Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07043, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07043
EGU General Assembly 2008

Earth's core formation aided by flow channelling instabilities induced by iron diapirs

G. Golabek (1,2), P.J. Tackley (1) and H. Schmeling (2)

(1) Geophysical Fluid Dynamics, Institute of Geophysics, ETH Zurich, Switzerland, (2) Institute of Earth Sciences, Section Geophysics, University Frankfurt, Germany (gregor.golabek@erdw.ethz.ch)

The core formation process remains poorly known. Isotopic constraints by Hf/W systematics indicate that larger metal melt pools formed within less than 100 Ma for planets such as the Earth or Mars. An unstable gravitational configuration of a dense molten metallic layer overlying a colder chondritic protocore is predicted by most studies for the time a planetary embryo reaches Mars-size. Impacts of predifferentiated planetesimals or Rayleigh-Taylor instabilities at the base of the iron layer can lead to the formation of iron diapirs in the protocore region. We propose the application of Stevenson's (1989) stress-induced melt channelling mechanism in the region surrounding an incipient iron diapir. We therefore perform numerical experiments solving the two-phase, two compositions flow equations within a 2D rectangular box or 3D cuboid with symmetrical boundary conditions. We apply the Compaction Boussinesq Approximation and include a depth-dependent gravity. We use a constant viscosity for the solid phase and a melt-fraction dependent rheology for the partially molten region. A systematic investigation of the physical conditions under which the melt channels can form is being performed in 2D and 3D, and results are being compared to the isotopic time scale of core formation. For sufficiently small retention numbers iron-rich melt channels develop within a region whose radius depends on the configuration of the deviatoric stress field. This leads to effective draining of the surrounding region and might initiate iron dykes or cascading daughter diapirs. Thus it is possible to extract iron melt also from deeper parts of the initially chondritic protocore without the need of silicate melting. This mechanism could effectively accelerate the process of

core formation and affect the metal-silicate equilibration in the deep planetary interior.