AFTON LODGE

J.E. Gordon

OS Grid Reference: NS417259

Highlights

The sediments exposed in stream sections at Afton Lodge include a high-level shelly clay with a fossil marine fauna. They form part of a suite of such deposits in Scotland which have featured prominently in studies of glacial history and sea-level change.

Introduction

The site at Afton Lodge (NS 417259) comprises a series of exposures along the Ladykirk Burn, 8 km north-east of Ayr, at an altitude of about 85 m O.D. It is important for representing the high-level marine deposits of west-central Scotland. Their origin, like that of similar deposits at Clava and Kintyre, has been the subject of considerable debate. Originally, the deposits were interpreted as *in situ* marine sediments, and later as ice-rafted blocks of frozen sea-floor sediments. Holden (1977a) reopened the debate, arguing that the deposits represent a pre-Late Devensian sea-level stand between 115 m to 150 m O.D. Sutherland (1981a) supported Holden's interpretation and further suggested that the high-level marine deposits found around Scotland were the product of isostatic downwarping in front of an expanding ice sheet, possibly during the Early Devensian. The deposits at Afton Lodge were first described by Eyles (1922) and subsequently by Eyles *et al*. (1949), Holden (1977a, 1977b) and Abd-Alla (1988).

Description

Eyles (1922) and Eyles *et al*. (1949) recorded the following sequence at Afton Lodge:

3.	Red till	up to 4.9 m
2.	Laminated, greyish-green, variegated clay	1.5 m
1.	Stiff, blue to black, stoneless clay with shells	0.6 m

The shelly clay extended for 300 m at an altitude of between 76 m and 91 m O.D. and yielded shells of nine species of mollusc (Table 16.1).

In his detailed study of the glaciation of central Ayrshire, Holden (1977a and 1977b) re-examined the Afton Lodge section and noted the following sequence of deposits:

3.	Sand and gravel comprising angular clasts up to 0.3 m in a red-brown, coarse, sandy, open-textured matrix	3 m
2.	Coarse gravel, dipping ESE at 5°	0.3 m
1.	Stiff, black, shelly, silty clay containing bivalves and foraminifera	5 m

He considered that bed 3 was not till as suggested by Eyles *et al*. (1949), but rather a slope-wash deposit. The typical till of the area did not overlie the shelly clay, but is its lateral equivalent and could be traced upstream from it. Holden described a sharp, vertical contact between these two units, but in fact they are interdigitated. Abd-Alla (1988) considered that the shelly clay was a marine deposit that could be distinguished on the basis of grain size distribution and geochemistry from shelly till at locations elsewhere in Ayrshire.

Holden (1977a, 1977b) described stratification in the upper part of bed 1, consisting of

alternate layers of coarse sand and silty clay; below, the deposit was a homogeneous silty clay. Shells of molluscs in the clay were nearly perfectly preserved. Small ones occurred whole, larger ones as fragments. Foraminifera and ostracods identified by M. Kean were listed by Holden (Table 16.2). As quoted by Holden, Kean reported that the assemblage was one which could be found in the Firth of Clyde today between 15 m and 50 m depth.

Interpretation

High-level marine deposits with shells in west-central Scotland were first described by Smith (1850b) in clays beneath till at 510 ft (155 m O.D.) at Chapelhall, near Airdrie. Crosskey (1865), however, believed that the shelly clay was in fact on top of the till and therefore conformed with the position of similar deposits throughout western Scotland (Clyde Beds). Geikie essentially followed Smith's interpretation of the deposits and, indeed, until the discovery of a similar shell bed at Clava, the Chapelhall site became a keystone in the marine submergence hypothesis of the 19th century, representing the minimum level of the transgression (J. Geikie, 1874, 1877). However, re-investigation of the site by a British Association Committee failed to reveal any evidence of a shelly clay (Horne *et al*., 1895).

Despite the setback at Chapelhall and doubts over Clava (Horne *et al*., 1894 minority report; Bell, 1895a, 1895b, 1897a), the submergence hypothesis still persisted (Reade, 1896; Smith, 1896a, 1898; Gregory, 1927), in part on the strength of the presence of marine shells in the till of west-central Scotland. Numerous instances of these were reported by Smith (1862, 1896c, 1898, 1901; Geikie *et al*., 1869; Eyles, 1922; Richey *et al*., 1930; Eyles *et al*., 1949). Generally the shells are scattered throughout the till, and they are clearly glacially derived (Eyles, 1922; Richey *et al*., 1930; Eyles *et al*., 1949) despite the contrary views of Smith (1898) and Gregory (1926). Locally, however, the shells occur in denser concentrations associated with intact masses of blue-grey, stoneless clay; for example at Afton Lodge where the best exposures now exist, Tarshaw and Catrine (Eyles *et al*., 1949).

