Chapter 15 Fife and lower Tay

Introduction

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This area includes the peninsula of Fife between the Firth of Tay and Firth of Forth, the lower Tay valley and Strathearn (Figure 15.1). The low-lying coastal areas and the lower parts of the valleys contain extensive accumulations of Late-glacial and Holocene marine deposits, the investigation of which has been the principal research theme in this area. The Fife and lower Tay area contains evidence for only one period of glaciation, that of the Late Devensian ice-sheet. It can reasonably be inferred, however, that the area was glaciated on more than one occasion and that the ice-moulded nature of most of the hills is the cumulative result of successive glaciations rather than solely the product of the last ice-sheet. Good evidence for glaciation of this region during the early Middle Pleistocene has been provided from the immediate offshore zone by Stoker and Bent (1985), and subsequent ice-sheet glaciation on at least three occasions may be inferred from evidence in neighbouring regions (Bowen *et al.,* 1986). The only feature that is known from the region to pre-date the last ice-sheet is the rock platform at, or close to, present sea level which can be followed around much of the coast of eastern Fife. This platform and its associated cliffline are overlain in places by glacial deposits and they have been presumed to be interglacial in origin (Sissons, 1967a).

Ice-moulded landforms and striated rock surfaces indicate that during the last ice-sheet glaciation, ice from the western Highlands moved into the region from the north-west (Geikie, 1900, 1902; Forsyth and Chisholm, 1977; Armstrong *et al.,* 1985). As the glaciation proceeded, the western part of the region continued to be affected by ice flowing from that direction, but to the east there was latterly a change to an easterly or even north-easterly movement. The transport of erratics and the general colour and composition of the till are in accord with these ice movements.

The most notable glacial deposits and landforms were produced during the period of ice-sheet retreat when extensive areas of sand and gravel were laid down and there was a widespread marine invasion of the lower ground around the coasts. Major accumulations of glaciofluvial sediments were deposited in the Wormit Gap, the northern Howe of Fife, near Barry in Angus and west of Loch Leven, these being areas that were topographically suitable for the isolation of 'dead'-ice masses and the concentration of meltwater drainage (Rice, 1961, 1962; Chisholm, 1966; Cullingford, 1972; Browne, 1977; Paterson, 1977; Armstrong *et al*., 1975, 1985).

Certain of these areas of 'dead' ice terminated in the sea which during deglaciation attained altitudes of between 30 m and 40 m OD around the coasts. The marine deposits from this period are typically red, laminated clays, the Errol beds (see Inchcoonans and Gallowflat) that contain a high-arctic faunal assemblage (Brown, 1867; Geikie, 1902; Davidson, 1932; Peacock, 1975c; Paterson *et al.*, 1981).These are found around all the coasts of the region and also within the Howe of Fife into which the sea penetrated at the time of deglaciation. The surface morphology of the marine sediments consists of a series of distinct terraces, which have been mapped and levelled by Cullingford (1972, 1977), Cullingford and Smith (1966, 1980) and Sissons and Smith (1965a). These studies have demonstrated that a succession of easterly sloping shorelines was formed progressively as the ice retreated to the west, each shoreline having a lower gradient than its predecessor. The 'staircase' of shorelines around Kincraig Point (Geikie, 1902; Smith, 1965) probably formed at this time.

The shoreline sequence and the associated marine and estuarine clays are as yet undated. However, the progressive change in gradient of the shorelines (a consequence of isostatic uplift) allows approximate ages to be extrapolated from the known ages of younger and lower-gradient shorelines (Andrews and Dugdale, 1970). Such a calculation suggests that eastern Fife was deglaciated prior to 15,500 BP and the remainder of the region became ice-free during the ensuing 2000 years (Sutherland, 1991a).

Only a limited number of sites (as at Creich Castle (Cundill and Whittington, 1983) and Black Loch (Whittington *et al.,* 1991a) have been investigated for Lateglacial pollen in order to provide evidence of terrestrial environmental change

following deglaciation. The marine record makes it clear that deglaciation occurred when the climate was still very cold, but no pollen evidence has been reported which accords with such conditions. This implies that either the sites investigated to date were locations of 'dead'-ice masses that did not melt until the climate ameliorated or that there was insufficient vegetation to provide enough identifiable contemporaneous pollen, given the apparently high background of derived or long-distance transported pollen grains (Cundill and Whittington, 1983).

