Kinghorn Coast, Fife

[NT 279 892]–[NT 272 869]

Introduction

The Kinghorn Coast GCR site lies on the coast of Fife between Kinghorn and Kirkcaldy [NT 279 892]–[NT 272 869]. The exposed easterly dipping sequence is of Brigantian age and includes equivalents of the upper parts of the Strathclyde Group and of the Lower Limestone Formation. This classic site is the best exposure of rocks of this age in West Fife and at its base shows the interlayering of sedimentary rocks with the extrusive volcanic rocks of the Kinghorn Volcanic Formation (Bathgate Group). The section has been described by Geikle (1900), who provides a good critical appraisal of earlier work, and by Gordon (1914), Macnair (1917), Wright (1925), Allen and Knox (1934) and Francis (1961). Guides to the site have been published by Francis (in Mitchell *et al.,* 1960) and MacGregor (1968). The site overlaps with the Burntisland to Kinghorn Coast site described by Stephenson *et al.* (2003) in the *Carboniferous and Permian Igneous Rocks of Great Britain North of the Variscan Front* GCR volume, and the Abden site described by Dineley and Metcalf (1999) in the *Fossil Fishes of Great Britain* GCR volume, and is adjacent to the Pettycur site described by Cleai and Thomas (1995) in the *Palaeozoic Palaeobotany of Great Britain* GCR volume.

Description

The lower parts of the 130 m succession (Figure 2.14), close to Kinghorn, consist of interbedded lavas and sedimentary rocks, which belong respectively to the Kinghorn Volcanic Formation (Bathgate Group) and to the Pathhead Formation (Strathclyde Group, Brigantian). The lowest unit within the site is a quartzose sandstone containing *Stigmaria.* Higher sedimentary intercalations within the volcanics are generally sandstones, siltstones and shales, which may be ashy and often contain plant remains (Geikie, 1900). Although some units, like the lowest bed, are palaeosols, others have been waterlaid and display structures such as ripple marks. The highest intercalation includes the First Abden Limestone, which is a marine unit. In the shales at the base of this intercalation is the Abden Bone Bed, a unit separately scheduled for its fish fauna (Dineley and Metcalf, 1999), but which also contains plant remains, arthropod material and *Lingula.* The limestone (4 m) and the shales immediately above (20 cm) and below (10 cm) it have yielded a fairly diverse marine fauna including *Sanguinolites abdenensis, Actinopteria persulcata* and *Schizophoria resupinata.* The junction between the upper shale and the overlying basaltic lava is irregular and the lava appears to have flowed over and loaded into a soft sediment. This lava is the second highest lava within the volcanic sequence and is separated from the highest lava by a red bole.

The transition from the Kinghorn Volcanic Formation into the overlying beds of the Lower Limestone Formation is well seen on the foreshore to the north-east of Abden Home (Figure 2.15). The highest lava in the local sequence is overlain by tuffs (6 m), which pass up through a red bole into a green fireclay. The fireclay is capped by a thin (25 mm) ironstone band, which is rich in the bivalve *Naiadites crassa.* This is separated from the overlying Second Abden Limestone by 2.5 m of fossiliferous shale. The tuffs, fireclay and shales show a marked decrease in thickness northwards (MacGregor, 1968). The Second Abden Limestone (3.5 m) is crinoidal and bedded with argillaceous partings. Close to the base it contains large colonies of *Siphonodendron,* and higher in the limestone (2.1 m above the base) interambulacral plates of the echinoid Arch*aeocidaris* are common.

