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Investigation of lunar crustal structure in future lunar seismic experiments

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The internal structure and the thickness of the lunar crust are important parameters to understand the lunar differentiation process and the material distribution in the Moon. The recent analysis of Kaguya gravity data have indicated that the lunar crust could have horizontal heterogeneity of its interior and thickness on global scale (e.g.,Namiki et al.,2009,Ishihara et al.,2009). On the other hand, the observation of the seismic phases which pass through the lunar crust and the crust-mantle boundary can give good information about material distribution in the lunar crust and calibration points of crustal thickness to estimate the global thickness from analysis of the gravity data. Currently, deployment of new high-performance broadband seismometers on the lunar surface is planned in Japan, USA, and Europa and so on. This broadband seismometer has sufficient performance to detect seismic phases more clearly compared with past Apollo lunar seismometers. Using this seismometer, we will be able to decide the lunar crustal structure with better accuracy and derive the better estimation of the global crustal thickness combined with Kaguya gravity data in the future lunar seismic missions.

In this study, I have evaluated number of detection of lunar seismic events using the broadband seismometer and compared accuracy of determination of the lunar crustal structure derived from analysis of the new events with those of Apollo seismic experiments. Among Apollo seismic data, waveforms of artificial impacts and meteoroid impacts occurred on the lunar surface have been main events to investigate the lunar crustal structure. I, therefore, evaluated the number of meteoroid impacts can be located by the broadband seismometer using a meteoroid impact list based on a meteoroid mass-flux. In addition, an investigation of the lunar crustal structure using the meteoroid impacts whose locations and origin times are decided from detection of impact flashes by the ground observation is supposed. In this case, we can obtain the information about the lunar crust from analysis of the seismic events detected at only one station. We have also calculated the number of the meteoroid impacts can be located from ground observation using an ephemeris and the number of the events can be detected by the broadband seismometer among the ground-observed impacts.

The number of detected meteoroid impacts and the accuracy of determination of the internal structure derived from analysis of the impact events depend on the geometry of the seismic network. For the reason, we searched the optimized seismic network composed from a few seismometers to locate the meteoroid impacts and determine the internal structure and the thickness of the lunar crust with best accuracy using the method developed by (Yamada et al., 2010). In this presentation, I will report the scientific gains related with the lunar crustal structure derived from seismic observation on the optimized network. Then, some appropriate locations for deployment of the seismometer to obtain the important knowledge of the lunar crust will be discussed based on our and previous results.

Keywords: Lunar exploration, Lunar crust, Seismic observation, Meteoroid impact, Detection of impact flash, Design of seismic network