Memoirs of the Soil Survey of Scotland

The Soils of the Country round Fife and Kinross

(Sheets 40 – Kinross and parts of 41 – Elie and 32 – Edinburgh)

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Preface

The soils of Fife and Kinross were surveyed between 1961 and 1974 by Mr. D. Laing together, in the early stages, with Mr. E. Lawrence and later with Mr. J. S. Robertson. Mr. Robertson studied and surveyed the vegetation together with Mr. E. L. Birse who also read the memoir manuscript and made many helpful suggestions. Mr. J. W. Muir assisted in soil correlation and classification. Maps and diagrams were prepared by Mr. W. S. Shirreffs and Mr. A. D. Moir of the Soil Survey Cartographic Section. Members of staff from other departments in the Macaulay Institute have contributed to the memoir in various ways: Mr. J. Logan and staff of the Soil Analysis Section of the Department of Mineral Soils, did the standard chemical analyses with the exception of those for exchangeable cations which were carried out by Dr. R. O. Scott and staff of the Department of Spectrochemistry: Mr. J. Logan checked the chapter on analytical data: Mr. D. C. Bain, Department of Mineral Soils, wrote the section on clay mineralogy based on differential thermal and X-ray methods: Dr. M. L. Berrow and Mr G. A. Reaves, Department of Spectrochemistry, wrote the section on trace elements: Dr. P. D. Hulme and Mr. R. A. Robertson, Department of Peat and Forest Soils, contributed the chapter on peat with field and laboratory assistance from Mr. A. T. Nicol.

The original manuscript was written by Mr. D. Laing and edited in the 1980's by Mr J. S. Robertson and Mr F. T. Dry. 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 included in the memoir were also produced in 2012, by Mr D. Donnelly.

Acknowledgements

The material for the section on climate was provided by the Meteorological Office, Edinburgh. Thanks are also due to Mr. M. Armstrong and Mr. I. Forsyth, Institute of Geological Sciences, Edinburgh for help in preparing the geological key in the section on parent materials and to Mr. G. M. Robertson, Mr. A. Bailie, Mr. A. Wynd, Mr. A. Taylor and Mr. D. W. Purdie of the East of Scotland College of Agriculture for advice given throughout the survey. 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 district described in this memoir covers the southern part of the area lying between the Firths of Tay and Forth and extends southwards to the estuary of the Forth from the lower margin of the Perth/Arbroath/Dundee district (Sheet 48/49) (Figure 1). The district occupies an area of approximately 1260 square kilometres and. includes a small area of east Perthshire, almost the whole of Kinross and the greater part of Fife. The largest towns are Kirkcaldy, which is one of the main industrial centres of the district, the ancient royal town of Dunfermline which is located on the southern and south-western approaches to Fife, and Glenrothes New Town, the current administrative centre of Fife.

Farming is the principal land-use in Kinross and north Fife, whereas the south and west of Fife is more industrial and densely populated with current and past areas of, both open-cast and deep mining of coal deposits. The eastern corner of Fife, otherwise known as the East Neuk has small settlements built around sheltered harbours, with an agricultural hinterland.

Physical Features

Major Structural Divisions

The physical structure has been modified considerably by the geological events of the Pleistocene. The landscape is strongly influenced by the nature of the underlying rocks and, in particular, to their resistance to weathering. It comprises two belts of hilly country, the Ochil Hills to the north and the Fife basaltic hills to the south, separated by a central tract of lower ground, the Kinross plain and the Howe of Fife, founded on less-resistant sedimentary rocks (Figure 2).

River Systems

The chief river in the north-western part of the district is the Eden which rises in the Ochil Hills above Milnathort and flows through the Howe of Fife and Strath Eden to the sea at St. Andrews. The west side of the district takes in a small portion of the course of the Devon Water which drains a considerable tract of the Ochil Hills. The River Leven, passing through the gap between Benarty Hill and the Lomond Hills, carries the drainage from Loch Leven to the Firth of Forth at Leven, while its tributary, the Ore, drains the east side of the Cleish Hills lying to the south-west of the Loch. The southern part of Fife is drained by several minor streams which flow directly to the estuary of the Forth.

Landform Regions

Four main landform regions (Figure 3) can be distinguished (Linton, 1951)
1) the Ochil Hills /
2) the interior lowlands of Fife and Kinross
3) the Fife basalt hills
4) the coastal fringe of Fife

Figure 1. Location of Area

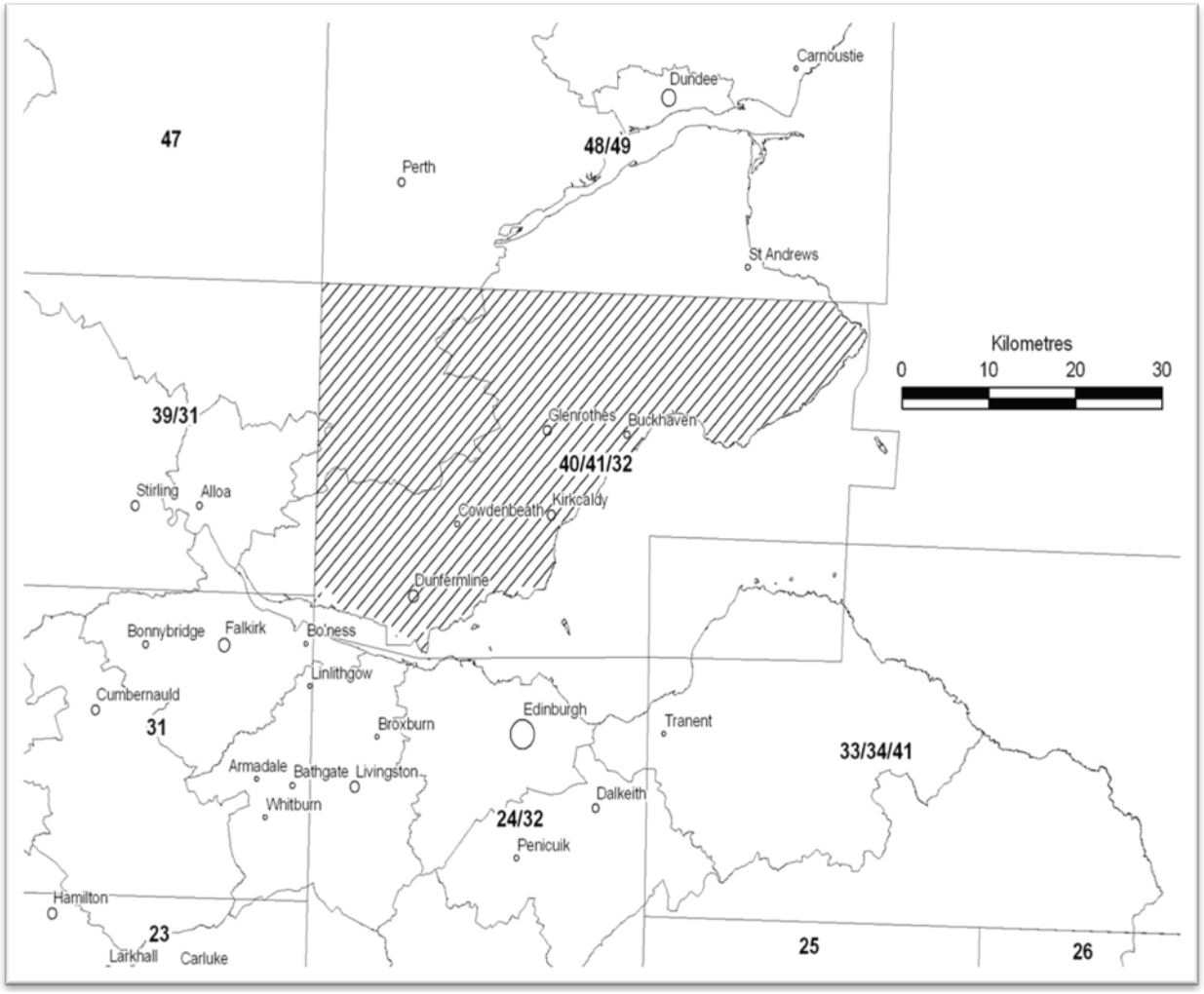


Figure 2. Relief

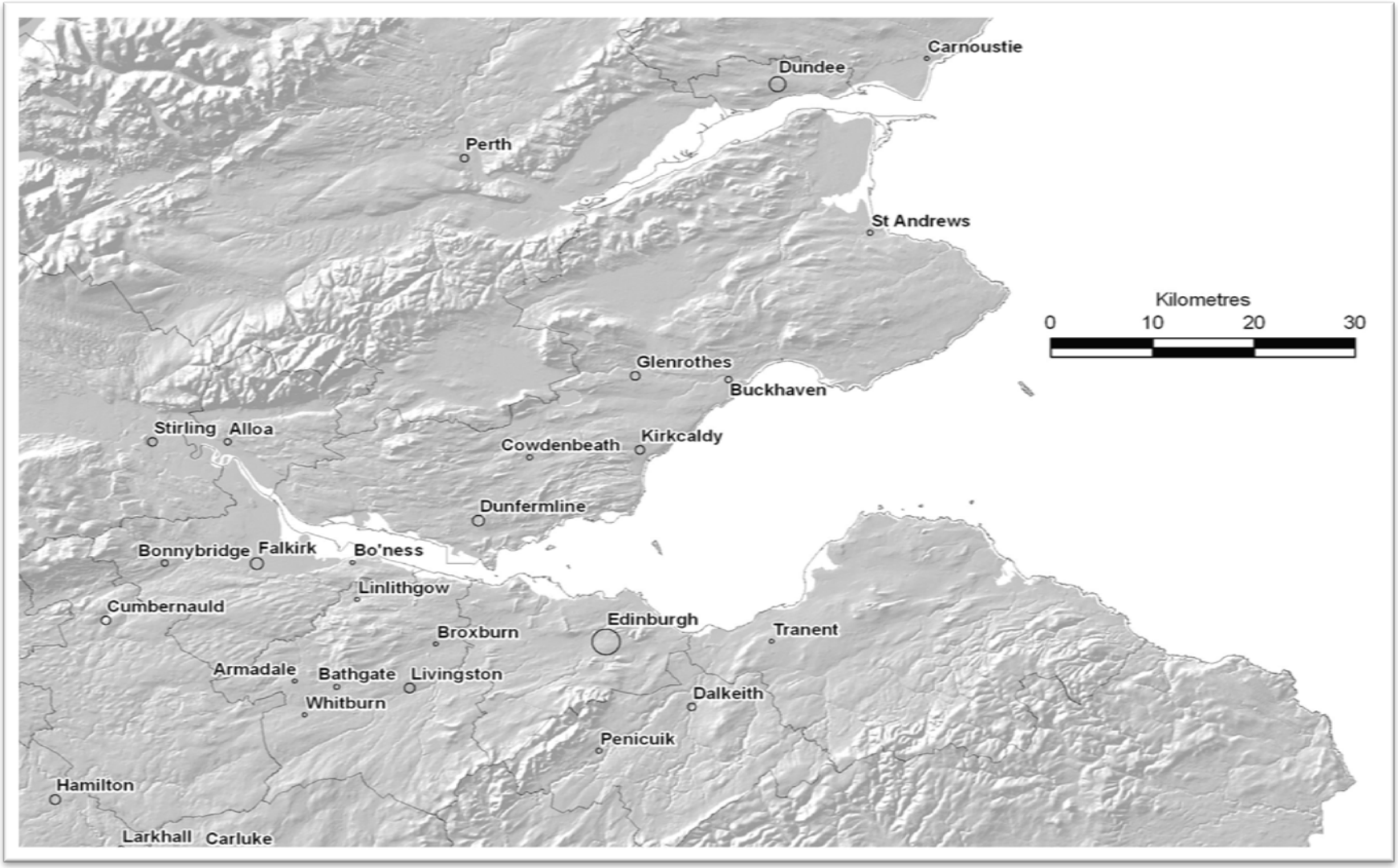
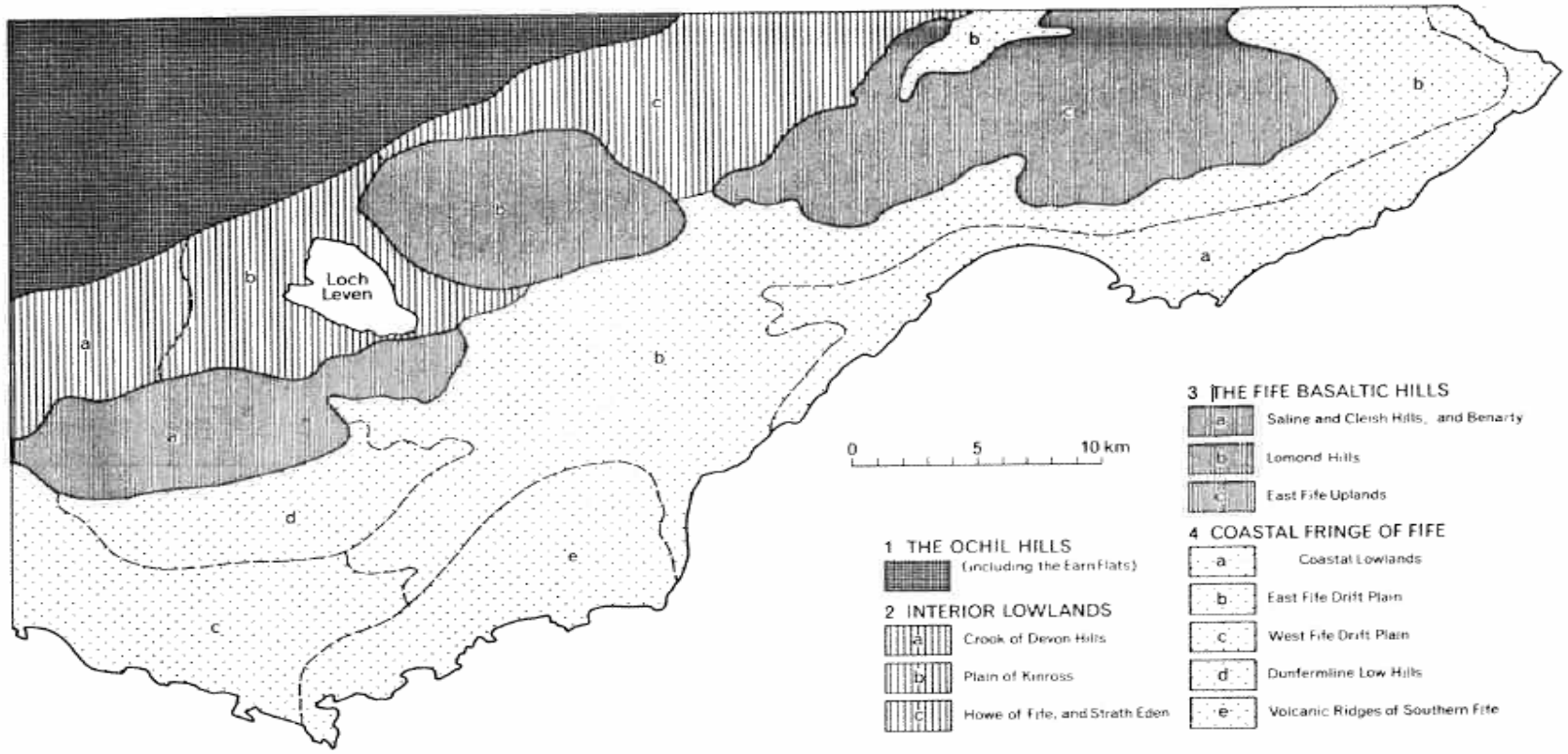


Figure 3. Landform Regions



In addition, a small area at the extreme north-western corner of the district represents the southern extension of the Earn Flats.

1. The Ochil Hills

The Ochil Hills trend north-eastwards from the western boundary of the sheet. The highest levels – Innerdouny (497 metres) and Mellock (479 metres) – are in the west, heights decreasing gradually to below 150 metres in the area north of Auchtermuchty

2. The interior lowlands of Fife and Kinross

This region can be divided into three sub-regions (Linton,1951):

a) the Crook of Devon hills
b) the plain of Kinross
c) the Howe of Fife and Strath Eden

The Crook of Devon hills trend east-west between the Ochil Hills to the north and the Cleish Hills to the south, extending westwards from the Kinross lowlands by the Crook of Devon to the sheet boundary.
Ranging in height from 120 metres to 180 metres, these hills consist for the most part of long undulating ridges with a general east and west trend. The ridges are frequently overlain by fluvioglacial sands and gravels and are separated by narrow hollows which at one time were probably lakes but are now filled with peat or alluvium.

The plain of Kinross extends north-eastwards from Loch Leven to Strathmiglo. The loch, which covers an area of 12.75 square kilometres and contains two main islands, Castle Island and St. Serf's Island, is surrounded by an alluvial plain of varying width marking a former level of the loch which was lowered by draining in 1830. This alluvial plain, sometimes referred to as the Leven Flats, gives way almost imperceptibly to drift deposits of the Kinross lowlands which occupy the remainder of the sub-region.

Lying between the Ochil Hills to the north and the Fife basaltic hills to the south are the Howe of Fife and Strath Eden. The Howe, which is drained throughout its entire length by the River Eden, extends north-eastwards from Strathmiglo to the vicinity of Pitlessie. A flat plain less than 60 metres above sea level at its highest point, the Howe varies in breadth reaching nearly 8 kilometres between Auchtermuchty and Freuchie. Thereafter, it narrows to about 1.6 kilometres near Pitlessie and, beyond the village, continues for 6.4 kilometres as the western end of Strath Eden. Extending beyond the margin of the district, Strath Eden follows the course of the river through Cupar to St. Andrews.

3. The Fife basalt hills

The topographical features of the Fife basaltic hills are more accentuated than those of the Ochils and the hills frequently rise abruptly from the surrounding lower ground. Three sub-regions (Linton, 1951) can be distinguished:

a) the Saline and Cleish Hills
b) the Lomond Hills
c) the East Fife Uplands

The Saline and Cleish Hills lie to the south of the Kinross Plain and separate Fife from Kinross. The highest hills are Dumglow, 379 metres and Knock Hill, 364 metres. Within this sub-region can be included Benarty Hill, 356 metres, situated at the southern margin of Loch Leven.

The Lomond Hills, rising on the east side of Loch Leven form the second sub-region and constitute the highest hill mass in the district with West Lomond, 521 metres, East Lomond, 448 metres and Bishop Hill, 394 metres. The hills are composed of marls, sandstones and limestones capped and preserved by a massive sheet of dolerite.

The east Fife uplands, lie to the east of the Lomonds, where the topography becomes highly complex with numerous dolerite intrusions, occurring without pattern resulting in a confused alternation of hills and valleys. In addition, there are frequent volcanic necks which tend to form grass-covered hills, the highest of which, Largo Law, 290 metres, is one of the best-known landmarks in east-central Scotland.

4. The coastal fringe of Fife

The coastal fringe of Fife comprises five subregions (Linton, 1951);

a) the coastal lowlands
b) the east Fife drift plain
c) the west Fife drift plain
d) the Dunfermline low hills
e) the volcanic ridges of southern Fife

The coastal lowlands which follow the coastline from Fife Ness to beyond Leven and extend inland to the line of the 30 metre contour, are generally rocky with occasional steep cliffs, the most striking of which occurs at Kincraig, 1.6 kilometres west of Elie. Relics of former raised beaches can also be seen along this coast, the most conspicuous occurring to the west of Kincraig where three terraces are recognised.

The east Fife drift plain borders the coastal lowlands and extends inland to the Fife basaltic hills Embracing the valleys of the River Leven and its tributary, the Ore, the plain circles the east Fife uplands to reach the northern margin of the sheet, at Kingsbarns. To the west the ground rises gradually to the Lochgelly plain. Here, the plain narrows between the Dunfermline low hills and the volcanic ridges of southern Fife to the south. The east Fife drift plain extends westwards of Dunfermline as the west Fife drift plain.

Westwards from Cowdenbeath, the Dunfermline low hills separate the west Fife drift plain from the Saline and Cleish hills. The Dunfermline low hills occur as isolated bosses of igneous rock, the highest of which are the Hill of Beath, 240 metres and Craigluscar, 227 metres.

The volcanic ridges of southern Fife constitute a belt of hilly country extending from Queensferry to Kirkcaldy and lying between the drift plain and the coast. The landscape is determined by the presence of hard and resistant outcrops of dolerite sills and by contemporaneous lava. Throughout the area, there are a number of prominent detached hills such as Dunearn Hill, 222 metres and the Binn of Burntisland, 193 metres.

Climate

The climate over much of the sheet area is similar to that of lower Tayside as described in the memoir for Perth, Arbroath and Dundee (Laing, 1976). There are only three places in the area for which reasonably long term climatological records exist. They are the Meteorological Office at Pitreavie Castle just north of Rosyth, a voluntary co-operating climatological station, now closed, at Pittencrieff Park, Dunfermline and a voluntary co-operating station at Kirkcaldy. Cupar lies just outside the district but is sufficiently close to provide data representative of Strath Eden and the Howe of Fife.

Rainfall

The average annual rainfall in millimetres is shown in Figure 4.The average annual rainfall is 630 millimetres along the coast and rises steadily from east to west across the district, reaching 890 millimetres in the central region and l270 millimetres in the Ochil Hills near the western margin of the sheet.

Temperature

Temperature data are available for only four stations (including Cupar). Monthly and annual averages of temperatures in degrees C are shown for these in Table 1. Figures for Kirkcaldy and Cupar refer to the standard period, 1931-1960. Records for Pitreavie and Pittencrieff Park are available for only part of the period and the averages for these have been estimated using a 12-year overlap from the Royal Observatory, Blackford Hill, Edinburgh.

January is the coldest month with a mean temperature of around 3°C while July is the warmest with mean temperature about 15°C. At both Pittencrieff Park and Cupar, minimum temperatures recorded are below 0°C and this must also be the case on higher around farther inland, particularlv on the Ochil Hills. In July, the daily maxima average is around 19°C.

Figure 4. Rainfall (average annual (mm), 1916-1950)

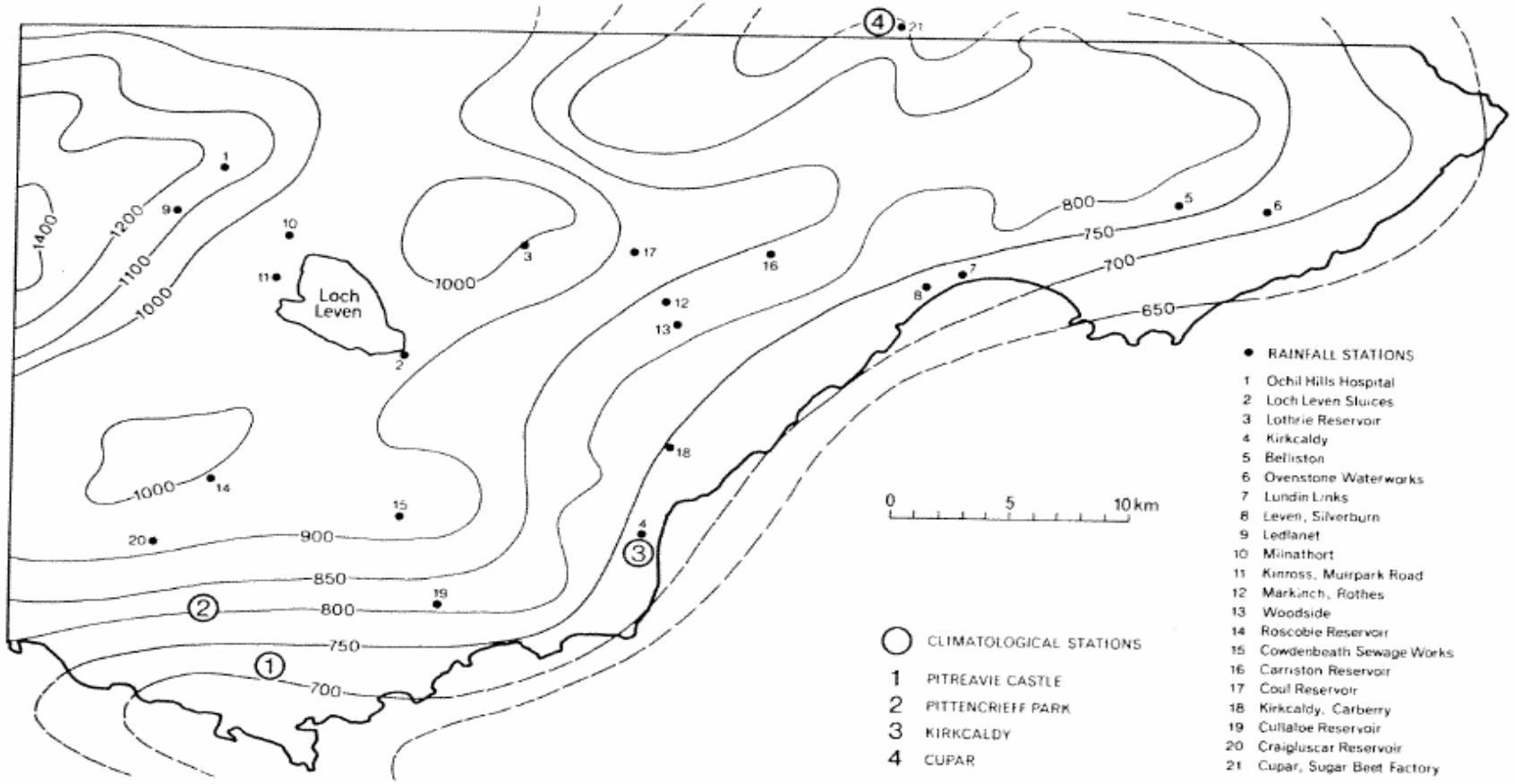


Table 1. Averages of daily maximum and minimum temperatures °C

Averages of daily maximum and minimum temperatures, ^{0}C								
	Pitreavie 40m		Pittencrieff Park 72m		Kirkcaldy 32m		Cupar 25m	
	Average Max	Average Min	Average Max	Average Min	Average Max	Average Min	Average Max	Average Min
January	5.2	0.6	5.4	-0.2	5.9	0.0	5.8	-0.3
February	6.6	1.1	6.3	0.6	6.6	0.4	6.7	-0.1
March	8.8	1.9	8.5	1.9	8.6	1.7	8.9	1.6
April	11.8	3.8	11.5	3.7	11.5	3.5	11.9	3.1
May	14.4	6.1	14.3	6.1	14.2	5.8	14.3	5.3
June	17.8	8.8	17.3	8.8	17.5	8.8	17.6	8.2
July	19.3	10.8	18.7	10.9	19.2	10.9	19.4	10.3
August	18.8	10.6	18.2	10.8	18.5	10.4	18.7	10.1
September	16.5	9.2	16.2	9.0	16.4	8.6	16.7	8.2
October	12.7	6.6	12.4	6.4	12.8	5.9	13.0	5.3
November	8.9	3.5	8.9	2.9	9.1	2.6	9.2	2.4
December	6.4	2.3	6.7	1.4	6.9	1.1	7.1	0.9
Year	12.3	5.4	12.1	5.2	12.3	5.0	12.4	4.6
	Estimated by comparison with long-term station				Standard period 1931-1960			

Assessment of Climatic Conditions

The climatic conditions of Scotland have been expressed in a series of three maps which illustrate essentially the degrees of summer warmth, winter cold and bioclimate (Birse and Dry, 1970, Birse and Robertson, 1970 and Birse, 1971). The first map based on accumulated temperature and potential water deficit, classifies Scotland into eighteen climatic regions (Birse and Dry, 1970). The coastal lowlands, together with much of the east Fife drift plain, are belts of warm and fairly warm, rather dry lowland. Fairly warm, moist lowland and foothill conditions are found in the east Fife uplands and extend southwards and westwards to include much of the low ground of south Fife and of Kinross. The lower and middle slopes of the Lomonds, the Saline and Cleish Hills and the Ochil Hills fall within the fairly warm, rather wet lowland and foothill zone. While the higher slopes and summits of the Ochils are rated as cool, wet foothill and upland, the other hills, where the rainfall is slightly lower, are classed as cool, rather wet lowland, foothill and upland.

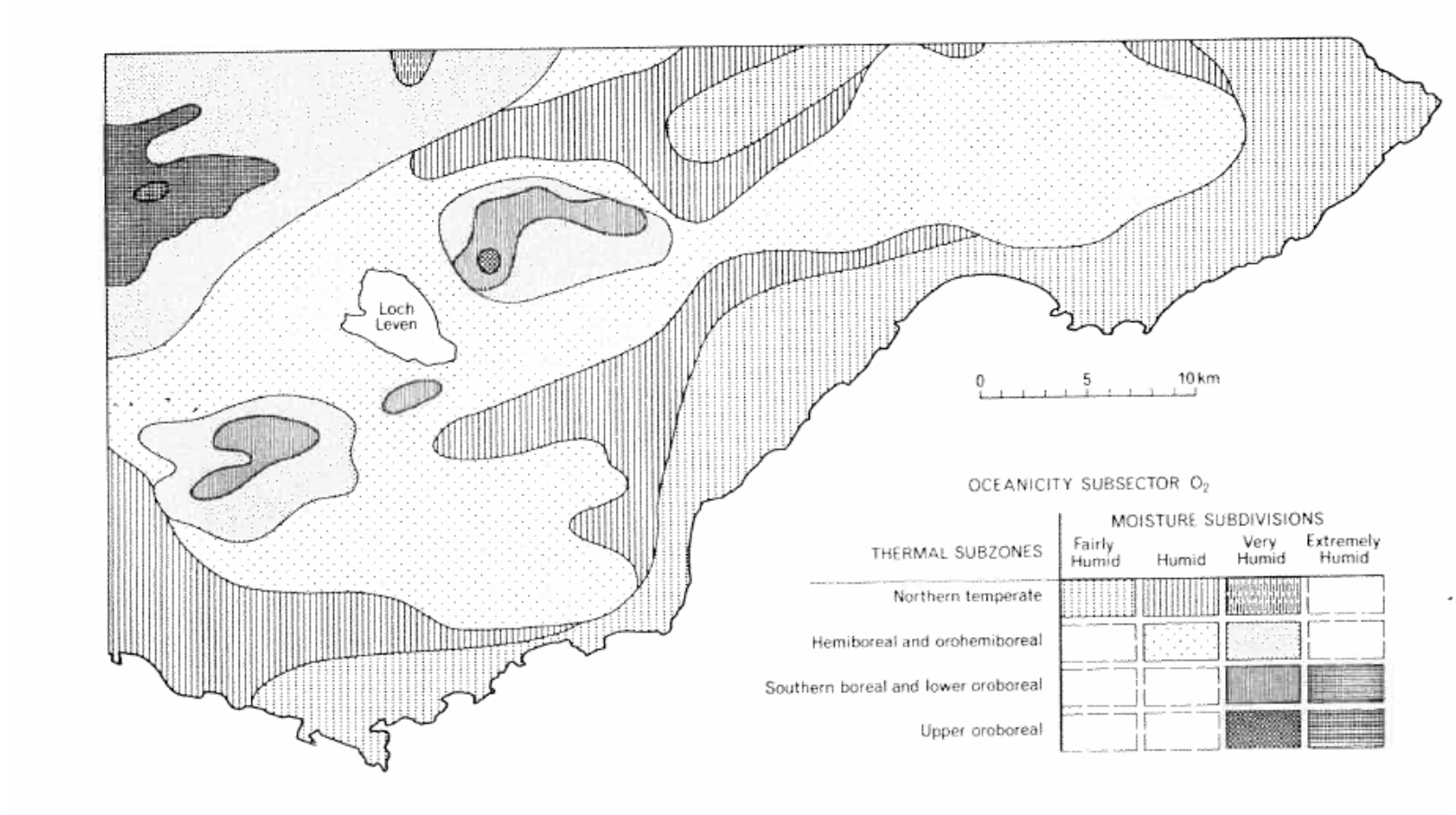
The second map illustrates measures of exposure and accumulated frost (Birse and Robertson, 1970). Much of the district is classed as moderately exposed, while the coastal fringe around and inland from Fife Ness, the east Fife uplands and the upper slopes of the Lomonds, the Cleish Hills and the Ochil Hills fall within the exposed category. Winters range from fairly mild to moderate and only on the summits of the three hill masses named above are they considered to be severe.

The third, bioclimate map is based on three parameters (Birse, 1971) and combines the information contained in the first two. These parameters are:

1) Thermal Zonation – from south to north and from low to high altitude
2) Oceanicity – the proximity to and influence of large areas of open sea
3) Moisture Status – as expressed by annual potential water deficit.

The bioclimatic subregions found across the sheet are delineated in Figure 5. The whole area lies within the euoceanic subsector (O2), the middle category of oceanicity.

Figure 5. Bioclimatic Sub-regions



2. Geology and Soil Parent Materials

As certain soil properties such as colour and texture are closely related to the composition of the underlying drift deposits or rock type on which the soils have developed, a brief description of the geology of the area is included in this section. The following information has been extracted from the geological memoir, The Geology of East Fife (Forsyth and Chisholm, 1977) and from the British regional geology, The Midland Valley of Scotland (MacGregor and MacGregor, 1948). A summary of the geology is given in Table 2 and Figure 6.

Geology

The region lies within the Midland Valley of Scotland and is formed mainly from Carboniferous sandstone, siltstone and mudstone sediments into which are intruded sills, dykes and volcanic necks of Carboniferous and early Permian age. Sandstones, Mudstones and conglomerate of Upper Old Red Sandstone age underlie the Carboniferous strata and rest unconformably on Lower Old Red Sandstone rocks, cropping out locally. Lavas of Lower Old Red Sandstone age form the Ochil Hills to the north-west.

During the period of maximum glaciation the whole region was covered by sheet ice. Although the east of Scotland is thought to have experienced a number of distinct, ice movements, there remains no good evidence for more than one period of till deposition. The general direction of ice movement was from west to east along the lines of the major valleys and till derived from Old Red Sandstone areas to the north and west has been carried over on to the Carboniferous sediments for several kilometres. This till locally contains igneous rock fragments from the Ochil Hills. Till derived from Carboniferous sediments covers most of the low ground of the region and may reach a depth of 20 metres in places, although it is usually much thinner than this. Again, contamination with igneous material may occur locally around many of the isolated basalt hills. Tills derived from rocks of the igneous uplands, with the exception of the Ochils mass, are very localised. The hilltops usually carry a stony residual material which has been formed by weathering *in situ*.

At the end of the final glaciation, with the retreat of the glaciers occupying the Forth and Tay valleys and smaller side valleys, meltwaters deposited fluvioglacial sands and gravels across the till plains either as hummocks or as flat terraces. Some sands and gravels were deposited during the period of high Late-glacial sea-levels and many such deposits lying at levels lower than about 36 metros O.D. were laid down in the sea or were subsequently reworked by it, forming the raised beaches which occur along the coast.

Freshwater alluvium is found along the courses of rivers and streams and at the sites of former lochs where basin and valley peat may also occur. Small areas of hill peat are confined to the upper slopes of the Ochil Hills. The largest area of blown sand covers most of the postglacial raised beach around the shores of Largo Bay, with smaller pockets occurring round the coast to the east.

Table 2. Summary of Geology

<table>
<tr><td colspan="5">SUMMARY of GEOLOGY</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ERA</td><td colspan="2">SYSTEM & SUBDIVISIONS</td><td>SPERFICIAL DEPOSITS</td><td></td></tr>
<tr><td rowspan="6">Quaternary</td><td rowspan="6">Pleistocene & Recent</td><td rowspan="6"></td><td>Blown sand</td><td></td></tr>
<tr><td>Peat</td><td></td></tr>
<tr><td>Alluvium</td><td></td></tr>
<tr><td>Raised beach deposits</td><td></td></tr>
<tr><td>Fluvioglacial sands & gravels</td><td></td></tr>
<tr><td>Glacial deposits (till, etc.)</td><td></td></tr>
<tr><td colspan="5">TERTIARY EROSION FOLLOWING LATE- AND POST-CARBONIFEROUS EARTH MOVEMENTS</td></tr>
<tr><td></td><td></td><td></td><td>SEDIMENTARY DEPOSITS</td><td>INTRUSIVE & EXTRUSIVE IGNEOUS ROCKS</td></tr>
<tr><td rowspan="5">Paleozoic</td><td rowspan="3">Carboniferous</td><td>Westphalian (Coal Measures)</td><td>Sandstones, shales, siltstones, mudstones and coals</td><td rowspan="3">Quartz-dolerite sills & dykes
(Permo-Carboniferous
Basaltic lavas
tuffs and agglomerates
with sills of olivine-dolerite & allied rocks</td></tr>
<tr><td>Namurian (Passage Group
Lower Limestone Group
Limestone Coal Group)</td><td>Sandstones, siltstones, mudstones with shales, limestones and coals</td></tr>
<tr><td>Dinantian
(Lower Limestone Group
Calciferous Sandstone Measures)</td><td>Sandstones, shales, siltstones, mudstones with dolomites, limestones and coals</td></tr>
<tr><td rowspan="3">Old Red Sandstone</td><td>Upper</td><td rowspan="2">Dominantly sandstones with some conglomerates & mudstones</td><td rowspan="3">Andesitic & basaltic lavas & tuffs</td></tr>
<tr><td>Unconformity</td></tr>
<tr><td>Lower</td><td>Sandstones & conglomerates</td></tr>
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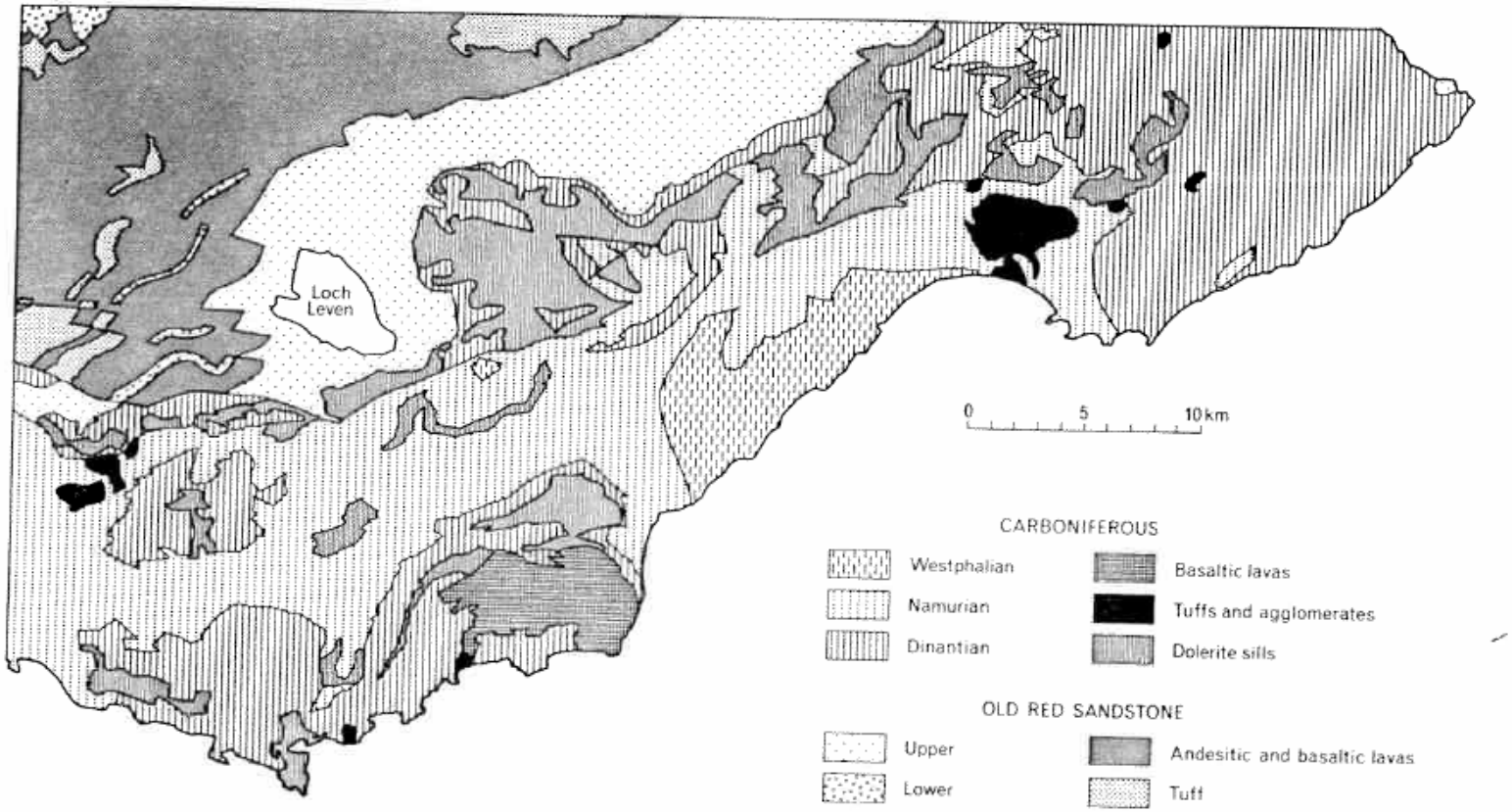
Figure 6. Geology



Parent Materials

The residual material formed by the weathering of exposed rock *in situ*, the tills deposited by the action of the ice-sheet and the sands and gravels laid down by the glacial meltwaters constitute the principal soil parent materials. Soils developed on clearly defined parent material are grouped together as a soil association (Chapter 3), and the distribution of the associations is given Figure 7. The following parent materials have been distinguished in the region.

Till derived from rocks of Old Red Sandstone age

1. Till and other drifts from intermediate lavas, mainly andesite and basalt – on the Ochils and Crook of Devon Hills.

Where the parent material has been formed as a result of the weathering of rock outcrops or has been transported downslope only short distances by solifluction, shallow brown or pale reddish brown residual soils of sandy loam or fine sandy loam texture have developed. The middle hill slopes and lower ground are covered by material which has been transported at least some distance by ice and the resulting brown or reddish brown till has a sandy loam texture with sandy clay loam in the wetter hollows. Occasionally the surface layers of this till have been modified by the action of water in Post-glacial times to give a coarser-textured material.

Soils developed on this range of parent materials belong to the **Sourhope Association**.

