Barnyards

C.R. Firth

Highlights

The sub-surface deposits at Barnyards include a sequence of estuarine sediments and peat. These provide a detailed record, supported by radiocarbon dating, of the changes in relative sea level that occurred in the Beauly Firth area during the Lateglacial and Holocene.

Introduction

The Barnyards site [NH 531 470] is an area of carseland (flat, low-lying area of silty clay deposits of estuarine origin) located 0.5 km north of Beauly. The Beauly Firth area provides important evidence for reconstructing Lateglacial and Holocene sea-level changes in northern Scotland. Until recently the Beauly carse deposits have received little detailed study. Early researchers, such as Horne and Hinxman (1914), Ogilvie (1923) and J.S. Smith (1968), noted only that Holocene raised beaches at '25 ft' and '15 ft' were present, and they made no detailed assessment of the carse deposits. In contrast, recent studies by Sissons (1981c), Haggart (1982, 1986, 1987), Firth (1984, 1989a) and Firth and Haggart (1989) have indicated that evidence of relative sea-level changes which date back to the Loch Lomond Stadial is present within the area. From stratigraphical and morphological studies these authors have identified seven former marine levels, two of which lie buried beneath later deposits. Barnyards is a key locality for interpreting the stratigraphic evidence.

Description

Horne and Hinxman (1914) first identified raised marine deposits in the Beauly area. They reported that the village of Beauly stands on a 'wide tract of marine alluvium, with a mean level of about 25 ft'. Ogilvie (1923) also recognized a '25 ft' raised beach in the Beauly carselands and he suggested that a lower '15 ft' beach was present. These views were reiterated by J. S. Smith (1968), who suggested that the carse deposits were Holocene in age. He also noted the presence of a degraded cliff landward of the carse and he considered that this erosional feature was also of Holocene age.

Eyles and Anderson (1946) provided brief details of the deposits in the Barnyards area, recording 3.4 m of carse clay overlying 0.3 m of peat. More detailed investigations of the stratigraphy of the Beauly Firth carselands have been undertaken subsequently by Sissons (1981c), Haggart (1982, 1986, 1987), Firth (1984) and Firth and Haggart (1989). Sissons (1981c) confined his investigations to the carselands south of the Beauly River and in the basin of Moniack Burn. He noted that the clay–silt carse deposits are underlain by an extensive gravel layer. Sissons (1981c) indicated that the gravel layer rises landward from below –1 m OD to a maximum altitude of 2 m OD. He noted that it rests on Lateglacial marine sediments and that it terminates landward near the base of the degraded cliff that backs the carselands. Between the cliff and the buried gravel layer he identified a steeply sloping surface of erosion, which rises to 6–6.5 m OD at the base of the cliff. Sissons (1981c) concluded that these buried features were marine in origin.

Similar stratigraphical investigations were conducted by Firth (1984) on the carselands north of the Beauly River (Figure 7.20). Firth (1984) also identified a buried gravel layer rising to near 2 m OD (for example, south-east of Windhill, (Figure 7.20)) and a steeply sloping erosion surface which terminated at the base of a degraded cliff, at an altitude of about 8 m OD. Firth (1984) also suggested that these features were marine.

Haggart (1982, 1986, 1987) undertook stratigraphical investigations of the carselands between Wellhouse and Barnyards ((Figure 7.20), AB). In this area he identified a sequence of marine and terrestrial deposits (Figure 7.21). At the base of the sequence till is overlain by light-grey, silty clay. The latter is truncated by a layer of silt, sand and gravel, which is succeeded by grey, clayey silt rising to an altitude of 7.6 m OD. This layer is overlain by peat, the base of which has been dated to 9610 ± 130 BP (Birm–1123). Haggart (1986) has interpreted this clayey silt/peat contact as a regressive overlap caused by a fall in relative sea level. An additional radiocarbon date from a buried peat layer farther seaward indicates that relative sea level was still falling after 9200 BP. Lying above the peat in the sequence is a grey, marine silty clay (carse deposits), which rises to a maximum altitude of 9.5 m OD. This in turn is overlain by another peat whose base has been dated to 5510 ± 80 BP (Birm–1122) (Haggart, 1982, 1986). Haggart (1982) also identified a light-grey, micaceous silty sand within the carse deposits. He noted that this sand layer rises to a maximum altitude of 9.3 m OD and is marine in origin. A similar deposit at Moniack, 4 km to the south-east, was dated to 7270 ± 90 BP (Birm–1126) (Haggart, 1982). A similar sequence of marine and terrestrial deposits was identified by Firth (1984) in the carseland north of Barnyards.

