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Plagioclase with High Ca Contents from the Central Farside Highland.

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Some lunar meteorites contain clasts of nearly pure calcic plagioclase with high An values and low FeO (1). We proposed that these meteorites are derived from the lunar farside on the basis of estimated low concentrations of Th and FeO by the remote sensing data on the farside of the Moon (2). The Lunar Magma Ocean (LMO) model deduced from the Apollo samples is not able to explain such dichotmy of the Moon. Nyquist et al. (3) performed Sm-Nd and Ar-Ar studies of pristine ferroan anorthosites (FANs) of the returned Apollo samples and showed that a whole rock Sm-Nd isochron for selected FANs yields an isochron age of 4.47 Ga . Mineralogical studies of lunar meteorites of the Dhofar 489 group (2) and Yamato 86032 , all possibly from the farside highlands, showed some aspects of the farside crust. Nagaoka et al. (1) reported that many fragments in such meteorites contain clasts of nearly pure calcic plagioclase with high An values.

Mineralogy of magnesian anorthosite clasts in Dhofar 489, 309 and 307 (2) was used to deduce the ejection site of the Dhofar 489 group. Presence of fine-grained magnesian granulitic clast, and many crystalline clasts with rapid growth features were interpreted in terms of a large impact basin associated with small cratering. Among a few large basins of the farside, the Dirichlet-Jackson (DJ) basin has a few large craters on the floor, and the formation age by Morota et al. (4) is 4.25 Ga, which agrees with the Ar-Ar age (4.23 Ga) of Dhofar 489 (2). Based on the Th map made by KGRS, Kobayashi et al. (5) showed that the lowest Th regions in the lunar farside occurs near the equatorial region and noted that the regions well correspond to the high Mg number region (DJ) measured by SP, of the farside crust (6). These rocks with low Th may be crystallized from less-evolved magma than the nearside crust. Anorthosites composed of nearly pure anorthite (PAN) with low Th at many locations in the farside highlands and a map of the Mg numbers (6) also showed that the region around the DJ basin is consistent with the Mg numbers (70 to 76) of the magnesian anorthositic clast in Dhofar 489 (2). A large impact, which excavated a basin of the farside might have produced granulites in deep ejecta of a smaller impact.

We investigated a process of decomposition of Ca-rich plagioclase with fulvic acid, which is a complex natural organic acid produced in humified soils (7). The Ca ion released from plagioclase can be used to fix carbon dioxide as calcite as in oolites, and is useful for reducing carbon dioxide from the atmosphere on the Earth.

References: (1) Nagaoka H., Takeda H. et al. (2012) 75th Ann. Meet. Meteorit Soc. Abstr no. 5197. (2) Takeda et al. (2006) Earth Planet Sci Lett 247, 171-184. (3) Nyquist L. E. et al (2013) LPSC 45th no. 1125. (4) Morota T. et al. (2011) JGU Meeting, PPS024-10. (5) Kobayashi S. et al. (2012) EPSL, 337-338, 10-16. (6) Ohtake M. et al. (2012) Nature Geosci., 5, 384-388. (7) Yazawa Y. et al. (2012) Chapter. 5, in Moon, B. Viorel Ed., XXXVIII, 750 p, 105-138, Springer.

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