Site 14 Moss of Cruden ('Buchan Ridge')

The Moss of Cruden, 11 km south-west of Peterhead, is an area of unusual geological interest (Hall, 1993a) (Figure A1.18). Together with the Moss of Auquharney, the Corse of Balloch and the Hill of Aldie, it forms part of the so-called 'Buchan Ridge' (Flett and Read, 1921) ((Figure 22), (Map 7)), a gently rounded, featureless, east-north-east-trending ridge that attains an elevation of about 140 m above OD. It provides the type localities for the Smallburn Sandstone, a small outlier of Devonian sandstone, the Moreseat Sandstone, a concealed outlier of Early Cretaceous age, and the Buchan Ridge Gravel Member of the Buchan Gravels Formation, of Neogene age. It also includes the important Late Pleistocene interstadial site at Camp Fauld. These sites are described in turn.

Smallburn Sandstone Formation

The Smallburn Sandstone Formation occupies a small area on the northern flank of the Moss of Cruden [NK 023 403]. Exposure is poor, but shallow pitting indicates that the sandstone rests on diorite and is partially concealed beneath Lower Cretaceous Moreseat Sandstone (Figure A1.18). The Smallburn Sandstone is a red-brown arkose, whose grains comprise dominantly quartz, with sudsidiary feldspar and lithic fragments of diorite and granite. Quartz and hematite coatings occur on grain surfaces, but development of quartz overgrowths is limited. Preserved porosity varies from 13 to 19 per cent. Clay mineralogy is dominated by interstratified mica-smectite, with some illite (information from R A Downie, Downie Geoscience Ltd, 62 Durwood Avenue, Shawlands, Glasgow). No palynomorphs appear to be preserved in the formation (information from L A Riley, Bovingdon, Herts, 1997).

Moreseat Sandstone Formation

Weathering and glacial disturbance of the Moreseat Sandstone Formation is widespread and it is only in the ground north of Moreseat that relatively fresh material was recovered from the base of trial pits (Figure A1.18). The Moreseat Sandstone here is a very dark grey, porous silty fine-grained glauconitic quartz arenite. Bioturbation is common, and burrows and moulds of mollusca are present. The rock contains well-preserved palynomorphs indicating a Late Hauterivian to Early Barremian age (information from

W Braham). Thin sections reveal a spicular quartz sandstone with a mixed terrigenous/calcareous mud matrix. Grains are dominantly of quartz, but, prior to the development of voids (moulds) after the dissolution of mollusc fragments and foraminifera, the dominant grain type would have been sponge spicules. Feldspar grains and bioclastic debris have also undergone significant dissolution. Macroporosity is around 30 per cent (information from A R Duncan, Maud, Aberdeenshire, 1997).

The Lower Cretaceous rocks north of the Moss of Cruden were originally fine-grained sandy siltstones, but they are typically decomposed to clayey fine-grained sands and sandy silty clays of vivid orange, tangerine, yellow and white hues.

Buchan Ridge Gravel Member

The Moss of Cruden is the type area of the Buchan Ridge Gravel Member, part of the Buchan Gravels Formation (compare with Flett and Read, 1921; McMillan and Merritt, 1980) (Figure 22). Exposures also occur at Skelmuir Hill (Bridgland et al., 1997), Whitestones Hill (Kesel and Gemmell, 1981) and Den of Boddam (Bridgland et al., 1997), and other concealed, small gravel masses may well exist (Flett and Read, 1921). At Moss of Cruden, the gravel deposit forms a broad ridge, orientated north-east–south-west, some of the highest ground in this part of Buchan. The type section of the Buchan Ridge Gravel Member occurs in BGS Borehole NK04SW/3 on the highest point of the ridge (McMillan and Merritt, 1980) (Figure A1.18), which proved at least 25 m of coarse flint and quartzite gravel, interbedded with pebbly sand and commonly bound by white kaolinitic clay. Reference sections have been recorded in temporary pits at Moss of Cruden (BGS records), Skelmuir Hill [NJ 987 413] (Bridgland et al., 1997), Boddam [NK 113 415] (Bridgland et al., 1997)

and in BGS Borehole NK04SE/6, near Berryley (McMillan and Merritt, 1980).

The Buchan Ridge Gravel Member is poorly exposed. Temporary excavations and boreholes show white, clay-bound coarse gravels with minor sand and silt units (Merritt, 1981). Gravel clasts are dominantly flint with subsidiary quartzite and vein-quartz. Clasts are generally well-rounded pebbles and cobbles and bear numerous chatter marks. The deposits originally contained less resistant clasts, probably mainly granite, but these have decomposed to ghosts of white sandy clayey silt. This decomposition extends throughout the known thickness of the deposit into the underlying granite and gneiss bedrock. Both sand and gravel units are bound and, in places, supported by, white, sandy clayey silt consisting of well-ordered kaolinite with minor illite (Hall, 1982).

The base of the Buchan Ridge Gravel Member in places contains large nodules of flint and boulders of quartzite (Plate 5a), (Plate 5b). Quartzite blocks up to 30 cm in diameter were recovered from a trial pit close to the western margin of the gravels at Moss of Auquharney [NK 019 400]. In pits at an elevation of approximately 130 m [NK 028 403] the base of the gravels revealed a lag of unworn, nodular flint with blocks up to 25 cm in diameter. In places the gravel is partially cemented by iron concretions containing goethite. Similar deeply weathered boulder gravel containing large nodular flints occurs on Skelmuir Hill at an elevation of about 148 m OD (Bridgland et al., 2000). The Buchan Ridge Gravel Member rests on kaolinised granite and metasedimentary rock (McMillan and Aitken, 1981; Hall et al., 1989) and on highly weathered Lower Cretaceous Moreseat Sandstone (Hall and Jarvis, 1994).

