Burghead, Morayshire

[NJ 107 691]–[NJ 122 691]

Introduction

The coastal cliffs and foreshore exposures in the vicinity of Burghead, especially close to the harbour wall, and along the coast to Cummingstown, are the type locality for the Burghead Sandstone Formation. This is a set of predominantly fluvial deposits, with coarse sediments indicating high-energy deposition. The unit occurs between the Late Permian Hopeman Sandstone Formation (see Chapter 2) and the Late Triassic Lossiemouth Sandstone Formation, but its age cannot be more precisely constrained.

Details of the Burghead Sandstone Formation have been documented by Westoll (1951), Peacock *et al.* (1968), and Frostick *et al.* (1988). The formation was initially termed the 'Burghead Sandstones' (Westoll, 1951), and subsequently the 'Burghead Beds' (Peacock *et al.,* 1968), and then formalized as the 'Burghead Sandstone Formation' (Warrington *et al.,* 1980). This formation may be partially coeval with the Lossiemouth Sandstone Formation (Peacock *et al.,* 1968).

Description

The Burghead area is encompassed within the GCR site known as 'Masonhaugh', selected not only for its Triassic stratigraphy, but also for coverage of the Late Permian Hopeman Sandstone Formation (see Chapter 2, GCR site report for Clashach to Covesea). It is protected within the Masonshaugh Site of Special Scientific Interest (SSSI), and was independently selected for the GCR for its fossil reptiles (see site report in Benton and Spencer, 1995).

The Burghead Sandstone Formation overlies the Hopeman Sandstone Formation and in places unconformably overlies Old Red Sandstone sediments; it is in turn overlain by the Lossiemouth Sandstone Formation (Warrington *et al.,* 1980). The contact between the Burghead Sandstone Formation and the Hopeman Sandstone Formation is not exposed at Burghead (Andrews *et al.,* 1990), although it can be seen farther east along the coast at Masonshaugh (Gillen, 1987), and is known from data collected from a borehole at Clarkly Hill (Figure 3.2). The Burghead Sandstone Formation is also exposed at Masonshaugh Quarry, Clarkly Hill and Inverugie, and Raddoch Wells.

The Burghead Sandstone Formation (Figure 3.2) comprises a thick sequence (up to 73 m) of cross-bedded and parallel-laminated, yellowish-brown and greyish-orange, medium- to coarse-grained sandstones, with some discontinuous pebbly and greenish yellow silty beds that dip gently towards the north. Clay is rarely seen in the coastal sections around Burghead. The sediments are cemented to various degrees by silica and calcite. Some of the bed boundaries and joint surfaces are marked by a thin layer of dark reddish-brown, haematite iron pan; these are most commonly associated with the finer-grained, silty sediments (Peacock *et al.,* 1968; Peacock, 1977; Gillen, 1987; Andrews *et al.,* 1990).

At the western end of Burghead Harbour wall ((Figure 3.2), columns 2 and 3), the cliffs expose a 3 m section of cross-bedded fine- to coarse-grained sandstone with thin beds of silt and strings of reworked siltstone pebbles (Figure 3.3). Pebbles are common and some are concentrated in conglomeratic beds; they consist largely of reddish quartzite, but include rarer clasts of vein quartz, gritty sandstone, and granulite. A small washout channel is exposed in the cliff section. The infilling sediments are cross-bedded, and the foresets dip towards the northeast (Peacock *et al.,* 1968).

North of the harbour wall, in Burghead Cliffs ((Figure 3.2), column 1), the sections are approximately 8 m high, and are dominated by thick, cross-bedded sandstone units. Pebble-rich beds and conglomeratic horizons may reach a maximum thickness of 1.3 m. Desiccation cracks have been recorded at this locality. The sediments here show varying degrees of induration, and may be cemented by either silica, or occasionally calcite (Peacock *et al.,* 1968).

North of Burghead, the Burghead Sandstone Formation is exposed on the wave-cut platform of the foreshore, where sandstones very similar to those exposed in the cliff sections (above) are overlain by approximately 1.5 m of calcareous sandstone with scattered quartz pebbles. The latter facies is also seen at Roman Well, in Burghead village, in an old railway cutting close to Masonshaugh, and on the foreshore close to the faulted contact with the stratigraphically older Hopeman Sandstone Formation (see Chapter 2, (Figure 2.5)) and (Figure 2.6)

Thin-section analyses of the Burghead Sandstone Formation show that the sandstones are composed primarily of quartz, with approximately 5% feldspar (microcline and untwinned alkali feldspars), and rare metamorphic quartz, granular quartz, strained vein quartz, chert, muscovite, and leucoxene. The heavy mineral suite includes zircon, tourmaline, and apatite. The cement may be either silica or calcite, as secondary quartz or chalcedony or plates of calcite that partially encase the clasts (Peacock *et al.,* 1968).

