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Viscosity of titanium-bearing silicate melts at high pressure

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Knowledge about viscosity of silicate melt is valuable for understanding the activity of magma in the planetary interiors. The high-Ti magmas erupted on the lunar surface. These magmas contains TiO2 up to 16 wt%. Because the viscosity change at high pressure is affected by the structural change of TO4-network, it is very interesting to know the influence of Ti on the pressure dependence of viscosity. We performed viscosity measurement of K2TiSi4O11 melt as an analogue of the lunar high-Ti magmas. Viscosity was measured by the falling sphere method using an X-ray radiography system. Experiments were performed at the NE7A station of the PF-AR synchrotron radiation facility in KEK, Tsukuba, Japan. We found that the viscosity of K2TiSi4O11 melt has a viscosity minimum at 3 GPa. Paris et al. (1994) reported that the coordination number of titanium increases with increasing pressure on the basis of the XANES spectra of glasses synthesized under high pressure. Our results suggest that the viscosity minimum of K2TiSi4O11 is strongly related to the coordination change of titanium. The viscosity minimum is also found in the terrestrial MORB magma. Recently, Sakamaki et al. (2013) proposed that the viscosity minimum causes the low velocity zone of seismic wave in the upper mantle. The present study suggests that the high-Ti melt causes an attenuating zone in the deep lunar mantle.

Keywords: magma, viscosity, moon, mantle