A ground probing radar survey (Greenwood et al., 1995) on the northern slope of the Moss of Cruden has confirmed that the feather edge of the Buchan Ridge Gravel Member rests on weathered Lower Cretaceous sandstone (see Appendix 3). Within undisturbed parts of the Buchan Ridge Gravel Member, low-angle cross-stratification dips towards the axis of the ridge ((Figure A3.3); line 1). Resistivity depth probes and ground probing radar indicate that around 15 m of Buchan Ridge Gravel Member lies beneath the crest of the ridge, resting on weathered granite. The gravels here fill a channel running north-east–south-west and parallel to the line of the ridge.

The Buchan Ridge Gravel Member is overlain by a variable thickness of till, and disturbance attributed to overriding ice is common. At Corse of Balloch, BGS Borehole NK04SW/4 (McMillan and Merritt, 1980) indicates that in situ Buchan Ridge Gravel Member is overlain by almost 10 m of till, derived in large part from the underlying gravel. Temporary excavations east of Camp Fauld revealed rafts of flint and quartzite gravel within till (Whittington et al., 1993). To the north of the ridge, a sheet of soliflucted flint gravel, up to 2 m thick, extends well downslope on to weathered granite (Hall, 1993a). This gravel forms part of the 'Flint-quartzite Head' deposits described in Chapter 6 that are widespread around the Buchan Ridge on sheets 87W Ellon and Peterhead 87E Peterhead (Maps 6 and 7).

Camp Fauld

This site [NK 049 410] lies on the southern slope of the Moss of Cruden, about 900 m north-west of Moreseat ((Figure A1.19), (Map 7)). It is important for the presence of a buried peat of probable Early Devensian age that separates two till units (Whittington et al., 1993). The lithostratigraphy described below generally follows that set up by Whittington et al. (1993), but in order to adhere more closely to internationally agreed guidelines on lithostratigraphical nomenclature, new names have been adopted here ((Table 7); (Figure A1.8)). Those proposed recently by Sutherland (1999) are not appropriate.

The stratigraphy is known only from trial pits. The oldest deposit recognised is the Camp Fauld Till Formation. This is at least 2 m thick and is a grey (2.5Y N5) to very dark grey (7.5YR N3) massive to crudely horizontally bedded diamicton with sparse pebbles. Clast lithologies comprise mainly rounded quartzite and flint, with lesser amounts of subangular granite, basic igneous, red sandstone and soft grey siltstone clasts. The matrix is a micaceous sandy silt and clay mineralogy is largely kaolinite, illite-smectite and minor glauconite. The diamicton rests on, and locally passes down into, and incorporates rafts of Moreseat Sandstone. The direction of ice flow during deposition of the Camp Fauld Till is difficult to establish owing to the dominance of very locally derived material. The presence of clasts of grey granite and red sandstone suggest transport from local outcrops to the west of the site.

