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## Meikle Ross (Borgue Coast)

[NX 634 446]–[NX 656 460]

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### Introduction

The Meikle Ross (Borgue Coast) site lies on the north margin of the Solway Firth, Kirkcudbrightshire. It embraces the cliff and foreshore of both the southern extremity of the Borgue coastline and, across a narrow stretch of water (The Sound) to the south-east, the island of Little Ross. The cliff and foreshore exposures of about 4 km of the mainland coastline, stretching from Mull Point on the west coast, to 200 m east of the ruins of Senwick Church in the east, and on Little Ross, the whole of the coastline (about 1 km), are included (Figure 4.65).

The strata exposed at the site have a general strike of ENE–WSW, and those of Wenlock age belong to what are now recognized as the younger part of the Hawick Group, and the Ross Formation, which is considered by most authors to form the lower part of the Riccarton Group (Kemp and White, 1985; Kemp, 1986; Cocks *et al.*, 1992). The contact between the two stratigraphical divisions is everywhere mapped as a fault; this fault, like the strike of the sediments, trends ENE–WSW. All the strata are steeply to highly inclined, or inverted.

The problems posed by the rocks of this site, and those on the nearby Balmae Coast to the east (see above in this chapter), are in an area the geological complexity of which was first recognized by Murchison (1851). The initial description was by Lapworth (1878), who recognized the structural complexity of the Southern Uplands as a whole, and although only making brief reference to the Kirkcudbright area, stated that the Riccarton Beds were of Wenlock age. Peach and Horne (1899) summarized Lapworth's work; they too considered that the Riccarton Beds approximated to the whole of the Wenlock, and they believed the Hawick Rocks to be older (Figure 4.63). The later stratigraphical schemes of Craig and Walton (1959) and Clarkson *et al.* (1975) differed radically from earlier ones. In these schemes, the Raeberry Castle Beds were considered the oldest and the Hawick Rocks as the youngest units in this area. More recent studies (Kemp, 1985; Kemp and White, 1985; White *et al.*, 1992) have brought general agreement about the stratigraphical order and age of the major lithostratigraphical divisions, the differences being more about questions of stratigraphical terminology rather than relative stratigraphical position (Figure 4.63).

The different opinions and the resolution of the problems have stemmed from the recognition of the true ages and relationships of the major groups of rocks that are preserved in this general area. Particularly, ages determined from graptolite and palynomorph biostratigraphy have contributed to the debate, and sedimentological and structural analysis have added to an understanding of the whole geological history.

The Meikle Ross (Borgue Coast) site and that of the Balmae Coast have particular geological importance for two major reasons. Firstly, they are crucial in the resolution of the dispute which extends back to the 19th century about the relative ages of the major groups of rocks exposed (the Hawick Group and the Riccarton Group), and secondly, they are important in the understanding of the overall geological structure of the Scottish Southern Uplands; their study culminated in the formulation of the 'accretionary prism' model of Leggett *et al.* (1982), a model that although generally accepted, has been challenged and refined more recently (see 'Interpretation' section below). In addition, the Meikle Ross site gives its name to and includes the type section of the Ross Formation (Kemp, 1986), and the site is crucial in understanding the character of the Riccarton Line in the southern part of the Southern Uplands.

### Description

The Hawick Group comprises very monotonous thinly to thickly bedded turbiditic greywackes and calcareous sandstones of Facies C and D type, with intercalated Facies F horizons of slumped sediment (Kemp, 1986). Interbedded with the turbidite facies are structureless red and olive-grey mudstones. The red mudstones are up to 5 m thick, and in the

olive-grey mudstones display distinctive packets of fine red laminae. As a whole, both in the general area and at the Meikle site, there are no body fossils. Diverse trace fossil assemblages are common, however; *Paleodictyon*, *Dictyodora scotica*, *Protovirgularia*, *Gordia* and forms of *Planolites* have been recorded (Benton, 1982).