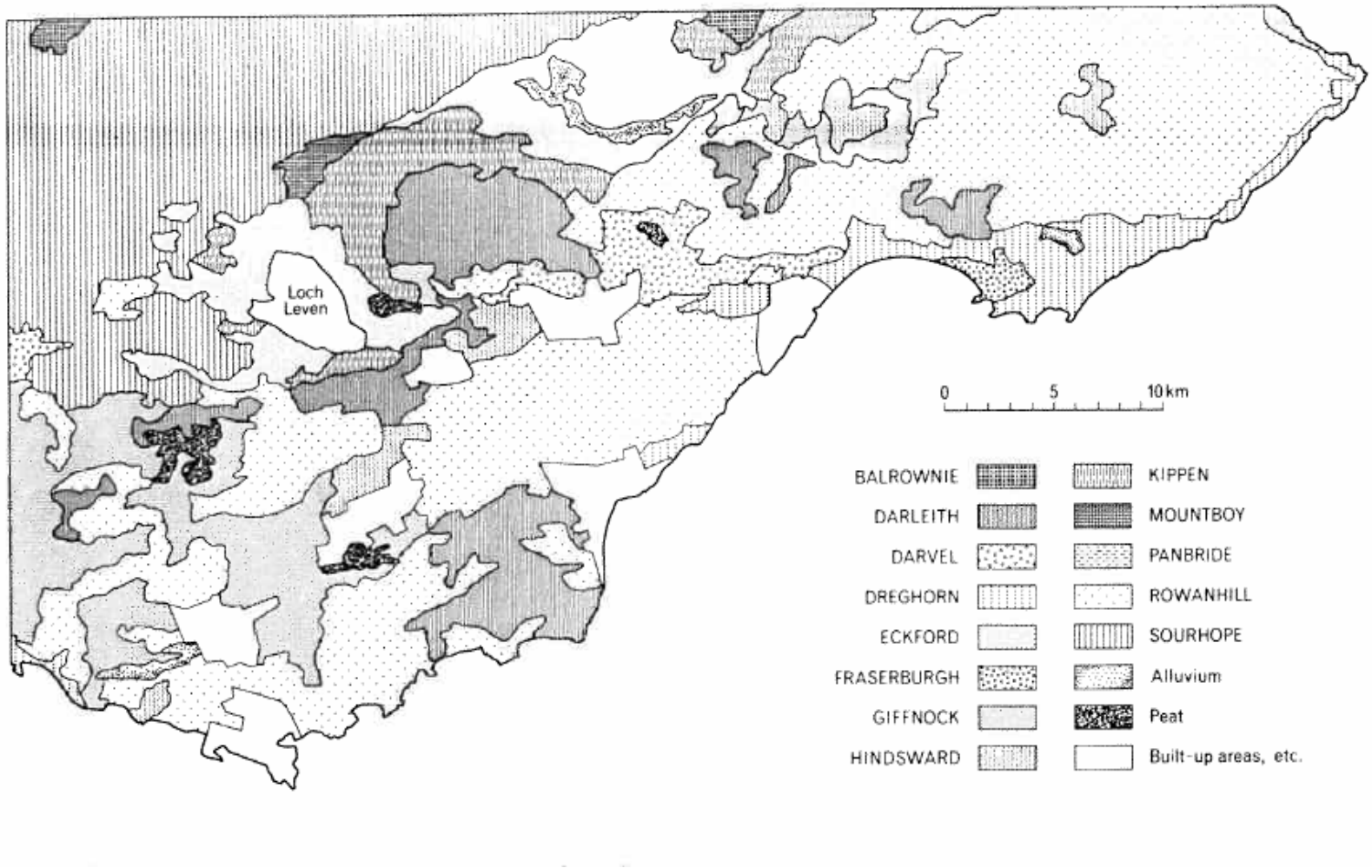
2. Till derived from Lower Old Red Sandstone sandstones and other sediments - around Springfield in Strath Eden and south of Dunning.

The locally confined reddish brown till derived from these sediments has a clay loam or sandy clay loam texture and gives rise to soils of the **Balrownie Association**. Where the surface layers have been water-modified, a coarser sandy loam or loamy sand material has resulted and soils on this deposit have been separated as the **Forfar Association**.

3. Till and residual material derived from Upper Old Red Sandstone sediments, mainly sandstones - the lower slopes of Benarty Hill, the Lomond Hills, Walton Hill and Hill of Tarvit.

The dominant soil-forming material of this type is reddish brown to pale yellow and white decomposed sandstone rock which gives rise to shallow residual soils on the flanks of the hills. Where till has been formed, it has a reddish brown colour and a clay loam texture. Locally, the till has been water-modified to give surface layers of a coarser texture. The soils developed on both till and decomposed rock belong to the **Kippen Association**.

Figure 7. Distribution of Soil Associations



4. Till derived from mixed lavas and sediments - lower slopes of the Ochils near Dunning, in local valleys and bordering the plain of Kinross.

Where parent material derived from sandstones and other sediments has been mixed with igneous rock of the Ochils mass, a till of variable colour and texture has been formed. On the hill flanks this till is a reddish brown stony sandy loam while that on the level ground and gentler slopes is a weak red sandy clay loam. Soils of the **Mountboy Association** have developed on these mixed tills.

Till derived from rocks of Carboniferous age

5. Till and residual material derived from sandstones and shales – extensive throughout the east Fife drift plain.

Till formed on these Carboniferous sediments constitutes the most common parent material of the region. It is of variable colour and texture, depending on the nature of the sandstone and the proportion of shale involved, and ranges from a grey or greyish brown sandy clay loam or clay loam to a reddish brown or weak red clay loam. In many places extensive water-sorting of the upper layers has occurred to give rise to a parent material of sandy loam texture. A dark grey residual material of silty clay loam texture has developed on very local outcrops of black or dark brown soft decomposing shale.

Soils of both till and residual material are grouped together as the **Rowanhill Association**.

6. Till and residual material derived from sandstones with some shales, coals and limestones - extensive throughout the west Fife drift plain.

A till which is very similar in many respects to that of the previous group has been separated on the basis of a higher sandstone content and a lower proportion of shales which results in a recognizably lighter colour overall. Generally, the till is of a light grey or light brownish grey colour and the texture is sandy clay loam or clay loam. In addition, there is often a higher proportion of unweathered and partially decomposed sandstone fragments present in the till body and, in places, the surface layers of the till have been reworked and resorted by water to give a coarser, sandy loam, texture,. On small areas of sandstone outcrops a sandy loam or loamy sand material has developed

Soils of the **Giffnock Association** are formed on this parent material.

7. Till derived from sandstone and shales with an admixture of basic igneous material – the volcanic ridges of southern Fife and the Fife basaltic hills.

Where material derived from Carboniferous sediments was smeared across the flanks of the intrusive igneous rocks, a mixed till containing a varying proportion of igneous material was formed. The till itself is similar in colour and texture to that of the Rowanhill Association, the main difference being in the presence of the igneous rock fragments in varying stages of decomposition, which appear as dark brown colorations in the till body.

Soil developed on this till form the **Hindsward Associsation**.

Drifts derived from intrusive rocks

8. Drifts derived from dolerite and basalt sills, dykes and volcanic necks – the volcanic ridges of southern Fife and the Fife basaltic hills, the Dunfermline low hills and the Isle of May.

The stony drift which is not far-travelled and the residual material of the hilltops and upper slopes is of a brown or yellowish brown colour and has a sandy loam or loamy sand texture while the lower slopes carry a shallow till of sandy clay loam. The parent material has been formed from a wide range of igneous rocks and the derived soils, although all included in the **Darleith Association**, have been subdivided into those formed on finer-textured drifts from basaltic lavas or basic intrusive rocks and those that have developed on the coarser-textured material derived mainly from dolerites and basic agglomerates.

Sands and gravels of recent or Pleistocene age

9. Fluvioglacial and morainic sands and gravels derived mainly from Old Red Sandstone sediments and lavas together with some Dalradian schists – near Drum, Carnbo and Dunning and north of Edensmuir Forest.

The colour of the deposits is usually reddish brown but can vary to brown when the proportion of lava or schist is high. Soils developed on this parent material form the **Gleneagles Association**.

10. Fluvioglacial sands and gravels derived mainly from Upper Old Red Sandstone sediments - extensive on the plain of Kinross round Loch Leven and throughout the Howe of Fife spreading into Strath Eden.

The colour of the sand fraction is brown or pale brown and the gravels are normally brown or reddish brown. Derived soils belong to the **Eckford Association**.

11. Fluvioglacial sands and gravels derived mainly from Lower Carboniferous igneous and sedimentary rocks - the east Fife drift plain between Leslie and Kennoway.

The texture of these deposits ranges from loamy fine sand to coarse gravel and the colour is usually brown. Soils developed on this parent material belong to the **Darvel Association**.

12. Upper river terrace deposits derived mainly from Old Red Sandstone sediments and lavas with some Dalradian metamorphics - the upper banks of the River Eden between Springfield and Cupar and bordering the Ceres Burn at Pitscottie.

Soils developed on the reddish brown or brown coarse sands and gravels are grouped as the **Carpow Association**.

13. Raised Beach deposits derived mainly from Old Red Sandstone sediments - Kingsbarns.

The deposits consist of brown or reddish brown sands and gravels with occasional lenses of silt or silty clay and are underlain in this locality by Carboniferous till. Soils which have formed on this parent material belong to the **Panbride Association**.

14. Raised Beach deposits derived mainly from Carboniferous igneous and sedimentary rocks - the coastal lowlands and the coastal fringe of southern Fife.

The parent material is brown in colour and the texture is sandy loam, loamy sand or sand, often with bands of gravel and sometimes with layers of fine sand or silt. The deposits are again underlain by Carboniferous till at depth and the soils developed on them form the **Dreghorn Association**.

15. Sandy raised beach deposits overlain by windblown shelly sand - Dumbarnie and St Ford Links between Lower Largo and Kincraig.

Soils formed on shelly sand are classed as the **Fraserburgh Association**.

16. Windblown quartzose sand with little or no shell fragments overlying parts of the coastal raised beach – north-eastern coast of Fife Ness, Elie, Earlsferry and Lundin Links. These soils are classed as **Links soils**.

17. **Dune sand** - Dumbarnie Links.

18. **Recent alluvium** - the most extensive deposits are round the margin of Loch Leven and the smaller lochs, along the Lynne Burn outside Dunfermline, the Pow Burn, the River Eden and the St Monans Burn.

The texture of the surface horizon of the alluvial soils ranges from loamy sand to sandy loam, silty loam and clay loam. Occasionally the alluvial bands are interspersed with peaty layers and the surface layer is also peaty.

19. *Basin and Valley Peat* - the more extensive deposits are Din Moss, the mosses round Loch Glow, Moss Morran, Portmoak Moss and Star Moss. The most easterly deposits occur at Peat Inn and Cassindonald.

20. *Hill Peat* - occurs as local patches on the upper slopes of the Ochils.

The relationships between the geology, parent materials and soil associations are summarised in Table 3.

Table 3. Geology, Parent Materials and Soil Associations

GEOLOGY, PARENT MATERIALS AND SOIL ASSOCIATIONS						
GEOLOGY		PARENT MATERIAL			SOIL ASSOCIATION	DISTRIBUTION
SYSTEM	ROCKS	TYPE	COLOUR	TEXTURE		
OLD RED SANDSTONE	Intermediate lavas, mainly andesite & basalt	Residual & shallow drift	brown or pale reddish brown	sandy loam to fine sandy loam	Sourhope	the Ochils, Crook of Devon Hills & east Fife uplands
		Till	brown or reddish brown	sandy loam to sandy clay loam		
		Water-worked till		sandy loam to loamy sand		
	Lower ORS sediments, mainly sandstones	Till	reddish brown	sandy clay loam to clay loam	Balrownie	around Springfield in Strath Eden & south of Dunning
		Water-worked till		sandy loam to loamy sand	Forfar	
	Upper ORS sediments, mainly sandstones	Residual	reddish brown to pale yellow and white	loamy sand to sand	Kippen	the lower slopes of Benarty, the Lomond Hills, Walton Hill & Hill of Tarvit
		Till	redddish brown	clay loam		
		Water-worked till		sandy loam		
	Mixed lavas & sediments	Till	reddish brown to weak red	loamy sand to sandy clay loam or clay loam	Mountboy	lower slopes of the Ochils near Dunning, in local valleys and bordering the plain of Kinross

CARBONIFEROUS	Sandstones & shales	Residual (shales)	dark grey	silty clay loam	Rowanhill	very local occurrences mainly in the east
		Till	grey and greyish brown to reddish brown and weak red	sandy clay loam to clay loam		extensive throughout the east Fife drift plain
		Water-worked till		sandy loam		
	Sandstones with some shales, coals & limestones	Residual (sandstones)	yellowish brown to pale yellow	sandy loam to loamy sand	Giffnock	small areas in the west of the coastal fringe, on the Crook of Devon Hills & on the east Fife uplands
		Till	light grey to light brownish grey	sandy clay loam to clay loam		extensive throughout the west Fife drift plain
		Water-worked till		sandy loam to sandy clay loam		
	Sandstones & shales with an admixture of basic igneous material	Till	grey and greyish brown	sandy clay loam to clay	Hindsward	the volcanic ridges of southerrn Fife & the Fife basaltic hills
	Dolerites & basic agglomerates	Residual & shallow drift	brown or yellowish brown	sandy loam to loamy sand	Darleith	the volcanic ridges of southern Fife, the Fife basaltic hills, the Dunfermline low hills, the Isle of May
	Basaltic lavas & basic intrusive rocks	Residual & shallow drift		fine sandy loam to loamy fine sand		
		Till		sandy clay loam to clay loam		

RECENT & PLEISTOCENE	ORS sediments & lavas together with some Dalradian schists	Fluvioglacial & morainic	reddish brown to brown	sand and gravel	Gleneagles	near Drum, Carnbo & Dunning & north of Edensmuir Forest
	Upper ORS sediments	Glacial & fluvioglacial	brown to pale brown brown or reddish brown	sand gravel	Eckford	extensive on the plain of Kinross round Loch Leven and throughout the Howe of Fife into Strath Eden
	Carboniferous igneous & sedimentary rocks	Fluvioglacial	brown	loamy fine sand to coarse gravel	Darvel	the east Fife drift plain between Leslie & Upper Largo
	ORS sediments & lavas with some Dalradian metamorphics	Upper river terraces	reddish brown to brown	coarse sand and gravel	Carpow	banks of the River Eden between Springfield & Cupar & bordering the Ceres Burn at Pitscottie
	Mainly ORS sediments	Raised beach	brown to reddish brown	sands and gravels, occasional lenses of silt or silty clay	Panbride	Kingsbarns

RECENT & PLEISTOCENE	Carboniferous sediments & igneous rocks	Raised beach	brown	sandy loam to loamy sand to sand; bands of gravel common. Occasional layers of fine sand or silt	Dreghorn	the coastal lowlands & the coastal fringe of southern Fife
		Raised beach over-lain by windblown sand	light brown	shelly sand	Fraserburgh	Dumbarnie & St Ford Links
			brown	quartzose non-shelly sand	Links	north-eastern coast of Fife Ness, Elie, Earlsferry & Lundin Links
		Dune sand		sand	Dunes	Dumbarnie Links
		Recent alluvium		loamy sand	Alluvium	most extensive deposits round margin of Loch Leven & the smaller lochs, along the Lynne Burn - Dunfermline, the Pow Burn, the River Eden & the St Monans Burn
				sandy loam		
				silt loam		
				clay loam		
				alluvium with peat layers and peaty surface horizon	Peaty alluvium	

RECENT & PLEISTOCENE		Peat			Basin & Valley	most extensive deposits are Din Moss, the mosses round Loch Glow, Moss Morran, Portmoak Moss & Star Moss. Most easterly deposits at Peat Inn & Cassindonald
					Hill	local patches on the upper gentle slopes of the Ochils

3. 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 of 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 Carpow, Darvel, Dreghorn, Eckford, Gleneagles, Fraserburgh and Panbride Associations produce mainly freely drained soils, whereas the heavier textures of the Giffnock, Hindsward and Rowanhill 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 1 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, as discussed in Chapter 2.

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.

Man has also significantly affected and influenced the soils of certain areas where open-cast coal mining has been practised by systematically stripping the soil, storing the material and subsequent reinstatment, after the coal has been extracted. This process has a drastic effect on the actual soil profile and great care has to be taken during all stages to minimise irreparable or long term damage to the soil material. The soil forming processes and agencies previously described, resume and interact on the reinstated material, although the development of a natural profile takes a very long time to develop and is greatly dependent on the nature of the material, the methods of reinstatement, the aftercare, management and land use.

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 4). 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 in the district. Lower categories, the major soil group and major soil subgroup occurring in the district are distinguished for the divisions. Lower categories, the major soil group and major soil subgroup are distinguished for the divisions. The distribution of major soil subgroups are shown in Figure 8.

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: Humus -Iron Podzols

Humus-iron podzols have surface L, F and H horizons, a thin Ah horizon, not always present which overlies a pale-coloured, strongly bleached E horizon with a low organic-matter content. The B horizons include a dark-coloured, humus enriched upper layer (Bh horizon) and a bright-coloured lower layer (Bs), the latter usually containing translocated iron and aluminium.and. Sometimes there is a sharp change into a paler, indurated B or BC horizon. Some of the humus-iron podzols in the area have been cultivated, destroying the characteristic podzolic upper horizons. Some variation in drainage status may be found.

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 Group: Gleys

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 & Valley 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.

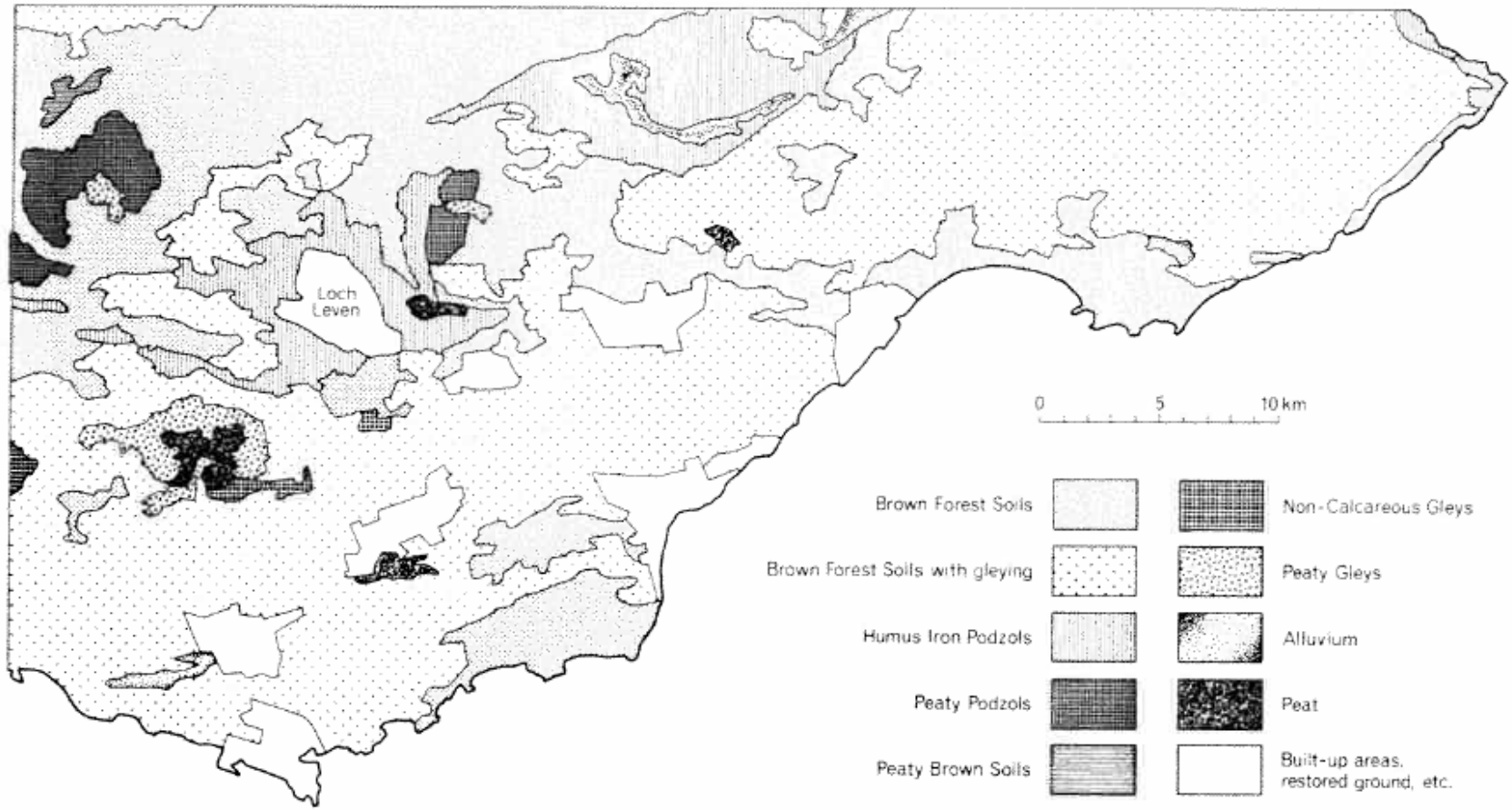
Major Soil Group: Blanket Peat

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 4. 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
	Alluvial Soils		Essil, Netherton, Culnacoyle, Kaime, Rockfield, Innes, Peebles, Traquair, Lochside, Shandwick, Bindal, Myreside, Heavyside, Geanies, Peat-alluvium, Alluvium undifferentiated
	Rankers		Skeletal soils
Leached Soils	Brown earths	Brown forest soils	Fourmerk, Urquhart, Garvock, Sourhope, Darleith, Drumain, Greenside, Forestmill, Darvel, Carpow, Dreghorn, Fraserburgh, (Balquhandy – peaty brown soil)
		Brown forest soils with gleying	Balrownie, Kippen, Butterwell, Kilgour, Mountboy, Bellshill, Gellyknowe, Dunlop, Reidston, Caprington, Winton, Macmerry, Sauchieburn, Aberdona, Kennet, Duncrahill, Quivox
	Podzols	Humis-iron podzols	Vinny, Redbrae, Frandy, Cringate, Bath Moor, Devilla, Gleneagles, Hexpath, Kilwhiss, Giffordtown, Panbride
		Peaty podzols	Cowie, Baidland, Dumglow
Gleys	Gleys	Noncalcareous gleys	Lour, Barras, Atton, Amlaird, Hindsward, Rowanhill, Butterdean, Giffnock, Woodend
		Peaty gleys	Edgerston, Lawsuit, Myres, Polquhairn, Scaurs
Organic Soils	Basin & Valley Peat		
	Blanket Peat		

Figure 8. Distribution of Major Soil Subgroups



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 50 centimetres and further separated where depths exceeded 1 metre.

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 occur in an intricate and often recurring pattern, it is not always possible to distinguish soil series even on the larger scale field maps. In these cases soil complexes are used as mapping units (Skythorn and Pilgrim complexes). The 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 soil 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 included in Chapter 4, Appendix 2 and discussed in Chapter 6. Percentages of minerals in the clay fraction are given in Appendix 3.

4. Soils

Introduction

Fifty eight soil series have been identified in the area surveyed. With the exception of seven, all have already been mapped in other parts of the country, twenty two being present in the Perth/Arbroath/Dundee district (Sheet 48/49) immediately to the north. Where possible, on the Fife/Kinross sheet, alluvial soils have been separated into series based on drainage and on the texture of the upper horizons.

Table 5 shows the area in square kilometres covered by each series and by other soil units, namely soil complexes, skeletal soils, alluvium, links, dunes, peat and mixed bottom land. 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 sixteen soil associations and other soil units found in the area are described in detail. The Balrownie, Forfar and Carpow Associations, which occur to a very limited extent in the north of the area, were not sampled.

The description and standard analytical data for each profile follows and, in most cases, a brief note on the results has 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. 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. Sixty two profiles are described in the text and standard analytical data are given for a further seventeen profiles in Appendix 2. In the description of many of the soil profiles, the soil textures 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 inclusion of markedly decomposed stones in the soil samples taken for analysis.

Table 5. Areas of Soil Categories (square kilometres)

	AREAS OF SOIL SERIES (SQ KM)											
	Brown Forest Soils		Humus-iron Podzols & Iron Podzols		Peaty Podzols	Peaty Brown Soils	Noncalcareous Gleys	Peaty Gleys		Soil Complexes	Skeletal Soils	Total Area
	SERIES											
ASSOCIATION	Freely Drained	Imperfectly Drained	Freely Drained	Imperfectly Drained	Freely Drained below iron pan	Freely Drained	Poorly Drained	Poorly Drained	Very Poorly Drained			
BALROWNIE		Balrownie (1)					Lour (0.02)					1
FORFAR			Vinny (1)									1
KIPPEN	Fourmerk (7)	Kippen (10)	Redbrae (5)									22
		Butterwell (7)										7
	Urquhart (23)	Kilgour (1)									2	26
MOUNTBOY	Garvock (2)	Mountboy (9)					Barras (0.02)					11
SOURHOPE	Sourhope (129)	Bellshill (43)	Frandy (8)		Cowie (10)	Balquhandy (3)	Atton (6)	Edgerston (1)	Lawsuit (0.19)	Skythorn (1)	1	202
		Gellyknowe (5)										5
DARLEITH	Darleith (54)	Dunlop (18)	Cringate (3)		Baidland (3)		Amlaird (1)	Myres (0.68)				81
	Drumain (44)									Pilgrim (1)		45
HINDSWARD		Reidston (39)			Dumglow (0.46)		Hindsward (4)	Polquhairn (2)				45
ROWANHILL		Caprington (225)					Rowanhill (9)					234
	Greenside (1)	Winton (28)										29
		Macmerry (109)					Butterdean (2)					111
		Sauchieburn (1)										1
GIFFNOCK		Aberdona (65)	Bath Moor (0.15)	Devilla (0.62)			Giffnock (9)	Scaurs (6)				81
		Kennet (0.47)										<1

	Forestmill (3)											3
GLENEAGLES			Gleneagles (2)									2
ECKFORD			Hexpath (32)	Kilwhiss (18)			Woodend (2)					52
			Giffordtown (30)									30
DARVEL	Darvel (23)	Duncrahill (4)										27
CARPOW	Carpow (3)											3
PANBRIDE			Panbride (2)									2
DREGHORN	Dreghorn (25)	Quivox (7)										32
FRASERBURGH	Fraserburgh (4)											4
TOTAL	318	572	81	19	13	3	33	10	<1	2	4	1056

ALLUVIAL SOILS							MISCELLANEOUS					
	Freely Drained	Impefectly Drained	Poorly Drained	Very Poorly Drained Undiferentiated	Undifferentiated							
Gravelly		Essil (3)	Netherton (0.03)				Undifferentiated Peat (4)		Mixed Bottom Land (9)			
Sandy	Culnacoyle (0.33)	Kaime (3)	Rockfield (4)	Innes (0.59)			Basin Peat 1 (1)		Opencast (13)			
Loamy	Peebles (2)	Traquair (8)	Lochside (2)				Basin Peat 2 (17)		Quarries (7)			
Silty		Shandwick (6)	Bindal (1)				Hill Peat 1 (0.55)		Bings etc. (3)			
Clayey		Myreside (3)	Heavyside (4)				Hill Peat 2 (0.62)		Built-up area (77)			
Peaty				Geanies (1)	PAL (6)		Links (2)		Lochs & Reservoirs (18)			
Undifferentiated					AL (7)		Dune Sand (2)					
TOTAL	2	23	11	2	13		27		127			205
												1261

Balrownie and Forfar Associations

These two closely related associations, although mapped on the sheet, are very limited in extent and the soils were not described in detail nor sampled for analyses. Both comprise the southern extremities of much larger areas on the Perth/Arbroath/Dundee soil map to the north.

Apart from a very small area of Lour Series to the south of Dunning, only the Balrownie Series (Balrownie Association), covering a total of about 1 square kilometre, has been mapped. It occurs in two small areas at the northern edge of the sheet - in Strath Eden and on the Earn Flats, beside Dunning. The series is an imperfectly drained brown forest soil with the generalised profile description of a 25-centimetre plough layer, of dark greyish brown sandy loam overlying a 10-centimetre B horizon of reddish brown sandy loam or sandy clay loam. The C horizon is of reddish brown sandy clay loam or clay loam texture.

Vinny is the only series of the Forfar Association mapped and covers an area of about 1 square kilometre bordering the Balrownie Series in Strath Eden. Although classed as freely drained podzols, Vinny Series soils are cultivated and have profiles which resemble those of brown forest soils. In general terms, the profile comprises a 28 centimetre plough layer overlying 18 centimetres of reddish grey loamy sand. The upper 30 centimetres of the C horizon have been water-sorted to give a pinkish grey sandy loam or loamy sand BC horizon with the unaltered dark reddish grey sandy clay loam till beneath.

Both Balrownie and Forfar Associations are described in detail in the memoir covering the soils round Perth, Arbroath and Dundee (Laing,1976).

Carpow Association

Covering only 3 square kilometres, the Carpow Association occurs in two localities - Strath Eden to the north-east of Springfield and bordering the Ceres Burn to the south-west of Pitscottie. These areas are the southern extensions of a much larger expanse in the Perth/Arbroath/Dundee map to the north.

Parent Material

Upper terrace river deposits rising above floodplain levels to 30 or 38 metes are the main constituents of the parent material. These consist largely of coarse sands and gravels derived from Old Red Sandstone sediments and lava with a proportion of Dalradian metamorphic material.

Soils

One series, Carpow, a freely drained brown forest soil, has been mapped in this area.

Carpow Series

Profile Description : No. 1 Tarvit Mill

Grid Reference	NO 363124
Slope	0^0
Aspect	Nil
Altitude	38 metres
Vegetation	Second year grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap1	0-30	Very dark greyish brown (l0YR5/2) sandy loam; moderate medium subangual blocky; friable; moist; no mottles;low organic matter; many fibrous grass roots; worms present; few stones mainly small subangular gravel. Clear smooth change into
Ap2	30-51	Dark brown (7.5YR32) sandy loam; weak medium subangular blocky; moist; no mottles; low organic matter; worms present; many fibrous grass roots; frequent stones mainly subangular sandstones, generally larger than in horizon above, with some angular fragments. Sharp smooth change into
Bw1	51-76	Brown (7.5YR5/4) loamy sand; weak fine crumb; friable; moist; no mottles; low organic matter; roots frequent becoming few with depth; many stones, subangular and rounded, with frequent angular sandstone fragments. Gradual change into
Bw2	76-104	Brown to strong brown (7.5YR4/4 to 5/6) loamy sand; weak fine subangular blocky, tending to medium crumb;

		moist; no mottles; low organic matter; few roots; many stones as above with more gravel and many angular sandstone fragments. Gradual change into
C	104-130+	Brown (10YR5/3) and light yellowish brown (l0YR5/4) coarse sandy gravel; moist; no mottles; no roots; many angular pieces of sandstone and frequent broken sandstone boulders.

Analyses Sample Numbers 254069-75							
Horizon	Ap1	Ap1	Ap2	Bx1	Bw2	C	C
Depth (cm)	5-13	20-28	36-43	56-64	81-89	107-114	122-129
Sand 50-2000 μm %	70.2	74.3	78.5	82.8	83.7	88.9	91.8
Silt 2-50 μm %	13.9	12.0	13.6	15.4	12.7	7.7	6.6
Clay <2 μm %	13.2	11.2	5.9	1.8	3.6	3.4	1.6
Calcium (me/100g)	10.52	9.63	7.63	4.56	2.43	1.66	1.66
Magnesium (me/100g)	0.50	0.54	0.42	0.29	0.16	0.12	0.16
Sodium (me/100g)	0.04	0.03	-	-	0.03	-	0.03
Potassium (me/100g)	0.23	0.23	0.21	0.21	0.03	-	
Hydrogen (me/100g)	3.87	4.38	4.38	2.23	1.21	0.70	1.21
Base Saturation %	74.4	70.5	65.4	69.5	68.7	71.8	61.6
pH (in water)	6.6	6.6	6.7	6.7	6.8	6.6	6.7
pH (in $CaCl_2$)	6.1	6.0	6.0	6.1	6.0	6.0	6.0
Loss on Ignition %	5.46	4.92	4.07	2.87	2.58	1.76	1.81
Carbon %	3.04	2.82	1.71				
Nitrogen %	0.34	0.32	0.23				
Organic Matter %	5.23	4.85	2.94				
Total Phosphorus (mg P_2O_5/100g)	396	394	304	199	168	170	152

- = less than lower limit of determination

The values for exchangeable calcium are high in the Ap1horizon, probably due to the application of lime and fertilizers. Percentage base saturation is high in all horizons. Throughout the profile, pH values in water are high (>6.5) and in M/l00$CaCl_2$, medium (6.0-6.5). Total P is high in the Ap horizon and moderate elsewhere. Analyses of Carpow Series profiles from the Perth/Arbroath/Dundee area indicate that the values for exchangeable calcium, for pH and for total phosphorus tend to be moderate while percentage base saturation is frequently moderate to high.

Darleith Association

The Darleith Association covers a total of 127 square kilometres and, apart from a small area in the Crook of Devon hills, is confined to the Fife basaltic hills and to the Coastal fringe of Fife. It occurs on the Saline and Cleish Hills, the Lomond Hills, the east Fife uplands, the Dunfermline low hills, and the volcanic ridges of southern Fife and on the Isle of May.

Parent Material
The parent material consists of drifts derived from basaltic lavas and various basic intrusive rocks. Over much of the area, particularly on higher ground, the parent material is formed from weathered rocks and is generally of coarse texture. On some of the lower slopes, the soils are developed on shallow tills of finer texture.

Soil
Seven series have been distinguished in the area. The two most extensive are the Darleith and Drumain Series, both freely drained brown forest soils, the former fine-textured and the latter coarse-textured. The Dunlop Series is an imperfectly drained brown forest soil with gleying, Cringate is a freely drained iron podzol and Baidland is a peaty podzol with free drainage below the pan. Amlaird is a poorly drained noncalcareous gley and Myres is a poorly drained peaty gley.

The Pilgrim Complex comprises soils of the Isle of May and is found on very uneven topography with frequent rock outcrops and soil-filled hollows.

Skeletal soils occur in a few small areas on hill tops or associated with rock outcrops.

Darleith Series

Darleith Series, covering a total area of 54 square kilometres, is the most extensive series in the association. A freely drained brown forest soil, it is developed on fine-textured drift derived from basaltic lavas and basic intrusive rocks. The largest area occurs on the volcanic ridges of southern Fife directly north of Burntisland. Smaller areas are found throughout the Fife basaltic hills and in the Crook of Devon hills. The soils are often shallow, overlying weathered rock.

Profile Description: No. 2 West Lethans

Grid Reference	NT054942
Slope	5^0
Aspect	North
Altitude	274 metres
Vegetation	Permanent Pasture
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-23	Dark greyish brown (10YR4/2) loam; moderate medium subangular blocky; friable; moist; no mottles; moderate organic matter; many fibrous grass roots; worms present, few stones. Sharp smooth change into

Bw1	23=53	Brown to strong brown (7.5YR4/4 to 5/6) clay loam; moderate coarse angular blocky; friable; moist; no mottles; low organic matter; many fibrous grass roots; many medium angular stones. Sharp irregular change into
Bw2	53-69	Greyish brown (10YR5/2) and yellowish brown (10YR5/4) gritty clay loam; moderate coarse angular blocky; moist; few faint fine ochreous mottles; frequent fine roots. Sharp wavy change into
C	69-89	Brown to dark brown (10YR4/4) clay loam; strong coarse angular blocky; friable; moist; no mottles; few roots; few stones. Sharp smooth change into
CR	89-147+	Dark greyish brown (10YR4/2) and brownish yellow (10YR6/6) rotten rock.

Subangular blocky structure with friable consistence in the Ap horizon is a characteristic of the series. Textures throughout are seldom coarser than clay loam. Some soils have an indurated horizon below the Bw.

Analyses Sample Numbers 235466-71						
Horizon	Ap	Bw1	Bw2	C	C	CR
Depth (cm)	7-15	30-38	56-64	74-84	102-112	137-147
Sand 50-2000 μm %	40.2	44.7	47.7	37.9	42.0	48.5
Silt 2-50 μm %	33.3	29.1	29.3	40.4	34.7	35.3
Clay <2 μm %	19.0	26.2	23.0	21.7	23.3	16.2
Calcium (me/100g)	2.67	3.12	4.82	6.34	3.46	4.29
Magnesium (me/100g)	0.84	1.04	2.55	3.85	3.85	6.09
Sodium (me/100g)	0.08	0.05	0.04	0.08	0.06	0.08
Potassium (me/100g)	0.17	0.09	0.13	0.19	0.21	0.28
Hydrogen (me/100g)	18.82	13.29	11.14	12.05	13.82	11.39
Base Saturation %	20.0	24.5	40.4	46.5	35.4	48.5
pH (in water)	4.6	4.8	4.7	4.8	4.6	4.8
pH (in $CaCl_2$)						
Loss on Ignition %	13.7	9.1	6.8	8.4	8.4	5.8
Carbon %	6.2	2.7	1.2			
Nitrogen %	0.55	0.26	0.10			
Organic Matter %	10.73	4.68	2.14			
Total Phosphorus (mg P_2O_5/100g)	333	322	161	218	386	171

As in most profiles of this series, the percentage silt is moderately high throughout. Values for exchangeable calcium, magnesium and potassium and for some base

saturation are moderate except for low calcium values n the A horizon and high magnesium in the CR horizon. Total phosphorus falls from high in the A and Bw1 to moderate in the Bw2 but rises again in the C horizon.
In other profiles of the Darleith Series there is generally a tendency for phosphorus to increase down the profile. Total phosphorus content in the soils of the Isle of May are understandably very high due to the large population of sea birds and a value of 2002 mg P_2O_5/100g was recorded in one soil. Sodium levels are also high in the island soils. More generally, soils of the series have high exchangeable calcium values and moderate or high magnesium and potassium values.

Drumain Series

Slightly less extensive than Darleith Series, Drumain Series covers an area of 44 square kilometres. A freely drained brown forest soil, it occurs most extensively on the Lomond Hills and on Benarty Hill, although smaller areas are found on all other hills with the exception of the Ochils. It differs from Darleith Series in its coarser texture, being derived from dolerites and basic agglomerates.

Profile Description No. 3 Drumain A

Grid Reference	NO215047
Slope	2^0
Aspect	North
Altitude	262 metres
Vegetation	Permanent Pasture
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-23	Dark brown (10YR4/3) sandy loam; moderate medium subangular blocky; friable, moist; no mottles; moderate organic matter; many fibrous grass roots; worms present; frequent medium subangular igneous stones. Sharp change into
Bw	23-33	Brown (7.5YR4/4) loamy sand; weakly indurated breaking down to fine crumb and single grain; moist; no mottles; low organic matter; few fine roots; many medium and small angular stones. Gradual change into
Bx	33-64	Dark yellowish brown (10YR4/4) and yellowish brown (10YR5/6) loamy coarse sand; strongly indurated; moist; diffuse distinct ochreous mottles in lower half of horizon; low organic matter; many medium and small angular igneous stones. Sharp undulating change into
C1	64-96	Strong brown (7.5YR5/6) sandy loam; weak coarse angular blocky; loose; moist; no mottles; low organic matter; few decomposed igneous rocks. Sharp change into
C2	96-140	Brown (7.5YR5/4) sandy loam; strong coarse angular blocky; firm; moist; common medium distinct dark yellowish brown (10YR5/8) mottles and faint grey coatings on peds; low organic matter; frequent

subangular stones.

Analyses Sample Numbers 235201-07							
Horizon	Ap	Bw	Bx	C1	C1	C2	C2
Depth (cm)	7-15	25-33	48-58	68-76	86-94	109-117	129-139
Sand 50-2000 μm %	50.5	74.6	75.1	70.7	72.9	68.2	59.3
Silt 2-50 μm %	32.9	18.7	18.6	24.1	22.7	21.4	31.5
Clay <2 μm %	8.4	4.3	4.1	5.2	4.4	10.4	9.2
Calcium (me/100g)	2.67	0.92	1.23	22.98	18.18	10.72	10.70
Magnesium (me/100g)	0.96	0.28	0.27	8.67	7.57	4.70	0.62
Sodium (me/100g)							
Potassium (me/100g)	0.29	0.02	-	0.20	0.12	0.05	0.08
Hydrogen (me/100g)	28.57	3.00	0.87	3.79	1.28	3.45	3.50
Base Saturation %	12.3	28.9	63.9	89.4	95.3	81.9	76.7
pH (in water)	4.3	4.5	4.6	4.9	5.0	5.0	5.1
pH (in $CaCl_2$)	3.4	3.8	3.8	4.1	4.1	4.2	4.3
Loss on Ignition %	15.2	4.8	4.4	3.6	3.6	2.4	2.9
Carbon %	7.43	0.79	0.68				
Nitrogen %	0.6	0.07	0.07				
Organic Matter %	12.78	1.35	1.21				
Total Phosphorus (mg P_2O_5/100g)	331	203	212	271	261	164	158

- = less than lower limit of determination

In contrast to the previous profile from the Darleith Series, the Drumain profile has lower silt content throughout except in the Ap and lower C2. The clay content of all horizons is also very low and only rises above 10% in the upper C2 sample. These figures reflect the coarser texture of the Drumain parent material. This soil exhibits a wide range in the levels of its various chemical constituents. Exchangeable calcium values are low in the upper part of the profile and high in the C horizon, magnesium is moderate in the A and B horizons and high below, and potassium alternates between moderate and low down the profile. Base saturation percentages are low in the Ap and Bw horizons but high below.

The above variability is reflected in further examples of the series and is perhaps due to the variable content of weathered igneous material in the profiles. Exchangeable calcium levels range from low to over 30me/100g, magnesium values are moderate or high and potassium values are moderate, becoming low with depth. Base saturation percentages may be high throughout the profile or, as in the example above, rise from low to high with depth. Total phosphorus levels are high and tend to decrease down the profile.

Dunlop Series

The Dunlop Series, covering a total area of 18 square kilometres, is developed on drift which is usually glacial till of clay loam texture. Imperfectly drained, it is classed as a brown forest soil with gleying and it occurs in small areas contiguous with the Darleith Series and to a lesser extent, the Drumain Series.

Profile Description No. 4 Easter Glasslie B

Grid Reference	NO241053
Slope	3^0
Aspect	South-east
Altitude	274 metres
Vegetation	Third or fourth year grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-25	Dark greyish brown (10YR4/2) clay loam; strong medium subangular blocky; friable; moist; no mottles; frequent stones; moderate organic matter; grass roots plentiful; worms present. Sharp irregular change to
B(g)	25-48	Yellowish brown (10YR5/4) clay loam; moderate medium subangular blocky; friable; moist; frequent faint yellowish brown (10YR5/6) mottles; frequent stones; low organic matter; grass roots plentiful. Gradual change into
Cg	48-102+	Light olive brown (2.5YR5/4) clay loam; moderate coarse angular blocky to prismatic; slightly plastic; wet-water coming in at 1 metre; many fine, prominent brownish yellow (10YR6/6) mottles; decomposing igneous rock gives dark coloration in lower half of horizon; frequent angular pieces of igneous rock; few roots

Analyses Sample Numbers 242777-81					
Horizon	Ap	B(g)	Cg	Cg	Cg
Depth (cm)	8-18	33-41	56-64	76-84	94-102
Sand 50-2000 μm %	31.6	40.0	39.5	44.1	45.0
Silt 2-50 μm %	42.5	36.4	32.7	30.6	38.0
Clay <2 μm %	19.0	23.6	27.8	25.3	17.0
Calcium (me/100g)	18.50	17.00	18.65	17.64	25.26
Magnesium (me/100g)	5.43	8.05	9.75	9.12	14.03
Sodium (me/100g)	0.12	0.06	0.12	0.08	0.15
Potassium (me/100g)	0.17	0.07	0.06	0.07	0.12
Hydrogen (me/100g)	7.83	4.46	2.70	2.57	3.73

Base Saturation %	75.7	85.0	91.2	91.2	91.3
pH (in water)	6.1	6.4	6.7	6.8	6.8
pH (in $CaCl_2$)	5.6	6.0	6.1	6.2	6.2
Loss on Ignition %	13.8	9.8	8.1	7.3	9.9
Carbon %	5.51	2.69			
Nitrogen %	0.66	0.37			
Organic Matter %	9.48	4.62			
Total Phosphorus (mg P_2O_5/100g)	400	297	259	372	978

High silt content is a notable feature in this profile with the amount of silt (2-50 μm) above 30 per cent in all horizons. Both exchangeable calcium and magnesium levels are high and increase with depth, while potassium levels are low. Base saturation percentages are high throughout the profile and values for total phosphorus are high in the surface horizon, moderate in the B(g) and upper Cg sample and rise to a very high level of 978 mg P_2O_5/100g in the deepest sample of the Cg horizon.

