Coupled chemical-fluid flow modelling of the Irish Carboniferous Basin.

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The aim of this work is to explore and evaluate a particular scenario for the formation of Irish-type Zn-Pb deposits through geodynamic modelling, with a focus on Waulsortian-hosted Zn-Pb deposits of the Central Irish Midlands.

The scenario involves promotion of continuous northward lateral flow through a unit simulating the Old Red Sandstone. An initial symmetrical horst geometry representing the stratigraphic units of the Irish Midlands and subsequent asymmetrical formats fail to produce the required flow pattern. However, increased fault permeability, associated with positive volumetric strain, does promote northward fluid flow through a similar permeability increase at the base of the Waulsortian Limestone at a rate of 82m/yr near the fault, decreasing to 6m/yr at the northern limit of permeability increase.

This result shows that under certain conditions and geometries, ore body formation is promoted (particularly on the LHS/north dipping fault where the net extensional displacement is greater than the thickness of the sub-Waulsortian seal, i.e. a breached aquifer/fluid mixing zone). However, this is not a unique solution and other scenarios are considered – particularly one where the metal bearing fluid interacts with basement rather than utilising the ORS as the aquifer.

The preferred mechanical and fluid flow scenario provides a template for subsequent coupled thermal and chemical reactions. A constant thermal gradient of 30°C/km is imposed; H2S is injected in the top and the bottom of the LHS/north dipping fault, in consecutive models, while SO42- is pumped at a constant rate through the southern boundary. The resultant mineralisation patterns and precipitation rates are compared with the mineralisation seen in the Irish Midlands. Further scenarios involve increasing the constant fluid rate at the southern boundary and injecting the H2S at different locations e.g.- the RHS/south dipping fault, or exchanging injection points of the sulphur species