MUIR OF DINNET

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OS Grid Reference: NJ430000

Highlights

The landforms at Muir of Dinnet include an assemblage of meltwater channels, eskers and related deposits. These are important in demonstrating the mode of deglaciation of the Late Devensian ice-sheet and the effects of topographic controls on the pattern of ice wastage. In addition, pollen and plant macro-fossils preserved in the sediments that infill the floor of Loch Kinord provide a detailed record of vegetational history and environmental changes during the Lateglacial and Holocene.

Introduction

The Muir of Dinnet site (centred on NJ 430000) occupies an area (*c.* 22.9 km^2) in the south-west corner of the Howe of Cromar, one of a number of major topographic basins in north-east Scotland, and part of the River Dee Valley east of Ballater. It is important on three main accounts: first, for its fine assemblage of glaciofluvial landforms demonstrating the progressive downwastage of the Late Devensian ice-sheet (Clapperton and Sugden, 1972; Sugden and Clapperton, 1975); second, in a historical context as the site of the supposed Dinnet Readvance ice limit (Synge, 1956); and third, for the Lateglacial and Holocene pollen and plant macrofossil records preserved in the sediments of Loch Kinord (Vasari and Vasari, 1968; Vasari, 1977). The geomorphology of the area has a long history of investigation (Jamieson, 1860b, 1874; Barrow *et al.*, 1912; Bremner, 1912, 1916a, 1920, 1925a, 1931; Charlesworth, 1956; Synge, 1956; Sissons, 1967a; Clapperton and Sugden, 1972; Sugden and Clapperton, 1975; Maizels, 1985).

Glacial and glaciofluvial landforms

Glacial and glaciofluvial landforms

The main glacial landforms of the area were described by Bremner (1931), Clapperton and Sugden (1972) and Sugden and Clapperton (1975). They include eskers and meltwater channels in the River Dee Valley between Milton of Tullich and Cambus o'May and on the eastern flank of Culblean Hill, an extensive area of dead-ice topography comprising kames and kettle holes around Lochs Davan and Kinord, and spreads of outwash gravels extending eastwards from Cambus o'May across the Muir of Dinnet and eastwards from the two lochs (Figure 8.10). Additional landforms of note are the roches moutonnées on Cnoc Dubh, and river terraces are present along the margins of the River Dee. Palaeochannels are extensively developed on terrace surfaces (Bremner, 1931) and also down-valley to the east of Dinnet (Maizels, 1985; Maizels and Aitken, 1991). Various sections are present in small pits in the glaciofluvial deposits but have not been described in detail, and in sections along the River Dee the glaciofluvial deposits are seen resting on till.

