Rhoscolyn

[SH 260 763]–[SH 272 751]

W. Gibbons

Introduction

The exposures of deformed metasedimentary rocks on the Rhoscolyn coast have become among the most intensively studied sites of structural geological interest in Great Britain. Following initial descriptions by Greenly (1919), they were re-interpreted by Shackleton (1954, 1969, 1975), became a subject of some controversy after a paper published by Barber and Max (1979), and a consequent focus of detailed structural studies by Cosgrove (1980), Lisle (1988), and Phillips (1991b). The site (Figure 7.12) has been chosen because it is quite simply world class in its exposure of multiple deformed metasedimentary rocks. There is nowhere better in Great Britain to observe and demonstrate three-dimensional fold geometry, cleavage-bedding relationships, and the superposition of several deformation phases on low-grade metasediments. Furthermore, although metamorphosed and highly deformed, these rocks preserve a recognizable lithostratigraphy and include excellent examples of sedimentary structures, making the site of interest to stratigraphers and sedimentologists as well as structural geologists. The site is the type locality for the Rhoscolyn Formation, the highest of three units that comprise the South Stack Group in western Anglesey (Phillips, 1991a). The combination of a varied and traceable lithostratigraphy combined with a complex structural history makes the site an excellent field laboratory for teaching geological mapping techniques.

Description

The main interest of this site focuses on the presence of a prominent NE-plunging, SE-verging fold known as the Rhoscolyn Anticline (Shackleton, 1969). The core of this structure runs inland beneath the Coastguard Lookout and the NE-plunge of the structure means that it can be superbly viewed in the coastline immediately to the south-west (Figure 7.13). These cliffs reveal intensely corrugated, well-bedded, turbiditic psammites and pelites. An early bedding-parallel (S_1) fabric is detectable in these metasediments, although no convincing examples of F_1 folds are present and it remains unclear whether 'D_1' was a significant tectonic event. The most prominent minor structures are related to the major anticline, with SE-verging asymmetry and a strong NW-dipping axial planar cleavage produced primarily by pressure solution acting on the sedimentary rocks during deformation. White quartz veins are commonly present parallel to this cleavage, and are especially abundant in the pelitic beds. North-easterly plunging cleavage-bedding intersections are particularly well preserved on bedding surfaces exposed around the Coastguard Lookout. Superimposed upon this S_2 cleavage are the effects of a later $(1)_3$) deformation phase, which has resulted in the localized folding of F_2 about gently NW-dipping axial surfaces (Figure 7.14).

To the west of the Coastguard Lookout the exposures reveal the gently dipping limb of the Rhoscolyn Anticline (Figure 7.13). The best exposures are again to be found on the coastline just above high water mark, and these show abundant folds commonly sculpted into three-dimensional forms by weathering. These exposures are especially good for demonstrating fold geometries, but also provide many readily accessible examples of the NW-dipping axial planar cleavage. This cleavage is locally folded by minor F_3 folds with flat-lying (or gently NW-dipping) axial surfaces and an associated S_3 axial planar spaced cleavage. Locally, it is also possible to observe late (D_4) conjugate kink bands with axes approximately parallel to both F_2 and F_3 fold axes.

In addition to the structural interest, this western side of the site is the best place to study the sedimentology of the Holyhead Formation, a sequence of thick quartzites and interbedded psammites (metasandstones) and pelites. There are also excellent sections in the South Stack Formation, the dominant lithology being of quartz-rich turbiditic metasandstone, in beds up to 3 m thick, interbedded with subordinate pelites. Sedimentary structures such as graded bedding and convolute lamination are locally well displayed.

To the south-east of the Coastguard Lookout the cliffs reveal the steep, south-easterly limb of the Rhoscolyn Anticline. Here the abundant and well-preserved minor structures can be compared with those on the opposite limb of the fold. The majority of the F_2 folds have an 'S' geometry, and cleavage-bedding relationships show the beds to be locally overturned into a steep north-westerly dip. These exposures are particularly good for examining structures within the pelitic facies of the Rhoscolyn Formation. These pelites show spectacular cascades of F_2 and F_3 folds, and are full of examples of folded quartz veins. In some localities it is possible to recognize all four deformation phases, providing the opportunity to differentiate their relative ages.