During the Lateglacial Interstadial an open grass–herb vegetation was dominant, with a lower representation of woody taxa, such as birch, than in the neighbouring regions.

Sea level fell during the early part of the interstadial, and throughout the region in the latter part of the Lateglacial it was below the level subsequently attained during the Holocene. There has been some disagreement as to the exact course of sea-level change during the Lateglacial and, in particular, over the age of a widespread marine erosional episode, evidence for which is found at or below present sea level (Sissons and Rhind, 1970; Browne and Jarvis, 1983). Sissons (1969, 1974d, 1976a) first identified this period of Lateglacial marine erosion (the landward margin of which he termed the Main Lateglacial Shoreline) on the southern side of the Forth valley and Firth of Forth, and Cullingford (1972) suggested correlation with gravel horizons in the Tay and Earn valleys. It was argued by Sissons (1974d, 1976a) that the erosion of this feature occurred during the latter part of the Lateglacial and was promoted by the severe climate of this period. The Main Lateglacial Shoreline is tilted to the south-east at a gradient of 0.17 m km^{-1}.

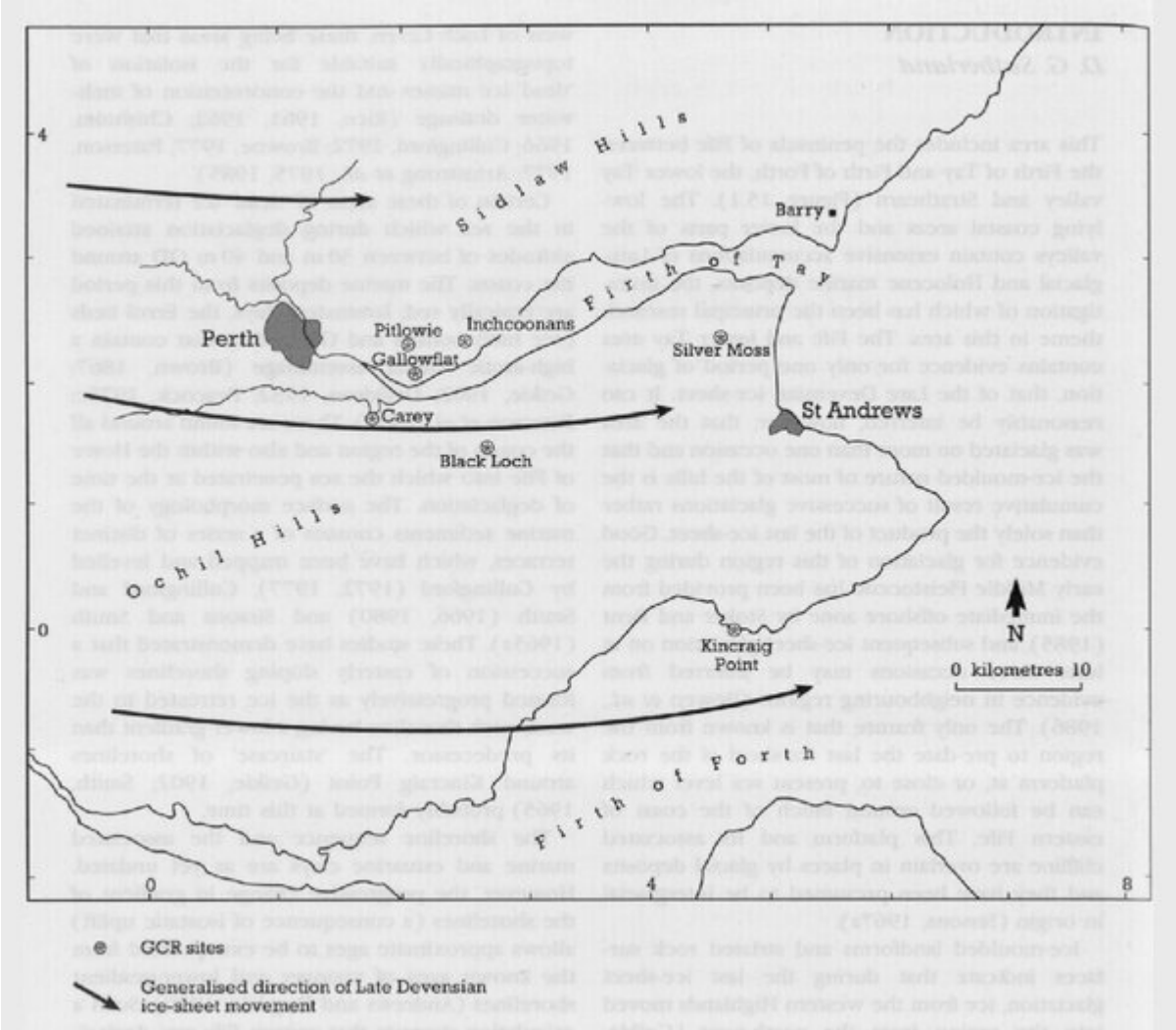
Paterson *et al.* (1981) and Armstrong *et al.* (1985) have discussed erosional features in the Tay and Earn area which they have correlated with the Main Lateglacial Shoreline. However, they suggested that these features formed during the early part of the Lateglacial when sea level was falling from the Main Perth Shoreline. They further suggested that during the latter part of the Lateglacial, sea level was particularly low resulting in the erosion of deep channels along the Tay estuary (see also Buller and McManus, 1971; McManus, 1972). It may be noted with respect to the correlations proposed by Paterson *et al.* (1981) that they provide no mechanism for an erosional event in the early Lateglacial in areas that are otherwise characterized by fine-grained sedimentation throughout the Lateglacial and Holocene. Browne and Jarvis (1983) have reported marine erosional features in St Andrews Bay. They correlated a surface cut across glacial and glaciomarine (Errol beds) sediments with the erosional surface identified by Sissons (1969, 1976a), but suggested that a bedrock surface at approximately the same altitude could have been inherited from an early phase of marine erosion prior to the Devensian. A further erosional surface cut across glacial and glaciomarine sediments at Buddon Ness, but overlain by Holocene deposits, has been described by Paterson (1981).

