Re-Os isotope systematics applied to the Tharsis Mine, Iberian Pyrite Belt Spain

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The Tharsis mine, a volcanogenic massive sulphide deposit, lies within a syncline of the Iberian Pyrite Belt. The sulphide ores occur in the Volcanogenic-Sedimentary Complex, with its massive and stockwork ores crosscutting Famennian to Visean (365–345 Ma) palinologically dated black shales. Intense structural deformation and moderate metamorphism (lower greenschist facies, prehnite-pumpeyllite) altered the deposit during the Hercynian orogeny. Previous geochemical studies used oxygen, hydrogen, sulphur, and lead isotopes to model depth/temperature conditions, biogenic input, and size of hydrothermal convection systems (Munha *et al.* (1986), Kase *et al* (1990), and Marcoux (1998). In general, each of the proposed models involved hydrothermal activity (generated by proximal or distal magmatic heat sources) in which metals were transported by reduced, metalliferous, seawater brines that leached metals from the surrounding crust, or were derived from a hydrous phase partitioned from a partial melt magmatic source. None of these investigations provided direct evidence for the origin of the ore forming metals or precise mineralization age determinations.

Utility of Re-Os

The Re-Os isotope system is ideal for addressing these genetic and geochronologic problems. As a genetic tracer, Re behaves incompatibly during mantle melting events, and concentrates in the melts, whereas Os is compatible and remains in the mantle. This relationship produces melts with elevated Re/Os ratios; consequently the crust will evolve highly radiogenic Os isotopic ratios in comparison to the mantle. Thus, elevated $^{187}Os/^{188}Os$ ratios (>.2) indicate the participation of a crustal component for metals, whereas lower ratios (~.13) characterize a mantle source. The Re-Os isotope system is also a powerful geochronometer for directly dating the mineralization of sulphides due to the elements' chalcophile nature. In this study, using the Re-Os isotopic system will enhance our understanding of the metals' origin and time of deposition during the hydrothermal processes associated with the formation of volcanogenic massive sulphide deposits. Eight ore samples were collected from different locations in the massive sedimentary pyrite. We obtained two distinctly different initial $^{187}Os/^{188}Os$ ratios of .42 and 4.2. This dichotomy could represent one hydrothermal precipitation event in which circulating fluids produced a heterogeneous initial isotopic signature due to the contribution of separate and distinct ore-forming fluids. The different initial ratios could also indicate two events (or more) in which different pulses of mixed fluids produced an isotopically complex system. The paragenetic relationships of these ores indicate multiple events for the sulphide deposition, thus supporting the second interpretation (Tornos *et al.* 1998). Although the previous suggestions are merely conjectures, the results indicate that a large crustal component existed in the ore forming metals in the Iberian Pyrite Belt. Other geochemical studies concluded that the Iberian Pyrite Belt ores formed in an environment analogous to the Kuroko deposits in Japan. Such results confirm that the fault-bounded, rifted, and thinned crust provided a source for ore forming metals. Also, Re-Os age estimates agree with the 350 Ma peak sulphide mineralization described by Lescuyer *et al.* (1998).

References

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