Interpretation

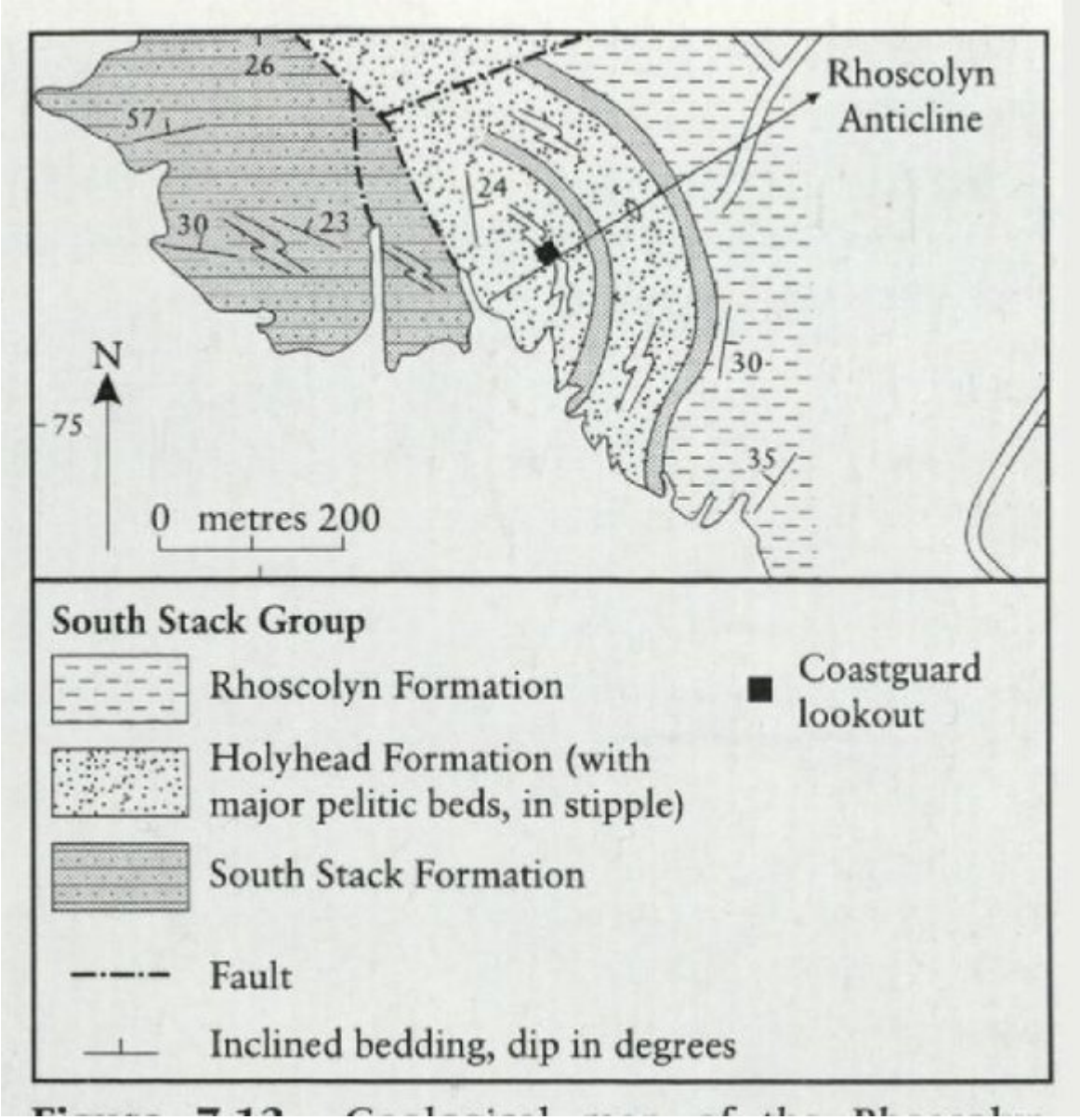
In terms of their tectonic setting, the strata of the Rhoscolyn Formation are interpreted to have been deposited in a submarine fan environment, within a NE–SW trending basin associated with a Precambrian or Cambrian subduction system (Wood, 1969; Phillips, 1991a). According to Phillips, the formation marks a return to a mid-turbidite fan facies, more typical of that seen in the Holyhead Formation at the South Stack GCR site, on the north-west limb of the Rhoscolyn Anticline.