Most soils of the series have chemical properties broadly similar to those outlined above. Exchangeable calcium values can be very high, especially in the Cg horizon, and 40 me/100g were recorded in a soil on Largo Law (where a magnesium value of 26 me/100g was recorded also). Total phosphorus levels are high and usually decrease with depth.

Cringate Series

The Cringate Series is a freely drained humus-iron podzol covering a total of 3 square kilometres. Distribution is confined to the Lomond Hills and to the Cleish Hills.

The soils are somewhat variable, but a typical profile comprises an L and F layer of 3 to 5 centimetres of fresh and decomposing plant remains, overlying about 3 centimetres of well decomposed organic matter, the H horizon. Below this, a dark greyish brown loam E horizon of 5 to 10 centimetres in depth is succeeded by 13 to 18 centimetres of strong brown loam, the Bs horizon. An indurated (Bx) horizon of brown to olive brown sandy loam overlies a C horizon of brown sandy loam, derived from decomposed rock.

Baidland Series

The Baidland Series, a peaty podzol with thin iron pan, is imperfectly or poorly drained in the surface layers but freely drained below the pan. It covers a total of 3 square kilometres and, apart from two small areas on the Cleish Hills, is confined to the upper slopes of the west Lomond and of Bishop Hill above 300 metres.

Profile Description No. 5 Munduff Hill

Grid Reference	NO193036
Slope	4^0
Aspect	East
Altitude	428 metres
Vegetation	Permanent Pasture
Drainage Class	Free below pan

Horizon	Depth (cm)	
L & F	0-5	Grass litter and fibrous humus
H	5-23	Black (5YR2/2) amorphous humus; moist; many fibrous roots. Sharp wavy change into
Eh	23-28	Dark greyish brown (10YR4/2) sandy loam to clay loam; moderate medium angular blocky; friable; moist; no mottles; high organic matter; many grass roots; few stones. Sharp wavy change into
Bf	28-28	Well developed iron pan, 1.5 mm thick
Bh	28-38	Dark brown (7.5YR3/2 sandy loam; moderate medium subangular blocky; friable; moist; no mottles; high organic matter; many grass roots; frequent stones. Clear irregular change into
Bs1	38-66	Brown (7.5YR4/4) gritty fine sandy loam; weak medium crumb; friable; moist; no mottles; low organic matter; many roots; many stones including many angular pieces of igneous rock. Gradual change into
Bs2	66-92	Yellowish brown (10YR5/4) sandy loam; weak medium subangular blocky; friable; moist; many distinct strong brown (7.5YR5/8) mottles; roots frequent, becoming few towards bottom of horizon; stones as above Sharp irregular change into
C	92-150	Brown (10YR4/3) decomposed igneous rock breaking down to stony coarse sand, loamy sand or sandy loam.

Analyses Sample Numbers 242158-66								
Horizon	H	Eh	Bh	Bs1	Bs2	C	C	C
Depth (cm)	10-18	23-28	28-36	51-59	74-81	97-104	114-122	142-150
Sand 50-2000 μm %	ND	45.3	60.9	63.7	70.3	78.9	64.2	76.7
Silt 2-50 μm %	ND	27.7	19.0	25.4	20.6	16.7	31.6	12.0
Clay <2 μm %	ND	11.7	6.8	6.2	6.5	2.0	2.0	3.1
Calcium (me/100g)	6.07	0.96	0.65	-	-	-	1.25	1.09
Magnesium (me/100g)	1.15	0.20	0.14	0.02	-	-	0.31	0.28
Sodium (me/100g)	0.23	0.12	0.08	0.04	0.04	0.03	0.05	0.06
Potassium (me/100g)	1.15	0.25	0.16	0.04	0.03	-	-	0.04
Hydrogen (me/100g)	111.3	42.5	41.0	14.3	8.4	7.7	10.4	10.4
Base Saturation %	7.2	3.5	2.5	0.7	0.8	0.4	13.4	12.3
pH (in water)	3.9	4.1	4.3	4.3	4.4	4.4	4.6	4.7
pH (in $CaCl_2$)	3.0	3.4	3.8	4.3	4.3	4.2	3.8	4.1
Loss on Ignition %	96.0	20.3	17.8	9.4	5.2	4.8	4.4	4.5
Carbon %	55.70	11.40	7.70					
Nitrogen %	2.10	0.60	0.40					
Organic Matter %	96.00	19.50	13.20					
Total Phosphorus (mg P_2O_5/100g)	276	230	356	362	336	364	384	331

- = less than lower limit of determination

Notable features are the deep H horizon with high loss on ignition, and the low base saturation and low pH values throughout the profile.

Below the organic horizons, soils of the series are markedly acid, with a pH range of 4.1 to 4.6 (3.4 to 4.2 in $CaCl_2$) and have very low levels of exchangeable cations and base saturation. Only potassium values are moderate and these decrease to low with depth. Total phosphorus content is moderate or high and usually decreases down the profile.

Amlaird Series

Amlaird Series, covering only 1 square kilometre, is classed as a poorly drained noncalcareous gley and, apart from a small patch in the volcanic ridges behind Burntisland, is confined to the Lomond Hills.

Profile Description No. 6 Drumain B

Grid Reference	NO216047
Slope	2^0
Aspect	North-east
Altitude	259 metres
Vegetation	Permanent Pasture
Drainage Class	Poor

Horizon	Depth (cm)	
Ap	0-28	Very dark greyish brown (10YR3/2) sandy silt loam; strong coarse subangular blocky; firm; moist; few medium distinct strong brown (7.5YR5/6) mottles; moderate organic matter; many fibrous grass roots; few stones. Sharp smooth change into
Bg1	28-74	Dark greyish brown (10YR4/2) sandy loam to loamy sand; weak medium angular blocky; soft; moist; many medium distinct mottles, strong brown (7.5YR5/8) in upper half of horizon and reddish brown (5YR4/4) in lower half; low organic matter; fibrous roots frequent, becoming few in lower half of horizon; frequent stones. Sharp change into
Bg2	74-86	Dark greyish brown (2.5Y4/2) and reddish brown (5YR4/3) loamy coarse sand; massive; weakly indurated in parts; moist; reddish brown (5YR4/3) to dark reddish brown (5YR3/4); iron oxide accumulations occur in a 5cm band at the bottom of the horizon and tend to dominate horizon colour; few roots; many stones. Sharp change into
Cg	86-117+	Light grey (10YR7/2) sandy loam or sandy silt loam; moderate coarse angular blocky, tending to prismatic; slightly plastic; wet; many coarse prominent strong brown (7.5YR5/8) mottles and light grey (10YR7/1) coatings on peds; low organic matter; frequent stones.

Analyses Sample Numbers 235208-12					
Horizon	Ap	Bg1	Bg2	Cg	Cg
Depth (cm)	10-25	43-53	76-81	86-94	102-117
Sand 50-2000 μm %	45.1	72.4	79.2	61.0	48.2
Silt 2-50 μm %	37.7	22.5	17.1	33.5	41.0
Clay <2 μm %	10.2	5.1	3.7	5.5	10.8
Calcium (me/100g)	2.95	8.91	8.01	16.30	9.33
Magnesium (me/100g)	1.88	1.98	2.64	7.62	4.57
Sodium (me/100g)	0.10	0.13	0.10	0.22	0.10
Potassium (me/100g)	-	-	-	0.03	0.03
Hydrogen (me/100g)	19.48	1.18	4.14	3.69	2.77
Base Saturation %	20.2	90.3	72.2	86.8	83.5
pH (in water)	4.4	4.8	4.8	5.1	5.3
pH (in $CaCl_2$)	3.4	4.0	4.5	4.9	4.9
Loss on Ignition %	14.0	3.7	3.2	2.3	3.0
Carbon %	6.21	0.72			
Nitrogen %	0.50	0.08			
Organic Matter %	10.67	1.23			
Total Phosphorus (mg P_2O_5/100g)	339	200	223	260	103

- = less than lower limit of determination

Notable features are high exchangeable calcium and high percentage base saturation in all horizons with the exception of the Ap horizon.

Myres Series

Myres Series is a poorly drained peaty gley, covering a total area of less than 1 square kilometre. It is confined to the Lomond Hills where it is frequently found contiguous with areas of Amlaird Series. There are also minor occurrences of a very poorly drained peaty gley which are too small to show separately on the soil map.

Profile Description No. 7 Drumain C

Grid Reference	NO217047
Slope	0^0
Aspect	Nil
Altitude	259 metres
Vegetation	Permanent Pasture
Drainage Class	Poor to Very Poor

Horizon	Depth (cm)	
Ah	0-28	Dark Brown (7.5YR3/2) sandy loam or loam; strong coarse subangular blocky; firm; moist; frequent fine distinct yellowish red (5YR5/6) mottles; high organic matter; many fibrous grass roots; few stones. Clear change into
Bg1	28-43	Dark greyish brown(10YR3/2) fine sandy loam; moderate coarse subangular blocky; slightly firm; moist; many medium distinct reddish brown (5YR4/4) mottles and faint light grey (10YR7/2) coatings on peds; low organic matter; frequent fibrous grass roots; few stones, occasional large ones at bottom of horizon. Sharp smooth change into
Bg2	43-71	Very dark greyish brown (10YR3/2) loamy sand; moderate coarse angular blocky; firm; moist, becoming wet at 66 cm; low organic matter; few fine roots penetrate to 63 cm; few stones. Gradual change into
Cg	71-129+	Dark olive grey (5Y3/2) and olive (5Y4/4) loamy sand; massive; slightly sticky; wet; many medium distinct reddish brown (5YR5/4) mottles and frequent, small patches of dark bluish grey (5B4/1) gleying; low organic matter; many decomposing stones.

Analyses Sample Numbers 235213-18						
Horizon	Ah	Bg1	Bg2	Cg	Cg	Cg
Depth (cm)	8-15	30-38	51-61	74-84	94-104	119-129
Sand 50-2000 μm %	47.4	50.7	76.5	79.7	83.1	77.4
Silt 2-50 μm %	27.5	35.4	20.0	15.6	12.9	19.1
Clay <2 μm %	9.0	7.9	3.5	4.7	3.5	3.5
Calcium (me/100g)	1.57	3.10	7.58	4.77	5.53	10.20
Magnesium (me/100g)	0.33	0.48	1.92	2.88	3.01	4.06
Sodium (me/100g)	0.09	0.10	0.09	0.09	0.09	0.11
Potassium (me/100g)	0.07	-	-	-	-	0.06
Hydrogen (me/100g)	18.48	6.62	7.69	6.02	4.67	5.69
Base Saturation %	10.0	35.7	55.5	56.3	64.9	71.8

pH (in water)	4.0	4.2	4.4	4.5	4.6	4.6
pH (in $CaCl_2$)	3.5	3.7	3.9	4.2	4.2	3.8
Loss on Ignition %	21.5	12.0	3.8	3.3	3.1	2.3
Carbon %	11.18	6.35	0.84			
Nitrogen %	0.81	0.48	0.06			
Organic Matter %	19.23	10.93	1.43			
Total Phosphorus (mg P_2O_5/100g)	365	311	293	205	215	296

- = less than lower limit of determination

The drift forming the parent material of this soil and of the previous profile, Drumain B, is derived mainly from quartz-dolerite. This accounts for the coarse textures throughout both profiles. In areas where the dominant rocks are basaltic lavas, soils of both series are of finer texture – silty loam and silty clay loam.

Pilgrim Complex

The Pilgrim Complex, covering 1 square kilometre, is found only on the Isle of May at altitudes between 12 and 38 metres on very uneven topography with frequent rock outcrops and soil-filled hollows. It includes pockets of organic soil, some small areas of formerly cultivated mineral soils with Drumain Series - type profiles and skeletal soils formed on the underlying coarser-grained dolerite. Most of the topsoils consist of organic matter sometimes mixed with ashy material derived from large quantities of coal burned in earlier times to form the Beacon which was the first lighthouse on the island. The organic matter has also been added to by the vast bird population.

Skeletal Soils

Skeletal soils cover a total area of 1 square kilometre and occur as small patches on the Lomond Hills, the Saline and Cleish Hills, the east Fife uplands and on the volcanic ridges of southern Fife.

Darvel Association

With a total of 27 square kilometres, the Darvel Association occurs in small isolated areas which are widespread throughout the coastal fringe of Fife.

Parent Material
The soils are developed on fluvioglacial sands and gravels and on old lake deposits derived mainly from Lower Carboniferous igneous and sedimentary rocks and ranging in texture from loamy sand to coarse gravel.

Soils
Two series of the association have been mapped in this district, Darvel Series, a freely drained brown forest soil and Duncrahill Series, an imperfectly drained brown forest soil with gleying. The soils are characteristically coarse-textured and stony.

Darvel Series

Darvel, the dominant series, covers a total area of 23 square kilometres and occurs most extensively on the north side of Markinch, extending eastwards to Leven and westwards to Leslie. Other small isolated patches of less than 0.5 square kilometres are found throughout the coastal fringe of Fife. The series is developed mainly on moundy or undulating topography.

Profile Description No. 8 Dalginch

Grid Reference	NO313026
Slope	2^0
Aspect	West
Altitude	130 metres
Vegetation	Third Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-30	Dark brown (10YR4/3) sandy loam; weak medium subangular blocky; friable; moist; no mottles; low organic matter; many fibrous grass roots; worms present; many subangular and rounded stones. Sharp smooth change into
Bw1	30-53	Brown to strong brown (7.5YR5/4 to 5/6) loamy sand; weak moderate angular blocky; friable; moist; no mottles; low organic matter; many fibrous grass roots; many stones as above, with frequent angular pieces of soft sandstone. Gradual change into
Bw2	53-68	Brown (7.5YR5/4) loamy sand; very weak fine subangular blocky to fine crumb; friable; moist; no mottles; low organic matter; frequent roots; stones as above but many larger. Clear smooth change into
C	68-102+`	Brown (7.5YR4/4) loamy sand; compacted in parts, but breaking down readily to single grain; moist; no mottles; low organic matter; no roots; many rounded and

subrounded stones, frequently greater than 8 cm in diameter.

This profile is taken from the Markinch area where the series is most extensive and the topography is undulating to moundy. Although the Ap horizon is 30 centimetres thick in this profile, it is normally less than 30.

Analyses Sample Numbers 268130-35						
Horizon	Ap	Ap	Bw1	Bw2	C	C
Depth (cm)	5-13	20-28	36-46	56-66	74-84	102-112
Sand 50-2000 μm %	74.0	75.0	74.0	77.0	83.0	77.0
Silt 2-50 μm %	18.0	19.0	22.0	19.0	15.0	19.0
Clay <2 μm %	8.0	6.0	4.0	4.0	2.0	4.0
Calcium (me/100g)	9.65	10.60	4.58	3.65	3.03	4.87
Magnesium (me/100g)	1.41	1.52	0.52	0.30	0.22	0.45
Sodium (me/100g)	0.12	0.12	0.12	0.07	0.06	0.09
Potassium (me/100g)	1.34	0.65	0.15	0.11	0.04	0.05
Hydrogen (me/100g)	5.0	4.1	5.8	4.8	3.6	3.2
Base Saturation %	71.4	75.9	48.2	46.1	48.6	63.2
pH (in water)	6.8	7.1	6.5	6.3	6.2	6.1
pH (in $CaCl_2$)	6.2	6.5	5.7	5.5	5.4	5.3
Loss on Ignition %	5.2	4.9	3.5	2.5	1.6	1.8
Carbon %	1.90	1.90	1.16			
Nitrogen %	0.16	0.18	0.13			
Organic Matter %	3.30	3.30	2.00			
Total Phosphorus (mg P_2O_5/100g)	197	187	116	90	75	86

Generally, base saturation levels are moderate to high as reflected in the above profile but show a marked decrease in the B horizon, as in the Duncrahill Series profile that follows. The pH values cover a wide range from low to high, although these are moderate in most profiles. Total phosphorus levels are moderate in the upper soil horizons and decrease with depth.

Duncrahill Series

This series is only 4 square kilometres in extent, the largest area occurring in the vicinity of Star Moss, about 3 kilometres north of Markinch. Smaller areas have been mapped on the outskirts of Leven and Methil and some 2 kilometres inland from Crail. The soils are developed, in most cases, on former lake deposits.

Profile Description No. 9 Broomfield A

Grid Reference	NO311035
Slope	6^0
Aspect	South
Altitude	97 metres
Vegetation	Permanent Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-20	Dark greyish brown (10YR4/2 to 3/2) loamy sand; weak medium angular blocky to medium crumb; moist; no mottles; low organic matter; earthworms present; many fine grass roots especially in turf layer; few small subangular pieces of sandstone. Sharp irregular change into
Bg	20-58	Brown (10YR5/3) loamy fine sand; very weak subangular blocky to fine crumb; friable; moist; many prominent yellowish red (5YR4/8) mottles down old root channels, and frequent patches of light grey (10YR7/2) gleying; low organic matter; frequent tongues of A material carried down by worms; frequent fine grass roots; many small to medium angular fragments of sandstone, some partially weathered and frequent rounded cobbles of quartz-dolerite, also partially weathered. Clear wavy change into
Cg1	58-84	Light grey (10YR7/1) fine sand; loose, single grain, banded; moist; frequent mottles as above down old root channels; gleying obscures horizon colour; few bands of dark grey (5Y4/1) material; frequent fine grass roots; frequent medium angular fragments of sandstone, some partially weathered. Clear wavy change into
Cg2	84-160+	Bands of light grey (10YR7/1) and dark grey (5Y4/1) fine sand; compact; moist; mottles as above down old root channels, frequent at top of horizon, becoming few with depth; few fine grass roots in upper part of horizon. This horizon is a varved lake deposit.

Analyses Sample Numbers 268173-79							
Horizon	Ap	Bg	Bg	Cg1	Cg2	Cg2	Cg2
Depth (cm)	5-13	25-33	46-53	69-76	91-99	116-124	152-160
Sand 50-2000 μm %	80.0	86.0	84.0	90.0	88.0	93.0	94.0
Silt 2-50 μm %	15.0	11.0	13.0	9.0	10.0	6.0	5.0
Clay <2 μm %	5.0	3.0	3.0	1.0	2.0	1.0	1.0
Calcium (me/100g)	10.50	2.71	0.45	0.40	0.40	0.43	0.23
Magnesium (me/100g)	1.52	0.43	0.17	0.08	0.11	0.06	0.04
Sodium (me/100g)	0.05	0.03	-	-	-	-	-
Potassium (me/100g)	0.03	0.03	-	-	-	-	-
Hydrogen (me/100g)	2.70	0.20	1.80	-	-	-	-
Base Saturation %	81.8	94.1	25.0	91.7	91.7	91.7	83.3
pH (in water)	6.8	6.9	6.4	6.8	6.5	5.5	5.2
pH (in $CaCl_2$)	6.3	6.3	5.7	6.0	5.7	4.5	4.2
Loss on Ignition %	5.8	1.6	1.8	1.2	1.9		
Carbon %	2.91	0.48	0.56				
Nitrogen %	0.29	0.04	0.08				
Organic Matter %	5.02	0.82	0.96				
Total Phosphorus (mg P_2O_5/100g)	162	40	92	20	17	16	10

- = less than lower limit of determination

Base saturation percentages are high throughout the profile, with the exception of the B horizon where they are low. Total phosphorus and exchangeable cations are very low. The pH values decrease down the profile.

Dreghorn Association

The Dreghorn Association occupies a total area of 32 square kilometres and is found along parts of the coastline between Fife Ness in the north-east and Torry Bay in the south-west.

Parent Material
The soils are developed on raised beach deposits formed largely from carboniferous igneous and sedimentary rocks. The deposits vary in texture from sandy loam or loamy sand to sand and frequently contain layers of gravel. Bands of fine sand or silt are sometimes present throughout the profile.

Soils
Two series have been separated in this area. Dreghorn Series is a freely drained brown forest soil while Quivox Series is a brown forest soil with gleying.

Dreghorn Series

The dominant series of the association, Dreghorn covers a total are of 25 square kilometres. It occurs normally between the 15 metre and 40 metre levels but, in one area, it has been mapped as high as 60 metres above sea-level. In the area around Fife Ness and south-westwards over the old airfield as far as Crail, gravel is generally conspicuous in the surface and upper horizons of the profile. Further west, along the coast, the deposits tend to be of finer texture with topsoils generally sandy loams or fine sandy loams and gravel less common, normally occurring only in subsoils or at depth. The most extensive area of the series is found around Elie extending westwards to Lundin Links and northwards to Colinsburgh where it has been mapped at an ltitude of 46 metres. Between East Wemyss and Dysart, gravel is found only occasionally and most profiles have loamtopsoils overlying sandy loam subsoils. The series reaches its highest altitude at 61 metres behind Dysart. Small isolated areas are found further along the coast as far as Torry Bay at the western margin of the sheet.

Profile Description No. 10 Ardross A

Grid Reference	NO507006
Slope	1^0
Aspect	South-west
Altitude	15 metres
Vegetation	Permanent Pasture
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-46	Very dark greyish brown (10YR3/2) sandy loam to loam; moderate medium subangular blocky; friable; moist; no mottles; low organic matter; many roots; worms present; frequent stones. Sharp smooth change into
Bw	46-63	Brown to dark brown (10YR4/3) sandy loam; weak medium subangular blocky; loose and very friable; moist; low organic matter; frequent roots; frequent stones,

		mainly small gravel. Gradual change into
B(g)	63-86	Brown (10YR4/2) with patches of greyish brown (10YR5/2) sandy loam; weak medium angular blocky breaking readily to single grain; moist; frequent fine yellowish brown (10YR5/8) mottles associated with weathering stones; roots frequent, becoming few; many stones with frequent pieces of angular sandstone. Clear change into
C	86-142+	Light yellowish brown (10YR6/4) stony loamy sand to sand; loose, single grain; moist; no mottles; many stones, rounded gravel and angular pieces of sandstone; frequent pieces of decomposing rock

Analyses Sample Numbers 254022-27 & 27A							
Horizon	Ap	Ap	Bw	B(g)	C	C	C
Depth (cm)	10-18	30-38	53-61	71-79	91-99	112-119	135-142
Sand 50-2000 μm %	61.4	60.9	61.5	73.9	85.5	90.6	87.5
Silt 2-50 μm %	14.7	17.4	28.6	14.4	8.4	6.1	8.2
Clay <2 μm %	20.3	18.7	7.4	9.5	6.1	3.3	4.3
Calcium (me/100g)	13.88	15.90	13.15	16.68	11.94	13.58	10.08
Magnesium (me/100g)	2.65	2.70	1.42	1.56	1.09	1.47	1.79
Sodium (me/100g)	0.19	0.19	0.12	0.14	0.67	0.11	0.12
Potassium (me/100g)	0.65	0.53	0.14	0.12	0.08	0.16	0.15
Hydrogen (me/100g)	4.42	1.95	-	-	-	-	-
Base Saturation %	79.8	90.9	100.0	100.0	100.0	100.0	100.0
pH (in water)	6.3	6.8	7.0	7.4	7.6	7.5	6.7
pH (in $CaCl_2$)	5.6	6.3	6.5	6.9	6.9	6.9	6.1
Loss on Ignition %	7.1	6.0	5.0	4.4	2.6	2.9	2.9
Carbon %	2.84	1.74	0.56				
Nitrogen %	0.36	0.22	0.07				
Organic Matter %	4.88	2.99	0.97				
Total Phosphorus (mg P_2O_5/100g)		169	143	145	158	204	208

- = less than lower limit of determination

This profile is a good example of the finer-textured soils of the series, with gravel becoming notable only below 30 centimetres. Exchangeable calcium is high throughout, while the percentage base saturation is high in the Ap and reaches 100 elsewhere.

Most profiles of the series show high or moderate to high values for exchangeable calcium in the upper horizons with high percentage base saturation throughout. Coarse-textured soils of this series generally have moderate values in lower horizons both for calcium and for base saturation.

Quivox Series

The total area of the series is only 7 square kilometres. An imperfectly drained brown forest soil, it occurs mainly in low-lying localities, the most extensive area being around St. Monans.

Profile Description No. 11 Balbougie

Grid Reference	NT142843
Slope	2^0
Aspect	South-east
Altitude	15 metres
Vegetation	Barley Stubble
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-36	Dark greyish brown (10YR4/2) sandy loam to loamy sand; moderate medium angular blocky; friable; moist; no mottles; low organic matter; frequent fine and cord roots of barley; worms present; no stones. Sharp irregular change into
B(g)	36-63	Brown (10YR5/3) loamy fine sand; weak fine crumb; friable; moist; many coarse faint strong brown (7.5YR5/8) mottles; frequent pale brown (10YR6/3) gleyed patches dominate colour at base of horizon; low organic matter but frequent tongues of A horizon material penetrate top of horizon; few roots; frequent small decomposing quartz stones and few decomposing igneous. Clear irregular change into
C(g)1	63-81	Grey (10YR5/1) fine sand with bands of silty clay loam; structureless; moist; many medium distinct strong brown (7.5YR5/8) mottles and light brownish grey (10YR6/2) gleyed patches; low organic matter; no roots; many weathering fragments of coal at one side of profile. Gradual irregular change into
C(g) 2	81-132+	Grey (10YR6/1) clay loam with thin bands of fine sand; massive; plastic; moist; many coarse distinct strong brown (7.5YR5/8) mottles associated with weathering sandstone; patches of light brownish grey (10YR6/2) gleying; frequent pieces of weathering sandstone towards base of profile.

Analyses Sample Numbers 259125-31							
Horizon	Ap	Ap	B(g)	C(g)1	C(g)2	C(g)2	C(g)2
Depth (cm)	8-15	23-30	46-53	69-76	86-94	104-112	124-132
Sand 50-2000 μm %	77.0	72.0	85.0	75.0	74.0	62.0	39.0
Silt 2-50 μm %	11.0	14.0	10.0	15.0	14.0	23.0	33.0
Clay <2 μm %	12.0	13.0	5.0	10.0	12.0	15.0	25.0
Calcium (me/100g)	5.77	6.38	2.72	7.15	5.92	5.93	7.51
Magnesium (me/100g)	0.23	0.31	0.19	0.99	1.56	2.23	4.21
Sodium (me/100g)	0.04	0.11	0.04	0.11	0.04	0.15	0.11
Potassium (me/100g)	0.08	0.14	0.03	0.05	0.05	0.08	0.18
Hydrogen (me/100g)	5.60	5.10	3.00	3.70	3.10	3.40	4.40
Base Saturation %	52.2	57.6	49.8	69.2	70.9	71.2	73.2
pH (in water)	6.1	6.3	6.3	6.7	6.8	6.7	6.6
pH (in $CaCl_2$)	5.5	5.8	5.6	5.9	6.0	7.0	5.8
Loss on Ignition %	4.3	4.4	2.2	3.8	3.2	4.1	5.9
Carbon %	1.90	1.90	1.04				
Nitrogen %	0.23	0.28	0.15				
Organic Matter %	3.27	3.27	1.78				
Total Phosphorus (mg P_2O_5/100g)	160	162	55	44	53	49	111

Although this profile has only moderate exchangeable calcium, profiles of the series generally show high values, particularly in upper horizons. Base saturation, too, is normally high throughout.

Eckford Association

This association covers a total area of 82 square kilometres extensively in the Howe of Fife and Strath Eden and on the plain of Kinross stretching westwards to the Crook of Devon Hills.

Parent Material

The parent material comprises glacial lake and fluvioglacial deposits consisting largely of sands and gravels. These are derived mainly from the Upper Old Red Sandstone sediments which underlie Strath Eden and the plain of Kinross and from the lavas of which the Ochil Hills are compose. The sand varies in colour from brown (7.5YR5/2) through light yellowish brown (10YR6/4) to pale brown (10YR6/3). Gravels are normally brown (7.5YR4/4 or reddish brown (5YR4/4).

Soils

Four series have been distinguished in the association. Hexpath and Kilwhiss, developed on sand, are podzols, the former freely drained and the latter imperfectly drained. Giffordtown Series, developed on gravel, is a freely drained podzol. Woodend Series developed mainly on sand, is a poorly drained noncalcareous gley.

Hexpath Series

This series is the most extensive in the association covering an area of 32 square kilometres and is slightly more extensive than the Giffordtown Series. It occurs mainly in the Howe of Fife and Strath Eden. Several smaller areas are found on the plain of Kinross and from which the following podzol, with upper horizons altered by cultivation, was taken. At one time, when Loch Leven was more extensive, the site was under water.

Profile Description No. 12 Lethangie

Grid Reference	NO131042
Slope	0^0
Aspect	Nil
Altitude	110 metres
Vegetation	Third Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-33	Very dark greyish brown (10YR3/2) loamy coarse sand; weak medium subangular blocky; friable, breaking readily to fine crumb; dry; no mottles; low organic matter; many fine grass roots; worms active; frequent small subangular and subrounded stones; charcoal fragments present. Gradual irregular change into
AB	33-43	Dark brown (7.5YR3/2) coarse sand; very weak fine subangular blocky; friable, breaking readily to fine crumb and single grain; dry; no mottles; low organic matter;

		frequent fine grass roots; horizon mixed due to worm activity; few stones as above. Sharp irregular change into
Bs(g)	43-63	Brown (7.5YR4/4) banded coarse sand and fine gravel; slightly compact, weak platy breaking readily to single grain; slightly moist; frequent coarse diffuse dark reddish brown (5YR3/4) mottles; low organic matter; a few tongues of upper horizon material carried down by worms; few fine grass roots at top of horizon; no stones. Sharp smooth change into
C1	63-89	Pale brown (10YR6/3) banded fine sand and gravelly coarse sand; loose; single grain; slightly moist; frequent diffuse mottles as above; few tongues of A horizon material carried down by worms; no roots; no stones. Clear smooth change into
C2	89-131+	Brown (7.5YR5/2) loamy coarse sand with pockets of finer material; structureless; friable; moist – seasonal water-table up to top of horizon; many coarse diffuse brown (7.5YR4/4) mottles; frequent small subangular and subrounded stones.

Analyses Sample Numbers 268136-43								
Horizon	Ap	Ap	AB	Bs(g)	C1	C2	C2	C2
Depth (cm)	5-13	20-28	38-41	51-58	74-81	94-102	109-117	124-132
Sand 50-2000 μm %	81.0	83.0	91.0	97.0	97.0	77.0	81.0	81.0
Silt 2-50 μm %	13.0	12.0	7.0	1.0	1.0	19.0	16.0	14.0
Clay <2 μm %	6.0	5.0	2.0	2.0	2.0	4.0	3.0	5.0
Calcium (me/100g)	11.60	15.00	8.59	1.21	0.48	6.86	8.55	8.08
Magnesium (me/100g)	0.36	0.21	0.20	0.07	0.06	0.19	0.42	0.72
Sodium (me/100g)	0.07	0.07	0.03	<0.03	<0.03	0.06	0.07	0.07
Potassium (me/100g)	0.11	0.09	0.06	0.03	0.05	0.27	0.29	0.29
Hydrogen (me/100g)	7.90	5.80	7.00	3.30	1.00	4.00	2.30	2.10
Base Saturation %	60.5	72.6	55.9	28.3	37.5	64.9	80.2	81.4
pH (in water)	6.0	6.7	6.7	6.3	5.8	5.6	6.1	6.2
pH (in $CaCl_2$)	5.6	6.3	6.0	5.5	5.0	4.6	5.2	5.3
Loss on Ignition %	7.3	7.6	5.3	1.8	0.6	2.1	2.1	2.2
Carbon %	3.69	3.41	1.49					
Nitrogen %	0.34	0.32	0.14					
Organic Matter %	6.30	5.90	2.60					
Total Phosphorus (mg P_2O_5/100g)	342	319	156	87	49	161	187	198

High percentage sand and low percentage organic matter are prominent features of the series. An AB horizon is not normally found and, in this case, probably results from deep ploughing. The presence of finer-textured material in the lower C2 is reflected in the higher values for base saturation and exchangeable cations. Total phosphorus content increases also in the C2 horizon.

Another example of the series shows also the effect of fine textural bands in the lower horizons, where exchangeable cation levels and base saturation percentages decrease with depth, then increase in the C horizon. A soil without these lenses exhibits an increase in base saturation percentage and a decrease in total phosphorus content down its profile. Overall, the soils have a wide range in pH from 4.4 to 6.7 in the upper horizons.

Kilwhiss Series

With a total area of 18 square kilometres, this series is confined to the Howe of Fife and to the plain of Kinross. (It covers almost the whole of St. Serf's Island, which, apart from a small area round the site of the old priory, was at one time under water when the level of Loch Leven was much higher). The following profile was taken from a very small pocket of the series occurring within an area of Hexpath Series in the Howe of Fife.

Profile Description No. 13 Edensmuir

Grid Reference	NO295 096
Slope	3^0
Aspect	South-west
Altitude	40 metres
Vegetation	Scots Pine plantation, approximately 30 years old
Drainage Class	Imperfect

Horizon	Depth (cm)	
L & F	0-5	Dark brown (7.5YR3/3) fine litter of pine needles and grass with some well decomposed fibrous material at base. Sharp change into
E	5-10	Greyish brown (10YR5/2) to grey (10YR5/1) loamy sand; very weak fine crumb to single grain; soft and loose; slightly moist; low organic matter; many fine fibrous roots, a few small tree roots; no stones. Sharp wavy change into
Bs	10-20	Yellowish brown (10YR5/6) sand; weak medium subangular blocky; soft and loose, breaking readily to single grain; slightly moist; no mottles; low organic matter; frequent fine fibrous roots and small woody tree roots; few fine gravel pebbles. Clear irregular change into
bE	20-38	Greyish brown (10YR5/2) to dark greyish brown (10YR4/2) fine sand; weak coarse angular blocky; soft and loose, breaking readily to single grain; slightly moist; few medium distinct strong brown (7.5YR5/6) mottles

		near base of horizon; low organic matter, few accumulations along root channels; frequent fine fibrous and few small tree roots. Clear irregular change into
bBs(g)	38-46	Yellowish brown (10YR5/4) sand; weak medium subangular blocky; soft and loose breaking readily to fine crumb and single grain; slightly moist; frequent medium distinct strong brown (7.5YR5/8) mottles; low organic generally, but few fine deposits along root channels; few fine fibrous roots and small tree roots. Gradual change into
C(g)	46-89+	Light yellowish brown (10YR6/4) sand; very weak coarse angular blocky; friable, breaking readily to fine crumb and single grain; moist; frequent medium and fine distinct strong brown (7.5YR5/8) mottles; few roots; few fine gravel pebbles.

The presence of buried horizons (bE and bBs(g)) is a common feature throughout the series in this forest area.

Analyses Sample Numbers 228114-20							
Horizon	L & F	Bs	bE	bBs(g)	C(g)	C(g)	C(g)
Depth (cm)	0-5	12-18	23-31	36-44	51-61	66-74	83-89
Sand 50-2000 μm %	ND	93.2	92.1	90.9	94.8	86.3	90.0
Silt 2-50 μm %	ND	2.6	2.6	3.9	1.8	9.5	6.6
Clay <2 μm %	ND	4.2	5.3	5.2	3.4	4.2	3.4
Calcium (me/100g)	5.10						
Magnesium (me/100g)	1.51	-	0.20	0.10	0.20		0.16
Sodium (me/100g)	0.37	0.05	0.10	0.10	0.05	0.05	0.13
Potassium (me/100g)	0.52	0.10	0.11	0.10	0.10	0.09	0.12
Hydrogen (me/100g)	42.20	5.13	6.40	2.99	9.50	12.69	8.03
Base Saturation %	15.1	2.8	6.0	9.1	3.6	1.1	4.9
pH (in water)	3.9	4.4	4.1	4.2	4.3	4.3	4.3
pH (in $CaCl_2$)	3.2	3.9	3.9	4.1	4.2	4.2	4.2
Loss on Ignition %	31.5	2.5	3.5	2.3	1.5	1.4	1.2
Carbon %	18.00	1.08	1.69	1.15	0.66	0.46	0.27
Nitrogen %	0.62	0.05	0.06	0.04	0.03	0.03	0.02
Organic Matter %	30.90	1.96	2.90	2.04	1.14	0.79	0.47
Total Phosphorus (mg P_2O_5/100g)	85	56	30	60	53	63	49

- = less than lower limit of determination

Typical of uncultivated podzols with coarse textures, this profile has low or moderate to low values of exchangeable bases except in the L and F horizons. Base saturation is low throughout.

Other examples of the series are markedly impoverished in exchangeable cations, with the exception of the surface horizons of the cultivated soils.

Giffordtown Series

The Giffordtown Series covers a total area of 30 square kilometres. It occurs on the plain of Kinross and in the Howe of Fife, where the most extensive single area has been mapped. Several areas have also been separated in the Crook of Devon Hills and on the footslopes of the Ochil Hills.

Profile Description No. 14 Kinloch

Grid Reference	NO276117
Slope	3^0
Aspect	North-east
Altitude	44 metres
Vegetation	Second or Third Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap1	0-25	Very dark brown (10YR3/3) sandy loam; moderate medium subangular blocky; friable; moist; no mottles; low organic matter; many fibrous grass roots; worms present; many subangular and rounded and few angular stones, mainly sansdstone and igneous rocks. Gradual change into
Ap2	25-41	Dark brown (7.5YR4/2) sandy loam; weak medium subangular blocky; friable; moist; no mottles; low organic matter; many grass roots; many stones as above. Sharp smooth change into
Bs	41-53	Reddish brown (5YR4/4) gravelly coarse sand; single grain; loose; dry; no mottles; low organic matter; frequent fibrous grass roots; many rounded stones of varying size 0.6 cm up to 5 cm diameter. Clear change into
C	53-122+	Reddish brown (5YR4/4), brown (7.5YR4/4) and dark brown (7.5YR3/2) coarse sandy gravel; single grain; loose; dry; no mottles; low organic matter; no roots; gravel as above but many larger sizes mainly from sandstone and igneous rocks with some quartzites (reddish sandstones prominent).

Analyses Sample Numbers 268229-34						
Horizon	Ap1	Ap2	Bs	C	C	C
Depth (cm)	7-15	28-36	43-51	63-71	89-99	112-122
Sand 50-2000 μm %	69.0	76.0	84.0	94.0	93.0	97.0
Silt 2-50 μm %	21.0	15.0	11.0	4.0	5.0	2.0
Clay <2 μm %	10.0	9.0	5.0	2.0	2.0	1.0
Calcium (me/100g)	6.59	5.05	5.38	3.35	3.04	3.34
Magnesium (me/100g)	0.54	0.46	0.50	0.20	0.23	0.22
Sodium (me/100g)	0.06	0.06	0.07	0.07	0.06	0.07
Potassium (me/100g)	0.32	0.18	0.11	0.06	0.06	0.06
Hydrogen (me/100g)	9.10	8.70	8.80	6.40	5.00	3.90
Base Saturation %	45.2	40.0	40.9	36.6	40.5	48.7
pH (in water)	5.6	5.9	6.4	6.3	6.1	6.3
pH (in $CaCl_2$)	5.3	5.3	5.5	5.5	5.2	5.6
Loss on Ignition %	6.6	5.3	4.9	2.8	2.1	1.9
Carbon %	2.91	2.05	1.22			
Nitrogen %	0.43	0.31	0.17			
Organic Matter %	5.00	3.50	2.10			
Total Phosphorus (mg P_2O_5/100g)	317	207	198	138	119	130

As in Hexpath Series (No. 12, Lethangie), percentage sand is high and organic matter low, but, because of the coarser texture in the C horizon, there is no increase in base saturation and the value remains moderate throughout.

Other examples of the series have properties typical of cultivated, gravelly soils in that levels of exchangeable cations and base saturation are moderate or high in the surface horizons and decrease rapidly with depth to low. The pH values are also frequently highest in the upper profile and decrease with depth, as do total phosphorus content.

Woodend Series

This series covers an area of 2 square kilometres and it occurs only in the Kinross lowland on the shores of Loch Leven.

Profile Description No. 15 Grahamstone

Grid Reference	NO176021
Slope	0^0
Aspect	Nil
Altitude	112 metres
Vegetation	Wet Pasture
Drainage Class	Poor

Horizon	Depth (cm)	
Ah	0-25	Dark reddish brown to black (5YR2/2 to 2/1) organic loamy sand; moderate coarse subangular blocky; friable; moist; no mottles; high organic matter; many fibrous grass roots; few stones. Sharp smooth change into
Bg1	25-38	Light grey (2.5YR7/2) sand; single grain; loose; moist to wet; low organic matter; few roots; frequent diffuse reddish yellow (7.5YR7/8) mottles; no stones. Clear change into
Bg2	38-64	Light grey (10YR7/2) and light brownish grey (10YR6/2) sand; single grain; loose; wet; frequent diffuse brownish yellow (10YR6/6) mottles; low organic matter; no roots; stones few in upper half of horizon, becoming frequent in lower half. Clear change into
Cg1	64-107	Light grey (2.5YR7/2) sand and gravelly sand; single grain; loose; wet; many medium prominent strong brown (7.5YR5/6) mottles which tend in places to obscure horizon colour; low organic matter; no roots; stones few in upper half becoming frequent in lower half of horizon. Clear change into
Cg2	107-122	Greyish brown to brown (10YR5/2 to 5/3) coarse sand; massive; wet; many diffuse yellowish brown (10YR5/6) mottles; few stones

Analyses Sample Numbers 268299-304						
Horizon	Ah	Ah	Bg1	Bg2	Cg1	Cg2
Depth (cm)	5-13	18-28	28-36	48-56	69-76	114-122
Sand 50-2000 μm %	83.0	81.0	93.0	95.0	95.0	99.0
Silt 2-50 μm %	11.0	14.0	6.0	3.0	4.0	<1
Clay <2 μm %	6.0	5.0	1.0	2.0	1.0	1.0
Calcium (me/100g)	25.00	25.50	3.31	1.20	1.51	2.11
Magnesium (me/100g)	2.17	2.27	2.18	0.20	0.26	0.31
Sodium (me/100g)	0.13	0.13	0.04	0.03	0.04	0.06
Potassium (me/100g)	0.12	0.14	0.04	0.02	0.02	0.03
Hydrogen (me/100g)	15.90	18.90	2.10	2.10	2.30	2.30
Base Saturation %	63.3	58.8	72.7	41.7	43.9	52.1
pH (in water)	5.8	5.2	5.8	6.4	6.5	6.7
pH (in $CaCl_2$)	5.0	5.1	5.6	5.8	6.1	6.3
Loss on Ignition %	21.8	21.1	0.6	0.6	0.6	0.5
Carbon %	11.80	11.60	0.09			
Nitrogen %	1.10	1.02	0.03			
Organic Matter %	20.30	20.00	0.20			
Total Phosphorus (mg P_2O_5/100g)	199	205	44	52	63	68

The area of Woodend Series from which this profile was taken is contiguous with an area of basin peat. The high organic content of the A horizons is probably a result of the whole area at one time being covered by peat. The very high exchangeable calcium in the surface layers is probably due to application of lime.

