Crystals stirred not shaken: Constraints on the solidification processes in magma oceans from direction numerical simulations

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A key challenge in constraining the solidification processes in magma oceans is determining the ability of individual crystals to decouple from vigorous thermal convection and settle out or float. In this contribution, we discuss how direct numerical simulations of crystal motion in magmatic flow can shed light on the geophysical and geochemical conditions under which crystals settling and flotation is possible in magma oceans. Our approach complements earlier studies by explicitly linking the thermal, petrological, and fluid dynamical evolution of a magma ocean and by focusing specifically on the effect of increasing crystal fraction on differentiation. We show that efficient crystal settling is only possible under special conditions and depends sensitively on the extent of early melting and the size of the planet.