Lunar farside crust to be explored by KAGUYA data and lunar meteorites

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Recent studies of remote sensing and lunar meteorites have revealed that the lunar crust has an asymmetric composition: The nearside crust is relatively Fe-rich with pyroxene, while the farside crust is relatively Mg-rich with olivine [1]. Lunar meteorite Dhofar 489 and the paired meteorites (Dhofar 489 et al.) are feldspathic impact-melt breccias which are most likely originated from the lunar farside crust [2]. They potentially serve as ground truth of the unexplored farside crust. They are most Mg-rich among known feldspathic samples from Apollo samples and lunar meteorites, and are dominated by olivine. Dhofar 489 et al. include clasts of magnesian anorthosite (96.5% plagioclase, 3.5% olivine) and spinel-bearing anorthositic troctolite (72% plagioclase, 25% olivine, 2.7% pyroxene, 0.3% spinel) [3]. Of the feldspathic lunar meteorites, the bulk-rock MgO content is positively correlated with modal abundance of olivine [4]. The olivine-dominated nature of Dhofar 489 et al. with the highest MgO content is in line with the above correlation.

In order to understand the unexplored farside crust, combined studies of samples and remote sensing are crucial. Cosmic-ray exposure histories of lunar meteorites show that lunar meteorites are generally ejected from a relatively shallow depth (a few to several meter deep) [5]. Extreme chemical and mineralogical compositions of some lunar meteorites enable us to constrain and specify the source region [6,7], utilizing remotely-sensed surface compositions. In the case of Dhofar 489 et al., the extremely Mg-rich and Fe-poor composition is a key constraint and the exclusive presence of olivine is another. Since MgO abundance and Mg/(Mg+Fe) ratio in the global feldspathic highland terrane (FHT) are not clearly defined, the second constraint does work at this time.

Dhofar 489 et al. have additional constraint for their source. The spinel-bearing anorthositic troctolite is estimated to have formed at 10-30 km deep based on the phase stability relation [2]. Thus, it would have been excavated from deep (possibly lower) crust of the farside, and incorporated into an impact melt. Since clasts of a crust about 10-30 km deep are present in Dhofar 489 et al., the source region should have been excavated down to a comparable depth by a crater of 100-180 km in diameter, on the basis of a simple cratering law.

With the above constraints, the source region of Dhofar 489 et al. would be associated with a crater of 100-180km in diameter, which excavated anorthositic troctolite on the farside. Based on the results of remote-sensing studies currently available [8-10], Keeler crater (10^oS, 162^oE, 132 km in dia.), Tsiolkovsky (20^oS, 129^oE, 185 km in dia.), and the area 1 (43^oS, 144^oE) in the South Pole-Aitkens basin are likely the sources. These craters and the surrounding areas merit detailed study with KAGUYA data to explore the lunar farside crust. Multi-band Imager (MI) and Spectral Profiler (SP) will constrain modal abundance and mineral composition, and X-ray spectrometer and Gamma-ray spectrometer will provide FeO, MgO contents and Mg/(Mg+Fe) ratio for these regions.

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