Balintore

[NH 854 734] and [NH 851 727]

Potential GCR site

J.K. Wright

Introduction

The Balintore GCR site comprises two shore exposures of Oxfordian rocks that can be seen only at low water; these are at Port-an-Righ [NH 854 734] and adjacent Cadh'-an-Righ [NH 851 727], 3.2 km south of Balintore (Figure 5.3). At Cadh'-an-Righ there is a complete section from the Bathonian Great Estuarine Series to the Middle Oxfordian dipping east at 70°. At Port-an-Righ, approximately 500 m further north, a more gently dipping section shows Lower and Middle Oxfordian rocks. The exposures abut immediately onto the south-eastern side of the Great Glen Fault. This is clearly visible in the foreshore approximately 2.5 km south-west of the village of Balintore and brings Callovian and Oxfordian strata into contact with the Devonian Old Red Sandstone.

It was Sir Roderick Murchison (1829b) who first described the site. He noted that the ledges eroding from the alternating harder and softer bands gave the appearance of seats at an ancient theatre. The foundation for modern work was laid by Judd (1873), and the area was subsequently studied by the Geological Survey (Lee, 1925). Buckman (1923–1925, p.47) and Arkell (1933) commented on the ammonite fauna. Sykes' (1975) revision of Oxfordian stratigraphy in Scotland emphasized the full significance of this site. Sykes and Callomon (1979) further revised the zonal stratigraphy of the Balintore section, and defined the base of the Middle Oxfordian Maltonense Subzone at this site.

Description

Balintore exposes a fine section through 53 m of Lower and Middle Oxfordian rocks that range from the basal Mariae to middle Tenuiserratum zones. The following section is revised from Sykes (1975) taking into account information from Sykes and Callomon (1979).

	Thickness (*m*)
Balintore Formation	
Port-an-Righ Siltstone Member, Tenuiserratum Subzone	
6. Fine-grained, argillaceous sandstone forming a prominent feature at low water mark	seen to 5.7
5. Coarse, dark, bituminous siltstone, rhythmically bedded in 0.1–1.8 m units, each coarsening upwards from silt to fine, argillaceous sandstone. An abundant, limited bivalve fauna of *Cucullaea* sp. and *Oxytoma* sp. is present at certain horizons. Ammonites are rare, including *Perisphinctes* spp., *Cardioceras* (*Maltoniceras*) *highworthensis* Arkell, *C.* (*Subvertebriceras*) *zenaidae* Ilovaisky and *C.* (*Miticardioceras*) *tenuiserratum* (Oppel)	16.0
Port-an-Righ Ironstone Member, Maltonense Subzone	

4b. Sandy clay with a prominent, red-weathering, nodular ironstone at the top containing *C.* (*Maltoniceras*) *schellwieni* Roden, *C.* (*M.*) *maltonense* (Young and Bird), *C.* (*M.*) *vagum* Ilovaisky, *C.* (*Cawtoniceras*) *cawtonense* (Blake and Hudleston), *C.* (*Subvertebriceras*) *zenaidae* Ilovaisky, *Perisphinctes* (*Dichotomosphinctes*) cf. *antecedens* Salfeld and *P* (*Arisphinctes*) *vorda* Arkell	0.50
Vertebrale Subzone	
4a. Sandy clays with several bands of red-weathering, nodular, chamosite-siderite ironstone nodules. *Cucullaea* sp. is common, with *Modiolus* sp. and *Gryphaea dilatata* J. Sowerby. Ammonites are common, including *Perisphinctes* (*Arisphinctes*) *helenae* de Riaz, *C.* (*Scoticardioceras*) *excavatum* (J. Sowerby), *C.* (*Subvertebriceras*) *densiplicatum* Boden, *C.* (*S.*) *zenaidae* and *Goliathiceras* (*Goliathites*) *capax* (Young and Bird)	1.7
Brora Arenaceous Formation	
Shandwick Siltstone Member, Cordatum Subzone	
3b. Alternations of more and less calcareous siltstones with *Cardioceras* spp.	2.4
Costicardia Subzone	
3a. Alternations of more and less calcareous siltstones with a basal sandy siltstone. *Pinna* sp. and *Pleuromya* sp. are the most common bivalves, with *Cardioceras* sp.	9.7
Brora Argillaceous Formation	
Shandwick Clay Member (*pars*) *, Costicardia Subzone*	
2b. Bioturbated sandy silts with *Cardioceras* (*Cardioceras*) *costicardia* S. Buckman, *C.* (*Vertebriceras*) *quadrarium* S. Buckman and *C.* (*V.*) cf. *altumeratum* Arkell	1.5
Bukowskii Subzone	
2a. Bioturbated sandy silts with *Cardioceras* spp.	2.6
1b. Grey-green clay with bands of carbonaceous debris and *C.* (*Scarburgiceras*) *bukowskii* Maire	approx. 8.0
Mariae Zone	
1a. Grey-green clays with pyritic burrow infillings and bands of carbonaceous debris. The bivalves are represented only by *Nuculoma* sp., but ammonites are sporadic, including *Cardioceras* (*Scarburgiceras*) *scarburgense* (Young and Bird) approx.	5.0
(continuation of Callovian Shandwick Clay)	

