Geophysical Research Abstracts,
Vol. 11, EGU2009-11932-2, 2009
EGU General Assembly 2009

Core segregation mechanism and compositional evolution of terretrial planets

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A singular event in the formation of the earth and terrestrial planets was the separation iron-rich melt from mantle silicate to form planetary cores. On Earth, and by implication other rocky planets, this process induced profound internal chemical fractionation, with siderophile elements (Ni, Co, Au, Pt, W, Re) following Fe into the core, leaving the silicate crust and mantle with strong depletions of these elements relative to primitive planetary material. Recent measurements of radiogenic 182W anomalies in the silicate Earth, Mars and differentiated meteorites imply that planetesimals segregated metallic cores within a few Myr of the origin of the solar system. Various models have been put forward to explain the physical nature of the segregation mechanism (Fe-diapirs, 'raining' through a magma ocean), and more recently melt flow via fractures. In this contribution we present the initial results of a numerical study into Fe segregation in a deforming silicate matrix that captures the temperature-dependent effect of liquid metal viscosity on the transport rate. Flow is driven by pressure gradients associated with impact deformation in a growing planetesimal and the fracture geometry is constrained by experimental data on naturally deformed H6 chondrite. Early results suggest that under dynamic conditions, fracture-driven melt flow can in principle be extremely rapid, leading to a significant draining of the Fe-liquid metal and siderophile trace element component on a timescale of hours to days. Fluid transport in planetesimals where deformation is the driving force provides an attractive and simple way of segregating Fe from host silicate as both precursor and primary agent of core formation. The potential for flow of metal-rich melt to induce local magnetic anomalies will also be addressed.