KIPPET HILLS

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Highlights

The landforms and deposits at Kippet Hills include an excellent assemblage of glaciofluvial features formed during the melting of the Late Devensian ice-sheet. They are also noted for their erratic content and shells of Early Pleistocene marine molluscs, derived from sources offshore. The locality provides important evidence for interpreting ice movements and the pattern of deglaciation in the coastal lowlands north of Aberdeen.

Introduction

The Kippet Hills (NK 030315) are located 7 km east of Ellon and comprise an esker ridge and an area (*c.* 10 km^2) of hummocky, ice-contact glaciofluvial deposits associated with the onshore movement of ice during the Late Devensian. Several kettle holes are present, including the impressive example now occupied by Meikle Loch. In addition, the deposits are noted for an assemblage of fossil shells similar to that of the Red Crag of East Anglia, believed to have been picked up from the floor of the North Sea and incorporated into the deposits by the ice. The locality has featured frequently in the literature on glacial studies in north-east Scotland, notably in the work of Jamieson (1858, 1860a, 1865, 1882a, 1906), and considerable attention has been focused on the origin of the deposits and the source of the shells (Wilson, 1886; Bell, 1895b, 1895c; Hull, 1895; Gregory, 1926; Simpson, 1955). The most recent work on the site is that of Gemmell (1975), Merritt (1981), Cambridge (1982) and Smith (1984).

Description

Extensive sand and gravel deposits in the Kippet Hills area form a striking assemblage of ice-contact glaciofluvial landforms (Gemmell, 1975; Merritt, 1981; Smith, 1984). These comprise a 3 km long esker ridge up to 15 m high (the Kippet Hills) and associated kames, kettle holes and terraces (Figure 8.9). The esker ridge continues northwards into an undulating, triangular-shaped feature (*c.* 0.3 km^2 in area), interpreted by Smith (1984) as a kettled delta. On the west side of the esker, the basin occupied by Meikle Loch forms a large kettle hole some 800 m long. Exposures in Whitefields Sand Pit (NK 032321) have revealed up to about 12 m of sands and gravels overlain by discontinuous red till (Gemmell, 1975; Merritt, 1981; Smith, 1984). Correlative shelly gravels and sands also occur at Bellscampie.

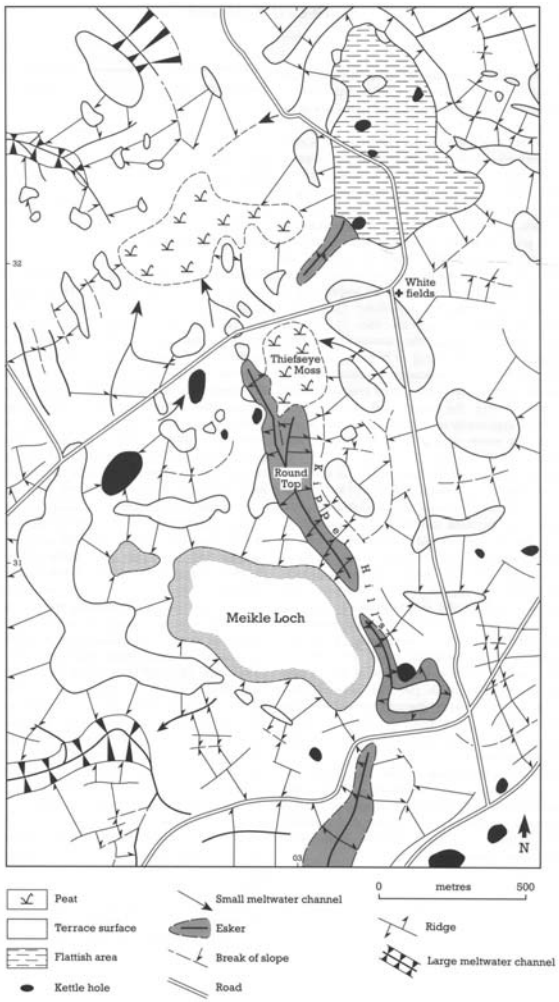

Figure 8.9: Geomorphology of the Kippet Hills (from Smith, 1984).

