Silicate melt viscosities at high pressure: Experimental results and its implication

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It is believed that the early Earth experienced several episodes of magma-ocean, with a major one just after the giant Moon-forming impact. In this framework, the viscosity of the silicate melts is a key to understand the dynamics of the magma ocean and the recrystallization processes.
We succeeded to extend the experimental measurements of silicate-melt viscosity up to about 30 GPa and more than 2500 K, by devising an *in-situ* falling sphere method coupled with boron-doped diamond heater and ultra-fast cameral (1000 f/s) in the multi-anvil apparatus. We determined viscosities of molten forsterite, enstatite and diopside from 5 to 30 GPa and at temperatures just above their liquidus; reproducibility of the measurements is within a few percents. Experimental uncertainties were estimated by Monte Carlo method based on the uncertainties of pressure, temperature, falling sphere velocities and sphere size.
The viscosity of the melt with forsterite composition increases with increasing pressure along the liquidus, while those of enstatite and diopside melt compositions decrease with increasing pressure. Melt viscosities of the three compositions are found very low, in the range of 0.01 to 0.1 Pa.s, at mantle pressure conditions. The extremely low viscosity implies a short life-time for the magma ocean (1-6 thousands years) and, potentially, a fractional crystallization.

Keywords: Magma ocean, Viscosity, Silicate melts, Boron doped diamond, High pressure