Fraserburgh Association

Soils of the Fraserburgh Association have been mapped on the coastal lowlands of Fife in an area 4 square kilometres in extent, lying to the west of Elie. The association covers the St. Ford Links on the south side of the Cocklemill Burn and on the north side extends westwards along the coast far as Carrick Villa, stretching inland to meet the raised beach soils of the Dreghorn Association.

Parent Material

The parent material consists mainly of wind-blown shelly sand underlain by sandy raised beach deposits.

Soils

Only one series, Fraserburgh, has been mapped in the district. Although in East Lothian and Caithness, it is classed as a brown calcareous soil, it is included here within the group of brown forest soils.

Fraserburgh Series

Profile Description No. 16 Muircambus

Grid Reference	NO465021
Slope	0^0
Aspect	Nil (top of mound)
Altitude	15 metres
Vegetation	Old Pasture
Drainage Class	Free

Horizon	Depth (cm)	
A1	0-10	Very dark greyish brown (10YR3/2) sand; weak medium subangular blocky, breaking readily to fine crumb and single grain; low organic matter; many grass roots; no stones; frequent fine shell fragments. Sharp smooth change into
A2	10-18	Dark greyish brown (10YR4/2) sand; single grain; loose; dry; no mottles; low organic matter; many grass roots; frequent shell fragments. Sharp wavy change into
Bw(g)	18-40	Pink to light brown (7.5YR7/4 to 6/4) sand; single grain; loose; dry; frequent coarse distinct strong brown (7.5YR5/6) mottles; frequent tongues of A horizon material; frequent fibrous grass roots; many small shelly fragments. Gradual change into
C	40-142+	Light brown (7.5YR6/4) to pale brown (10YR6/3) sand, becoming slightly coarser with depth; very coarse angular blocky, breaking readily to single grain; slightly moist; few coarse distinct strong brown (7.5YR5/6) mottles; many fine very dark greyish brown (10YR3/2) horizontal bands

becoming more closely spaced with depth; few tongues of A horizon continue down from B horizon and occasional pockets of A horizon material associated with animal burrows; few grass roots down to 81 centimetres; frequent horizontal bands of shell fragments.

Analyses Sample Numbers 233528-35								
Horizon	A1	A2	Bw(g)	C	C	C	C	C
Depth (cm)	0-7	10-18	25-33	46-53	71-79	94-102	114-122	132-140
Sand 50-2000 μm %	94.7	95.0	98.4	98.4	99.2	99.2	99.2	99.2
Silt 2-50 μm %	3.7	3.4	-	-	0.8	0.8	0.6	0.6
Clay <2 μm %	1.6	1.6	1.6	1.6	0	0	0.2	0.2
Calcium (me/100g)	38.89	40.69	51.90	38.12	39.23	49.60	55.64	72.93
Magnesium (me/100g)	0.96	0.49	0.41	0.53	0.49	0.57	0.78	0.86
Sodium (me/100g)	0.26	0.33	0.36	0.33	0.35	0.39	0.42	0.47
Potassium (me/100g)	0.16	0.18	0.03	0.04	0.05	0.04	0.06	0.08
Hydrogen (me/100g)								
Base Saturation %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pH (in water)	7.0	7.2	7.1	7.7	7.6	7.8	7.9	7.9
Loss on Ignition %	8.4	4.3	3.2	3.5	3.8	1.6	4.4	5.4
Carbon %	3.31	1.52	0.82					
Nitrogen %	0.29	0.11	0.03					
Organic Matter %	5.68	2.62	1.41					
Total Phosphorus (mg P_2O_5/100g)	144	88	59	56	49	43	41	41

The pH is high and the exchangeable calcium very high throughout, although it should be remembered that, in addition to displacing calcium from exchange sites within the organic matter and clay mineral complex, the analytical leachate used can dissolve some free calcium carbonate from shell fragments. Sodium also provides a notable feature, with the high exchangeable values in all horizons probably resulting from sea spray. Magnesium values are moderate and potassium values are low except in A1 and A2.

These properties are reflected in other examples of the series from nearby localities.

Giffnock Association

Covering a total of 84 square kilometres, the Giffnock Association occurs mainly in the south-west of the district on the west Fife drift plain, on the Dunfermline low hills and on foot-slopes of the Saline and Cleish Hills. Isolated areas are also found on the foot-slopes of the Lomond Hills, on the east Fife drift plain and on the east Fife uplands.

Parent Material

The main parent material is till derived from Carboniferous sandstones with some shales, coals and limestones. In some small areas, as a result mainly of water action, the till has partially sorted upper layers; in others, Carboniferous sandstone forms the parent material of a residual soil.

Soils

Seven soil series of the association have been distinguished in this area. Aberdona and Forestmill are both brown forest soils, the former imperfectly and the latter freely drained. Giffnock and Scaurs are, respectively, noncalcareous and peaty gleys, and both are poorly drained. Of the three remaining series, each less than 1 square kilometre in extent, Kennet is an imperfectly drained brown forest soil, and Bath Moor and Devilla are freely drained and imperfectly drained podzols.

Aberdona Series

Aberdona is the dominant series of the association mapped on the sheet, and it covers a total of 65 square kilometres.

The Aberdona Series occurs mainly on the west Fife drift plain and on the Dunfermline low hills. An isolated area covering some 6 square kilometres has been mapped in the east Fife uplands.

Profile Description No. 17 KIrkton B

Grid Reference	NT146922
Slope	5^0
Aspect	South-east
Altitude	160 metres
Vegetation	Third Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-20	Very dark greyish brown (2.5Y3/2) clay loam; strong coarse angular blocky; firm; moist; few fine distinct yellowish red (5YR5/8) mottles; low organic matter; many grass roots; worms present; frequent stones. Sharp smooth change into
Bg1	20-36	Light brownish grey (2.5Y6/2) sandy clay loam; moderate medium angular blocky; firm; moist; many strong brown

		(7.5YR5/6) mottles and light brownish grey patches which dominate horizon colour; low organic matter; roots frequent, becoming few with depth; frequent stones, with many pieces of weathering sandstone. Sharp wavy change into
Bg2	36-71	Grey to light grey (10YR6/1) clay loam, massive; plastic when wet; moist; many coarse reddish yellow (7.5YR6/8) mottles and grey coatings round stones. Sharp irregular change into
Cg	71-127+	Dark grey (7.5YR4/0) clay loam; massive; plastic when wet; moist; frequent yellowish red (5YR5/6) and yellowish brown (10YR5/8) mottles; frequent stones, mainly weathering sandstones and some soft shale.

Analyses Sample Numbers 242180-86							
Horizon	Ap	Bg1	Bg2	Bg2	Cg	Cg	Cg
Depth (cm)	8-15	25-33	43-51	61-68	81-89	99-107	119-127
Sand 50-2000 μm %	45.2	59.0	42.9	40.6	38.1	38.7	35.9
Silt 2-50 μm %	27.1	22.2	25.5	24.9	29.7	31.6	32.2
Clay <2 μm %	23.3	18.8	31.6	34.5	31.6	29.7	35.9
Calcium (me/100g)	13.20	4.40	6.57	5.98	5.84	5.83	5.52
Magnesium (me/100g)	2.57	0.70	1.67	2.57	3.61	3.98	3.50
Sodium (me/100g)	0.06	-	0.05	0.06	0.07	0.06	0.09
Potassium (me/100g)	0.32	0.14	0.07	0.07	0.12	0.15	0.15
Hydrogen (me/100g)	2.10	1.58	2.94	4.39	5.11	4.83	4.24
Base Saturation %	88.5	76.8	74.0	66.4	65.3	67.6	68.5
pH (in water)	6.1	5.7	5.2	4.6	4.8	4.7	4.8
pH (in $CaCl_2$)	5.8	5.3	4.8	4.1	4.2	4.2	4.4
Loss on Ignition %	8.72	3.45	5.25	6.22	6.17	6.63	7.62
Carbon %	3.42	0.46	0.62				
Nitrogen %	0.27	0.04	0.04				
Organic Matter %	5.88	0.78	1.07				
Total Phosphorus (mg P_2O_5/100g)	171	57	42	61	57	87	106

The presence of more sandstones and fewer shales among the parent rocks of the Aberdona Series as compared with those from which Caprington Series is derived, is reflected in the higher percentage sand and lower percentage silt of the Aberdona soils. While both series have high percentage base saturation throughout, the values for Aberdona are generally lower than that for Caprington, as are also the pH values.

The above profile reflects the properties of the series in that exchangeable calcium levels are moderate, magnesium values are moderate, increasing with depth, and potassium content is moderate or low. Excluding the Ap horizon, total phosphorus values are low and increase to moderate with depth.

Giffnock Series

This series covers a total area of 9 square kilometres. A poorly drained noncalcareous gley, it is found generally on lower slopes of hills or in low-lying areas contiguous to drainage channels.

Profile Description No. 18 Kirkton A

Grid Reference	NT148925
Slope	3^0
Aspect	North
Altitude	162 metres
Vegetation	Rough Pasture with *Juncus* dominant
Drainage Class	Poor

Horizon	Depth (cm)	
A	0-25	Dark grey (5Y4/1) silt loam; moderate coarse angular blocky; firm; moist; common fine yellowish red (5YR4/8) mottles; low organic matter; many grass and other roots; frequent stones. Sharp smooth change into
Bg	25-41	Light grey (N6/0) clay loam; moderate medium angular blocky; firm; moist; ,amy medium prominent strong brown (7.5YR5/8) mottles and light brownish grey (10YR6/2) coatings on peds which together tend to obscure base colours; low organic matter; few roots; frequent stones with sandstone dominant and many black specks of coal. Gradual change into
Cg1	41-89	Grey (N5/0) clay loam; moderate medium angular blocky; firm; moist; many prominent yellowish brown (10YR5/8) and strong brown (7.5YR5/8) mottles; low organic matter; frequent stones, mainly soft weathering sandstone with some pieces of shale. Gradual change into
Cg2	89-132	Dark grey (N4/0) clay; massive; plastic when wet; firm when moist; frequent medium distinct strong brown mottles; frequent stones – mainly weathering sandstone and fine pieces of soft shale.

Analyses Sample Numbers 242754-57, 57A, 57B, 57C							
Horizon	A	Bg	Cg1	Cg1	Cg2	Cg2	Cg2
Depth (cm)	7-15	30-38	53-61	68-76	91-99	109-117	124-132
Sand 50-2000 μm %	46.6	44.9	51.5	53.5	51.7	50.0	49.4
Silt 2-50 μm %	29.7	24.4	23.7	21.2	19.4	23.8	22.4
Clay <2 μm %	19.2	30.7	24.8	25.3	28.9	26.2	28.2
Calcium (me/100g)	5.81	4.43	3.30	2.75	3.84	4.45	5.36
Magnesium (me/100g)	0.40	0.63	1.01	1.66	4.23	4.87	5.64
Sodium (me/100g)	0.09	0.05	0.05	0.05	0.08	0.10	0.11
Potassium (me/100g)	0.22	0.08	0.08	0.08	0.10	0.10	0.12
Hydrogen (me/100g)	5.92	6.06	6.90	6.42	6.51	5.85	4.72
Base Saturation %	52.3	46.0	38.6	41.4	55.8	62.0	70.3
pH (in water)	4.8	4.9	4.9	4.8	4.9	5.1	5.3
pH (in $CaCl_2$)	4.5	4.3	4.2	4.2	4.9	5.0	5.2
Loss on Ignition %	8.94	5.90	5.27	5.22	6.62	6.49	7.00
Carbon %	3.67	1.43	1.49				
Nitrogen %	0.33	0.09	0.07				
Organic Matter %	6.30	2.46	2.55				
Total Phosphorus (mg P_2O_5/100g)	110	51	61	58	77	93	106

Although the results of the mechanical analyses when plotted on the triangular diagram (Appendix 1) show the texture of the A horizon to be clay loam, the presence of silt was sufficiently noticeable in the field sample to justify classifying the soil as silty. In the Cg2 horizon the presence of weathring sandstone probably accounts for the texture, as determined from the mechanical analyses, being sandy clay loam, although the field texture recorded is clay. The amount of clay in the C horizon of the Giffnock Series is frequently higher than in the above profile and can sometimes be greater than 40 per cent (Mitchell and Jarvis,1956). The grey colour in all horizons of the Kirkton profile suggests that it contains more black shale than soils from the Kilmarnock area, which have browns and light browns.

Properties of the series as a whole are broadly similar to those outlined above, with moderate levels of exchangeable calcium, magnesium and base saturation, and moderate or low values for potassium. Total phosphorus content is low in al but the A horizon.

Scaurs Series

The Scaurs Series is a very poorly drained peaty gley covering 6 square kilometres. It is confined to the Saline and Cleish Hills subregion where it occurs mainly on gentle slopes bordering areas of peat.

Profile Description No. 19 Lethans Muir

Grid Reference	NT067944
Slope	$1\text{-}2^0$
Aspect	West
Altitude	267 metres
Vegetation	Flying Bent (*Molinia*) Grassland
Drainage Class	Poor

Horizon	Depth (cm)	
L		Traces of grass litter.
F	0-13	Very dark brown (10YR2/2) fibrous peaty matter with many roots.
O	13-20	Black (10YR2/1) humified organic matter; frequent roots. Sharp change into
E	20-28	Pinkish grey (7.5YR6/2) clay loam; weak coarse prismatic to massive; firm; moist; few fine brownish yellow (10YR6/6) mottles; faces of weak structural units coated with organic matter; frequent roots, many apparently dead; few stones. Clear change into
Bg1	28-60	Brownish yellow (10YR6/6) clay; weak coarse prismatic to massive; plastic; wet; greyish brown (10YR5/2) structure faces; low organic matter; frequent roots; no worms; few stones; Gradual change into
Bg2	60-86	Brownish yellow (10YR6/6) and grey (10YR6/1) silty clay; massive; very plastic; wet; few roots. Gradual change into
Cg1	86-109	Dark grey (N4/0) silty clay; massive; very plastic; wet; frequent coarse distinct brownish yellow (10YR6/6) mottles and strong brown (7.5YR5/8) linings to many root channels; few roots; few igneous stones. Gradual change into
Cg2	109-134	Dark grey (N4/0) silty clay; massive; firm; moist; frequent fine distinct light olive-brown (2.5Y5/6) mottles often lining root channels; few roots, many being rotten; few stones.

Analyses Sample Numbers 235263-69							
Horizon	F	O	E	Bg1	Bg2	Cg1	Cg2
Depth (cm)	2-10	15-20	27-35	50-60	68-81	94-104	122-134
Sand 50-2000 μm %	ND	ND	42.3	25.9	9.3	6.4	6.8
Silt 2-50 μm %	ND	ND	26.2	30.2	45.6	48.9	45.9
Clay <2 μm %	ND	ND	31.5	43.9	45.1	44.7	47.3
Calcium (me/100g)	9.12	4.07					0.92
Magnesium (me/100g)	6.13	1.36	0.21	0.08	0.26	0.63	1.00
Sodium (me/100g)	0.55	-	-	-	0.04	0.12	0.05
Potassium (me/100g)	0.72	-	-	0.04	0.09	0.17	0.23
Hydrogen (me/100g)	90.68	72.14	17.48	12.23	14.65	13.58	16.00
Base Saturation %	15.4	7.0	1.2	1.0	2.6	6.2	12.1
pH (in water)	3.7	3.4	3.5	3.5	3.5	3.7	3.6
pH (in $CaCl_2$)	2.5	2.2	2.2	2.4	2.3	2.4	2.2
Loss on Ignition %	84.3	42.6	6.7	7.8	10.3	10.9	11.8
Carbon %	47.78	23.44	1.65				
Nitrogen %	2.19	0.90	0.08				
Organic Matter %	82.17	40.31	2.84				
Total Phosphorus (mg P_2O_5/100g)	300	123	53	88	173	172	146

- = less than lower limit of determination

Notable features in the above profile, which is typical of most of the series, are high percentage of organic matter in both F and O horizons and the high percentage of clay throughout, especially in the Bg and Cg horizons. Percentage base saturation and pH values are low throughout.

Forestmill Series

A residual soil developed on Carboniferous sandstone, Forestmill Series is classed as a freely drained brown forest soil. It covers only 3 square kilometres and occurs as small isolated areas mainly in western subregions of the coastal fringe. A few areas are found on lower slopes of the Crook of Devon Hills and on the east Fife uplands.

Profile Description No. 20 Cuttlehill

Grid Reference	NT156893
Slope	3^0
Aspect	South-east
Altitude	152 metres
Vegetation	Third Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-30	Dark greyish brown (10YR4/2) sandy loam; weak medium subangular blocky; friable; dry; no mottles; low organic matter; many fibrous grass roots; many stones, mainly subangular pieces of sandstone and some lava. Sharp smooth change into
Bw1	30-53	Yellowish brown (10YR5/6) sandy loam to loamy sand; very weak medium to fine subangular blocky; friable; slightly moist; no mottles; low organic matter with occasional tongues of Ap horizon material in crevices between stones; many grass roots; many stones, mainly large angular pieces of sandstone. Sharp smooth change into
Bw2	53-79	Pale yellow (2.5Y7/4) fine sand; very weak medium to fine subangular blocky breaking readily to single grain; friable; dry; no mottles; low organic matter; few fibrous grass roots; many stones as above. Sharp wavy change into
C	79-157	Pale yellow (2.5Y7/4) and very pale brown (10YR7/4) shattered and decomposing sandstone, breaking down to medium and coarse sand; few fine fibrous roots penetrate down cracks in upper part of horizon.

Analyses Sample Numbers 235477-82						
Horizon	Ap	Bw1	Bw2	C	C	C
Depth (cm)	8-18	36-46	61-71	84-94	109-119	147-157
Sand 50-2000 μm %	60.4	76.4	91.6	85.4	88.0	90.8
Silt 2-50 μm %	19.9	13.6	6.8	10.8	9.0	7.0
Clay <2 μm %	16.0	7.9	1.6	3.8	3.0	2.2
Calcium (me/100g)	2.90	2.57	0.60	0.60	0.60	0.60
Magnesium (me/100g)	1.04	0.52	0.18	0.22	0.18	0.34
Sodium (me/100g)	0.04	0.03	-	0.03	-	0.03
Potassium (me/100g)	0.15	0.07	-	0.04	-	-
Hydrogen (me/100g)	6.21	2.22	2.10	2.39	2.46	2.55

Base Saturation %	39.9	59.0	27.1	27.1	24.1	27.6
pH (in water)	5.2	5.6	5.8	5.7	5.9	5.9
pH (in $CaCl_2$)	4.9	5.4	5.7	5.4	5.7	5.7
Loss on Ignition %	7.38	4.19	1.22	2.24	1.72	1.58
Carbon %	2.84	0.93	0.15			
Nitrogen %	0.20	0.07	0.02			
Organic Matter %	4.88	1.59	0.26			
Total Phosphorus (mg P_2O_5/100g)	189	133	24	33	37	17

- = less than lower limit of determination

The main features of this series are the coarse textures throughout the profile, particularly in the B and C horizons where there is a high proportion of weathered sandstone.

The Cuttlehill profile above has low or very low levels of exchangeable calcium and potassium, and moderate or low levels of magnesium. Base saturation percentages are low, except in the Ap and Bw1 horizons, and total phosphorus content decreases from moderate to low with depth.

These characters are reflected in most other soils of the series with the exception of the exchangeable magnesium values, which are more usually low or very low. These chemical properties depend very much on the composition of the underlying sandstone, which is typically very low in exchangeable cations. There are two profiles, however, where bands of much richer material have influenced the overlying soil. In the first of these, at Lingo, the exchangeable calcium, magnesium and base saturation levels increase markedly in the CR horizon and a second soil on Benarty Hill has levels high of calcium throughout the profile and a magnesium value of 38 me/100g in the weathered rock.

Kennet Series

This series is one of the highly important group which includes the Vinny, Butterwell, Gellyknowe and Macmerry Series, of soils developed on water-sorted materials occurring throughout the till-covered lowlands. It covers less than 1 square kilometre and is found contiguous to areas of the Aberdonna Series in the Crook of Devon Hills at the western margin of the district. It is an imperfectly drained brown forest soil.

Profile Description No. 21 Barnhill

Grid Reference	NT011964
Slope	3^0
Aspect	South
Altitude	137 metres
Vegetation	Second Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-23	Dark greyish brown (10YR4/2) fine sandy loam; moderate medium angular blocky; friable; moist; many fine distinct yellowish red (5YR4/6) mottles; moderate organic matter; many fine fibrous grass roots; earthworms active; few small subangular and subrounded stones. Sharp wavy change into
ABg	23-36	Greyish brown (10YR5/6) sandy loam; weal medium subangular blocky; friable; moist; many medium and fine prominent yellowish red (5YR4/6) mottles; gleying dominates horizon colour; low organic matter; fine grass roots frequent, becoming few towards base of horizon; patches of upper horizon carried down by earthworms; frequent small subangular and subrounded stones. Sharp wavy change into
Bg	36-51	Greyish brown (10YR5/2) sandy clay loam; moderate medium angular blocky; friable; moist; (slightly plastic when wet); many medium and coarse prominent strong brown (7.5YR5/6) mottles and light brownish grey (10YR6/2) patches on ped faces which tend to dominate horizon colour; low organic matter; few fine roots; frequent small subangular stones, mainly pieces of decomposing sandstone; horizon show evidence of water-sorting. Clear change into
Cg1	51-66	Horizon colour dominated by mottling and gleying; clay loam with indications of some water-sorting; strong coarse angular blocky to prismatic; plastic when wet, moist; many coarse diffuse strong brown (7.5YR5/6) mottles and prominent grey (N/6) gleying on ped faces; low organic matter; no roots; many medium angular pieces of sandstone, some partially weathered, and many fine fragments of soft black shale and coal. Gradual change into
Cg2	66+	Dark greyish brown (10YR4/2) and dark grey (10YR4/1) clay loam; strong coarse angular blocky to prismatic; plastic when wet; moist; frequent medium distinct yellowish brown (10YR5/8) mottles often associated with weathered sandstone; prominent grey (N/6) gleying on ped faces; many stones as above, with higher proportion of shale and coal and more weathered sandstone.

Analyses Sample Numbers 288646-50					
Horizon	Ap	Abg	Bg	Cg1	Cg2
Depth (cm)	5-13	25-33	41-48	56-64	69-76
Sand 50-2000 μm %	69.0	72.0	51.0	53.0	44.0
Silt 2-50 μm %	16.0	14.0	25.0	22.0	30.0
Clay <2 μm %	15.0	14.0	24.0	25.0	26.0
Calcium (me/100g)	5.42	3.73	5.88	6.35	8.05
Magnesium (me/100g)	0.35	0.22	0.79	2.25	4.35
Sodium (me/100g)	0.04	<0.03	0.06	0.03	0.04
Potassium (me/100g)	0.15	0.13	0.08	0.11	0.11
Hydrogen (me/100g)	6.5	5.6	5.2	5.2	5.6
Base Saturation %	47.8	42.3	56.7	62.7	69.2
pH (in water)	5.0	5.8	5.9	5.9	6.2
pH (in $CaCl_2$)	4.6	5.0	5.0	4.8	5.0
Loss on Ignition %	6.5	5.0	5.6	6.5	7.9
Carbon %	2.59	1.29	0.88	1.34	
Nitrogen %	0.25	0.13	0.06	0.06	
Organic Matter %	4.50	2.20	1.50	2.30	
Total Phosphorus (mg P_2O_5/100g)	136	79	42	46	51

Lower values of silt and clay, particularly in the upper horizons, as compared with No 17 (Aberdona Series), is a feature of this series and reflects the water-sorted material in which the soils are developed.

Exchangeable calcium and magnesium values are moderate and increase with depth, as do base saturation percentages. Exchangeable potassium levels are moderate. Total phosphorus content decreases with depth, from moderate to low.

Other examples of the series have similar properties, but exchangeable calcium and base saturation levels are high on some profiles.

Devilla Series

Devilla is an imperfectly drained humus-iron podzol which covers a total of less than 1 square kilometre. It occurs in two areas on the slopes of the Cleish Hills and in two smaller areas on the Dunfermline low hills.

Profile Description No. 22 South Lethans

Grid Reference	NT057946
Slope	5^0
Aspect	North
Altitude	219 metres
Vegetation	Common Bent-Fescue Grassland
Drainage Class	Imperfect

Horizon	Depth (cm)	
L, F and H	0-5	Fresh and decomposed litter; thin layer of well decomposed humus at base. Sharp change into
E	5-7.5	Light brownish grey (10YR6/2) fine sandy loam; weak medium to fine subangular blocky; friable; moist; no mottles; many fine fibrous roots, few cord roots; frequent tongues of 'H' horizon material; no stones. Sharp wavy change into
B(g)	7.5-23	Brown (10YR5/3) fine sandy loam; moderate medium to coarse angular blocky; friable; moist; many fine faint yellowish brown (10YR5/6) mottles and patches of grey (10YR6/1) gleying; low organic matter; many fine fibrous roots; few small subangular sandstones Gradual change into
Cg1	23-61	Light grey (10YR7/2) and pale yellow (5Y8/4) sandy loam; weak coarse angular blocky; friable; moist; many medium to coarse prominent strong brown (7.5YR5/8) mottles with grey gleying dominating much of horizon colour; low organic matter; few roots; frequent large slabs of sandstone, readily decomposing. Sharp change into
Cg2	61-76+	Light grey (10YR7/2) sandy loam; moderate medium subangular blocky; friable; moist; many medium distinct strong brown (7.5YR5/6) mottles with gleying tending to dominate horizon colour; low organic matter; few roots; frequent large sandstone slabs as above.

Analyses Sample Numbers 270670-75						
Horizon	L, F & H	E	B(g	Cg1	Cg1	Cg2
Depth (cm)	0-5	5-7.5	10-18	28-35	48-58	66-76
Sand 50-2000 μm %	ND	74.0	72.0	75.0	77.0	67.0
Silt 2-50 μm %	ND	20.0	23.0	19.0	14.0	22.0
Clay <2 μm %	ND	6.0	5.0	6.0	9.0	11.0
Calcium (me/100g)	3.18	0.31	0.12	0.02	<0.02	0.02
Magnesium (me/100g)	2.32	0.23	0.08	<0.02	0.04	0.12
Sodium (me/100g)	0.36	0.11	0.02	0.02	0.11	0.04
Potassium (me/100g)	2.43	0.23	0.11	0.04	0.04	0.04
Hydrogen (me/100g)	51.8	13.2	8.5	4.5	3.8	6.3
Base Saturation %	13.8	6.4	3.4	2.2	5.0	3.1
pH (in water)	5.0	4.4	4.3	4.1	4.3	4.4
pH (in $CaCl_2$)	4.1	3.7	3.8	3.9	4.1	4.0
Loss on Ignition %	54.4	9.9	6.6	2.9	2.5	3.4
Carbon %	30.70	5.66	3.15			
Nitrogen %	2.40	0.59	0.24			
Organic Matter %	52.80	9.70	5.40			
Total Phosphorus (mg P_2O_5/100g)	427	136	101	52	43	48

Levels of cations and base saturation are very low throughout the mineral profile, as is typical of coarse-textured soils. Only exchangeable potassium and total phosphorus values are moderate and these decrease to low with depth.

These properties hold true for soils of the series as a whole, but occasionally a soil will be encountered which has a high proportion of more base-rich sandstone in the profile and this is reflected in high exchangeable calcium values and moderate levels of magnesium and base saturation.

Bath Moor Series

A freely drained humus iron podzol, Bath Moor is less extensive than the Devilla Series. It occurs only in a few small isolated areas throughout the Aberdona Series.
Generalised Profile Description
Three centimetres of litter and fermenting humus, overly 2.5 centimetres of a black humus H horizon. This is succeeded by about 15 centimetres of dark greyish brown loamy sand, the E horizon, which gives way to 18 centimetres of a yellowish brown loamy sand, B horizon. The C horizon is made up of light brown sandy loam.

Ponesk Series

Bordering an area of basin peat, but too small to be separated on the map, a peaty podzol with iron pan has developed (Ponesk Series).

Profile Description No. 23 Heath Cottage

Grid Reference	NT169895
Slope	3^0
Aspect	West
Altitude	137 metres
Vegetation	Dry Atlantic Heather Moor
Drainage Class	Imperfect

Horizon	Depth (cm)	
L and F	0-1.5	*Calluna* litter and roots
H/Ah	1.5-9	Black (5YR2/1) organic loam; weak medium subangular blocky; friable; moist; no mottles; high organic matter; many fibrous grass roots and woody tree roots; few small angular stones, mainly sandstone. Sharp smooth change into
E(g)	9-16.5	Brown (7.5YR4/2) sandy loam; weak medium subangular blocky; friable; moist; frequent medium distinct yellowish brown (10YR5/6) mottles; low organic matter, but accumulations from above horizon down old root channels; many roots as above; frequent very small stones. Sharp irregular change into
Bf	16.5	Diffuse discontinuous iron pan
Bg1	16.5-34	Yellowish brown (10YR5/4 to 5/3) fine sandy loam; weak medium subangular blocky; firm; moist; frequent medium distinct strong brown (7.5YR5/6) and reddish brown (5YR5/4) mottles; low organic matter; frequent fibrous roots; frequent stones, mainly pieces of decomposing sandstone and some soft shales. Gradual change into
Bg2	34-44	Light yellowish brown (10YR6/4) fine sandy loam; weak medium subangular blocky; firm; moist; many medium prominent strong brown mottles with grey (10YR6/1) patches and coatings on peds; low organic matter; frequent fibrous roots; stones as above. Sharp irregular change into
Cg1	44-60	Grey (10YR5/1) sandy loam; moderate medium subangular blocky; firm; slightly plastic when wet; moist; many medium and fine distinct strong brown (7.5YR5/6) mottles and light grey (10YR7/1) coatings on peds; low organic matter; few roots; many pieces of decomposing sandstone and frequent patches of black shale.
Cg2	60-103	Grey (5YR5/1) sandy clay loam; strong medium

subangular blocky; firm; slightly plastic when wet; moist; many medium distinct strong brown (7.5YR5/8) mottles and light grey deposits which tend to dominate horizon colour; low organic matter; stones as above but generally larger.

Analyses Sample Numbers 248115-21							
Horizon	H/Ah	E(g)	Bg1	Bg2	Cg1	Cg2	Cg2
Depth (cm)	1.5-9	9-16.5	22-29	37-42	47-55	68-75	96-103
Sand 50-2000 μm %	ND	66.8	62.2	63.2	64.9	51.9	53.7
Silt 2-50 μm %	ND	22.0	23.9	24.1	22.7	26.7	25.7
Clay <2 μm %	ND	6.7	13.9	12.7	12.4	21.4	20.6
Calcium (me/100g)	-	-	-	-	-	-	-
Magnesium (me/100g)	0.39	0.12	0.04	0.04	0.03	0.04	0.08
Sodium (me/100g)	0.15	0.06	0.04	0.07	0.03	0.03	0.04
Potassium (me/100g)	0.44	0.12		0.05	0.04	0.06	0.05
Hydrogen (me/100g)	26.50	12.47	4.30	3.14	7.90	10.20	11.40
Base Saturation %	3.6	2.4	1.8	4.9	1.3	1.3	1.3
pH (in water)	3.8	4.0	4.3	4.4	4.4	4.3	4.3
pH (in $CaCl_2$)	3.1	3.4	4.0	4.0	4.0	3.9	3.9
Loss on Ignition %	28.8	9.0	4.0	3.9	5.9	6.5	7.2
Carbon %	11.66	3.55	0.78				
Nitrogen %	0.50	0.15	0.04				
Organic Matter %	20.02	6.12	1.34				
Total Phosphorus (mg P_2O_5/100g)	143	102	65	54	57	70	70

- = less than lower limit of determination

In all horizons, exchangeable calcium is less than the lower limit of determination. Magnesium is moderate in the organic surface horizon and low elsewhere. Potassium is moderate in H/Ah and in E(g) and low in other horizons. Percentage base saturation is very low throughout. Total phosphorus is low in all horizons except the H/Ah and the E(g) where values are moderate.

Gleneagles Association

Covering a total of 1 square kilometre, the Gleneagles Association occurs in four small areas – in the Earn flats around Dunning, on the foot-slopes of the Ochil Hills at Dalqueich in the Crook of Devon around Drum, and in Strath Eden a little to the north-west of Springfield. In the Perth/Arbroath/Dundee district to the north the association covers an area of 4.4 square kilometres.

Parent Material

The parent material consists of fluvioglacial and morainic sands and gravels derived mainly from Old Red Sandstone sediments and lavas together with some Dalradian schists. The colour of the deposits, particularly the sand fraction, is normally reddish brown as the dominant component of the parent material is red sandstone. Where there is a higher proportion of lava or Dalradian schist among the parent rocks, the colour varies from reddish brown to brown.

Soils

Gleneagles Series

Gleneagles, the only series found in the district, is a freely drained humus-iron podzol. Two profiles are described, one which is which is cultivated, dominantly sandy and mainly reddish brown and an uncultivated one which contains a high proportion of gravel and is brown throughout.

Profile Description No. 24 Dunning Hill

Grid Reference	NO021141
Slope	0^0 (top of mound)
Aspect	Nil
Altitude	69 metres
Vegetation	Second Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-23	Brown to dark brown (10YR4/3 to 3/3) loamy sand; moderate medium angular blocky; friable; dry; no mottles; low organic matter; many fibrous grass roots; few rounded and subrounded stones. Sharp smooth change into
Bs1	23-41	Reddish brown (5YR4/3) sand; weak medium subangular blocky; friable; dry; no mottles; low organic matter, but occasional tongues down old root channels; frequent grass roots; few stones as above. Gradual change into
Bs2	41-61	Reddish brown (5YR4/3) sand; weak medium subangular blocky; friable; slightly moist; no mottles; low organic matter, but occasional tongues down old root channels; roots frequent becoming few towards bottom of horizon; no stones. Clear change into

C	61-142	Brown to reddish brown (7.5YR5/4 to 5YR5/3) sand; very weak fine subangular blocky, breaking readily to single grain; friable; moist; frequent horizontal lines of iron oxide accumulation following old bedding planes; low organic matter; few roots – one or two penetrate to about 102 cm; no stones.

Analyses Sample Numbers 268235-41							
Horizon	Ap	Bs1	Bs2	C	C	C	C
Depth (cm)	8-15	28-36	46-53	68-76	91-99	114-122	135-142
Sand 50-2000 μm %	87.0	90.0	95.0	93.0	95.0	99.0	99.0
Silt 2-50 μm %	8.0	7.0	4.0	5.0	4.0	<1	<1
Clay <2 μm %	5.0	3.0	1.0	2.0	1.0	1.0	1.0
Exchangeable Cations							
Calcium (me/100g)	8.07	8.99	2.12	2.27	2.42	2.41	2.41
Magnesium (me/100g)	0.17	0.28	0.07	0.08	0.06	0.06	0.09
Sodium (me/100g)	0.07	0.07	0.05	0.05	0.07	0.08	0.04
Potassium (me/100g)	0.53	0.23	0.09	0.11	0.07	0.08	0.34
Hydrogen (me/100g)	4.80	3.90	3.70	3.00	2.30	1.50	1.20
Base Saturation %	64.7	71.1	38.3	50.0	53.1	63.4	70.7
pH (in water)	6.2	7.1	6.2	6.8	7.0	7.0	6.9
pH (in $CaCl_2$)	5.9	6.3	5.4	6.1	6.2	6.3	6.0
Loss on Ignition %	4.2	2.4	1.5	1.5	1.4	1.2	1.0
Carbon %	1.92	0.69	0.29				
Nitrogen %	0.28	0.51	0.04				
Organic Matter %	3.30	1.20	0.50				
Total Phosphorus (mg P_2O_5/100g)	325	253	163	112	97	91	70

Percentage sand is high throughout the profile. Exchangeable calcium is high in the Ap and Bs1 horizons, a feature also noted in a comparable profile from Inchrye from the Perth/Arbroath/Dundee soil map. Base saturation is high except in the Bs2 and upper C. The pH values in water are high except in the A and Bs2, but all are higher than those recorded for the Inchrye profile.

Profile Description No. 25 Naemoor B

Grid Reference	NO016007
Slope	8^0
Aspect	South
Altitude	137 metres
Vegetation	Felled Coniferous Woodland
Drainage Class	Free

Horizon	Depth (cm)	
L and F	0-5	Mixed grass and other litter, fresh and decomposed
A	5-7.5	Very dark grey (5YR3/1) organic loam; weak fine crumb; Friable; moist; no mottles; high organic matter; many fibrous grass roots and frequent woody roots; frequent stones, mainly small subangular and subrounded from igneous and metamorphic rocks. Sharp change into
Bs	7.5-41	Dark brown (7.5YR3/2) loamy fine sand; weak fine crumb; friable; moist; no mottles but frequent coarse patches of yellowish red (5YR4/8) silty loam; low organic matter; many fine grass roots and frequent medium woody roots; many stones as above, but larger with frequent boulders >15 cm in diameter. Sharp irregular change into
Bx	41-117	Brown (10YR5/3) loamy sand to sand; weakly indurated; moist; No mottles; low organic matter; few roots; many small and medium stones, mainly well-rounded; few large subangular stones; sand and gravel from mixed metamorphic rocks, Old red Sandstone sediments and igneous rocks. Gradual change into
C	112-127	Brown (7.5YR4/4) sandy gravel.

Analyses Sample Numbers 279501-06						
Horizon	LF	A	Bs	Bx	Bx	C
Depth (cm)	0-5	5-7.5	18-30	51-61	83-91	119-132
Sand 50-2000 μm %	ND	ND	79.0	92.0	82.0	80.0
Silt 2-50 μm %	ND	ND	16.0	4.0	14.0	16.0
Clay <2 μm %	ND	ND	5.0	4.0	4.0	4.0
Exchangeable Cations						
Calcium (me/100g)	9.60	4.45	1.26	0.91	1.06	2.75
Magnesium (me/100g)	2.96	1.99	0.39	0.04	0.08	1.47
Sodium (me/100g)	0.47	0.23	0.10	0.03	0.04	0.13
Potassium (me/100g)	1.35	0.69	0.17	0.11	0.11	0.16

Hydrogen (me/100g)	50.00	49.50	27.70	4.10	4.70	5.60
Base Saturation %	21.8	13.0	6.2	21.1	21.7	43.6
pH (in water)	4.7	4.3	4.2	4.8	4.7	5.2
pH (in $CaCl_2$)	3.9	3.6	4.0	4.6	4.3	4.4
Loss on Ignition %	59.6	39.4	15.3	3.0	3.1	3.3
Carbon %	29.60	22.10	3.00			
Nitrogen %	1.89	1.69	0.17			
Organic Matter %	51.0	38.0	5.2			
Total Phosphorus (mg P_2O_5/100g)	355	286	218	127	134	87

Although this is an uncultivated profile, exchangeable calcium is again high in the surface horizon. Apart from the C horizon where the value is moderate, all horizons have base saturations which are low or border on low. With the exception of the C where the value is moderate, all horizons have low pH.

Hindsward Association

This association covers 45 square kilometres and is found in the vicinity of igneous intrusions throughout the Carboniferous till regions. It has been mapped on the Fife basaltic hills and on the hills bordering the east and west Fife drift plains.

Parent Material

The soils are developed on till derived from Carboniferous sandstones and shales with a varying admixture of basic igneous material from the intrusions which pierce the till cover. Although similar in texture to the parent material of the Rowanhill association, the till contains a moderate to high content of igneous stones or rock fragments and normally shows dark brown colorations due largely to the presence of decomposed igneous material.

Soils

Four soil series have been separated. Reidston, the dominant series, is an imperfectly drained brown forest soil, and Dumglow is a peaty podzol with free and sometimes imperfect drainage below the iron pan. Hindsward is a poorly drained noncalcareous gley and Polquhairn is a poorly drained peaty gley.

Reidston Series

Reidston Series has a total area of 39 square kilometres and occurs in all four subregions mentioned. It is most extensive on the east Fife uplands and covers only a few small areas in the other three subregions.

Profile Description No. 26 Redwells

Grid Reference	NT228990
Slope	5^0
Aspect	South-west
Altitude	114 metres
Vegetation	Oat Stubble
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-28	Dark brown (7.5YR3/2) sandy loam to sandy clay loam; moderate medium subangular blocky; friable; moist; no mottles; low organic matter; many fibrous grass roots; worms present; frequent stones. Sharp smooth change into
Bg	28-46	Grey (10YR5/1) sandy clay loam to clay loam; strong coarse angular blocky; friable; moist; frequent medium distinct strong brown (7.5YR5/6) mottles and light grey coatings on ped faces; low organic matter; few roots; frequent stones, mainly subangular igneous and some rotting sandstones. Gradual change into
Cg	46-79	Grey (7.5YR5/0) sandy clay loam to clay loam; moderate

		medium angular blocky; friable; moist; many medium prominent strong brown (7.5YR5/6) mottles, light grey coatings on ped faces; low organic matter; few roots; many stones both igneous and sandstone, frequent pieces of soft shale. Gradual change into
C(g)	79-126+	Grey (7.5YR5/0) sandy clay loam to clay loam; moderate coarse angular blocky; firm; moist; few fine distinct strong brown mottles; dark brown (7.5YR4/2) parches from decomposing igneous rocks; low organic matter; stones as above but larger.

Analyses Sample Numbers 248074-79						
Horizon	Ap	Bg	Cg	Cg	C(g)	C(g)
Depth (cm)	8-15	33-41	51-58	69-76	91-99	119-127
Sand 50-2000 μm %	48.9	44.6	44.1	54.8	53.0	50.0
Silt 2-50 μm %	28.7	29.4	29.8	23.5	24.4	26.5
Clay <2 μm %	18.5	26.0	26.1	21.7	22.6	23.5
Exchangeable Cations						
Calcium (me/100g)	9.42	18.86	19.35	11.51	8.43	7.18
Magnesium (me/100g)	0.89	1.85	2.75	3.62	4.02	3.84
Sodium (me/100g)	0.04	0.07	0.07	0.09	0.07	0.07
Potassium (me/100g)	0.14	0.13	0.13	0.13	0.14	0.17
Hydrogen (me/100g)	5.65	1.47	0.78	0.69	-	-
Base Saturation %	65.0	93.4	96.6	95.8	100.0	100.0
pH (in water)	5.7	6.5	6.8	6.9	7.3	7.1
pH (in $CaCl_2$)	5.0	5.8	6.1	6.2	6.4	6.4
Loss on Ignition %	7.83	6.03	6.81	5.73	4.89	5.43
Carbon %	2.86	1.70	2.02			
Nitrogen %	0.20	0.06	0.06			
Organic Matter %	4.92	2.92	3.45			
Total Phosphorus (mg P_2O_5/100g)	287	72	77	131	127	136

Apart from a slight drop below 8 in the C(g) horizon, exchangeable calcium is high throughout, reaching very high levels in the Bg and the Cg. Magnesium and potassium both have moderate values and base saturation is high throughout, reaching 100 in the C(g) horizon.

