

---

## Chapter 8 North-east Scotland

### Introduction

D. G. Sutherland and J. E. Gordon

North-east Scotland covers the mainly lowland area between lower Strathspey and Aberdeen (Figure 8.1). Geologically, it is underlain by the same Dalradian metamorphic rocks and younger granitic intrusions as the central and south-west Highlands, and hence its lowland character indicates a distinctive geomorphological evolution. Since the early Tertiary, north-east Scotland has been a 'hinge zone' between the mountain zone to the west, which has been uplifted and subsequently dissected to produce spectacular mountain scenery, and the North Sea Basin, which has undergone continuing downwarping (Hall, 1987). This relative stability has resulted in the preservation of Tertiary gravel deposits and extensive areas of deeply weathered bedrock.

The Tertiary gravels occur in two distinct groups, a western quartzite gravel group, best exemplified at Windy Hills, and an eastern flint gravel group, most extensively preserved at the Moss of Cruden (Figure 8.1). The western gravels are generally accepted to be fluvial in origin (McMillan and Merritt, 1980; Hall, 1987), deposited by a precursor of the present River Ythan, but the origin of the flint gravels is disputed, possibly being marine (McMillan and Merritt, 1980), possibly fluvial (Hall, 1982) or possibly glacial and glaciofluvial (Kesel and Gemmell, 1981).

Two distinct types of weathered bedrock have been recognized in north-east Scotland (Hall, 1985, 1986; Hall *et al.*, 1989a). An older, less widespread type is characterized by more intensive alteration to clay minerals (Pittodrie), whereas the younger, more widespread type is less chemically altered, having typically disintegrated to a granular sand, with the great proportion of the original minerals preserved (Hill of Long-haven Quarry; see also Clunas, Chapter 7). The alteration has taken place under humid temperate conditions; the older weathering type is probably Miocene in age, and the younger type of late Tertiary to early Pleistocene age. Depths of weathering vary considerably, up to a maximum of over 50 m. Local controls on the development and preservation of the weathered bedrock have been relief, bedrock type and limited glacial erosion (Hall, 1986; Hall and Sugden, 1987; Sugden, 1989).

The low intensity of glacial erosion of northeast Scotland that is implied by the preservation of the Tertiary sediments and the weathering profiles is matched by a longer record of Quaternary glacial (and non-glacial) events than has been found anywhere else in Scotland. The most outstanding site is at Kirkhill. There, and at the neighbouring Leys Quarry, evidence has been found for at least three periods of ice-sheet glaciation, separated by possibly two interglacials, the earlier of which was succeeded by an interstadial period. Deposits of four periods of periglacial activity are interstratified with the glacial and interglacial/interstadial sediments (Connell *et al.*, 1982; Hall, 1984a; Connell and Hall, 1987). Unfortunately, the ages of the Kirkhill deposits have not been established, although certain correlations have been proposed: Hall and Connell (1991) have tentatively correlated the glacial episodes with the Early Devensian, the 'Woistonian' and the Anglian.

A weathered till at Kirkhill, which represents the middle of the three glaciations, may correlate with weathered tills at Boyne Bay (see below) (Peacock, 1966; Hall, 1984b) and Kings Cross, Aberdeen (Synge, 1963). The weathering of the till has been considered to have occurred under interglacial conditions (Hall, 1984a) and may correlate with the palaeosol preserved at Teindland (FitzPatrick, 1965; Edwards *et al.*, 1976) in lower Strathspey. This weathered till may also correlate with the Bellscamphie Middle Till, suggesting correlation of the Bellscamphie Lower Till with the earliest known glaciation at Kirkhill and Leys. The grey till reported by Jamieson (1906) as overlying the equivalent of the Bellscamphie Middle Till, would then be correlated with upper till at Kirkhill. However, some apparently weathered tills (e.g. at Moreseat — Hall and Connell, 1982) may reflect the incorporation of weathered bedrock rather than prolonged *in situ* weathering (A. M. Hall, unpublished data).

The occurrence of tills superposed, at certain localities, upon the above weathered tills, and possibly correlative palaeosols, indicates subsequent ice-sheet glaciation, and three distinct drift sheets are recognized: the Inland 'Series',

the Red 'Series' and the Blue Grey 'Series' (Hall, 1984b) (Figure 8.1). If the weathering episode occurred during the Ipswichian, then Devensian glaciation is implied, but it is uncertain whether there was one or two periods of glaciation of north-east Scotland during the Devensian and, indeed, whether the whole region was glaciated during the Late Devensian (Clapperton and Sugden, 1977; Hall, 1984b; Sutherland, 1984a; Hall and Connell, 1991). For example, at King Edward [NJ 722 561] till and glaciofluvial gravels overlie an apparently *in situ* shell bed at c. 46 m OD (Jamieson, 1866; Horne in Read, 1923; Sutherland, 1984b). If the shell bed is indeed *in situ*, then its radiocarbon and amino acid age (Miller *et al.*, 1987) implies Early Devensian glaciation. Further, the nearby Middle Devensian interstadial deposit at Crossbrae Farm, unaffected by subsequent glaciation (Hall, 1984b), suggests that at least part of the north-east was ice-free at the time of the last glacial maximum.

