

# Construction of Internal Thermal Structure of the Moon

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Recently, many celestial body are explored, both of the quality and the amounts have been enhanced. Because the moon is an only celestial body where the heat flow experiments were carried out, we can construct the thermal model of the moon comparatively easily. Heat flow measurement provides the most direct method of estimating bulk abundance of refractory elements such as U and Th.

It is thought that there is enormous significance of constructing lunar thermal structure precisely in order to explore the origin or thermal history of the planets in the solar system.

In order to construct a lunar thermal model, we first estimate the thermal conductivity distribution of the lunar crust. Because the lunar crust is very porous and dry, the effect of porosity in the lunar rocks on the thermal conductivity must be carefully treated. Mizutani and Osako (1974) gave one method of estimating the thermal conductivity in lunar crust on the basis of Walsh and Decker's study. In the present study, we introduce another new method of estimating the thermal conductivity of porous rocks using Gibiansky and Torquato (1998) theory which gives us the upper and lower bound of the thermal conductivities for porous rocks. Both methods are relied on the premise that porosity distribution in the lunar crust is estimated from the seismic wave velocity distribution.

The abundance of heat generating elements on the lunar surface is estimated from the Th abundance obtained with the gamma-ray spectrometer on board the Lunar Prospector mission, assuming the K/U and Th/U ratios are constant for all lunar rocks. The vertical distribution of the heat generating elements were assumed to decrease exponentially with depth, as is assumed in many terrestrial heat flow studies. The skin depth of the exponential decrease is taken to be a parameter, which will be determined from comparison of the calculated heat flow and observed heat flow values.

Another important parameter is the mantle heat flow; in the present case, we assume a heat flow at a depth of 200 km, which is a bottom boundary of our numerical simulation.

The 3-D numerical calculation of the steady state heat conduction equation is made, using the recent results of topography, and crustal thickness distribution of the moon. From the comparison of the numerical calculation with the observed heat flow values obtained at Apollo 15 and 17 landing sites, we obtain the following conclusion:

(1) The temperature distribution in the moon is very dependent on the distribution of the thermal conductivity in the lunar crust. Referring to the temperature distribution inferred by the electromagnetic observation, we estimate the appropriate skin depth,  $D$ , which indicates the degree of the upper concentration of the heat generating elements in the crust, to be about 20 km. This value is about twice as much as that of the terrestrial one, therefore, the lunar crust is considered to be generated in large quantity in a short-period without much successive differentiation from magma ocean.

(2) The bulk U abundance of the moon is evaluated to be 25 to 35 ppb. However, this abundance would reduced significantly to be 14 to 26 ppb when considering the focusing effect. Using this value, global average of lunar surface heat-flow is estimated to be 10.0 ~ 12.5 mW/m<sup>2</sup>. This broad range of this possible abundance in refractory elements indicates that the bulk composition of the moon still remains an unsolved problem even our progress in the precise treatment of the thermal model.