Dunbar, East Lothian

[NT 661 778]

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Introduction

The GCR site of Dunbar contains an excellent range of rocky coastal landforms within a 2 km stretch of coastline. Of exceptional note is a series of emerged and submerged shore platforms, often backed by cliffs of varying heights, including features that pre-date the last (Late Devensian) glaciation. Four distinct shore platforms are preserved, ranging in altitude from 25 m above OD, to 11 m below OD (Rhind, 1965; Sissons, 1967, 1976; Hall, 1989; Gordon and Sutherland, 1993). These landforms are representative of erosional coastal features found along the east coast of Scotland and are important for the interpretation of former sea-level changes and processes of rock coast development. The site is important in terms of Quaternary reconstruction and is included in the Quaternary of Scotland GCR coverage (Gordon and Sutherland, 1993). In addition to intertidal shore platforms, there are stacks, cliffs, offshore skerries and coarse gravels.

Considerable local geological variation occurs and the eight main rock types can be generalized into three divisions: the Old Red Sandstone in the east and its igneous intrusions; the basaltic tuffs of the central headland; and the Lower Carboniferous sandstones, cementstones and cornstones in the west together with their numerous dykes and pipes (Francis, 1975) (Figure 3.23). The foreshore is characterized by numerous volcanic intrusions that run through the fractured sandstone, mudstone and cement-stone, as well as well-defined shatter zones at the junction between the bedded tuffs and brec- cias and the adjacent sedimentary rocks. Complex variations in intertidal shore platform morphology occur and, while there is less variation in the geology of the cliffs, these also show changes in height, slope and indentation that are related to rock type.

The nearshore seabed slope offshore of North Berwick is relatively gentle at 1:60 out to –20 m depth. Tidal range is about 4.5 m at mean spring tides. Dunbar is relatively sheltered from the west and south but is dominated by waves from between 20°N and 60°N, the approach directions of 35% of the storm and 60% of swell waves (Ramsay and Brampton, 2000b). The only information on nearshore wave conditions is from the Torness sea-wall construction *c.* 10 km to the south, which shows the largest waves to approach from 45°N to 90°N.

Description

Although altitudinal overlap occurs, the land-forms of the area are best described by treating the emerged shore platforms separately from the intertidal features. The highest emerged platform (A, (Figure 3.23)) is one of a number of fragments that occur at 16 to 25 m OD between North Berwick and Berwick-upon-Tweed (Rhind, 1965; Hall, 1989). This emerged shore platform lies at an elevation of *c.* 20 m OD at Dunbar and its surface shows evidence of ice-moulding (Hall, 1989) and a thin cover of glacial till and of the drift tail of a crag-and-tail is preserved on its surface (Sissons, 1967, Hall, 1989).

A second platform (B, (Figure 3.23)) coincides with the present intertidal zone and reaches a maximum width of more than 300 m west of Long Craigs, where it truncates the underlying sediments and agglomerates (Clough *et al,* 1910, Francis, 1975). For about 1 km west of the Harbour, the platform is backed by a 20 m-high cliff composed of volcanic tuffs and sandstones and into which are cut several shallow caves. Several stacks protrude above the platform surface. Present-day gravel and boulder beaches mainly occur at the heads of the embayments in the cliffline.

Farther west, the backing cliff of the intertidal platform is degraded and fronted by Holocene beach deposits resting on a third platform (C, (Figure 3.23)) at an intermediate level, separated from the lower intertidal platform (B, (Figure 3.23)) by a rock step 1–2 m high (Gordon and Sutherland, 1993). Fragments of this platform, whose front edge lies between 2 and

4 m OD are found intermittently along much of the coastline between Aberlady and Torness (Hall, 1989). The relationships between the three platforms are best seen in section at [NT 6633 7899] (Gordon and Sutherland, 1993). The lowest platform (D, (Figure 3.23)) occurs offshore at depths of between –11 and –13 m OD.

The intertidal landforms of the area vary depending on location and geology: the offshore skerries; the Old Red Sandstone in the east; the tuffs and agglomerates in the central section; and the Carboniferous sandstones with dykes in the west.

The 12 low skerries that lie approximately shore-parallel offshore from the Yetts to Long Craigs are part of a single Late Carboniferous quartz-dolerite dyke. They provide a degree of protection from wave processes at low tide but serve to widen the zone of wave breaking at high tide and consequently result in wave energy dissipation on the shore at high tide.

