

Solubility of Alkali Elements and Chlorine in Sulfide Melts Under Magmatic Conditions: Implications for Ore Genesis

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A notable characteristic of magmatic sulfide occurrences within mafic intrusions is their frequent spatial association with hydrous and alkali- and chlorine-bearing minerals. The reason for this consistent proximity has been a subject of debate. Although prior interpretations have often invoked post-magmatic fluid activity or late alteration processes, the specific affinity of these mineral types for sulfides has persisted as an open question, suggesting a possible fundamental genetic relationship underlying these occurrences. To explore this potential link, we conducted experiments focused on quantifying the capacity of sulfide melts to incorporate sodium, potassium, and chlorine under conditions mimicking those found within the Earth. The outcomes of our investigations demonstrated a substantial degree of dissolution for alkali metals (reaching concentrations up to 3.5 wt %) and chloride (up to 0.3 wt %) at elevated temperatures (1100–1250 °C) and high pressures (0.5–1 GPa), under oxygen fugacities typical of the Earth's mantle ($\Delta\text{FMQ} = -2$ to 0). From these experimental findings, we infer that potassium, sodium, and chlorine may play a significant role in the mobilization of metals from the mantle source. This could be accomplished through their influence on reducing the melting temperatures of sulfides and by facilitating their upward movement via density reduction. Subsequently, during the cooling and solidification of these sulfide melts, the incorporated elements would be released. This expulsion could lead to the enrichment of adjacent silicate minerals or contribute to the formation of a later fluid phase. Consequently, this mechanism offers a potential explanation for the observed mineral assemblages and could also enhance the capacity of magmatic-derived hydrothermal fluids to form ore deposits.