Chapter 17 Lothians and Borders

Introduction

D.G. Sutherland

This area includes the lowlands of the Lothians along the southern shore of the Firth of Forth and the coastal area south to Berwick (Figure 17.1). Inland it extends west to the A74 across the Southern Uplands and south to the Tweed Valley. The area of highest ground, rising to 840 m OD at Broad Law, lies between Peebles and Moffat, and other hill groups (Lammermuir Hills, Moorfoot Hills) have summits up to 500–700 m OD. The Lothians area was one of the key areas in Scotland for the elaboration of many of the concepts related to ice-sheet glaciation and glacial sediments and landforms. In this area many of the early observations on both large- and small-scale features of ice moulding were made and the relationships between clast orientation, striations on rock surfaces and ice-flow direction were noted.

The earliest interpretation of striations in the region as being the product of ice flow was that of Agassiz (1841b) for a rock surface on Blackford Hill, which is today commemorated by a plaque at Agassiz Rock. Although the concept of multiple glaciation was also advanced at an early stage in this area (Croll, 1870b; J. Geikie, 1877, 1894) and sequences containing distinct glacial sedimentary units were described (see below), all the presently known glacial deposits are now attributed to the advance and retreat of the last ice-sheet and the subsequent Loch Lomond Readvance. However, marine erosional features are known that pre-date at least the last glaciation and these are well displayed at Dunbar. There, an ice-moulded high rock platform occurs at approximately 23 m OD (Sissons, 1967a), and a platform at about present sea level can also be seen to pass under glacial sediments along the East Lothian coast.

The earliest phase of the last glaciation was an advance into the Lothians and northern Southern Uplands by ice originating in the south-west Highlands. This ice deposited a basal till, with a characteristic erratic assemblage, found widely in the Midlothian basin (Kirby, 1968) as well as across the Moorfoot Hills (Aitken *et al.,* 1984). The direction of movement was generally from west to east in the north-west of the region, with a south-easterly component near the east coast. Subsequently, Southern Uplands ice expanded to exclude the Highland ice from virtually the whole of the region, with the exception of the coastal fringe of the Firth of Forth. As elsewhere along the southern Central Lowlands (Chapter 16) this second phase of glaciation resulted in the deposition of a till containing Southern Uplands erratics on top of the earlier till (see Hewan Bank and Keith Water). In the Lothians this ice moved in a north-easterly direction carrying erratics of Tinto Hill felsite to the outskirts of Edinburgh and the Midlothian basin (McCall and Goodlet, 1952; Mitchell and Mykura, 1962). In the Borders area the only evidence of glaciation is that of Southern Uplands ice which flowed down the Tweed Valley, the direction of flow being demonstrated by transport of erratics (Kerr, 1978) and by a major drumlin field (Sissons, 1976b). This ice was dominantly nurtured in the hills of the eastern Southern Uplands, but a small ice-cap may have developed on the Cheviot Hills (Clapperton, 1970).

The retreat phase of the ice-sheet resulted in the production of spectacular sequences of meltwater channels and glaciofluvial sediments. These are best developed and have been most intensively studied in the Lothians and northern hills of the Southern Uplands (Sissons, 1958a, 1958b, 1960, 1961a, 1963b; Price, 1960, 1963a; Kirby, 1969c; McAdam and Tulloch, 1985; Davies *et al.,* 1986). Particularly outstanding meltwater channels occur along the northern face of the Lammermuir and Moorfoot Hills, as at Rammer Cleugh and by Carlops in the Midlothian basin. These channels were formed as the Southern Uplands ice retreated towards the south-west. In the area between the retreating Southern Uplands ice and the Highlands ice, which still occupied the Firth of Forth, a sequence of outwash terraces was deposited (Kirby, 1969c). A third till unit (the Roslin Till) in the Midlothian basin was interpreted by Kirby (1968, 1969b) as having been deposited on top of these outwash gravels during a readvance of the Highland ' ice, but Martin (1981) disputed this interpretation. Instead, he suggested that the Roslin Till was not a single lodgement till but the result of deposition of debris flows during the general deglaciation sequence.