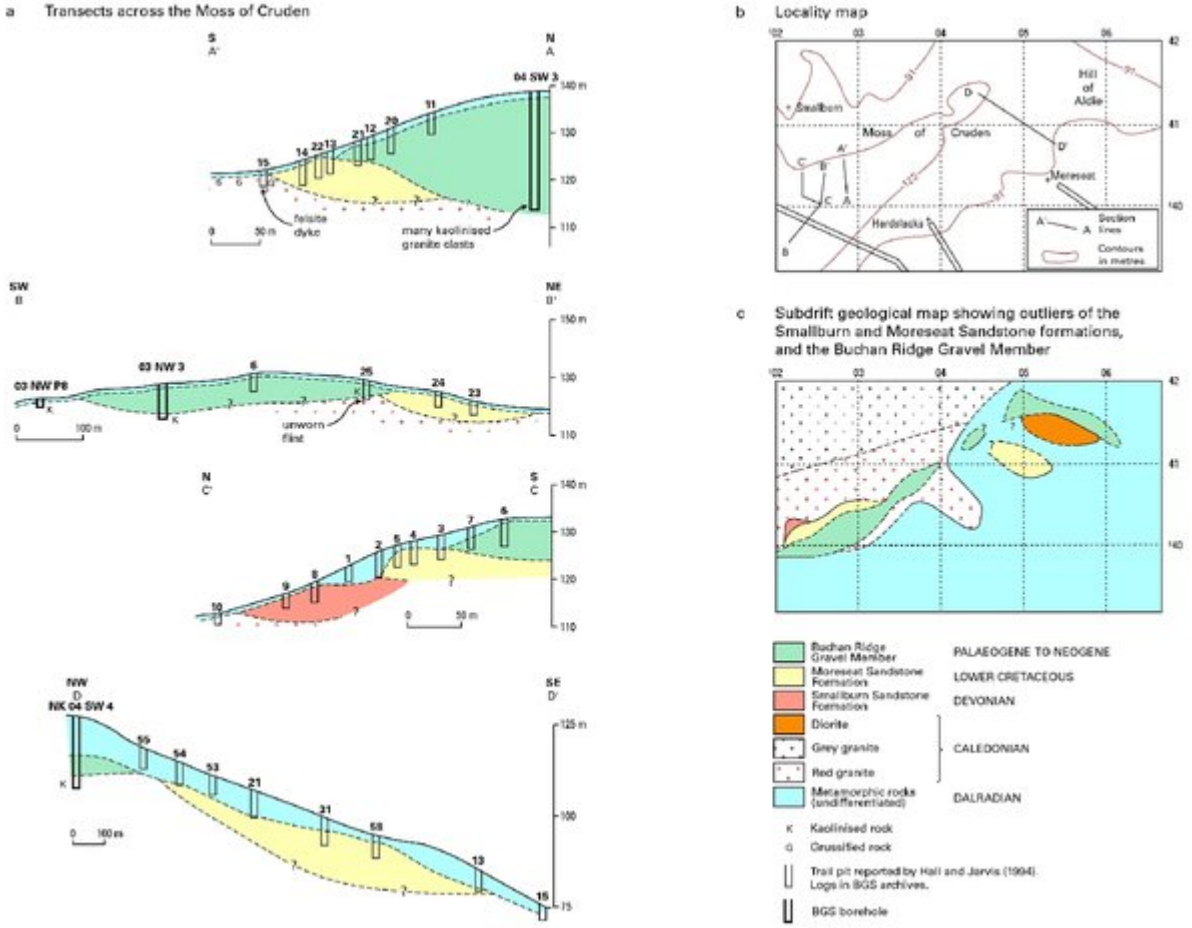
The Berryley Peat Bed is up to 0.5 m thick in pit A and rests on the mottled top of the Camp Fauld Till (Figure A1.19). The peat is truncated by, and both reworked and sheared into, the lower 30 cm of the overlying Aldie Till. In Pit B, the peat bed rests on bedrock and is overlain by sands and gravels containing stringers of peat. This unit is separated from the overlying Aldie Till by a gravel-rich diamicton with a strong downslope clast fabric (Figure A1.19). This intervening deposit, named here as the Hardslacks Gelifluctate Bed, appears to mark a phase, or phases, of periglacial conditions and slope instability.

The Aldie Till at Camp Fauld is a greenish grey (5GY 6/1) sandy diamicton that is massive or shows a crude horizontal bedding and is up to 2.5 m thick. Clast lithology is dominated by broken rounded pebbles and cobbles of flint and quartzite reworked from the Buchan Gravels Formation, with sparse mica-schist, granite, basic igneous and red sandstone clasts. The matrix is kaolinitic quartz sand. Away from the type-site, the character of the Aldie Till varies greatly in response to marked lateral changes in bedrock and even drift geology. On the Buchan Ridge Gravels at Hill of Aldie, the Aldie Till closely resembles that at Camp Fauld. However, in the area underlain by the Moreseat Sandstone Formation, it is indistinguishable from the underlying Camp Fauld Till. To the north and east of Camp Fauld, the Aldie Till partly incorporates large masses of weathered brown sand with sparse quartzite clasts of unknown derivation and origin. This sand, named here as the Moreseat Farm Sand Bed, was also probably formerly exposed at an infilled gravel pit [NK 0529 4108], from where a cobble of brown, porous arkose of Lower Cretaceous appearance was recovered in 1979. BGS Borehole NK04SE/2 shows that this unit of sand is up to 7 m thick, and rests on a dark grey till that may be equivalent to the Camp Fauld Till.

