Pressure-induce structural change of germanate melts and effects of chemical compositions

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Structures of liquid silicates, in particular their responses to compression, are of great interest for geophysics and material science. SiO2 melts is a main constituent of all geologically relevant (magma), and a prototype of network-forming liquids, which have possibilities for observing pressure-induced polymorphic phase transition. However, the experimental study of structural change of liquid silicates is difficult because extreme pressures and temperatures are needed and the number of in-situ technique for observing liquid structure is restricted under such conditions. Germanates are structural analogs of silicates. Most germanates undergo comparable phase transition but at lower pressure, hence they have been used as model compounds which can be more easily studied on pressure-induced structural change.

In order to examine the pressure-induced structural change of liquid germanates, short range order of liquid germanates have been investigated by means of high-pressure and high-temperature in situ X-ray absorption fine structure (XAFS).

Two types of liquid germanates, $Li_2Ge_4O_9$ and $SrGeO_3$, show an abrupt fourfold-sixfold coordination number change around 3 GPa. The coordination number change is completed below 4 GPa upon which a high-density liquid consisting of octahedrally coordinated germanium is stabilized. Coordination number changes in both liquid germanates occurs within narrow pressure range of less than 1 GPa in spite of a wide diversity in chemical composition. These results suggest that there would be less effects of coexisting cations on the local structural change around Ge comparing with solid state. By considering the analogy of germanates to silicates, several implications for the evolution and dynamics of the Earth's interior can be extracted.