

Coupled Redox and Volatile Evolution in Arc Magmatic Systems: Implications for Porphyry Copper Fertility

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Understanding the processes that control porphyry copper formation remains a central challenge in economic geology. In particular, the relationship between magmatic redox state, volatile budgets, and their evolution through time in arc systems is still debated, partly due to the difficulty of tracking these parameters across successive magmatic stages.

Here, we investigate the temporal evolution of redox conditions and volatile systematics in arc magmatic systems using mineral-scale geochemical proxies preserved in intrusive rocks. This approach allows us to evaluate how these parameters vary across different stages of magmatic evolution and to assess their potential role in controlling metal transfer from magmas to hydrothermal fluids.

We observe systematic variations in both redox indicators and volatile-related signatures that appear to be closely coupled through time. We explore potential processes driving these trends, including progressive degassing, changes in melt composition and source contributions, and evolving geodynamic conditions within long-lived magmatic systems.

We discuss the implications of these observations for the development of ore-forming conditions in arc environments and evaluate how coupled redox–volatile evolution may influence magmatic fertility. Together, these results provide a framework for linking magmatic processes to mineralization and for refining exploration strategies based on geochemical signatures.