Experimental modeling of the cooling of partially crystallized magma ocean:
Application to the thermal history of terrestrial bodies.

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By the end of accretion, the temperature of terrestrial bodies is high enough so that their mantle is largely molten, forming an homogeneous magma ocean (MO). Because of efficient convective and radiative heat transfers, the MO is likely to crystallize quickly, producing a mixture of liquid silicate bearing crystals in suspension. In the case of the Moon, the late stage of the MO solidification is characterized by the crystallization of plagioclase lighter than the surrounding melt, and leading to the formation of a flotation layer. The large amount of anorthosite in the current lunar crust is an evidence justifying this scenario.

The present work develops an experimental approach to characterize and model the behavior of this kind of a floating lid of particles at the top of a convective body. We use a 30x30x5 cm^3 tank filled with a viscous fluid bearing PMMA beads. Both secular cooling and bulk radiogenic heating drive convection in a MO. Experimentally, homogeneous internal heating throughout the fluid is produced thanks to a modified microwave oven. *Laser Induced Fluorescence* method is used for temperature imaging, whereas the fluid velocity is measured by *Particles Imaging Velocimetry*.

We first consider the stability of a layer of light crystals at the top of a convective magma ocean. We identify four different regimes: (1) a partial erosion regime, (2) a total erosion regime, where the lid is totally unstable, (3) a deposition regime, where the bulk fluid is hot enough to let particles settle at the bottom of the tank, and (4) a coexistence regime, where particles settle at the top and at the bottom of the tank. We show that the inversion of the buoyancy of the beads relative to the fluid is not appropriate to explain their settling behavior. This result underlines that a special emphasis has to be put on the competition between the buoyancy of beads and the vigor of convection. Thus, a criteria derived from the balance between buoyancy energy of beads and energy carried out by the convective fluid yields a satisfying description of the influence of fluid motion on the stability of the flotation layer.