenitatis basin by the LRS data. The surface ages in the Serenitatis basin have been determined by crater counting (Hiesinger et al., 2000). Based on them, we can also determine the ages of some subsurface strata. The chronology of subsurface strata implies that the prominent echoes are probably from buried regolith layers accumulated during the depositional hiatus of mare basalts between 3.55 and 3.44 billion years ago. The mare ridges in the southern part of Selenitatis basin were formed after 2.84 billion years ago. The basalts that accumulated during this quiet period have a total thickness of only a few hundred meters. These observations suggest that mascon loading did not produce the tectonics in Serenitatis after 3.55 billion years ago. Global cooling probably dominated the tectonics after 2.84 billion years ago (Ono et al. 2009).