Capel Curig

[SH 707 563]

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Highlights

The crags east of Dyffryd Mymbyr contain excellent examples of deformed accretionary lapilli which provide an important measure of the amount of crustal strain which affected the volcanic rocks of Snowdonia during the Caledonian Orogeny. The deformed lapilli also give an indication of the nature of Caledonian strain in this area; the site is therefore important as part of a network representing the regional structural pattern.

Introduction

The site shows outcrops of the Dyffryn Mymbyr Tuff; the highest tuff unit of the Capel Curig Volcanic Formation (Caradoc Series). This member only occurs on the north-west limb of the periclinal Capel Curig Anticline (Howells *et al.,* 1978) and is characterized by beds rich in whole and fragmented accretionary lapilli indicative of subaerial deposition. The deformed lapilli record the state of strain in this component fold of the Snowdonia Syncline — see (Figure 4.1) and (Figure 4.2). The lapilli tuff at Capel Curig has become a standard for the practical illustration of strain measurement in undergraduate teaching and in numerous textbooks (for example, Ramsay, 1967; Ramsay and Huber, 1983).

The Capel Curig district was first investigated in a systematic fashion by Jukes, Aveline, and Selwyn who undertook the primary survey, started in 1848, with maps and sections published by the Geological Survey (1851–55). The structure and stratigraphy of the district were also outlined in the North Wales memoir (Ramsay, 1866, 1881). The first detailed map and description was that of Williams (1922). In recent years, the district around Capel Curig has been incorporated in regional strain studies (Siddans, 1971; Coward and Siddans, 1979; Wilkinson, 1987, 1988). A number of studies have concentrated on volcanological and stratigraphical aspects of the Capel Curig Volcanic Formation (Francis and Howells, 1973; Howells *et at,* 1978, 1979) and descriptions of the area have appeared in the field guides of Roberts (1979) and Howells *et al.* (1981).

Description

The site consists of a single exposure of the Dyffryn Mymbyr Tuff, located 200–300 m to the ENE of Dyffryd Mymbyr. The exposure forms a prominent crag, 10–20 m high, overlooking an area of large fallen blocks.

The bedded Dyffryn Mymbyr Tuff lies on the north-west limb of the NE–SW-trending periclinal Capel Curig Anticline. The SW-plunging closure of this fold is well displayed in the sandstones underlying the Capel Curig Volcanic Formation on Creigiau'r Garth to the south. At the GCR site, the tuffs dip at approximately 20° to the north-west, the bedding being defined by colour variations and by different concentrations of the ellipsoidal accretionary lapilli. On a small scale, minor irregularities can be seen in bedding orientation. The higher parts of the crag are composed of paler crystal tuff with few lapilli.

Cleavage is somewhat variable in intensity and irregular in orientation, refracting between lithologies. The general dip is 70° to the north-west, and the steep face of the crags runs approximately parallel to the 050°–060° strike. Large cleavage surfaces >0.15 m apart define units containing weaker cleavage surfaces which are discontinuous and occasionally anastomose around the lapilli.

The best examples of the strained accretionary lapilli can be observed at the base of the crags on either side of a small wall. Individual lapilli are near-perfect ellipsoids. They have *x* dimensions from 1 to 25 mm which on cleavage (*xy*) planes, pitch 70° from the north-east, illustrating the steep nature of extension. Some, although by no means all, of the larger

crystal fragments in the surrounding tuff are also elongated parallel to the long axes of the lapilli. The y axis of the lapilli is parallel to the gently plunging axis of the south-west end of the Capel Curig Anticline. Large joint surfaces intersecting the face of the crags produce planes approximating to the (*xz*)axes in which flattening in the plane of cleavage can be observed. Overall, axial ratios in the lapilli (*x*>*y*>*z*)approximate to 4:3:1.

Interpretation

The Dyffryd Mymbyr site has been chosen as a representative location displaying excellent strain markers and showing the intensity of deformation in Snowdonia.

The Capel Curig Anticline is a component fold of the Snowdonia Syncline and it lies within the central zone of that structure. It is one of the best examples of periclinal folding in Snowdonia. The fold typifies the north-east end of the synclinorium, being an open, NE–SW-trending symmetrical structure. Towards the south-west, folds decrease in wavelength and interlimb angle — see Trum y Ddysgl. All folds are characterized by the absence of meso-scale folding and an absence of hinge-zone thickening.

