Differentiation and long-term thermal history of the Moon

Kiyoshi Kuramoto[1]

[1] Cosmosci., Hokkaido Univ.

http://www.cosmo.sci.hokudai.ac.jp/˜keikei

Redistribution of radiogenic elements likely plays key roles on the long-term thermal evolution of the Moon. Their transport to the lunar shallow layer and deep interior is required for the rapid cooling of lunar lithosphere and for the late heating of lunar interior inducing mare volcanism, respectively

In the Moon, the most important career of radiogenic elements is KREEP components, which are significantly concentrated in the incompatible elements such as K, rare earth elements and P. These components are likely produced as residual liquid during the course of crystallization of lunar magma ocean. Contamination of KREEP components into lunar highland crust is major mechanism for the crustal concentration of the radiogenic elements. On the other hand, the KREEP components are also enriched in Fe and Ti. Hence, they becomes dense associated with solidification and may settle toward the lunar interior, resulting to the late heating of lunar interior.

The lunar surface exhibits significantly heterogeneous distribution of Th, a observable representative of radiogenic elements. Its high concentration is observed in the near side of the Moon. Because the highest concentrations are located in areas with relatively high crater density, the lateral heterogeneity in radiogenic elements was likely formed earlier than the end of heavy bombardment era. Concentration of the mare volcanism in the near side also implies that the concentration of radiogenic elements on the surface may range inside the lunar mantle.

On the earth, the plate subduction causes recycling of crustal rocks enriched in radiogenic elements into the deep mantle. On the moon, in contrast, the recycling of differentiated rocks seems to have been minimal since the completion of gravitational overturn of the earliest mantle which had unstably stratified due to the fractional crystallization of the magma ocean. Due to the lack of recycling, the radiogenic elements monotonically concentrate into the crust associated with volcanism and become less effective for the heating of the deep interior. Such acceleration of cooling of lunar interior may be an important reason for the decay of mare volcanism on the moon.