The Ross Formation is predominantly characterized by monotonous thin- to medium-bedded calcareous sandstones of the classical turbidite Facies C and D. Massive coarse sandstones with a maximum thickness of 10 m referable to Facies B occur sporadically, and lithologies of very coarse sand or larger grade are very rare. Facies F slumped units occur to a maximum thickness of 3 m; these hemipelagite units are usually developed as 0.1 to 3 m beds within Facies C turbidite mudstone and siltstones, and as rather thinner units (of 1–100 mm thickness) in Facies I units. The type section of the Ross Formation lies on the west side of the Meikle Ross peninsula.

The Ross Formation, unlike the Hawick Group, has an almost total absence of trace fossils. Graptolites, the major group available for biostratigraphical dating of the formation, have been obtained from many localities at the Meikle Ross site (White in Kemp, 1986). Although they are not well preserved, they have enabled most of the Wenlock succession to be recognized here, although the very top of the series has not been proven. Of the macrofossils, other than the graptolites, only orthoconic cephalopods have been collected. Graptolites have been collected from both the lower and the upper units, which have been recognized in the Ross Formation. The lower unit yielded *Cyrtograptus centrifugus*, *Cyrtograptus insectus*, *Retiolites geinitzianus geinitzianus*, *Retiolites geinitzianus angustidens*, *Monoclimacis vomerina vomerina*, *Monoclimacis vomerina basilica*, and *Monograptus priodon*, which together indicate a *centrifugus* to *murchisoni* Biozone age. The upper unit contains a fauna in which *Monograptus riccartonensis* is dominant, and which also includes *Monograptus firmus sedberghensis*, *Monograptus radotinensis inclinatus*, *M. priodon*, *M. vomerina vomerina* and *M. vomerina basilica*. These indicate the presence of the *riccartonensis* Biozone.

Separating the Hawick Group in the north of the site from the Ross Formation in the south is a major fault, which here represents the presence in the area of an important structural feature, the Riccarton Line. This line can be traced in the sequences of the Southern Uplands (and their stratigraphical equivalents) from the east coast of Scotland to Dundalk in Northern Ireland. Everywhere, it is taken to mark the southern boundary of the Hawick Group (Kemp, 1986). At the Meikle Ross site, a 500 m wide, highly complex and tectonized zone immediately south of the Riccarton Line (the 'zone with red beds and graptolite beds'; (Figure 4.65)), indicates the complex tectonic intercalation of rocks of the distinctive red mudstones of the Hawick Group and the contrasting, dark, argillaceous and graptolitic turbidites of the Ross Formation.

## Interpretation

In the Southern Uplands many NE–SW trending strike faults are present, and although the sequence as a whole youngs to the south-east, individual fault-bounded sequences young to the north-west. There are at present two major geotectonic models that have been proposed to explain the evolution of the rocks of this region, to which the Meikle Ross site has contributed. McKerrow *et al.* (1977) and Leggett *et al.* (1979a, b; 1982) suggested that the Southern Uplands, including the rocks exposed at this site, resulted from the formation of an 'accretionary prism'. However, Stone *et al.* (1987) proposed that the rocks of the Southern Uplands were deposited in a back-arc basin. Both of these models include the development of an imbricate thrust stack, but on a sedimentary sequence deposited in different geotectonic positions. These two models are fully described in the Balmae Coast site report above.