The Port-an-Righ section is the type section for each of the four members listed above (Sykes, 1975). Ammonites and bivalves make up the bulk of the fauna at Balintore. Of the seven subzones represented here, three subzonal index ammonites have been recorded by Sykes. A stratigraphical log of the section is given in (Figure 5.4).

Interpretation

The base of the Oxfordian sequence at Balintore lies within the Shandwick Clay, whose grey-green clays and bioturbated silts with carbonaceous horizons contrast strongly with the equivalent sandier accumulations at Brora (see GCR site report for Brora, this volume). The striking chamositic sands with bands of red-weathering chamosite-siderite nodules of the Port-an-Righ Ironstone represent a lithofacies unique to eastern Scotland. They have their closest comparisons in the diminutive outcrop of Oxfordian strata adjacent to the Great Glen Fault at nearby Bow Buoy Skerry, Eathie, where there

occurs a condensed facies with *Rhaxella* spicules (Phemister, 1936). The nodular texture is possibly due to the diagenesis of *Thalassinoides* burrows (Sykes, 1975).

The Port-an-Righ Ironstone and the overlying Port-an-Righ Siltstone were deposited during a marine transgression in the Inner Moray Firth Basin. This transgression was contemporaneous with a regression and the deposition of quartz sand in the Hebrides Basin (Sykes, 1975). The tectonic settings that controlled sedimentation in the two basins were thus quite different. A further stratigraphical interest of the Oxfordian sequence at Balintore lies in a comparison with the equivalent succession to the north-east at Brora, which displays coarser-grained rocks (Figure 5.2). The relationship of the Balintore and Brora localities to the Great Glen Fault is also of interest (see site report for Brora, this volume).

One of the most important aspects of the palaeontology is the well-preserved ammonite fauna of the Port-an-Righ Ironstone. Bed 4a yields a good Vertebrale Subzone fauna; a typical *Cardioceras* is illustrated in (Figure 5.5). The occurrence of several species of *Maltoniceras* in Bed 4b indicates the Maltonense Subzone. However, this subzone is only thinly developed, the appearance of *Cardioceras* (*M.*) *tenuiserratum* (Tenuiserratum Subzone) in the overlying Port-an-Righ Siltstone demonstrating the condensed nature of the Port-an-Righ Ironstone. Its 2.2 m thickness includes both the Vertebrale Subzone and the Maltonense Subzone. This is the only known locality in the United Kingdom where the transition from the Vertebrale Subzone into the Maltonense Subzone can be seen in a continuously fossiliferous succession. Sykes and Callomon (1979) therefore defined the base of the Maltonense Subzone at this locality beneath Bed 4b. The substantial perisphinctid fauna of the Port-an-Righ Ironstone and of the overlying Siltstone is one of the northernmost appearances of such Tethyan ammonites and enables correlation of the Boreal and Sub-Boreal zonal schemes. Ammonites in the Shandwick Clay Member indicate the Scarburgense, ?Praecordatum, Bukowskii and Costicardia sub-zones of the Mariae and Cordatum Zones.