In general, soils of the Reidston Series have moderate or high levels of exchangeable calcium and magnesium and moderate potassium values throughout their profiles. Percentage base saturation is moderate or high, increasing with depth usually. There is a wide range in pH values within individual profiles, 4.5 to 7.2 in

one case, and the surface horizons tend to be more acid. Total phosphorus levels show an interesting trend, being moderate or high in the A horizon, low in the Bg and upper C, and increasing again to moderate in the lower C horizons.

Hindsward Series

Hindsward Series covers only 4 square kilometres and is found mainly on the Saline and Cleish Hills. Small isolated areas occur on the east Fife drift plain and on the east Fife uplands.

Profile Description No. 27 Clockmadron

Grid Reference	NO429090
Slope	2^0
Aspect	North-west
Altitude	92 metres
Vegetation	Soft Rush Pasture
Drainage Class	Poor

Horizon	Depth (cm)	
Ap	0-23	Very dark brown (10YR3/2) sandy loam; moderate medium subangular blocky; friable; moist; few fine distinct yellowish red (5YR4/6) mottles; moderate organic matter; many fine grass roots and frequent medium to coarse *Juncus* roots; worms present; few medium subangular stones. Sharp smooth change into
Bg1	23-41	Light olive-brown (2.5Y5/4) sandy silt loam; moderate medium angular blocky to prismatic; firm; moist; many medium prominent reddish yellow (7.5YR6/8) mottles; low organic matter, but few tongues of Ap horizon down old root channels; frequent fine grass roots; frequent angular pieces of sandstone and igneous rock. Sharp wavy change into
Bg2	41-71	Grey to light grey (5Y6/1) sandy loam to sandy clay loam with pockets of loamy sand to sand (evidence of water-sorting); moderate coarse subangular blocky in parts, with other parts massive; firm; moist; many medium and fine prominent strong brown (7.5YR5/6) mottles; light grey gleying dominates horizon colour; low organic matter; few fine roots; many subangular and subrounded stones with high proportion of igneous and some weathered sandstone. Sharp wavy change into
Cg	71-137	Grey (N5/0) clay loam to clay; massive; plastic; wet; frequent medium to fine distinct strong brown (7.5YR5/6) mottles and many dark brown (10YR4/3) patches from weathering igneous rock; gleying masked by grey base colour; low organic matter; no roots; frequent stones as above, many weathered.

Analyses Sample Numbers 268205-11							
Horizon	Ap	Bg1	Bg2	Bg2	Cg	Cg	Cg
Depth (cm)	8-15	28-36	43-51	61-69	79-86	101-109	129-137
Sand 50-2000 μm %	65.0	46.0	66.0	76.0	50.0	46.0	55.0
Silt 2-50 μm %	29.0	36.0	26.0	16.0	27.0	32.0	24.0
Clay <2 μm %	6.0	18.0	8.0	8.0	21.0	20.0	19.0
Exchangeable Cations							
Calcium (me/100g)	5.58	5.88	24.10	1.68	0.07	11.60	12.00
Magnesium (me/100g)	3.17	2.03	0.96	0.04	0.05	8.53	7.74
Sodium (me/100g)	0.18	0.21	0.18	0.04	<0.03	0.18	0.18
Potassium (me/100g)	0.07	0.07	0.13	0.02	<0.02	0.19	0.17
Hydrogen (me/100g)	1.70	7.20	11.50	6.10	5.70	5.30	4.30
Base Saturation %	84.1	53.2	68.8	22.8	1.7	72.8	82.4
pH (in water)	6.4	5.7	5.9	6.2	6.4	6.8	6.8
pH (in $CaCl_2$)	6.2	4.9	4.7	5.0	5.3	5.6	5.6
Loss on Ignition %	12.4	6.1	3.1	3.0	4.9	4.6	4.3
Carbon %	5.94	1.22	0.36				
Nitrogen %	0.58	0.10	0.04				
Organic Matter %	10.20	2.10	0.60				
Total Phosphorus (mg P_2O_5/100g)	195	93	43	46	96	136	130

The subsoil textures recorded in the field description suggest higher clay percentages than are shown in the analytical results. This can be explained by the presence of weathered stones, particularly sandstones which have been broken down inadvertently during preparation of the sample for analysis. Notable features are the very high values for exchangeable calcium in the Bg2 and the high values for both calcium and magnesium in the lower Cg. Base saturation is high except in the Bg1, Bg2 and upper Cg horizons.

One other example of this series exhibits similar properties, but has high values for exchangeable calcium and base saturation throughout. In both soils, levels of total phosphorus follow the same pattern as those of the Reidston Series.

Polquhairn Series

Covering a total area of 2 square kilometres, the Polquhairn Series, a poorly drained peaty gley, has been mapped in a few small areas on upper slopes of the Saline and Cleish Hills at altitudes between 244 and 305 metres.

Profile Description No. 28 Hardiston Hill A

Grid Reference	NT059963
Slope	1^0
Aspect	East
Altitude	274 metres
Vegetation	Bog Heather Moor
Drainage Class	Poor to Very Poor

Horizon	Depth (cm)	
L and F	0-8	Fresh and decomposed litter; many roots.
O1	8-13	Dark reddish brown (5YR2/2) amorphous humus; very friable; moist; many fine grass roots and few cord roots; Sharp change into
O2	13-41	Dark reddish brown (5YR3/2) peaty humus; amorphous; friable; moist; many fibrous grass roots, few cord roots. Sharp change into
Eg	41-54	Dark greyish brown (10YR4/2) fine sandy loam; moderate medium angular blocky; friable; moist; many patches of light brownish grey (10YR6/2) gleying; low organic matter; frequent roots; many small pieces of decomposing sandstone. Sharp irregular change into
Cg	54-89	Grey to dark grey (N5/0 to 4/0) clay; massive; firm; moist; few faint fine reddish brown (5YR4/4) mottles with grey gleying dominating horizon colour; low organic matter; frequent rounded and subrounded stones – mainly sandstones and some shale with greenish sandstone prominent and dark greenish grey (5GY4/1) sandy loam lenses.

Analyses Sample Numbers 279507-12						
Horizon	L & F	O1	O2	Eg	Cg	Cg
Depth (cm)	0-8	8-13	18-28	43-51	66-74	82-89
Sand 50-2000 μm %	ND	ND	ND	81.0	54.0	52.0
Silt 2-50 μm %	ND	ND	ND	13.0	19.0	19.0
Clay <2 μm %	ND	ND	ND	6.0	24.0	27.0
Exchangeable Cations						
Calcium (me/100g)	6.86	4.28	2.80	1.23	1.23	1.23
Magnesium (me/100g)	3.05	2.23	0.33	0.26	1.30	1.60
Sodium (me/100g)	0.65	1.04	0.14	0.05	0.07	0.08
Potassium (me/100g)	2.91	1.32	0.25	0.09	0.17	0.19
Hydrogen (me/100g)	65.3	81.1	72.4	22.0	10.6	9.9

Base Saturation %	17.1	9.9	4.6	6.8	20.9	23.8
pH (in water)	4.7	4.4	3.7	4.1	4.7	4.7
pH (in $CaCl_2$)	3.6	3.7	3.1	3.8	3.8	3.8
Loss on Ignition %	93.7	91.1	26.5	9.4	5.0	4.8
Carbon %	51.40	54.20	14.70			
Nitrogen %	1.99	2.76	0.72			
Organic Matter %	88.50	88.30	25.30			
Total Phosphorus (mg P_2O_5/100g)	341	323	131	61	33	31

None of the metallic cations reach high values, but in most cases, all are notably higher in the organic horizons than in the mineral layers. Total phosphorus is high in the L, F and O1 horizons, and low elsewhere except in the O2.

Dumglow Series

A peaty podzol with iron pan, Dumglow is the smallest series in the association and occupies a total area of 0.5 square kilometres. Comparable with the Cowie Series of tbe Sourhope Association and the Baidland Series of the Darleith Association, Dumglow is imperfectly or poorly drained in the surface horizons but freely, and sometimes imperfectly, drained below the iron pan.

Profile Description No. 29 Hardiston Hill B

Grid Reference	NT057964
Slope	4^0
Aspect	South
Altitude	282 metres
Vegetation	Common Bent-Fescue Grassland
Drainage Class	Imperfect

Horizon	Depth (cm)	
LF	0-8	Dark reddish brown (5YR3/2) litter of grass and many dead fine roots; many fine and medium roots. Clear change into
H	8-28	Dark reddish brown (5YR3/2) amorphous peaty humus; moderate medium angular blocky; friable; moist; high organic matter; many fine and medium roots; no stones; Sharp smooth change into
E	28-38	Greyish brown (10YR5/2) sandy loam; moderate medium subangular blocky; firm; moist; frequent patches of dark reddish brown (5YR3/2) humus staining and of very pale brown (10YR7/4) weathered sandstone; moderate organic matter; few fine roots; few small angular igneous stones and pieces of weathered sandstone. Sharp irregular change into
Bf	38	Discrete iron pan

Bg	38-58	Greyish brown (2.5Y5/2) silty clay loam; weak medium subangular blocky; firm; moist; many fine to medium reddish yellow (7.5YR6/6) mottles and frequent medium concentrations of strong brown (7.5YR5/8) colour associated with igneous stones; low organic matter; few roots; few medium subrounded sandstones and frequent small partially weathered igneous stones. Gradual change into
Cg	58-102	Grey (10YR6/1) clay loam to clay; massive tending to coarse prismatic; firm; moist; many fine distinct strong brown (7.5YR5/8) and brownish yellow (10YR6/6) mottles with coarse patches of light grey (10YR7/1) gleying on ped faces; low organic matter; no roots; few small to medium subangular pieces of sandstone; frequent patches of partly weathered sandstone and frequent small weathered black shales. Sharp smooth change into
CR	102-119	Light brownish grey (10YR6/2) and light grey (10YR7/2) weathered sandstone rock.

Analyses Sample Numbers 279513-20							
Horizon	LF	H	E(g)	Bg	Cg	Cg	CR
Depth (cm)	3-8	13-28	30.5-38	43-51	66-74	92-99	112-119
Sand 50-2000 μm %	ND	ND	71.0	56.0	53.0	75.0	94.0
Silt 2-50 μm %	ND	ND	19.0	22.0	19.0	10.0	3.0
Clay <2 μm %	ND	ND	10.0	18.0	28.0	15.0	4.0
Exchangeable Cations							
Calcium (me/100g)	3.39	1.80	0.93	0.93	0.92	0.91	0.90
Magnesium (me/100g)	1.97	0.81	0.22	0.12	0.16	0.12	0.08
Sodium (me/100g)	0.35	0.19	0.06	0.04	0.04	<0.02	<0.02
Potassium (me/100g)	1.37	0.47	0.17	0.16	0.21	0.16	0.09
Hydrogen (me/100g)	82.1	88.3	28.8	18.1	11.7	6.5	3.1
Base Saturation %	8.5	3.6	4.6	6.7	10.0	15.6	26.2
pH (in water)	4.6	4.0	3.7	4.5	4.5	4.7	4.7
pH (in $CaCl_2$)	3.7	3.2	3.4	4.0	4.0	4.0	4.1
Loss on Ignition %	78.4	61.6	10.1	7.9	5.0	2.2	0.9
Carbon %	45.60	34.70	5.06				
Nitrogen %	2.66	1.48	0.27				
Organic Matter %	78.40	59.60	8.70				
Total Phosphorus (mg P_2O_5/100g)	407	205	74	128	67	34	13

Notable features are low exchangeable calcium except in the LF horizon and low magnesium except in LF and H horizons. Exchangeable sodium is high in LF and, except in the H and E horizons, is low elsewhere; potassium is high in LF and low only in the CR horizon. Base saturation is low except in the CR horizon.

Kippen Association

With a total area of 55 square kilometres, the Kippen Association is much more extensive here than in the Perth/Arbroath/Dundee sheet to the north. It occurs mainly on the plain of Kinross, on the western slopes of the Lomond Hills and in the Howe of Fife and Strath Eden.

Parent Material

The parent rocks of the association are sandstones of Upper Old Red Sandstone age. Decomposed sandstone, ranging in colour from a reddish brown to pale yellow and white, is the most extensive parent material. The other parent materials are a reddish brown till derived from the sandstones, and a till with partially water-sorted upper layers.

Soils

Six series have been separated. Urquhart and Fourmerk are freely drained brown forest soils, Kilgour, Kippen and Butterwell are imperfectly drained brown forest soils and Redbrae is a humus-irin podzol, freely drained.

Urquhart Series

Urquhart Series, developed on decomposed sandstone, has been mapped on lower western and north-western slopes of the Lomond Hills and in the Howe of Fife. It occurs, also, on lower northern and western slopes of Benarty Hill on the south side of Loch Leven. It covers a total area of 23 square kilometres.

Profile Description No. 30 Wester Gospetry

Grid Reference	NO159063
Slope	3^0
Aspect	West
Altitude	130 metres
Vegetation	Third Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-30	Dark brown (7.5YR3/2) sandy loam; strong medium angular blocky; friable; slightly moist; no mottles; low organic matter; many grass roots; worms present; frequent stones. Sharp smooth change into
A	30-48	Dark brown (7.5YR4/2) and brown (7.5YR4/4) sandy loam to loamy sand; weak medium angular blocky; friable; slightly moist; no mottles; low organic matter; many grass roots; frequent stones. Sharp change into
Bw	48-71	Reddish brown (5YR5/4) to yellowish red (5YR5/6) loamy sand; slightly compacted; slightly moist; no mottles; low

		organic matter; roots frequent becoming few at bottom of horizon; many stones with large proportion of angular pieces of red sandstone. Sharp smooth change into
C	71-114	Brown to light brown (7.5YR5/4 to 6/4) sand; very weak medium angular blocky; loose; slightly moist; no mottles; low organic matter; few roots; many stones as above. Sharp change into
R	114-124	Shattered red sandstone.

The uncultivated A horizon is not a normal feature of the Urquhart Series although deep A horizons of up to 50 centimetres are not uncommon on lower slopes of the Lomond Hills in the Gospetry area. The sandstone in this locality is reddish brown, as in the type Urquhart profile. Further east, at Balmalcolm in the Howe of Fife, soils developed on Upper Old Red Sandstone sediments which range from brown to white in colour have been included in the Urquhart Series.

Analyses Sample Numbers 242174-79						
Horizon	Ap	A	Bw	C	C	C
Depth (cm)	7-17	35-43	53-63	74-81	89-97	104-112
Sand 50-2000 μm %	65.8	76.3	85.7	89.5	90.5	94.6
Silt 2-50 μm %	21.9	18.6	11.3	7.7	6.7	2.6
Clay <2 μm %	10.0	5.1	3.0	2.8	2.8	2.8
Exchangeable Cations						
Calcium (me/100g)	7.18	2.12	1.21	0.91	0.91	
Magnesium (me/100g)	0.15	0.04	0.04	0.03	0.03	0.02
Sodium (me/100g)	0.03	-	-	-	-	0.05
Potassium (me/100g)	0.05	-	0.03	-	-	-
Hydrogen (me/100g)	4.19	5.68	3.16	1.66	1.50	0.71
Base Saturation %	63.9	27.6	28.9	36.1	38.5	9.0
pH (in water)	5.2	4.4	4.8	4.9	5.0	5.2
pH (in $CaCl_2$)	5.2	4.3	4.7	4.8	4.9	5.1
Loss on Ignition %	4.68	3.21	3.05	1.07	1.01	0.62
Carbon %	1.82	1.23	0.49			
Nitrogen %	0.18	0.12	0.05			
Organic Matter %	3.14	2.10	0.84			
Total Phosphorus (mg P_2O_5/100g)	280	206	178	112	119	74

- = less than lower limit of determination

In this profile, high percentage sand and low percentage clay are prominent features and, apart from calcium in the Ap horizon, exchangeable bases have low values throughout.

In general, soils of the series reflect the properties of the above profile. Base saturation percentages, however, cover a wide range from very low to over 80, but they are moderate generally and often increase with depth, unlike total phosphorus values which are moderate in the upper profile and decrease in the lower horizons. The pH values are low to moderate and increase with depth.

Fourmerk Series

The series covers a total of 7 square kilometres. The largest single area occurs on the lower western slopes of the Lomond Hills. Smaller areas are found in the Crook of Devon Hills and in the Howe of Fife and Strath Eden.

Profile Description No. 34 Barrington

Grid Reference	NO214092
Slope	1^0
Aspect	North
Altitude	94 metres
Vegetation	Second Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-25	Dark brown (7.5YR3/2) sandy loam; weak medium subangular blocky; friable; moist; no mottles; low organic matter; many fine fibrous grass roots; large earthworms active; frequent stones, mainly subangular and subrounded less than 3 cm. Sharp smooth change into
Bw	25-30	Brown (7.5YR4/4) sandy loam to fine sandy loam; weak medium subangular blocky tending to platy; friable; moist; no mottles; low organic matter; frequent fine tongues of A horizon material down worm channels; many fine grass roots; frequent stones as above but smaller. Sharp wavy change into
Bx(g)	30-66	Weak red (2.5YR4/2) to reddish brown (5YR4/3) sandy loam; indurated, breaking under moderate pressure to moderate medium angular blocky and to medium crumb; moist; frequent fine faint yellowish red (5YR5/6) mottles; low organic matter; few fine fibrous grass roots; large earthworms in resting stage in upper part of horizon; many small and medium stones, decomposing, igneous and some sandstone; induration becomes weaker with depth. Gradual change into
C	66-84+	Weak red (2.5YR4/2) sandy loam, becoming finer textured with depth; breaks down to weak medium subangular blocky and medium crumb; low organic

matter; no roots; frequent to many stones, up to 10 centimetres diameter, mainly sandstone and igneous, the latter partially weathered.

The indurated Bx horizon is normally a feature of the series. The degree of induration varies but is often quite strong. The texture of the C horizon is frequently sandy clay loam or clay loam.

Analyses Sample Numbers 288651-55					
Horizon	Ap	Bw	Bx(g)	Bx(g)	C
Depth (cm)	8-15	25-30	36-43	51-58	76-84
Sand 50-2000 μm %	70.0	69.0	70.0	70.0	75.0
Silt 2-50 μm %	22.0	22.0	19.0	20.0	16.0
Clay <2 μm %	8.0	9.0	11.0	10.0	9.0
Exchangeable Cations					
Calcium (me/100g)	8.81	4.53	2.41	2.10	4.22
Magnesium (me/100g)	2.58	1.53	0.90	0.71	0.87
Sodium (me/100g)	0.06	0.03	0.03	0.04	0.08
Potassium (me/100g)	0.13	0.15	0.13	0.15	0.19
Hydrogen (me/100g)	5.70	3.50	5.90	5.50	4.30
Base Saturation %	67.0	64.1	37.0	35.3	55.5
pH (in water)	6.3	6.4	6.1	6.7	5.3
pH (in $CaCl_2$)	5.8	5.7	5.2	4.9	4.5
Loss on Ignition %	9.4	4.9	3.9	3.5	2.6
Carbon %	4.37	1.60	0.55	0.35	
Nitrogen %	0.51	0.15	0.06	0.05	
Organic Matter %	7.5	2.8	0.9	0.6	
Total Phosphorus (mg P_2O_5/100g)	324	253	337	226	119

Apart from a high calcium value in the A horizon (which is not unexpected in a cultivated soil) exchangeable calcium, magnesium and potassium are all moderate throughout, while percentage base saturation is high in the Ap and Bw, and moderate in other horizons. Total phosphorus is high in the Ap and upper Bx(g) and moderate elsewhere.

Profiles from other localities exhibit properties similar to those above, with the exception of one soil in which values for exchangeable cations are low. A notable feature is the decrease in pH value with depth.

Kilgour Series

Kilgour Series is an imperfectly drained brown forest soil developed on weathered sandstone. It covers 1 square kilometre and occurs as a small area around Kilgour Farm in the Howe of fife, extending westwards as a narrow strip by Drumdreel Wood.
A typical profile comprises a dark greyish brown loam A horizon about 30 centimetres thick overlying a yellowish brown loamy sand or sand B horizon which rest on sandstone.

Kippen Series

This series covers 10 square kilometres and occurs mainly in the Howe of Fife and Strath Eden with a small area on the plain of Kinross. The parent material is a reddish brown till of clay loam texture.

Profile Description No. 31 Falkland

Grid Reference	NO243078
Slope	2^0
Aspect	North
Altitude	84 metres
Vegetation	Fourth Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-30	Dark brown (7.5YR3/2) sandy loam; moderate medium subangular blocky; friable; moist; few fine distinct yellowish red (5YR4/8) mottles usually associated with decomposing stones; low organic matter; many fine grass roots; worms present; frequent stones, mainly subangular igneous and some sandstone. Sharp smooth change into
Bg	30-51	Reddish brown (5YR4/3) sandy clay loam; moderate medium subangular blocky; firm; moist; many fine diffuse reddish yellow (7.5YR6/8) mottles and pinkish grey (7.5YR7/2) coatings on ped faces; low organic matter; few roots; worms present; many stones, mainly subangular igneous with frequent decomposing sandstone. Clear change into
Cg	51-84	Reddish brown (5YR5/3) clay loam; strong coarse angular blocky; firm; moist; few faint fine brownish yellow (10YR6/8) mottles and frequent fine patches of pinkish grey (7.5YR6/2) gleying; low organic matter; few roots; worms present; frequent small stones, many being decomposed igneous and sandstone fragments; few bright sandstones.

Analyses Sample Numbers 279491-95					
Horizon	Ap	Ap	Bg	Cg	Cg
Depth (cm)	5-13	20-28	35-43	58-66	76-84
Sand 50-2000 μm %	68.0	62.0	68.0	53.0	56.0
Silt 2-50 μm %	22.0	24.0	22.0	28.0	25.0
Clay <2 μm %	10.0	11.0	10.0	19.0	19.0
Exchangeable Cations					
Calcium (me/100g)	14.60	14.50	9.25	12.10	13.50
Magnesium (me/100g)	2.18	1.00	1.10	2.57	3.34
Sodium (me/100g)	0.09	0.07	0.04	0.09	0.11
Potassium (me/100g)	0.58	0.44	0.50	0.27	0.26
Hydrogen (me/100g)	3.20	3.90	3.30	2.50	2.20
Base Saturation %	84.5	80.4	76.8	85.8	88.7
pH (in water)	6.7	6.4	6.8	6.8	6.9
pH (in $CaCl_2$)	6.3	6.1	6.1	6.0	6.1
Loss on Ignition %	6.9	6.4	4.7	5.5	3.4
Carbon %	3.27	2.87	0.54		
Nitrogen %	0.25	0.24	0.06		
Organic Matter %	5.60	4.90	0.90		
Total Phosphorus (mg P_2O_5/100g)	338	333	187	80	126

The field textures recorded for the Bg and Cg horizons are sandy clay loam and clay loam respectively. The presence of decomposed sandstone in both horizons doubtless explains why the textures as determined in the laboratory and using the triangular diagram (Appendix 1) are coarser than those determined in the field. In all horizons, calcium is high while both magnesium and potassium have moderate values. Base saturation is high throughout as is pH (water) except in the lower Ap.

The chemical properties expressed above do not reflect the very broad range in values of the series as a whole. While both exchangeable magnesium and potassium values are comparable with the Falkland profile, those for calcium are low or moderate more usually and base saturation levels range from very low to high, increasing down the profile. The pH values range also from low to high and total phosphorus is moderate usually but levels increase with depth in some profiles and decrease in others. This range in chemical properties probably reflects the variable nature of the Old Red Sandstone sediments.

Butterwell Series

Slightly less extensive than the Kippen Series, Butterwell Series covers an area of 7 square kilometres and is found mainly in the Howe of Fife, in Strath Eden and on the plain of Kinross. It is developed on till similar to the Kippen Series but with upper layers which are coarse-textured as a result of water-sorting. The series is normally found in low-lying areas bordering drainage channels or contiguous with areas of recent alluvium.

Profile Description No. 32 Springfield Wood

Grid Reference	NO337127
Slope	0^0
Aspect	Nil
Altitude	70 metres
Vegetation	30-Year Scots Pine Wood, closed canopy
Drainage Class	Imperfect

Horizon	Depth (cm)	
L	0-1	Brown pine needle litter
FH	1-5	Very dark brown (10YR2/2) well-decomposed humus with frequent bleached quartz grains; frequent roots. Sharp change into
Ah	5-15	Very dark greyish brown (10YR3/2) organic loam; compact, breaking down under moderate pressure to angular blocky and under further pressure to weak fine crumb; slightly moist; patches of humus staining; high organic matter; many roots, mainly of trees; frequent subangular stones. Sharp wavy change into
Bw	15-25	Reddish brown (5YR4/3) sandy loam; weak platy, breaking readily to fine crumb; moist; no mottles; low organic matter; few stones. Sharp change into
Cg(x)	25-56	Dark reddish grey to reddish brown (5YR4/2 to 5/3) sandy loam; strong platy; slightly indurated; slightly moist; many medium prominent strong brown (7.5YR5/6) mottles and many prominent grey mottles on structure faces; no organic matter; few roots; frequent stones, mainly angular sandstones up to 15 cm. Gradual change into
2Cg	56+	Weak red (2.5YR4/2) varying with depth to reddish brown (2.5YR4/4) clay loam; strong coarse prismatic; moist; diffuse brown (7.5YR5/4) mottles within peds; grey gleying on structure faces and along old root channels; prominent black manganese dioxide staining; few roots; stones as above.

Analyses Sample Numbers 169276-81						
Horizon	FH	Ah	Bw	Cg(x)	2Cg	2Cg
Depth (cm)	1-5	7.5-12	15-23	35-46	71-81	96-106
Sand 50-2000 μm %	ND	58.9	62.7	57.9	50.9	51.1
Silt 2-50 μm %	ND	21.8	21.7	23.6	24.5	24.9
Clay <2 μm %	ND	4.6	11.5	18.5	24.6	24.0
Exchangeable Cations						
Calcium (me/100g)	11.04	2.50	0.62	2.13	7.70	9.24
Magnesium (me/100g)	2.34	0.67	0.07	1.93	7.71	6.03
Sodium (me/100g)	0.52	0.18	0.12	0.20	0.45	0.59
Potassium (me/100g)	1.02	0.31	0.10	0.12	0.21	0.23
Hydrogen (me/100g)	54.65	34.54	17.51	4.21	2.15	1.04
Base Saturation %	21.4	9.6	4.9	51.0	88.2	93.9
pH (in water)	3.8	3.9	4.5	5.0	5.4	5.9
Loss on Ignition %	55.40	19.60	8.15	2.82	3.46	3.09
Carbon %	31.56	10.51	4.72			
Nitrogen %	1.41	0.44	0.18			
Organic Matter %	54.12	18.08	8.10			
Total Phosphorus (mg P_2O_5/100g)	159	97	114	44	86	107

Excluding the FH horizon, the levels of exchangeable calcium and magnesium and the percentage base saturation increase from low to high down the profile. There is an unusual dip in all values in the B horizon and this feature was noted also in two further profiles from nearby localities. The pH range is from 3.8 in the surface horizon to 5.9 in the 2Cg, somewhat lower than the norm of the series.

This profile has the coarse-textured water-sorted upper horizons which are typical of the series. Water-sorting is frequently found down to 60 centimetres or more. The effect is well displayed in the following cultivated profile.

Profile Description No. 33 Freuchie

Grid Reference	NO285074
Slope	2^0
Aspect	East
Altitude	38 metres
Vegetation	Second Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-23	Very dark brown (10YR2/2) clay loam; strong coarse angular blocky; friable; moist; no mottles; low organic matter; many fibrous grass roots; worms present; frequent subangular stones. Sharp wavy change into
Bg1	23-28	Reddish brown (5YR4/3) loamy sand; weak medium subangular blocky; friable; moist; many fine distinct yellowish red (5YR5/6) mottles; low organic matter; frequent roots; frequent stones as above. Sharp wavy change into
Bg2	28-56	Reddish brown (5YR4/3) sandy loam; weak coarse angular blocky; friable; moist; frequent medium to fine distinct yellowish red (5YR5/6) mottles; low organic matter; few roots; frequent subangular stones with red sandstone prominent; horizon is strongly water-sorted. Gradual change into
C(g)1	56-104	Dark reddish grey (5YR4/2) sandy loam; moderate medium subangular blocky; firm; moist becoming wet in lower half of horizon; frequent fine faint yellowish red (5YR4/6) mottles; low organic matter; few roots; few stones. Gradual change into
C(g)2	104-137	Reddish brown (5YR4/3) sandy loam to sandy clay loam; coarse angular blocky; plastic; moist to wet; no mottles; low organic matter; no roots; frequent stones.

Analyses Sample Numbers 268285-90						
Horizon	Ap	Bg2	C(g)1	C(g)1	C(g)2	C(g)2
Depth (cm)	8-15	33-41	58-66	91-99	112-119	129-137
Sand 50-2000 μm %	45.0	64.0	72.0	70.0	68.0	65.0
Silt 2-50 μm %	32.0	27.0	15.0	20.0	18.0	19.0
Clay <2 μm %	19.0	9.0	13.0	10.0	14.0	16.0
Exchangeable Cations						
Calcium (me/100g)	24.80	9.12	8.53	11.00	17.80	28.70
Magnesium (me/100g)	1.61	0.71	0.95	3.25	5.20	5.20

Sodium (me/100g)	0.25	0.14	0.14	0.10	0.14	0.12
Potassium (me/100g)	0.30	0.09	0.11	0.13	0.24	0.24
Hydrogen (me/100g)	5.40	1.80	1.60	1.30	1.40	1.30
Base Saturation %	83.3	84.9	85.8	91.8	94.3	96.4
pH (in water)	6.7	7.4	7.4	8.3	8.6	8.7
pH (in $CaCl_2$)	6.3	6.6	6.7	7.4	7.8	7.8
Loss on Ignition %	9.00	1.60	1.70	1.80	2.30	2.60
Carbon %	3.97	0.23	0.49			
Nitrogen %	0.34	0.06	0.03			
Organic Matter %	6.80	0.40	0.80			
Total Phosphorus (mg P_2O_5/100g)	227	128	136	140	155	143

Soils of the Butterwell Series are broad-ranging in their chemical properties, probably because of the different proportions of sedimentary rocks in the parent material, but commonly the levels of exchangeable cations are moderate and base saturation percentages are moderate to high, increasing with depth. The pH values are usually greater than 5.0 and total phosphorus levels decrease from moderate to low down the profile.

Redbrae Series

The Redbrae Series covers an area of 5 square kilometres and extends over the western and north-western slopes of the Lomond Hills at altitudes between 180 and 270 metres.

Profile Description No. 35 Easter Balgedie

Grid Reference	NO177043
Slope	15^0
Aspect	North-west
Altitude	206 metres
Vegetation	Blaeberry Heath
Drainage Class	Free

Horizon	Depth (cm)	
LF	0-4	Very dark brown (10YR2/2) fibrous humus. Sharp change into
HA	4-13	Black to very dark brown (10YR2// to 2/2) organic loam; weak medium subangular blocky; friable; moist; no mottles; moderate organic matter; many fibrous grass roots and frequent woody *Vaccinium* roots; frequent stones, mainly small subangular sandstones. Sharp change into
E	13-33/43	Dark grey (10YR4/1) sandy loam; moderate medium subangular blocky; friable; moist; many fibrous grass roots; frequent stones, with numerous small decomposing yellowish red (5YR4/6) sandstones. Sharp irregular change into

Bf	33/43	Iron pan, well-developed in parts, otherwise diffuse
Bs	33/43-54	Strong brown (7.5YR5/6) loamy sand; slightly compact, breaking readily to fine crumb; moist; low organic matter; few roots; frequent sandstones. Clear change into
Bx	54-82	Yellow (10YR7/6) with patches of reddish yellow (7.5YR7/6) loamy sand; strongly indurated in parts, breaking to fine subangular blocky and single grain; low organic matter; frequent pieces of sandstone, generally larger than above horizon and tending to become pinker with depth. Gradual change into
C	82-112	Pale brown(10YR7/4) with patches of reddish yellow (7.5YR6/6) loamy sand; massive; low organic matter; many pieces of sandstone.

This profile has the dark grey E and strong brown Bs of the humus-iron podzol. The iron pan is not a typical feature and probably indicates the presence at one time of a peaty surface horizon.

Analyses Sample Numbers 248122-29							
Horizon	LF	HA	E	Bs	Bx	C	C
Depth (cm)	0-4	5-13	21-28	46-54	64-71	87-94	104-112
Sand 50-2000 μm %	ND	64.6	70.4	81.2	82.2	86.3	82.3
Silt 2-50 μm %	ND	17.9	20.2	11.7	11.7	8.7	13.5
Clay <2 μm %	ND	4.5	3.3	6.1	6.1	5.0	4.2
Exchangeable Cations							
Calcium (me/100g)	8.23	0.92	-	-	-	-	-
Magnesium (me/100g)	4.17	0.98	0.08	0.33	0.02	-	-
Sodium (me/100g)	0.31	0.07	0.04	-	-	-	-
Potassium (me/100g)	3.71	0.30	0.07	-	-	-	-
Hydrogen (me/100g)	37.50	16.56	23.46	5.87	3.56	3.02	2.93
Base Saturation %	30.5	12.1	0.8	5.3	0.6	-	-
pH (in water)	4.7	4.2	4.2	4.8	4.8	4.9	4.8
pH (in $CaCl_2$)	3.8	3.4	3.7	4.3	4.4	4.5	4.5
Loss on Ignition %	69.05	17.36	12.18	1.98	1.64	1.62	1.64
Carbon %	39.70	6.07	5.12				
Nitrogen %	1.92	0.25	0.22				
Organic Matter %	68.30	10.43	8.81				
Total Phosphorus (mg P_2O_5/100g)	405	134	106	50	47	47	47

- = less than lower limit of determination

High percentage sand and low percentage clay are prominent features. Exchangeable bases have moderate to low vales except in the LF horizon where calcium, sodium and potassium are high and magnesium moderate.

Skeletal Soils

Skeletal soils cover 2 square kilometres and occur along the northern and western scarp slopes of the Lomond Hills. The soils are shallow and overlie sandstone which outcrops in places.

Mountboy Association

The Mountboy Association occupies a total area of only 11 square kilometres. Apart from three small areas, on the lower slopes of Benarty Hill, in the Howe of Fife and on the east Fife uplands, the association is confined to lower slopes of the Ochil Hills, and to the plain of Kinross. It occurs more extensively in the Perth/Arbroath/Dundee district to the north and is also found in north-east Angus.

Parent Material

Derived from Old Red Sandstone lava and sediments, the till which forms the main parent material can vary from a weak red sandy clay loam with massive structure and frequent small subangular pieces of igneous and sandstone rock to a reddish brown sandy loam with many stones, mainly sandstone. In some areas, particularly in the vicinity of igneous intrusions, coarse-textured drift deposits derived largely from Old Red Sandstone sediments overlie lava rock.

Soils

Three soil series have been mapped. Garvock is a freely drained brown forest soil, Mountboy is an imperfectly drained brown forest soil with gleying, and Barras is a poorly drained noncalcareous gley.

Garvock Series

The Garvock Series occupies a total area of only 2 square kilometres and is found mainly to the north of Loch Leven where it has been mapped on the south-eastern slopes of the Ochils and on the plain of Kinross. Small areas also occur on the north-eastern slopes of the Ochils at the northern margin of the district and on Walton Hill in the east Fife uplands.

Profile Description No. 37 Bannetty A

Grid Reference	NO159082
Slope	2^0
Aspect	West
Altitude	114 metres
Vegetation	Second Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-28	Dark brown (7.5YR3/2) sandy silt loam; strong medium angular blocky; friable; moist; no mottles; moderate organic matter; worms present; many grass roots; few small and medium subangular sandstone and igneous stones with few fragments of Dalradian rock. Sharp smooth change into
Bw	28-46	Reddish brown (5YR4/3) loamy sand; weak medium to fine crumb; very friable; moist; no mottles; low organic matter; few roots; many stones as above, with frequent

		large slabs of friable red sandstone. Clear change into
B(x)	46-61	Reddish brown (5YR4/3) and dark reddish grey (5YR4/2) loamy coarse sand; weakly indurated, breaking down to fine angular blocky; moist; no mottles; low organic matter; no roots; many stones with large soft red sandstones dominant. Clear change into
C1	61-84	Reddish brown (2.5YR4/4) loamy sand; weak fine crumb; loose; moist; no mottles; low organic matter; no roots; many stones, mainly decomposing sandstones. Gradual change into
C2	84-117	Horizon dominated by large angular slabs of dusky red (2.5YR3/2) sandstone with reddish brown (2.5YR4/4) loamy sand in interstices; rocks break down readily.

Analyses Sample Numbers 254057-62						
Horizon	Ap	Ap	Bw	B(x)	C1	C2
Depth (cm)	5-13	18-25	33-41	51-58	69-79	104-117
Sand 50-2000 μm %	26.5	41.3	78.5	85.0	85.9	81.1
Silt 2-50 μm %	50.0	39.0	14.1	9.7	7.9	11.7
Clay <2 μm %	17.5	13.7	5.3	5.3	6.2	7.2
Exchangeable Cations						
Calcium (me/100g)	12.19	13.13	2.46	0.91	0.91	0.91
Magnesium (me/100g)	1.37	1.71	0.42	0.16	0.12	0.21
Sodium (me/100g)	0.04	0.03	-	-	-	-
Potassium (me/100g)	0.24	0.47	0.18	0.12	0.16	0.17
Hydrogen (me/100g)	9.68	9.30	5.93	3.86	2.62	1.71
Base Saturation %	58.9	62.2	34.1	23.6	31.2	43.0
pH (in water)	6.2	6.3	6.2	6.0	5.9	6.1
pH (in $CaCl_2$)	5.6	5.7	5.3	5.1	5.2	5.4
Loss on Ignition %	12.05	11.99	4.20	2.61	2.07	2.24
Carbon %	5.00	4.55	1.00			
Nitrogen %	0.63	0.57	0.13			
Organic Matter %	8.62	7.82	1.72			
Total Phosphorus (mg P_2O_5/100g)	553	605	227	167	137	141

- = less than lower limit of determination

Soils of the Garvock Series vary in texture according to the relative proportions of igneous and sedimentary rocks in the drift forming the parent material, but they are generally coarser than those of the Mountboy Series, and stones throughout the

profile tend to be larger and more numerous. In the above profile, red sandstone is dominant, giving rise to coarse textures in the B and C horizons. The influence of coarser textures is reflected to some extent in the values for exchangeable cations. Apart from the A horizon where the value is high, calcium is low throughout. Magnesium is low except in the A and Bw. Potassium is moderate. Percentage vase saturation reaches a high value in the lower A but is moderate elsewhere.

Mountboy Series

Covering a total area of 9 square kilometres, Mountboy Series, the dominant series, occurs mainly in two areas of the Ochil Hills – on the north-western slopes overlooking Dunning and on the south-eastern slopes about 3 kilometres north of Loch Leven. Except in two areas at altitudes around 244 metres, the series is always found below 180 metres.

Profile Description No. 36 Bannety B

Grid Reference	NO159083
Slope	3^0
Aspect	South-west
Altitude	120 metres
Vegetation	Second Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-23	Dark brown (7.5YR3/2) sandy silt loam; moderate medium subangular blocky; friable; moist; no mottles; low organic matter; frequent grass roots; worms present; frequent small angular and subangular sandstone and igneous stones. Clear smooth change into
Bw(g)	23-46	Brown (7.5YR5/2) sandy loam; moderate coarse subangular blocky; wet; slightly plastic; few fine distinct yellowish red (5Yr5/8) mottles; very low organic matter; few roots; many angular and subangular stones, mainly small to medium igneous with some sandstone. Clear irregular change into
Bwg	46-61	Weak red (2.5YR4/2) sandy clay loam; weak coarse prismatic to massive; slightly plastic; wet; many fine distinct yellowish red (5YR5/8) mottles associated with weathering stones, and coarse patches of reddish grey (5YR5/2) gleying; low organic matter; few roots; many small stones as above and many rotting stones, both igneous and sandstone. Clear irregular change into
C(g)1	61-97	Reddish brown (5YR5/3) sandy clay loam to clay loam; massive; firm; moist; many small patches of weathered stone giving a mottled appearance; no roots; frequent small to medium subangular and subrounded igneous stones and baked sandstones. Gradual change into
C(g)2	97-135+	Weak red (2.5YR4/2) clay loam; massive; wet;

no mottles; plastic; many small subangular fragments of sandstone and igneous rock and many very small stones; water standing at 97 centimetres.

Analyses Sample Numbers 254063-68 & 64A							
Horizon	Ap	Bw(g)	Bwg	C(g)1	C(g)1	C(g)2	C(g)2
Depth (cm)	8-15	30-38	51-58	66-74	84-92	104-112	127-135
Sand 50-2000 μm %	36.5	65.3	60.4	37.3	44.6	42.4	44.8
Silt 2-50 μm %	42.7	16.4	21.8	42.6	29.3	32.4	30.2
Clay <2 μm %	15.8	15.6	17.8	20.1	26.1	25.2	25.0
Exchangeable Cations							
Calcium (me/100g)	13.80	8.63	8.59	12.82	12.68	12.68	12.66
Magnesium (me/100g)	1.53	1.34	1.90	3.59	3.63	3.96	3.36
Sodium (me/100g)	0.04	0.04	0.11	0.09	0.09	0.11	0.11
Potassium (me/100g)	1.15	0.37	0.13	0.30	0.28	0.32	0.07
Hydrogen (me/100g)	6.00	4.42	2.15	1.55	1.54	1.13	0.92
Base Saturation %	73.5	70.2	83.5	91.6	91.7	93.9	94.7
pH (in water)	6.4	6.3	6.4	6.5	6.8	6.9	7.0
pH (in $CaCl_2$)	5.9	5.6	6.0	5.9	6.0	6.2	6.3
Loss on Ignition %	10.05	5.30	3.63	3.60	3.02	2.95	2.77
Carbon %	3.93	1.35	0.31				
Nitrogen %	0.46	0.15	0.05				
Organic Matter %	6.77	2.31	0.53				
Total Phosphorus (mg P_2O_5/100g)	402	189	110	154	154	179	182

Exchangeable calcium is high throughout; potassium is high in the Ap horizon and low in the lower C(g)2 sample. Percentage base saturation is high with pH values moderate in the Ap and B horizons, rising to high in the C.

Another example of the series at Blairhead also has high levels of calcium throughout, but exchangeable potassium is moderate in all horizons and pH values are high in the Ap and B horizons.

Barras Series

The Barras Series, a poorly drained noncalcareous gley, occupies an area of only 0.02 of a square kilometre at the northern margin of the sheet, 1.5 kilometres to the north of Springfield village.

Panbride Association

Stretching from the northern margin of the district above Kinsbarns to the Randerston area, a little east of the Cambo Burn, the Panbride Association covers 1square kilometre of the coastal lowlands and represents the southern extension of a larger area in north-east Fife. It overlies the areas of raised beach lying between the 7.5 to 30 metre contours.