The calcareous sandstone, exposed in the intertidal zone to the north of Burghead village, is characterized by a bimodal distribution of clasts. The coarser fraction typically comprises well-rounded grains and small pebbles of quartz, quartzite, strained vein quartz, calcareous sandstone, and chert. The finer-grained matrix comprises well-sorted material, with an average grain size of 0.2 mm. The clasts are composed of sub-rounded to angular quartz, with chert, calcite and untwinned feldspars. Accessory minerals include haematite, leucoxene, zircon, tourmaline, and possibly ruffle and epidote. The cement is granular and platy calcite, which preserves structures that may be organic in origin (Peacock *et al.,* 1968).

In the cliffs below the Coastguards' Station the Burghead Sandstone Formation has been disrupted by a substantial fault, and large blocks of sandstone are scattered across the foreshore. The Burghead Sandstone Formation sediments are unfossiliferous.

Interpretation

The Triassic sediments in the Burghead area were deposited in a subsiding half-graben, associated with movements along the Great Glen Fault (Frostick *et al.,* 1988).

The environment of deposition of the Burghead Sandstone Formation has been debated. Peacock *et al.* (1968) thought that the 'Burghead Beds' were deposited in a floodplain environment, while Williams (1973) found evidence for both point-bar sequences and floodplain environments. Frostick *et al.* (1988) ascribed the whole sequence to ephemeral streams. The dominance of plane bedding, the abundance of clay intraclasts (mud curls ripped from pools where suspended sediment had settled out), imbricated pebbles, large channel width/depth ratios, and high sediment loads are all characteristic of ephemeral streams. The lower plane-bed facies gives way to trough cross-bedded sand facies at intervals in the succession (Figure 3.2), which suggests a change to more incised channels and deeper flood flows with better-developed secondary currents.

The sediments suggest that the rivers experienced abrupt changes in gradient, associated with fault movement, followed by periods of tectonic stability (Frostick *et al.*, 1988). The orientation of the infilled river channel and the associated cross-bedding foresets indicate that sediment transport was mainly from the south-west, in rivers and streams flowing towards the northeast (Gillen, 1987).

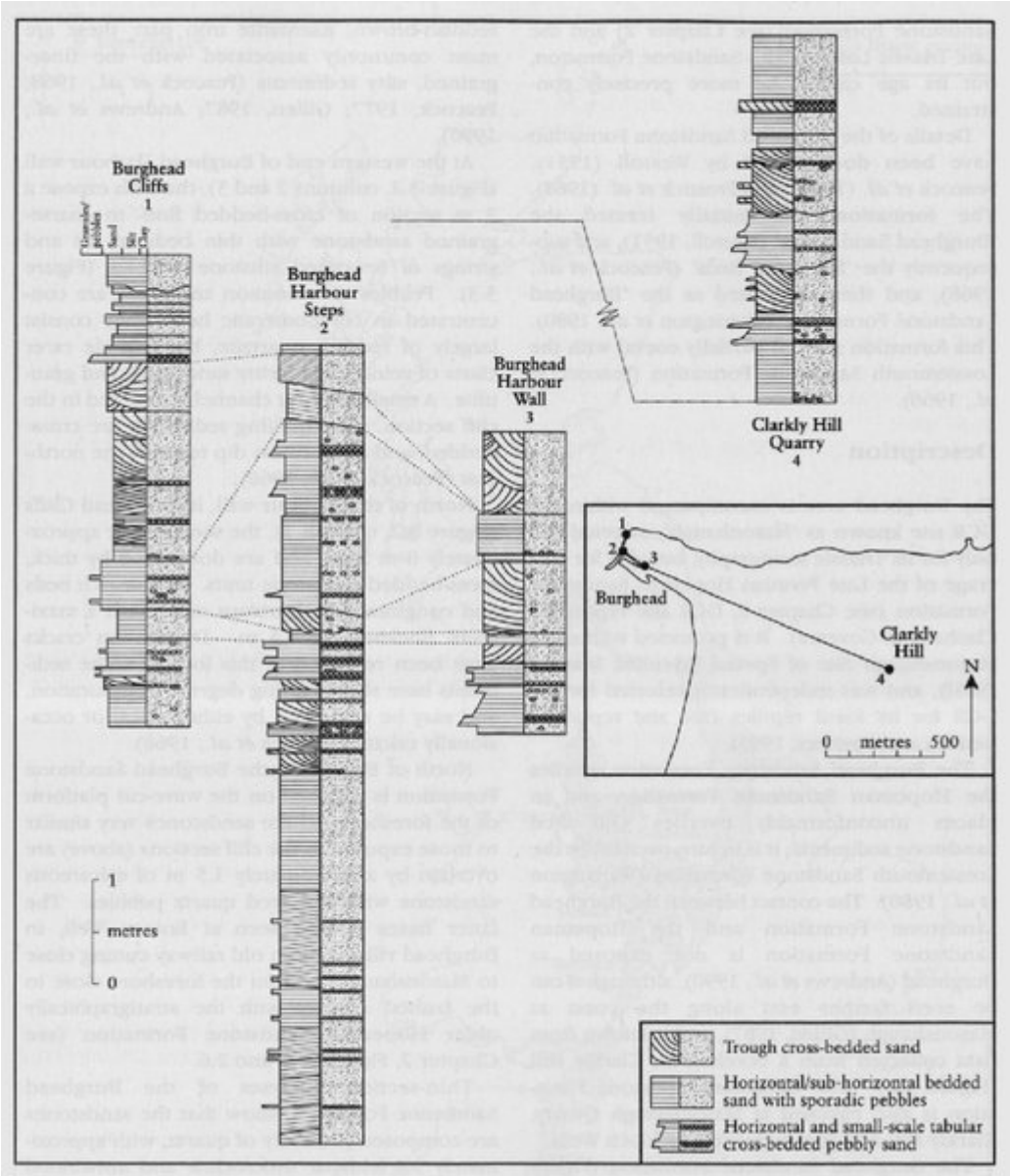
The iron pan layers, associated with joint and bedding plane surfaces, have a diagenetic origin and were formed by the precipitation of iron minerals (for example haematite) from circulating groundwaters (Gillen, 1987).

