Glaciofluvial deposits, Quaternary, Cainozoic of north-east Scotland


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Glaciofluvial deposits

Glaciofluvial deposits are sediments laid down primarily by waters issuing from ice sheets and glaciers. The source of the water also includes rainfall and run-off from ice-free slopes as well as melting ice. Two main categories of deposit have been distinguished on the basis of their geomorphology and shown on all the 1:50 000 maps of the district, but the name applied to these categories varies from map to map (table below). On the more recently published maps, mounded deposits are classified as ice-contact deposits whereas terraced spreads are termed sheet deposits. The two categories are described in general terms below, before details are given. As glaciofluvial deposits are commonly laid down some distance away from former ice margins, the link between ice-source and deposit is less strong than in tills, and it is therefore more practical to describe their areal distribution rather than by lithostratigraphical group.

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**Glaciofluvial ice-contact deposits**

Deltaic foresets dipping eastwards, capped by poorly stratified topset gravel at Lochinvar pit, near Elgin. P104109.

Climbing ripple-drift cross-lamination in deltaic sands at Kirkmyres pit, near Fraserburgh. P104110.

Glaciofluvial ice-contact deposits consist mainly of sand and gravel, but include subsidiary beds of diamicton, silt and clay (P104109; P104110). The sediments were laid down in supraglacial, englacial, subglacial and ice-marginal drainage systems. Hummocky topography is characteristic, but flat-topped plateaux are also included. Steep-sided ridges of gravel (eskers) are shown.
individually on the 1:50 000 geological maps where space permits, whereas rounded hillocks of sand and gravel (kames) and flat-topped mounds (kame-plateaux) are not delineated from other, more irregularly shaped mounds and undulating spreads. Ice-contact deposits are typically associated with kettleholes, which are the result of buried masses of ice melting out slowly after deposition of the sediment surrounding and overlying them. Steep slopes that were formerly in contact with the ice are commonly still recognisable. The kames and kame-plateaux are composed typically of laminated muds that coarsen upward into sands and then gravelly deposits that formed as fan-deltas in ephemeral ice-marginal lakes. Lenses of diamicton and large boulders are common, having been deposited as debris flows, slurry and falls directly from the ice surface onto the accumulating glaciofluvial sediments.

The moundiness of ice-contact deposits is mainly the result of postdepositional collapse of the sediment bodies once the ice supporting them had melted. The sediments forming such mounds are commonly offset by normal faults. Reverse faults commonly occur where sediments have sagged into basinal structures (McDonald and Shilts, 1975). As glacier-ice rarely becomes totally stagnant as it melts out, many ice-contact deposits have been ‘nudged’, and in places more severely deformed, by minor glacial advances. Deposits formed at such active ice fronts are commonly disrupted by thrust faults and have been glacially overridden locally, leading to compaction and the deposition of till. Sequences such as these can be very complicated and therefore difficult to appraise and exploit commercially as aggregates.

The district does not include many large eskers and those that do occur are generally isolated, low-lying ribbon eskers that were laid down by subglacial meltwaters at retreating ice margins. Eskers are formed mainly of gravel, but it is commonly very coarse and bouldery.

**Glaciofluvial sheet deposits**

Glaciofluvial sheet deposits were laid down mainly by braided streams in a proglacial environment leading to the accumulation of fan-shaped, elongate bodies and spreads of ‘outwash’ sand and gravel (sandur). Distinct terraces formed when parts of the outwash plain, or fan, were abandoned as streams graded to lower levels. Although sandar deposits generally become less coarse and more sandy downstream from the ice margin, many sheet deposits in the district coarsen upwards, which indicates that they accumulated during still-stands or minor glacial re-advances. Many sheet deposits pass upstream into glacial drainage channels.

Kettleholes do occur within sheet deposits, but they generally are not as large or as common as in the ice-contact deposits. The sheet deposits are also relatively more homogeneous and dense, less disrupted by faults and glaciitectonic dislocations, contain fewer lenses of till, fewer large boulders and are consequently relatively easy to appraise and exploit commercially as aggregates.

**Descriptions of glaciofluvial deposits by geological sheet**

The resource potential of the glaciofluvial deposits is described more fully in Bulk mineral resources.

**Sheet 95 Elgin**
Glacial and glaciofluvial features and the distribution of tills in the Elgin district. P915371.

A large part of this sheet is underlain by glaciofluvial deposits that form significant resources of sand and gravel. The deposits are varied, both in composition and distribution, and the observations given below are based on the more detailed descriptions of Peacock et al. (1968) and Aitken et al. (1979).

