
Morroch Bay and Port of Spittal Bay

[NX 018 523]–[NX 014 526] [NX 019 521]

Introduction

Morroch Bay shows the largest exposure of the Moffat Shale Group in south-west Scotland and shows an unfaulted contact with the overlying greywacke sandstones of the Portpatrick Formation. The Moffat Shale Group contains a succession of fossil faunas, the youngest of which serves to date the base of the Portpatrick Formation, which is itself generally unfossiliferous. At Port of Spittal Bay, immediately to the south of Morroch Bay, the lowest part of the Portpatrick Formation is again visible, interleaved with units of the quartzose Glenwhargen Formation. A graptolite fauna just below the base of the Portpatrick Formation there is significantly younger than that at Morroch Bay, illustrating the diachronous nature of the base of the greywackes.

The section at Morroch Bay was described by Peach and Horne (1899, pp. 402–408), Stone (1995, p. 17, fig. 9a) and Rushton and Tunnicliff (1996). Features of Port of Spittal Bay were described by Stone (1995, p. 27), who also gave further references and (in his appendix 2) details of the graptolite faunas.

Description

At Morroch Bay the intertidal exposure of the Moffat Shale Group is about 400 m across, extending from [NX 018 523] to [NX 014 526], with the Portpatrick Formation making the headlands at either end of the bay (Figure 15.3). The Moffat Shales, which dip steeply and strike south-west out to sea, are divided into the Glenkiln and Lower Harden Shale formations and are intruded by a number of substantial dykes that are approximately concordant with the bedding. The section shows evidence of folding and faulting (Stone, 1995, p. 47) but in general youngs northwards, except where structural imbrication is indicated by the duplication of certain fossil zones.

Peach and Horne (1899, p. 403) considered that the Moffat Shale of Morroch Bay was brought up in a complex anticline and explained the alternation of shale and greywacke beds at the north end of the bay by isoclinal folding. Modern interpretation regards the Moffat Shale as brought up on a major thrust fault at the south end of the bay, with the oldest Moffat Shale adjacent to the fault, where the Glenkiln Shale Formation, which includes cherts and red, green and black mudstones, is faulted against greywackes of the Portpatrick Formation at the southern end of the bay, where it forms a large, though structurally disturbed, outcrop. Graptolites of the *Nemagraptus gracilis* graptolite zone were found in black shales at the southern end of the outcrop, and conodonts, probably of the *Pygodus anserinus* conodont zone, were collected from red shales (Bergström and Orchard, 1985). Farther north, graptolite faunas of the *Climacograptus peltifer* Zone were found. Peach and Horne (1899, p. 404) also recorded a faulted sliver of Hartfell Shale Formation, but this has not been confirmed.

Near the middle of the bay, the Glenkiln Shale gives way to the Lower Hartfell Shale, which consists of black siliceous mudstones of the rarely encountered *Climacograptus wilsoni* Zone. Graptolites collected there include the type material of *Dicellograptus angulatus* Elles and Wood. Conodonts from these black shales include the Caradoc species *Periodon grandis* (Armstrong *et al.*, 1990).

North of the *wilsoni* Zone are black shales alternating with beds of greywacke, the shales yielding graptolites of the *Dicranograptus clingani* Zone. The overall pattern of steeply dipping beds and northward younging is disturbed by a major fault, north of which chert and fossiliferous Glenkiln Shale are re-introduced, again followed by Lower Hartfell Shale, with graptolites of the *clingani* Zone.

Towards the north end of the bay, thick beds of greywacke alternate on a 1–2 m scale with shaly beds of the *clingani* Zone; the base of this succession is the type locality for *Plegmatograptus nebula* Elles and Wood. These *clingani* Zone shales are now considered to be interbedded with greywacke beds at the base of the Portpatrick Formation, and Peach

and Horne's idea of isoclinal folding is considered to be untenable (Peach and Horne, 1899). Above its base, the Portpatrick Formation consists of massive andesitic-rich greywackes derived from the south-west. These occupy the coastal cliffs northwards for about 6 km, and there is evidence that the northernmost parts of the Portpatrick Formation lie in the next higher graptolite zone of *Pleurograptus linearis* (Stone, 1995, p. 9).

Port of Spittal Bay, about 300 m south-east of Morroch Bay [NX 019 521], is also the site of a major thrust fault, with quartzose greywackes of the Shinnel Formation, probably of Ashgill (*anceps* Zone) age, to the south (Stone, 1995, p. 28). To the north, an outcrop of Lower Hartfell Shale with graptolites of the *linearis* Zone underlies the andesitic greywackes of the Portpatrick Formation. A few tens of metres above the base of the Portpatrick Formation, pale interbeds of quartz-arenite (Figure 15.4), less than 1 m thick, are considered to represent part of the Glenwhargen Formation (Stone, 1995, p. 27).

