Tynaspirit

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Highlights

The infilled kettle hole at Tynaspirit contains detailed sedimentary and pollen records, supported by radiocarbon dating, of the vegetational history and environmental changes that occurred during the Lateglacial and early Holocene. In conjunction with evidence from nearby Mollands, Tynaspirit is important for establishing the glacial chronology at the end of the Late Devensian.

Introduction

The site at Tynaspirit [NN 666 047] is an infilled kettle hole located on the north side of the A84, about 0.5 km south-east of Cambusbeg Farm. The identification of the limits of the Loch Lomond Readvance has been based upon geomorphological evidence, but the chronology of the glacial event has in many areas rested largely upon relative dating by pollen stratigraphy, supported at some sites by radiocarbon dating. The basis of this approach has been outlined by Sissons *et al.* (1973). The site of Tynaspirit not only illustrates the methodology employed, but together with the evidence from the neighbouring site of Mollands (see above) provides a critical test of its application (Lowe, 1977, 1978; Lowe and Walker, 1977). Together these sites offer one of the strongest lines of support for dating the readvance and they are unique in their close geographical proximity to the local geomorphological evidence. Palynological data for later parts of the Holocene have also been reported from this site (Lowe, 1982a, 1982b).

Description

The drift geology of the area around Callander in Perthshire has been evaluated most recently by Thompson (1972) and Merritt and Laxton (1982). In summary, there are two major suites of glacial/ fluvial landforms in the Teith Valley that are separated by a clear arcuate terminal moraine (the Callander Moraine, (Figure 13.9)), which is best observed from the A84 looking north towards Drumdhu Wood [NN 644 074]. To the south-east of this moraine, from the quarries near Cambusbeg to those at Easter Coillechat [NN 688 038], there is an extensive spread of sand and gravel mounds, mapped by Thompson as a series of kames and kame terraces with '' occasional eskers. To the north-west of the moraine, as far as Kilmahog [NN 611 083], smaller-scale terraces, eskers and moraines have been mapped. Those deposits lying 'outside' (to the south-east of) the terminal moraine have been dated to the time of decay of the Late Devensian ice-sheet, whereas the Callander Moraine marks the maximum position of the Loch Lomond Readvance glacier (Merritt *et al.,* 1990), which originated in the higher ground to the north and west, the ice moving down the valleys currently occupied by Lochs Lubnaig, Katrine and Venacher. The landforms lying 'within' the moraine were thus attributed to melting of this younger ice mass (see also Smith *et al.,* 1978).

The boggy, peat-filled depression at Tynaspirit occupies a kettle hole within the suite of sand and gravel mounds considered to date from the melting of the Late Devensian ice-sheet. A small lochan formerly occupied the depression, and a suite of lake sediments and peats has built up to the present ground level. The site was chosen for detailed study since it provided an opportunity to test the suggested chronology of events in the Teith valley. However, the results of stratigraphic investigations undertaken at this site also have much wider significance.

Coring at the site revealed several minor basins within the boggy area, but detailed investigations concentrated on two of these: the deepest basin (T1 – 6.65 m depth), and a shallower one (T2 – 4.45 m depth) which contained richer organic sediments more suitable for radiocarbon dating. Both basins contain a 'tripartite' sediment sequence at their base (Figure 13.12). For example, at T2 (Figure 13.13) the lowermost 0.33 m comprises (1) a basal set of inorganic sediments (beds 1 to 3), (2) an organic-rich layer (beds 4 to 6) and (3) an upper bed of inorganic sediments (bed 7). Experience has shown that this 'tripartite' sequence is typical of successions spanning the Lateglacial period (13,000 to 10,000 BP), an assertion

which can be readily confirmed by pollen stratigraphy (see Lowe and Walker, 1977, 1984).

At Tynaspirit the relative age of the sediment succession was established through pollen analysis and confirmed by radiocarbon dating (Lowe, 1977, 1978; Lowe and Walker, 1977); five radiocarbon dates (Hv–4984, Hv–4985 and Hv–4987 to Hv–4989) were obtained (Figure 13.13). Seven local pollen assemblage zones have been defined (T2a to T2g) (Figure 13.13), but the sequence can be simplified as follows.

