

The close association between oxidized magmas and porphyry deposits

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Essentially all porphyry deposits are closely associated with oxidized magmas at convergent margins. The best oxygen fugacities for porphyry mineralization is $\Delta\text{FMQ} +2$ to $+4$ [1]. This is controlled by the interactions between sulfur and iron. Sulfur is the most important geosolvent controlling the behavior of Cu and other chalcophile elements. A small amount of residual sulfide can hold a large amount of Cu. Sulfate is the dominant sulfur species at $>\Delta\text{FMQ} +2$, which is over 10 times more soluble than sulfide. The solubility of sulfur increases from ~ 1000 ppm up to >1 wt. % [2], such that less than 10 % partial melting can eliminate residual sulfides even in subducted slabs. The final porphyry mineralization is controlled by sulfate reduction, which is usually initiated by magnetite crystallization, accompanied by decreasing pH and correspondingly increasing oxidation potential of sulfate. Hematite forms once sulfate reduction lowers the pH down sufficiently, driving the oxidation potential of sulfate up to the hematite–magnetite oxygen fugacity (HM) buffer, which is $\sim\Delta\text{FMQ} +4$. Given that ferrous iron is the most important reductant responsible for sulfate reduction during porphyry mineralization, the highest oxygen fugacity favorable for porphyry mineralization is the HM buffer. Sulfate reduction and ferrous Fe oxidation form H^+ , which causes pervasive alteration zones in porphyry Cu deposits. The amount of H^+ released during mineralization and alkali contents in the porphyry together control the intensity of alteration. Reduced magmas are not favorable for porphyry mineralization. Reduced porphyry deposits so far reported are either just host rocks away from the causative porphyry or were reduced through assimilation of reducing components during emplacement.

[1] Sun, W.D., *et al* 2013. The link between reduced porphyry copper deposits and oxidized magmas. *Geochimica et Cosmochimica Acta*, **103** 263-275.

[2] Jugo, P.J., 2009. Sulfur content at sulfide saturation in oxidized magmas. *Geology*, **37** (5): 415-418.