Sea-level changes during the early and middle Holocene are more clearly understood and are particularly well documented in this region. The sites at Carey (Cullingford *et al.,* 1980) and Silver Moss (Chisholm, 1971; Morrison *et al.,* 1981) provide details of the early Holocene changes, including the Main Postglacial Transgression, and the site at Pitlowie (Smith *et al.,* 1985b) has been the focus of the most detailed study in Scotland to date of the minor changes in sea level at the time of the maximum of that transgression, when the Main Postglacial Shoreline was formed. These various sites show that at the beginning of the Holocene, sea level was about 3 m OD in the lower Earn valley but that it progressively fell, reaching a low, probably below present sea level, at around 8000 BP. Subsequently there was a rapid rise in sea level culminating at around 6100 BP at Pitlowie, and at prior to 5900 BP at Silver Moss. The Silver Moss site also contains evidence of a brief marine invasion of the coastal zone at around 7000 BP (Morrison *et al.,* 1981). This event (described above — see Maryton) has been observed at sites throughout the east coast of Scotland (Smith *et al.,* 1985a; Dawson *et al.,* 1988; Haggart, 1988b; Long et al*.,* 1989a).

The Main Postglacial Shoreline formed at the maximum of the transgression has been shown to be isostatically tilted towards the south-east at a gradient of approximately 0.08 m km' (Sissons, 1983a). During the subsequent fall of sea level to the present level, lower shorelines were formed (Cullingford, 1972) but these are not well dated.

Holocene terrestrial environmental change has been studied in considerable detail at Black Loch. This site provides evidence of early and middle Holocene forest expansion and development, but it is particularly notable for the detail of the late Holocene changes in vegetation consequent upon Man's impact from the Neolithic onwards.

References



(Figure 15.1) Location map of the Fife and the Lower Tay area.