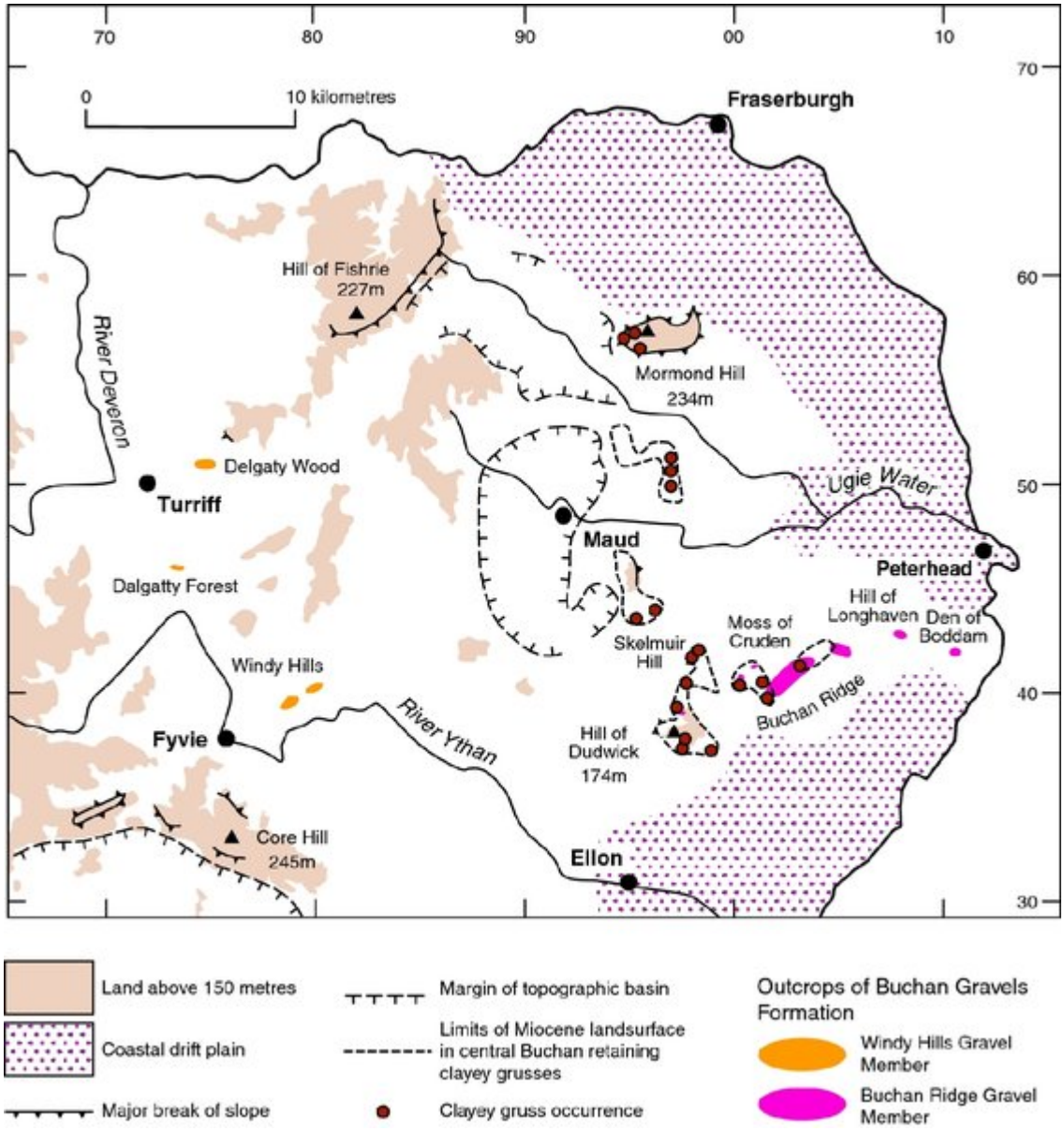
South and east of Moreseat, the Aldie Till passes beneath red clayey diamictons of the Logie-Buchan Drift Group. It thickens on the southern and eastern slopes of the Moss of Cruden in accord with the apparent eastward carry of flint and red granite from the Moss of Cruden, and its weak north-west–south-east clast fabric. These features indicate that the unusual till thickness is probably a product of only minor subsequent glacial erosion as it lies in the lee of the Buchan Ridge. The presence of red granite erratics on the Moss of Cruden has been used to infer ice movement from the north-east prior to the last glaciation (Bremner, 1934a, 1939; Synge, 1956). However, the situation is complicated by the presence of coarse-grained red granites, similar to the Peterhead Granite, in the ground 1 km north and west of Moreseat.

The Berryley Peat Bed has yielded radiocarbon ages (SRR–3724) of 39 590 ± 550 BP for the humic fraction and 34 600 ± 910 BP for the humin fraction (Whittington et al., 1993) and luminescence ages of 160 ± 16 and 251 ± 24 ka BP (Duller et al., 1995). The significance of these contrasting ages is uncertain. Pollen analysis of peat layers from the adjacent pits suggests that the peat formed during an interstadial in which birch–pine woodland first developed, probably followed by tundra vegetation in which *Bruckenthalia spiculifolia* was present. This heath is found today in the Balkan Mountains, but is extinct in Scotland (Whittington, 1994). The vegetation assemblage of the Berryley Peat, including the presence of *Bruckenthalia*, is akin in certain aspects to that found at other Early Devensian sites in Scotland at Allt Odhar and Sel Ayre. Hence, the Berryley Peat may correlate with Oxygen Isotope Stage 5c or 5a, when pine–birch woodlands developed widely in north-west Europe during the Brørup and Odderade Interstadials (Behre, 1989) (Figure 7).

