Scaling Laws for heat Partitioning in Terrestrial Planets During Core Formation

Henri Samuel (1) & Paul J. Tackley (2)

(1) Bayerishes Geoinstitut, Universitaet Bayreuth, Germany

(2) ETH Zuerich, Institut fuer Geophysik, Switzerland

Core formation is the first major differentiation event that determines the initial conditions from which terrestrial planets have evolved until present.
The separation of metal and silicate in terrestrial planets is likely to generate substantially large amounts of heat by conversion of potential energy into thermal energy via viscous heating.
While estimating the total amount of gravitational heating in a planet is relatively straightforward, determining its partitioning between the silicate and metallic part is not a trivial task.

We thus investigate dynamically the heat partitioning between metal and silicate during core formation by negative diapirism. We model numerically the sinking of iron-rich diapirs through a viscous silicate mantle, in axisymmetric geometry. We carried a parameter study in which viscous heating as well as several viscous rheologies were considered and systematically varied.

We developed a simple semi-analytical "sphere-shell" model that captures the essential physics and we subsequently use it to derive general scaling laws for the time evolution of heat distribution between the iron-diapirs and the silicate material.
These scaling laws are then used to determine the heat distribution within terrestrial planets during their growth and early differentiation.