

## The solubility of Au in H<sub>2</sub>O-H<sub>2</sub>S gas mixtures

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Magmatic-hydrothermal systems commonly contain high proportions of vapor and, in some cases, the vapor phase may be dominant. Moreover, there is increasing evidence that this phase can transport appreciable concentrations of metals. In the case of gold, there is also evidence that it may even partition preferentially into the vapor over the liquid. In a previous study, we demonstrated that neutral solvated sulfide gaseous complexes of Au significantly enhance the solubility of gold in the vapor phase [1]. It is also known from other studies that the formation of hydrated species may positively influence the solubility of metals in liquid-undersaturated vapor. Therefore, it is reasonable to propose that the preferential partitioning of gold into vapor relative to liquid is due to the increased stability of hydrated complexes of Au involving reduced sulfur in H<sub>2</sub>O-H<sub>2</sub>S gas mixtures. We report here the results of an experimental study designed to test this hypothesis

The experiments were carried out in titanium alloy autoclaves at temperatures from 300 to 365°C and total pressures (estimated from the independently measured PVTx properties of H<sub>2</sub>S-H<sub>2</sub>O gas mixtures) up to 300 bars. The results of the study show that the solubility of Au in H<sub>2</sub>O-H<sub>2</sub>S gas mixtures increases with temperature and *f*H<sub>2</sub>S. The solubility of Au at 300-350°C and fugacities of H<sub>2</sub>O up to about 100 bars appears to be controlled dominantly by sulfide or bisulfide complexes of Au solvated by H<sub>2</sub>S. However, at greater fugacities of H<sub>2</sub>O, solvation of complexes of Au with reduced sulfur by water molecules is pronounced and increases the solubility of Au by more than one order of magnitude over that in pure H<sub>2</sub>S. Based on the results of our experiments, we propose that there may be as many as four molecules of H<sub>2</sub>O in the hydration shell of gaseous sulfide or bisulfide Au species at 350°C. Thus, with increasing pressure, the solubility of Au in the aqueous vapor containing H<sub>2</sub>S will rapidly increase and, at conditions typical for natural hydrothermal systems the formation of hydrated sulfide/bisulfide complexes may be sufficient to explain the concentration of gold to economic levels.

[1] Zezin D.Yu. Migdisov Art.A. Williams-Jones A.E. (2007) The solubility of gold in hydrogen sulfide gas, An experimental study, *GCA* **71**, 3070-3081.

## Electrical conductivity of MgO at high pressure and high temperature

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Periclase (MgO) has been the subject of extensive study because it is relevant as an end-member of magnesiowüstite (Mg,Fe)O, which is proposed to be the second most abundant phase in the lower mantle. The electrical conductivity of MgO has been measured in a KAWAI-type multianvil high-pressure apparatus at 20 GPa and in the temperature range 700-1700K. A MgO+5% Cr<sub>2</sub>O<sub>3</sub> octahedral pressure medium with 10 mm edge length was used, the edge length of tungsten carbide anvils was 31 mm and their truncated edge length was 4.0 mm. All of the reproducible and reversible conductivity data were fitted to Arrhenius equation  $\sigma = \sigma_0 \exp(-\Delta H/kT)$  by a Levenberg-Marquardt nonlinear procedure, where the activation enthalpy  $\Delta H = \Delta E + P\Delta V$  with activation energy  $\Delta E$  and activation volume  $\Delta V$ . As a result, the preexponential factor, activation energy and activation volume were calculated to be  $\sigma_0 = 8745 \pm 2$  S/m,  $\Delta E = 1.057$  eV, and  $\Delta V = 0.292$  cm<sup>3</sup>/mol, respectively. Comparing the previous magnesiowüstite (Mg<sub>1-x</sub>Fe<sub>x</sub>)O and perovskite-magnesiowüstite assemblages data, the large activation energy and positive activation volume were inconsistent with the small and large polaron conduction mechanism. As a result, the ionic mobility, the diffusion coefficient of the Mg vacancy and the self-diffusion coefficient of Mg ion were estimated in this study, which suggested that the ionic conduction caused by the migration of Mg<sub>Mg</sub><sup>x</sup> via V<sub>Mg</sub><sup>''</sup>, can be the conduction mechanism in periclase (MgO) at high temperature and pressure.

This work was supported by funds from the Natural Science Foundation of China (No. 40537033, 40374025) and Program for New Century Excellent Talents in University (NCET-05-0553). We gratefully acknowledge financial support from COE-21 Collaborative Research Program at ISEI, Misasa, Japan.