
WINDY HILLS

J. E. Gordon and D. G. Sutherland

OS Grid Reference: NJ791394

Highlights

Windy Hills is a locality of outstanding importance for a suite of quartzite gravels deposited by a pre-Quaternary river. The sedimentary characteristics of the gravels and their subsequent, post-depositional modifications provide unique evidence for interpreting long-term landscape evolution in north-east Scotland.

Introduction

The Windy Hills site lies about 12 km south-east of Turriff. It covers two areas (total 0.43 km²) between NJ 786392 and NJ 805402 on the top of a low ridge orientated south-west to north-east, overlooking the River Ythan to the south-east. The crest of the ridge, at about 120 m OD, is some 90 m above the valley bottom. Windy Hills is important for the unique, so-called 'Pliocene' gravels of Buchan. Long recognized as lithologically distinct deposits because of their very high proportions of quartzite and flint (Christie, 1831), the gravels were discussed in early papers by Ferguson (1850, 1855, 1857, 1877, 1893), Jamieson (1858, 1865, 1874, 1882b, 1906) and Wilson (1886), and they were described in some detail in an important paper by Flett and Read (1921). More recently there has been renewed interest in these deposits (Clapperton, 1977; Gemmell and Kesel, 1979, 1982; Koppi and FitzPatrick, 1980; McMillan and Merritt, 1980; Kesel and Gemmell, 1981; McMillan and Aitken, 1981; Merritt, 1981; Merritt and McMillan, 1982; Hall, 1982, 1983, 1984c).

The gravels (termed the Buchan Gravels by McMillan and Merritt (1980) and Buchan Gravels Group by Hall (1984c)) occur in a restricted area of Buchan (Figure 8.1) and comprise two lithologically distinct groups of well-rounded, water-worn pebbles discontinuously capping a number of hilltops at altitudes between 75 m and 150 m OD: a western quartzite-dominated group in the Windy Hills and Turriff areas (termed the Windy Hills Gravels by McMillan and Merritt (1980) and Windy Hills Formation by Hall (1984c)), and an eastern flint-dominated group on the summits of a broad ridge running north-east from the Hill of Dudwick (NJ 979378) to Stirling Hill (NK 125413) (termed the Buchan Ridge Gravels by McMillan and Merritt (1980) and Buchan Ridge Formation by Hall (1984c)). It has been assumed in the past that these two distinct groups are of the same age although there is no evidence that this is so.

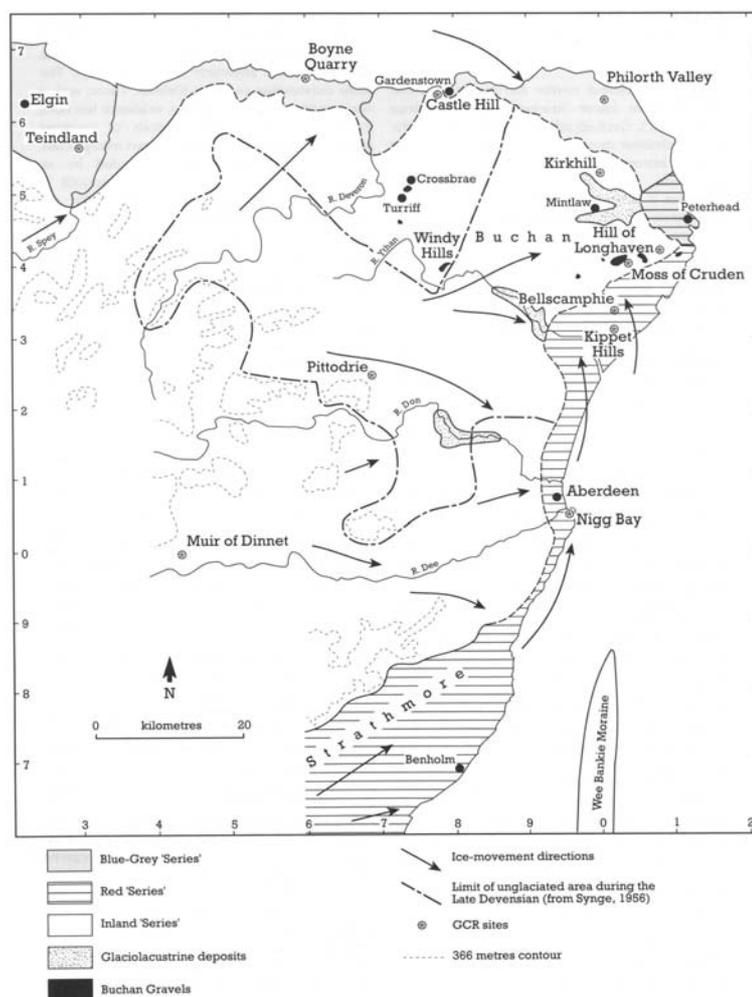


Figure 8.1: Location map and principal features of the Quaternary geomorphology of north-east Scotland (from Hall and Connell, 1991).

