

**A History of N-S Faulting in the Wessex Basin including New Evidence from the
Clay Vale.**

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Abstract

Recent remapping of the Sidmouth and Wellington areas by the British Geological Survey has demonstrated a large number of faults orientated in a North-South direction. In the Sidmouth area these faults complicate the pattern of Jurassic and Triassic strata beneath the Cretaceous. The pattern of faulting continues onto the Wellington sheet to the North, where the faults appear to terminate against prominent WNW-ESE faults such as the Hatch fault. The N-S faulting is thought to be driven by regional E-W extension of the Wessex Basin, causing subsidence from the mid Triassic into the Jurassic, with later reactivation in places.

The Clay Vale is an area around Ilchester, dominantly underlain by clays of Lower Jurassic age, belonging to the Blue Lias Formation and the Charmouth Mudstone Formation. The area lies to the East of Wellington on the junction of the Yeovil and Glastonbury geological map sheets. Few faults are currently shown within these formations on the published Geological Survey maps. New evidence of abundant small scale N-S faulting is presented from the Clay Vale, demonstrating the continuation of the same structural regime in this area.

The new data from the Clay Vale has also been used to test the viability of using NEXTMAP digital images to survey faults in low-lying ground where traditional field techniques for mapping structure are difficult.

New evidence of N-S faulting in the Jurassic geology of the Clay Vale

The Clay Vale is located in South Somerset near to the towns of Yeovil, Ilchester and Iminster. The area is largely underlain by clay-rich formations of Lower Jurassic age (Figure 1). The formations dominant in this area are the Blue Lias Formation and the Charmouth Mudstone Formation; both of which belong to the Lias Group. The area under review lies on the boundary of the Yeovil and Glastonbury geological map sheets, where few faults are currently shown on the published Geological Survey maps.

Much of the area is low-lying with semi-wooded valleys and there are few distinct topographic features, so small stratigraphic displacements are difficult to spot in the field unless a clear section can be viewed. Within this area much of the geology is also obscured by overlying drift deposits.

Research work carried out by Mr Hugh Prudden over the last 40 years in and around the Clay Vale in south Somerset has involved the logging of four major gas and water pipelines, and extensive roadwork's on the A303. During the summer of 2006 continuous sections were exposed by the excavation of a new pipeline across the region. The Ilchester to Barrington natural gas pipeline is a 16km, underground pipeline connecting two surface stations. During construction, Mr Prudden conducted detailed mapping and logging of the pipeline trenches and has produced a wealth of

new data including the position of previously unknown faults along the length of the trench.

Figure 2a shows faulting on the currently published BGS maps in solid linework whilst new data is shown as stippled. All new data shown which does not lie along the position of the trench was also collected by Mr Hugh Prudden during his research over the last 40 years. The approximate route of the Ilchester to Barrington pipeline is shown as an inset map (figure 2b).

A significant number of the new faults recorded in the Clay Vale are orientated approximately N-S. This is important to note as it helps to give an idea of the structural history of this area in the wider context of tectonic activity in South West England.

Continuing Research

The mapping of faults in low-lying, relatively featureless, ground underlain primarily by clay formations still remains a difficulty to the field geologist. Only in areas where ground has been newly excavated can small-scale structures be noted with any degree of accuracy. However, the British Geological Survey is currently testing methods where structure not visible on the ground may be picked out from the air by the production of a digital shaded relief map using a software application called NEXTMAP. These images differ from the more conventional aerial photography as the scales can be altered to suit a range of different applications and the image can be lit from various angles to best show any slight variation in topography.

Figures 3a and 3b show a small area of the Clay Vale near to Martock. Figure 3a is a digital shaded relief map, produced by the British Geological Survey using NEXTMAP. The ridges apparent on the image seem to correspond with the general trend of faults shown on the conventional map image (figure 3b). The British Geological Survey is currently using the NEXTMAP data alongside conventional methods to test out the reliability of results. Further work will be needed, but this may be a way in which structural data can be inferred in areas of difficult ground.

Geographical location of major N-S structures mapped in SW England

N-S trending faults are common in some parts of SW England. Large scale N-S orientated faulting is seen on the Sidmouth geological map sheet (326 and 340) and can be followed to the north into the Wellington area (geological map sheet 311). These large-scale structures were first noted by De la Beche (1839) in his early surveys of the area when he noted faulting on the eastern side of the Blackdown Hills running down to the coast.

In the Sidmouth area the structures mainly affect Triassic and Jurassic rocks beneath the Cretaceous sediments. The main faults downthrow to the west causing repetition of the stratigraphy in some areas. In some places these faults are seen to displace the Cretaceous age Upper Greensand Formation, bringing it into contact with the younger Chalk Group and the Jurassic age Lias Group rocks. In this area the N-S structures dominate and only minor faulting is observed in other directions. To the north on the Wellington sheet the N-S Faults appear to terminate against the prominent WNW-ESE faults such as the Hatch fault. Faults of similar trend to the Hatch Fault cross the district near Staple Fitzpaine, and to the south of Wellington: the latter marks the

boundary between the quartzite pebble-dominated Budleigh Salterton Pebble Beds to the south, and the limestone pebble facies to the north.