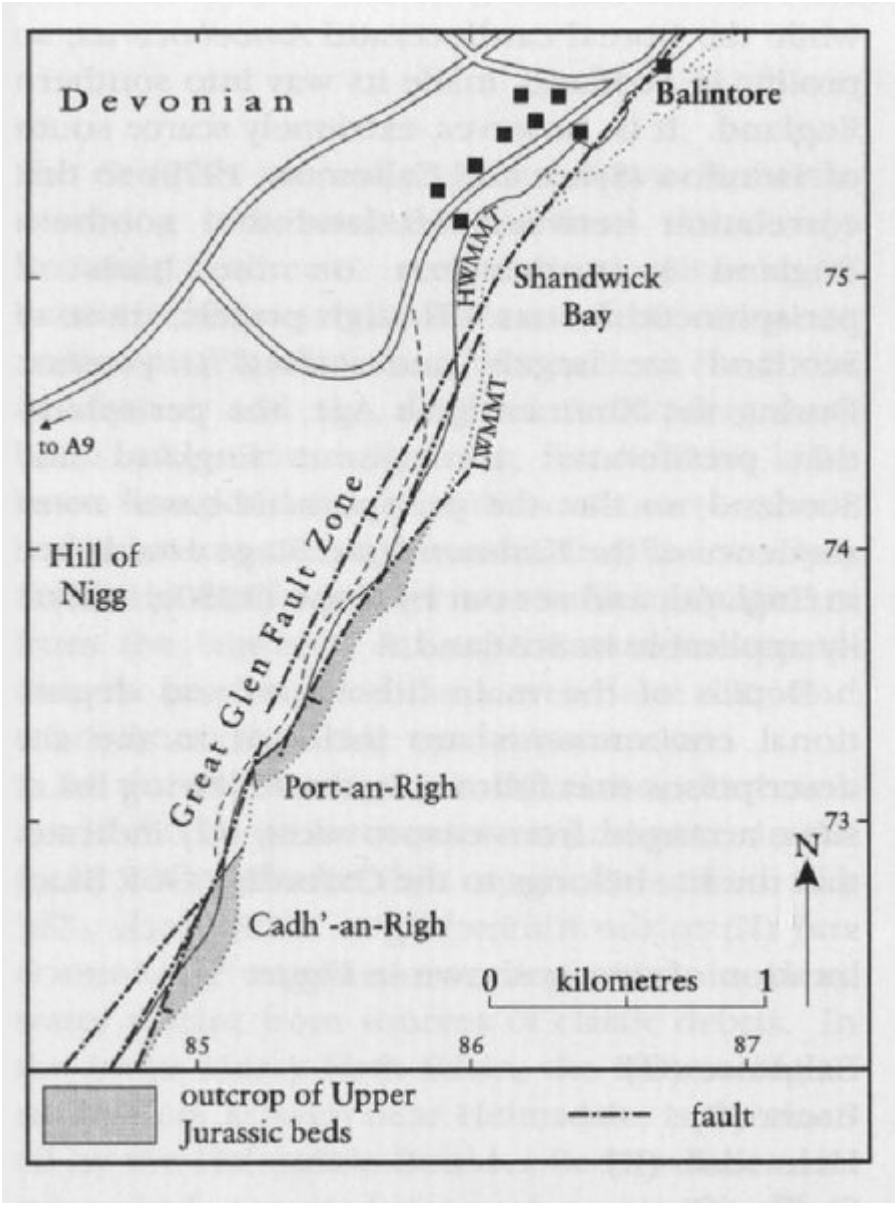
Upper Oxfordian beds are not known *in situ* at Balintore, but must be present just offshore (Sykes, 1975). Limestone nodules found on the beach here yield *Perisphinctes* (*Dichotomoceras*) *dichotomus* S. Buckman and *Amoeboceras* aff. *serratum* (J. Sowerby), of Serratum Zone age. This suggests that the Upper Oxfordian is present in an argillaceous facies with limestone nodules very similar in facies to that of the equivalent Flodigarry Shales at Staffin (see site report for Staffin, this volume).

The bivalves occurring in these silts and clays provide an excellent example of soft sediment infauna with the individuals often found in life position. *Pinna* and *Pleuromya* occur thus in the Shandwick Siltstone, while surface-dwelling forms dominate in the Port-an-Righ Ironstone and Siltstone members. In the clays, faunal diversity is low, and only *Nuculoma* and *Pleuromya are at all* common.