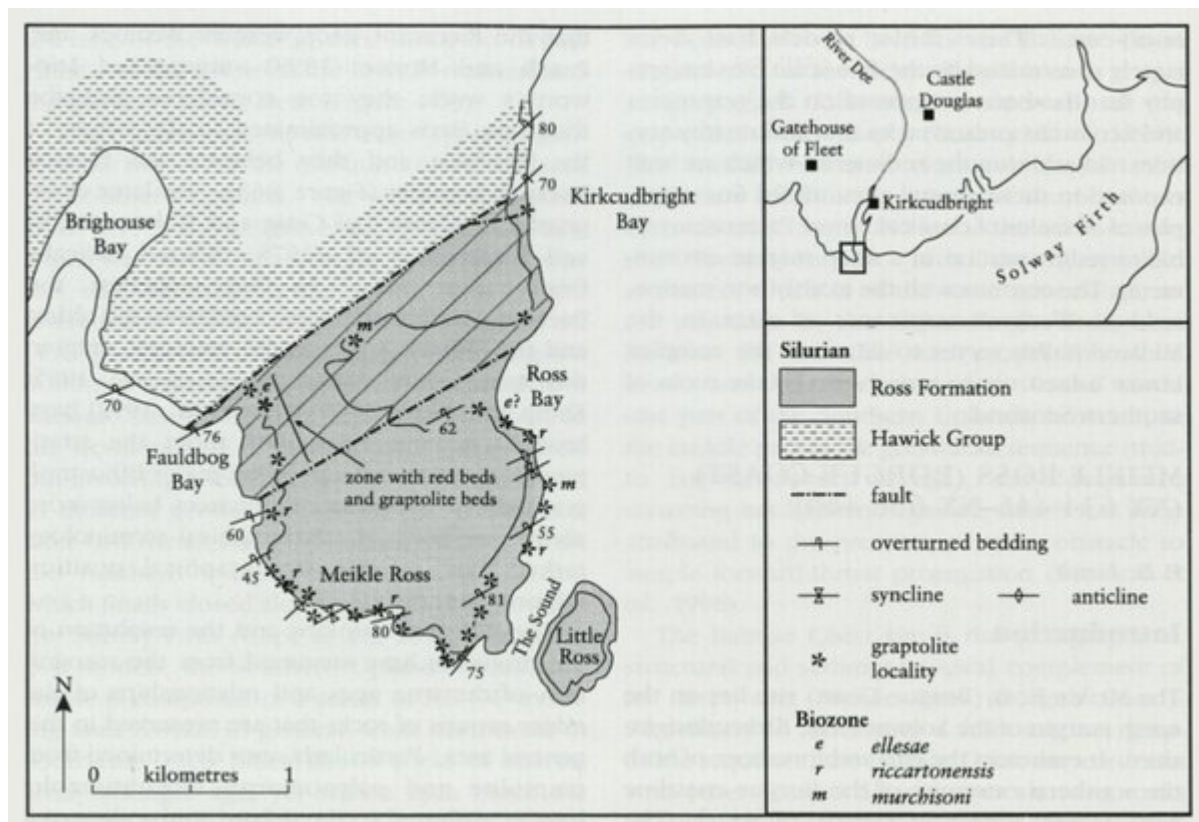
This Meikle Ross (Borgue Coast) site networks very closely with the Balmae Coast site to the east. Each of the two exhibit a fully marine, offshore, graptolitic sedimentary sequence that is in stark contrast to the Scottish Midland Valley sites, which are now not far geographically removed, but which were deposited in very different tectonostratigraphical situations. The Midland Valley sites in the Pentland Hills (Lyne Water and Lynslie Burn site), in the Hagshaw–Lesmahagow area (Ree Burn–Glenbuck Loch site), and the eastern part of the Girvan Inlier (Knockgardner site), all illustrate the early onset of non-marine conditions at about the Llandovery–Wenlock boundary, or at latest in early Wenlock times.

## Conclusions

This Meikle Ross (Borgue Coast) site and its sister site to the east (Balmae Coast) have much historical importance. Lapworth in the late 19th century was first to describe the rocks of this area in an attempt to resolve the geological problems that had been earlier recognized by Murchison. The sites have great significance for understanding the structural development of the Southern Uplands of Scotland, and for the interpretation of the mechanisms involved in the progressive narrowing and destruction of the Iapetus Ocean. Recent biostratigraphical refinement has allowed new insights into the differences of this closure in this area as compared to that in the Peebles area about 100 km to the north-east.

The site houses the type section of the Ross Formation, and illustrates the complex structural interdigitation of the Hawick Group and the Ross Formation at, and just south of, the structurally important Riccarton Line. In addition, the well-exposed sediments in this coastal site show excellent examples of most of the facies of Lower Palaeozoic turbidite sedimentation.

## References



(Figure 4.65) Geology of the Meikle Ross (Borgue coast) area, SSW of Kirkcudbright, Southern Uplands (modified from Clarkson et al., 1975, with minor revision of lithostatigraphical terminology after White et al., 1992).