Also uncertain is the status of deposits found along the coasts, such as at Boyne Bay, Castle Hill and the Red 'Series' drift deposits that occur inland of the east coast southwards from Peterhead (see Bellscamphie). These deposits consist of interstratified tills, glaciolacustrine, glaciomarine and glaciofluvial sediments (Murdoch, 1977; Hall, 1984b; Peacock, 1984b). They are coeval with lacustrine deposition along valleys, such as those of the Ugie Water and River Ythan (McMillan and Aitken, 1981; Merritt, 1981), and this implies that for at least part, if not all, of the period when the glacial sediments were being deposited, the interior of Buchan was ice-free. Glaciomarine sediments at St Fergus have been radiocarbon dated to approximately 15,000 BP (Hall and Jarvis, 1989). These sediments rest on glacial deposits derived from the Moray Firth but their stratigraphic relationship to the Red 'Series' deposits remains to be established. The presence of pre-Quaternary palynomorphs in radiocarbon-dated material from the Red 'Series' at Errolston indicates that the date obtained is of no practical value in establishing the age of these deposits (Peacock, 1984b; Connell *et al.*, 1985). Other possible interglacial or interstadial sites in northeast Scotland, at Tippetty Brickworks and Balmedie Village, have not been confirmed (cf. Bremner, 1938, 1943a; Peacock, 1980b; Edwards and Connell, 1981).

During final ice retreat, glaciofluvial deposition resulted in the formation of major esker and kame systems parallel to the coast (Kippet Hills), in places associated with glacial lakes (Merritt, 1981; Thomas, 1984; Aitken, 1991); lakes also formed along valleys inland (Aitken, 1990).

Elsewhere, sequences of large outwash terraces were constructed along some principal valleys, the relationships of these to both ice-decay features and raised sea levels being particularly well exemplified in lower Strathspey. In topographically suitable hollows, stagnant ice masses became isolated from the main retreating ice mass, resulting in the formation of complex sequences of kames, kettle holes and eskers (Muir of Dinnet).

