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Modelling the thermal history of Vesta: time scale of accretion and differentiation.

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Vesta is the only known intact primordial asteroid in the Solar System showing an internal differentiated structure, as inferred by its spectral connection with HED meteorites (Keil et al. 2002, Scott 2007, Coradini et al. 2011). Recent results (Schiller et al. 2011) indicate a faster cooling of the interior of Vesta than previously thought. If confirmed, this would imply that the thermal history of Vesta diverges from the generally accepted picture (Ghosh & Mc Sween 1998). Using the thermal evolution code (Formisano et al. 2011) we developed, we are simulating several thermal and structural evolution scenarios of Vesta, by varying the delay Δtd in the injection of 26Al in Vesta, which controls the strength of radiogenic sources. We consider a primordial Vesta as a sphere of radius 270 Km with the initial temperature fixed to 200 K. The initial composition is a homogeneous mixture of silicatic (77%) and metallic (23%) material. Our code solves contemporary the heat equation with the source term (i.e. the energy is supplied by the decay of 26Al, 60Fe) and the equation for the mass transfer in a porous medium, by using a finite difference 1D method. When the melting temperature of Fe-FeS is reached, the percolation of the iron into the silicatic matrix takes place while, when the melting temperature of silicate is reached, the differentiation and subsequent core formation occur. Since our model does not take in account heat removal mechanisms other than the conduction and the irradiation at the surface, our results supply a reliable picture of the thermal history of Vesta up until the onset of the differentiation. When compared to the data provided by HED meteorites, our results suggest short accretion and differentiation times of Vesta respect to the condensation of CAIs. The scenarios characterized by Δtd > 2 Ma show temperatures not reaching the melting temperature of silicate and for this reason they are incompatible with the basaltic magmatism suggest by HEDs (Keil et al. 2002, Bizzarro et al. 2005). In the scenarios with 1.5 Ma < Δtd < 2 Ma, silicate melting occurs at about t = 6 Ma: this is incompatible with the crystallization ages of the oldest HEDs (Schiller et al 2011, Bizzarro et al. 2005). Finally, values of Δtd < 1 Ma are the most compatible with the geologic history of Vesta as suggested by HEDs.