Lunar lava tubes are important from various science perspectives and provide potential sites for future lunar base construction [Coombs, & Hawke.,1992, Haruyama et al.,2012, Hörz., F., 1975, Oberbeck et al., 1969]. Since the insides of lava tubes are shielded from cosmic radiation, particle implantation, and micro-meteorite bombardment, they are expected to have preserved original lava compositions, textures, and even volatiles that can tell us the evolutionary history of the Moon. The radiation and meteorite bombardment that disturbs the geologic record on the surface of the Moon also makes it a harsh place for humans and instruments. Thus, the inside of an intact lava tube could be one of the most scientifically interesting and safest places on the Moon from an exploration perspective.

Lava tubes form beneath the surface of a cooled lava flow, thermally insulating the lava within the tube, allowing it to be transported for long distances. Theoretical studies indicate that lava flowing in a tube can travel significantly further than analogous channel-fed or surface lava flows [Kezhehlyi, et al., 1995].

Techniques based on gradiometry and cross correlation were utilized to isolate the target signal of mass deficits from GRAIL gravity data. Chappaz et al. (2017) detected several locations of horizontally extended mass deficits. One of the mass deficits is in an area containing the rille A at Marius Hills in which a skyhole lava has previously been discovered [Haruyama et al., 2009]. Kaku et al. (2017) investigated radar data from the Lunar Radar Sounder (LRS) onboard SELENE (Kaguya) for the mass deficit area and found a distinctive two-peaked radar echo pattern, suggesting the existence of a subsurface intact lava tube. We examine the LRS echo data reflected from a few tens to a few hundred meters’ depth in mare regions.

The left figure shows the results that mark locations corresponding to the characteristic features of two-peak echo patterns similar to those found near the Marius Hills Hole. The colors of the circular points denote the power difference between the two echo peaks (ΔPrb): the first echo peak is from the nadir surface and the second echo peak is from the ceiling or floor of a subsurface cave such as a lava tube.

Some candidate sites for the presence of a cave exhibit strong second echo peaks; the lower the ΔPrb value (for instance, in regions of orange to red and purple colors in LRS data at location T1 close to MHH), the more likely the presence of a subsurface cavity. The candidate sites are observed globally in the mare region.

We investigated the LRS data to detect subsurface intact lava tubes from a few tens of meters to a few hundred meters’ depth for the mare region. Several locations exhibit the characteristic double-peak echo patterns that were seen near the Marius Hills Hole. These locations are potential candidate sites for the presence of underground lava tubes or cavernous voids. Our in-depth study of a few locations indicates that there likely exist lava tubes a few hundred meters wide with an arch-shaped roof structure such as those seen at Rima Mairan.