THE EFFECTS OF MAGMA MIGRATION ON THE EVOLUTION OF THE MOON, J. L. Ahern, School of Geology and Geophysics, Univ. of Oklahoma, Norman, OK 73019; D. L. Turcotte, Dept. of Geol. Sciences, Cornell Univ., Ithaca, NY 14853.

Magma migration has affected the evolution of the moon in two important ways: First, the upward migration of melts has resulted in redistribution of the radioactive elements in the lunar interior. This has had a significant effect on the thermal history of the moon. Second, magma migration is a differentiation process, and, as such, is responsible for the formation of the lunar crust.[1] In this paper we present a set of models of the thermal evolution of the moon which include the effects of magma migration. The models incorporate the following features:

1) Heat conduction is modelled by finite difference approximation.
2) An initially uniform distribution of radioactive elements causes volumetric heating. Some portion of the lunar interior may melt due to radioactive heat sources.
3) A porous-flow magma migration model[2,3] is presented which predicts that any extensive partial melts will migrate upward and pool at the top of the partial melt zone. This phenomenon is incorporated in the finite difference model.
4) Incompatible radioactive elements join the partial melts. The model thus accounts for redistribution of heat sources to the surface.
5) Initially, a magma ocean is assumed to exist on the lunar surface. Convective cooling of this magma body and any internal magma bodies which develop is modelled using parameterized mantle convection.
6) The heat transfer due to solid-state convection is simulated by increasing the conductivity of regions close to the melting temperature.

Several models are presented with different initial temperatures, degrees of partial melting, and radioactive heat-source distribution. The models help to place constraints on the early thermal state of the moon and allow us to investigate processes by which the lunar crust may have evolved. At least one of the models agrees very well with several constraints on lunar evolution (Figure 1). The light solid line represents the initial temperature distribution of this model, assuming 25% melting of the outer 350 km of the moon, which results in a 75 km magma ocean. Due to convection, the magma ocean quickly freezes. There is a second partial melting episode between 3900 and 3200 mybp in which magma from the deep interior migrates upward and pools at 450 km. This magma, rich in radioactive elements, may be able to penetrate the lunar crust by diapirism, convective upwelling, or migration along cracks induced by thermal stresses or meteorite impact. Interaction of this magma with the near-surface rocks may be responsible for the mare basalts. Present-day temperatures are given by the dashed line in figure 1. Temperatures are subsolidus (dark solid line) throughout the moon. Present-day heat-flow for this model is 0.50 HFU, in good agreement with the global estimate of 0.46 HFU[4] based on Apollo 15 measurements.

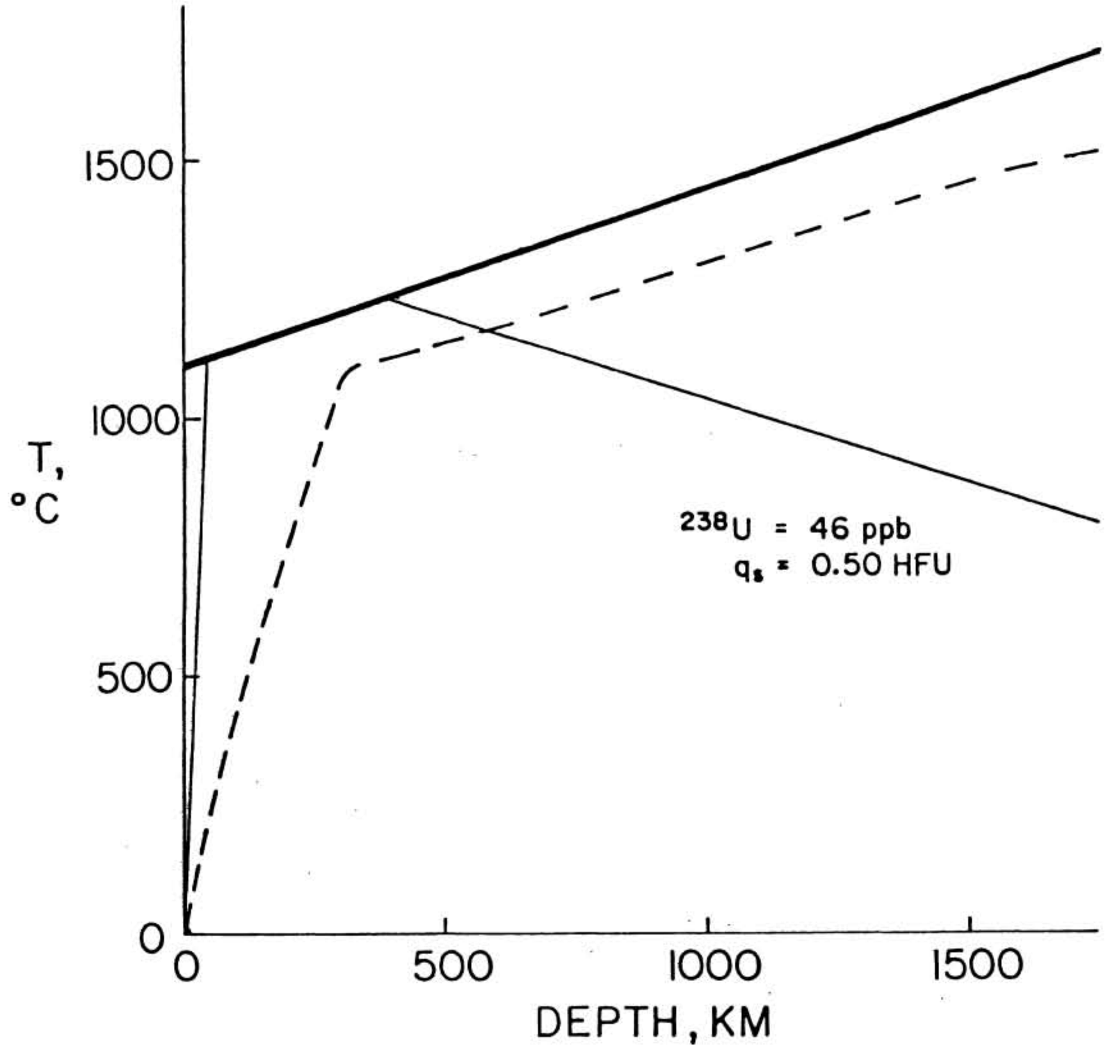

Figure 1. Initial (light solid line) and present-day (dashed line) temperatures of the moon. Solidus of basalt is also shown (dark solid line).

REFERENCES:
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