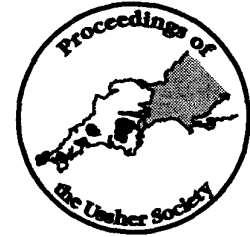


## THE STRUCTURAL AND REGIONAL SETTING OF THE ROCKS OF THE RUSEY HEADLAND

E. THOMPSON AND J. W. COSGROVE

Imperial College, University of London, London, SW7 BP.



### INTRODUCTION

This short article on the geology of the Rusey headland aims to clarify the detailed geology of a short section of the North Cornish coast (figure 1), and to demonstrate that the unique features seen on this headland reflect the fact that it occupies an important position in the regional tectonic framework.

The Cornubian peninsula comprises a series of Devonian-Carboniferous basins, filled with turbidites, shales and sandstones. These basins were inverted and thrust into a series of nappes during the Variscan orogeny. All the basins were inverted along northerly directed thrusts. The northernmost of these basins, the Culm basin, was unique in developing a zone of southerly directed back-thrusting along its southern margin, (Coward and Smallwood, 1984). This accommodated the bi-directional expulsion of Culm sediments, both northwards, onto the Hercynian foreland in South Wales, and southwards. This paper describes the location of the Rusey structures within this regional framework.

### THE FACIES OF THE RUSEY AREA

To the north of the Rusey headland, the alternating shales and sandstones of the Crackington Formation turbidites crop out. Individual sandstone beds within this formation may exceed a metre in thickness. To the south of the headland, the Boscastle Beds, which consist of blue-black shales and volcanics, crop out. A zone of tectonic disturbance approximately 230 m wide now separates these two formations. This 130 m wide section exposed at Middle Strand, (Figures 1 & 2a), is composed of uniform mid-grey shales, with iron-rich bands 2 to 3 cm thick. In contrast, the exposure on the Rusey headland, (100 m wide), is comprised of dark blue-grey to black shales with intercalated sandstones c. 10 cm thick. Bedding strikes  $019^\circ$  and dips  $17^\circ$ - $27^\circ$  east on the northeastern side of the headland. On the south-western side the local deformation is so complex that a representative bedding dip cannot be determined. An intense cleavage, formed by the parallel alignment of minerals, is associated with this deformation. Its orientation is highly variable. These rocks are structurally underlain by shales which contain a band of quartz matrix supported breccia, up to 3 m thick, with a mean strike and dip of  $162/44^\circ$  east, (figure 2b). Within the limited exposure, the host shales do not contain sandstone layers. They have a well developed slaty cleavage, which has a strike of  $016^\circ$  and a dip of  $59^\circ$  east. This fabric probably formed during the development of the breccia.

All the rocks described here are Carboniferous in age and palaeontological data, (Selwood, Stewart and Thomas, 1985), places both the Crackington Formation and the northernmost exposures of the Boscastle Formation, immediately to the south of the headland, in the Namurian. This supports the interpretation made by E.C. Freshney, (page 22, B.G.S. Memoir, 1972), who places the rocks both to the south-west and to the north of the Rusey fault in the  $H_{1a}$  and  $E_{2c}$  zone, dated as Namurian. Further to the south the rocks are of Viséan age. The sources cited above do not explicitly state that samples were taken from a zone of tectonic disruption. Therefore, whilst it is clear that the rocks immediately to the north and south of the tectonised

zone are of the same age, this may not be true for the rocks *within* the zone. It is interesting to note, however, that although the Boscastle and Crackington Formations are separated by a major dislocation zone, the beds within that zone are lithologically intermediate between the distal facies of the Boscastle beds and the more proximal facies of the Crackington Formation.

