Late Carboniferous structures, Northern England

Introduction

Map showing the main structures associated with late Carboniferous to early Permian deformation in northern England. Section A–B is shown in Figure 49). P916078.
Cross-section through the Solway and Vale of Eden basins. Line of section is shown on Figure 48 (after Chadwick et al., 1995. The Northumberland–Solway Basin and adjacent areas. BGS Subsurface Memoir. P916079).


Syn-Variscan tectonism in northern England — the peripheral effects of the orogenic deformation farther south — was dominated by reactivation of faults that had already played major roles in the earlier development of the region. Thus, apportioning fault movements to particular events can be difficult. The clearest evidence for syn-Variscan deformation comes from structures that affect...
Carboniferous rocks but are truncated by the unconformity at the base of the overlying Permian strata. The principal structural features that date from this episode are summarised in (P916078).

**Solway Basin**

Seismic reflection profiles across the Solway Basin have been interpreted to show Carboniferous rocks folded into the north-north-easterly trending Solway Syncline and the complementary Carlisle and Bewcastle anticlines; the folds are truncated by the unconformity at the base of the Permian sequence (P916079). The Bewcastle Anticline is asymmetrical with a steeply dipping north-west-facing limb. The fold is cut obliquely by the Goat Island–Lyne Fault, which is inclined south-east but throws down to the north-west; like many similar structures it was formed by reverse reactivation of an earlier synsedimentary normal fault. The eastern margin of the Carlisle Anticline is marked by the Brackenhill Fault, a westerly dipping reverse fault which also shows a significant strike-slip component in its late Carboniferous movements. It was subsequently reactivated as a normal fault during Permian extension.

At the southern margin of the basin, reactivation of the Maryport Fault was accompanied by regional uplift in the hanging wall, which led to substantial erosion and the formation of the unconformity at the base of the Permian succession. As with many of the long-lived faults in northern England, further reactivation of this fault continued to play an important role in controlling the ensuing Permian sedimentation.

**Northumberland Basin and Cheviot Block**

The Northumberland Basin lacks structures on the scale and intensity of those seen in the Solway Basin. Several small-scale anticlines are associated with the hanging-wall blocks of the Stublick and Ninety Fathom faults at the southern margin of the basin. The distribution of these suggests dextral transpression. In the centre of the basin, the east-north-east-trending Antonstown and Sweethope faults are early Carboniferous normal faults that have opposing inclinations: strata within the hanging walls formed a gentle anticline, probably during late Carboniferous times. A wealth of smaller-scale structures including faults and folds is particularly well displayed on the Northumberland coast (P689517). The relatively simple fault pattern comprises west- to west-south-west-trending conjugate sets of normal dip-slip faults parallel to the major basin-bounding structures. There are also subordinate, separate sets of wrench faults parallel to the normal faults.

Over the Cheviot Block, the southern boundary of which approximates to the Swindon and related faults, structure within the Carboniferous rocks is dominated by abundant eastnorth-east-trending dextral, and subordinate east-south-east-trending sinistral, strike-slip faults. Oblique to these are two large asymmetrical anticlines with steep, west-facing limbs that are cut by high-angle reverse faults. The Holborn Anticline and its associated Hetton Fault trend north-north-west, and the Lemmington Anticline and the Bolton Fault trend north-north-east; each anticline is approximately 18 km long and 2.5 to 5 km wide, and forms a broad periclinal dome. Farther north, and in contrast to the structures described above, the north-north-westerly trending Berwick Monocline faces east. This structure can be traced for at least 14 km before it gradually dies out southwards, but north of Berwick-upon-Tweed the steep limb is a high angle reverse fault, juxtaposing Carboniferous rocks against Silurian and Old Red Sandstone strata. Again, these features are inferred to arise from reverse reactivation of syndepositional faults.
Vale of Eden and Alston Block

At the eastern margin of the Vale of Eden, the north-west-trending Pennine Fault System has a long, complex history of reactivation and at outcrop it forms a dextral strike-slip duplex. Syn-Variscan movements include formation of an easterly facing monocline that was breached by several westerly dipping reverse faults. Carboniferous rocks in the Vale of Eden form a broad shallow syncline with axial trace orientated a little anticlockwise from the Pennine Fault System; the fold is truncated by the fault system. Subsequent Permian extension on the Pennine Fault System influenced contemporaneous sedimentation within the Vale of Eden half-graben. On the Alston Block, the almost north–south Burtreeford Disturbance is, along its southern part, another east-facing, faulted monocline. This lies on the western flank of the Weardale Pluton, and appears either to predate, or to be contemporaneous with the earliest Permian emplacement of the Great Whin Sill.

Over the centre of the Alston Block, Dinantian and Namurian strata form a gentle, open periclinal fold with an approximately west–east axis, referred to as the Teesdale Dome. This structure may have been initiated during late Carboniferous times, but doming could equally have occurred much later, during Cenozoic uplift. To the east in Durham, Coal Measures strata form a broad, irregular south-east-trending and plunging structure referred to as the Boldon Syncline. Upper Coal Measures strata are preserved in the axial region near Sunderland. Overlying Permian rocks are unaffected by this structure confirming that deformation occurred in late Carboniferous and early Permian times. Offshore, the Vane Tempest Structure is an east-facing north-north-westerly trending asymmetrical anticline.

In south Durham the west–east orientated Trimdon Anticline and its complementary syncline to the south affect Carboniferous rocks, but much of the Middle Coal Measures was eroded from the axial region of the structure prior to deposition of Permian strata in the area. The anticline is asymmetrical with a steep northern limb and developed in the hanging wall of the reactivated Butterknowle Fault, which marks the southern margin of the Alston Block.

Dent Fault System

At the western margin of the Askrigg Block, a complex set of folds and faults known as the Dent Fault System has the form of a positive flower structure in cross-section and a contractional strike-slip duplex in map view. Within the Lower Palaeozoic basement, a precursor of the Dent Fault was reactivated, forcing development of an easterly facing, north-north-east-trending monocline in the Carboniferous cover rocks. The periclinal Taythes Anticline, west of the steep limb of the monocline, formed as a result of interference with earlier, Acadian folds. Rupture of the steep limb of the monocline then produced the westerly dipping Dent Fault, the hanging wall of which was fractured by near-vertical faults (P916080). These structures are linked kinematically through north-north-west to east-south-east shortening during syn-Variscan sinistral transpression.

Bibliography


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