Cormorant Rock (Craig y Fulfran)

[SN 583 830]

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Highlights

The Cormorant Rock site exposes a series of folds produced during the Caledonian Orogeny. The cleavage has unusually complex geometrical relationships with the folds. Small-scale folds, termed 'tectonic ripples' in the older literature, have recently been interpreted as products of deformation which preceded the main Caledonian tectonism.

Introduction

The site is located at the foot of the main sea-cliffs opposite the Cormorant Rock sea-stack. The rocks are interbedded turbidite sandstones, siltstones, and mudstones of the Llandovery Series (Lower Silurian) Aberystwyth Grits Formation (Wood and Smith, 1958; Cave and Haim, 1986). The site has been selected for the unusually complex geometrical relationships between cleavage and folds which it shows, and for its anomalous small-scale folds, first recorded and described as 'tectonic ripples' by Wood (1958) and recently discussed by Fitches *et al.* (1986).

Description

The dominant structure comprises an anticline–syncline pair (Figure 4.15)A with a wavelength of *c.* 10 m, steep and nearly N–S axial planes, and a gentle to moderate southerly plunge. These folds probably represent regional deformation structures. Cleavage is mostly weak and ill-defined, and has complex relationships with the folds. In places it is axial planar, but in the anticlinal hinge zone it forms a very open downward-divergent fan and lies at only a small angle to bedding.

Of particular interest are the small-scale folds of bedding developed in the eastern limb of the syncline. These 'tectonic ripples' (Wood, 1958) are illustrated in (Figure 4.15)B and C. These folds are open to close, S-shaped asymmetrical structures with wavelengths of about 0.30 m and amplitudes of about 0.10 m. Their axial planes are reclined and hinge lines plunge gently northward; they are not coaxial with the host syncline. A weak cleavage, marked by feeble grain alignment in sandstone and a fissility in finer rocks, is restricted to hinge zones, where it makes upward convergent fans in shales and downward convergent fans in sandstones (Figure 4.15)B. Calcite-filled saddle-reefs have developed in some inner arcs of these small folds, at the interfaces between sandstone and shale (Figure 4.15)C.

Interpretation

The anticline and syncline at this site are considered by Fitches *et al.* (1986) to represent regional, end-Caledonian folds on the basis of their N–S, steep axial planes which are parallel with other regional folds of the district. The cleavage is probably also an end-Caledonian structure, but the reason for its very strong divergence in the anticline hinge is unclear. One explanation is that it formed in the site of intense extensional strain on the outer arc of the folds, contemporaneously with folding, as illustrated in a theoretical model by Ramsay and Huber (1987, Figure 21–26), for example, and from Snowdonia by Wilkinson (1988, (Figure 4.31)). Alternatively, the cleavage may locally have formed after the host layers were folded, as observed at the North Clarach site.

The 'tectonic ripples' in the limb of the syncline are not parasitic to that larger fold; they have the wrong sense of asymmetry, their axial planes and hinge lines are incongruent with respect to those of the larger fold, and the main cleavage appears to cut obliquely across them. Fitches *et al.* (1986) inferred that they preceded the development of the syncline and attributed them to gravity gliding toward the north-west which took place before, or as a precursor to, the

regional deformation. On these grounds, the small folds were assigned to a family of early structures, other members of which are considered to be represented at Allt Wen and Traeth Penbryn, for example.

