Sulphur solubility in hydrous silicic melts at different oxygen fugacities

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The solubility of sulphur (S) in felsic silicate melts has implications on the volatile budget of degassing magmas and associated volcanic eruptions. Further, the S content in hydrous magmas controls the formation of magmatic sulfides which are likely to scavenge metals, and thus, control ore formation.

The solubility of sulphur in felsic melts is less well understood than in mafic melts and this study tests the solubility behaviour of S under different oxygen fugacities. We have conducted piston-cylinder experiments using a dacitic melt composition and anhydrite as starting materials. Two different run conditions at 850 °C and 2 kbar and 1000 °C and 3 kbar were applied, respectively. Oxygen fugacity was varied from NNO−1 to NNO+6.5 using different mineral buffers in a double capsule assembly. The inner capsule was loaded with anhydrite followed by the dacite mix and again by anhydrite on top. About 10 wt% H2O was added and the run duration was 3–7 days.

Quenched glasses showed many vesicles in the 850 °C and 2 kbar runs, indicating the exsolution of a fluid phase, whereas the 1000 °C runs showed only small fractures upon quenching. The quenched glasses contain small crystals (plagioclase, pyroxene) and irregular quench structures.

A Cameca SX100 electron microprobe was used to determine the S concentration in the glasses. Due to some heterogeneities in the quenched glasses, the concentration variation for some experiments causes the errors to overlap, and thus, obscure a trend of S concentrations under varying oxygen fugacities. This issue is currently under investigation and we are testing different analytical procedures in order to obtain smaller variations for some glasses. Overall, the concentrations for the lower temperature and pressure experiments are lower than for the higher temperature experiments. Whether this is a temperature or pressure effect will be evaluated in further experiments.

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Spectrophotometry of Au(III)-halide complexes

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Understanding the mobility of gold in near-surface, low T environments will aid the development of effective exploration strategies, particularly as many new low-temperature deposits are typically low-grade and contain 1–3 g/tonne total gold. This presents challenges for successful exploration and hydrometallurgical processing, especially in playa environments and where saline groundwater is used in mineral processing. Knowledge of the speciation behaviour and reaction chemistry of gold in brines is therefore potentially of twofold economic significance, leading to advances in both finding and recovering the resource. Despite the perception of gold as a highly resistate element, it is mobile under a range of weathering environments and has been directly observed to exist in three natural oxidation states; Au(0), Au(I) and Au(III). All of these states are mobile so knowledge of the speciation behaviour of gold in a given environment is a prerequisite for understanding its mobility. The present study describes a UV–Vis spectrophotometric study designed to identify the aqueous species and measure the formation constants of Au(III)-halide complexes to quantify chloride/bromide ligand competition in oxidised Au–H2O–halide environments. Under near-surface conditions, the [AuCl4]− complex undergoes ligand substitution with Br− according to the series [AuCl4−nBrn]−, where n = 0–4. Initial modelling suggests formation constants (Log βn for Au3+ + 4L− → [AuL4]−; L = Cl− or Br−) for the series are 25.3, 27.5, 29.5, 31.0 and 32.2, respectively. Good agreement is noted between these results and the electrochemical study of Chateau et al. (1966) for the two end-member complexes [AuCl4]− and [AuBr4]−. The intermediate complexes (n = 1,2,3), identified here for the first time, are predicted to predominate in solution even at low [Br]/[Cl] ratio, suggesting that inclusion of the whole series of complexes in gold speciation models may result in a more accurate description of the solutions involved in gold-mobility in the oxidised weathering zone and provide a deeper understanding of ligand competition in saline ore-processing systems.

Reference

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