In a series of papers on the glaciation of north-east Scotland, Jamieson described the Kippet Hills deposits in some detail (Jamieson, 1858, 1860a, 1865, 1882a, 1906). He noted their sinuous, esker-like form and composition of local lithologies, together with significant amounts of red and grey sandstone, limestone and calcareous shale which he thought might be Jurassic or Permian. He identified a number of mollusc shells mixed through the gravels and an imprint of a fossil fish in a piece of limestone (Jamieson, 1858). He published species lists (Jamieson, 1860a, 1882a), noting the similarity of the assemblage to the Red Crag of Norfolk, although certain shells were anomalous. Jamieson also recorded that red clay with glacial characteristics was draped over the ridges and hollows, but there were apparently no traces of glacial deposits beneath the sands and gravels at Kippet Hills (Jamieson, 1858, 1865).

The most recent work has confirmed many of the previous observations. Merritt (1981) considered there to be a broad, threefold stratigraphic sequence in the area comprising a basal, dark clayey till, a widespread brown till, and a complex series of interbedded sands, gravels, clays and till. This last element in the sequence was found in the Kippet Hills. A borehole near the highest part of the esker revealed 3.6 m of red till overlying 21 m of well-sorted sand and gravel (Merritt, 1981), conforming with the stratigraphy at Whitefields Sand Pit. Merritt (1981) carried out a stone count of 10–14 mm gravel at the Whitefields pit. This showed that 41% of the clasts were ?Jurassic limestone and calcareous siltstone. Pebbles of yellow, shelly sandstone, possibly of Pliocene age were also found at this locality.

Cambridge (1982) was unable to confirm the shell identifications of Jamieson (1882a), but amino acid (D-alloisoleucine : L-isoleucine) ratios on *Arctica islandica* (L.) reported by Smith (1984) implied an Early to Middle Pleistocene age for those specimens:

Laboratory No.	Free	Ratio Total
BAL-90A	1.097	0.537
BAL-90B	1.084	0.586

Interpretation

From his observations, Jamieson (1858, 1865) at first concluded that the Kippet Hills were *in situ* Crag deposits of marine origin formed during the late Tertiary, and were part of the same sequence of sand and gravel beds exposed in coastal sections at Collieston. Later he argued that in contrast to the latter, which were undisturbed, the Kippet Hills had been ploughed up by land ice into their present topographic form (Jamieson, 1865). However, in the course of further work Jamieson (1882a) noted grey till with local erratics underneath the deposits at Collieston and recognized that both they and the Kippet Hills sands and gravels were glacigenic deposits.

Jamieson (1906) observed that the red clay occurred both above and below the sand and gravel mounds in the Kippet Hills area, concluding that both were part of the same series of red deposits characteristic of the Aberdeenshire coast (Jamieson, 1882b). The latter he associated with his "Second Glaciation', during which local ice from the west gave way to ice moving north along the coast from Strathmore. Originally he speculated about a local source in the Ythan estuary for the shell beds (Jamieson, 1882a), but later believed the material to have been transported to the Scottish coast by Scandinavian ice then entrained by the Strathmore ice (Jamieson, 1906). The red clay was then deposited during the wastage of the Strathmore ice in a glaciolacustrine or marine environment. It is a feature of Jamieson's work that although he recognized the glacial derivation of the red deposits and in places their boulder clay composition, he did not satisfactorily distinguish the till lithologies from the water-laid lithologies and therefore interpreted the whole succession in terms of the latter.

In the Geological Survey Memoir accompanying Sheet 87, Wilson (1886) recognized the same sequence of deposits as Jamieson, but reversed the interpretation: the Kippet Hills and Collieston gravels were interglacial marine beds, equivalent to those supposedly at Clava and King Edward, and the overlying red clays were a true glacial deposit. Bell (1895b) reviewed the respective interpretations of Jamieson and Wilson and concluded that both the shelly gravels and the till were in fact glacial in origin. Hull (1895) disagreed with Bell's interpretation, invoking submergence to explain both the sands and gravels and the clays. Bell (1895c), however, effectively rebutted Hull's arguments.