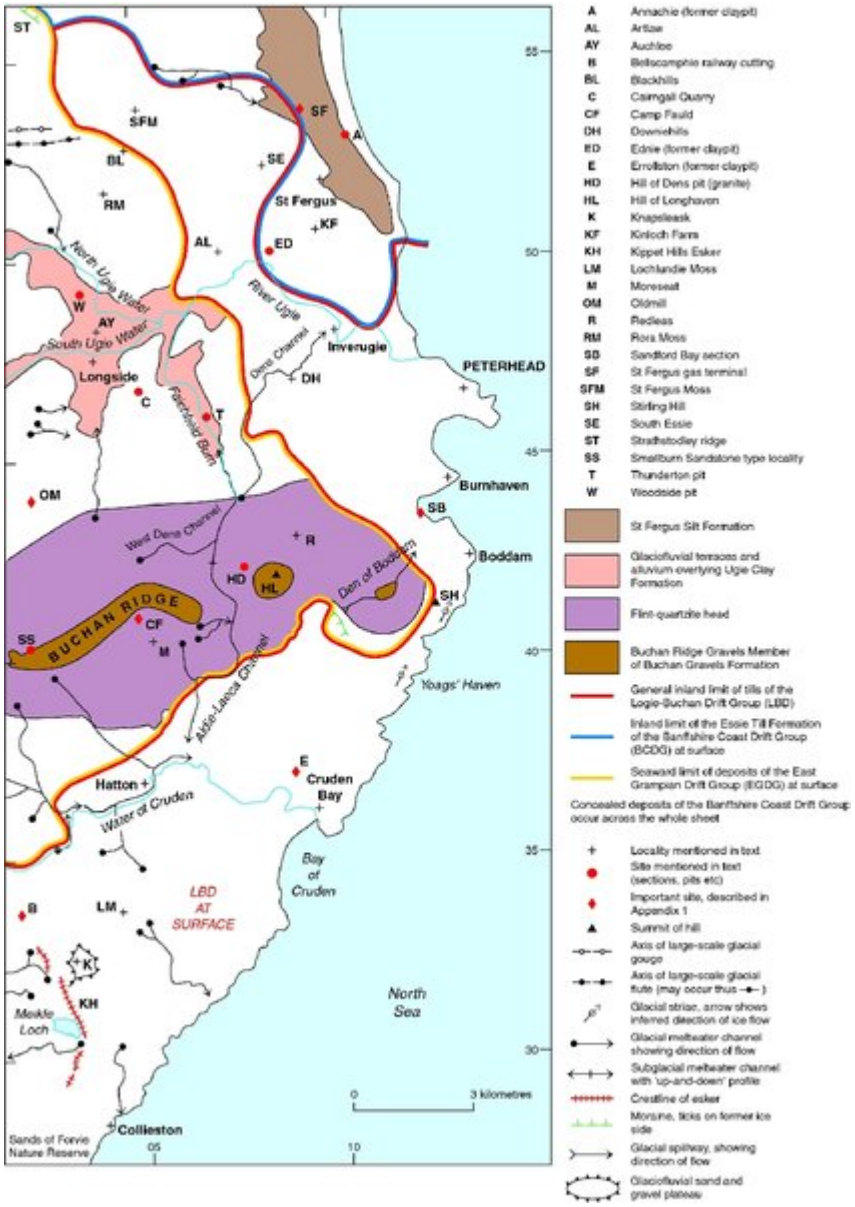
References



(Figure A1.18) Investigations on the Buchan Ridge (after Hall and Jarvis, 1994).



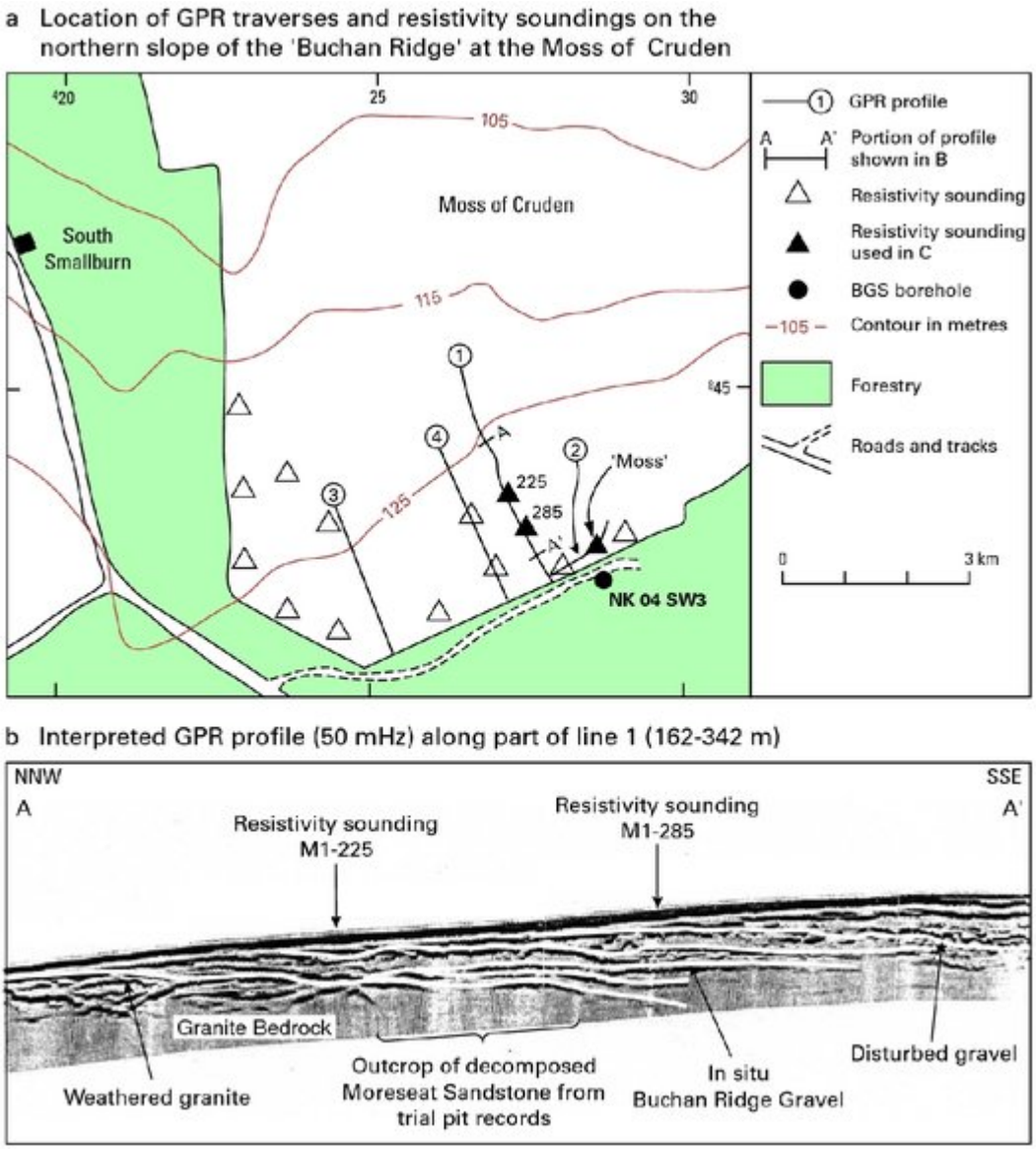
(Figure 22) Distribution of Miocene land surface and major topographical features (after Hall, 1985).



