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Porphyry copper enrichment linked to excess aluminium in plagioclase

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Porphyry copper deposits provide around 75%, 50% and 20% of world copper, molybdenum and gold, respectively [1]. The deposits are mainly centred on calc-alkaline porphyry magmatic systems [2,3] in subduction zone settings [1]. Although calc-alkaline magmas are relatively common, large porphyry copper deposits are extremely rare and increasingly difficult to discover. Here, we compile existing geochemical data for magmatic plagioclase, a dominant mineral in calc-alkaline rocks, from ‘fertile’ (porphyry-associated) and ‘barren’ magmatic systems worldwide. We show that plagioclase from ‘fertile’ systems is distinct in containing ‘excess’ aluminium. This signature is clearly demonstrated in a case study carried out on plagioclase from the ‘fertile’ La Paloma and Los Sulfatos copper porphyry systems in Chile. In addition to this, the presence of concentric zones of high excess aluminium suggests its incorporation as a result of magmatic processes. As excess aluminium has been linked to high melt water contents, the concentric zones may record injections of hydrous fluid or fluid-rich melts into the sub-porphyry magma chamber. We propose that excess aluminium may exclude copper from plagioclase so enriching the remaining melts. Furthermore, this chemical signature can be used as an exploration indicator for copper porphyry deposits.

References:

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