Transport of Au, platinum-group elements, Ni and Cu in a S-vapor

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There are a number of experiments demonstrating that platinum-group elements (PGE), Au, Ni and Cu have high partition coefficients between silicate melt and base metal sulfide liquid and between silicate melt and alloys. Thus in igneous systems the distribution of PGE is thought to largely be controlled by a combination of sulfides and alloys. The role of vapors in controlling PGE is much less understood and yet some volcanic vapors do contain PGE. Furthermore, transport of PGE, S, Cu and Ni by vapor have been suggested for some ore deposits such as Noril'sk and Duluth. The purpose of our study was to investigate whether: Au, PGE, Ni and Cu could be transported by a S-vapor, whether there was a preferential transport of some elements; and as which species the elements were transported

Twenty-three runs using the tube-in-tube technique were carried out. A S-rich $(FeNiCu)_{1-x}S$ doner doped with 2000 ppm of Au and PGE's was placed in the outer tube and S-poor FeS receiver in the inner tube. The tubes were then evacuated and heated to 1000 ^{O} C or 1100 ^{O} C for 2 days, after which they were quenched and the run products mounted and polished. The compositions of the phases were determined by microprobe and ICP-MS laser ablation.

Copper Ni, Au, Pd and Pt were found to be present in the receiver and thus were transported by the S-vapor. Iridium, Rh and Ru concentrations in the receiver were close to detection level (20 ppb) and thus transport by a S-vapor seems unlikely for these elements. The order of mobility for the precious metals appears to be Au>Pd~Pt>>Ru~Rh~Ir. In most runs Ni was more mobile than Cu. These observations suggests that deposits from S-vapor should be enriched in Ni, Cu, Au, Pt and Pd and depleted in Rh, Ru and Ir. Neither Cu nor Au showed a positive correlation with $f\mathrm{S}_2$ suggesting that these elements were transported as metals in the S vapor. Platinum, Pd and Ni concentrations correlated with $f\mathrm{S}_2$ suggesting that these elements were transported as S-species. In those runs where Rh, Ru and Ir concentrations were > detection limit there is a positive correlation with $f\mathrm{S}_2$ suggesting that these elements were transported as S-species, but as there are only a few data points this conclusion is tentative.

Experimental study of boron transport in vapor phase to 200°C

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Dissolution experiments of boric acid in under-saturated water vapor at 100, 120, 155 and 171°C were performed in 40 cm^3 titanium-alloy (VT-8) reactors put in an air-thermostated oven SNOL-3.5M. Open titanium ampoule containing 0.5 to 1 g of dry solid was placed into the autoclave. Weighted amount of de-ionized and degassed water was introducedat the bottom of the reactor outside the ampoule. Pressure was estimated from the reactor free volume and loaded amount of water according to PVT properties of pure water vapor. At the end of the run, the reactor was quenched in cold water for 15 min., the ampoule was weighted, and the solid and water condensed on the reactor walls and bottom were washed with de-ionized water. Boron concentrations aqueous solutions were measured using colorimetry with the ash-rezorcine complex.

The results obtained shows that at low water pressures boron concentration decrease with H2O pressure. This can be interpreted by the formation in the vapor of dehydrated boron species: $H_3BO_3(s)=HBO_2(g)+H_2O(g)$. But at H_2O pressures close to the saturation, we find other dependence - increasing of boron concentration with H_2O pressure, that is likely to be interpreted by the formation of hydrated species. The quantification of species stoichiometry was estimated by $\lg P(H_2O)-\lg X(B)$ plot as hydrated polymer $H_8B_2O_7$. The reaction of boric acid solubility in this condition is $2H_3BO_3(s)+H_2O(g)=H_8B_2O_7(g)$.

Vapor-aqueous solution partition coefficients were determined at 100 and 155°C at the saturated vapor pressure of the system using a special titanium reactor which allows sampling of the vapor phase through a capillary tubing during the run. The values of partition coefficients for boron between water vapor and aqueous solution of boric acid were found to be independent of boron solution concentrations up to 2 mol B/kg H_2O. In more concentrated solutions we find the dependence of partition coefficients. This result has a good agreement with solubility of boric acid in non-saturated vapor and other data.

The results of this study imply that hydrolysis and hydration could be also important for other elements in H_2O vapor phase. These processes should be taken into account to accurately model element fractionation and chemical equilibria during both magma degassing and fluid boiling.

Acknowledgement

This research was supported by RFBR 03-05-64696.