CROFTAMIE

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Highlights

The sequence of deposits at Croftamie includes plant detritus interbedded between two tills. The organic material has yielded important palaeoenvironmental and dating information, allowing the glacial history of the area during the Late Devensian to be established. The site provides important evidence for the timing of the Loch Lomond Readvance in the type area.

Introduction

The section at Croftamie (NS 473861), which occurs in a cutting along the now disused Forth and Clyde Junction Railway, is important for Late Devensian stratigraphy in the type area for the Loch Lomond Readvance. It shows the stratigraphic relationship between the Wilderness Till (deposited by the main Late Devensian ice sheet) and the Gartocharn Till (deposited by a piedmont glacier during the Loch Lomond Stadial). Beds of organic detritus (plant remains representative of a dwarf shrub/grassland association) and laminated lake sediments, occur between the two tills. Radiocarbon assay of the organic sediments has allowed a limiting date on the maximum of the Loch Lomond Readvance in its type area (Rose *et al.*, 1988). This important site also has a long history of research (McFarlane, 1858; Smith, 1858; Jack, 1875; Simpson, 1933; Rose *et al.*, 1988).

Description

At the time of their discovery, the deposits at Croftamie generated considerable interest because of their fossil content. Mcfarlane (1858) and Smith (1858) described 12 ft (3.7 m) of till overlying 7 ft (2.1 m) of blue clay. Near the bottom of the latter, just above sandstone bedrock, the antler of a reindeer, *Rangifer tarandus* (L.) and a number of marine shells were found. Jack (1875) correlated the till above the clays at Croftamie with the distinctive shelly till unit which he identified in the lower Endrick valley. He listed the macrofauna found in numerous till exposures in the area including *Arctica islandica* (L.), *Nicania montagui* (Dillwyn), *Neptunea antiqua* (L.), *Littorina littorea* (L.), and *Balanus* sp. from Croftamie.

The most recent investigations of the Croftamie deposits are by Rose (1981) and Rose *et al.*, 1988). The sequence comprises:

5.	Till with marine fauna derived from Clyde beds (Gartocharn Till)	up to 5 m
4.	Rhythmically laminated clays and silts (Blane Valley Silts)	up to 0.4 m
3.	Felted plant detritus	up to 0.08 m
2.	Till, mainly of locally derived bedrock (Wilderness Till)	up to 1.5 m
1.	Old Red Sandstone bedrock.	

The Wilderness Till is associated with an ice sheet moving west–east glaciation during the Late Devensian glacial maximum. The Blane Valley Silts are interpreted as diatactic varves formed in a proglacial lake dammed back in the Blane Valley by the Loch Lomond Readvance. The number of varves indicates that the lake existed for at least 50 years. The overlying Gartocharn Till includes material incorporated from Clyde beds deposited in the Loch Lomond area during the Lateglacial Interstadial. The organic detritus (bed 3) contains a sparse, poorly preserved pollen assemblage (dominantly Caryophyllaceae, *Salix*, Gramineae, Cyperaceae and Cruciferae, but also with *Artemisia*, *Valeriana* and *Selaginella*) typical of an open habitat, dwarf

shrub/grassland environment, and gave a radiocarbon date of 10,560 + 160 BP (Q–2673) (Rose *et al*., 1988). It therefore accumulated during the Loch Lomond Stadial before the onset of the glacial lake sedimentation.

Interpretation

The significance of the Croftamie deposits in interpreting the Pleistocene sequence in Scotland was recognised in the last century. Together with other fossil remains in the drift of Scotland, the reindeer horn was considered to provide evidence for ameliorating climatic conditions and restricted ice extent at some time during the Pleistocene before a subsequent ice advance (Geikie, 1863a). Jack (1875) concluded that the marine fauna had been alive during one of the milder phases of the glacial period when Loch Lomond was an arm of the sea, although in conditions slightly colder than at present. The shelly till was therefore the product of subsequent glaciation. The explanation of the evidence was also adapted by later workers in the area (Geikie, 1894; Bell, 1895d; Cunningham Craig (1901), following some discussion as to whether the marine event was a local extension of the sea into Loch Lomond or a great interglacial submergence (J. Geikie, 1874, 1877).