Most of the deposits west of the Spey valley are moundy and were laid down during deglaciation at the margin of ice occupying the Moray Firth as it retreated west-north-westwards. Meltwaters draining that ice, together with streams draining the partly deglaciated areas to the south, were constrained to flow around the retreating margin, creating deep drainage channels such as the Black Burn valley, to the west of the River Lossie, and the Blackhills channel, south of Lhanbryde (P915371). The Spey valley would also have functioned as an overflow channel. Much of the sand and gravel lying between Elgin and the Spey was laid down as fans at the mouths of these, and other minor channels, or as deltas in temporary lakes held back by the ice cap (P104109). Good examples of deltaic sand and gravel laid down by southeastward flowing meltwaters occur at Lochinvar Pit, near Elgin and at Rothes Glen pit (NJ 254 527), south of Elgin (P915371).

Deltaic foresets dipping eastwards, capped by poorly stratified topset gravel at Lochinvar pit, near Elgin. P104109.

Many of the deposits around Elgin were laid down on remnants of stagnant glacier ice that later
melted to form kettle-holes and brought about the generally moundy topography. The deposits of glaciofluvial sand and gravel tend to coarsen upwards, but to fine north-eastwards away from each source. Kame-plateaux amongst the mounds are commonly formed of fine-grained glaciolacustrine deposits capped by sand and gravel. Sand predominates to the north of the A96 trunk road, around Elgin and Lhanbryde, and it forms particularly large mounds towards the coast, for example at Binn Hill (NJ 305 656).

The glaciofluvial deposits to the north and north-east of Elgin become less moundy towards the coast where those occurring below about 35 m above OD appear to have been wave-washed locally. These undulating spreads are formed mainly of sand, silt and clay with subordinate gravel, and they merge with Late-glacial raised beach deposits, at about 30 m above OD, around Kinloss and Loch Spynie, indicating contemporaneous glaciofluvial and marine sedimentation at the former ice front. To the east of the Spey, two gently undulating to moundy spreads of sand and pebbly sand lie between Fochabers and Buckie.

A distinctive suite of deposits lie between Kinloss and Lossiemouth where several east-north-east-oriented ridges, with flat tops descending towards the east-north-east, are separated by depressions. The sand and gravel forming the ridges tends to coarsen upwards into boulder gravel and the sequences are locally capped by till. The depressions are underlain by silts and clays, and parts of the ridges are formed of these lithologies too, commonly displaying complex soft-sediment gravitational deformation structures. The sands and gravels forming the ridges were probably laid down within ice-walled chasms at the ice margin, which possibly connected with the sea. The silts and clays were deposited following retreat of the ice margin westwards. A similar style of sedimentation, possibly ice-proximal glaciomarine, has been proposed for the Ardersier Silts and Alturlie Gravels formations of the Banffshire Coast Drift Group occurring farther to the west (Merritt et al., 1995; Fletcher et al., 1996).

A prominent feature of the lower Spey valley is a series of gravelly terraces that formed during the whole period between the retreat of the last glaciers and the present day. The river floodplain and low-lying alluvial terraces are deeply incised into a set of older late-glacial ones. The most extensive ‘Mosstodloch’ terrace, and higher terraces to the south of Mosstodloch, are regarded as glaciofluvial because they contain kettleholes or merge into moundy glaciofluvial deposits (P915371). Lower terraces are probably mainly of Loch Lomond Stadial age, or younger. The Mosstodloch terrace merges downstream into moundy ice-contact deposits around Garmouth, indicating that ice still lay to the north-west when the terrace formed. Ice probably completely blocked off the lower reaches of the Spey valley downstream of Fochabers at an earlier stage, causing a large lake to be ponded up — the ‘Fochabers Glacial Lake’ (Peacock et al., 1968). Thinly laminated glaciolacustrine clays underlie parts of the Trochelhill and Balnacoul glaciofluvial terraces in the vicinity of Fochabers.

Sheet 96W Portsoy and sheet 96E Banff
Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 96E Banff. P915373.

Tentative reconstructions of former proglacial lakes in north-east Scotland. P915289.

The glaciofluvial sands and gravels occurring on these sheets have been divided into two assemblages. The predominantly moundy deposits inland of Cullen, Portsoy, Whitehills and Banff have been placed in the Blackhills Sand and Gravel Formation of the Banffshire Coast Drift Group. Deposits in the valley of the River Deveron, upstream of Bridge of Alvah, are not divided, and are placed in the East Grampian Drift Group, together with terraced deposits in the valleys of the burns of Boyndie, Durn, and Deskford (P915373).

File:P221167.jpg
Convolute lamination in tectonised glaciolacustrine
silts from the Blackhills Sand and Gravel Formation. P221167. File:P221173.jpg
Channel-fill cross-bedded gravels forming glaciofluvial sheet deposits in Danshillock pit, south of Macduff. P221173.