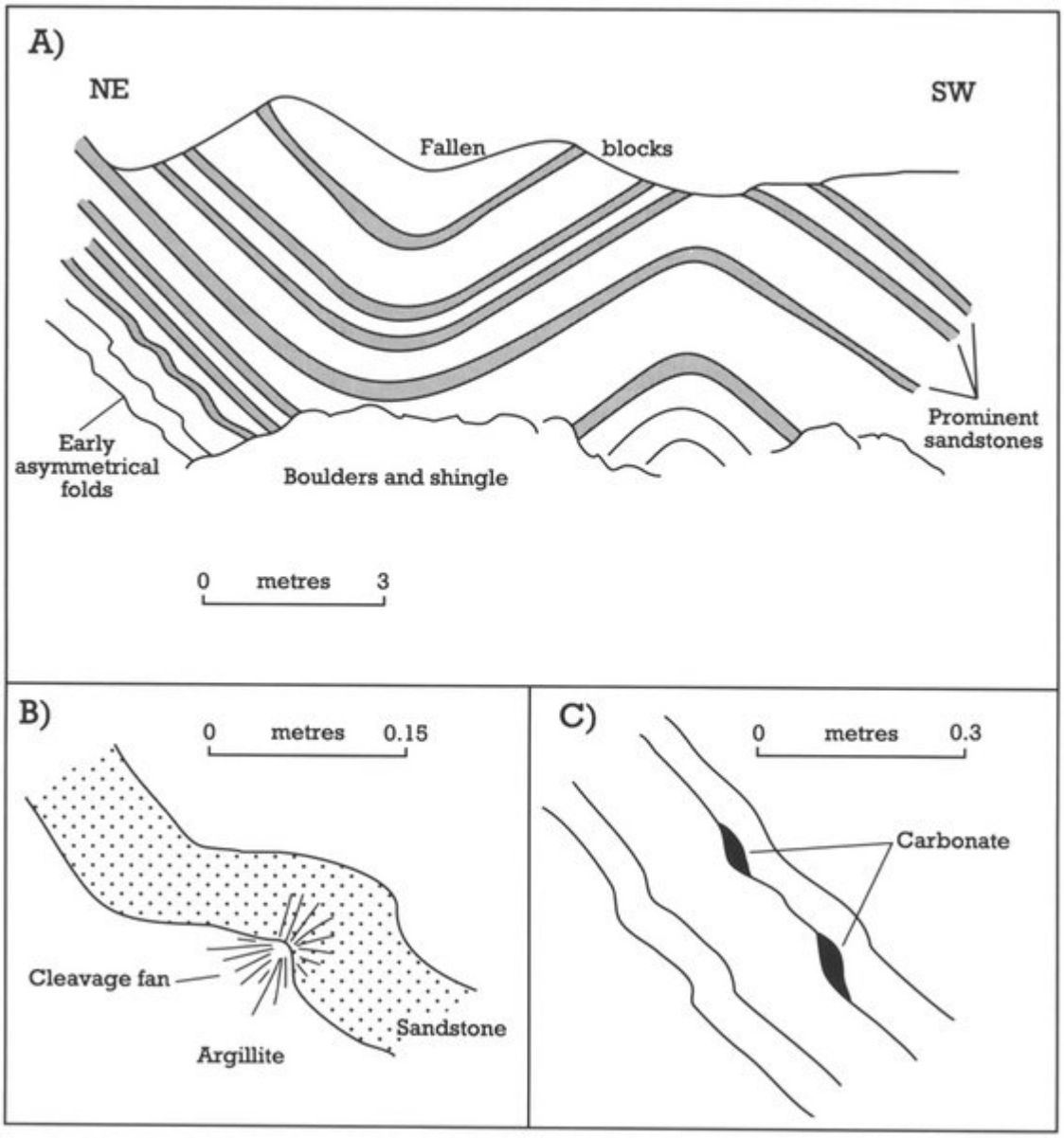
Recent examination by the author of other 'tectonic ripples' in the Aberystwyth Grits between Clarach and Borth, a few kilometres north of Cormorant Rock, has prompted consideration of an alternative explanation for these structures. Rather than being folds caused by compression along bedding, the ripples are more likely to be narrow, almost uniformly spaced ductile shear zones. Each shear zone is inclined at a high angle to bedding which it deflects down to the west by a few centimetres. A weak cleavage, developed along each zone, is oriented obliquely to the zone margin in a manner consistent with downwards ductile displacement on the west side. These structures are almost certainly older than the regional folding and cleavage for reasons discussed above.

The presence of the calcite-filled saddle-reefs in the hinges of some 'tectonic ripples' implies that the host sediments were sufficiently cohesive to allow the opening of cavities during the early deformation. Such brittle behaviour may imply that the sediments were at least partially lithified by this stage.

Conclusions

The small folds of the Cormorant Rock site provide information on deformation that preceded the main Caledonian folding and cleavage development in this part of the Welsh Basin. They have formed either by gravity gliding or as a result of movement on small slip surfaces (ductile shear zones). The larger-scale, but still comparatively lesser-order folding, and cleavage, here were the product of the Caledonian mountain-building phase. They are orientated in the typical N–S manner of other Caledonian structures in the region, but the cleavage is locally stongly divergent from the planes which bisect the fold limb-pairs (axial planes) of the folds. It is not clear why this is the case, but it may be due to some localized strain in the outer arcs of the folds or it may, more simply, indicate that the cleavage was formed after the folding. The site is an important one for studying the effects of the Caledonian Orogeny in this .region. Because the site exemplifies relationships between folds and cleavage which are not yet fully understood, it is an important locality for current and future research.

References



(Figure 4.15) Craig y Fulfran. (A) Regional deformation folds with early asymmetrical small-scale folds on the northeastern limb, further illustrated in (B) and (C). (B) shows cleavage fans and (C) saddle-reefs in hinge zones (after Fitches et al., 1986, figures 6(A), (C), and (B)).