Shackleton (1954, 1969, 1975) used the sedimentological strucures preserved by these exposures to reinforce his interpretation of the South Stack Group as right-way-up and so disprove an earlier interpretation by Greenly (1919). Shackleton (1969) drew a sketch profile through the Rhoscolyn Anticline and demonstrated the pronounced asymmetric vergence towards the south-east. This was one of the first examples of geologists using sedimentological way-up criteria to determine the stratigraphy and fold facing directions within polydeformed terranes. Rhoscolyn has been at the centre of a controversy concerning the structural interpretation of the metasedimentary sequence in north-west Wales known as the Monian Supergroup. The more pelitic New Harbour Group overlies the South Stack Group on Holy Island. The greater deformation of the New Harbour pelites led Barber and Max (1979) to argue that they were older than, and had been thrust over, the underlying South Stack Group. Detailed work on the pelites of the Rhoscolyn Anticline, however, has shown that the pelites interbedded within the South Stack, Holyhead and Rhoscolyn formations have undergone a comparable deformation history to those in the overlying New Harbour Group (Cosgrove, 1980; Khonstamm, 1980; Phillips, 1991b; Gibbons *et al.,* 1994).

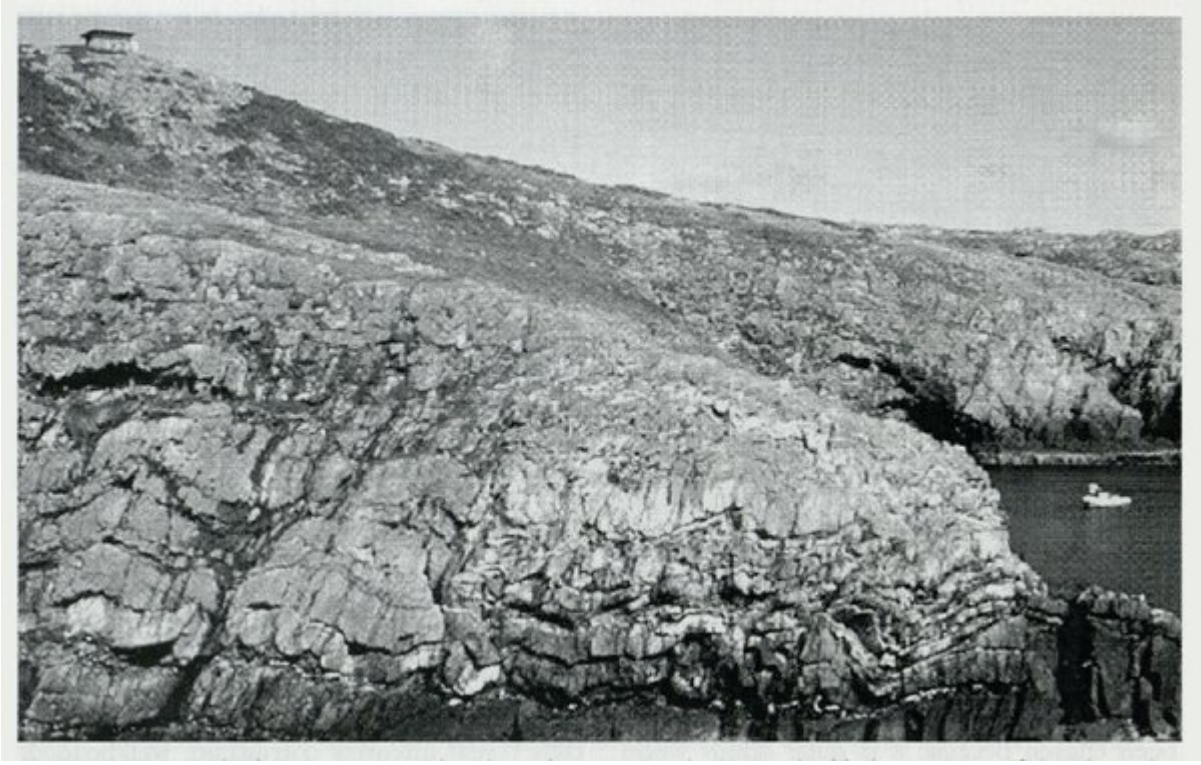
Conclusions

The coastline at Rhoscolyn is arguably the best place in Great Britain to study the effect of folding and cleavage formation on a sequence of bedded sedimentary rocks. The spectacular and photogenic exposure of the Rhoscolyn Anticline, visited regularly by numerous school and university field parties, provides a textbook example of a large asymmetric fold with associated minor folds. Several deformation phases have been recognized within these metasediments, which nevertheless commonly preserve original sedimentary structures and form part of a coherent lithostratigraphy. The site is the type locality of the Rhoscolyn Formation, deposited in a turbidite fan environment. It has yielded key evidence to support the interpretation of the South Stack Group as being older than the overlying New Harbour Group.

