Memoirs of the Soil Survey of Scotland

The Soils of the Country round Banchory, Stonehaven and Forfar

(Sheets 66/67 – Banchory & Stonehaven and 57 – Forfar)

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Preface

This memoir combines two 1:63 360 scale soil maps, Sheet 66/67 (Banchory and Stonehaven) published originally in 1963 and Sheet 57 (Forfar) in 1961. Both were reprinted with minor revisions in 1981 and 1979 respectively.

Survey of the soils of Sheets 66/67 and 57 commenced in the late 1940's and continued throughout the 1950's. Considerable revision, some remapping and correlation with adjacent sheets were undertaken before publication in the 1960's.

The soils of Sheet 66/67 were surveyed by a number of surveyors but principally by R. Glentworth, J. W. Muir, J. C. C. Romans, E. L. Birse, J. Smith and B. M. Shipley. Sheet 57 was surveyed by J. W. Muir, J. C. C. Romans, D. Laing, J. Smith and R Glentworth. Maps were prepared by A. L. Bleszynski and W. S. Shirreffs. Many other members of staff of the Macaulay Institute for Soil Research contributed to the content of this memoir, particularly H. G. M. Hardie, J. Logan and staff of the Soil Analysis Section of the Department of Pedology and R. L. Mitchell and staff of the Department of Spectrochemistry for the analytical data.

It is unclear who the authors of the original manuscript were, but it is thought to comprise R. Glentworth, J. C. C. Romans, D. Laing, B. M. Shipley and E. L. Birse. Much of the writing was done in the 1970's with a major revision and incorporation of analytical data undertaken by D Laing in 1979. Further editing was carried out in 1984 by D. W. Futty. These edits were incorporated and the final manuscript was compiled by Mr J. S. Bell in 2012 who attempted to update aspects of the text. Inevitably however, certain sections e.g. climate, are based on historical datasets and are described in terms more appropriate to the time of the survey and the original writing than the current situation. Hence, the format, style and content follow that of the original manuscript with only minor amendments made to the text. The soil classification also follows the 1984 version. The maps and figures included in the memoir were produced in 2012 by Mr. D. Donnelly. Previous memoirs include chapters on Peat, Vegetation, Agriculture, Forestry and Trace Elements, but these were not available for inclusion in this particular memoir.

Acknowledgements

The material for the section on climate was provided by the Meteorological Office, Edinburgh. Acknowledgement is also made to farmers and landowners in the district without whose co-operation the survey could not have been completed.

1. Description of the Area

Location and Extent

The area described in this memoir is situated in east Scotland and lies to the south and west of Aberdeen, and the north and west of Arbroath. It comprises some 2258 square kilometres of which 1347 are on Sheet 66/67 (Banchory and Stonehaven), and 911 on Sheet 57 (Forfar) (Figure 1). The northern section is wholly within Grampian Region, the major part lying in Kincardineshire (between the Rivers North Esk and Dee), while a small part lies north of the Dee in Aberdeenshire. The southern section is in Tayside Region and lies south of the North Esk in Angus.

In the part of the area lying outwith the Grampian Highlands, there is an even distribution of small towns and villages. The largest town is Arbroath, with a population of over 22,000. Forfar, the county town of Angus, and Stonehaven, the county town of Kincardineshire, together with Brechin, Montrose, Laurencekirk, Banchory and Aboyne, are appreciably smaller, with populations ranging between 2200 and 13200. Industry, much of which is directly or indirectly related to agriculture or latterly, oil, is on a relatively small scale. There is a seasonal tourist trade which is of particular significance to the coastal resorts of Arbroath, Montrose and Stonehaven and Banchory and Aboyne situated in Royal Deeside.

Physical Features

Major Structural Divisions

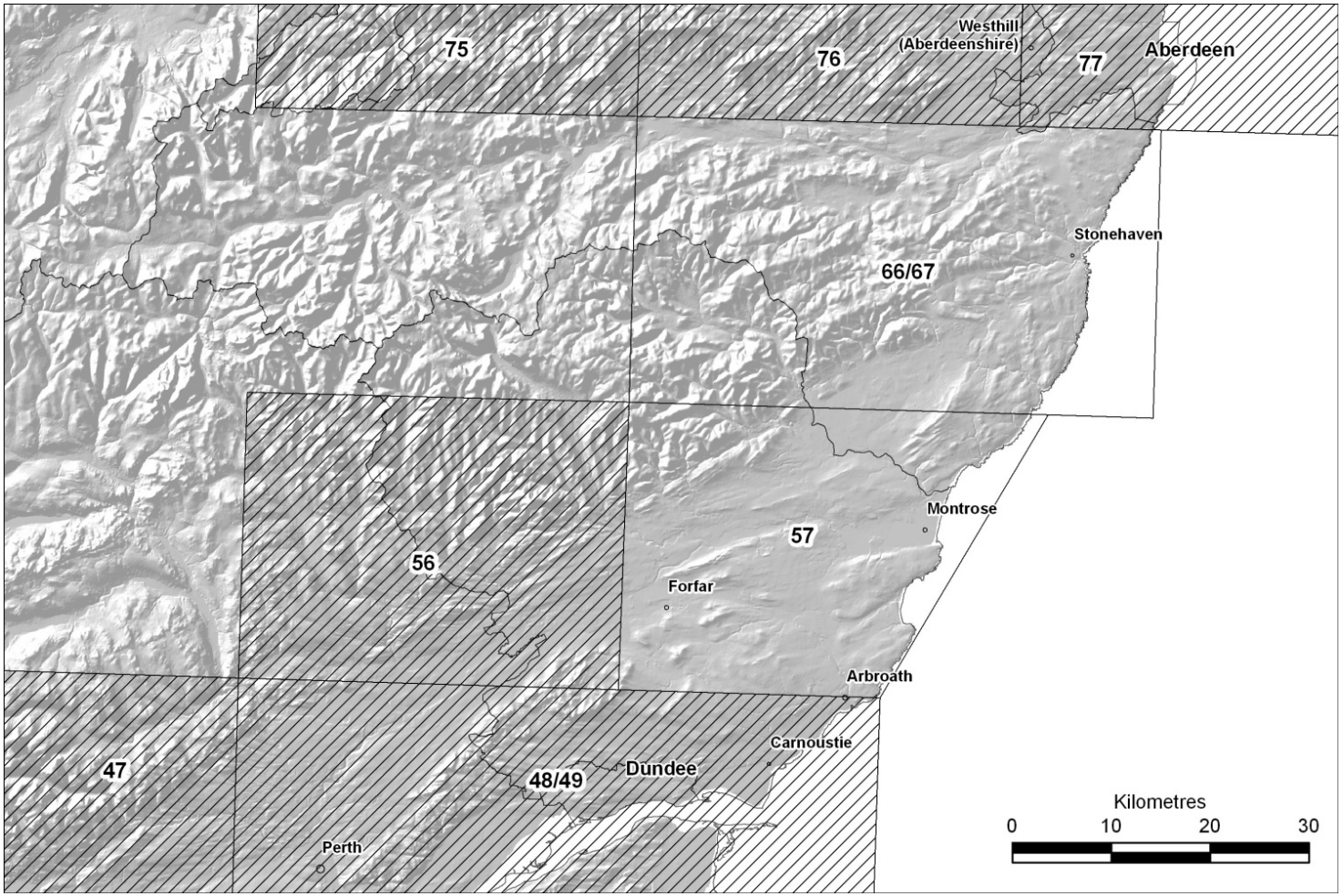
The main structural feature of the area is the Highland Boundary Fault which runs from Stonehaven to the Clyde and divides the terrain into two major physical regions, highlands and lowlands. North of the fault, in the Grampian Highlands, the basement rocks are folded metamorphics of the Dalradian into which granite has been intruded. South of the fault, in the lowland region, rocks of the Lower Old Red Sandstone Formation underlie the Sidlaw range and the Strathmore area (Figure 2). Within these two major physical regions, fourteen landform regions can be recognised, each having their own distinctive physical characteristics (Figure 3).

River Systems

The drainage of the region is dominated by three rivers, the Dee, the North Esk and the South Esk. All have their sources in the Grampian Highlands. Subsidiaries of the Dee are the Water of Tanar and the Water of Feugh. The latter joins the Dee at Banchory and joined by the Waters of Dye and Avon. These tributaries rise in the Grampians and flow in a north-easterly direction. The eastern extremity of the Grampians is drained by the Cowie and Bervie Waters, the former entering the sea at Stonehaven and the latter at Inverbervie. The North Esk in its upper reaches of Glen Esk drains an extensive catchment area of the Grampians and is joined by the Water of Tarf. Its lower reaches in Strathmore drain the southern part of the Howe of the Mearns, and the western slopes of the Garvock hills via its tributary, the Luther Water.

Figure 1. Location of Area

Figure 2. Relief



The South Esk, rising outwith the surveyed area, in Glen Clova, crosses Sheet 57 (Forfar) from west to east and drains the lowlands about Noranside, Aberlemno and Montreathmont Moor, finally discharging into the sea through the Montrose Basin.

The Forfar-Lunan channel, which crosses Sheet 57 to the south of the South Esk, empties westwards from Forfar Loch via the Dean Water and the River Isla into the Tay and eastwards from Balgavies Loch into the Lunan Water. The watershed of this system runs in an irregular line from Forfar to Dilty Moss by way of Dunnichen and Fotheringham Hills. The Brothock Water and other small streams drain the country about Arbroath, Carmyllie and Inverkeilor.

Landform Regions

The landscape pattern is determined by the solid geology, modified in detail mainly by the effects of glaciation. The units delineated in Figure 3 have been distinguished on the basis of the field knowledge of their surface characteristics; each has a type of relief or a particular slope pattern which is a recurrent feature of that locality.

North of the Fault

1. Dee Valley
2. Strachan basin and the Feugh valley
3. Netherley and Skene lowlands
4. Grampian foothills
5. Grampian Highlands

South of the Fault

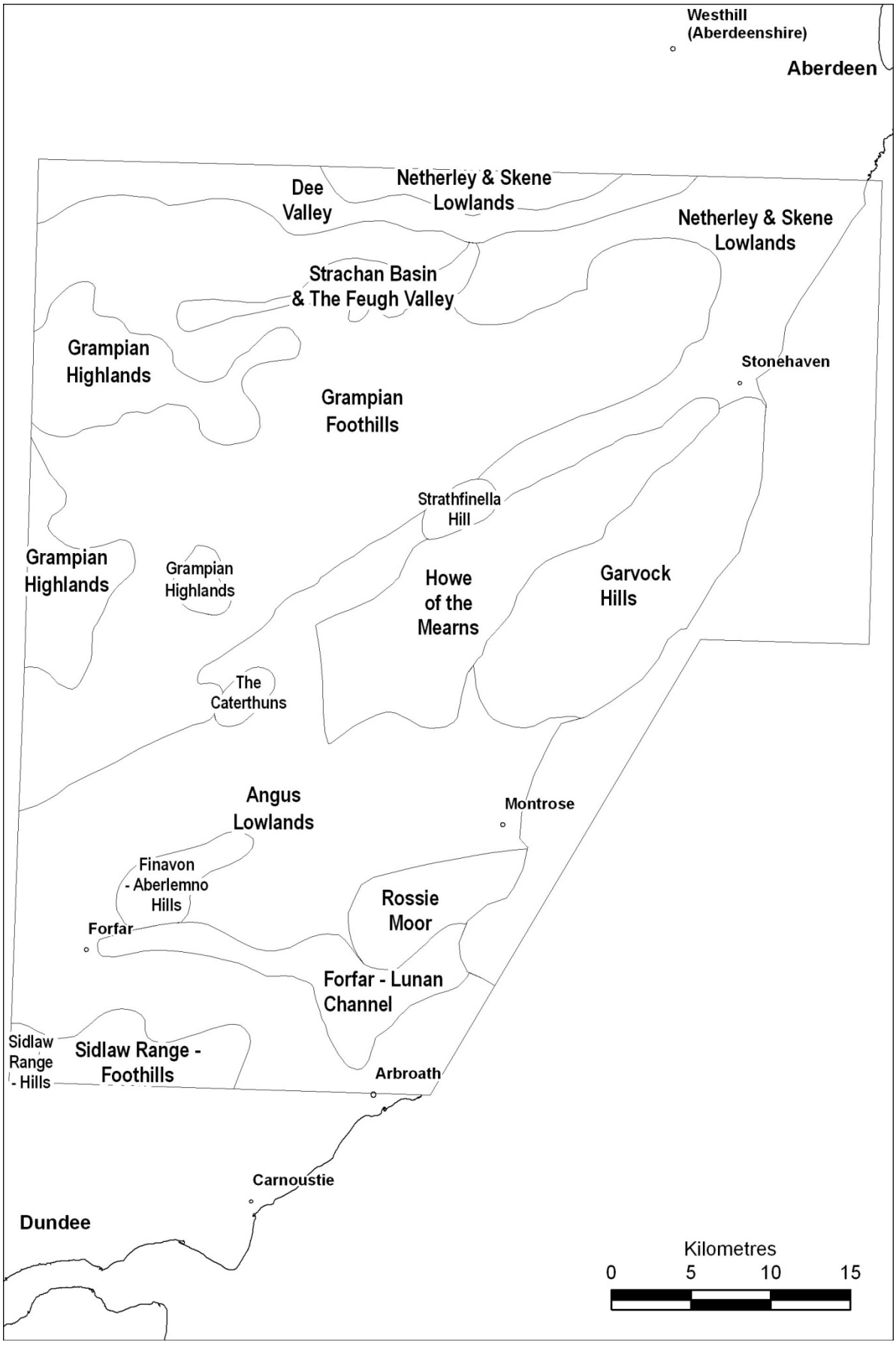
6. Strathmore
    - (a) Howe of the Mearns
    - (b) Angus lowands
    - (c) Finavon - Aberlemno hills
    - (d) Rossie Moor
    - (e) Forfar - Lunan channel
    - (f) Strathfinella Hill and the Caterthuns
    - (g) Garvock hills

7. The Sidlaw Range
    - (a) Sidlaw Hills
    - (b) Sidlaw foothills

1. The Dee Valley

The Dee valley traverses Sheet 66/67 from the Moor of Dinnet (150 metres) eastwards to Peterculter (30 metres). East of Banchory the valley is about 1.5 kilometres wide and the containing slopes are gentle or moderate. Between Banchory and Kincardine O'Neil, the river is confined to a narrow channel with steep sides, while further west and as far as Dinnet, the valley is again about 1.5 kilometres in width, with gently sloping sides and an extensive alluvial flood plain.

Figure 3. Landform Regions



2. The Strachan basin and the Feugh valley

The Strachan basin and the Feugh valley run east and west, parallel to the Dee valley. They form a broad basin within the Grampian foothills and contain extensive flats of fluvioglacial gravels and alluvium. At the head of the basin is the Forest of Birse, a steep-sided highland glen. Lying at altitudes below the basin, the valley of the Feugh narrows to a rock-cut channel which joins the Dee valley at Banchory.

3. The Netherley and Skene lowlands

The Netherley lowlands, lying to the south of the Dee, occupy the coastal region north of Stonehaven and extend westwards to Banchory. The area is comparable with, and an extension of, the Skene lowlands which occur on the north side of the river.

The relief is gently rolling slopes with occasional peat-filled depressions, and the altitude seldom exceeds 150 metres. The underlying granite and granitic gneiss crop out in places and the land is characteristically bouldery with fields separated by stone dykes.

4. The Grampian foothills

The Grampian foothills occur mainly south of the Dee and lie at an elevation lower than 610 metres. Within the belt of Dalradian rocks north of the fault, slopes are moderately steep and smooth. The foothills west and south of Banchory are formed of granite and have craggy skeletal summits and irregular convex and concave bouldery slopes. Between altitudes of 270 and 490 metres, blanket peat is extensively developed on the summits of many of the hills. Conifer plantations are frequent on the granite hills, with the smooth, south-facing slopes remaining heather-covered and used for sheep pastures.

5. The Grampian Highlands

The Grampian Highlands are a high level extension of the foothills with The Braid Cairn (886 metres) the highest point. Other prominent hills are Mount Battock (779 metres), Hill of Gairney (756 metres), Cock Cairn (728 metres), Black Hill (693 metres) and the Hill of Wirren (677 metres). Slopes vary from moderate to steep and the relief is strongly rolling to hilly.

6. The Vale of Strathmore

The Vale of Strathmore, lying between the Highland Boundary Fault and the Sidlaw range, extends from Stonehaven to beyond Forfar. It is underlain throughout by rocks of the Old Red Sandstone Formation and in the broadest of geomorphological terms has the conformation of a wide vale bordered by the Grampian Highlands on the one side and the Sidlaw Hills on the other. The following units are contained within it:

(a) The Howe of the Mearns occupies the northern extremity of the Vale of Strathmore and consists of gently rolling land north of the River North Esk. Bounded

on the east by the Garvock hills and on the west by Strathfinella and the Grampian foothills, it lies mainly at altitudes of 46 to 150 metres.

(b) The Angus lowlands cover most of the low ground between the North Esk and the Sidlaw foothills, and lie mainly below 122 metres. This subregion consists of a broad, smooth, gently rolling plain with long, low, parallel ridges aligned in a north-east to south-west direction. The ridges are the glacially smoothed edges of the underlying sandstones.

(c) The Finavon - Aberlemno hills rise to a height of over 240 metres and are formed of parallel ridges of resistant sandstone and conglomerate. These ridges have steep scarp slopes and a strike pattern similar to that of the Angus lowlands.

(d) Rossie Moor (150 metres) forms the highest part of a prominent, broad, smooth area of rising ground underlain by lavas and interposed between the Montrose Basin and Lunan Bay.

(e) The Forfar - Lunan channel is a pronounced meltwater channel flanked by high terraces of sand and gravel and occupied by alluvium and a series of small lochs. The valley sides are dissected and have steep, strongly undulating slopes.

(f) Strathfinella Hill and the Caterthuns are sandstone hills with flat, heather-clad summits which rise to altitudes of between 270 and 415 metres. They are separated from the Grampian foothiils by a valley through which passes the Highland Boundary Fault. The footslopes are of rolling farmland, whereas the mid-slopes are moderately steep and, on Strathfinella Hill, are extensively planted with conifers.

(g) The Garvock hills are situated on the eastern side of the Howe of the Mearns and rise to between 120 and 180 metres. They form the eastern edge of the Strathmore syncline and are composed of Old Red Sandstone conglomerates and sandstones, together with contemporaneous lavas. The undulating relief is caused by the underlying rock strata which protrude as ridges with a north-east to south-west trend producing short irregular slopes.

7. The Sidlaw Range

(a) The Sidlaw Hills; only the northern extremity, Hayston Hill (309 metres) occurs in the area. It forms a flat plateau or upland of 4 square kilometres at the south-west corner of Sheet 57.

(b) The Sidlaw foothills form a transition from the Angus lowlands to the Sidlaw Hills; the region slopes northwards and eastwards from the Sidlaws (270 metres) to the lowlands (60 metres). Isolated lower hills protrude, giving an irregular rolling relief.

2. Climate

The climate of the district may conveniently be described as being in conformity with the natural features and landforms. Nearly one half of the area - Strathmore and the associated coastal belt - comprises a major lowland region. With its north-east to south-west orientation, Strathmore differs from the other lowland regions of the Dee valley and the Strachan basin which have a mainly northerly aspect. Both areas have much in common climatologically but significant variations between one and the other are due mainly to the differing exposures.

North of the Highland Boundary Fault, the Grampian foothills form an irregular, almost 'corrugated', area of rising ground, where climate is associated with altitude and aspect. It is appropriate in this instance to consider the transition from lowlands to foothills at altitudes around 150 to 180 metres. The 150-metre contour aligns very closely with the position of the fault line, from which the land rises to about 460 metres. At altitudes above 460 metres a cold wet upland climate predominates.

Lowlands and Foothills

The region lies in the peripheral zone of the North Atlantic depression systems. Atlantic 'lows' approaching the Hebrides, chiefly in autumn and early winter, bring eastern Scotland wholly into their circulation, but the situation can be quickly changed by a surge of pressure from western European high pressure systems. Another seasonal phase, tending to recur in spring (and of greater frequency in recent years) is the development of an anti-cyclone in the more northerly latitudes, bringing easterly winds.

In relation to its latitude, the lowland region from Stonehaven to beyond Forfar has a mild climate for which a high frequency of westerly winds is largely responsible. It is moderately dry with a good proportion of bright days; hard winter frosts are fully compensated for by warm days in late spring and early summer. The Dee valley area has a less mild climate, being open to winds from the north and east.

Winds

Except during May to July, when the mean pressure gradients are less pronounced, the predominant winds are from west to north-west over the northern part of the area, and westerly to south-westerly in the remainder of the area. While gale force winds are infrequent over the foothills and the low-land regions, some of the deep re-entrant valleys form convenient funnels where considerable increases in wind speed may occur locally when the general wind blows parallel to the valley. The effect may be strengthened by the development of valley winds encouraged by large near-surface temperature differences associated with the proximity of the mountains. Thus at Glensaugh, near Fettercairn, the average gale frequency is as high as 13 days per annum.

Gales are more likely to be violent when they come from west to north-west, usually behind a cold front. Occasionally a deep depression moves to the northern North Sea, giving, over east Scotland, northerly gales to which the Dee valley is exposed.

An example of this was the disastrous gale of 31st January 1953 which damaged extensive areas of forest in Deeside.

Winds from a north-easterly direction, which prevail frequently in the spring and early summer, are invariably cold. They often bring showery weather and are, in many cases, the prelude to spring frosts. Easterly sea breezes develop readily on the coast on the warmer days of the year, penetrating as far as the southern foothills of the Grampians (16-24 kilometres). They frequently bring in fog from the sea.

Rainfall

The average annual rainfall over the whole area south of the Highland Boundary Fault, except over the higher ground of the Dee valley and the Netherley and Skene lowlands, is between 760 and 890 millimetres. From about 685 millimetres over the driest section, the coastal strip between Stonehaven and the Bervie Water, the annual average rises to around 1525 millimetres on the higher ground.

As will be seen from Table 1, the seasonal rainfall pattern is similar for all stations below 230 metres. The dry period in the first half of the year, common to much of eastern Scotland, is well marked. There is a sharp drop in the average figures from January to February, and the five months up to June together account for only about one-third of the year's total. March is normally the driest month in most areas, but May, prone to showery weather, is the least reliable of the drier months. An increase of 25 millimetres or more in July gives a secondary maximum peak in the rainfall curve preceding the maximum of October and/or November.

October is also the wettest month at altitudes above 300 metres but from October to January substantial rainfall may be expected.

Rain is recorded on some 170 to 180 days annually near the coast, the frequency increasing north-westwards to about 200 days in the foothills. With increasing altitude this figure rises more rapidly to an estimated 230 days at heights of approximately 460 metres, the average rainfall approaching 1270 millimetres. At greater altitudes, the number of rain-days probably does not increase significantly, but the duration and thus the amount of rain per rain-day is greater.

In the foothills, in Strathmore, and in the northern lowlands, periods of a week or so without measurable rain occur some four or five times annually on average, but any dry spell rarely exceeds nine to ten days. In July 1955, however, 28 consecutive dry days were recorded at Glensaugh.

Table 1. Average Rainfall (millimetres, 1916-50)

Station	Altitude (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Montrose	5	63.5	49.8	42.4	46.7	58.4	46.0	73.2	70.1	67.8	79.2	71.6	63.0	731.1
Arbroath	29	57.9	47.2	40.6	39.4	54.1	41.9	66.8	62.0	63.2	73.4	64.0	56.1	666.6
Brechin	37	72.9	57.2	48.0	53.8	64.8	50.5	81.3	79.5	73.7	88.9	83.6	74.7	828.9
Muchalls	64	65.0	47.5	43.9	49.0	59.7	47.5	77.7	67.3	68.8	81.0	77.7	70.4	755.5
Glamis Castle	61	87.1	62.2	50.6	47.2	66.8	49.5	78.7	86.1	72.6	90.4	86.9	80.0	858.1
Glentanar House	168	90.2	63.5	57.9	62.7	69.3	54.9	89.2	87.4	82.6	103.4	96.8	91.2	949.1
Glensaugh	108	87.1	66.3	59.4	64.3	77.2	59.4	97.0	92.2	88.1	105.9	102.1	91.2	990.2
Glen Lee	474	124.5	82.6	80.0	81.3	92.7	72.4	115.6	116.8	106.7	137.2	133.4	127.0	1270.2

Snow

According to Thompson (private communication), over the main lowland area the percentage of the average annual precipitation which falls as snow and hail increases from about 6 to 7 per cent in the south to about 10 per cent in the north. Over a wide coastal zone, winds off the sea cause the snow to melt quickly, and this is particularly true in the Montrose - Arbroath area where the long-term average number of days of snow-cover per season is around 16, as compared with more than 20 at Muchalls. Towards the foothills, where the maritime effect is lessened, the number of days with snow lying increase.

Much of the snow is brought by cold air masses from the north. Unlike Strathmore, the Dee valley and adjacent lowlands have little shelter from this direction. The Howe of the Mearns falls into an intermediate category, receiving the 'spill-over' from the northern area augmented by the snowfall brought in with the north-east winds.

The lower foothills have an average of some 33 days of snow falling and an equal number of days of snow lying (Glensaugh). Increasing altitude is associated not only with increased annual precipitation, but also with an increased percentage falling as snow. At 460 metres, snow-cover probably averages some 80 days per season. Wide variations from the average, however, occur in individual years, and at altitudes of 150 to 300 metres in the 1962-63 season, snow-cover persisted for 75 to 90 days. January and February are the months with greatest snowfall.

Temperature

The range of mean monthly temperatures throughout the year is approximately 11°C over the lowlands and somewhat higher inland. The coldest month is January with a mean value of 2.5°C as compared with 14°C in July.

Average afternoon maxima for July are consistently around 18°C and are not sensitive to altitudinal change, whereas winter maxima, normally around 7°C, are affected more by altitude and situation.

During long winter nights, especially when little or no wind occurs, average minimum temperatures fall and in January and February reach freezing point or below except along the narrow coastal zone. In the foothills and upper valleys the average minimum night temperature does not rise above freezing point until March.

A maximum temperature range of 53°C from the coldest winter night to the warmest summer afternoon is shown in the very long-term records for the foothills and associated glens and very large ranges are on record in the flat lowlands. Summer maximum readings of 26.7°C or more have occurred during the period May to August from the coast to the 300-metre level. Extremes of winter cold when the temperature falls below -18°C occur in the glens such as the upper reaches of the North Esk and those of the Waters of Dye, Feugh and Tanar. In the lowlands -16°C has been registered at Arbroath and -12°C at Stonehaven. An overnight temperature of -11°C is commonplace throughout the region in midwinter. The average date for the first frost over the lowlands, even near the coast, is between the 18th and 20th October and the last between the 2nd and 7th May. The period of

frost duration is obviously longer in the upper valleys and is progressively prolonged with increasing altitude until around 300 metres. The average period of frost extends from the 23rd August to the 3rd June, with no month entirely frost-free. A feature of these intensely cold winter nights, particularly in 'glen' situations, is the extremely rapid rise in temperature to 0C during the forenoon and some times above by midday.

A mean minimum temperature of 0°C or below for any month, implies a frequency of frosty nights during that month. A reasonable expectation for much of Strathmore (based on the Glensaugh data) is an average of some 28 to 30 days per winter season, with 9 to 10 such days in both January and February. The year to year variation is however considerable - from 6 to 10 days in a mild winter to some 55 to 60 days in a severe winter.

Sunshine

On the basis of long-term averages, the lowlands and foothills of east Scotland rank, with Morayshire, as the sunniest parts of the mainland. The mean annual isohel for 1300 hours of sunshine per year follows the general line of the 225-metre contour. Although sunshine data are available for only three stations, Table 2 gives some indication of the variation in sunshine within the district.

Table 2. Average Sunshine (hours, 1931-60)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arbroath	56	86	115	166	198	200	180	157	139	102	63	43	1505
Stonehaven	52	76	105	147	175	179	154	141	124	91	57	41	1342
Ferrercairn*	54	78	106	144	178	168	148	139	115	82	56	43	1311

* Derived computation

It is of agricultural significance that spring is normally the most consistently sunny period of the year, with May the sunniest month on the whole, although at the coast, June is almost comparable. In spring, sunshine figures for the high ground show little variation from those of the Arbroath area. In summer, this relatively small range of variation extends from the coast only as far as the lower foothills, due largely to the considerable increase in cloudiness inland. With the onset of the autumn rains resulting in greater cloudiness over the hills, the difference in sunshine between the coast and the high ground increases to over one hour per day. Bright winter days raise the average sunshine figures to levels comparable with southern England in spite of the much shorter day in Scotland.

Föhn and Haar

Föhn conditions prevail when the westerly air stream, having already lost a high proportion of its moisture, spills over the final ridge of the mountain barrier and loses much of its momentum, as it descends to the valley floors and the lowlands. In its descent the air is warmed and the relative humidity consequently falls; the lower clouds break up and often disappear. By day, the sunshine helps to raise the air

temperature and brings a further decrease in relative humidity, although at night the clear skies encourage radiative cooling. Föhn may last for a few hours or for as long as two days. It occurs at all seasons, but the effects are more obvious in autumn; in winter it plays a part in snow melting.

Haar (sea-fog) is a phenomenon mainly of spring and early summer in which easterly winds of penetrating dampness bring unseasonably low day temperatures. Warm air from the continent as it drifts over the North Sea absorbs moisture and is cooled to near sea temperature. The haar may be so dense that it persists over large areas for perhaps two or three days.

The Growing Season

The meteorological parameters which have been discussed all have a place in the complicated pattern of vegetation growth and enough is now known to enable data for some of the elements to be used to give definite indications of growth rates and the periods during which growth may be sustained. The availability, or otherwise, of the necessary soil moisture can be indicated by offsetting the incidence and amount of the rainfall against the evapo-transpiration. Penman (1948) utilises mean values of wind speed, temperature, sunshine and vapour pressure to derive the average evapo-transpiration (PT) from a grass-covered surface assuming that ample moisture is available to the roots. Assessments for Angus and Kincardineshire are reproduced in Table 3.

Table 3. Average Evapo-transpiration (PT)

Potential Transpiration	Apr	May	Jun	Jul	Aug	Sep	Summer	Winter	Year
mm	44	67	79	75	64	32	359	62	421

Comparison with the average rainfall figures suggests that excessively dry soil conditions rarely occur in the foothills and over much of the lowlands. The period of greatest drought risk is that from mid-May to mid-July especially on the lighter soils and in the coastal zone.

The duration of the growing season in the coastal zone, on the basis of a threshold value for a mean daily temperature of 5.6^0C, varies from 235 days in the north to 245 days in the south, extending from approximately the last week in March to the third week in November. Towards and within the uplands, the growing season normally begins three weeks later and ends a fortnight earlier. A total of around 220 days is probably valid for the Forfar area and the lower Dee valley. With increasing altitude the length of the growing season is reduced to 200 days at 300 metres.

Some indication of the average growth rates is given by the accumulated temperatures in Table 4. The accumulated temperature is a summation of the periods of time during which the temperature exceeds the threshold of 5.6^0C expressed in ‘day-degrees’ and for which the value is conveniently calculated from the average monthly temperatures by a method due to Shellard (1959). The general distribution over the whole year shows a maximum of over 2500 day-degrees in the Arbroath area decreasing northwards along the coast to 2400. The totals decrease

towards the north-west at first relatively slowly across the lowlands and then more rapidly with increasing altitude from around 2200 day-degrees at 150 metre to less than 2000 at. 300 metres (cf. Balmoral to the north-west).

Table 4. Average Accumulated Temperatures above 5.6°C (day-degrees, 1931-60)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arbroath	37	51	96	126	220	363	487	477	360	211	78	53	2559
Glensaugh	25	29	68	89	182	330	443	425	303	152	51	34	2131
Balmoral	25	25	62	63	164	318	425	394	264	127	31	31	1929

It is perhaps appropriate to restate some of the advantages (and disadvantages) accruing to the district as suggested by the detailed examination of the various climatic factors already discussed. The relative freedom from strong to gale winds, whilst reducing the potential evapo-transpiration to some extent, has the obvious practical advantage of minimising physical damage to the growing vegetation. In winter, however, the infrequency of strong winds is a factor in the incidence of severe frost. The tendency to showery weather in May mitigates the risk of vegetative stress due to moisture shortage in what is otherwise a rather prolonged dry season, but the attendant low temperatures tend to slow down or check growth. The haars of later spring and early summer also slow down growth and in varying degree reduce the insolation. The föhn, however, is particularly beneficial in autumn and contributes to the high values of winter sunshine. Föhn conditions with their higher temperatures also affect mean monthly temperatures and help to prolong the growing season well into the autumn.

Uplands

Climatic data for the uplands are limited. At 600 metres and above, the obvious features of note are cool summers, the short growing season, the persistence of frost in winter and the accumulations of snow in some, if not all, winters.

Winds, which at these altitudes conform more closely to those of the free atmosphere, probably have a mean value of about 8 metres per second in a quiet month, and 10 metres per second or above in a moderately disturbed month. Near-surface winds, funnelled round peaks and ridges, frequently exceed speeds in the free air, whereas on the sheltered lee side of higher masses, speeds are considerably lower. In most months it is not unusual to have one period in which a sustained wind of around gale force (17 metres per second) persists for 24 hours or even more across an exposed area. At the climax of a -severe storm, a sustained speed (as opposed to a gust speed) of 38 metres per second or more is highly likely.

Rainfall assessments indicate an increase from about 1270 millimetres at 460 metres, to some 1524 millimetres or more annually at the highest points in the region. This total is considerably lower than those on the ‘oceanic’ west side of the Scottish mainland owing to the shelter provided by the extensive mountain masses to the main windward side. The drier period from February to June has, on average, about one third of the annual rainfall, with March and June the driest months. October and November have the highest monthly average) whilst July has an equal

expectancy with December. Of the annual precipitation, about 20 per cent probably falls as snow at around 760 metres with a decrease toward lower altitudes. A considerable amount of snow is blown off the highest peaks by strong winds and deposited at lower levels in more sheltered zones. The average number of days of snow lying on a reasonably level and not over-exposed area above 610 metres is of the order of 100 to 110 days per season, but the number is increased by one third or more for areas prone to accumulate drifts.

The mean monthly temperature in upland areas may be assessed, approximately, by a reduction of 1.8°C per 300 metres to the period averages of a suitably located lower-level station. The mean monthly maximum of temperature is appreciably lower than would be expected on this basis, particularly in spring when incursions of polar air bring very low temperatures in the uplands as compared with those in the valleys, and the threshold of 5.6°C for the growing season may not be attained until well into May. Downhill airflow (katabatic wind) is a recognised feature of the climate of these areas, especially in fine, quiet spells. Consequently, there is the anomaly that the occurrence of the first night frost of the autumn in the uplands occurs considerably later than the earliest frosts in the associated valleys, whilst, in addition, on very cold nights, the valley bottom is often colder than at the higher levels.

July is the warmest month and in most years the temperature at the highest levels can be expected to reach 18°C on the warmest days. Temperatures exceeding 21°C occur in some years at 760 metres and, around this altitude, the mean daily temperatures through the harsh winter from November to February are mostly at freezing point or below with mean minimum temperatures well below. March and early April can be equally cold. February is probably the coldest month, since January, more subject to the influence of Atlantic depressions, may have periods of ‘milder’, cloudy and wet weather. Periods when the uplands are warmer than the valleys are not altogether rare and the temperature difference may sometimes be 5.6°C or more. This occurs during quiet anticyclonic weather, usually in the colder part of the year when the inversion above the surface frosty layer falls to about 610 metres, or lower.

Bioclimatic Assessment

The following assessment is taken from the map of bioclimatic sub regions devised by Birse (1971) and based on two earlier maps, Birse and Dry (1970) and Birse and Robertson (1970). The scheme depends on three measures, (1) thermal zonation from south to north and from low to high altitude, (2) oceanicity, i.e. the proximity to and the influence of large areas of open sea and (3) moisture status as represented by the annual potential water deficit.

Apart from the coastal strip, 15-20 km wide, which is influenced by the North Sea and is in the euoceanic subsector, the rest of the area falls within the hemioceanic or least oceanic subsector of Scotland. The greater part of the area lies within the hemiboreal and orohemiboreal sub-zones. A narrow coastal strip stretching from Inverbervie to Arbroath has a high degree of oceanicity and is classed in the fairly humid northern temperate zone. The zone extends inland under more humid conditions in the valleys of the Rivers North and South Esk and along the Forfar - Lunan channel.

The rising ground of the Grampian foothills, the Sidlaw foothills, and, to a lesser extent, the Garvock hills, lies within the very humid lower oroboreal sub-zone. Climatic conditions become more severe at higher elevations (over 500 metres) on the Grampians with thermal sub-zones ranging from very humid upper oroboreal to extremely humid orohemiarctic. The summits of The Braid Cairn (886 metres) and Mount Battock (779 metres) are in the very humid lower oroarctic subsector of Scotland.

3. Geology and Soil Parent Materials

Solid Geology

The Highland Boundary Fault divides the district into two geologically distinct regions. North of the fault, the country is hilly to mountainous and is underlain by Dalradian schists. Granite, intruded into the schists, forms the higher mountains and also occurs throughout much of the Dee Valley. South of the fault, the area is mainly lowland and is floored by sediments of the Lower Old Red Sandstone Formation. Lavas contemporaneous with the sediments are also present, particularly on the coastal side. The metamorphic and igneous rocks occupy the north-western half of the surveyed area and the sedimentary rocks the south-eastern part.

Table 5 is a summary of the rocks and recent unconsolidated deposits occurring in the district; the rocks of Cambro-Ordovician, Upper Old Red Sandstone and Permo-Carboniferous age are, however of little importance in the soil parent materials.

Table 5. Summary of the Geology

Quaternary	Recent and Pleistocene	Windblown sand
		Peat
		Freshwater alluvium
		Estuarine alluvium and saltings
		Raised beach deposits
		Fluvioglacial sands and gravels
		Tills
Upper Palaeozoic	Permo-Carboniferous	Dolerites
	Upper Old Red Sandstone	Conglomerates and sandstone
	Lower Old Red Sandstone	Sandstones, conglomerates, marls, flagstones and andesitic and basaltic lavas
Lower Paleozoic	? Late Silurian	Granites
	Cambro-Ordovician	Black shales, cherts and spilites
	Dalradian	Mica-schists, quartz-schists, quartzites, slates, phyllites and gneisses

The Dalradian rocks in this area are mainly quartzites, mica-schists, quartz-schists, gneisses, slates and phyllites. Features of the pelitic and semi-pelitic schists are the zones of metamorphic index minerals including biotite, garnet, kyanite, staurolite, andalusite and sillimanite, the formation of these minerals being a function of the intensity and pattern of metamorphism. Although mineralogically different, these rock types are of comparatively uniform composition.

Granite

Granite underlies the northern half of Sheet 66/67 and is classed as one of the Newer Granites. Most of the Mount Battock mass and the southern part of the Hill of Fare mass crop out in the area; the granite being pink, coarse-grained and porphyritic. In certain localities it is so soft and decomposed that it can be quarried with pick and shovel; it does however retain the original structure of the unweathered rock and the minerals appear to be in a fresh condition. Fine-grained aplite dykes and veins are of frequent occurrence, but are of little significance to the soils.

Old Red Sandstone

The Lower Old Red Sandstone of Strathmore is of great thickness, reaching about 7500 metres. This great thickness of material includes lavas and ash poured out from subaerial volcanic vents. The following sequence has been established by Campbell (1913):

(a) Strathmore Group: bright red shales and marls, passing into flagstones and massive false-bedded sandstones
(b) Garvock Group: mainly sandstones and conglomerates in which most of the boulders are of rock types occurring in the Highland areas
(c) Arbuthnott Group: hypersthene-andesites and basalts with a zone of conglomerates and sandstones at the base
(d) Crawton Group: mainly lavas with an underlying series of conglomerates containing Highland and acid volcanic materials
(e) Dunnottar Group: coarse conglomerates with intercalated, thin, brown sandstones; the conglomerates are composed mainly of quartzite stones, but other Highland rocks occur.

It is considered that the above sediments accumulated under hot desert conditions on the dissected land surface of an intermontane basin of the Caledonides. During this period, the Grampian Highlands probably rivalled the Alps in height. The conglomerates occurring throughout the succession were formed of material brought down from the mountainous regions by torrents which raged through the gorges after periods of heavy rainfall. The outstanding size of many of the boulders in the conglomerates (30-90 centimetres) is striking evidence of the transporting power, a function of both gradient and velocity of the mountain torrents of the period. The sandstones were deposited further from the mountains. The marls may have been wind-borne loess, deposited in water, perhaps in playa lakes i.e. seasonal lakes. There are nine distinct parent materials derived almost wholly from the Old Red Sandstone rocks in the surveyed area.

Pleistocene Glaciation

It is probable that, during the Pleistocene Period, the area of north-east Scotland, generally, experienced three cycles of glaciation. The first has left little evidence of its passage. The second was the most intensive; at its peak, the British and Scandinavian ice-sheets were locked edge to edge roughly along the line of the present sea coast from perhaps south Yorkshire to the Moray Firth. The final glacial

period was of relatively low intensity, a coalescence of piedmont glaciers from the Grampians which may have formed a continuous sheet almost reaching the coast.

Of the passage of the first ice-sheet very little is known. Sections in the Glen Esk - Lethnot area in which three tills are noted have been described by Bremner (1936), but little convincing evidence remains of the direction of ice movement.

The second and third ice sheets have left more solid evidence of their passage and, in general, have followed approximately the same direction of movement through this district, that is, west-south-west to east-north-east.

It is apparent, from the work of Bremner and others, that during the second or maximum glaciation, ice leaving the Central Highland area of dispersal found its way down into Strathmore and was partially deflected north-eastwards by the Sidlaw Hills in the general direction of Stonehaven. Old Red Sandstone erratics have been carried several miles up Glen Prosen (Bremner, l934) and are evidence of the passage of ice. It is a matter of general experience in north-east Scotland that, whilst erratic boulders may be carried a long distance, the bulk of the finer till material is always derived locally, especially where the till is less than about 1 metre in thickness. The observations by Campbell (1934) of occurrences of black shelly boulder clay at a number of coastal localities between Inverbervie and St. Cyrus suggest the existence of a substantial Scandinavian ice-sheet across what is now the bed of the North Sea, and its stabilisation along the Scottish coast, slightly prior to the maximum development of the British ice-sheet.

Superficial Deposits

A range of superficial deposits on which the soils have subsequently developed, cover much of the landscape. Glacial till deposits are the most extensive occurring on the undulating lower ground and the lower and mid hill slopes, where they exhibit a range of colours and textures which are dependant upon the parent rock or rocks over which the glacier traversed e.g. the differences between soils developed on Old Red Sandstone derived till compared with those of till derived from schist or granite rocks. At the same time, probably towards the end of the Glacial Period, the upper part of some tills, notably those derived from Lower Old Red Sandstone sediments have been re-sorted by water action. The upper part of the till has been noticeably altered in structure and in texture and is generally coarse and sandy. This re-sorted material is usually found in low-lying areas and adjacent to drainage channels, which supports the theory that it is derived from till modified by water action and is extensive throughout Strathmore and the Howe of the Mearns.

At the end of the Pleistocene period, with the approach of milder climatic conditions, the ice started to disappear, producing abundant melt-waters which, in addition to causing notable local erosion, transported and deposited over wide areas, vast amounts of sand and gravel. These deposits often flank valley sides and invariably occur as late Glacial outwash terraces, raised beaches or distinctly moundy terrain e.g. around Forfar, Edzell, Montrose and Inverkeillour on Sheet 57 and along the Dee and North Esk valleys and around Auchenblae and Catterline on Sheets 66 and 67.

Coastal raised beaches between Inverbervie and Portlethen are evidence of late-Glacial coastal deposits laid down when the sea level was higher, and now occur about 30 metres above the current sea-level.

The estuarine and lacustrine deposits near Montrose, Anniston and Glamis may all date from the melt stage of the second glacial period. The various channels which cross the area are probably of the same age and may have formed part of a gradually expanding network of meltwater channels, initially formed along the coastal belt between the two waning ice-sheets. Both the estuarine clay at Montrose and the lacustrine clay at Anniston are in part overlain by extensive deposits of sand and, to a lesser extent gravel. Much of the deposit at Montrose was dug away in the past for use as ship's ballast.

More recent alluvial deposits laid down by the action of water are associated with the flood plains of the major streams and rivers. These can, in some areas be extensive e.g. along parts of the Rivers Dee, North and South Esk or thin narrow ribbons along some of the small streams.

Peat deposits formed since the retreat of the glaciers can either occur in localised and relatively small basins, often in valley situations where water collects with high water-tables and the rate of decomposition of organic matter is slow, initiating the build up of organic matter or in hill and upland situations where higher rainfall and cooler temperatures are contributory factors in the accumulation of peat deposits. These latter deposits tend to be larger in areal extent and are extensive in hill areas in the north-west of Sheet 57 and throughout Sheets 66 and 67.

Windblown sand deposits are being continually deposited along areas of the coast as dunes and links, some of which are stabilised by vegetation cover, others which are not vegetated and are in the process of continual movement. The main areas, exclusively on Sheet 57, are to the north of Montrose.

Residual, shallow and loacally derived deposits, usually with a high content of angular stones, occur most notably on the higher land where rock, either outcrops or is close to the surface.

Parent Materials

Soils developed on clearly defined parent material are grouped together as a soil association (Chapter 4), and the distribution of the associations is given Figures 4 and 5. The following parent materials have been distinguished in the region.

Till of the **Balrownie Association**

The Balrownie till is derived from Lower Old Red Sandstone sediments, mainly sandstone but containing flagstone, shale, and minor conglomerates. It is a reddish brown, sandy clay loam till with a coarse prismatic structure which becomes massive at a depth of 90 to 120 centimetres. At greater depths, usually below 180 centimetres, the soil is weakly calcareous. Where some surface modification by water-sorting has taken place, as on the flatter parts of the Angus lowlands, the Balrownie Series is widely distributed. The surface and B horizons of the imperfectly

drained Balrowriie Series are frequently coarser in texture than the C horizon or till. The parent material of the freely drained Aldbar Series is a reddish brown sandy loam till which occurs mainly on hill slopes and the till is shallow, passing into sandstone or shale rock at 60 to 90 metres.
Till of the Countesswells Association

The till is derived from granite or granitic gneiss and may vary in colour from pink to pale yellowish brown according to the colour of the parent rock. On convex slopes the till is of coarse sandy loam texture and contains many stones and boulders; these are less abundant on the lower footslopes and the till texture is often loam or sandy clay loam. Fragments of quartz and feldspar, from coarse sand to grit size, are always conspicuous in the till. Decomposed granite, exposures of which can be seen in Glen Dye and on the Cairn o' Mount road contributes to the high content of this coarse material in the till.

Till of the **Deecastle Association**

The till is derived locally in the Dee valley from outcrops of calc-silicate rocks, but is contaminated with material from nearby rock types and also from more distant sources in the upper Dee valley. The stones include angular fragments of weathered calc-silicate rock with occasional subangular pieces of granite, acid gneiss and basic igneous rock. The calcium carbonate has been largely weathered out of the calc-silicate rocks, although fragments can be found which effervesce with dilute acid. The till itself is nearly neutral in reaction, with no free calcium carbonate, and is generally shallow, overlying the parent rock. Only the larger areas have been mapped and smaller areas are included within the Tarves Association. The till is a gritty sandy loam with occasional layers of sandy clay loam. The influence of the high calcium status is seen in the occurrence of cowslip, *Primula veris*, near rock exposures.

Till of the **Dinnet Association**

Occurring in the Dee valley, this parent material was originally considered as a readvance till deposit which had incorporated former fluvio-glacial gravels. It is now believed to be fluvio-glacial material of an esker complex which was formed during the down-wasting stage of the last main ice-sheet. Within this deposit are cobbles or sub-rounded stones comprising quartzite, acid gneiss, schist, granite, hornblende-schist, basic igneous rocks and serpentine. Those from acid rocks are largely unweathered; the basic stones often have a weathered outer skin whilst the occasional serpentine stones are strongly decomposed. Up to 15 metres of the fluvio-glacial material can be seen where the River Dee cuts into the deposit but it thins out towards the sides of the valley and grades into till of the Countesswells and Tarves Associations. The parent material is pale yellow in colour and generally of stony loamy sand texture. A distinctive feature is the strongly developed indurated layer. In places this causes the retention of water in the upper layers of the soil and attempts to put drains in the wetter parts have sometimes had to be abandoned because of the great difficulty of penetrating the thick indurated layer.

Figure 4. Distribution of Soil Associations

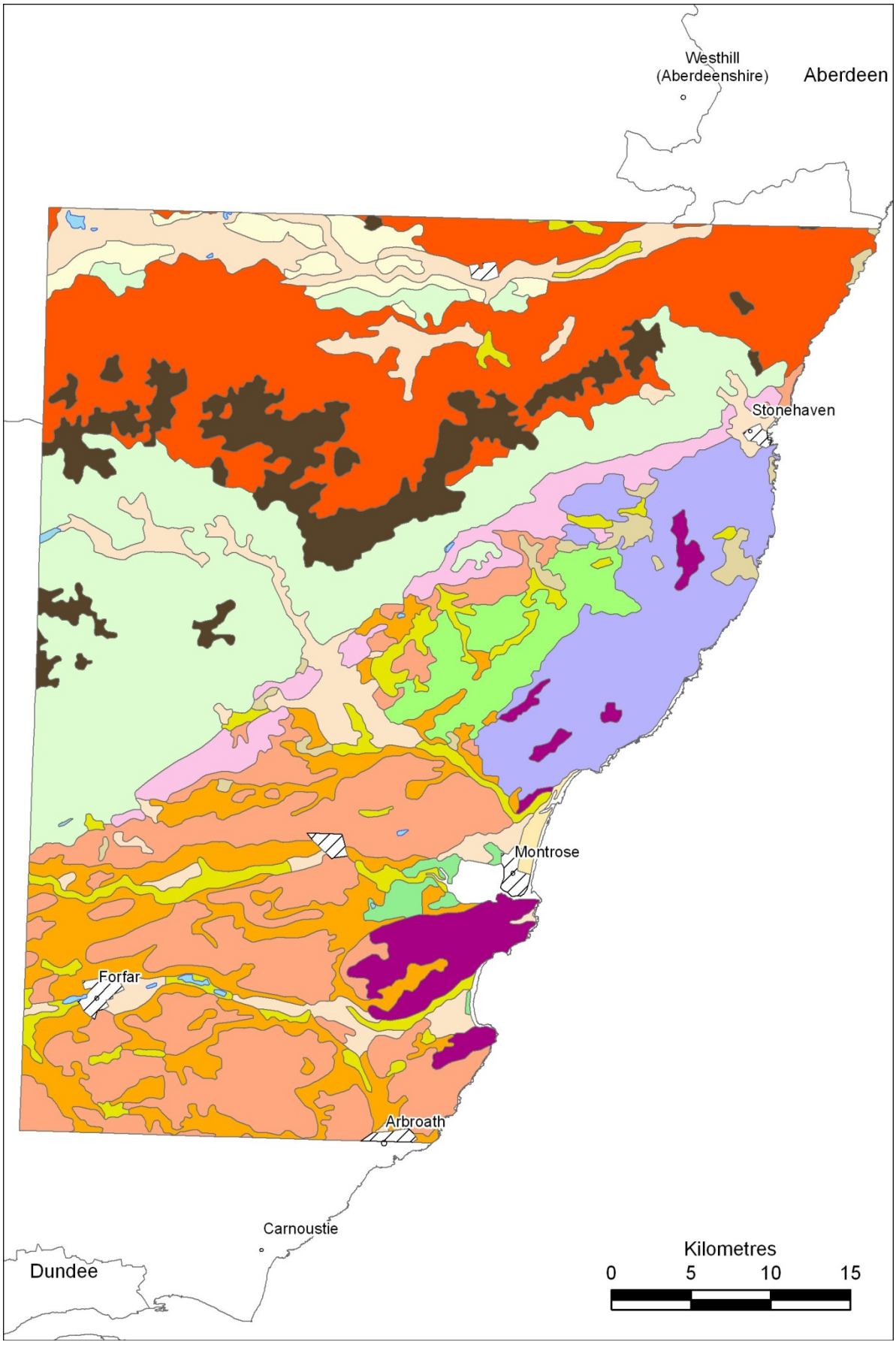
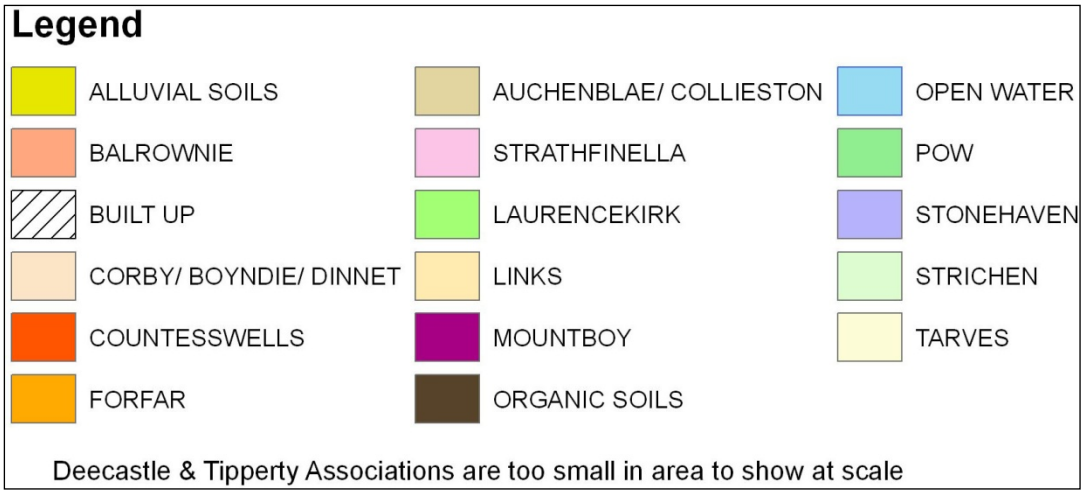


Figure 5. Soil Associations Legend



Drift of the **Forfar Association**

The parent material consists of reddish brown water-sorted drift, variable in texture and sometimes vaguely stratified. The texture is generally sandy loam but may range from loamy sand to loam. Red clay loam till derived from Old Red Sandstone sediments usually underlies the soil below profile depth. The association occurs on smooth level to gently sloping topography at an altitude of 60-90 metres.

Till of the **Laurencekirk Association**

The most notable feature of this till is the bright red colour which is inherited from the parent rocks, the marls and fine-grained sandstones of the Lower Old Red Sandstone Formation. The marl rock is sometimes slightly calcareous and breaks into coarse cubical blocks. Whilst the greater part of the association area is till-covered, occurrences of residual soil are also mapped. When the bedrock occurs within 4 feet of the soil surface, it is soft, and differs little from the till. The till varies in texture from a fine sandy loam to clay (15 to 40 per cent clay) and small pieces of schist are normally present. These are often soft and can be rubbed out into yellow iron-stained grains of sand size. The texture of the soil and upper portion of the till is in some cases lighter than that of the till below.

Till of the **Mountboy Association**

The parent material is derived from andesitic lavas and sediments of Lower Old Red Sandstone age. Over the association as a whole the lava varies in content from dominant source rock to a subsidiary constituent. Thus the Garvock Series, the freely drained member of the association, is developed on shallow till with a high content (> 50%) of lava. On the other hand, the Mountboy Series which is imperfectly drained is derived from till containing a high proportion (> 50%) of sandstone sediments. While the parent material of the Garvock Series is brown or purplish brown in colour and of sandy loam or loam texture, the Mountboy Series is developed on a reddish brown loam or sandy clay loam till. The andesitic lava is relatively high in phosphorus and this is reflected in the soil analysis.

Till of the **Stonehaven Association**

The parent material is derived from conglomerates, sandstones and lavas of the Lower Old Red Sandstone. Stones from the conglomerate predominate and these are quartzites, gneisses, schists and granites, although at Dunnottar, the cobbles are mainly quartzite. The lava is andesitic but fragments of acid tuff occur locally in the till. The proportion of stones in the till is generally insufficient to interfere seriously with cultivation, but on the ridges and hill summits, stoniness is sometimes excessive. The texture of the Stonehaven till is mainly sandy clay loam to clay loam; it is compact, reddish brown in colour and manganese staining is conspicuous on the faces of the cubical peds. Internal drainage through the till is slow. Coarser tills of stony sandy loam texture are associated with the summits of hills and drain freely.

Till of the **Strathfinella Association**

Sandstones of Lower Old Red Sandstone age are the major source rocks of the Strathfinella till, together with schists, phyllites, schistose grits, granite and small conglomerate pebbles. The colour is pale reddish brown and the texture stony gritty sandy loam. The till has an altitudinal range from about 120 metres to 300 metres and thins out with increasing altitude.

Till of the **Strichen Association**

The till is derived mainly from inter-bedded quartz-mica-schists and more acid schists. North of the River North Esk the hills are covered by a thin yellow till of stony loamy sand texture. South of the North Esk, the slopes tend to be less steep and the till, which is often much thicker (>1.2 metres), is a stony sandy loam. The till in the surveyed area is derived almost entirely from local rocks, dominantly quartz-schists and quartzites but including occasional granite and felsite boulders. Locally, and particularly on upper slopes the underlying rock, which is highly quartzose, modifies the composition of the drift. In areas with poor drainage conditions, the till is pale yellow with ochreous and grey mottles and of loam to sandy clay loam texture.

