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Viscosity of K2TiSi4O9 melt at high pressure and high temperature

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Viscosity of magma (silicate melt) at high pressure is very important to understand the magmatic processes in the terrestrial planets. However, detailed knowledge about the relation between the pressure dependence of viscosity and the pressure-induced structural change of melt is still insufficient. In this study, the viscosity of melt with K2TiSi4O9 composition was measured by in-situ falling sphere method at high pressure, because the structures of K2TiSi4O9 glasses quenched from melts at high pressure were investigated using XANES (X-ray absorption near edge structure) spectra by Paris et al. (1994). The viscosity was measured using an X-ray radiography technique with a large volume multi-anvil apparatus at BL14C2 beamline at the Photon Factory, KEK, Japan. The settling velocity of a platinum sphere was measured in X-ray images. X-ray diffraction data of a pressure marker was collected by the energy-dispersive method using a pure-Ge solid state detector soon after the observation of the sphere falling. The pressure at the run condition was determined by using the equation of state for MgO. We observed that the viscosity of K2TiSi4O9 melt decreased up to 3.3 GPa. However, viscosity increased with increasing pressure above 4.2 GPa. On the basis of XANES spectra of K2TiSi4O9 glasses, Paris et al. (1994) showed that the coordination number of titanium increased with increasing pressure. The viscosity minimum of K2TiSi4O9 melt between 3.3 and 4.2 GPa suggests that the melt becomes depolymerized under high pressure.

Keywords: magma, silicate melt, viscosity, high pressure