Parent Material

The parent material consists of coastal raised beach deposits composed mainly of sands and gravels. These deposits are derived from Old Red Sandstone sediments and lavas, although in the Kingsbarns - Cambo area the influence of Carboniferous material is very evident, as the profile below shows.

Soils

Only one series, the freely drained Panbride, has been mapped in this area.

Panbride Series

Profile Description No. 38 East Newhall

Grid Reference	NO608114
Slope	2^0
Aspect	North-east
Altitude	15 metres
Vegetation	Permanent Pasture
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-25	Dark brown (7.5YR4/2) sandy loam; weak coarse subangular blocky; friable; moist; no mottles;low organic matter; many grass roots; worms present; frequent stones, mainly subangular sedimentary and igneous. Sharp smooth change into
Bw	25-51	Brown (7.5YR4/4) loamy sand; weak medium angular blocky; friable; moist; few fine distinct strong brown mottles in lower half of horizon; low organic matter; roots frequent, becoming few towards bottom of horizon; frequent stones as above, with yellowish brown sandstones common, and frequent sandstones with manganese dioxide coatings. Clear change into
C(g)1	51-74	Brown (10YR5/3) loamy sand to sand; weak medium angular blocky; very fraible; wet; many fine faint strong brown mottles; light brownish grey (10YR6/2) patches of gleying; low organic matter; few roots; frequent stones as above. Gradual change into
C(g)2	74-104	Brown (10YR5/3) coarse sand with occasional patches of

		finer texture; massive; wet; non-plastic; few dead roots; many stones, mainly angular and subangular pieces of sandstone. Sharp smooth change into
Cg	104-129	Dark grey (N4/0) fine sand with occasional silt bands; massive; non-plastic; wet; water-table at 112 centimetres; few stones; bands of black coal material.

Analyses Sample Numbers 254041-46						
Horizon	Ap	Bw	C(g)1	C(g)2	C(g)2	Cg
Depth (cm)	8-15	33-41	58-66	76-84	94-102	122-130
Sand 50-2000 μm %	71.3	83.6	86.9	90.5	94.8	89.1
Silt 2-50 μm %	18.6	10.7	9.3	5.7	3.6	7.1
Clay <2 μm %	6.8	5.7	3.8	3.8	1.6	3.8
Exchangeable Cations						
Calcium (me/100g)	6.10	5.50	3.94	3.02	3.02	4.86
Magnesium (me/100g)	1.25	1.13	0.91	0.87	0.91	1.66
Sodium (me/100g)	0.11	0.09	0.07	0.09	0.04	0.04
Potassium (me/100g)	0.38	0.08	-	0.17	0.06	0.08
Hydrogen (me/100g)	3.26	1.53	-	-	-	-
Base Saturation %	70.7	81.8	100.0	100.0	100.0	100.0
pH (in water)	6.4	6.8	6.8	7.1	7.4	7.1
pH (in $CaCl_2$)	5.7	6.0	6.3	6.4	6.5	6.6
Loss on Ignition %	6.09	2.89	1.95	3.69	0.90	3.76
Carbon %	1.40	0.56	0.26			
Nitrogen %	0.17	0.06	0.03			
Organic Matter %	2.40	0.97	0.45			
Total Phosphorus (mg P_2O_5/100g)	153	124	88	101	90	100

- = less than lower limit of determination

When compared with profiles of the series from Angus and from north-east Fife, the above profile has generally coarser textures, percentage sand being higher in most cases. Percentage base saturation and pH values are slightly higher throughout the profile. This probably results from the presence of Carboniferous material.

Rowanhill Association

Rowanhill is the largest association in the district. Covering a total area of 375 square kilometres, it occurs extensively throughout the coastal fringe of Fife and on parts of the Fife basaltic hills.

Parent Material

Till derived from Carboniferous sediments, mainly sandstones and shales, forms the parent material of the greater part of the association. Two variants of the till have been distinguished, differing mainly in colour. The more extensive of the two is a grey or greyish brown clay loam or sandy clay loam containing frequent pieces of decomposing sandstone and soft black or dark brown shale. The other variant, a reddish brown to weak red clay loam, occurs in only a few small areas, in contrast to its distribution in the Tayside district to the north, where it is by far the more extensive. As the two tills tend to merge into one another it is usually difficult to determine on the ground the boundaries between them. Another type of parent material is till with an overlying partially water-sorted layer. In several localities, there are minor occurrences of soil developed directly on black or dark brown shale but only a few are sufficiently large to separate on the soil map as a residual series.

Soils

Seven series of the association have been distinguished in the area surveyed. Caprington, Winton, Macmerry and Sauchieburn belong to the major soil subgroup of brown forest soils with gleying, Greenside is a freely drained brown forest soil, and Rowanhill and Butterdean are poorly drained noncalcareous gleys.

Caprington Series

The Caprington Series is the most extensive and occupies 225 square kilometres. It is developed on a grey or greyish brown till of clay loam or sandy clay loam texture. An imperfectly drained brown forest soil, the series occurs mainly on the east Fife drift plain, on parts of the west Fife drift plain, and on lower slopes of the Dunfermline Hills and of the Saline and Cleish Hills.
Generally, the soils of the series have a dark grey brown clay loam or sandy clay loam surface horizon, with a strong coarse angular blocky structure, overlying a brown or greyish brown sandy clay loam or clay loam B horizon, with coarse angular blocky structure tending to prismatic. The C horizon, which is weakly prismatic or massive, is a dark grey brown to dark grey clay loam, with the clay content increasing with depth.

Profile Description No. 39 Gibliston

Grid Reference	NO503054
Slope	3^0
Aspect	East
Altitude	84 metres
Vegetation	Permanent Pasture
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap(g)	0-33	Very dark grey (10YR3/1) clay loam; strong medium subangular blocky; firm; moist; many medium distinct strong brown (7.5YR5/8) mottles; moderate organic matter; many roots; worms present; frequent stones, mainly angular and subangular pieces of sandstone and limestone. Gradual change into
B(g)	33-76	Very dark grey (10YR3/1) with patches of dark brown (10YR4/3) clay loam; strong medium angular blocky; firm; moist; mottles as above; low organic matter; few roots; many stones as above but larger; many soft decomposing shale fragments. Gradual change into
C(g)1	76-99	Dark grey (10YR4/1) to very dark grey (10YR3/1) clay loam; strong medium angular blocky; firm; moist; mottles as above but less frequent; stones as above; Sharp change into
C(g)2	99-132+	Very dark brown (10YR3/2) clay loam; strong medium subangular blocky; firm; moist; few fine distinct strong brown (7.5YR5/6) mottles; stones as above but less frequent, payches of soft shale, increasing below 117 centimetres.

Analyses Sample Numbers 253748-54							
Horizon	Ap(g)	Ap(g)	B(g)	B(g)	C(g)1	C(g)2	C(g)2
Depth (cm)	5-13	23-30	41-48	66-74	84-91	99-107	124-132
Sand 50-2000 μm %	27.1	21.6	37.5	30.8	40.2	30.5	36.0
Silt 2-50 μm %	41.7	44.5	36.8	41.6	35.6	45.0	38.7
Clay <2 μm %	25.4	29.4	25.7	27.6	24.2	24.5	25.3
Exchangeable Cations							
Calcium (me/100g)	35.60	44.70	38.60	42.40	40.00	27.10	31.60
Magnesium (me/100g)	1.80	1.70	2.10	2.80	3.20	3.80	4.90
Sodium (me/100g)	0.13	0.13	0.13	0.19	0.18	0.13	0.11
Potassium (me/100g)	0.30	0.20	0.20	0.20	0.50	0.20	0.20
Hydrogen (me/100g)	-	-	-	-	-	-	-

Base Saturation %	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pH (in water)	6.9	7.7	7.8	7.8	8.0	7.8	7.7
pH (in $CaCl_2$)	6.9	7.3	7.4	7.5	7.5	7.5	7.4
Loss on Ignition %	11.60	9.00	7.50	8.40	7.50	5.80	6.90
Carbon %	4.80	2.60	2.20				
Nitrogen %	0.30	0.10	0.10				
Organic Matter %	8.3	4.5	3.8				
Total Phosphorus (mg P_2O_5/100g)	228	173	180	138	120	183	151

- = less than lower limit of determination

Notable features are the high percentage of silt and the moderately high percentage of clay throughout the profile. Exchangeable calcium is very high and greater than 35 me/100g except in the C(g)2 horizon. All horizons are completely base-saturated, while pH is high and over 7 except un the upper Ap(g) sample.

The following profile, from the Crook of Devon Hills subregion near the western margin of the sheet is notable for the high proportion of sandstones and shales recorded throughout. Mechanical analyses show lower clay, and, in the C(g) horizons, higher silt contents than in the previous profile, although these differences are not noted in the field textures.

Profile Description No. 40 Gelvan B

Grid Reference	NO050020
Slope	2^0
Aspect	South-east
Altitude	190 metres
Vegetation	Permanent Pasture (wet)
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap(g)	0-23	Very dark greyish brown (10YR3/1 to 3/2) sandy silt loam; moderate coarse angular blocky; firm; moist; frequent fine diffuse yellowish red (5YR4/6) mottles; low organic matter; frequent grass roots; worms present; frequent small to medium subangular stones (sandstone). Clear Irregular change into
B(g)	23-33	Greyish brown (10YR5/2) sandy silt loam with many light brownish grey patches and infilled cracks of sandy loam and sand; massive, tending to coarse prismatic; firm; moist; mottles as above; low organic matter; no roots; frequent small subangular stones, sandstone and igneous rocks with few large subangular sandstones. Clear change into
BC(g)	33-53	Brown (7.5YR5/2) clay loam with many light brownish grey (2.5YR5/2) vertical cracks and patches of silty clay loam; massive; moist; many medium distinct yellowish

		red (5YR4/6) mottles; many subangular sandstones of various sizes, frequent weathered pieces of sandstone, igneous rock and fragments of shale. Clear change into
Cg1	53-89	Reddish grey (5YR5/2) sandy silt loam; massive; very firm; moist; many diffuse yellowish red (5YR4/6) mottles and frequent grey (10YR6/1) pipes around old root channels; frequent large subangular stones and small boulders; some pieces of weathered sandstone and igneous rock. Frequent shale fragments. Gradual change into
Cg2	89-107	Dark grey (5YR4/1) sandy silt loam; massive; plastic; very moist; many coarse diffuse yellowish red (5YR4/6) mottles; many subangular and subrounded pieces of sandstone. Clear change into
Cg3	107+	Dark grey (10YR4/1) stony clay loam; massive; very plastic; wet; few mottles; many very small fragments of sandstone and shale, frequent larger subrounded pieces of shale; water-table at 105 centimetres.

Analyses Sample Numbers 248102-08							
Horizon	Ap(g)	B(g)	BC(g)	Cg1	Cg1	Cg2	Cg3
Depth (cm)	5-15	23-33	38-48	56-68	76-86	91-101	117-127
Sand 50-2000 μm %	47.5	40.5	31.6	32.4	33.6	33.6	34.7
Silt 2-50 μm %	37.9	42.2	41.1	49.1	49.5	50.3	46.3
Clay <2 μm %	10.4	17.3	22.3	18.5	16.9	16.1	19.0
Exchangeable Cations							
Calcium (me/100g)	11.10	5.40	4.60	4.30	4.90	5.00	5.80
Magnesium (me/100g)	0.80	0.60	1.60	2.80	3.50	3.70	2.30
Sodium (me/100g)	0.22	0.22	0.07	0.12	0.17	0.17	0.20
Potassium (me/100g)	0.20	0.20	0.10	0.20	0.20	0.20	0.20
Hydrogen (me/100g)	1.60	1.20	1.70	3.40	2.80	2.20	2.90
Base Saturation %	88.5	84.4	78.5	68.6	76.5	80.3	74.7
pH (in water)	6.8	6.4	5.8	5.5	5.6	5.7	5.6
pH (in $CaCl_2$)	6.4	5.8	5.0	4.7	4.7	4.8	4.4
Loss on Ignition %	8.4	4.3	4.3	3.9	3.3	3.4	3.1
Carbon %	3.20	0.50	0.40				
Nitrogen %	0.20	0.03	0.02				
Organic Matter %	5.50	0.90	0.70				
Total Phosphorus (mg P_2O_5/100g)	190	51	51	131	198	224	254

Percentage clay is less than 20 in all horizons except the BC(g). Clay contents, lower than in the previous profile, are reflected in the lower values for exchangeable cations. The abnormally low pH values in all horizons but the cultivated layer reflect the high proportion of shale in the profile. Base saturation is high throughout. Total phosphorus is low in the B(g) andBC(g) horizons.

Generally, in soils of this series, exchangeable calcium levels are high throughout the profile, the base saturation is high and pH values range 6.0 to 7.5, but are always lower when there is a high proportion of decomposed shale. Total phosphorus levels are moderate to low.

Winton Series

Winton Series occurs over an area of 28 square kilometres. The parent material is a sandy clay loam or clay loam till varying in colour from reddish brown to weak red derived mainly from sandstone. An imperfectly drained brown forest soil, the series occurs mainly on the plain of Kinross and in the Howe of Fife on gently rolling slopes, but isolated areas have been mapped on rolling slopes in other subregions of the district.

Profile Description No. 41

Grid Reference	NO392104
Slope	2^0
Aspect	North
Altitude	110 metres
Vegetation	Third Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-28	Dark greyish brown (10YR4/2) fine sandy loam; strong coarse angular blocky; firm; moist; few fine faint brownish yellow (10YR6/6) mottles; low organic matter; many fibrous grass roots; worms present; few stones. Sharp smooth change into
Bg	28-43	Brown (7.5YR5/4) sandy clay loam; moderate medium subangular blocky; firm; moist; many medium distinct brownish yellow (10YR6/8) mottles and light grey (10YR7/2) coatings on ped faces; low organic matter; frequent fibrous grass roots; stones as above with occasional decomposed stones. Sharp irregular change into
Cg	43-130+	Reddish brown (5YR4/3) clay loam (sandy clay loam in parts); firm; moist; frequent medium distinct brownish yellow mottles and light grey (10YR7/2) coatings on ped faces; low organic matter; few fibrous roots penetrating to 63 centimetres; few stones, becoming frequent with depth.

Analyses Sample Numbers 235190-94					
Horizon	Ap	Bg	Cg	Cg	Cg
Depth (cm)	8-15	33-41	56-64	84-94	120-129
Sand 50-2000 μm %	52.7	57.4	50.7	54.0	38.5
Silt 2-50 μm %	27.6	23.3	24.5	23.7	42.2
Clay <2 μm %	16.6	19.3	24.8	22.3	19.3
Exchangeable Cations					
Calcium (me/100g)	12.58	7.16	10.27	11.19	9.31
Magnesium (me/100g)	1.21	0.90	3.41	5.84	4.50
Sodium (me/100g)	0.08	0.04	0.07	0.09	0.08
Potassium (me/100g)	0.05	0.08	0.12	0.16	-
Hydrogen (me/100g)	6.47	10.22	1.12	1.79	1.50
Base Saturation %	68.3	44.5	92.5	90.6	90.3
pH (in water)	5.1	5.3	5.5	5.6	5.8
pH (in $CaCl_2$)	4.5	4.7	4.9	5.0	5.1
Loss on Ignition %	6.20	3.10	3.30	2.80	2.60
Carbon %	2.74	0.60	0.42		
Nitrogen %	0.24	0.05	0.04		
Organic Matter %	4.70	1.00	0.70		
Total Phosphorus (mg P_2O_5/100g)	257	75	56	144	154

- = less than lower limit of determination

Exchangeable calcium is high except in the Bg, and magnesium is high in the middle Cg sample; potassium is low in the Ap and Bg. Apart from the Bg, all horizons have high base saturation. Phosphorus is low in the Bg and upper Cg sample.
Under woodland some podzolisation takes place and a profile of the following type is developed. Because of their isolated occurrence, these podzolic soils have not been separated on the soil map and they have been included in the Winton Series.

Profile Description No. 42 Torloisk Wood

Grid Reference	NO356059
Slope	0^0
Aspect	Nil
Altitude	190 metres
Vegetation	Coniferous Plantation, about 25 years old
Drainage Class	Imperfect

Horizon	Depth (cm)	
L & F	0-5.5	Very dark greyish brown (10YR3/2) litter and fibrous organic maater; abundant fibrous grass and plant roots.
H	5.5-13	Very dark brown (10YR2/2) well-decomposed humus; few fine bleached sand grains; many fibrous grass roots, common woody tree roots. Sharp irregular change into
E(g)	13-19	Very dark greyish brown (10YR3/3) fine sandy loam; weak medium subangular blocky, breaking readily to coarse crumb; friable; moist; no mottles; moderate organic matter; many fibrous grass roots; common stones. Sharp irregular change into
B(g)	19-33	Brown (7.5YR5/4) sandy loam; moderate coarse angular blocky, breaking to medium angular blocky and coarse crumb; friable; moist; medium faint strong brown (7.5YR5/6) mottles, frequent in upper half, becoming few below; low organic matter; fibrous grass roots frequent in upper half, becoming few in lower half; moderate stone content, mainly subangular pieces of sandstone with some lava. Sharp smooth change into
Bg	33-51	Reddish brown (5YR4/3) sandy clay loam; strong angular blocky to prismatic structure; firm; moist; many medium distinct strong brown (7.5YR5/6) mottles and frequent pinkish grey (7.5YR6/2) coatings on ped faces; low organic matter; few roots; stones as above. Clear smooth change into
Cg	51-92	Weak red (2.5YR4/2) clay loam; strong coarse prismatic; firm; moist; frequent strong brown mottles as above and few faint fine light grey (10YR6/1) coatings on peds; many stones with pale yellow and red sandstone prominent.

Analyses Sample Numbers 208398-404							
Horizon	L & F	H	E	B(g)	Bg	Cg	Cg
Depth (cm)	0-5	6-9	13-15.5	23-31	38-48	56-66	76-86
Sand 50-2000 μm %	ND	ND	67.4	66.8	56.6	58.6	60.0
Silt 2-50 μm %	ND	ND	16.8	16.5	16.5	18.6	19.4
Clay <2 μm %	ND	ND	8.9	14.6	29.9	22.8	20.6
Exchangeable Cations							
Calcium (me/100g)	12.06	-	-	4.58	6.88	7.35	1.83
Magnesium (me/100g)	5.57	0.28	0.02	3.17	3.69	3.24	0.58
Sodium (me/100g)	1.13	0.11	0.04	0.28	0.18	0.15	-
Potassium (me/100g)	2.73	0.16	0.03	0.14	0.14	0.13	0.21
Hydrogen (me/100g)	39.22	44.09	21.58	13.36	12.33	11.25	2.92
Base Saturation %	35.4	1.2	0.4	61.2	88.3	96.6	89.7
pH (in water)	5.6	4.3	5.0	4.9	5.7	6.1	6.6
pH (in $CaCl_2$)							
Loss on Ignition %	59.20	31.40	13.80	4.30	3.30	3.10	2.70
Carbon %	30.50	14.50	6.10				
Nitrogen %	1.30	0.90	0.60				
Organic Matter %	52.50	24.90	10.50				
Total Phosphorus (mg P_2O_5/100g)	167	158	105	74	34	58	92

- = less than lower limit of determination

Exchangeable calcium, magnesium, sodium and potassium are all high in the L and F. Base saturation is high in the B(g) and in all horizons below, but is low in the H and E(g).

Soils of the series normally have moderate levels of magnesium and potassium throughout their profiles, but exchangeable calcium values are very variable. Base saturation percentages are low or moderate in the upper horizons and increase to high with depth and pH values increase also down the profile. Levels of total phosphorus are moderate.

The presence of decomposed sandstones in the till is reflected in the finer field textures compared with those calculated from the laboratory analyses.
In certain uncultivated areas or areas of semi-natural vegetation where peat or peaty humus has accumulated, peaty podzols with iron pan have developed but their occurrence is too scattered and in patches too small to warrant separation at the

scale of the soil map. The following profile was exposed in Forestry Commission woodland.
Profile Description No. 43 Blairadam Forest

Grid Reference	NT119936
Slope	5^0
Aspect	West
Altitude	190 metres
Vegetation	Scots Pine plantation (about 25 years old)
Drainage Class	Free below pan

Horizon	Depth (cm)	
LF	0-3	Dark reddish brown (5YR3/2) pine, fern and moss litter.
H1	3-5	Black (10YR2/1) well-decomposed humus
H2	5-13	Dark reddish brown (5Y3/2) peat; weak coarse angular blocky; moist; many fibrous roots. Sharp change into
Ah	13-18	Black (10YR2/1) fine sandy loam; strong medium subangular blocky; firm; moist; no mottles; high organic matter; few roots; few stones, but many fine bleached sand grains. Sharp change into
E	18-31	Greyish brown (10YR5/2) fine sandy loam to loamy sand; moderate coarse angular blocky; friable; moist; no mottles; low organic matter; few roots; few large pieces of sandstone' Sharp irregular change into
Bf	31	Iron pan
C	31-76	Reddish yellow (7.5YR6/8) decomposing sandstone with interstitial pockets of fine sandy loam.

Analyses Sample Numbers 232288-94						
Horizon	LF	H1	H2	Ah	E	C
Depth (cm)	0-3	3-5	5-13	13-18	21-28	33-43
Sand 50-2000 μm %	ND	ND	ND	65.8	83.1	83.5
Silt 2-50 μm %	ND	ND	ND	13.5	10.5	10.1
Clay <2 μm %	ND	ND	ND	3.7	6.4	6.4
Exchangeable Cations						
Calcium (me/100g)	7.56	3.78	-	-	-	-
Magnesium (me/100g)	4.37	2.74	0.66	0.17	-	-
Sodium (me/100g)	0.95	0.90	0.44	0.11	0.04	0.03
Potassium (me/100g)	1.51	0.45	-	-	-	-
Hydrogen (me/100g)	86.53	87.37	88.40	37.68	10.70	6.96
Base Saturation %	14.3	8.3	1.2	0.7	0.4	0.4

pH (in water)	4.0	3.7	4.1	4.2	4.2	4.5
pH (in $CaCl_2$)	3.0	2.9	2.8	2.9	3.2	4.0
Loss on Ignition %	87.70	79.60	83.80	22.70	3.10	2.20
Carbon %	50.52	45.91	47.81			
Nitrogen %	1.87	1.84	1.52			
Organic Matter %	87.00	78.90	82.20			
Total Phosphorus (mg P_2O_5/100g)	244	334	163	58	38	47

- = less than lower limit of determination

Exchangeable cations have low values, except in organic surface horizons, and base saturation is low throughout. The pH is low and does not rise above 4.5. Total phosphorus is low in all mineral horizons.

Macmerry Series

The Macmerry Series, an imperfectly drained brown forest soil, occurs extensively throughout the area of the association over 109 square kilometres, mainly in low-lying areas frequently bordering streams or drainage channels and often contiguous to spreads of recent alluvium or fluvioglacial sand and gravel. The parent material is till which is of coarser texture than that of Caprington Series because of partial re-sorting by water.

Profile Description No. 44 Dundonald

Grid Reference	NT218941
Slope	3^0
Aspect	North-east
Altitude	107 metres
Vegetation	Third or Fourth Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap(g)	0-23	Very dark greyish brown (2.5YR3/2) sandy loam; moderate coarse subangular blocky; firm; moist; few fine distinct strong brown (7.5YR5/6) mottles; moderate organic matter; many fibrous grass roots; worms present; frequent stones. Sharp smooth change into
Bg1	23-48	Brown (10YR5/3) to yellowish brown (10YR5/4) sandy loam; moderate coarse angular blocky; friable; moist; many coarse distinct strong brown (7.5YR5/6) mottles and grey coatings on ped faces; low organic matter; roots frequent, becoming few below 40 centimetres; worms present in upper half of horizon; frequent stones (sandstone, igneous rocks and some shale), the number increasing with depth; Sharp change into
Bg2	48-58	Greyish brown (10YR5/2) sandy loam to loamy sand; weak coarse subangular blocky; loose; moist; many coarse distinct strong brown mottles; low organic matter;

		frequent stones as above; Sharp change into
Cg	58-83+	Dark grey (7.5YR4/0) sandy looam to clay loam; strong medium prismatic; plastic; mist; frequent medium prominent strong brown (7.5YR5/6) mottles; low organic matter; frequent stones with numerous rotting pieces of sandstone.

Analyses Sample Numbers 225485-90						
Horizon	Ap(g)	Bg1	Bg1	Bg2	Cg	Cg
Depth (cm)	5-15	25-33	38-46	48-56	61-69	76-84
Sand 50-2000 μm %	54.5	63.6	60.9	72.5	43.0	53.5
Silt 2-50 μm %	23.2	15.8	18.5	14.0	24.0	20.8
Clay <2 μm %	17.1	17.9	18.4	13.5	33.0	25.7
Exchangeable Cations						
Calcium (me/100g)	10.60	6.30	5.20	4.40	8.70	6.90
Magnesium (me/100g)	0.70	0.40	0.30	0.40	1.60	2.10
Sodium (me/100g)	0.06	0.03	-	0.03	0.04	0.06
Potassium (me/100g)	-	-	-	-	-	-
Hydrogen (me/100g)	7.60	6.30	5.20	6.40	7.40	5.70
Base Saturation %	59.8	51.7	51.3	42.8	58.3	61.1
pH (in water)	6.0	5.9	6.0	5.9	6.1	6.1
pH (in $CaCl_2$)	5.5	5.3	5.4	5.4	5.5	5.6
Loss on Ignition %	10.40	5.50	4.40	3.70	6.50	5.20
Carbon %	5.40	2.00	1.30	1.20	2.00	1.50
Nitrogen %	0.30	0.10	0.10	0.10	0.10	0.10
Organic Matter %	9.20	3.50	2.20			
Total Phosphorus (mg P_2O_5/100g)	172	59	36	36	46	55

- = less than lower limit of determination

The increase in clay content from the water-sorted upper horizons to the underlying till is notable. Exchangeable calcium is high in the Ap and in the upper Cg sample. Base saturation just reaches a high level in the lower Cg sample. Total phosphorus is low except in the Ap horizon.

Soils of this series typically have moderate or high levels of exchangeable calcium, moderate magnesium levels and low or moderate potassium levels throughout their profiles. Base saturation percentages are moderate or high and increase with depth, as do pH values, which are somewhat variable but fall broadly in the range 6.0 to 7.0 in the surface horizons of cultivated soils. Total phosphorus levels are moderate or low and usually decrease with depth.

Butterdean Series

Butterdean Series, a poorly drained noncalcareous gley, is also developed on partially water-sorted till. It occupies 2 square kilometres and occurs in a few small low-lying localities throughout the area of the association.

Profile Description No. 45 Wester Balbeggie

Grid Reference	NT275958
Slope	0^0
Aspect	Nil
Altitude	76 metres
Vegetation	Third Year Grass
Drainage Class	Poor

Horizon	Depth (cm)	
Ap	0-23	Very dark brown (10YR2/2) clay loam; moderate medium subangular blocky; friable; moist; few fine distinct brownish yellow (10YR6/6) mottles usually associated with decomposed stones; high organic matter, fine pockets of peat at base of horizon; many fibrous grass roots; frequent stones; Sharp irregular change into
Bg1	23-38	Light brownish grey (10YR6/2) fine sandy loam; moderate medium angular blocky; firm; moist; frequent medium distinct strong brown (7.5YR5/6) mottles at bottom of horizon; low organic matter; many grass roots; frequent stones, mainly angular sandstones Sharp irregular change into
Bg2	38-48	Light brownish grey (2.5Y6/2) sandy clay loam; moderate coarse subangular blocky; firm; moist; many medium and coarse strong brown (7.5YR5/8) mottles; fibrous grass roots frequent, becoming few at bottom of horizon; frequent stones. Sharp irregular change into
BCg	48-79	Grey (10YR6/1) sandy clay loam to clay loam; moderate medium subangular blocky; firm; moist; mottles as above and grey coatings round stones; no roots; stones as above. Sharp irregular change into
Cg	79-119+	Grey (10YR5/1) and dark brown (7.5YR3/2) clay loam; massive; plastic; wet; frequent medium distinct strong brown mottles; many pieces of sandstone and frequent fine fragments of coal and soft shale.

Analyses Sample Numbers 248055-60						
Horizon	Ap	Bg1	Bg2	BCg	Cg	Cg
Depth (cm)	7-15	28-36	41-46	61-71	84-91	119-127
Sand 50-2000 μm %	49.2	61.4	60.8	50.6	47.8	46.3
Silt 2-50 μm %	27.3	26.7	23.4	29.4	30.0	28.3
Clay <2 μm %	10.2	11.9	15.8	20.0	22.2	25.4
Exchangeable Cations						
Calcium (me/100g)	12.50	-	-	-	2.30	3.40
Magnesium (me/100g)	1.00	0.08	0.18	0.60	3.80	5.30
Sodium (me/100g)	0.09	-	-	-	0.07	0.11
Potassium (me/100g)	0.05	0.03	0.05	0.05	0.08	0.08
Hydrogen (me/100g)	14.40	6.80	6.70	8.20	5.90	3.90
Base Saturation %	48.8	1.6	2.5	7.1	51.8	69.3
pH (in water)	5.5	4.5	4.4	4.5	4.3	6.0
pH (in $CaCl_2$)	5.1	4.1	4.1	4.1	4.6	5.0
Loss on Ignition %	17.7	4.6	4.0	4.6	5.7	5.7
Carbon %	8.50	1.50	0.80			
Nitrogen %	0.40	0.05	0.03			
Organic Matter %	14.70	2.60	1.40			
Total Phosphorus (mg P_2O_5/100g)	171	57	49	73	83	98

- = less than lower limit of determination

The organic nature of the Ap horizon shows that the field was formerly moorland which has since been cultivated. The decrease in water-sorting with depth is reflected in the increasing clay content in the BCg and Cg horizons. Exchangeable calcium is high in the Ap while magnesium is high in the Cg. Potassium is low throughout. Percentage base saturation is high in lower Cg sample and low elsewhere except in the Ap and upper Cg sample. Total phosphorus is low except in the Ap.

A second profile examined near Largoward has somewhat different chemical properties. Exchangeable calcium levels are high throughout the profile and magnesium levels and base saturation percentages are moderate or high. Total phosphorus values are low or moderate and increase with depth.

Rowanhill Series

Rowanhill Series, dominant in Ayrshire where the association was first named, covers a total area of only 9 square kilometres in the Fife/Kinross sheet. Developed on a grey clay loam or clay till, the series is a poorly drained noncalcareous gley and

is found on gentle slopes or low-lying areas. The first profile described is taken from east Fife, the second from Kinross-shire.

Profile Description No. 46 Brewsterwells

Grid Reference	NO478101
Slope	2^0
Aspect	North-east
Altitude	160 metres
Vegetation	Third Year Grass
Drainage Class	Poor

Horizon	Depth (cm)	
Ap	0-23	Very dark greyish brown (2.5Y3/2) sandy silt loam to clay loam; strong medium subangular blocky; firm; moist; few fine distinct strong brown (7.5YR5/8) mottles; moderate organic matter; many grass roots; worms present; frequent stones. Sharp wavy change into
Bg	23-31	Grey to light grey (10YR5/1 to 6/1) sandy silt loam; moderate medium subangular blocky; firm; moist; many medium prominent strong brown mottles and patches of light grey gleying; low organic matter; few roots; worms present; many stones, mainly soft weathering sandstone with some igneous rocks. Clear wavy change into
Cg1	31-81	Dark grey (N4/0) clay loam; massive; plastic; wet; many medium distinct yellowish brown (10YR5/6) mottles generally occurring in vertical streaks down horizon; low organic matter; few roots; frequent stones, mainly soft weathered sandstone. Sharp wavy change into
Cg2	81-140	Dark greenish grey (5G4/1) sandy clay loam; massive; plastic; wet, water-table at 119 centimetres; no mottles; low organic matter; no live roots, but remnants of old tree roots; many stones, increasing in number in lower half of horizon – mainly weathered sandstone giving coarser texture (sandy loam and loamy sand), and some shales.

Analyses Sample Numbers 268188-94							
Horizon	Ap	Bg	Cg1	Cg1	Cg2	Cg2	Cg2
Depth (cm)	7-15	23-30	38-46	69-76	87-94	104-112	132-140
Sand 50-2000 μm %	38.0	45.0	40.0	47.0	68.0	80.0	76.0
Silt 2-50 μm %	41.0	36.0	37.0	32.0	24.0	17.0	19.0
Clay <2 μm %	14.0	17.0	23.0	21.0	8.0	3.0	5.0
Exchangeable Cations							
Calcium (me/100g)	0.80	15.90	14.80	11.20	12.30	8.80	8.30

Magnesium (me/100g)	2.20	3.00	5.00	6.50	8.40	5.60	5.20
Sodium (me/100g)	0.11	0.04	0.06	0.10	0.19	0.16	0.13
Potassium (me/100g)	0.06	0.06	0.10	0.10	0.08	0.07	0.06
Hydrogen (me/100g)	2.80	7.60	4.30	5.00	6.60	12.00	12.60
Base Saturation %	53.3	71.4	82.3	78.2	76.1	55.1	52.3
pH (in water)	6.6	6.8	6.6	6.4	5.3	5.0	5.1
pH (in $CaCl_2$)	6.3	6.1	5.8	5.3	4.6	4.3	4.3
Loss on Ignition %	14.7	4.6	5.8	5.7	7.2	5.6	7.9
Carbon %	7.10	1.40	2.10				
Nitrogen %	0.60	0.20	0.10				
Organic Matter %	12.20	2.30	3.60				
Total Phosphorus (mg P_2O_5/100g)	320	106	100	143	249	283	320

The influence of weathered sandstone is reflected in the results of mechanical analyses, which show much lower values for clay percentages than indicated by the field textures. Exchangeable calcium values are high throughout, with the exception of the Ap horizon, and magnesium is high in all but the Ap and Bg layers. Base saturation percentages are moderate or high. Total phosphorus values are moderate or high. Total phosphorus values are moderate or high and, excluding the Ap horizon, increase with depth.

Profile Description No. 47 Gelvan C

Grid Reference	NO053019
Slope	2^0
Aspect	South-east
Altitude	175 metres
Vegetation	Sixth Year Grass Pasture
Drainage Class	Poor

Horizon	Depth (cm)	
Ap	0-23	Very dark greyish brown (2.5Y3/2) clay loam; moderate medium subangular blocky; slightly plastic; moist; few fine distinct yellowish red (5YR5/6) mottles; low organic matter; many fibrous grass roots. Sharp smooth change into
Bg1	23-43	Greyish brown (10YR5/2) clay loam; strong coarse angular blocky; slightly plastic; moist; many prominent yellowish red (5YR4/6) mottles; low organic matter; few fibrous grass roots; moderate stones, mainly reddish brown and pale yellow decomposed sandstone with some igneous rocks; mottles occur as streaks down old root channels; frequent light grey coatings on peds. Gradual change into
Bg2	43-66	Grey (10YR5/1) silty clay loam; moderate medium angular blocky; firm; moist; many prominent mottles as above, and light grey coatings on peds; low organic

		matter; few roots; stones as above, with frequent pieces of soft coal and shale. Clear change into
Cg1	66-109	Grey to greyish brown (10YR5/1 to 5/2) clay loam; moderate medium subangular blocky; slightly plastic; moist; many prominent yellowish red (5YR5/6) and strong brown (7.5YR5/6) mottles which in places tend to dominate horizon colour; low organic matter; many stones, with sandstone, coals and shales frequent; light grey coatings on peds. Sharp smooth change into
Cg2	109-145+	Dark grey (5YR4/1) clay loam; massive; plastic; moist to wet; few fine faint reddish brown mottles at top of horizon; low organic matter; many stones of larger size than above; water seeping in at top of horizon.

Analyses Sample Numbers 248095-101							
Horizon	Ap	Bg1	Bg2	Cg1	Cg1	Cg2	Cg2
Depth (cm)	7-15	28-36	51-58	71-79	94-102	114-122	137-145
Sand 50-2000 μm %	36.9	28.5	8.0	52.8	42.2	45.7	47.7
Silt 2-50 μm %	41.9	54.5	70.6	31.1	40.5	35.1	35.0
Clay <2 μm %	17.1	17.1	21.4	16.1	17.3	19.2	17.3
Exchangeable Cations							
Calcium (me/100g)	12.70	7.90	5.40	5.80	8.00	8.60	8.60
Magnesium (me/100g)	0.70	0.90	1.90	3.40	5.40	3.40	2.30
Sodium (me/100g)	0.22	0.22	0.22	0.30	0.36	0.41	0.38
Potassium (me/100g)	0.20	0.20	0.20	0.20	0.30	0.30	0.30
Hydrogen (me/100g)	2.40	2.60	4.00	2.90	3.60	4.00	4.30
Base Saturation %	85.0	77.7	65.7	76.9	79.5	76.1	73.0
pH (in water)	6.8	6.2	5.6	6.0	5.9	5.5	5.3
pH (in $CaCl_2$)	6.3	5.4	4.8	5.2	5.1	4.5	4.4
Loss on Ignition %	8.30	5.10	4.90	4.20	3.40	3.10	3.00
Carbon %	3.00	0.70	0.60				
Nitrogen %	0.18	0.03	0.03				
Organic Matter %	5.20	1.20	0.90				
Total Phosphorus (mg P_2O_5/100g)	216	67	168	216	274	266	257

As in the previous profile, No 46, the presence of decomposed sandstone has resulted in lower percentages of clay than are indicated by the field textures. Exchangeable calcium is high except in Bg horizons and in the upper Cg1 sample; magnesium is high only in the lower Cg1 sample and base saturation is high throughout.

Greenside Series

Covering a total area of 1 square kilometre, the Greenside Series occurs in only a few small localities throughout the association. A freely drained brown forest soil which frequently has a compact or indurated Bx horizon, it is developed on a till of sandy loam or loam texture and has the generalised profile of 23 centimetres of dark greyish brown clay loam A horizon overlying 13 centimetres of brown sandy loam B horizon. This is succeeded by an indurated (Bx) layer of pinkish brown fine sandy loam, 13 centimetres thick, which rests on a reddish brown sandy loam C horizon.

Sauchieburn Series

Developed on soft decomposing shale, the Sauchieburn Series is an imperfectly drained brown forest soil and it occurs in a few, small, isolated areas throughout the association.

Profile Description No. 48 South Baldutho

Grid Reference	NO508064
Slope	4^0
Aspect	East-north-east
Altitude	130 metres
Vegetation	Third Year grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap(g)	0-20	Dark grey (10YR4/1) silty clay; strong coarse angular blocky; firm; moist; frequent medium distinct brownish yellow (10YR6/6) mottles and greyish brown (10YR5/2) coatings on peds; moderate organic matter; frequent fibrous grass roots; worms present; frequent stones, mainly small pieces of sandstone and shale. Sharp smooth change into
B(g)	20-36	Dark grey (N4/0) silty clay; strong coarse angular blocky, breaking to laminar structure due to decomposed shale bands; moist; mottles and gleying as above, becoming more prominent with depth; low organic matter; frequent grass roots; many weathered stones, mainly shales and some igneous rocks. Gradual change into
Cg	36-99	Dark grey (N4/0) soft weathered shale; laminar structure; many coarse strong brown (7.5YR5/6) iron oxide deposits; few roots to 61 centimetres. Gradual change into
CR	99-124.5	Dark grey (N4/0) soft shale, less weathered than above.

Analyses Sample Numbers 253770-74					
Horizon	Ap	B(g)	Cg	Cg	CR
Depth (cm)	5-13	25-33	51-58	86-94	117-124
Sand 50-2000 μm %	17.2	2.9	8.2	Would not disperse	
Silt 2-50 μm %	42.5	48.8	41.8		
Clay <2 μm %	40.3	48.5	50.0		
Exchangeable Cations					
Calcium (me/100g)	29.50	22.20	10.70	35.80	63.10
Magnesium (me/100g)	2.20	2.30	1.80	1.90	3.60
Sodium (me/100g)	0.16	0.14	0.11	0.04	0.09
Potassium (me/100g)	0.40	0.2	0.2	0.1	0.1
Hydrogen (me/100g)		1.40	11.10	30.50	17.30
Base Saturation %	100.0	94.5	53.3	55.4	79.5
pH (in water)	7.0	6.9	4.5	2.6	3.8
pH (in $CaCl_2$)	6.9	6.6	4.2	2.5	3.8
Loss on Ignition %	10.80	11.30	12.10	13.00	13.90
Carbon %	2.60	1.90			
Nitrogen %	0.20	0.10			
Organic Matter %	4.50	3.20			
Total Phosphorus (mg P_2O_5/100g)	219	164	342	166	225

Notable features are the very high percentages of silt and clay in the upper horizons. Exchangeable calcium is exceptionally high in all horizons except the upper Cg sample and percentage base saturation is high except in the Cg.

Sourhope Association

Covering a total area of 207 square kilometres, Sourhope is the second largest association in the district. It occurs extensively in the Ochil Hills in the north-west corner of the district; a few small areas have been mapped in the east Fife uplands and in the Crook of Devon Hills.

Parent Material

The parent material is derived from intermediate lavas of Lower Old Red Sandstone Age and, over the greater part of the association area, it consists of glacial till which varies in colour from brown to pinkish brown and in texture from sandy loam to sandy clay loam. A till with water-sorted upper horizons has been separated also. On the upper slopes and hill tops, the till is absent or very thin so that the overlying soils are mainly residual and developed on decomposed lava. On some summits and on scree slopes, shallow skeletal soils have developed on rock rubble.

Soils

Nine soil series have been mapped. Sourhope, a brown forest soil, Frandy, a humus-iron podzol and Balquhandy, a peaty brown soil, are all freely drained. Cowie, a peaty podzol with iron pan, is imperfectly or poorly drained above the iron pan but freely drained below. Bellshill and Gellyknowe Series are both imperfectly drained brown forest soils. Atton is a poorly drained noncalcareous gley, while Edgerston and Lawsuit are peaty gleys, the former poorly and the latter very poorly drained. In addition, there is one soil complex, the Skythorn Complex, of blanket peat, skeletal soil and peaty ranker.

Sourhope Series

Sourhope Series covers 129 square kilometres and as on the Perth/Arbroath/ Dundee sheet to the north, is the dominant series of the association. The main parent material is a shallow stony till, generally of gritty loam texture, but, on some upper slopes and hilltops where the till is absent or very thin, the overlying soil is mainly residual and developed on decomposed lava. Because of the difficulty in mapping them separately, the soils developed on till and the residual soils have both been included in the same series.

Profile Description No. 49 Gelvan A

Grid Reference	NO052014
Slope	3^0
Aspect	South-east
Altitude	191 metres
Vegetation	Fourth Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-28	Dark brown (7.5YR2/2) sandy silt loam; moderate medium subangular blocky; friable; slightly moist; no mottles; moderate organic matter; frequent grass roots; earthworms present; few large pieces of andesite and frequent medium subangular and subrounded stones; Clear irregular change into
AB	28-35	Dark brown to brown (7.5YR3/2 to 4/2) sandy silt loam; moderate coarse angular blocky; friable, crumb structure down roots; slightly moist; no mottles; low organic matter, but tongues of AP horizon material penetrate as a result of ploughing; frequent small angular and subangular andesite stones. Clear irregular change into
Bw	35-48	(Pinkish) brown (7.5YR4/2) sandy silt loam; massive; compact; moist; no mottles; few roots penetrate down tongues of material from above horizon; many small subangular and angular stones and few subangular andesite boulders; few small weathered andesite stones. Sharp change into
Bx	48-69 `	(Pinkish) brown (7.5YR4/2) stony sandy loam; indurated; moist; few faint yellowish red (5YR4/6) mottles; no roots; many angular and subangular very large stones and boulders, some weathered; many small angular pieces of andesite. Clear change into
C	69-129+	Dark reddish grey (5YR4/2) stony sandy loam; massive; compact; slightly plastic; very moist; no mottles; stones as above.