This geographical juxtaposition is compatible with deposition from turbidite flows sourced from the north. Thus the Crackington Formation can be interpreted as a well developed AB(C) section of the Bouma sequence, the Boscastle Formation as the finer grained end of that sequence, a D/E sequence with some C units and the Rusey beds as an intermediate sequence with a higher percentage of C units, but still essentially a CDE section. This interpretation, based on

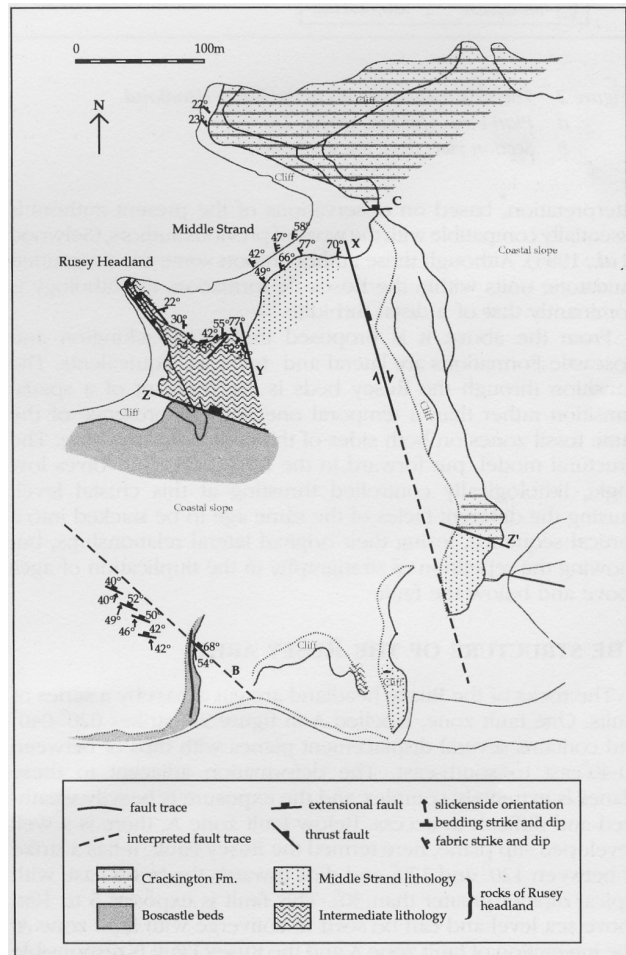


Figure 1. Geological map of the Rusey area, North Cornwall

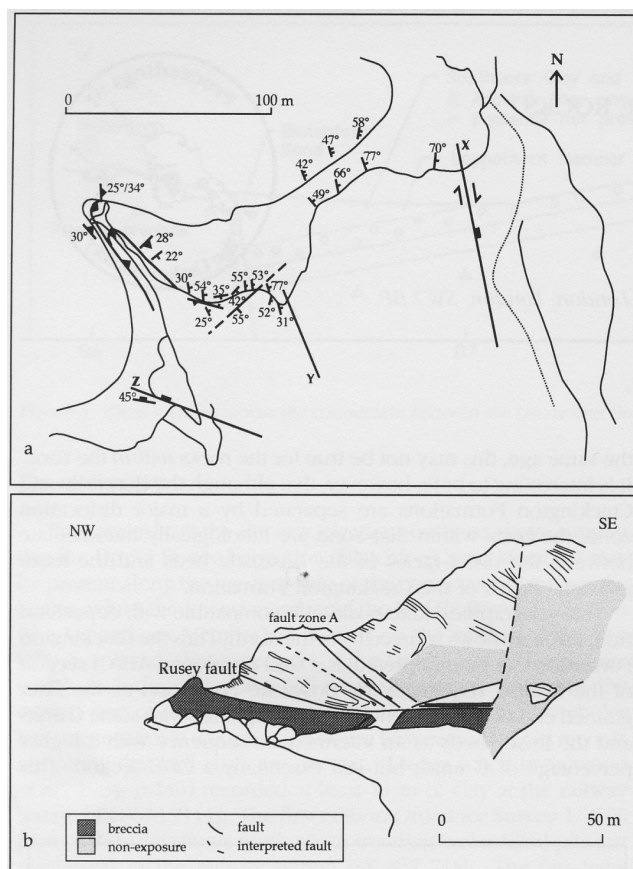


Figure 2. The structural elements of the Rusey Headland.