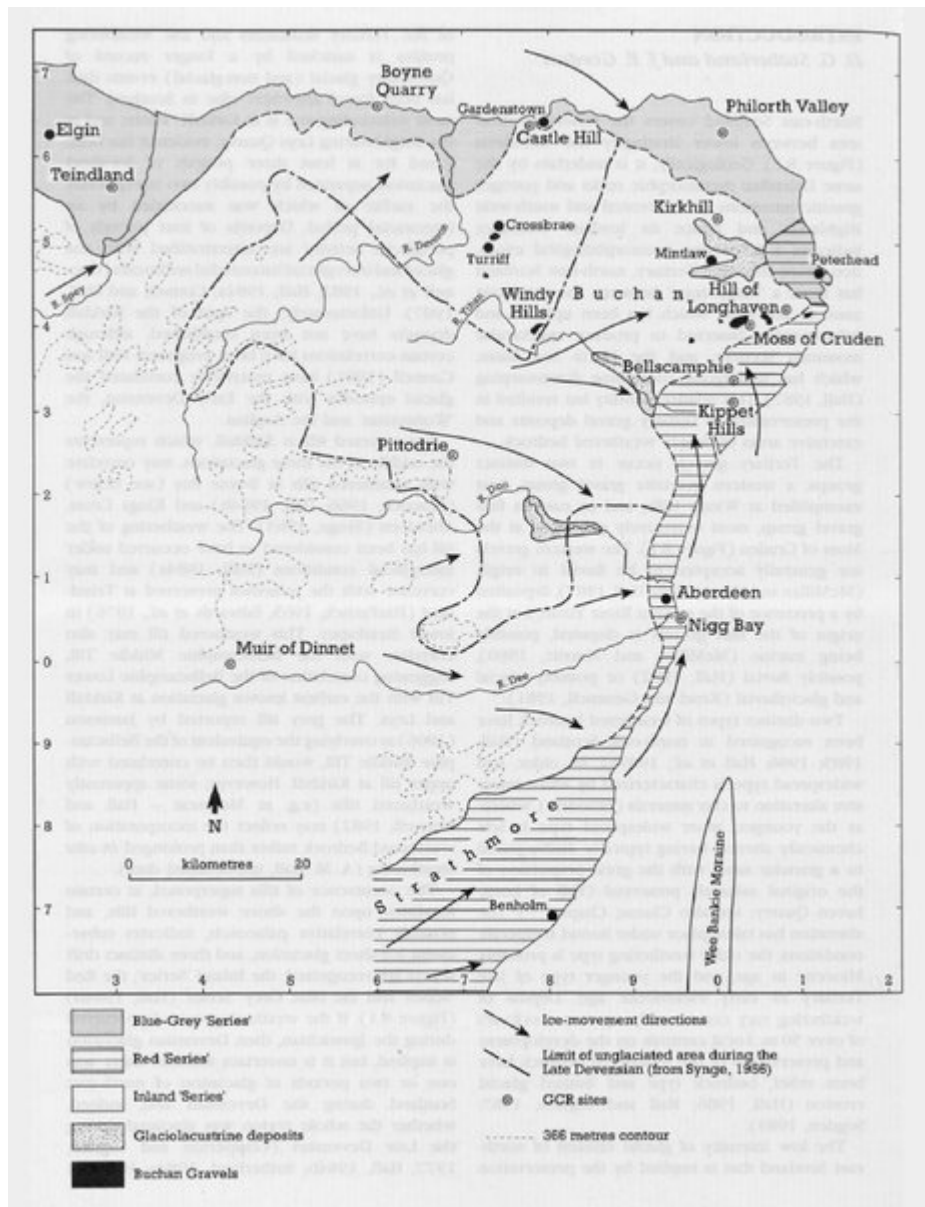
Environmental change during the Lateglacial has been relatively little studied in the north-east, although radiocarbon-dated Lateglacial Interstadial profiles have been described from Loch Kinord (Muir of Dinnet), Loch of Park and Garra Hill (Donner, 1957; Vasari and Vasari, 1968; Vasari, 1977). These sites indicate that an initial phase of open-habitat vegetation was succeeded by closed heath and scrub vegetation. Interestingly, two pine needles were recovered from Lateglacial deposits at Loch Kinord, suggesting local occurrence of pine in this area during the interstadial. Locally, tree birch may also have developed.

The Loch Lomond Stadial resulted in a return to tundra vegetation with marked slope instability and inwashing of sediment into closed basins. Sediment cores show a typical Lateglacial 'tripartite' sequence (Gunson, 1975), and radiocarbon dates have been obtained from peat beneath solifluction deposits at several sites (Clapperton and Sugden, 1977; Hall, 1984b; Connell and Hall, 1987). It is also possible that at this period some of the fossil frost polygon networks found in north-east Scotland were formed, although formation during the retreat of the last ice-sheet is also possible (Gemmell and Ralston, 1984, 1985; Armstrong and Paterson, 1985). Whatever the timing, the impact of periglacial processes on the soils of north-east Scotland has been widespread (FitzPatrick, 1956, 1958, 1969, 1972, 1975a, 1987; Galloway, 1961b, 1961c; Connell and Hall, 1987).

During the Holocene, sea level was below that of the present day for considerable periods. In the middle Holocene, the Main Postglacial Transgression resulted in marine invasion of the lower parts of the river valleys, with deposition of estuarine silts, fine sands and clays on terrestrial peats and fluvial muds. The transgression reached its maximum after 6100 BP in the Ythan valley (Smith *et al.*, 1983) and between 6300 and 5700 BP in the Philorth valley (Smith *et al.*, 1982). The subsequent regression was accompanied by renewed terrestrial sedimentation in the valley mouths.

Holocene vegetation history has been investigated at several localities (Durno, 1956, 1957), but there are few well-dated pollen profiles. The most detailed studies have been at sites in the Dee Valley at Loch Kinord (see Muir of Dinnet), Loch Davan, Loch of Park and Braeroddach Loch (Vasari and Vasari, 1968; Edwards, 1978). During the middle Holocene, pine forest developed in the western part of the area, whereas birch–hazel forest was predominant to the east and on the coastal lowlands (Vasari and Vasari, 1968; Gunson, 1975; Birks, 1977). The impact of Man on the landscape is apparent in the pollen and sediment records before 5000 BP (Edwards, 1978, 1979b; Edwards and Rowntree, 1980).

### References



(Figure 8.1) Location map and principal features of the Quaternary geomorphology of north-east Scotland (from Hall and Connell, 1991).