The surface morphology of the Beauly carse-lands has been mapped in detail by Firth (1984). He noted that the degraded cliff truncates Lateglacial marine deposits and extends as far west as Windhill (Figure 7.20). Directly south of Windhill, a broad sand ridge with a maximum altitude of 10.3 m OD has been identified (Haggart, 1982; Firth, 1984). Both Haggart (1982) and Firth (1984) have interpreted this ridge as a Holocene sand spit. Firth (1984) has also indicated that five separate terrace levels are present in the carselands. The highest level at 9.0–9.8 m OD occurs west of the sand ridge (Figure 7.20). Lower levels are present at 7.5–6.6 m, 5.8–5.9 m, 4.8–5.0 m and 3.1 m OD, each lower level extending farther east. On the slopes west of the carselands Firth (1984) identified a series of Lateglacial marine terraces at 19.6 m, 18.7 m, 13.4–13.0 m, and 11.5 m OD (Figure 7.20); to the north of the carselands a kettled outwash surface grades into a Lateglacial shoreline fragment at 27 m OD.

Interpretation

The stratigraphical and morphological investigations of the carse deposits in the Beauly area provide a detailed sequence of Late Quaternary relative sea-level movements for northern Scotland. It is agreed by all authors that the carse deposits are of Holocene age, a fact reinforced by the palaeoenvironmental evidence presented by Haggart (1982, 1986). In contrast, some debate exists over the age of the degraded cliffline. The early researchers (Horne and Hinxman, 1914; Ogilvie, 1923; J. S. Smith, 1968) proposed that the cliff was Holocene in age, being formed at the culmination of the Main Postglacial Transgression. In contrast, Sissons (1981c) and Firth (1984) suggested that the cliff was formed in association with the buried gravel layer and was a Lateglacial feature. This view was advanced for three reasons. First, the cliff, the steeply sloping surface of marine erosion and the buried gravel layer are continuous. Second, the cliff is partly buried by a variety of Holocene deposits. Third, the deposition of the Holocene silty clays (carse deposits) could not have occurred at the same time as the erosion that produced the cliff.

Sissons (1981c) and Firth (1984) concluded that the buried gravel layer was formed by marine erosion during a slow transgression that occurred during the Loch Lomond Stadial. Both authors correlated the inner margin of the buried gravel layer at about 2 m OD with the Main Lateglacial Shoreline identified in the Forth estuary (Sissons, 1969, 1976a). Sissons (1981c) suggested that the marine transgression must have continued at a faster rate in order to produce the marine erosion surface which separates the buried gravel layer from the degraded cliff. This transgressive event culminated at 7–8 m OD. Similar steeply sloping surfaces of marine erosion have been identified in the Forth estuary (Sissons, 1976a).

Haggart (1982, 1986) suggested that relative sea level then fell at the beginning of the Holocene, with marine-estuarine, grey, clayey silt being deposited in the Barnyards area up to an altitude of 7.6 m OD until about 9600 BP. Haggart (1986) proposed that these buried marine deposits were equivalent to the Main Buried Beach identified in the Forth and Tay estuaries (see Western Forth Valley and Carey) (Sissons, 1966; Cullingford *et al.,* 1980).

Haggart (1982, 1986) presented evidence that relative sea level continued to fall during the early Holocene, until around 8800 BP, when a major transgression started, during which the marine, grey silty clay was deposited. Interruption of the deposition of the silty clays occurred around 7200 BP (Haggart, 1982, 1986, 1987, 1988b) with the formation of a grey, micaceous, silty fine sand layer. This deposit was thought to represent either a period of increased marine transgression or a storm surge event (Haggart, 1982, 1986, 1987, 1988b). It has been correlated with similar deposits identified throughout eastern Scotland (see Silver Moss and Maryton) (Smith *et al.,* 1985a; Dawson *et al.,* 1990), and is now ascribed to a tsunami associated with the second Storegga Slide on the Norwegian continental slope (Dawson *et* a*l*., 1988; Long *et al.*, 1989a).

