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Fault interactions, fault kinematics, and evolution of the structural framework in the Irish Lower Carboniferous

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Fault systems in the Irish Lower Carboniferous are important in relation to its subsurface groundwater, geothermal and mineral resources. For example, major base metal deposits in the world-class Irish Orefield occur in association with normal faults. Despite their economic importance, however, the fault networks and structural framework at depth are still poorly constrained. The Irish Carboniferous Basin is an excellent area to study the extensional fault systems and evolution of rift basins, given the relatively low amounts of later compressional deformation and metamorphism, and because high-quality subsurface datasets exist from several decades of mineral exploration. Our work aimed at developing a coherent structural framework for the Lower Carboniferous in Ireland, to unravel the geometries and kinematics of faulting in a carbonate-dominated rift basin that developed on top of a strong pre-existing structural template in the underlying basement rocks.

We have defined the geometry of key fault systems in the rift across a wide range of scales, using three-dimensional integrated analysis of large datasets. These datasets include public and proprietary onshore 2D reflection seismic, mapping, drillhole, micro-palaeontological, aeromagnetic, electromagnetic, and ground gravity data. Our work has revealed the nature of segmentation patterns and interactions of normal faults, including synthetic and conjugate relay zones. Quantification of fault parameters, kinematic analysis and kinematic restoration have allowed us to gain insights into the distribution of extension during rifting in time and space, using growth sequences and facies changes on faults. The analysis of this structural framework in relation to several mineral deposits, and in combination with lithofacies distribution and the development of bathymetry during basin formation, allows us to better understand current and past fluid flow pathways, especially in relation to base metal mineralising events.