The role of CO2 in porphyry molybdenum deposits: constraints from partition coefficients for molybdenum between a CO2-bearing saline fluid and a felsic melt.

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Porphyry-type molybdenum deposits, many of which are in China, supply most of the World's molybdenum. Of particular importance are the molybdenum deposits located in the Qinling-Dabie region that are responsible for more than half of China's molybdenum production. A feature that distinguishes this suite of deposits from the better-known Climax and Endako sub-type of porphyry molybdenum deposits is their formation from CO2-rich magmatic-hydrothermal fluids [1-2]. The role of CO2, if any, in the transport of molybdenum by these fluids, however, is poorly understood. To address this issue, we conducted experiments on the partitioning of molybdenum between a fluid containing H2O-CO2, H2O-NaCl, or H2O-NaCl-CO2 and a felsic melt at 850 °C and 100 and 200 MPa. The compositions of fluid inclusions trapped in quartz during the experiments and the composition of the coexisting melt were analyzed with LA-ICP-MS and were used to determine partition coefficients for molybdenum between fluid and melt ($D_{Mo} = C_{Mo}^{fluid}/C_{Mo}^{melt}$) in the above systems. The results of the experiments show that in the H2O-CO2 system there is almost no change in $D_{Mo}$ with increasing $X_{CO2}$. In the H2O-NaCl system, the $D_{Mo}$ increases progressively with increasing salinity. Addition of > 0.1 mole% CO2 to a H2O-NaCl fluid causes the fluid to separate into a high-density brine and a low-density vapor. The $D_{Mo}$ for the brine is significantly higher than the $D_{Mo}$ for the supercritical conditions of the H2O-NaCl system (Fig.1). Based on our experimental results and the characteristics of ore-forming fluids (CO2-bearing vapor and brine inclusions invariably coexist in Dabie-type porphyry Mo deposits), the presence of CO2 promotes the exsolution of separate brine and vapor phases from felsic magmas, a process that leads to an increase in $D_{Mo}$ for the brine and is critical in forming Dabie-type porphyry molybdenum deposits.

Reference