

Structure of Lower Carboniferous basins of NW Ireland, and its implications for structural inheritance and Cenozoic faulting

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ABSTRACT

The geometry of Lower Carboniferous basins across the northern part of Ireland is characterised by a gradual change in polarity of structure from a predominantly southward dipping fault system in Northern Ireland through the Lough Allen Basin and into a mainly northward dipping fault system of Connemara in the southwest. This polarity change is reflected in the emergence of northward facing uplifted footwall blocks, such as at Croagh Patrick and the Ox Mountains, in the southwest, with southward facing blocks in the northeast. Despite these structural changes, there is a great degree of along-strike continuity of Lower Carboniferous structure, strain and displacement, with the system forming a link between comparable sized and coeval basins in northern England and Scotland to the east and the Canadian Maritime Provinces to the west. The spatial distribution of Carboniferous normal faults suggests that Caledonian structure, such as the Fair Head-Clew Bay line, plays an important role in the localisation of Post-Caledonian strain, although the reactivation of individual Caledonian structures may be less common. The terrain of the west of Ireland is strongly influenced by major Carboniferous faults offsetting the base Carboniferous unconformity, as opposed to previously suggested Cenozoic normal faulting of a Tertiary peneplain.

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1. Introduction

Previous work has established the basic geometry and growth of Lower Carboniferous extensional basins in the British Isles and attributed their existence to an approximately N–S extension during the Lower Carboniferous (e.g. Fraser and Gawthorpe, 1990, 2003; Guion et al., 2000; Figs. 1 and 2). The Lower Carboniferous structure of Britain comprises laterally discontinuous faults, together with related footwall highs and associated basins, a configuration which is particularly well-defined because of the availability of seismic datasets in addition to both outcrop and borehole data (Fig. 1). By contrast, the geometry and growth of Lower Carboniferous basins in Ireland is often difficult to establish, mainly because of the paucity of seismic data and because of the relatively poor outcrop and poorly preserved Carboniferous stratigraphic record (Fig. 3). High quality subsurface fault data associated with Irish Pb–Zn mines represent an important, though often localised, departure from the generally less well-defined regional

Carboniferous structure. Despite these difficulties, recent work has managed to provide good definition of the structure of Carboniferous basins in parts of Ireland. This paper presents a detailed consideration of the post-base Carboniferous structure of a well-defined zone, approximately 80 km wide, trending NE–SW from the north of Ireland through to Connemara: post-base Carboniferous structures are those which post-date the local base of the Carboniferous succession which is of variable, though generally Lower Carboniferous, age. This zone includes areas of Ireland where structural definition and timing constraints for post-base Carboniferous faults can be quite poor, such as in the west of Ireland, where associated structures are not well exposed and post-base Carboniferous sequences are poorly preserved. Nevertheless, using constraints from previously published work, basic map data and this study's analysis, it is possible to investigate a number of key issues related to the structure of this zone including: (i) the nature of along-strike structural and strain variations, (ii) the potential impact of later Cenozoic faulting and (iii) the impact of earlier structure on post-base Carboniferous faulting.

The first issue this study will examine is the distribution of structure, strain and displacement along this system, from the Carboniferous basins of the Fintona Block in the north and the Lough Allen Basins in Leitrim, further south into the post-base

