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Dynamics of Magma Ocean Crystallization

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The thermochemical evolution of the magma ocean has profoundly influenced the differentiation of the planet, the core-formation process, the structure and dynamics of the mantle, and the time history of the magnetic field. A magma ocean is a very complex system at extreme conditions. Though there is little hope to realistically simulate the full dynamics of a magma ocean, a well-balanced model approach to the magma ocean phenomenon will help us better understand key features of transport phenomena in the magma ocean and their importance.

So far, numerical simulations of magma oceans have mostly used one-dimensional parameterizations for the progressing solidification. As already mentioned, a direct numerical simulation of the magma ocean at the level of individual crystals would go far beyond the capabilities of today's computer systems. We present a single-continuum model based on classical mixture theory [1] with a hybrid approach to model the processes in the mush region.

[1] Bennon, W.D., Incropera, F.P. 1987. Int. J. Heat Mass Transfer 30, 2161–2170.

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