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Contrasting Sources for Cu-Polymetallic and Pb-Zn Mineralisation in Ireland: Constraints from Lead Isotope Modelling

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Several lead isotope studies have been undertaken on the economically important Pb-Zn deposits of central Ireland, but there are little data for the low grade Cu-dominated red-bed hosted mineralisation of SW County Cork, or the small carbonate-hosted Cu-Ag deposits in the southwest of Ireland.

The origin of lead and other metals in the Carboniferous carbonate-hosted base metal deposits of the Irish Midlands is commonly cited as the underlying Caledonian basement. Published data show a very restricted range of isotopic data for any particular deposit, a linear trend of isotopic data on the $^{207/204}$Pb versus $^{206/204}$Pb plot and a systematic geographical variation of $^{206/204}$Pb data in Carboniferous lead-zinc deposits, becoming more radiogenic from NE to SW irrespective of mineralisation style, age or host rock (O'Keefe, 1986). Isoplumbs of $^{206/204}$Pb ratios parallel structures and lithological contacts within the Caledonian basement and cross-cut the Carboniferous lithologies.

The Devonian Red Bed-hosted deposits occur either as low-grade stratiform deposits and minor veinlets with disseminated bornite and djurleite e.g. Mt. Gabriel, or as major quartz veins with copper and iron sulphides, Mo, Pb, and Bi phases, sulpharsenides and antimony-bearing sulphosalts as at Allihies and Ballycummisk (Ni Wen et al., 1999). There is a considerable inhomogeneity of data for the early disseminated mineralisation, even within one deposit on both $^{207/204}$Pb v $^{206/204}$Pb and on $^{208/204}$Pb v $^{206/204}$Pb plots. For the minor veinlets there is a more restricted distribution whilst data for ores from the major quartz veins show a clustered array on both $^{207/204}$Pb v $^{206/204}$Pb and $^{208/204}$Pb v $^{206/204}$Pb plots.

The Courceyan carbonate-hosted Cu-Ag deposits form three groups: Cu-Ag + Hg-As-Sb-U epigenetic deposits, characterised by chalcopyrite and tennantite near surface, bornite and chalcocite at depth and sometimes by high level Hg or U enrichment, e.g. Gortdrum; Cu-Ag ±Zn, Pb, As, Co, Ni stratabound deposits characterised by chalcopyrite-tennantite-bornite, sphalerite-galena and arsenical ores e.g. Muckross and Blue Hole, Ross Island; and Cu-Ag ±As, Mo, Co, Ni epigenetic vein deposits characterised by veins with chalcopyrite-tennantite, traces of Ag, Ni-cobaltite, molybdenite, pyrite, secondary stromeyerite and native silver e.g. Western Mine, Ross Island (Ixer and Pattrick 1995).

Lead isotope data for the stratabound Cu-Ag mineralisation shows a very restricted range of isotopic data for each deposit and indicates an age of c. 350 Ma ±10, close to that of the age of sedimentation which at Ross Island has a confirmed mid-Courceyan age (c. 355 Ma) based on conodont data. This age for the Cu-Ag mineralisation is similar to model ages calculated for several of the major Irish lead-zinc deposits (e.g. Anderson et al., 1998. In contrast, for the epigenetic Cu-Ag vein deposits the lead isotope data indicates a younger age of 280 ±10 Ma for ore formation. At Blue Hole epigenetic chalcopyrite-tennantite-calcite veins cross-cut bedded sphalerite-galena ores at very high angles, so isotopic ages confirm field relations.

The 280 ±10 Ma for the younger phase of carbonate-hosted mineralisation has important implications for the timing of the Variscan orogeny in SW Ireland. Chalcopyrite-tennantite ores occur along pressure solution cleavage, which developed prior to major folding and thrusting. The thrusting episode which emplaced the mineralised tectonic sheet of Ross Island west of Killarney must post date 280 Ma as the mineralised pressure solution cleavage has been deformed by the thrusting.

Both the Pb-Zn mineralisation of the Irish Midlands, and the Cu-Ag dominated mineralisation of the southwest are hosted in Courceyan carbonates, yet have very different ore assemblages. The difference in ore assemblages is attributed to a contrast in source rocks. In the Midlands the Pb-Zn ore-bearing carbonates are underlain by lower Palaeozoic greywackes with late Devonian red beds of minimal thickness. In contrast, in the Munster Basin, thick clastic sequences underlie the Cu deposits. Ore-fluid compositions were moderately saline NaCl-dominated brines with maximum temperatures >200ºC. Under normal geothermal gradients, a source area at these temperatures would be at a depth of about 5km, so for the Cu-Ag and Cu-Fe deposits of southwest Co. Cork the source of the ore metals would have been entirely in red beds, whereas for Pb-Zn deposits of the Midlands the source for the bulk of the ore metals, and particularly the lead, was almost entirely Lower Palaeozoic turbidites.

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