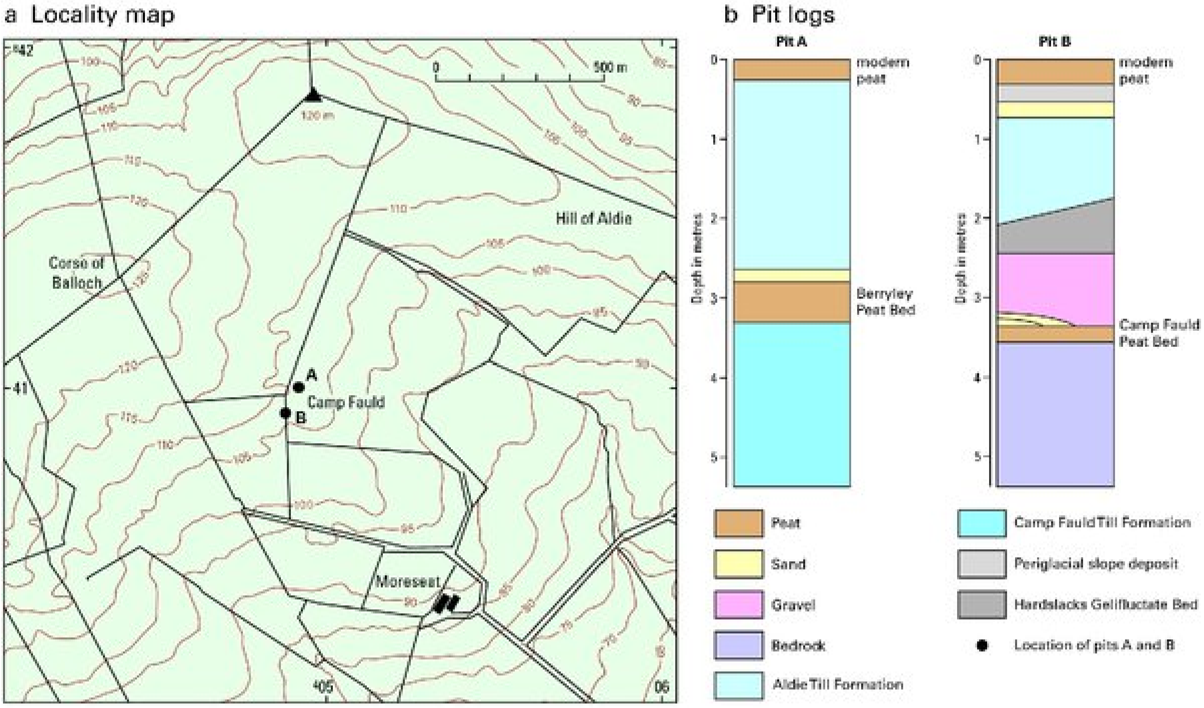
(Map 7) Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 87E Peterhead.

(Plate 5a) Flint clasts recovered from the base of the Buchan Ridge Gravel Member in a trial pit on the Moss of Cruden [NK 0253 4024]. Little-worn flints such as these were either derived directly from a former cover of Chalk in the area or from a remanié flint deposit. This evidence suggests that the present terrain lies close to the level of the sub-Cenomanian surface. (a P104122, b P104121).

(Plate 5b) Flint clasts recovered from the base of the Buchan Ridge Gravel Member in a trial pit on the Moss of Cruden [NK 0253 4024]. Little-worn flints such as these were either derived directly from a former cover of Chalk in the area or from a remanié flint deposit. This evidence suggests that the present terrain lies close to the level of the sub-Cenomanian surface. (a P104122, b P104121).



(Figure A3.3) Buchan Ridge. a Location of GPR traverses and resistivity soundings on the northern slope of the 'Buchan Ridge' at the Moss of Cruden b Interpreted GPR profile (50mHz) along part of line 1 (162–342 m).