Interpretation

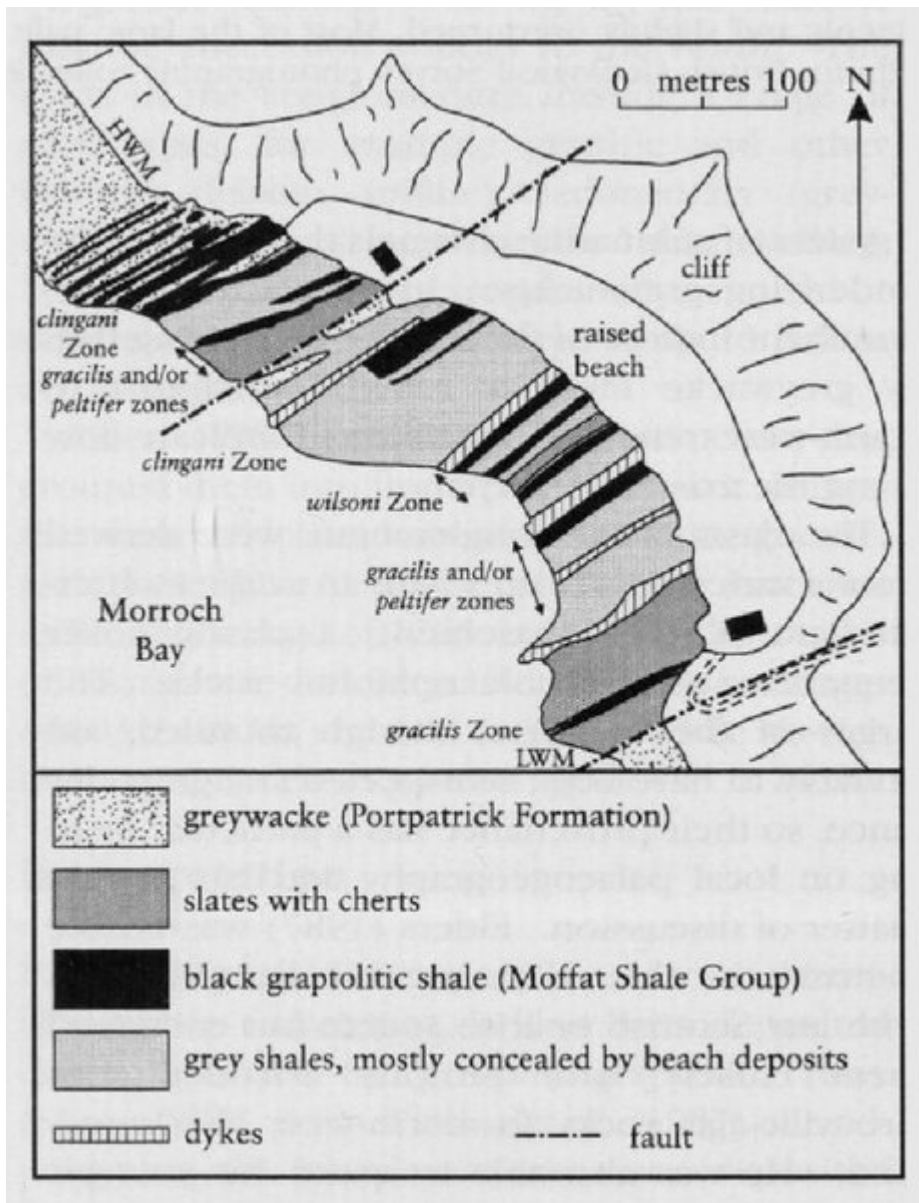
Morroch Bay exposes the best succession of Moffat Shale in south-west Scotland, including representatives of all the graptolite zones from *gracilis* to *clingani*, and has also yielded conodont faunas that confirm the correlation of the *anserinus* conodont zone with the *gracilis* Zone. The distribution of faunas illustrates unusually clearly the style of imbrication of the succession as inferred for many parts of the Southern Uplands of Scotland (Rushton *et al*, 1996a). The stratigraphical contact at the base of the Portpatrick Formation is the clearest available and dates the base of the formation there as within the *clingani* Zone.

