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Proposed sample return mission from the lunar farside highland

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Compositional information of the lunar highland is important for understanding the bulk composition and solidification of the lunar magma ocean and for estimating the internal structure of the Moon. However, recent studies [1][2] indicate that the previous understanding [3] of the lunar highland composition based primarily on the lunar samples returned from the nearside by Apollo and Luna missions is insufficient for understanding the overall crustal composition because more primitive highland materials with different composition from the current sample collection, which we do not have, are present in the farside highland.

Therefore, we are proposing a sample return mission to the lunar farside highland to fill the gap in our knowledge by obtaining the most primitive highland material and investigating such previously unknown samples. Information from these samples, such as crystallization age, major and trace element composition, isotopic composition, and crystal texture, are important for understanding the cooling and solidification history of the lunar magma ocean, formation of the crust, degree of differentiation when the highland material crystallized, and composition of the bulk lunar magma ocean.

A region around Freundlich-Sharonov and Dirichlet-Jackson basin where Th content is the lowest [1] and the Mg# (Mg/[Mg+Fe] in mole percent in mafic minerals) is the highest [2], both suggesting that this region is the most primitive highland on the lunar surface, is a potential sampling site. The proposed mission consists of one lander with return capability, a manipulator to collect both regolith and small (a few centimeters in diameter) rocks from around the lander, and spectral cameras for sample selection. Further study is required to estimate the minimum sample requirement of sample number and weight to achieve our scientific goal.

[1] S. Kobayashi, LPSC, #1795 (2010).
[2] M. Ohtake et al., LPSC, #1977 (2011).
[3] P. Warren, Am. Mineralogist, 78, 360-376 (1993).

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