

PGE transport in sodium silicate melt: Insights from X-ray absorption spectroscopy

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The Platinum Group Elements (PGE) have significant economic value for their unique physical and chemical properties. The majority of PGE are associated with magmatic systems and form reefs within layered mafic intrusions. However, the processes that transport and deposit PGEs are still in dispute, i.e., magmatic or late hydrothermal processes? Thus, a fundamental molecular understanding of the speciation of PGE in magmatic and hydrothermal liquids is critical to constraining accurate petrogenetic and ore deposit models. Most existing experimental data on PGE species in silicate melt are calculated based on the variation in PGE solubility as a function of oxygen fugacity (f_{O_2}). A recent study found Pt existed as a Pt-Cl complex ($PtCl_4^{2-}$) in hydrothermal chloride-bearing fluids using Synchrotron X-ray absorption spectroscopy (XAS)^[1]. Currently, no direct investigations are available for the complexation of PGE with silicate species. Here we build on recent work showing that hydrous (40 wt% H₂O) Na silicate liquids exist in equilibrium with quartz+feldspar - a continuous change in composition down temperature may truly bridge the gap between traditional silicate melts and hydrous fluids as it represents a near 50:50 mass ratio of H₂O to sodium silicate.

In this study we experimentally measured the bonding environments around Pt/Pd in H₂O-riched alkali silicate liquids combining XAS measurements. Initial samples were synthesized in a gold capsule using a rapid quench cold-sealed vessel at a range of temperatures (T) (550-760 °C) and 1 kbar by adding a certain amount of hydrous sodium disilicate (~30 wt% H₂O), quartz, albite and Pt/Pd oxides or chlorides sources. The quenched samples were further analyzed with XANES/EXAFS at the 13-ID-E beamline, APS. By comparing the Pt L3-edge (Fig. 1) or Pd K-edge spectra between experimental liquids and references, our preliminary results show that the positions of the absorption edge and white line (the first intensive peak of the spectrum) of the Pt/Pd samples are identical to Pt/Pd foil standards, exhibiting a zero-valence state at oxygen fugacity (f_{O_2}) near Ni-NiO. Currently double capsule experiments using oxidizing buffers are underway to investigate PGE species with different f_{O_2} , T , H₂O/melt ratio and Cl content.

[1] Tagirov, GCA, 2019

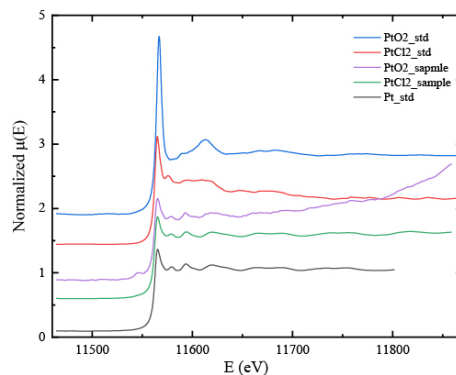


Fig. 1. The Pt L3-edge spectra of experimental liquids and reference substances: Pt foil, Pt²Cl₂, Pt⁴O₂, std: standard. Note for sample PtO₂, the baseline increasing from 11.7 KeV is due to the influence of Au (from capsule) dissolved in the melt.