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On The Differentiation And Formation Timescales of Terrestrial Planets

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The formation of a planetary core in terrestrial planets is still not well understood. It is commonly assumed that the separation of the iron and silicate phase happened rather rapidly. However, it is still unclear how and when this process took place. Some reasonable scenarios are imaginable (Stevenson, 1990): percolation of liquid iron along grain boundaries in the silicate matrix, rainfall of iron droplets in a molten planetary mantle or sinking of large iron blobs (diapirs) though the solid planetary interior.

Recent research has lead to the conclusion that even relatively small bodies like asteroids can be differentiated. Merk et.al. (2002) showed that the interior is strongly heated due to the decay of ^{26}Al. Sometimes even the solidus temperature of silicate material is exceeded. Yoshino et. al. (2003) show that heating within planetesimals by decay of short-lived radionuclides can increase the temperature sufficiently above the iron-sulphur melting point($\approx 1000^{\circ}$C) and thus trigger the fast segregation of iron alloy. Therefore even small planetesimals (30km radius) are expected to be at least partially differentiated. Since these objects would have been most abundant in the terrestrial region of the protoplanetary nebula (Kokubo, 2000), it is not unlikely that the Earth and other terrestial planets formed by accretion of previously differentiated planetesimals.

We set up a number of models to simulate the differentiation of small planetesimals by sinking of iron droplets within the silicate matrix of these bodies. We evaluate for instance the influence of the size of this bodies, the internal temperature distribution, the density or the viscosity. Further we compare the obtained differentiation times to the growth and collision times of planetesimals in the proto-planetary disc.