Why El Abra is a Cu-only porphyry

H. A. Cocker[1]*, J.-W. Park[1], I. H. Campbell[1] and D. L. Valente[2]

[1]Research School of Earth Sciences, The Australian National University, Acton ACT 0200 Australia (*correspondence: helen.cocker@anu.edu.au)

[2]Whaleback Hub, BHP Billiton, P.O. Box 655 Newman 6753, Western Australia

The extreme silicate melt-sulfide melt partition coefficients of platinum group elements (PGE; Ru, Rh, Pd, Os, Ir, and Pt), which are appreciably higher than those for Cu and Au, make them valuable indicators of sulfide saturation in evolving melts [i.e. 1]. PGE have been successfully used to identify sulfur saturation in mafic systems [e.g. 2] but analytical difficulties have limited their application in felsic systems. Recent advances in the inductively coupled plasma mass spectrometry (ICP-MS)-NiS fire assay-isotope dilution method [3] mean it is possible to measure the PGEs at concentrations as low as 1 to 20 ppt, so rocks with very low abundances can be analyzed, including felsic suites. As a consequence, PGE geochemistry can be used to identify the onset of sulfide saturation in evolving felsic magmas. We hypothesized that if a fractionating magma system becomes sulfide saturated before it becomes fluid saturated most of the Cu and Au will be trapped in sulfides in a plutonic chamber and be unavailable to enter a magmatic hydrothermal fluid. Alternatively, if fluid saturation occurs before sulfide saturation most of the Cu and Au will be available to partition into the hydrothermal fluid, which could lead to the formation of an economic Cu and/or Au deposit.

We report results from the first comprehensive study of PGE in felsic magmas associated with an economic porphyry system. Abundances of Pt and Pd in felsic rocks from the El Abra-Pajonal intrusive complex and porphyry Cu deposit, Chile, drop rapidly in samples with MgO values below 2.5 wt. %, following sulfide saturation of the magmas, which occurs slightly before volatile saturation and formation of the copper deposit. We suggest that the amount of sulfide melt that formed was enough to strip the PGE and Au from the magma but not Cu, because of the lower partition coefficient of Cu relative to the precious metals, which explains why El Abra is a Cu only porphyry deposit rather than a Cu-Au deposit.

[1] Campbell and Barnes (1984) *Can. Mineral.*. **22**, 151-160
[2] Keays and Lightfoot (2007) *Miner. Deposita.* **42**, 319-336
[3] Park *et al* (2012) *Geochim. Cosmochim. Acta* **93**, 63-76