Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19326

Volatile and Trace Element Evolution in Apatite from Ore-forming Volcanic Systems, West Luzon Arc, Philippines

GEORGE STONADGE[1], ANDREW J MILES[2] AND DANIEL J SMITH[2]

[1]The University of Leicester
[2]University Of Leicester
Presenting Author: grs17@leicester.ac.uk

Volatiles are key for scavenging, transporting, and concentrating metals in volcanic systems. Recording these events is crucial for the study and prediction of mineralization in porphyry copper deposits (PCD) - the world's main source of copper. Recent advances in our understanding of volcanic apatite have revealed promising methods for identifying volatile exsolution pertinent to ore-formation. However, studies using host minerals as a means of constraining the relative order in which different apatite crystals form have produced conflicting interpretations [1,2], precluding a robust interpretation of how volatiles evolve over time in ore-forming magmas. Here, we present the volatile and trace element compositions of volcanic apatite measured by Secondary Ion Mass Spectrometry to obtain a clearer interpretation of volatile behaviour.

Apatites from Pinatubo - a well-studied volcanic analogue for PCDs - show a decrease in XCl/XOH and increase in XF/XCl with increasing REE (X = mole fraction). We propose that this change is driven by increases in XF and REE with concurrent decreases in XCl over time. Fluorine and the REEs are incompatible in silicate minerals and fluid phases and their concentrations therefore, increase during crystallization. Chlorine, by contrast, preferentially partitions into fluid under volatile-saturated conditions. We thus conclude that apatite from Pinatubo records volatile exsolution that is driven by crystallization. Sulphur concentrations are highest at low XF/XCl values (0.1-0.75 wt.%) and decrease sharply with increases in XF/XCl perhaps recording the extraction of this ore-forming component after small amounts of volatile-saturated crystallization. A second volcanic system, Taal, has no evidence of Cu mineralization. Here, as REE increase with time, XF/XCl decreases and XCl/XOH increases. This is the opposite trend to Pinatubo and can only be recreated with undersaturated crystallization. The absence of Cu mineralization at Taal may be due to a lack of volatile saturation and S (< 0.024 wt.%) which are key for generating PCDs.

These results have broad application for understanding the volatile evolution in arc magmas and forming predictive tools for PCDs.

References

[1] Popa et al., 2021. Chemical Geology, 570, p.120-170. doi:10.1016/j.chemgeo.2021.120170

[2] Stock et al., 2018. Journal of Petrology 59(12):2463-92. doi:10.1093/petrology/egy020