

## CHAPTER 2

### The North East Coastline of Scotland

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**ABSTRACT:** The coastline of Northeast Scotland in plan is determined by faults running close inshore to both North Sea and Moray Firth coasts. Three broad subdivisions can be identified where differences of lithology and orientation have created distinctive coastal scenery. The events of recurrent glaciation during the Pleistocene are much more pertinent to the soft coast geomorphology of Northeast Scotland. In terms of their current coastal dynamics, the beaches of Northeast Scotland can be subdivided into three groups. Within this developed region, the coastline has for the most part, remained relatively unaffected by intensive use. Shallow offshore gradients, potentially mobile surfaces, low quality soils and a tendency to poor drainage have preserved the dune and links areas from urban and industrial use. The broad planning strategy for future management might, therefore, appear to be that of preserving or maintaining the status quo whilst allowing local, well-managed developments to proceed, as long as they conform to a general regional plan for balanced coastal zone development.

#### The Geological Skeleton

The coastline of Northeast Scotland in plan is determined by faults running close inshore to both North Sea and Moray Firth coasts. Along the northern margin, an east-west trending system of faults can be identified by steep gravity gradients north of Fraserburgh. This line also coincides with the orientation of a prominent bathymetric deep. Off the east coast, recent geological work by the *Institute of Geological Science* has confirmed the pioneer Quaternary work of Jamieson which indicated that relatively recent geological strata of Permo-Triassic age lie close inshore. For both north and east coasts, the detail of the coastal plain, within which the soft coastal elements have

accumulated, is governed by the varying lithologies of the solid geology along the land margin. Three broad sub-divisions can be identified where differences of lithology and orientation have created distinctive coastal scenery.

- (a) **The Highland schists of the Banffshire coast**
- (b) **The granites, gneisses and schists of the east coast of Aberdeenshire, to the north of the Highland Boundary Fault**
- (c) **The younger sedimentaries downfaulted south of the Highland Boundary Fault, the outliers at Pennan, together with the downwarped sedimentary formations of the Moray Firth basin, west of Spey Bay**

The Banffshire coast consists of a generally high rocky coastline with small bays orientated in sympathy with the rapidly changing geological succession of the Highland schists. Beach units are small and generally separated from each other by rock cliff headlands and deep water. The bayhead orientation is continued inland by strike-stream valleys, often markedly overfit in relation to current fluvial activities, and the fluvial input, with the exception of the Deveron, is generally small. The coastal scenery is bedrock-dominated and rapidly changing in character along the geological succession.

On the east Aberdeenshire coast, the role of the underlying bedrock, although by no means uniform, is subordinate to Pleistocene and post-Pleistocene events. With the notable exception of the granite coastline north of Collieston (especially at Buchan Ness), and the intricate cliff coast between Girdleness and Stonehaven, the character of the coast is of extensive arcuate dune-backed embayments, hinged on low bedrock outcrops and lag glacial deposits. Fluvial inputs while locally significant, are not impressive in their supply of beach material.

West of the Spey and south of Stonehaven, the younger sedimentary rocks form substantial lengths of high cliff coast, with variation in character according to lithology. Particularly impressive are the Devonian conglomerate sea cliffs at Fowl's Heugh, just south of Dunnottar. On the north coast Permian sandstones form a very distinctive series of low sea cliffs between Covesea and Burghead, but west of this point, and between Lossiemouth and Portgordon, the coastline is dominated by major strandplains of late- and post-glacial age, again as in the case of the east Aberdeenshire coast, supported by bedrock outcrops.

In relation to the soft and therefore potentially dynamic coastal elements, the solid geology forms a varied platform on which beaches and landward blown sand deposits have accumulated. But over more than 80% of the sandy beaches, bedrock geology forms a minor element in their evolutionary history and present characteristics. Exceptions occur on the Banffshire, Kincardineshire and Moray coasts, where the beach units are set in small bayhead situations resting on rock platforms. Here the beach arc and its landward landform characteristics are closely governed by the geological framework within which it is lodged.