Till of the **Tarves Association**

Till of the Tarves Association occurs along the Dee valley as far east as Banchory. It is derived mainly from mixed gneisses ranging from quartzose gneiss to hornblende-gneiss together with some calc-silicate rock. Granitic and basic igneous material is also included with, more rarely, weathered fragments of serpentine. The till is of sandy loam texture and is usually shallow, overlying relatively unweathered rock which is locally exposed. Where there are thicker deposits of the till, it may be sandy clay loam in texture. The thicker till is mildly acid or near neutral, whereas the shallow till over rock is often moderately acid.

Water-sorted deposits of the **Collieston Association**

Along the coast near Portlethen, Muchalls and Inverbervie, are small areas associated with the 30 metre raised beach and consist of bands of water-sorted sand, modified till and sometimes clay. The deposits are mainly reddish in colour but sometimes layers of yellow and grey sand occur. Although the character of the material may vary considerably the textures most frequently encountered are sandy loam and loamy sand.

Fluvioglacial deposits of the **Auchenblae Association**

Red water-sorted coarse sand and fine gravel together with bands of coarse gravel occur as sporadic mounds and ridges throughout the Vale of Strathmore.
These deposits are extensive south-east of Auchenblae, south-east of Drumlithie and west of Catterline. The deposits are derived from igneous and metamorphic rocks together with occasional sandstone and marls. Exposures sometimes reveal the deeper strata (below 3 metres.) to be sand and gravel stained brown rather than

red. The presence of marl fragments imparts a marked reddish colour and an increase in base status.

Fluvioglacial sand of the **Boyndie Association**

The fluvioglacial sand which forms the Boyndie Association parent material is usually found in association with glacial drainage channels and commonly occurs together with gravel of the Corby Association. It is yellowish brown with relatively few pebbles and is derived from granite and Dalradian schists.
Fluvioglacial gravel of the Corby Associaton

Gravel mounds and terraces of fluvio-glacial and possibly morainic origin give rise to soils of the Corby Association. The gravel is derived mainly from Dalradian schists and granite rocks. The deposits, which are usually several metres thick and yellowish brown in colour, have irregular layers which vary from fine sand to cobbles of up to 23 centimetres in diameter.

Estuarine alluvium of the **Pow Association**

The soils of the Pow Association which are developed on silty estuarine alluvium occur at a height of about 9 metres O.D. at the mouth of the River South Esk on the west side of the Montrose Basin.

Lacustrine Sediments of the **Tipperty Association**

Red lacustrine silt and clay derived from Old Red Sandstone sediments occurs in four small areas about Stonehaven. In its type locality at Tipperty, Aberdeenshire, it is a varved clay. In Kincardineshire, it is a stone-free, stratified clay which always occurs below the 30 metre contour. A deposit on the western outskirts of Stonehaven was formerly worked for brick and tile making. It has a strong prismatic structure within soil depth but is massive below and the clay is often calcareous below 1.2 metres.

4. Soil Formation, Classification and Mapping

Soil Formation

Soil is a natural body containing mineral and organic matter which covers the earth's surface and supports life. Distinction of soil from non-soil at depth can be difficult, because soil material may have little, if any organic matter apparent to the naked eye and yet be affected by soil-forming processes. For practical purposes, however, non-soil can be said to have been reached where the material contains little or no organic matter and shows little alteration with depth, other than geologic changes.

In most soils the soil profile, a vertical section through the soil, is differentiated into layers or horizons which vary in character, number, thickness and clarity of form. These horizons have been formed by processes of soil formation which include weathering, leaching and gleying.

Weathering in soils involves the physical and chemical alteration of the parent material. In temperate regions physical weathering is mainly caused by the expansion exerted in pores and fissures as water freezes, resulting in shattering of rock and comminution or rock particles. Oxygen, carbon dioxide and organic acids dissolved in rain water cause chemical weathering, the rate of which varies according to the quantity and temperature of the water. As a result of chemical weathering, primary minerals are hydrolysed into the simple salts and oxides of their constituent elements, while soil clays are also formed.

The process of *leaching* involves the removal in the drainage water of soluble salts, leaving less soluble products, such as resistant minerals (e.g. clay minerals and quartz) and aluminium and iron oxides, to accumulate. A proportion of basic cations, such as those of sodium, potassium, calcium and magnesium, can remain associated with clay minerals and organic matter as part of the exchange complex. Intense leaching resulting from high rainfall favours the steady displacement of these cations by hydrogen ions. The rate of chemical weathering on materials of only moderate base status is low and often insufficient to maintain the supply of basic cations so that the degree of acidity tends to be greater in the upper horizons than in the horizons beneath. These acid conditions depress the activity of micro-organisms relative to that of higher plants, reducing the rate of mineralization of organic matter which consequently often accumulates on the surface as raw humus. Products of raw humus and plant litter are thought to be responsible for podzolisation, a leaching process involving the transport from the upper horizons of iron and aluminium compounds which may be re-deposited in the less acid conditions of lower horizons.

Soils under conditions of free drainage are well aerated, and brown, yellow and red colours predominate in layers that are mainly mineral. Where downward water movement is impeded, however, the soil pores and spaces may largely be water-filled for long periods, thus excluding air and oxygen. Under these anaerobic conditions ferric ions are readily reduced to the ferrous state giving grey and blue hues indicative of *gley* formation. The ferrous compounds are relatively soluble and migrate (often laterally) in the soil, but they become re-oxidised where water-logging is intermittent and the ferric oxides give rise to ochreous mottles, iron pans or concretions. Manganiferous compounds form oxidised products as a result of a similar process. Under anaerobic conditions the rate of chemical weathering in soils

is generally faster, and because downward leaching is often impeded, wet soils usually have a higher content of nutrients available to plants. The rate of breakdown of organic matter is slower, however, and this material generally accumulates on the surface as peat or a peaty layer within the soil.

These processes are controlled by factors which can be grouped (after Jenny, 1941) as parent material, climate, relief, biotic agencies and time. These soil-forming factors interact with one another, and in the case of biotic agencies are in turn affected by soil conditions. Soils are formed by the combined action of these factors, but by comparison of soils, differences in soil genesis can be inferred and conclusions drawn as to the influence of a particular soil-forming factor.

Parent Material

Parent materials affect the course of soil formation mainly through their base content and the impedance they offer to natural drainage. As a rule, rock materials that are richer in bases are more easily weathered, so that bases are both more abundant and more readily released. The majority of parent materials in the area surveyed have low to moderate amounts of exchangeable bases; but the shelly sands and gravels, and tills with a limestone component, often have exchange complexes which are completely base-saturated.

Soil drainage is affected by the texture and consistence of the parent material, texture being the particle-size distribution and consistence, the degree of cohesion or adhesion of the material. The coarse-textured parent materials of the Auchenblae, Boyndie, Corby and Dinnet Associations produce mainly freely drained soils, whereas the heavier textures of the Laurencekirk, Stonehaven, Pow and Tipperty Associations normally give rise to imperfectly and poorly drained soils.

Climate

The most important climatic elements affecting soil formation are temperature and rainfall, upon which depend the energy available for weathering and biotic activity and the water for leaching and gleying. Climate has been described in Chapter 2 and much of its variation over the area is attributable to topographic features, temperature falling and rainfall increasing as elevation rises. In Post Glacial times there have been periodic long-term changes in climate, but the continuing overall effect on the soils has been one of leaching and mild weathering.

Any surplus rainfall occurring after potential evapo-transpiration and run-off, especially in the winter months, is available for pedogenic processes and whilst water can become limiting for plant growth during the summer months, particularly on coarse-textured soils, leaching and gleying processes are predominant.

When the climate becomes colder and wetter as elevation rises, podzolisation and the build-up of organic horizons are increasingly favoured. On the highest land, still lower temperatures and increased exposure reduce the growth of higher plants and less organic matter accumulates; the cold climate also causes a slower rate of chemical weathering. Freeze-thaw processes during the winter months are thought to be responsible for the physical mixing of mineral and organic matter and for the loose fabric of the upper soil layers at high altitudes. A similar though less intense

process operates in all soils from time to time during the winter, the freezing of soil moisture tending to break up clods into smaller aggregates.

Relief

The significant influence of relief on climate has already been mentioned. Relief and parent material are also inter-related, a parent material often occurring on a characteristic topography.

Relief has a more direct influence on soil genesis through its effect on the water relationships of soil. The hydrologic conditions are affected by the influence of slope on infiltration of rainfall and by the effect of relief on position of the water-table. While increasing steepness of slope, as would be expected, gives a greater likelihood of free drainage through the soil, it also retards soil development as it reduces leaching down the profile and causes down-slope soil movement (colluviation); podzolised soils are thus less likely to occur. Gleying is favoured in receiving sites, i.e. those receiving more water from the slopes above than lost by run-off, and in such sites the water-table is usually closer to the surface. Where springs occur, mineral-rich ground waters often cause water-logged conditions for long periods, but they also maintain a base status higher than in surrounding areas and may thus retard the build-up of organic matter.

Relief influences micro-climate through the effect of aspect: north-facing slopes receive less radiation, giving lower soil temperatures which are conducive to a build-up of organic matter and to podzolisation.

Biotic Agencies

Plant communities and the activities of man affect one another and both are affected by soil conditions, so that biotic agencies cannot be regarded as independent variables. Some of the effects of these agencies can nevertheless be inferred from historical evidence and from the character of the present soils.

Established plant communities affect the soil partly through the amount and nature of their leaf litter which in turn affects the form of humus, the rate of mineralization of organic matter, the amount of nutrients available for plant growth and the rate of acidification. The process of leaching can be retarded both by the fixing of nutrients from lower layers of soil and their retention in plants and plant remains. Mixing of soil horizons by tree fall can also counteract leaching.

The soil fauna and flora are much affected by soil conditions. Soils that are no more than moderately acid usually have a large population of micro-organisms and many earthworms which ingest plant remains and soil and excrete them as an intimate mixture, mull humus. The burrowing activity of earthworms parallels the action of plant roots in retarding the leaching of plant nutrients. Earthworms are less numerous, however, in strongly leached and podzolised soils and here fungi and mites aid other micro-organism in the decomposition of the organic matter, which is usually of the acid or mor form.

Man’s activity as a cultivator has had a marked effect on the soils of the area. Operations carried with the objective of improving the environment for agriculture and forestry, include heather burning, ploughing, draining and the application of fertiliser. The combined effects on the soils of centuries of cultivation and fertiliser

application has been to counter the effects of leaching by raising the base status and reducing the degree of acidity, so that many cultivated soils show no trace of the podzolised surface horizons that may once have been present. Cultivation can also improve soil drainage by disrupting an iron pan or indurated layer, and field drains in poorly drained soils can ameliorate water-logging to the degree that leaching replaces gleying as the main soil process.

The establishment of forests influence the soils in a number of ways. Drainage and pre-planting cultivation can reduce gleying and result in mixed soil horizons and although fertilisers are applied, these are not in the quantities used in agriculture. The trees also affect the soil, mainly through their litter, with increased podzolisation processes more apparent under coniferous plantations.

Time

Soil-forming processes in the area were initiated at the end of the last cold period, about 10 000 years ago. Many of the soils are also of this age, although on the lower raised beaches and terraces, the blown sand and alluvial deposits, the soils are younger and usually show less mature development, horizons being only weakly developed.

Soil Classification

The soils mapped and described in this memoir have been classified according to the system adopted by the Soil Survey of Scotland in which soil series are the basic mapping unit and comprise soils with a similar type and arrangement of horizons developed on similar parent material. Soil series often extend over large areas and consist of many profiles which are not all precisely the same but show some variations of character at different sites. Series with similar horizons arranged in the same sequence are placed in the same major soil subgroup. The subgroups comprise soils developed on different parent materials which appear to have been formed by similar processes and to be at a similar stage of development. Major soil groups include two or more major soil subgroups, the soils of which show broad similarities in the arrangement but some variation in the nature of their horizons. Major soil groups are further arranged into divisions, the highest category of the system (Table 6). Four divisions can be separated in this area on the basis of the main soil processes operating: Immature Soils, Leached Soils, Gley Soils and Organic Soils. A fifth division comprising non-leached soils is not described as no soils within this division are mapped on Sheets 66/67 and 57. Lower categories, the major soil group and major soil subgroup occurring in the district are distinguished for the divisions.

In the description which follows, the categories of the classification are defined mainly in terms of the characteristics of their master horizons (see Appendix 1).

DIVISION OF IMMATURE SOILS

Immature soils are characterised by indistinct or weakly developed horizons which are generally restricted to surface organic horizons or A horizons resting directly on little-altered parent material or rock.

Major Soil Group: Lithosols

Lithosols are restricted in depth and have continuous, coherent and hard rock within 10 centimetres of the surface. Only an H, O or A horizon is likely to be present above rock.

Major Soil Group: Regosols

Regosols have a thin, weakly developed A horizon, which rests directly on unconsolidated material. The soils are generally on parent material of windblown sand.

Major Soil Group: Alluvial Soils

Alluvial soils are developed on recently deposited freshwater, estuarine or marine alluvium and exhibit little profile differentiation or modification to the parent material. The presence of an A or an O horizon together with some mottling and weak structure in the subsoil, are characteristic features.

Major Soil Group: Rankers

Rankers have H, O or A surface horizons more than 10 centimetres thick which rest directly on hard noncalcareous rock or rubble derived from such rock. Incipient E and B horizons can be present.

DIVISION OF LEACHED SOILS

Leached soils are characterised by an absence of free lime and by an acid reaction in their A and B horizons. Their lower horizons may show some gleying expressed as mottling.

Major Soil Group: Brown Earths

A uniformly coloured B horizon, a mull or moder humus type and a moderately acid reaction are the characteristic features of the brown earth; ideally each horizon merges into the one underneath.

Major Soil Subgroup: Brown Forest Soils

Brown forest soils are freely drained and have a moderately acid reaction and humus of the moder type. There is either a clear change from the A to B horizon but a sharp change to the underlying horizon or each horizon merges into the one below.

Major Soil Subgroup: Brown Forest Soils with gleyed B and C horizons

Brown forest soils of this type have a moderate base status and a moderately acid reaction, the B and C horizons showing some gleying. The soils are frequently found on parent material of moderately fine and fine texture.

Major Soil Group: Podzols

In their semi-natural state, podzols have surface H or O horizons overlying an illuviated grey bleached E horizon with weak structure. They have a strongly acid reaction, and their B horizons usually contain illuviated sesquioxides of iron and aluminium and sometimes also illuviated organic matter.

Major Soil Subgroup: Iron Podzols

Iron podzols have raw humus H horizon above a strongly bleached E horizon and a well developed bright Bs. Sometimes there is a sharp change into a paler, indurated B or BC horizon. Many of the iron podzols in the area have been cultivated, destroying the characteristic podzolic upper horizons.

Major Soil Subgroup: Peaty Podzols

Peaty podzols have a thick (usually more than 8 centimetres) accumulation of organic matter above an eluviated E which usually shows signs of gleying, the impedance being due to a thin often continuous iron pan (Bf). A horizon of humus accumulation (Bh) may be present above the iron pan. Below the iron pan a brightly-coloured iron-enriched Bs horizon is usually present.

DIVISION OF GLEYS

Gleys are mineral or peaty soils which have developed under conditions of intermittent or permanent water-logging. Often prominent in uncultivated soils is a pale-coloured eluviated and gleyed Eg horizon beneath which the horizons are grey with a greenish or bluish tinge with ochreous mottling. These colours are secondary and mask the colour inherited from the parent material.

Major Soil Subgroup: Noncalcareous gleys

Noncalcareous gleys have no free calcium in the upper horizons. Any accumulation of organic matter on the surface of these soils is slight (less than 2-3 centimetres) and an Eg horizon, often well defined, is present in the semi-natural soils.

Major Soil Subgroup: Peaty Gleys

Peaty gleys have no free calcium in the upper mineral horizons which, as the soils are seldom cultivated, usually include a prominent gleyed eluviated Eg horizon. Above the mineral soil is a thick (usually over 5 centimetres) accumulation of raw organic matter.

DIVISION OF ORGANIC SOILS

Organic soils encompassing hill and basin peats are formed under water-logged conditions and have been mapped where the surface organic matter exceeds 30 centimetres. **Later maps and surveys have invoked 50 centimetres as the determining depth.**

Major Soil Group: Basin Peat

Basin peat develops initially under the influence of ground-water in depressions or very poorly drained basins. The profile shows a vegetation sequence more complex than that of hill or blanket peat.

Major Soil Group: Hill Peat

Hill or blanket peat, sometimes called climatic or zonal peat, is an organic formation which develops at high elevations on high-lying plateaux, convex and concave slopes, generally as a result of climatic conditions of high rainfall, low temperature and high humidity, and on gentle slopes at low elevations where parent materials are strongly acidic. The profile tends to be of more uniform composition from profile top to bottom than that of basin peat.

Table 6. Classification of Soil Series

CLASSIFICATION OF SOIL SERIES			
Division	Major Soil Group	Major Soil Subgroup	Series
Immature Soils	Lithosols		Skeletal soils
	Regosols		Links, Dune Sand, Raised Beach deposits
	Alluvial Soils		Alluvium undifferentiated
	Rankers		Skeletal soils
Leached Soils	Brown earths	Brown forest soils	Drumforber, Oldcake, Garvock, Cairnrobin, Tarves, Deecastle, Fungarth, Raemoir, Dinnet, Kinord
		Brown forest soils with gleying	Laurencekirk, Luther, Mountboy, Stonehaven, Balrownie, Tipperty, Collieston, Thistlyhill, Baikies, Ingliston
	Podzols	Iron podzols	Newton, Shields, Aldbar, Vinny, Strathfinella, Tillypronie, Strichen, Counteswells, Oldtown, Auchenblae, Boyndie, Corby, Forfar, Trusta, Dess, Maryfield, Annniston, Leys
		Peaty podzols	Garrold, Gaerlie, Charr
Gleys	Gleys	Noncalcareous gleys	Muirfoot, Barras, Balhagarty, Lour, Vigean, Marshmire, Ledmore, Pitmedden, Anniegathel, Terryvale, Ferrar, Candy, Dallachy, Mulloch, Pow
		Peaty gleys	Auquhollie, Strathgyle, Forgie, Findowrie, Pettymuck, Hythie, Drumlasie, Mundurno
Organic Soils	Basin & Valley Peat		
	Blanket Peat		

The smallest soil unit suitable for taxonomic study is the soil profile, a vertical section through the soil as revealed in a pit or exposure, which consists of layers or horizons roughly parallel to the ground surface and differing from each other in such characteristics as colour, texture, stoniness, structure, consistence and organic content, as a result of the differential removal and addition of material by pedological processes. The terms used for profile description and horizon nomenclature are defined and described in Appendix 1. The characteristics of each profile and its horizon sequence allows the soil to be assigned to a major soil sub group and ultimately to a soil series.

Soil series are further placed into soil associations according to the parent material on which they are developed. The soil association being defined as a group of soils developed on the same or related parent materials which characteristically occur together on the landscape. The parent materials found in the area are described in Chapter 3, but briefly the parent materials of an association consist of the drifts, including moraines and tills, derived from similar rocks. The soils of an association differ from each other principally in those features of their morphology conditioned by their hydrologic state or natural drainage. The association brings together the soils of a particular landscape formation and soils which have common features inherited from their parent material. Soil associations are usually named after the location where the association was first mapped and soil series are similarly named. The most extensive series usually has the same name as the association.

Soil Mapping

The principal mapping units are the soil series and their extent and the boundaries between them are shown on the soil map. After a brief reconnaissance to establish the parent material and soils most extensive in the area, the detailed soil survey was undertaken by systematically traversing the country, in directions as far as possible at right angles to anticipated soil boundaries. Soil boundaries were established by digging small inspection pits or by making auger borings at suitable intervals and recording the results on Ordnance Survey 1:25 000 scale maps. Soils are often related to the relief and the vegetation, and an understanding of these relationships greatly aids the drawing of boundaries. Peat soils were mapped where organic surface horizons were greater than 30 centimetres.

As much as possible of the detail shown on the field maps is reproduced on the published maps but the limitations of the reduced scale (1:63 360) make it impractical to delineate areas less than about 1 hectare. The area of a soil series shown on the published map may consequently include small areas of other soil series. It must also be appreciated that the boundaries between mapping units are rarely as sharp as represented by the lines on the soil map; there is generally a broad transitional belt over which the soil changes gradually and progressively from that typical of one mapping unit to another. The boundary is drawn where the critical change is thought to occur, but soils lying near to this line on either side will closely resemble one another, showing greater differences the further they extend from the boundary.

Where the soils occurred in an intricate and often recurring pattern, it was not always possible to distinguish soil series even on the larger scale field maps. In these cases soil complexes were used as mapping units (Mongour Complex). Individual complexes are characterised by the nature and relationships of their constituent soils and, like soil series, have a range of variation from the mode of the unit.

During the course of the survey, profile pits (larger than the inspection pits) were dug and described at selected sites, typical of each soil series. The depth of the pit varies but is commonly to 1 metre or deep enough to reach the unaltered parent material. The description included the location and the general features of the site and the profile, as well as details of each horizon as seen in the exposed face of the pit. The standard terms and horizon symbols used for these descriptions are defined and explained in Appendix 1. Each horizon, where practical, was sampled and subjected to routine chemical analyses. Selected samples were further analysed by chemical, mineralogical, differential, thermal, x-ray and spectrochemical methods. The analytical results are given in Appendix 2 and discussed in Chapter 6.

5. Soils

Introduction

Sixty four named soil series have been identified in the area surveyed, forty two of which also occur on either Sheet 76 (Inverurie) or Sheet 77 (Aberdeen) to the north or Sheet 48/49 (Perth and Arbroath) to the south.

Table 7 shows the area in square kilometres covered by each series and by other soil units, namely soil complexes, skeletal soils, alluvium, saltings, links, dunes, raised beach soils, peat, mixed bottom land and quarries and built-up areas The soil units which make up a soil association are arranged horizontally. Each association bears the name of one of its component series, usually that of the dominant one in the area where the series was first described. The names along the top of the table are those of the major soil group classification.

In this chapter, the seventeen soil associations and other soil units found in the area are described in detail.

The description for each profile follows and, in most cases, any salient points have been added. Each profile description has been taken from an actual pit and profiles were selected which show morphological characteristics considered to represent the average or modal form of the soils. Details of local variations and phase differences are given in the text immediately after the description. Sixty six profiles are described and standard analytical data are given for these and a further forty five profiles in Appendix 2. For the purposes of comparison, ranges of analytical data are discussed rather than actual figures and definitions of the ranges for organic matter, exchangeable cations, pH, base saturation and total phosphorus are given in Chapter 6. Where pH values have been quoted, these refer to measurement in water. In the description of many of the soil profiles, the soil textures recorded in the field at the time of the profile description and sampling are often finer than those calculated from the laboratory analyses of the same profiles. This is due, in part, to the high proportion of sandstone in the parent materials and the unavoidable inclusion of markedly decomposed stones in the soil samples taken for analysis.

Table 7. Areas of Soil Series (square kilometres)

	Brown Forest Soils		Iron Podzols		Peaty Podzols	Non-calcareous Gleys	Peaty Gleys			
Association	Series									
	Freely drained	Imperfectly drained	Freely drained	Imperfectly drained	Freely drained below iron pan	Poorly drained	Poorly drained	Very poorly drained	Skeletal soils	Total (sq km)
Auchenblae			Auchenblae 22			Candy 1				23
Balrownie			Aldbar 128							330
		Balrownie 196				Lour 4		Findowrie <1	2	
Boyndie			Boyndie 18	Anniston 1		Dallachy 0.5				19
Collieston	Cairnrobin <1	Collieston 2				Marshmire <1				3
Corby	Kinord 5		Corby 102	Leys 3		Mulloch 5		Mundurno 1		116
Countesswells	Raemoir 9		Countesswells 117	Dess 60	Charr 106	Terrryvale 35	Strathgyle 13	Drumlasie 7	37	384
Deecastle	Deecastle 1									1
Dinnet	Dinnet 18		Oldtown 3	Maryfield 1		Ferrar 2				24
Forfar			Vinny 74	Forfar 120		Vigean 6				200

Laurencekirk	Drumforber 2									67
	Oldcake 11	Laurencekirk 21								
		Luther 25	Newton 7			Muirfoot 1				
Mountboy	Garvock 45	Mountboy 15				Barras <1			<1	61
Pow		Ingliston 4				Pow 7				11
Stonehaven		Stonehaven 83	Shields 56			Balhagarty 21		Forgie 1	1	162
Strathfinella			Strathfinella 55	Trusta 8	Garrold 3	Ledmore 5				71
Strichen	Fungarth 22	Baikies 16	Strichen 105		Gaerlie 147	Anniegathel 42	Auquhollie 3	Hythie 5	39	379
Tarves	Tarves 34	Thistlyhill 3	Tillypronie 1			Pitmedden 3		Pettymuck 0.5	1	42
Tipperty		Tipperty 1								1
Total (sq km)	147	366	688	193	256	133	16	15	80	1894
Hill Peat	150	Basin Peat	14	Peat/Skeletal	6					170
Links	4	Dune Sand	<1	Raised Beach	2					6
Saltings	1	Alluvium and Mixed Bottom Land	177	Quarries and Built-up Areas	10					188
								Total area		2258

Auchenblae Association

The Auchenblae Association covers an area of 23 square kilometres and some sixty separate occurrences have been mapped throughout the Vale of Strathmore.

Distribution

The association occurs along the line of the Highland Boundary Fault where sand and gravel moraines and terraces have been deposited at the mouths of the glens. In the central and eastern parts of the Vale of Strathmore these deposits are related to, and associated with, former glacial meltwater channels. Some of the larger areas occur at Dunnottar, Auchenblae, Drumlithie and Catterline. Moundy to undulating topography is common to the whole association. The most northerly occurrences within the surveyed area are on Mains of Ury, Stonehaven; the most southerly are found at Kirkbuddo and in nearby localities at the northern end of the Sidlaw Hills. The association is used as rotational arable land. Gravel pits are of common occurrence on many of the knolls.

Parent Material

The parent material is a red, water-sorted sand and fine gravel, with coarser cobbly bands occurring less commonly. It is derived from sandstones and mudstones of Old Red Sandstone age together with Dalradian schists and gneisses; some igneous rock is usually present. The stones are rounded to subangular. Near the coast, about Mains of Dunnottar, Crawton and over the large area at Catterline, the underlying sandstones, conglomerates, mudstones and lavas have contributed largely to the deposit. In the Catterline area, at Fernyflatt Farm, sand rather than gravel predominates. In places, only the upper part of the deposit is reddish stained, the lower part being similar in colour to the gravel of the Corby Association but in general the sands and gravels of the Auchenblae Association contain more silt and clay and more mica than the Corby Association. The deposits on average vary in thickness from 1.5 to 6 metres, although at Auchenblae they are greater than 9 metres.

Soils

The dominant series, Auchenblae, is freely drained and contains both iron podzols and brown forest soils. The poorly drained Candy Series, a noncalcareous gley, is of very small extent.

Auchenblae Series

The freely drained Auchenblae Series, covering 22 square kilometres, is the main representative of the association. It occurs on moundy terrain and. in the surface horizons there is frequently evidence of disturbance by burrowing rodents. An indurated horizon (Bx) is normally present and the soil is classed as an iron podzol. Included within this series are some brown forest soils.

Profile Description: No.33. Knowehead

Grid Reference	NO538636	
Altitude	107 metres	
Slope	Moderate	
Vegetation	Rotational grass	
Drainage Class	Free	
Horizon	Depth	
Ap	0-20 cm	Dark brown (7.5YR4/2) coarse sandy loam; crumb; moderate organic matter; many medium gravel stones; many fibrous roots. Sharp change into
Bs	20—41 cm	Yellowish red (5YR5/6) coarse sandy gravel; single grain; loose; some dark organic staining; generally low organic matter; frequent fibrous roots; moist. Sharp change into
B(x)	41—56 cm	Light reddish brown (5YR6/4) coarse sandy gravel; indurated breaking into single grain; low organic matter; frequent medium cobbles; few roots; moist. Gradual change into
C	56 cm +	Reddish yellow (5YR6/6) coarse sandy gravel; single grain; compact in places; few large cobbles up to 13 centimetres; a few roots penetrate to 102 centimetres; moist; no mottles.

The Ap horizon is higher in silt, clay and organic matter than the underlying horizons, and has a crumb structure. The quality of the soil is largely dependent on the thickness and texture of this horizon since the Bs and Bx horizons are sufficiently coarse to have free to excessive drainage and low nutrient status. A weakly or moderately indurated horizon, which few roots penetrate, is usually present.

Candy Series

The Candy Series, a poorly drained noncalcareous gley, covers 1 square kilometre, occurring in depressions and channels between mounds of sand and gravel, sites which are difficult or impossible to drain.

Profile Description: No.78. (Candy)

Grid Reference	NO797802
Altitude	85 metres
Slope	Level
Vegetation	Old grass with *Agrostis canina*, *Ranunculus acris*, *Rumex acetosella*, *Juncus bufonius*, *Arrhenatherum avenaceum*
Drainage Class	Poor

Horizon	Depth (cm)	
Ap	0-20	Very dark greyish brown (10YR3/2 sandy loam with frequent small cobbles; weak structure; high organic matter; many fibrous roots; wet. Sharp change into
Bg	20-76	Pale brown (10YR6/3) coarse sandy loam; weak sub-angular blocky, breaking readily into single grain; low organic matter; few fine roots penetrate to 75 centimetres; few to frequent yellowish brown (10YR5/6) mottles, and staining from decomposing schist rocks.
at 76		Discontinuous lens of grey clay, water oozing in rapidly.
76-107+		Stony gravel, mainly of schist and gneiss with conglomerate cobbles and some lava.

The surface horizon and the underlying Bg horizon are of moderately coarse texture, having a clay content of about 10 per cent and a silt content of 10 to 20 per cent.

For additional analytical data see profiles No.34. Candy and No.35. Cairndrumin, Appendix 2.

Balrownie Association

This is the most extensive soil association within the lowland part of the Vale of Strathmore. In all, it covers 330 square kilometres.

Distribution

The soils of the association are widely distributed throughout the lowland part of Sheet 57 and in the south-east part of Sheet 66/67. Their north-west margin is formed by the line of the Grampian Foothills from Glen Ogil to Stonehaven; only scattered areas extend north of the River North Esk to Stonehaven. The eastern margin excludes the Montrose Basin and the high land of Rossie Moor to the south, together with the sandy lower reaches of the Lunan valley. Elsewhere, excluding the valley of the South Esk and the Forfar-Lunan channel, Balrownie is the dominant association, with enclaves of the Forfar Association occurring within it. The soils are largely confined to the lower ground between 60 and 150 metres with lower-lying areas in the coastal parishes of Arbroath and St. Vigeans and a few marginal extensions up to 210 metres on the lower slopes of the Sidlaw Hills. The general topographic picture is one of low-angle slopes, gentle undulations, and rising ground on the lower slopes of hills. There is a regional west-south-west – east-north-east alignment of the lowland landscape, a feature dictated by the strike of the underlying Lower Old Red Sandstone sedimentary rocks. This has produced broad rises between the main east – west river valleys, broken by low parallel west-south-west – east-north-east ridges and undulations.

Parent Material

The soils are developed on a reddish brown loam or clay loam till in which there is a general admixture of arenaceous and shaly rocks of Lower Old Red Sandstone age and some Dalradian schists. Within the district true limestones are scarce, but most

of the arenaceous strata contain some weakly calcareous sandstones and calcareous shaly bands, and the till is believed to have been slightly calcareous originally. At the normal soil profile depth of 1 to 1.2 metres the till is no longer calcareous, but where deep sections are available for examination the till is usually found to be slightly calcareous at depths between 1.8 and 3 metres below the surface, indicating the extent of post-glacial leaching. It is possible that the calcareous marl bands underlying and among the stratified peat and silt deposits in Forfar, Rescobie and Balgavies Lochs were formed from the precipitation of calcium carbonate leached from the till.

Over much of the low ground in Strathmore the upper layers of the till have been considerably modified by periglacial activity including some degree of water-sorting during the cold periods of valley glaciations subsequent to the melting of the last main ice-sheet. The resultant solum available for soil development consists of up to about 60 centimetres of modified or roughly sorted till of sandy loam or loam texture (15 to 20 per cent clay) overlying a more compact clay loam or sandy clay loam till. Such a solum inevitably shows considerable local variation. The modified layer may be locally almost absent, or form the whole of the soil profile; in the latter case, when the modified layer is greater than 60 centimetres thick the soils are distinguished as those of the Forfar Association. By contrast, much of the hilly ground in the south-west forming the outliers and foothills of the Sidlaw Hills is underlain by a thin till derived from grey and brownish grey flagstones and shales. These were formerly quarried on Turin Hill, Balmashanner Hill, and to a lesser extent around the lower slopes of Hayston Hill. The rather shallow glacial till closely reflects the change in lithology, and the soils have a characteristic fine sandy loam texture. Similar soils occur on parts of Hill of Finavon, Fothringham Hill and Gallow Hill and while the till on these hilly sites does not have the periglacially modified or water-sorted surface layers characteristic of the undulating till plain, it shows the effects of general mass movement or colluvial rather than surface modification.

In the parishes between Brechin and Marykirk, the clay content of the underlying till tends to be higher than normal, although the soils are similar to the rest of the association. Other areas of the finer-textured till, containing 24 to 28 per cent clay, are generally of limited extent but have been found on and around Montreathmont Moor, around Kirkbuddo in the south central part, and between Ethie Haven and Auchmithie in the south-east of Sheet 57.

Soils

Four series have been distinguished: the Balrownie Series, an imperfectly drained brown forest soil, the Aldbar Series a freely drained iron podzol, the Lour Series, a poorly drained noncalcareous gley and the Findowrie Series, a very poorly drained peaty gley. The Balrownie and Aldbar Series account together for some 97 per cent of the association and the Lour Series for most of the remainder. The Findowrie Series is rarely encountered as most of the very poorly drained soils in Strathmore are found in areas of alluvium or mixed bottom land.

Balrownie Series

The Balrownie Series is the most extensive lowland series within the area. It covers 196 square kilometres, of which only a small part lies on Sheet66/67, comprising a coastal strip situated north of Stonehaven, a smaller inland area lying 1.6 kilometres west of the town, and a small area at the southern margin which extends on to Sheet 57. The series attains its maximum development on Sheet 57 where it is the dominant series with a fairly even distribution throughout the Vale of Strathmore. The soils are generally podzolic when encountered in the semi-natural state, but are indistinguishable from weakly gleyed brown forest soils after cultivation.

The bulk of the series lies below 150 metres, but some extends locally to 210 metres on the Sidlaw Hills in the south-west corner of Sheet 57.

The parent material variations of this series have been extensively described on page 43. On the low ground the thickness of the till is often more than 1.2 metres and has been found to exceed 1.8 metres on Montreathmont Moor and in many other localities.

One of the most noticeable variations within the series is the presence or absence of an indurated, Bx, horizon. It has not been practicable to utilise this as a diagnostic characteristic in mapping, as there is an almost complete gradation between the two profile types. The extremes are readily recognisable, a hard indurated (Bx) horizon in one, and a weakly gleyed (B(g)) horizon, with prismatic or coarse subangular blocky structure, in the other. Between these are variable intergrades with slightly indurated or compact horizons and no prismatic structure.

The standard analytical data for a number of profiles of this series have been averaged to provide a comparison between the cultivated and semi-natural states. For the profile with an indurated layer, the mechanical analyses indicate a higher clay content in the Ap and B(g) horizons of the cultivated soil than in the A and B(g) horizons of the semi-natural soil. This may be partially accounted for by a natural tendency to select the best land for cultivation. Exchangeable calcium and pH values in the cultivated profile are significantly higher in all horizons down to the base of the indurated layer. Below this layer they become comparable with those in the semi-natural soil. By contrast the figures for exchangeable potassium, magnesium and sodium show no significant differences at any depth. This suggests that the main effect of 200 years of modern arable agriculture has been to maintain equilibrium in the profile in respect of all major plant nutrients other than lime, the excess of which leaches gradually down the profile, even penetrating the relatively impermeable Bx horizon. This makes it easier to understand why, in the arable profile without indurated layer, the pH and exchangeable calcium values right down to the C horizon are usually significantly higher than in the comparable profile with indurated layer.

Two profiles are described. The first, a semi-natural soil from Montreathmont Moor, with an indurated layer; the second, a representative arable soil from Bonnyton Farm, both classified as a brown forest soil with gleying.

Profile Description: No.19. Montreathmont Moor

Grid Reference	NO593540
Altitude	75 metres
Slope	Level, top of low east - west ridge
Vegetation	*Calluna vulgaris*, *Erica tetralix*, *Trichophorum cespitosum*, *Deschampsia flexuosa*, *Nardus stricta*, *Juncus effusus*, various mosses
Drainage Class	Imperfect

Horizon	Depth (cm)	
L	0-3	Litter
F	3-8	Dark reddish brown (5YR3/2) fibrous humus
Ah	8-13	Very dark greyish brown (10YR3/2) humose sandy loam; medium subangular blocky; friable; few small stones; frequent roots; moist. Clear change into
ABg	13-28	Dark yellowish brown (10YR3/4) sandy loam; medium subangular blocky; soft and friable; frequent stones, mainly schist erratics; many roots; moist; rather patchy coloured, with few grey and rusty mottles. Clear change into
B(g)	28-36	Light reddish brown (5RY6/4) sandy loam; subangular blocky; rather compact; frequent stones; few roots present but number decreasing steadily with depth; moist; few grey and rusty mottles (the latter generally associated with weathered stones). Clear change into
Bx(g)	36-48	Reddish brown (5YR4/3) sandy loam; compact, indurated; frequent stones; a few roots penetrate this horizon; moist; few to frequent grey and rusty mottles. Gradual change into
BC(x)(g)	48-58 cm	Reddish brown (5YR4/4) sandy loam to loam; compact and slightly indurated; otherwise as above. Clear change into
C(g)	58-107+	Reddish brown (5YR4/4) loam; weak coarse subangular blocky to prismatic; few vertical grey cracks with rusty edges; frequent stones, mainly schist and red sandstone; no roots; moist; few rusty mottles and a little black manganese staining.

Profile Description: No. 16. Bonnyton

Grid Reference	NO450429
Altitude	125 metres
Slope	Gentle
Vegetation	Rotational grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-23	Dark greyish brown (10YR4/2) loam; weak subangular blocky to crumb; few stones; many grass roots; worms present; moist; no mottles. Clear change into
B(g)1	23-31	Reddish brown (5YR4 and 4/3) sandy loam to loam with some dark brown vertical streamers of Ap horizon material; prismatic; moist; few diffuse grey and rusty mottles. Clear change into
B(g)2	31-41	Reddish brown (5YR4/3) loam; coarse subangular blocky to prismatic; frequent stones, mainly schist and red sandstone with some lava; few roots tending to concentrate between structure units; no worms seen but probably present; moist; few grey and rusty mottles. Gradual change into
BC	41—64	Reddish brown (5YR4/3) loam; coarse subangular blocky; stones as above but with more large boulders up to 15 - 20 diameter centimetres present; few roots; moist; few grey and rusty mottles. Gradual change into
C	64-107+	Reddish brown (5YR4/3) loam; coarse subangular blocky, becoming massive with depth; frequent stones; few roots present to about 91 centimetres; moist; some water seeping into profile pit at 96 centimetres.

The pH value of the Bx(g) horizon, in seminatural profiles, does not exceed 5.6 and the pH value of the C(g) horizon at a depth of 1 metre is often below 6.6. The profile has also been noted on parts of Forest Moor.

A common podzolic variant on Montreathmont Moor has an L/F horizon consisting of litter and fibrous humus overlying A(g) and B(g) horizons. Below this, an indurated B horizon may be weakly developed or absent, and there is some evidence of clay deposition in pores and on structure faces, at or a little below this level. The pH values in the C horizon at 1 metre, range above or below 6.6, but so far have not been found to exceed 6.9 in semi-natural profiles. In cultivated soils, C horizon pH values up to 7.2 have been found. It is uncertain to what extent these higher values should be ascribed to the gradual build-up of lime during several hundred years of cultivation, as it is reasonable to suppose that the best semi-natural soils would have been among the first to be selected for cultivation.

For additional analytical data see profiles No.15. Denmark, No.17. Wood of Aldbar, No.18. Kincaldrum Hill and No.20. Chapelton in Appendix 2.

In the New Statistical Account for the parish of Kinnell, published in 1845, it states that turf-cutting rights on Montreathmont Moor were actively exploited between 1659 and about 1790 when the moor was divided up among the neighbouring estates. The practice was certainly operative prior to 1659, as reference is made to a change in the 'keepership' of the moor - in which control of the turf-cutting rights was vested. It may go back to the monastic period around 1200, to which reference is also made. The present immature state of the raw humus H horizon on Montreathmont Moor is probably correlated with the extent and thoroughness of this practice of turf-cutting rather than with any very recent switch in soil profile type from brown forest soil to podzol. Pollen analyses of remnants of the original peaty turf indicate that formation of the underlying A horizon may date back either to the beginning of the Sub-Atlantic period, or to the beginning of the previous Sub-Boreal period. The extensive arable soils of this series, however, do not all show clear residual evidence of podzolic B horizons after cultivation, and, morphologically, look much more like weakly gleyed brown forest soils. The soils of the series, taken as a whole, are certainly a less strongly leached group than those of many other series developed on more acid parent materials, and have been shown on the map key as 'brown forest soils'. It will be appreciated that this designation is a compromise based more on cartographic convenience than on pedogenic definition. These soils should most probably be regarded as bisequal - although to a varying extent.

Aldbar Series

This series covers 128 square kilometres and includes freely drained soils which are podzols or cultivated soils derived from podzols. On Sheet 66/67 (Banchory and Stonehaven) these soils have been mapped to a limited extent along the lower south-facing slopes of the Grampian foothills, south of the Highland Boundary Fault. On Sheet 57 (Forfar) they are found in a similar topographic setting along the Highland edge between Menmuir and Memus. In addition, they extend from the hill edge, 3 to 5 kilometres southwards into the undulating lowland country around Noranside, although the pattern on the ground is discontinuous. An extensive belt of these soils runs from Hillside west-south-west through Brechin into the parish of Aberlemno. All these localities in the northern part of Sheet 57 clearly reflect the east-north-east to west-south-west, regional strike of the underlying Old Red Sandstone strata. South of the Forfar-Lunan channel the series has a more random distribution, occupying the scattered outlying hills and ridges of the Sidlaw Hills.

The altitudinal range of the series is from about 45 metres in the south-east to over 300 metres on Hayston Hill in the south-west, although the greater part of it lies between 60 and 210 metres. Between the Grampian foothills and the River South Esk the series is developed on till generally more than 1.2 metres thick and containing about 20 per cent clay. The till is derived from a mixture of Lower Old Red Sandstone strata, in which a rather sandy version of the bright red Edzell shales is noticeable. On the Aberlemno ridges and the scattered outliers of the Sidlaw Hills further south, shallower soils 60 to 90 centimetres thick, overlying sandstone, are more general, and the local lithology becomes more strongly reflected in the parent material, the nearer the semi-residual condition is approached. The flaggy sandstones of the Aberlemno ridges and the hills of the extreme south-west give rise to soils in which fine sand is noticeable in the field texture. The, low quarry-riddled hills around Carmyllie are of sandstone with thin conglomerate bands and

contributed much freestone to the Dundee area in the recent past; they are overlain by soils of distinctly coarser texture. The usual texture range of the series is sandy loam or loam with a clay content ranging from 15 and 23 per cent.

The following two profiles from Broom Farm and from Finavon Hill illustrate a freely drained soil developed on till from the arable region and a shallow, almost residual, soil from cut woodland.

Profile Description: No. 37. (Broom)

Grid reference	NO476594
Altitude	130 metres
Slope	gentle
Vegetation	Rotational grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-23	Dark reddish brown (5YR3/3) loam; medium subangular blocky; friable; frequent medium and small red sandstones; many fibrous grass roots; worms present; moist; no mottles. Clear change in
Bw	23-33	Reddish brown (5YR5/4) loam with darker brown vertical streamers and patches of Ap horizon material; medium and fine subangular blocky; frequent medium and small stones; frequent grass roots; worms present; moist; few faint rusty mottles present. Clear change into
Bx	33-43	Reddish brown (5YR5/3) sandy loam; compact and indurated; frequent large, medium and small subangular stones, mainly red sandstones and Dalradian schists; few roots present in upper 3-5 centimetres; moist; few rusty mottles present. Gradual change into
B(x)	43-58	Reddish brown (5YR5/4) sandy loam; compact, but less indurated than above - induration decreasing with depth; frequent stones as above; no roots; moist; few rusty mottles present. Gradual change into
BC	58-76	Reddish brown (5YR4/4) loam; weak coarse subangular blocky; compact; frequent stones; no roots; moist; few faint rusty mottles. Gradual change into
C	76-94+	Reddish brown (5YR4/4) loam (somewhat finer than above; massive; compact; frequent stones; no roots; moist; few faint rusty mottles.

Profile Description: No. 40 Finavon Hill

Grid Reference	NO502553
Altitude	210 metres
Slope	Gentle
Vegetation	Cut woodland with *Deschampsia flexuosa*, *Festuca ovina*, *Luzula* sp., *Viola* sp., *Vaccinium* spp. and various mosses.
Drainage Class	Free

Horizon	Depth (cm)	
L	0-3	Grass and moss litter
H	3-5	Black (5YR2/1) greasy humus with some bleached sand grains. Sharp change into
Ah	5-15	Dark reddish brown (5YR3/2) humose sandy loam; loose crumb; few stones, red sandstone and schist; many grass roots; no worms; moist; no mottles. Clear change into
Bs(m)	15-19/28	Reddish brown (5YR4/4) humose fine sandy loam; crumb; compact; weakly cemented; few stones; frequent roots; moist; no mottles. Clear irregular change into
Bw	19/28-41	Reddish brown (5YR3/4) fine sandy loam; subangular blocky; slightly compact; a few fragments of red sandstone, becoming more frequent towards base of horizon; frequent roots almost to base of profile; moist; no mottles. Sharp irregular change into
R	28-41+	Shattered red sandstone at variable depth.

The greater part of this series lying below 180 metres is, or has formerly been, under arable cultivation; the remainder, on higher ground, mostly around Aberlemno and south-west of Forfar, is mainly planted woodland, rough grazing, or heather moor.

For additional analytical data see profiles No. 36. Chapelton, No.38. Wood of Aldbar and No.39. Kincaldrum Hill in Appendix 2.

Lour Series

This series, with a total area of 4 square kilometres, comprises the poorly drained noncalcareous gleys of the Balrownie Association. The soils are found mainly in the central part of Sheet 57 occurring in depressions in the till plain, aligned in an east-north-east to west-south-west direction. Small areas occur on the southern part of Sheet 57 between Forfar and Carmyllie, and occasional patches on the southern edge of Sheet 66/67, east of the Edzell flat. In the central area the series is found at altitudes between 60 and 120 metres, but further south in the outlying hills of the Sidlaws, occasional localities have been mapped up to 240 metres.

The parent material of the series ranges from unmodified till to till material with alluvial affinities which has undergone strong solifluction. Texturally it falls well within the range of the rest of the association with clay contents of 15 to 25 per cent. Generally the base status of the profile is considerably higher than that of the (comparable) imperfectly drained soil. The pH values usually exceed 7 between 45 and 75 centimetres from the surface, and Cg horizon pH values over 7.5 are

sometimes found in both cultivated and uncultivated profiles. Total phosphorus never exceeds 0.2 per cent in any horizon, but the high pH values in the Bg and Cg horizons are generally accompanied by a rise in acetic acid extractable phosphorus to between 30 and 50 mg per 100 g as compared with less than 5 mg per 100 g in the more acid A horizons. In one semi-natural profile from Forest Moor there was no appreciable rise in extractable phosphorus in the Bg and Cg horizons, whilst an arable profile from Peathill Farm showed a sharp rise in extractable phosphorus up to pH 8.2, followed by a marked drop when the pH value exceeded 8.5.

Profile Description: No. 79. Forest Moor semi-natural profile

Grid reference	NO427553
Altitude	90 metres
Slope	Level
Vegetation	*Juncus effusus* and J*. acutifloris*, with some grasses, *Ranunculus acris*, *Cirsium palustre* and various mosses.
Drainage	Poor

Horizon	Depth (cm)	
L/F	0-3	Root mat
A	3-18	Very dark greyish brown (10YR3/2) loam; weak subangular blocky to massive; few stones; frequent roots; no worms; wet; no appreciable mottles. Gradual change into
Eg	18-24	Dark brown (7.5YR4/2) loam; weak subangular blocky to massive; few stones; frequent roots; wet, some water seeping from base of this layer; few rusty mottles. Sharp change into
Bg	24-38 cm	Yellowish red (5YR5/6) and greyish brown (10YR5/2) loam; prismatic breaking down to coarse subangular blocky; frequent stones, many soft and weathered; frequent roots, becoming fewer with depth; very moist; prominent grey and rusty mottles present. Gradual change into
BCg	38-58	Reddish brown (2.5YR4/5), yellowish red (5YR5/7) and light brownish grey (10YR6/2) loam; prismatic breaking to coarse subangular blocky; frequent stones mainly schist erratics, red sandstone and. mudstone with a few lava fragments - most of the stones are soft and weathered; few roots present; very moist; frequent prominent grey and rusty mottles. Gradual change into
Cg	58-102+	Reddish brown (5YR5/3), brown (7.5YR5/5) and light brownish grey (10YR6/2), loam; prismatic; frequent stones as in horizon above; few roots present to 76 centimetres; very moist, with water seeping from sides and base of pit; prominent grey and rusty mottles present throughout.

For additional analytical data see profile No.80. Wood of Aldbar in Appendix 2.

Findowrie Series

This series, which occupies less than 1 square kilometre, is a peaty gley with very poor drainage and occupies the marshy, permanently wet depressions adjacent to Duns Loch, and near Findowrie and Knowhead farms.
On account of excessive wetness and the insignificant extent of the series, the soils have not been sampled.

Skeletal Soils

Skeletal soils cover a total area of approximately 1 square kilometre and have been mapped on Hill of Finavon, on Turin Hill and on Guthrie Hill. The profile consists, generally, of a shallow layer of organic loam overlying shattered sandstone or bare sandstone rock.

Boyndie Association

The soils of the Boyndie Association occupy 19 square kilometres. The main areas are situated in the Vale of Strathmore and north of the Montrose Basin. They occur adjacent to the Lunan Water at Lunan Bay, north, west and south of the Loch of Forfar and to the west of Edzell. Small areas also occur in the Dee valley, east and west of Park and near Crathes Castle.

Parent Material

The parent material is a fluvioglacial outwash sand, mainly of medium coarseness and sometimes containing a small amount of gravel; in the area west of Forfar the sand has a finer texture. Generally the deposits are considerably more than 1.2 metres thick and occur at an elevation between 15 and 60 metres. They occur as river terrace or raised beach materials, usually with a flattish topography. The sand is siliceous and is probably derived mainly from acid igneous and metamorphic rocks

Soils

The soils of the Boyndie Association consist of three series, Boyndie, a freely drained iron podzol, Anniston, an imperfectly drained iron podzol, and Dallachy, a poorly drained noncalcareous gley. Drainage impedance in these soils is caused by the presence of relatively impermeable till just below the profile. The soils of the Boyndie Series have a sand texture and an inherently low base and moisture retention capacity.

Boyndie Series

This is the dominant series of the association covering 18 square kilometres. The soils are predominantly cultivated, often with deep sandy loams passing into loamy sands and are classified as humus-iron podzols occurring on a gently rolling landscape.

Profile Description: No. 42. Anniston

Grid Reference	NO673489
Altitude	30 metres
Slope	Gentle
Vegetation	Rotational grass
Drainage	Free

Horizon	Depth (cm)	
Ap	0-45 cm	Dark brown (10YR3/3) sandy loam; fine crumb becoming weak subangular blocky below 23 centimetres; compact; moderate organic matter; few small stones; many roots; worms present; moist; no mottles. Sharp change into
A	45-53	Very dark brown (10YR2/2) coarse sandy loam; crumb; loose; few small pebbles; many roots; moist; no mottles. Gradual change into
Bs	53-71	Brown (7.5YR5/5) loamy coarse sand with small gravel-sized pebbles; weak crumb breaking into single grain; loose; low organic matter; frequent roots; moist. Clear change into
Bs(x)	71-84	Yellowish brown (10YR5/6) sand with alternating bands of dark brown (7.5YR4/4) sand; weakly indurated, breaking into single grain; few roots; moist. Clear change into
C	84-114+	Stratified bands of strong brown (7.5YRS/8) and light yellowish brown (2.5Y6/4) sand; compact, breaking easily into single grain; no roots; moist; few faint medium grey and reddish brown mottles.

The most notable feature of these soils is their sandy texture; the surface horizon however has a markedly higher content of silt and clay than the B and C horizons. Because of their coarse texture many of the soils have a low base-exchange capacity and are markedly leached and depleted of bases in the B and C horizons. In the coastal areas, however, some soils are highly saturated throughout the profile. It is not known if this is due to calcium carbonate inherent in the sand or whether it has been applied as a soil amendment. The finer texture of the deep, Ap horizon and the greater content of organic matter are together responsible for the crumb structure and the friable consistence. The Bs horizon is coloured by accumulated iron and normally overlies a horizon with some degree of induration or cementation. Although the soil has long been under cultivation, evidence in the Bs and Bs(x) horizons is such as to indicate that the soil was originally a humus-iron podzol.

For additional analytical data see profile No.41. Dryleys in Appendix 2.

Anniston Series

The Anniston Series covers approximately 1 square kilometre and has been distinguished in only one area, south of Inverkeilor, where it overlies lacustrine clay below profile depth. This impermeable stratum is responsible for drainage impedance. The series belongs to the imperfectly drained class and has been

placed in the major soil subgroup of iron podzols. All of the series is under cultivation.

Profile Description: No. 64. Myreside, Inverkeilor)

Grid reference	NO6650048700
Altitude	20 metres
Slope	Flat
Vegetation	Old pasture
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-31	Dark brown (7.5YR4/2) coarse sandy loam; moderate medium crumb; friable; moderate organic matter; few small stones; many roots in upper 13 centimetres; moist; faint ochreous staining along root tracks. Clear smooth change into
E(g)	31-36	Pale brown (10YR6/3) with greyish cast; loamy coarse sand; weak fine to medium crumb; very friable; frequent roots; worms present; few medium yellowish brown (10YR5/6) mottles. Clear wavy change into
Bw(g)1	36-51	Light brown (7.5YR6/4) coarse sand; weak crumb breaking into single grain; low organic matter except in worm channels infilled with Ap horizon material; no stones; few roots; moist; medium distinct strong brown (7.5YR5/6) mottles, few above, many below. Clear smooth change into
Bw(g)2	51-76	Brown (7.5YR5/4) coarse sand; single grain; few roots; wet; iron staining surrounding vertical fossil root tracks. Diffuse change into
Cg	76-102+	Brown (7.5YR5/4) with slight reddish cast; coarse sand; single grain; wet; water rising to 86 centimetres.

The soil is subject to a seasonally fluctuating water-table indicated by the presence of ochreous mottles from 36 centimetres downwards. With a profile on coarse sandy parent material having a very low moisture retention capacity, this is agriculturally beneficial. Below 51 centimetres the soil is near neutral in reaction and, possibly as a result of good management, the level of soluble phosphate is highly satisfactory.

Dallachy Series

This series occupies only a small patch of less than 3 hectares situated east of Park Station, Deeside. The series is poorly drained due to underlying till impeding the drainage. In contrast to a dark brown sandy loam surface horizon with a moderately developed medium crumb structure, the subsurface Bg and Cg horizons are dark grey to greyish brown with frequent medium distinct ochreous mottles occurring between 5 and 60 centimetres. Beneath this, the soil is very wet and has a single grain structure. The pasture consists of old grass with rushes (J*uncus* sp.).

Collieston Association

The Collieston Association is developed on a mixed parent material derived from rocks of Old Red Sandstone and Dalradian age, the contribution from the Old Red Sandstone predominating. Of small extent and covering 3 square kilometres, it is located in the coastal areas near Inverbervie, Muchalls and Portlethen.

Parent Material

Below 30 metres, the parent material consists of water-sorted stratified deposits forming part of the 30-metre raised beach. Above this altitude, the parent material is a modified drift, affected to some degree by water sorting and solifluction processes. Around Inverbervie, at a height of less than 30 metres the parent material consists of a reddish brown, coarsely stratified, fluvioglacial deposit varying within the profile from gravel to lacustrine clay. Generally, a considerable depth of gravel underlies the solum. The stone content is mainly of Old Red Sandstone origin consisting of conglomerate cobbles, sandstones and marls together with Dalradian rocks. In the Portlethen vicinity, where the greater part of the association in the present survey is located, the association extends from the cliff tops to about 60 metres. Solifluction down slope from the surrounding higher ground is considered to be responsible for the sorting of the drift but it is not markedly stratified. Schists and gneisses together with Old Red Sandstone rocks are present in the surface horizons. The parent material is distinctly reddish brown in colour, typical of the Old Red Sandstone, but the base of the till is less red, and contains a high proportion of mica-schists, often in a soft and decomposed condition.

Soils

Gravel and sand generally occur in the lower horizons of the soils throughout the areas below 30 metres, and particularly around Inverbervie. The textural variation within the solum may be extreme, ranging from gravel to stone free lacustrine clay. This variability is found in the soils on the flat terrace on either side of the Bervie Water. At Portlethen, the land is gently sloping from about 60 metres and the parent material is a modified reddish brown till of sandy clay loam or coarser texture. The dominant soil series on these slopes and on the flat terraces at Inverbervie is the Collieston Series, an imperfectly drained brown forest soil. The imperfect drainage at Portlethen is due to run-off water from adjacent high ground causing a higher water-table, and at Inverbervie it is due to impedance by a clay layer. The Marshmire Series, which is poorly drained, is developed on flat or depressional sites and only occurs in a small area adjacent to Cammachmore Bay. The freely draining Cairnrobin Series occurs only in the north-east corner of Sheet.66/67 but it is contiguous with a larger area on Sheet 77 (Aberdeen) to the north (Glentworth and Muir, 1963).

