Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS22-02 Room:103 Time:May 22 14:30-14:45

Sample return from the lunar farside highland proposed for the future lunar exploration mission

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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 indicate that the previous understanding of the lunar highland composition based primarily on the lunar samples returned from the nearside by Apollo and Luna missions are insufficient for understanding the overall crustal composition because more primitive highland materials with different composition (higher Mg#, which indicates solidification from the more primitive magma) 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. This mission is proposed as a second stage lunar landing mission after a first in-situ measurement mission, which obtains age information and chemical composition of the landing site. Techniques obtained by the first in-situ measurement mission will enable the sample return mission to land on a precisely selected location and to do in-situ compositional measurements and select suitable samples. Information acquired by analyzing these returned 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.

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. Landing site candidates are investigated by using high resolution spectral data obtained by Kaguya.

Keywords: Next decade for planetary explorations, sample return, moon, highland crust