

STRUCTURE OF THE CULM BASIN: RAPID MAPPING OF THE TIVERTON SHEET AND THE LATEST VARISCAN INVERSION IN DEVON

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The Silesian (Upper Carboniferous) sedimentary rocks of the Culm Basin, to the west of Tiverton, belong to the Crackington and Bude formations. These comprise turbidite and debrite sandstone, interbedded with mudstone. In the field the formations are differentiated on the basis of bed thickness and weathering characteristics of the sandstone packages.

In the study area although bedrock is commonly obscured by overlying superficial deposits, the character of these deposits can be used as an indicator of bedrock geology. Using both bedrock and superficial analytical techniques, the Crackington / Bude boundary has been mapped in the study area. Tracing of large scale structure has been helped by the use of shaded relief digital terrain models, however, in areas of moorland the distinctive featurings is not present and there are no indicators of the underlying bedrock structure.

Geophysical data, in particular a recent gravity survey, provide considerable information on the structure of the Culm Basin. It is clear that the east-west trend of the Tiverton Trough, depicted by a negative gravity anomaly over the Permo-Triassic infill, continues westwards in the Silesian sedimentary rocks. Further west of the Tiverton Trough an area of relatively high gravity covers the area of Witheridge and Rackenford moors. North of this is a negative gravity anomaly whose northern boundary lies close to the crop of the basal Crackington Formation and whose southern margin follows the Crackington / Bude boundary. The strong east-west linear nature of the gravity anomalies indicates that the structure controlling the northern boundary of the Tiverton Trough was probably active during Variscan inversion. The gravity high over Witheridge is thought to be related to the presence of dense, earlier Palaeozoic rocks that form a structural high underlying the Silesian; given its linear nature and its alignment with the northern boundaries of both the Tiverton and Crediton troughs.

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INTRODUCTION

The Tiverton District is situated to the north of Exeter in Devon. In this paper references to 'the district' are held to be contiguous with the boundaries of the Tiverton 1:50000 map sheet number 310 (Figure 1). The work described in this paper was carried out in large part as a rapid re-mapping exercise of the area, the majority of which was previously mapped by W.A.E. Ussher in 1871-97, with some additions in the 1960s.

The district contains the boundary between Palaeozoic rocks deposited in the Culm Basin and the overlying Permian and Mesozoic cover (Figure 2). The Palaeozoic rocks in the district comprise Devonian-Lower Carboniferous limestones and black shales passing stratigraphically upwards into Silesian (Upper Carboniferous) sandstone and mudstone. The Silesian rocks underlie the majority of the area and are divided into the Crackington Formation and the overlying Bude Formation (Edmonds *et al.*, 1968; Freshney *et al.*, 1972). Both formations are part of the Culm Measures as described in Sedgewick and Murchison (1889).

Following the deposition of the Bude Formation the rocks were deformed by compression during the Variscan Orogeny. This deformation was complex, involving several phases of shortening through thrusting and folding (Lloyd and Chinnery, 2002) that might have begun during the latest stages of deposition. Deformation propagated northwards and it is probable that in the district the main period of compression followed the end of deposition.

After the culmination of the Variscan Orogeny in the Upper Carboniferous, uplift and extension allowed deposition of Permian sediments over the Tiverton district. Today these are best preserved in the Tiverton Trough, an east-west trending depocentre filled by Permo-Triassic sedimentary rocks. However, evidence suggests that Permian rocks covered a significant part of the district and have been subsequently eroded.

Although Ussher (1892) attempted to differentiate the Culm Measures, current maps of the district do not show this, simply listing the whole crop of Silesian rocks as 'greywackes, sandstones and shaly mudstones'. There is no biostratigraphic control in the district and coupled with poor outcrop, a lack of distinctive lithologies and the complex structural history, this has made the tracing of beds particularly difficult. However, a combination of rapid mapping, examination of superficial deposits and use of topography images and geophysical data has allowed the construction of a geological model for the district.

SILESIA SEDIMENTARY ROCKS

Differentiating and mapping the Crackington and Bude formations

Crackington and Bude formation sedimentary rocks cover much of the central and western Tiverton district (Figure 2). Both formations comprise interbedded sandstone and mudstone, with a regional dip towards the south. The older Crackington Formation is exposed north and west of the