Cairnrobin Series

The Cairnrobin Series, less than 1 square kilometre in extent, is a freely drained cultivated brown forest soil developed on water-sorted drift, and it has a variable texture throughout the profile. The surface horizons are usually reddish brown loams, the basal horizons are of stratified sand and gravel, and reddish clay bands

or a water-modified till form the B horizons. An indurated horizon (Bx) is usually present. The thickness of the surface horizon is about 30 centimetres and former B horizons have often been incorporated in this topsoil.

Collieston Series

The Collieston Series, an imperfectly drained brown forest soil covering 2 square kilometres, is developed on gentle slopes in the coastal areas about Portlethen, Muchalls and Inverbervie. At Portlethen the parent material is a till, modified by solifluction in its upper part to produce loam textures, and contains subangular stones composed of Dalradian schist and gneiss in addition to Old Red Sandstone rocks. The reddish brown sandy clay loam till is coarser textured at the base where it overlies an earlier drift containing a high proportion of soft and decomposed mica-schist and gneiss stones. In areas of this association below altitudes of 30 metres, subsurface horizons are usually stratified and coarse-textured but clayey layers also occur. Raised beach deposits bordering the north and south banks of the Bervie Water have profiles as described below. Adjacent to the encircling Stonehaven Association which is developed on a clay loam till, the Collieston Series soils have a higher clay content than those nearer the river, where the profiles are coarser textured and developed on gravel.

Soils with deep surface horizons of 40 centimetres or more occur near Inverbervie, Portlethen and Muchalls.

Profile Description: Pitcarry (No analytical data)

Grid Reference	NO828736
Altitude	30 metres
Slope	Level
Vegetation	Rotational grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-41	Dark reddish brown 5YR3/3) sandy clay loam; medium crumb in upper 10 centimetres passing into medium and coarse angular blocky; firm; moderate organic matter; frequent stones of O.R.S. conglomerate and sandstone, subangular Dalradian mica-schist, quartz-schist, gneiss; frequent fine roots; moist; fine distinct ochreous mottles towards base. Clear change into
B(g)1	41-76	Yellowish red (5YR5/6) gravelly sandy loam, in places gravelly sandy clay loam; medium subangular blocky; friable, breaking into single grain; very low organic matter except in worm channels filled with Ap horizon material; many stones, mainly rounded to subrounded, predominance of conglomerate cobbles, sandstone, schist, and few of red marl; few roots; moist; frequent distinct fine grey mottles, ochreous mottles masked by general red colour of horizon. Sharp change into
B(g)2	76-92	Red to weak red (10YR5/6 to 5/4) clay; massive when

		moist, moderate platy when dry; very low organic matter; few small subangular stones; few dead roots; moist; no mottles. Sharp smooth change into
C1	92-127	Reddish brown (2.5YR4/4) loamy fine sand; very weak subangular blocky breaking to single grain; friable; no organic matter; few small subangular quartzite stones; no roots; moist; sand very micaceous.
C2	127+	Stony gravelly coarse sand; single grain; no organic matter; stones are conglomerate cobbles, sandstone and mixture of Dalradian schist; no mottles; sand micaceous in finer fraction.

The Ap horizons of the Collieston Series are loams varying in thickness from 20 to 60 centimetres and in colour from very dark brown when the organic matter content is high to reddish brown when it is moderate to low. Both surface and subsurface horizons are generally friable and permeable but indurated horizons (Bx) occur in coarse-textured profiles.

On a detailed survey at a larger scale, the Collieston Series could be subdivided into soils with predominantly fine and those with predominantly coarse-textured subsurface horizons.

Marshmire Series

The Marshmire Series, a noncalcareous gley, occurs in only one small area of less than 1 square kilometre at Cammachmore Bay, where it is developed on a flat site associated with a drainage channel. The profile has a dark reddish brown loam surface horizon 20 to 28 centimetres thick underlain by a greyish brown sandy loam Ag horizon. In the prismatic-structured Bg horizon, fine ochreous mottling is present within the peds, while grey coatings appear on the external faces of the prisms. The Cg horizon is a reddish brown massive clay loam. The series is closely comparable with the Balhagarty Series of the Stonehaven Association and with the Lour Series of the Balrownie Association.

Corby Association

The soils of the Corby Association, covering 116 square kilometres, are formed on fluvioglacial and morainic gravel and are the coarsest-textured soils of the region. Frequently, areas of gravel merge into water-sorted sand, the parent material of the Boyndie Association.

Distribution

Mounds of gravel, deposited as retreat moraines and fluvioglacial terraces, are often found in the glens and along stream courses; larger areas occur in the river valleys viz, the Dee valley from Loch Kinord to Park, the Feugh valley and the Strachan basin, the North Esk from Invermark by Edzell to Inglismaldie, the South Esk in the Tannadice area, and the Lunan Water from Forfar to Friockheim.

Isolated bodies of the Corby Association are found scattered sporadically throughout the area.

Parent Material

Gneiss, schist and quartzite from the Dalradian together with granite are the main components of the gravel, but local variations occur reflecting the nature of the underlying rock. The aggregates are rounded and subangular and the clay and silt content is low. Appreciably more of the finer material occurs in the surface and B horizons than in the C horizon and the texture of the parent material varies from stony coarse gravel to sandy fine gravel.

Examples of retreat moraines with a characteristic moundy topography occur between Glen Dye and the Haugh of Strachan, at Friockheim, and also east of Forfar. The well-defined fluvioglacial gravel terraces along the rivers are 7 to 30 metres higher than the present flood plain. West of Aboyne they are flat and 1.6 kilometres in width, but in many places the terraces are dissected. They consist of stratified gravel. The moundy gravel, which is of morainic kame or esker origin, is usually water-sorted to a greater or lesser extent.

Within the soil profile there is a strongly indurated (Bx) horizon, which in an exposure often overhangs the lower material. Below this layer the gravel is loose and structureless. Where gravel passes laterally into sand, the parent material becomes that of the Boyndie Association.

Soils

Six series of the Corby Association have been distinguished. In addition to the established Corby Series, a freely drained iron podzol, a freely drained brown forest soil named the Kinord Series has been mapped. The Tarbothill Series, a peaty podzol with iron pan and free drainage below the pan has not been mapped in this area; soils of this genetic subgroup do occur, but the iron pan is discontinuous and the soils have been included in the Corby Series. The imperfectly drained Leys Series, an iron podzol, usually occurs where the gravel deposits are thinner and underlain by till. The poorly drained Mulloch Series, a noncalcareous gley, and the very poorly drained Mundurno Series, a peaty gley, occupy depressional areas such as oxbow channels.

Kinord Series

The Kinord Series, like the Corby Series, is developed on coarse gravel and is freely drained. It covers 5 square kilometres in Deeside adjacent to Loch Kinord. The soil described is a brown forest soil, occurring under an open birch scrub with a heath vegetation.

Profile Description: No.1. Moor of Dinnet

Grid Reference	NO431972
Altitude	175 metres
Slope	Level
Vegetation	Open birch scrub with *Erica cinerea*, *Calluna vulgaris*, *Arctostaphylos uva-ursi*. *Calluna vulgaris*, *Agrostis canina*, *Festuca ovina*, *Carex pilulifera*,
Drainage	Free

Horizon	Depth (cm)	
F	0-3	Very dark brown (10YR2/2) partly humified *Erica* and *Arctostaphylos* litter. Sharp change into
Ah1	3-5	Very dark brown (10YR2/2) humose sandy loam speckled with light grey (10YR7/2) mineral grains; weak medium to fine crumb; friable; few stones; frequent roots; occasional small worms; moist; no mottles. Sharp change into
Ah2	5-15	Very dark brown (l0YR2/2) humose sandy loam with light grey (10YR7/2) mineral grains; massive, breaking into medium to fine angular and subangular blocky; frequent stones; frequent to many roots; few worms; moist; no mottles. Sharp change into
Ah3	15-25	Very dark greyish brown (10YR3/2) to very dark brown (10YR2/2) humose loamy coarse sand; medium subangular blocky breaking into fine subangular blocky and crumb; friable; frequent stones up to 23 centimetres in diameter; many roots; worms present; moist; no mottles. Sharp irregular change into
Bw1	25-38	Dark brown (7.5YR3/2) and brown (7.5YR4/4) stony sandy loam; massive, breaking into medium and fine subangular blocky; friable and porous; many stones; frequent roots; no worms; very dark brown (10YR2/2) vertical tongues of A horizon material about 3 centimetres wide; moist; few strong brown (7.5YR5/8) mottles. Gradual change into
Bw2	38-68	Dark brown (7.5YR3/2) and yellowish brown (10YR5/4 and 5/6) stony loamy coarse sand; weak subangular blocky in upper part, single grain below; many stones; frequent to few roots; moist; few faint rusty mottles. Gradual change into
Bw3	68-112	Dark yellowish brown (10YR4/4) stony loamy coarse sand with local concentrations of dark brown (7.5YR3/2) along major root channels; few roots, locally frequent in humose parts. Gradual change into
C	112+	Yellowish brown (10YR5/4) and brown (7.5YR4/4) stony coarse sand; subangular and rounded stones up to 60-90 centimetres diameter, dominantly composed of acid schist and granite with a proportion of basic rocks,

epidiorite, hornblende-schist and serpentine; slightly cemented rusty haloes round basic stones; roots penetrate to 168 centimetres; moist.

The main features of the profile are the depth to which organic matter and roots penetrate and the absence of any appreciable induration or cementation. The humus form is the mull/moder type in which the presence of earthworms was observed to a depth of about 50 centimetres. Ant hills are also a notable feature of this locality. Owing to the coarse texture, structure is not well expressed. Subangular blocky is most strongly developed from 5 to 15 centimetres and persists to a depth of 38 centimetres, below which the structure is single grain.

Corby Series

The Corby Series, covering 102 square kilometres, is the most extensive soil in the association. It has considerable variability, ranging from a freely drained iron podzol or podzol with incipient iron pan to a humus-iron podzol. These differences are largely eliminated on cultivation.

Profile Description: No.44 Dinnet Burn

Grid Reference	NO456997
Altitude	160 metres
Slope	Gentle on terrace with micro-relief
Vegetation	*Calluna vulgaris*, *Erica cinerea*, *Polytrichum* spp., scrub birch
Drainage	Free

Horizon	Depth (cm)	
F	0-3	Dark reddish brown (5YR3/2) fibrous partially decomposed humus; many roots; few worms; moist. Sharp change into
Ah	3-9	Black (5YR2/l) humose loam with particles of quartz and feldspar; weak structure; firm; frequent roots; moist. Sharp change into
AE	9-12	Very dark grey (5YR3/1) coarse sandy loam with cobbles and fine gravel; weak subangular blocky; frequent roots; variation in humus staining; moist. Sharp change into
,Bs	12-46	Yellowish red (5YR5/8) coarse sandy loam with blotches of dark brown humus staining and reddish yellow (5YR6/8) patches; medium subangular blocky; friable; frequent stones up to 23 centimetres diameter of gneiss, granite and basic igneous; frequent roots; moist; no mottles but irregular variations in colour due to differing humus contents; some charcoal. Sharp change into
Bx	46-61	Brown (10YR5/3) stony loamy coarse sand; platy; moderately indurated; roots penetrate down softer parts; moist; no mottles; organic staining along ped faces and small manganese/iron concretions present locally.

		Sharp change into
BC(x)	61-108	Brown (10YR4/3) stony coarse sand; weakly indurated breaking into single grain; frequent 3 centimetre diameter stones; few large boulders; no roots; moist; no mottles.
		Gradual change into
C	018-117+	Pink (7.5YR7/4) stony, coarse sandy gravel; single grain; loose; very moist at 127 centimetres; no mottles.

The profile has a textural range from sandy fine gravel to cobbly coarse gravel. In uncultivated profiles, organic matter penetrates to a depth of 50 centimetres to the top of the indurated Bx horizon. It imparts a characteristic blotchy appearance to the Bhs horizon in which patches of dark reddish brown (5YR2/3) humus staining are interspersed with yellowish red (5YR5/8) patches. Roots penetrate to the cemented or compact layer where they generally stop. The presence of cracks or softer parts permits the penetration of some roots. The humus form is the mor type; earthworms are present in the F horizon although they do not occur elsewhere in the profile. The structure is very weak subangular blocky, except in the Bx horizon, where it is platy. The C horizon is loose gravel, 3 metres or more thick.

For additional analytical data see profile No.43. Arnhall Birch Wood in Appendix 2.

Leys Series

The soils of the Leys Series cover 3 square kilometres and belong to the subgroup of iron podzols; drainage is imperfect. The series occurs on gentle or flat sites on gravel deposits in which either a stratum of finer texture or underlying till is responsible for impeding the drainage. The profile resembles that of the Corby Series but the Bhs(g) and the indurated Bx(g) horizons show some mottling. The series is suitable for cultivation. Small areas of this series have been mapped on lower Deeside, on Tarfside, in Glenesk and around Edzell.

Mulloch Series

The Mulloch Series, a noncalcareous gley covering a total area of 5 square kilometres, is poorly drained. Occurring in the Dee valley in small patches, it is found throughout the association and is most extensive east of Edzell. It occupies flat sites which may contain, or are adjacent to, peaty hollows. An impervious layer at depth together with a low topographical position is responsible for the presence of a fluctuating water-table in the solum.

Profile Description: No. 81 Balbegno South

Grid reference	NO642723
Altitide	60 metres
Slope	Level
Vegetation	Rotational grass
Drainage	Poor

Horizon	Depth (cm)	
Ap	0-23	Very dark brown (10YR2/2) sandy loam; weak medium subangular blocky; moderate organic matter; few stones; many fine roots; worms present. Sharp change into
Eg	23-41	Grey (10YR6/1) gravelly coarse sand; weak medium subangular blocky; loose; lenses of fine sand; low organic matter; frequent fine roots with ochreous staining surrounding root holes; worm channels with Ap horizon material. Clear change into
Bg	41-75	Pale brown (10YR6/3) coarse sandy gravel; single grain; loose; diffuse grey and ochreous mottles; horizontal band of ochreous staining 3 centimetres thick at 64 centimetres. Gradual change into
Cg	75-120+	Coarse sandy gravel with little fine material; single grain; loose; stones mainly quartzite, quartz-mica-schist, granite and a little sandstone; some stones are soft, rotten and stained with ochre. Water standing at 117 centimetres.

The morphological features are influenced by the coarse texture of the parent material. Structure in all horizons is weak. Beneath the dark coloured Ap horizon is a grey leached Eg horizon with iron accumulations around roots. Ochreous mottling is more pronounced in the Bg horizon below and in this, horizontal accumulations of iron have frequently been observed which are probably related to the fluctuation of the water-table. As a result of artificial drainage, mainly by ditches, the poorly drained Mulloch Series has frequently been developed from the Mundurno Series, a peaty gley.

For additional analytical data see profile No.82. Balbegno North in Appendix 2.

Mundurno Series

This series, a very poorly drained peaty gley, occupies less than one square kilometre and is always found near basin peat deposits. Some of the series was formerly overlain by basin peat which has since been removed for fuel. The soils are normally too wet for cultivation and often support a vegetation dominated by *Juncus* sp.

Profile Description: No.104. Dryplaid Farm

Grid reference	NO626698
Altitude	50 metres
Slope	Level
Vegetation	*Polygonum persicaria*, *Alopecuris geniculatus*, *Ranunculus repens*, *Juncus effusus*
Drainage	Very poor

Horizon	Depth (cm)	
Ah	0-20	Black (5Y2/2) peaty sandy loam; medium subangular blocky; loose; high organic matter; frequent cobbles - schist, granite and Old Red Sandstone of 8-10 centimetre diameter; many roots. Sharp change into
Eg	20-35	Dark greyish brown (2.5Y4/2) and light brownish grey (2.5Y6/2) coarse sandy gravel; low organic matter with vertical streaks of black (5Y2/2) Ah horizon material; pebbles as above; many roots; moist; rusty mottles associated with rotten stones. Sharp change into
Bg	35-53	Light yellowish brown (2.5Y6/4) and light brownish grey (2.5Y6/2) stony coarse sandy gravel; weak crumb to single grain; low organic matter; few roots to the base; moist; frequent medium grey mottles with vertical ochreous stains following root tracks. Gradual change into
Cg	53-84+	Light brownish grey (2.5Y6/2) coarse sandy gravel; single grain; water standing at 61 centimetres; no mottles.

Dull grey colours with little mottling, and in the case of coarse-textured soils, weak structure, are characteristic. Some peaty gleys have been observed to have concentrations or coatings of iron oxide.

Countesswells Association

The Countesswells Association, developed on till derived from granite and granitic gneiss, covers 384 square kilometres on Sheet 66/67(Banchory and Stonehaven); it does not occur on Sheet 57 (Forfar). A large part of the association is hill land within the Grampian foothills which is under moorland, heath or coniferous plantation. The western part, located in the Grampians, lies at an altitude of between 610 and 920 metres where skeletal soils and bare rock are extensive. The highest point is The Braid Cairn, 872 metres. Arable land, generally below 240 metres, is confined to the Dee valley and to the Netherley - Skene lowlands, where it is similar in many respects to areas of the association described in previous memoirs (Glentworth, 1954; Glentworth and Muir, 1963).

Distribution

The association extends over the northern half of Sheet 66/67 and the southern half of the adjoining Sheets 76 (Inverurie) and 77 (Aberdeen) to the north. Covering a total area of some 1036 square kilometres, the association is one of the most extensive in the north-east of Scotland. On Sheet 66/67 (Banchory/Stonehaven) the association extends in a continuous belt of some 8 to 16 kilometres in width from the western margin of the sheet to the coast between Aberdeen and a point 4 kilometres north of Stonehaven.

Parent Material

The parent material comprises till and drifts derived from granite and granitic gneiss, both rocks being rich in quartz, orthoclase feldspar and biotite. In the Grampians and the Grampian foothills the rock is a coarse-textured pink granite whereas over the greater part of the Netherley – Skene lowlands it is a grey granite or granitic gneiss. The area derived from pink granite is the more extensive and the parent materials are generally coarser textured. On well-drained slopes with convex relief, the till derived from pink granite is light reddish brown (5YR6/4) while that derived from grey granite is light yellowish brown (2.5Y6/4). These tills are 6 metres thick on the flanks of the hills but only 1.2 metres or less on the higher slopes. They have a stony coarse sandy loam texture and large boulders and stones are common both in the till and in the surface horizon. Grey colours and finer textures - loam or sandy clay loam - are associated with wet or poorly drained sites. Stone dykes built in the eighteenth century from boulders and stones removed from the fields on reclamation are a common feature of the arable land. The boulder-strewn surfaces of the uncultivated land of this association are a reminder of the considerable difficulties which have in the past been overcome to produce the present farmland. Rock outcrops are frequent throughout most of the association. The summits of the Grampian hills are skeletal and often covered with large joint blocks either *in situ* or displaced some distance from their source.

The pink granite is sometimes deeply weathered and soft enough to be dug with a spade. Exposures of this can be seen on the Cairn o' Mounth road or on the Charr road in the Glendye Estate, where in a stream section, the weathering extends to 30 metres in depth. It is considered that the decomposed or rotten granite is a remnant of the Tertiary weathering profile. This material, it is thought, has largely been planed off by ice during the Pleistocene glaciation. It is also possible that many of the subrounded boulders which pepper the surface of moorland areas are core stones, or the remains of joint blocks from the formerly deeply weathered Tertiary mantle.

A degree of water-sorting can be observed in the upper part of the Countesswells till in certain localities, notably in the Strachan basin, in the vicinity of the Loch of Leys, round the Loch of Park and in the poorly drained areas of the Netherley lowlands. The evidence for this is a partial stratification and sorting into a particular size grade, usually varying from loamy sand to loamy fine gravel. While this is a feature which could be mapped in some places, in others it is not possible at the 1:25 000 scale. It is not thought to be agriculturally significant due to the coarse texture of the association as a whole and has not therefore been shown on the map.

Soils

A wide range of major soil subgroups occurs, from skeletal soils on frost-shattered debris and peaty podzols on the flatter plateaux of the Grampian foothills associated with extensive blanket bog, to brown forest soils of low base status on the foot slopes. The other groups present are humus-iron podzols, imperfectly drained iron podzols, noncalcareous gleys and peaty gleys. The distribution of the major soil subroups is closely related to relief, rainfall and to the texture of the parent material. The convex slopes overlain by till of coarse texture give rise to the Charr Series, a

peaty podzol with iron pan developed under a rainfall of 1143 to 1270 millimetres, to the Countesswells Series, a freely drained humus-iron podzol and to the Raemoir Series, a freely drained brown forest soil. The other series, Dess, an imperfectly drained iron podzol, Terryvale, a poorly drained noncalcareous gley and Drumlasie, a very poorly drained peaty gley, are formed on a till of coarse sandy loam texture overlying sandy clay loam.

The series with free and imperfect drainage have a clearly recognizable iron-enriched B horizon (Bs), characteristic of a podzol. Cultivation in arable land has obliterated the organic Ah and leached E horizons of the former iron podzols and peaty podzols and the soils are mapped as the Countesswells or Dess Series. The friable, strong brown Bs horizon is underlain by a dense indurated Bx horizon which prevents root penetration and limits the thickness of the available rooting material. The thickness of material above the indurated horizon is thus of significance in the cropping of arable land and in tree growth and stability.

Raemoir Series

The Raemoir Series, which covers 9 square kilometres, has been mapped mainly on lower slopes of the Grampian foothills bordering the Dee valley between Banchory and Aboyne. A few small areas are found on the north side of the River Dee. These areas are largely uncultivated and under birch or birch/pine, frequently with a ground vegetation of grasses and bracken, and have been grazed by cattle and sheep. The parent material contains some basic igneous rocks but is mainly derived from granitic gneiss and granite. From the Bs horizon downwards the Raemoir Series resembles the Countesswells but the upper horizon is brown and mineral which contains earthworms, whereas the Countesswells has L/F and H horizons of raw organic matter and a bleached E horizon. The Raemoir Series is freely drained and representative of the brown forest soil major soil subgroup.

ProfileDescription: No. 2 Tilbouries Wood

Grid Reference	NO830985
Altitude	140 metres
Slope	Moderate
Vegetation	*Corylus avellana*, *Mercurialis perennis*, *Oxalis acetosella*
Drainage	Free

Horizon	Depth (cm)	
L	0-1	Hazel leaf and twig litter
A1	1-11	Dark greyish brown (10YR4/2) sandy loam; medium to coarse crumb; friable; moderate organic matter of mull/moder type; many medium tree and fine roots; few worms; no mottles. Clear change into
A2	11-23	Dark yellowish brown (10YR4/4) sandy loam; weak medium crumb cohering into weak subangular blocky; friable; moderate organic matter; many 5-20 centimetre diameter subangular granite stones; many medium-sized

		roots; earthworms present; moist; some mixing with upper horizon. Diffuse change into
Bs	23-66	Strong brown (7.5YR5/8) gritty loamy coarse sand; moderate medium crumb; friable; some mixing of upper horizon material; moderate to high organic matter; stones (5-8 centimetres daimeter) smaller than horizon above; frequent roots; moist. Sharp change into
Bx	66-86	Pale brown (10YR6/3) gritty stony sandy loam; indurated; low organic matter; accumulation of grey fine material round stones; few roots penetrate; few coarse ochreous mottles. Gradual change into
C	86-102	Pale brown (10YR6/3) stony sandy loam; low organic matter; no roots; moist; few coarse ochreous mottles.

Although the profile has a well-developed, iron-enriched, friable Bs horizon, the soil is classified as a brown forest soil on the morphology of its surface horizons; it might equally be described as a brown podzolic soil. The humus type is a moder with the mineral fabric and organic matter intimately mixed. The humus penetrates deeply into the Bs horizon which is marked by a diffuse boundary and has a higher content of organic matter than that of the Countesswells Series, an iron podzol. Earthworms are present in the A and Bs horizons. The Bx horizon is strongly indurated with a coarse platy structure and the peds are stained on the underside with organic matter. Roots fail to penetrate this horizon and proliferate at the upper surface of it.

For additional analytical data see profile No.3. Raemoir in Appendix 2.

Countesswells Series

Occurring on moderate slopes, the Countesswells Series covers 117 square kilometres. In their undisturbed state, the soils are humus-iron podzols. Extensive tracts on the south side of the Dee valley have been planted with conifers. Other areas support vegetation of dry heath. In the Netherley lowlands only the well-defined rises have the Countesswells Series and these are cultivated. Under semi-natural conditions as in the profile below, the series has 8 to 13 centimetres of litter and often 3 centimetres of H layer overlying the bleached E horizon which is often 5 to 8 centimetres thick and characteristic of the podzol profile. However heather burning and cultivation destroy these upper horizons and the cultivated Countesswells Series may contain soils which were formerly peaty podzols.

Profile Description: No. 45. Allachy, Glentanar

Grid Reference	NO477923
Altitude	270 metres
Slope	Moderate
Vegetation	Native Pinewood with *Pinus sylvestris*, *Vaccinium myrtillus, Calluna vulgaris*, *Pteridium aquilinum*
Drainage	Free

Horizon	Depth (cm)	
LF	0-8	Dark reddish brown (5YR2/2) twig and leaf litter rich in fungal mycelia
H	3-13	Dark reddish brown (5YR2/2) well-decomposed, soft mor humus; moist. Clear change into
E	13—25	Reddish grey (5YR5/2) loamy sand; very weak coarse subangular blocky; friable; low organic matter; frequent roots; moist; organic staining. Clear change into
Bh	25-58	Dark reddish brown (5YR3/3) sandy loam; weak coarse subangular blocky; friable; high organic matter giving blotched or marbled appearance; many roots concentrated at base of horizon. Sharp change into
Bx	58-94	Light reddish brown (5YR6/4) loamy coarse sand; strongly indurated; fissures partly filled with roots and organic matter; no mottles; organic staining on under sides of platy structural peds; a coating of silt or very fine sand surrounding stones. Gradual change into
C	94-115+	Reddish yellow (5YR6/6) coarse sandy loam; massive; firm; frequent stones; no mottles.

The litter layer seldom exceeds 13 centimetres in thickness. When dry, the E horizon is greyish brown (10YR5/2). With cultivation, the litter layer, the E horizon and part of the Bh horizon are incorporated into the plough layer (Ap horizon) to give a dark greyish brown (2.5Y4/2) horizon of sandy loam texture. The high content of dark brown organic matter present in the Bh horizon of the uncultivated soil is depleted to give a B horizon low in organic matter and customarily of a brownish yellow (10YR6/6) colour. The thickness of the Bs horizon in the Countesswells Series is usually less than that of the Raemoir Series. Indurated Bx horizons are common in the Countesswells and Charr Series. Both exhibit the same properties of a coarse platy structure with dark brown organic staining on the under-side of the peds, a coating of finer material around stones and the presence of numerous pin-hole-sized cavities in the peds. The degree of induration is sufficient to prevent root penetration, but grey-coated fissures are occasionally found through which roots are able to penetrate. The horizon usually has a higher content of stony gravel and coarse separates than the Bs horizon. The induration is strongest at the top of the horizon and fades out on passing into the C horizon in which boulders and stones are profuse.

Dess Series

The Dess Series, covering 60 square kilometres, is developed on a loam or sandy clay loam till and is found at altitudes below 240 metres on gentle slopes on both sides of the Dee valley from Banchory eastwards; it is also extensive in the Skene and Netherley lowlands. The drainage class is imperfect, and intermediate between the freely drained Countesswells Series and the poorly drained Terryvale Series. At the drier end of the range the soils have moderately well-developed indurated horizons (Bx); at the wetter end, induration is weak. In the vicinity of the Loch of Leys, Loch of Park and in the Strachan basin, soils with water-sorted upper horizons occur but have not been distinguished on the 1:63 360 soil map. Apart from some

areas under woodland, north of .Banchory, the series is under arable cultivation, and tends to provide the most desirable farmland of the whole association.

Profile Description: No.65. Westside, Maryculter)

Grid Reference	NO860994
Altitude	120 metres
Slope	Gentle
Vegetation	Rotational grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-28	Dark greyish brown (10YR4/2) loam; moderate medium subangular blocky; friable; moderate organic matter; many roots; moist; no mottles.Clear change into
Bwg	28-51	Yellowish brown (10YR5/4) loam; medium subangular blocky; friable; low organic matter; frequent stones; many roots; moist; frequent faint strong brown (7.5YR5/6) mottles, grey mottles at base. Clear change into
Bx(g)	51-66	Light yellowish brown (10YR6/4) stony coarse sandy loam; moderate coarse platy; moderately indurated; low organic matter; few granite stones, rotten and decomposed; few roots; frequent distinct strong brown (7.5R5/6) mottles; few large grey vertical fissures with roots penetrating. Gradual change into
C(g)	66-109+	Yellowish brown (10YR5/4) stony sandy clay loam; weak coarse angular blocky becoming massive with depth; plastic; few fine roots; wet; frequent coarse distinct ochreous mottles and faint grey mottles. Large granite boulders.

The sandy clay loam parent material has a higher clay content and a greater thickness than that of the Countesswells, Raemoir and Charr Series. In the Ap, Bg and C(g) horizons the soil has a morphological resemblance to the Countesswells series but is distinguished from it by the presence of appreciable ochreous mottles in the B horizons. The degree of induration in the Bx(g) horizon is less than in the Raemoir, Countesswells and Charr Series and some roots penetrate to the C(g) horizon. The C(g) horizon of stony sandy clay loam is massive and similar to that of the Cg horizon of the poorly drained Terryvale Series.

Charr Series

The Charr Series, 106 square kilometres in extent, is widely distributed on the moderate slopes of the Grampian foothills, often above 300 metres. It borders the extensive area of hill peat which stretches across the central part of the Banchory/Stonehaven sheet from near the Slug road to the western margin of the map. It is also found on a number of low hills throughout the Netherley Iowlands. The parent material is a bouldery, stony, coarse sandy loam derived from granite and granitic gneiss. The series is uncultivated and supports a wet heath community with *Erica tetralix* and *Calluna* co-dominant. As a member of the major soil subgroup

of peaty podzols the soil profile has, as its most salient feature, a thin iron pan which is between 1.5 and 3 millimetres thick. Above the iron pan the drainage varies from free to poor, and below the pan it is free. The series merges into hill peat when the thickness of the O layer exceeds 30 to 45 centimetres (on later maps the cut-off was 50 centimetres. Much of the hill peat appears to be underlain by an iron pan.

Profile Description: No.73. Glendye

Grid reference	NO631842
Altitude	270 metres
Slope	Moderate
Vegetation	*Calluna vulgaris*, *Erica tetralix*, *Trichophorum cespitosum*, *Pleurozium schreberi*, *Cladonia* spp.
Drainage	Poorly drained above Bf horizon, freely drained below

Horizon	Depth (cm)	
L	0-3	Litter
F	3-13	Dark brown (7.5YR3/2) partially decomposed organic matter; fibrous; many live fine roots
	13-15	Lens of grey (l0YR6/l) quartzose coarse sand
O	15-33	Black (2.5Y2/0) well-decomposed organic matter; structureless; soft and plastic when wet, hard, medium angular blocky when dry, with marked wide shrinkage cracks. Sharp change into
Eg	33-56	Greyish brown (2.5Y5/2) moist, drying into light brownish grey (2.5Y6/2) coarse sandy loam with few irregular horizontal bands of dark organic staining; fine subangular blocky; non-plastic; concentration of thin band of black organic matter and roots at base of horizon. Sharp change into
Bf	at 56	Thin continuous iron pan 3 millimetres thick. Sharp change into
Bx	56-79	Light brown (7.5YR6/4) coarse sandy loam; weak coarse platy breaking under strong pressure into single grain; strongly indurated fine material around subangular granite and gneiss stones; no roots; dark brown staining on underside of peds; frequent pin-holes in peds; frequent faint ochreous mottles. Clear change into
C	79-124	Reddish brown (5YR5/4) stony coarse sandy loam, texture becoming coarser with depth; no roots; no mottles. Sharp change into
R	124+	Pink granite, weathered *in situ*.

The peaty podzol profile, with its well-defined horizons and distinctive thin iron pan, makes it one of the most striking soils of Scotland. The thin iron pan (Bf horizon) which has been observed to pass through fresh unweathered stones, forms a continuous barrier dividing the profile into two parts. The main effects of the pan are to divert vertical drainage laterally and to prevent root penetration. Beneath

the pan the profile is freely drained and from the standpoint of its contribution to plant growth is inert. Above the pan the lower part of the E horizon is usually wet and gleyed and at its base there is a concentration of organic matter, water and roots which are unable to penetrate the horizons below. The strongly indurated Bx horizon with its tendency to coarse platy structure is similar to that of both the Raemoir and Countesswells Series.

On more favourable sites, generally at lower altitudes, a variant of the above profile often occurs with a Bs horizon very similar to that of the Countesswells Series. Several stages of development of the peaty podzol profile are recognized in which a relationship exists between the thickness of the well-decomposed O layer and the position of the iron pan in the profile. When the O layer is comparatively thin, less than 15 centimetres (when not the result of burning) the iron pan is situated between the E and the top of the Bs horizon. When the O layer is from 15 to 30 centimetres thick as in the profile described, the iron pan is more usually located at the top of the Bx, i.e. at the top of the indurated layer and the Bs horizon is absent. When the iron pan occurs on top of the indurated layer the combination is such as to present an impenetrable barrier preventing the downward movement of roots and water and causing a concentration of organic matter and gleying above it. When an iron pan is positioned between the E and Bs horizons, it is normally insufficiently continuous to prevent the penetration of water and roots to the horizons below in certain places. Where this occurs there is a tongue of grey gleyed material.

For additional analytical data see profile No.74. Cairn o' Mount in Appendix 2.

Terryvale Series

Developed on gentle slopes and flat sites, Terryvale Series, which covers 35 square kilometres, is extensive in the Netherley lowlands. The parent material, of loam or sandy clay loam texture, is a till of some 1.2 to 3.6 metres in thickness. The fact that most of the series is under cultivation has been made possible by the introduction of a tile drainage system and open ditches to take off surplus water. The drainage class of the series is poor, and the major soil subgroup a noncalcareous gley. The soils are suitable only for limited cropping.

Profile Description: No.84. Ballogie

Grid Reference	Not Known
Altitude	150 metres
Slope	Gentle
Vegetation	Rotational grass with *Trifolium repens*, *Lolium perenne*, *Dactylis glomerata*, *Phleum pratense*, *Cynosurus cristatus*, *Prunella vulgaris*, *Ranunculus acris*; *Bellis perennis*
Drainage	Poor

Horizon	Depth (cm)	
Ap	0-25	Dark greyish brown (10YR4/2) coarse sandy loam; moderate medium subangular blocky; moderate organic matter; frequent stones; many fine roots; few fine

		distinct yellowish red (5YR5/6) mottles associated with root tracks. Clear change into
Eg	25-38	Light brownish grey (10YR6/2) coarse sandy clay loam to coarse sandy loam, variable; weak medium subangular blocky; friable; low organic matter; some tongues of Ap horizon material penetrate; few decomposed stones; many fine roots; worms present; moist; frequent fine prominent strong brown (7.5YR5/8) mottles and streaks. Sharp change into
Bg1	38-61	Light brownish grey (10YR6/2) stony coarse sandy loam with lenses of grey sand and gritty clay; weak coarse angular blocky; friable; few roots; frequent strong brown (7.5YR5/8) mottles and yellowish brown (10YR5/8) staining from decomposing rocks. Gradual change into
Bg2	61-76	Light yellowish brown (10YR6/4) coarse sandy clay loam; moderate coarse angular blocky; firm; few roots; frequent coarse distinct strong brown (7.5YR5/6) mottles. Gradual change into
Cg	76-109+	Light yellowish brown (10YR6/4) sandy clay loam; massive; plastic; few roots; frequent coarse distinct strong brown (7.5YR5/8) mottles and frequent coarse grey (10YR6/1) mottles.

Under semi-natural conditions an LF layer, 5 to 8 centimetres thick, is present at the surface. Cultivated Ap horizons are dark greyish brown in colour suggestive of a higher content of organic matter than they are found to contain. Below the Ap horizon there is a leached Eg horizon with a characteristic grey colour (a podzolic gley horizon) and weak subangular blocky structure. The Bg horizons are browner as a result of iron mottling. The clay content increases in these horizons and the structural units are more clearly defined. In the Cg horizon the structure is massive and in some cases the permanent water-table occurs at a depth of about 75 centimetres: the dominant colours of the horizon then become grey (5Y5/1) and olive-grey (5Y4/2).

For additional analytical data see profile No.83. Westside, Maryculter in Appendix 2.

Strathgyle Series

Strathgyle Series, 13 square kilometres in extent, has been mapped in moorland areas of the Grampian and Grampian foothills regions. It occurs on moderate slopes on hillsides, and on gentle slopes in depressions associated with drainage channels. It has a peaty surface and is classed as poorly drained. The upper horizons are water-sorted and there may be an irregular arrangement of subsurface horizons in which lenses of organic matter alternate with mineral matter washed in. The Cg horizons are customarily less gleyed and have brown or pinkish brown colours rather than the grey gleyed colours of the upper wetter horizons. The major soil subgroup is a peaty surface-water gley.

Profile Description: No. 101. Glen Catt

Grid Reference	NO536930
Altitude	240 metres
Slope	Gentle to moderate
Vegetation	*Calluna vulgaris*, *Juncus acutiflorus*, *Carex binervis*, *Nardus stricta*, *Festuca ovina*, *Agrostis* sp., *Potentilla erecta*, *Polytrichum commune*, *Sphagnum* sp. *Hypnum cupressiforme*, *Hylocomium splendens*, *Pleurozium schreberi*
Drainage	Poor

Horizon	Depth (cm)	
F	0-9	Dark reddish brown (5YR3/2) partially decomposed organic matter; fibrous and rooty; moist
O	9-18	Very dark brown (10YR2/2) well-decomposed organic matter; finely laminated; intimately bound by fine roots mostly dead; moist. Clear change into
Ah	18-25	Very dark brown to very dark greyish brown (10YR2/2 to 3/2) humose coarse sand and gritty loam; weak coarse subangular blocky; firm; few granitic stones; few live roots, many dead roots; moist. Clear change into
Eg	25-28	Light brown (7.5YR6/4) gritty sandy loam; weak subangular blocky tending to massive; few granite stones; very few live roots; frequent dead roots; few fine faint strong brown (7.5YR5/8) mottles. Clear but irregular change into
Bg1	28-51	Light brownish grey (10YR6/2) with slight bluish cast in places, gritty sandy loam; weak coarse subangular blocky; firm; granite stones up to 20 centimetres; frequent dead roots including remains of rotten tree roots (birch); frequent coarse distinct strong brown mottles (7.5YR5/8) and iron pipes round old root channels. Clear change into
Bg2	51-69	Grey to light grey (5Y6/1 to 7/1) gritty sandy loam with pockets and lenses of sand and sandy clay loam; massive; frequent dead tree roots; wet; frequent iron pipes, few fine strong brown (7.5YR5/8) mottles. Clear change into
Cg	69-155+	Light reddish brown (5YR6/3) becoming pinkish grey (7.5YR6/3) at depth, stony gritty sandy loam; massive; few dead roots to 102 centimetres; frequent grey (N6/0) and strong brown (7.5YR5/6) mottles to 81 centimetres, few below.

Certain features such as the peaty F and O horizons, the greyish Eg and the strongly gleyed Bg1 horizon with its iron tubes round the old root channels place this soil in the peaty gley subgroup. In the Cg horizon the gleyed features are less obvious and

colours occur of a higher hue, such as light brown and pinkish grey. These soils are not affected by a permanent ground-water table as in the Drumlasie Series. Excess water passes laterally through the Eg and Bg1 horizons. Some improvement of the grazings is effected by digging open ditches to improve the drainage. Many of the soils show evidence of a water-sorted parent material and colluvial effects in the form of irregular lenses of sorted mineral separates throughout the profile.

For additional analytical data see profile No. 102. The Drum, Glentanar in Appendix 2.

Drumlasie Series

Covering an area of 7 square kilometres, Drumlasie Series is the least extensive series of the Countesswells Association. Occurring in depressional areas which are usually surrounded by the Terryvale Series, it is common in the Netherley lowlands. A number of patches too small to be shown on the 1:63 360 map are recorded on the 1:25 000 field sheets. Most of the areas have been partially drained and are improved, but because of the low-lying situation and very poor drainage, the series is often left in pasture for long periods. The parent material is a till of loam or coarse sandy loam texture normally more than 1.2 metres thick and containing numerous boulders. The series belongs to the major soil subgroup of peaty gleys.

Profile Description: No.105 Pitdelphin

Grid Reference	NO649909
Altitude	90 metres
Slope	Level
Drainage	Very poor
Vegetation	Old grass with *Holcus lanatus*, *Agrostis canina*, *Juncus effusus*, *Ranunculus acris*, *Cirsium palustre*, *Polytrichum* sp., *Sphagnum* sp. and other mosses
Drainage Class	Very Poor

Horizon	Depth (cm)	
FH	0-3	Black (5YR2/1) decomposed organic matter; many fibrous roots with some mineral particles intermixed; wet. Sharp change into
Ag	3-15	Dark olive-grey (5Y3/2) gritty sandy loam; massive; low organic matter; many roots; wet. Gradual change into
Eg	15-28	Pale olive (5Y6/4) coarse sandy loam; weak coarse subangular blocky; few roots; wet; few faint yellowish brown mottles around roots. Sharp change into
Bg1	28-38	Olive-grey (5Y5/2) gritty loamy coarse sand with horizontal lenses of darker hue; massive; slightly plastic; wet; irregular iron oxide tubes round cavities of dead roots. Sharp change into
Bg2	38-58	Pale yellow (5Y7/4) gritty sandy loam; massive; few live roots; iron oxide tubes round root channels, frequent faint yellowish brown (10YR5/6) mottles.

		Gradual change into
Cg	58-69+	Light brownish grey (2.5Y6/2) gritty coarse sandy loam, massive; no roots; no mottles. Water rapidly filled the pit to 43 centimetres.

The surface horizon of the Drumlasie Series is very variable. Many of the soils were formerly overlain by 2 or 3 metres of peat which has since been removed. Cultivation has incorporated a variable amount of mineral matter in the surface layer but the horizon is usually rich in organic matter. It is easily damaged and often has an irregular uneven surface (due to trampling and poaching by livestock). The predominant colour of the profile from the Eg horizon downwards is grey and the structure throughout is weak to massive. Some iron mottling occurs in the Bg1 horizon. A noticeable feature of the Bg2 horizon is the iron oxide tubes which surround the channels formerly occupied by roots. The level of the ground-water table was formerly at the level of the mineral soil, but drainage systems have usually reduced it to about the Bg1 horizon. The coarse texture of the Drumlasie Series is commonly due to the water-sorted nature of the parent material, a result of the topographic situation in depressions and near to drainage channels.

For additional analytical data see profile No.106. Auchnahar in Appendix 2.

Skeletal Soils

Skeletal soils occur on the summits of the hills in the Grampians and the Grampian foothills where they are associated with rock outcrops. The profile consists of a thin mor humus layer over an A or E horizon resting on granite or granitic gneiss.

Deecastle Association

The Deecastle Association occurs in small areas along the Dee valley in the vicinity of Aboyne. An area of 1 square kilometre has been mapped, although this is not the complete extent of the association as many occurrences are too small to delineate.

Parent Material

The parent material is largely residual weathered calc-silicate rocks, with frequent to abundant angular fragments of the rock and a few rounded stones of basic igneous rocks, acid gneiss and schist. The texture of the finer material in the upper horizons is sandy loam or loam but in the lower horizons, pockets of clay loam may be interstitial between angular fragments of rock.

Deecastle Series

There is only one series, Deecastle, a freely drained brown forest soil. Under semi-natural conditions the upper horizons are acid and leached but the lower horizons show a fairly high base saturation. This is sometimes reflected in the vegetation by the occurrence of species such as the cowslip, *Primula veris*, and the wild strawberry, *Fragaria vesca*. Although some areas are cultivated, the series is predominantly uncultivated, occurring in areas of rough grazing, birch woodland and coniferous plantation.

Profile Description: No.4. Birsemore

Grid Reference	NO535976
Altitude	160 metres
Slope	Moderately steep
Vegetation	Birchwood with hazel, *Holcus lanatus*, *Poa pratensis*, *Deschampsia flexuosa*, *Poa trivialis*, *Agrostis tenuis*, *Pteridium aquilinum*, *Geum urbanum*, *Veronica chamaedrys*, *Viola riviniana*, *Rhytidiadelphus squarrosus* and *Thuidim tamariscinum*.
Drainage	Free

Horizon	Depth (cm)	
Ah	0-10	Very dark greyish brown (10R3/2) humose loam (mull-like moder); fine crumb near surface, fine subangular and crumb towards base; frequent angular and subangular calc-silicate, granite, gneiss and basic igneous stones; many fine roots; frequent medium-sized tree roots and bracken rhizomes; worms active; no mottles. Gradual change into
AB	10-23	Very dark greyish brown to dark brown (10YR3/2 to 3/3); gritty sandy loam; fine subangular blocky tending to coarse crumb; many stones; frequent roots; worms active; moist; no mottles. Gradual change into
Bw	23-43	Yellowish brown (10YR5/4) gritty sandy loam to loam; medium to fine subangular blocky; friable; frequent to many angular and few subangular stones, all sizes up to 30 centimetres diameter present, mostly calc-silicate rock; frequent roots; worms active bringing down tongues of Ah horizon material; moist; no mottles. Sharp but irregular change into
Bx	43-76	Light brownish grey (2.5Y6/2) to brown to light yellowish brown (10YR5/3 to 6/4); gritty sandy loam to loam; medium subangular blocky; moderately indurated; many angular stones and a few subangular erratics; few to locally frequent roots; worms may be present down soft patches; moist; few faint rusty mottles down soft patches. Gradual irregular change into
C	76-121+	Light olive-brown (2.5Y5/4) gritty sandy loam; massive with slight tendency to platy structure; frequent to many angular and subangular stones; no worms; moist; a little rusty staining tending to occur in horizontal bands.

Induration in the Bx horizon can range from weak to moderate or this horizon may be absent, the Bw horizon either passing gradually into the parent material, interstitial between angular fragments of calc-silicate rock, or overlying massive partly weathered rock. Calcite is present in the fresh parent rock, but there is no free calcium carbonate in the soil and it is unlikely that the soil ever was calcareous.

For additional analytical data profile see No.5. Craigrae Beg in Appendix 2.

Dinnet Association

The Dinnet Association is developed on till formed by readvance glaciation in the Dee valley (Synge, 1956). It covers an area of 24 square kilometres and occurs as a narrow belt along the valley from west of Dinnet, eastwards to Banchory. A minor portion of the association is found along the burn of Cattie and two areas occur in channels adjacent to the main channel of the River Dee at Potarch and Sluie.

Parent Material

The parent material is now considered to be fluvioglacial in origin and associated with an esker complex formed during the down-wasting stage of the last main ice-sheet. Previously it was thought to be a till formed by the action of the readvance of a valley glacier over the ground moraine, gravelly moraines and fluviatile deposits left by the retreat of an earlier glacier, and it may have been modified locally by the action of meltwater. The till is derived from rocks of a wide range of composition, from quartzite to ultrabasic and including a proportion of calc-silicate rock. The frequent subrounded stones in the deposit are largely of acid rocks. The finer particles may contain a higher proportion of the material derived from the more basic rocks. The texture is loamy sand or, less frequently, sandy loam, and the upper horizons of the soils often have a higher silt content than the C horizon, which may indicate the deposition of windblown material in late-glacial times.

Soils

The range in altitude is narrow - from 45 to 210 metres and there is no altitudinal zonation of major soil subgroups. Four soil series are mapped. The most extensive soil is the Dinnet Series, a freely drained brown forest soil; the occurrence of an area of iron podzol, the Oldtown Series, around Drumnagesk is due to past treatment of the land as well as to the more stony nature of the till on an area of very flat topography. Imperfectly drained iron podzols, Maryfield Series are not extensive, but occur in association with the Oldtown Series on level or gently sloping land whilst Ferrar Series, a poorly drained noncalcareous gley occurs in receiving sites on lower lying land. One of the most distinctive features of the soils is the extremely hard and thick indurated layer which is found even in some of the poorly drained soils.

Dinnet Series

The Dinnet Series, covering 18 square kilometres, is a brown forest soil which in the past has undergone some degree of podzolization. It is freely drained and present usage of the land varies from arable agriculture and permanent grazing to coniferous plantations. The semi-natural vegetation under grazing is often a heath with *Calluna vulgaris* dominant but with *Arctostaphylos uva-ursi*, *Erica cinerea* and *Genista anglica* frequent species and *Lathyrus montanus* and *Pyrola media* occasional species. Under broad-leaved trees, as in the oakwood at Dinnet, there is a grassy woodland floor vegetation with frequent *Viola riviniana*, *Potentilla erecta* and *Luzula pilosa* and, in the oakwood itself, *Rubus saxatilis*. Earthworms are common throughout this series, even in *Calluna*-dominant areas.

Profile Description: No.6. Clearfield)

Grid Reference	NO467996
Altitude	180 metres
Slope	Gentle
Vegetation	Heath with *Calluna vulgaris*, *Deschampsia flexuosa*, *Festuca ovina*, *Anemone nemorosa*, *Erica cinerea*, *Arctostaphylos uva-ursi*, *Lathyrus montanus*, *Pleurozium schreberi*, *Hylocomium splendens*, *Campanula rotundifolia*, *Pyrola media*, *Genista anglica*.
Drainage	Free

Horizon	Depth (cm)	
F	0-1	Dark reddish brown (5YR3/2) humus with abundant rootlets.
A	1-25	Very dark grey (5YR3/1) loam; medium to fine subangular blocky; firm; moderate organic matter; many medium subrounded stones — quartzite, granite, schist and basic igneous; many roots; worms present; moist. Clear but very irregular change due to worm activity into
Bw	25-51	Dark reddish brown (5YR5/4) to strong brown (7.5YR5/6) fine sandy loam; medium to large subangular blocky; friable to crumb; low organic matter except in worm channels; frequent to few stones - smaller than above; frequent roots; irregular blotching due to varying content of humus; moist. Clear change into
Bx1	51-81	Dark yellowish brown (10YR3/4) loamy fine sand; indurated; low organic matter; frequent small subrounded stones; no roots; fine reticulations of rust-staining in pores and on surface of structure planes; moist. Gradual change into
Bx2	81-102	Pale brown (10YR6/3) gritty loamy sand; indurated; frequent small stones, few medium boulders; rust-staining on some stones and occasionally along former root channels; moist. Clear change into
C(xg)	102-140	Light grey (2.5Y7/2) stony loamy sand; medium platy; firm to indurated at top becoming loose towards base; frequent small stones with few large stones; moist; frequent yellowish brown (10YR5/6) mottles. Clear change into
C	l40+	Brown (10YR5/3) sandy loam; fairly compact; moist.

The F layer is very thin and underlain by the dark or very dark brown A horizon which varies between 20 and 25 centimetres in thickness in which earthworms are active. Many of the soils currently under semi-natural vegetation are believed to have been under the plough at one time, but even where it is unlikely that the plough has been used, the A horizon is often 20 centimetres thick, although it can be as shallow as 10

centimetres. The grains of quartz sand are somewhat bleached and are evidence of the former podzolic nature of the soil.

The Bs horizon may be as much as 50 centimetres thick and in such situations there is a decrease in the iron oxide staining from the top of the horizon to the base. The pale brown, strongly indurated Bx horizon shows some evidence of drainage impedance in the form of slight mottling and iron staining in fine cavities and sometimes passes imperceptibly into the underlying parent material.

Oldtown Series

The Oldtown Series, an iron podzol, covers 3 square kilometres on the low eminence at Drumnagesk. The stone content of the till is higher than usual. The development of the upper horizons of an iron podzol is probably due to historical causes, as the physical and chemical characteristics of the horizons below the A horizon are indistinguishable from those of the brown forest soils.

A considerable area is under coniferous plantation or secondary birchwood after felling of conifers, and the remainder is arable land.

Profile Desription: No.46. Drumnagesk

Grid Reference	NO565984
Altitude	140 metres
Slope	Gentle
Vegetation	Open birchwood with heathy ground vegetation; *Betula verrucosa*, *Calluna vulgaris*, *Deschampsia flexuosa*, *Hylocomium splendens*, *Pleurozium schreberi*.
Drainage	Free

Horizon	Depth (cm)	
L	0-2	Litter of *Calluna* and birch
F	2-7	Dark reddish brown (5YR2/2) humus with many rootlets. Sharp change into
Ah	7-22	Black (5YR2/1) humose loam; medium to coarse sub angular blocky; firm; frequent roots; one worm seen but little evidence of worm activity; many bleached sand grains (horizon may have been formed by mixing of humus and E horizons by spade or plough in past); moist. Sharp irregular change into
Bw	22-50	Brown (7.5YR4/4) in upper part becoming dark yellowish brown (10YR4/4) in lower, sandy loam; fine to medium subangular blocky; friable breaking to very fine subangular blocky and fine crumb; roots frequent becoming few with depth; irregular blotching due to varying humus content; iron enrichment mainly in upper 13 centimetres with lower part of horizon olive-brown (2.5Y4/4) in colour and firm in consistence; low humus concentration at base of horizon; moist.

		Sharp change into
Bx	50-91	Yellowish brown (10YR5/4) stony loamy sand; medium subangular blocky to coarse platy; very strongly indurated; frequent rust-staining on structure faces and on vesicular pores in upper 13 centimetres and ochreous linings on some of the pores in lower part of horizon where structure is more massive; no roots. Gradual change into
BCx	91-109	Brown (10YR5/3) stony loamy sand; massive with slight tendency to platy; indurated; moist. Gradual change into
C1	109-129	Brown (10YR5/3) stony loamy sand to sandy loam; massive; moist; compact. Clear change into
C2	129-147	Greyish brown to brown (10YR5/2 to 5/3) stony loamy sand to sandy loam; more loose than above; very moist and water tending to collect in pit below 137 centimetres.

The L and F horizons were formed under the present vegetation and the preceding crop of conifers, but the Ah horizon, as noted in the profile description, had been disturbed by ploughing or digging prior to the planting of conifers. This turning over of the upper horizons seems to have been carried out throughout this local area, even where the land was put down to trees and not agricultural crops. It is possible that a period of growing agricultural crops may have preceded the planting of trees. On the present day arable land, the plough layer is darker than that of the arable land adjacent to brown forest soils under semi-natural vegetation.

Maryfield Series

This series covers approximately 1 square kilometre and is mainly associated with the Oldtown series at Drumnagesk It is an imperfectly drained iron podzol which occurs on level or very gently sloping sites and because of the difficulty of agricultural improvement it is largely uncultivated.

Profile Description: No. 66. Maryfield

Grid Reference	NO567985
Altitude	130 metres
Slope	Level
Vegetation	*Nardus stricta*, *Calluna vulgaris*, *Erica tetralix*, *Trichophorum cespitosum*, *Betula pubescens*, *Carex* spp. *Cladonia impexa*
Drainage	Imperfect

Horizon	Depth (cm)	
H	0-3	Black (10YR2/1) humose loam speckled with light grey (10YR7/l) and white (10YR8/l) mineral grains; crumb; few stones of various sizes; many roots; moist to very moist; no mottles. Gradual change into
Ah	3-15	Black (10YR2/1) humose loam; weak coarse angular blocky, breaking under slight pressure to medium and fine subangular blocky; frequent stones, mostly schist and gneiss, sizes up to 10-15 centimetres; frequent roots; moist to very moist; no mottles. Gradual change into
E(g)1	15-41	Dark grey (10YR4/1), occasionally greyish brown (10YR5/2), sandy loam; weak angular blocky with slight tendency to platy; frequent stones; few roots; moist; few mottles but a general dull greyish coating over horizon. Sharp change into
E(g)2	41-48	Dark greyish brown (10YR4/2) sandy loam; weak subangular blocky; frequent stones; few roots; moist, slight water seepage. Sharp irregular change into
Bm(g)	48-58	Brown (10YR5/3) to yellowish brown (10YR5/6) with a little dark yellowish brown (10RY4/4), sandy loam; cemented with concretionary patches of iron; stone sizes up to 46 centimetres diameter; no roots; moist; strong concretionary iron mottles. Gradual change into
Bx(g)	58-81	Yellowish brown (10YR5/4) to light yellowish brown (10YR6/4) coarse sandy loam; strongly indurated; frequent stones; no roots; small (1 millimetre) discontinuous vesicular pores throughout; moist; a few brownish yellow (10YR6/6) mottles. Sharp change into
Cx(g)	81-107	Pale brown (10YR6/3) coarse sandy loam; indurated, but less strongly than above, induration decreasing slightly with depth; frequent stones; no roots; moist; few, distinct brownish yellow (101R6/6) and grey mottles.

This soil is periodically very wet and at other times very dry presenting a difficulties for agricultural improvement because of the strongly indurated layer which extends to a considerable depth. Attempts to dig drains both manually and mechanically have been abandoned in recent years. As a result of the iron cementation, the upper part of the Bm(g) horizon is almost impervious to the passage of water, and the horizons above are strongly gleyed. The soil tends towards the wetter end of the imperfectly drained class.

Ferrar Series

The poorly drained noncalacreous gley, Ferrar Series, covers 2 square kilometres, and occupies topographic positions rather similar to the imperfectly drained podzol. It is influenced to a greater degree by the movement of water from higher slopes and the soil is more continuously wet. In addition, it tends to occupy gently concave hollows and channels where the influence of meltwater from wasting ice has been stronger and where deposits of soliflucted material have accumulated.

