Influence of rotation in iron and silicat particles in an early magma ocean

A. Möller, U. Hansen
University of Münster, Institut of Geophysics

During its evolution, the Earth most likely experienced a 'Giant Impact' in which a Mars size body hit the early planet. Today it seems widely accepted that the origin of the Moon is a result of this Giant Impact. Another consequence of such an impact would be the formation of a 'Deep Magma Ocean', i.e. a layer of molten material, extending to a depth of about $1000km$. Transport of heat and matter in a vigorously convecting Magma Ocean plays a key-role for the further evolution and differentiation of the Earth. The sinking of iron droplets in the convecting Magma Ocean probably provides an effective mechanism leading to the separation of metallic and silicate material. Dense material would finally pond at the bottom of the magma ocean. An instability of this dense material (Rayleigh-Taylor Instability) could lead to a rapid formation of the the Earth's Core. Further, the dynamics of a Magma Ocean under the influence of dense silicate crystals is interesting to study, since it leads to a better understanding of layer formation in the later Earth's mantle. We employed a 3D cartesian numerical model with finite Prandtl number, in order to study the sinking of heavy particles in a vigorously convecting environment. Differently from most approaches we have included the effect of rotation on the flow dynamics. While a significant role of rotation can be ruled out for the today's Earth's mantle, due to the high viscosity of the mantle material, this is not the case for a magma ocean. Our numerical fluid model is based on a Finite Volume discretization, while the numerical model for the iron droplets based on an discret element model for the simulation of granular Material. The particles influence the fluid flow throught the chemical component of the fluid model, wich is the volumetric ratio of the particle in each fluid cell. The particles themselves experience the force of the fluid throught the fluids drag. Also gravitational and corriolis forces act on the particles. In our simulations unlike to other approaches the particles are much smaller than the numerical fluid cells, thus saving computational effort. The parallel model in 3D is capable of modeling fluid-particle systems with over 10^6 particles. With the help of computer experiments, using this method, we want to archieve a better understanding of the setteling processes in the early magma ocean.

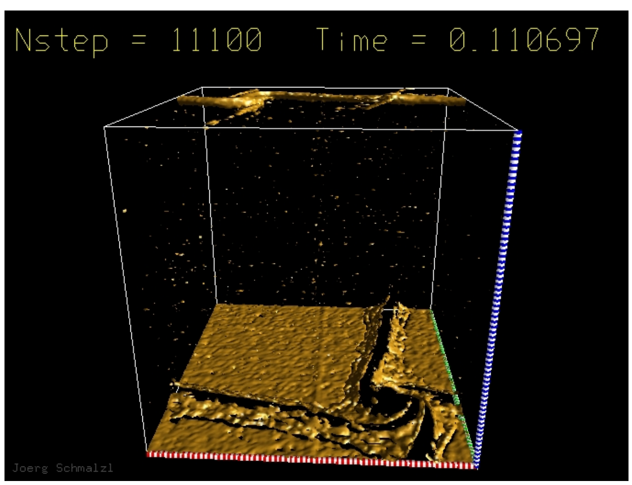

Abbildung 1: First impressions of the behavior of heavy tracers in a convecting and rotating fluid. This picture shows the chemical component, wich is volumetic ratio of the particles in the fluid. The Parameters for this case are $Ra = 3 \cdot 10^4$, $Ta = 10^4$, $Pr = 1.0$ with over $1.5 \cdot 10^6$ particles.