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The Welsh Borderland Fault System: still active after 600 million years

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WOODCOCK, N.H. (1994). The Welsh Borderland Fault System: still active after 600 million years. *Proceedings of the Shropshire Geological Society*, **10**, 4–6. The Welsh Borderland Fault System comprises three major strands: the Church Stretton Fault, the Pontesford Lineament and the Towy Lineament. In the latter two cases the fault zone exists at depth and is represented at the surface by alignments of topographic features and surface structures. The general alignment of the system is due to its having had its major period of movement in Caledonian times. Evidence is presented to demonstrate that there may have been a lot more movement on these faults that was previously appreciated.

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TECTONIC ACTIVITY

The 1990 earthquake in Shropshire originated on the Welsh Borderland Fault system. This fault system appears on satellite images and follows the north-east to south-west grain of the country. Although not always visible at the surface, the fault system is present at depth and is a major control on the structures and depositional features of the surface cover.

The system extends from Pembrokeshire north into the Manchester area. One branch extends south into the South Wales Coalfield where it affects the alignment of major valleys such as the Swansea Valley. The system is the natural geological boundary between the lower Palaeozoic rock of Wales and the younger rocks of England.

For a more substantial account of this topic, maps and sections, the reader is referred to the various publications by the author listed in the references (Woodcock, 1984a; 1984b; 1988; 1990; Woodcock & Gibbons, 1988).

STRUCTURAL SETTING

The fault belt is made up of three major strands: the Church Stretton Fault, the Pontesford Lineament and the Towy Lineament. In the latter two cases the fault zone exists at depth and is represented at the surface by alignments of topographic features and surface structures. The general alignment of the system is due to its having had its major period of movement in Caledonian times, a characteristic it shares with other major fault systems in Britain.

During early Palaeozoic times this fault belt marked the boundary between a shallow water or emergent area on the English side and a deep water basin filling with marine sediments on the Welsh side. A further fault system along the Menai Straits marked the northern boundary of the deep water Welsh Basin.

Within the basin, fault systems in the basement with a northeast-southwest orientation, parallel to the Welsh Borderland faults, influenced the pattern of sedimentation and subsequently affected the structures in the surface cover. Typically, the intra-basin faults at depth are replaced by folds in the younger sediments above.

A recurrent theme of the geography of the fault system is the presence of elongate slivers of older or more resistant rocks bounded by marginal faults and set within younger and generally less resistant strata. This results in isolated areas of craggy high ground along the fault system and these have frequently been chosen as the sites for prehistoric hill forts and more recent castles. A notable example is Montgomery Castle, others are Caer Caradoc and the Wrekin. North of the Wrekin the faults are not topographically as strongly expressed as further south.

STRUCTURE AND STRATIGRAPHY

The geological or stratigraphic history of the fault belt is based largely on comparisons of the rock types occurring in the fault-bounded blocks at particular times. In addition, the presence of unconformities demonstrates periods of non-deposition or erosion in particular blocks.

In general terms, the rocks may be divided into four groups: shallow marine clastic sediments, limestones, non-marine mainly fluvial sandstones and deepwater sediments. Early on, there are major contrasts between the rocks in one fault belt and those in the next. For example, the Cambro-Ordovician rocks of the Church Stretton area do not continue across into the Shelve area where there is a much more continuous sequence of Ordovician sediments which includes some volcanics. This is good evidence that since Ordovician times the faults may have moved enough to bring into juxtaposition rocks which originated in areas which were previously much further apart.

A detailed analysis of the sedimentary record allows some estimate of when the major movements on faults may have occurred. Conversely, the Silurian and Devonian sequences seem to run across the fault belts without being displaced in a major way. However, the faults do seem to control the transition from shallow water to deep water environments. This suggests that while the faults were still active they did not have such a major effect as in the earlier times.

This sort of approach is restricted by our lack of knowledge of Cambrian and Ordovician rocks in central Wales and by the fact that early events, in this case movements on faults, are overprinted by later events. Many of these faults have experienced recurrent movements.

MOVEMENT ON THE WELSH BORDERLANDS FAULT SYSTEM

The various phases of movement on the Welsh Borderlands Fault System can be related to the major tectonic events that have affected Britain through geological time.

For example, there is a distinct deformation event in latest Ordovician times which affected the Welsh Borderland Fault System. The evidence for this is particularly strong along the Pontesford lineament around the Builth inlier and in the Shelve area where Lower Silurian rocks (Llandovery) rest with angular unconformity on Ordovician rocks. This event (the Shelvian of Toghill) is a clear and discrete event of folding and faulting restricted to, and at its most intense, along the Welsh Borderland Fault System. In outcrop, steeply dipping fault planes exhibit slickensides which indicate a strike slip movement and it is suggested that the cause of this deformation was the collision between England and Wales and the continental mass of Baltica. An alternative favoured by Dr. Woodcock is the subduction of the former oceanic ridge beneath the Welsh Borderlands.