### **Glaciations, Deglaciation and Changing Land-Sea Relationships**

The events of recurrent glaciation during the Pleistocene are much more pertinent to the soft coast geomorphology of Northeast Scotland. The glacial history of Northeast Scotland involved successive advances of ice both from the Moray Firth basin and from the Deeside-Donside area. In Banffshire, the cliffs are capped by till and by the enigmatic coastal gravels, both of which contain material of Cretaceous origin derived from offshore. On the east coast of Aberdeenshire and Kincardine a red till derived from Strathmore and from offlying submarine sandstone outcrops forms a prominent capping to the sea cliffs, as at Dunnottar and Hackley Head. At several points both on the east and north coasts, ancient elements of the preglacial coastline are plugged with glacial till even in relatively high energy situations, testifying to the relatively slow evolution of the inherited pre-Pleistocene bedrock coastal landforms. Examples of till-plugged sea stacks occur at Covesea and immediately south of the Bay of Nigg. Impressive sections of superimposed coastal tills were formerly exposed at the Bay of Nigg.

As the ice melted, large quantities of fluvio-glacial materials were released into the coastal zone, the materials being transported down preglacial river valleys as in the case of the Spey and Findhorn, or more directly released from impressive meltwater channels as in the Pennan-Troup Head area. The high-cliff coast near New Aberdour is dissected by deeply incised coastal ravines which are partly of meltwater origin. In situations where ice-fronts rested near to the present coastline, as occurred between Aberdeen City and the Ythan, and at the Binn Hill just west of the Spey, sorted materials were released to be later incorporated into recent coastal strandplains. Large quantities of material travelled down the Spey and Findhorn which acted as major late-glacial spillways, as attested by the huge lateral fluvio-glacial terraces of their lower and middle valley sections.

Land-sea relationships changed as a result of the interplay of isostatic rebound of the land and eustatic change in sea level. The result was to cause shoreline displacement, initially rapid and latterly slowing down. Where unconsolidated materials were subject to wave action, strandplains were formed representing the land-sea relationship at that time, and subsequent land rebound raised these to form the late-glacial shorelines which fringe the interior edges of the major coastal embayments. On occasion, the late-glacial sea overtopped the bedrock cliffs, and resorted the coastal gravels mentioned earlier to form beach gravels as at Portknockie. On the east coast of Aberdeenshire, late-glacial beaches at about 30 m. O.D. can be identified inland of the Loch of Strathbeg. Marine clays were deposited in sheltered coastal situations as at Cruden Bay and Tippetty, often associated with a cold water fauna. After this phase of relatively high sea level, it is evident that sea level dropped to a level below that of the present time, resulting in river and estuarine rejuvenation. As climate ameliorated, vegetation spread into the emerging coastal zone.

## **Shoreline Regularisation**

Later in response to the warming world climate, sea levels rose rapidly, and the coastal zone was inundated by a major marine transgression (the Flandrian transgression) which caused a landwards migration of the shoreline, leading to the burial of peats and their capping with marine deposits. The highest point of the post-glacial transgression is marked by the well-marked sea cliff at about 6 m. O.D. which can be traced almost continuously from Strathbeg in the north to Aberdeen City in the south. It also formed the well-defined inland margin of the Moray strandplains as at the Binn Hill. Final land emergence caused a second seaward shoreline displacement, during which vast quantities of sands and gravels were made available for shoreline regularisation. Successive shingle bars hinged on till or isolated bedrock headlands mark the progress of this final period of shoreline displacement. In areas where substantial coastal embayments existed, as in the Moray coast or the east coast of Aberdeenshire, regularisation involved the construction of the wide strandplains on which blown sand accumulated. On occasion blown sand deposits extended landward of the marine limit forming a veneer on till and fluvio-glacial landforms. In response to dominant wind and wave activity, shingle spits were built, deflecting the Ythan to the south on the east coast, and the Spey and Lossie to the west on the north coast. The smooth arcuate nature of the coastal plain between Aberdeen and Collieston, between Buchanhaven and Inzie Head, and between Spey Bay and Lossiemouth represent a final shoreline equilibrium form achieved through the recycling of sediment by wave and current. West of Burghhead, active shoreline progradation continues through the building westwards of spits and bars. Much of the material is derived from re-cycling of existing forelands as in Burghhead Bay, resulting in problems of coastal edge erosion, as waves and currents sweep the material westwards into the Inner Moray Firth.

