The failure of the half-space cooling (HSC) model, employed by Kelvin in his historic attempt for investigating the cooling history of the mantle and at estimating the age of the Earth, has remained an unsolved paradox for more than a century. Contribution of radiogenic heat, unaccounted for in the HSC model, is often pointed out as the prime reason for the failure of the Kelvin’s approach. In the present work, we point out that this traditional interpretation is incorrect and that the difficulty in accounting for the cooling history of the mantle stems from ignoring the role of thermally buffered solidification. With appropriate modifications in the HSC model it is possible to obtain a better understanding of the thermal evolution of the mantle and arrive at an estimate of the age of Earth, compatible with results of radiometric methods. More importantly, there is no need to invoke neither the hypothesized mechanism of “enhanced mantle conductivity” (as proposed by Perry, 1895) nor the contribution of radiogenic heat (as proposed by Holms, 1915). The new thermal model takes into account explicitly the effects of latent heat and also variations in thermally buffered solidification, with parameter values derived from heat flow and bathymetric variations of oceanic lithosphere. Possibly, lateral variations in the rates of solidification have been responsible for upper mantle heterogeneities.