Another major event is associated with the unconformity which separates the Carboniferous rocks from the Devonian and earlier ones. This event seems to represent the time when southern Britain collided with North America. There is well known and obvious evidence for the transition from shallow to deep marine conditions across the fault belt prior to this event. In the Silurian, rocks like the Wenlock Limestone are representative of the shallow water and these contrast with turbidity flow deposits in the central Welsh Basin. At this time the faults were probably dip-slip faults with a downthrow on the Welsh side which allowed the accumulation of large thicknesses of sediment in the basin.

The collision with North America was associated with closure, deformation and shortening of the Welsh basin during the Caledonian Orogeny. During this event in the late Silurian and Devonian, the faults in the basement were reactivated to operate as reverse faults which caused folding of the overlying sediment pile into complex structures which consist of drapes of sediments formed over the basement steps.

This event is represented in the Old Radnor area by steeply-dipping Precambrian rocks overlain by limestones of Wenlock age. The whole sequence is cut by steep faults with slickensides which indicate that the movement was again strike-slip.

If this sort of evidence is collated it is possible to define four major phases of movement on the Borderland fault system. These events correspond to major unconformities in the rock record in the late Precambrian, late Ordovician, Devonian and a late Carboniferous to Permian event which is related to the Variscan Orogeny.

These later events show up well on the gravity maps of southern Britain where the fault belts juxtapose low and high density rocks with the boundary marked by zones of steep gravity gradients. One of these fault belts runs along the margin of the Cheshire basin where it separates the low gravity rocks of the Cheshire basin from the denser rocks of the Pennines toward Manchester. Another branch of the system from the Towy Lineament runs up the west side of the basin. The younger rocks of the Cheshire basin are confined between these two fault zones. A similar pattern is seen on the geomagnetic field maps where there is more variability of the field in the more strongly magnetised older rocks to the east of the fault system. To the west they are buried and masked by the younger, less magnetised sediments and the pattern is smoother and more uniform.

ONGOING ACTIVITY

Evidence that the System is still active in a minor way comes from the events of 2nd April 1990 when the Bishops Castle earthquake occurred, causing significant damage in Shrewsbury. This was a particularly interesting event in that it was probably the first time it has been possible to locate a British earthquake along a known fault belt. Maps of the intensity show that a lot of Britain was affected. Analysis of historic records for earthquakes shows that, despite the variability of interpretation by different workers, the Welsh Borderland Fault System does have some control over where earthquakes occur in this area.

Only two recent earthquake events in this area have good instrumental records but it is still possible to define a pattern to the distribution of earthquakes. Most of the area of the old rocks in the Central Wales Basin is quiet and, with the exception of along the Bala Fault, all the activity is concentrated along the Menai Straits and on the southeast edge of the basin. It is striking that the Welsh Borderland Fault System forms a boundary between seismically quiet and active areas.

Most of the activity along the Welsh Borderland Fault System is in the southern part and some of the shocks may have been induced by mining. It may be that the bend on the system is partly responsible for the activity being restricted to the south as only the southern part is oriented favourably for slip in the present tectonic stress regime where Britain is being compressed from northwest to southeast. This is ultimately caused by the spreading of the north Atlantic.

The talk concluded by suggesting that there may have been a lot more movement on these faults that was previously appreciated. A watercolour by Rucker hanging in the Fitzwilliam Museum in Cambridge shows a view of Llangollen complete with a castle which is now near Dublin! Either the title is suspect or there has been some 200 km of movement since the work was painted in the end of the eighteenth century!

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REFERENCES

Woodcock, N.H. (1984a). Early Palaeozoic sedimentation and tectonics in Wales. *Proceedings of the Geologists' Association*, **95**, 323-335.

Woodcock, N.H. (1984b). The Pontesford Lineament, Welsh Borderland. *Journal of the Geological Society of London*, **141**, 1001-1014.

Woodcock, N.H. (1988). Strike-slip faulting along the Church Stretton Lineament, Old Radnor Inlier, Wales. *Journal of the Geological Society of London*, **145**, 925-933.

Woodcock, N.H. & Gibbons, W. (1988). Is the Welsh Borderland Fault System a terrane boundary? *Journal of the Geological Society of London*, **145**, 915-923.

Woodcock, N.H. (1990). Transpressive Acadian deformation across the Central Wales Lineament. *Journal of Structural Geology*, **12**, 329-337.

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