- a. Plan view, (for key, see fig. 1)  
 b. Section view from the south-west

observations of the present authors is essentially compatible with the work of previous authors, (Selwood *et al.*, 1985). Although these authors report some coarse grained sandstone units within the Boscastle formation, the lithology is dominantly that of a distal turbidite.

From the above it is proposed that the Crackington and Boscastle Formations are lateral and temporal equivalents. The transition through the Rusey beds is the remnant of a spatial transition rather than a temporal one and the presence of the same fossil zones on both sides of the fault is unsurprising. The structural model, put forward in the next section, involves low angle, lithologically controlled thrusting at this crustal level, causing the different facies of the same age to be stacked into a vertical sequence, losing their original lateral relationships, but showing the repetition of stratigraphy in the duplication of ages above and below the fault.

### THE STRUCTURE OF THE RUSEY AREA

The rocks of the Rusey headland are cut across by a series of faults. One fault zone, labelled A in figure 2b, strikes 020°-040° and contains several displacement planes with dips of between 20-40° east to south-east. The deformation adjacent to these planes is extremely complex and the exposure is heavily weathered and difficult to access. Below fault zone A, there is a well developed slip plane, here termed the Rusey Fault. It has a strike of between 120° and 170° and dips towards the north-east, with typical dips of greater than 30°. This fault is exposed 5 to 10m above sea level and can be seen to converge with fault zone A. The interaction of fault zone A and the Rusey Fault is responsible for the local complexity of the deformation. These faults are interpreted as thrusts, and direct evidence for this is provided by

folds, the dissection of folds into thrust bound fold hinges and fault/bedding relationships. These structures give a top to the north-west sense of movement for all the thrusts, although considerable variation in fold axis orientation occurs in the area of fault interaction. Slickensides are not developed on these fault surfaces.

The rocks below the Rusey fault are pelites that have been affected by multiphase deformation. They contain a main breccia band, a number of subsidiary breccia bands, and a large amount of quartz veining. The top and bottom of the main breccia band are characterised by sharply defined surfaces. The upper surface strikes 155° and dips 55° east-north-east whilst the basal one strikes 170° and dips 30-36° east. These orientations indicate that the band has a wedge or lensoid geometry and may not be laterally persistent. Similar sharply defined surfaces are developed within the band. These internal surfaces have orientations that are broadly coincident with those of the bounding surfaces of the main breccia band, striking 146-160° and dipping at between 40°-65° east-north-east, (typically around 50°). They have highly distinct subhorizontal slickensides, invariably oriented between 330°-340°. This orientation is consistent with that measured for slickensides found on similar sharply defined surfaces within a second exposure of the Rusey breccia, at the top of Rusey cliff. At this location, the breccia is cut by an extensional fault, termed here the Cliff Fault, (figure 1, fault B). The fault plane has a strike of 132°, a dip of 68° north-east and slickensides which plunge at 43-48° towards 346-352°. These slickensides combined with drag of the beds abutting the fault indicate that the extension was accompanied by an important element of sinistral strike-slip motion. Some layers of the breccia exposed on the cliff top show the same style of rootless folding that is seen in the Culm facies above the Rusey Fault on the beach.

Because the headland is bounded both to the north-east and south-west by major steeply dipping faults, difficulties exist in correlating the rocks exposed there with the surrounding geology. To the north-east there are two dislocations exposed in the cliffs at the back of Middle Strand, (faults X & Y, figure 1). From the cliffs, the trace of the most easterly of these, (fault X) can be followed as a topographic feature. It strikes approximately north - north-west, though the fault surface is not exposed. Bedding immediately to the west of the fault trace dips at 70°-80° northeast, whereas away from the fault trace the dip decreases to 50° north-east. This implies that there is dip-slip on the fault, with the eastern side being downthrown. In addition, as the beds approach the fault trace, their strike rotates from 315° to 005°, indicating an element of dextral strike-slip, (Figure 1), fault X. Between fault X and the Rusey headland there is another fault, (Y). Although there is no systematic rotation of bedding strike, as the fault trace is approached, there is a decrease in dip, (to c.40°), which indicates that the area to the west, (the Rusey headland), has been downthrown by this fault. The dislocation is subvertical and the outcrop covered in scree and difficult to access. The trace of this fault has a north-north-west trend but is much less defined than that of fault X.

