

Wet terrestrial magma ocean and dry lunar magma ocean: origin of the differences in the earth and lunar crusts

Eiji Ohtani[1]

[1] Institute of Mineralogy, Petrology, and Economic Geology, Tohoku University

It has been suggested that the difference between the earth and moon is not only their size but also for the volatile contents in their bodies. Previous works have been suggested that the earth was born wet with the ocean and we can now expect water of the amount of another ocean mass in the mantle transition zone, i.e., transition zone can accommodate water a few times greater than the present ocean mass. It has been suggested that oceanic crust mainly composed of granitic rocks can be formed by partial melting of the crustal and mantle materials under the wet conditions.

Our experiments indicate that komatiite magmas observed in Archean and some of the silica enriched cratonic peridotites can be formed as the products of the hydrous melting and the solid residue formed by partial melting. We also conducted the density measurement of hydrous basalt at high pressure and temperature. This experiment revealed that water dissolved in the magma is highly compressible, and there is a density crossover at the base of the upper mantle for the basaltic magma containing about 2 wt. % water. Thus, there is a density crossover between magma and residual crystals even in the hydrous magma ocean.

On the other hand, it is well known that the moon is under the dry conditions. Granitic rocks which are abundant in the earth crust are very rare in the moon reflecting its dry condition. It has been suggested that the lunar magma ocean was essentially dry. Flotation and accumulation of anorthite crystals in the surface of the moon is believed to be the cause of the formation of the lunar anorthosite crust. We made density measurements of the lunar basalt magma, green glass, by sink float experiments. This experiment confirmed that anorthite crystals are buoyant in the dry basaltic magma in the moon. We can not expect anorthosite crust in the earth, since anorthite crystals are denser than the wet magma ocean in the earth, since water in the magma is very compressible and small amount of water reduces the magma density significantly in the shallow depths of the terrestrial wet magma ocean. Water could be the most important factor responsible for the differences in the crustal materials between the earth and moon.