Global Mapping of elemental abundance on lunar surface by SELENE gamma-ray spectrometer

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Elemental composition on the surface of a planet is very important information for solving the origin and the evolution of the planet and also very necessary for understanding the origin and the evolution of solar system. Planetary gamma-ray spectroscopy is extremely powerful approach for the elemental composition measurement.

Gamma-ray spectrometer (GRS), which will be on board SELENE, advanced lunar polar orbiter, employed a Ge detector as the main detector, therefore it will enable us to observe compositions of more elements (Th, Fe, O, Si, Mg, Al, Ca, K, U, Ti, etc.) on the moon than past Apollo missions and Lunar Prospector had done. The GRS will observe the whole area of the moon including the polar region and will provide the global mapping of the elemental composition of lunar surface material for more chemical element than Lunar Prospector did, with higher sensitivity.

The major topics of lunar science from SELENE/GRS observation are expected to be:

(1)Refractory element abundance can provide useful information of the differentiation and the formation of lunar crust. Abundance ratio of the refractory element, Ca, Al, U, Ti, etc. of primitive meteoroid is almost same as of earth-type planet, however the absolute abundance depends on planet and so the differentiation is thought to occur after collection into the planet, that is, refractory element abundance couldn't be changed from just after the planet formation, independent of the thermal history. That idea can be applied to lunar study, so quantifying the abundance is key to study the origin.

(2)The radioactive decay of U, Th out of the refractory element is energy of thermal flow in the moon. SELENE/GRS observation will provide more precise measurement of those elements, which can indicates the thermal flow precisely and help us to understand the thermal history of the moon.

(3)Based on the SELENE/GRS observation, we will obtain information on the mantle material. Volcano activity is very important in the formation of lunar surface and also very universal in planetary formation and the surface formation. However, volcanic composition variation in region and era has not been observed. Global mapping of lunar surface material by SELENE/GRS will provide information on lunar volcanic activity history.

(4)The existence of water ice has been expected since 1960's and has been not only a scientific interest that comet and meteoroid bombardment could transport it to the moon, also interest in terms of lunar utilization, that is very necessary for human activity. Lunar Prospector and Clementine observation indicate the existence, however SELENE/GRS can provide direct evidence of the existence observing gamma ray from Hydrogen nucleus. And also the GRS may observe other volatiles that could be trapped in the polar region if they are enough abundant for observation.

Furthermore we can combine the topographic data and the GRS data and may obtain the chemical composition of the lunar deep crust, which is possibly in exposure to space, and then will obtain important knowledge on the origin and the evolution of the moon.

In this study, we will show the estimation of the observational limit and the spatial resolution of the GRS and will discuss reachable scientific goals of SELENE/GRS.