The Burghead Sandstone Formation appears to grade into the Lossiemouth Sandstone Formation, and hence it may be Carnian (?and pre-Carnian) in age. How far down it goes in the Triassic System is unclear. Peacock *et al.* (1968) and Warrington *et al.* (1980) hint, in a diagram, that it might fill the whole time between the Hopeman and Lossiemouth Sandstone formations, hence some 20–25 million years, and including the Induan, Olenekian, Anisian, Ladinian, and early Carnian stages. For such a coarse clastic unit, such an age span is unlikely and there is probably a major hiatus in deposition between the Hopeman Sandstone and Burghead Sandstone formations.

Conclusions

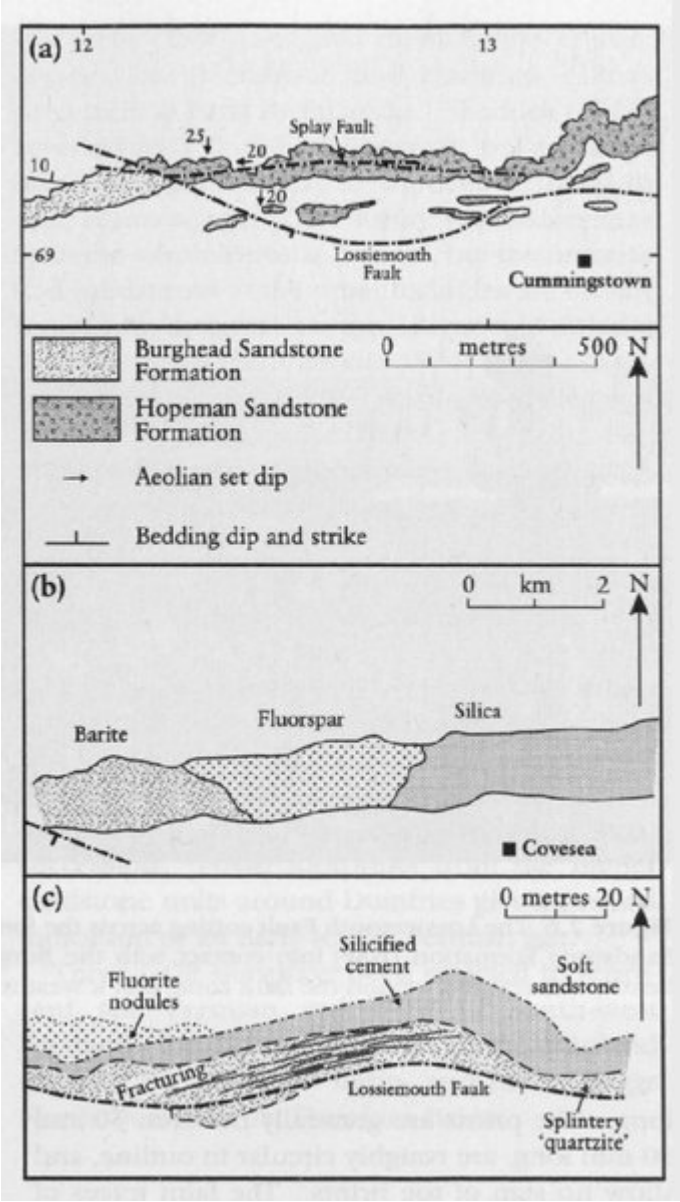
The cliffs and foreshore exposures around Burghead are the type locality for the Burghead Sandstone Formation, and an important site for the interpretation of Triassic stratigraphy and palaeoenvironments in the Moray Firth region. The sediments comprise thick sequences of cross-bedded sandstones, with pebble beds and occasional siltstone horizons, deposited on point bars and floodplains by a system of rivers and streams.