The arcuate nature of the Snowdonia Syncline (convex to the north-west) was initially interpreted as a primary feature of the deformation by Shackleton (1953) and, later, by Dewey (1969). In contrast, Helm *et al.* (1963) suggested that refolding was responsible. This was disputed by Coward and Siddans (1979) who argued for (NW–SE) compression against the rigid indentor of the Berwyn Hills. Campbell *et al.* (1985) favoured this latter model, but suggested that the indentor was the NW-dipping concealed extension of the Tan y Grisiau microgranite. Strain has been measured in the volcanic rocks of Snowdonia (Siddans, 1971; Roberts and Siddans, 1971; Coward and Siddans, 1979; Wilkinson, 1987, 1988) using a variety of volcanogenic markers (siliceous nodules, rhyolite clasts, tuff clasts, and accretionary lapilli). The compilation of strain data by Coward and Siddans (1979) is incompatible with refolding and, therefore, disagrees with the interpretation of Helm *et al.* (1963). Wilkinson (1987) showed strain in Snowdonia to be heterogeneous, but approximating overall to plane strain with a vertical extension rarely exceeding 130% in tuffs.

The Dyffryd Mymbyr site displays excellent examples of strained accretionary lapilli. The steep, north-westerly plunge of the x axis, sub-horizontal NE–SW *y* axis, and shallow southeasterly plunging *z* axis shown by these lapilli are typical throughout Snowdonia. In common with the Lower Palaeozoic succession throughout North Wales, this indicates vertical extension in response to NW–SE compression during the main phase deformation, although the extent of deformation varies with location and lithology (cf. Alexandra Quarry). The lapilli may indicate a higher state of strain and a more pronounced flattening deform, ation in the volcanics than that shown by other strain markers because of the likelihood of a higher volume loss in these other lithologies than in the more massive volcanics (Wilkinson, 1987).

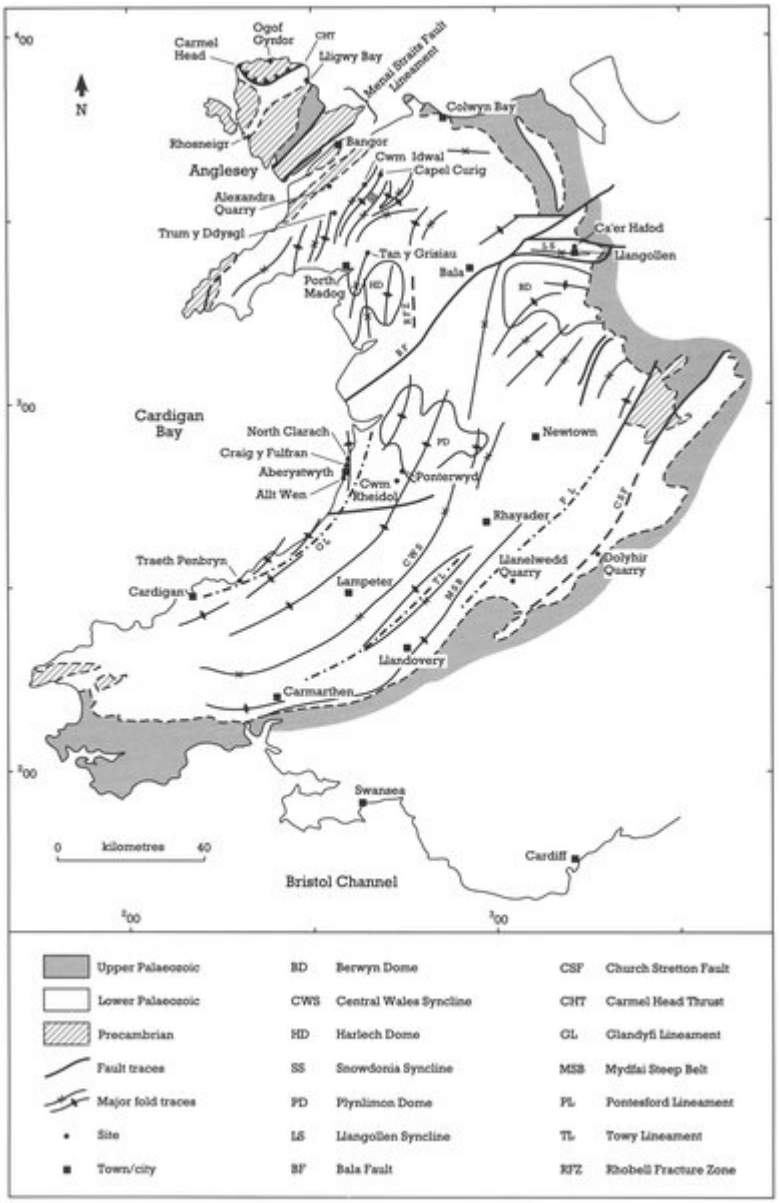
The regional variations in strain values and structural style have still to be incorporated in a widely accepted tectonic model. The variety of models: basement control (Shackleton, 1953; Dewey, 1969); 'thin-skinned' tectonics (Coward and Siddans, 1979; Campbell *et al.,* 1985); oblique-slip (Woodcock, 1984b)) were summarized by Wilkinson (1987), whose own work emphasizes the heterogeneous nature of strain in the Ordovician volcanic sequence. This heterogeneity has recently been considered in the models of Wilkinson (1988), Smith (1988) and Wilkinson and Smith (1988). They suggest that the style of structures and the intensity of strain developed in the Palaeozoic cover was determined by the orientation and distribution of basement faults which were active during sedimentation and deformation.