Bremner did not discuss the Kippet Hills in detail in his interpretation of the glacial sequence in Aberdeenshire. However, as part of his "Second Glaciation' (Bremner, 1934a, 1938), he envisaged, first, deposition of basal grey till by local ice, second, deposition of the sands and gravels with bands of red clay in advance of Strathmore ice encroaching onshore, and third, deposition of the red clay as the latter ice decayed (Bremner, 1916b).

Gregory (1926) described the Kippet Hills as a "pseudokame' or residual ridge following denudation, by unspecified processes, of a sheet of glaciofluvial drift. He also mentioned raised beach deposits in the upper part of one exposure, but these have not been recorded by other authors.

Simpson (1955) interpreted the Kippet Hills as part of a suite of glaciofluvial landforms extending from south of Nigg Bay (see below) northwards along the Aberdeenshire coast and deposited by the last ice-sheet. The content of shells and erratics in the sediments suggested that the ice had crossed the sea floor. Subsequent detailed studies on the mineralogy of the deposits in the area support this hypothesis (Glentworth *et al.*, 1964). Further evidence for ice moving onshore in north-east Scotland is provided by the presence of Upper Cretaceous

erratics in the Belhelvie area (Gibb, 1905; Hill, 1915). Smith (1984) studied the morphology of the Kippet Hills, concluding that they were deposited by a subglacial stream where it emerged from the decaying ice into a standing body of water; the red clay was then deposited by glaciolacustrine sedimentation. A similar explanation was invoked for deposits at Strabathie to the south of the Kippet Hills by Thomas (1984).

The abundant occurrence of late Tertiary to Early Pleistocene erratics in a limited area around the Kippet Hills led Sutherland (1984a) to suggest that deposits of that age were likely to occur *in situ* in the immediate vicinity. Hall and Connell (1991) have suggested derivation of the shells from the Early to Middle Pleistocene Aberdeen Ground Formation, which occurs offshore (Stoker *et al.*, 1985).

Kippet Hills is important both for glacial landforms and stratigraphy. Although much of the interest in the site has centred on the sediments, Kippet Hills does provide a particularly fine assemblage of ice-contact glaciofluvial landforms. These form part of the Red "Series' deposits in north-east Scotland (see Hall, 1984b), associated with ice moving northwards along the North Sea coast and also inland during the Late Devensian. They are important in contributing to the geomorphological and sedimentological evidence for interpreting the pattern of glaciation and deglaciation of the area during the Late Devensian. In particular, it appears from the evidence at Kippet Hills and other sites (see Hall, 1984b) that the inland ice had receded at the time of expansion and wastage of the coastal ice (Hall, 1984b) and that ice-marginal lakes were present (see Bremner, 1916b; Murdoch, 1977; Merritt, 1981; Hall, 1984b; Thomas, 1984; Thomas and Connell, 1985). Kippet Hills is also notable for an assemblage of fossil shells unique in Scotland that were derived from the floor of the North Sea in the immediate vicinity and reworked into glaciofluvial deposits as ice moved onshore during the last glaciation.

Conclusions

Kippet Hills is important for a series of glacial meltwater landforms and deposits formed by the last (Late Devensian) ice-sheet (approximately 17,000–16,000 years ago). These include an esker ridge, kames, terraces and kettle holes. The deposits have a long history of research and have featured in most studies of the glaciation of north-east Scotland. In addition to their geomorphological interest, the deposits at Kippet Hills are noted for their content of fossil molluscan shells and erratic material (boulders of rock types not occurring locally) derived apparently from the sea floor and carried onshore by the ice. The landforms and deposits at Kippet Hills contribute significant evidence for interpreting the pattern of glaciation and deglaciation in this part of Scotland.

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