

Platinum-group elements fractionation by selective complexing

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Even though the platinum-group element (PGE) concentrations in magmatic ores and basaltic rocks are at the low ppm to low ppb level, the noble metals Os, Ir, Ru, Rh, and Pt commonly form discrete mineral phases, many at liquidus temperature. The most common platinum-group minerals (PGM) are PGE alloys, sulfides, arsenides, sulfarsenides, and tellurides. We investigate experimentally the behavior of Os, Ru, Ir, Rh and Pt in S-As-Te-bearing sulfide and silicate systems between 1300 and 900°C. We show that long before saturation is reached in silicate and sulfide melts discrete (μm -sized) PGM can crystallize as liquidus phases, some (if not all) PGE occur in associated form, in the form of nanoclusters, nano-particles, and nano-phases (Helmy et al. 2013). Osmium tends to associate preferentially with other PGE to form metal-metal associations, Ru associates mostly with S, Ir and Rh seem to prefer the anionic ligands As and S, and Pt associates preferentially with Fe, As, and Te. When finally discrete phases become stable, the PGM associations likely reflect the chemical affinities of the PGE with their preferred ligands that were stable at superliquidus temperature as nanophases: Os as metallic Os-Ir-Ru alloys, Ru mostly as sulfide (RuS₂ laurite), the elements Ir, Rh as sulfarsenides (irarsite IrAsS, hollingworthite RhAsS) and Pt as arsenide and telluride (sperrylite PtAs₂, moncheite PtTe₂). The distribution of the noble metals among silicate, sulfide, and metal phases may be governed by the surface properties of of their nano-associations rather than by the chemical affinities of the metals or their charged cationic species. Selective complexing followed by physical separation leads to noble metal fractionation in nature. Caution is advised in applying simple system experiments that do not contain the appropriate anionic ligands to model the fractionation of PGE in complex natural compositions.

[1] Helmy H. *et al.* (2013) *Nature Communications*, **4**, DOI: 10.1038/ncomms3405.