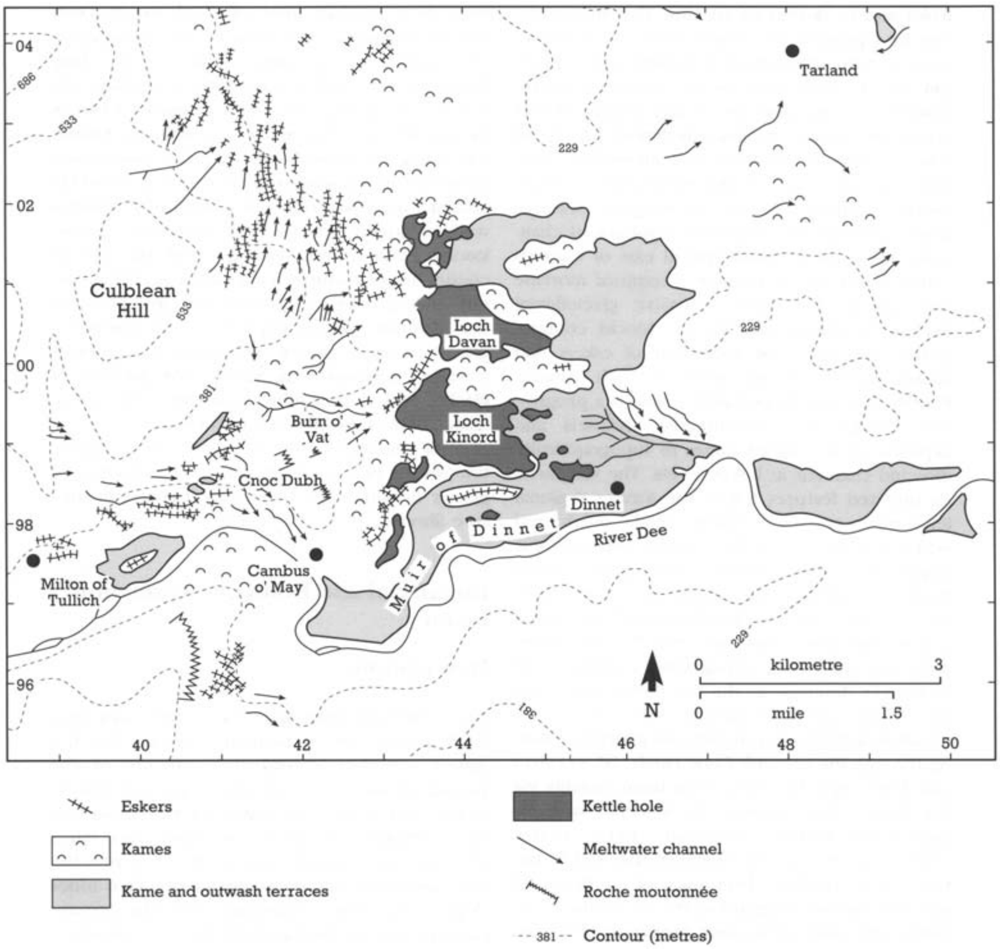

Figure 8.10: Geomorphology of the Muir of Dinnet (from Clapperton and Sugden, 1972).

Lateglacial and Holocene vegetation history

The pollen and plant macrofossil sequences from Loch Kinord are of particular interest for the almost complete record they provide of the Lateglacial and early Holocene vegetation history of the area. Vasari and Vasari (1968) described the sediments (a sequence of organic lake muds and silts) and organic contents of cores from the loch, and correlated the sequence of pollen zones (Figure 8.11) they identified with the Jessen–Godwin scheme. Recognizing that the respective pollen zones might not be synchronous because of regional variations in environmental factors, Vasari (1977) obtained radiocarbon dates (HEL-174, and HEL-418 to HEL-421) to provide a geochronometric framework for the Lateglacial stratigraphy of the site. On this basis he was able to correlate the zonation of the Loch Kinord pollen record with the conventional British scheme and also with the continental sequence of chronozones.

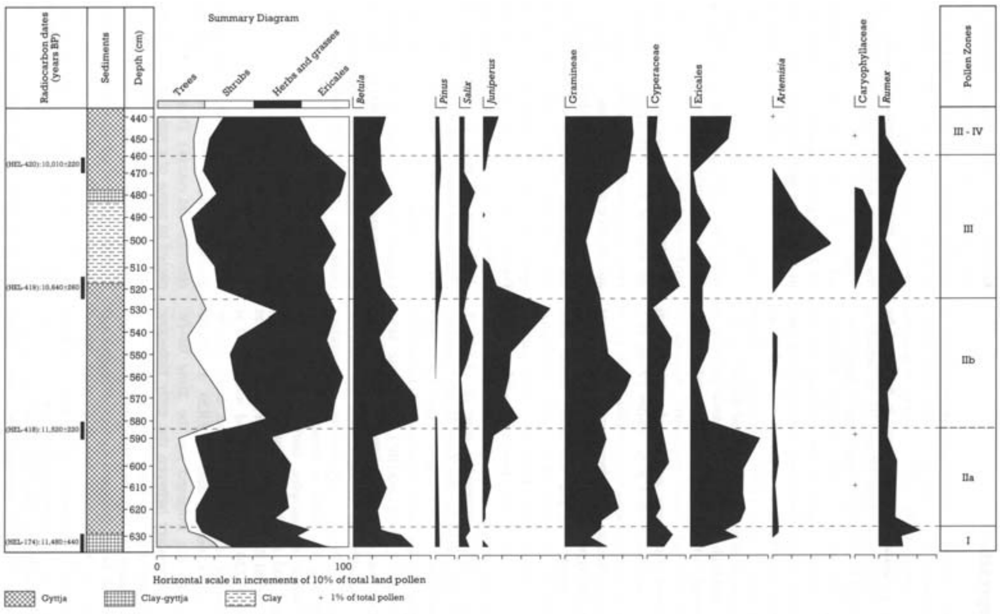

Figure 8.11: Loch Kinord: relative pollen diagram showing selected taxa as percentages of total land pollen (from Vasari, 1977).

Glacial and glaciofluvial landforms

Jamieson (1860b) first described gravel mounds in the Dee Valley east of Ballater and a great spread of water-rolled gravel extending across the Muir of Dinnet. Initially he explained the deposits as the product of marine processes (Jamieson, 1860b), but later reinterpreted them as moraines and an outwash spread representing a halt stage in the gradual retreat of the last ice-sheet from a limit on the coast at Aberdeen (see Nigg Bay) into the centre of the Cairngorms (Jamieson, 1874).

Barrow *et al*. (1912) noted Jamieson's observations and the gravelly nature of the moraines. They related the moraines and the associated outwash spread to a valley glacier debouching from the constriction of the Dee Valley at the Muir of Dinnet during a phase of local valley glaciation after the ice maximum episode.

