

# PGEs transport in hydrous sodium silicate melts: a study from X-ray absorption spectroscopy

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The Platinum Group Elements (PGEs) have significant economic value for their unique properties. The major deposits of PGEs are “reefs” which form within layered mafic-ultramafic intrusions. However, the processes that transport and deposit PGEs are still in dispute, i.e., magmatic or late hydrothermal processes? Thus, a fundamental understanding of the speciation of PGEs in magmatic and hydrothermal liquids is critical to constrain accurate petrogenetic and ore deposit models. Most existing data on PGEs species in silicate melt are calculated based on the variation in solubility vs. oxygen fugacity ( $fO_2$ ). A recent study found Pt existed as a  $PtCl_4^{2-}$  complex in hydrothermal Cl-bearing fluids using Synchrotron X-ray absorption spectroscopy (XAS)<sup>[1]</sup>. Currently, no direct investigations are available for the complexation of PGEs with silicate species.

In this study we experimentally determine the oxidation state and bonding environment of Pt/Pd in H<sub>2</sub>O-rich alkali silicate liquids<sup>[2]</sup> using synchrotron-based XAS as a function of  $fO_2$  and Cl contents at 750 °C, 1 kbar. Samples were synthesized using a rapid quench cold-sealed vessel with the double capsule method to impose  $fO_2$ . Quenched samples were analyzed with XAS at the 13-ID-E beamline, APS. By comparing the Pt L<sub>3</sub>-edge or Pd K-edge spectra between experimental products and references (Fig. 1), our results show that the Pt/Pd samples are identical to PtO<sub>2</sub> and PdO standards, respectively, under the most oxidized condition (Mn<sub>3</sub>O<sub>4</sub>-Mn<sub>2</sub>O<sub>3</sub>), with a Pt-O distance ~ 1.70 Å and a Pd-O distance ~ 1.44 Å (uncorrected for phase shift). This implies that Pt predominantly exists as Pt<sup>4+</sup>O<sub>2</sub>, while Pd exists as Pd<sup>2+</sup>O in the glasses. Notably, a decrease in the absorption edge and white line was observed under more reduced conditions, indicating reduction to lower valence states. When  $fO_2$  decreases to NNO, the spectrum closely resembles the reference Pt/Pd metal. No Pt-Cl or Pd-Cl scattering was observed in any of the measured samples, despite the addition of 12% Cl in the glass. We propose that the main Pt/Pd species should thus be the metallic phase under typical redox conditions of magmas linked to mafic intrusion, making efficient Pt/Pd transport challenging.

References:

1. Tagirov, GCA, 2019; 2. Lundstrom, JGR, 2020.