Description

The most extensive occurrence and best exposures of the quartzite gravels are at Windy Hills. Detailed accounts of their stratigraphic relations and sedimentary character have been given by Flett and Read (1921), Read (1923), FitzPatrick (1975a, 1975b), Clapperton (1977), McMillan and Merritt (1980) and Kesel and Gemmell (1981). At Windy Hills over 10 m of predominantly quartzite gravels interbedded with white quartz sand overlie deeply weathered and kaolinized pelitic schist (Koppi, 1977; Koppi and FitzPatrick, 1980; Kesel and Gemmell, 1981; Hall *et al.*, 1989a). The quartzite pebbles are comparatively fresh and unweathered and some show chatter marks, in contrast to occasional cobbles of granite and schist, which are nearly always decomposed to a kaolinitic sand. A small number of flint pebbles is also present, some weathered with a dull grey or white rind, and the very rare presence of chert of Lower Cretaceous age is also recorded (Flett and Read, 1921; Hall, 1987). Jamieson (1865) reported the presence of (?) Late Cretaceous fossils typical of the Chalk associated with the flints at Windy Hills, but gave no specific identifications; his observations have not been confirmed. However, among the flints at Delgaty, near Turriff, Christie (1831) found fossils, principally of sponges or alcyonaria. Details of fossils from other sites are given by Salter (1857) and Ferguson (1857).

Clast imbrication and rare cross-bedding indicate that the gravels were deposited by water flowing from approximately west-south-west to east-north-east (McMillan and Merritt, 1980; Kesel and Gemmell, 1981). Preservation of such sedimentary structures implies little disturbance of the gravels since deposition, but the upper 1 m has been cryoturbated. This shows several features associated with periglacial modification: ice-wedge casts up to a metre across, vertically aligned clasts, an indurated horizon, clasts with silt cappings and an increase

in clast concentration at the surface (FitzPatrick, 1975a, 1975b, 1987). The gravels are only overlain by patches of till (Bremner, 1916b; Kesel and Gemmell, 1981), but unweathered erratics have been incorporated into the upper layer of the gravels, probably by frost churning (Clapperton, 1977).

Interpretation

The quartzite of the gravels was considered by Flett and Read (1921) to be unlike that of any known quartzite outcrop in north-east Scotland but was comparable to the quartzite of Scaraben in Caithness. Koppi (1977) and Kesel and Gemmell (1981), however, examined the quartzite in thin section and concluded that it was most probably derived from Banffshire quartzites. This conclusion was supported by the heavy-mineral assemblage associated with the gravels. Hall (1987) has suggested the further possibility that much of the quartzite debris was recycled from Devonian conglomerates.

Jamieson (1858, 1865) originally interpreted the gravels to be locally derived and of pre-glacial marine origin, but later suggested glacial derivation from the floor of the Moray Firth (Jamieson, 1906). Wilson (1886) thought that they were residual deposits from a denuded chalk cover and had been glacially reworked. Flett and Read (1921) concluded that the gravels were remnants of formerly more extensive marine deposits resting on an old platform and were of Tertiary, possibly Pliocene, age.

Recent interpretations are agreed that the Windy Hills gravels are fluvial in origin (McMillan and Merritt, 1980; Kesel and Gemmell, 1981; Hall 1982, 1983, 1987), although Kesel and Gemmell (1981) also considered a glaciofluvial origin as a possibility in view of certain grain-surface textures, identified on a scanning electron microscope, suggestive of glacial transport.