Eyles *et al*. (1949) argued that the shelly clays were sea-floor sediments transported onshore in a frozen state by ice and deposited as erratics. They considered that the clays were too isolated in occurrence to be *in situ*, pre-glacial or interglacial marine deposits.

The hypothesis of ice moving onshore in Ayrshire from the Firth of Clyde had earlier been suggested by Bell (1871), Craig (1873) and Smith (1891). From the distribution of erratics, drumlin orientations and the very existence of the shelly till, Eyles *et al*. (1949) also concurred that the ice movement during the glacial maximum in central Ayrshire was from the west. During a later phase, however, this trend was reversed. In north Ayrshire the same patterns had been established by Richey *et al*. (1930) and the shelly till there explained in a similar manner. Further support for the movement of ice eastwards was later provided by Maclellan (1969) working in Lanarkshire.

Holden argued that bed 1 was a marine clay and was *in situ*. His key evidence was that the ice movement in the area was offshore. In his study of the glacial evidence in central Ayrshire he found no support for any ice movement from the west. The northern part of central Ayrshire was glaciated by Highland ice moving south, then bifurcating to the east and west as it encountered ice from the Southern Uplands. The topographic location of Afton Lodge, in the lee of a ridge to ice moving from the north-east, was admirably suited to the preservation of a marine deposit. Holden's other arguments for the deposit being *in situ* are not altogether convincing. His doubts regarding the feasibility of ice transporting large masses of unconsolidated sediment with the bedding preserved are not supported by reports of large-scale block inclusions or till rafts elsewhere (Moran, 1971; Dreimanis, 1976; Aber, 1985; see also Clava). Holden also argued that the marine clays at Clava and Kintyre were remarkably similar to those at Afton Lodge and proposed that they too were *in situ*. Since there was no evidence of a Lateglacial or Holocene submergence of the required magnitude, and the fauna at Afton Lodge were warm temperate, he concluded that the Afton Lodge and Kintyre deposits represented a pre-Late Devensian sea-level stand of between 115 m and 150 m O.D.

The general conclusions reached by Holden (1977a) were supported by Sutherland (1981a) in a wider study of the high-level shell beds in Scotland. Sutherland argued that these deposits were *in situ* and demonstrated that, with the possible exception of Clava, isostatic depression

in front of an expanding Scottish ice sheet could have been sufficiently great to explain the altitudes at which the marine clays occurred. The faunas associated with the shell beds were indicative of the North Atlantic Drift reaching the Scottish coasts at the time of the formation of the deposits, and Sutherland suggested that this was compatible with the evidence of Ruddiman *et al*. (1980) that a relatively mild oceanic climate in the North Atlantic accompanied the build up of ice sheets in the northern hemisphere. The explanation offered by Sutherland apparently entailed an Early Devensian expansion of the Scottish ice. However, to date, no unambiguous evidence has been discovered for an Early Devensian glaciation of Scotland (Bowen *et al*., 1986; see also Chapter 5). Furthermore, amino-acid analyses of shells from the high-level marine deposits suggest that they may not all have formed contemporaneously (see Tangy Glen and Clava; D.G. Sutherland, unpublished data). However, the general mechanism for the formation of the high-level shell beds proposed bySutherland (1981a) may be correct even if the chronology is in error.

Afton Lodge is therefore an important site representing the high-level marine clays of west-central Scotland. There is a continuing debate as to whether these sediments are indeed*in situ* and represent a marine transgression pre-dating the Late Devensian ice-sheet glaciation or whether they are very large ice-transported erratics (see Clava, Tangy Glen and Burn of Benholm). On either interpretation the sediments preserve a marine fauna indicative of the climate at the time of deposition. Amino acid analysis of the contained shells is likely to help resolve the outstanding question as to the age of the marine event represented by the clays.

Conclusions

Afton Lodge is notable for a high-level deposit of marine clay containing shells of marine molluscs. It is one of several such deposits in Scotland, which are of critical importance for studies of Quaternary history. It has been questioned whether these sediments, with their marine fossils, are evidence of a former high sea-level or of the transport of marine sediments by a former ice sheet on to the land. Although the precise age, origin and correlations of the deposit at Afton Lodge have yet to be firmly established, its importance for research, as part of the network of high-level shell beds, is unquestioned.

Reference list

Abd-Alla, M.A.A. (1988) Mineralogical and geochemical studies of tills in south-western Scotland. Unpublished PhD thesis, University of Glasgow.

Aber, J.S. (1985) The character of glaciotectonism.*Geologie en Mijnbouw*, **64**, 389–95.

Bell, D. (1871) On the aspects of Clydesdale during the glacial period.*Transactions of the Geological Society of Glasgow*, **4**, 63–9.

