

## Distribution of subsurface voids in a region with shield-like topography on the Mare Tranquillitatis revealed by Lunar Radar Sounder (LRS) onboard SELENE

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The lava eruption style is an important factor for understanding the surface evolution process and internal condition on the Moon. Recently discovered large shield-like topographies suggest that the eruption may not be a flood-type basalt caused by meteorite impact, as previously thought, but a non-flood type basalt caused by internal driving forces (e.g., involvement of volatile materials) (Spudis et al. 2013). However, it is unclear whether the lunar shield-like topography is truly due to non-flood type basalt because there is no central caldera which is common in Earth's shield volcanoes. Since lava tubes and gas cavities expected to be formed on the Moon are commonly observed in non-flood type lava areas on Earth, we have noticed that their presence and distribution can be used as indicators of non-flood type lava on the Moon.

We investigated the existence and distribution of subsurface voids under the Cauchy shield on the Mare Tranquillitatis using the Lunar Radar Sounder (LRS) onboard SELENE to clarify the existence of non-flood-type basalt eruption on the Moon. Because the LRS receives not only reflections from the nadir subsurface structures, but also reflections from off-nadir surface structures (Kobayashi et al. 2002), evaluation of off-nadir surface scattering effects is necessary to detect subsurface echoes (Kobayashi et al. 2020). Therefore, we developed a surface scattering simulation code using high-precision elevation data (SLDEM2013), and made it possible to detect subsurface echoes without the influence of surface scattering. As a result, plenty of subsurface echoes were discovered at the Cauchy shield. These echoes have reflection intensities of stronger than -15 dB and widths of less than 3 km. Furthermore, we performed the reflection intensity analysis using the radar equation method for the cases of layered structures, tube voids, and cylindrical voids. We found that subsurface echoes are weaker than -15 dB for layered structures without regolith layers. For layered structures with regolith layers of more than 3 m, the subsurface echoes are stronger than -15 dB. However, since lunar regolith layers are thought to be with horizontal large scales, it is considered that subsurface echoes of less than 3 km detected by LRS are not echoes from layered structures. For tube voids and cylindrical voids, it was found that subsurface echoes of more than -15 dB can be reproduced even though the cavity widths are less than 3 km. These results indicate that subsurface echoes with reflection intensities of more than -15 dB and widths of less than 3 km obtained from LRS data are likely to originate from subsurface voids. Therefore, it is possible that subsurface voids exist throughout the Cauchy shield. This suggests that the Cauchy shield was likely formed in a non-flood-basalt eruption style.

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