Profile Description: No.85. Ferrar

Grid reference	NO479991
Altitude	165 metres
Slope	Gentle
Vegetation	*Erica tetralix*, *Molinia caerulea*, *Carex* spp., *Potentilla erecta*, *Lathyrus montanus*, *Festuca ovina*, *Polygala serpyllifolia*, *Trifolium medium*, *Genista anglica*, *Calluna vulgaris*, *Succisa pratensis*, *Hylocomium splendens*, *Hypericum pulchrum*.
Drainage	Poor

Horizon	Depth (cm)	
A	0-13	Very dark grey (10YR3/1) loam; weak fine subangular blocky to fine crumb; plastic; moderate organic matter; many roots; worms present; very moist. Clear change into
Ag	13-38	Dark grey (10YR4/1) stony gritty sandy loam to loam; weak fine subangular blocky; plastic; moderate organic matter; many subrounded boulders up to 38 centimetres diameter; many roots; wet - water seeping out of this horizon. Sharp change into
Eg	38-43	Light grey (2.5Y7/2) to light brownish grey (10YR6/2) loamy sand to sandy loam; weak subangular blocky to massive; few stones; few roots; moist to very moist. Sharp change into
Bf	at 43	Strong discontinuous iron pan
Bx(g)	43-74	Brown (10YR5/3) and yellowish brown (10YR5/6) in upper, brown to pale brown (10YR5/3 to 6/3) in lower part, sandy loam to loamy sand; massive to very weak platy; strongly indurated; small (up to 1 millimetre diameter) vesicular pores present; frequent stones, sizes up to 5-8 centimetres diameter; no roots; moist; few faint rusty mottles. Sharp change into
C(g)	74-89+	Pale brown (10YR6/3) sandy loam to loamy sand; compact and slightly indurated; small (up to 1 millimetre diameter) vesicular pores present; frequent stones, sizes up to 15 centimetres diameter; no roots; moist; few yellowish brown (10YR5/4) mottles.

The profile described, which is characteristic of the largest area of poorly drained soil at Ferrar, is one in which the strongly indurated layer is the main cause of the drainage impedance. The soil is not a typical noncalcareous gley but one which has probably developed from an imperfectly drained soil by sealing up of the pores of the lower horizons or by an increase in surface water from upper slopes. On water-modified till a ground-water gley is found.

Forfar Association

Forfar is the second largest association in lowland Strathmore. It covers 200 square kilometres of which more than 90 per cent lies on Sheet 57 (Forfar).

Distribution

On Sheet 57 the association extends up the western edge in a sinuous band from Inverarity in the south to Forfar, and northwards across Forest Muir to Memus. Eastwards it follows the Forfar – St. Vigeans channel to Arbroath, and the valley of the River South Esk to the Montrose Basin. A more discontinuous belt skirts the Grampian foothills eastwards from Fern, and spreads around the edges of the Edzell gravel flats and along the lower reaches of the River North Esk. Irregular patches occupy hollows and channels in the central part between Aberlemno and Montreathmont, and in the south central area between Forfar and Carmyllie. On Sheet 66/67 there is a limited north-easterly extension of the mixed outwash deposits around the Edzell flats, and some small patches in the valleys of the Cowie Water and the Carron Water near Stonehaven. The altitudinal range of the association is from about 15 to 165 metres with the greater part lying between 45 and 120 metres. Topographically it is generally related to gently sloping lower valley sides, and gently undulating ground on the till plain.

Parent Material

The parent material of this group of soils is closely related geomorphologically to that of the Balrownie Association, both being glacial deposits derived from Lower Old Red Sandstone strata. In the Balrownie Association, a periglacially modified upper layer with a fairly porous fabric and a clay content of 15 to 20 per cent overlies a more compact till. Locally, the modified layer of the Forfar Association has characteristically lower clay contents, usually within the range of 5 to 12 per cent, and can be up to 75 or 100 centimetres thick. Soils developed on such material were first encountered in the broad colluvial hollow trending west-south-west to east-north-east and lying just to the north of Forfar. Another parent material complex, which had previously been described as an alluvium-till transition material, was included within the Forfar Association.

Soils

Three series make up the Forfar Association, the imperfectly drained Forfar Series being the most extensive, although the freely drained Vinny Series is widespread. The poorly drained Vigean Series is of very limited extent and confined to hollows and low-lying sites.

In the semi-natural state, the freely and imperfectly drained series are acid podzolic soils from which exchangeable calcium has been strongly leached. The surface pH is about 4, and pH 5 is seldom exceeded at 45 centimetres below ground surface. Indeed, in the freely drained soils with a deep coarse-textured solum, pH5 is rarely exceeded at 75 centimetres. After cultivation, fertilizers leach readily into the solurn, and within the area covered by this memoir only one value below 5.7 has been

recorded. Values between 6 and 7 are common in all horizons of arable soils and exchangeable calcium values are appreciable throughout.

The poorly drained soils are noncalcareous gleys, and their practical field drainage problems tend to be related to topographic difficulties, rather than to any lack of permeability of the profile.

Vinny Series

The soils of the Vinny Series are freely drained podzols, covering 74 square kilometres and have been mapped over an altitude range from 15 to about 165 metres.

Semi-natural soils of the Forfar Association are to be found on Forest Moor north of Forfar and within Montreathmont Forest, south of Brechin, where the Forfar soils form coarser-textured patches in a gently undulating landscape dominated by the Balrownie Association. By historic accident the soils of Montreathmont Forest have been rather anomalously exempted from the general pattern of agricultural improvement in Strathmore, and a profile of the Vinny series from this area is described below.

Profile Description: No.48. Montreathmont

Grid Reference	NO567550
Altitude	100 metres
Slope	Gentle
Vegetation	Scots pine plantation with understory of scattered patches of *Deschampsia flexuosa*, *Vaccinium vitis-idaea* and mosses
Drainage	Free

Horizon	Depth (cm)	
L	0-6	Pine needle litter.
F	6-15	Black fibrous humus; subangular blocky; friable
H	15-16	Black (10YR2/1) well-decomposed greasy mor humus
Ah	16-23	Very dark greyish brown (10YR3/2) humose sandy loam; medium subangular blocky; few stones; many roots; moist; no mottles. Gradual change into
AB	23-30	Greyish brown (10YR5/2) sandy loam; medium subangular blocky; few stones; frequent roots, Gradual change into
Bw1	30-41	Brown (10YR5/3) to yellowish brown (10YR5/4) loamy sand; crumb; frequent stones, mostly O.R.S. flags, with quartzite and quartz-mica-schist; frequent roots; few faint rusty mottles. Gradual change into
Bw2	41-53	Brown (10YR5/3) to yellowish brown (10YR5/6) loamy sand; weak subangular blocky; compact; frequent stones; few roots. Gradual change into
BCx	53-76+	Reddish brown (5YR4/4) loamy coarse sand; compact

		and indurated, pieces of indurated material breaking down under pressure to single grain; many stones; no roots. Gradual change into
C	76-97+	Reddish brown (2.5YR4/4) stony gritty loamy coarse sand; loose and fragmented.

The finer texture of the surface horizons in the soils developed on alluvial-till transition material is illustrated below by a profile from arable land at Balnacake near Brechin.

Profile Description: No.47. Balnacake

Grid Reference	NO560579
Altitude	60 metres
Slope	Moderately steep
Vegetation	Old grass
Drainage	Free

Horizon	Depth (cm)	
Ap	0-36	Dark brown (7.5YR3/2) fine sandy loam; subangular blocky to crumb; few stones (hard schist erratics) in the upper part, but becoming more frequent (schist, sandstone and lava) towards the base; many grass roots; many worms; moist; no mottles. Clear change into
Bw1	36-51	Dark yellowish brown (10YR4/4) fine sandy loam; weak crumb; frequent stones; frequent grass roots; worm channels present; moist; no mottles. Clear change into
Bw2	51-64	Brown (7.5YR4/4) sandy loam to fine sandy loam; strong crumb; frequent stones; locally frequent grass roots; moist; no mottles. Sharp change into
Bw3	51-79	Reddish brown (5YR4/4) sandy loam to loamy sand; subangular blocky; soft and friable above, becoming compact below; frequent stones; few roots present; moist; few fine grey and rusty mottles. Gradual change into
Bx	79-104	Reddish brown (5YR4/4) sandy loam to loamy sand; compact and indurated; frequent stones; no roots; moist; few fine grey and rusty mottles. Gradual change into
C	104+	Reddish brown (2.5YR4/4) sandy loam

Other freely drained cultivated soils developed from the Montreathmont type of semi-natural profile have coarser-textured surface horizons, generally 25 to 30 centimetres thick, overlying a coarser-textured sandy loam or loamy sand Bw horizon. They are otherwise very similar in their general physical and chemical characteristics to the cultivated profile described above. Both the profiles described show some slight rusty mottling, and it is unusual for these soils to show the morpholological indication of completely free internal drainage. The amount of impedance is very small and restricted to slight seasonal waterlogging in and just above the indurated layer where this horizon is well developed.

For additional analytical data see profile No.49. Heatherstacks in Appendix 2.

Forfar Series

The Forfar Series, covering 120 square kilometres, is the dominant series of the association and the second largest in lowland Strathmore. The soils are imperfectly drained podzols, most of which are cultivated. The distribution pattern and altitude range for this series are those for the association as a whole, although most of the arable ground is found between 60 and 120 metres.

A comparison of the available analyses relating to profiles developed on the deep modified till characteristic of the former Drumgley Series, now incorporated within the Forfar Series, shows that the semi-natural soils are virtually devoid of exchangeable calcium down to a depth of 75 to 100 centimetres below the surface, while the cultivated soils have built up a large reserve of exchangeable calcium at this depth. This accumulation of calcium occurs at about the junction of the coarse-textured modified till and the underlying dense till of the Balrownie type, and is about twice as great as that found in modal soils of the Balrownie Series. This suggests that the rate of leaching through the upper coarse-textured horizons of the Forfar Series may be up to twice as great as the rate of leaching through the equivalent horizons of the Balrownie Series. It is this difference in texture and permeability of the fabric of the upper half of the solum which is the essential distinction between these two series.

The four profiles described below illustrate the range included within the Forfar Series. The semi-natural soils are from Montreathmont Moor about 10 kilometres south of Brechin, and the cultivated soils are from North Mains of Kinnettles about 5 kilometres south-west of Forfar and from Newdyke farm about 5 kilometres south-east of Forfar.

Profile Description: No.67. (Montreathmont

Grid Reference	NO574539
Altitude	90 metres
Slope	Gentle
Vegetation	Scots pine plantation with *Calluna vulgaris*, *Vaccinium myrtillus*, *Erica tetralix*, *Deschampsia flexuosa*, *Nardus stricta*, *Molinia caerulea*, *Juncus communis*, *Ulex europaeus*, *Hylocomium splendens*, *Polytrichum* sp., *Hylocomium squarrosus*
Drainage	Imperfect

Horizon	Depth (cm)	
L	0-5	Heather and moss litter
FH	5-10	Black humus with some mineral matter; many live roots; a thin smear of black greasy humus at base.
AEg	10-33	Dark greyish brown (10YR4/2) sandy loam with very dark greyish brown (10YR3/2) humus-stained patches in the upper and lower 8 centimetres; weak subangular blocky; frequent stones (flaggy O.R.S. sandstone,

		quartzite, quartz-schist); frequent live and dead roots; moist; few rusty mottles present near the base. Sharp change into
Bf	33	Irregular thin iron pan, with root mat above; very few roots penetrate the pan
Bx	33-43	Brown (10YR5/3) gritty loamy coarse sand; weak platy; strongly indurated; frequent small and medium sized stones; no roots; moist; prominent rusty mottles associated with patches of concretionary iron. Gradual change into
Bw	43-48	Reddish brown (5YR4/4) loamy coarse sand; weak platy; compact; frequent stones; no roots; moist; few faint rusty mottles. Sharp change into
BC	48-66	Reddish brown (2.5YR4/4) loam; coarse subangular blocky; frequent stones; moist; few to frequent vertical grey cracks with rusty margins, infilled with loamy sand. Gradual change into
C	66-102+	Reddish brown (2.5YR4/4) loam; weak subangular blocky with some horizontal lamination; many stones; moist; vertical grey cracks penetrate about 15 centimetres into this horizon, narrowing rapidly; water flowing into base of pit at about 81 centimetres.

Profile Description: No.68. North Mains of Kinnettles

Grid Reference	NO436472
Altitude	135 metres
Slope	Gentle
Vegetation	3rd year grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-33	Very dark greyish brown (10YR3/2) sandy loam; crumb; moderately compact; frequent stones, schist and sandstone; many grass roots; worms present; slightly moist. Sharp change into
Bw(g)1	3-51	Brown (10YR4/3) sandy loam to loamy sand; compact with hard concretions and softer patches; frequent stones; roots tend to concentrate down soft patches; few worm channels; slightly moist; few grey and rusty mottles. Sharp change into
Bw(g)2	51-71	Reddish brown (5YR4/3) sandy loam; massive; compact; frequent stones; few roots; no worms present; moist; few faint grey and rusty mottles; one vertical grey crack with rusty margins penetrates this horizon. Sharp change into
C	71-163+	Reddish brown (5YR4/3 and 5YR5/3) loam; massive; frequent stones; no roots; moist; few grey and rusty mottles.

Profile Description: No.70. Montreathmont

Grid Reference	NO574538
Altitude	90 metres
Slope	Gentle
Vegetation	Scots pine plantation with *Calluna vulgaris*, *Erica tetralix*, *Deschampsia flexuosa*, *Carex* sp., *Potentilla erecta*, *Polytrichum* sp., *Hylocomium splendens*, *Pleurozium schreberi*
Drainage Class	Imperfect

Horizon	Depth (cm)	
L	0-1	Heather and moss litter
F	1-8	Black humus; friable; and moist
AEh	8-13	Dark greyish brown (10YR4/2) humose loam with bleached quartz grains; subangular blocky; few small and medium-sized stones; many roots; moist. Sharp change into
AB	13-20	Patchy dark greyish brown to dark brown (10YR4/2 to 4/3) and very dark brown (10YR2/2) sandy loam; subangular blocky; few small and medium-sized stones; frequent roots; few patches of rusty mottles. Clear change into
Bw(g)	20-56	Reddish brown (5YR5/3) loamy sand with streamers of organic staining from the horizon above following root channels; angular to subangular blocky; slightly compact; frequent stones of large and medium-sized angular and subangular O.R.S. flags, quartz-schist and quartzite increasing in quantity with depth; frequent to few roots, decreasing gradually with depth; moist; few patches of rusty mottles. Gradual change into
Bx(g)	56-79+	Reddish brown (2.5YR4/4) gritty loamy sand; coarse platy; compact and indurated; many stones with large pieces of soft sandstone and small rounded pebbles of quartzite and quartz-schist.

Profile Description: No.69. Newdyke

Grid Reference	NO479479
Altitude	105 metres
Slope	Gentle
Vegetation	3rd year grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-30	Dark reddish brown (5YR3/3) sandy loam; subangular blocky; friable; few small stones, mainly hard schist erratics and O.R.S. sandstone; many grass roots, decreasing in number in lower 8 centimetres; worms present; moist. Sharp change into
Bw(g)1	30-43	Reddish brown (5YR4/4) sandy loam to loamy sand; angular to subangular blocky; friable; few stones; frequent to few grass roots; vertical worm channels present; moist; many faint grey and rusty mottles. Clear change into
Bw(g)2	43-61	Reddish brown (5YR4/4) coarse sandy loam; weak prismatic breaking to coarse subangular blocky; frequent stones of hard and soft schist and O.R.S. sandstone; few grass roots tending to concentrate down structure planes; worm channels in upper 10 centimetres; moist; few grey and rusty mottles, the latter mainly associated with rotten stones. Gradual change into
Bw(g)3	61-89	Reddish brown (5YR4/3) sandy loam; weak prismatic breaking to coarse subangular blocky; frequent stones; few roots present to 79 centimetres; no worms; moist, becoming very moist at base; few grey and rusty mottles present; but rather less than in horizon above. Sharp change into
BC(g)	89-107	Reddish brown (5YR4/3) patchy sandy loam and loamy sand; weak subangular blocky structure; frequent stones; no roots; wet, water flows from this horizon into the pit; few rusty mottles. Sharp change into
C	107-119+	Reddish brown (2.5YR4/4) loam.

These four profile descriptions show the range of parent material and genetic type within this series. They also illustrate the practical difficulties of distinguishing the intermediate or non-modal soils of the Forfar and Balrownie Series in the field.

Vigean Series

This series, like the other poorly drained soil series of lowland Strathmore, is of limited extent and occupies only 6 square kilometres, or about 4 per cent of the total area of the Forfar Association. The soils are noncalcareous gleys though patches of peaty gley may occasionally be included. Many areas are too small to delineate, and others can be distinguished only with difficulty, from alluvial deposits. Particular

difficulty was encountered in the ground immediately to the north of Forfar, in hollows on the northern part of Montreathmont Moor, and in the slightly corrugated strike topography south of Kirkton of Menmuir. The texture of the parent material is not noticeably finer than in the rest of the association and, as in the other two series, the clay content is little more than 12 per cent.

The profile described below is an arable soil from Grange of Conon farm about 5 kilometres south of Friockheim.

Profile Description : No.86. Grange of Conon

Grid Reference	NO583443
Altitude	113 metres
Slope	Gentle
Vegetation	2nd year grass
Drainage	Poor

Horizon	Depth (cm)	
Ap	023	Dark brown (10YR4/3) sandy loam; subangular blocky; compact; few small stones; many grass roots; worms present; moist; small pieces of free lime; no mottles. Sharp change into
Bg1	23-43	Brown (7.5YR5/4) coarse sandy loam to loamy sand; strong prismatic; few stones, generally less than 3 centimetres in diameter, soft and weathered; few roots; worms present; moist; strong vertical light brownish grey (10YR6/2) and. rusty streaks with few light brownish grey and yellowish brown (10YR5/8) mottles associated with rotten stones. Gradual change into
Bg2	43-79	Reddish brown (5YR5/4 and 5/3) sandy loam and loamy sand, with occasional lenticles of coarse sand; prismatic; frequent stones, often weathered, of hard and soft schists and O.R.S. sandstone; few roots penetrate to base of this layer; no worms; moist; light brownish grey (10YR6/2) and rusty mottles, vertically streaked above becoming patchy below. Clear change into
Cg	79-102	Reddish brown (5YR4/3) sandy loam; weak prismatic; frequent stones mostly weathered schist; no roots; no worms; moist to wet with water seeping into pit from base of this layer; few rusty mottles associated with rotten stones. Sharp change into
C	102+	Reddish brown (5YR4/3) loam

Laurencekirk Association

The soils of the Laurencekirk Association are characterized by their bright red colour inherited from the red marls, mudstones and fine-grained sandstones of the underlying Old Red Sandstone Formation. They are of medium texture and occupy the flatter part of the Howe o' the Mearns.

Distribution

The association covers an area of 67 square kilometres extending southwards from Bridge of Mondynes to the River North Esk, bounded in the west by a line from Auchenblae to Fettercairn and in the east by the base of the Garvock Hills. Within this area are enclaves of alluvium and parts of the Auchenblae Association.

Parent Material

The main parent material is a red till generally of clay loam texture. It is derived from the Strathmore Group of strata of the Lower Old Red Sandstone Formation which consists of bright red shales and marls passing into flagstones. The till is 9 metres thick in exposures along the Water of Kair but this thickness is exceptional. In places the soils are formed on the residual marl, which is soft and can be dug with a spade. Erratics of schist, gneiss and granite are present in the till together with sandstone and miscellaneous pebbles. The schists, gneisses and sandstones are usually soft and partially decomposed. Internal drainage in the till is restricted and results in a notable amount of manganese staining on the structural units. Ochreous mottling, though present, tends to be obscured by the bright colour of the parent material. The till is slightly calcareous below about 1.8 to 2.4 metres and has a near-neutral reaction in the C horizon of the soil profile. Below a depth of 1.2 metres the till is massive.

Bordering the Luther Water and near its junction with the River North Esk, the till has been subjected to some water sorting. The process has resulted in soils with sandy loam texture overlying a clay or clay loam (till) C horizon, similar to those described in the Balrownie and Forfar Associations.

Soils

Six series are distinguished, namely Drumforber, Oldcake, Laurencekirk, Luther, Newton and Muirfoot. The Drumforber and Oldcake Series are freely drained brown forest soils, the former occurring on the residual marl and the latter on till. A more level situation and a higher clay content in the parent material gives rise to the Laurencekirk Series, an imperfectly drained brown forest soil, the most widespread of all the series in the association. The Luther Series is developed on water-sorted parent material, the profile having coarser-textured surface and B horizons to a depth normally not exceeding 60 centimetres. It is an imperfectly drained brown forest soil with slight gleying in the B and C horizons. The Newton Series is a freely draining iron podzol eith A and B horizons modified by water-sorting. A poorly drained, noncalcareous surface-water gley, with surface horizons which coarser in texture than the B horizon, is distinguished as the Muirfoot Series.

Drumforber Series

The Drumforber Series, a freely drained brown forest soil, covers 2 square kilometres, mainly around Fordoun. It is developed on soft residual marl and fine-grained sandstone on gently sloping sites. Slight manganese staining appears in the Bw horizon and is more pronounced in the C.

Profile Description: No.7. Lower Powburn

Grid Reference	NO745748
Altitude	65 metres
Slope	Gentle
Vegetation	Rotational grass
Drainage	Free

Horizon	Depth (cm)	
Ap	0-31	Reddish brown (2.5YR4/4) loam; medium subangular blocky; friable; moderate organic matter; few stones - angular mudstone, subangular schist and small conglomerate pebbles; many grass roots. Sharp change into
Bw	31-56	Weak red (10R4/4) loam with high content of marl fragments (3 centimetres or less diameter); massive, breaking into irregular clods; friable; low organic matter; few roots; moist; slight manganese staining on rock fragments. Gradual change into
C	56-122+	Angular fragments of mudstone with interstitial weak red (10R4/5) loam; surface of mudstone softer than interior; frequent manganese staining on surface of mudstone fragments.

Oldcake Series

The Oldcake Series, like the Drumforber Series, is a freely drained brown forest soil which is developed on till and is more extensive, covering 11 square kilometres. The series occurs on moderate slopes as on the western footslopes of the Garvock Hills and on rising ground with convex slopes. The free drainage may be attributed to slope and sometimes, in addition, to slightly coarser textures than are found in the imperfectly drained Laurencekirk Series with which it is associated.

Profile Description: No.8. Northhill Wood

Grid Reference	NO698746
Altitude	60 metres
Slope	Moderate to gentle
Vegetation	Birch and rowan 6 to 12 metres tall with *Agrostis* spp., *Festuca* spp., *Poa* spp., *Anthoxanthum odoratum*, *Holcus lanatus*, *Deschampsia cespitosa*,*Succisa pratensis, Potentilla erecta*, *Veronica chamaedrys*, *Juncus effusus*, *Ulex europaeus*, *Rubus idaeus*.

Drainage	Free	
Horizon	Depth (cm)	
L	0-3	Dark brown fibrous litter
F	3-5	Dark brown (7.5YR4/2) decomposed litter; many live roots
Ah	5-15	Reddish grey (5YR5/2) merging to light brown (7.5YR6/4) fine sandy loam; weak coarse blocky; very friable; very high organic matter; many fine roots. Sharp change into
Bw	15-31	Reddish brown (2.5YR4/4) clay loam; medium, becoming coarse, subangular blocky; few stones; many fine roots. Gradual change into
C	31-117+	Red (10R5/8) clay loam; massive and compact; plastic; fine roots penetrate to 76 centimetres; few soft and decomposed mudstone stones; some black manganese staining.

A rich ground flora is associated with this brown forest soil. In the upper horizons the profile is freely drained. A slight drainage impedance in the C horizon is indicated by the presence of manganese staining but this is insufficient to place the soil in the imperfectly drained class. The clay content of the subsurface horizons is between 25 and 30 per cent. These horizons have no restriction to root penetration in the form of an indurated layer. The soils are inherently rich in nutrients and the series is mainly arable.

Laurencekirk Series

The Laurencekirk Series is the dominant series, covering 21 square kilometres; it occurs on almost level to gently sloping sites and is an imperfectly drained brown forest soil with gleyed B and C horizons. The parent material is a red till of sandy clay loam to clay loam texture (25 to 30 per cent clay content). The combination of moderately fine textures and low-angle slopes appears to be the cause of the imperfect drainage of the series. Mostly cultivated, it is considered one of the top-yielding soils in east Scotland, although it requires some tile draining.

Profile Description: No.21. Goseslie

Grid Reference	NO657699
Altitude	55 metres
Slope	Gentle
Vegetation	Rotational grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-23	Reddish brown (5YR4/3) loam; medium subangular and fine blocky; soft and friable; few stones, mainly schist; many roots; worms present; moist. Sharp change into
B(g)1	23-41	Reddish brown (5YR5/4) clay loam; medium angular blocky; plastic when moist, extremely firm when dry; moderate organic matter; stones mainly schist and

		Old Red Sandstone marl, part weathered; frequent roots; grey mottles on faces of peds. Sharp change into
B(g)2	41-61	Yellowish red (5YR5/6) clay loam; coarse prismatic, breaking transversely into coarse angular blocky; stones as above; roots present between peds; grey and ochreous mottles on faces of peds. Sharp change into
C(g)	61-102+	Dark red (2.5YR3/6) clay loam; massive; plastic, stones more numerous than above, mainly schist; moist; few faint grey and ochreous mottles in upper part, decreasing with depth.

The intensity of the colour increases with depth as does the clay content, the C(g) horizon having 32 per cent clay, 7 per cent more than in the cultivated surface horizon. Grey and ochreous mottling, indications of wetness, are more clearly developed in the B(g) horizon immediately underlying the Ap horizon, the mottling decreasing with depth. Black manganese staining is frequent in the B(g) horizons.

Luther Series

This series, covering 25 square kilometres, occurs next to the Luther Water and near the River North Esk where it forms an ill-defined higher terrace. It is also found where streams arising in the Grampian foothills or the Garvock Hills spill out on to the low ground. Its main distinguishing feature is the water-sorted nature of the upper horizons. In some soils this is distinct and the texture is gravelly loam down to a depth of 60 centimetres or more; in others, the topsoil is sandy loam. The underlying till is generally a massive, red, sandy clay loam. While the surface soils may bear comparison with the Auchenblae Series and with the Forfar Series, both in colour and texture, the underlying subsoil or C horizon differs from these series in being derived from the bright red mudstone or marl rather than from the sandstone.

Profile Description: No.22. Blackiemuir

Grid Reference	NO705725
Altitude	60 metres
Slope	Gentle
Vegetation	3rd year rotational grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-25	Dark reddish grey (5YR4/2) loam; medium subangular blocky; firm; moderate to high organic matter; frequent stones, small subangular schist and gneiss with few 10–centimetre diameter conglomerate cobbles; frequent to many roots; frequent worms; moist. Gradual change into
AB	25-36	Dark reddish grey (5YR4/2), with reddish, yellow and grey patches from decomposing stones, sandy loam; weak fine subangular blocky; friable; moderate to low organic matter; many small subangular, few medium

		subrounded stones; frequent roots; moist; few faint fine mottles. Clear change into
B(g)1	36-48	Reddish brown (5YR5/4) stony loamy sand; weak subangular blocky breaking into single grain; low organic matter; few fine roots; worm tracks with filling of surface soil; moist; variegated mottle colours. Sharp change into
B(g)2	48-76	Weak red (10R5/4) sandy clay loam; massive to weak coarse prismatic; firm; fine black manganese staining locally; few stones, mainly small marl fragments with larger quartzites and schists; few roots and worm tracks; moist, few faint rusty mottles down fissures of more sandy material; clay skins. Gradual change into
C	76-112+	Weak red (10R5/4) sandy clay loam; massive, some vertical cracks with greyish sand grains; few large stones and many fragments of soft marl; many roots; manganese staining on fine pores and channels; moist.

The texture of the horizons overlying the B(g)2 varies from loamy sand to loam, the coarsest texture generally occurring immediately above the B(g)2 or C horizon. The upper water-sorted material is generally less than 60 centimetres thick, and the colour is less bright than that of the massive till. The stone content of the upper layers is largely schist rather than marl as in the till parent material. Imperfect drainage resulting from the gentleness of the slope and the underlying massive clayey till is, however, insufficient to have a deleterious effect on the use of the soil.

Newton Series

This series also has modified surface horizons which are coarser in texture than the till. It occurs on convex slopes on gently rising ground and is freely drained. Under semi-natural vegetation the soil profile shows attributes akin to an iron podzol. The series covers 7 square kilometres.

Profile Description: No. 50. Woodside of Thornton

Grid Reference	NO675735
Altitude	75 metres
Slope	Strong
Vegetation	Scots pine plantation with birch and *Vaccinium myrtillus, Deschampsia flexuosa*, *Oxalis acetosella*, *Pleurozium schreberi*, *Lophocolea bidentata*
Drainage	Free

Horizon	Depth (cm)	
L	0-5	Pine needles, *Vaccinium* and mosses
H	5-6	Black amorphous humus; many roots; moist. Irregular change into
Ah	6-14	Very dark brown (10YR2/2) sandy loam; weak subangular blocky; friable; high organic matter; few schist stones partly decomposed; frequent small tree roots; moist; blotches of dark brown (7.5YR3/2) mixed B horizon

		material. Clear irregular change into
AB	14-20	Reddish brown (5YR4/3) fine sandy loam; fine to medium subangular blocky; friable; moderate organic matter; frequent small tree roots; moist; some blotching due to varying humus content. Gradual change into
Bw	20-43	Reddish brown (2.5YR4/4) loam; medium subangular blocky; friable; few small decomposed schist stones, subangular quartzites and rotten mudstone; few roots; moist. Gradual change into
C	43-112+	Reddish brown (2.5YR5/4 to 4/4) sandy clay loam; massive; firm; frequent stones up to 23 centimetres diameter; few roots.

The litter layers are 5 centimetres thick and the accumulation of decomposed organic matter is 1 to 3 centimetres thick. An E horizon has not yet developed, but the upper part of the A has a speckling of quartz grains which are clear and uncoated and may be considered to form an incipient E horizon. The horizon has a marbled appearance of dark and pale colours due to variation in the amount of organic matter. The B horizon possibly obscures the appearance of iron accumulation due to the inherent hue of the parent material. The texture of the upper horizons down to the base of the B horizon at a depth of 43 centimetres is coarser than that of the till C horizon.

More strongly podzolized horizons occur where the texture of the water-sorted layer is coarser. The soil described above is nearer to a brown forest soil than an iron podzol.

Muirfoot Series

The Muirfoot Series is a poorly draining noncalcareous gley found in low-lying sites throughout the association. Despite the fine-textured nature of the parent material, this soil series surprisingly covers only 1 square kilometre.

Profile Description: No. 87. Goseslie

Grid Reference	NO658700
Altitude	55 metres
Slope	Flat
Vegetation	Rotational grass
Drainage	Poor

Horizon	Depth (cm)	
Ap	0-23	Reddish brown (5YR4/3) loam; medium blocky; firm; few stones, mainly schists up to 8 centimetres; many roots; worms present; moist; no mottles. Sharp change into
Ag	23-31	Reddish brown (5YR5/3) (colour variable) sandy loam; coarse prismatic breaking horizontally into medium angular blocky; small and medium-sized schist stones, some partially decomposed red marl; frequent roots;

		worm tracks; moist; prominent grey prism faces, with rusty mottles and occasional ochreous staining in interiors of peds. Clear change into
Bg	51-79	Reddish brown (5YR5/4) sandy clay loam; colour variegated - grey in upper part becoming paler with depth; strong coarse prismatic, breaking into angular blocky; stones as above, many soft and rotten, few greater than 8 centimetres diameter; few roots following grey gleyed surface of prisms; moist. Sharp change into
Cg	79-112+	Dark red (2.5YR3/5) clay loam till; coarse prismatic becoming massive with depth; plastic and sticky; frequent red marl stones, fewer schists; few roots to 91 centimetres; moist; faces of prisms coated with grey silt.

The colour of the A horizon is frequently greyish, particularly in the uncultivated soils where the surface layer is a mull with coarse crumb structure. A textural difference is generally observable between the upper horizons and the Cg horizon; in the soil described there is a difference in clay content of some 12 per cent which may be due to water-sorting. Prismatic structure and mottling is marked between a depth of 23 and 76 centimetres, the ochreous mottling being apparent in the interior of the peds. The soils are surface-water gleys and, where cultivated, have been intensively tile drained. The uncultivated land supports a *Deschampsia cespitosa* ground cover with birch, alder and willow. These soils require ditching and draining before any agricultural use.

Mountboy Association

The soils of the Mountboy Association are formed on a till derived mainly from lava with some sandstone of the Lower Old Red Sandstone Formation and a small amount of Dalradian schist. Almost all the soils are acid brown forest soils and they cover a total area of 61 square kilometres, located in the coastal belt between Stonehaven and .Lunan Bay. Noncalcareous gleys and skeletal soils are limited in extent both covering <1 square kilometre in area.

Distribution

The most extensive tract of the association lies between the Montrose Basin and the Lunan Water where it occupies some 39 square kilometres of the Usan peninsula. A smaller area occurs south of Lunan Bay and south-east of Inverkeilor. Between Stonehaven and the River North Esk, the association occupies the upper parts of the Garvock Hills of which the Cairn Tower of Johnston, 279 metres, is the highest point, with Bruxie Hill, 8 kilometres south of Stonehaven, the most northerly. The association forms a number of enclaves within the Stonehaven Association. With the exception of three small areas on the south of Dunnichen Hill, east of .Forfar, the whole of the association lies within some 8 kilometres of the coast.

Parent Material

The parent material is a reddish brown till derived from andesitic lava together with a varying amount of sandstone and conglomerate of Lower Old Red Sandstone age;

there is frequently a smaller amount of quartz-schist and mica-schist from the Dalradian. The thickness of the till is generally less than 1.2 metres but it varies greatly over a small area and in places there are frequent small outcrops of lava rock. The till has been deposited by ice movement along the strike of the country from west-south-west to east-north-east, and the resulting mixture of red sandstone and lava drift tends to be spread over the larger lava outcrops and for some distance to the east and north-east. The till of the Mountboy Association, in which andesite is the dominant component, differs from that of the Stonehaven Association in which lava is subsidiary to conglomerate and sandstone. Because of the irregular configuration of the lava outcrops, the distribution of the till as a soil parent material is rather uneven. The beds of lava tend to be gently inclined to the south-east. The parent material ranges from a reddish brown modified till, only slightly different from that of the .Balrownie Association, through a till having a mixed stone content with a high proportion of lava and a distinct purplish cast in the reddish brown colour, to a shallow, brown or slightly reddish brown, semi-residual till occurring around the actual lava outcrops. The latter variant may bear comparison with the parent material of the Darleith or Sourhope Associations depending on the type of lava.

In the area of the association situated on the north side of Lunan Bay, the topography is gently sloping, falling on all sides from Rossie Moor, and on the south side of the bay it is level or gently sloping. In both localities, the parent material around the margins is thick and contains less of the lava component. The areas occurring on the Garvock Hills occupy ridges and flattened summits; the tills are stony and shallow, with bed-rock at 45-60 centimetres, and contain less than 10 per cent clay.

Soils

Three soil series and a few areas of skeletal soils are represented in this association. As a result of the topography, the coarse texture, and the loose consistence of the parent material, the majority of the soils are freely drained, and are separated as the Garvock Series. When a lava pavement planed smooth by glaciation underlies the till, the internal drainage of the soil is adversely affected, giving rise to the imperfectly drained Mountboy Series. The poorly drained .Barras Series occurs only on Bruxie Hill where it occupies depressions and a drainage channel. It is closely allied to the Balhagarty Series of the Stonehaven Association. The Garvock and Mountboy Series are respectively a brown forest soil and a brown forest soil with gleyed B and C horizons, but in both, indurated horizons are frequently present. Skeletal soils on lava outcrops are of minor extent

Garvock Series

The Garvock Series, covering 45 square kilometres, is the most extensive of the association; it is located on hilltops and ridges of the Garvock Hills and on the low hills of Rossie Moor. The parent material is a shallow, rather stony, sandy loam till and the soil is freely drained.

Profile Description: No.9. Leys of Barras

Grid Reference	NO828778
Altitude	120 metres
Slope	Gentle
Vegetation	2nd year grass
Drainage	Free

Horizon	Depth (cm)	
Ap	3-13	Dark reddish brown (5YR3/4) loam; medium crumb; friable; high organic matter; frequent angular lava stones; many roots; worms present; moist; no mottles. Sharp change into
Bx	13-43	Reddish brown (5YR4/4) gritty sandy loam; moderately indurated, breaking into ill-defined coarse blocky peds; low organic matter; frequent stones, angular fragments of lava and subangular to rounded sandstone and schist; few fine roots penetrate; no worms; no mottles. Gradual change into
C	43-76	Dark reddish grey (5YR4/2) gritty loam; weak coarse blocky; loose; frequent stones, mainly small angular lava fragments with a few mica-schist and sandstone; no roots; moist; no mottles. Sharp change into
R	76	Smooth glaciated pavement of andesitic lava

The soils are shallow, the depth to rock being seldom more than 90 or 120 centimetres. Rock outcrops are, however, uncommon but stoniness is a feature of the shallower profiles. A crumb structure in the surface horizon is particularly noticeable in the soils under old grass. The change to the Bx horizon is usually sharp and its reddish brown colour has a purplish cast which cannot be distinguished on the Munsell chart but is somewhat different from the B horizon colour of the soils derived from sandstones or conglomerate rock of the Lower Old Red Sandstone. The texture of the B horizon is commonly found to be appreciably coarser than that of the Ap horizon. An indurated horizon (Bx) is usually present.

For additional analytical data see profiles No.10. Bruxie Hill and No.11. West Mains of Dunnichen in Appendix 2.

Mountboy Series

The Mountboy Series, 15 square kilometres in extent, occurs to the south of the Montrose Basin and to the south of Lunan Bay. It is associated with the gentle slopes and shallow depressions of the broad mass of rising ground underlain by lava. Subsurface horizons are finer textured than those of the Garvock Series, being loams or sandy clay loams. As a result of the gently sloping topography, the whole of the series is arable land.

Profile Description: No.23. Piterriehill

Grid Reference	NO658548
Altitude	120 metres
Slope	Gentle
Vegetation	4th year grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-20	Dark brown (10YR3/3) sandy loam; medium and coarse crumb; friable; moderate to low organic matter; frequent stones of lava and schist; frequent fine roots; moist. Sharp change into
B(g)(x)	20-31	Light reddish brown (5YR6/3) sandy loam with grey (5YR5/1), dark reddish brown (5YR3/3) and yellowish red (5YR5/6) mottles associated with pieces of rotten lava; very coarse crumb to medium subangular blocky; weakly indurated; many fine roots; worms present; moist. Clear change into
Bx(g)	31-41	Reddish brown (2.5YR4/4, sandy loam; coarse blocky to prismatic; low organic matter; indurated; few roots; moist; mottling and stones as above. Sharp change into
BCx(g)	41-76	Reddish brown (2.5YR4/4)with purplish cast sandy clay loam; indurated but decreasing with depth; moderate stone content of schists and lavas; few roots; moist; faint rusty mottling with scattered black manganese staining. Gradual change into
C(g)	76-114	Reddish brown (2.5YR4/4) sandy clay loam; massive, with tendency to coarse platy; slightly plastic; stones mainly angular pieces of lava; wet; decrease from ochreous and grey mottles to faint ochreous mottles.

The surface horizon is seldom more than 23 centimetres thick and the texture is usually a friable loam. The B(g)1 horizon in the above profile is a sandy loam and has a lower clay content than the Ap and basal horizons; this is not a consistent feature and suggests local water sorting. The subangular blocky structure tending to prismatic extends to the C(g) horizon and in some soils there is weak induration. Mottling is fairly common in the B(g)1 but decreases with depth; variegated colours are associated with decomposed schist, sandstone and lava stones. A platy structure is discernible in the compact till of the C(g) horizon.

For additional analytical data see profile No.24. Drumbertnot in Appendix 2.

Barras Series

The Barras Series is of very small extent, covering less than 1 square kilometre. It is a poorly drained noncalcareous gley occurring in small depressions and drainage channels on Bruxie and Leys Hills.

Profile Description: No.88. Leys of Barras

Grid Reference	NO829783
Altitude	115 metres
Slope	Gentle
Vegetation	3rd year rotational grass
Drainage	Poor

Horizon	Depth (cm)	
Ap	0-25	Dark brown (7.5YR4/2) sandy loam; fine to medium crumb; friable; moderate organic matter; frequent lava, sandstone and schist stones; many roots; worms present; moist. Clear change into
Bg1	25-36	Brown (7.5YR4/4) clay loam; medium prismatic breaking into medium angular blocky; firm; stone content as above; frequent roots; moist; many faint fine grey and rusty mottles. Clear change into
Bg2	36-69	Brown (10YR5/3) clay loam; coarse strong prismatic breaking into coarse angular blocky; plastic; grey silt coating on ped faces and around stones; low organic matter; fine roots; worms present; moist; prominent ochreous and yellow brown (10YR5/6) mottles; variegated colours from rotten lava, schist and sandstone stones. Clear change into
BCg	69-79	Reddish brown (5YR4/4) sandy loam; massive to coarse prismatic; firm; moist; coarse grey mottles on structure planes fading out with depth, fine rusty mottling through coarse peds. Gradual change into
Cg	79-104	Reddish brown (5YR4/4) gritty coarse sandy loam; massive, breaking into single grain on pressure; increased stone content; no roots; wet; coarse prominent grey mottles, few faint ochreous mottles; water seeping in.

The texture of the Bg horizons, a clay loam with almost 40 per cent silt (2-50μm) contrasts markedly with that of the Ap and Cg horizons which are sandy loams. The colour down to 60 centimetres is difficult to assess overall due to grey and ochreous mottles and to variegated colours from decomposed stones; below 60 centimetres the reddish brown colour characteristic of the Old Red Sandstone appears. The structure is crumb in the Ap horizon and prismatic or coarse angular blocky in the middle or high clay part of the profile, the accompanying change in clay content being from 4 to 26 per cent. The amount of exchangeable magnesium is high, the pH approaches neutrality with depth, and the amount of readily soluble phosphate is very high throughout the profile.

Skeletal Soils

Skeletal soils cover less than 0.5 a square kilometre and have been separated in two small areas of the Garvock Hills and in a small area of the Angus lowlands, some 2 kilometres south-east of inverkeilor. The soils are generally found on hilltops or on steep slopes and have a shallow A horizon overlying rock rubble.

Pow Association

The soils of the Pow Association have teen reclaimed from muddy reed flats where the River South Esk and the Pow and Tayock Burns meet the tidal water of the Montrose Basin.

Distribution

They occupy an area of 11 square kilometres situated mainly on the western side of the Montrose Basin with a small patch occurring on the northern side. The area has been drained by ditches and, in places, banks have been erected to reduce the hazard of flooding.

Parent Material

The parent material consists of estuarine alluvium of silt loam texture which, in places, overlies gravel and sand at a depth of about 1.2 metres.

Soils

Two series have been separated, the Ingliston Series, a brown forest soil with imperfect drainage which has been derived from a poorly drained gley by drainage improvement, and the Pow Series, a poorly drained gley, slightly calcareous below 30 centimetres.

Ingliston Series

This series occurs on alluvium which is at a slightly higher elevation and is underlain by sand or gravel at a depth of 90 to 120 centimetres. It occupies an area of 4 square kilometres.

Profile Description: No.25. Mains of Dun

Grid Reference	NO678589
Altitude	2 metres
Slope	Flat
Vegetation	Rotational grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-33	Dark brown (10YR4/3) silty clay loam; medium crumb aggregated into weak subangular blocky; sticky when wet, firm when dry; low organic matter; no stones; many roots; moist; few fine distinct yellowish brown (10YR5/4) mottles. Clear change into
B(g)1	33-56	Greyish brown (10YR5/2) silt loam; medium prismatic; slight stratification with fine sand layers; low organic matter; no stones; roots penetrate between peds; some yellowish brown (10YR5/8) staining along root channels within peds, becoming distinct rusty channels at base of horizon. Gradual change into
B(g)2	56-86	Greyish brown (10YR5/2) silt loam; strong coarse prismatic; roots penetrate between peds; moist; strongly developed iron tubes surrounding root channels within peds. Clear smooth change into
Cg	86-127	Dark grey (5Y4/l) fine sandy loam; massive; sticky; few roots to 102 centimetres; wet; iron tubes around roots fade with depth. Sharp smooth change into
2Cg	127-140+	Dark grey (5Y4/l) coarse sand; single grain; wet; water rising rapidly to 102 centimetres.

Prom the evidence of the rusty coatings surrounding root channels, which only develop under conditions of a high water-table, and the massive structure, it is clear that artificial drainage has improved aeration and resulted in the development of the prismatic structure in the B(g) horizons. A pH of 3.2 and an increase in organic matter at a depth of 90-107 centimetres indicates the presence of a buried surface horizon.

Pow Series

The Pow Series occurs adjacent to the Tayock Burn, the Pow Burn and the River South Esk and is developed on alluvium more than 122 centimetres thick. It occupies an area of 7 square kilometres.

Profile Description: No. 89. Arrats Mill

Grid Reference	NO648584
Altitude	8 metres
Slope	Flat
Vegetation	Rotational grass
Drainage	Poor

Horizon	Depth (cm)	
Ap	0-23	Pale brown (10YR6/3) (dry), dark brown (10YR4/3) (moist), silty clay loam; fine crumb; friable; few small stones; frequent grass roots; moist. Clear smooth change into
Ag	23-53	Grey (5Y6/1) silty clay loam; medium prismatic;

		rather firm; no stones; many roots; moist; frequent fine strong brown (7.5YR5/6) mottles. Smooth change into
BCg	53-99	Grey (5Y5/1) silty clay loam; coarse prismatic; sticky; few roots; wet; many distinct medium to coarse yellowish brown (10YR5/4) mottles. Smooth change into
Cg	99-112+	As above, massive, with more pronounced iron mottles

There is a distinct rise in the amount of organic matter in the basal horizon which suggests the presence of a buried surface horizon. The profile is 100 per cent saturated throughout, and between the depths of 30 and 122 centimetres the pH varies between neutrality and 7.7.

Stonehaven Association

The Stonehaven Association covers 162 square kilometres along the coastal side of the Howe of the Mearns. The parent material is a till of stony sandy loam to clay loam texture derived from sandstones and conglomerates of Lower Old Red Sandstone age, with some lava. The surface texture varies from clay loam to sandy loam but sandy clay loam is most common; the stone content, dominantly cobbles derived from the conglomerate, varies from moderate to very high.

Distribution

The association covers the rolling to hilly country between Stonehaven and the River North Esk, a distance of 29 kilometres, and extends inland for some 8 to 10 kilometres. Within this area, which embraces the Garvock Hills, there are enclaves of the Mountboy and Auchenblae Associations. A few isolated areas of the association are situated about Drumlithie.

Parent Material

The till on which the soils are developed is derived from sandstones and conglomerates of Lower Old Red Sandstone age together with contemporaneous lavas. The rocks belong to four of the groups recognized by Campbell (1913), viz, the Garvock, Arbuthnott, Dunottar and Crawton groups; these groups are described in Chapter 3. While the stone content of the Stonehaven till is frequently moderate, in some cases it is sufficiently high to interfere with cultivation; the stoniness increases and sometimes becomes excessive on ridges and hill summits where the till is thin. The till is probably 1.2 to 2.5 metres thick over the association as a whole.

The underlying rocks have a strike in a north-north-east to south-south-west direction; drainage channels and areas of poorly drained gleys are orientated in this direction, as are also the summits and ridges. Slopes of much of the arable land lying to the east or to the west are at right angles to the strike.

Soils

The Stonehaven Association extends over an altitudinal range from 30 to about 240 metres, the greater part lying below 150 metres.

Rainfall over the narrow coastal strip is approximately 710 millimetres, the remainder of the area receiving around 890 millimetres.

Four major soil subgroups are recognized in the association - brown forest soils with gleying, iron podzols, noncalcareou gleys and peaty gleys. Of these, the brown forest soil with gleying, the Stonehaven Series, covers 55 per cent of the association. Most of the series is arable land. The iron podzol, Shields Series, occurs on the ridge and hill summits, parts of which are rough grazings; this series is frequently stony and coarse-textured in contrast to the other soils of the association which are moderately fine-textured. The poorly drained Balhagarty Series and the very poorly drained Forgie Series are located in low-lying ground and depressions.

Stonehaven Series

The Stonehaven Series, covering 83 square kilometres, is located on gentle to moderate slopes which face either west-north-west or east-south-east, at right angles to the strike of the underlying rock. The parent material is a moderately stony sandy clay loam, with conspicuous conglomerate-derived cobbles in the surface horizon. The drainage class is imperfect and the major soil subgroup is a brown forest soil with gleying. Virtually the whole of the series is cultivated.

Profile Description: No.27. Easter Tulloch

Grid Reference	NO773717
Altitude	160 metres
Slope	Moderate
Vegetation	3rd year rotational grass with *Dactylis glomerata*, *Lolium perenne*, *Phleum pratense*, *Trifolium repens*, *Ranunculus repens*
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-23	Brown (7.5YR4/2) sandy clay loam; medium crumb; friable; moderate organic matter; frequent cobbles generally 8 centimetres diameter; many grass roots; moist. Clear change into
B(g)	23-56	Weak red (2.5YR5/2) sandy clay loam; coarse angular blocky; firm; low organic matter; surface soil tonguing down worm holes; large black manganese stains on planes between peds concentrated at 38-46 centimetres; moist; grey skins on ped faces and yellow ochreous mottles. Gradual change into
C(g	56-107	Reddish brown (2.5YR4/4) clay loam till with variable stone content; blocky passing into massive; plastic; few roots to 76 centimetres; wet; ochreous staining from occasional decomposed schists, but fewer mottles than above.

The surface horizon has a loam or sandy clay loam texture, a medium crumb structure, and a friable consistence. The stone content is generally sufficiently high

to be a disadvantage to cultivation. A firm angular or subangular blocky structure is associated with the B(g) horizon which is frequently slightly higher in clay content than either the Ap or the C(g) horizons. Manganese staining on the faces of the peds is generally observed in this illuvial horizon in a comparatively narrow band approximately 8 or 10 centimetres thick which is usually situated below the concentration of rusty and grey mottling. The transition into the C(g) horizon is accompanied by a colour change into a distinctly reddish brown till and a structural change from the well-defined coarse blocky peds into a massive stony clay loam. Exposures have shown that the till is calcareous below about 2 metres.

For additional analytical data see profiles No.26. Upper Criggie and No.28. Uras in Appendix 2.

Shields Series

The Shields Series, covering 56 square kilometres, is located on the upper slopes and ridges of the Garvock Hills. The reddish brown till on which it is developed is usually about 1.2 metres thick. It has a high content of 8-centimetre diameter conglomerate cobbles and a smaller proportion of subangular pieces of lava is commonly present, the stones being derived from alternating beds of conglomerate and lava which underlie the area and are readily seen at Crawton. The texture of the till is a stony sandy loam or stony sandy clay loam. Drainage is free and the soil is classified as an iron podzol.

Profile Description: No.51. Easter Tulloch)

Grid Reference	NO773716
Altitude	160 metres
Slope	Level, top of moderate slope
Vegetation	3rd year rotational grass with *Dactylis glomerata*, *Lolium perenne*, *Phleum pratense*, *Agrostis tenuis*, *Holcus lanatus*, *Trifolium repens*, *Ranunculus repens*
Drainage	Free

Horizon	Depth (cm)	
Ap	0-23	Brown (7.5YR5/2) stony loam; medium crumb; loose; moderate organic matter; many quartzite cobbles derived from Old Red Sandstone conglomerate; many roots; no mottles. Clear change into
Bw	23-51	Reddish brown (5YR5/3) stony loam; medium subangular blocky; friable to firm; moderate to low organic matter; pebbles as above; frequent roots; worm channels with Ap horizon material; no mottles. Clear change into
Bx	51-76	Reddish brown (5YR5/4) stony loam; medium subangular blocky; indurated; many sandstone and quartzite pebbles with some lava pieces, few roots. Clear change into
C	66-117+	Reddish brown (2.5YR4/4) stony sandy clay loam; stone content as above.

The uncultivated semi-natural soils can vary from the iron podzol to the brown podzolic major soil subgroups, the profile characteristics being closely related to the texture, and hence to the base richness, of the parent material. In both of these groups a Bw or Bs horizon and an indurated Bx horizon are present and the soils show signs of podzolisation. The organic surface horizons of the iron podzol are well developed, being about 10 centimetres thick, and an E horizon is present. In the brown podzolic variant, the texture is finer, the organic surface horizons consist mainly of the L and F layers, which, together, are about 5 centimetres thick, and there is a trace of an E horizon.

In the cultivated profile described, the Ap horizon consists of a friable to loose stony loam in which the cobbles derived from the conglomerate are the most striking feature. Throughout the profile the stoniness largely obscures the structural features. The Bw horizon has a brighter red colour than the Ap horizon. The Bx horizon is indurated with embedded rounded pebbles and is very difficult to dig with a spade. An increase in clay content occurs in the C horizon. The thickness of the till in this series is generally less than in the Stonehaven Series.

For additional analytical data see Profiles No. 52. Uras, No.53. Upper Criggie (uncultivated) and No.54. Upper Criggie in Appendix 2.

Balhagarty Series

The Balhagarty Series, a poorly drained noncalcareous gley, covers 21 square kilometres. It is distributed throughout the association in depressions and gently sloping footslopes, forming an intricate pattern with an obvious orientation in a north-east to south-west direction. Uncultivated areas are sometimes found, as on Kenshot Hill where the soil has a moder surface which is dark-coloured but contains only a moderate amount of organic matter. The surface horizons of the cultivated soils are low in organic matter and are greyish brown or dark greyish brown in colour. Some profiles show signs of water-sorting, having 30 centimetres of sandy loam overlying sandy clay loam, the reddish brown colour of the till becoming apparent only in the Cg horizon at 90 to 120 centimetres.

The series is almost all tile-drained but the presence of *Juncus* spp. indicate areas where drainage needs attention.

Profile Description: No.92. Easter Tulloch

Grid Reference	NO772717
Altitude	150 metres
Slope	Level, base of moderate slope
Vegetation	3rd year rotational grass
Drainage	Poor

Horizon	Depth (cm)	
Ap	0-20	Greyish brown (10YR5/2) sandy clay loam; coarse crumb to medium subangular blocky; slightly plastic; moderate to low organic matter; frequent rounded cobbles and some lava stones; frequent fine roots;

		rusty mottles round root holes in base of horizon. sharp change into
Bg1	20-31	Yellowish red (5YR5/6) sandy clay loam; weak prismatic; sticky; low organic matter; frequent to few roots; moist; grey faces on peds and in pockets surrounding cobbles; fine distinct yellowish mottles, with redder colours in interior of peds. Gradual change into
Bg2	31-41	Yellowish red (5YR5/8) clay loam; weak prismatic; plastic; sticky when wet; low organic matter; frequent cobbles; few roots, some dead woody roots, 1 centimetre thick; many coarse prominent yellow mottles. Gradual change into
BCg	41-117+	Reddish brown (2.5YR4/4) clay loam; massive; very sticky; frequent cobbles and decomposed schist stones; few fine roots to 117 centimetres, old dead woody roots, 1 centimetre thick; large worms to 102 centimetres; frequent fine ochreous mottles decreasing to few fine faint at base.

The surface horizon of sandy clay loam has a moderate content of 8-centimetre diameter cobbles together with pieces of lava and, locally, the texture may sometimes be a stony clay loam. The structure is subangular blocky, the consistence slightly plastic, and rusty mottles occur along the root channels. A paler, Ag horizon, marking the region of maximum wetness and gleying, is apparent in uncultivated soils. This horizon is largely absent in cultivated profiles due both to cultivation and to the improvement of drainage by tile drains. Grey gleyed faces occur on the weak prismatic structure of the Bg horizons but ochreous mottles are so frequent as to impart a yellowish red coloration to the overall appearance of the soil. The interior of the peds exhibits shades of reddish brown. There is a slight increase in the clay and silt content and a reduction in the amount of sand in the Bg horizons so that the textural profile is a sandy clay loam in the surface and. Cg horizons and a clay loam in the Bg horizons. The decrease in the frequency of grey and ochreous mottles, and the reddish brown coloration of the Cg horizon, differentiate the profile as a surface-water gley.

For additional analytical data see profiles No. 90. Uras, No.91. Upper Criggie and No.93 Kenshot Hill in Appendix 2.

Forgie Series

The Forgie Series, 1 square kilometre in extent, is the least extensive series of the association and is very poorly drained peaty gley. It is located in depressions, along water courses, and on moorland flushes. A surface horizon very high in organic matter and. a subsoil affected by excessive wetness, are characteristic features of the series.

Profile Description: No.107. Kenshot Hill

Grid Reference	NO785722
Altitude	175 metres
Slope	Gentle
Vegetation	*Nardus stricta*, *Juncus squarrosus*, *Erica tetralix*, *Calluna vulgaris*, .*Narthecium ossifragum*, *Potentilla erecta*, *Eriophorum vaginatum*, *Pedicularis palustris*, *Scabiosa succissa*, *Sphagnum* spp.and mosses
Drainage	Very poor

Horizon	Depth (cm)	
H	0-15	Very dark brown (10YR2/2) spongy fibrous turf; many roots. Sharp change into
Ag	15-31	Pale brown (10YR6/3) stony loam; brown organic staining in top 3 centimetres of horizon; massive; plastic; moderate organic matter; frequent conglomerate-derived cobbles with few lava stones; frequent roots; very wet; many coarse prominent grey mottles. Diffuse change into
Bg	31-51	Light brown (7.5YR6/4) stony sandy clay loam; massive; plastic; frequent conglomerate-derived cobbles with few lava stones; very wet; grey coatings and prominent distinct ochreous mottles. Diffuse change into
Cg	51-117+	Reddish brown (5YR5/3) stony clay loam; massive; plastic; frequent conglomerate-derived cobbles with few lava stones; few live roots to base; many grey mottles and prominent ochreous patches.

