The Mount Isa Copper Deposit: an example of a crustal metal source with a mantle signature

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The Eastern Creek Volcanics of the Mount Isa Inlier are a likely source of copper for the giant hydrothermal Mount Isa Deposit in northern Australia. New Os isotopic data for the volcanic rocks and copper ore provide compelling evidence of this relationship. The present study is also an example of mantle-like Os signatures in sulphide ore that can be attributed to a crustal metal source.

The Mount Isa Copper Deposit had an $^{187}Os/^{188}Os$ signature of 0.29±0.17 at the time of formation (~1380Ma), which could be interpreted as having a significant mantle component and limited crustal imput (which would yield an Os isotopic signature closer to 1). The Eastern Creek Volcanics are 450 million years older than the Mount Isa Copper Deposit and therefore, should have a crustal Os signature and thus be excluded as the metal source for the deposit.

The Eastern Creek Volcanics have a range in Os isotopic signatures which reflect their mantle source and eruption history. Importantly, the initial Os signature of the magma was 0.114±0.067 at the time of eruption (~1830Ma); this is subchrondritic and is most likely the result of melting of the subcontinental lithospheric mantle. The low Re content in the magma resulted in the very slow accumulation of radiogenic ^{187}Os with time. Therefore, the Eastern Creek Volcanics maintained mantle-like signatures for a significant period of geological time. At the time of copper deposition, the Os signature of the volcanic rocks would have ranged between 0.15 and 0.23. This is slightly lower than the signature of the copper ore.

The lower half of the Eastern Creek Volcanics experienced crustal contamination from the felsic basement during eruption. This process added a crustal component to the Os signature of parts of the volcanic sequence. The contaminated volcanic rocks had an Os signature of between 0.58 and 0.81 at the time of copper deposition, slightly higher than the signature of the copper ore.

Overall, the Os isotopic signature of the Mount Isa Copper Deposit falls midway between the signatures of the the uncontaminated and contaminated Eastern Creek Volcanics. It is therefore suggested that the Os signature of the copper ore reflects the homogenised Os signature of the entire volcanic sequence, due to large scale hydrothermal fluid circulation and leaching of metals. The metal source is crustal, but reflects the mantle characteristics of the source rocks.