Randerston Coast, Fife

[NO 608 118]–[NO 639 097]

Introduction

The Randerston Coast GCR site extends from Fife Ness [NO 639 097], 3 km north-east of Crail, north-west up the East Fife coast to Cambo Ness [NO 608 118], 4 km north of Crail. It includes the type locality of the Fife Ness Formation (Strathclyde Group) and beds belonging to the underlying Clyde Sandstone Formation (Inverclyde Group) and the overlying Anstruther Formation (Strathclyde Group). The site has long attracted the attention of geologists and provides a unique opportunity to examine successions of early Carboniferous (Tournaisian-?Holkerian) age in the north-eastern part of the Midland Valley. The sections have been described by Geikie (1902), who largely drew on the work of Kirkby (1880, 1901), and this work has been updated by Forsyth and Chisholm (1977). A guide to part of the area has been published by MacGregor (1968).

Description

The continuity of succession within the site is disrupted by faults, which divide the section up into a number of discrete areas, and give rise to gaps within the sequence and to some uncertainties as to the exact stratigraphical position of some parts of the sequence. The lowest beds in the succession belong to the Clyde Sandstone Formation (formerly the 'Balcomie Beds'), the base of which is not seen. They crop out to the north of Fife Ness [NO 631 102]–[NO 623 106] and consist of variegated mudstones and sandstones with conglomeratic layers and concretionary limestones and dolomites (Forsyth and Chisholm, 1977). Within the conglomeratic layers, clasts of lava and cementstone have been found (Forsyth and Chisholm, 1977; Browne, 1980b). The Clyde Sandstone Formation is conformably overlain by the basal 60 m of the Fife Ness Formation, which is 'characterized by the presence of white sandstones and the absence of coals and marine bands' (Forsyth and Chisholm, 1977). Grey and red mudstones also occur. A further 180 m assigned to higher parts of the Fife Ness Formation occur in the vicinity of Fife Ness. Near the base there are a number of dolomite bands containing algae, ostracodes, *Spirorbis* and fish remains (Forsyth and Chisholm, 1977). Fife Ness itself is formed of one particularly thick (23 m) sandstone with an erosive base.

The junction between the Fife Ness Formation and the Anstruther Formation is not exposed but strata believed to lie near the base of the Anstruther Formation are seen in a fault-bounded syncline [NO 621 107]–[NO 617 110]. These beds, which are about 85 m thick, show cyclical sequences of sandstone, siltstone and shale. Although seatearths are well developed, coals are absent or poorly developed. Two marine bands, the Wormistone Marine Bands, contain molluscan faunas, and the lower band is particularly rich in gastropods (Geikie, 1902; Forsyth and Chisholm, 1977).

The remainder of the succession, which includes the well-known Randerston Limestones, is exposed in another fault-bounded tract within which the dominant structure is the Randerston Syncline [NO 616 112]–[NO 608 118]. The succession has been recorded in detailed measured sections by Kirkby (1880, 1901; Geikie, 1902) who recognized and numbered in descending sequence 11 limestones. The section is about 130 m thick and is largely made up of cyclical sequences of sandstone, siltstone and shale with a few thin coals. Sandstones often show ripple cross-lamination, cross-bedding or convoluted bedding. The dolomitic limestones often contain a molluscan fauna which may be either marine or non-marine. Limestone VIII is rich in the non-marine bivalve *Paracarbonicola* while Limestone V contains marine forms such as *Schizodus, Sanguinolites, Naiadites,* orthoconic nautiloids and *Murchisonia.* Limestone VII is locally unique in containing the rhynchonellid brachiopod *Camarotoechia.* It also contains the bellerophontids *Bellerophon randerstonensis* and *Bucaniopsis undatus* (Weir, 1931) and other molluscs. Perhaps the best known limestone is Limestone IX, which contains algal balls and ostracodes. Within this red-coloured haematitic limestone (20 cm) the size of the algal balls increases upwards and in places towards the top they coalesce to form a stromatolitic layer (Figure 2.11). Bennison (1961) made a study of the dwarf specimens of *Naiadites* recorded by Leitch (1942) from the mudstone above Limestone IX and also described *Naiadites* and *Paracarbonicola* from above Limestone X (Bennison, 1960, 1961).

Limestone X at Randerston is the type locality for *Paracarbonicola elegans,* which is the type species of its genus (Kirkby, 1880; Hind, 1894–1896; Bennison, 1960; Brand, 1998). These beds are all assigned to the Anstruther Formation.