Interpretation

The earliest pollen zone (T2a) is dominated by pollen of herbaceous taxa, such as *Rumex,* grasses, sedges and *Thalictrum,* and of dwarf shrubs. The assemblage reflects an open, treeless landscape varying from stoney, bare soils on steep or exposed sites to a luxuriant heath associated with rich herb vegetation in more favoured localities. The end of this phase is dated to 12,750 ± 120 BP (Hv–4989) confirming that the sediments began to accumulate at Tynaspirit immediately or shortly after wastage of the Late Devensian ice-sheet in the Teith valley.

The next two pollen zones (T2b and T2c) record the increasing importance of birch and juniper in the vicinity of the site. The data are interpreted as indicating the gradual spread of birch and juniper copses across the Teith valley, with perhaps more extensive birch woodland in sheltered valley-bottom sites. At the same time it is likely that the ground cover of dwarf shrubs and herb vegetation continued to fill across unwooded sections of the valley, and that organic detritus built up within the developing soils. It appears that a major expansion of birch and juniper occurred in the area at 12,395 ± 195 BP (Hv–4988), but that these communities were severely disturbed and all but disappeared from the area by 11,385 ± 290 BP (Hv–4987). Overall, the pollen data imply a relatively mild climatic episode from perhaps as early as 12,750 to about 11,400 years ago.

Zone T2d is characterized by a return to minerogenic sedimentation, a dramatic reduction in birch percentages, an initial reduction in juniper and a return to high percentages of dwarf-shrub and herbaceous taxa. Those taxa common in the basal assemblage (zone T2a) (for example, *Rumex,* Compositae, grasses and sedges) are also well represented in zone T2d. The term 'rever-tance' is used to denote a return to the open, treeless conditions inferred for zone T2a. However, the later phase (zone T2d) records much higher representations of taxa indicative of bare, disturbed stoney surfaces, such as the clubmosses (*Selaginella* and *Lycopodium*)and the wormwoods or mugwort (*Artemisia*). The evidence suggests a harsh climatic environment, dated to between 11,385 ± 290 and 10,420 ± 160 BP (Hy–4985).

These conclusions are supported by the results of more recent investigations in the area by Merritt *et al.* (1990). Organic silts discovered beneath till at Callander have been assigned to the Lateglacial Interstadial on the basis of radiocarbon dating, pollen stratigraphy and their arthropod fauna. A radiocarbon date of 12,750 ± 70 BP (SRR–2317) from basal sediments matches almost exactly the date from the base of the Tynaspirit organic sediments, and the till overlying the dated organic silts is ascribed to the Loch Lomond Readvance.

Zones T2e to T2g record the development of woodland within the Teith valley. A progressive succession of (from base) *Empetrum,* juniper and birch, followed by the immigration of *Corylus is* a sequence recognized at numerous sites in Britain, one which characterizes the start of the Holocene Stage. From the dominance in the pollen assemblages of birch and juniper in particular, and from the highly organic nature of the lake sediments (beds 8 to 11), it is concluded that a woodland cover clothed much of the lower lying area of the Teith valley, and that correspondingly organic-rich soils had developed by about 9,260 ± 100 BP (Hv–4984).

The simplest explanation of the Tynaspirit succession, and the most important conclusions based upon the reported data, are as follows.

The Late Devensian ice-sheet must have disappeared from the lower parts of the Teith valley some time prior to about 12,800 BP. Several dates from other sites in Scotland (Sissons, 1976b; Gray and Lowe, 1977b; Sutherland, 1984a) indicate that around 13,000 BP or shortly after, most of the British Isles was ice-free.

Relatively stable and probably mild climatic conditions persisted for almost 2000 years. Whether or not ice disappeared entirely from Scotland during this period remains a contentious point (Sutherland, 1984a), one that is difficult to resolve on the basis of available evidence. Certainly the evidence from Tynaspirit would seem to imply substantial retreat of ice from the Callander area.

The data from Tynaspirit support Thompson's view (1972) that any glacier readvance into this area during the Loch Lomond Stadial did not extend beyond the vicinity of Callander and that an earlier suggestion by Francis *et al.* (1970) that the readvance extended to Drumvaich (*c.* 1 km east-south-east of Tynaspirit) is incorrect.