The surface horizon is a mor humus containing 46 per cent organic matter and forming a wet rooty turf. Brown organic staining is noticeable in the upper part of the mineral horizon. Structure throughout the profile is massive but close inspection indicates that the grey mottling forms a continuous coating on the faces of coarse prismatic units. Grey colours predominate in the Ag and Bg horizons to depths of between 38 and 50 centimetres, thereafter the inherent red colour of the Old Red Sandstone-derived till can be seen. The Cg horizon is a clay loam, appreciably finer in texture than the overlying horizons. The soil is stony throughout.

Skeletal Soils

Skeletal soils cover about 1 square kilometre and have a shallow A horizon overlying conglomerate rock. Small areas have been separated on the Bervie Brow and on Gourdon Hill.

Strathfinella Association

The Strathfinella Association occurs along the south-eastern side of the Highland Boundary Fault, extending in an intermittent belt from the vicinity of Memus near the western margin of Sheet 57 to north of Stonehaven. It covers an area of 71 square kilometres.

Distribution

On Sheet 57, the main location is on the elevated ridge comprising the hills of Shandford, Tullo, Menmuir and the White and Brown Caterthuns. On Sheet 66/67, Strathfinella Hill and Herscha Hill are the principal localities, but smaller isolated unnamed hills to the north-east and south-east of Strathfinella are included in the association areas. The association also covers the lower western slopes of Carmont Hill and Hill of Megray on Sheet 66/67 together with other areas which are rolling rather than hilly.

The altitudinal range is from about 60 to 300 metres.

Parent Material

The parent material is a till derived primarily from arenaceous strata of the Lower Old Red Sandstone. There is also a small proportion of quartz-schist, quartzite, and felsite. These latter rocks originate in the area north of the fault and have been glacially transported south-eastwards. Under free drainage conditions the till has the characteristic reddish brown colour of the Old Red Sandstone and, with a clay content of between 10 and 15 per cent, a texture of loamy sand or fine sandy loam. Finer textures occur among soils in the wetter locations.

Soils

Four series have been distinguished, of which Strathfinella, a freely drained iron podzol, is the most extensive. Trusta, an iron podzol with imperfect drainage, Ledmore, a noncalcareous gley with poor drainage and Garrold, a peaty podzol with iron pan, all cover much smaller areas.

Strathfinella Series

The Strathfinella Series is the largest of the association, covering 55 square kilometres. The parent material is a sandy loam till of comparatively shallow depth with a moderate stone content of sandstone, Dalradian schist and felsite. It covers convex slopes on areas which, in the main, lie at altitudes of over 150 metres. The soil is a freely drained iron podzol and much of the series is uncultivated dry heath used for sheep pasture.

Profile Description: No.58. Edzell Hill

Grid Reference	NO581703
Altitude	210 metres
Slope	Steep
Vegetation	Heath with *Agrostis* spp., *Descharnpsia flexuosa*, *Anthoxanthuni odoratum*, *Ulex europaeus*, *Calluna vulgaris*, *Hylocomiuin splendens*, *Rhytidiadelphus squarrosus*, *Polytrichum commune*.
Drainage	Free

Horizon	Depth (cm)	
Ah	0-20	Dark reddish brown (5YR3/2) sandy loam; moderate medium crumb; friable; moderate organic matter; frequent to many stones of metamorphic schist and red sandstone with few cobbles; many roots. Sharp change into
Bw	20-33	Dark reddish brown (2.5YR3/4) sandy loam; weak coarse crumb; friable; moderate organic matter; frequent stones as above; frequent fine roots; some mixing of Ah horizon material down fissures and worm holes. Sharp change into
Bx	33-58	Dark reddish brown (2.5YR3/4) loam; weak coarse platy; strongly indurated; low organic matter; fewer stones than above; no roots. Diffuse change into
BC	58-81	Reddish brown (2.5YR4/4) loam; compact, compactness decreasing with depth; frequent stones. Gradual change into
C	81-101+	Reddish brown (5YR5/4) stony loam to coarse sandy loam till.

The Ah horizon, which has at one time been cultivated, is shallow and of sandy loam texture. The Bw horizon has a similar texture and is friable and soft. The amount of organic matter is comparatively high both from tree root decomposition and mixing with the Ah horizon material. An accumulation of organic matter at the base of this horizon is sometimes present. No mottling occurs. The Bx horizon in the profile described has a loam texture with 10 per cent more clay than the Ap horizon; this is unusual for the Bx horizon in which the principal characteristic, together with induration, is coarse texture. A litter layer of 5 to 8 centimetres and an E horizon of about 5 centimetres are found in the undisturbed profiles.

For additional analytical data see profiles No. 55. White Caterthun, No.56. White Caterthun and No.57. Arnbarrow in Appendix 2.

Trusta Series

This series is found on gentle concave slopes. It covers only 8 square kilometres and is an iron podzol with imperfect drainage.

Profile Description: No.72. Lower Finella HillI

Grid Reference	Not known
Altitude	180 metres
Slope	Gentle
Vegetation	Agrostis – Fescue grassland, *Pteridium aquilinum*
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-13	Dark brown (7.5YR3/2) sandy loam; moderate medium crumb; friable; moderate organic matter; many roots; few stones. Clear change into
Bw(g)	13-30	Light reddish brown (5YR6/3) gritty fine sandy loam; weak coarse crumb; friable; moderate organic matter; frequent roots; few small stones; faint ochreous mottling; Sharp change into
Bs	30-51	Strong brown (7.5YR5/6) gritty fine sandy loam; medium subangular blocky; firm; few roots; frequent medium stones of O.R.S. sandstone and quartz-schist. Sharp change into
C	51-66+	Dark reddish brown (5YR3/3) loamy coarse sand; many stones. (This horizon is probably decomposed O.R.S. conglomerate).

The profile is similar to the Strathfinella Series except that it has iron mottling in the B horizon. The Ap horizon is a sandy loam or fine sandy loam, the C horizon a sandy loam. The pH throughout the profile is slightly higher than in the comparable freely drained profile and the percentage base saturation is also higher.

For additional analytical data see profile No.71. Drumtochty in Appendix 2.

Garrold Series

The Garrold Series accounts for only 3 square kilometres or 1 per cent of the association. It is a peaty podzol with iron pan and has been mapped only on the north-facing slope of Strathfinella Hill.

Profile Description: No.75. Strathfinella)

Grid Reference	Not known
Altitude	Not known
Slope	Moderately steep
Vegetation	Heath with *Calluna vulgaris*, *Vaccinium myrtillus*, *Deschampsia flexuosa*, *Erica tetralix*, *Pohlia nutans*, *Dicranum scoparium*, *Campylopus flexuosus*, *Leucobryum glaucum* - 3-4 years after burning
Drainage	Free to imperfect below iron pan

Horizon	Depth (cm)	
FH	0-3	Black slightly fibrous humus; fine subangular blocky; Tending to massive; many roots; very moist. Clear change into
O	5-18	Black (5YR2/1) amorphous peat; coarse prismatic; very firm; many roots, root mat between peds; lens of washed mineral material; moist. Sharp change into
E	18-20	Reddish grey (5YR5/2) to very dark grey (5YR3/1) stony gritty sandy loam; weak fine subangular blocky; frequent fine roots. Gradual change into
E(g)	20-33	Brown (7.5R5/2) to very dark grey (5YR3/1) stony sandy loam; medium subangular blocky to massive; fairly firm; few to frequent roots; irregular blotching due to areas of high organic matter; moist. Sharp change into
Bf	33	Thin weak discontinuous iron pan.
Bs	33-74	Reddish brown (5YR4/5) loam; fine to medium subangular blocky; friable; low organic matter; subangular schist stones; few roots; moist. Gradual change into
Bx	74-99	Reddish brown (5YR4/3) stony gritty sandy loam; medium subangular blocky to coarse platy; moderately indurated; few roots; occasional iron staining in old root channels; moist. Gradual change into
C1	99-114	Reddish brown (5YR4/3) stony gritty sandy loam; massive; compact; moist. Gradual change into
C2	114+	Reddish brown (5YR4/3) stony gritty sandy loam; massive; compact; moist.

The E horizon is a layer of mineral wash from upper slopes and may be absent in other profiles.

Ledmore Series

The poorly drained Ledmore Series is a noncalcareous gley. It is of minor extent, covering only 5 square kilometres, and the largest area is situated some 3 kilometres north-east of Strathfinella Hill on gentle concave slopes. It is developed on a sandy clay loam or clay loam till derived from sandstone with some conglomerate and containing schist and quartzite; the schist stones are frequently soft and decomposed.

Profile Description: No.94. Mains of Glenfarquhar

Grid Reference	NO718808
Altitude	160 metres
Slope	Gentle
Vegetation	Rotational grass
Drainage	Poor

Horizon	Depth (cm)	
Ap	0-25	Very dark greyish brown (10YR3/2) loam; weak coarse crumb; very friable; moderate organic matter; quartzite and schist stones up to about 8 centimetres diameter; frequent roots; frequent worms; moist. Sharp change into
Eg	23-36	Pale brown (10YR6/3) loam; coarse prismatic breaking into medium angular blocky; low organic matter; frequent stones, hard and soft schist, small pieces of rotten sandstone with few conglomerate cobbles; frequent roots in upper part, few in lower; moist; grey coatings on prism faces and stones; faint grey and rusty mottles, few rusty mottles from decomposing stones. Clear change into
Bg	36-64	Brown to strong brown (7.5YR5/4 to 5/6) clay loam; coarse prismatic; low organic matter; large and small, hard and soft schist stones, few to frequent sandstones and few conglomerate cobbles; few roots to 90 centimetres; moist; coarse prominent pinkish grey (7.5YR7/2) and reddish yellow (7.5YR6/8) mottles with grey coatings on prism faces and stones. Diffuse change into
Cg	64-102+ cm	Reddish brown (5YR4/3) clay loam till; massive; frequent stones; no live roots; a few vertical grey channels; wet; prominent ochreous mottles decreasing with depth.

The Ap horizon has a coarse crumb structure and a moderate to low organic matter content. There is a distinct pale-coloured Eg horizon with an angular blocky structure which passes into a B(g) horizon with a marked coarse prismatic structure, and a noticeable amount of grey and ochreous mottling; there is also a rise in the clay content. The reddish brown colour of the Cg horizon is inherited from the high proportion of sandstone contributing to the till.

For additional analytical data see profile No.95. White Caterthun in Appendix 2.

Strichen Association

The Strichen Association is extensive covering 379 square kilometres, predominantly along the southern edge of the Grampians and Grampian foothills, just to the north of the Highland Boundary Fault. Occurring throughout Sheet 66/67 (Banchory and Stonehaven) and in the north-west corner of Sheet 57 (Forfar), the association encompasses a suite of major soil subgroups. The soils are developed on till derived from a mixture of acid schists with textures ranging from sandy loam to sandy clay loam.

Distribution

The association is found along the southern edge of the Grampians from about 3 kilometres west of Stonehaven on Sheet 66/67 to the north-west corner of Sheet 57. Its northern margin extends from the Cowie Water west-south-westwards to Sturdy Hill, 8 kilometres due north of Edzell and thence west-north-westwards along the north side of Glen Esk through Hill of Fingray to the western edge of Sheet 66/67, near the Hill of Saughs. Other small areas occur further north on Sheet 66/67 in the hill country south of the Dee valley. An area of about 3 square kilometres is situated to the south of Dinnet, another of about 19 square kilometres lies between the Dee and the Water of Feugh, while a third extends on the east side of the Feugh as far as Tilgahillie Castle. The altitude range of these soils is considerable - from between 120 and 150 metres along the Highland edge to nearly 760 metres on the highest hilltop.

Parent Material

The soils are developed on a till derived from mixed acid schists, with a textural range from sandy loam to sandy clay loam. The till is very uniform in character over the whole southern Grampian region. There are, however, variations which enable the regional till to be separated into two broad subgroups. The first, derived from flaggy quartz-schists and quartz-mica-schists with occasional bands of argillaceous schists, is characterised by a distinct fine sandy feel and contains over 15 to 20 per cent of international-grade silt (2-20μm). This material is found in a belt roughly 3 kilometres wide along the Highland edge from Stonehaven to Glen Esk, and over all the hill country on the south side of Glen Esk. The other till, derived from rather coarser quartz-schists and quartz-mica-schists, is developed mainly on the northern side of Glen Esk. The field texture is a sandy loam or coarse sandy loam, and mechanical analyses usually show that less than 15 per cent of International-grade silt is present.

On the level at which soil series are distinguished, local variations in the till composition become significant. Along the lower south-facing slopes of the Highland edge the till may contain Cambro-Ordovician rocks, ranging from shales to siliceous limestones. The slight improvement in base status conferred by this admixture, together with the favourable aspect, has led to the development of brown forest soils, rather than podzols. Similarly, in the Tarfside area on the north side of Glen Esk, in an area near the Clattering Bridge, and locally along the south side of the Dee valley, small outcrops of calc-silicate rock or hornblende-schist among the acid schists have contributed towards a slight improvement in base status of the till. Where the areas

involved are significant and the soils developed are freely drained, they have also been included within the subgroup of brown forest soils. Along the northern margin of the main Grampian schist area, and in most of the Deeside localities, there is also local contamination of the till with granitic material. This is recognisable in the field by the development of unusually strong thin iron pan soils and, petrographically, by an increase in the proportion of potash feldspars found in the fine sand fraction. Good exposures illustrating this feature can be seen on the north side of Glen Esk, in gullies on the south-facing slope of Hill of Fingray, and in forest road sections along the Cowie Water, west of Stonehaven. In general, the thickness of the till is closely related to the relief. In the valley bottoms and on the lower slopes there are thick deposits of till, but on the upper slopes the thickness tails out rapidly, and at 460 metres, 40 centimetres is a generous average. Above this height there is generally only a thin veneer of till, with skeletal subalpine soils, rock outcrops, or hill peat.

Soils

Seven series are represented together with closely related skeletal soils. Fungarth and Baikies Series are freely and imperfectly drained brown forest soils respectively, Strichen is a freely drained iron podzol and Gaerlie is a peaty podzol which is generally freely drained. Three gley series have been distinguished. Anniegathel is a poorly drained noncalcareous gley, while Auquhollie and Hythie are peaty gleys, the former poorly and the latter very poorly drained.

Along the Highland edge, the soils of the association show a marked altitudinal zonation. On the highest hilltops where the hill peat is eroded, alpine and subalpine soils are developed on the shattered rock debris. These have generally been included on the map within the category of skeletal soils. The greater part of the hilltops; and upper hillslopes are covered by hill peat, the formation of which, according to Durno and Romans (1969), began about 7500 years ago at the Boreal-Atlantic Transition. The peat is now much eroded and gullied, particularly on the hill summits and around the lower margins. Peaty podzols are extensively developed in a band 105 to 120 metres wide below the hill peat on the middle and upper slopes where the humic E horizons have also been extensively eroded, and in addition, they have been subjected to regular rotational heather burning for many years. The peaty podzols merge into iron podzols on the middle and lower hillslopes. Because of the extensive destruction of E horizons that has taken place, this boundary is not very distinct. Brown forest soils are found in discontinuous patches along the southern edge of the Grampians, marking the presumed site of former birch - rowan woodlands. The height at which any particular soil within this sequence occurs shows a gradual but steady rise from east to west. On Sheet 66/67, the lower limit of the hill peat is found at about 165 metres; it rises gradually to about 460 metres at the western edge of Sheet 57. Similarly, the lower limit of the peaty podzols drops below 165 metres in the east and rises to around 340 metres in the west; a short distance beyond the western margins of this district, in lower Glen Isla, it is found above 385 metres. The brown forest soils, where distinguished, range up to about 120 metres in the east and 225 metres in the west.

All the soil series within the podzolic catena formed on the acid schist till can be assumed to have possessed mor humus H horizons under semi-natural conditions. In the gley section of the catena, the Anniegathel Series includes uncultivated soils

with surface mor humus L, F and H layers up to about 15 centimetres thick, and soils with a cultivated surface horizon. The soil profile below the surface layers has rusty and grey mottled horizons resulting from intermittent oxidation and reduction, due to a fluctuating soil water-table in the upper half of the profile. The Hythie Series includes the very poorly drained peaty gleys which, in the semi-natural state, have moderately thick peaty O horizons overlying a wet, blue-grey, permanently anaerobic subsoil. The Auquhollie Series has been separated to include an intermediate category of poorly drained peaty gleys.

Fungarth Series

This series consists of freely drained brown forest soils, with mull surface horizons. It covers an area of 22 square kilometres and the distribution is divided almost equally between south Deeside and the slopes of the Highland boundary edge.

In Deeside, the series has been mapped between 150 and 385 metres on the hills around lower Glen Tanar, and from about 75 to 270 metres between Finzean and Tilgahillie Castle. Along the Highland edge, it is found on the lower south-facing slopes of the Grampians, immediately north of the Highland Boundary Fault. In the east, a strip 4 kilometres long is situated 1 kilometre north of Fetteresso Castle and rises from 60 to 125 metres. The next area is found about 16 kilometres to the south-west, where it extends from Glensaugh to the mouth of Glen Esk, with an altitude range of 105 to 240 metres. Thereafter, from Glen Esk to Glen Ogil, there are discontinuous patches of the freely drained Fungarth Series interspersed with rather larger areas of the imperfectly drained Baikies Series. Profiles in this region, tend to have weak brown podzolic, rather than iron podzolic profiles. These westerly localities lie mostly between 150 and 225 metres.

Where brown podzolic profiles have developed, it is usually found that there has been some slight local enrichment of the till with more basic material. The Deeside localities, particularly the westerly one around Glen Tanar, can be closely correlated with known outcrops of calc-silicate rock, formerly worked to produce low-grade agricultural lime. Occasional basic erratics, derived from epidiorites and hornblende-schist which outcrop to the west of Sheet 66/67, occur in the till along the Dee valley, but their contribution of basic material to the till is difficult to assess.

Along the southern edge of the Grampians, the development pattern is closely related to the outcrops of Cambro-Ordovician rocks which occur along the Highland Boundary Fault, and whose influence on the till can sometimes be established locally. The till along the Highland edge also contains a small proportion of Lower Old Red Sandstone material.

Profile Description: No.13. Tillyarblet

Grid Reference	NO520673
Altitude	240 metres
Slope	Moderately steep
Vegetation	Rough grassland with *Anthoxanthum odoratum*, *Deschampsia flexuosa*, *Calluna vulgaris*, *Vaccinium myrtillus*, *Potentilla erecta* and scattered gorse.
Drainage	Free

Horizon	Depth (cm)	
LF	0-5	Very dark brown (10YR2/2); few stones; many fine roots; no worms; moist. Clear change into
A	5-18	Dark brown (10YR3/3) fine sandy loam; weak medium subangular blocky breaking easily into fine subangular blocky; few stones; many fine roots; no worms; moist. Clear change into
AB	18-28	Brown (10YR4/3) fine sandy loam; fine crumb; frequent quartz-schist stones; many roots; no worms; moist; no mottles, but few rusty fragments of schist. Clear change into
Bw1	28-48	Dark yellowish brown (10YR4/4) fine sandy loam; crumb; friable; porous; frequent small angular pieces of quartz-schist; fine roots present; no worms; moist; few fine faint rusty mottles. Gradual change into
Bw2	48-64	Olive-brown to light olive-brown (2.5Y4/4 to 5/4) fine sandy loam; otherwise as above. Sharp change into
Bx	64-76	Light olive-brown (2.5Y5/4) fine sandy loam; weak platy; indurated; many stones, angular pieces of quartz-schist with long axes lying roughly parallel to slope; no roots; few rusty mottles.
R	76+	Shattered quartz-schist rock

The main features of this profile are the thickness of the combined A and AB horizons, 23 centimetres, and the thickness of the friable Bw1 horizon, 20 centimetres. The profile differs from the majority of those of the Strichen Series in being less leached and in providing a deeper rooting medium above the indurated layer, at which root penetration stops. The maintenance of this profile in the semi-natural state, under present day climatic conditions, has apparently been dependent on the survival of birch woodland.

In Deeside, most of the soils of this series are either under plantation, scrub birchwood, or rough grazing with bracken. A minor proportion is under arable cultivation. By contrast, along the Highland edge with its favourable southerly aspect over 90 per cent of the series is at present under cultivation.

For additional analytical data see profile No.12. Corsedardar Wood in Appendix 2.

Baikies Series

As originally defined and described (Soil Survey Board Report No. 8, 1955) this series contained imperfectly drained soils of the Strichen Association whose semi-natural profile was an iron podzol in which the B horizon was gleyed. Subsequently (Glentworth and Muir, l963), the definition was extended to include imperfectly drained brown forest soils which have weakly developed brown podzolic profiles. In the area covered by sheets 66/67 and 57, the series covers 16 square kilometres and both profile types are encountered. It is developed only to a very limited extent in Deeside, the greater part occurring along the Highland edge from Stonehaven to the western margin of Sheet 57. There are other limited areas in Glen Esk and Glen Lethnot.

Profile Description: No.29. Milton of Tarfside

Grid Reference	NO4640081300
Altitude	270 metres
Slope	Gentle
Vegetation	*Calluna vulgaris*, *Erica tetralix*, *Erica cinerea*, *Nardus stricta*, *Juncus sguarrosus*, *Potentilla erecta* and mosses
Drainage	Imperfect

Horizon	Depth (cm)	
H	0-8	Black mor humus, lower part slightly mineralised; many roots. Sharp change into
Eh	8-13	Very dark brown (10YR2/2) drying to dark greyish brown (10YR4/2), speckled with white quartz grains, humose sandy loam; weak platy to subangular blocky; many small and medium schist stones; frequent roots; no worms; moist; no mottles. Clear change into
AB(g)	13-23	Pale yellow (2.5Y7/4) with darker humus-stained patches, loam to fine sandy loam; weak subangular blocky; frequent small and medium schist stones; frequent to many roots; no worms; moist; fine distinct rusty mottles. Clear change into
Bs(g)1	23-41	Patchy stained yellowish brown and yellow (10YR5/4) and 7/8) fine sandy loan; crumb; frequent medium and small schist stones; many roots in upper part, frequent in lower: no worms; moist; few to frequent faint rusty mottles. Gradual change into
Bs(g)2	41-48	Yellowish brown and yellow (10YR5/4 and 7/8) fine sandy loam; subanglar blocky in upper part becoming more compact in lower; frequent stones; frequent roots; no worms; moist; faint grey and rusty mottles. Sharp change into
B(x)(g)	48-74	Light olive-brown and pale yellow (2.5Y5/4 and 7/4) fine sandy loam; slightly indurated, upper 10-13 centimetres comprising zone of maximum induration; frequent stones, mostly large, medium and small

		subangular to rounded schists; few roots penetrate soft patches; no worms; moist; few grey and rusty mottles present in the lower part. Gradual change into
C(g)	74-99+	Light yellowish brown (2.5Y6/4) fine sandy loam till; weak subangular blocky; frequent stones; few roots in the upper part; no worms; moist; few grey and rusty mottles in the upper 15 centimetres, mottles becoming more frequent and prominent below.

The series occurs in association with the Fungarth and Strichen Series. The upper horizons of soils in the semi-natural state show various degrees of podzolisation as evinced by the development of the Eh horizon. The Bs(g) horizons are invariably of a yellowish brown colour typical of podzol B horizons, and have iron mottling present in only a moderate degree. Mottling, in which grey and ochreous colours occur, increases with depth. Some degree of induration is found at about 45 centimetres. The greater part of the series is under arable cultivation and occupies positions along the lower south-east-facing slopes of the Grampian edge. It forms very good arable land with few limitations.

For additional analytical data see profile No.30. Anniegathel in Appendix 2.

Strichen Series

The soils of this series are found on the middle and lower slopes of the southern Grampian Hills and also, to a limited extent, on the hilltops of the Grampian foothills along the south side of the Dee valley. They are freely drained iron podzols and their total area extends to about 105 square kilometres. The altitudinal range of the series extends from about 105 metres near Stonehaven to over 340 metres in the west, but, as both the upper and lower limits rise gradually from east to west, the zonal belt does not in fact extend over a vertical range of more than 120 to 180 metres at any particular locality. The parent material range of this series closely parallels that of the Gaerlie Series, with perhaps a somewhat greater predominance of the fine sandy loam till. Discontinuous thin iron pans are occasionally developed in these soils, but they are very uncommon.

Profile Description: No.61. Milton of Tarfside

Grid Reference	NO4650081400
Altitude	280 metres
Slore	Gentle
Vegetation	*Calluna vulgaris*, *Erica cinerea*, *Potentilla erecta*, *Trientalis europea*, *Deschampsia flexuosa*
Drainage	Free

Horizon	Depth (cm)	
LF	Trace	Surface mor humus.
Ah	0-5	Very dark brown (10YR2/2) humose sandy loam; subanular blocky to crumb; few schist stones present; frequent roots; moist. Sharp change into
E	5-13	Very dark brown (10YR2/2) speckled with white quartz

		grains, organic sandy loam; massive, breaking down to weak subangular blocky; few large angular schist stones; frequent roots; no worms; moist; no mottles. Sharp wavy change into
Bs	13-33	Yellowish brown and yellow (10YR5/6 and 7/8) fine sandy loam; crumb; friable; frequent stones, mainly small and medium acid schists; frequent roots; no worms; moist; no mottles. Sharp irregular change into
B(s)	33-43	Light olive-brown and yellow (2.5Y5/4 and 7/8) fine sandy loam; subangular blocky; frequent large, medium and small schist stones; few roots; no worms; moist; few localised rusty mottles. Sharp change into
Bx	43-99	Light yellowish brown to pale yellow (2.5Y6/4 to 7/4) fine sandy loam; moderately indurated; many stones; no roots; moist; few rusty mottles. Gradual change into
C	99+	Pale yellow (2.5Y7/4) fine sandy loam till; massive, breaking down to weak subangular blocky; many stones; no roots; moist; few grey and rusty mottles present.

The LF horizon is sometimes absent as a result of rotational heather burning. The E horizon is very dark brown when moist but dries out showing bleached sand grains and a grey colour. The friable yellowish brown Bs horizon is conspicuous but changes abruptly, often at a comparatively shallow depth, into the indurated Bx horizon.

For additional analytical data see profiles No. 59. Anniegathel, No. 60. Glensaugh and No: 62. Milton in Appendix 2.

Gaerlie Series

The Gaerlie Series, a peaty podzol covering 147 square kilometres, is the most extensive within the association. It is generally freely drained, although where an iron pan has developed there may be some drainage impedance in the E horizon. The parent material of this series varies from a fine sandy loam till on the south side of Glen Esk and along many of the hills between Glen Esk and Stonehaven, to a sandy loam or, locally, a coarse sandy loam to the north side of Glen Esk. South of Glen Esk, the thin iron pan is occasionally developed but the Bf horizon usually consists of a humus accumulation ranging from a slightly cemented humus pan up to 3 centimetres thick to a layer of humose fine sandy loam with strong crumb structure. On the coarser material north of Glen Esk, and also on the finer-textured till occurring between Glen Esk and Stonehaven, the normal thin iron pan underlying a gleyed E horizon is more commonly found. This pan becomes noticeably more strongly developed as the boundary is approached between the schist-derived till of the Strichen Association and the granite-derived till of the Countesswells Association.

The profile described below has no iron pan and is characteristic of the country south of Glen Esk.

Profile Description: No. 76. Clash of Wirren

Grid Reference	NO487753
Altitude	412 metres
Slope	Moderate
Vegetation	*Calluna vulgaris*, with mosses, mainly *Hypnum cupressiforme* and *Plagiothecium undulatum*
Drainage Class	Free

Horizon	Depth (cm)	
L	0-1	Heather litter
F	1-2	Dark reddish brown (5YR2/2) fibrous raw humus; moist. Sharp change into
O	2-15	Dark reddish brown (5YR2/2) fibrous peat; compact; massive. Sharp change into
Eh	15-20	Very dark grey (10YR3/1) humose fine sandy loam; compact; medium to coarse subangular blocky breaking to fine subangular blocky; quartz-schist stones up to 10 centimetres diameter; frequent roots; no worms; moist; no mottles; evidence of slight humus pan at base; Sharp change into
Bsh	20-30	Dark brown (10YR3/3) fine sandy loam; medium subangular blocky breakling to fine subangular blocky; soft; many angular quartz-schist stones of varying sizes; frequent roots; no worms; moist; some variegated humus staining. Gradual change into
Bs1	30-51	Dark yellowish brown (10YR4/4) fine sandy loam; medium to coarse subangular blocky breaking to fine subangular blocky; soft; frequent quartz-schist stones; frequent roots; moist; no mottling. Sharp change into
Bs2	51-64	Yellowish brown (10YR5/6) fine sandy loam; medium angular to subangular blocky breaking to fine subangular blocky; soft; few angular and frequent subangular to rounded stones up to 10 centimetres diameter; occasional roots; moist; no mottling Sharp change into
C	64-112	Yellowish brown (10YR5/6) becoming light yellowish brown (2.5Y6/4) below102 centimetres fine sandy loam; weak coarse subangular blocky with tendency to platy between 64 and 89 centimetres and massive below; moderate stone content up to 10 centimetres diameter but becomes stonier with larger stones up to 20 centimetres diameter below 102 centimetres depth; occasional roots in upper part of horizon; moist; no mottling

The thickness of peaty humus forming the L and F horizon may vary locally from 0 to 25 centimetres, but is frequently less than 8 centimetres.

The profile below describes a variant of the Gaerlie Series which has an iron pan.

Profile Description: Glensaugh (No analytical data)

Grid Reference	Not known
Altitude	340 metres
Slope	Moderate
Vegetation	*Calluna vulgaris* abundant and dominant
Drainage	Poor above pan, free below

Horizon	Depth (cm)	
LF	0-4	Dark brown (10YR3/3) litter and fibrous raw humus
H	4-25	Black (10YR2/1) greasy humus
Eg	25-33	Dark grey (N4/0) stony sandy loam becoming greenish grey (5G5/l) above the iron pan; subangular blocky in upper part, massive below; frequent small stones; frequent roots. Sharp change into
Bf	at 33	Discontinuous thin iron pan
Bs	33-58	Yellowish brown (10YR5/6) fine sandy loam; subangular blocky to crumb; friable: frequent stones. Sharp change into
Bx	58+	Yellowish brown (10YR5/4) stony sandy loam; compact and indurated above, induration decreasing gradually with depth.

This profile with thin iron pan is characteristic of the country between Glen Esk and Stonehaven. With very limited exceptions, the soils of this series are generally found above the limits of arable cultivation, their use being restricted to the seasonal grazing of sheep, and to sporting purposes such as grouse and deer moors.

For additional analytical data see profile No.77. Gaerlie in Appendix 2.

At about 460 metres, the parent material usually thins out sharply and the Bs horizon is several centimetres thick, with iron-stained fine sandy loam penetrating the cracks in the underlying schist rock. Higher up the hill, under the peat hags, the whole profile, which usually includes a gleyed Eg horizon underlain by a thin iron pan, is telescoped into about 15 centimetres of till material and soft rotten schist. The vegetation at this altitude may include additional species, such as *Empetrum nigrum*, *Juncus squarrosus*, *Trichophorum cespitosum*, and mosses, with *Rubus chamaemorus* spreading over the deeper peat.

At about 610 metres, where site conditions are favourable and the hill peat has been eroded, there is a gradual transition from peaty podzol to subalpine soil. The transition is complete at about 760 metres but can only be observed at a few localities on the extreme western edge of Sheet 66/67 where an unusual depth of till has survived the effects of periglacial erosion on the high plateau around the head of Glenmark.

Anniegathel Series

The soils of the Anniegathel Series, extending over 42 square kilometres, are noncalcareous gleys and make up one of the more extensive, although minor series of the Strichen Association. Most areas of the series are located on drainage-receiving sites situated on the lower hill slopes around Glen Esk, with other smaller areas distributed between Glen Lethnot, the slopes along the Highland edge, and the smaller glens. By virtue of their topographic situation, these soils are commonly associated with the freely drained iron podzols rather than peaty podzols, but this relationship is not invariable.

Profile Description: No.96. Milton of Tarfside

Grid Reference	NO467813
Altitude	270 metres
Slope	Gentle
Vegetation	*Calluna vulgaris*, *Erica cinerea*, *Erica tetralix*, *Empetrum nigrum*, *Nardus stricta*, *Molinea caerulea*, *Potentilla erecta*, *Orchis ericetorum*, mosses.
Drainage	Poor

Horizon	Depth (cm)	
H1	0-8	Very dark brown (10YR2/2) to black (10YR2/1) mor humus with frequent roots
H2	8-10	Black (5Y2/1 slightly mineralised greasy mor humus
Ahg	10-15	Black (5Y2/2) humose loamy fine sand; weak subangular blocky; few stones; frequent roots; no worms; moist. Sharp change into
Eg	15-33	Pale olive (5Y6/3) fine sandy loam, subangular blocky; many stones, mostly acid schist of all sizes with a few granite boulders; many roots; no worms; moist; many distinct rusty mottles generally associated with rotten stones. Sharp change into
Bg	33-86 cm	Pale yellow (5Y7/3) above, becoming pale yellow to pale olive (5Y6/3) below, fine sandy loam; coarse prismatic breaking down to coarse subangular blocky; many stones; frequent roots in upper part, becoming few below; no worms; moist; rusty patches associated with rotten pieces of stone scattered throughout. Clear change into
Cg	86-96+	Pale olive (5Y6/4) and light grey (10YR7/1) fine sandy clay loam; weak prismatic; frequent to many stones; live roots absent, some dead ones preserved within vertical iron-stained tubes; rusty mottles otherwise absent from this horizon.

The subsurface horizons have grey, pale olive or pale yellow colours with ochreous mottling and a tendency to a weak prismatic structure. No iron concentrations or indurated horizons occur.

The soil usually occurs on footslopes, receiving excess run-off from the large surrounding catchment areas and subject to a fluctuating ground-water table. The greater part of the series is in moorland used for grazing. In the uncultivated land, there has frequently been some attempt to drain the soils by open ditches. Where the soil is used for arable agriculture, a tile drainage system is necessary for successful improvement and cultivation. Ideally, drainage improvement is best effected by removing surplus ground-water by deep trap drains on the uphill side of the affected area.

For additional analytical data see profiles No.97. Glensaugh, No.98. East Town and No.99. Anniegathel in Appendix 2.

Auquhollie Series

The soils included within the Auquhollie Series are of very limited extent (3 square kilometres) and are restricted mainly to Glen Lethnot and to an area lying 5 to 6 kilometres north-west of Stonehaven. The profile has thicker H or O horizons than is usual in the Anniegathel Series, and a poorly drained subsoil, distinct from the anaerobic, very poorly drained subsoil of the Hythie Series. The soils found in Glen Lethnot are considered to be examples of a type of soil more commonly found in the west and south-west of Scotland. They are essentially poorly drained ground-water gleys which have developed deep peaty surface horizons. By contrast, the soils found near Stonehaven between the old Roman camp of Raedykes and Craggiecat Hill are developed on the cut-over parts of former peat mosses. The profile includes the basal layer of the peat overlying a dull grey subsoil whose formerly anaerobic upper horizons now possess the prismatic structure and diffuse rusty coloration symptomatic of the fluctuating water-table of a poorly drained gley. Some of the reclaimed peat bog soils adjoin the boundary with the Countesswells Association and in consequence the soil parent material contains a proportion of granitic gneiss in addition to acid schists.

Profile Description: No.103. Clash of Wirren

Grid Reference	NO488747
Altitude	330 metres
Slope	Moderate
Vegetation	*Calluna vulgaris*, *Juncus effusus*, *Juncus squarrosus*, *Polytrichum commune*, *Empetrum nigrum*, *Sphagnum recurvum*, *Pleuroziurn schreberi*, *Sphagnum nemoreum*
Drainage	Poor

Horizon	Depth (cm)	
F	0-5	Dark reddish brown (5YR3/2) partly decomposed humus; loose; many fine roots very moist. Clear change into
H	5-20	Black to dark reddish brown (5YR2/1 to 3/2) amorphous humus with birch bark and old cord root remains; coarse subangular blocky to massive; fairly firm; frequent fine roots; very moist. Sharp irregular change into
A(g)	20-25	Dark brown (7.5YR4/2) sandy loam; medium to coarse

		subangular blocky; slightly plastic; frequent small to medium platy schist stones; many dead cord roots, few live; moist. Clear change into
E(g)	25-36	Pale brown (10YR6/3) with dark brown (7.5YR3/2) humus staining on structure faces, sandy loam; medium to coarse subangular blocky; friable; frequent small platy fragments of schist, many strongly weathered, few hard vein quartz stones; frequent dead roots; very moist. Clear change into
Bg1	36-56	Greyish brown (2.5Y5/2) sandy loam; coarse subangular blocky tending to medium. prismatic; frequent subangular fragments of schist in different stages of weathering; frequent dead roots; very moist; frequent rusty staining along old root channels. Clear change into
Bg2	56-69	Olive-grey (5Y5/2) and dark greyish brown (2.5Y4/2) with dark brown (7.5YR3/2) root channels, stony sandy loam; friable, looser than horizon above; many dead cord roots and frequent old root channels. Sharp change into
Bg3		Greenish grey (5GY5/1) with few dark brown (7.5YR4/4) mottles, sandy loam; coarse subangular blocky to massive; frequent subangular schist stones, less weathered than in horizon above; frequent old root channels; very moist. Gradual change into
Cg	81-173+	Greenish grey (5GY5/1) sandy clay loam; massive with tendency to prismatic; coarser-textured water-bearing layer at 96-l09 centimetres; frequent schist stones up to 10 centimetres diameter; frequent old root channels at top of horizon, rare at 122 centimetres; very moist; no mottles.

The soil is extremely low in exchangeable calcium and magnesium; acetic soluble phosphate is also very low. The pH rises from 4.0 at the surface to 4.7 at 1.5 metres.

Hythie Series

With a total area of 5 square kilometres, this series is the smallest within the Strichen Association. It occupies small patches in concave sites scattered throughout the valleys and lower hill slopes of the Grampians. The soils are very poorly drained peaty gleys, with peaty surface layers and grey structureless anaerobic subsoil horizons. Many of the soils of this series are situated in small channels which drain areas of the Gaerlie Series (peaty podzols) and pass through areas of the Strichen Series (iron podzols).

Profile Description: No.109. Milton of Tarfside

Grid Reference	NO464813
Altitude	270 metres
S lope	Gentle
Vegetation	*Calluna vularis*, *Erica tetralix*, *Juncus effusus*, *Empetrum nigrum* with patches of *Nardus stricta* and *Deschampsia flexuosa*, *Polytrichum* sp., *Sphagnum* sp.
Drainage	Very poor

Horizon	Depth (cm)	
LF	0-5	Turf layer
O	5-26	Black (5Y2/2) peaty humus; weak subangular blocky; many roots; moist. Sharp change into
Ah	26-36	Very dark brown (10YR2/2) humose sandy loam; weak subangular blocky; many roots; moist. Sharp change into
Eg	36-38	Light olive-grey (5Y6/2) sandy loam; massive; small pieces of decomposing schists, with few pieces of hard quartz-schist; frequent roots; no worms; very moist; few medium distinct mottles. Sharp change into
Bg	38-94	Light grey (10YR7/1) fine sandy loam; massive; frequent stones including large and small pieces of acid schist, the smaller stones generally completely rotten; frequent live roots present in the upper part, only dead roots below; no worms; moist; rusty iron-staining surrounds the root channels. Sharp change into
Cg	94-107	Grey (10YR6/1) and pale olive (5Y6/3) fine sandy loam; massive; stones as above and frequently decomposed; no roots; moist; rusty mottles associated with fragments of rotten schist

In the above profile the values for exchangeable calcium are high in the organic surface horizons, low in the Eg and Bg and moderate in the Cg horizon. The pH values are 4.3 and 5.3 in the organic horizons and rise to 6.4 in the Cg horizon. Acetic soluble phosphate is high in the Bg horizons and low in the lower part of the Ah and Cg. Results of analyses indicate that plants growing in situations of poor and very poor drainage have higher amounts of the trace elements cobalt, copper, manganese, molybdenum and nickel, and also higher contents of phosphorus.

For additional analytical data see profile No.110. East Town in Appendix 2.

Skeletal Soils

Skeletal soils cover a total of 37 square kilometres and occur generally at altitudes above 450 metres on the Grampians and on upper parts of the Grampian foothills. The bare hilltops frequently carry a patchy stunted vegetation of *Calluna vulgaris*, *Vaccinium myrtillus*, *Empetruri nigrum*, mosses and lichens overlying a profile of the type:

0-5 cm	Gritty fibrous humus.
5-30 cm	Frost-shattered rock debris with interstitial gritty humus.
30-40 cm	Dark brown to yellowish brown humus-stained sandy loam.
40-75 cm	Yellowish brown sandy loam till over schistose rock at 75 cm+

Tarves Association

The Tarves Association, one of the most extensive in Aberdeenshire, is confined in this area to the Dee valley, west of Durris and the valley of the Feugh. It covers 42 square kilometres. Towards the valley bottoms, it is bounded by soils of the Dinnet and Corby Associations on the alluvial flats of the River Dee, and, at the higher elevations on the south side of the river, by the Countessells and Strichen Associations.

Distribution

The major area lies between Banchory and Kincardine o'Neil on both sides of the Dee, and a second fairly extensive area is found on the Glentanar Estate on the south side of the river. Other minor areas occur north-west of Aboyne and on the farms of Nether Tillygarmond and Tillylair in the Strachan basin. The lower altitudinal limit is around 60 metres in the Banchory area south of the Dee, and the upper is 490 metres on Black Craig, Glentanar.

Parent Material

The parent material is a till derived from acid and basic rocks with a preponderance of acid rocks. In the Dee valley till there is a proportion of calc-silicate rock, although with its yellowish brown colour, and texture, generally a sandy loam with deeper pockets of sandy clay loam, it is similar to the typical Tarves till. Much of it is shallow and stony and there are frequent rock outcrops. Where the outcrops are of calc-silicate rocks, the soils belong to the Deecastle rather than the Tarves Association.

Soils

Four major soil subgroups are represented in the area - brown forest soils (Tarves and Thistlyhill Series), iron podzols (Tillypronie Series), noncalcareous gleys (Pitmedden Series) and peaty gleys (Pettymuck Series). Peaty podzols have not been mapped although very small areas of these soils have been observed.

The freely drained soils are developed on a sandy loam till whilst the soils of the other drainage classes are developed on both sandy loam and sandy clay loam tills.

Tarves Series

This is the dominant series, covering 34 square kilometres and occurring over the full range of altitude. The terrain is rather rocky, often with very shallow till in which there are frequent boulders. As a consequence, the greater extent is uncultivated and. the land is used mainly for grazing and forestry.

The series comprises freely drained brown forest soils.

Profile Description: No.14. Balnacraig

Grid Reference	NO583983
Altitude	180 metres
Slope	Moderate
Vegetation	Felled mixed woodland replanted in Scots pine, with *Agrostis tenuis*, *Festuca rubra*, *Anthoxanthum odoratum*, *Veronica chamaedrys*, *Galium saxatile*, *Viola riviniana*, *Campanula rotundifolia*, *Pseudoscleropodium purum*, *Rhytidiadelphus squarrosus*
Drainage	Free

Horizon	Depth (cm)	
A	0-15	Very dark greyish brown (10YR3/2) fine sandy loam; coarse crumb; friable; frequent stones, mostly angular and subangular pieces of intermediate to basic gneiss; many roots; worms present; moist; no mottles. Sharp irregular change into
Bw	15-28	Dark yellowish brown (10YR4/4) with irregular patches of dark brown (10YR3/3 to 4/3) and yellowish brown (10YR5/6) fine sandy loam; fine subangular blocky to fine crumb; frequent stones, commonly 5 to 3 centimetres diameter, with few larger; roots frequent; few worms; moist; no mottles. Sharp change into
Bx	28-36	Brown to yellowish brown (10YR5/3 to 5/4) with dark brown (10YR3/3) humus staining, fine sandy loam to loam; strong medium to coarse angular to subangular blocky; strongly indurated; frequent stones up to 10 centimetres diameter in size; locally frequent roots between peds; no worms; moist; some iron and humus staining; horizon not continuous. Gradual to clear change into
B(x)	36-51	Yellowish brown (10YR5/4) sandy loam; coarse subangular blocky to coarse platy; slightly to moderately indurated; few roots followinq softer patches; no worms; moist; few local rusty mottles. Gradual irregular change into
BC	51-76	Brown (10YR5/3) sandy loam; massive; rather compact; many stones; clay skins lining fine pores which may be

		old root holes; few roots present locally following the softer patches from above; no worms; moist; few faint rusty mottles. Gradual change into
C	76-86+	Brown to light yellowish brown (10YR5/3 to 10YR6/4) sandy loam following cracks between shattered rock; texture becoming coarser with depth; massive; many stones. Gradual change into shattered rock.

Earthworms are active in the surface horizons and the humus form is a mull or mull-like moder (Kubiena, 1953). The intensity of the induration in the Bx horizon varies and the upper part may be undergoing pedological change into aBs horizon. Shattered rock underlies the profile at no great depth and the C horizon is often dominated by angular fragments of rock.

Thistlyhill Series

The Thistlyhill Series, covering 3 square kilometres, occurs on a sandy clay loam till on Glentanar Estate and on Nether Tillygarmond Farm in the Strachan basin. It also occurs on a sandy loam till near the Burn of Canny. The till in both cases is usually thick and, even in the coarser-textured soils, there is often material of finer texture at depth. The land is mainly cultivated and the soil is an imperfectly drained brown forest soil.

Profile Description: No.31. Tillycairn

Grid Reference	NO4680097300
Altitude	230 metres
Slope	Moderate
Vegetation	Rotational grass
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-20	Very dark greyish brown (10YR3/2) loam; fine to medium subangular blocky; firm, breaking under slight to moderate pressure to fine subangular blocky; frequent stones, commonly 5 to 13 centimetres diameter in size; frequent to many roots; worms present; moist; no mottles; some admixture of B(g1) material by ploughing. Sharp irregular change into
B(g)1	20-36	Brown (10YR5/3) sandy clay loam; coarse subangular blocky tending to prismatic; firm, breaking under moderate pressure to fine subangular blocky; frequent stones; frequent roots down structure faces and worm channels; moist; frequent fine faint yellowish brown (10YR5/6 and 5/8) mottles, some small and distinct vertical grey cracks. Clear change into
B(g)2	36-53	Greyish brown (10YR5/2) and brown (10YR5/3) sandy clay loam; fine to medium subangular blocky tending to coarse platy; fairly compact; small vesicular pores with clay skins lining pores and surrounding stones; frequent

		stones, commonly 5 to 8 centimetres in size; few roots, mostly down grey cracks; no worms; moist; few yellowish brown (10YR5/6 and 5/8) mottles; prominent vertical grey cracks 3 centimetres or less across, with pale brown (10YR6/3) centres. Gradual change into
C(g)	53-81+	Brown (10YR5/3) sandy clay loam; massive to laminated; clay-lined pores and clay-coated stones present; frequent stones, smaller sizes than above; no roots; moist; few faint rusty mottles throughout, distinct rusty colours confined to edges of grey cracks which become bluish grey with depth.

Induration is absent in the profile described above, but is usually present where the texture of the B horizon is a sandy loam. A distinct feature is the gleying of former frost cracks which had been formed under freeze-thaw conditions at the end of the glacial period. Where the land has been planted with conifers and several crops of trees have been removed, the upper horizons of the soil are those of a podzol; the extent of this soil, however, is very small.

Tiilypronie Series

The Tillypronie Series is of a very minor extent (1 square kilometre) and occurs on low hills at Drumgesk, near Aboyne and at Knappach, near Banchory. Its presence on these sites is due largely to past history. Heathy woodland probably occupied them before they were turned over to agricultural use, and the soil, being adjacent to the Dinnet Association, is coarser in texture, and stony. A third small area of the series is found on the upper hill slopes in Blackhall Forest near Banchory. The series is a freely drained iron podzol.

Profile Description: No.63. Inverey, Finzean

Grid Reference	NO612954
Altitude	140 metres
Slope	Moderately steep
Vegetation	Heath with *Calluna vulgaris*, *Nardus stricta*, *Deschampsia flexuosa*, *Luzula pilosa*, *Erica cinerea*, *Potentilla erecta, Genista anglica*, *Pleurozium schreberi* and *Cladonia impexa*
Drainage	Free

Horizon	Depth (cm)	
F	0-4	Dark reddish brown (5YR3/2 to 3/3); fibrous humus; many roots; no worms; moist; no mottles. Sharp change into
H	4-5	Black (5YR2/1) greasy humus; massive; many roots; no worms; moist. Sharp change into
Ah	5-9	Very dark grey (5YR3/1) with pinkish grey (5YR7/2) mineral grain specks, humose sandy loam; fine to medium subangular blocky; frequent very small stones; frequent roots; no worms; moist; no mottles.

		Sharp change into
Bh	9-18	Dark brown (7.5YR3/2) humose loam; medium to coarse subangular blocky; firm; frequent stones up to 8 centimetres diameter in size; frequent roots; no worms; moist, irregular blotching due to varying humus content; few rusty mottles. Gradual change into
Bs1	18-36	Dark brown (7.5YR3/2) and dark yellowish brown (10YR4/4) fine sandy loam; massive to weak subangular blocky; fairly firm; porous; few stones up to 8 centimetres diameter in size; frequent roots decreasing in number with depth; no worms; moist; no mottles, irregular humus staining. Gradual irregular change into
Bs2	36-46	Yellowish brown (10YR5/4) fine sandy loam; medium to coarse subangular blocky; moderately friable with local indurated fragments present; frequent stones up to 8 centimetres diameter in size; few to frequent roots; no worms; moist; no mottles, some irregular humus staining; distinct humose root mat at base above indurated layer. Sharp change into
Bx	46-81	Brown (10YR5/3) and pale brown (10YR6/3) gritty sandy loam; massive tending to large platy and strongly indurated; frequent stones us to 36 centimetres diameter in size; no :roots; moist; few yellowish brown (10YR5/6) mottles. Gradual change into
B(x)	81-96	Yellowish brown (10YR5/4) gritty sandy loam; massive; compact, weakly indurated; distinct stone layer between 76 and 86 centimetres; moist; few yellowish brown (10YR5/6) mottles, weakly developed greyish (10YR5/3 to 6/3) cracks. Gradual change into
C	96-120+	Yellowish brown (10YR5/4) gritty sandy loam to loamy sand; massive but looser than above; frequent stones up to 13 centimetres diameter in size; no roots; moist, water tending to seep in around 94 centimetres; strongly developed pale brown (10YR6/3) cracks 3 to 4 centimetres across with yellowish brown (10YR5/8) 6-millimetre margins.

The F and H horizons are distinct and well developed, but the leached E horizon is highly humose and only about 4 to 5 centimetres thick. The ABh horizon has a moderate organic-matter content with local high concentrations of humus. Induration of the Bx horizon is fairly strong and, as in many soils within the forest zone, disruption of the upper part of the horizon by tree fall has caused the inclusion of indurated fragments within the Bs horizon. Where the plough has been used, there is mixing of the upper horizons, but these retain the blackish colour of podzol surface horizons for some time.

Pitmedden Series

Widely distributed throughout the area of the Tarves Association, the Pitmedden Series covers only 3 square kilometres in this district. It occurs in channels and depressions or on sloes where there are springs and the ground-water rises in the profile. Little of the series is cultivated, as it is associated mainly with the Tarves Series under semi-natural vegetation. The series is a poorly drained noncalcareous gley.

Profile Description: No.100. Inverey, Finzean

Grid Reference	NO618954
Altitude	140 metres
Slope	Moderate
Vegetation	Wet pasture with *Nardus stricta*, *Agrostis canina*, *Briza media*, *Agrostis tenuis*, *Festuca rubra*, *Succisa pratensis*, *Plantago lanceolata*, *Veronica chamaedrys*, *Rhytidiadelphus squarrosus*, *Hylocomium splendens*, *Acrocladium cuspidatum*
Drainage	Poor

Horizon	Depth (cm)	
Ah	0-10	Dark grey (10YR4/1) humose loam; fine subangular blocky and fine crumb; friable but sticky; few stones; many roots; worms present; moist; no mottes. Sharp change into
A	10-28	Dark grey to dark greyish brown (10YR4/1 to 4/2); sandy loam to loam; medium and fine subangular blocky; sticky; few small stones; frequent to many roots; worms present; few rusty mottles at base. Sharp change into
Bg1	28-38	Strong brown (7.5YR5/6), light brownish grey (2.5Y6/2 and 10YR6/2) gritty sandy loam; massive to weak subangular blocky; frequent stones; frequent roots in upper part and few in lower; few worm channels; moist to wet, water seeping out; frequent grey and few rusty mottles. Sharp change into
Bg2	38-46	Grey to light brownish grey (10YR6/1 to 6/2) sandy clay loam; weak prismatic breaking to coarse subangular blocky; frequent hard and weathered stones up to 30 centimetres diameter; few roots tending to concentrate between structure units; no worms; moist; coarse grey and rusty mottles. Gradual change into
BCg	46-76	Brown to pale brown (10YR5/3 to 6/3) with yellowish red (5YR5/6) and light grey (7.5YR7/0) clay loam; weak coarse prismatic breaking to coarse subangular blocky; frequent large and small granitic gneiss stones, soft pieces of dark basic gneiss and schist; few roots tending to concentrate between structure units; moist; prominent grey and rusty mottles becoming fewer with depth. Gradual change into

Cg	76-129+	Pale brown (10YR6/3) with brownish yellow (10YR6/6) and light brownish grey (10YR6/2) clay loam till; massive; compact and sticky; frequent stones and boulders up to 46 centimetres diameter in size; few roots to 91 centimetres; moist; grey and rusty mottles gradually becoming fewer with depth

Large earthworms are common in the A horizons and the low stone content may be partly duo to their activities. In the lower Bg horizons, the structure is dominated by weak coarse prisms and roots are confined almost entirely to the spaces between these structure units.

Pettymuck Series

This series is very limited in extent, covering less than 1 square kilometre, and the only area worthy of note is adjacent to Moss Maud. It occurs in depressions, and the upper mineral layers have often been modified by the action of glacial meltwater. The drainage is very poor and the soil is a peaty gley.

Profile Description: No.111. Westside, Sluie

Grid Reference	NO628987
Altitude	140 metres
Slope	Level
Vegetation	Marshy pasture with *Carex nigra*, *Agrostis canina*, *Equisetum fluviatile*, *Potentilla palustris*, *Epilobium palustris*, *Sphagnum squarrosum*
Drainage	Very poor

Horizon	Depth (cm)	
O	0-25	Very dark greyish brown (10YR3/2) to dark brown (7.5YR3/2) peaty humus; moderately to slightly decomposed; mainly derived from *Sphagnum* but including remains of *Carex*, *Equisetum*, etc.; many roots; wet. Sharp change into
Ag	25-30	Dark brown (7.5YR3/2) stony loamy coarse sand; massive; stones 3 to 10 centimetres diameter; frequent to many roots; no worms; wet, water seeping out; humus content rather variable locally; thickness of horizon varies from 5 to 13 centimetres. Sharp change into
Eg	30-41	Olive-grey (5Y5/2) sandy loam; massive with some vertical fissures containing more sandy material; compact; few small stones; frequent cord roots, *Eguisetum* rhizomes, and old woody roots (which do not extend into O horizon); no worms; very moist; very little rusty staining. Clear to gradual change into
Bg	41-81	Grey (5Y5/1) and dark grey (5Y4/1) sandy clay loam; massive to coarse prismatic (faintly laminated); compact;

		few stones up to 10 to 13 centimetres diameter; few to frequent live roots, frequent dead roots; no worms; moist; cracks between prisms slightly paler grey and sometimes sightly humus-stained; few rusty mottles, traces of iron pipes down some fine root channels. Gradual change into
BCg	81-102	Grey (5Y5/1) and dark grey (5Y4/1) sandy loam to sandy clay loam; massive, with some vertical cracks which are fewer and narrower than in horizon above; plastic, less compact than above; few to frequent stones; few live roots, frequent dead roots (frequent soft tree roots to base of profile); very moist; no appreciable mottles. Gradual change into
Cg	l02-147+	Grey (5Y5/1) sandy loam to sandy clay loam; massive, becoming laminated with depth; frequent small subangular stones up to 15 centimetres diameter; frequent dead roots; wet; no mottles.

The presence of obvious remains of *Sphagnum* suggests that peat formation is still active and it is probable that a surface layer of peat was stripped off in the past for fuel, otherwise the thickness of the present layer would be much greater. The gleyed lower horizons are remarkably uniform in colour, with little or no iron oxide staining, and the structure is essentially massive. The vertical cracks with infilling of more sandy material are probably relict from freeze-thaw conditions at the end of the Pleistocene glaciation, and unrelated to pedogenic processes.

Skeletal Soils

Skeletal soils are not extensive covering 1 square kilometre on hill slopes and hill summits, where rock is either close to, or, at the surface. The areas are very localised and small in extent, occurring predominantly north of the Dee, on Crag Farrar and Sluie Hill, with the main area south of the river on the lower, north-facing slopes of Slai na Gour.

Tipperty Association

The Tipperty Association is developed on red lacustrine silty clay derived from Old Red Sandstone material. Small areas have been mapped in the locality of Stonehaven, where they occur at altitudes below 30 metres.

Distribution

The soils of this association are located at New Mains of Urie, north of Stonehaven, on the Home Farm of Fetteresso, on Braehead Farm, and south-west of Stonehaven railway station. The individual areas are small, not exceeding 16 hectares and the total area of the association is less than 1 square kilometre.

