Modelling the thermal evolution of chondritic asteroids and comparison to geochronological data

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We present spherically symmetric thermal evolution models for ordinary and carbonaceous chondritic asteroids of the 100 km sized class assuming an onion shell structure. The hydrostatic pressure and heat conduction equation are solved by finite difference or element methods. The models consider heating by radioactive decay (^{26}Al, ^{60}Fe), sintering of the powder-like initial material, and melting of the material at higher temperatures. The porosity- and temperature-dependence of the heat conductivity is considered [1-3].

The models are fitted to closing ages and closure temperatures of a number of radioactive decay systems for H chondrites, acapulcoites, and lodranites, to model the thermal evolution of the parent bodies of the H chondrites and of the acapulcoites and lodranites by varying its model parameters and the depth of the burial layers of the meteorites. For all cases the observed cooling history can be fitted very well indicating that the onion shell model can successfully describe the evolutionary history of those parent bodies. The models also indicate that the bodies formed rapidly compared to the half-life of ^{26}Al.

Measured values of the bulk heat conductivity of chondritic material from different meteorites vary by a factor of ~4. This is most likely due to differences in the composition and structure of the material. Thermal models depend significantly on the bulk heat conductivity. In earlier work we treated the bulk heat conductivity as a free parameter in our models and used a parametrised dependence on porosity.

To improve models we determine the value of the heat con-ductivity of chondritic material by numerical modelling. We model the rate of heat flow in a heterogeneous medium consisting of several materials and including pore space. We solve the heat conduction equation for a cube with a certain mineral compo-sition and pore distribution to derive an effective heat conduc-tivity for composed media. We present the current progress of this modelling for chondritic matter of different composition to explore the dependence of heat conductivity on the composition and its implication for thermal models of asteroids.

[1] Henke et al. 2012 *A&A* **537**, A45, [2] Henke et al. 2013 *Icarus* **226**, 212, [3] Gail et al. 2015 *A&A* **576**, A60