The 10,420 ± 160 BP date from Tynaspirit suggests that the harsh climatic conditions that promoted the Loch Lomond Readvance had substantially improved by some time earlier than 10,400 years ago, since the dated sample is not from the earliest post-stadial sediments at the site. This date, together with the evidence from the neighbouring site of Mollands, led to a revision of the estimated age of deglaciation in parts of Scotland at the close of the Loch Lomond Stadial (see Gray and Lowe, 1977b; Lowe, 1978; Lowe and Walker, 1980). However, recent studies at Croftamie (Rose *et* al., 1988) and South Shian and Balure of Shian (Peacock *et al.,* 1989) have indicated that Loch Lomond Readvance glaciers at those localities attained their maximum extents relatively late in the Stadial, after 10,500 BP.

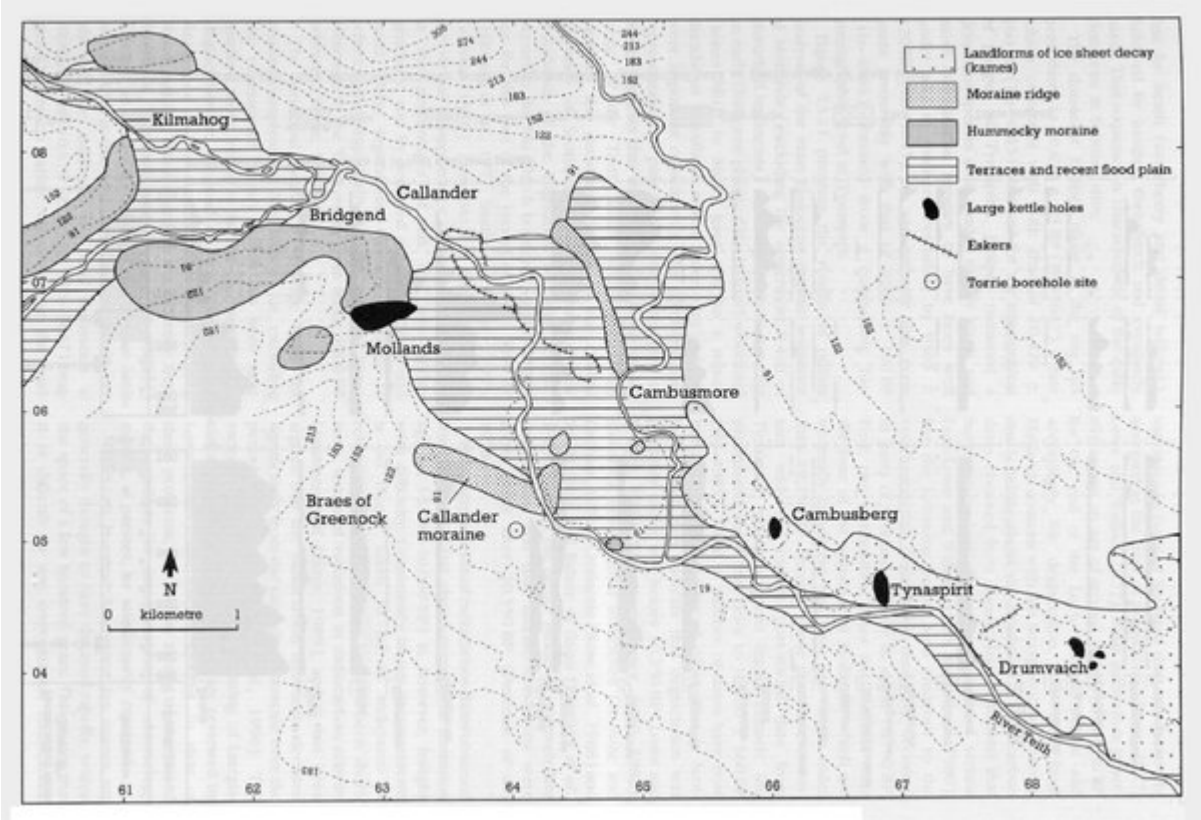
The close association of (1) Late Devensian ice-sheet landforms of deglaciation, (2) Loch Lomond Readvance landforms, including a well-defined ice limit, and (3) two sites (Tynaspirit and Mollands) providing relative and absolute dating controls on the ages of those landforms, is rare in the British Isles. The internally consistent radiocarbon dates and very close association of the field evidence collectively provide one of the strongest lines of support presently available for the Late Devensian chronology outlined earlier in this report. The area around Callander is therefore outstanding for exemplifying the field relations of the geomorphological evidence together with the pollen stratigraphy and radiocarbon dating evidence for the Lateglacial in Scotland. Tynaspirit is therefore a site of major importance in the Quaternary geology of the British Isles.

