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Porphyry Cu±Mo±Au and IOCG deposits in continental interiors

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Porphyry Cu±Mo±Au and IOCG deposits share many similar features, including an association with calc-alkaline to mildy alkaline subvolcanic intrusions, metal contents, and alteration styles (Groves et al., 2010; Sillitoe, 2010). They differ most obviously in the preponderance of Fe-sulfides in porphyry deposits versus Fe-oxides in IOCG deposits, which reflects higher S-contents in the former. IOCG deposits are also more abundant than porphyry deposits in Precambrian rocks, whereas porphyry deposits are found most abundantly in Mesozoic and Cenozoic rocks; IOCG deposits also tend to have larger high-temperature alteration footprints.

The recent recognition of a broad class of post-subduction porphyry deposits that occur in post-arc, off-arc, or distal arc settings in continental interiors (Hou et al., 2009; Richards, 2009) provides a link to IOCG deposits that are most commonly associated with incipient continental rifting environments. We suggest that such deposits share a source in previously subduction-modified continental lithosphere, re-melted during later tectonic events such as rifting or collision. Differences in S abundance in the deep lithospheric source region may control whether the resulting deposits are S-rich (i.e., porphyry-type deposits) or S-poor (i.e., IOCG deposits).

We further suggest that, notwithstanding arguments relating to preservation of supracrustal sequences in Precambrian rocks, the extreme scarcity of porphyry deposits in older arc sequences indicates that S-rich conditions in subduction zones (and resultant lithospheric residues) were not widespread until the Phanerozoic, when the deep oceans became oxidized following the Neoproterozoic Oxygenation Event (Shields-Zhou and Och, 2011). Prior to this, in the Precambrian, anoxic deep ocean conditions resulted in low seawater sulfate concentrations, low S contents in subducted seafloor-altered oceanic crust, and low S contents in resultant arc magmas (Prouteau and Scaillet, 2013). Such S-poor magmas would have had the potential to form IOCG deposits, but S-rich magmas and derivative porphyry deposits may have been restricted to locally oxidizing environments, such as shallow-water subduction zones. Conversely, S-rich magmas and porphyry deposits are favoured in the Phanerozoic, whereas conditions for the formation of S-poor calc-alkaline magmas and IOCG deposits may be restricted in time and/or place to subduction zones in locally anoxic deep ocean conditions, or remobilization of relatively S-poor deep crustal residues of prior arc magmatism during later tectonic events such as rifting or collision.

Key words: Porphyry deposits, IOCG deposits, sulfur content, Precambrian, Phanerozoic, Neoproterozoic Oxygenation Event

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