Few details are available on shorelines formed during ice retreat and it is not known whether there are shorelines that correlate with those identified in eastern Fife by Cullingford and Smith (1966) (Chapter 15). However, the proximity of the

two areas suggests that deglaciation of the East Lothian coastline probably occurred at some time between 17,000 and 14,000 BP. The marine limit, formed at the time of deglaciation, rises westwards along the coast from around 14 m OD (Sissons *et al.,* 1966) or 22 m OD (Davies *et al.,* 1986) near Dunbar to over 34 m west of Edinburgh and up to 38 m at Stirling (Sissons *et al.,* 1966). Deglaciation of the coast west of Edinburgh probably occurred between 14,000 and 13,000 BP, and a particularly pronounced shoreline was formed when the ice-front was in the Stirling/Larbert area. This shoreline, termed the Main Perth Shoreline (Sissons and Smith, 1965a), slopes towards the south-east at a gradient of about 0.43 m km" (Smith *et al.,* 1969), declining in altitude to about 5 m OD near Dunbar. As the ice retreated up the Firth of Forth, poorly-sorted glaciomarine deposits were laid down close to the ice-front (Sissons and Rhind, 1970); these were succeeded at greater distance from the ice by laminated silts and clays containing a restricted arctic marine fauna (Browne *et al.,* 1984).

A number of sites have been investigated that provide information on the evolution of the vegetation during the Lateglacial (Newey, 1965a, 1970; Mannion, 1978a; Webb and Moore, 1982; Alexander, 1985). Particularly interesting among these sites is Beanrig Moss (Webb and Moore, 1982) because of its detailed macrofossil record. The earliest vegetational communities following deglaciation were of pioneer plants. No radiocarbon dates are available from the earliest phase of vegetational development, although it is reasonable to infer that some areas were deglaciated well before the opening of the Lateglacial Inter-stadial (at around 13,000 BP). It was probably at this time of cold climate that the fossil ice-wedge polygons identified in Berwickshire (Greig, 1981) were formed.

During the interstadial itself a mosaic of different vegetational communities developed, Webb and Moore (1982) identifying juniper scrub with sparse tree birches, well-drained grasslands, damp, tall-herb meadows, dwarf-shrub heaths and open-ground communities as the principal elements. As elsewhere in Scotland, certain sites suggest a single uninterrupted phase of vegetational development during the inter-stadial, whereas others show a period of vegetational 'revertence' during the first half of the interstadial, (Alexander, 1985). This is typically reflected in a reduction in the proportion of woody plants, as represented in the pollen record. No radiocarbon dates closely bracket this brief phase and its status remains uncertain.