Following detailed fieldwork in the area Simpson (1928, 1929, 1933) developed ideas of Jack, Geikie and Cunningham Craig, assembling the evidence and formulating carefully the case for a Lateglacial readvance of ice in the Loch Lomond valley following a period of marine occupation. He observed that shelly till only occurred inside a prominent end moraine which he traced around the southern end of Loch Lomond (see Aucheneck, and Gartness). He called the glacial event the Loch Lomond Readvance and noted that it was also represented in theWestern Forth Valley (see below).

Charlesworth (1956) subsequently extended the limits of the readvance, incorporating the Loch Lomond and Forth valley landforms and deposits as part of his Lateglacial "Stage M" or "Moraine Glaciation". The name Loch Lomond Readvance, however, was retained by Sissons (1965, 1967a) who revised the ice limits suggested by Charlesworth. More recently these limits have been further established over large areas of the Highlands and Islands and the Southern Uplands (Sissons *et al*., 1973; Sissons, 1979e, 1983b).

The detailed work of Rose (1981) and Rose *et al*. (1988) has allowed a clearer interpretation of the full sequence of events at Croftamie: (1) deposition of till by the Late Devensian ice sheet (Wilderness Till); (2) deposition of marine clayey silts (Clyde beds) (elsewhere in the area); (3) formation of a proglacial lake by the advancing Loch Lomond Readvance (Blane Valley Silts); (4) deposition of the shelly till (Gartochern Till), in part derived from Clyde beds sediments; and (5) maintenance of the proglacial lake which drained into the Forth valley (Blane Valley Silts). The radiocarbon date from the organic sediments implies that the Loch Lomond glacier reached its maximum extent after 10,560 + 160 BP, in agreement with the evidence from the Vale of Leven that glaciomarine sedimentation continued until after 10,350 + 125 BP (SRR–1529) (Browne and Graham, 1981). This also accords with the inference that the Loch Lomond Stadial glacier in the Western Forth valley reached its maximum extent between 10,500 BP and 10,100 BP (Sissons, 1983a; Sutherland, 1984a), and that the Creran glacier reached its maximum after 10,500 BP and perhaps as late as 10,000 BP (seeSouth Shian and Balure of Shian) (Peacock *et al*., 1989). However, these dates are significantly at variance with dates previously obtained elsewhere that have been used to infer the time of the maximum glacier extent (see Sutherland, 1986; Rose *et al*., 1988): they are at least 400 years younger than the other dates from sediments over-ridden by Loch Lomond Stadial glaciers, and they also overlap in age ranges with dates from lacustrine sediments that were deposited immediately on retreat of the stadial glaciers (Rose *et al*., 1988) (see also Kingshouse, Loch an t-Suidhe, Mollands, Tynaspirit, Rhu Point and Loch Cleat). Rose *et al*. (1988) argued that this variance could relate to three factors. First, many of the dates are from marine shells, but environmental and sedimentation factors tend to favour a higher probability of sampling shells from the middle part of the interstadial, rather than the later part (see alsoSutherland, 1986). Second, there may be errors in the dates on basal organic lake sediments caused by mineral carbon and hard water contamination (see Sutherland, 1980). Third, because of variations in individual glacier dynamics and glacier response to climate, the fluctuations of the glaciers are likely to have been diachronous. Since the material dated atCroftamie is plant detritus, the date obtained should be less susceptible to mineral carbon and hard water errors than dates

obtained from organic lake sediments (gyttja); Rose *et al*. (1988) suggested that dates on the latter material may be slightly too old. The evidence from Croftamie and Inverleven therefore indicates relatively later deglaciation of Loch Lomond Readvance glaciers than suggested elsewhere (Lowe, 1978; Lowe and Walker, 1980, 1984; Walker and Lowe, 1980, 1982; Dawson *et al*., 1987a) (but see Kinghouse). A further complication in interpreting the different radiocarbon dates arises from the variations in atmospheric radiocarbon production have occurred during the Lateglacial (Ammann and Lotter, 1989; Zbinden *et al*., 1989; Bard *et al*., 1990), but this may have affected all the dates.

