Re-determination of lunar crustal thickness around the Apollo landing site by analyzing Apollo artificial impacts' seismic data combined with LRO's products

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It has been about 50 years since the seismometers were deployed on the Moon in the Apollo missions. Since then, some topics have been studied by analyzing the lunar seismic data. For example, core size, composition of the Moon, velocity structure of the lunar interior and so on. The lunar internal structure gives us important information about origin and evolution of the Moon. For instance, we can estimate bulk abundance of Al from lunar crustal thickness and it gives constraints for the lunar formation. In the previous lunar seismic analyses, the artificial impacts were often used to constrain the lunar crustal thickness because of known source locations and impact times from the tracking of the impactors. Five S-IVB rocket boosters and four Lunar Module impacts were deliberately impacted on the surface of the Moon to generate the seismic waves. All of them were succeeded to track except for Apollo 16 S-IVB booster. Loss of radio contact between the Apollo 16 S-IVB left large uncertainties on the location of the impact. However, the precise source locations of the five S-IVB impacts were updated with Lunar Reconnaissance Orbiter(LRO) image data recently. The updated locations resulted in change in the reference source locations for the travel time analysis with these artificial impacts. Especially, as for Apollo 16 S-IVB, we found that its impact site estimated in Apollo era was different from the precise one by about 30 km. In this study, we re-analyzed artificial impacts' seismic data using the precise source locations to determine more accurately the crustal thickness of the Moon. We will present the crustal thickness around the Apollo landing site and discuss the effect of local structure that might affect the travel time analyses. We will also discuss implications for future lunar seismic exploration for better understandings of lunar crustal structure.

Keywords: Moon, Apollo lunar seismic data, Lunar interior exploration, LRO