Conclusions

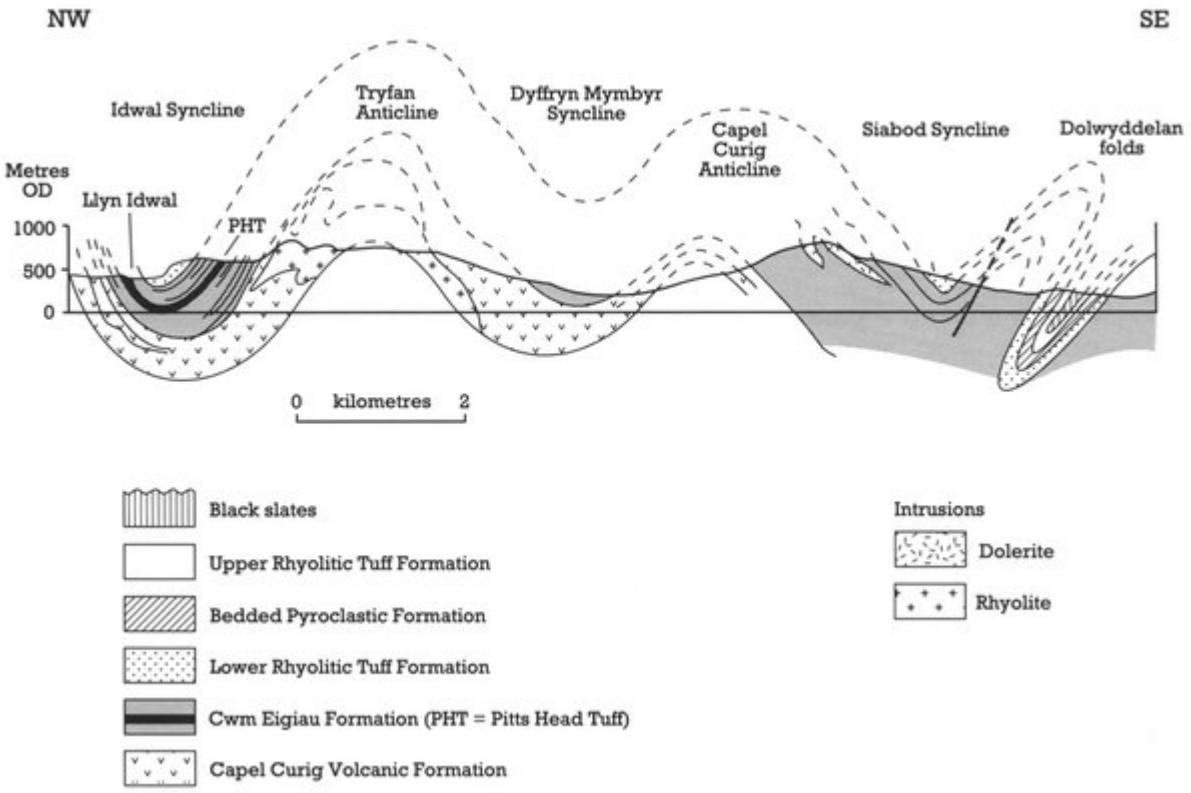
The tuffs at this locality contain accretionary lapilli (originally, spherical hailstone-like accumulations of volcanic ash). These now perfect ellipsoidal objects are excellent indicators with which the Caledonian strain within the Ordovician volcanic rocks of Snowdonia can be measured. Their degree of distortion makes it possible to assess the actual amount of tectonic deformation (crustal shortening) to which Snowdonia was subjected during the Caledonian mountain-building episode, around 400 million years before the present.

Strain measurement has played an important role in interpreting the structure of the Caledonian Orogenic Belt of North Wales, and there is ongoing research in this field. This site lies within the Capel Curig Anticline, probably the best example of the periclinal folds of Snowdonia, and it illustrates the open structural style of the northeastern end of the Snowdonia Synclinorium, contrasting markedly with the site at Trum y Ddysgl where deformation was more acute.

References



(Figure 4.1) Map showing the traces of the principal folds and faults of Caledonian age in Wales. The localities described in the text are also shown.



(Figure 4.2) Section through the major folds of Snowdonia (after Wilkinson, 1988).