The transgressive event which deposited the carse silty clays culminated at about 6500 BP with the formation of the highest Holocene shoreline fragment in the area, at 9.5 m OD (Haggart, 1982; Firth, 1984; Firth and Haggart, 1989). Firth (1984) correlated this shoreline fragment with the Main Postglacial Shoreline, which has been identified throughout eastern Scotland (Sissons and Smith, 1965b; D.E. Smith, 1968; Morrison *et al.,* 1981). Relative sea level then fell to its present level via intermediate shorelines at 7.5 m, 5.9 m, 4.9 m and 3.1 m OD. These shoreline fragments formed the basis of the Holocene shorelines diagram produced by Firth (1984) and Firth and Haggart (1989), which incorporated six tilted shorelines declining in altitude towards N20°E.

The sequence of deposits at Beauly represents a key stratigraphic record of Late Quaternary environmental and geomorphological changes in northern Scotland. In this respect it complements the interest at Munlochy Valley, where the evidence is principally morphological. It demonstrates that a slow transgression during the Loch Lomond Stadial culminated in the formation of the Main Lateglacial Shoreline, and illustrates the subsequent rapid transgression that formed the marine erosion surface. The area also reveals the early Holocene regression, during which the Main Buried Beach was formed. Similarly the area records the Holocene transgression that culminated in the formation of the Main Postglacial Shoreline, as well as a possible storm surge deposit dated to 7200 BP. The four, lower, Holocene shorelines demonstrate interruptions in the subsequent fall of relative sea level to its present level.

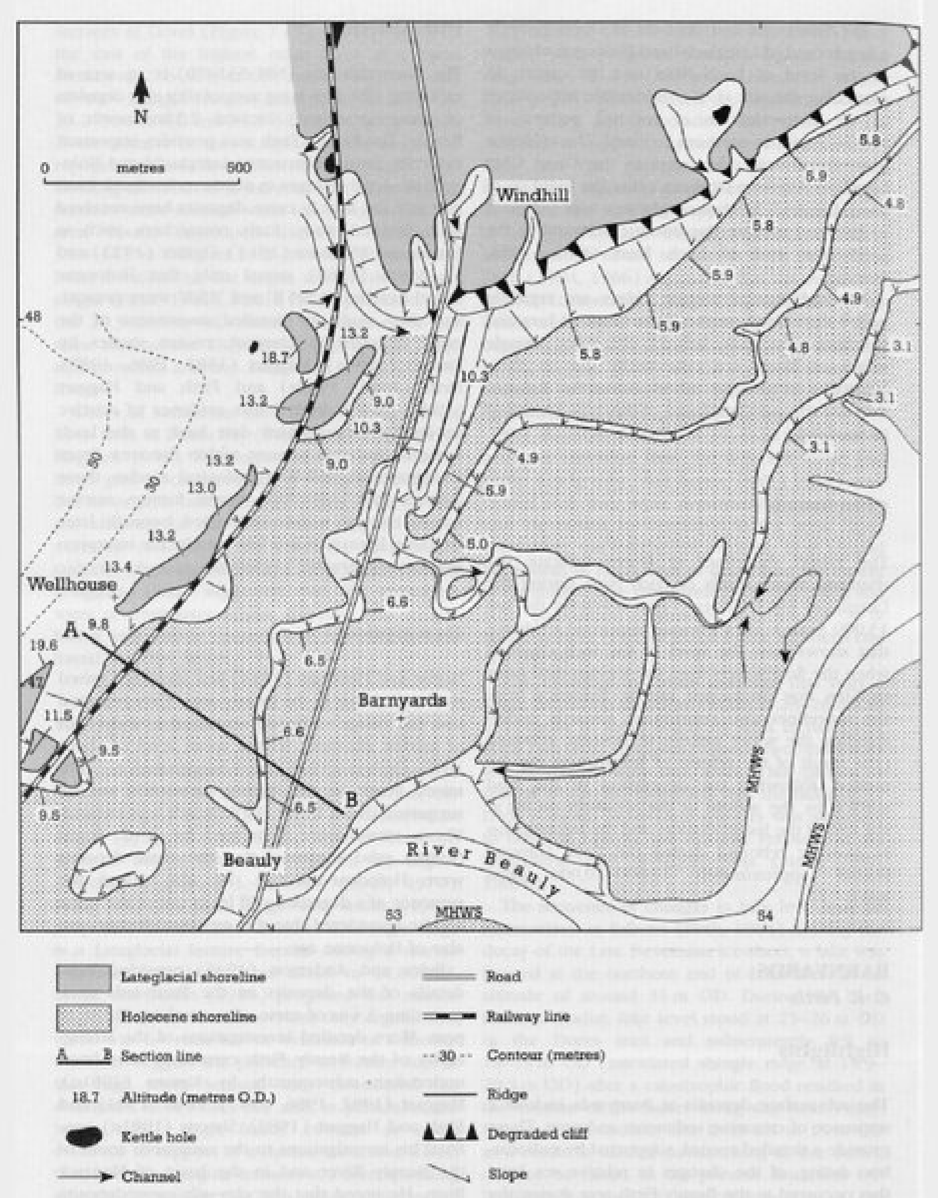
Similar changes in relative sea level have been identified in other areas of Scotland, namely the Forth and Tay estuaries (Morrison *et* al., 1981) and more recently at Creich in the Dornoch Firth (Smith *et al,* 1991b). However, the Beauly carse deposits are important because they contain a wealth of stratigraphical and morphological evidence within such a limited area. Haggart (unpublished data) has suggested that further stratigraphi-cal investigations may identify an equivalent to the Lower Buried Beach of the Forth Valley (Sissons, 1966).