Another fault occurs to the south-west of the headland, (fault Z, figure 2a). Although the fault plane is not exposed, the beds immediately to the south-west strike 104° and dip approximately 45° north. Drag on the beds indicate that the Rusey headland is downthrown to the north-north-east. The convergence of faults Z and Y isolate the Rusey headland as a downfaulted block. Because of poor exposure it is not possible to determine the exact slip vectors for any of these three faults.

### DISCUSSION

Because the rocks of the Rusey headland are separated from the adjacent rocks by faults, it is difficult to determine their exact relationship with the regional metasediments. The occurrence of faulting and brecciation at the boundary between the Boscastle beds and the Rusey beds indicates that this junction has acted as an important displacement horizon, with kinematic indicators demonstrating thrust movements. This interpretation is compatible

with the tectonic framework for the region, in which major thrusting and inversion of the Culm basin occurred in association with the Variscan orogeny.

The presence of thrust and folded layers both on the Rusey headland and in the footwall of the Cliff Fault suggests that the rocks at both these locations are in proximity to an important thrust plane. In addition, both localities contain the highly characteristic Rusey Breccia. The combination of these two features enables the thrust zones exposed at the top and bottom of the cliff to be correlated with confidence. The Cliff fault is therefore interpreted as a major extensional fault, downthrowing to the north-east. From the orientations of faults Z, Z', B and C, (see Figure 1), it seems likely that the Cliff Fault belongs to an array of normal faults present in this area, all of which downthrow to the north-east. Thus it is concluded that initially the Rusey beds were thrust north-west over the Boscastle beds and that subsequently the area underwent a north-east — south-west extension.

The original relationship between the rocks of the Rusey headland and the rocks east of fault X and north of Middle Strand is unclear because the boundary between them is not exposed. However the abrupt change in facies across the boundary and the field evidence of faulting, (see Figure 1), indicate that this boundary may be faulted.

On the basis of the sediments contained in the three units, it seems likely that the Boscastle Formation, the beds of the headland and the Crackington Formation formed as part of the same sedimentary system, despite the evidence for a major tectonic discontinuity between the Boscastle Formation and the rocks of the Rusey headland. This conclusion is compatible with the paleontological evidence, which indicates that the rocks have retained their original stratigraphic relationship to each other.

## CONCLUSIONS

Having considered the stratigraphy and structure of the Rusey headland and its adjacent areas it is proposed that;

- \* The thrust faults and the breccia exposed on the Rusey headland and at the Cliff Fault are located at the site of a major lithological change, i.e. between the Boscastle shales and the High Cliff/Crackington turbidites.
- \* The area underwent considerable extension and oblique/ strike-slip faulting, post-thrusting, although the relative timing of these later events cannot be determined from this field area.
- \* The rocks south of the headland and the rocks which comprise the headland, although now structurally separate, were deposited as part of the same sedimentary succession and deformed by the same tectonic events.
- \* The rocks to the north and east of the Rusey headland and the rocks which comprise the headland are probably part of the same depositional system, though their precise relationship cannot be determined from the field data acquired to date.

E. A. T wishes to thank Imperial College for a number of individual field grants that made the work presented here possible. This project is also funded by an Imperial College Research Bursary.

## REFERENCES

- COWARD, M.P. and SMALLWOOD, S. 1984. An interpretation of the Variscan tectonics of SW Britain. In: *Variscan tectonics of the North Atlantic region*, Eds: HUTTON, D.H.W and SANDERSON, D.J. Special Publication Geological Society, London, **14**, 89-102
- SELWOOD, E.B. STEWART, U. and THOMAS, J.M. 1985. Upper Palaeozoic sediments and structure in north Cornwall—a reinterpretation. *Proceedings of the Geological Association*. **96**, 129-141.
- FRESHNEY, E.C. McKEOWN, M.C. and WILLIAMS, M. 1972. Geology of the coast between Tintagel and Bude. *Memoirs of the Geological Survey of Great Britain*, H.M.S.O.