The base of the Portpatrick Formation overlies graptolites of the *linearis* Zone in Port of Spittal Bay and is therefore appreciably younger there than at Morroch Bay (Figure 15.5). The pale beds of quartz-arenite occurring above the base are noteworthy because, although they are not known at the north end of Morroch Bay, they are present at Black Head, 3 km north of Portpatrick and near the locality where graptolites of the *linearis* Zone were found. They provide further evidence that the base of the Portpatrick Formation at Morroch Bay extends much farther down stratigraphically than at Port of Spittal Bay, illustrating more clearly than elsewhere the strong south-east diachroneity of the base of the Portpatrick Formation. The juxtaposition of the older and younger developments of the base of the Portpatrick is thought to represent successive thrust slices of a regularly imbricated southward-propagating thrust stack (Stone, 1995; Rushton *et al.*, 1996a).

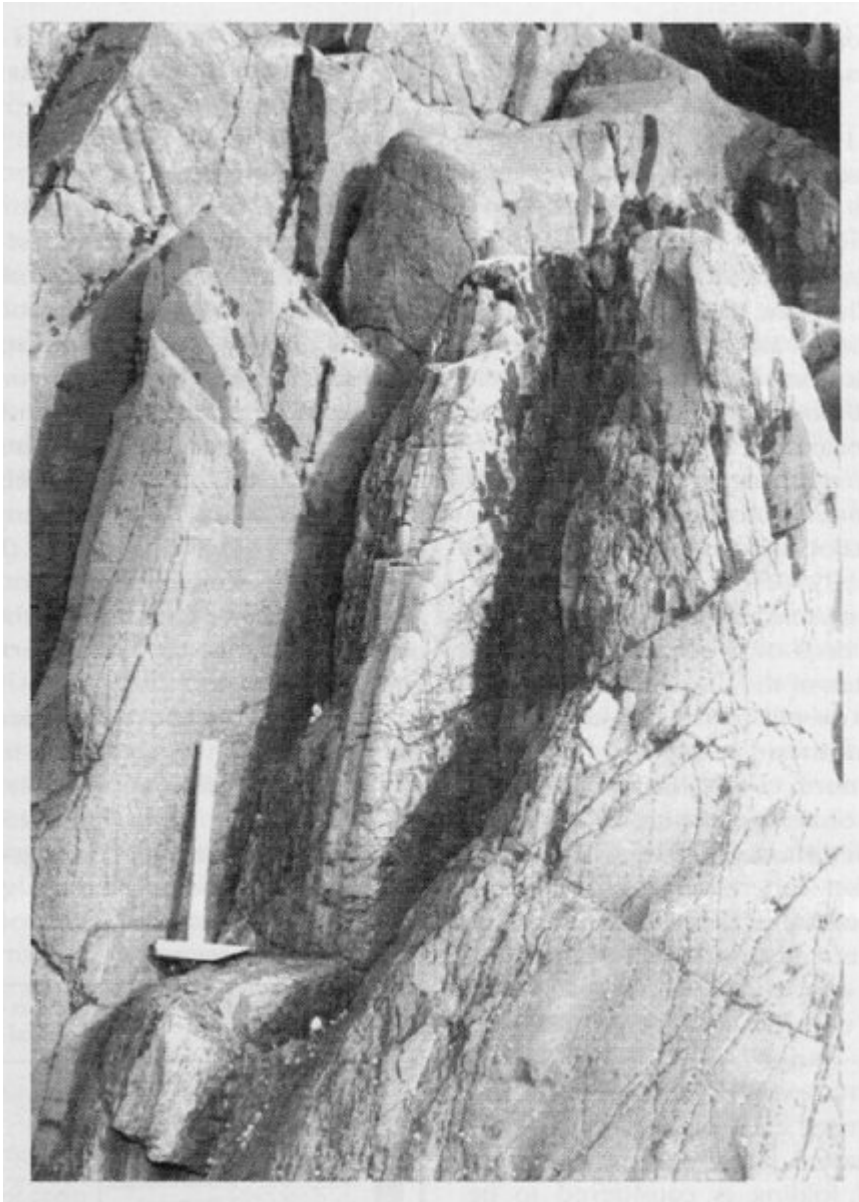
Conclusions

Morroch Bay is a significant exposure of the Ordovician part of the Moffat Shale Group in south-west Scotland, and one of the few exposures showing all the graptolite zones of the Glenkiln and Lower Hartfell divisions. Fossils from these exposures help to elucidate the structure in the area and serve to date the Portpatrick Formation. Contrasts between the sections at Morroch Bay and Port of Spittal Bay indicate the gradual way in which the sandstones of the Portpatrick Formation progressed southwards and covered the shales of the Moffat Group.