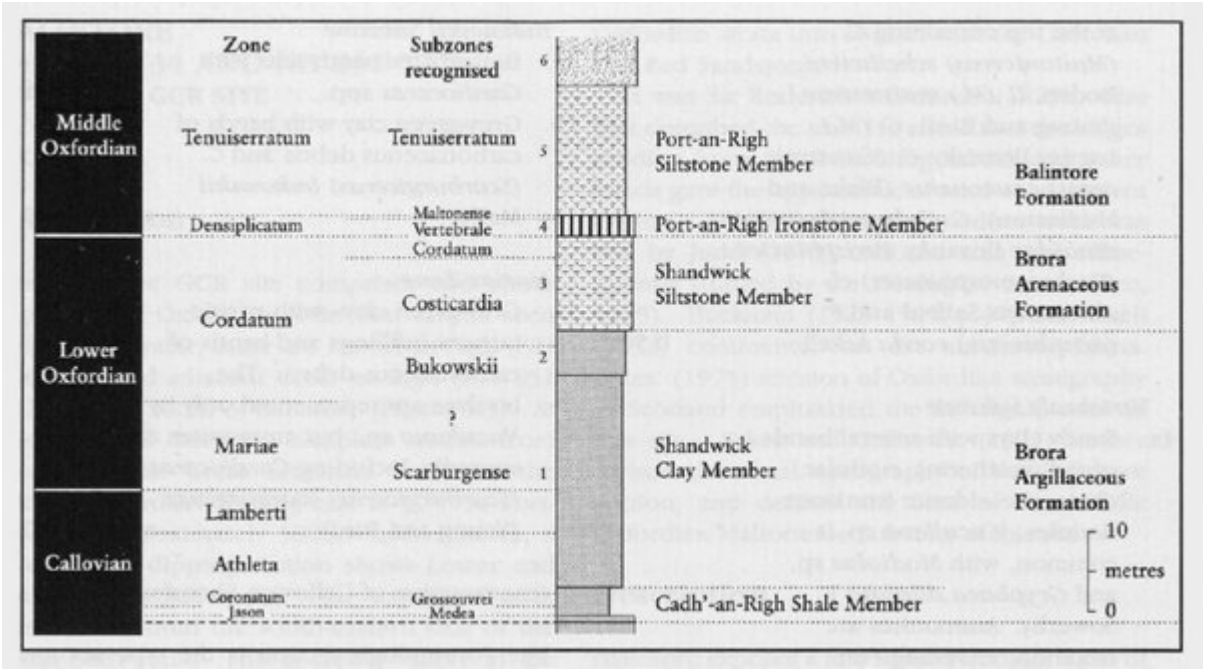
Conclusions

These two separate foreshore outcrops constitute the most important locality in eastern Scotland for correlation of Oxfordian strata. They contain the stratotype locality for four members of the Moray Firth Oxfordian sequence, and the type section of the base of the Boreal Middle Oxfordian Maltonense Subzone. They contain the only exposures in eastern Scotland yielding good ammonite faunas in offshore marine facies (see (Figure 5.8)). This is a key exposure for understanding sedimentation in the Late Jurassic Epoch in the Moray Firth Basin.

