Pt is highly mobile in high T brines

HANLEY, J.J. AND MUNGALL, J.E.

Department of Geology, University of Toronto, Toronto, Ontario, Canada (hanley@geology.utoronto.ca)

Introduction

Many large PGM (platinum group metals) deposits (Merensky, Sudbury, Lac de Iles) host early stage aqueous fluid inclusions which are extremely saline (30-90 wt% eq. NaCl). The role that these fluids played in redistributing the PGM at the magmatic-hydrothermal interface (>500°C) has not been previously investigated experimentally.

Experimental Method

The solubility of Pt metal in hypersaline (20-70 wt% NaCl), high temperature (600-800°C) fluids is being investigated at 1 to 2 kbar in Au capsules using cold seal bombs under simultaneously controlled pH and fO_2 using the solid buffer assemblages $NaAlSi_3O_8$-Al_2SiO_5-SiO_2 and MnO-Mn_3O_4. Pt solubility is measured by collecting all capsule fluid and quench products using an aqua regia leach, and analysing the leachate for Pt by ICP-MS.

Results

Table 1 summarizes experimental conditions and measured Pt solubilities from two experimental runs at P_{H2O} = 1.5 kbar and total run time = 200 hrs for each experiment.

Table 1. Experimental results

#	T	pH	log fO_2	Cl_{tot}	a_{Cl-}	[Pt]
1	600°C	4.83	-15.6	50wt%	0.21	341 ppm
2	600°C	4.64	-15.6	70wt%	0.33	609 ppm

Discussion

At 600°C, Pt solubility appears to increase with increasing salinity and decreasing pH and in general is very high in the brines. Based on this preliminary data, Pt solubility at these conditions may be governed by the following reaction, based on the dependance of Pt solubility on a_{Cl-} and pH:

$$Pt_{(s)} + 1/2O_2 + 2H^+ + Cl^- = PtCl^+ + H_2O_{(l)}$$

Pt-hydroxychloride complexes may also be important at these conditions. The dominating complex is uncertain at this time.

The Pt solubilities measured are two to four orders of magnitude higher than those measured previously for other PGM at slightly lower T (400 - 500°C), lower fO_2 (Ni-NiO to Re-ReO_2), and much lower salinities (<9 wt% KCl)[1]. Even assuming a two to three order of magnitude decrease in solubility for a more geologically realistic fO_2, these results demonstrate that most of the primary Pt concentration in such deposits could be redistributed, provided that slightly acidic conditions are maintained (neutral pH at 600°C is ~5.8). We have not yet ruled out the possibility of Pt-Au alloying as an explanation for the high solubilities measured, but at the least, this data demonstrates that Pt is highly mobile in high temperature, hypersaline fluids.

References

[1] Xiong, Y. and Wood, S.A., (2000), *Contrib. Min. Pet.*, 68, 1-28.

Late Archean-Early Proterozoic Formation and Reworking of a Porphyry Cu(Mo) Deposit Recorded in Molybdenite: Re-Os Dating at Malanjkhand, Central India

J. HANNAH[1], H. STEIN[1], A. ZIMMERMAN[1], R. MARKEY[1], S.C. SARKAR[2], AND A.B. PAL[3]

[1] AIRIE Program, Colorado State University, Fort Collins, CO 80523-1482 USA (hstein@cnr.colostate.edu)
[2] Geol Sciences, Jadavpur University, Kolkata 700032 India
[3] Malanjkhand Copper, HCL, Malanjkhand 481116 India

The origin of the giant porphyry Cu(Mo) deposit at Malanjkhand (100 mt @ >1% Cu) has been debated, both from the aspect of origin (porphyry, lode type, or sedex) and age (Proterozoic or Archean). The deposit is situated in a composite granodiorite to tonalite batholith that is locally highly deformed. Non-robust dating (Rb-Sr, K-Ar) yields intrusion ages that span the early Proterozoic. The bulk of the mineralization occurs in a sheeted, steeply dipping, and intensely deformed “quartz reef” that is 2 km long and up to 200 m wide. A small portion of the mineralization is contained in altered granitoid as disseminations or veinlets rimming dynamically recrystallized quartz and feldspar grains. Quartz reef and granitoid are locally intertwined, occurring as lenses within one another. Based on geologic relationships, the mineralization in the quartz reef is younger.

Re-Os dating of molybdenite at Malanjkhand demonstrates that this Cu(Mo) deposit is of latest Archean-earliest Proterozoic age, and appears to capture two subsequent episodes of metamorphic reworking. We suggest that the deposit was originally associated with K- and silica-rich regions of a large porphyry Cu(Mo) system that suffered brittle-ductile deformation and dynamic recrystallization, coinciding with development of quartz reef mineralization. Two samples of granitoid-hosted disseminated molybdenite each yield identical ages of 2493 ± 8 Ma. Replicate analyses of one reef sample yield ages of 2479 ± 8 and 2474 ± 9 and replicate analyses of a second reef molybdenite yield ages of 2449 ± 8 and 2455 ± 8 Ma. Another reef sample, however, yields a Re-Os age of 2494 ± 8 Ma, suggesting that at least part of the reef formed contemporaneously with the disseminated mineralization in the intrusion. Brittle-ductile deformation and reworking continued for at least 40 m.y. We believe that high Re concentrations, as seen at Malanjkhand (400-600 ppm), are typical of subduction-related porphyry ore-forming processes that include mantle involvement. Archean porphyry Cu examples appear to be relatively rare, but dating may be essential in identifying them.

References

Sarkar, S.C., Kabiraj, S., Bhattacharya, S., and Pal, A.B. (1996) *Mineralium Deposita* **31**, 419-431.

Stein H.J., Markey R.J., Morgan J.W., Hannah J.L., and Scherstén A. (2001) *Terra Nova* **13**, 479-486.