Between Victoria Harbour and the peninsula to the west of the bathing pool, most of the coast consists of an intertidal abrasion platform developed on tilted Upper Old Red Sandstone, although steep rugged cliffs cut in basanite occur at Castle Rocks near the harbour entrance and low irregular stacks occur to the south of the harbour. The surface of the intertidal platform is very uneven and is crossed by bedding and minor joint systems that have been selectively eroded. A patchy scattering of subangular boulders occurs on the surface. In the west, the distinctive conical stack of Dove Rock is a volcanic plug composed of basanite girdled by rings of tuff and breccia.

The intertidal zone of the central section comprises a series of wide seaward-dipping platforms cut in mixed tuffs and agglomerates and crossed by quartz-dolerite dykes, minor faults and distinctive rectangular fracture patterns that have produced numerous clefts and slot-like inlets. Isolated residual rock pinnacles and stacks of up to 8 m high interrupt the surface, for example, at Bath Rock and Pincod. A great variety of micro-morphological features occurs on the platform surface. Close to the platform surface potholes and sand- and gravel-filled pools occur whereas higher up pitting and honeycomb features are found. The platforms are backed by low but bold, near-vertical cliffs, with the cliff-platform junctions often masked by accumulations of boulders and gravel.

In the west, between the shatter zone and the sandy beach of Belhaven Bay, a bold north-west facing conglomerate cliff gives way along the line of shatter to a rock projection, which extends into Belhaven Bay. A fringing sand and gravel beach extends from the end of the cliff westward at the upper edge of the shore platform to merge at its western extremity with a low emerged ('raised') beach and dune area. Traversing the main rock platform, in a south-west to north-east direction, is a narrow, but prominent, quartz-dolerite dyke that rises from the adjacent surface as a rocky ridge.

Interpretation

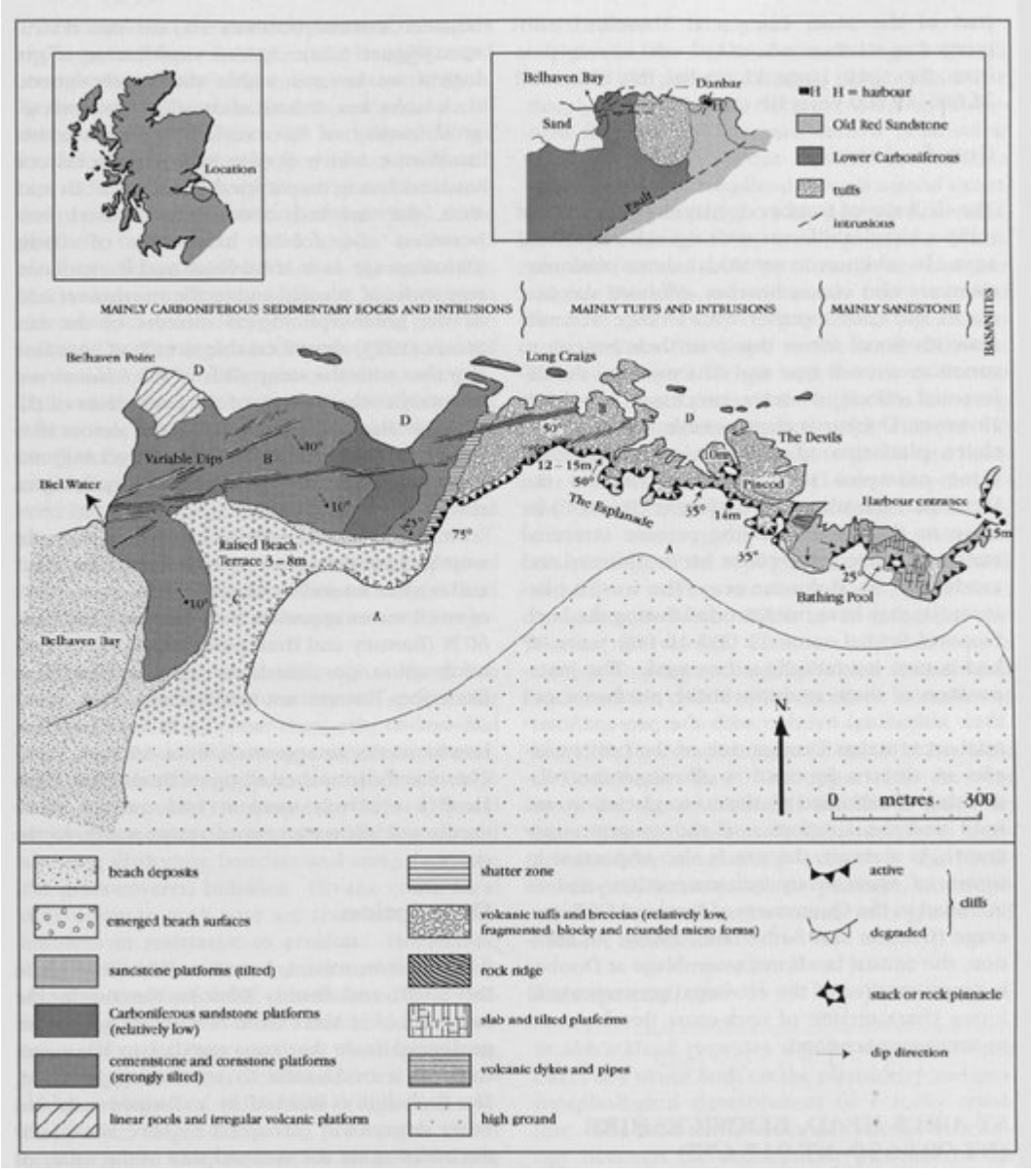
A great variety of rock coastal forms exists within a small area at Dunbar. The juxtaposition of structural and lithological settings, together with changes in wave exposure and abrasion, have produced a broad range of cliff forms that show striking variations in plan and profile. At the micro-morphological scale, there exists a wealth of forms on the shore platform surface that are related to weathering processes, such as solution and pitting, and also a range of micro-forms related to abrasional processes. For example, on the intertidal platform to the north and west of the headland, narrow linear pools separated by densely spaced 30 cm-high ridges are partly structurally and lithologically controlled and partly the result of differential abrasion. To the north and west of the headland, the intertidal zone consists of lower shore platforms with many local differences in form according to rock type and structure. The low angle of dip of the strata (5–15°) produces a corrugated platform with changes in form and colour according to lithology.