The Blackhills Sand and Gravel Formation includes shell fragments and sparse clasts of sedimentary rocks and fossils derived from the floor of the Moray Firth in addition to rocks occurring locally, or farther to the west and south-west. Many of the well-rounded clasts in these sediments have been derived from Old Red Sandstone conglomerates. Some deposits accumulated as outwash fans at the margin of ice retreating westwards. Other deposits accumulated as deltas in lakes held up by glacier ice that remained offshore (P915289), abutting the coast. A reference section occurs in Brandon Howe pit (NJ 667 637) within the Hills of Boyndie, south-west of Banff, where over 12 m of sand with minor lenses of gravel and widespread seams of silt was formed in a distal outwash fan that prograded south-eastwards. Sands and silts displaying soft-sediment deformation due to loading and dewatering are exposed in a small pit at Tipperty (NJ 671 608) (P915373; P221167).

Degraded glaciofluvial terraces lie within several of the valleys, particularly those of the Deveron and the Burn of Boyndie. Unlike the Blackhills Sand and Gravel Formation deposits, which were laid down mainly by meltwaters flowing south or south-eastwards from ice situated to the north, these deposits were laid down by meltwaters flowing towards the Moray Firth. The deposits therefore contain clasts derived from the south, including basic igneous rocks that are commonly weathered and friable. Such deposits are exposed at Danshillock pit (P915373; P221173).

Sheet 97 Fraserburgh

Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 97 Fraserburgh. P915374.

About one third of this sheet is underlain by glaciofluvial and glaciodeltaic deposits, which occur mainly in a broad swathe between New Aberdour and Loch of Strathbeg (P915374). Apart from fragmentary terraces in the valley of the North Ugie Water, most of the deposits have been assigned to the Blackhills Sand and Gravel Formation. These deposits contain clasts and shell fragments (including Nuculana pernula) derived from the floor of the Moray Firth, in addition to locally occurring clasts. Fragments of porous limestone and spiculitic sandstone of Cretaceous age are
common. Both moundy and terraced spreads are equally represented on the sheet.

Climbing ripple-drift cross-lamination in deltaic sands at Kirkmyres pit, near Fraserburgh. P104110.

The moundy deposits were laid down as fans and deltas within lakes dammed up against ice of the Moray Firth ice stream to the north (P915289B). Typical deltaic coarsening-upward sequences of sand and gravel occur at two pits in the vicinity of Blackhills (NJ 924 612) (P104110), the type locality of the formation, and at Pitnacalder (NJ 872 628), near New Aberdour. Deposition was mainly from flow directed towards the south-east. Several of the moundy sediments were glacitectonically disturbed during, and shortly after deposition, by the ice to the north, which remained active and locally re-advanced to lay down a local capping of till (Merritt et al., 2000, fig. 26). One of the larger moundy deposits form the Sinclair Hills, south of Fraserburgh (P915374).

There are two major spreads of terraced glaciofluvial sand and gravel on the sheet. Both were formed by braided meltwater streams flowing east or south, and then towards the sea, which, at the time, stood no higher than 5 m above OD (Peacock, 1997). Meltwaters also flowed south-eastwards into the valley of the North Ugie Water to lay down terraces there, and others formed the upper part of an outwash fan at Todholes (NJ 843 570), where an important series of events has been established at [Howe of Byth Quarry - locality, Cainozoic of north-east Scotland|Howe of Byth pit.

**Sheet 86E Turriff**
Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 86E Turriff. P915375.

The glaciofluvial deposits on this sheet are mainly restricted to the degraded terraces within the valley of the River Deveron north of Turriff, the ‘misfit’ valleys of the Idoch Water and Burn of King Edward, and the upper reaches of the Ythan upstream of Fyvie (P915375). It is likely that the present northward drainage of the Deveron was re-established only at a late stage in the deglaciation of the district. Before then, while ice still occupied the Moray Firth and the coast, meltwaters discharged southwards into the Ythan system via a major spillway at Towie (NJ 746 440). Substantial terraced deposits of sand and gravel were laid down around Turriff, and underlie the site of the town’s new sewage works. An excavation into a high terrace there revealed imbricate gravels deposited by southerly flowing water. Meltwaters also flowed southwards through the Afforsk spillway, south-east of Gardenstown (P915374), where they fed into the catchment of the Burn of King Edward. Extensive terraces occur at the lower end of that valley, sloping towards the valley of the River Deveron. An isolated, but prominent terrace lies to the north of New Byth, at Tippercowan (NJ 815 551), whereas several north-north-east or south-southwest orientated kames and eskers lie between the Deveron, north of Turriff, and Aberchirder.

Sheet 87W Ellon
Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 87W Ellon.