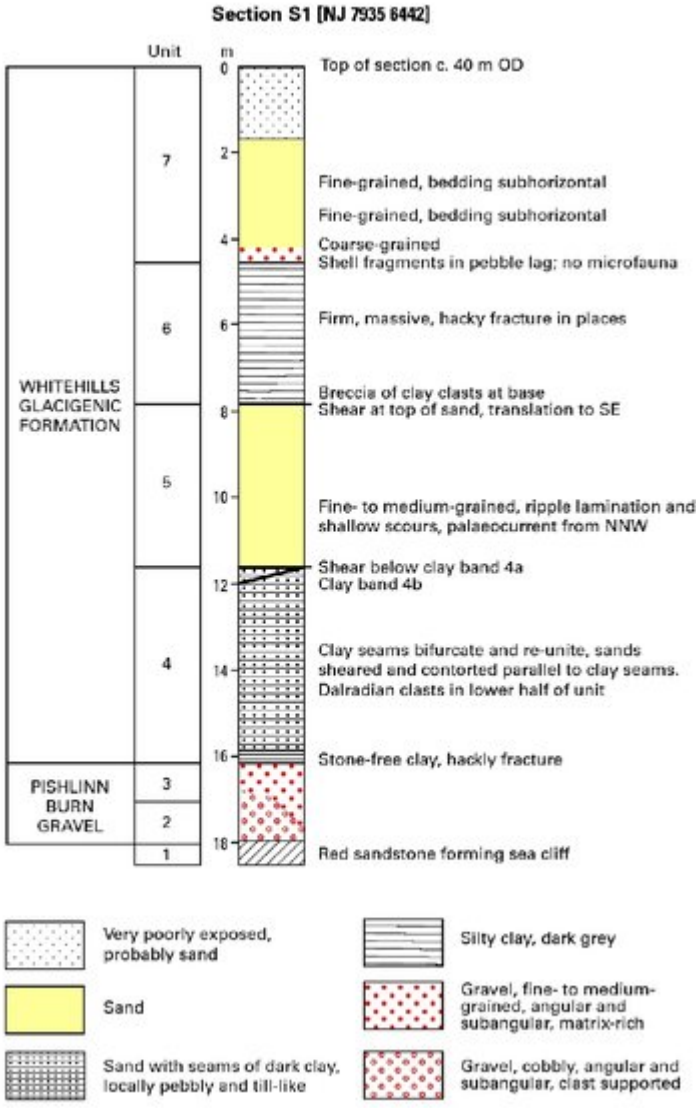
(Figure A1.19) Camp Fauld site (after Whittington et al., 1993).

Oxygen Isotope Stage	Teindland/Elgin	Boyne Limestone Quarry/Keith	Gardenstown/Banff	Byth/Crossbrae	Kirkhill/Leys	Peterhead/Cruden	Ellon/Fyvie	Aberdeen	Banchory	Stonehaven
Flandrian (Holocene) 1										
Loch Lomond Stadial 2a		Garral Hill Gelifluctate Bed		Todholes Gravel Bed			Woodhead Gelifluctate Bed			
Windermere Interstadial 2b		Garral Hill Peat Bed		Thistlehill Peat Bed			Woodhead	Mill of Dyce Peat Bed	Loch of Park Gyttja Bed	Glenbervie Peat Bed
Dimlington Stadial 2c	Spynie Clay Formation Waterworks Till Formation Tofthead Till Formation	Kirk Burn Silt Formation Airnhoth Till Member Blackhills Sand & Gravel Formation Old Hythe Till Formation	Kirk Burn Silt Formation Airnhoth Till Member Blackhills Sand & Gravel Formation Crovie Till Formation	Crossbrae Gelifluctate Bed Auchmedden Gravel Formation Byth Till Formation	Manse Gelifluctate Bed Kirkhill Church Sand Formation East Leys Till Formation Hythe Till Formation	St Fergus Silt Formation Ugie Clay Formation Essie Till Formation Hatton Till Formation Sandford Bay Till Member	Ugie Clay Formation Kippet Hills Sand & Gravel Hatton Formation Bearnie Till Member Auchinachries Sand & Gravel Formation	Tullos Clay Member Drumlithie Sand & Gravel Formation Glen Dye Silts Formation Mill of Forest Till Formation Nigg/Kingswells Till members Ness Sand & Gravel Member Den Burn Till Member	Lochton Sand & Gravel Formation Glen Dye Silts Formation Banchory Till Formation	Drumlithie Sand & Gravel Formation Ury Silts Formation Mill of Forest Till Formation
early Late Devensian glaciation	Allanside Till Formation	Whitehills Glacigenic Formation	Whitehills Glacigenic Formation		Corse Diamicton Formation	Rafts at Oldmill	Pitlurg Till Formation	Anderson Drive Diamicton Formation		
3				Howe of Byth Gravel Formation	Corsend Gelifluctate Bed					
4	Woodside Diamicton Formation		Pishlins Burn Gravel Bed			Aldie Till Formation Hardslacks Gelifluctate Bed				
5a-d	Badentinan Sand Bed			Crossbrae Farm Peat Bed		Berryley Peat Bed				Burn of Benholm Peat Bed
Ipswichian Interstadial 5e	Teindland Palaeosol Bed Orbliston Sand Bed	Truncated palaeosol			Fernieslack Palaeosol Bed	Moreseat Farm Sand Bed				
6?	Deanshillock Gravel Formation Red Burn Till Formation	Crag of Boyne Till Formation		Crossbrae Till Formation	Rottenhill Till Formation West Leys Sand & Gravel Formation Camphill Gelifluctate Bed Bellmedden Sand Bed	Camp Fauld Till Formation	Pitlurg Till in part? Tillybrex Sand & Gravel Formation Bellscamphie Till Formation			Benholm Clay Formation Birnie Gravel Formation
7?					Kirkhill Palaeosol Bed					
8?					Pitsow Sand & Gravel Formation Kirkton Gelifluctate Bed Denend Gravel Formation Leys Till Formation					
References	Hall et al. (1995)	Sheet 86W Godwin and Willis (1959) Peacock and Merritt (2000a)	Sheet 96E Peacock and Merritt (1997)	Hall et al. (1995) Whittington et al. (1998)	Connell and Hall (1987)	Sheet 87E Connell and Hall (1987) Whittington et al. (1993)	Sheet 87W Connell and Hall (1987) Hall and Jarvis (1993)	Bremner (1931, 1943) McLean (1977) Munro (1986) Murdoch (1977)	Sheet 66E Vasari (1977)	Sheet 67 Auton et al. (2000)