Parent Material
The parent material is a red lacustrine silty clay which is calcareous below 1.5 metres. It occurs as a stone-free deposit at Brickfields near Stonehaven railway station, where it was once worked for brick- and tile-making.

Bands of water-bearing sand are present in the massive silty clay. In Aberdeenshire the deposit, which also occurs at altitudes of less than 30 metres is a varved clay with laminae 1.5 to 6 millimetres thick. In the present areas, the clay deposits are thinner, less than 2 metres thick, and generally contain a proportion of stones and cobbles of 2.5 to 10 centimetres diameter, which appear to have been brought in by solifluction from adjacent higher ground.

Tipperty Series

The Tipperty Series, the only representative of the association which has been mapped in Kincardineshire, is an imperfectly drained brown forest soil with gleying. The series occupies level to gently sloping sites. All the land has long been under cultivation and has been tile-drained.

Profile Description: No.32. New Mains of Urie

Grid Reference	NO872873
Altitude	30 metres
Slope	Level
Vegetation	Rotational grass with *Dactylis glomerata*, *Lolium perenne*, *Phleum pratense*, *Cynosurus cristatus*, *Ranunculus repens*, *Ranunculus acris*, *Trifolium repens*, *Bellis perennis*, *Cirsium arvense*
Drainage	Imperfect

Horizon	Depth (cm)	
Ap	0-28	Dark reddish brown (5YR3/4) clay loam; medium crumb in upper part passing into fine angular blocky; firm; moderate organic matter; frequent stones; many fine roots; moist; no mottles. Clear change into
B(g)	28-86	Red (2.5YR4/6) silty clay; medium and coarse angular blocky; firm; low organic matter; few cobbles and stones; fine roots between peds; moist; frequent strong brown (7.5YR5/8) mottles and fine grey mottles inside peds decreasing with depth; large worm holes; surface soil intermixed in upper part of horizon; moist. Diffuse change into
C(g)	86-127+	Red (2.5YR4/6) silty clay; massive; firm; moist; few occasional stones and cobbles up to 10 centimetres diameter; no roots; no worms; few faint yellowish red (5YR5/8) mottles and few distinct medium grey mottles.

The thickness of the Ap horizon is generally greater than the 28 centimetres quoted in the profile, but in places, the plough turns up red subsoil. A marked crumb structure develops in ploughed land following overwinter exposure to frost. The stone content varies from slight to moderate throughout the profile. Rusty and grey mottles in the B(g) horizon indicate a drainage impedance, a result of the high clay content and very gentle slopes. Earthworm activity is marked and large channels, 5 millimetres in diameter, penetrate the blocky peds. A considerable amount of mixing

of the Ap horizon material has occurred in the upper 15 centimetres of the B(g) horizon. Fine roots penetrate to the base of the B(g).

The presence of stones is not in keeping with a lacustrine clay deposit, but less stony and stone-free variants do occur. The soil mapped at Brickfields is the modal Tipperty; elsewhere, it bears comparison with the Peterhead Series of Aberdeenshire (Glentworth and Muir, 1963).

Alluvium

Alluvium is widespread throughout the district and, together with mixed bottom land covers a total area of 177 square kilometres. Both river and lacustrine alluvium are found, the former being by far the more extensive. No separation of the two forms has been made on the soil map. River alluvium is found along the banks of rivers and streams and also in former overflow channels. Lacustrine alluvium is generally associated with ponds and hollows which, in many cases, represent the sites of post-glacial lakes. Apart from a narrow band bordering the western edge of the Montrose Basin and mapped as Saltings, all the alluvium in the district has been deposited by fresh water.

While many of the alluvial soils are coarse-textured and permit free or moderately free drainage, in some cases, layers of fine-textured material e.g. silts and clays, hold up water and render the soil drainage imperfect to poor. Because of the difficulty of distinguishing between drainage categories in most alluvial soils, no separation of drainage series has been made on the map and all have been classed as undifferentiated alluvium.

Alluvium follows the course of the River Dee from Dinnet eastwards to Peterculter and also extends up the valleys of the tributary streams, the Feugh and Tanar. As the underlying rocks in these areas consist of granite or granitic gneiss, the alluvial deposits are generally coarse-textured varying from sandy loam to loamy sand with gravel occurring at depth. In Strathmore, alluvium occurs extensively along parts of both the Rivers North and South Esk. Gravel terraces are common and the deposits are mainly coarse sandy although the influence of schistose rocks and fine-grained sandstones gives rise in places to fine sandy textures.

Alluvial deposits are also associated with several of the smaller streams and water-courses such as the Bervie Burn, the Devilly Burn and the Forfar – Lunan channel. Silty textures are sometimes found among alluvial soils in the Howe of the Mearns and this is probably due to the presence of marls or mudstones from which the parent material of the Laurencekirk Association is derived.

Saltings

Bordering an area of the Ingliston Series, a narrow band of marine alluvium (saltings) occurs where the River South Esk enters the Montrose Basin, at its western margin. The saltings, covering a total area of 1 square kilometre, consist largely of thin *Phragmites* peat overlying estuarine mud and are very poorly drained.

Raised Beach Deposits

Raised beach deposits consisting mainly of coarse sand, and shelly gravel, cover a total area of 1 square kilometre and extend along the coast as a narrow strip from Nether Knox southwards through Johnshaven to East Mathers.

Links and Dunes

Windblown sand overlies the raised beach deposits which stretch down the coast from St. Cyrus to the River North Esk and extend on the south side of the river as far as the mouth of the river South Esk at Montrose. The sand has been stabilised mainly by rough acid grassland except along the narrow coastal strip between St. Cyrus and the North Esk where it has accumulated as dunes. These dunes are moundy and unstable, and support little vegetation other than clumps of marram grass (*Ammophila arenaria*) and lymegrass (*Elymus arenarius*) which achieve partial fixation of the sand. The soils developed on stabilized winblown sand are classed as Links. The sand, which is largely quartzose is usually coarse and, except in a few cases where some impedance occurs, the soils are freely drained. Profiles are immature with dark brown loamy sand, 25 to 28 centimetres thick, overlying brown sand.

Organic Soils

Organic soils encompassing hill and basin peats are formed under water-logged conditions.

Hill Peat

Hill peat covers 150 square kilometres on the broad summits, ridges and upper slopes of the Grampians and higher hills of the Grampian Foothills landform regions. It is most extensive on Sheet 66/67 (Banchory and Stonehaven) stretching from the Shank of Donald Young in the south-west corner,stretching north-eastwards to Little Shiel Hill, encompassing most of the intervening hill summits, but is less extensive on Sheet 57 (Forfar), being restricted to the highest summits and ridges in the north-west corner. Hill peat usually occurs in association with skeletal soils and/or peaty podzols.

Basin Peat

Basin peat covers 14 square kilometres in several localised basins in the Netherley and Skene lowlands on Sheet 66/67, with some of the larger areas being e.g. Red Moss, Portlethen Moss. It is more restricted in occurrence on Sheet 57 to more linear features in the Forfar-Lunan Channel, east and west of Forfar and larger mosses south of Forfar such as Dilty Moss at Carmyllie.

Peat-Skeletal (Mongour) Complex

Areas of peat-skeletal complex occur solely on Sheet 66/67, on the high ground to the south of Kirkton of Durris and along the western margin of the sheet on Braid

Cairn. The complex covers a total of 6 square kilometres and consists of peat and rock (granite)

Mixed Bottom Land

The term Mixed Bottom Land is applied to the unit of soils occurring in narrow streams and drainage channels and also occasionally on valley sides. The soils are mostly a mixture of alluvial deposits of varying age, origin, texture and drainage. Because of their heterogeneous composition, they cannot correctly be classed either as alluvium or as an association, and the smallness of the area they cover makes separation of drainage series on the one inch soil map impossible.

Quarries and Built-up Areas (BUA)

Areas of quarries and the built-up land of the larger settlements, as assessed at the time of survey, occupy10 square kilometres.

6. Discussion of Analytical Data

Profiles representative of the various soil series mapped were described and sampled during the survey and standard physical and chemical analyses have been carried out. Appendix 2 gives standard analytical data relating to the profiles described in Chapter 5 and to other representative profiles.

Standard Analytical Data

Loss on Ignition

The loss in weight of a soil sample resulting from ignition at 850°C for two hours is due mainly to the removal of organic matter by oxidation to carbon dioxide and water, to the loss of carbon dioxide resulting from the decomposition of any free calcium carbonate present and to the loss of structural water from clay minerals.

The highest values for loss on ignition occur in soils with organic or humose horizons. In peaty podzols, loss on ignition values are frequently 70 to 90 per cent in the L, F and H or O horizons (over 90 per cent in Nos. 75 and 76), although effects of burning and of trampling by livestock can reduce the value considerably (40 per cent in the F horizon of No. 73). In Nos. 74 (Charr Series) and 75 (Garrold Series) there is an increase in loss on ignition from the upper to the lower E horizon; this may be a result of the root mat development above the iron pan. The peaty gleys also show high values ranging from 66 to 97 per cent in the F and H horizons. In No. 108, the effect of trampling and burning resulting in lower loss on ignition is evident in the H horizon, where the value is less than 40 per cent. In the F and H horizons of noncalcareous gleys and of brown forest soils, losses on ignition seldom rise above 50 per cent. Exceptions are found in Nos. 6 (79 per cent in the F horizon), 12 (63 per cent in the F horizon) and 96 (66 per cent in the H horizon). In the cultivated soils, the value rarely rises above 15 per cent.

Soil Separates

Soil separates - sand, silt and clay - were determined by mechanical analysis, using the size limits of both the International Scheme and that adopted by the U.S. Department of Agriculture. These are shown in Appendix 2. The analyses provide a means of checking the validity of soil texture assessments made by hand in the field. Where discrepancies between field and laboratory textures occur, they are often due to the presence of organic matter which makes the field texture more difficult to assess. In the field there is also a tendency to overestimate the clay content of some mineral soils, particularly in the presence of coarse sand. In Table 8 the soil series are arranged according to the textural class of the uppermost mineral horizon.

An estimate has been made of the areas of the various textural classes. At one end of the scale, coarse-textured soils from the Auchenblae, Boyndie and Corby Associations, together with Links soils, cover 153 square kilometres; at the other, fine-textured soils of the Laurencekirk, Pow, Stonehaven and Tipperty Associations occupy 141 square kilometres. Moderately coarse-textured soils cover the largest area, 582 square kilometres, with soils of moderately coarse to medium textured next most extensive with 324 square kilometres. Medium- to moderately fine-

textured soils occupy 273 square kilometres. Moderately fine-textured soils cover 30 square kilometres, while coarse- to moderately coarse-textured soils cover 314 square kilometres.

Table 8. Textural Class of Series (uppermost mineral horizon)

Association	Coarse-Textured Soils	Coarse to Mod Coarse	Moderately Coarse-Textured Soils	Mod. Coarse to Medium-Textured Soils	Moderately Fine-Textured Soils	Medium to Mod. Fine Textured Soils	Fine-Textured Soils
Auchenblae	Auchenblae						
	Candy						
Balrownie				Aldbar		Balrownie	Lour
Boyndie	Boyndie	Dallachy					
	Anniston						
Collieston			Cairnrobin			Collieston	Marshmire
Corby	Corby	Mulloch					
	Kinord	Mundurno					
		Leys					
Countesswells		Charr	Countesswells	Terryvale			
		Strathgyle	Raemoir	Drumlasie			
			Dess				
Deecastle				Deecastle			
Dinnet			Dinnet				
			Oldtown				
			Maryfield				
			Ferrar				
Forfar			Forfar				
			Vinny				
			Vigean				
Laurencekirk			Luther		Newton	Drumforber	Laurencekirk
						Oldcake	
						Muirfoot	
Mountboy			Barras	Garvock	Mountboy		
Pow							Pow
							Ingliston
Stonehaven			Forgie			Shields	Stonehaven
							Balhagarty
Strathfinella			Garrold	Strathfinella	Trusta	Ledmore	

Table 8. Textural Classof Series (uppermost mineral horizon) continued

Association	Coarse-Textured Soils	Coarse to Mod Coarse	Moderately Coarse-Textured Soils	Mod. Coarse to Medium-Textured Soils	Moderately Fine-Textured Soils	Medium to Mod. Fine Textured Soils	Fine-Textured Soils
Strichen		Gaerlie	Fungarth	Anniegathel			
			Baikies	Auquhollie			
			Strichen	Hythie			
Tarves		Tarves		Thistlyhill			
		Tillypronie					
		Pitmedden					
		Pettymuck					
Tipperty							Tipperty
Links	Links						
TOTAL	153	314	582	324	30	273	141

Exchangeable Cations

The content of exchangeable cations – calcium, sodium and potassium – in the soil gives some indication as to the presence of nutrients readily available to plants. Values measured in milligram equivalents (me) per 100 grams of soil are graded low, moderate and high as follows:

	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)
Low	<3	<0.3	<0.05	<0.1
Moderate	3 - 8	0.3 - 5	0.05 - 0.25	0.1 - 1
High	>8	>5	>0.25	>1

Exchangeable Calcium

Highest values for exchangeable calcium are found in the organic horizons of uncultivated soils. In Profiles Nos. 12, 108, 110 and 111 the figures are 25, 29, 46 and 31 respectively, and in many others, values in L, F and H horizons are greater than 10. In Profile No. 7, the value is low in the lower C and high in all other horizons. Imperfectly drained brown forest soils generally have high or moderate to high values, for example, Profiles Nos. 16, 17, 22, 24, 28, 31 and 32. Podzols generally show low values throughout except in organic topsoils and in the surface horizons of cultivated soils where exchangeable calcium may be moderate to high as a result of fertiliser application. In general there is a decrease down the profile, although in some cases the values rise again in the C horizon, for example, Nos. 36, 38, 39, 49, 51, 62 and 69. Imperfectly drained cultivated podzols tend to have slightly higher values, ranging from moderate to low. Results for noncalcareous gleys are somewhat variable. Many cultivated profiles have moderate to high exchangeable calcium throughout, with highest values in the Ap and/or C horizons. In Profiles Nos. 80, 90 and 92, values are high throughout. The mineral horizons of peaty gleys have moderate or low values. Exceptions are found in No. 108 where exchangeable calcium is high throughout the profile and in No. 110 where the value is 21 in the Ahg.

Exchangeable Magnesium

Most brown forest soils show moderate or low values of magnesium throughout the profile. High values are sometimes found in the organic surface horizons of uncultivated soils, for example, Profile No. 1 and in the C horizons of certain cultivated soils, for example, Nos. 8, 9, 11, 17, 28 and 32. Iron podzols frequently have high values in LF layers with moderate to low values elsewhere and a similar pattern is generally found among peaty podzols. In noncalcareous gleys, levels of exchangeable magnesium are generally moderate to low but increase down the profile, frequently reaching high values in the C horizon as in Nos. 88, 90, 91 and 93. One profile of the Anniegathel Series, No. 97, has a high magnesium value in the Ap horizon. Peaty gleys have high levels in organic surface horizons and usually moderate or low values in mineral horizons, for example Nos. 101, 102 and 103. The highest value for exchangeable magnesium, 28.6, is found in the FH horizon of No. 111, a very poorly drained peaty gley of the Pettymuck Series.

Exchangeable Sodium

Brown forest soils show moderate values for exchangeable sodium, apart from Nos. 20, 21 and 24, where the value is greater than 0.25 in the C(g) horizon, in No. 25 where it is 0.35 in the B(g)2 and in No. 32 where it is 0.27 in the upper Ap and in the upper C(g) samples. Iron podzols tend to have moderate or low levels of exchangeable sodium except in the case of uncultivated soils where values for organic surface horizons are generally high, for example, Nos. 44, 45, 46, 56, 62 and 63. In No. 50, a profile of the freely drained Newton Series, exchangeable sodium is high in the LF and H layers and also in the lower C horizon. Noncalcareous gleys show moderate values throughout except in Nos. 87, 95, 96, and 99 where the value drops to low in the Bg or Cg horizons. High levels of exchangeable sodium are found in the organic horizons of the peaty gleys, with the value falling to moderate or low in the mineral horizons, for example, Nos. 101, 102, 103, 105 and 111.

Exchangeable Potassium

Uncultivated brown forest soils generally have high levels of exchangeable potassium in organic surface horizons and moderate to low or low levels in mineral horizons, for example, Nos. 12 and 13. Most cultivated soils show moderate values. Podzols have moderate or low values except in L, F and H horizons, for example, Nos. 45, 46, 50, 63, 66 and 70. Peaty podzols follow a similar pattern, for example, Nos. 75, 76 and 77. Results for the peaty gleys are variable although several show high values in organic surface horizons with low or moderate to low values in mineral layers, for example, Nos. 101, 103, 105 and 111.

Exchangeable Hydrogen

Values for exchangeable hydrogen tend to decrease with depth in all the major soil subgroups. Exceptions are found in No. 62, a freely drained iron podzol, in No. 76, a peaty podzol with free drainage below the iron pan and in Nos. 87, 92, 96 and 99, poorly drained noncalcareous gleys. In all of these, there are slight increases in the Cg horizon. Highest values for exchangeable hydrogen occur in the organic surface horizons of all major soil subgroups, for example, Nos. 67, 71, 75, 101, 102 and 103 where the values all exceed 80 me/100 g.

Percentage Base Saturation and pH

Base saturation is calculated by expressing the total exchangeable bases, i.e. calcium, magnesium, sodium and potassium, as a percentage of the total exchangeable cations which includes, in addition, exchangeable hydrogen. The values of percentage base saturation are graded as follows:

Low	<20%
Moderate	20 - 60%
High	>60%

An acid soil has a low pH value (4.0 to 5.0), a neutral or near neutral soil has a moderate value (6.0 to 7.0) and an alkaline soil a high pH (greater than 7.0).

Acid soils generally have a low percentage saturation, for example, No. 43 (Corby Series), No. 45 (Countesswells Series), No. 46 (Oldtown Series), while in neutral and near neutral soils, the percentage is high or the soil may be completely saturated, for example,. No. 20 (Balrownie Series), No. 22 (Luther Series) and No. 24 (Mountboy Series). Base saturation varies with past liming and the majority of the cultivated soils have high values in the Ap horizon, for example, No. 7 (Drumforber Series), No. 69 (Forfar Series), No. 31 (Thistlyhill Series). High values are associated with moderately fine-textured soils such as No. 32 (Tipperty Series), No. 28 (Stonehaven Series) while the lowest values occur in profiles developed on parent materials with moderately coarse or medium texture, for example, No. 55 (Strathfinella Series) and No. 72 (Trusta Series).

Low pH values, ranging from 4 to 5 but occasionally below 4, are found among the uncultivated soils, particularly those developed on sands and gravels, on material derived from Dalradian rocks or from granite, for example, No. 43 (Corby Series), No. 62 (Strichen Series), No. 45 (Countesswells Series). For the cultivated soils the range is from 5 to 6.5 or, occasionally, to 7. Highest values are usually found in poorly drained fine-textured gleys such as No. 89 (Pow Series) where the pH is greater than 7 except in the Ap horizon, No. 32 (Tipperty Series) where the pH is 6.7 or above except in the upper Ap sample, No. 91 (Balhagarty Series) where pH rises to 7.5 in the upper Cg sample. Among the profile analyses shown in Appendix 2, the highest values noted are for an imperfectly drained profile, No. 24 (Mountboy Series) where the pH is greater than 7 in all horizons and is actually 7.9 in the upper Ap sample. This, together with the high value for exchangeable calcium, is probably the result of liming shortly before the profile was sampled.

Carbon and Nitrogen

Determinations were made of carbon and nitrogen on upper horizons of profiles. The carbon:nitrogen ratio can be used to indicate the degree of decomposition or humification of the residues which make up the soil organic matter. Thus, in the surface horizon of uncultivated soils where organic residues are large and little humification has taken place, carbon contents and carbon:nitrogen ratios are high. In cultivated soils, on the other hand, organic matter has been incorporated in the mineral horizons and is humified so that surface horizons are relatively much richer in nitrogen and carbon:nitrogen ratios are comparatively low. A comparison of data shows that for uncultivated soils the ratios are frequently over 30 (Nos. 73, 74, 107 and 111) while cultivated soils usually have values around 10 to 15 (Nos. 38, 16 and 7).

Total and Readily Soluble Phosphorus

The soils were analysed for their total content of phosphorus and also for their acetic-soluble or readily soluble phosphorus. Values, expressed as milligrams of P_2O_5 per 100 grams of soil, are graded for comparison:

	Total P_2O_5	Acetic-soluble P_2O_5
Low	100	3
Moderate	100 - 300	3 - 10
High	>300	>10

Total phosphorus is generally moderate or low in brown forest soils developed on coarse-textured parent materials with highest values occurring in organic horizons of uncultivated soils, for example, Nos. 1 (Kinord Series), No. 3 (Raemoir Series), and No. 6 (Dinnet Series). Cultivated soils frequently have high phosphorus in the Ap horizon, for example, Nos. 9, 10 and 11 (Garvock Series), Nos. 26, 27 and 28 (Stonehaven Series). Iron podzols have moderate or low values, tending, in most cases, to decrease down the profile. Two notable exceptions are No. 33 (Auchenblae Series) which, apart from the C horizon, has high values throughout, and No. 52 (Shields Series), with values high in the Ap and Bw(x) and moderate in the Bx and C. Quite a few peaty podzol profiles for which analyses are available show somewhat variable results. Highest figures are found in organic surface horizons. In noncalcareous gleys, highest values occur in surface horizons. In coarse-textured soils, there is a tendency for values to decrease down the profile to the C horizon, for example, Nos. 81 and 82 (Mulloch Series). In finer-textured soils, the value generally falls in the B horizon and rises again in the C, for example, Nos. 89 (Pow Series), 92 and 93 (Stonehaven Series). With peaty gleys, highest values are again found in the organic surface horizons. Thereafter, the value falls to low in the B, but generally rises again to moderate in the C horizon. Some profiles show notably high total P_2O_5 in F or H horizons, for example, Nos. 103 (Auquhollie Series) and 105 (Drumlasie Series).

Freely and imperfectly drained uncultivated soils are generally low in readily soluble phosphorus except in the case of organic-rich surface horizons when values are usually high. Exceptions are Nos. 73 and 74 (Charr Series) where all horizons, apart from one, show low values of readily soluble phosphorus. Most cultivated soils have moderate or high values, the highest being found usually in the C horizon. The highest values of all occur in the C horizons of the poorly and very poorly drained soils, No. 90 (Balhagarty Series), No. 80 (Lour Series) and No. 111 (Pettymuck Series).

Summary of Analytical Methods

1. Soil separates (sand, silt and clay) were determined by a modification of the hydrometer method (Bouyoucos, 1927a, l927b).

2. The exchangeable cations were determined in a neutral normal ammonium acetate leachate, calcium, sodium and potassium being determined by flame photometry (Ure, 1954) and magnesium colorimetrically (Hunter, 1950), or by direct photometry (Scott and Ure, 1958).

3. Exchangeable hydrogen was determined by electrometric titration of a neutral normal barium acetate leachate (Parker, 1929). pH was determined in aqueous suspension by means of the glass electrode.

4. Total carbon was determined by a wet combustion method using standard potassium dichromate solution (Walkley and Black, 1934).

5. Total nitrogen was determined by a semi-micro-Kjeldahl method (Markham, 1942).

6. Total phosphorus was determined by a colorimetric method using hydrazine sulphate, after fusing the soil with sodium carbonate (Muir, 1952).

7. Readily soluble phophorus was determined colorimetrically in a 2.5 % acetic acid extract (Williams and Stewart, 1941).

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Appendix 1: Methods and Definitions

Soils

SOIL CLASSIFICATION

The system of soil classification used in this publication is described in many of the Soil Survey of Scotland's previous publications and in Chapter 4. It is based principally on the recognition of typical examples of soil subgroups rather than on the definition of properties discriminating between groups; such types of classification are typological, as opposed to definitional (Butler, 1980).

SOIL PROFILE DESCRIPTIONS

The standard terms used in the descriptions of soil profiles are listed and defined briefly. They are mainly those of Soil Survey Staff (1951) and Hodgson (1974).

Slope

The terms used to describe slope are: gentle (0—3°), moderate (3—7°), strong (7—11°), moderately steep (11—15°), steep (15—25°) and very steep (>25°).

Drainage class

Drainage class is assessed from profile morphology, particular attention being paid to the amount of grey and ochreous mottling present. In general, well-drained soils have horizons with a uniform colour and little or no mottling, whereas soils with impeded natural drainage have ochreous or grey mottling, or both. The drainage classes recognized are: free, imperfect, poor and very poor.

Colour

The names and notations of the soil colours are those of the Munsell Soil Color Charts (Munsell Color Company. Inc., 1954).

Texture

Soil texture is a measure of the relative amounts of sand, silt and clay present in the mineral soil material of less than 2 millimetres in diameter. Texture is assessed in the field by working a moistened sample between finger and thumb and checked in representsative profiles by particle-size analysis in the laboratory.

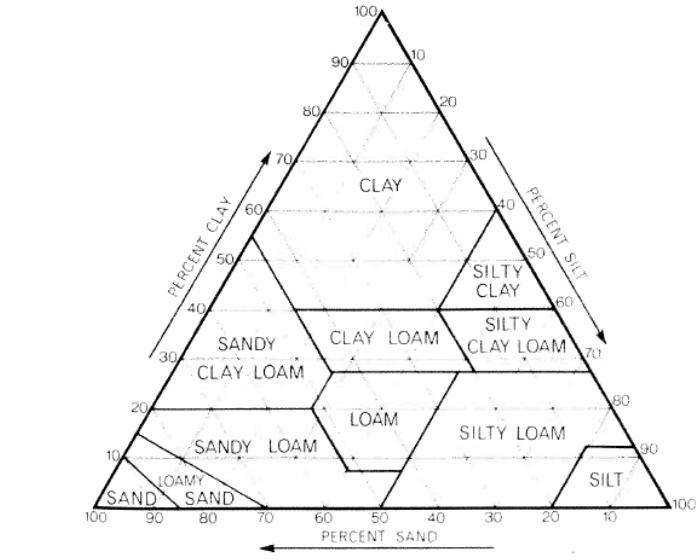
Two textural classifications based on different particle-size grades were in use at the time of the survey: United States of America Department of Agriculture (USDA) and the International Scheme. Early samples (approximately pre 1954) were analysed using solely the International size fractions, but post 1954 both schemes were adopted. The size fractions of each scheme are given in Table 9 below.

Table 9. U.S.D.A. and International Textural Size Fractions

	U.S.D.A. Scheme		International Scheme
Name of Separate	Effective Diameter (range) µm		Effective Diameter (range) µm
Sand	2000-50		2000-20
Silt	50-2		20-2
Clay	<2		<2

The textural class names are ascertained from the triangular diagram (Figure 6) used in conjunction with the range of grain sizes established by the United States Department of Agriculture (USDA) (1951). Soil textures are assigned by noting the area in which the size grade composition occurs when plotted on the diagram.

Figure 6. The Percentage of Clay (<2µm), Silt (2-50µm) and Sand (50-2000µm) in the U.S.D.A Basic Soil Textural Classes



Stones

Terms describing frequency are: none (0 per cent volume), few (1 - 5 per cent), common (5 - 15 per cent), many (15 - 35 per cent), abundant (35 - 70 per cent) and very abundant (>70 per cent).

Sizes of stones are: very small (<6 millimetres diameter), small (6 millimetres - 2 centimetres), medium (2 - 6 centimetres), large (6 - 20 centimetres), very large (20 - 60 centimetres) and boulders (>60 centimetres).

Shape can be rounded, subrounded, subangular, angular or platy (tabular).

Structure

Structure is the aggregation of the primary soil particles into compound units (peds). Grade, size and shape are described. Grade refers to the degree of development: terms are structureless, weak, moderate and strong; soil horizons which are structureless are either massive or single-grain.

There are four main shapes of structure unit, each with five size classes.

Angular and subangular blocky structures have peds with three axes of about equal length. Neighbouring peds interlock. Sizes are very fine (<5 millimetres diameter), fine (5 - 10 millimetres), medium (10 - 20 millimetres), coarse (20 - 50 millimetres), and very coarse (>50 millimetres).

Crumb and granular structures also have peds with three axes of about equal length, but the peds do not interlock with their neighbours. The size ranges are very fine (<1 millimetre diameter), fine (1 - 2 millimetres), medium (2 - 5 millimetres), coarse (5 - 10 millimetres) and very coarse (>10 millimetres).

Prismatic structures have units in which the vertical axis is distinctly longer than the two horizontal axes. The sizes are very fine (<10 millimetres diameter), fine 10 -20 millimetres), medium (20 - 50 millimetres), coarse (50 - 100 millimetres) and very coarse (>100 millimetres).

Platy structures have units with the vertical axis much less than the two horizonal axes. Sizes are very fine (<1 millimetre thick), fine (1 - 2 millimetres), medium (2 - 5 millimetres), coarse (5 - 10 millimetres) and very coarse (>10 millimetres).

Consistence

Consistence is an expression of the degree of cohesion of the soil material. A different set of terms is used for each moisture state.

Consistence when wet is described in terms of plasticity (non-plastic, slightly plastic, plastic or very plastic) and stickiness (non-sticky, slightly sticky, sticky or very sticky).

Consistence when moist can be loose, very friable, friable, firm, very firm or extremely firm.

Consistence when dry (uncommon in Scottish soils) is either loose, soft, slightly hard, hard, very hard or extremely hard.

Cementation

Soil material can be cemented by substances such as calcium carbonate, humus, silica or compounds of iron, manganese or aluminium. The degree of cementation is described as weak, medium or strong.

Induration

Indurated horizons are compact, brittle, and are more resistant to vertical than to horizontal disruption. The terms for describing the degree of induration are weak, medium and strong.

Roots

The terms for describing size are: very fine (<1 millimetre diameter), fine (1 - 2 millimetres), medium (2 - 5 millimetres), coarse (5 - 10 millimetres) and very coarse (>10 millimetres).

Kind can be fleshy, fibrous or woody.

Root frequency, determined by estimating the number of very fine or fine roots in a l0 x 10 centimetres area of the vertical face of the soil profile, is described as: none (0 roots per l0 x 10 centimetres), few (1 - 10), common (10 - 25), many (25 - 200) or abundant (>200).

Horizon boundary

The boundaries between soil horizons are described as sharp (<2 centimetres), clear (2 - 5 centimetres), gradual (5 - 12 centimetres) or diffuse (>12 centimetres).

SOIL HORIZON SYMBOLS

Master horizons

Master horizons are represented by capital letters. Arabic figures are used as suffixes to indicate vertical subdivision (e.g. Cl, C2).

Transitional horizons with properties of two master horizons are shown by the combination of two capital letters e.g. AE, EB, BC.

In layered parent materials Arabic numerals are used as symbol prefixes when it is necessary to distinguish lithological or textural contrasts (e.g. 2C when the C horizon differs from the material in which the solum (A and B) is presumed to have formed).

L Fresh annual litter, normally loose, plant structures obvious.

F Decomposed litter, only some of the original plant structures obvious.

H Well-decomposed organic matter formed under aerobic conditions.

Plant structures not visible. May be mixed with some mineral matter.(Mor humus).

O Peaty material formed under wet, anaerobic conditions.

A Mineral horizons formed at or near the surface that show an accumulation and incorporation of organic matter or which have a morphology acquired by soil formation but lack the properties of E or B horizons.

E Eluvial horizons underlying an H, 0 or A horizon from which they can be normally differentiated by a lower content of organic matter and lighter colour - particularly when dry. Usually they show a concentration of sand and silt fractions with a large component of resistant minerals resulting from a loss of clay, iron or aluminium.

B A mineral horizon in which there is little or no obvious rock structure and having one or both of the following:

(i) alteration of the original material involving solution and removal of carbonates; liberation or residual accumulation of silicate clays or oxides; formation of granular, crumby, blocky or prismatic peds; or (normally) some combination of these:

(ii) illuvial concentration of silicate clay or iron, aluminium or humus.

C A mineral layer of unconsolidated material from which the solum is presumed to have formed.

R Underlying consolidated bed-rock sufficiently coherent when moist to make hand digging with a spade impracticable.

Subhorizons

A lower case letter may be added to the capital letter to qualify the master horizon designation. More than one letter can be used if necessary, e.g. Bhs 1 indicates the first of the two horizons enriched in humus and sesquioxic material. Symbols may be bracketed if the feature development is weak.

b Buried (e.g. bA).

f Sharply defined thin iron pan.

g Horizon with gley features.

h Accumulation of organic matter in a mineral horizon (e.g. Ah or Bh).

m A cemented horizon, other than a thin iron pan.

p Disturbed by ploughing.

s Accumulation of sesquioxidic material.

t Accumulation of illuvial clay

w Alteration in situ in accordance with section (i) of the description of the B horizon.

x Indrated layer, compacted but not cemented.

Appendix 2: Standard Analytical Data for Profiles

Brown Forest Soils – freely drained

Profile No. 1. Moor of Dinnet Corby Association Kinord Series Lab Numbers 172213 – 21

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	0 - 3	46.7	N.D.	N.D.	N.D.	N.D.	N.D.	12.78	5.25	0.40	1.08	32.3	37.7	4.8	23.29	0.90	119	5.6	Low clay. Mainly low Ca, Mg, K and % base saturation below F horizon. Low total and readily soluble P_2O_5
Ah1	5 - 15	13.3	65	26	83	8	2	1.23	0.48	0.16	<0.02	22.4	7.7	4.6	7.37	0.24	68	0.8	
Ah2	18 - 25	10.9	69	24	82	10	2	0.61	0.27	0.10	0.07	16.1	6.1	4.6	5.89	0.19	57	0.7	
Bw1	28 - 38	9.5	73	18	84	7	4	<0.15	0.12	0.08	<0.02	11.9	1.7	4.8	5.04	0.21	63	0.5	
Bw2	51 - 61	5.6	90	5	92	3	2	<0.15	0.04	0.09	0.07	4.3	4.4	4.9	2.81	0.11	57	0.4	
Bw3	102-112	2.3	95	3	97	<1	2	<0.15	0.07	0.07	<0.02	2.1	6.3	5.1			51	0.7	
C	158-168	1.4	97	1	97	1	2	<0.15	0.11	0.08	0.04	0.9	19.8	5.4			62	1.7	

N.D. = Not Determined

Profile No. 2. Tilbouries Wood Countesswells Association Raemoir Series Lab Numbers 111403 – 06

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A1	3 - 10	9.9	64	21	72	13	10	3.56	1.25	0.10	0.34	9.6	35.3	5.5	4.23	0.31	136	1.9	Low clay. Moderate or low exchangeable bases. Moderate % base saturation in A and Bs horizons, high in C horizon. Moderate total P_2O_5. Low readily soluble P_2O_5 except in C horizon
A2	13 - 20	7.7	64	20	73	11	12	2.63	0.59	0.08	0.18	6.7	34.2	5.7	3.17	0.23	120	1.4	
Bs	36 - 46	6.0	71	21	80	11	6	2.01	0.47	0.08	0.10	7.9	25.2	5.8			107	1.4	
C	91 - 102	1.7	62	30	78	14	6	0.76	0.08	0.04	0.07	0.5	67.7	5.8			131	21.2	

Profile No 3. Reamoir Countesswells Association Raemoir Series Lab Numbers 198002 – 07

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	0 - 5	18.5	46	30	63	13	10	2.37	0.80	0.23	0.43	20.9	15.5	4.2	10.02	0.52	119	1.3	Mainly low Ca, Mg and K. Low % base saturation. Moderate total P2O5. Low readily soluble P2O5 in upper horizons.
AB	8 - 13	10.7	58	25	69	14	12	<0.15	0.07	0.09	0.10	10.4	2.4	4.8	2.06	0.18	96	1.1	
Bs	22 - 30	7.4	63	26	75	14	8	<0.15	0.07	0.06	0.05	11.1	1.6	4.8	1.89	0.20	108	1.3	
BC	38 - 46	6.4	67	20	76	11	10	<0.15	<0.02	0.06	0.02	9.5	0.8	4.5			160	2.2	
BCx	61 - 69	4.5	69	18	79	8	10	<0.15	0.03	0.06	0.04	5.7	2.2	4.5			171	12.9	
CR	76 - 81	1.9	86	9	91	4	5	<0.15	<0.02	0.04	0.03	0.2	25.0	4.7			108	6.7	

Profile No. 4. Birsemore Deecastle Association Deecastle Series Lab Numbers 173663 – 71

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	3 - 10	24.6	48	27	65	11	6	3.14	1.02	0.12	0.23	28.0	13.9	4.4	13.04	0.70	173	2.5	Low clay in C horizon. Moderate or low exchangeable bases. Low % base saturation in Ah and AB, high in C horizon. Moderate total P_2O_5. Low readily soluble P_2O_5 in Ah and AB, high in C horizon.
AB	10 - 23	11.1	46	33	61	18	15	2.17	0.41	0.11	0.20	13.4	17.7	4.6	4.94	0.31	122	1.9	
Bw	28 - 38	6.2	49	30	60	19	18	1.08	0.25	0.08	0.04	2.3	38.9	4.7	2.19	0.18	112	2.1	
Bx	43 - 51	4.4	53	30	64	19	15	1.07	0.50	0.11	<0.02	1.4	53.8	5.1			119	6.4	
Bx	56 - 66	3.0	54	32	66	20	15	0.76	0.27	0.10	<0.02	4.4	20.5	5.3			98	10.0	
C	81 - 91	2.3	73	19	80	13	8	3.34	0.79	0.12	<0.02	2.4	63.8	6.0			150	13.2	
C	97 - 102	2.3	70	24	78	16	6	3.33	0.81	0.13	<0.02	2.4	64.0	5.8			109	18.1	
C	104-112	1.8	86	28	78	16	6	2.72	0.66	0.13	0.04	1.6	69.5	6.0			134	49.8	
C	119-127	2.0	70	27	80	17	3	3.32	0.78	0.13	<0.02	1.3	77.0	6.2			143	43.4	

Profile No. 5. Craigrae Beg Deecastle Association Deecastle Series Lab Numbers 159234 – 41

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	0 - 3	43.6	N.D.	N.D.	N.D.	N.D.	N.D.	5.59	3.44	0.24	1.07	47.0	18.0	4.4	19.85	0.64	111	2.6	Mainly moderate exchangeable bases (high Ca in C(g) horizon). Low or moderate % base saturation in upper horizons, high in C(g) and C horizons. Moderate total P_2O_5 in upper horizons, low in C(g) and C horizons. Low readily soluble P_2O_5.
A	3 - 10	19.0	66	16	76	5	4	2.37	0.96	0.13	0.48	20.2	16.3	4.9	9.82	0.43	114	<0.1	
A	13 - 23	13.5	69	17	79	7	7	3.60	0.81	0.17	0.24	13.7	26.1	5.4	4.88	0.29	105	<0.1	
Bw	25 - 33	9.1	70	20	82	8	6	2.70	0.74	0.14	0.14	12.7	22.7	5.6			113	<0.1	
Bw	36 - 43	8.1	64	21	75	10	12	5.92	1.80	0.29	0.23	11.0	42.9	5.6			123	<0.1	
C(g)	46 - 56	4.4	49	27	62	14	22	14.58	4.27	0.38	0.27	4.7	80.7	6.4			56	0.4	
C(g)	56 - 66	4.2	44	21	51	14	33	12.91	2.74	0.25	0.20	5.3	75.1	6.5			50	<0.1	
C	76 - 86	4.2	72	14	79	7	12	7.31	1.79	0.23	0.24	4.8	66.6	6.0			87	0.6	

N.D. = Not Determined

Profile No. 6 Clearfield Dinnet Association Dinnet Series Lab Numbers 159442 – 48

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	0 - 1	78.8	N.D.	N.D.	N.D.	N.D.	N.D.	1.90	<0.02	0.64	0.26	68.7	3.9	4.0	40.75	1.58	169	30.7	Low clay. Mainly low Ca, Mg and K. Low % base saturation. Mainly moderate total P_2O_5 and high readily soluble P_2O_5.
A	5 - 15	9.6	64	25	80	10	6	<0.15	0.59	0.10	0.20	13.6	6.2	4.1	5.48	0.24	55	0.9	
Bw	30 -41	5.9	64	28	80	12	6	<0.15	0.11	0.10	0.06	12.4	2.1	4.3	2.92	0.14	55	<0.1	
Bx1	56 - 66	1.8	67	25	80	12	8	<0.15	<0.02	0.06	<0.02	4	1.5	4.3			68	1.0	
Bx2	86 - 97	1.0	65	27	77	15	8	<0.15	<0.02	0.05	<0.02	1.5	3.1	4.3			75	8.7	
C(x)(g)	114-124	0.9	69	24	78	15	7	<0.15	<0.02	0.07	<0.02	2.1	3.2	4.4			55	3.9	
C	140-150	1.2	65	21	73	13	14	<0.15	1.17	0.13	0.08	3.6	27.8	5.4			63	12.6	

Profile No. 7 Lower Powburn Laurencekirk Association Drumforber Series Lab Numbers 178895 – 99

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 10	7.0	38	36	57	16	23	20.28	0.79	0.19	0.43	<0.1	100.0	6.3	2.25	0.19	268	32.5	Mainly moderate exchangeable bases (high Ca in Ap and Bw horizons). High % base saturation. Mainly moderate total P_2O_5 and high readily soluble P_2O_5.
Ap	20 - 30	6.2	46	30	61	16	21	14.99	0.95	0.15	0.35	0.6	96.3	5.6	1.90	0.15	233	26.4	
Bw	36 - 46	4.9	57	23	66	14	18	9.55	0.97	0.20	0.21	2.0	84.5	6.4			192	9.6	
C	76 - 91	3.5	58	25	71	12	17	8.44	1.72	0.11	0.43	<0.1	100.0	6.7			80	12.3	
C	102-117	3.8	59	26	68	17	15	2.85	2.09	0.19	0.40	<0.1	100.0	6.6			99	29.9	

Profile No. 8 Northhill Wood Laurencekirk Association Oldcake Series Lab Numbers 61594 – 98

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	5 - 10	21.8	N.D.	N.D.	61	13	12	0.96	1.89	N.D.	0.61	29.7	10.5	4.6	10.80	0.46	178	1.7	Mainly moderate exchangeable bases. Low or moderate % base saturation in upper horizons, high in lower C samples. Mainly moderate total P_2O_5. Low readily soluble P_2O_5 in Ah and Bw, high in lower two C samples.
Bw	15 - 25	5.2	N.D.	N.D.	48	22	28	0.68	1.42	N.D.	0.26	9.3	20.2	5.1	0.76	0.08	74	0.5	
C	41 - 51	3.8	N.D.	N.D.	44	23	30	4.63	5.64	N.D.	0.29	2.4	21.6	5.8	0.12	0.05	115	8.9	
C	66 - 76	2.9	N.D.	N.D.	42	26	29	6.91	8.09	N.D.	0.28	0.9	94.8	6.2			153	43.3	
C	91 - 107	3.4	N.D.	N.D.	42	23	31	7.24	5.88	N.D.	0.23	1.0	93.1	6.4			173	67.7	

N.D. = Not Determined

Profile No. 9 Leys of Barras Mountboy Association Garvock Series Lab Numbers 120449 – 52

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	17.9	35	39	52	22	13	9.23	1.16	0.26	0.43	18.4	37.6	5.8	8.03	0.61	458	8.2	Moderate or high exchangeable bases. Moderate % base saturation, high in C horizon. High total P_2O_5 in Ap and Bx horizons, moderate in C horizon. High readily soluble P_2O_5 in C horizon.
Bx	18 - 28	6.5	69	17	78	8	11	4.91	0.93	0.16	0.25	7.3	46.2	5.6	1.02	0.07	343	8.6	
Bx	36 - 43	5.3	67	23	78	13	7	6.78	1.46	0.21	0.38	6.2	58.6	5.8			325	15.8	
C	61 - 71	4.8	31	48	52	28	18	16.08	7.22	0.71	0.16	4.4	84.5	6.6			255	60.0	

Profile No. 10 Bruxie Hill Mountboy Association Garvock Series Lab Numbers 75564 – 68

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	3 - 13	43.2	N.D.	N.D.	N.D.	N.D.	N.D.	3.92	0.82	N.D.	0.38	64.9	7.3	5.1	21.50	1.38	398	1.5	Low clay. Low or moderate exchangeable bases. Low % base saturation (moderate in lower CR sample). High total P_2O_5 in A and B horizons, moderate in CR. Low readily soluble P_2O_5 in upper horizons.
A	18 - 25	15.2	N.D.	N.D.	66	20	7	0.61	0.28	N.D.	0.18	25.8	4.0	5.3	4.62	0.35	394	1.4	
Bw	30 - 41	14.4	N.D.	N.D.	66	18	9	0.13	0.19	N.D.	0.16	23.4	1.9	5.2	3.39	0.34	370	1.6	
CR	46 - 66	6.8	N.D.	N.D.	88	6	2	1.39	0.88	N.D.	0.05	15.8	12.8	5.2			229	11.5	
CR	66+	4.1	N.D.	N.D.	87	6	6	4.28	2.15	N.D.	0.09	7.3	47.0	5.7			279	13.7	
						6													

N.D. = Not Determined

Profile No. 11 West Mains of Dunnichen Mountboy Association Garvock Series Lab Numbers 105472 – 74

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A	3 - 13	28.3	N.D.	N.D.	N.D.	N.D.	N.D.	2.98	1.51	0.31	0.87	37.6	12.9	4.8	14.00	0.88	312	2.6	Low clay in Bw and CR horizons. Mainly moderate exchangeable bases (high Ca and Mg in CR). Low % base saturation in A horizon. Moderate or high total P_2O_5. Low or moderate readily soluble P_2O_5.
Bw	23 - 30	14.6	44	41	66	19	8	7.85	3.34	0.28	0.45	24.7	32.6	5.6	6.48	0.47	240	0.8	
CR	41 - 48	5.1	66	24	83	7	7	14.95	7.64	0.28	0.53	13.8	63.0	6.1			225	4.6	

N.D. = Not Determined

Profile No. 12 Corsedardar Wood Strichen Association Fungarth Series Lab Numbers 172532 – 37

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	0 - 3	2.5	N.D.	N.D.	N.D.	N.D.	N.D.	25.38	3.38	0.76	1.73	51.7	37.7	4.3	34.52	1.24	194	5.1	Low Ca, Mg and K below F horizon. Low % base saturation below F, low pH. Mainly moderate total P_2O_5. Low readily soluble P_2O_5 below F
Ah	3 - 10	17.4	48	27	65	11	11	<0.15	0.30	0.23	0.31	20.4	4.0	4.3	9.25	0.31	110	0.8	
AB	13 - 23	11.1	50	32	66	16	12	<0.15	0.06	0.06	0.08	11.8	1.7	4.2	5.12	0.15	81	0.5	
Bw	28 - 38	14.6	57	26	73	11	10	<0.15	0.05	0.07	0.04	18.2	0.9	4.3			117	0.7	
Bw	56 - 66	14.4	55	31	71	15	8	<0.15	0.05	0.07	0.06	17.1	1.0	4.6			137	0.9	
CR	86 - 94	3.2	69	20	79	10	11	<0.15	0.02	0.06	0.04	3.1	3.7	4.5			68	0.8	

N.D. = Not Determined

Profile No. 13 Tillyarblet Strichen Association Fungarth Series Lab Numbers 172176 – 82

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
LF	0 - 5	45.9	N.D.	N.D.	N.D.	N.D.	N.D.	5.58	2.70	0.35	1.33	32.2	23.6	4.2	24.42	1.30	272	12.6	Low exchangeable bases and % base saturation below LF horizon. Low pH. Moderate total P_2O_5. Low readily soluble P_2O_5 below LF, moderate in Bx.
A	5 - 15	13.1	51	32	68	15	11	<0.15	0.35	0.08	0.19	15.0	4.0	4.2	5.22	0.33	136	0.8	
AB	20 - 28	9.4	52	32	67	17	11	<0.15	0.10	0.07	0.16	10.3	3.1	4.4	4.04	0.24	115	0.4	
Bw1	28 - 36	8.1	46	36	67	16	13	<0.15	0.05	0.05	0.10	9.8	2.0	4.6	2.57	0.16	137	0.2	
Bw1	41 - 48	7.4	45	38	64	19	13	<0.15	<0.02	0.05	0.07	6.9	1.8	4.6	1.79	0.15	143	0.5	
Bw2	51 - 58	5.8	40	38	57	21	19	<0.15	0.05	0.05	0.07	6.0	2.7	4.7	1.12	0.07	125	0.8	
Bx	66 - 76	4.5	48	33	60	20	17	<0.15	0.06	0.05	<0.02	4.4	2.4	4.9	0.56	0.03	138	4.2	

N.D. = Not Determined

Profile No. 14 Balnacraig Tarves Association Tarves Series Lab Numbers 172538 – 44

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A	3 - 13	12.1	54	27	68	12	14	3.08	0.76	0.12	0.37	9.5	31.3	4.7	6.40	0.33	95	1.4	Low exchangeable bases and % base saturation below A horizon. Low pH. Low total P_2O_5 in upper horizons. Readily soluble P_2O_5 ranges from low in A to high in lower horizons.
Bw	18 - 28	6.3	46	34	63	17	18	<0.15	0.10	<0.03	0.08	7.5	2.5	5.0	2.50	0.14	83	0.8	
Bx	28 - 36	5.3	50	32	64	18	16	<0.15	0.07	<0.03	0.08	6.4	2.3	4.9	1.70	0.09	92	4.5	
B(x)	41 - 51	4.2	46	34	62	18	18	<0.15	0.07	<0.03	0.10	5.0	3.3	4.9			67	5.3	
BC	51 - 58	3.0	54	31	66	18	15	<0.15	0.16	<0.03	0.08	4.9	4.7	5.0			76	14.3	
BC	66 - 76	2.6	54	31	67	18	15	<0.15	0.22	<0.03	0.08	3.0	9.1	5.0			105	17.4	
C	81 - 86	2.7	57	28	68	16	16	<0.15	0.03	<0.03	0.08	2.7	3.9	4.8			110	17.7	

Brown Forest Soils with gleying

Profile No.15 Denmark Balrownie Association Balrownie Series Lab Numbers 105674 – 79

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	8.0	50	30	64	17	16	5.38	0.72	0.16	0.08	7.2	47.0	6.1	3.46	0.15	180	4.5	Moderate exchangeable bases. High % base saturation below Ap. High pH in C(g) horizon. Moderate or low total P_2O_5. High readily soluble P_2O_5 in C(g) horizon.
B(g)1	23 - 30	2.5	56	25	67	13	17	4.57	0.75	0.16	0.05	2.2	72.1	6.1	0.32	0.04	65	6.5	
B(g)2	38 - 46	2.7	57	25	65	17	16	6.72	1.04	0.13	0.10	1.8	81.4	6.6	0.14	0.03	74	9.0	
C(g)	53 - 61	2.1	58	25	70	13	15	7.74	1.58	0.13	0.11	1.1	89.8	6.8			98	28.1	
C(g)	71 - 81	1.8	59	24	70	14	15	7.48	1.87	0.11	0.11	<0.1	100.0	7.0			112	39.8	
C(g)	94 - 104	1.8	58	28	70	16	14	7.30	1.24	0.12	0.11	<0.1	100.0	7.0			248	55.1	

Profile No. 16 Bonnyton Balrownie Association Balrownie Series Lab Numbers 105498 – 503

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	6.1	49	28	59	19	19	7.70	0.66	0.12	0.08	4.2	66.8	6.1	2.09	0.18	179	8.3	Mainly moderate exchangeable bases. High % base saturation. Moderate to low total P_2O_5. High readily soluble P_2O_5 below Ap horizon.
B(g)1	23 - 30	2.8	48	30	60	18	20	7.35	0.44	0.10	0.10	2.2	78.5	6.2	0.29	0.05	79	12.6	
B(g)2	33 - 41	2.5	55	24	62	17	18	9.10	0.62	0.11	0.10	1.5	86.8	6.2	0.21	0.04	73	11.0	
BC	51 - 61	2.0	54	26	64	17	18	9.15	0.61	0.11	0.10	1.1	90.0	6.6			106	31.0	
C	76 - 84	1.8	55	27	64	18	16	8.25	0.66	0.11	0.10	0.9	91.3	6.8			135	50.3	
C	97 - 107	1.7	57	25	67	15	16	8.10	0.69	0.10	0.10	<0.1	100.0	7.2			132	56.4	

Profile No. 19 Wood of Aldbar Balrownie Association Balrownie Series Lab Numbers 105658 - 62

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	6.0	51	26	62	16	19	8.45	0.29	0.11	0.34	4.3	67.7	6.1	2.15	0.22	167	7.6	Moderate or high exchangeable bases. High % base saturation. Moderate or low total P_2O_5. High readily soluble P_2O_5 in C(g) horizon.
B(g)1	28 - 36	3.9	60	23	62	13	22	8.41	0.67	0.14	0.13	2.3	80.3	6.5	0.73	0.08	102	7.9	
B(g)2	51 - 58	2.9	50	28	63	15	19	9.37	1.49	0.18	0.15	1.3	89.5	6.3			68	2.7	
BC(g)	69 - 76	2.8	45	29	58	17	23	9.53	2.58	0.17	0.18	1.7	88.0	6.2			85	3.5	
C(g)	102-112	2.7	52	23	57	18	22	7.26	6.20	0.21	0.22	1.5	90.0	6.3			148	35.2	

Profile No. 18 Kincaldrum Hill Balrownie Association Balrownie Series Lab Numbers 98507 – 13

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	8.4	N.D.	N.D.	59	15	22	5.24	0.22	0.10	0.10	7.1	44.5	5.8	3.28	0.25	192	5.5	Moderate or low exchangeable bases. Moderate % base saturation in upper horizons, high in lower. Mainly moderate total P2O5. Moderate or low readily soluble P2O5 (high in lower C(g) sample).
Bw	23 - 30	5.6	N.D.	N.D.	65	13	19	3.38	0.14	0.08	0.05	5.0	42.2	6.3	1.22	0.10	145	2.6	
B(g)	30 - 38	4.1	N.D.	N.D.	67	13	18	2.16	0.22	0.07	0.07	4.5	39.9	6.3	0.73	0.05	143	5.6	
Bx(g)	43 - 53	3.2	N.D.	N.D.	58	19	20	5.19	0.72	0.10	0.07	2.2	73.3	6.4			79	5.7	
BCx(g)	63 - 74	3.1	N.D.	N.D.	57	18	22	7.08	1.48	0.11	0.09	1.0	90.2	6.6			65	2.8	
C(g)	79 - 86	2.3	N.D.	N.D.	73	12	13	5.04	1.28	0.15	0.10	0.3	95.4	7.0			133	4.3	
C(g)	89 - 99	2.5	N.D.	N.D.	72	10	16	5.95	1.48	0.16	0.12	<0.1	100.0	7.1			125	14.9	

N.D. = Not Determined

Profile No.19 Montreathmont Moor Balrownie Association Balrownie Series Lab Numbers 91987 – 92

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	8 - 13	13.0	N.D.	N.D.	75	11	8	0.62	0.54	0.16	0.19	18.5	7.5	4.3	7.30	0.29	101	1.4	Moderate or low exchangeable bases. Low % base saturation in Ah and AB(g) horizons, moderate in Bx(g) and high in C(g) horizon. Moderate total P_2O_5. Low readily soluble P_2O_5 in upper horizons, high in lower.
AB(g)	13 - 20	6.8	N.D.	N.D.	54	25	18	<0.15	0.16	0.11	0.08	10.8	3.1	5.0	2.60	0.14	106	0.9	
Bx(g)	38 - 46	2.8	N.D.	N.D.	64	15	18	0.46	0.60	0.13	0.07	2.9	30.7	5.6	0.30	0.04	82	2.7	
C(g)	58 - 66	2.2	N.D.	N.D.	61	14	22	2.60	2.68	0.19	0.13	1.9	74.5	6.0			113	10.2	
C(g)	79 - 86	2.1	N.D.	N.D.	63	13	22	3.97	3.46	0.22	0.14	1.4	84.5	6.2			143	23.2	
C(g)	97 - 107	2.1	N.D.	N.D.	61	15	22	4.12	2.60	0.22	0.13	1.4	83.2	6.3			138	20.6	

N.D. = Not Determined

Profile No. 20 Chapelton Balrownie Association Balrownie Series Lab Numbers 88303 – 07

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	8 - 20	6.8	N.D.	N.D.	53	20	23	13.42	0.28	0.10	0.14	0.5	96.7	6.2	2.58	0.22	140	9.4	Moderate exchangeable bases (high Ca in Ap horizon). High % base saturation. Low or moderate total P2O5. High readily soluble P2O5 in lower C sample, low or moderate in horizons above.
B(g)1	28 - 36	3.2	N.D.	N.D.	61	13	23	3.97	0.38	0.11	0.11	<0.1	100.0	6.2	0.56	0.08	78	1.8	
B(g)2	41 - 51	2.1	N.D.	N.D.	68	11	19	3.51	0.82	0.13	0.08	0.5	89.5	6.2			53	1.1	
C	58 - 71	1.8	N.D.	N.D.	58	13	28	5.54	2.30	0.18	0.13	<0.1	100.0	6.4			75	3.4	
C	107-117	2.3	N.D.	N.D.	60	14	24	5.86	2.48	0.27	0.15	<0.1	100.0	6.6			111	34.3	

N.D. = Not Determined

Profile No. 21 Goseslie Laurencekirk Association Laurencekirk Series Lab Numbers 114415 – 19

