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Early differentiation of planetesimal and the origin of iron meteorites

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Iron meteorites have experienced melting, separation from silicate, and re-solidification during its history. According to analytical studies the separation of metal from silicate had taken place during first a few Myr of solar system and the size of the parent body of iron meteorites are estimated to be from 10 km to several 100 km. Theoretical studies also suggest that the parent body should be larger than 10 km and should be formed during fist 2 Myr to achieve the melting temperature of metallic alloy via heating due to decay of short-lived radioisotopes. These studies seem to be consistent with each other but the mechanism and the condition to be satisfied to form iron meteorites are not revealed so far.

Thus we construct a numerical model to simulate thermal evolution of planetesimals taking into account the melting and separation from silicate of metallic alloy. In this model, planetesimals are assumed to be formed instantaneously and heated by decay of short-lived radioisotopes such as 26-aluminum and 60-iron. Planetesimals are porous just after their formation but pores decrease by sintering due to pressure and temperature effects. When the temperature exceeds the solidus temperature of metallic alloy, molten metal starts migration via permeable flow through silicate media to form metallic core. The metallic core contains a certain amount of impurities at the first time but eventually pure iron precipitate with decrease of core temperature.

We carry out the numerical model for various conditions such as planetesimal sizes, the instantaneous formation time of the planetesimal, the size of silicate grains, and the initial composition of the planetesimal. In this presentation we will present the parameter dependency of numerical results and discuss the condition to form iron meteorites.