Viscosity of silicate melts at high pressure measured by *in-situ* falling sphere method

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The Earth experienced an early episode of magma ocean, in particular after the giant Moon-forming impact. Some partial melting still occurs today in the upper mantle. The viscosity of magma is a key to understand the various magmatic processes that can occur within the Earth. However, the accurate measurement of the silicate melt viscosity at high pressure has been limited to 13 GPa due to the high melting temperature and extremely low viscosity of silicate melt. We succeeded to extend the viscosity measurement to higher pressure by devising the *in-situ* falling sphere viscometry with boron doped diamond heater and ultra-fast cameral (1000 f/s) in Multi-anvil apparatus. Boron doped diamond is an ideal heater material for *in-situ* falling method because of its X-ray transparency and refractoriness exceeding 3000 C.
Viscosities of forsterite and diopside compositions were measured at 10 GPa, just above the liquidus temperature.The viscosity of enstatite composition was measured twice at 10 and 15 GPa, to confirm the good reproducibility.The viscosity of forsterite, enstatite, and diopside composition at 10 GPa are measured to be 0.023, 0.023 and 0.038 Pa.s, respectively. Forsterite and enstatite melts have similar viscosities, while diopside melt has much higher viscosity.The viscosity of forsterite composition at 15 GPa is 0.013 Pa.s, which is much lower than that at 10 GPa.
The experimental pressure range can be extended to higher than 23 GPa with the present cell assembly. The viscosity data at the higher pressure can be used to constrain the partitioning of gravity energy between the metal and silicate melts during the core formation. It can be used as well to estimate the largest grainsize of crystals entrained during the magma ocean solidification, which enables us to distinguish fractional or batch solidification of the magma ocean.

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