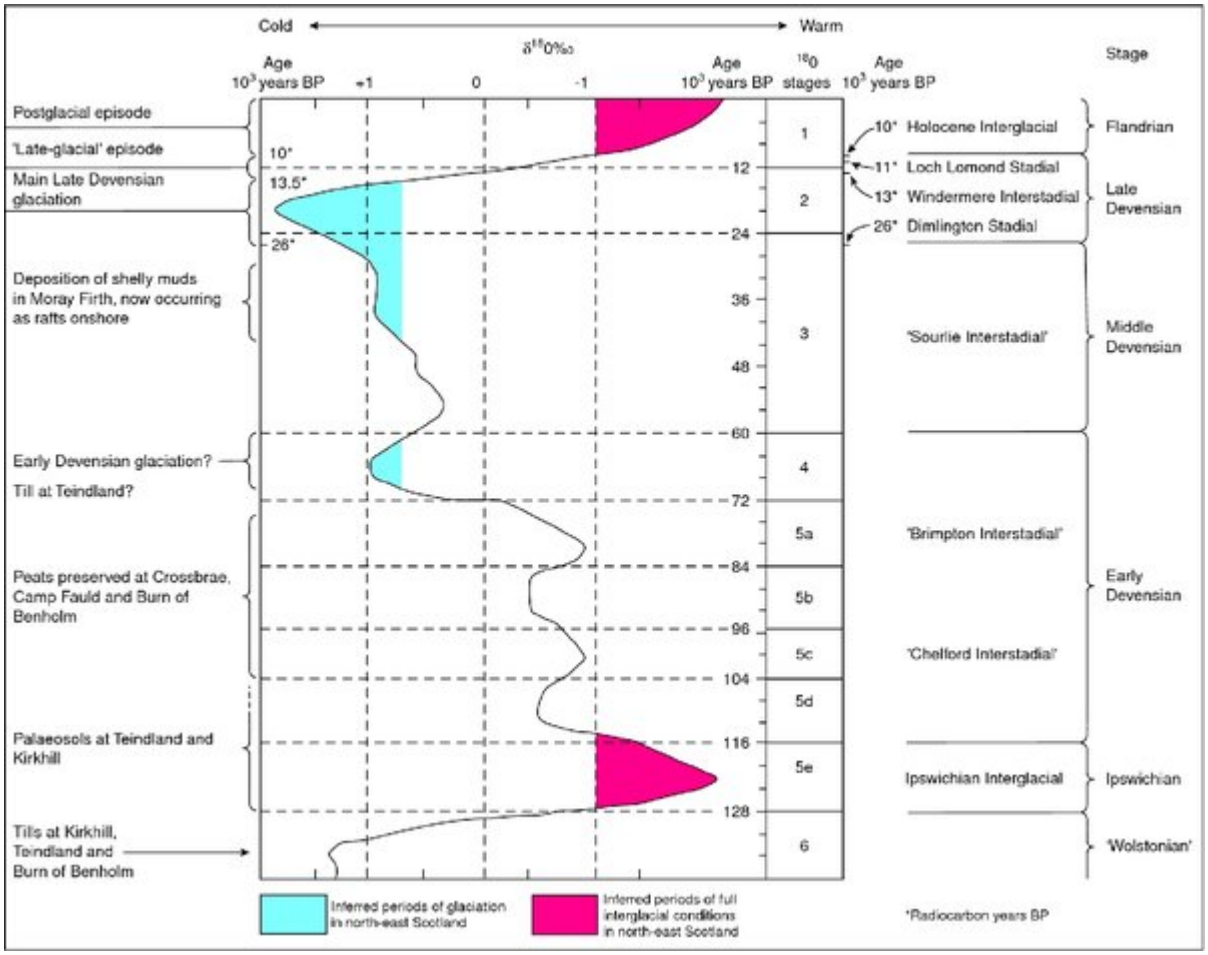
NOTE: In general, minimal ages are shown. For example, Crossbrae Gelifluctate Bed may be OIS 2c to 4, Anderson Drive Diamicton may be OIS 6, Kirkhill Palaeosol Bed may be OIS 9 or 11.
All Peat and Palaeosol beds are assigned to the group of the underlying or enclosing deposit.
Italicised units are informal: they have not been entered into the BGS Lexicon.

Central Grampian Drift Group East Grampian Drift Group Banffshire Coast Drift Group Logie-Buchan Drift Group Mearns Drift Group [box] Dated unit

(Table 7) Correlation of lithostratigraphical units in north-east Scotland.



(Figure A1.8) Lithological log of Section S1 at Castle Hill (after Peacock and Merritt, 1997).



(Figure 7) The 'SPECMAP' oxygen isotope curve for the last glacial—interglacial cycle (after Imbrie et al., 1984) with climato-stratigraphical stages and selected events in north-east Scotland.