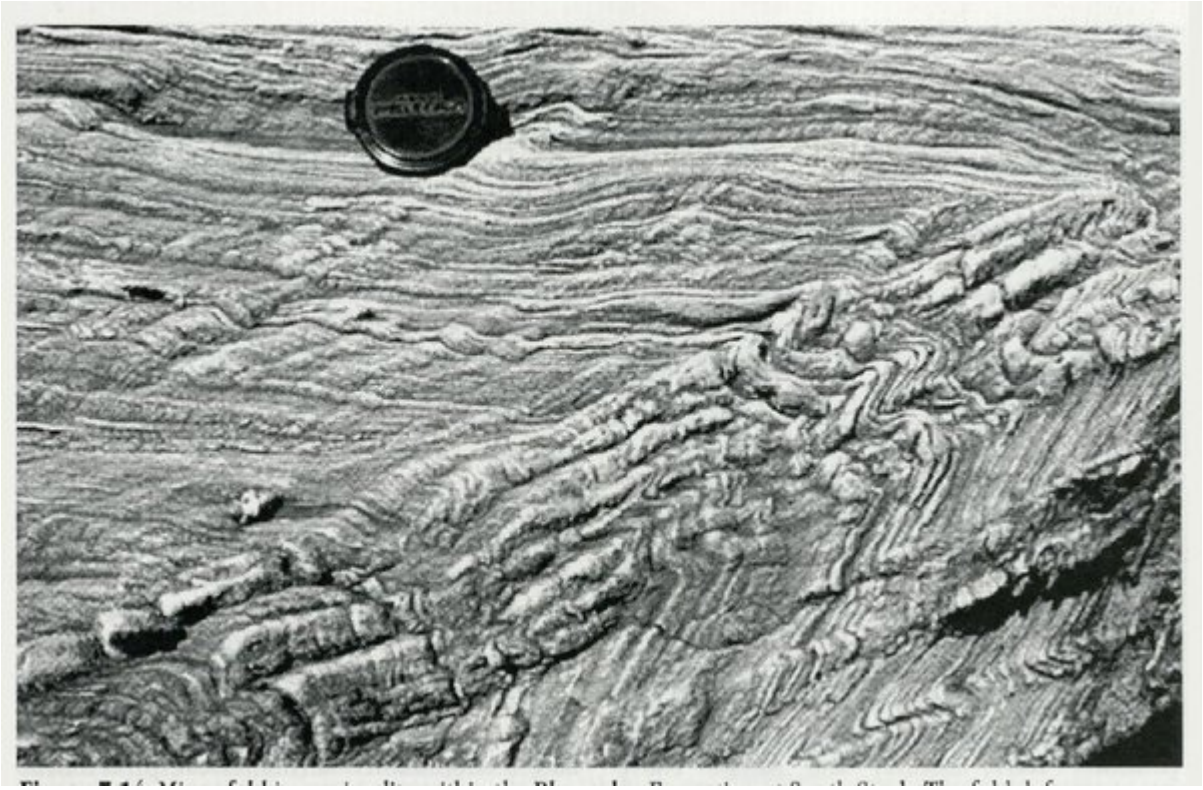
References



(Figure 7.12) Geological map of the Rhoscolyn Anticline. Modified from Phillips (1989, fig. 4.24)



(Figure 7.13) View looking east across the Rhoscolyn site. Gently dipping bedded psammites of the Rhoscolyn Formation (South Stack Group) on the north-western limb of the Rhoscolyn Anticline showing minor folds and steeply NW-dipping cleavage. The core of the anticline runs beneath the Coastguard Lookout (top left) from which the beds dip south-eastwards to the sea. (Photo: W Gibbons.)



(Figure 7.14) Minor fold in semi-pelite within the Rhoscolyn Formation at South Stack. The fold deforms an earlier cleavage (usually designated S3) and a new pressure-solution spaced cleavage can be seen developing axial planar to the fold. (Photo: W Gibbons.)