Tynaspirit, together with Mollands, is also significant in illustrating one of the two methodological approaches used in dating the Loch Lomond Readvance. In many areas the chronology of the event has been established through pollen stratigraphy and sometimes radiocarbon dating of organic lake sediments at sites inside and outside the inferred ice limits (Donner, 1957; Sissons *et al.,* 1973; Walker, 1975a; Walker *et al.,* 1988; Tipping, 1988). The other approach has involved radiocarbon dating of marine shells and organic deposits incorporated or overridden by Loch Lomond Readvance glaciers (see South Shian and Balure of Shian, Rhu Point, Croftamie, and the Western Forth Valley). These two approaches have tended to produce contrasting conclusions, the time of the maximum of the readvance inferred from the first approach often being apparently earlier than that inferred from the second approach. It remains to be established whether this contrast is due to methodological problems (see Mollands) or whether it does indeed reflect diachroneity in the response of the various glaciers to rapid climatic change at the Late Devensian–Holocene boundary.

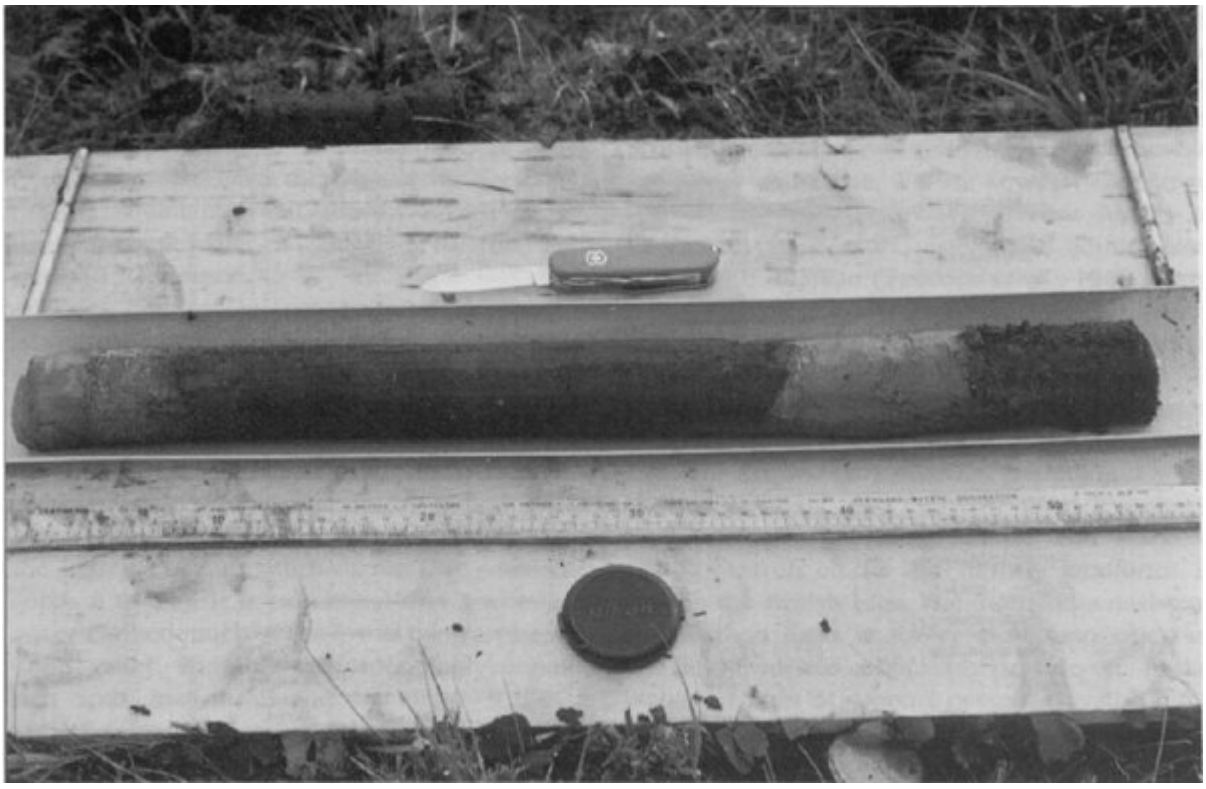
Conclusion

