HOKKAIDO UNIVERSITY

Title	Solubility of AgCl in NaCl-Bearing Solutions at 250℃ and 400℃ under Different Pressures
Author(s)	Gupta, Alok K.
Citation	北海道大学理学部紀要, 18(3), 445-448
Issue Date	1978-03
Doc URL	https://hdl.handle.net/2115/36665
Type	departmental bulletin paper
File Information	18_3_p445-448.pdf

Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

Jour. Fac. Sci., Hokkaido Univ., Ser. IV,
vol. 18, no. 3, Mar., 1978, pp.445-448.

SOLUBILITY OF AgCl IN NaCl-BEARING SOLUTIONS AT 250°C AND 400°C UNDER DIFFERENT PRESSURES.

by

Alok K. Gupta

(with 3 figures)

(Contribution of the Department of Geology and Mineralogy
Faculty of Science, Hokkaido University, No. 1547)

Abstract

Solubility measurements of AgCl in NaCl-bearing solutions at different temperatures and pressures show that with the increase of temperature, pressure and NaCl concentration the solubility also increases. The results show that at 250°C and 50 bar the solubility of AgCl in a 2 molar solution is 4.55% whereas in a 1.5 molar solution it can be as high as 25% at 400°C and 1120 bar. The study suggests that silver can be transported as silver-chlorine complexes by ore-bearing fluids.

Introduction

Fyfe and Henley (1973) considered that ore deposits represent fossil remnants of hydrothermal systems in the crust. According to them formation of ore and gangue minerals therefore may be related to the movements of hot fluids through fracture system or zones of structural weaknesses of the rocks, where they are concentrated. The fluid inclusions associated with ore deposits are often found to be saline (Roedder, 1967). Study of natural hot waters collected at a temperature of 340°C from the bore holes at Salton Sea shows high concentrations of Na, K and Cl and notable amounts of Cu, Zn, Pb, Mn and Ag (Barnes, 1967). Henley (1971) demonstrated that the solubility of gold drastically increases in the system quartz-muscovite-K-feldspar-hematite-magnetite-2 molar KCl at a pressure of 2 kb. These observations indicate that halogen content of the fluids may influence the solubility of the metals in the ore-forming fluids. Solubility of AgCl in NaCl-bearing solutions of different molarities was therefore studied to see if the presence of chloride has any significant effect on the solubility of Ag. Accumulation of such solubility data involving various other metals should provide more informations regarding the role of chloride in the fluid transport processes.

Experimental Technique

Experiments were performed in seated quartz tubes (18 cm long with an inside diameter of 0.5 cm). A AgCl crystal cut in the form of a cube, was carefully weighed and then placed inside a tube. The weight of the tube plus the crystal was measured. A known volume of solution of desired molarity was

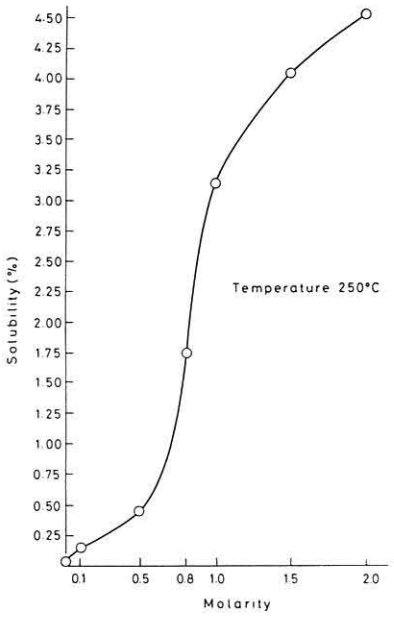

Fig. 1 Solubility of AgCl in NaCl-bearing solutions of different molarities at 250°C. The density of vapor phase in all experiments is 0.65 ± 0.05.

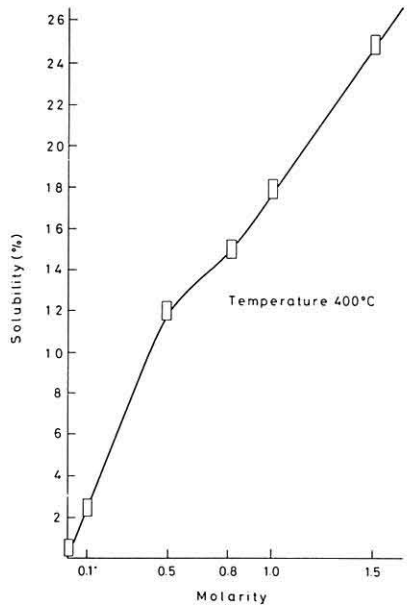

Fig. 2 Solubility of AgCl in NaCl-bearing solutions of different molarities at 400°C. The density of vapor phase is 0.65 ± 0.05.