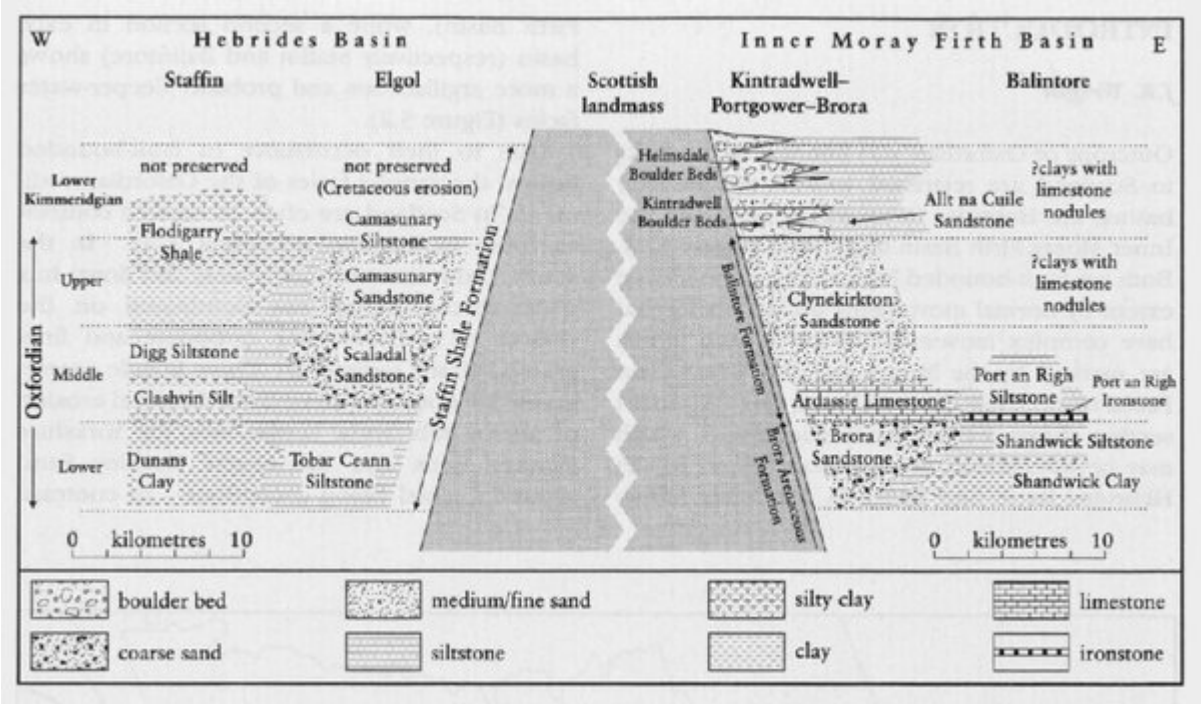
References



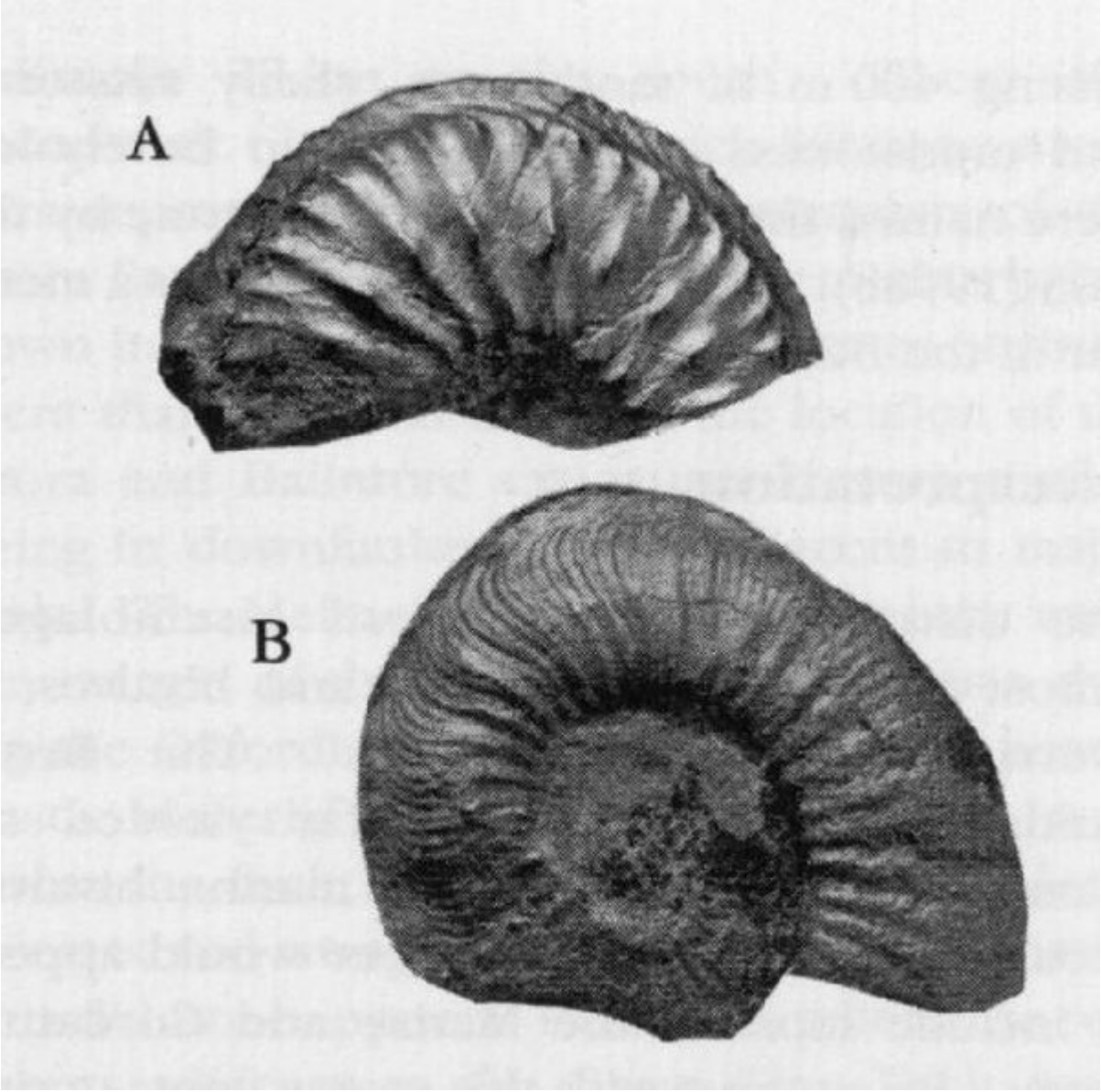
(Figure 5.3) Locality map of the Balintore GCR site. Geological information from BGS Sheet 94 (Cromarty) (1973).



