Characteristics of subsurface structures of the western mare regions estimated from Lunar Radar Sounder Data

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Lunar Radar Sounder (LRS) detects echoes reflected from subsurface discontinuities where dielectric constants of the rocks change. In this presentation, we aim to discuss geologic characteristics of lunar western maria based on the LRS data. First, we compare depths of the subsurface discontinuities echoes and previous estimation of mare basalt thickness. Secondly, we examine the characteristics of the areas where subsurface echoes are either detectable or undetectable.

We compare previous estimations of basalt thickness and estimated depths of the possible subsurface echoes observed in the LRS data. Actual depth of the observed echo is estimated by assuming the dielectric constant of the layer(s) through which radar is propagated. We assume that dielectric constant is 4.0 when the calculated depth is shallower than 1 km, while dielectric constant is assumed to be 8.0 when the calculated depth exceeds 1 km by using a dielectric constant of 4.0. These values of dielectric constants are common in Apollo lunar samples. As a result, the estimated depths of the subsurface discontinuities are much shallower than the previous estimations. In addition, subsurface reflectors are predominantly horizontal, while base of maria should have large topographic relief because of heavy bombardments. Therefore these subsurface discontinuities are not basements of the maria but boundaries within mare deposits. These subsurface boundaries are possibly regolith layers or some interfaces between basalt layers where electromagnetic properties abruptly change.

Clear subsurface echoes are detected in only a few areas of Mare Humorum, Mare Imbrium, Sinus Iridum, Oceanus Procellarum among the western maria. LRS data under Mare Cognitum, Mare Nubium, Sinus Aestuum do not show distinct echoes from subsurface discontinuities. If the detectable boundaries are regolith layers, they might be too thin to be observed by LRS in these areas. Or, if the detectable subsurface boundaries are some interfaces related to compositional change between mare deposits, it is possible that the permittivity contrast between mare deposits under the undetectable areas is small. In order to investigate the reasons of such regional difference, we weigh surface age, FeO and TiO_2 contents, and surface-echo intensities of the detectable areas against those of undetectable areas. Detectable areas seem to correspond to areas where surface age is older than about 3.0 byr according to the previous estimates. Regolith layer thickness of lunar surface is strongly associated with the absolute surface age. In addition, the rate of regolith accumulation is not constant with time and is considered to be higher for times earlier than 3.5 byr ago. It is possible that basalt layers under the boundaries have formed when the rate of regolith accumulation has been much higher than recent period. In case that the subsurface boundaries are some composition-related interfaces between mare deposits, characteristics of mare volcanisms may had changed significantly before 3.0 byr ago. Detectable areas of subsurface echoes also correspond to areas where FeO and TiO_2 contents are relatively low within the mare region. There seems to be no clear correlation between surface echo intensities and the detectability.