Evidences of asymmetric crustal and mantle evolution of the Moon from lunar meteorites

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Basic understanding of lunar science founded in the Apollo era has been continuously updated with additional data from recent orbital satellites and lunar meteorites. Yet, the difficulty has been that ground truth to calibrate remotely sensed data are limited to Apollo and Luna samples from the central nearside, and also that provenances of lunar meteorites randomly sampling the Moon have not been easily identified. Lunar meteorites recently studied by our group were able to be linked to specific area or site on the Moon. They are of extreme importance not only in providing the ground truth of unexplored regions, but also in refining the calibration quality of the remote sensing data.

The latest studies of the feldspathic lunar meteorites from farside (Dhofar 489 et al. and Yamato-86032) have shown that the lunar crusts of nearside and farside have distinct mineralogical and geochemical compositions in Mg/(Mg + Fe) (mg#) ratio and Th. The farside crust is one or two order magnitude lower in Th, relative to the nearside crust represented by Apollo 16 samples. Interestingly, mg# of farside crust is somewhat variable. Crystalline impact-melt breccia Dhofar 489 shows extremely high mg# (70 - 78), beyond the range of ferroan anorthosite (mg# = 45 - 67) from the nearside crust. In contrast, regolith breccia Yamato-86032 has low mg# (60) within the range of the ferroan anorthosite. These data imply that relatively wide range of mg# (60 - 78) does exist in the farside crust, and some are overlapped with that of nearside crust. Yet, it is not well known whether the mg# variation occurs continuously in global scale or just represent local varieties. Since mg# is closely related to the crystallization stage from magma, it is a key to understand the crystallization process of the crust in the primordial magma ocean. The global elemental and mineralogical mapping of SELENE will provide an answer to this fundamental question.

Another recent study of paired basaltic lunar meteorites (Yamato-793169, Asuka-881757, MET 01210, and MIL 05035) showed that they represent the first ground truth of cryptomaria, originated from a 3870 Ma-aged basalt flow erupted on the south-western limb of the nearside. With their chemical and isotopic compositions, the study further implied that the isotopic and chemical compositions of the source mantle for lunar mare basalts are distinct even within the nearside (between Procellarum KREEP Terrane (PKT) and outside the PKT) , and possibly on the farside. Combined science data of SELENE will greatly contribute to the search for cryptomare deposits on the entire surface of the Moon, the studies on their geological setting, distribution and mineral chemistry, and better understanding of lunar global magmatic evolution.