

Inversion Effects on Zn-Pb Mineralization Across the Rathdowney Trend, South-central Ireland

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Inversion tectonics associated with N-S compression during the Variscan and Alpine orogenies have significantly modified the mineral endowed NE-SW Rathdowney Fault Trend (RFT), south-central Ireland. The RFT hosts world-class Zn-Pb-Ag deposits at Lisheen and Galmoy, and Rapla prospect. Our study combines aeromagnetic, borehole, and outcrop data with petrography, cathodoluminescence microscopy, microXRF and SEM-EDS mapping and U-Pb LA-ICP-MS geochronology of fault rocks and vein infill to constrain the geometry, nature, timing and effects of inversion structures on mineralization across the Irish Ore Field.

Mineralization occurs as massive, semi-massive and disseminated galena, sphalerite, pyrite and marcasite, replacing host rocks during a Mississippian N-S extension phase. Orebodies are stratabound within dissolution-precipitation breccias of dolomitized limestones, predominantly in the hanging walls of ENE-WSW trending, laterally discontinuous segmented normal fault arrays of <250m displacement. Associated extensional calcite veins yield U-Pb ages of $342.0 \pm 9.6/14.5$ Ma.

Variscan inversion produced folds, reverse faults, hanging wall buttressing and reverse reactivation of mineralized normal faults. This deformation is characterized by NE - SW trending dextral oblique-slip reverse faults that laterally offset earlier normal faults and orebodies by ~100m, accommodating displacements of 150 – 400 m. Reactivation of pre-existing normal fault segments results in dextral oblique-slip displacement of relay ramps and fault zones. Coeval grey-white hybrid extensional-shear calcite veins yield ages of $302.4 \pm 6.3/11.5$ Ma.

Subsequent N-S Alpine inversion is expressed by fold tightening and development of NNW-SSE dextral and NE-SW sinistral strike-slip faults, with associated white blocky calcite veins dated to $67 \pm 9.6/9.8$ – 28.9 ± 7 Ma. These inversion events resulted in an interplay of folding, duplicated and lateral offset of mineralization. Both inversion phases significantly modified the orebodies geometry and continuity along the RFT. Recognition of inversion-related structural overprint is therefore critical for accurate targeting and resource evaluation in Irish type Zn-Pb systems.