Coexisting melt and fluid inclusions at Batu Hijau: evidence for primary magmatic aqueous fluids and their relationship to mineralisation

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In most theoretical models of orthomagmatic ore deposit formation primary magmatic aqueous fluids derived from, or contained in, the parental magma are a critical agent. Melt and fluid inclusion studies show that primary magmatic aqueous fluids do exist, can be preserved, and their compositions approximate the compositions of the originally trapped phases [1].

At Batu Hijau Porphyry Copper-Gold Deposit, Sumbawa, Indonesia [2], we show that primary magmatic fluid inclusions exist in quartz phenocrysts from samples of pre- and post-mineralisation felsic intrusives. We also show that the coexisting melt and primary magmatic fluid inclusions represent immiscible melt and fluid phases coexisting in the parental magma. Since these inclusions are protected in quartz phenocrysts, and show no sign of significant post-trapping contamination, their compositions (which we analyse by LA-ICPMS) approximately correspond to those of the respective phases pre-trapping.

Significantly, given that Batu Hijau is a copper deposit, there is an increase of 2-3 orders of magnitude in Cu concentrations between pre- and post-mineralisation primary magmatic fluid inclusions, but no equivalent increase in any other measured element concentrations, and no significant increase in Cu concentrations in coexisting melt inclusions. These results are consistent with efficient sequestering of Cu from the parental melt into an immiscible aqueous phase, and the consequent production of a Cu-depleted residual magma, or with the intrusions having been emplaced with Cu already present as a phase (aqueous fluid?) independent of the silicate melt.

These results suggest that if coexisting primary melt and fluid inclusions can be found in a suite of rocks, they may provide a relatively simple, rapid, and inexpensive test of mineralising potential and/or verification of syn-, pre-, or post-mineralisation status, as well as providing a tool to enhance our understanding of volatile phase exsolution and its relationship to mineralisation.

We gratefully acknowledge the assistance of John Hammond, Newmont Australia Limited, and Steve Garwin.

References

[1] Roedder, E. (1984), Fluid Inclusions, Reviews in Mineralogy, **12**.

[2] Irianto B., Clark G.H.(1995), AIMM, **9/95,** 299-304.