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	5.0	36	37	51	21	25	10.11	1.05	0.12	0.50	2.3	83.8	6.7	1.59	0.15	130	10.9	Mainly moderate exchangeable bases. High % base saturation in upper horizons, moderate in lower. Moderate or low total P_2O_5.
B(g)1	23 - 30	3.9	32	35	46	21	29	8.95	1.78	0.14	0.33	2.3	82.7	6.2	0.70	0.06	70	2.5	
B(g)2	41 - 48	4.2	18	52	37	34	28	7.35	2.86	0.20	0.27	3.9	73.6	5.4			70	1.8	
C(g)	61 - 69	3.0	31	38	41	29	28	5.12	3.02	0.23	0.28	6.4	57.5	5.2			130	3.0	
C(g)	94 - 104	3.2	32	33	47	18	32	4.50	2.60	0.27	0.31	7.0	52.3	5.0			170	3.4	

Profile No. 22 Blackiemuir Laurencekirk Association Luther Series Lab Numbers 178908 – 12

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	5 - 15	5.9	52	26	64	14	19	10.62	0.43	0.11	0.12	1.9	85.8	6.6	2.75	0.16	198	28.9	Mainly moderate exchangeable bases. High % base saturation. Moderate total P_2O_5 and high readily soluble P_2O_5.
AB	25 - 36	4.0	66	20	76	10	12	7.04	0.33	0.11	0.10	1.7	81.5	6.5	1.08	0.06	146	11.2	
B(g)1	36 - 48	2.7	72	19	84	8	8	4.12	0.31	0.10	0.07	0.4	92.2	6.5			121	12.1	
B(g)2	66 - 76	2.5	53	30	67	16	17	9.06	2.54	0.16	0.16	<0.1	100.0	6.6			122	17.0	
C	102-112	2.2	51	30	64	17	19	8.60	1.57	0.16	0.18	<0.1	100.0	6.6			135	32.8	

Profile No. 23 Piterriehill, Bonnyton Mountboy Association Mountboy Series Lab Numbers 92823 – 28

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	8.1	N.D.	N.D.	62	17	17	3.38	0.26	0.11	0.42	6.8	39.0	5.6	3.42	0.25	216	4.1	Mainly moderate exchangeable bases. Moderate % base saturation in upper horizons, high in lower. Moderate or low total P_2O_5. High readily soluble P_2O_5 in C(g), moderate and low in horizons above.
B(g)(x)	20 - 30	4.8	N.D.	N.D.	64	22	12	1.38	0.08	0.07	0.20	5.8	22.9	5.7	1.55	0.09	107	1.0	
Bx(g)	33 - 41	2.9	N.D.	N.D.	63	14	20	1.22	0.16	0.07	0.10	4.3	26.7	5.9	0.72	0.05	112	3.6	
BCx(g)	41 - 48	2.5	N.D.	N.D.	62	14	22	3.03	0.82	0.13	0.10	2.4	62.8	5.9			66	2.6	
BCx(g)	51 - 56	2.5	N.D.	N.D.	62	14	22	3.34	1.20	0.14	0.11	2.4	66.4	5.7			72	3.3	
C(g)	79 - 89	1.9	N.D.	N.D.	61	15	22	4.84	2.02	0.16	0.15	1.0	89.6	6.2			121	24.2	

N.D. = Not Determined

Profile No. 24 Drumbertnot Mountboy Association Mountboy Series Lab Numbers 92829 – 33

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	7.2	N.D.	N.D.	56	18	22	22.20	0.36	0.16	0.15	<0.1	100.0	7.9	2.52	0.22	225	7.5	High or moderate Ca, mainly moderate Mg, moderate Na, low or moderate K. High % base saturation and pH. Moderate total P_2O_5 in upper horizons, low in lower. Variable readily soluble P_2O_5.
Ap	25 - 30	5.1	N.D.	N.D.	57	19	22	11.20	1.08	0.21	0.08	<0.1	100.0	7.3	1.68	0.15	183	2.7	
B(g)1	33 - 38	3.5	N.D.	N.D.	62	14	20	7.80	1.94	0.24	0.07	<0.1	100.0	7.3			115	5.7	
B(g)2	41 - 48	2.6	N.D.	N.D.	66	12	20	6.87	2.24	0.22	0.07	<0.1	100.0	7.4			88	12.3	
C(g)	58+	3.1	N.D.	N.D.	65	12	20	12.10	8.00	0.31	0.14	<0.1	100.0	7.6			66	7.5	

N.D. = Not Determined

Profile No. 25 Mains of Dun Pow Association Ingliston Series Lab Numbers 92834 – 40

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	5.4	N.D.	N.D.	25	43	30	9.36	0.98	0.22	0.34	3.4	76.5	6.1	1.56	0.13	224	24.1	Low clay in 2Cg horizon. Ca decresses with depth from high to low. Moderate Mg, Na and K. High % base saturation in upper horizons. Mainly moderate total P_2O_5. High readily soluble P_2O_5 in upper horizons.
Ap	25 - 30	5.2	N.D.	N.D.	21	47	30	8.88	1.42	0.25	0.40	3.4	76.4	6.3	1.29	0.13	219	22.3	
B(g)1	36 - 43	2.7	N.D.	N.D.	33	50	14	6.86	1.54	0.24	0.24	0.5	94.8	6.6	0.52	0.06	139	59.5	
B(g)1	48 - 55	3.6	N.D.	N.D.	27	53	17	5.94	1.58	0.35	0.22	1.9	80.9	5.8			126	25.6	
B(g)2	63 - 74	3.5	N.D.	N.D.	44	42	11	1.98	0.56	0.17	0.18	6.2	31.9	4.4			102	0.8	
Cg	97-107	4.2	N.D.	N.D.	58	29	8	0.76	1.46	0.05	0.05	17.2	11.9	3.2			131	1.6	
2Cg	130-140	0.9	N.D.	N.D.	95	3	1	1.21	0.90	0.09	0.11	1.9	54.8	4.0			71	7.2	

N.D. = Not Determined

Profile No. 26 Upper Criggie Stonehaven Association Stonehaven Series Lab Numbers 61920 – 24

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	8.3	N.D.	N.D.	54	22	20	3.12	1.14	N.D.	0.25	10.3	30.6	5.1	3.91	0.31	301	8.0	High Ca in C(g horizon), moderate or low above. Moderate Mg and K. Moderate % base saturation (high in lower C(g)). Moderate total P_2O_5. Variable readily soluble P_2O_5.
B(g)	33 - 46	5.0	N.D.	N.D.	65	18	14	1.28	0.37	N.D.	0.10	5.1	24.5	5.3	0.84	0.11	181	2.3	
B(g)	56 - 66	5.3	N.D.	N.D.	66	18	14	2.64	1.66	N.D.	0.04	5.3	45.0	5.6	0.60	0.08	209	5.1	
C(g)	76 - 86	3.8	N.D.	N.D.	56	22	19	9.42	N.D.	N.D.	0.08	2.6	N.D.	6.2			108	7.5	
C(g)	94 - 104	3.1	N.D.	N.D.	67	15	15	8.25	4.04	N.D.	0.15	2.2	85.0	6.3			139	15.4	

N.D. = Not Determined

Profile No. 27 Easter Tulloch Stonehaven Association Stonehaven Series Lab Numbers 70197 – 201

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	8.7	N.D.	N.D.	54	19	24	4.56	0.87	N.D.	0.16	14.0	28.6	5.3	2.27	0.30	330	9.1	Moderate or high Ca and Mg, mainly moderate K. Moderate % base saturation in upper horizons, high in lower. Moderate P_2O_5. Variable readily soluble P_2O_5.
B(g)	30 - 41	3.2	N.D.	N.D.	60	15	22	4.82	0.14	N.D.	0.05	5.4	52.5	5.6	0.55	0.07	144	2.2	
B(g)	46 - 56	2.9	N.D.	N.D.	62	13	23	8.22	3.57	N.D.	0.10	4.2	74.1	5.6	0.24	0.05	111	3.6	
C(g)	66 - 76	4.3	N.D.	N.D.	51	17	30	14.50	10.40	N.D.	0.17	3.4	87.9	5.9			104	0.6	
C(g)	91 - 107	3.6	N.D.	N.D.	55	14	28	16.10	8.20	N.D.	0.17	2.6	90.7	6.0			136	14.0	

N.D. = Not Determined

Profile No. 28 Uras Stonehaven Association Stonehaven Series Lab Numbers 69907 – 10

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 15	8.6	N.D.	N.D.	43	21	32	12.57	1.87	N.D.	0.29	10.1	59.4	6.0	1.80	0.26	427	19.5	High Ca, moderate or high Mg, mainly moderate K. High % base saturation. High total P_2O_5 in Ap, moderate below. High readily soluble P_2O_5 in Ap and C(g) horizons, low in B(g)(x) and moderate in B(g).
B(g)(x)	33 - 43	4.4	N.D.	N.D.	50	17	31	11.82	4.83	N.D.	0.12	4.2	80.0	6.4	0.26	0.06	122	1.1	
B(g)	56 - 66	4.1	N.D.	N.D.	51	19	29	12.12	6.19	N.D.	0.06	3.3	84.8	7.0			125	6.6	
C(g)	91 -107	3.9	N.D.	N.D.	69	9	18	18.17	14.25	N.D.	0.16	2.4	93.4	6.8			171	11.0	

N.D. = Not Determined

Profile No. 29 Milton of Tarfside Strichen Association Baikies Series Lab numbers 119197 – 03

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Eh	8 - 13	9.6	69	20	79	10	6	0.31	0.31	0.09	0.17	9.9	8.2	4.3	5.50	0.27	88	2.7	Low or moderate exchangeable bases. Low % base saturation in upper horizons, high in lower. Low total and readily soluble P_2O_5.
AB(g)	15 - 23	4.2	61	23	73	11	14	<0.15	0.04	0.06	0.04	8.8	1.6	5.1	1.60	0.10	58	1.2	
Bs(g)1	28 - 38	8.0	44	43	76	11	9	0.16	0.07	0.06	0.04	4.3	7.4	5.3	2.80	0.15	122	0.9	
Bs(g)2	41 - 48	4.5	56	27	69	14	15	0.15	0.05	0.05	0.04	5.0	5.5	5.0			88	1.1	
B(x)(g)	51 - 58	2.6	55	25	66	15	17	0.61	0.19	0.07	0.08	<0.1	100.0	5.5			52	1.0	
B(x)(g)	63 - 74	2.6	51	23	61	13	23	2.44	0.78	0.09	0.11	<0.1	100.0	5.6			62	0.8	
C(g)	89 - 99	2.9	56	22	64	13	20	4.12	0.94	0.11	0.15	<0.1	100.0	5.6			64	0.8	

Profile No. 30 Anniegathel Strichen Association Baikies Series Lab Numbers 114409 – 14

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	5 - 15	15.4	36	45	62	18	12	0.31	0.18	0.07	0.37	15.7	5.6	4.7	7.64	0.36	165	1.0	Low Ca and Mg, moderate Na and K. Low % base saturation. Moderate total P_2O_5. Low readily soluble P_2O_5.
B(g)	15 - 25	7.7	47	35	65	17	15	<0.15	<0.02	0.05	0.18	8.8	2.7	4.9	2.00	0.11	116	0.6	
B(x)(g)	30 - 38	4.2	54	35	73	15	10	<0.15	0.02	0.04	0.15	2.7	7.1	4.9	0.58	0.05	93	1.4	
B(x)(g)	46 - 53	2.9	46	40	66	19	12	<0.15	0.03	0.06	0.15	1.7	12.4	5.0			95	0.8	
Cg	66 - 74	3.7	45	35	59	21	16	0.15	0.26	0.09	0.18	3.2	17.5	5.4			124	0.6	
Cg	89 - 99	3.5	44	35	58	20	18	0.46	0.23	0.07	0.20	3.2	23.1	5.3			135	0.7	

Profile No. 31 Tillycairn Tarves Association Thistlyhill Series Lab Numbers 172623 – 27

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 10	8.1	47	27	59	15	22	8.54	0.64	0.08	0.14	1.1	90.0	5.7	3.34	0.24	239	11.2	Moderate exchangeable bases. High % base saturation. Moderate total P_2O_5. High readily soluble P_2O_5.
B(g)1	23 - 30	3.8	52	24	62	13	25	9.28	1.92	0.10	0.14	2.7	80.7	5.9	0.76	0.73	146	12.2	
B(g)2	43 - 48	2.2	54	25	62	17	22	7.91	2.10	0.12	0.11	1.0	91.3	6.2			144	42.4	
C(g)	58 - 66	1.8	57	25	65	17	19	7.94	2.54	0.15	0.11	1.4	88.5	6.4			152	51.3	
C(g)	74 - 81	2.0	56	27	66	17	18	7.32	2.91	0.15	0.13	0.6	95.5	6.7			160	53.1	

Profile No. 32 New Mains of Urie Tipperty Association Tipperty Series Lab Numbers 126831 – 36

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 10	12.1	28	33	40	21	33	17.61	2.22	0.27	0.28	4.5	82.0	6.2	4.70	0.34	253	8.8	High U.S.D.A. silt in C(g) horizon. High Ca, moderate or high Mg, moderate Na and K. High % base saturation. Moderate total P2O5 in Ap horizon, low below. Moderate readily soluble P2O5 in Ap horizon and lower C(g) sample, low in other horizons.
Ap	15 - 25	8.9	27	33	39	21	35	17.83	1.69	0.23	0.23	3.5	84.9	6.7	2.55	0.25	176	3.6	
B(g)	33 - 43	5.0	31	33	43	22	33	12.22	1.81	0.21	0.19	0.9	94.1	6.9	0.37	0.03	97	0.6	
B(g)	58 - 69	4.4	30	33	40	23	33	12.66	2.67	0.23	0.22	<0.1	100.0	7.0			82	0.4	
C(g)	89 - 99	4.5	8	53	19	42	37	9.04	6.41	0.27	0.22	0.8	95.2	6.9			69	0.5	
C(g)	112-122	3.9	23	49	35	38	24	6.81	6.83	0.25	0.19	1.0	93.4	6.9			75	8.0	

Iron Podzols – Freely Drained

Profile No. 33 Knowehead Auchenblae Association Auchenblae Series Lab Numbers 88408 – 11

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	8 - 18	7.7	N.D.	N.D.	65	15	16	6.68	0.38	0.08	0.19	16.0	31.4	5.1	3.56	0.28	585	46.4	Low silt and clay. Moderate or low exchangeable bases. Moderate % base saturation. High total and readily soluble P_2O_5 (moderate total P_2O_5 in C horizon).
Bs	23 - 30	3.8	N.D.	N.D.	84	5	7	2.46	0.14	0.07	0.22	11.7	19.9	5.7	1.22	0.09	422	37.2	
B(x)	43 - 53	2.8	N.D.	N.D.	86	4	8	1.54	0.16	0.07	0.17	8.3	18.9	5.8			332	25.2	
C	91 - 102	2.8	N.D.	N.D.	83	5	9	3.69	0.30	0.13	0.17	5.4	44.5	6.0			208	21.9	

N.D. = Not Determined

Profile No. 34 Candy Auchenblae Association Auchenblae series Lab Numbers 70550 – 54

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A	3 - 15	7.2	N.D.	N.D.	75	10	12	2.16	0.22	N.D.	0.19	9.8	20.8	5.3	2.11	0.18	212	13.3	Low silt and clay. Low Ca and Mg, moderate K. Moderate or low % base saturation. Moderate total P_2O_5. High readily soluble P_2O_5.
Bw	36 - 46	2.4	N.D.	N.D.	88	4	5	<0.15	<0.02	N.D.	0.11	3.1	5.2	5.4	0.27	0.03	165	21.2	
Bw	61 - 71	1.7	N.D.	N.D.	93	1	5	0.31	<0.02	N.D.	0.15	2.3	16.8	5.3			158	22.8	
C	76 - 86	2.2	N.D.	N.D.	87	6	5	0.82	<0.02	N.D.	0.14	2.6	27.2	5.4			140	35.2	
C	107 - 122	1.8	N.D.	N.D.	94	1	3	1.08	0.30	N.D.	0.11	2.0	42.4	5.4			154	34.7	

N.D. = Not Determined

Profile No. 35 Cairndrum Auchenblae Association Auchenblae Series Lab Numbers 83436 – 41

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	3.7	N.D.	N.D.	84	3	9	1.57	0.26	<0.03	0.16	0.6	76.6	5.5	1.52	0.14	164	11.9	Low silt and clay. Low exchangeable bases. High % base saturation. Moderate total P2O5 in Ap, low below. High readily soluble P2O5 in upper Ap sample, mainly low below.
Ap	25 - 36	3.6	N.D.	N.D.	78	12	7	2.77	0.28	<0.03	0.09	0.7	81.8	6.0	1.73	0.14	132	2.8	
B1	43 - 53	2.9	N.D.	N.D.	85	4	10	1.37	0.16	<0.03	<0.02	<0.1	100.0	5.8			89	2.8	
B2	74 - 84	1.5	N.D.	N.D.	94	2	4	0.35	0.18	<0.03	<0.02	<0.1	100.0	5.9			64	3.1	
C	102-112	1.4	N.D.	N.D.	93	2	3	0.65	0.12	<0.03	<0.02	<0.1	100.0	5.7			66	2.5	
C	122-132	1.6	N.D.	N.D.	92	2	4	1.11	0.16	<0.03	<0.02	<0.1	100.0	5.5			47	1.2	

N.D. = Not Determined

Profile No. 36 Chapelton Balrownie Association Aldbar Series Lab Numbers 88297 – 302

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	9.7	N.D.	N.D.	57	15	23	8.85	0.24	0.10	0.16	6.4	59.3	6.2	3.96	0.35	183	3.6	Low or moderate exchangeable bases. Moderate % base saturation in upper horizons, high in lower. Moderate total P_2O_5 in upper horizons, low in lower. Moderate and low readily soluble P_2O_5.
Bs	25 -36	5.9	N.D.	N.D.	69	13	16	1.72	0.10	0.08	0.12	6.2	24.0	5.8	1.58	0.16	124	1.0	
Bw	48 - 56	5.1	N.D.	N.D.	73	9	16	1.56	0.14	0.13	0.05	5.0	27.5	5.8	0.88	0.11	130	2.0	
B(x)	64 - 74	2.5	N.D.	N.D.	71	11	16	1.83	0.29	0.12	0.04	0.7	75.7	5.8			58	5.2	
C1	86 - 96	2.2	N.D.	N.D.	72	12	14	2.13	0.70	0.19	0.04	1.2	71.8	5.7			68	6.3	
C2	112-122	2.1	N.D.	N.D.	64	13	21	4.28	1.78	0.18	0.11	1.2	84.0	6.2			74	6.6	

N.D. = Not Determined

Iron Podzols – Freely Drained continued

Profile No. 37 Broom Balrownie Association Aldbar Series Lab numbers 88335 – 40

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	7.9	N.D.	N.D.	60	16	21	6.30	0.14	0.07	0.10	4.7	58.3	6.1	3.11	0.30	201	4.1	Low or moderate exchangeable bases. High % base saturation in Bx and B(x) horizons, moderate in other horizons. Moderate total P_2O_5. Moderate or high readily soluble P_2O_5.
Bw	23 - 33	4.8	N.D.	N.D.	61	16	21	2.46	0.16	0.07	0.06	2.4	53.8	6.2	1.14	0.12	165	3.6	
Bx	36 - 43	2.6	N.D.	N.D.	64	17	17	1.22	0.10	0.06	0.06	<0.1	100.0	6.3	0.21	0.04	118	14.1	
B(x)	48 - 56	2.7	N.D.	N.D.	64	16	18	2.43	0.18	0.07	0.11	<0.1	100.0	6.2			104	8.6	
BC	61 - 71	2.4	N.D.	N.D.	63	14	21	0.33	0.26	0.10	0.13	2.6	23.8	5.6			117	11.8	
C	84 - 94	2.4	N.D.	N.D.	58	15	25	0.45	1.00	0.12	0.18	1.7	51.0	5.6			122	28.2	

N.D. = Not Determined

Profile No. 38 Wood of Aldbar Balrownie Association Aldbar Series Lab Numbers 105651 – 57

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	6.2	53	27	66	13	17	6.30	0.14	0.10	0.24	5.3	56.1	6.0	2.21	0.21	209	10.3	Moderate or low exchangeable bases. Moderate % base saturation in upper horizons, high in lower. Moderate total P_2O_5, low in lower B(x) sample. Variable readily soluble P_2O_5 down profile.
Bw1	28 - 36	3.5	56	29	77	9	11	3.21	0.11	0.07	0.08	3.1	52.6	6.3	0.75	0.09	130	1.8	
Bw2	46 - 53	2.4	71	21	83	9	6	2.59	0.09	0.08	0.08	1.8	60.8	6.3	0.34	0.05	148	6.5	
B(x)	58 - 66	1.8	67	19	80	6	12	3.34	0.19	0.10	0.08	1.6	69.7	6.3			161	16.1	
B(x)	76 - 84	2.5	54	25	65	15	18	6.73	1.45	0.14	0.14	3.0	73.6	5.6			82	5.5	
C(g)	89 - 97	2.4	48	31	61	19	18	6.44	1.41	0.14	0.14	1.7	82.5	5.6			116	12.7	
C(g)	107-117	2.5	52	27	62	17	19	8.15	2.72	0.14	0.19	1.6	87.2	5.9			115	19.9	

Profile No. 39 Kincaldrum Hill Balrownie Association Aldbar Series Lab Numbers 98502 – 06

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A	3 - 13	10.2	N.D.	N.D.	58	19	18	3.74	0.40	0.12	0.16	11.7	27.4	5.5	4.41	0.29	210	1.5	Low or moderate exchangeable bases. Moderate % base saturation (high in C horizon). Moderate total P_2O_5. Low readily soluble P_2O_5 in A and Bs horizons, moderate in Bx, and high in C.
Bs	25 - 30	5.5	N.D.	N.D.	61	16	21	2.02	0.18	0.13	0.10	7.4	24.7	5.8	1.21	0.10	163	2.1	
Bx	46 - 56	3.4	N.D.	N.D.	66	16	15	1.53	0.12	0.14	0.04	2.9	39.1	5.9			143	7.4	
Bx	64 - 71	2.8	N.D.	N.D.	68	14	15	1.99	0.26	0.14	0.04	2.2	52.3	5.8			135	7.9	
C	79 - 89	2.4	N.D.	N.D.	74	11	12	3.35	0.96	0.14	0.04	1.3	78.1	5.8			138	11.2	

N.D. = Not Determined

Profile No. 40 Finavon Hill Balrownie Association Aldbar Series Lab Numbers 109990 – 92

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	5 - 10	23.6	50	28	68	9	5	0.97	0.41	0.12	0.30	41.3	4.2	4.5	11.90	0.73	222	1.4	Low or moderate exchangeable bases. Low % base saturation and pH. Moderate total P_2O_5. Low readily soluble P_2O_5.
Bs(m)	15 - 18	15.1	59	23	73	10	10	0.32	0.13	0.09	0.09	34.8	1.8	4.7	6.79	0.39	177	0.9	
Bw	25 - 33	8.8	49	27	62	14	19	0.32	0.05	0.08	0.05	15.0	3.2	4.9			232	1.5	

Iron Podzols – Freely Drained continued

Profile No. 41 Dryleys Boyndie Association Boyndie Series Lab Numbers 99642 – 48

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	7.7	N.D.	N.D.	69	12	16	9.07	0.54	0.14	0.10	5.1	66.0	6.3	2.58	0.25	292	19.4	Low silt and clay. Low or moderate exchangeable bases. High % base saturation. Moderate total P_2O_5 in Ap horizons, low below. High readily soluble P_2O_5 in surface horizon, moderate below.
A	28 - 38	5.7	N.D.	N.D.	74	10	13	9.48	0.62	0.14	0.04	2.5	80.3	6.7	1.86	0.14	228	9.4	
A	51 - 61	3.9	N.D.	N.D.	79	8	9	6.73	0.38	0.11	0.04	<0.1	100.0	7.2	1.26	0.10	176	3.3	
Bs	74 - 79	1.4	N.D.	N.D.	97	<1	1	2.12	0.10	0.05	<0.02	0.1	94.3	6.9			67	3.4	
Bw	86 - 94	1.2	N.D.	N.D.	98	1	<1	1.81	0.12	0.05	<0.02	<0.1	100.0	7.0			77	4.6	
C	104-109	1.5	N.D.	N.D.	96	<1	2	1.82	0.16	0.07	<0.02	<0.1	100.0	7.3			82	2.4	
C	124-135	0.9	N.D.	N.D.	99	<1	<1	1.21	0.06	0.05	<0.02	<0.1	100.0	7.0			82	4.8	

N.D. = Not Determined

Profile No. 42 Anniston Boyndie Association Boyndie Series Lab Numbers 98418 – 24

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	6.7	N.D.	N.D.	70	13	14	5.98	0.40	0.09	0.12	6.4	50.8	5.8	2.62	0.21	201	4.9	Low silt and clay. Moderate Ca, Mg and K in upper Ap sample, low below. Moderate % base saturation in upper Ap samples, low below. Moderate total P_2O_5 in Ap horizon, low below. Moderate readily soluble P_2O_5.
Ap	30 - 41	5.9	N.D.	N.D.	76	9	12	2.46	0.18	0.08	0.04	8.3	24.9	5.7	2.33	0.16	171	3.1	
A	46 - 51	6.7	N.D.	N.D.	81	6	9	1.23	0.14	0.05	0.04	10.6	12.3	5.4	2.18	0.15	122	3.0	
Bs	63 - 71	3.0	N.D.	N.D.	87	5	5	0.61	0.06	0.04	0.02	4.4	14.1	5.3			89	3.2	
Bsx	76 - 84	2.5	N.D.	N.D.	91	4	3	0.61	0.04	0.05	0.04	4.1	16.0	5.2			95	3.5	
C	91 - 99	1.8	N.D.	N.D.	92	3	3	0.30	0.04	0.05	0.02	2.5	14.0	5.4			73	4.2	
C	107-114	1.4	N.D.	N.D.	94	5	<1	0.30	0.06	<0.03	<0.02	1.6	19.6	5.6			90	5.2	

N.D. = Not Determined

Profile No. 43 Arnhall Birch Wood Corby Association Corby Series Lab Numbers 69979 – 84

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
LF	1 - 4	62.6	N.D.	N.D.	N.D.	N.D.	N.D.	14.05	0.03	0.14	0.93	78.0	16.3	4.1	8.05	1.28	275	18.1	Low silt and clay. Mainly low exchangeable bases below H horizon. Low % base saturation. Moderate total P_2O_5, except bottom C sample, which is low. Mainly low readily soluble P_2O_5 below LF horizon.
H	5 - 13	23.8	N.D.	N.D.	64	10	9	1.32	1.24	<0.03	0.57	49.3	6.0	4.0	9.35	0.72	183	2.1	
A	15 - 25	16.8	N.D.	N.D.	71	10	7	<0.15	0.22	<0.03	0.25	41.7	4.1	4.5	5.11	0.33	202	1.5	
Bm	30 - 38	10.3	N.D.	N.D.	81	10	4	<0.15	0.04	<0.03	0.11	24.2	0.6	4.7	2.56	0.15	150	1.0	
C	46 - 61	4.8	N.D.	N.D.	95	<1	1	<0.15	<0.02	<0.03	0.06	8.5	0.7	4.7			142	1.8	
C	91 - 107	2.3	N.D.	N.D.	93	1	4	0.51	0.04	<0.03	0.04	4.4	11.7	5.1			89	6.2	

N.D. = Not Determined

Profile No. 44 Dinnet Burn Corby Association Corby Series Lab Numbers 173647 – 54

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	0 - 1	77.5	N.D.	N.D.	N.D.	N.D.	N.D.	3.29	5.87	0.44	2.05	60.9	16.1	4.0	40.77	1.29	202	21.7	Low silt and clay. Low exchangeable bases below Ah horizon. Low % base saturation and pH. Moderate and low total P_2O_5. Mainly moderate and low readily soluble P_2O_5 (high in F horizon).
Ah	1 - 6	34.8	N.D.	N.D.	N.D.	N.D.	N.D.	7.78	1.92	0.36	0.73	32.2	25.1	4.0	17.70	0.81	124	4.4	
AE	6 - 9	8.8	66	23	79	10	7	1.53	0.55	0.08	0.96	14.8	13.0	4.1	4.54	0.19	72	1.2	
Bs	25 - 36	5.2	71	19	81	9	8	<0.15	0.07	0.04	0.04	5.8	2.5	4.6			66	0.7	
Bx	43 - 51	3.6	83	14	89	7	4	<0.15	0.08	0.04	0.02	3.2	4.2	4.8			84	0.5	
BC(x)	63 - 71	0.4	94	6	95	4	1	<0.15	0.08	0.04	<0.02	2.3	4.9	4.8			110	0.8	
BC(x)	84 - 94	1.6	96	3	97	2	1	<0.15	0.07	0.03	<0.02	2.4	4.0	5.0			145	1.4	
C	109-117	1.2	95	4	97	2	1	<0.15	0.04	0.03	<0.02	1.2	5.5	5.3			92	10.2	

N.D. = Not Determined

Iron Podzols – Freely Drained continued

Profile No. 45 Allachy, Glentanar Countesswells Association Countesswells Series Lab numbers 159250 – 58

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
LF	0 - 2	69.0	N.D.	N.D.	N.D.	N.D.	N.D.	10.30	3.49	0.25	1.05	77.8	16.2	4.1	39.86	1.10	155	11.9	High exchangeable bases in LF and H horizons, low Ca and Mg below, moderate or low Na and K below. Low % base saturation and pH. Moderate total P_2O_5 in LF and H, mainly low below. High readily soluble P_2O_5 in LF and H , low below.
LF	2 - 7	86.0	N.D.	N.D.	N.D.	N.D.	N.D.	16.06	7.83	0.52	1.62	131.9	16.5	3.8	52.52	1.62	170	18.1	
H	8 - 13	90.0	N.D.	N.D.	N.D.	N.D.	N.D.	13.39	9.19	0.61	1.83	148.0	14.5	3.6	55.68	1.61	167	24.3	
E	16 - 23	4.6	66	21	77	11	11	<0.15	0.14	0.04	0.17	9.1	5.0	3.8			24	<0.1	
Bh	28 - 38	17.9	65	17	75	7	5	<0.15	0.13	0.08	0.15	40.0	0.9	4.1			89	<0.1	
Bh	49 - 56	17.7	62	20	75	6	5	<0.15	0.05	0.08	0.11	38.9	0.6	4.2			102	<0.1	
Bx	59 - 69	2.2	65	24	75	14	12	<0.15	<0.02	<0.03	0.04	5.7	3.2	4.2			38	1.4	
Bx	76 - 89	1.5	67	23	77	12	11	<0.15	<0.02	0.04	0.08	3.9	6.0	4.5			25	1.8	
C	104-115	1.4	64	23	74	13	14	<0.15	<0.02	0.04	0.04	4.1	1.9	4.3			26	0.4	

N.D. = Not Determined

Profile No. 46 Drumnagesk Dinnet Association Oldtown Series Lab Numbers 172371 – 79

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	2 - 5	92.5	N.D.	N.D.	N.D.	N.D.	N.D.	2.11	8.31	1.01	1.52	102.3	11.2	4.2	53.15	1.79	185	20.8	Low clay. Low Ca, Mg and K below F horizon. Low % vase saturation. Low total P_2O_5. Low readily soluble P_2O_5 in upper horizons (high in F), high in lower horizons.
Ah	8 - 18	20.5	52	29	69	12	4	<0.15	0.56	0,37	<0.02	26.3	3.4	4.2	10.07	0.50	82	1.0	
Bw	20 - 28	9.0	61	31	78	14	3	<0.15	0.05	0.09	0.07	9.3	2.2	4.6	2.74	0.16	53	0.5	
Bw	38 - 46	5.8	58	33	76	15	7	<0.15	0.07	0.09	0.06	7.7	2.8	4.8	2.48	0.07	80	0.8	
Bx	51 - 58	1.4	67	26	80	13	7	<0.15	0.04	0.07	<0.02	1.7	6.1	4.9			85	7.4	
Bx	76 - 84	1.5	71	22	83	10	6	<0.15	0.02	0.07	<0.02	1.6	5.5	4.5			97	12.7	
BCx	97-104	1.5	70	24	84	11	5	<0.15	0.09	0.07	0.06	1.6	11.8	5.2			87	13.8	
C1	119-127	1.1	68	27	78	17	5	<0.15	0.07	0.10	0.06	1.6	12.4	5.3			83	22.7	
C2	140-147	0.9	71	26	84	13	3	<0.15	0.07	0.20	0.06	1.3	19.9	5.5			84	28.4	

N.D. = Not Determined

Iron Podzols – Freely Drained continued

Profile No.47 Balnacake Forfar Association Vinny Series Lab Numbers 105645 - 50

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	7.7	50	27	60	17	18	5.09	0.26	0.14	0.08	8.9	35.0	5.8	2.64	0.31	192	1.5	Moderate or low exchangeable bases. Moderate % base saturation (high in lower Bx sample). Moderate total P_2O_5. Low readily soluble P_2O_5 in upper horizons, moderate or high in lower.
Ap	28 - 36	6.4	51	27	63	16	18	6.48	0.31	0.12	0.07	6.1	53.5	6.4	2.32	0.24	175	0.9	
Bw1	41 - 51	6.1	54	28	69	14	15	4.93	0.24	0.80	0.03	6.2	49.2	6.4	1.69	0.19	164	1.0	
Bw3	64 - 74	3.7	69	19	78	9	9	2.45	0.11	0.05	0.03	4.0	39.8	6.4			168	5.5	
Bx	79 - 89	2.8	70	20	81	10	7	3.21	0.08	0.05	0.03	2.3	59.8	6.4			137	3.9	
Bx	94 - 104	2.3	61	28	76	13	9	4.58	0.26	0.11	0.11	1.5	77.0	6.6			136	11.4	

Profile No. 48 Montreathmont Forfar Association Vinny series Lab Numbers 88418 – 23

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	8 -15	22.9	N.D.	N.D.	68	10	6	0.96	0.82	0.14	0.32	61.0	3.5	4.2	12.65	0.50	141	1.1	Mainly low Ca, Mg and K. Low % base saturation and pH. Moderate total P_2O_5. Low readily soluble P_2O_5 above C horizon.
Ah	16 - 23	16.5	N.D.	N.D.	74	9	5	<0.15	0.24	0.12	0.17	42.8	1.2	4.7	7.94	0.37	189	0.8	
AB	23 - 30	8.7	N.D.	N.D.	75	12	9	<0.15	0.10	0.07	0.09	29.1	0.9	4.8	3.56	0.20	180	0.7	
Bw1	30 - 41	4.2	N.D.	N.D.	78	9	11	<0.15	0.06	0.06	0.04	11.0	1.4	4.9			142	1.3	
Bw2	41 - 48	3.8	N.D.	N.D.	81	6	9	<0.15	0.02	0.06	0.04	7.8	1.5	4.8			118	1.0	
C	86 - 97	1.2	N.D.	N.D.	90	3	6	<0.15	0.02	0.07	0.02	3.7	2.9	5.0			103	10.8	

N.D. = Not Determined

Profile No. 49 Heatherstacks Forfar Association Vinny Series Lab Numbers 98496 - 501

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	8.8	N.D.	N.D.	67	14	15	8.68	0.38	0.11	0.23	6.1	60.2	6.1	3.52	0.26	196	5.0	Low or moderate exchangeable bases, (high Ca in Ap horizon). High % base saturation, moderate in Bs horizon. Moderate total P_2O_5, low in B(x)2. Moderate or low readily soluble P_2O_5.
Bs	30 - 38	4.2	N.D.	N.D.	74	11	13	4.45	0.18	0.08	0.10	3.8	55.7	6.3	1.05	0.09	112	0.9	
B(x)1	43 - 53	2.4	N.D.	N.D.	82	9	7	2.29	0.14	0.10	0.05	1.6	62.3	6.4	0.31	0.04	137	3.3	
B(x)2	64 - 74	2.0	N.D.	N.D.	76	9	13	5.80	0.46	0.14	0.07	1.0	87.3	6.1			71	0.5	
BC	91 - 99	1.6	N.D.	N.D.	82	9	8	6.25	0.56	0.15	0.07	0.6	92.1	6.1			105	10.2	
C	104-114	1.8	N.D.	N.D.	77	10	11	7.80	1.38	0.11	0.09	1.6	85.5	6.5			106	9.2	

N.D. = Not Determined

Profile No. 50 Woodside of Thornton Laurencekirk Association Newton Series Lab Numbers 178900 – 07

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
L	0 - 5	89.8	N.D.	N.D.	N.D.	N.D.	N.D.	0.00	7.98	0.64	1.27	89.3	18.5	4.1	52.31	1.68	210	17.7	Low or moderate exchangeable bases below H horizon. Low % base saturation in upper horizons, moderate in lowe. Moderate total P2O5. High readily soluble P2O5 in L horizon, variable below.
H	5 - 6	54.0	N.D.	N.D.	N.D.	N.D.	N.D.	5.87	3.36	0.95	0.95	75.5	12.8	3.9	30.85	1.40	226	8.7	
Ah	6 - 14	13.9	49	36	70	15	8	<0.15	0.30	0.19	0.08	33.6	1.7	4.2	7.66	0.31	151	0.3	
AB	14 - 19	16.7	48	33	61	19	16	<0.15	0.03	0.09	0.03	12.0	1.2	4.6			146	0.4	
Bw	25 - 35	4.1	45	33	60	18	20	<0.15	0.03	0.09	0.03	6.0	2.4	4.6			99	1.2	
C	51 - 61	3.0	47	31	59	18	23	<0.15	0.77	0.17	0.05	5.7	14.7	5.0			82	2.8	
C	91-101	2.9	44	36	59	21	20	2.15	2.68	0.26	0.10	3.6	58.8	5.4			102	6.9	
C	107-117	2.6	43	36	58	21	21	1.07	2.85	0.27	0.10	3.5	54.9	5.5			117	14.3	

N.D. = Not Determined

Iron Podzols – Freely Drained continued

Profile No. 51 Easter Tulloch Stonehaven Association Shield Series Lab Numbers 70202 – 06

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	9.2	N.D.	N.D.	57	18	21	5.66	0.71	N.D.	0.22	15.7	29.5	5.4	2.81	0.32	196	16.6	Moderate exchangeable bases (high Ca and Mg in C horizon). Moderate % base saturation (high in C horizon). Moderate total P_2O_5 (high in lower Bw sample). High readily soluble P_2O_5 (moderate in upper Bw sample).
Bw	23 - 33	6.0	N.D.	N.D.	62	17	18	4.55	0.76	N.D.	0.16	14.1	27.9	5.5	0.62	0.09	238	8.9	
Bw	41 - 51	5.3	N.D.	N.D.	62	18	18	3.63	0.68	N.D.	0.15	14.1	24.0	5.2	0.24	0.05	436	10.5	
Bx	61 - 76	4.2	N.D.	N.D.	61	18	19	6.13	1.34	N.D.	0.19	14.1	35.2	5.1			172	19.2	
C	102-117	4.0	N.D.	N.D.	56	18	25	11.54	6.96	N.D.	0.30	4.7	80.0	5.6			174	29.5	

N.D. = Not Determined

Profile No. 52 Uras Stonehaven Association Shields Series Lab Numbers 69911 – 14

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	9.8	N.D.	N.D.	44	23	28	12.98	2.35	N.D.	0.25	10.8	59.1	5.9	2.38	0.32	460	6.2	Moderate Ca and Mg (high Ca in Ap horizon), low K (moderate in Ap). Moderate % base saturation. High total P_2O_5 in upper horizons, moderate in lower. Moderate or high readily soluble P_2O_5.
Bw(x)	53 - 61	6.9	N.D.	N.D.	56	17	24	3.99	1.05	N.D.	<0.02	14.8	25.4	5.3	0.87	0.16	346	13.8	
Bx	66 - 76	4.4	N.D.	N.D.	56	17	25	5.36	0.88	N.D.	0.06	10.6	37.3	5.1			169	13.6	
C	97 - 112	3.9	N.D.	N.D.	53	20	24	8.13	2.43	N.D.	0.08	7.0	60.6	5.0			119	9.6	

N.D. = Not Determined

Profile No. 53 Upper Criggie (uncultivated) Stonehaven Association Shields Series Lab Numbers 61611 – 15

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	5 - 13	21.5	N.D.	N.D.	63	10	11	0.96	0.97	N.D.	0.23	41.8	4.9	4.2	11.16	0.45	147	2.4	Low Ca, moderate or low K. Low % base saturation and pH. Moderate total P_2O_5. Low readily soluble P2O5 in upper horizons, high in lower.
Bw	18 - 30	6.5	N.D.	N.D.	55	21	21	<0.15	N.D.	N.D.	0.07	13.7	1.0	4.8	0.69	0.12	198	1.4	
Bx	41 - 56	5.2	N.D.	N.D.	66	13	19	0.20	N.D.	N.D.	0.10	7.5	1.3	4.7	0.60	0.08	172	4.5	
C	76 - 91	3.8	N.D.	N.D.	73	11	13	0.20	N.D.	N.D.	0.08	7.9	3.4	4.7			175	10.9	
C	117-127	3.1	N.D.	N.D.	73	9	8	<0.15	0.36	N.D.	0.65	8.1	6.6	4.7			142	23.4	

N.D. = Not Determined

Profile No. 54 Upper Criggie Stonehaven Association Shield Series Lab Numbers 61616 – 20

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	15.1	N.D.	N.D.	55	20	17	4.70	1.01	N.D.	0.12	16.4	26.2	5.2	7.17	0.48	282	3.1	Low or moderate exchangeable bases and % base saturation. Moderate total P_2O_5. Moderate readily soluble P_2O_5 in upper horizons, high in lower.
Bw1	18 - 28	5.1	N.D.	N.D.	63	18	16	1.22	N.D.	N.D.	0.06	8.9	12.6	5.3	1.33	0.13	208	4.5	
Bw2	33 - 48	5.1	N.D.	N.D.	70	17	10	1.28	N.D.	N.D.	0.10	9.5	12.7	5.1			144	8.8	
Bw2	63 - 76	3.2	N.D.	N.D.	68	17	12	0.81	N.D.	N.D.	0.05	9.7	8.1	5.1			168	24.1	
C	91 - 107	4.0	N.D.	N.D.	71	14	11	1.54	0.64	N.D.	0.05	7.4	23.2	5.1			160	19.5	

N.D. = Not Determined

Profile No. 55 White Caterthun Strathfinella Association Strathfinella Series Lab numbers 86066 – 70

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 11	11.0	N.D.	N.D.	72	11	12	0.82	0.84	0.03	0.46	15.5	12.2	4.4	6.06	0.28	106	1.0	Low or moderate exchangeable bases. Low % base saturation and pH. Moderate total P_2O_5, low in C horizon. Low readily soluble P_2O_5 in upper horizons, moderate in lower.
Bw1	18 - 28	9.7	N.D.	N.D.	63	15	17	<0.15	0.36	<0.03	0.25	14.2	4.1	4.8	3.18	0.16	134	0.8	
Bw2	33 - 43	7.5	N.D.	N.D.	60	16	21	<0.15	0.30	<0.03	0.13	6.3	6.4	4.7			152	1.7	
Bx	58 - 69	3.7	N.D.	N.D.	56	20	21	<0.15	0.28	<0.03	0.09	6.1	5.7	4.8			103	4.8	
C	86 - 94	2.9	N.D.	N.D.	63	13	21	<0.15	0.36	<0.03	0.10	5.7	7.4	4.9			88	5.4	

N.D. = Not Determined

Profile No. 56 White Caterthun Strathfinella Association Strathfinella Series Lab Numbers 86050 – 54

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
FH	3 - 8	77.7	N.D.	N.D.	N.D.	N.D.	N.D.	3.71	4.26	0.89	0.72	66.8	12.5	3.9	37.80	1.59	182	11.1	Mianly low exchangeable bases. Low % base saturation and pH. Moderate or low total P_2O_5. High readily soluble P_2O_5 in FH horizon, low in middle horizons, moderate in C horizon.
E	8 - 15	8.7	N.D.	N.D.	71	12	13	0.15	0.22	0.13	0.25	10.9	6.5	4.1	3.92	0.19	63	1.4	
Bw1	15 - 23	9.3	N.D.	N.D.	66	11	18	<0.15	0.08	0.06	0.14	8.3	3.3	4.6			89	1.2	
Bw2	23 - 30	5.8	N.D.	N.D.	70	10	17	0.15	0.06	0.04	0.11	6.3	5.4	4.6			126	1.4	
C	51 - 61	2.6	N.D.	N.D.	71	12	14	<0.15	0.12	<0.03	0.04	4.4	3.8	4.8			187	9.3	

N.D. = Not Determined

Profile No. 57 Arnbarrow Strathfinella Association Strathfinella Series Lab Numbers 69990 – 93

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0- 20	7.1	N.D.	N.D.	54	18	25	2.98	0.46	N.D.	0.22	7.9	31.8	5.2	2.52	0.21	251	6.3	Low clay in C horizon. Low Ca and Mg, moderate K. Moderate % base saturation (high in C horizon). Moderate total P_2O_5. Moderate readily soluble P_2O_5 in Ap, low in Bs, and high in Bx and C horizons.
Bs	33 - 48	6.4	N.D.	N.D.	59	17	22	2.78	0.17	N.D.	0.10	6.1	33.4	5.6	1.50	0.14	222	2.0	
Bx	56 - 66	2.9	N.D.	N.D.	72	13	12	0.89	0.09	N.D.	0.10	1.4	44.3	5.7			183	15.9	
C	97 - 112	1.9	N.D.	N.D.	84	9	5	0.57	0.13	N.D.	0.11	0.2	78.0	5.6			155	17.7	

N.D. = Not Determined

Profile No. 58 Edzell Hill Strathfinella Association Strathfinella Series Lab Numbers 83406 – 10

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	3 - 13	9.3	N.D.	N.D.	72	11	13	1.29	0.48	0.06	0.22	10.8	16.0	5.4	4.48	0.26	121	0.5	Low or moderate exchangeable bases. Low % base saturation in upper horizons, moderate in lower. Moderate total P_2O_5 in upper horizons, low in lower. Low readily soluble P_2O_5.
Bw	23 - 30	7.3	N.D.	N.D.	74	9	14	0.67	0.14	0.07	0.07	6.3	13.1	5.7	1.53	0.15	109	0.2	
Bx	38 - 48	2.6	N.D.	N.D.	62	12	23	<0.15	0.10	<0.03	0.06	2.1	9.7	5.3			64	0.9	
BC	63 - 74	2.8	N.D.	N.D.	59	15	24	0.82	0.58	<0.03	0.10	4.0	27.1	5.6			61	0.3	
C	86 - 94	2.7	N.D.	N.D.	71	12	14	0.59	0.52	<0.03	0.11	2.6	32.0	5.7			91	1.2	

N.D. = Not Determined

Iron Podzols – Freely Drained continued

Profile No.59 Anniegathel Strichen Association Strichen Series Lab Numbers 86777 - 81

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
FH	3 - 10	34.5	N.D.	N.D.	N.D.	N.D.	N.D.	0.65	1.08	0.21	0.52	29.3	7.8	4.1	20.10	0.79	237	1.1	Mainly low Ca, Mg and K, moderate Na. Low base saturation. Moderate total P_2O_5. Low readily soluble P_2O_5.
E	10 - 15	12.6	N.D.	N.D.	58	16	20	<0.15	0.32	0.07	0.19	13.9	4.0	4.6	5.23	0.29	150	1.0	
Bs	20 - 28	6.6	N.D.	N.D.	52	23	22	0.16	0.16	0.04	<0.02	4.6	7.3	4.9			179	1.9	
Bx	53 - 63	3.7	N.D.	N.D.	53	20	23	<0.15	0.16	0.05	0.03	1.4	15.0	5.0			106	2.1	
C	97 - 107	3.8	N.D.	N.D.	54	18	24	<0.15	0.16	0.05	0.03	1.3	16.1	5.1			107	1.8	

N.D. = Not Determined

Profile No. 60 Glensaugh Strichen Association Strichen Series Lab Numbers 61578 – 82

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 18	10.2	N.D.	N.D.	37	25	33	14.99	0.37	N.D.	0.16	3.4	82.1	6.5	5.56	0.29	285	1.0	High Ca in Ap horizon, low below. Low or moderate K. High % base saturation in Ap, low in Bs and upper C horizon sample, moderate in bottom C sample. Moderate total P_2O_5 (high in lower Bs sample). Low or moderate readily soluble P_2O_5.
Bs	33 - 48	6.3	N.D.	N.D.	55	25	17	0.68	N.D.	N.D.	N.D.	7.0	8.9	5.3	0.92	0.11	283	N.D.	
Bs	61 0 74	8.0	N.D.	N.D.	58	23	14	0.27	N.D.	N.D.	0.06	8.9	3.6	5.3			392	2.8	
C	81 - 96	5.1	N.D.	N.D.	54	23	20	0.26	N.D.	N.D.	0.12	2.3	14.0	5.3			164	6.4	
C	102-109	4.4	N.D.	N.D.	64	15	19	0.26	N.D.	N.D.	0.06	0.9	26.3	5.4			145	3.9	

N.D. = Not Determined

Profile No. 61 Milton of Tarfside Strichen Association Strichen Series Lab Numbers 119204 – 09

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
E	5 - 13	7.9	70	23	83	10	3	0.46	0.32	0.09	0.17	3.5	22.8	4.4	4.21	4.21	53	3.3	Mainly low exchangeable bases. High % base saturation below Bs horizon. Mainly low total P_2O_5 and moderate readily soluble P_2O_5.
Bs	15 - 25	9.5	66	22	77	11	7	<0.15	0.12	0.07	0.08	4.9	5.2	4.6	3.32	0.19	135	0.9	
B(s)	36 - 43	3.2	57	28	69	15	12	<0.15	0.02	0.04	0.04	<0.1	100.0	5.0			79	4.3	
Bx	61 - 71	2.9	55	26	68	13	16	<0.15	0.02	0.03	0.04	<0.1	100.0	4.9			86	5.0	
Bx	74 - 81	2.5	60	24	72	11	14	<0.15	<0.02	0.03	0.04	<0.1	100.0	4.8			81	3.8	
Bx	86 - 96	2.4	55	23	66	12	20	<0.15	0.04	0.05	0.14	<0.1	100.0	4.8			83	3.6	

Profile No. 62 Milton Strichen Association Strichen Series Lab Numbers 178927 – 33

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
LF	0 - 4	65.2	N.D.	N.D.	N.D.	N.D.	N.D.	<0.15	2.18	0.38	2.35	75.4	6.1	4.0	38.64	1.26	217	5.9	Mainly low exchangeable bases. Low % base saturation and pH. Low total P2O5 (moderate in LF). Moderate or low readily soluble P2O5.
A	4 - 9	13.6	68	21	85	4	4	<0.15	0.35	0.08	0.25	20.8	3.2	4.0	7.49	0.47	82	1.6	
E	13 - 20	7.3	59	28	75	13	9	<0.15	0.02	0.03	0.06	10.5	1.0	4.3	3.21	0.17	93	<0.1	
Bs	38 - 46	5.0	62	24	75	11	11	<0.15	0.02	0.02	0.05	8.4	1.1	4.5			77	0.2	
Bs	46 - 53	2.2	74	18	84	8	9	<0.15	<0.02	0.01	<0.02	3.4	0.6	4.6			76	5.3	
Bx	76 - 84	2.3	66	20	74	12	15	<0.15	<0.02	0.03	0.07	2.1	4.6	4.6			85	4.8	
C	101-114	2.4	57	26	68	14	18	0.61	0.03	0..04	0.07	6.8	10.0	4.5			84	3.0	

N.D. = Not Determined

Iron Podzols – Freely Drained continued

Profile No. 63 Inverey, Finzean Tarves Association Tillypronie Series Lab Numbers 172553 – 63

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	0 - 4	91.0	N.D.	N.D.	N.D.	N.D.	N.D.	19.23	7.64	0.39	2.95	77.9	27.9	4.2	52.56	1.33	205	30.4	Mainly low exchangeable bases below H horizon. Low % base saturation below H horizon, low pH. Moderate total P_2O_5 (low in Bx horizon). High readily soluble P_2O_5 in F and lower horizons.
H	4 - 5	66.5	N.D.	N.D.	N.D.	N.D.	N.D.	8.22	3.84	0.22	1.75	67.3	17.3	3.9	38.75	1.22	204	8.2	
Ah	5 - 9	23.2	59	22	71	10	2	<0.15	1.30	<0.03	0.73	34.0	5.6	3.8	13.34	0.91	141	1.8	
Bh	10 - 18	14.1	62	28	77	14	3	<0.15	0.23	<0.03	0.23	28.9	1.6	4.4	7.20	0.27	116	0.9	
Bs1	20 - 28	12.1	63	26	77	12	5	<0.15	0.08	<0.03	0.25	28.5	1.2	4.6			135	0.7	
Bs2	36 - 43	8.0	50	32	64	19	14	<0.15	0.05	<0.03	0.11	14.2	1.2	4.7			113	1.4	
Bx	46 - 51	2.9	58	26	68	16	17	<0.15	<0.02	<0.03	0.11	7.8	1.4	4.7			82	6.6	
Bx	63 - 71	2.2	69	24	78	14	8	<0.15	<0.02	<0.03	0.09	2.2	4.0	4.8			94	13.0	
BC(x)	81 - 91	2.1	74	19	82	10	8	<0.15	0.1	<0.03	0.08	3.0	5.7	4.7			116	16.6	
C	99 - 109	2.5	72	21	81	11	7	<0.15	0.04	<0.03	0.09	2.9	4.5	4.9			155	34.1	
C	112-120	2.6	70	22	80	12	8	<0.15	0.07	0.05	0.09	2.4	8.0	4.8			110	15.3	

N.D. = Not Determined

Iron Podzols – Imperfectly Drained

Profile No. 64 Myreside, Inverkeilor Boyndie Association Anniston Series Lab Numbers 110002 – 07

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	5.0	77	12	81	8	9	5.34	0.85	0.07	0.08	1.8	77.7	6.2	1.90	0.20	161	15.2	Low clay. Low exchangeable bases below Ap horizon. High % base saturation (moderate in upper Bw(g)2 . Moderate total P2O5 in Ap horizon, low below. High readily soluble P2O5.
Ap	25 - 30	1.8	85	9	87	6	5	5.00	0.78	0.04	0.03	0.9	86.6	6.7	0.53	0.08	106	25.2	
Bw(g)1	36 - 43	0.9	94	5	96	4	<1	2.41	0.18	0.05	0.03	1.3	68.8	6.7	0.15	0.05	81	23.1	
Bw(g)2	53 - 61	0.6	99	<1	99	<1	<1	1.66	0.10	0.03	0.02	1.5	55.4	7.0			80	22.1	
Bw(g)2	69 - 76	0.5	98	2	99	1	<1	1.51	0.14	0.03	0.03	<0.1	100.0	7.1			73	18.7	
Cg	91 - 102	0.6	99	<1	99	<1	<1	1.66	0.16	0.04	0.08	<0.1	100.0	6.3			56	16.8	

Profile No. 65 Westside, Maryculter Countesswells Association Dess Series Lab Numbers 60836 – 40

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 20	11.2	N.D.	N.D.	59	20	16	2.31	2.47	N.D.	0.07	13.5	26.4	5.2	5.26	0.34	273	2.5	Low or moderate exchangeable bases. Moderate % base saturation in Ap horizon, low in Bw(g), high below. Moderate total P_2O_5. Low readily soluble P_2O_5, moderate in Bx(g).
Bw(g)	30 - 43	6.5	N.D.	N.D.	60	16	21	1.03	0.18	N.D.	0.08	12.2	9.6	5.2	2.17	0.13	161	2.3	
Bx(g)	56 - 66	1.7	N.D.	N.D.	71	13	14	0.93	0.40	N.D.	0.06	0.4	75.8	5.5			126	8.8	
C(g)	76 - 91	2.1	N.D.	N.D.	58	15	25	2.53	1.14	N.D.	0.12	1.3	73.9	5.7			186	0.2	
C(g)	99 - 109	2.3	N.D.	N.D.	59	12	26	2.74	1.48	N.D.	0.15	0.7	86.6	6.0			116	2.9	

N.D. = Not Determined

Profile No. 66 Maryfield Dinnet Association Maryfield Series Lab Numbers 172380 – 87

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	0 - 2.5	50.7	N.D.	N.D.	N.D.	N.D.	N.D.	5.96	2.77	0.58	1.11	37.6	21.7	4.0	29.22	1.06	169	4.4	Low clay. Mainly low exchangeable bases below H horizon. Low % base saturation. Low total P_2O_5 below Ah horizon. Low or moderate readily soluble P_2O_5 (high in Cx(g) horizon).
Ah	5 - 13	24.5	54	24	68	10	4	<0.15	0.15	0.08	0.06	31.6	0.9	4.2	12.59	0.59	160	1.5	
E(g)1	25 - 36	6.4	68	23	80	11	6	<0.15	0.03	0.17	0.06	10.8	2.4	4.7	2.51	0.13	74	2.0	
E(g)2	41 - 48	5.3	63	28	78	13	7	<0.15	0.09	0.21	0.10	7.7	5.0	4.9			81	2.7	
Bm(g)	48 - 58	3.4	67	25	82	10	9	<0.15	0.02	0.09	<0.02	4.6	2.3	5.1			93	0.8	
Bx(g)	58 - 66	1.6	75	21	86	10	5	<0.15	0.03	0.04	0.02	2.2	3.9	5.0			86	3.7	
Bx(g)	74 - 81	1.4	77	20	86	11	3	<0.15	0.07	0.05	0.02	1.8	7.3	5.0			87	8.2	
Cx(g)	97 - 107	1.1	72	23	84	11	5	<0.15	0.02	0.06	0.02	0.8	10.9	5.3			84	14.5	

N.D. = Not Determined

Profile No. 67 Montreathmont Forfar Association Forfar Series Lab Numbers 88430 – 38