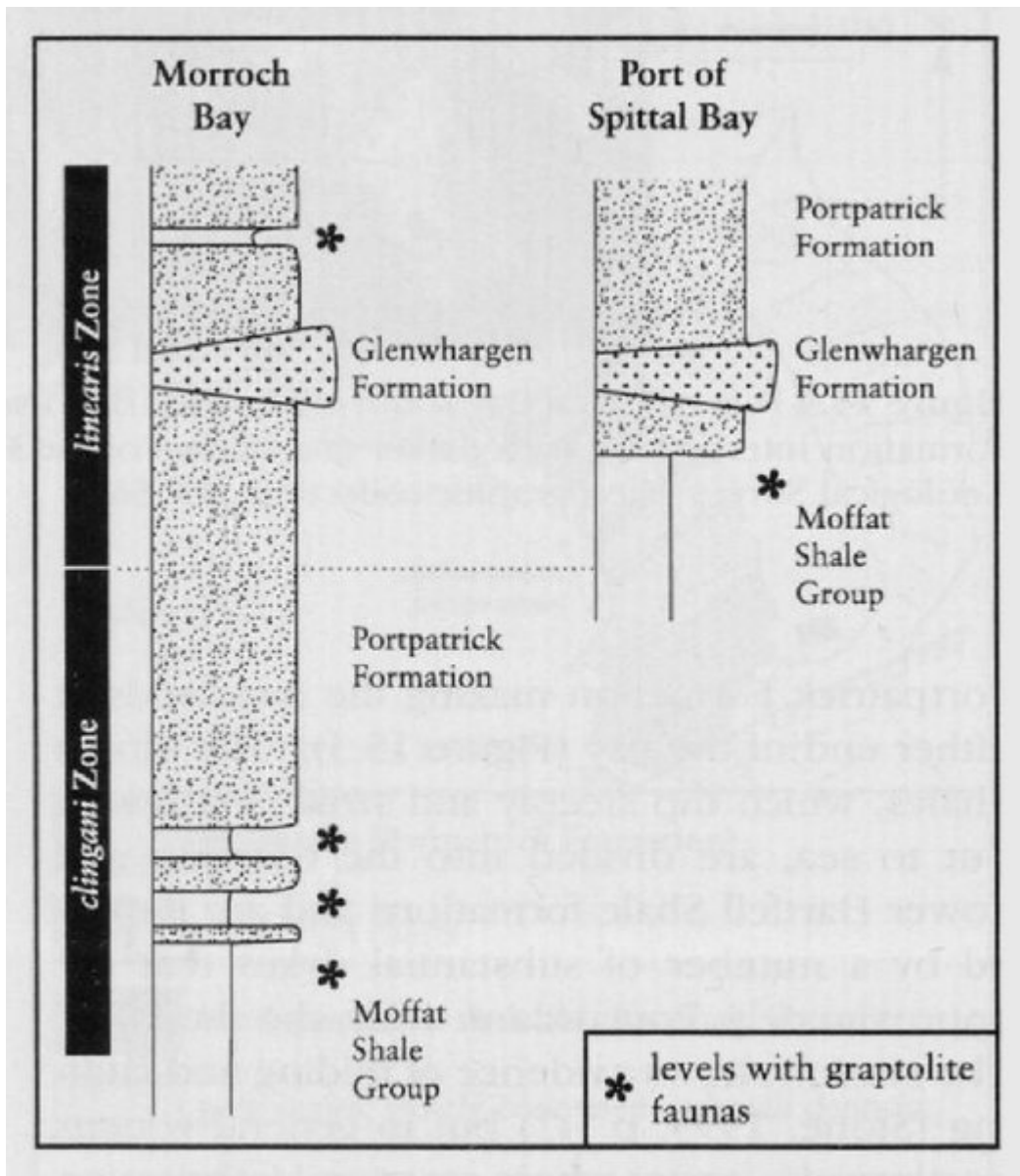
[References](#)



(Figure 15.3) Geological sketch-map of Morroch Bay, showing the distribution of graptolite faunas, after Rushton and Tunnicliff (1996, fig. 63).



(Figure 15.4) Port of Spittal Bay, south of Morroch Bay. The pale bed is a quartzose sandstone of the Glenwhargen Formation interbedded with darker greywackes of the Portpatrick Formation. See (Figure 15.5) (Photo: British Geological Survey photographic collection, D3756.)



(Figure 15.5) Comparison of the stratigraphical succession at and north of Morroch Bay with that at Port of Spittal Bay, showing that the onset of deposition of the Portpatrick Formation greywackes was markedly diachronous.