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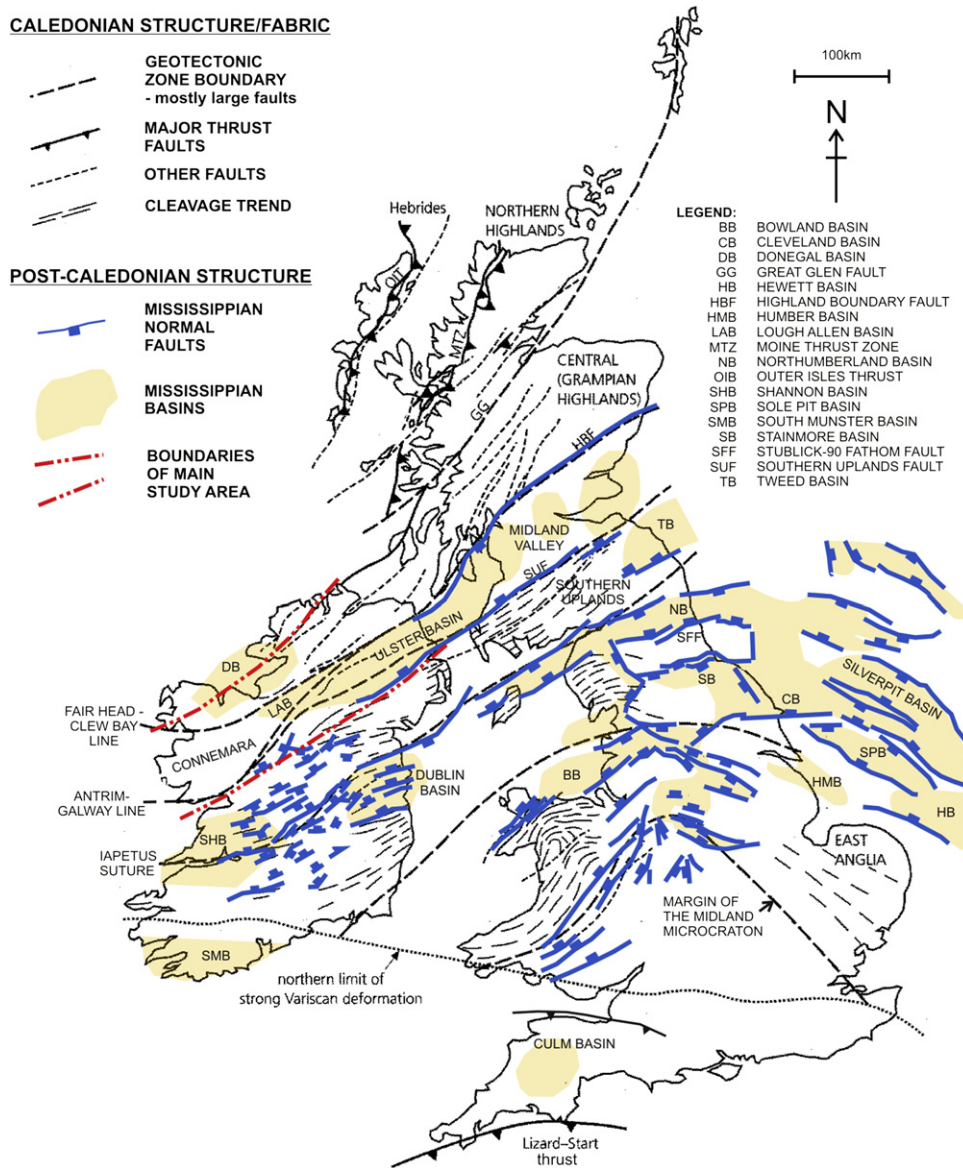


Fig. 1. Map showing the distribution of Lower Carboniferous (i.e. Mississippian age) basins and associated major faults alongside the Caledonian fabric and structures across the UK and Ireland (compiled from the work of Guion et al., 2000; Woodcock and Strachan, 2000; Johnston et al., 1996). The boundary of the study area is highlighted.

Carboniferous faults of the Ox Mountains and into Clew Bay and Connemara (Figs. 1 and 3). We will attempt to define the structure and timing of the fault system within this zone and the extent to which it is similar to those of better constrained study areas in both Britain and Ireland (Guion et al., 2000; Price and Max, 1988; Johnston et al., 1996; Sevastopulo and Wyse Jackson, 2009). Our analysis will investigate the continuity of strain along the system and will consider whether the system is consistent with the lateral continuity of Lower Carboniferous structure from Britain through Ireland and into the Canadian Maritime Provinces (Mitchell, 1992).

The second issue examined relates to previous work suggesting the importance of a phase of Cenozoic normal faulting in the westernmost part of this zone around Clew Bay and Connemara (Dewey and McKerrow, 1963; Dewey, 2000; Badley, 2001). The deeper level of erosion in this area compared to further NE, combined with poor exposure, presents significant difficulties in constraining the timing and growth of large, NE–SW to E–W trending post-base Carboniferous normal faults. These faults are defined in this region where they juxtapose Lower Carboniferous

rocks against older Lower Palaeozoic basement and offset the base Carboniferous surface (a regional unconformity) by several hundreds of metres, downthrown to the north (Figs. 3 and 4). Previous work argued for a Cenozoic phase of normal faulting to account for what was considered to be the ‘fresh’ appearance of the faulted Connemara landscape (Fig. 4c), which was interpreted to represent a faulted Cenozoic peneplain (Dewey and McKerrow, 1963; Dewey, 2000). This study reviews previously cited evidence, investigates Cenozoic faulting on a regional scale (offshore and onshore) and examines differences between syn- and post-Lower Carboniferous fault displacements, in an attempt to define the significance of Cenozoic normal displacements on the west of Ireland landscape.

The final major issue considered is the extent to which post-base Carboniferous faulting is controlled by earlier structure. Previous work has suggested that basement structure has a major impact on the geometry and localisation of later structures. This relationship has been advocated by previous workers studying Carboniferous basins in the UK (e.g. Bott, 1987; Kimble et al., 1989; Fraser and

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