Between the Second Abden Limestone and the Seafield Tower Limestone (= Charlestown Main Limestone) there are 26 m of sandstones and argillaceous sandstones into which has been intruded a teschenite sill. The Seafield Tower Limestone (3.5 m) is overlain by 14 m of calcareous shales and crinoidal limestone bands. These contain an abundant fauna of solitary and compound rugose corals (zaphrentids and *Siphonodendron*), brachiopods (productoids, gigantoproductids, *Schizophoria, Cleiothyridina,* spiriferoids), gastropods (*Pseudozygopleura, Straparollus*), nautiloids, echinoids (*Archaeocidaris*) and crinoids (*Parazeacrinites, Phanocrinus, Ureocrinus, Onychocrinus, Platycrinites*). The shales are overlain by a thick (16 m) cross-bedded sandstone (Seafield Tower Sandstone) on the outcrop of which

Seafield Tower has been built.

The succession above the thick sandstone is 60 m thick and is a variable and cyclical sequence of limestones, shales, siltstones and sandstones (Wright, 1925; Allen and Knox, 1934; Francis, 1961). Four marine intervals have been distinguished. These are the Seafield Marine Band and the Kinniny Limestones (Lower, Middle and Upper) (Allen and Knox, 1934; Francis, 1961). The Lower Kinniny Limestone contains algal masses (MacGregor, 1968) but the Middle Kinniny Limestone is the most fossiliferous. The Upper Kinniny Limestone marks the top of the Lower Limestone Formation.

Interpretation

The Kinghorn Coast GCR site shows instructively the relationship between volcanism and sedimentation and the encroachment of marine deposition onto the volcanic pile of the Kinghorn Volcanic Formation. The quartzite near the base is of historical importance as in the past it 'attracted attention during the famous controversy between the Neptunists and Plutonists' (Geikie, 1900). Although the correlation of the First Abden Limestone and Second Abden Limestone is still uncertain, the occurrence of the P_2 goniatite *Sadeticeras newtonense* in a laterally equivalent section (Currie, 1954; and see Roscobie Quarry GCR site report, this chapter) indicates that the upper parts of the succession, above and including the Seafield Tower Limestone, are of uppermost Brigantian age (George *et al.,* 1976; Browne and Woodhall, 1999). Compared with equivalent sections in East Fife, the succession of these beds is thinner and coals are absent or thinner. Conversely, the Seafield Tower Limestone is considerably thicker than its equivalent in the St Monance area. These differences reflect the site's depositional position on the relatively positive feature of the Burntisland High.

The shales below the First Abden Limestone contain a sequence of faunal assemblages, which were collectively studied by Macnair (1917), and became known as the 'Abden Fauna' but are now referred to as the 'Macnair Fauna' (Wilson, 1989). This fauna has been a major consideration in debates about the correlation of beds at the top of the Strathclyde Group and the base of the Lower Limestone Formation (Macnair, 1917; Wilson, 1979, 1989; Whyte, 1981). Macnair (1917) considered that this faunal succession, which included a basal fish layer, was characteristic of the Hurlet Limestone horizon and used it as a guide to correlation throughout the Midland Valley. However, elements of the Macnair Fauna, including the bone bed, can be found at other horizons and, in the unusual Kinghorn succession, it is not clear whether the First Abden Limestone or the Second Abden Limestone or even both is the equivalent of the Hurlet Limestone (Wilson, 1989). Irrespective of which limestone correlates with the Hurlet Limestone and marks the local base of the Lower Limestone Formation, the lower part of the succession belongs to the Strathclyde Group and is probably all of early Brigantian (P_1) age.

The fauna of the shales that underlie the Second Abden Limestone were the subject of a major and innovative palaeoecological study by Ferguson (1962, 1963). Within the transgressive shale sequence, four successive topozones were recognized, from a low-diversity *Lingula* and *Streblopteria* dominated assemblage towards the base, to an *Eomarginifera,* coral and bryozoan community at the top (Ferguson, 1962).