Glaciofluvial deposits are not common on this sheet, especially the moundy variety. This is a paradox, because there is extensive evidence of the activity of glacial meltwaters in the form of drainage channels. Furthermore, many of the deposits that do exist were laid down by meltwaters entering the district from the north, via the valleys of the River Ythan and North Ugie Water, at a relatively late stage in the deglaciation of the region. Part of the explanation for the apparent scarcity of glaciofluvial deposits may be that the meltwaters laid down sands and gravels in the deeper valleys where they are now concealed beneath alluvial, solifluction and gelification deposits.

Glaciofluvial terraces lie within the valley of the Ythan, downstream of Methlick, and in the valley of the North Ugie Water, downstream of Strichen. Some of the deposits of the Ythan are locally very coarse indeed, especially at Bellmuir (NJ 875 365) and Ardlethen (NJ 920 320), and might have been deposited during catastrophic flood events (Maizels and Aitken, 1991). The terraces in both valleys were partly built up by meltwaters entering the main valleys from tributaries, to the north and west, during westward retreat of the East Grampian ice sheet. The gravels in both valleys tend to become finer downstream, where the lower lying terraces rest on extensive fine-grained glaciolacustrine deposits and descend to the level of the main postglacial beach. Downstream of Ellon, a former valley of the River Ythan lies to the south of the present one and is largely filled with glaciofluvial deposits. Glaciofluvial terraces also occur in the catchment of the South Ugie Water, in the vicinity of Stuartfield and Old Deer.
Correlation of lithostratigraphical units in north-east Scotland. P915347.

The deposits described above have all been assigned to the East Grampian Drift Group, together with a solitary east-north-east trending esker near Auchorthie (NJ 923 523). Other moundy glaciofluvial deposits are situated close to the boundary of the Logie-Buchan Drift Group deposits in the south-east part of the sheet. This boundary is most clearly defined to the south of Ellon in the vicinity of Cross Stone, where a pit (NJ 9523 2822) reveals about 5 m of poorly bedded gravel becoming more sandy upwards. The clasts include gneisses, quartzites, psammites, mica-schist and granites, which are all typical of deposits derived from the East Grampian ice sheet, and the bedding appears to indicate an easterly palaeocurrent. There are glacitectonic structures present that have been caused by ice pushing from the east, and the deposit is locally capped by red till. It appears that the deposit formed at the margin of the ‘Logie-Buchan’ ice, which pushed inland to form the two arcuate, asymmetric moraine ridges that lie to either side of the deposit (P915376).

Several moundy deposits occur at the boundary of the two groups in the vicinity of the Hill of Auchleuchries (NK 006 365). However, the sandy deposits forming the hill (Auchleuchries Sand and Gravel Formation; P915347) are capped by yellowish brown till of the East Grampian Drift Group, not red till, and at Tillybrex, 1.5 km to the south-southwest, at least 11 m of weathered gravels (Tillybrex Sand and Gravel Formation; P915347) with no morphological expression, are capped by red till. The Tillybrex gravel was deposited by westward flowing meltwater. There are clearly complicated sequences preserved along the boundary of the two groups. For example, the gravels at Tillybrex almost certainly predate the Late Devensian, and other older glaciofluvial deposits crop out from beneath till in the vicinity of Leys pit (NK 004 524) and at Oldmill (NK 023 440).

Sheet 87E Peterhead
Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 87E Peterhead. P915377.

The glaciofluvial deposits occurring on this sheet have been assigned to three groups (P915377). Most of the deposits lie close to the boundaries of the former East Grampian ice sheet with the coastal ice streams that laid down the Banffshire Coast and Logie-Buchan drift groups (shown on the published map as inland, blue-grey and red series respectively). Extensive spreads of terraced sand and gravel lie at the confluence of the North Ugie and South Ugie waters, where they overlie up to 25 m of laminated silts and clays. The sediments were deposited by meltwaters flowing from the west into lakes held up against ice of the deflected Moray Firth ice stream to the east (P915289). This took place after the East Grampian ice sheet had begun to retreat westwards.

The Kippet Hills Esker looking northwards from Broom Hill, near Collieston. P219697.

In the south part of the sheet, glaciofluvial deposits are commonly interbedded with red diamictons and silts of the Logie-Buchan Drift Group, but individual beds are generally too thin to map out, or
they are concealed. Several, more extensive deposits occur around Hatton. A pit in the village (NK 054 371) revealed over 10 m of deltaic calcareous sand with seams of red diamicton beneath a drape of red clay. The sequence included a bed of brown diamicton possibly derived from East Grampian ice. A ridge of pebbly sand lying to the west of the village, at the boundary of the Logie-Buchan and East Grampian drift groups, is also capped by red till although the pebbles were probably derived from East Grampian ice. This body of sand coarsens upwards and is possibly similar to the deposit forming the Hill of Auchleuchries, on Sheet 87W Ellon, and both deposits rest on dark grey-coloured tills.