Bremner (1912, 1920, 1931) subsequently described the deposits between Ballater and Dinnet in greater detail, concluding that they represented a distinct stage of valley glaciation equivalent to Geikie's Fourth Glacial Stage (Geikie, 1894). He based this conclusion on the interpretation of certain landforms, such as lateral moraines and marginal meltwater channels along the valley sides, moraines in the valley floor that were fresher than those down the valley and contrasts in the lithology and composition of two superimposed "tills'. However, there was no conclusive evidence to suggest complete deglaciation or an interglacial period immediately prior to the valley glaciation.

Charlesworth (1956) believed the Dinnet deposits and landforms marked the local limit of his Stage M, a Lateglacial ice readvance equivalent to the Loch Lomond Readvance of Simpson (1933). Synge (1956), too, reached the conclusion that "a massive terminal moraine' at Dinnet marked the limit of what he called the Dinnet Readvance, the local equivalent of the Loch Lomond Readvance. Sissons (1965, 1967a), however, correlated the Dinnet deposits with the Perth Readvance. He suggested they reflected the rapid downwasting of ice leading to stagnation and the formation of dead-ice topography following this readvance.

Subsequent detailed mapping in the Dinnet area by Clapperton and Sugden (1972) led them to dismiss the idea of an ice readvance in the Dee Valley. Instead, they related the assemblage of landforms and deposits to meltwater drainage in a progressively downwasting ice-sheet, concluding that their remarkable concentration near Dinnet was explained by the topography of the area, which allowed a large mass of ice to become isolated from the main ice-sheet in the Tarland Basin and downwasted *in situ*. This interpretation is supported by several lines of evidence, subsequently summarized in Sugden and Clapperton (1975). First, many of the features formerly described as moraines are in fact of glaciofluvial origin; they form complex, interlinked systems of eskers, kames, kettle holes and meltwater channels. Second, many of the meltwater channels formerly interpreted as ice-marginal features display typical characteristics of subglacial channels. Third, the outwash spread east of Cambus o'May is not associated with a terminal moraine but appears to reflect extensive glaciofluvial deposition around stagnant ice blocks contemporaneously with the formation of eskers and kames within the ice west of Loch Kinord. Fourth, and most importantly, there is a progressive change from ice-directed channels and deposits on the higher slopes to topographically directed channels at lower levels. The subglacial ice-directed features follow the former regional ice-surface gradient, which trends north and north-east out of the Dee Valley and are best displayed on the northern and higher eastern flanks of Culblean Hill (Figure8.10). At lower levels on the east side of Culblean Hill they trend across and downslope into the Tarland Basin, reflecting increasing topographic influence on meltwater drainage as the ice downwasted. On the south side of Culblean Hill, eskers and channels at higher levels indicate meltwater flow up through the col with Cnoc Dubh (NJ 421991) and down on to the floor of the basin, notably via the Burn o'Vat channel (NJ 435996) with its spectacular pothole (Bremner, 1912, 1916a, 1925a). At lower levels, however, they follow the Dee Valley. During a later stage of ice decay an ice mass became stagnant in the lee of the Cnoc Dubh spur, with subsequent formation of kames, kame terraces, kettle holes and outwash gravels. Lochs Davan and Kinord are two particularly impressive kettle holes associated with this final stage of ice decay, being about 0.6 km and 1 km in diameter, respectively. Complete deglaciation had occurred at least by 11,520 + 220 BP (HEL–418), the oldest date obtained from a core taken from Loch Kinord byVasari (1977), and probably much earlier, since the Loch Builg area farther to the west is inferred to have been deglaciated before 12,000 BP (Clapperton *et al.*, 1975).

In the context of this latest interpretation of events in the Dinnet area it should be noted that Bremner (1920) had, much earlier, recognized the evidence for downwasting ice and the presence of a residual mass of dead ice in Loch Kinord isolated by the form of the topography. This pattern of ice-sheet decay in the Late Devensian is typical of many parts of Scotland and northern England (see the Cairngorms) but is particularly well-exemplified atMuir of Dinnet where the relationships between the assemblage of landforms are clearly seen within a relatively compact area. Not only are individual landforms well-developed (meltwater channels, eskers, kames, kettle holes, terraces), but the overall continuum of features makesMuir of Dinnet an outstanding area for geomorphology. The site also illustrates particularly well the evolution of a glacial drainage system during ice-sheet downwastage, demonstrating clearly the pattern of glacial and topographic controls. The close association of meltwater channels and eskers is also of significant interest, and offers opportunities for detailed study and reconstruction of glacier dynamics and hydrological characteristics (seeShreve, 1972, 1985a, 1985b).