Evidence from Tynaspirit in conjunction with that from Mollands, is important for establishing the pattern and timing of glaciation and environmental change during the Lateglacial, the period between about 13,000 and 10,000 years ago. The sediment and pollen data from the site, supported by radiocarbon dating, provide a full record of Lateglacial environmental conditions from the time of wastage of the main Late Devensian ice-sheet (approximately 13,000 years ago), indicating that Loch Lomond Readvance glaciers did not extend as far as the site. In contrast, Mollands contains only a Holocene pollen record, indicating that the ice limit which lies between it and Tynaspirit was formed during the Loch Lomond Readvance (approximately 11,000–10,000 years ago). Together these two sites provide a particularly good illustration of this type of approach used to date Loch Lomond Readvance deposits.

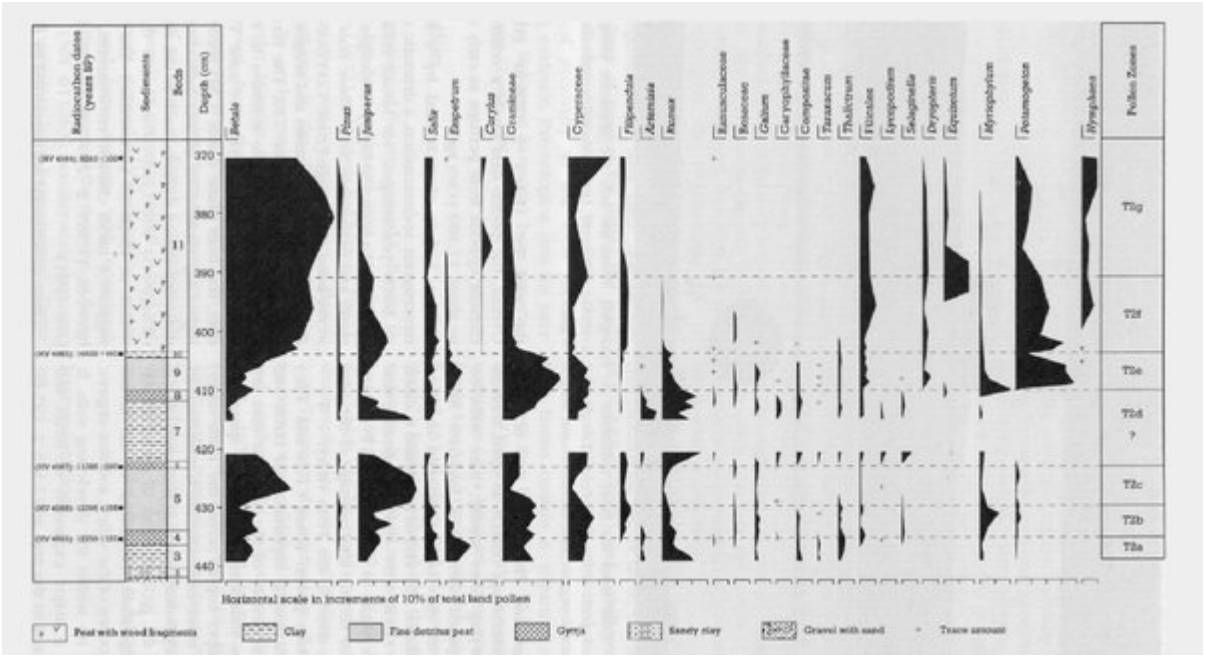
References



(Figure 13.9) Glacial and glaciofluvial landforms of the Callander area (from Lowe, 1978, after Thompson, 1972).



(Figure 13.12) Core from the basal sediments at Tynaspirit. From the left, the sequence comprises Late Devensian minerogenic sediments, organic Lateglacial Interstadial sediments, Loch Lomond Stadial silts and clays, and early Holocene organic lake muds. (Photo: M. J. C. Walker.)



(Figure 13.13) Tynaspirit: relative pollen diagram showing selected taxa as percentages of total land pollen (from Lowe, 1978).