The area is an integral member of a national network of Quaternary sites which illustrate the changes in relative sea level in Scotland (see Silver Moss, Western Forth Valley, Carey, Dryleys, Maryton and Philorth Valley). The area also provides details which are important in the determination of regional and national patterns of isostatic movements in the British Isles (Haggart, 1989; Shennan, 1989). For example, Firth and Haggart (1989) noted apparent shifts in the isobases of different shorelines, implying, if confirmed, shifts in the centre of isostatic uplift between the formation of different shorelines (see also Gray, 1983, 1985). Furthermore, the gradients of shorelines in the Moray Firth area are steeper than expected from existing isobase maps (Sissons, 1967a, 1983a; Jardine, 1982) suggesting that the pattern of isostatic uplift in Scotland may not be represented by a simple ellipsoid (Firth and Haggart, 1989). In addition, the complexity of isostatic uplift is attested from comparison of sea-level curves from the Western Forth Valley, Lower Strathearn, the eastern Solway Firth and the inner Moray Firth, which suggests apparent differences in relative rates of uplift between the different areas (Haggart, 1989).

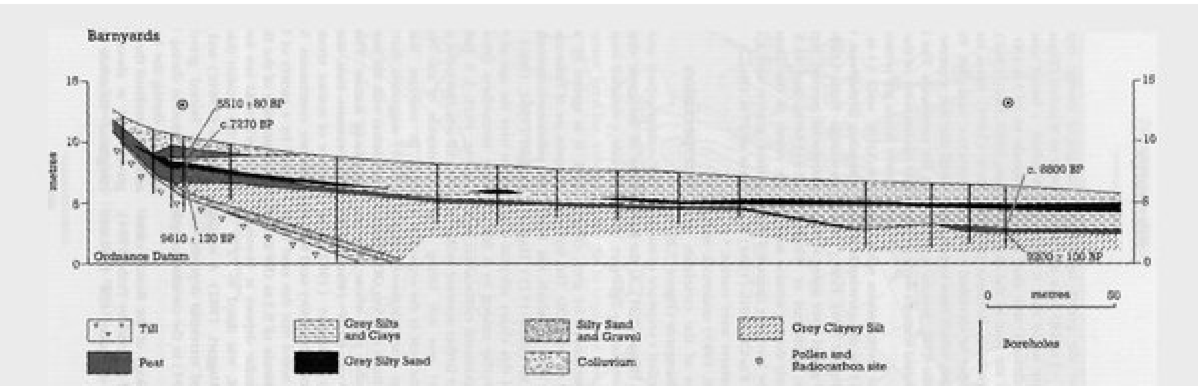
Conclusion

The sediments at Barnyards contain a detailed record of relative sea-level changes in the Beauly Firth area during the Lateglacial and Holocene (approximately the last 13,000 years). The record shows several significant fluctuations in relative sea-level position, providing valuable comparisons with the changes that are documented at reference sites elsewhere in Scotland. Together, the records from these sites allow the wider patterns of isostatic movements (movements of the Earth's crust triggered by ice-sheet growth and loading, and melting and unloading) and sea-level changes to be established.

References



(Figure 7.20) Geomorphology of the Beauty carselands (from Firth, 1984).



(Figure 7.21) Section through the Beauly carselands at Barnyards showing the sequence of Late Devensian and Holocene deposits (frem Haggert 1986)