Croftamie is a site of highest importance in several respects. It provides a key sequence of Lateglacial deposits in the type area for the Loch Lomond Readvance. In stratigraphic terms, it unequivocably demonstrates the superposition of Loch Lomond Stadial till on till deposited by the main Late Devensian ice sheet. It is the only site at which plant material has been used to date the maximum of the Loch Lomond Readvance. Moreover, the results of this dating, corroborated by additional dates from Inverleven and South Shian and Balure of Shian, provide significant new evidence that the maximum extent of the Loch Lomond Readvance glaciers may have occurred after 10,500 BP. The interest at Croftamie complements that at Aucheneck, Gartness and South Loch Lomond (Portnellan, Ross Priory and Claddochside), and together these sites provide a comprehensive demonstration of the Lateglacial stratigraphy and landforms, both glacial and marine, in the area where the Loch Lomond Readvance was first recognised.

Conclusions

Croftamie is important for interpreting the glacial history in the type area for the Loch Lomond Readvance. The site has a long history of research and is particularly significant in showing organic deposits interbedded between tills deposited by the Late Devensian ice sheet (approximately 18,000 years ago) and a Loch Lomond Readvance glacier (approximately 10,500 years ago). The organic deposits represent a warmer phase between the two glacial episodes, and the pollen they contain provides details of environmental conditions during that period. The organic deposits also provide an important means of dating the readvance. Croftamie is therefore a key reference site for establishing particular details of the nature and timing of the Loch Lomond Readvance.

Reference list

Ammann, B. and Lotter, A.F. (1989) Late-Glacial radiocarbon and palynostratigraphy on the Swiss plateau. *Boreas*, **18**, 109–26.

Bard, E., Hamelin, B., Fairbanks, R.G. and Zindler, A. (1990) Calibration of the 14C timescale over the past 30,000 years using mass spectrometric U-Th ages from Barbados. *Nature*, **345**, 405–10.

Bell, D. (1895d) Notes on ?The Great Ice Age' in relation to the question of submergence. *Geological Magazine*, dec. 4, vol. 2, 321–6; 348–55 and 402–5.

Browne, M.A.E. and Graham, D.K. (1981) Glaciomarine deposits of the Loch Lomond stade glacier in the Vale of Leven between Dumbarton and Balloch, west-central Scotland. *Quaternary Newsletter*, **34**, 1–7.

Charlesworth, J.K. (1956) The late-glacial history of the Highlands and Islands of Scotland. *Transactions of the Royal Society of Edinburgh*, **62**, 769–928.

Cunningham Craig, E.H. (1901) Dunbartonshire. In *Summary of Progress of the Geological Survey of the United Kingdom for 1900*. Memoirs of the Geological Survey. London, HMSO, 138–9.

Dawson, A.G., Lowe, J.J. and Walker, M.J.C. (1987a) The nature and age of the debris accumulation at Gribun, western Mull, Inner Hebrides. *Scottish Journal of Geology*, **23**, 149–62.

Geikie, A. (1863a) On the glacial drift of Scotland. *Transactions of the Geological Society of Glasgow*, **1**, 1–190.

Geikie, J. (1874) *The Great Ice Age and its Relation to the Antiquity of Man*. 1st Edn. London, W. Isbister, 575pp.

Geikie, J. (1877) *The Great Ice Age and its Relation to the Antiquity of Man*. 2nd edn. London, Daldy, Isbister & Co. 624pp.

Geikie, J. (1894) *The Great Ice Age and its Relation to the Antiquity of Man*. 3rd ed. London, Edward Stanford, 850pp.

Jack, R.L. (1875) Notes on a till or boulder clay with broken shells, in the lower valley of the River Endrick, near Loch Lomond, and its relation to certain other glacial deposits. *Transactions of the Geological Society of Glasgow*, **5**, 5–25.

Lowe, J.J. (1978) Radiocarbon-dated Lateglacial and early Flandrian pollen profiles from the Teith Valley, Perthshire, Scotland. *Pollen et Spores*, **20**, 367–97.

Lowe, J.J. and Walker, M.J.C. (1980) Problems associated with radiocarbon dating the close of the Lateglacial period in the Rannoch Moor area, Scotland. In *Studies in the Lateglacial of North-west Europe* (eds J.J. Lowe, J.M. Gray and J.E. Robinson). Oxford, Pergamon Press, 123–38.

Lowe, J.J. and Walker, M.J.C. (1984) *Reconstructing Quaternary Environments*. London, Longman, 389pp.

