

# The speciation and solubility of platinum in crustal and upper mantle fluids

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Platinum is an important metal that has a wide range of applications from catalysis to healthcare. Yet its mobility and speciation in geochemical environments have been difficult to establish. Recent experimental and modeling results for platinum speciation and solubility have investigated the role of chloride-bearing fluids in the transport of platinum [1,2]. Building on these studies, we used experimental thermodynamic properties of aqueous Pt(II) chloride complexes [1] [2] combined with advances in the estimation of the standard partial molal volumes at ambient conditions in the Deep Earth Water (DEW) model [3, 4], we developed Helgeson-Kirkham-Flowers (HKF) equations of state for aqueous platinum chloride complexes to enable the prediction of Pt solubility and speciation over wide temperature and pressure ranges. Our model was initially calibrated at 900°C and 2 kbar using experimental data [1,2] to account for the increased Pt(II) solubility with increased chloride concentrations in NaCl-HCl fluids in equilibrium with crystalline Pt. Our aqueous speciation model included Pt<sup>++</sup>, PtCl<sup>+</sup>, PtCl<sub>2</sub>, PtCl<sub>3</sub><sup>-</sup>, and PtCl<sub>4</sub><sup>-2</sup>, the first three of which varied proportionately at lower chloride concentrations. However, at very high chloride concentrations approaching 32 molal Cl, PtCl<sub>4</sub><sup>-</sup> became the dominant species, in agreement with previous studies [1,2]. The results enable refinement of the prediction of the standard partial molal entropies and heat capacities [5] needed in the DEW model of the principal complexes of aqueous Pt. Developing such effective models is crucial for broader and deeper insight into the mobility and speciation of Pt and the platinum group elements in general.

[1] Sullivan et al. (2022). *Geochim. Cosmochim. Acta*, 316, 253–272.

[2] Tagirov et al. (2015). *Geochemistry International*, 53(4), 327–340.

[3] Sverjensky et al. (2014). *Geochim. Cosmochim. Acta*, 129, 125–145.

[4] Huang and Sverjensky (2019), *Geochim. Cosmochim. Acta*, 254, 192.

[5] Sverjensky et al. (1997), *Geochim. Cosmochim. Acta*, 61, 1359.