N-S trending faults are well exposed in the old quarry workings on Ham Hill, 8km west of Yeovil. Quarry faces at the northern end of the hill show smoothed slickensides with horizontal striations and right stepping en-echelon faces lined with calcite crystals. These features are identified as indicating dextral strike-slip movement (Prudden, 2005).

In the Devonian to Carboniferous rocks of the Plymouth area N-S structures are also apparent. In the Bere Alston district of the Tamar Valley large mineralised veins extend southward from Calstock for about 6km, cutting through folded rocks of Late Devonian to Late Carboniferous age. These crosscourses were dated by Scrivener *et al.* (1994) at $236 \pm 3\text{Ma}$, which establishes a Mid-Late Triassic age. These are comparable with the Herodsfoot and Menheniot N-S trending vein complexes, which have also undergone radiometric dating to provide dates of $230 \pm 10\text{Ma}$ or Mid - Late Triassic (Leveridge *et al.* 2002) These N-S orientated crosscourses are post-granite, hydrothermally mineralised structures, not related to the main granite mineralisation events in SW England.

In the Torquay area N-S faults are locally numerous, and in some areas these displace the dominant E-W structures. Polyphase brecciation and many stages of carbonate infill shows complex movement on the N-S faults and suggests that these were major fluid pathways (Leveridge *et al.* 2003).

In other surrounding parts of the SW England the structure appears to be dominated by E-W trending structures. Dominantly E-W faulting is found in the Wessex Basin to the East of Sidmouth and in the Crediton Trough area, near Exeter.

History of major N-S faulting in SW England

During the Carboniferous the structural regime in SW England was controlled by the events of the Variscan Orogeny. This major compressional deformation event formed northwards verging folds and north to north-west directed thrust faults giving the all Carboniferous and older rocks of SW England a general E-W or ENE-WSW strike.

The change in structural direction from compression to extensional rebound started to occur in the latest Carboniferous or Lower Permian, producing an angular unconformity between Lower and Upper Permian rocks (Edwards & Scrivener, 1999; Leveridge *et al.* 2003). However, the change to tectonic conditions favouring the formation of N-S structures probably occurred during the Early Triassic just prior to the deposition of the Budleigh Salterton Pebble Beds Formation. Prior to this time the main direction of sedimentation came from Dartmoor, but a change in sediment provenance to Northern France is observed at this time. It is entirely probable that the sediment pathways were following large N-S structures. Smith and Edwards (1991) observe that the Budleigh Salterton Pebble Beds were formed in the channels of a large river flowing from south to north. These structures are very important as they mark a significant change in the evolution of the basin at this time. They may still be seen today as seen as growth faults in the Triassic sediments (Edwards & Gallois 2004). Recent examinations during the re-mapping of the Sidmouth area have revealed that this area is thought to have been a structural high with a major basement

structure reactivated during the tectonic movements of the Triassic (Edwards & Gallois, 2004). The Plymouth area crosscourses were also formed at this time. These are large mineralised structures, dated by Scrivener *et al.* (1994) and Leveridge (2002) as 230-240Ma.

The N-S orientated faulting in SW England affects a range of rocks from the Triassic through to the Jurassic and Cretaceous. On a global scale the Triassic saw the start of the breakup of Pangea (failed opening of the Atlantic). However, looking at a smaller scale, the N-S faulting in SW England is generally attributed to movements during the formation of the Wessex Basin when reactivation of earlier Variscan E-W faults caused regional E-W extension and subsidence, contributing to the formation of N-S orientated fault zones. (Chadwick, 1985, 1993, Bristow *et al.* 1991.) This subsidence provided the accommodation space for the Triassic to Jurassic age sediments. The N-S fault zones were first formed in the Triassic, but were also intermittently active through the Jurassic. Following the period of extension there was an eastward tilting and gentle folding of Jurassic rocks. Some late movement along earlier formed structures is apparent during the Cretaceous, and possibly even later, when the start of Atlantic opening would be likely to cause some periods of major reactivation.

Conclusions

Previous research and mapping has shown that N-S trending faults are common in SW England, but only a few had been noted as far north as the Clay Vale of Ilchester (Somerset). The opportunity to collect detailed structural data in an area difficult to evaluate during standard mapping surveys has produced a wealth of new data. This new data presented above shows the importance of N-S faulting in the structural

evolution of the SW England during the Jurassic. It also reinforces previous interpretations of the structural history of the area and indicates that the structural high postulated in the Sidmouth area (Edwards & Gallois, 2004) also had influence further to the north than previous research had inferred.

The new data also presents an opportunity to compare the high resolution digital images produced on NEXTMAP to actual field observations. Although the NEXTMAP images appeared to show structures running through this area any interpretations would not be valid until they were checked on the ground. The apparent close comparison between the image and the field data suggests that this may be a new way of clarifying the structure of an area where field conditions make standard mapping difficult. Fieldwork could then be concentrated in particular areas to assess the validity of interpretation

To conclude, the new data from the Clay Vale adds value to the interpretations of the structural history of SW England and has shown a possible new method of structural interpretation in areas of similar, low-lying ground.

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