Distribution of the Logie-Buchan Drift Group and related features. P915297.

One of the best examples of a ‘ribbon’ esker in the entire district lies to the east of Meikle Loch (P219697). The Kippet Hills esker stands up to 15 m high and is partially buried beneath red diamicton. It appears to connect with three mounds of sand and gravel lying to the north. The easternmost mound at Knapsleask is flat-topped and formed as an outwash fan. The fan and esker were laid down by meltwaters flowing northwards through a lobe of ice that pushed onshore between Aberdeen and Peterhead (P915297). The deposits contain a significant proportion of dolomite, limestone and calcareous siltstone from the sea bed, together with shell fragments derived from the offshore Aberdeen Ground Formation.

Several isolated mounds of glaciofluvial and glaciodeltaic sand and gravel lie within the area formerly covered and weakly glaciated by the East Grampian ice sheet. Some of the deposits have poor surface expression and probably predate the last glaciation, like the one at Oldmill. Others contain materials derived locally; for example, the deposit at Redleas (NK 093 430) is composed mostly of fragments of weathered granite, and gravelly deposits around the Buchan Ridge contain many rounded clasts derived from the Buchan Gravels Formation.

Sheet 76E Inverurie
Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 76E Inverurie. P915378.

Glaciofluvial deposits are widespread on this sheet (P915378). They were laid down mostly at the margin of the East Grampian ice sheet as it retreated westwards across the area. The pattern of retreat was greatly affected by the topography, especially by the high ground formed by Bennachie, Cairn William, Green Hill and the Hill of Fare in the west of the sheet. As the ice margin reached this crescentic ridge that reaches 300 to 500 m above OD, meltwaters carved out several major channels across cols and deposited sands and gravels on, and amongst, stagnant ice left stranded in the lee of the hills. Some of this stagnant ice blocked the engorged stretch of the Don valley upstream of Port Elphinstone, causing meltwaters to be diverted eastwards via another set of channels across the lower ridge lying between Kemnay and Inverurie. Water from these channels debouched into the valley of the River Don in the vicinity of Kintore, giving rise to fans of sand and gravel. A similar ice blockage also occurred farther upstream, east of Castle Forbes (NO 622 191). It caused meltwaters to be diverted northwards, where they cut a precipitous gorge into fresh granite bedrock called ‘My Lord’s Throat’ (NJ 635 197).

A good example of one of the routes taken by meltwaters across the sheet can be demonstrated around Kemnay. Meltwaters passed through the col crossed by the A944 road at Tillyfourie, where they laid down moundy glaciofluvial gravels and cut channels through morainic deposits dumped there. The water passed through stagnant ice to the east of the col to lay down the gravels that now form eskers in the valley of the Ton Burn and beyond towards Kemnay. The main esker terminates to the north of Kemnay amongst moundy deposits of sand and gravel. From here, meltwaters passed through the deep channel at Tom’s Forest and laid down the large fan of sand and gravel at Tavelty, just to the north of Kintore. At a slightly earlier stage in the deglaciation, meltwaters flowed directly eastwards via channels at Leschangie to lay down a sheet of sand and gravel to the south of Gauch Hill (NJ 787 151).

The gorge of the River Don upstream of Monymusk also served as a major conduit for meltwaters across the high ground. Initially, meltwaters flowed eastwards across the col (about 265 m OD) between Bennachie and Millstone Hill cutting channels through the morainic mounds in the valley bottom. At Pitfichie, they took a more direct route eastwards than the present river and laid down
moundy deposits of sand and gravel around Blairdaff (NJ 703 180) ([Rothens](#)). Other routes taken by meltwaters across the high ground led to the cutting of deep channels across several cols between the Hill of Fare and Green Hill (NO 636 098).

A similar pattern of westward ice retreat occurred in the south-eastern part of the sheet, where ice stagnated in the lee of the Hill of Fare. One route taken by subglacial meltwaters led to deposition of moundy deposits, including an esker, between East Finnercy (NJ 767 042) and Roadside of Garlogie. Another route is traced by the esker forming Horsewell Hillocks (NJ 779 019), west of Hardgate. The valley of the Corskie/Kinnernie Burn carried meltwaters that laid down moundy deposits of gravel, including eskers, upstream of Dunecht (NJ 754 091), and more sandy, terraced deposits downstream towards the Loch of Skene. Sandy glaciofluvial deposits also lie to the east of the loch, beneath alluvium, and they form an extensive spread in the valley of the Leuchar Burn downstream of Garlogie (NJ 782 057).