In the case of the smaller bayhead beaches, the processes of change are less dramatic, as a balance appears to exist between material supplied from cliff and offshore sources, and that lost from the beach by downcombing during heavy swell. On the Banffshire coast, where each unit is separated from its neighbour by cliff coasts and stretches of deep water, each beach unit functions separately, but in the Inner Moray Firth, where large units are linked in arcuate coastal sweeps, coastal edge erosion is associated with deflation of the exposed dune faces. Backshore erosion at Burghhead Bay has in the past revealed exposures of the peat which formed during the shoreline regression phase preceding the Flandrian.

## **The Building of Dune Systems and Human Impacts**

On top of the shingle forelands where the constituent material reflects the formerly abundant supply of fluvial and fluvial-glacial materials, sand deflated from the drying upper beaches has accumulated as dune systems. These vary locally in their form and complexity. The relatively simple successive foredunes of Strathbeg, St. Fergus and Lossie form massive ridges separated by slacks. At the Sands of Forvie, and to a lesser extent Culbin, the forms are much more complex, including parabolic dunes whose

current activity and pattern of evolution makes them of great physiographic interest. Here the older late- and post-glacial landform elements are largely buried by a blown sand landscape carrying evidence of sequent occupation. In both Culbin and Forvie, the story of prehistoric and historic sand-blow cannot be separated from the activities of man. Historical and neo-historical sand-blow at Culbin resulted in 20th century afforestation of the dunes, but at Forvie, the dunes continue to evolve naturally.

The very large beach units and their backing forelands described above contrast in size with the small bayhead units set within a rock-girt coastline. Here the beaches rest on rock platforms and are generally backed by settlements nestling on the post-glacial ledges, at the base of a marked sea cliff, generally of bedrock, capped with till, and overlain by thin and often discontinuous blown sand deposits. The blown sand landforms are small by comparison with the North Sea coast beaches, and are generally inactive, partially masked and modified from their original characteristics. They can be regarded as degraded 'links'. These small beach units have frequently been modified in the 18th and 19th century through the construction of harbours, as at Hopeman.

In terms of their current coastal dynamics, the beaches of Northeast Scotland can be subdivided into three groups.

- 1. The massive arcuate plains consisting of long sand bays of gentle arc, backed by extensive foredune ridges, successively built outwards by shoreline regularisation. These are characteristic of the North Sea coast of the region north of Aberdeen. The blown sand deposits in this group have distinctive dune forms largely in their original state. The coastline is a relatively high energy one, with marked seasonal changes in the beach and coastal edge, but sand supplies both longshore and offshore appear to be available for coastal edge replenishment.**
- 2. The beaches west of the Spey are equivalent in scale to those in the preceding group but differ in the relative proportion of sand and shingle involved in their construction. Fluvial inputs have been more significant in their evolution, together with a uni-directional pattern of sediment movement westwards. The thickness of blown sand resting on the shingle forelands is variable, with on occasion only vestiges remaining as in the case of Spey Bay links. Recurrent sand-blow in the immediate past has been countered through afforestation, with the result that much of the original mobility of the dune landforms has ended. As the offshore gradient shallows westwards, mud- and sand-flats appear, and spits and offshore bars have formed. The ample supplies of sediment available during their construction have apparently declined in recent times, and the distal portions of the arcs are tending to build at the expense of the proximal (updrift) portions with the result that beach material starvation is leading to considerable coastal edge erosion as at Burghead Bay and the proximal portions of Whiteness Head.**



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