McFarlane, J. (1858) Memorandum of shells and a deer's horn found in a cutting of the Forth and Clyde Junction Railway, Dumbartonshire. *Proceedings of the Royal Physical Society of Edinburgh*, **1**, 163–5.

Peacock, J.D., Harkness, D.D., Housley, R.A., Little, J.A. and Paul, M.A. (1989) Radiocarbon ages for a glaciomarine bed associated with the maximum of the Loch Lomond Readvance in west Benderloch, Argyll. *Scottish Journal of Geology*, **25**, 69–79.

Rose, J. (1981) Field guide to the Quaternary geology of the south eastern part of the Loch Lomond basin. *Proceedings of the Geological Society of Glasgow 1980-81*, 1–19.

Rose, J., Lowe, J.J., Switsur, R. (1988) A radiocarbon date on plant detritus beneath till from the type area of the Loch Lomond Readvance. *Scottish Journal of Geology*, **24**, 113–24.

Simpson, J.B. (1928) In *Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the year 1927*. Part 1. Geological Survey of Great Britain. London, HMSO, 59–60.

Simpson, J.B. (1929) The valley glaciation of Loch Lomond. *Report of the British Association for the Advancement of Science for 1928*, 547–8.

Simpson, J.B. (1933) The late-glacial readvance moraines of the Highland border west of the River Tay. *Transactions of the Royal Society of Edinburgh*, **57**, 633–45.

Sissons, J.B. (1965) Quaternary. In *The Geology of Scotland* (ed. G.Y. Craig). Edinburgh, Oliver and Boyd, 467–503.

Sissons, J.B. (1967a) *The Evolution of Scotland's Scenery*. Edinburgh, Oliver and Boyd, 259pp.

Sissons, J.B. (1979e) The Loch Lomond Stadial in the British Isles. *Nature*, **280**, 199–203.

Sissons, J.B. (1983a) Shorelines and isostasy in Scotland. In *Shorelines and Isostasy* (eds D.E. Smith and A.G. Dawson). London, Academic Press, 209–25.

Sissons, J.B. (1983b) Quaternary. In *Geology of Scotland* 2nd edn. (ed. G.Y. Craig). Edinburgh, Scottish Academic Press, 399–424.

Sissons, J.B., Lowe, J.J., Thompson, K.S.R. and Walker, M.J.C. (1973) Loch Lomond Readvance in the Grampian Highlands of Scotland. *Nature Physical Science*, **244**, 75–7.

Smith, J.A. (1858) Notice of the horn of a reindeer (*Cervus tarandus*, Linn), found in Dumbartonshire. *Proceedings of the Royal Physical Society of Edinburgh*, **1**, 247–49. (Also *Edinburgh New Philosophical Journal*, **6**, 165–7).

Sutherland, D.G. (1980) Problems of radiocarbon dating deposits from newly deglaciated terrain: examples from the Scottish Lateglacial. In *Studies in the Lateglacial of Northwest Europe* (eds J.J. Lowe, J.M. Gray and J.E. Robinson). Oxford, Pergamon Press, 139–49.

Sutherland, D.G. (1984a) The Quaternary deposits and landforms of Scotland and the neighbouring shelves: a review. *Quaternary Science Reviews*, **3**, 157–254.

Sutherland, D.G. (1986) A review of Scottish marine shell radiocarbon dates, their standardisation and interpretation. *Scottish Journal of Geology*, **22**, 145–64.

Walker, M.J.C. and Lowe, J.J. (1980) Pollen analyses, radiocarbon dates and the deglaciation of Rannoch Moor, Scotland, following the Loch Lomond Advance. In *Timescales in Geomorphology* (eds R.A. Cullingford, D.A. Davidson and J. Lewin). Chichester, John Wiley, 247–59.

Walker, M.J.C. and Lowe, J.J. (1982) Lateglacial and early Flandrian chronology of the Isle of Mull, Scotland. *Nature*, **296**, 558–61.

Zbinden, H., Andrée, M., Oeschger, H., Ammann, B., Lotter, A., Bonani, G. and Wölfli, W. (1989) Atmospheric radiocarbon at the end of the last glacial: an estimate based on AMS radiocarbon dates on terrestrial macrofossils from lake sediments. *Radiocarbon*, **31**, 795–804.