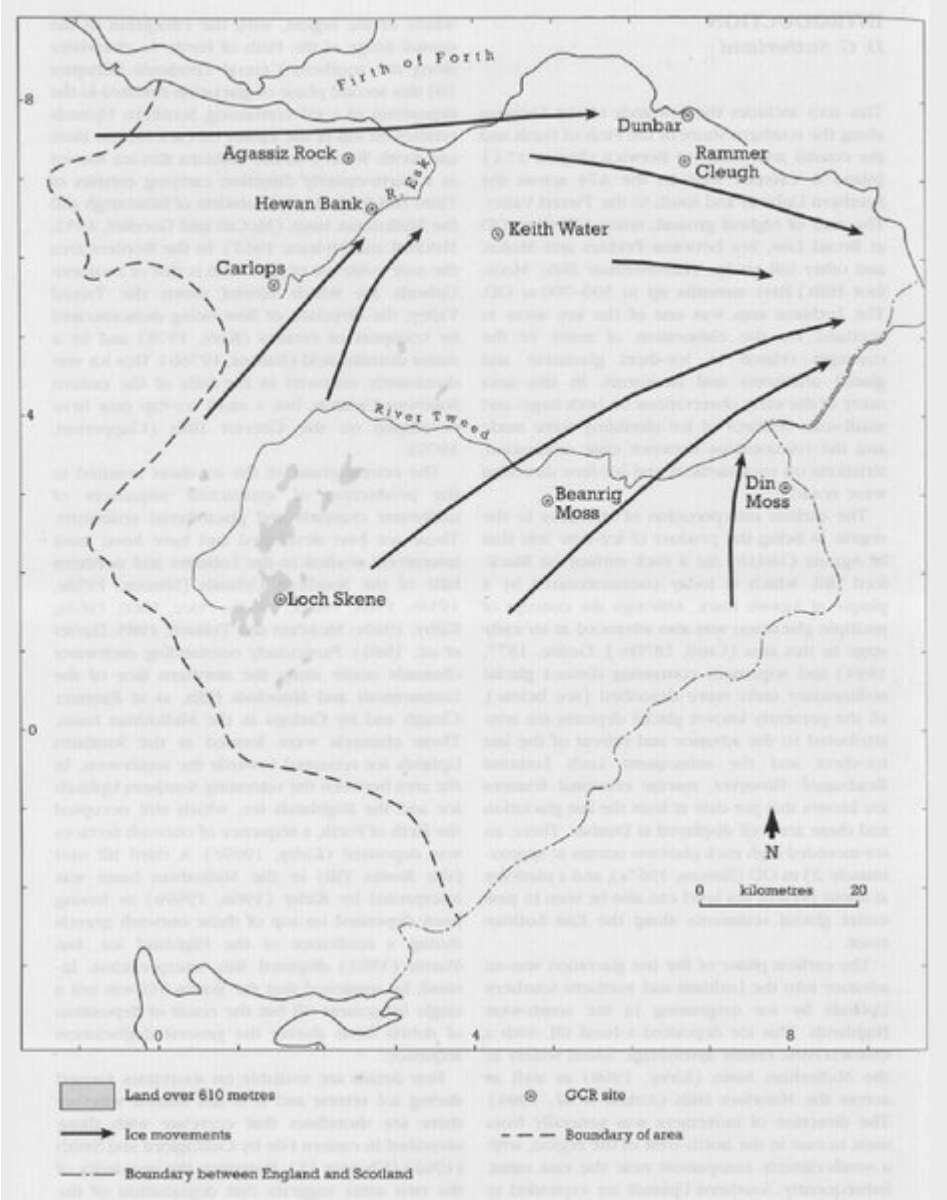
The Loch Lomond Stadial is registered unequivocally across the region as a period of severe climate during which small valley and corrie glaciers developed in the higher hills of the Southern Uplands, as around Loch Skene. The vegetation was composed of bare-ground communities, even at low altitudes, and a subdivision of the stadial sediments can be made into an early phase with relatively low values of *Artemisia* pollen and a later phase with much increased values of *Artemisia.* This may reflect an earlier more moist and a later drier climate. A similar inference may be drawn from an assemblage of fossil beetles from Corstorphine in Edinburgh (Coope, 1968). Along the coast marine erosion was apparently particularly effective during the stadial and a pronounced erosional surface and accompanying shoreline, the Main Lateglacial Shoreline, was produced (Sissons, 1969, 1976a; Browne *et al.,* 1984; Browne, 1987). This shoreline is isostatically tilted at approximately 0.17 m km' towards the south-east, descending from close to present sea level near Grangemouth to well below it along the Berwickshire coast (Eden *et al.,* 1969; Sissons, 1976a), and rivers such as the Tweed (Rhind, 1972) may have eroded deep valleys in their lower reaches at this period. Fluvial and slope activity were also enhanced inland, as is indicated by the contemporaneous deposition of a large alluvial fan in the former Corstorphine Loch (Bennie, 1894; Tait, 1934; Newey, 1970), and solifluction deposits in the former Holyrood Loch (Sissons, 1967a, 1971).

The early Holocene witnessed a rapid progression of vegetational communities from a period of juniper scrub dominance at around 10,000 BP through a period of birch and hazel woodland to the development of mixed deciduous forest of mainly oak and birch throughout most of the region by 8500 BP. A detailed and well-dated record of these changes is available from Din Moss (Hibbert and Switsur, 1976). Just before 5000 BP a reduction in elm pollen marks the start of human interference, with the eventual expansion of heath, grassland and bog communities as the forest was cleared. A trend in climate to more moist and cooler conditions over the same period may also have contributed to this change in the vegetation. A detailed record of Holocene environmental changes based on pollen and diatoms is also available from Linton Loch (Mannion, 1978a, 1978b, 1978c, 1978d, 1981a, 1981b, 1982).

Sea level was relatively low during the early Holocene but marine transgression was under way by about 7500 BP (Robinson, 1982). The transgression culminated in the formation of the Main Postglacial Shoreline some time between

the above date and 5500 BP, at which time extensive shell beds were deposited along part of the East Lothian coast (Smith, 1971; McAdam and Tulloch, 1985). After the formation of the Main Postglacial Shoreline a series of lower shorelines was formed. These have not been accurately dated.

References



(Figure 17.1) Location map of the Lothians and Borders area.