Glaciofluvial sands and gravels form mounds 5 to 15 m high and low-lying terraces around Torphins and Gallow Cairn (NO 639 010). These deposits are associated with a major former route of glacial drainage along the valley of the Burn of Beltie. This drainage route continues south-eastwards, along the valley of the Burn of Canny, to meet the valley of the River Dee at Invercanny Waterworks, 2 km upstream of Banchory on Sheet 66E. Smaller mounds of gravel and sand south of Milltown of Campfield (NJ 648 004) almost block modern drainage along another former route of meltwater flow that also extends on to the adjoining Banchory sheet (see below).

The north of the sheet contains ground that is similar in many respects to that covered by the Ellon sheet, on which moundy glaciofluvial deposits are relatively sparse and terraced deposits are restricted to the main valleys. The valley of the River Urie was ponded up for a while during deglaciation by ice that blocked the valley of the River Don between Inverurie and Kintore. A large lake formed upstream of Inverurie in which deltas of sandy gravel were laid down. Many of these deltaic deposits now form terraces on either side of the Urie.

**Sheet 77 Aberdeen**

![Glacial and glaciofluvial features and the distribution of glaciogenic deposits on Sheet 77 Aberdeen. P915379.](#)
Two contrasting suites of glaciofluvial deposits occur on this sheet (P915379). Most have been assigned to the East Grampian Drift Group, but moundy red, silty sands and gravels of the Logie-Buchan Drift Group lie along the coast, extending inland for up to about 3 km to the north of Aberdeen. The latter deposits were laid down at the boundary between the East Grampian ice sheet and ice that pushed onshore from the North Sea. During deglaciation, the parting (‘unzipping’) of the two bodies of ice appears to have started in the north, leading to ponding of meltwaters between them in the ice-free enclave thus formed (P915289).

The deposits of the Logie-Buchan Drift Group in the north of the sheet include a ridge that extends from Drums (NJ 990 227) towards Newburgh, where it has been truncated by the River Ythan (P915297). A short fragment of the ridge lies on the northern bank of the Ythan at Waterside, and the meltwaters that formed it probably continued northwards to form the Kippet Hills esker at Slains, on Sheet 87E Peterhead. To the north of Drums the ridge is locally boulder strewn and probably formed at the landward margin of ‘Logie-Buchan’ ice. To the south, the ridge merges into a belt of moundy deposits formed of interbedded reddish brown sands, gravels, silts and diamictons. The belt arcs around low-lying ground at Balmedie (NJ 964 177), which appears to have been occupied by ice while the sequence was laid down.

Contoured rockhead surface beneath the City of Aberdeen. P915293.

Most of the glaciofluvial deposits on the sheet were laid down by precursors of the rivers Don and Dee. Those of the latter river occur mainly as terraces within the present valley, although deposits lying to the south of Torry indicate that the river formerly took a more direct route to reach the sea at Nigg Bay (P915293). Meltwaters also flowed into the Dee valley from the north, but they did not lay down deposits quite as extensively as shown on the 1:50 000 map published in 1980. Likewise the belt of deposits lying between Cadgerford (NJ 835 056) and Blackburn, and between Craibstone (NJ 867 111) and Bankhead are also not as extensive as shown on that map (Sand and gravel resources, Sheet 77 Aberdeen).

The River Don formerly took a direct route to the coast instead of turning southwards at Dyce. This was probably partly due to ice blocking the valley downstream of Dyce and partly because the river was flowing towards the sea at a higher level than today. Large resources of sand and gravel in the form of mounds and ridges formerly occurred between Corby Loch (NJ 925 145), a large kettlehole, and the coast at Blackdog (NJ 963 141), but many of the deposits have been worked out. Gravels laid down from eastward flowing braided rivers predominate around Bishops’ Loch and Corby Loch.
(Aitken, 1995, 1998), but many of the deposits to the east formed as deltas and consequently contain sequences that coarsen upwards from silty sands into coarse gravels. Particularly good sections in deltaic deposits were formerly exposed at Strabathie (NJ 955 136), in a pit that is now used as a landfill site.

A particularly large deposit of sand and gravel lies in the middle of the valley of the River Don in the vicinity of Liddell’s Monument (NJ 869 153), where it has been exploited at Mill of Dyce pit. This deposit formed as a fan delta at the margin of the East Grampian ice sheet when it was situated immediately to the west. The ice then retreated upstream and a lake was held back behind the deposits, which blocked the valley. Meltwaters entered the main valley from side valleys to form kame terraces, especially around Hatton of Fintray. The ice front probably stood in the vicinity of Straloch (NJ 860 211) at about the same time as the Mill of Dyce deposit formed. However, although terraced deposits of gravel were laid down between there and Newmachar, they are not as extensive as shown on the 1:50 000 map published in 1980 (Sand and gravel resources, Sheet 77 Aberdeen).

