Geophysical Research Abstracts, Vol. 8, 03049, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03049

Differentiation of Terrestrial Planets by Diapirism: Comparing Mars And Earth

R. Ziethe (1), W.Benz (1), D. Giardini (2)

(1) Physikalisches Institut, University of Berne, Sidlerstr.5 CH - 3012 Bern, Switzerland (ruth.ziethe@phim.unibe.ch),
(2) Institut für Geophysik, ETH Zürich, ETH Hönggerberg HPP P1, 8093 Zürich, Switzerland

The formation of a planetary core in terrestrial planets is still not well understood. It is commonly assumed that the formation of an iron core at the center of the terrestrial planets happened rather rapidly. However, it is still unclear how the separation of iron and silicate material took place within different terrestrial planets. Some reasonable scenarios were suggested by 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. Here we focus on one single process, which is the sinking of kilometer sized iron drops. Although this aspect of core formation may not have been the only one happening, it might still have dominated for some time. We want to investigate, whether the sinking of very large iron drops is an effective process, capable of bringing the iron to the planets center in a short time ($\approx$30Ma) even for planets with a smaller gravitational acceleration than the Earth.

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 is exceed. 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°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. The cores or terrestrial planets may then be considered as a kind of blended composite of pre-formed cores.

To test the theory mentioned above we set up models of proto-planets which have roughly the size of the present Earth and Mars, which consists of a mixture of silicate and iron, where the iron is represented by randomly distributed blobs, which should represent the pre-formed cores.

We find that the sinking of large iron drops happens rather fast. The cores can be finished within a couple of million years. However, one has to keep in mind, that the model is currently rather simple. Future work will not only include more effects that play a significant role in terrestrial core formation, but also take results from planet formation models and cosmochemistry into account.