References

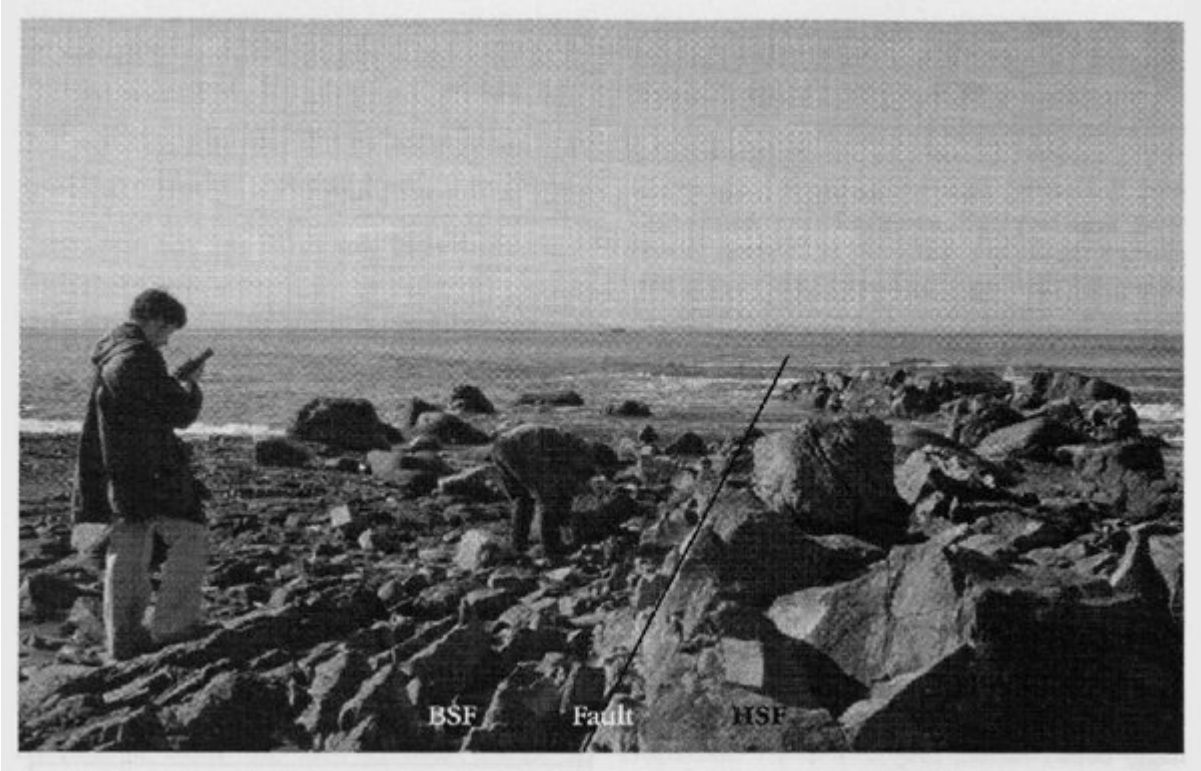


(Figure 3.2) Measured sections at four sites in the Burghead GCR site, showing characteristic sequences and lateral relationships. (After Frostick et al., 1988.)

(Figure 3.3) The Burghead Sandstone Formation in Burghead Cliffs, Masonshaugh site. The cross-bedding in the sand dune deposits of the Hopeman Sandstone Formation is of a much larger scale than the cross-bedding in these water-lain deposits. (Photo: C. MacFadyen.)



(Figure 2.5) The Hopeman Sandstone Formation at Masonshaugh. (a) Detail of the faulted contact between the Burghead Sandstone Formation (Triassic in age) and the Hopeman Sandstone Formation (Permian), showing the major fault zone, western termination of the Lossiemouth Fault. (b) The regional zonation of barite, fluorspar, and silica cements in the Hopeman Sandstone Formation along the north coast of Morayshire. (c) Details of the cement zone around the Lossiemouth Fault as it cuts across the beach at Masonshaugh at [NJ 131 693], showing zones of fluorite and silicified cements in the sandstone. (After Edwards et al., 1993.)



(Figure 2.6) The Lossiemouth Fault cutting across the foreshore at Masonshaugh Quarry, bringing the Hopeman Sandstone Formation (HSF) into contact with the Burghead Sandstone Formation (BSF). The sandstone is heavily mineralized around the fault zone, and it weathers slowly. (Photo: M. J. Benton.)