

MECHANISMS CONTRIBUTING TO SULPHIDE FRACTIONATION: EVIDENCE FOR SULPHIDE MELT PERCOLATION AND COMPOSITIONAL VARIATION RELEVANT TO THE BUSHVELD COMPLEX, SOUTH AFRICA – IMPLICATIONS FOR PLATINUM MINERALIZATION

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PGE mineralization in Rustenburg Layered Series of the Bushveld complex is strikingly focused on chromite bearing horizons in the Merensky and UG2 reefs. The mechanisms by which this association is achieved are not completely clear, yet it is known that these horizons also mark the sites of injections of new magma. The mechanisms by which the association between chromitite and PGE concentration is achieved are not clear, however it is argued that sulphide melt had an important role to play considering that other PGE mineralized reefs in the Bushveld, e.g. Platreef, contain almost no chromite (Cawthorne, 1999). Current BC mineralization models struggle to address the details of the role played by the sulphide fraction of the magma. For example, if PGE's have been concentrated in chromitite by immiscible sulphide liquids, why are the PGE concentrations in the reefs apparently too high to be reconciled with their current sulphide contents (Godel et al, 2007)? This has prompted several authors to argue that the reef horizons have lost sulphur or sulphide (Naldrett & Lehmann, 1988). In this work, the concept proposed by Godel et al (2007), that chromitite layers may have acted as a physical barrier to denser downwards percolating sulphide melts is investigated experimentally. Experiments were performed at 1Atm between 1250 to 850°C, to constrain phase relations in a Merensky Reef sulphide proxy [Cu (4.69 Wt%), Ni (11.79 Wt%), Fe (45.7 Wt%), S (36.9 Wt%) + 100ppm pt]. The liquidus was bracketed between 1100 and 1050 °C, where the first *mss* crystals were noted; *mss* exists in equilibrium with melt until 850 °C, where the melt fraction is so low that melt only exists as inclusions in larger *mss* grains. Chromite-sulphide melt interaction was investigated by allowing sulphide melt, at 1050°C - 900°C and 4kbar, to move downwards through two layers of partially melted pyroxenite that were separated by a narrow (2mm) thick layer of chromite. Image analysis on BSE images demonstrate that the median sulphide melt–chromite dihedral angle is extremely low, ~11° compared to ~33° for silicate minerals. These angles are far lower than the percolation threshold (60°) for natural systems, however low fractions of sulphide melt are trapped within the chromite layer by virtue of the fact that the wet the grain boundaries so efficiently and capillary forces (“sponge” effect) hold the melt in the chromite layer. In contrast, within the silicate layer, sulphide melt coalesces promoting vertical movement. Additionally, sulphide melt existing above 950°C preferentially leaches Fe²⁺ from chromite causing *Mss* to crystallize. This lowers the S concentration of the melt, lowering Pt solubility which results in the formation of Pt alloys within chromitite. The further removal of sulphide melt from chromitite layers by re-crystallizing chromites or/and percolation could contribute to extremely high Pt/S within chromitites. Sulphide compositional trends do indicate that bulk sulphides in the Merensky chromitites represent a differentiated Cu-rich melt, and highly preferential partitioning of Pt (D=0.013) caused this melt to be concentrated with Pt. In conclusion, experimental evidence does indicate that chromitites likely acted as a reservoir for evolved Pt-Cu-Ni rich sulphide melts, and that secondary process, including the leaching of Fe²⁺ from chromite caused large amounts of Pt alloys to precipitate in chromitites.

Reference list:

- Cawthorne RG (1999) Platinum-group element mineralization in the Bushveld Complex – a critical reassessment of geochemical models. *South African Journal of Geology*. 102: 268-281.
- Eales HV 2000 **Implications of the chromium budget of the Western Limb of the Bushveld Complex**. *South African Journal of Geology*, 103: 141 - 150

- Finnigan CS, Brenan JM, Mungall JE and McDonough WF, 2008, Experiments and Models Bearing on the Role of Chromite as a Collector of Platinum Group Minerals by Local Reduction, *Journal of Petrology*, 49:9, 1647-1665.
- Godel, B.; Barnes, S.-J. and Maier, W. D. (2007) Platinum-group elements in sulphide minerals, platinum-group minerals, and the whole rock of the Merensky Reef (Bushveld Complex, South Africa): Implication for the formation of the reef. *Journal of Petrology*, 48, 1569-1604.
- Naldrett AJ and Lehmann J, 1988. Spinel non-stoichiometry as the explanation for Ni- Cu- and PGE-enriched sulphides in chromitites. *In Geoplatinum '87* (eds. H. Prichard P. Potts J. Bowles and S. Cribb) Elsevier London p. 93-110.