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Revised thermal evolution models of the Moon: Influence of the crustal thermal conductivity

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Early thermal evolution models of the Moon have usually used an average thermal conductivity of 4 W/mK for both the mantle and the crust. However, as the conductivity decreases strongly with increasing porosity for atmosphere less bodies like the Moon, much lower values are expected in the upper regolith-megaregolith layer. Here, the thermal conductivity is about 0.005 W/mK at the surface and increases due to compaction to about 2 W/mK at the bottom of the megaregolith layer. This layer is estimated to extend to a depth of about 20 km. The solid anorthositic crust has a thermal conductivity of only about 2 W/mK. In the present study, we examine the influence of a low crustal thermal conductivity on the Moon's thermal evolution. We use numerical models of mantle convection, parameterized and 3-d spherical. The influence of the crustal thickness, the depletion of radioactive elements in the mantle, the mantle rheology and possibly a stratification of the mantle due to freezing of an early magma ocean will be considered. In general, the results show that the cooling history differs significantly from the results of earlier evolution models and higher temperatures of the lunar interior can be expected. Depending on the depletion of the mantle in radioactive elements, a partial melt zone could have been present in the deep mantle for most of the Moon's evolution due to the thermal blanketing of the crust.