Structural Model of the Lough Allen Basin: Implications for Shale Gas Exploration and Production

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ABSTRACT

The Lough Allen Basin of NW Ireland preserves a considerable thickness of Lower Carboniferous shales widely recognised for their shale gas potential. A 3D tectonostratigraphic model has been developed for the basin from available seismic and aeromagnetic data and from geological mapping constraints. The model shows that the basin is principally of Lower Carboniferous age, with associated growth sequences extending from perhaps uppermost Devonian times through to the top of the Lower Carboniferous. Structurally, this NE-striking basin is broadly grabenal towards its centre, changing in polarity from north-facing faults in the SW to south-facing faults in the NE, a distinctive geometry which may be responsible for basin preservation. Displacement transfer between opposed dipping faults generates complex internal fault systems, characterised by rhombohedral and conjugate geometries. The Carboniferous basin geometry is largely controlled by pre-existing structure with normal faults parallel and adjacent to major pre-existing Grampian-Caledonian terrane boundaries, with the lateral extension of the Highland Boundary Fault responsible for the NW basin margin. The two main bounding faults have been subjected to multiple reactivations which extend into Tertiary times during which sinistral strike-slip reactivations of several hundreds of metres are linked to Alpine-related approximately N-S compression. Similar aged faults elsewhere in Ireland are associated with accentuated groundwater and hydrocarbon flow, a scenario which has negative implications for shale gas activity. Our study of the Lough Allen Basin suggests that fault reactivation over protracted geological time is responsible for the creation of a complex system of faults and fractures, some of which will be conductive. Many seismically mappable faults are seen to breach overlying sequences and could potentially provide flow connectivity from prospective shale-gas reservoirs to shallower groundwater aquifers. Compared to typical US shale gas provinces, complexity of structure could be a major issue in some UK and Irish shale gas basins.