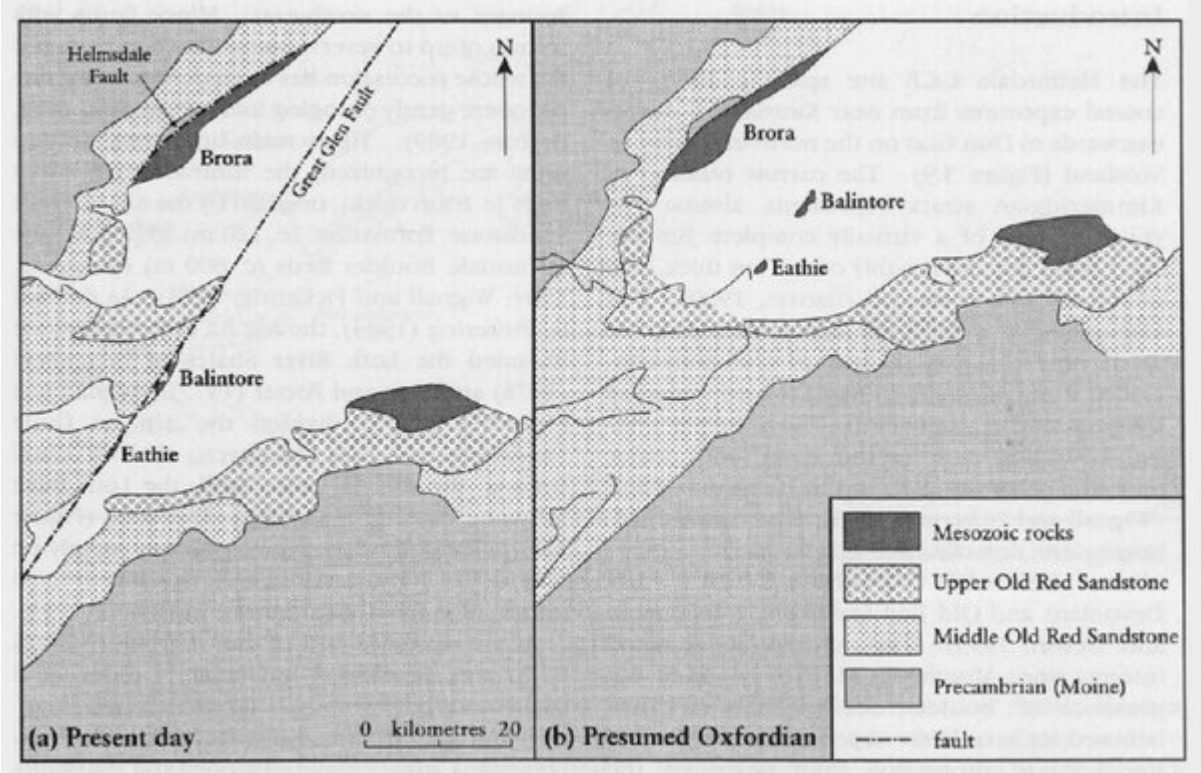
(Figure 5.4) Stratigraphical log of the Balintore section (after Sykes, 1975, fig. 4).



(Figure 5.2) Schematic cross-section to show the relations of the near-shore and distal members in the Hebrides and Inner Moray Firth Basins. Beds such as the Brora Sandstone and the Ardassie Limestone originally extended eastwards over the Scottish landmass but have been removed by Kimmeridgian erosion. The Helmsdale Boulder Beds continue up into the Portlandian Stage.



(Figure 5.5) Ammonites from the Balintore Formation of eastern Scotland. (A) Cardioceras (Subvertebriceras) densiplicatum Boden. Bed 4, Port-an-Righ Ironstone Member, Balintore, ES3, x1. (B) C. (Plasmatoceras) tenuicostatum Nikitin. Ardassie Limestone, Brora, ES2, x 1. (Photos: K. D'Souza. Specimens in the J.K. Wright Collection.)



(Figure 5.8) Diagram showing possible post-Jurassic movement on the Great Glen Fault (after Sykes, 1975, fig. 2).