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
FH	5 - 10	58.5	N.D.	N.D.	N.D.	N.D.	N.D.	1.03	1.04	0.05	0.99	83.2	3.6	3.9	33.70	1.12	171	2.8	Low or moderate exchangeable bases. Low % base saturation in upper horizons, moderate in lower. Moderate or low total P2O5. Low readily soluble P2O5 in upper horizons, high in C horizon.
AE(g)	10 - 18	7.1	N.D.	N.D.	74	12	10	<0.15	0.14	0.10	0.08	20.0	1.6	4.5	3.70	0.14	61	1.0	
AE(g)	20 - 28	6.1	N.D.	N.D.	76	10	11	<0.15	0.08	0.09	0.06	17.3	1.3	4.8	2.27	0.10	61	1.0	
AE(g)	28 - 33	5.8	N.D.	N.D.	78	10	9	<0.15	0.04	0.07	0.06	14.7	1.1	4.9	2.18	0.09	74	1.4	
Bx	36 - 43	2.8	N.D.	N.D.	77	12	8	0.15	0.02	0.06	0.04	7.2	3.6	5.0			108	1.0	
Bw	43 - 48	1.8	N.D.	N.D.	83	7	9	0.15	0.02	0.07	0.06	5.1	5.5	5.2			99	2.6	
BC	51 - 63	2.2	N.D.	N.D.	61	18	19	1.23	0.94	0.11	0.13	6.0	28.8	5.3			84	6.9	
C	71 - 81	2.2	N.D.	N.D.	62	17	19	3.21	1.48	0.16	0.14	4.8	51.0	5.7			118	22.8	
C	91 - 102	2.0	N.D.	N.D.	62	15	21	3.21	2.02	0.14	0.14	4.9	53.6	5.9			90	11.2	

N.D. = Not Determined

Profile No. 68 North Mains of Kinnettles Forfar Association Forfar Series Lab Numbers 142725 - 30

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	6.0	65	21	73	12	14	4.15	0.14	0.04	0.11	6.4	40.7	5.6	1.49	0.12	222	16.1	Moderate or low exchangeable bases. Moderate % base saturation in upper horizons, high in lower. Moderate or low total P_2O_5. Mainly high readily soluble P_2O_5 (low in bottom C(g) sample).
Bw(g)1	36 - 46	2.6	90	7	92	4	4	0.76	0.03	<0.03	0.05	1.9	31.3	5.8	0.37	0.04	125	7.6	
Bw(g)2	56 - 66	2.0	76	18	83	11	6	2.88	0.25	0.04	0.13	2.2	60.2	6.0	0.09	0.03	85	12.6	
C(g)	74 - 84	2.2	66	18	75	9	17	5.53	1.18	0.05	0.13	2.9	70.3	6.2			72	13.7	
C(g)	99 - 109	2.4	65	17	71	10	18	6.12	1.85	0.07	0.15	0.7	92.6	6.4			86	17.7	
C(g)	147-163	2.2	71	15	78	8	14	4.89	1.88	0.07	0.11	1.1	86.2	6.3			102	<0.1	

Profile No. 69 Newdyke Forfar Association Forfar Series Lab Numbers 105466 – 71

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	6.0	62	20	73	9	15	6.81	0.32	0.13	0.07	2.6	74.0	6.9	1.77	0.15	143	6.2	Moderate or low exchangeable bases. High % base saturation and pH. Moderate total P_2O_5 (low in Bw(g)1 horizon). High readily soluble P_2O_5 (moderate in Ap).
Bw(g)1	30 - 41	1.6	82	12	87	7	5	2.87	0.42	0.06	0.03	1.0	77.9	6.5	0.11	0.04	79	10.3	
Bw(g)2	51 - 58	1.2	74	19	84	9	6	3.80	0.46	0.08	0.03	0.5	89.0	6.4	0.07	0.03	107	30.2	
Bw(g)3	71 - 81	1.2	74	18	85	7	7	3.94	0.49	0.10	0.07	<0.1	100.0	7.1			111	36.4	
BC(g)	91 - 102	0.8	76	20	88	8	4	2.57	0.26	0.07	0.03	<0.1	100.0	7.6			99	42.5	
C	109 - 119	1.6	51	37	66	22	11	6.10	0.69	0.11	0.13	<0.1	100.0	7.5			142	56.2	

Profile No. 70 Montreathmont Forfar Association Forfar Series Lab Numbers 88424 – 29

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	1 - 8	83.0	N.D.	N.D.	N.D.	N.D.	N.D.	7.78	5.74	0.92	1.51	132.5	10.7	3.6	43.50	1.30	131	13.2	Low Ca, Mg and K below F horizon. Low % base saturation and pH. Low or moderate total P_2O_5. Mainly low readily soluble P_2O_5 below F horizon.
AEh	8 - 13	12.5	N.D.	N.D.	74	12	8	0.16	0.24	0.16	0.15	32.0	2.2	4.6	6.17	0.25	68	1.0	
AB	13 - 20	7.9	N.D.	N.D.	76	13	8	<0.15	0.08	0.09	0.06	18.3	1.2	4.7	3.18	0.15	66	1.0	
Bw(g)	25 - 36	3.0	N.D.	N.D.	76	9	12	<0.15	0.02	0.06	0.08	7.2	2.2	4.8			102	2.2	
Bx(g)	56 - 66	2.9	N.D.	N.D.	81	6	10	<0.15	0.06	0.06	0.06	5.6	3.1	5.0			96	2.1	
Bx(g)	71 - 79	2.1	N.D.	N.D.	82	7	8	<0.15	0.02	0.06	0.04	5.0	2.5	5.1			99	7.6	

N.D. = Not Determined

Profile No. 71 Drumtochty Strathfinella Association Trusta Series Lab Numbers 69882 – 87

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	5 - 8	67.1	N.D.	N.D.	N.D.	N.D.	N.D.	4.32	4.01	N.D.	0.83	95.5	8.8	3.7	20.60	1.24	205	N.D.	Mainly low exchangeable bases. Low % base saturation and pH. Moderate total P_2O_5. Low readily soluble P_2O_5 in E horizon and upper Bw sample, moderate in lower Bw sample and upper C sample, high in lower C sample.
E	10 - 13	7.1	N.D.	N.D.	69	12	15	0.23	0.37	N.D.	0.12	15.4	3.9	4.0	2.50	0.14	123	1.3	
Bw	20 - 30	9.3	N.D.	N.D.	73	10	12	<0.15	0.16	N.D.	0.07	22.0	1.6	4.8	2.35	0.12	127	0.8	
Bw	46 - 61	8.3	N.D.	N.D.	76	11	10	0.71	0.05	N.D.	0.10	12.5	6.4	4.9			198	4.4	
C	76 - 86	4.8	N.D.	N.D.	71	15	11	0.34	N.D.	N.D.	0.04	5.9	6.2	5.0			169	9.0	
C	112-117	3.3	N.D.	N.D.	78	8	11	N.D.	0.15	N.D.	0.07	4.4	4.9	5.0			178	18.1	

N.D. = Not Determined

Iron Podzols – Imperfectly Drained continued

Profile No. 72 Lower Finella Hill Strathfinella Association Trusta Series Lab Numbers 95656 – 59

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	5 - 10	9.5	N.D.	N.D.	61	10	25	1.08	0.66	0.49	0.41	12.2	17.8	4.9	4.09	0.28	179	1.1	Low Ca, low or moderate Mg and K, high Na. Low % base saturation and pH. Moderate total P_2O_5. low readily soluble P_2O_5.
Bw(g)	18 - 28	6.5	N.D.	N.D.	63	12	21	0.15	0.16	0.31	0.21	10.6	7.3	4.7	2.42	0.17	162	0.8	
Bs	33 - 46	7.3	N.D.	N.D.	73	10	13	<0.15	0.04	0.37	0.07	10.1	4.5	4.9			261	2.9	
C	56 - 66	3.9	N.D.	N.D.	75	11	10	<0.15	0.04	0.29	0.03	5.0	6.7	5.0			129	2.3	

N.D. = Not Determined

Peaty Podzols

Profile No. 73 Glendye Countesswells Association Charr Series Lab Numbers 62355 – 60

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	5 - 15	40.0	N.D.	N.D.	N.D.	N.D.	N.D.	1.28	1.62	N.D.	0.53	25.0	12.0	4.2	24.60	1.03	170	3.9	Low or moderate exchangeable bases. Low % base saturation in upper horizons, moderate in lower. Low pH. Moderate or low total P_2O_5. Low readily soluble P_2O_5 below F horizon.
O	20 - 30	78.5	N.D.	N.D.	N.D.	N.D.	N.D.	0.96	0.69	N.D.	0.41	52.3	3.5	4.5	42.40	1.07	206	1.4	
Eg	36 - 51	4.6	N.D.	N.D.	66	15	14	N.D.	N.D.	N.D.	0.25	4.7	5.0	4.6	1.96	0.13	90	0.8	
Bx	58 - 79	3.8	N.D.	N.D.	64	17	16	0.34	N.D.	N.D.	0.13	3.2	13.0	4.8			108	1.5	
C	84 - 91	2.6	N.D.	N.D.	70	14	14	0.20	N.D.	N.D.	0.51	1.3	35.0	4.9			90	2.1	
C	109 - 122	2.0	N.D.	N.D.	78	10	13	N.D.	0.09	N.D.	0.76	1.0	45.0	4.9			90	0.8	

N.D. = Not Determined

Profile No. 74 Cairn o' Mount Countesswells Association Charr Series Lab Numbers 61941 – 47

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	18 - 23	65.7	N.D.	N.D.	N.D.	N.D.	N.D.	1.38	3.64	N.D.	0.23	44.3	10.6	4.2	54.00	1.27	150	1.4	Low Ca, low K below H horizon. Low or moderate % base saturation, low pH. Low total P_2O_5 (moderate in H) and readily soluble P_2O_5 below H horizon.
E	25 - 36	5.9	N.D.	N.D.	82	11	6	N.D.	N.D.	N.D.	<0.02	5.5	34.5	4.4	2.94	0.12	80	0.9	
E	43 - 53	9.4	N.D.	N.D.	78	11	11	0.28	N.D.	N.D.	0.05	11.2	2.1	4.6	3.94	0.17	60	0.9	
Bxs	53 - 63	6.2	N.D.	N.D.	74	14	12	0.31	N.D.	N.D.	0.07	3.8	9.2	4.9			80	0.5	
Bw	79 - 91	3.4	N.D.	N.D.	87	7	6	<0.15	N.D.	N.D.	0.05	1.6	10.4	4.8			80	0.6	
C	102-117	3.7	N.D.	N.D.	85	8	8	1.91	N.D.	N.D.	0.06	1.7	53.5	4.9			70	0.6	

N.D. = Not Determined

Profile No. 75 Strathfinella Strathfinella Association Garrold Series Lab Numbers 179158 – 66

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
FH	0 - 3	92.2	N.D.	N.D.	N.D.	N.D.	N.D.	12.83	7.30	0.34	1.63	133.6	14.2	3.6	55.04	2.00	216	29.9	Low exchangeable bases below H horizon. Low % base saturation and pH. Low total P_2O_5 and readily soluble P_2O_5 below H horizon.
O	5 - 15	77.5	N.D.	N.D.	N.D.	N.D.	N.D.	4.18	3.29	0.22	0.78	82.6	9.3	3.7	46.16	1.79	166	9.4	
E	18 - 20	8.6	64	22	80	5	19	<0.15	0.51	<0.03	0.08	12.4	4.6	3.9	4.58	0.42	55	1.6	
E(g)	20 - 33	10.4	63	22	76	9	10	<0.15	0.09	<0.03	0.04	24.7	0.6	4.1	5.27	0.18	72	0.3	
Bs	38 - 48	9.8	63	21	72	12	11	<0.15	<0.02	<0.03	<0.02	15.0	0.1	4.5			111	0.1	
Bs	63 - 71	6.0	61	25	73	12	12	<0.15	<0.02	<0.03	<0.02	8.7	0.1	4.6			86	0.6	
Bx	76 - 86	4.5	65	23	76	12	10	<0.15	<0.02	<0.03	<0.02	7.9	0.1	4.6			75	1.6	
C1	102-109	4.3	67	21	76	12	10	<0.15	<0.02	<0.03	<0.02	5.1	0.2	4.7			71	1.8	
C2	114-122	4.4	67	21	76	12	10	<0.15	<0.02	<0.03	0.21	4.4	4.5	4.7			82	1.5	

N.D. = Not Determined

Profile No. 76 Clash of Wirren Strichen Association Gaerlie Series Lab Numbers 175073 – 81

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
L	0 - 1	93.3	N.D.	N.D.	N.D.	N.D.	N.D.	19.04	8.11	0.55	1.92	43.4	40.6	4.6	46.47	1.57	181	32.9	High exchangeable bases in L, F and O horizons, mainly low belo. Low % base saturation (moderate in L horizon), low pH. Moderate total P_2O_5. High readily soluble P_2O_5 in L, F and O horizons, low below.
F	1 - 3	94.4	N.D.	N.D.	N.D.	N.D.	N.D.	10.18	7.24	0.79	2.50	80.0	20.6	3.8	54.37	1.73	212	35.1	
O	3 - 13	90.5	N.D.	N.D.	N.D.	N.D.	N.D.	<0.15	4.09	0.63	1.51	85.3	6.8	3.7	52.70	2.10	310	19.3	
Eh	15 - 20	16.6	59	17	70	6	12	<0.15	0.31	0.10	0.12	24.2	2.1	3.9			116	1.2	
Bsh	23 - 28	11.4	55	22	66	10	18	<0.15	0.17	0.07	0.04	23.3	1.2	4.2			159	0.7	
Bs1	41 - 51	9.8	54	28	69	14	13	<0.15	0.05	0.06	0.03	11.9	1.2	4.6			192	0.4	
C	63 - 71	4.9	55	29	68	16	14	<0.15	0.05	0.08	0.03	4.7	3.3	4.6			129	0.8	
C	89 - 96	3.6	63	26	75	15	11	<0.15	0.03	0.04	0.03	2.1	4.6	5.0			119	1.8	
C	104-112	7.1	65	21	73	13	11	<0.15	<0.02	0.04	0.03	2.6	3.0	4.8			126	3.0	

N.D. = Not Determined

Peaty Podzols continued

Profile No. 77 Gaerlie Strichen Association Gaerlie Series Lab Numbers 70235 – 40

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	3 - 8	75.5	N.D.	N.D.	N.D.	N.D.	N.D.	2.83	1.38	N.D.	1.54	57.3	9.1	3.8	32.05	1.36	254	12.5	Low clay in lower horizons. Low or moderate exchangeable bases. Low % base saturation. Moderate total P_2O_5. High readily soluble P_2O_5 in H, Bx and C horizons, low in others.
E	10 - 15	15.5	N.D.	N.D.	72	10	10	0.39	0.37	N.D.	0.28	27.5	3.6	4.3	5.94	0.34	154	0.8	
Bs	18 - 28	11.3	N.D.	N.D.	68	13	14	2.27	0.11	N.D.	0.06	20.8	10.5	4.9	3.86	0.20	196	N.D.	
Bsh	33 - 43	13.4	N.D.	N.D.	67	18	8	N.D.	N.D.	N.D.	0.10	21.3	0.5	4.9			204	0.4	
Bx	51 - 66	6.0	N.D.	N.D.	74	16	8	N.D.	N.D.	N.D.	0.06	8.5	0.7	5.0			173	10.2	
C	96 - 112	6.8	N.D.	N.D.	76	16	5	0.06	0.06	N.D.	0.11	5.3	7.5	5.1			174	13.4	

N.D. = Not Determined

Noncalcareous Gleys

Profile No. 78 Candy Auchenblae Association Candy Series Lab Numbers 70546 – 49

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	17.3	N.D.	N.D.	63	21	12	6.64	0.78	N.D.	0.15	20.7	26.8	5.0	5.61	0.54	282	1.1	Low clay in Cg horizon. Moderate or low exchangeable bases. Moderate % base saturation in Ap and Bg horizons, high in Cg. Moderate total P2O5. Low readily soluble P2O5 in Ap horizon , high below.
Bg	25 - 36	2.4	N.D.	N.D.	80	9	9	2.15	0.46	N.D.	0.03	4.9	34.8	5.0	9.34	0.04	151	10.3	
Bg	51 - 61	2.8	N.D.	N.D.	73	14	11	3.92	0.83	N.D.	0.04	4.1	53.7	5.3			170	17.5	
Cg	97 - 107	1.8	N.D.	N.D.	88	5	5	3.58	0.74	N.D.	0.11	2.1	68.3	4.6			161	15.1	

N.D. = Not Determined

Profile No. 79 Forest Moor Balrownie Association Lour Series Lab Numbers 98514 – 19

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A	3 - 13	11.9	N.D.	N.D.	64	15	15	4.64	1.02	0.21	0.14	10.6	36.0	5.6	5.72	0.34	197	4.7	Moderate exchangeable bases. Moderate % base saturation in A and Eg horizons, high below. Moderate total P_2O_5. Moderate or high readily soluble P_2O_5.
Eg	18 - 23	8.3	N.D.	N.D.	60	16	20	3.84	0.84	0.18	0.12	6.4	43.8	5.9	2.51	0.16	196	11.7	
Bg	28 - 36	3.3	N.D.	N.D.	65	14	17	3.04	0.76	0.13	0.04	1.9	67.5	5.9	0.62	0.06	129	14.7	
BCg	43 - 51	2.3	N.D.	N.D.	61	18	19	5.19	1.52	0.15	0.10	1.0	88.0	6.4			117	4.9	
Cg	66 - 76	2.1	N.D.	N.D.	68	13	17	5.19	1.14	0.12	0.10	<0.1	100.0	7.0			151	5.2	
Cg	91 - 102	1.6	N.D.	N.D.	68	14	16	5.34	0.98	0.12	0.12	<0.1	100.0	7.2			158	7.7	

N.D. = Not Determined

Profile No. 80 Wood of Aldbar Balrownie Association Lour Series Lab Numbers1105663 – 67

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	6.9	32	27	42	16	27	13.75	0.77	0.16	0.27	3.2	82.6	6.8	2.21	0.19	179	9.9	High Ca, moderate Mg, Na and K. High % base saturation and pH. Moderate total P_2O_5. High readily soluble P_2O_5 in Cg horizons, moderate or low above.
Bg1	25 - 33	8.1	21	25	30	16	50	19.80	1.79	0.20	0.25	4.0	84.5	6.7	1.34	0.15	161	1.3	
Bg2	43 - 51	4.4	26	30	36	21	41	19.52	3.15	0.18	0.24	1.9	92.8	6.7			106	4.3	
Cg	71 - 79	4.1	31	23	38	16	44	14.35	4.51	0.18	0.27	<0.1	100.0	7.2			162	37.4	
Cg	99 - 109	3.5	31	24	42	13	41	12.88	3.87	0.17	0.28	<0.1	100.0	7.6			179	67.6	

Profile No.81 Balbegno South Corby Association Mulloch Series Lab Numbers 70216 – 19

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 15	10.8	N.D.	N.D.	57	18	20	14 .7	0.60	N.D.	0.08	6.3	70.9	6.3	3.95	0.28	245	19.6	Low clay in Bg and Cg horizons. Mainly low exchangeable bases (high Ca in Ap horizon). Mainly high base saturation. Moderate total P_2O_5. High readily soluble P_2O_5 in Ap and Eg horizons, moderate below.
Eg	23 - 30	3.8	N.D.	N.D.	71	13	12	3.04	0.22	N.D.	0.09	2.5	57.5	5.7	0.48	0.03	153	29.8	
Bg	43 - 53	1.5	N.D.	N.D.	34	61	4	1.83	0.10	N.D.	0.07	0.6	76.3	5.5			143	9.8	
Cg	102-117	1.3	N.D.	N.D.	55	42	2	1.70	0.18	N.D.	0.03	0.2	90.1	5.8			125	6.3	

N.D. = Not Determined

Profile No. 82 Balbegno North Corby Association Mulloch Series Lab Numbers 70212 - 15

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	8.0	N.D.	N.D.	68	17	11	5.69	0.48	N.D.	0.08	2.9	68.4	6.6	2.83	0.23	218	18.8	Low clay below surface horizon. Mainly low exchangeable bases. High % base saturation. Moderate total P_2O_5. High readily soluble P_2O_5.
Eg	25 - 36	2.6	N.D.	N.D.	84	7	6	3.60	0.18	N.D.	0.05	0.4	90.4	6.3	0.43	0.05	156	23.4	
Bg	56 - 69	1.6	N.D.	N.D.	93	3	2	1.79	0.10	N.D.	0.08	0.2	90.7	5.9			155	15.7	
Cg	112-137	1.2	N.D.	N.D.	94	3	2	2.49	0.19	N.D.	0.08	0.2	93.1	5.9			139	11.1	

N.D. = Not Determined

Profile No.83 Westside, Maryculter Countesswells Association Terryvale Series Lab Numbers 60772 - 76

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	11.1	N.D.	N.D.	55	16	23	8.91	0.76	N.D.	0.17	2.3	80.9	5.6	5.84	0.38	291	6.4	Mainly low Ca. Moderate Mg and K. High % base saturation. Moderate total P_2O_5. Moderate readily soluble P_2O_5 in Ap, high below.
Eg	20 - 30	1.8	N.D.	N.D.	68	15	15	2.04	2.78	N.D.	0.14	0.8	85.9	5.7	0.27	0.05	132	30.0	
Bg1	46 - 61	1.7	N.D.	N.D.	63	16	20	2.45	1.31	N.D.	0.11	1.1	77.9	6.0	0.04	0.05	N.D.	16.0	
Bg2	69 - 76	1.8	N.D.	N.D.	60	14	24	1.97	1.46	N.D.	0.19	0.2	94.2	6.8			148	12.4	
Cg	86 - 99	1.8	N.D.	N.D.	58	16	24	1.84	1.35	N.D.	0.23	0.4	88.9	5.4			133	13.1	

N.D. = Not Determined

Profile No. 84 Ballogie Countesswells Association Terryvale series Lab Numbers 54542 – 46

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 20	4.8	N.D.	N.D.	69	10	16	2.50	0.10	N.D.	0.08	6.6	29.0	5.2	2.34	0.19	142	9.4	Low or moderate exchangeable bases. Moderate % base saturation in Ap and Eg horizons, high below. Moderate or low total P_2O_5. Mainly moderate readily soluble P_2O_5 (high in Bg2 horizon).
Eg	25 - 38	2.2	N.D.	N.D.	63	15	19	2.43	0.37	N.D.	0.07	2.3	55.8	5.3	0.31	0.07	71	5.5	
Bg1	51 - 58	1.0	N.D.	N.D.	80	6	13	1.08	0.41	N.D.	0.10	0.9	65.0	5.4			85	9.7	
Bg2	63 - 76	1.9	N.D.	N.D.	59	12	27	3.52	0.96	N.D.	0.14	0.6	89.0	5.8			99	16.2	
Cg	94 - 109	1.8	N.D.	N.D.	63	13	23	3.20	0.77	N.D.	0.14	0.5	88.5	5.7			106	2.7	

N.D. = Not Determined

Profile No. 85 Ferrar Dinnet Association Ferrar Series Lab Numbers 172222 - 27

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A	3 - 10	12.3	68	24	83	9	2	7.17	2.18	0.22	0.23	8.3	54.2	5.5	7.06	0.38	65	1.6	Low clay. Mainly low Ca, mg and K. Moderate % base saturation (high in C(g) horizon). Low total P_2O_5. Low readily soluble P_2O_5 in upper horizons, high in lower.
Ag	30 - 38	4.6	69	24	82	11	5	2.65	0.76	0.21	0.14	4.0	48.3	5.4	2.18	0.16	36	1.4	
Eg	38 - 43	1.0	69	25	81	13	6	0.75	0.25	0.08	0.04	2.0	34.5	5.7	0.39	0.04	33	8.5	
Bx(g)	43 - 51	1.3	67	26	81	12	7	0.60	0.20	0.08	0.06	1.9	33.3	5.5			50	11.8	
Bx(g)	63 - 74	0.6	67	26	79	13	7	<0.15	0.05	0.09	<0.02	0.7	17.3	5.7			62	28.3	
C(g)	81 - 89	0.8	67	26	78	14	7	0.68	0.32	0.11	0.04	0.4	75.2	5.9			54	28.2	

Profile No. 86 Grange of Conon Forfar Association Vigean Series Lab Numbers 109993 – 97

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	5.2	65	19	78	7	13	9.73	3.18	0.10	0.13	1.6	89.1	6.8	1.77	0.23	205	18.2	Mainly moderate exchangeable bases. High % base saturation and pH. Moderate total P_2O_5 in Ap horizon, low below. High readily soluble P_2O_5 in Ap, Bg2 and Cg horizons.
Bg1	25 - 36	1.6	66	25	79	11	8	5.47	0.77	0.07	0.07	0.3	95.0	6.9	0.27	0.06	46	1.9	
Bg2	46 - 56	1.6	75	15	83	7	8	5.02	0.68	0.08	0.07	0.1	98.2	7.0			50	4.5	
Bg2	66 - 76	1.7	63	24	74	12	11	5.65	1.56	0.10	0.13	0.4	95.5	6.9			75	16.3	
Cg	91 - 102	1.7	67	19	76	10	12	5.19	1.75	0.10	0.15	0.4	95.5	6.5			90	19.9	

Profile No. 87 Goseslie Laurencekirk Association Muirfoot Series Lab Numbers 114420 – 24

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 10	4.6	51	28	63	16	19	7.65	0.48	0.10	0.23	1.2	88.0	6.6	1.62	0.14	178	18.5	Mainly moderate exchangeable bases. High % base saturation. Mainly moderate total P_2O_5. High readily soluble P_2O_5.
Ag	23 - 30	2.3	55	27	66	16	15	4.89	0.96	0.07	0.26	1.2	84.4	5.4	0.24	0.05	92	18.1	
Bg	41 - 48	2.7	40	34	52	22	23	9.36	4.03	0.16	0.31	0.6	96.0	5.8			141	23.9	
Bg	61 - 69	2.5	44	28	51	20	26	5.08	0.38	0.03	0.18	1.7	76.7	5.9			149	25.2	
Cg	94 - 104	2.8	33	37	45	25	27	6.01	2.15	0.13	0.23	1.7	83.2	6.2			156	26.1	

Profile No. 88 Leys of Barras Mountboy Association Barras Series Lab Numbers 120458 – 63

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	7.9	76	17	83	10	4	11.98	2.39	0.23	0.16	8.0	64.7	5.9	3.13	0.23	244	19.7	High or moderate Ca and Mg, moderate Na and K. High % base saturation. Moderate or low total P_2O_5. High readily soluble P_2O_5 (moderate in Bg1 horizon).
Bg1	25 - 36	4.5	33	39	50	23	26	11.45	4.50	0.25	0.16	4.1	80.2	6.1	1.13	0.11	104	8.6	
Bg2	46 - 53	3.0	40	37	54	24	19	11.11	7.05	0.21	0.16	3.0	86.3	6.2	0.39	0.04	69	15.0	
Bg2	61 - 69	2.1	84	11	89	6	4	7.26	5.33	0.15	0.11	2.5	83.8	6.9			67	21.3	
BCg	71 - 79	2.2	72	18	82	9	7	7.24	5.19	0.15	0.11	2.5	84.4	6.9			88	35.2	
Cg	94 - 104	2.4	64	22	74	12	12	11.52	7.53	0.25	0.15	0.7	95.8	7.0			202	80.7	

Profile No. 89 Arrat's Mill Pow Association Pow Series Lab Numbers 85869 – 72

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	8 - 18	4.6	N.D.	N.D.	29	41	28	9.25	0.26	0.08	0.10	<0.1	100.0	6.6	1.20	0.14	116	4.9	High silt. Mainly moderate exchangeable bases.High % base saturation and pH. Mainly moderate total P_2O_5. Moderate readily sioluble P_2O_5 in Ap horizon, high below.
Ag	30 - 41	3.4	N.D.	N.D.	37	39	21	8.80	2.10	0.09	0.13	<0.1	100.0	7.2	0.35	0.06	103	22.8	
BCg	63 - 81	3.2	N.D.	N.D.	24	48	25	7.89	3.50	0.10	0.17	<0.1	100.0	7.7			86	24.6	
Cg	102-112	5.1	N.D.	N.D.	22	48	27	7.57	3.90	0.11	0.22	<0.1	100.0	7.6			133	25.1	

N.D. = Not Determined

Profile No. 90 Uras Stonehaven Association Balhagarty Series Lab Numbers 69903 – 06

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	7.8	N.D.	N.D.	44	23	29	14.70	2.00	N.D.	0.05	8.8	65.8	6.1	1.68	0.26	344	23.7	High Ca, moderate Mg (high in Cg, low K. High % base saturation. Moderate total P_2O_5 (high in Ap). High readily soluble P_2O_5 (moderate in Bg1 horizon).
Bg1	38 - 48	6.2	N.D.	N.D.	46	22	29	14.80	2.56	N.D.	0.02	5.8	74.9	6.3	0.96	0.19	157	7.2	
Bg2	56 - 69	3.3	N.D.	N.D.	53	19	24	13.20	2.75	N.D.	0.05	3.0	83.5	6.5			140	22.8	
Cg	102-117	3.5	N.D.	N.D.	49	18	30	18.30	5.29	N.D.	0.10	2.3	91.8	6.6			184	84.5	

N.D. = Not Determined

Profile No. 91 Upper Criggie Stonehaven Association Balhagarty Series Lab Numbers 61931 – 35

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 18	9.0	N.D.	N.D.	54	17	25	4.46	0.80	N.D.	0.17	5.3	50.7	5.1	3.65	0.29	243	2.8	Moderate exchangeable bases (high Ca in lower Cg sample and Mg in upper Cg sample). Moderate % base saturation in surface horizon, high below. Moderate total P_2O_5. High readily soluble P_2O_5 in Bg2 and lower Cg sample.
Bg1	23 - 33	2.9	N.D.	N.D.	60	21	16	6.32	2.08	N.D.	0.10	1.4	86.0	5.8	0.36	0.05	102	3.7	
Bg2	38 - 46	2.9	N.D.	N.D.	69	15	13	6.56	2.75	N.D.	0.12	0.9	91.2	6.0	0.20	0.02	135	16.9	
Cg	61 - 76	3.8	N.D.	N.D.	55	19	23	7.99	5.24	N.D.	0.18	N.D.	100.0	7.5			124	6.2	
Cg	91 - 102	2.7	N.D.	N.D.	59	20	18	8.37	4.73	N.D.	0.18	N.D.	100.0	7.3			160	37.3	

N.D. = Not Determined

Profile No. 92 Easter Tulloch Stonehaven Association Balhagarty Series Lab Numbers 70207 – 11

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	5.7	N.D.	N.D.	54	17	27	8.30	1.36	N.D.	0.10	8.4	53.8	5.6	2.59	0.21	240	10.6	High Ca, mainly moderate Mg and K. Moderate % base saturation in surface horizon, high below. Moderate total P_2O_5. High readily soluble P_2O_5.
Bg1	22 - 30	3.2	N.D.	N.D.	55	18	24	10.30	2.24	N.D.	0.05	2.9	81.0	6.2	0.33	0.03	146	12.9	
BCg	46 - 56	3.2	N.D.	N.D.	50	18	29	21.60	5.77	N.D.	0.18	1.7	94.0	6.5	0.10	0.02	176	74.4	
BCg	76 - 86	3.6	N.D.	N.D.	51	18	28	13.80	4.76	N.D.	0.11	1.7	91.6	6.4			170	56.7	
BCg	102-117	3.4	N.D.	N.D.	56	14	27	21.00	4.09	N.D.	0.20	3.8	87.0	6.3			215	47.4	

N.D. = Not Determined

Profile No. 93 Kenshot Hill Stonehaven Association Balhagarty Series Lab Numbers 70220 – 25

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
A1	3 - 6	15.3	N.D.	N.D.	70	13	9	1.44	1.80	N.D.	0.32	17.6	16.8	4.8	5.13	0.31	165	2.2	Low or moderate Ca, moderate or high MG, moderate K. Low % base saturation in surface horizon, moderate in middle horizons, high in lower. Moderate or low total P_2O_5. Low readily soluble P_2O_5 (moderate in Cg horizon).
A2	8 - 16	3.5	N.D.	N.D.	60	21	16	<0.15	1.31	N.D.	0.13	5.6	22.0	5.3	0.62	0.05	101	0.9	
Ag	18 - 30	3.3	N.D.	N.D.	60	20	17	0.76	1.66	N.D.	0.15	4.5	35.2	5.3	0.40	0.01	96	0.9	
Bg	36 - 46	3.6	N.D.	N.D.	60	13	24	2.18	3.88	N.D.	0.16	5.2	54.5	5.6			93	0.3	
Bg	56 - 66	4.0	N.D.	N.D.	54	18	27	3.26	8.46	N.D.	0.26	4.4	73.3	5.9			89	0.1	
Cg	91 - 107	3.8	N.D.	N.D.	52	16	28	5.67	11.45	N.D.	0.26	2.6	87.0	6.2			122	4.5	

N.D. = Not Determined

Profile No. 94 Mains of Glenfarquhar Strathfinella Association Ledmore Series Lab Numbers 121823 – 27

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	9.2	40	35	53	22	21	5.91	0.54	0.10	0.22	8.2	45.0	5.6	3.83	0.27	294	9.9	Mainly moderate exchangeable bases. Moderate % base saturation in Ap horizon, high below. Moderate or low total P_2O_5. Moderate readily soluble P_2O_5 in Ap horizon, low below.
Eg	23 - 30	3.7	39	37	50	27	20	3.84	1.16	0.11	0.07	2.9	64.2	5.4	0.76	0.06	71	0.9	
Bg	41 - 48	3.8	29	39	40	28	28	4.01	3.43	0.19	0.08	0.8	90.7	5.5			62	0.6	
Cg	66 - 76	3.9	31	34	40	25	31	4.97	4.69	0.22	0.20	1.0	91.0	5.1			50	0.6	
Cg	91 - 102	3.5	36	35	48	23	26	4.34	3.84	0.18	0.18	1.6	84.0	5.5			109	0.7	

Profile No. 95 White Caterthun Strathfinella Association Ledmore Series Lab Numbers 86061 – 65

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	5 - 13	9.6	N.D.	N.D.	54	18	24	7.10	1.96	0.24	0.57	4.7	67.8	5.3	4.13	0.26	134	1.4	Mainly moderate exchangeable bases. High % base saturation. Moderate or low total P_2O_5. Low readily soluble P_2O_5 in upper horizons, high in Cg horizon.
Bg1	25 - 36	3.4	N.D.	N.D.	57	18	22	6.34	1.66	0.08	0.14	<0.1	100.0	5.8	0.38	0.05	60	2.0	
Bg2	46 - 56	2.4	N.D.	N.D.	59	24	15	6.78	1.62	0.08	0.15	<0.1	100.0	6.0			81	6.8	
Cg	63 - 74	2.1	N.D.	N.D.	79	4	15	7.08	1.16	0.08	0.15	<0.1	100.0	6.1			106	14.4	
Cg	86 - 96	2.3	N.D.	N.D.	65	14	19	8.33	1.70	0.04	0.18	<0.1	100.0	6.7			124	20.1	

N.D. = Not Determined

Profile No. 96 Milton of Tarfside Strichen Association Anniegathel Series Lab Numbers 119185 – 90

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H2	8 - 10	65.6	N.D.	N.D.	N.D.	N.D.	N.D.	2.08	2.10	0.46	1.42	53.0	10.2	4.1	34.18	2.51	392	10.7	Moderate or low exchangeable bases. Low % base saturation in upper horizons, high in lower. High total P_2O_5 in upper horizons, low in lower. Moderate or low readily soluble P_2O_5.
Ahg	10 - 15	42.7	N.D.	N.D.	N.D.	N.D.	N.D.	0.33	0.48	0.13	0.20	46.6	2.4	4.2	18.30	1.24	305	3.9	
Eg	20 - 30	2.9	66	20	74	12	11	<0.15	0.08	0.04	<0.02	3.8	3.1	4.6	1.12	0.07	43	1.3	
Bg	41 - 51	2.3	52	32	67	17	14	0.30	0.21	0.04	<0.02	2.8	16.6	5.1			41	3.0	
Bg	61 - 71	2.3	66	25	77	14	7	1.97	0.61	0.06	<0.02	1.3	66.9	5.9			43	3.5	
Cg	86 - 96	2.8	54	32	69	17	11	2.59	1.07	0.07	0.09	2.6	60.0	5.7			46	0.8	

N.D. = Not Determined

Profile No. 97 Glensaugh Strichen Association Anniegathel Series Lab Numbers 61583 – 87

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 13	14.3	N.D.	N.D.	44	23	26	14.90	6.38	N.D.	0.18	8.3	72.4	6.1	6.31	0.37	175	1.1	High Ca and Mg in Ap horizon, low Ca and moderate Mg below, moderate K (low in upper Bg1 sample). High % base saturation in Ap, moderate below. Mainly moderate total P_2O_5. Low readily soluble P_2O_5.
Bg1	18 - 25	7.9	N.D.	N.D.	47	20	28	2.75	0.73	N.D.	0.08	9.5	27.4	5.1	3.22	0.19	107	0.3	
Bg1	33 - 46	4.0	N.D.	N.D.	52	25	21	2.60	1.03	N.D.	0.10	4.1	47.7	5.4	0.67	0.06	78	N.D.	
Bg2	66 - 81	4.5	N.D.	N.D.	55	24	19	2.53	1.42	N.D.	0.16	4.7	46.1	5.3			115	0.6	
Cg	97 - 107	3.7	N.D.	N.D.	55	20	22	1.80	1.10	N.D.	0.22	4.0	43.7	5.4			148	1.0	

N.D. = Not Determined

Profile No. 98 East Town Strichen Association Anniegathel Series Lab Numbers 62336 – 40

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	0 - 15	9.0	N.D.	N.D.	50	20	25	6.46	1.29	N.D.	0.15	2.9	73.3	5.6	3.39	0.30	163	4.2	Moderate or low exchangeable bases. High % base saturation. Moderate or low total P_2O_5. High readily soluble P_2O_5 in Bg horizon.
Bg	20 - 30	4.4	N.D.	N.D.	68	14	17	3.60	1.52	N.D.	0.09	0.5	89.2	5.5	0.51	0.08	102	12.8	
Bg	41 - 51	3.7	N.D.	N.D.	64	20	13	3.57	1.52	N.D.	0.08	0.3	95.4	5.8	0.43	0.07	101	21.2	
Cg	51 - 66	4.3	N.D.	N.D.	81	8	12	1.84	0.96	N.D.	0.37	N.D.	100.0	5.8			60	6.4	
Cg	107-122	4.2	N.D.	N.D.	65	18	15	1.66	1.06	N.D.	0.06	0.9	75.4	5.2			73	1.5	

N.D. = Not Determined

Profile No. 99 Anniegathel Strichen Association Anniegathel Series Lab Numbers 86771 – 76

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	0 - 10	44.5	N.D.	N.D.	N.D.	N.D.	N.D.	1.76	1.28	0.42	0.63	23.1	15.0	4.6	25.40	0.96	139	1.1	Mainly low exchangeable bases. Mainly low % base saturation. Low and moderate total P_2O_5. Low readily soluble P_2O_5.
Ag1	10 - 14	10.6	N.D.	N.D.	55	24	16	0.16	0.32	0.08	<0.02	11.0	4.4	4.2	2.80	0.15	39	0.8	
Ag2	15 - 24	7.5	N.D.	N.D.	59	20	17	0.15	0.26	0.06	<0.02	10.5	4.3	5.0	2.74	0.14	44	0.7	
Ag2	33 - 42	4.7	N.D.	N.D.	57	18	23	0.15	0.16	0.07	0.03	5.3	7.2	5.2			60	0.7	
Bg	58 - 69	3.7	N.D.	N.D.	59	15	23	0.15	0.18	0.05	0.03	1.0	30.1	5.3			65	2.5	
Cg	86 - 94	2.6	N.D.	N.D.	72	11	14	0.15	0.10	0.03	0.02	1.3	18.9	5.4			146	1.9	

N.D. = Not Determined

Noncalcareous Gleys continued

Profile No. 100 Inverey, Finzean Tarves Association Pitmedden Series Lab Numbers 172545 – 52

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	3 - 10	14.8	61	24	74	11	8	7.29	1.32	0.11	0.28	15.7	36.4	5.1	8.22	0.48	216	2.9	Moderate exchangeable bases. Moderate % base saturation in Ah and A horizons, high below. Moderate total P_2O_5. High readily soluble P_2O_5 below A horizon.
A	18 - 25	10.9	62	23	73	12	10	5.85	0.93	0.08	0.16	16.4	29.9	5.0	5.54	0.30	186	3.3	
Bg1	30 - 38	2.9	66	26	82	10	9	2.72	0.41	0.02	0.09	1.9	62.7	5.4	0.54	0.04	99	18.7	
BCg	58 - 66	2.6	56	30	70	16	14	5.44	1.44	0.11	0.14	3.7	66.0	6.0			115	19.8	
Cg	76 - 86	2.1	56	30	68	18	15	6.55	1.67	0.07	0.15	3.3	72.0	5.9			117	27.8	
Cg	91 - 99	1.9	54	30	64	19	17	5.76	1.52	0.06	0.16	3.2	70.0	5.8			114	37.0	
Cg	102-109	1.7	50	34	67	16	17	5.77	1.38	0.06	0.16	3.4	68.7	6.3			133	43.3	
Cg	122-129	1.8	52	33	66	18	16	5.76	1.58	0.06	0.16	2.7	73.7	6.3			162	54.0	

Peaty Gleys – Poorly Drained

Profile No. 101 Glen Catt Countesswells Association Strathgyle Series Lab Numbers 173689 – 700

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	0 - 8	96.5	N.D.	N.D.	N.D.	N.D.	N.D.	13.94	9.87	0.93	1.93	89.4	23.0	4.3	55.87	1.25	170	23.9	Low clay. High exchangeable bases in F and H horizons, moderate or low below. Moderate % base saturation (low in H and Ah horizons). Low or moderate total P_2O_5 (high in H horizon). Variable readily soluble P_2O_5 down profile.
H	10 - 18	84.3	N.D.	N.D.	N.D.	N.D.	N.D.	6.88	5.76	0.97	2.63	83.8	16.2	3.9	48.37	1.83	367	5.4	
Ah	18 - 25	47.3	N.D.	N.D.	N.D.	N.D.	N.D.	7.17	0.96	0.27	<0.02	46.7	15.2	4.3	27.28	1.06	129	1.3	
Eg	25 - 28	2.2	76	16	84	8	8	0.60	0.41	0.05	<0.02	3.9	21.2	4.7	1.21	0.11	28	0.8	
Bg1	33 - 41	1.9	69	19	78	10	12	1.06	0.76	0.07	<0.02	1.9	49.5	4.8			36	1.8	
Bg2	51 - 56	1.9	66	25	77	14	10	1.36	0.84	0.07	<0.02	1.9	53.9	5.1			60	7.3	
Bg2	56 - 61	1.5	68	24	78	13	8	1.06	0.79	0.06	<0.02	1.4	57.0	5.0			57	11.8	
Cg	69 - 76	1.3	74	21	83	12	4	1.06	0.62	0.05	<0.02	1.4	54.9	5.1			72	15.6	
Cg	94 - 102	1.6	85	9	90	4	5	0.60	0.15	0.06	<0.02	2.6	23.8	3.9			89	1.4	
Cg	119-132	0.9	81	17	88	10	2	0.90	0.11	0.05	0.18	1.1	52.8	4.8			103	6.0	
Cg	135-145	0.8	84	14	89	9	3	0.60	0.12	0.04	<0.02	1.5	33.6	5.0			95	8.6	
Cg	147-157	1.0	73	22	81	14	6	0.91	0.33	0.06	<0.02	1.9	40.5	5.0			133	7.2	

N.D. = Not Determined

Profile No. 102 The Drum, Glentanar Countesswells Association Strathgyle Series Lab Numbers 173655 – 62

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F	3 - 13	97.1	N.D.	N.D.	N.D.	N.D.	N.D.	17.03	10.39	0.68	0.45	136.5	17.3	3.6	51.49	1.31	119	11.2	Mainly low exchangeable bases below F horizon. Low % base saturation (moderate in E and Eg), low pH. Low Total P_2O_5 and readily soluble P_2O_5 below F horizon.
E	20 - 28	2.6	86	6	88	4	8	2.72	0.28	0.12	0.11	4.4	41.9	4.0	1.29	0.13	33	1.2	
Eg	33 - 43	1.2	85	9	90	4	6	0.60	0.11	0.04	0.04	1.9	29.2	4.4	0.43	0.04	22	1.0	
Bg	51 - 61	2.0	66	20	74	12	15	<0.15	0.11	0.04	0.04	4.1	4.4	4.5			26	0.4	
Bxg	63 - 71	2.8	69	16	76	9	16	<0.15	0.09	0.05	0.06	5.7	3.4	4.7			38	0.9	
Bxg	89 - 94	3.4	59	21	68	13	20	<0.15	0.10	0.07	0.09	6.3	4.0	4.7			51	1.4	
Cg1	114-124	3.9	62	20	72	11	18	<0.15	0.06	0.06	0.02	6.9	2.0	4.8			63	1.0	
Cg2	150-160	2.9	68	19	75	11	14	<0.15	0.02	0.04	<0.02	4.7	1.3	4.9			63	1.6	

N.D. = Not Determined

Peaty Gleys – Poorly Drained continued

Profile No. 103 Clash of Wirren Strichen Association Auquhollie Series Lab Numbers 175082 – 92

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	5 - 11	82.1	N.D.	N.D.	N.D.	N.D.	N.D.	13.71	6.23	0.74	1.68	82.3	21.4	4.0	46.49	2.82	565	13.9	Low and moderate exchangeable bases below H horizon. Low % base saturation and pH. High total P_2O_5 in H horizon, low or moderate below. High or moderate readily soluble P_2O_5 in H horizon, low below.
H	11 - 20	73.9	N.D.	N.D.	N.D.	N.D.	N.D.	4.21	3.15	0.45	0.56	57.9	12.6	4.3	42.94	1.21	436	6.2	
A(g)	20 - 25	8.3	78	15	85	8	4	<0.15	0.41	0.08	0.04	14.2	3.6	4.6	4.31	0.16	76	0.8	
E(g)	25 - 36	2.9	73	20	85	8	7	<0.15	0.11	0.04	0.02	6.2	2.7	4.8	1.52	0.08	60	1.6	
Bg1	41 - 51	3.1	72	20	85	8	8	<0.15	0.04	0.04	0.02	2.6	3.7	4.9			72	2.2	
Bg2	56 - 69	3.5	79	12	85	6	10	<0.15	0.18	0.05	0.02	4.9	4.9	4.9			130	2.9	
Bg3	71 - 81	2.6	63	22	74	11	15	<0.15	0.12	0.06	0.09	3.0	8.4	4.8			98	2.3	
Cg	96 - 107	3.6	67	21	76	10	13	<0.15	0.11	0.06	0.13	3.1	8.9	4.8			125	1.8	
Cg	122-129	2.7	54	26	67	14	19	<0.15	0.12	0.07	0.23	2.3	15.2	4.7			117	1.1	
Cg	142-155	3.5	52	28	66	14	20	<0.15	0.11	0.07	0.29	3.8	11.0	4.7			137	1.4	
Cg	160-173	2.7	51	28	64	14	21	<0.15	0.12	0.14	0.31	2.5	18.9	4.7			123	0.9	

N.D. = Not Determined

Peaty Gleys – Very Poorly Drained

Profile No. 104 Dryplaid Farm Corby Association Mundurno Series Lab Numbers 117938 – 42

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ah	3 - 13	20.6	45	30	61	14	10	15.95	0.85	0.13	0.16	15.6	52.3	5.9	10.98	0.52	211	8.7	Low clay. Low exchangeable bases below Ah (high Ca in Ah horizon). Moderate % base saturation in Ah, high below. Moderate or low total P_2O_5. Moderate readily soluble P_2O_5 in Ah horizon, high below.
Eg	25 - 33	1.8	73	22	82	12	6	2.87	0.18	0.06	0.03	<0.1	100.0	6.6	0.36	0.04	99	18.7	
Bg	38 - 46	1.1	92	7	92	7	2	2.27	0.23	0.04	0.05	<0.1	100.0	6.7			84	15.9	
Cg	53 - 63	1.7	83	11	88	7	4	1.66	0.17	0.04	0.03	<0.1	100.0	6.9			115	19.7	
Cg	74 - 84	1.1	94	5	95	3	2	1.36	0.14	0.04	0.05	0.6	73.7	6.7			88	14.6	

Profile No. 105 Pitdelphin Countesswells Association Drumlasie Series Lab Numbers 433616 - 20

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
F H	0 -3	75.3	N.D.	N.D.	N.D.	N.D.	N.D.	6.44	4.86	0.76	2.23	57.1	20.0	4.6	44.31	1.96	443	5.3	Low exchangeable bases below F & H horizon. Mainly moderate or low % base saturation (high in Cg horizon). High total P_2O_5 in F&H horizon, low below. Moderate readily soluble P_2O_5 in F & H horizon, low in Eg and Bg horizons, high in Cg.
Ag	3 - 13	6.4	70	18	77	11	9	0.15	0.09	0.11	0.11	5.2	8.2	4.8	3.56	0.20	78	2.0	
Eg	20 - 28	3.9	70	17	78	10	9	0.30	0.07	0.07	0.05	2.7	15.6	5.4			44	2.5	
Bg1	28 - 38	2.4	68	18	78	11	11	0.46	0.24	0.13	0.07	1.0	47.9	5.3			25	0.9	
Cg	58 - 69	1.6	71	20	80	11	7	0.61	0.24	0.04	0.08	0.5	66.4	5.5			76	13.4	

N.D. = Not Determined

Profile No. 106 Auchnahar Countesswells Association Drumlasie Series Lab Numbers 83885 – 90

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
Ap	3 - 13	10.4	N.D.	N.D.	51	20	24	11.60	0.44	0.03	0.11	4.9	71.3	6.2	4.78	0.30	192	5.6	Low or moderate exchangeable bases (high Ca in Ap horizon). High % base saturation in Ap and Cg horizons, moderate in Ag and bg horizons. Moderate or low total and readily soluble P_2O_5.
Ag	29 - 36	2.8	N.D.	N.D.	46	27	25	4.20	1.28	<0.03	0.06	5.4	50.5	5.9	0.22	0.05	44	2.0	
Bg1	39 - 48	1.9	N.D.	N.D.	74	10	14	1.87	0.98	<0.03	<0.02	5.2	35.6	5.9			79	8.5	
Bg2	58 - 69	2.1	N.D.	N.D.	61	13	24	2.04	1.00	<0.03	0.09	6.0	34.3	5.7			58	1.4	
Bg2	79 - 86	2.6	N.D.	N.D.	59	14	24	2.04	1.66	<0.03	0.18	5.4	41.8	5.4			111	0.9	
Cg	94 - 104	1.9	N.D.	N.D.	71	13	14	0.96	0.74	<0.03	0.16	<0.1	100.0	6.0			100	5.5	

N.D. = Not Determined

Profile No. 107 Kenshot Hill Stonehaven Association Forgie Series Lab Numbers 70226 – 30

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	3 - 13	75.2	N.D.	N.D.	N.D.	N.D.	N.D.	5.85	4.28	N.D.	0.55	65.2	14.1	4.2	27.10	0.63	268	15.6	Moderate or low exchangeable bases. Low % base saturation in H and Ag horizons, moderate in Bg and upper Cg sample, high in lower Cg sample. Moderate total P_2O_5. High readily soluble P_2O_5 in H horizon, low or moderate below.
Ag	18 - 28	4.2	N.D.	N.D.	64	17	16	<0.15	0.40	N.D.	0.10	4.0	12.3	5.0	1.60	0.05	106	1.3	
Bg	33 - 46	3.2	N.D.	N.D.	61	17	19	0.64	2.84	N.D.	0.07	8.3	30.0	5.4	0.27	0.01	242	5.9	
Cg	56 - 66	3.2	N.D.	N.D.	63	13	21	1.85	3.23	N.D.	0.10	6.6	43.7	5.7			110	1.4	
Cg	102-117	3.1	N.D.	N.D.	59	9	29	4.18	7.10	N.D.	0.13	4.2	73.3	6.1			159	7.6	

N.D. = Not Determined

Profile No. 108 Upper Criggie Stonehaven Association Forgie Series Lab Numbers 61925 – 30

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
H	0 - 20	36.6	N.D.	N.D.	N.D.	N.D.	N.D.	28.60	3.88	N.D.	0.34	27.9	54.1	5.3	19.20	1.33	337	1.7	High Ca, moderate Mg and K. Moderate % base saturation in H horizon, high below. High total P_2O_5 in H horizon, moderate below. Low readily soluble P_2O_5 in H horizon, high below.
Ag	30 - 41	2.6	N.D.	N.D.	70	14	13	9.18	2.30	N.D.	0.13	0.7	94.7	6.5	0.68	0.07	117	21.3	
Bg	58 - 69	2.4	N.D.	N.D.	76	13	11	8.54	1.97	N.D.	0.11	N.D.	100.0	6.8	0.28	0.05	125	21.1	
Bg	58 - 69	2.7	N.D.	N.D.	73	14	11	10.90	2.35	N.D.	0.16	0.5	96.4	6.6			146	31.5	
Cg	81 - 91	2.2	N.D.	N.D.	78	10	13	13.98	2.88	N.D.	0.19	0.5	97.2	6.8			162	35.3	
Cg	102-122	2.4	N.D.	N.D.	79	10	11	14.95	3.06	N.D.	0.19	N.D.	100.0	6.8			165	50.6	

N.D. = Not Determined

Profile No. 109 Milton of Tarfside Strichen Association Hythie Series Lab Numbers 119191 – 96

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
O	5 - 13	80.0	N.D.	N.D.	N.D.	N.D.	N.D.	16.98	3.01	0.52	0.97	80.5	21.1	4.3	51.49	2.32	311	4.4	Moderate or low exchangeable bases (high Ca in O and Ah horizons). Moderate % base saturation in O and Ah horizons, high below. Low total P_2O_5 below Ah horizon. Variable readily soluble P_2O_5 down profile.
Ah	28 - 36	21.5	53	21	62	12	10	9.10	0.94	0.18	0.10	30.0	25.7	5.3	13.35	0.55	170	1.1	
Eg	36 - 38	2.7	56	28	68	16	14	2.43	0.33	0.09	0.04	1.0	74.0	5.5			68	9.1	
Bg	46 - 53	1.7	65	26	76	15	7	2.27	0.33	0.06	0.04	0.7	80.5	5.0			67	15.2	
Bg	63 - 74	2.0	61	25	73	13	12	1.82	0.33	0.07	0.04	<0.1	100.0	4.8			68	15 .9	
Cg	96 - 108	2.1	59	22	70	12	16	5.32	0.67	0.13	0.22	<0.1	100.0	6.4			68	1.4	

N.D. = Not Determined

Peaty Gleys – Very Poorly Drained continued

Profile No. 110 East Town Strichen Association Hythie Series Lab Numbers 62350 – 54

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
O	0 - 20	66.0	N.D.	N.D.	N.D.	N.D.	N.D.	45.80	1.92	N.D.	0.07	29.2	62.1	5.0	35.80	2.73	309	1.3	Moderate or low exchangeable bases (high Ca in O and Ahg horizons, high Mg in Ahg). High % base saturation. Moderate total P_2O_5 (high in O horizon). Low readily soluble P_2O_5 in O and Ahg horizons, low below.
Ahg	30 - 38	25.7	N.D.	N.D.	N.D.	N.D.	N.D.	21.40	7.34	N.D.	N.D.	6.6	81.4	5.7	15.30	0.66	154	2.6	
Ag	41 - 51	3.4	N.D.	N.D.	56	22	19	5.73	2.99	N.D.	0.08	0.3	97.1	6.6	1.03	0.08	134	36.5	
Bg	61 - 76	2.8	N.D.	N.D.	62	17	17	4.38	3.00	N.D.	0.09	0.4	95.2	6.0			117	22.5	
Cg	96 - 109	3.0	N.D.	N.D.	64	16	17	4.58	2.13	N.D.	0.87	0.1	98.4	6.8			109	12.5	

N.D. = Not Determined

Profile No. 111 Westside Tarves Association Pettymuck Series Lab Numbers 173672 – 79

Horizon	Depth (cm)	Loss on Ignition	Soil Separates					Exchangeable Cations (m.e./100g.)					% Saturation	pH	% Carbon	% Nitrogen	mg./100g. Total P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand U.S.D.A.	% Silt U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
O	3 - 13	95.1	N.D.	N.D.	N.D.	N.D.	N.D.	31.03	28.65	1.59	1.98	45.9	58.0	5.1	43.71	1.11	205	5.2	High exchangeable bases in O horizon, moderate or low below. Moderate or high % base saturation. Moderate or low total P_2O_5. High readily soluble P_2O_5 below Ag horizon, moderate or low below.
O	15 - 25	84.4	N.D.	N.D.	N.D.	N.D.	N.D.	24.66	9.32	1.13	0.89	41.4	46.5	4.9	43.82	1.22	230	3.6	
Ag	25 - 30	5.7	83	8	87	4	6	4.57	1.33	0.14	<0.02	8.0	43.2	5.2	2.81	0.14	58	1.7	
Eg	33 - 38	1.7	70	19	76	12	12	1.96	0.88	0.10	<0.02	2.8	51.2	5.6			116	34.4	
Bg	43 - 51	2.1	61	20	71	10	19	2.73	1.63	0.11	0.09	2.6	63.7	5.3			82	13.8	
Bg	63 - 71	1.5	58	25	70	13	17	2.42	1.35	0.11	0.13	3.8	51.5	5.2			121	34.8	
BCg	91 - 99	3.4	66	20	73	13	14	2.27	1.06	0.10	0.13	1.6	69.4	5.1			122	50.5	
Cg	137-147	6.2	59	23	67	15	16	1.96	0.81	0.07	0.1	1.5	66.1	5.3			130	52.1	

N.D. = Not Determined