Lateglacial and Holocene vegetation history

The main features of the vegetation succession at Loch Kinord are as follows (Vasari and Vasari, 1968; Vasari, 1970, 1977). Open vegetation (Zone I) dominated by *Rumex* is followed by more closed vegetation (Zone II) in which a succession from Rumex–Empetrum to Juniperus–Betula assemblages occurs. Climatic deterioration is then thought to be reflected in the dominance of *Juniperus* over *Betula* (latter part of Zone II), which, as it progressed, led to an impoverished flora (Zone III; Loch Lomond Stadial) with *Salix*, *Artemisia* and *Rumex* prominent, although tree birch remained present. A transitional zone (III – IV; Loch Lomond Stadial – early Holocene) shows successive maxima of *Empetrum*, *Juniperus* and *Betula*. Light birch forests then succeeded park tundra (Zone IV), followed by an expansion of *Corylus* (Zone V). In a marked change *Pinus* becomes the dominant tree pollen type in the latter part of Zone VI, and *Ulmus* appears for the first time. *Alnus* then increases in frequency (Zone VIIa) and *Ulmus* declines (Zone VIIb). From the latter part of Zone VI to Zone VIII, pine – birch – alder forest assemblages prevail.

Vasari (1977) obtained a date of 11,520 + 220 BP (HEL-418) for the Zone IIa/IIb boundary and speculated that the Zone I/II boundary might correlate with the Older Dryas/AllerØd chronozone boundary (11,950 – 11,800 BP). The Zone II/III boundary was dated at 10,640 + 260 BP (HEL-419), and although younger than the AllerØd/Younger Dryas chronozone boundary (11,000 BP), this date is comparable to dates from similar stratigraphic horizons at sites in Scotland and northern England (Vasari, 1977). The Zone III/Zone III – IV boundary was dated at 10,010 + 220 BP (HEL-420) and was placed at the rise of *Empetrum* at the start of the Holocene. A further date of 9,820 + 250 BP (HEL-421) was obtained for the Zone III – IV/Zone IV boundary between the early Holocene juniper and birch maxima.

The vegetation sequence described from Loch Kinord has been discussed in its wider regional context by Vasari and Vasari (1968), Vasari (1970, 1977), Gunson (1975) and O'Sullivan (1975). The Lateglacial pollen record at Loch Kinord broadly parallels that found elsewhere in north-east Scotland, although the colder phase interrupting the Lateglacial Interstadial at several other sites is absent at Loch Kinord. In north-east Scotland as a whole radiocarbon dates suggest that the climatic deterioration of the Loch Lomond Stadial started later than in central and western Scotland, whereas the stadial phase was of much shorter duration (Vasari, 1977).

The Holocene vegetation history recorded in the deposits at Loch Kinord was reconstructed by Vasari and Vasari (1968) using the Jessen–Godwin scheme of pollen zonation. In transition Zone III–IV, the pollen diagram shows successive peaks in *Empetrum* and *Juniperus*, and in Zone IV, in *Betula*, indictaing a development from open park-tundra to birch forest. In Zone V *Corylus* spread into the area and reached its maximum; *Quercus* and *Ulmus* also appear in the pollen spectra in this zone. During the earlier part of Zone VI, birch–hazel forest continued to predominate, but later *Pinus* became the dominant tree species. At the start of Zone VII, *Alnus* expanded, although pine, particularly, and birch continued to dominate the tree pollen. In Zone VIII, *Alnus* expanded further at the expense of birch and pine. Overall, the Holocene vegetation sequence at Loch Kinord shows greater affinity with that developed in upper Deeside and Strathspey (see Abernethy Forest) than with lowland Aberdeenshire, particularly in the expansion and subsequent predominance of pine in the middle Holocene (Vasari and Vasari, 1968; Gunson, 1975; O'Sullivan, 1975; Birks, 1977; Edwards, 1978). Evidence from nearby Loch Davan and Braeroddach Loch indicates human impact on the vegetation of the area starting around 5300 BP, followed by a series of clearance and regeneration episodes (Edwards, 1978, 1979b; Edwards and Rowntree, 1980).

Conclusions

Muir of Dinnet is noted for its assemblage of glacial meltwater landforms (notably meltwater channels and eskers). These were formerly interpreted in terms of a valley glacier readvance, but are now thought to relate to the pattern of deglaciation of the last ice-sheet (approximately 14,000–13,000 years ago). The landforms illustrate clearly how the glacial drainage system developed and, particularly, how it was increasingly influenced by the form of the underlying topography as ice wastage progressed. In addition to this geomorphological interest, the site is important for the pollen and larger plant remains preserved in the sediments of Loch Kinord. These record an almost complete sequence of the vegetation history and environmental changes in this area of north-east Scotland during the Lateglacial and the Holocene (approximately the last 13,000 years). Muir of Dinnet is therefore an important reference area for interpreting the patterns of landscape change both at the end of, and following, the last glaciation.

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