Numerical models for the wide-range of thermal processing of planetesimals and asteroids in the early solar system

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Meteorite parent bodies underwent moderate to extreme thermal processing in the early solar system. Parent bodies of achondrite and iron meteorites experienced planetary differentiation [1], whereas, the chondrite parent bodies are known to have suffered thermal metamorphism and/or aqueous alteration. However, the recent paleomagnetic records of some of the chondrites indicate partial differentiation of these bodies [2]. The widespread presence of the two short-lived nuclides ^{26}Al and ^{60}Fe in the early solar system [3] has been considered as the plausible heat source for the thermal processing of planetesimals. We have developed comprehensive numerical codes for the differentiation of planetesimals and asteroids [1, 4]. In the present work, we have performed numerical simulations of the partial differentiation of chondrite parent bodies to understand their proposed thermal history [2]. Further, we have also looked into the possibility of the thermal metamorphism in the outer regions of the partially differentiated planetesimals. We have performed linear accretion growth of (~50% porous) planetesimals of radii 100 and 270 kms, with uniformly distributed ^{26}Al and ^{60}Fe. The larger body corresponds to the asteroid, 2 Pallas that is considered to be the source of carbonaceous chondrites [2]. The heat conduction partial differential equation with the heat source terms was solved numerically using the finite difference method [1, 4]. The sintering of the planetesimals was performed in the temperature range 670-700 K, whereby, the planetesimal lost its porosity, and the thermal conductivity was raised by three orders of magnitude. We numerically performed the gradual growth of iron core subsequent to core-mantle differentiation [1, 4]. The possibility of crust-mantle differentiation was also explored in tune to the Vesta differentiation models [4]. Our results indicate that in order to produce a chondritic crust along an iron core dynamo, the accretion of planetesimal might have continued beyond the initial 5 million years of the solar system. Further, it is extremely important to understand sintering as the anticipated temperature range lies in the regime of thermal metamorphism of chondrites.

References

[1] S. Sahijpal et al., *Meteoritics and Planetary Science* **42**, 1529-1549 (2007).
[2] B.P. Weiss et al., *41st LPSC Conference,* Abstract 1688 (2010).
[3] S. Sahijpal and G. Gupta, *Meteoritics and Planetary Science* **44**, 879-890 (2009).
[4] G. Gupta and S. Sahijpal, *40th LPSC Conference,* Abstract 1530 (2009).