An important facet of the Windy Hills site is that the gravels, together with the associated deep weathering, glacial and periglacial phenomena, hold important clues about landscape evolution and environmental change in north-east Scotland during the late Tertiary and Pleistocene (see also Moss of Cruden):

1. The weathering characteristics of both the gravels and the underlying bedrock led Hall (1983, 1987) to conclude that the gravels were probably Neogene in age, being deposited along a proto-Ythan valley. Subsequent surface lowering has resulted in topographic inversion with the gravels now occupying hill-top positions.
2. The presence of flint has been used as evidence of Late Cretaceous marine transgression (Wilson, 1886; Flett and Read, 1921; Hall, 1983, 1987).
3. Hall (1983, 1985, 1987) associated the kaolinitic alteration in the gravels and the underlying bedrock with his clayey gress weathering type. The latter is older (probably Miocene in age) than the gress weathering type (Pliocene to Pleistocene in age) based on a greater degree of alteration (see Hall *et al.*, 1989a).
4. The occurrence of deep-weathering profiles and the Windy Hills and Buchan Ridge gravels also testify to the limited and selective nature of glacial erosion in the Buchan area (Clayton, 1974; Hall, 1982, 1986; Hall and Sugden, 1987), despite the evidence for repeated ice-sheet invasion during the Quaternary (see Kirkhill).

Windy Hills is the most important locality for the quartzite gravels of probable Tertiary age of north-east Scotland. The site is complementary to that of Moss of Cruden, where flint gravels of broadly similar age are preserved, although the origin of the two gravel bodies may not be the same. The gravels provide a rare insight into the middle to late Tertiary environment of north-east Scotland and their occurrence, together with that of contemporaneous deep-weathering profiles, provides an important reference level for the extent of glacial erosion in this region.

Conclusions

Windy Hills is the type area for the famous quartzite gravels of Buchan. These deposits are now

agreed to have been formed by a pre-Quaternary river; subsequent erosion has lowered the adjacent landscape, leaving the gravels in their present hill-top location. The gravels show evidence of weathering and frost-disturbance and are locally overlain by glacial deposits. They are important for the unique evidence they provide about the long-term evolution of the landscape in north-east Scotland, both before and during the Quaternary ice ages.

Reference list

- Bremner, A. (1916b) Problems in the glacial geology of northeast Scotland and some fresh facts bearing on them. *Transactions of the Edinburgh Geological Society*, **10**, 334–47.
- Christie, J. (1831) On the occurrence of chalk-flints in Banffshire. *Edinburgh New Philosophical Journal*, **10**, 163–4.
- Clayton, K.M. (1974) Zones of glacial erosion. *Institute of British Geographers Special Publication*, **7**, 163–176.
- Ferguson, W. (1850) Notice of the occurrence of chalk flints and Greensand fossils in Aberdeenshire. *Philosophical Magazine*, **37**, 430–8.
- Ferguson, W. (1855) On the geological features of part of the district of Buchan, in Aberdeenshire, including notes on the occurrences of chalk-flints and Greensand. *Proceedings of the Philosophical Society of Glasgow*, **3**, 35–50.
- Ferguson, W. (1857) Note on the chalk-flints and Greensand found in Aberdeenshire. *Quarterly Journal of the Geological Society of London*, **13**, 88–9.
- Ferguson, W. (1877) On the occurrence of chalk flints and Greensand fossils in Aberdeenshire. *Transactions of the Edinburgh Geological Society*, **3**, 112–21.
- Ferguson, W. (1893) On the occurrence of chalk flints and Greensand in the north-east district of Aberdeenshire. *Transactions of the Buchan Field Club*, **3**, 61–78.
- FitzPatrick, E.A. (1975a) Particle size distribution and stone orientation patterns in some soils of north east Scotland. In *Quaternary Studies in North-east Scotland* (ed. A.M.D. Gemmell). Aberdeen, Department of Geography, University of Aberdeen, 49–60.
- FitzPatrick, E.A. (1975b) Windy Hills. In *Aberdeen Field Excursion Guide*. Aberdeen, Quaternary Research Association, 23–5.
- FitzPatrick, E.A. (1987) Periglacial features in the soils of north-east Scotland. In *Periglacial Processes and Landforms in Britain and Ireland* (ed. J. Boardman). Cambridge, Cambridge University Press, 153–62.
- Flett, J.S. and Read, H.H. (1921) Tertiary gravels of the Buchan district of Aberdeenshire. *Geological Magazine*, **58**, 215–25.
- Gemmell, A.M.D. and Kesel, R.H. (1979) Developments in the study of the Buchan flint deposits. In *Early Man in the Scottish Landscape* (ed. L.M. Thoms). *Scottish Archaeological Forum*, **9**. Edinburgh, Edinburgh University Press, 66–77.
- Gemmell, A.M.D. and Kesel, R.H. (1982) The 'Pliocene' gravels of Buchan: a reappraisal: reply. *Scottish Journal of Geology*, **18**, 333–5.
- Hall, A.M. (1982) The 'Pliocene' gravels of Buchan: a reappraisal: discussion. *Scottish Journal of Geology*, **18**, 336–8.
- Hall, A.M. (1983) Deep weathering and landform evolution in north-east Scotland. Unpublished PhD thesis, University of St Andrews.
- Hall, A.M. (1984c) Central Buchan. In *Buchan Field Guide* (ed. A.M. Hall). Cambridge, Quaternary Research Association, 27–45.
- Hall, A.M. (1985) Cenozoic weathering covers in Buchan, Scotland and their significance. *Nature*, **315**, 392–5.
- Hall, A.M. (1986) Deep weathering patterns in north-east Scotland and their geomorphological significance. *Zeitschrift für Geomorphologie*, NF, **30**, 407–22.
- Hall, A.M. (1987) Weathering and relief development in Buchan, Scotland. In *International Geomorphology 1986*. Part II. (ed. V. Gardiner). Chichester, John Wiley and Sons Ltd, 991–1005.
- Hall, A.M. and Sugden, D.E. (1987) Limited modification of mid-latitude landscapes by ice sheets. *Earth Surface Processes and Landforms*, **12**, 531–42.
- Hall, A.M., Mellor, A.M. and Wilson, M.J. (1989a) The clay mineralogy and age of deeply weathered rocks in north-east Scotland. *Zeitschrift für Geomorphologie*, NF, Supplementband, **72**, 97–108.
- Jamieson, T.F. (1858) On the Pleistocene deposits of Aberdeenshire. *Quarterly Journal of the*

