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Influence of rotation on iron particles in an early magma ocean

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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. 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 discrete element model for the simulation of granular Material. The particles influence the fluid flow through the chemical component of the fluid model, which is the volumetric ratio of the particle in each fluid cell. The particles themselves experience the force of the fluid through the fluids drag. Also gravitational and Coriolis 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. In our present work we study the influence of strong rotation on the iron droplets with a rotation axes parallel to the gravitational acceleration like on the earth pole and with an rotation axes perpendicular to gravity like on the equator. Depending on the Rossbynumber of the system we find a different behavior of the particles. For the poles the particles fall nearly with stokes velocity to the bottom. Where as for the equatorial case the particles can stay suspended depending on the strength of the Coriolis force acting against gravity. Although our study is just in the beginning this scenario may lead to a interesting setup for the following core formation processes.