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Solid-liquid silicate equilibrium at HP/HT: Application to a crystallizing magma ocean

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The nature of mantle phases both at solidus and at liquidus represents a key part in the understanding of the dynamics of the deep mantle. At the end of Earth's accretion and after the core-mantle segregation, the possibility of a basal magma ocean at the top of the CMB depends on the physical properties of materials at relevant pressure and temperature. Seismic observations such as ultralow-velocity zones (ULVZs) and large low-shear velocity provinces (LLSVPs) raise the question of the existence of partially molten regions in the present mantle.
We built a solid-liquid thermodynamic data base of silicates in the MgO-FeO-SiO_2 system from the available experimental and computational data. We compute self-consistent phase equilibria in this system and show that our model is in good agreement with melting experiments and partionning coefficient measurements. We predicts both the inversion of the solid phase at incipient crystallization (ferro-periclase below 28 GPa, perovskite after) and the inversion of the liquid/solid density contrast with depth. Based on this thermodynamic approach, we discuss our preliminary results on the geodynamical evolution of the Earth magma ocean by computing the sequence of crystallization of this magma and the associated segregation dynamics.