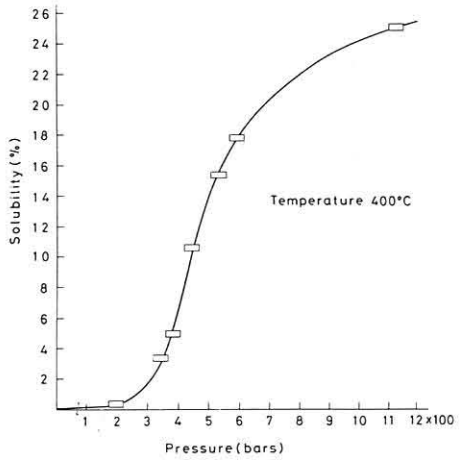

Fig. 3 Solubility of AgCl at 400°C under various pressures in a NaCl-bearing solution, the molarity of which is 1.5.

then poured inside the tube by means of a pypette. The tube containing the crystal and the solution was weighed. The height of the column of the solution was measured and then the other end of the tube was fused. A piece of wet cotton was wrapped around the tube to prevent any loss of solution during the process of fusing. The height of the solution was measured again to ensure that the volume of the solution remained constant.

Experiments were carried out in an externally heated pressure vessel at different temperatures and pressures. At a given temperature if the density of the vapor phase is known; the vapor pressure inside the tube can be estimated by using the table of Kennedy and Holser (1966). The density of the vapor phase was determined from the knowledge of the heights of the solution column and the tube. After the experiments the vessel was quenched in water, the quartz tube was taken out of the vessel and cut by a saw. The AgCl crystal was throughly washed in distilled water. It was then dried in an oven for about an hour and then carefully weighed. The loss of weight of the crystal gave the amount of AgCl, that was dissolved by the solution. It should be pointed out here that although the mechanism is simple a slight error in the measurement of weight could cause significant error in the solubility measurements. Some selected runs were therefore repeated to check their reliability.

Discussion

Experimental results of the investigation are summarized in Figs. 1, 2 and 3. The study indicates that with the increase in the concentration of NaCl in the solution the solubility also increases. Comparison of Fig. 1 with Fig. 2 shows that if the molarity of the solution is kept constant the solubility of AgCl increases. For example in a 1.5 molar solution if the density of the vapor phase is 0.65 the solubility of AgCl is 15.7% at 400°C in contrast to 4.03% at 250°C. Fig. 3 demonstrates that as the pressure increases the solubility of AgCl also increases. The rate of increase is low between 1 and 250 bars but it increases drastically between 300 and 600 bars and at pressures more than 900 bar it approaches a constant value. Experimental results show that the solubility of AgCl in a 2 molar solution at 250°C and 50 bar is 4.5% which is equivalent to 3.42% Ag whereas in a 1.5 molar soltion the solubility at 400°C and 1128 bar is 25%, which correspond to 18.81% Ag. The study shows that like gold, silver can also be transported by fluids as chloride complexes, the compositions and exact nature of which were not determined in this study.

These results clearly demonstrate that the presence of chlorides in a hydrothermal fluid probably plays a significant role (Fyfe and Henlay, 1973 and Fyfe, 1974) in dissolving metals, present in insignificant amounts from

rocks in deeper level of the crust where P-T conditions are high. As the solubilities of Au and Ag increase at higher temperatures and pressures the saline fluid will be enriched in these elements. However, as it moves upward and passes through the thrust or shear zones, a drop in the P-T condition in the upper level of the crust would lower the solubility of these elements and cause their precipitation along the zones of structural weaknesses in the host rock.

Acknowledgements

This study was carried out at the University of Western Ontario. The author is indebted to Professor W.S. Fyfe, who suggested the problem.

Reference

Barnes, H.L., 1967. *Geochemistry of hydrothermal ore deposits.* Holt, Rinehart and Wilson. New York.

Roedder, E., 1967. *Fluid inclusions as samples of ore fluids.* Holt, Rinehart and Wilson. New York.

Fyfe, W.S., R.W. Henley, 1973. Some thoughts on chemical transport processes with particular reference to gold. *Mineral Sci. Eng.* 5(4), 295-303.

Fyfe, W.S., 1974. *Geochemistry.* Carledon Press. Oxford. Kennedy, G.C., W, T. Holser, 1966. Pressure-temperature and phase relations of water and carbon dioxide. *Hand book of physical constants* (ed. S.P. Clark, Jr). G.S.A. Mem. 97, 311-383.

(Received on Oct. 31, 1977)