Bell, D. (1895a) On the alleged proofs of submergence in Scotland during the glacial epoch – II. Clava and other northern localities. *Transactions of the Geological Society of Glasgow*, **10**, 105–20.

Bell, D. (1895b) The shelly clays and gravels of Aberdeenshire considered in relation to the question of submergence. *Quarterly Journal of the Geological Society*, **51**, 472–9.

Bell, D. (1897a) The ?great submergence' again Clava, etc, Part II.*Geological Magazine*, dec. 4, vol. 4, 63–8.

Bowen, D.Q., Rose, J., McCabe, A.M. and Sutherland, D.G. (1986) Correlation of Quaternary glaciations in England, Ireland, Scotland and Wales.*Quaternary Science Reviews*, **5**, 299–340.

Craig, R. (1873) On the glacial deposits of north Ayrshire and Renfrewshire.*Transactions of the Geological Society of Glasgow*, **4**, 138–64.

Crosskey, H.W. (1865) On the *Tellina calcarea* bed at Chappel Hall, near Airdrie. *Quarterly Journal of the Geological Society*, **21**, 219–21.

Dreimanis, A. (1976) Tills: their origin and properties. In*Glacial Till. An Inter-disciplinary Study* (ed. R.F. Leggett). *The Royal Society of Canada Special Publications*, **12**. Ottawa, Royal Society of Canada, 11–49.

Eyles, V.A. (1922) In *Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1921*. London, HMSO, 77–8.

Eyles, V.A., Simpson, J.B. and McGregor, A.G. (1949)*Geology of Central Ayrshire*. (Explanation of One-Inch Sheet 14). 2nd Edition. Memoirs of the Geological Survey of

Scotland. Edinburgh, HMSO, 160pp.

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, A., Geikie, J. and Peach, B.N. (1869) Ayrshire: southern district (Explanation of Sheet 14). Memoirs of the Geological Survey of Scotland. Edinburgh, HMSO, 27pp.

Gregory, J.W. (1926) The Scottish kames and their evidence on the glaciation of Scotland. *Transactions of the Royal Society of Edinburgh*, **54**, 395–432.

Gregory, J.W. (1927) The moraines, boulder clay and glacial sequence of south-western Scotland. *Transactions of the Geological Society of Glasgow*, **17**, 354–76.

Holden, W.G. (1977a) The glaciation of Central Ayrshire. Unpublished PhD thesis, University of Glasgow.

Holden, W.G. (1977b) Afton Lodge. In *Western Scotland I* (ed. R.J. Price). INQUA X Congress 1977. Guidebook for Excursion A12. Norwich, Geo Abstracts, 12–3.

Horne, J., Robertson, D., Jamieson, T.F., Fraser, J., Kendal, P.F. and Bell, D. (1894) The character of the high-level shell-bearing deposits at Clava, Chapelhall and other locations. *Report of the British Association for the Advancement of Science for 1893*, 483–514.

Horne, J., Robertson, D., Jamieson, T.F., Fraser, J., Kendall, P.F. and Bell, D. (1895) Character of the high-level shell-bearing deposits at Clava, Chapelhall, and other localities (Chapelhall section). *Report of the British Association for the Advancement of Science for 1894*, 307–15.

Moran, S.R. (1971) Glaciotectonic structures in drift. In *Till. A Symposium* (ed. R.P. Goldthwait). Ohio, Ohio State University Press, 127–48.

Reade, T.M. (1896) The present aspects of glacial geology. *Geological Magazine*, dec. 4, vol. 3, 542–51.

Richey, J.E., Anderson, E.M., MacGregor, A.G., Bailey, E.B., Wilson, G.V., Burnett, G.A. and Eyles, V.A. (1930) The Geology of North Ayrshire. (Explanation of One-Inch Sheet 22). Memoirs of the Geological Survey of Scotland. 2nd edn. Edinburgh, HMSO, 417pp.

Smith, J. (1850b) On the occurrence of marine shells in the stratified beds below the till. *Quarterly Journal of the Geological Society of London*, **6**, 386–8.

Smith, J. (1891) The great ice age in the Garnock Valley. *Transactions of the Geological Society of Glasgow*, **9**, 151–91.

Smith, J. (1896a) The great submergence: an interpretation of the Clava section, near Inverness, Scotland. *Geological Magazine*, dec. 4, vol. 3, 498–502.

Smith, J. (1898) The drift or glacial deposits of Ayrshire. *Transactions of the Geological Society of Glasgow*, **11**, (supplement), 134pp.

Sutherland, D.G. (1981a) The high-level marine shell beds of Scotland and the build-up of the last Scottish ice sheet. *Boreas*, **10**, 247–54.