Sheet 66E Banchory

![Glacial and glaciofluvial features and the distribution of glacigenic deposits on Sheet 66E Banchory. P915380.](image)

The glaciofluvial deposits on the northern two thirds of the sheet have been assigned to the Lochton Sand and Gravel Formation of the East Grampian Drift Group, whereas those in the south belong to the Drumlithie Sand and Gravel Formation of the Mearns Drift Group. The deposits of the former group were laid down at the margin of the East Grampian ice sheet as it retreated slowly westward (P915380). Clasts of coarse-and fine-grained granite predominate, but gritty and micaceous psammitte and schistose semipelte become more numerous in gravels in the valley of the River Dee, downstream of Banchory.

Much of the meltwater flowed towards the valley of the River Dee where substantial amounts of sand and gravel accumulated as kettled terraces. The thickest known deposits in the valley form a moundy spread in the vicinity of Park Pit, Drumallan (NO 797 978), where a minor still-stand occurred during ice retreat (Brown, 1993). Significant meltwater flow (directed towards the east and north-east) also took place to the north of the Dee valley, along channels linking linear ice-scoured
basins. Moundy and terraced spreads of sand and gravel flank the basin north of Upper Lochton and others occur along the Bo Burn, south of the Raemoir Hotel; similar sands and gravels are also concealed beneath alluvial deposits.

Large amounts of meltwater entered the Dee valley from the south via the valleys of tributaries such as the Feugh and the Burn of Sheeoch. Once the ice front had retreated, meltwater drainage along the Dee valley was generally unrestricted. However, the valleys of the southern tributaries lay more or less parallel to the retreating ice margin and as a result drainage was impeded by masses of decaying ice. Meltwaters were ponded up and sequences of laminated silts, coarsening upwards into sand and cobble gravel, were laid down as fan-deltas. These deltaic sediments now commonly occur as kettled terraces and as flat-topped and irregular mounds. A most impressive kettled terrace (the Pitdelphin Wood Terrace), which stands up to 30 m above the level of the floodplain of the Water of Dye (Auton et al., 1990), occurs between Pitdelphin Farm (NO 654 912) and Bogarn (NO 657 903). The upward coarsening glaciofluvial sand and gravel forming the terrace averages about 13 m in thickness and overlies glaciolacustrine silt and clay resting on till.

Large masses of stagnant ice were stranded in the lee of hills as the margin of East Grampian ice retreated westwards, giving rise to hummocky glaciofluvial and morainic deposits and many eskers. Eskers are most common along the southern side of the valley of the River Feugh, in the vicinity of Strachan (NO 674 923), and in the valley of the Burn of Sheeoch farther east; they are formed mainly of coarse, clast-supported gravel. A group of eskers that have an unusual south-east trend occurs on the northern side of the valley of the River Feugh (P915380). They contain clasts of fine-grained basic igneous rocks, which are generally absent in the adjacent glaciofluvial gravels such as exposed in Cammie Wood pit (P220858; P915380).

File:P220858.jpg


The glaciofluvial deposits in the south of the area were formed mainly when the East Grampian ice sheet began to retreat north-westwards and the Strathmore ice stream retreated south-westwards. Meltwaters formed lakes between the two ice masses, which acted as sediment traps in which coarsening-upward deltaic sequences were laid down. At first the ponding took place high in the valleys to the south-east of the main watershed, for example, in the upper reaches of the Carron Water around Snob Cott (NO 801 885), where a considerable thickness of coarse-grained sand and gravel was laid down in contact with decaying ice. These deposits, assigned to the Lochton Sand and Gravel Formation, are characterised by clasts of granitic and metamorphic rocks. Ponding subsequently occurred at lower levels in minor valleys, such as those around Pitrichie (NO 795 825), and the valley of the Burn of Caldcotts, upstream of Fettercairn, before the valleys of the Bervie Water and Luther Water were inundated. Deposition of sand and gravel derived from south-eastward flowing meltwaters from the retreating East Grampian ice sheet was concentrated around Auchenblae, where a large fan was laid down flanking the Luther Water.