-
- Geological Society of London*, **14**, 509–32.
- Jamieson, T.F. (1865) On the history of the last geological changes in Scotland. *Quarterly Journal of the Geological Society of London*, **21**, 161–203.
- Jamieson, T.F. (1874) On the last stage of the glacial period in North Britain. *Quarterly Journal of the Geological Society of London*, **30**, 317–38.
- Jamieson, T.F. (1882b) On the Red Clay of the Aberdeenshire coast and the direction of ice-movement in that quarter. *Quarterly Journal of the Geological Society of London*, **38**, 160–77.
- Jamieson, T.F. (1906) The glacial period in Aberdeenshire and the southern border of the Moray Firth. *Quarterly Journal of the Geological Society of London*, **62**, 13–39.
- Kesel, R.H. and Gemmell, A.M.D. (1981) The 'Pliocene' gravels of Buchan: a reappraisal. *Scottish Journal of Geology*, **17**, 185–203.
- Koppi, A.J. (1977) Weathering of Tertiary gravels, a schist, and a metasediment in north-east Scotland. Unpublished PhD thesis, University of Aberdeen.
- Koppi, A.J. and FitzPatrick, E.A. (1980) Weathering in Tertiary gravels in north-east Scotland. *Journal of Soil Science*, **31**, 525–32.
- McMillan, A.A. and Aitken, A.M. (1981) The sand and gravel resources of the country west of Peterhead, Grampian Region. Description of 1:25,000 Sheet NK04 and parts of NJ94, 95 and NK05, 14 and 15. *Mineral Assessment Report, Institute of Geological Sciences*. No. 58, 99pp.
- McMillan, A.A. and Merritt, J.W. (1980) A reappraisal of the 'Tertiary' deposits of Buchan, Grampian Region. *Report of the Institute of Geological Sciences*, No. 80/1, 18–25.
- Merritt, J.W. (1981) The sand and gravel resources of the country around Ellon, Grampian Region. Description of 1:25,000 resource sheets NJ93 with part of NJ82, 83 and 92, and NK03 and parts of NK02 and 13. *Mineral Assessment Report, Institute of Geological Sciences*, No. **76**, 114pp.
- Merritt, J.W. and McMillan, A.A. (1982) The 'Pliocene' gravels of Buchan: a reappraisal. *Scottish Journal of Geology*, **18**, 329–32.
- Read, H.H. (1923) The Geology of the country round Banff, Huntly and Turriff. (Lower Banffshire and north-west Aberdeenshire). (Explanation of Sheets 86 and 96). *Memoirs of the Geological Survey of Scotland*. Edinburgh, HMSO, 240pp.
- Salter, J.W. (1857) On the Cretaceous fossils of Aberdeenshire. *Quarterly Journal of the Geological Society of London*, **13**, 83–7.
- Wilson, J.S.G. (1886) Explanation of sheet 87. North-east Aberdeenshire, and detached portions of Banffshire. *Memoirs of the Geological Survey of Scotland*. Edinburgh, HMSO, 32pp.