The A horizon in this series is normally from 22 to 30 centimetres deep; the presence of an AB horizon in the above profile results from deep ploughing. An indurated horizon is normally present, especially when the texture is sandy loam or loam. With finer textures, induration is usually absent or very weak.

Analyses Sample Numbers 248087-94								
Horizon	Ap	Ap	AB	Bw	Bx	C	C	C
Depth (cm)	3-13	15-25	28-36	38-48	53-63	74-84	99-109	124-134
Sand 50-2000 μm %	36.2	34.3	36.9	45.1	51.2	54.0	48.0	53.9
Silt 2-50 μm %	45.2	49.2	42.9	39.9	36.0	30.9	34.9	31.0
Clay <2 μm %	12.3	10.2	15.4	15.0	12.8	15.1	17.1	15.1
Exchangeable Cations								
Calcium (me/100g)	10.00	10.00	7.00	5.90	5.40	11.80	13.80	14.30
Magnesium (me/100g)	0.60	0.50	0.30	0.30	0.30	1.50	3.80	5.50
Sodium (me/100g)	0.23	0.21	0.21	0.25	0.27	0.30	0.30	0.30
Potassium (me/100g)	0.20	0.20	0.20	0.20	0.20	0.30	0.40	0.50
Hydrogen (me/100g)	10.40	10.30	10.10	6.10	7.70	6.00	3.80	3.10
Base Saturation %	51.4	51.5	43.3	51.8	44.5	70.0	83.0	87.2
pH (in water)	5.9	5.9	5.9	5.9	5.7	5.4	5.5	5.8
pH (in $CaCl_2$)	5.4	5.4	5.2	5.1	5.0	4.6	4.8	5.2
Loss on Ignition %	12.60	12.60	9.60	5.30	5.20	4.50	4.50	4.4
Carbon %	4.80	4.90	3.40					
Nitrogen %	0.40	0.40	0.30					
Organic Matter %	8.28	8.58	5.83					
Total Phosphorus (mg P_2O_5/100g)	527	484	447	161	231	176	206	255

Exchangeable cation levels are moderate in all but the C horizon, where calcium and magnesium are high, and in the Ap horizon, where calcium is high. Base saturation percentages are moderate or high and increase with depth; total phosphorus values are moderate or high also.

In general, soils of the series have very variable chemical properties, due in part to the proportion and nature of the partially decomposed andesite fragments present in the profile. Most soils show an increase in base saturation percentages and a decrease in total phosphorus content with depth. One soil, on Pepper Knowe near Largoward, has unusually high levels of calcium, magnesium and total phosphorus in the profile (31.6 me/100g, 20.1 me/100g and 112 mg P_2O_5/100g respectively) and this may indicate that the hill top was the site of an ancient fortification.

Frandy Series

The Frandy Series, a freely drained humus-iron podzol, covers 8 square miles and is found mainly on upper slopes of the Ochil Hills under a blaeberry heath vegetation. It occurs on strongly rolling to hilly relief, normally at altitudes above those of the Sourhope Series.

Profile Description No. 50 Butter Road

Grid Reference	NO062060
Slope	15^0
Aspect	South
Altitude	335 metres
Vegetation	Blaeberry Heath
Drainage Class	Free

Horizon	Depth (cm)	
L & F	0-5	Litter of grass and *Calluna* and partially decomposed material.
HA	5-9	Dark reddish brown (5YR2/2) amorphous humus; moderate medium subangular blocky; friable; moist; high organic matter; many fine wiry grass roots, frequent woody roots; no stones; few bleached sand grains. Clear smooth change into
AEh	9-24	Dark reddish brown (5YR3/2) slightly gritty organic clay loam; weak medium angular blocky to fine crumb; friable; moist; no mottles; high organic matter; many fine wiry and cord roots, few woody roots; many small and medium angular and subangular fragments of lava up to 10 centimetres diameter. Gradual change into
Bh	24-37	Very dusky red (2.5YR2/2) silt loam; moderate medium angular blocky; friable; moist; no mottles; high organic matter; many fine wiry and cord roots; many stones as above. Clear wavy change into
Bs1	37-67	Reddish brown to dark reddish brown (5YR4/3 to 3/3) fine sandy loam; moderate medium angular blocky; friable; moist; no mottles; low organic matter; many fine cord and wiry roots; many angular and subangular lava fragments up to 20 centimetres diameter. Clear smooth change into
Bs2	67-85	Reddish brown to dark reddish brown (as above) gritty stony loamy sand; structure dominated by stones and grit; moist; no mottles; low organic matter; frequent fine roots; many small to medium angular and subangular stones, mainly less than 5 centimetres. Sharp change into
Bx	85-95	Dark brown (7.5YR4/2) gritty loamy sand; moderately indurated; moist; no mottles; few fine roots penetrating down cavities between stones; many small angular and subangular stones, mainly less than 5 centimetres diameter but occasionally up to 15 centimetres. Sharp irregular change into
C	95-118	Dark reddish grey (5YR4/2) gritty loamy sand; moderately indurated; material is interstitial between large angular pieces of lava up to 25 centimetres diameter; few fine roots around stones.

The thickness of the HA horizon is variable and may be slightly greater or less than in the above profile. High organic matter is a feature of the AE horizon. The Bh horizon is frequently found but may not always be present. The stony gritty texture of the Bs2 is a feature but may not always be as clearly defined as in the profile above. Induration varies in degree but is sometimes absent.

Analyses Sample Numbers 288656-63								
Horizon	L & F	HA	Aeh	Bh	Bs1	Bs2	Bx	C
Depth (cm)	0-5	5-9	14-22	27-34	47-55	70-80	85-95	111-118
Sand 50-2000 μm %	ND	ND	ND	ND	67.0	80.0	83.0	80.0
Silt 2-50 μm %	ND	ND	ND	ND	27.0	15.0	12.0	14.0
Clay <2 μm %	ND	ND	ND	ND	6.0	5.0	5.0	6.0
Exchangeable Cations								
Calcium (me/100g)	2.75	0.51	0.15	0.53	0.35	0.48	4.29	6.94
Magnesium (me/100g)	4.18	1.68	0.76	0.20	0.09	0.21	1.84	3.90
Sodium (me/100g)	0.42	0.24	0.17	0.09	0.10	0.08	0.12	0.16
Potassium (me/100g)	4.45	1.21	0.55	0.18	0.06	0.06	0.08	0.16
Hydrogen (me/100g)	82.40	68.70	76.10	73.30	17.50	12.30	12.50	10.80
Base Saturation %	12.5	5.0	2.1	1.4	3.3	6.3	33.6	50.8
pH (in water)	4.8	4.6	4.6	4.8	5.0	5.0	5.2	5.4
pH (in $CaCl_2$)	3.7	3.6	3.9	4.3	4.6	4.4	4.3	4.3
Loss on Ignition %	77.90	50.90	46.90	37.40	12.10	8.10	5.40	5.4
Carbon %	41.60	28.10	23.10	14.80	3.89			
Nitrogen %	2.34	1.85	1.52	1.00	0.32			
Organic Matter %	71.60	48.30	39.80	25.40	6.70			
Total Phosphorus (mg P_2O_5/100g)	146	396	365	354	299	329	280	239

Exchangeable calcium values in the mineral horizons are very low, magnesium values are moderate, except in the Bh and Bs horizons, and potassium values are low to moderate. Base saturation percentages are very low in the upper profile but become moderate in the Bx and C horizons. Total phosphorus levels are high, becoming moderate with depth, and pH values are acid throughout.

These chemical properties are reflected in one other example of the series recorded in Glen Wood, north of Strathmiglo.

Balquhandy Series

Balquhandy Series, a freely drained peaty brown soil, covers an area of 3 square kilometres. Developed on drift derived from andesitic rock, it occurs on hill-tops and

upper slopes of the Ochil Hills, generally at altitudes between 305 and 427 metres. It is frequently contiguous to areas of the Frandy Series.

Profile Description No. 51 Blaeberry Hill

Grid Reference	NO029099
Slope	2^0
Aspect	South-west
Altitude	366 metres
Vegetation	Common White Bent Grassland
Drainage Class	Free

Horizon	Depth (cm)	
L & F	0-3	Litter of moss and grass
H	3-13	Very dark brown (10YR2/2) peaty humus; many fine wiry and cord roots. Sharp smooth change into
Ah	13-18	Very dark brown (7.5YR3/2) organic loam; weal medium angular blocky; friable; moist; no mottles; high organic matter; many cord and frequent wiry roots; many small subangular and subrounded andesite stones; horizon very variable in width. Gradual irregular change into
Bh	18-28	Dark reddish brown (5YR3/2) silt loam; moderate medium to fine angular blocky to crumb; friable; moist; frequent distinct yellowish red (5YR5/6) mottles associated with weathered surfaces of stones; moderate organic matter; many cord roots, especially as mats on stone surfaces and at base of horizon; many small and medium, some large, subangular and angular fragments (up to 10 centimetres diameter) of andesite. Clear smooth change into
BC	28-64	Dark brown (7.5YR4/2) fine sandy loam; moderate medium angular blocky; friable; moist; no mottles; low organic matter; frequent cord roots, usually as root mats on stone surfaces; stones dominate horizon-angular fragments of andesite (up to 15 centimetres) and few slabs (up to 35 centimetres). Sharp irregular change into
R	64+	Andesite bed-rock of large angular slabs *in situ*.

Analyses Sample Numbers 288633-37					
Horizon	H	Ah	Bh	BC	BC
Depth (cm)	3-10	13-18	20-26	36-43	56-64
Sand 50-2000 μm %	ND	ND	ND	65.0	73.0
Silt 2-50 μm %	ND	ND	ND	25.0	19.0
Clay <2 μm %	ND	ND	ND	10.0	8.0
Exchangeable Cations					
Calcium (me/100g)	21.80	5.83	0.45	0.26	0.18
Magnesium (me/100g)	2.10	0.36	0.09	0.04	0.03
Sodium (me/100g)	0.43	0.19	0.10	0.08	0.05
Potassium (me/100g)	1.93	0.48	0.07	0.04	0.04
Hydrogen (me/100g)	56.80	64.90	51.60	26.10	17.30
Base Saturation %	31.6	9.6	1.4	1.6	1.7
pH (in water)	5.2	4.9	4.9	4.9	5.0
pH (in $CaCl_2$)	4.2	3.9	4.1	4.4	4.4
Loss on Ignition %	61.20	32.20	26.30	15.80	10.20
Carbon %	35.30	14.60	15.00	5.61	
Nitrogen %	2.10	1.02	0.88	1.16	
Organic Matter %	60.70	25.20	25.90	9.64	
Total Phosphorus (mg P_2O_5/100g)	389	344	370	343	283

Notable features in this profile are the high values in the H horizon for exchangeable calcium, sodium and potassium, and the high total phosphorus in all horizons except the lower BC. Exchangeable cation levels in the mineral soil are low, except in the Ah horizon, and base saturation percentages are low also. Soil pH values are acid.

One other profile from Stronachy, showed similar chemical properties, but with slightly higher values for magnesium and potassium in the upper horizons.

Cowie Series

The Cowie Series, a peaty podzol with iron pan, covers a total area of 10 square kilometres and occurs on upper slopes of the Ochil Hills at altitudes above 300 metres. Imperfectly or poorly drained in the surface horizons, the profile is freely drained below the iron pan.

Profile Description No. 52 Stronachy A

Grid Reference	NO057083
Slope	15^0
Aspect	East
Altitude	372 metres
Vegetation	Dry Atlantic Heather Moor
Drainage Class	Imperfect above iron pan, free below

Horizon	Depth (cm)	
L & F	0-5	Dark reddish brown (5YR3/3) litter, fresh and decomposing.
H1	5-13	Dark reddish brown (5YR3/2) well-decomposed humus; moderate medium subangular blocky; friable; many fine fibrous roots and frequent woody roots. Clear change into
H2	13-33	Dark reddish brown (5YR3/2) peaty humus; moderate medium subangular blocky; firm; moist; frequent fine fibrous roots. Sharp smooth change into
E(g)	33-48	Dark brown (7.5YR3/2) fine sandy loam; moderate medium subangular blocky; friable; moist; few fine distinct strong brown (7.5YR5/6) mottles and frequent patches of light brownish grey (10YR6/2) gleying; moderate organic matter; frequent fine fibrous roots, becoming few at bottom of horizon; frequent subangular pieces of decomposed igneous rock. Sharp wavy change into
Bf	48-48	Thin well-developed iron pan (2 to 3 millimetres)
Bs	48-66	Dark yellowish brown (10YR4/4) gritty fine sandy loam; weak medium angular blocky; friable; moist; no mottles; low organic matter; few fine roots; many angular and subangular pieces of igneous rock. Gradual change into
C	66-107+	Brown (7.5YR4/4) gritty loamy fine sand; weal medium angular blocky; friable; moist; no mottles; low organic matter throughout, but few fine manganese accumulations around stones; few roots; stones as above but more numerous.

An important feature of the series is the H horizon which is sometimes thinner than in the above profile but is normally more than 5 centimetres thick. Gleying in the E(g) is variable being more prominent in some and less in others. The iron pan forming the Bf horizon may occasionally be discontinuous or less well developed, but, in most cases, it proves a strong barrier to roots which frequently accumulate above it as a mat. The horizons below the iron pan are freely drained. In some soils there is an indurated horizon (Bx) below the Bs.

Analyses Sample Numbers 270633-40							
Horizon	L & F	H1	H2	E(g)	Bs	C	C
Depth (cm)	0-5	8-13	18-25	38-46	53-61	76-86	99-107
Sand 50-2000 μm %	ND	ND	ND	70.0	66.0	78.0	77.0
Silt 2-50 μm %	ND	ND	ND	26.0	34.0	19.0	21.0
Clay <2 μm %	ND	ND	ND	4.0	<1.0	3.0	2.0
Exchangeable Cations							
Calcium (me/100g)	10.60	2.97	0.68	0.16	0.13	0.34	0.23
Magnesium (me/100g)	5.97	2.85	0.77	0.24	0.06	0.13	0.09
Sodium (me/100g)	0.26	0.18	0.19	0.14	<0.03	0.08	<0.03
Potassium (me/100g)	1.03	1.14	0.15	0.05	<0.02	<0.02	<0.02
Hydrogen (me/100g)	120.80	122.40	121.60	46.00	22.80	15.70	18.20
Base Saturation %	12.9	5.5	1.5	1.3	0.9	3.7	1.6
pH (in water)	4.0	4.2	4.2	3.9	4.7	4.4	4.4
pH (in $CaCl_2$)	3.0	3.2	3.2	3.7	4.3	4.3	4.2
Loss on Ignition %	94.90	92.50	95.10	19.70	13.60	9.80	9.90
Carbon %	54.70	53.40	54.20				
Nitrogen %	2.40	2.30	2.20				
Organic Matter %	94.00	91.80	93.20				
Total Phosphorus (mg P_2O_5/100g)	224	304	164	181	221	263	329

Values for exchangeable calcium, magnesium, sodium and potassium are high in the L and F horizons; all values are low to very low below the iron pan. Base saturation is low throughout. Total phosphorus levels increase with depth in the mineral horizons, the opposite to the normal trend.

Examples from other localities confirm the very low levels of exchangeable cations and base saturation in the acid soils of the series.

Bellshill Series

The Bellshill Series is an imperfectly drained brown forest soil and covers a total area of 43 square kilometres. It occurs mainly on lower south-eastern slopes of the Ochil Hills and the plain of Kinross, west of Loch Leven. A few small isolated areas have been mapped on the east Fife uplands, north of Largo Bay.

Profile Description No. 53 Over Binzian

Grid Reference	NO073139
Slope	12-15^0
Aspect	North-east
Altitude	152 metres
Vegetation	Third or Fourth Year Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-33	Dark brown (7.5YR4/2) fine sandy loam; strong medium angular blocky; friable; moist; few fine distinct reddish yellow (7.5YR6/8) mottles mainly associated with weathered stones; low organic matter; many fibrous grass roots; many subangular stones, mainly igneous with some sandstone; worms present. Clear wavy change into
B(g)1	33-48	Reddish brown (5YR5/3) fine sandy loam; moderate medium subangular blocky; firm; moist; frequent fine distinct yellowish red (5YR5/8) mottles and light grey (10YR7/2) coatings on ped faces; low organic matter but occasional fine tongues down root channels; frequent fine grass roots; worms present; frequent stones as above but larger. Gradual change into
B(g)2	48-66	Reddish brown (5YR4/3) fine sandy loam; moderate medium subangular blocky; firm; moist; few fine distinct yellowish red (5YR5/8) mottles; low organic matter; few roots; stones as above. Gradual change into
C(g)	66-120	Reddish brown (5YR5/3) to dark reddish grey (5YR4/2) sandy clay loam to clay loam; strong coarse subangular blocky; plastic; moist; few faint fine yellowish red (5YR5/8) mottles and faint pinkish grey (5YR6/2) coatings on ped faces; low organic matter; no roots; frequent small and medium, many large, subangular stones, mainly of igneous composition.

Analyses Sample Numbers 268242-48							
Horizon	Ap	Ap	B(g)1	B(g)2	C(g)	C(g)	C(g)
Depth (cm)	5-13	20-28	36-43	56-64	76-84	94-102	112-119
Sand 50-2000 μm %	56.0	51.0	56.0	52.0	49.0	52.0	50.0
Silt 2-50 μm %	29.0	32.0	33.0	31.0	34.0	29.0	33.0
Clay <2 μm %	13.0	15.0	11.0	17.0	17.0	19.0	17.0
Exchangeable Cations							
Calcium (me/100g)	10.70	9.61	7.62	9.16	10.10	10.10	9.64
Magnesium (me/100g)	1.79	0.79	0.83	1.63	2.93	3.23	3.64
Sodium (me/100g)	0.10	0.11	0.09	0.10	0.10	0.12	0.10
Potassium (me/100g)	0.19	0.13	0.13	0.19	0.23	0.27	0.27
Hydrogen (me/100g)	4.30	5.10	3.70	2.80	2.60	2.50	2.20
Base Saturation %	74.8	67.5	70.2	79.9	83.7	84.6	86.1
pH (in water)	6.7	6.5	6.6	6.9	7.0	7.1	7.3
pH (in $CaCl_2$)	6.3	5.9	5.8	5.9	6.0	6.1	6.3
Loss on Ignition %	4.90	4.20	2.60	2.10	2.20	2.20	2.20
Carbon %	1.99	1.49	0.49				
Nitrogen %	0.30	0.21	0.07				
Organic Matter %	3.40	2.60	0.80				
Total Phosphorus (mg P_2O_5/100g)	219	190	144	170	195	199	198

Exchangeable calcium values are high and those of magnesium and potassium are moderate throughout the profile. Base saturation is high in all horizons and total phosphorus levels are moderate.

The chemical properties of the series as a whole are wide-ranging, especially that of exchangeable calcium which can be very low, moderate or very high, but the overall trend is for cation levels and base saturation to increase with depth. Exchangeable magnesium and potassium values are low or moderate, but one soil from Rires has a magnesium content of 21.8 me/100g in the lowest sample. This is due to the horizon being made up entirely of decomposed igneous rock which has a high content of both calcium and magnesium. This may explain also the variation in chemical properties of the soils of the series, caused by the different proportions of weathered material in the profiles. Total phosphorus values are low or moderate in the upper horizons and, in a number of cases, increase with depth.

Gellyknowe Series

The Gellyknowe Series is an imperfectly drained brown forest soil developed on coarse-textured deposits, generally more than 0.6 metres thick, which overlie till. The total area mapped is only 5 square kilometres, although narrow tongues of the series, too small to separate on the map, frequently occur throughout the Bellshill Series contiguous to drainage channels or areas of recent alluvium. The largest area borders part of the Killoch Burn to the west of Kinross; smaller areas border the alluvium of the Pow Burn south-west of Loch Leven.

Profile Description No. 54 Parks of Aldie

Grid Reference	NO057983
Slope	3^0
Aspect	South-east
Altitude	150 metres
Vegetation	Permanent Pasture
Drainage Class	Imperfect

Horizon	Depth (cm)	
A	0-25	Very dark greyish brown (10YR3/2) sandy loam; moderate medium angular blocky; friable; dry; no mottles; moderate organic matter; earthworms present; many fine grass roots; frequent small and medium subangular fragments of andesite. Gradual change into
AB	25-41	Dark brown (10YR3/3) sandy loam; moderate medium subangular blocky; friable, breaking to coarse crumb; dry; no mottles; low organic matter, but intermixture of material from upper horizon due to earthworm activity; charcoal present; frequent fine grass roots; frequent large subangular andesite stones. Clear smooth change into
B(g)	41-53	Dark reddish brown (5YR3/3) gritty loamy sand; slightly compact, breaking to weak crumb; moist; many coarse diffuse brownish yellow (10YR6/6) mottles; few fine grass roots; many medium and small subrounded andesite. Sharp change into
Bx(g)	53-76	Dark reddish brown (5YR3/4) loamy coarse sand to sandy loam; moderately indurated; moist; mottles as above; no roots; many small, medium and large subrounded andesite stones, frequently weathered. Clear change into
C(g)1	76-97	Yellowish red (5YR4/6) loamy coarse sand; weak platy to massive; moist; few coarse diffuse mottles as above; many small and medium subrounded andesite stones. Gradual change into
C(g)2	97-142	Dark reddish grey (5YR4/2) sandy loam; massive; plastic; wet; many fine diffuse yellowish brown (10YR5/8) mottles and patches of grey which tend to dominate horizon colour; many partially weathered andesite stones.

Analyses Sample Numbers 268258-64							
Horizon	A	AB	B(g)	Bx(g)	C(g)1	C(g)2	C(g)2
Depth (cm)	7-15	28-36	43-51	58-68	84-92	104-112	134-142
Sand 50-2000 μm %	64.0	66.0	77.0	74.0	82.0	72.0	76.0
Silt 2-50 μm %	31.0	31.0	21.0	24.0	16.0	24.0	20.0
Clay <2 μm %	5.0	3.0	2.0	2.0	2.0	4.0	4.0
Exchangeable Cations							
Calcium (me/100g)	13.50	3.87	3.06	4.60	5.03	13.40	10.50
Magnesium (me/100g)	1.36	0.85	0.62	0.88	0.87	3.88	3.05
Sodium (me/100g)	0.23	0.18	0.15	0.20	0.18	0.32	0.24
Potassium (me/100g)	0.67	0.13	0.13	0.09	0.08	0.20	0.17
Hydrogen (me/100g)	10.80	11.90	8.50	7.10	5.60	4.10	3.10
Base Saturation %	59.4	29.6	32.0	44.9	52.5	81.3	81.9
pH (in water)	5.9	5.5	5.7	5.8	6.0	6.6	6.7
pH (in $CaCl_2$)	5.6	4.3	5.0	5.2	5.3	5.7	5.7
Loss on Ignition %	11.10	7.80	3.20	3.10	2.10	2.90	2.00
Carbon %	6.09	3.13	0.63				
Nitrogen %	0.57	0.31	0.08				
Organic Matter %	10.50	5.40	1.10				
Total Phosphorus (mg P_2O_5/100g)	415	351	144	131	106	122	106

Although the profile description shows sandy clay loam texture in the C(g)2 horizon, clay content, according to the analysis, is very low. This can be explained by the presence of many partially weathered stones which provide coarse textured material. There is, however, a marked increase in exchangeable calcium and magnesium and in percentage base saturation in the C(g)2 horizon. Total phosphorus is high in both the A and AB horizons.

Atton Series

Developed on till of clay loam texture, the Atton Series covers a total area of 6 square kilometres, and occurs mainly in the Ochil Hills, on lower slopes and in valleys. Several small areas are also found in the Crook of Devon Hills and in the plain of Kinross. The series is poorly drained and is classed as a noncalcareous gley.

Profile Description No. 55 Wester Deuglie

Grid Reference	NO106119
Slope	3^0
Aspect	South
Altitude	198 metres
Vegetation	Permanent Pasture
Drainage Class	Poor

Horizon	Depth (cm)	
Ah	0-28	Dark reddish brown (5YR3/2) sandy loam; moderate medium subangular blocky; firm; very moist; no mottles; high organic matter; few stones; many fibrous grass roots, frequent *Juncus* roots. Sharp wavy change into
Bg	28-66	Reddish brown to reddish grey (5YR5/3 to 5/2) sandy loam; moderate coarse angular blocky; plastic; wet; frequent medium distinct reddish yellow (7.5YR6/6) mottles and pale grey (7.5YR6/2) coatings on ped faces; low organic matter; frequent fibrous grass roots; frequent stones, mainly angular and subangular pieces of andesite; water running in at 93 centimetres. Gradual change into
Cg	66-122+	Reddish brown (5YR5/3) clay loam; massive; firm; moist; few faint mottles as above; low organic matter; few roots, one or two penetrating to 82 centimetres; frequent stones as above.

Analyses Sample Numbers 278279-84						
Horizon	Ah	Bg	Bg	Cg	Cg	Cg
Depth (cm)	7-15	30-38	50-58	71-79	94-102	114-122
Sand 50-2000 μm %	70.0	57.0	59.0	49.0	45.0	50.0
Silt 2-50 μm %	25.0	34.0	26.0	29.0	30.0	29.0
Clay <2 μm %	5.0	9.0	15.0	22.0	25.0	21.0
Exchangeable Cations						
Calcium (me/100g)	10.40	7.65	7.63	10.20	10.30	9.18
Magnesium (me/100g)	1.38	1.42	2.30	4.25	3.89	3.05
Sodium (me/100g)	0.23	0.20	0.18	0.22	0.21	0.18
Potassium (me/100g)	0.24	0.08	0.10	0.19	0.24	0.24
Hydrogen (me/100g)	15.60	6.50	3.20	11.70	2.70	2.50
Base Saturation %	43.9	58.9	76.1	56.0	84.4	83.5
pH (in water)	5.2	6.3	7.0	7.2	7.5	7.4
pH (in $CaCl_2$)	5.2	5.6	6.1	6.3	6.6	6.6
Loss on Ignition %	21.70	3.80	2.60	2.70	2.50	2.30
Carbon %	9.00	0.62	0.15			
Nitrogen %	0.78	0.07	0.06			
Organic Matter %	15.50	1.10	0.30			
Total Phosphorus (mg P_2O_5/100g)	222	163	97	113	133	167

Soils of this series generally have higher clay contents than in the above profile. In south-east Scotland where the Sourhope Association was first mapped, Muir, (1956), percentage clay in subsoil horizons of the Atton Series is frequently greater than 30. In this profile exchangeable calcium is high in all horizons with the exception of the Bg, magnesium values are moderate and potassium values are moderate, except in the upper Bg sample.

Other examples of the series exhibit similar properties. Exchangeable cation levels, base saturation percentages and pH values increase with depth and total phosphorus contents are moderate. One soil at Greenhill has a magnesium content of 12.2 me-100g in the C horizon, a reflection of the composition of the parent material.

Edgerston Series

With the exception of two small areas in the Crook of Devon Hills, the Edgerston Series is confined to the Ochil Hills, the main area being located in the valley of the Warroch East burn. Covering a total area of 1 square kilometre, the series is poorly drained and is classed as a peaty gley.

Profile Description No. 56 Naemoor A

Grid Reference	NO020011
Slope	0^0
Aspect	Nil
Altitude	metres
Vegetation	Soft Rush Pasture
Drainage Class	Poor

Horizon	Depth (cm)	
O	0-23	Dark reddish brown (5YR3/2) peaty loam; weak medium subangular blocky; friable in upper half of horizon, firm in lower; moist, becoming wet with depth; no mottles; high organic matter; many fibrous grass roots; no stones; no worms. Sharp smooth change into
Bg	23-58	Greyish brown (2.5Y5/2) sandy silt loam; massive; plastic; wet; many medium prominent strong brown (7.5YR5/8) mottles with grey gleying dominating horizon colour; low organic matter; frequent grass roots and few large dead tree roots; many subangular and subrounded stones, 5-7 centimetres diameter, mainly sandstone. and igneous rocks. Gradual change into
Cg1	58-92	Dark reddish grey (10R4/1) loamy sand; massive; sticky; wet; few fine faint yellowish brown (10YR5/8) mottles; low organic matter; few dead fibrous roots; stones as above, but larger and more numerous with some up to 15 centimetres diameter. Clear change into
Cg2	92-119+	Reddish grey (5YR5/2) to grey (5YR5/1) sandy loam; massive; sticky; wet; water-table at 102 centimetres; many stones as above.

A prominent feature of this series is the peaty surface horizon which is always more than 5 centimetres thick and frequently around 12 to 15 centimetres. The Bg horizon is strongly gleyed and has prominent strong brown mottles; the Cg horizon shows only faint yellowish brown mottles.

Analyses Sample Numbers 259157-61					
Horizon	O	Bg	Bg	Cg1	Cg2
Depth (cm)	8-18	33-41	48-56	69-79	109-119
Sand 50-2000 μm %	ND	48.0	59.0	81.0	79.0
Silt 2-50 μm %	ND	41.0	26.0	14.0	13.0
Clay <2 μm %	ND	11.0	13.0	5.0	8.0
Exchangeable Cations					
Calcium (me/100g)	19.76	8.51	9.18	4.52	3.76
Magnesium (me/100g)	1.13	0.71	0.96	0.67	0.75
Sodium (me/100g)	0.14	0.11	0.11	0.09	0.07
Potassium (me/100g)	0.34	0.05	0.04	0.03	0.07
Hydrogen (me/100g)	28.70	7.70	8.40	7.90	8.10
Base Saturation %	42.7	54.9	55.1	40.2	36.5
pH (in water)	4.7	5.7	5.6	5.0	4.9
pH (in $CaCl_2$)	4.5	4.9	4.9	4.4	4.3
Loss on Ignition %	49.20	4.80	5.60	3.60	3.20
Carbon %	29.30	1.47			
Nitrogen %	2.27	0.10			
Organic Matter %	50.50	2.53			
Total Phosphorus (mg P_2O_5/100g)	396	83	137	125	164

Exchangeable calcium is high in the O and Bg horizons. Potassium is low in all horizons except the O horizon. Total phosphorus is high in the O and low in the upper Bg.

Lawsuit Series

This series covers a total area of less than 1 square kilometre and is usually found contiguous to areas of the Edgerston Series or to areas of blanket peat. Classed as a peaty gley, it is very poorly drained and has a profile very similar to Edgerston Series.

Skythorn Complex

Covering a total area of 1 square kilometre, the Skythorn Complex occurs on the Ochil Hills over an altitude range from 300 to 500 metres. It has been mapped on the middle slopes of Lendrick hill and at or near the summits of Carmodle, Mellock Hill, Innerdouny Hill, Coalcraigy and Skymore Hill. The main components of the complex are blanket peat, skeletal soil on intermediate lavas and a peaty ranker in which a peaty layer of variable thickness overlies rock.

Skeletal Soils

Skeletal soils cover a total area of 1 square kilometre with the largest single area on Mellock Hill and several much smaller pockets on hill summits throughout the Ochil Range.

Alluvial Soils

Alluvial soils cover a total area of 51 square kilometres and are found throughout most of the landform regions in the district, being more widespread in the lowland areas and occurring only occasionally in certain valleys of the uplands. On the Perth/Arbroath/Dundee soil map, all alluvial soils were mapped as undifferentiated alluvium; in Kinross and East Fife, 14 series have been separated on the basis of texture and drainage, the texture being judged on the surface horizons – those of significance as the rooting zone. Where it was not possible to distinguish individual series, alluvial soils were separated as undifferentiated alluvium.

Soils

Profiles from several of the more important series are described.

Heavyside Series

The Heavyside Series is a poorly drained soil of clayey texture, covering a total area of 4 square kilometres. Two of the larger spreads are found bordering the Pow Burn in the Crook of Devon Hills subregion, south-west of Loch Leven and bordering the Lyne Burn on the west Fife drift plain to the west of Dunfermline.

Profile Description No. 57 Keavil B

Grid Reference	NT071857
Slope	0^0
Aspect	Nil
Altitude	37 metres
Vegetation	Third Year Grass
Drainage Class	Poor

Horizon	Depth (cm)	
Ap	0-41	Dark grey (10YR4/1) clay loam; moderate coarse angular blocky to prismatic; moist; slightly plastic when wet; few fine faint strong brown (7.5YR5/6) mottles; low organic matter; many fibrous grass roots; few stones. Gradual change into
Cg1	41-79	Greyish brown to grey (10YR5/2 to 5/1) clay loam; massive; firm; moist; many medium prominent strong brown (7.5YR5/8) mottles; low organic matter; fibrous grass roots frequent, becoming rare towards bottom of horizon; few stones, but many fragments of soft black shale. Gradual change into
Cg2	79-117	Greyish brown (2.5YR5/2) clay loam; massive; firm; moist; many diffuse prominent strong brown mottles; low organic matter; many small pieces of soft shale and coal. Sharp smooth change into
Cg3	117-122	Grey (10YR5/1) clay loam; massive; firm; moist; many medium prominent strong brown (7.5YR5/8) mottles; low organic matter; no stones' Sharp change into

2Cg	122+	Grey (10YR5/1) sandy loam with occasional patches of finer texture; massive; moist; frequent mottling as above; low organic matter; no stones.

Analyses Sample Numbers 248035-42								
Horizon	Ap	Ap	Cg1	Cg1	Cg2	Cg2	Cg3	2Cg
Depth (cm)	8-15	25-33	46-53	66-74	81-89	102-109	117-122	142-150
Sand 50-2000 μm %	23.3	26.3	41.9	33.8	26.5	39.8	40.9	67.9
Silt 2-50 μm %	41.7	43.2	32.8	41.4	48.3	39.5	35.4	18.9
Clay <2 μm %	28.9	30.5	25.3	24.8	25.2	20.7	23.7	13.2
Exchangeable Cations								
Calcium (me/100g)	20.75	19.24	15.44	14.70	18.53	13.35	10.80	5.78
Magnesium (me/100g)	2.29	1.36	1.06	1.19	2.01	2.54	3.08	2.10
Sodium (me/100g)	0.13	0.11	0.07	0.07	0.09	0.09	0.07	0.07
Potassium (me/100g)	0.18	0.10	0.08	0.08	0.10	0.08	0.05	0.04
Hydrogen (me/100g)	5.50	3.98	3.00	2.77	3.77	3.64	3.35	3.67
Base Saturation %	81.0	84.1	84.8	85.3	84.6	81.7	80.8	68.5
pH (in water)	6.4	6.6	6.7	6.8	6.9	6.8	6.7	6.1
pH (in $CaCl_2$)	6.0	6.1	6.3	6.3	6.4	6.3	6.1	5.3
Loss on Ignition %	12.20	9.60	7.30	7.00	8.70	7.60	6.60	4.2
Carbon %	4.08	2.45	1.31					
Nitrogen %	0.30	0.14	0.08					
Organic Matter %	7.03	4.22	2.25					
Total Phosphorus (mg P_2O_5/100g)	285	188	189	214	292	267	290	141

Notable features of the analyses are the high values for exchangeable calcium (except in the 2Cg horizon) and for percentage base saturation. The pH(water) values are also high, except in the upper Ap and the 2Cg.

A further example from Coal Farm, St Monans, has high levels of exchangeable magnesium in all but one of the lower horizons and the total phosphorus values are lower than those of the Keavil soil.

Bindal Series

The Bindal Series is poorly drained and has a surface horizon of silty loam texture. With a total area of 1 square kilometre, the series is confined mainly to the plain of Kinross and to Strath Eden, with a few smaller areas in other subregions.

Kaime Series

Developed on sandy deposits, the Kaime Series is imperfectly drained and covers a total area of 3 square kilometres. It has been mapped mainly on the east Fife drift plain with a few smaller areas in the east Fife uplands.
Profile Description No. 58 Lochend

Grid Reference	NO184002
Slope	0^0
Aspect	Nil
Altitude	107 metres
Vegetation	Young Grass
Drainage Class	Imperfect

Horizon	Depth (cm)	
Ap	0-25	Dark greyish brown (10YR4/2) loamy sand; weak medium angular blocky; friable; moist; few faint fine yellowish red (5YR5/4) mottles; low organic matter; many fine grass and frequent plant roots; worms present; no stones. Sharp smooth change into
Cg	25-33	Greyish brown (10YR5/2) clay loam; strong medium prismatic; firm; moist; many medium and coarse prominent strong brown (7.5YR5/6) mottles associated mainly with old root channels; gleying provides main colour of horizon; low organic matter generally, but moderate in old root channels; frequent fine roots; no stones. Sharp smooth change into
2C(g)	33-46	Pale brown (10YR6/3) medium to fine sand; weak medium subangular blocky, breaking readily to fine crumb and single grain; moist; few medium to fine faint strong brown (7.5YR5/8) mottles; faint indications of gleying; organic matter occurring down old root channels and in bands throughout horizon; few fine roots. Sharp smooth change into
3C(g)	46-89	Greyish brown (10YR5/2) fine sandy loam to loamy fine sand; weak coarse angular blocky; non-sticky; wet; few faint fine yellowish red (5YR4/6) mottles associated with old root channels, becoming frequent, coarse and distinct below 61 centimetres; low organic matter; few live and many dead fine roots, few dead cord roots; water-table at 76 centimetres.

Analyses Sample Numbers 288627-32						
Horizon	Ap	Ap	Cg	2C(g)	3C(g)	3C(g)
Depth (cm)	2.5-10	15-23	25-33	35-43	56-64	81-89
Sand 50-2000 μm %	81.0	80.0	21.0	89.0	75.0	89.0
Silt 2-50 μm %	10.0	11.0	47.0	7.0	14.0	8.0
Clay <2 μm %	9.0	9.0	28.0	4.0	11.0	3.0
Exchangeable Cations						
Calcium (me/100g)	5.82	6.89	17.30	3.66	7.52	5.34
Magnesium (me/100g)	0.42	0.59	1.65	0.25	0.59	0.38
Sodium (me/100g)	0.05	0.05	0.12	<0.03	0.05	0.04
Potassium (me/100g)	0.04	0.06	0.05	<0.02	<0.02	<0.02
Hydrogen (me/100g)	5.60	5.00	7.50	<0.1	8.60	0.20
Base Saturation %	53.1	60.3	71.8	100.0	48.7	76.6
pH (in water)	5.6	5.9	5.9	6.0	5.6	5.8
pH (in $CaCl_2$)	5.0	5.3	5.2	5.2	4.9	5.0
Loss on Ignition %	3.30	3.50	8.00	1.50	5.00	2.70
Carbon %	1.53	1.24	2.30	0.58		
Nitrogen %	0.18	0.14	0.28	0.07		
Organic Matter %	2.63	2.13	3.94	1.01		
Total Phosphorus (mg P_2O_5/100g)	133	135	149	41	103	63

Profiles of the series generally show high percentage sand throughout except in one or more subsoil horizons (in this case the Cg) where textures are finer and drainage is impeded. In the above profile, the percentages of silt and clay rise appreciably in the Cg and the amount of exchangeable calcium is also high.

Culnacoyle Series
Culnacoyle, the freely drained series on sand, is much less extensive (0.33 square kilometres) than the Kaime Series and has been mapped in two small areas – on the plain of Kinross and on the Lomond Hills.

Profile Description No. 59 Nochnary

Grid Reference	NO270097
Slope	0^0
Aspect	Nil
Altitude	43 metres
Vegetation	First Year Grass
Drainage Class	Free

Horizon	Depth (cm)	
Ap	0-30	Dark brown (7.5YR4/2) sandy loam; moderate medium angular blocky; friable; moist; no mottles; low organic matter; many fine fibrous grass roots; large earthworms; few stones, mainly small angular sandstone and igneous rocks; large worms. Sharp wavy change into
C(g)	30-48	Very pale brown (10YR7/4) loamy sand; very weak medium subangular blocky, breaking readily to fine crumb and single grain; moist; frequent medium diffuse reddish yellow (7.5YR6/6) mottles; many localised accumulations of Ap horizon material and organic matter; few roots; few stones, but many fine fragments of charcoal. Sharp wavy change with layer of darker fine sand, 5 millimetres thick at base of horizon.
2C(g)	48-74	Light brown (7.5YR6/4) sand; single grain; moist; frequent diffuse distinct reddish yellow (7.5YR6/6) mottles; frequent bands of organic matter; few tongues of Ap horizon material; few roots; no stones. Sharp smooth change into
3C(g)	74-89+	Light brown (7.5YR6/4) fine sand; weak coarse subangular blocky, breaking readily to fine crumb and single grain; moist; frequent fine distinct strong brown (7.5YR5/8) mottles; frequent fine bands of organic matter; no roots; no stones.

Analyses Sample Numbers 288621-26						
Horizon	Ap	Ap	C(g)	2C(g)	2C(g)	3C(g)
Depth (cm)	5-13	20-28	36-43	51-58	63-71	81-89
Sand 50-2000 μm %	73.0	77.0	89.0	93.0	87.0	90.0
Silt 2-50 μm %	17.0	14.0	8.0	4.0	8.0	7.0
Clay <2 μm %	10.0	9.0	3.0	3.0	5.0	3.0
Exchangeable Cations						
Calcium (me/100g)	8.42	7.96	4.88	4.11	5.81	4.21
Magnesium (me/100g)	2.22	1.58	0.52	0.25	0.39	0.27
Sodium (me/100g)	0.04	0.07	0.03	<0.03	0.03	0.03
Potassium (me/100g)	0.19	0.25	0.06	0.06	0.08	0.04
Hydrogen (me/100g)	0.70	4.70	4.70	<0.1	<0.1	0.40
Base Saturation %	94.0	67.7	53.9	100.0	100.0	91.9
pH (in water)	6.4	6.1	6.5	6.4	6.5	6.4
pH (in $CaCl_2$)	5.8	5.4	5.7	5.7	5.7	4.8
Loss on Ignition %	4.00	3.40	1.60	1.00	2.10	1.70
Carbon %	1.52	1.26	0.89	0.55		
Nitrogen %	0.17	0.15	0.11	0.07		
Organic Matter %	2.62	2.16	1.52	0.95		
Total Phosphorus (mg P_2O_5/100g)	207	180	135	138	136	76

High percentage sand and low percentage clay are the most notable features in this series. The above profile has high base saturation in all horizons except the C(g).

Peaty AlluvialSoils-Undifferentiated

This map unit covers an area of 6 square kilometres. It is a complex of peat and alluvium in which peaty layers are interspersed with alluvial bands throughout the profile. The soils normally have peaty or highly organic surface layers and are generally associated with former lake sites where basin peat has developed, or with stream channels in areas of peat.

The following profiles were taken in the Lomond Hills subregion.

