Structural evolution of the Zn-Pb mineral deposits of south-central Ireland.

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It has long been known that the combined effect of structure and preferential host horizons controls the distribution of ore within the carbonate-hosted Zn-Pb deposits of the Irish Midlands. We explore the extent to which structures, and faults in particular, have acted as conduits or traps for mineralising fluids with particular reference to high quality 3-D data from Lisheen mine, combined with supplementary constraints from Silvermines and Galmoy (Bonson et al. 2005). Our datasets include underground maps together with large drill-hole databases (sometimes including over 1300 drill-holes), incorporated in 3-D geological models within the Vulcan modelling software system. We demonstrate that an improved definition of the 3-D structure and structural history is an essential step in understanding the hydrothermal flow system in Irish Zn-Pb deposits.

Mineralisation in all 3 mines occurs dominantly as replacements of Courceyan-aged carbonates, forming stratabound lenses at the base of a regionally dolomitised limestone and minor stratabound and fault-hosted mineralisation in an underlying sequence of argillaceous limestones. The deposits each occur between major ENE-E trending, north-dipping normal fault arrays: the ca. 220 m throw Rathdowney Fault System to the southeast and the 100+ m throw Barnalisheen Fault System to the northwest (Fig.1). Stratigraphic constraints indicate that both systems were initiated in the Late Courceyan. Although they appear to have been originally isolated, these fault systems are now linked by a large-scale intervening relay ramp (ca. 2500 m wide, Lisheen relay of Fig.1) containing related minor normal faults with variable trends. These minor faults often bound individual ore lenses or high-grade pods within the deposit area.

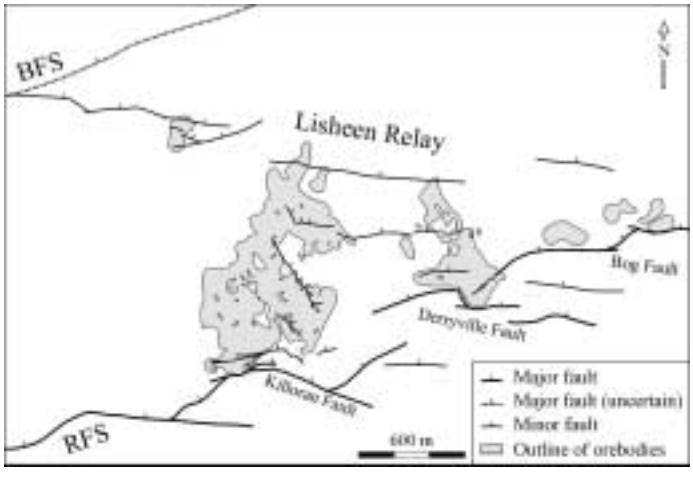

Figure 1. Structural map of Lisheen mine drawn at the base of the Waulsortian Limestone Complex showing the main normal faults. RFS: Rathdowney Fault System; BFS: Barnalisheen Fault System.

The main ore bodies of the Lisheen deposit are bounded to the south-east by the Rathdowney Fault System. This system consists of a kinematically coherent, en-échelon array of three E-W trending, north-dipping fault segments with maximum throws of ca. 220 metres: the Killoran, Derryville and Bog segments. These fault segments are linked by left-stepping relay zones (450 to 500 m wide) with generally intact relay ramps. Significant smaller-scale lateral and vertical segmentation along the Killoran and Derryville segments is accompanied by the formation of relay zones (up to 150 m wide), which breached at an early stage and are now characterised by fault-bounded lenses of densely faulted and brecciated rocks. The thicker and higher-grade ore-lenses are generally found within these breached relays.

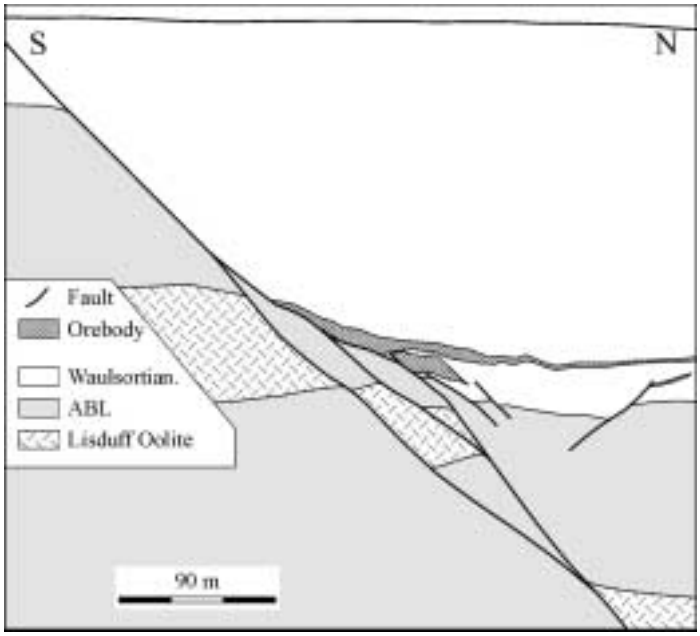

Figure 2. Cross-section through the Killoran Fault.

Ore textures and cross-cutting relationships indicate that main-stage mineralisation is essentially post-faulting. Ore distributions demonstrate the important role of faulting, and related segmentation, in both the migration and trapping of metal-bearing fluids. Grade distribution patterns and thickness contour maps suggest that upward flow of the metal-bearing fluids was largely restricted to the strongly deformed and brecciated, within-segment, breached relays along the Rathdowney Fault System, rather than the intact relays between segments, which remained essentially un-mineralised. Since the three main fault segments are each bounded by ore bodies, this scale of segmentation nevertheless indirectly exercised a significant control on the larger-scale distribution of ore. By contrast, minor faults within the deposit often bound individual ore lenses or high-grade pods, particularly within the Barnalisheen to Rathdowney Ramp (Lisheen relay ramp in Fig.1), a feature which suggests that not only were these faults important controls on lateral flow but they could also act as traps to mineralising fluids. This localised trapping is attributed to the presence of clay material (usually solution seams) along slip surfaces, which either prevented or retarded across-fault fluid flow.