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Did a whole-crustal hydrothermal system generate the Irish Zn-Pb orefield?

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Current models[1] for the genesis of the giant Irish Carboniferous-hosted Zn-Pb orefield propose shallow (<10 km depth) hydrothermal circulation within Lower Palaeozoic basement rocks of the Iapetus Suture Zone as the main metal source. However several lines of evidence, e.g., from He[2], S[2,3] and Os[4] isotopes, and the possible role of contemporary volcanism[5] point to deeper, including mantle, fluid source(s) and/or pathways.
The Iapetus Suture Zone in Ireland is uniquely favoured to evaluate the scale of hydrothermal circulation because of the presence there of granulite-facies lower crustal xenoliths at four widely separated localities. These were carried to the surface from $\sim$22-28km (and deeper levels) by Lower Carboniferous alkali basaltic lavas and diatremes[6,7]. They provide the only possible direct samples of the lower crust and are of appropriate age.
U-Pb zircon geochronology demonstrates that the xenoliths experienced high temperature (>700°C) metamorphism and melting during the Acadian orogeny at $\sim$390Ma and during separate episodes of extension at $\sim$ 381-373Ma and $\sim$362Ma. Sm-Nd garnet dating shows that the lower crust remained hot or was re-heated to $\sim$600°C at $\sim$341Ma during Lower Carboniferous volcanism, also associated with extension and, in part, coincident with the mineralization[1].
Isotopic data from the xenoliths correspond closely to Sr and Nd isotopic analyses of gangue calcite[8] and galena Pb[9] isotopic data from the major ore deposits. While Zn contents of the xenoliths permit them to be metal sources, their mineralogy and texture provide an enriched template and a plausible extraction mechanism. In situ analyses of modally-abundant biotite and garnet show significant enrichment in Zn (and other relevant metals) as well as order of magnitude depletion of Zn during retrograde alteration, providing a metal-release mechanism and pointing to a hydrothermal fluid system operating at least to depths of $\sim$ 25km.

References

[1] Wilkinson, J.J. & Hitzman, M.W. 2015. The Irish Pb-Zn orefield: The view from 2014. In: Archibald, S.M. and Piercey, S.J. (eds) Current Perspectives on Zinc deposits. Irish Association for Economic Geology, pp. 59-72.; [2] Davidheiser-Kroll, B., Stuart, F.M. & Boyce, A.J. 2014. Mineralium Deposita, 49, 547–553; [3] Elliott, H. 2015. Unpublished PhD thesis, University of Southampton; [4] Hnatyshin, D., Creaser, R.A., Wilkinson, J.J. & Gleeson, S.A. 2015. Geology, 43, 143-146; [5] McCusker, J. & Reed, C. 2013. Mineralium Deposita, 48, 687–695; [6] Van den Berg, R., Daly, J.S. & Salisbury, M.H. 2005. Tectonophysics, 407(1-2), 81–99; [7] Hauser, F., O'Reilly, B.M., Readman, P.W., Daly, J. S. & Van den Berg, R. 2008. Geophysical Journal International 175, 1254-1272; [8] Walshaw, R.D., Menuge, J.F. & Tyrrell, S. 2006. Mineralium Deposita, 41, 803-819; [9] Everett, C.E., Rye, D.M. & Ellam, R.M. 2003. Economic Geology, 98, 31-50 and references therein.