Sulfur isotopic zonation in the Cadia porphyry Au-Cu deposits, NSW

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The Cadia district of central western NSW includes four alkalic porphyry Au-Cu deposits (Ridgeway, Cadia East, Cadia Hill and Cadia Quarry) and two iron-copper-gold skarn deposits (Big and Little Cadia), which together contain >1000t Au and >4Mt Cu. These porphyry and skarn deposits formed at the culmination of magmatism in the Late Ordovician to Early Silurian Macquarie island arc.

Porphyry gold-copper ore at Cadia occurs in stockwork and sheeted quartz-sulfide-(carbonate) vein systems associated with alkalic quartz monzonite intrusive complexes. Each of the porphyry deposits has a core of potassic and/or calc-potassic alteration, and peripheral halos of propylitic alteration. Both the potassic and propylitic zones are cut by late stage phyllic-altered fault zones. Ridgeway and Cadia East are characterised by bornite-rich cores surrounded by chalcopyrite-rich halos and peripheral zones of pyrite mineralization. Sulfide zonation at Cadia Hill and Cadia Quarry is defined by chalcopyrite-rich cores and pyrite-rich halos. Cadia Hill also has high-level bornite mineralisation.

The propylitic alteration zones at each of the deposits can be divided into two domains. The inner domain is distinctly reddened due to strong hematite alteration of feldspar minerals in the volcanic wall rocks and intrusions. In contrast, the outer propylitic subzone does not contain hematite, and the rocks have subdued grey-green colours.

The Ridgeway, Cadia Hill and Cadia East deposits have distinctive sulfur isotopic zonation patterns. Sulfides in the high grade cores of the depositrs are characterised by low $\delta^{34}S_{sulfide}$ values (-10 to –4‰), consistent with sulfide precipitation from oxidized (sulfate-predominant) magmatic-hydrothermal fluids. In contrast, pyrite in the propylitic alteration halos typically have $\delta^{34}S_{sulfide}$ values near 0‰. There is a gradual increase in $\delta^{34}S_{sulfide}$ values outwards from the deposit cores through the propylitic halos which cannot be explained by simple cooling. Water-rock interaction during propylitic alteration probably caused magmatic sulfate reduction via oxidation of ferrous iron-bearing minerals, resulting in enrichment of $^{34}\Sigma$ ιν πψριτε ανδ τηε διστινχτιϖε ρεδδενεδ, ηεματιτε–ριχη προπψλιτιχ αλτερατιον δομαινσ.

Ουρ ρεσυλτσ σηοω τηατ συλφυρ ισοτοπε αναλψσεσ ηαϖε ποτεντιαλ αππλιχατιονσ ιν τηε εξπλορατιον οφ αλκαλιχ πορπηψρψ δεποσιτσ. Δετεχτιον οφ δεπλετεδ $\delta^{34}S_{sulfide}$ values in the propylitic alteration zone is potentially indicative of proximity to the mineralised core of a porphyry system.