Interpretation

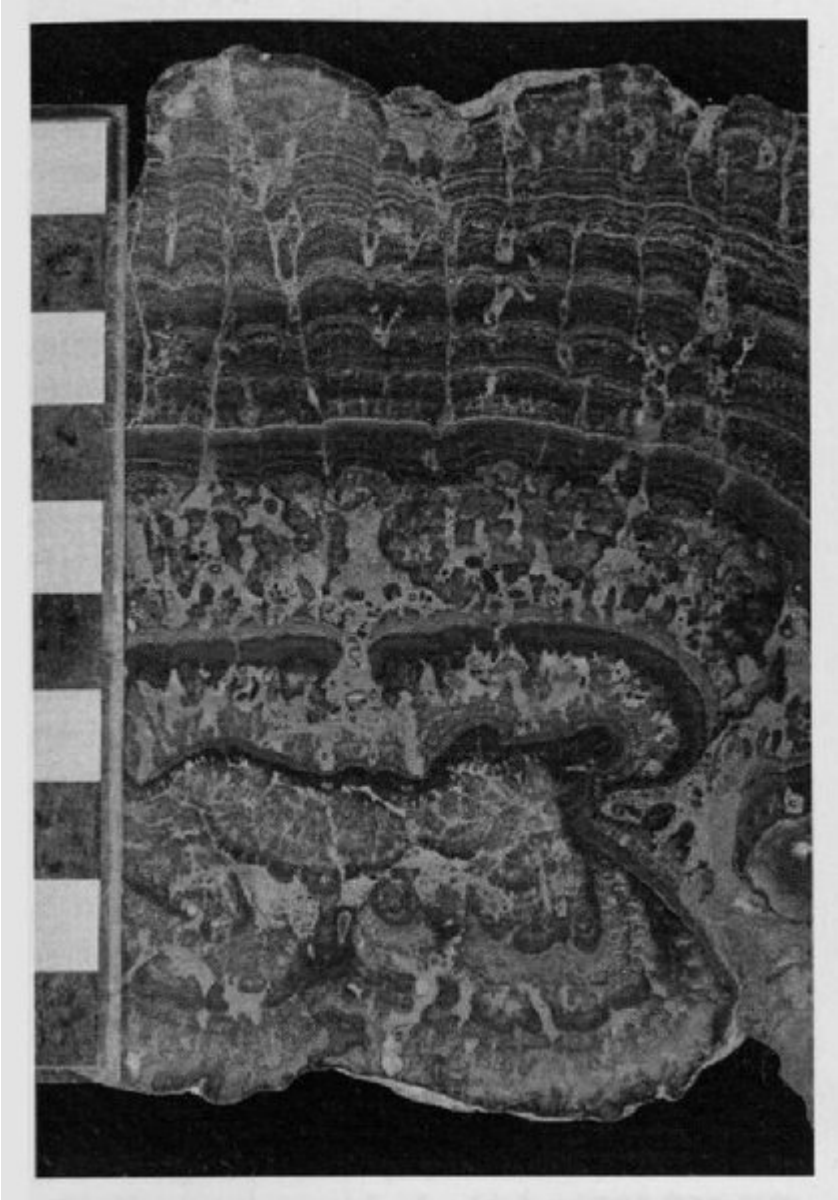
The Randerston sections are unique and provide a record of changing environment conditions during the earliest parts of the Carboniferous Period in East Fife. The re-assignment of the Balcomie Beds to the Clyde Sandstone Formation (Browne *et ed.,* 1999) follows Browne's (1980b) discussion of the characters of the Balcomie Beds and the significance of cementstone clasts, which may have been derived from the older Ballagan Formation. The Clyde Sandstone Formation appears to have been deposited in a braided fluviatile environment with overbank mudrocks and pedogenic carbonates indicating a semi-arid environment (Forsyth and Chisholm, 1977; Browne *et al.,* 1999). The lithological passage to the Fife Ness Formation may represent a change to a slightly less energetic fluvial and lacustrine environment and this continues up into the Anstruther Formation, which was deposited in thin cyclical units in lacustrine and fluvial environments in which enclosed shallow water bodies played an important role (Browne *et al.,* 1999). In contrast to the preceding formations, the deposits of the Anstruther Formation indicate that marine conditions occasionally penetrated into the area. The abundant but low-diversity marine and non-marine faunas and the dolomitic content of the Wormistone Marine Bands and the Randerston Limestones suggest that these formed in high-stress environments with variable or occasionally elevated salinity.

The stratigraphical position of the Randerston Limestones and their associated sequence presents an unresolved stratigraphical problem. These limestones are not known at outcrop anywhere else. Forsyth and Chisholm (1977) considered that they might be comparable in general character to the lower part of the sequence recorded in the Anstruther Borehole. However, palynological studies (Neves *et al.,* 1973) have indicated a correlation with the uppermost part of the Anstruther Formation. The chronostratigraphy of the succession is thus not fully established but it probably ranges from a Tournaisian to at least Holkerian age.

Conclusions

An important Lower Carboniferous (Tournaisian–Holkerian) aged succession with unique features occurs at the Randerston Coast GCR site in extensive coastal sections. Lower Strathclyde Group and upper Inverdyde Group strata, including the lower Anstruther Formation, the Fife Ness Formation and the Clyde Sandstone Formation, exhibit important and highly instructive facies changes of palaeoenvironmental, palaeoclimatic and palaeogeographical significance. The predominantly molluscan marine and non-marine faunas found at several levels throughout the section (Randerston Limestones and Wormistone Marine Bands) are the earliest fossil occurrences in the East Fife sequence and are not known elsewhere. The site is therefore significant in that it contains the earliest examples of non-marine bivalves in the Carboniferous System of the UK. These faunas are the precursors of non-marine assemblages found in the Upper Carboniferous where they have proved particularly useful in stratigraphical correlation (*sec* Cleal and Thomas, 1996). Furthermore, palynological (spore) studies carried out here provide controversial evidence of stratigraphical interest at this absolutely key Lower Carboniferous locality.

References



(Figure 2.11) Limestone IX of the Randerston Limestones (Anstruther Formation, Strathclyde Group) showing the development of stromatolites from a large overturned oncoid. Note the 10 cm scale bar, divided into 1 cm intervals. (Photo: M.A. Whyte.)