Controls on Solubility and Deposition of Quartz, Calcite, and Fluorite in Boiling, Saline Hydrothermal Systems

JK Barrier[a], M Steele-MacInnis[a]

[a]Earth and Atmospheric Science, University of Alberta, AB, Canada

Hydrothermal systems are responsible for the transport and deposition of minerals in many deposit types. Epithermal deposits are near-surface hydrothermal systems that are correlated to underlying intrusive hydrous magmas which are either the source of the fluids or provide the thermal energy required for fluid circulation. Fluids in these systems range from nearly pure H_2O through to saline fluids of up to >10 wt% NaCl equivalent, and boiling is an important depositional mechanism for both ore and gangue minerals in such epithermal systems. As fluids ascend and boil, dissolved components are no longer able to remain in solution, and are precipitated to form veins.

Numerical modeling of quartz solubility in pure H_2O along the boiling curve shows that quartz precipitation is dependent on the temperature at which the fluid boils, the rate that the fluid temperature decreases, and the extent of vaporization. Here, we have applied a new model for the solubility of quartz, calcite, and fluorite in H_2O-NaCl fluids to investigate how fluid salinity and temperature in boiling systems affect the deposition and transport of these common gangue minerals. Our results show that at 0 wt% NaCl (i.e., pure H_2O), mineral solubilities increase with increasing temperature in both the liquid and vapor, but solubility in the liquid phase reaches a maximum around 300 °C, and decreases with increasing temperature thereafter. As fluid salinity increases, all three minerals show enhanced solubility, especially in the liquid phase. Our results also show that boiling-induced deposition of all three minerals is enhanced with increasing salinity of the fluid. At 15 wt% salinity, our results reveal that the optimal temperature for rapid deposition of these minerals differ, with quartz deposition being optimal at lower T of 410-430 °C compared to calcite and fluorite deposition which are optimized at higher T of 430-475 °C.

Corresponding author: jbarrier@ualberta.ca