Gravels of the Drumlithie Sand and Gravel Formation include moundy ice-contact sands and gravels interbedded with reddish brown flow-tills, which were laid down close to the glaciofluvial fan at Auchenblae. However, these moundy deposits were banked against the Strathmore ice as it retreated south-westwards. All of the sand and gravel deposited by meltwaters from the Strathmore ice stream in the Pitrichie, Glenbervie and Auchenblae areas, contains clasts derived from the
adjacent Devonian bedrock and psammitic and granitic clasts, most of which were derived from the upland to the north-west. Most of the durable clasts within the gravels around Auchenblae consist of quartzite and psammite pebbles, the bulk of which were derived from nearby outcrops of Old Red Sandstone conglomerate. A significant proportion of the psammite and many of the weathered granitic clasts can be matched locally with adjacent outcrops of Dalradian and Caledonian granitic bedrock.

Much of the coarse gravel which forms mounds on the flanks of the western headwater tributary of the Burn of Caldcotts (the Burn of Balnakettle) is assigned to the Lochton Sand and Gravel Formation as it contains no Devonian clasts. A typical gravel deposit, 3.7 m thick, containing small intraformational ice-wedge casts, was exposed in a small working (NO 620 752) north-east of Mains of Balnakettle. Farther up the valley, a coarsening-upward sequence of reddish brown sands and gravels of the Drumlithie Sand and Gravel Formation, with abundant clasts of Devonian rocks, is exposed in the back-scar of a landslip (NO 618 757) on the southwestern side of the burn (Balanakettle). The sand and gravel has been tectonised and overridden by East Grampian ice which laid down a thin, moderate brown, silty till, containing a preponderance of local Dalradian schistose psammite and semipelite clasts. These topographical and stratigraphical relationships suggest that a minor re-advance of East Grampian ice took place. This occurred after the initial retreat of Strathmore ice and deposition of its outwash on the flanks of the upland.

The deposits of the Drumlithie Sand and Gravel Formation within Strathmore itself are typically vivid reddish brown in colour and relatively silty. They contain abundant clasts of friable sandstone and mudstone and decomposed andesitic lava. Many deposits are concealed beneath red, clayey flow tills, as for example, to the east of Auchenblae and to the south-east of Drumlithie. The final south-westward retreat of the Strathmore ice stream was marked by the deposition of eskers in the vicinity of Bomershanoee Wood (NO 734 754), Meikle Fiddes (NO 799 808) and Little Wairds (NO 798 785).

**Sheet 67 Stonehaven**

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As on the adjoining Sheet 66E Banchory to the west (see above), the glaciofluvial deposits on the
northern half of the Stonehaven sheet have been assigned to the Lochton Sand and Gravel Formation, whereas those in the south belong to the Drumlithie Sand and Gravel Formation. Again, ponding occurred between the East Grampian ice sheet and the Strathmore ice stream, with the latter retreating south-westwards as deglaciation proceeded (P915381). The ponding occurred mainly in the valleys of the Cowie and Carron waters, but several minor valleys descending toward the North Sea were also affected. This led to the deposition of coarsening-upward, sandy deltaic sequences in the vicinity of Cantlayhills (NO 881 905). Meltwater drainage carved a deep drainage channel between Ury Home Farm (NO 859 882) and Logie (NO 886 888) and laid down a fan of silty cobble gravel at its eastern end. The channel was formed near the front of the Strathmore ice stream, during a still-stand in its retreat, and shortly after its parting from the East Grampian ice sheet.

Thick, coarsening-upward, deltaic-style deposits form mounds on the sides of both major valleys. However, whereas in the Cowie catchment the deposits contain mainly durable clasts derived from metamorphic rocks and granites, those of the Carron catchment are dominantly more sandy and include friable sandstone and mudstone clasts and are commonly interbedded with reddish brown silt and clay. The terraced spreads of coarse gravel in the floor of the valley of the Cowie Water, which have been extensively worked inland from Stonehaven, were laid down by meltwater from the East Grampian ice sheet draining south-east towards the coast. These granite and psammite-dominated gravels were deposited on top of reddish brown glaciolacustrine silts and clays (Ury Silts Formation) of the Mearns Drift Group. The gravels contain isolated ‘rip-up’ clasts of reddish brown clay.

Meltwaters flowing north-eastwards from the retreating Strathmore ice stream deposited eskers that connect with moundy deltaic deposits in the vicinity of Brucklaywaird (NO 826 840), Muirtown of Barras (NO 837 813) and Fawsyde (NO 846 772). Kame terraces and moundy deltaic deposits were also formed at several localities where the north-western boundary of the retreating Strathmore ice stream withdrew south-eastwards from high ground. For example, deposits occur in the vicinity of Foggie Brae (NO 827 845), Dunnottar Square (NO 864 848), to the west of Roadside of Catterline (NO 860 792) and at the mouth of the Catterline Burn (NO 866 777). Moundy kame deposits occur at Uras Knaps (NO 876 810) and Greenden (NO 811 776), and terraced deposits lie on both banks of the Bervie Water at Inverbervie.

References

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