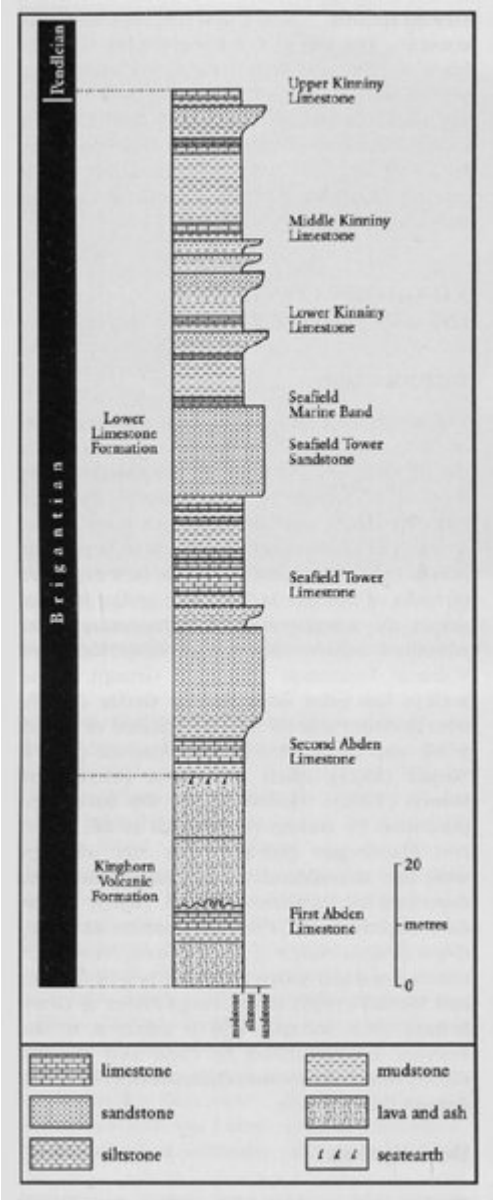
The taxonomy of the crinoid fauna of the Seafield Tower Limestone was extensively studied by Wright (1912, 1914b, 1920, 1925, 1939, 1950–1960) and although generally similar in character and composition to the faunas of Invertiel Quarry and Roscobie Quarry (see GCR site reports, this chapter), the site has provided type and figured material for a number of species. Wright (1926, 1927) included material from Seafield in his pioneering studies of variation in the cups of *Parazeacrinites koninckі, Ureocrinus bockshii* and *Phanocrinus calyx*.

The four marine horizons above the Seafield Tower Limestone have been named and correlated with successions elsewhere in Central and West Fife (Allen and Knox, 1934; Francis, 1961). They form an important reference section for these beds (Wilson, 1989) and in the correlations between West and East Fife (Forsyth and Chisholm, 1977) and between Fife and both the Central Coalfield and the Lothians (Wilson, 1989).

Conclusions

The Kinghorn Coast GCR site is one of the key Dinantian (Brigantian) sites in the Midland Valley of Scotland. It is historically noteworthy and 'is not only one of the most continuous but also one of the most interesting in the East of Scotland' (Macnair, 1917). The site is extremely important in showing Strathclyde Group and Lower Limestone Formation strata interbedded with, and overlying, lavas of the Kinghorn Volcanic Formation (Bathgate Group). In addition, it shows important contrasts with sections elsewhere in its stratigraphical make-up and relative proportions of different lithologies. The shales adjacent to the Seafield Tower Limestone and the First Abden Limestone and Second Abden Limestone are all highly fossiliferous, and have been the subject of detailed palaeontological and palaeoecological studies.

References



(Figure 2.14) Simplified sedimentary log of the upper part of the Kinghorn Volcanic Formation and of the Lower Limestone Formation at the Kinghorn GCR site with intrusive igneous rocks omitted. After Francis (1961).

(Figure 2.15) Exposure of the top of the Kinghorn Volcanic Formation (foreground) and overlying beds of the Lower Limestone Formation in the foreshore at the Kinghorn GCR site with the Second Abden Limestone in the middle distance. (Photo: British Geological Survey, No. D5227, reproduced with the permission of the Director, British Geological Survey, © NERC, all rights reserved (1PR/19–39C).)