

Compositions of fluid phases and quartz solubility in H₂O-NaCl-CO₂ fluids in mesothermal gold deposits

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Hydrothermal fluids in orogenic and intrusion-related gold deposits are dominated by H₂O-NaCl-CO₂ fluids. In this study, thermodynamic modeling was conducted to constrain the fluid properties and quartz dissolution/precipitation behavior under single- and two-phase conditions in the H₂O-NaCl-CO₂ system at temperatures of 300 to 500 °C and pressures of 0 to 3.5 kbar.

Increasing CO₂ and/or NaCl contents shift the solvus to higher pressures and temperatures, expanding the pressure-temperature region of L+V immiscibility. Isopleths of CO₂ content in coexisting, immiscible vapor and liquid confirm that fluid phase separation cannot produce fluids of pure CO₂ through the studied P-T-x ranges. Rapid drop in pressure is an efficient mechanism driving fluid immiscibility at specific ranges of temperature and composition, producing liquid-rich inclusions with relatively high salinity, and vapor-rich inclusions with relatively low CO₂ content. In contrast, immiscibility driven primarily by cooling will take place only in the case of initial fluids with relatively high CO₂ contents (>10 mol. %), and gives rise to diverse fluid inclusion types: producing a liquid with low salinity and low CO₂ contents and a high-density vapor with moderate to high CO₂ contents up to ~65 mol. %.

Quartz solubility in the H₂O-NaCl-CO₂ fluids shows strong dependence on temperature, pressure, and CO₂ content. Solubility of quartz generally decreases with decreasing temperature and pressure, and increasing CO₂ content both in the single- and two-phase fluids, but exhibits retrograde behavior in the L+V field and near the phase boundary between single-phase and L+V. In orogenic gold deposits, decompression-induced quartz precipitation during pressure fluctuation is dominant in bedding-parallel shear veins. Fault-related extensional veins are associated with initial decompression-induced quartz precipitation and subsequent cooling-dominated deposition.