At the larger scale, the shore platforms at Dunbar demonstrate the relationship between marine erosion, sea level and glaciation. Shore platforms occur at four main levels in this area (Rhind, 1965; Sissons, 1967, 1976; Hall, 1989; Gordon and Sutherland, 1993) although differentiation between levels is often problematic. The highest platform (A) is ice-moulded and has a till cover indicating that it pre-dates the Late Devensian glaciation, although its age is unknown (Hall, 1989). Similarly, the ages of the next two lower platforms (B) and (C) are unknown, although evidence from elsewhere suggests that they too pre-date the last ice sheet (Hall, 1989), with the lower of the two (B) suffering partial stripping of its till cover and renewed marine erosion in the present intertidal zone during the Holocene Epoch. It is

possible that both platforms form part of an intertidal platform equivalent to the Low Rock Platform of western Scotland (Dawson, 1980a). The offshore platform has been correlated with a buried gravel layer and platform farther west in the Firth of Forth and a submerged platform at Burnmouth farther south. As a result, it may be part of the Main Lateglacial Shoreline, submerged in south-east Scotland, and so may date from the Loch Lomond Stadial that occurred 11 000–10 000 years BP (Sissons, 1974).

Conclusions

The GCR site of Dunbar displays a wide range of rocky coastal landforms within a relatively small area. In addition to intertidal shore platforms, there are also coarse beaches, offshore skerries, stacks and cliffs together with a range of small-scale erosional forms that owe their genesis to variations in rock type and structure and the differential effects of wave processes on these. However, Dunbar is most notable for a series of shore platforms of different ages, including three examples that probably pre-date the Devensian glaciation. Two of these (B and C) lie dose to the altitude of the present intertidal zone and consequently have been exhumed and eroded by the Holocene sea. The lowest platform (D) may have been eroded during the Loch Lomond Stadial some 11 000–10 000 years BP and is now isostatically submerged. The juxtaposition of these multiple shore platforms and their altitudinal overlap with the present intertidal area, makes Dunbar one of the best examples in eastern Scotland to illustrate the relationship of exhumed platforms to glaciation, sea level and the landforms of the contemporary coast. As a result, the site is also important in terms of Quaternary reconstruction and is included in the Quaternary of Scotland GCR coverage (Gordon and Sutherland, 1993). In addition, the coastal landform assemblage at Dunbar is representative of the erosional processes and forms characteristic of rock-coast development in south-east Scotland.



(Figure 3.23) Geomorphological map and geological sketch map of the Dunbar GCR site showing a series of emerged rock shore platforms that have been eroded across a varied geology and are backed by cliffs of varying heights. Platform A lies at c. 20 m OD and is ice-moulded; Platform B is intertidal; Platform C underlies emerged Holocene beach deposits and Platform D is subtidal. (After Gordon and Sutherland, 1993.)