Profile Description No. 60 Easter Glasslie A

Grid Reference	NO241052
Slope	2^0
Aspect	South-east
Altitude	277 metres
Vegetation	Permanent Pasture
Drainage Class	Poor

Horizon	Depth (cm)	
Ah	0-23	Very dark greyish brown (10YR3/2) organic fine sandy loam; moderate coarse angular blocky; slightly plastic; wet; frequent distinct grey and rusty mottles; high organic matter; many grass roots; worms present; few stones. Sharp smooth change into
Cg1	23-38	Greyish brown to dark greyish brown (10YR5/2 to 4/2) silty clay; massive; plastic; wet; frequent prominent grey (10YR6/1) and yellowish brown (10YR5/6) mottles partly obscuring horizon ground colour; many grass and *Juncus* roots; no stones. Sharp change into
Cg2	38-69	Very dark grey (10YR3/1) sandy clay loam; massive; wet; many fine distinct strong brown (7.5YR5/6) mottles; low organic matter; roots as above. Sharp change into
bO	69-117	Very dark brown (10YR2/2) fibrous peat; wet; roots frequent becoming rare towards bottom. sharp change into
2Cg	117-155	Olive-grey (5Y4/2) clay loam to clay; massive; plastic; wet; no mottles; many dead roots.

Analyses Sample Numbers 242187-92						
Horizon	Ah	Cg1	Cg2	bO	bO	2Cg
Depth (cm)	7-15	25-33	53-61	73-81	96-104	147-155
Sand 50-2000 μm %	17.8	4.8	52.5	ND	47.6	33.5
Silt 2-50 μm %	43.6	47.6	29.7	ND	31.6	25.3
Clay <2 μm %	27.5	47.6	17.8	ND	3.6	31.2
Exchangeable Cations						
Calcium (me/100g)	12.20	14.03	10.64	45.40	21.30	12.38
Magnesium (me/100g)	4.67	7.32	6.65	13.62	8.85	6.86
Sodium (me/100g)	0.29	0.20	0.06	0.37	0.17	0.13
Potassium (me/100g)	1.11	0.15	0.05	0.15	0.03	0.10
Hydrogen (me/100g)	20.12	10.23	3.38	28.30	10.30	4.25
Base Saturation %	47.5	68.0	83.9	67.8	74.8	82.2
pH (in water)	4.59	4.98	5.29	4.91	4.90	5.01
pH (in $CaCl_2$)	4.41	4.60	5.10	4.80	4.85	4.82
Loss on Ignition %	22.23	8.51	6.07	69.05	23.03	5.24
Carbon %	8.75	3.28	1.85			
Nitrogen %	0.84	0.38	0.17			
Organic Matter %	15.05	5.65	3.18			
Total Phosphorus (mg P_2O_5/100g)	387	189	190	398	183	97

Fine textures are found except in the buried peat horizon (bO). Very high values for exchangeable calcium and also for magnesium, except in the Ah horizon, are notable features in this profile. As might be expected, the highest values are found in the upper layer of the buried peat horizon which shows, in addition, high total phosphorus.

In contrast, the following profile from the east Fife drift plain is coarse-textured throughout, except in the peaty horizon.

Profile Description No. 61 Broomfield B

Grid Reference	NO310033
Slope	4^0
Aspect	North
Altitude	99 metres
Vegetation	Permanent Grass
Drainage Class	Poor

Horizon	Depth (cm)	
Ah	0-25	Dark brown (7.5YR3/2) fine sandy loam to loam; moderate medium angular blocky; fraible; moist; no mottles; high organic matter; many fibrous grass roots; worms present; few stones. Clear wavy change into
bO	25-33	Dark reddish brown (5YR3/2 to 2/2) amorphous peat; slightly plastic; moist; worms present; frequent roots; no stones. Sharp wavy change into
Cg1	33-69	Light brownish grey to greyish brown (10YR6/2 to 10YR5/2) sand; weak medium subangular blocky; friable; moist; frequent medium distinct brownish yellow (10YR6/8) mottles; low organic matter; roots frequent becoming few towards bottom of horizon; few stones. Gradual change into
Cg2	69-142	Greyish brown (10YR5/2) loamy sand to sand; single grain; wet; many medium and fine prominent strong brown (7.5YR5/8) mottles and frequent iron pipes around old root channels; low organic matter; frequent stones, often partly weathered.

Analyses Sample Numbers 268180-87								
Horizon	Ah	Ah	bO	Cg1	Cg1	Cg2	Cg2	Cg2
Depth (cm)	5-13	15-23	25-30	36-43	56-63	74-81	112-119	135-142
Sand 50-2000 μm %	69.0	67.0	ND	89.0	83.0	83.0	91.0	74.0
Silt 2-50 μm %	24.0	28.0	ND	8.0	14.0	14.0	6.0	21.0
Clay <2 μm %	7.0	5.0	ND	3.0	3.0	3.0	3.0	5.0
Exchangeable Cations								
Calcium (me/100g)	0.63	0.63	0.89	0.45	0.56	0.45	0.42	0.53
Magnesium (me/100g)	1.80	0.60	1.73	0.27	0.43	0.39	0.26	0.81
Sodium (me/100g)	0.06	0.06	0.12	<0.03	0.65	<0.03	<0.03	0.04
Potassium (me/100g)	0.06	0.04	0.09	0.06	<0.02	<0.02	<0.02	<0.02
Hydrogen (me/100g)	19.10	22.00	35.30	7.00	7.40	3.60	3.50	1.00
Base Saturation %	11.9	5.6	7.4	10.3	17.8	20.0	16.7	58.3
pH (in water)	5.1	4.6	4.2	4.7	4.6	5.0	5.6	5.9
pH (in $CaCl_2$)	4.6	4.1	3.9	4.1	4.0	4.4	5.0	5.2
Loss on Ignition %	20.20	21.60	67.70	1.50	1.90	1.40	1.00	2.1
Carbon %	10.90	11.60	38.20					
Nitrogen %	1.10	1.03	2.78					
Organic Matter %	18.80	19.90	65.70					
Total Phosphorus (mg P_2O_5/100g)	311	315	246	69	94	65	32	141

Percentage sand is high throughout, except in the bO horizon. Exchangeable calcium is low throughout and magnesium is mostly moderate. Percentage base saturation is low, except in the lowest Cg2 sample.

The wide contrast between the analyses for the Easter Glasslie and the Broomfield profiles serves to emphasise the wide range which can exist within the undifferentiated peaty alluvial soils.

Links

Links soils cover a total area of only 2 square kilometres. On the Perth/Arbroath/ Dundee sheet to the north, these soils are much more extensive and 42 square kilometres have been mapped along the coasts of Angus and north-east Fife.

The parent material is windblown sand which overlies parts of the lowest coastal raised beach, at 7.5 metres. The sand from which the Links soils are derived is largely quartzose. In this area, fragments of shell are frequently present in the sand although not in sufficient quantity to warrant classifying the soils as Fraserburgh Association. Links soils have been mapped between Kingsbarns and Fife Ness, around Elie and bordering Largo Bay on the outskirts of Leven. The drainage is free, although areas of imperfect drainage, too small to map, do occur.

Profile Description No. 62 Ardross B

Grid Reference	NO504004
Slope	2^0
Aspect	South-west
Altitude	7.5 metres
Vegetation	Permanent Pasture
Drainage Class	Free

Horizon	Depth (cm)	
A1	0-5	Dark brown (7.5YR3/2) turf layer dominated by grass roots; Single grain; frequent bleached sand grains. Clear smooth change into
A2	5-13	Very dark greyish brown (10YR3/2) loamy sand to sand; weak coarse angular blocky; very friable; low organic matter; many grass roots and frequent dead plant roots; occasional snail shells; many bleached sand grains; no stones. Clear irregular change into
C	13-2155+	Brown (7.5YR4/4) sand: very friable, breaking readily to single grain; slightly moist; frequent dark brown (7.5YR3/2) patches of organic-rich sand along root channels and at 58 centimetres (remains of old surface horizon); grass roots frequent in top 3- centimetres, becoming few below, and dead cord roots frequent throughout; few marine snail shells (complete); no stones.

Analyses Sample Numbers 254028-35								
Horizon	A1	A2	C	C	C	C	C	C
Depth (cm)	0-5	5-13	20-28	46-53	71-79	96-104	122-130	147-155
Sand 50-2000 μm %	76.0	88.2	97.0	93.7	93.3	94.3	94.7	93.9
Silt 2-50 μm %	9.2	4.0	1.8	2.0	2.6	1.6	1.6	2.6
Clay <2 μm %	2.3	2.3	1.2	1.2	1.2	1.2	1.2	1.2
Exchangeable Cations								
Calcium (me/100g)	47.40	43.40	24.20	24.10	24.92	24.90	24.22	25.61
Magnesium (me/100g)	2.43	1.36	0.74	0.70	0.74	0.70	0.66	0.70
Sodium (me/100g)	0.47	0.29	0.18	0.21	0.21	0.21	0.18	0.20
Potassium (me/100g)	0.91	0.15	0.04	0.03	-	-	-	0.03
Hydrogen (me/100g)	-	-	-	-	-	-	-	-
Base Saturation %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
pH (in water)	7.1	7.5	7.9	8.2	8.3	8.3	8.5	8.6
pH (in $CaCl_2$)	6.8	7.1	7.4	7.5	7.4	7.7	7.7	7.8
Loss on Ignition %	16.60	11.00	1.40	6.10	5.80	5.70	4.90	4.6
Carbon %	3.04	5.68	2.04					
Nitrogen %	0.38	0.61	0.08					
Organic Matter %	5.23	4.78	3.52					
Total Phosphorus (mg P_2O_5/100g)	173	103	95	112	79	90	72	74

- = less than lower limit of determination

Exchangeable calcium is very high throughout, as are pH values both in water and in $CaCl_2$. This can be explained partly by the presence of shells, although the amount of these or of other finer shelly material was not sufficiently evident in the field to warrant classifying the profile within the Fraserburgh Association. The profile is also fully base-saturated. Values for exchangeable sodium are high in both A horizons. This is due to accumulation of sodium chloride from sea-spray.

Dunes

Along the eastern margin of Largo Bay, windblown sand has accumulated as dunes. These are moundy and unstable, but partial fixation of the sand is achieved by the limited vegetation they support, such as clumps of marram grass (*Amophila arenaria*) and lyme-grass (*Elymus arenarius*).

Peat

Peat, comprising both basin and valley peat, and blanket peat cover in total 23 square kilometres of which 1 square kilometre is basin and valley peat (50-100 centimetres deep), 17 square kilometres is >100 centimetres deep, <1 square kilometres of blanket or hill peat (50-100 and >100 centimetres deep). Undifferentiated peat accounts for 4 square kilometres. The peat consists of accumulations, on the mineral surface, of organic matter more than 50 centimetres thick. Similar accumulations, but less than 50 centimetres thickness, also occur and form the surface horizons of soils classified in the peaty podzol or peaty gley major soil subgroup. The mode of formation, the composition and the properties of peat are described in the next chapter.

Mixed Bottom Land

Mixed bottom land is the cartographic unit used to represent soil complexes occurring along narrow stream channels. The unit comprises narrow tracts of alluvial soils, too small to be shown individually, and soils, often skeletal, on the banks which sometimes border water courses. The soils are very varied in profile morphology, age and parent material. This unit has been mapped over 9 square kilometres of the area.

5. Peat

Peat is an accumulation of partly decomposed plant remains formed where excess moisture has inhibited the normal processes of decomposition by soil microorganisms, primarily aerobic bacteria and fungi. Prolonged water-logging or flooding of the soil through inadequate natural drainage, high rainfall or low evapotranspiration can greatly restrict the supply of oxygen to such organisms and so reduce their activity. Low soil temperature, high acidity and nutrient deficiency likewise inhibit the breakdown of plant residues. The factors that influence peat development are therefore functions of climate, topography, geology and soil. In Britain, conditions conducive to peat formation are found in lake basins and poorly drained valleys and, most frequently, on poor acid soils in areas of high rainfall. Criteria for differentiating peat from related organo-mineral soils are somewhat arbitrary, however, in this account, a surface layer greater than 0.3m thick containing more than 60 per cent organic matter is classified as peat which in the area under review covers less than 2 per cent of the land.
Most of the deposits examined showed signs that cutting for domestic fuel was once common practice. However, by the end of the eighteenth century, coal was firmly established as the main fuel throughout the area (Sinclair, 1791-1799) and by the mid-nineteenth century the extraction of fuel peat had virtually ceased (New Statistical Account, 1845). More recently a number of mires have been drained and afforested or cultivated and reseeded for agricultural use. Extraction is currently confined to one deposit where granulated peat is produced for the horticultural market.

Most of the mires occur in the south and west of the area. Three main types were distinguished, namely confined (basin) mire, unconfined (blanket) mire and partly-confined (intermediate and valley) mire (Hulme, 1980).
Confined mires occur within topographic basins contained on all sides by mineral ground. Many of the small mires in the area are of this type. Unconfined mires blanket the mineral terrain and are checked only by major breaks in slope. They are represented here by a few small, poorly-developed areas of hill peat. Partly-confined mires, being intermediate in character, have features in common with both preceding types and generally occur within valleys or on terraces. They are well represented in this area, especially around Loch Glow.

The following account is based on field investigations of a number of mires within the area. Survey procedures varied depending on the size and complexity of each deposit. Normally, representative sampling sites were selected following a reconnaissance survey but on the largest mire (Moss Morran) these were located at the intersection of grid lines where both surface levels and peat depths were recorded. At each sampling site, complete cores were extracted in 0.5m sections and their gross botanical composition and the degree of decomposition (von Post, 1922; Table 6) determined in the field. Sealed sub-samples of each section were taken for the laboratory determination of ash and moisture contents. Selected cores were also sampled for chemical analysis and a more detailed stratigraphic examination of fossil plant components. The nature of the vegetation, land-use characteristics and general morphological and hydrological features of each mire were also recorded.

Table 6. Modified version of the von Post Scale for assessing the degree of decomposition of peat.

Degree of Decomposition	Nature of water expressed on squeezing	Proportion of peat extruded between fingers	Nature of plant residues	Description
H1	Clear, colourless	None	Unaltered, fibrous, elastic	Undecomposed
H2	Almost clear, yellow-brown	None	Almost unaltered	Almost undecomposed
H3	Slightly turbid, brown	None	Most remains easily identifiable	Very slightly decomposed
H4	Turbid, brown	None	Most remains identifiable	Slightly decomposed
H5	Strongly turbid, contains a little peat in suspension	Very little	Bulk of remains difficult to identify	Moderately well decomposed
H6	Muddy, much peat in suspension	One third	Bulk of remains unidentifiable	Well decomposed
H7	Strongly muddy	One half	Relatively few remains identifiable	Strongly decomposed
H8	Thick mud, little free water	Two thirds	Only resistant roots, fibres and bark etc. identifiable	Very strongly decomposed
H9	No free water	Almost all	Practically no identifiable remains	Almost completely decomposed
H10	No free water	All	Completely amorphous	Completely decomposed

Botanical nomenclature follows Clapham, Tutin and Warburg (1962), Paton (1965) and Smith (1978). Common names of vascular plants are given in brackets where the species is first mentioned.

Moss Morran (NT 174900)

This deposit, situated just south of Cowdenbeath, covers approximately 200 hectares and is the largest mire in Fife. Results of a grid survey of the main part of the mire show that the peat overlies a series of small basins and intervening ridges. The maximum depth recorded was 8.0 metres. For many years this deposit has been utilised as a source of horticultural peat. Machine-cut sods are air-dried in the field to a moisture content of around 50 to 55 per cent. After harvesting, the sods are shredded to provide granulated peat moss which is sold in bags, bale or in bulk.

As a result of peat cutting operations most of the surface vegetation has been removed from the site and only a few species typical of oligotrophic (nutrient poor) mire remain including *Calluna vulgaris* (heather), *Erica tetralix* (cross-leaved heath) and *Eriophorum vaginatum* (cotton grass). Due to the effect of drainage, *Betula pubescens* (birch) now thrives on the drier banks and cutover areas but *Sphagnum* spp. (bog mosses) are relatively sparse and are mainly restricted to the wetter parts of the mire.

Six cores, ranging in depth from 2.5 to 7.0 metres, were examined and sampled for analysis. In general, these showed the presence of two main horizons namely, a lower relatively thin layer of highly decomposed peat with some wood (*Betula*) remains and an upper zone composed of slightly to moderately well decomposed *Sphagnum* peat. Sedge remains were recorded near the bottom of the core taken from the deep basin near the western edge of the deposit. Variations, with depth, in the degree of decomposition, moisture content and ash content for the same core illustrates the very high field moisture content and low ash content of the relatively undecomposed *Sphagnum* peat.

Din Moss (NT 070935)

This deep partly-confined raised mire, located approximately 10km north-west of Moss Morran, covers an area of 60 hectares of which about one third has been afforested. Of the 17 depths recorded, 11 exceeded 9.5 metres, the maximum being 12.0 metres. At the time of survey, the vegetation of the unplanted area was dominated by a young grass sward in which the main species were *Lolium perenne* (rye grass), *Holcus lanatus* (Yorkshire fog) and *Deschampsia flexuosa* (wavy hair grass). Several species of the bog flora which survived the reseeding treatments were also recorded, including *Calluna*, *Empetrum nigrum* (crowberry), *Vaccinium oxycoccus* (cranberry), *Eriophorum vaginatum*, *Narthecium ossifragum* (bog asphodel) and *Sphagnum papillosum*.

Two complete cores from the deepest part of the deposit were sampled in O.5m sections for the determination of botanical composition and degree of decomposition and for subsequent laboratory analysis. To a depth of around 6.0 metres, the peat consists of relatively undecomposed *Sphagnum* remains together with small amounts of *Calluna*, *Eriophorum* fibre and monocot roots. Six other cores, taken to a

depth of 6.5 metres, confirmed that this thick horizon of *Sphagnum* peat occurs over most of the bog area. Below 6.5 metres the peat exhibits a slightly higher degree of decomposition and is composed mainly of sedge and *Phragmites* (reed) remains and *Betula* twigs.

Moisture contents are high throughout, ranging from 90 to 96 per cent. Except in the surface and basal layers, ash contents seldom exceed 2.0 per cent. For all samples, the degree of decomposition in the upper 6.5 metres of this deposit ranges from H2 to H8 although the proportion of values above H5 increases only slightly with depth.

Results of the chemical analysis of samples from an 11.0 metre core taken before the mire was re-seeded are shown in Table 7. Ash residues from samples of oven dry milled peat ignited at 500^0 – 550^0 C were dissolved in dilute hydrochloric acid. From this solution total calcium, sodium, potassium and magnesium were determined spectrochemically. Total phosphorus and total nitrogen were determined in an acid digest by colorimetric methods and pH values were measured in a 1:2 suspension in water using a glass electrode.

The pH is low throughout the profile, the only trend being a slight tendency for values to increase with depth. Values for calcium are somewhat higher in the upper 2 metres than in the subsequent 4 metres but increase markedly thereafter towards the base of the deposit. Values for sodium, potassium and phosphorus are very low and show neither marked differences nor consistent trends. Apart from a slight tendency to increase with depth in the top 2 metres, values for magnesium show no consistent variation. Results for nitrogen range from 0.66 to 1.82 per cent, the lowest values tending to occur in the middle of the profile. The predominance of high quality *Sphagnum* peat in this deposit underlines its potential as a source of raw material for horticulture and related purposes although the viability of a fully mechanised production system may be limited by the size of the area available.

Table 7. Results of Analysis of a Peat Core from Din Moss

Depth (m)	Ash (%)	pH	% total oven-dry weight					
			Ca	Na	K	Mg	P	N
0 - 0.5	2.80	3.25	0.168	0.016	0.010	0.094	0.025	1.17
0.5 - 1.0	2.60	3.65	0.198	0.014	0.005	0.114	0.024	1.82
1.0 - 1.5	1.50	3.90	0.162	0.019	0.003	0.171	0.017	1.18
1.5 - 2.0	1.28	3.88	0.111	0.025	0.005	0.203	0.014	1.12
2.0 - 2.5	1.38	3.98	0.078	0.032	0.012	0.185	0.014	1.20
2.5 - 3.0	0.98	4.00	0.060	0.034	0.012	0.152	0.012	1.13
3.0 - 3.5	0.80	4.10	0.042	0.034	0.016	0.131	0.011	1.05
3.5 - 4.0	0.93	4.10	0.060	0.038	0.019	0.152	0.012	0.87
4.0 - 4.5	0.90	4.05	0.069	0.040	0.210	0.165	0.012	0.74
4.5 - 5.0	0.90	4.10	0.078	0.038	0.019	0.177	0.011	0.66
5.0 - 5.5	0.90	4.20	0.096	0.035	0.019	0.165	0.012	0.70
5.5 - 6.0	0.98	4.08	0.129	0.028	0.019	0.146	0.014	0.80
6.0 - 6.5	1.20	4.03	0.224	0.026	0.018	0.137	0.016	0.88
6.5 - 7.0	1.35	4.03	0.318	0.023	0.016	0.128	0.017	0.95
7.0 - 7.5	1.35	4.13	0.337	0.019	0.012	0.090	0.026	1.27
7.5 - 8.0	2.30	4.18	0.504	0.016	0.012	0.085	0.025	1.59
8.0 - 8.5	2.88	4.28	0.578	0.015	0.013	0.087	0.022	1.48
8.5 - 9.0	2.48	4.30	0.870	0.011	0.013	0.105	0.020	1.54
9.0 - 9.5	3.93	4.33	1.008	0.012	0.013	0.108	0.022	1.60
9.5 - 10.0	4.15	4.30	0.990	0.010	0.012	0.105	0.021	1.53
10.0 - 10.5	5.30	4.18	1.003	0.009	0.016	0.116	0.020	1.49
10.5 - 11.0	11.28	3.15	0.770	0.008	0.016	0.118	0.027	1.70

Roscobie Muir (NT 095947)

This deposit is located within a partly-confined complex of interlinked valley and basin mires around Loch Glow. Part of the complex encroaches onto the more gentle slopes of the surrounding hills and is similar to blanket mire. Where the peat is shallow or flushed, the vegetation is dominated by *Molinia caerulea* (purple moor-grass or flying bent) and *Deschampsia flexuosa*. On the deeper peat *Calluna*, *Erica tetralix*, *Vaccinium oxycoccus*, *Eriophorum angustifolium*, *Sphagnum* spp. and other plants characteristic of oliogotrophic mire predominate. However, the presence of *Molinia*, *Deschampsia flexuosa* and, more locally, *Viola palustris* (marsh violet) and *Epilobium palustre* (marsh willow-herb) in these areas suggests parts of the complex are still in a stage of transition to ombrotrophic mire. Over large areas of the complex, this natural developmental sequence has been halted due to ploughing and afforestation of the deeper peat with *Picea sitchensis* (Sitka spruce). On the shallow peat, *Betula* and *Alnus* (alder) have been planted for their amenity value.

Four cores ranging in depth from 0.5 to 4.5 metres were extracted from Roscobie Muir for field examination and laboratory analysis. The results are shown in Table 8. In contrast to the previous two sites, the high values recorded for the degree of decomposition and ash content indicate that this deposit has been affected by minerotrophic water during most or all of its development. This is confirmed by the vegetational history of the mire determined by the microscopical examination of plant remains obtained by wet-sieving consecutive samples of the peat core (Table 8). The basal horizon (350-440cm) represents a period of inwash from adjacent slopes and was succeeded (220-350cm) by a tall-herb fen and birch-scrub community. This site was next dominated by a sedge fen (130-220cm) followed by a transitional community (30-130cm) in which *Sphagnum imbricatum* was abundant. Finally, a late transitional community (0-30cm), similar to the present vegetation developed.

TABLE 8. Roscobie Muir, detailed peat stratigraphy core.

0— 30cm	Peat composed largely of sedge root and rhizomes and *Sphagnum* fragments; some *Juncus* (rush) and *Carex* (sedge) seeds, ericoid twigs and *Homalothecium nitens*.
30—130	Sedge/*Sphagnum imbricatum* peat with abundant ericoid twigs; occasional remains of *H. nitens*, *Hylocomium splendens*, *Aulacomnium palustre* and Polytrichum sect. Juniperinifolia and seeds of *Menyanthes* and *Carex*.
130-220	Sedge peat; with *Sphagnum* spp.., Phragmites, Thuidium tamarisicinum and seeds of *Carex* and Viola (violet).
220-350	Sedge/wood (*Betula*) peat with abundant *Phragmites*; occasional *Carex* and Lychnis flos-cuculi (ragged-robin) seeds, fern sporangia and *Sphagnum* spp.
350-440	Mineral (silt and sand) with a little *Betula* wood and occasional *S. imbricatum* leaves.

Bankhead Moss (NO 445102)

Bankhead Moss lies 8km south-west of St. Andrews and is one of the few remaining mires of east Fife. This classic raised basin mire with a typical dome-shaped centre covers an area of 15 hectares and is surrounded by arable land. Although the raised part of the mire has been reduced in area by cutting, the centre of the dome remains relatively intact except for lint holes dug and formerly used for flax retting until the mid—nineteenth century (Livingstone, 1952). In 1966 the mire became a nature reserve administered by the Scottish Wild Life Trust.

The vegetation can be divided into several distinct categories (Burgess, 1974; Caseldine and Gordon, 1978). *Betula pubescens* woodland has colonised the relatively dry margins of the central dome and encircles a small area of raised bog vegetation in which a few pine saplings and small birch trees have become established. Here, the characteristic plants are *Calluna*, *Eriophorium vaginatum* and *Sphagnum capillifolium*. Other typical raised bog species include *Narthecium ossifragum* and *Drosera rotundifolia* (sundew). The lint holes were originally about 5 metres deep but have become overgrown and infilled and now appear as shallow depressions in the mire surface carpeted mainly with *Sphagnum recurvum*. The eastern part of the mire contains three eutrophic (nutrient rich) vegetation types dominated by *Filipendula ulmaria* (meadow sweet), *Filipendula* and *Salix atrocinerea* (willow) and *Deschampsia flexuosa*, respectively. Areas of pasture occur along the margins of the deposit and a plantation of *Pinus sylvestris* (Scots pine) has been established near the southern boundary.

Two complete cores, 7.3 and 7.0 metres respectively, were taken from the dome centre for stratigraphic examination and laboratory analysis. The results are presented in Table 9. Values for the degree of decomposition range from H2 to H8 and show considerable variation with depth. Ash contents are generally low although values gradually increase with depth in the lower, minerotrophic horizons. Botanical analysis of one of the cores (Table 9) revealed a basal horizon (690-700cm) composed predominantly of the remains of aquatic plants. This is succeeded by peat derived from semi-aquatic vegetation (600-690cm) which in turn gave way to a fen community with birch scrub. Finally (0-470cm) raised bog vegetation became established once peat accumulation had raised the level of the mire surface above the influence of ground water.

TABLE 9. Bankhead Moss, detailed peat stratigraphy of a core from the mire centre.

0-470cm	*Sphagnum*/*Eriophorum vaginatum* peat with abundant *Calluna* and *Erica tetralix* (*S. imbricatum* present between 30 and 130cm
470—660	Woody (*Betula*) peat with moderate amounts of sedge, *E. vaginatum* and *Sphagnum*; occasional remains of *Calluna*, *Phragmites*, *Eguisetum* (horsetail), *Homalothecium nitens*, *Hylocomium splendens*, *Aulacomnium palustre*, *Polytrichum* spp. and *Calliergon cordifolium*; seeds of, eg., *Carex*, *Lychnis flos-cuculi*, *Ranunculus flammula*, *Menyanthes* and *Potentilla palustris*.

660-690 Woody, *Sphagnum* sect Cuspidata and Calliergonella *cuspidata* peat with *Phragmites* and sedge remains and seeds of *Carex*, *Filipendula ulmaria*, *Empetrum nigrum*, *L. flos-culi* and *Potentilla palustris*.

690-700 Sand with abundant *Potamogeton* and sedge remains and seeds of Carex, Menyanthes, *Lycopus europaeus*, *Nymphae alba* and Potamogeton *natans*.

Lendrick Hill (N) 018035)

As previously mentioned, a few small areas of hill peat occur towards the western part of the map area. The largest deposit, on Lendrick Hill, comprises some 40 hectares of shallow peat, mostly less than 1 metre deep. The surface vegetation is dominated by *Nardus-Agrostis-Molinia* (mat-grass, bent, purple moor-grass) grassland. Plants more usually associated with hill peat vegetation occur locally and include Eriophorum *vaginatum*, *E. angustifolium*, *Vaccinium myrtillus* (bilberry), *Sphagnum capillifolium*, *Polytrichum commune* and *Juncus squarrosus* (heath rush). The peat is generally moderately to highly decomposed (H4-H8).

Most of the other mires within the map area are located in small basins or valleys and show signs of having been cut over. Some like Portmoak Moss (NO 180010) and Waterbuts (NT 147990) have been afforested and others, including Star Moss (NO 310040) and Treasses (NO 420090), now support birch scrub or rough grazing. Part of Portmoak Moss has been improved by reseeding to pasture.

6. Discussion of Analytical Data

Profiles representative of the various soil series mapped were described and sampled during the survey of the district and standard physical and chemical analyses were carried out on each sample. Samples from selected profiles representing each association were submitted also for trace element analyses. Appendix 2 gives standard analytical data for profiles (nos 63 to 81) used for trace element analyses but not described in the Soils Chapter. Some profiles were subjected to more detailed investigation by mineralogical, differential thermal, x-ray and spectrochemical methods and the results of these examinations are discussed later in this chapter. Appendix 3 gives percentages of minerals in the clay fraction.

Standard Analytical Data

Analyses have already been given in the text for the representative profiles described. It is intended in this chapter to examine and compare briefly the more important results for different major soil subgroups although, because of limited number of profiles available, it is not possible always to show meaningful trends. In making assessments for different soil subgroups, the analyses for profiles described in the text have been augmented by those for other representative profiles from the district.

Loss on Ignition

Loss on ignition increases with depth in the soil profile for all major soil subgroups. The values are highest in the organic horizons of peaty podzols (No.43 Blairadam Forest, No.52 Stronachy A, No.5 Munduff Hill, No.56 Naemoor A), the peaty brown soil (No.51 Blaeberry Hill) and the podzols (No.50 Butter Road and No.35 Easter Balgedie). All these profiles have loss on ignition in excess of 50% except Naemoor A where the value is 49.2. The peaty podzol (No.23 Heath Cottage) and the peaty gley (No.19 Lethans Muir) which follow the general trend and show a decrease in loss on ignition with depth in the upper layers, do however, show an increase in the Cg horizon. A similar increase has also been noted in the Cg horizon of some noncalcareous gleys (No.18 Kirkton A and No.6 Drumain B) and in the Cg horizons of some brown forest soils with gleying (No.17 Kirkton B and No4. Easter Glassie B).

Soil Separates

Soil separates - sand, silt and clay - determined by mechanical analysis and expressed according to the scheme of the U.S. Department of Agriculture (Soil Survey Staff, 1951) are used to obtain an estimate of soil texture with the triangular texture diagram shown in Appendix 2. This provides a means of checking the validity of soil texture assessments made in the field. The field assessment may differ from that obtained using laboratory analysis due to the presence of organic matter. There is also a tendency to overestimate the clay content of some mineral soils, particularly in the presence of coarse sand.

Table 10 shows the soil series arranged on the basis of the texture determined for the B horizon. The area of each class is shown to the nearest square kilometre. Moderately fine-textured soils together cover the largest area, 333 square

Table 10. Textural Classes of Soil Series B Horizons								
Association	Coarse-Textured Soils (sands, loamy sands)		Moderately Coarse-Textured Soils (sandy loams)		Medium-Textured Soils (loams, silt loams, silts)	Moderately Fine-Textured Soils (clay loams, sandy clay loams, silty clay loams)		Fine-Textured Soils (sandy clays, silty clays, clays)
	Coarse textured	Coarse to moderately coarse textured	Moderately coarse textured	Moderately coarse to medium textured		Medium to moderately fine	Moderately fine	
Balrownie						Balrownie, Lour (1)		
Forfar			Vinny (1)					
Kippen	Redbrae, Urquhart, Kilgour (29)	Fourmerk, Butterwell (14)				Kippen (10)		
Mountboy		Garvock (2)	Mountboy (9)					
Sourhope		Balquhandy, Frandy, Gellyknowe (16)	Cowie (10)	Sourhope, Bellshill, Atton, Edgerston (179)				
Darleith	Drumain (44)		Baidland (3)		Darleith, Dunlop (72)			
Hindsward				Hindsward (4)	Reidston (39)			
Rowanhill			Macmerry, Butterdean (111)		Winton (28)	Caprington (225)	Rowanhill (9)	
Giffnock	Forestmill (3)		Kennet (<1) Bath Moor (<1)	Devilla (<1)			Aberdona (65) Giffnock (9)	Scaurs (6)
Gleneagles	Gleneagles (2)							
Eckford	Hexpath, Giffordtown, Woodend (64)	Kilwhiss (18)						
Darvel	Darvel, Duncrahill (27)							
Carpow		Carpow (3)						
Panbride	Panbride (2)							
Dreghorn		Dreghorn, Quivox (32)						
Fraserburgh	Fraserburgh (4)							
Links	Links (2)							
Alluvium	Culnacoyle, Kaime, Rockfield, Innes (8)					Bindal, Shandwick (7)	Heavyside, Myreside (7)	
Areas to nearest sq km	**185**	**85**	**135**	**184**	**139**	**243**	**90**	**6**

kilometres, while moderately coarse-textured soils occupy 319 square kilometres. Coarse-textured soils extend to 270 square kilometres, while medium-textured soils occupy 139 square kilometres. The remaining group of fine-textured soils occupies only 6 square kilometres. Although approximate, these estimates of textural classes and the areas they cover, indicate the variations in soil texture throughout the district. The advantages and disadvantages of coarse texture and of fine texture have already been noted in the chapter on Soils.

Exchangeable Cations

The amount of exchangeable bases in the soil gives some indication of the presence of nutrients readily available to plants. Determinations were made of exchangeable calcium, magnesium, sodium and potassium. For the purposes of comparison, values measured in milligram equivalents (meq) per l00g of soil are graded low, moderate and high:-

	Ca	Mg	Na	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 are found in soils of the Fraserburgh Series which are classed in this instance within the Brown Forest Soils subgroup. In profile No. 16, (Muircambus) the value rises from 39 me/100g in the A1 to 73 in the lowest C horizon. It should be noted, however, that these values are probably higher than the actual figure for exchangeable calcium due to the presence of calcium carbonate from the shell deposits in the parent material. Very high values are also found in the Links soils where laboratory examination shows evidence of the presence of calcareous material not evident in the field examination.

In cultivated soils, values for exchangeable calcium are often high, as a result of agricultural liming. Lowest values are found in mineral horizons of uncultivated soils. Many brown forest soils have moderate to high values. In some cases, as in the Sourhope profile, (No. 49, Gelvan A) and in the Drumain profile, (No. 3 Drumain A) the amount of exchangeable calcium is lower in the B than in the A horizon and increases again in the C. Two other profiles from East Fife, not described in the text, are worthy of note. A Darleith profile from Largo Law (N0. 63) has exchangeable calcium which ranges from 32 me/100g in the A to 39 me/100g in the C and a Sourhope profile from Pepper Knowe has values from 20.5 me/100g in the A to 31.6me/100g in the C.

The calcium values in brown forest soils with gleying tend to be moderate or high. The Dunlop profile (No. 4 Easter Glasslie), has fairly high values throughout, ranging from 18 to 25 and in the Bellshill profile, (No. 53 Over Binzian), exchangeable calcium values exceed 8 except in the B(g)1. Podzols and peaty podzols normally have low or zero values except in organic surface horizons where the figures are sometimes high, (No. 35 Easter Balgedie), No. 22, South Lethans and No. 5 Munduff Hill). Because gley soils are not extensive, only a few profiles are available. Among the noncalcareous gleys, No. 55 (Wester Deuglie and No. 47 (Gelvan) have

moderate and high values while No. 46 (Brewsterwells) has high values except in the A horizon. Some peaty gleys e.g. No. 19 (Lethans Muir) have low or nil values except in .organic surface horizons, while others such as No. 56 (Naemoor A) have high values in the surface and B horizons and moderate in the C horizon.

Exchangeable Magnesium

Brown forest soils, both freely and imperfectly drained, have moderate values although one or two profiles such as No. 41 (Denhead)5) and No. 3 (Drumain) show high values in the C horizon and No. 4 (Easter Glasslie B) has high values throughout. Mineral gleys have as a rule moderate values in upper horizons and frequently high values in the C (No. 18 Kirkton A and No. 27 Clockmadron). Peaty gleys, No. 19 (Lethans Muir) and No. 28 (Hardiston Hill A) show moderate or high exchangeable magnesium in organic surface layers and moderate or low values in mineral horizons; No. 56 (Naemoor) has moderate values throughout. Humus-iron podzols and peaty podzols, (No. 22, South Lethans, No. 29 Hardiston Hill B, and No. 35 Easter Balgedie) have moderate values in L, F and H horizons and low or zero values in succeeding horizons down the profile. Lowest values for exchangeable magnesium are found in coarse-textured uncultivated soils, for example No. 13 (Edensmuir) an iron podzol of the Kilwhiss Series where the highest value is 1.5 me/100g in the L and F and in all other horizons the value is low or zero.

Exchangeable Sodium

High values are found in the Fraserburgh Series and in Links soils although in both cases this is due to sea spray. High values also occur in the organic surface horizons of podzols, peaty podzols, peaty brown soils and most peaty gleys. While most noncalcareous gleys show moderate or low exchangeable sodium, profile No. 47 (Gelvan C has high values in the C horizon.

Exchangeable Potassium

The majority of the soils show moderate to low values of exchangeable potassium, and, while in many profiles there is a decrease from the surface downwards, this is not always the case. High values are found in organic surface horizons of uncultivated soils, (No. 22 South Lethans, No. 28, Hardiston Hill A, No. 32 Springfield Wood), in the surface horizon of a peat-aluvium soil under permanent grass, (No. 61, Easter Glasslie A) and in the surface horizon of a cultivated soil, (No. 8, Dalginch). The highest value occurs in the L and F horizons of a Frandy Series profile, (No. 50, Butter Road).

Percentage Base Saturation and pH

pH values were measured both in water and in CaC12 solution. The lower values obtained by the latter method are considered to be closer to the effective pH of the solution in immediate contact with the soil particles. Values referred to in this section are those measured in water. For the purposes of comparison pH and percentage base saturation are graded as under:

	pH	Base Saturation
Low	<5.0	<20%
Moderate	5.0—6.5	20—60%
High	>6.5	>60%

Soils of the Fraserburgh Series are completely base saturated and have high pH values. As would be expected the highly calcareous Links soils in this area and the raised beach soils of the Dreghorn and Panbride Associations also have high pH and percentage saturation. Brown forest soils with gleying (No. 53, Over Binzian), No. 4 Easter Glasslie B, and No. 33 Freuchie) have high percentage saturation and moderate to high pH values while No. 39, (Gibliston), is completely base saturated and has pH values ranging from 6.9 to 8. Low percentage saturation and low pH values are found in podzols and peaty podzols except in organic surface horizons where values are sometimes moderate.

Gley soils show somewhat variable results. Among mineral gleys, No. 55, (Wester Deuglie) shows an increase down the profile from moderate to high both in percentage saturation and in pH while in No. 47 (Gelvan C), values tend to decrease from the A down to the Cg horizon. Among the peaty gleys, No. 19 (Lethans Muir) has low values throughout while No. 28 (Hardiston Hill A), has low saturation in upper horizons increasing to moderate in the Cg with low pH values throughout.

Total Phosphorus

Expressed as milligrams of $P_2 0_5$ per l00g of soil and graded:

Low	<100
Moderate	100—300
High	>300

Total phosphorus is generally highest in surface horizons, particularly the organic horizons of uncultivated soils, a notable exception being found in a profile of the Dunlop Series, (No. 4, Easter Glasslie), where total phosphorus is 400 mg/100g in the A horizon and 978 in the C horizon. Several other profiles (No. 52, Stronachy A and No. 40, Gelvan B) also have highest values in the C horizon. In the majority of the soils examined, lowest values are reached in B horizons and thereafter there is an increase in the C, although in some profiles (No. 16, Muircambus, No. 1, Tarvit Mill, and No. 24, Dunning Mill), values decrease downwards from the A to the C.

Mineralogy

Clays

The clay fraction is defined as that fraction with particles of effective diameter less than 2 μm. It is composed mainly of crystalline layer-silicate minerals but can also contain poorly-ordered iron oxide phases, amorphous aluminosilica gels and minor amounts of other crystalline silicates such as quartz and feldspar.

A range of profiles typical of the most common series of the area have been examined, mainly by X-ray diffraction techniques, and the results for a selection of these profiles are given in Appendix 3 The most striking feature of these results is that kaolinite is present in every horizon of every profile. This is to be expected in the profiles derived from Carboniferous and Upper Old Red Sandstone sediments but kaolinite is present and even abundant in some horizons of profiles derived from volcanic rocks (Darleith and Sourhope Association soils).

The clays from the Darleith Association are fairly typical of that association in that they are dominated by trioctahedral phases. An interstratified chlorite-vermiculite is the main mineral in the mineral horizons of profiles Nos. 2 and 5, whereas in profile No. 65, smectite dominates. The H horizon of profile No. 5 is S dominated by amorphous material. The other phases present in these soils are kaolinite with lesser amounts of quartz and feldspar, and sometimes illite.

The Sourhope Association, the other association in this area derived from lavas, has some similarities in clay mineralogy to the Darleith in that trioctahedral minerals also occur (smectite and interstratified chloritevermiculite) but the clay assemblages are more kaolinitic throughout, and both profiles (Nos. 56 and 76) contain interstratified phases with illite as a component.

The clay mineralogy of the association with the largest areal extent, the Rowanhill, is dominated by kaolinite with illite usually in subordinate amounts, reflecting the strong influence of inheritance from the Carboniferous Sandstones. Of the four profiles examined, well-crystallized kaolinite is dominant in all horizons of two, is co-dominant in one, and is more variable in one (No. 42). In profile No. 73, interstratified minerals with illite as a component are codominant in the lower two horizons, but decrease markedly in the uppermost horizon. Trioctahedral phases are sometimes present e.g. chlorite and vermiculite in profile No. 42. Quartz in subordinate amounts is ubiquitous and small amounts of feldspar are commonly present. The Giffnock Association is similar to the Rowanhill in its derivation from Carboniferous sandstones, shales and limestones and its clay mineralogy is also very similar (profile Nos. 17 and 19) being very much dominated by wellcrystallised kaolinite. Profile No. 17 is a little unusual in containing subordinate amounts of smectite in the C horizon.

The one profile (No. 72) examined which is developed from Upper Old Red Sandstone sandstones has a clay mineralogy fairly typical of the Kippen Association-abundant kaolinite, illite and interstratified illite-smectite in the C horizon with subordinate amounts of chlorite, quartz and feldspar. The illite-smectite decreases in the Bg horizon and is absent from the Ap. Illite develops vermiculite and smectite

interlayers towards the profile surface and these become interlayered with aluminium in the Ap (expressed as chloritevermiculite).

The soils developed on sands and gravels, be they fluvioglacial derived from Upper Old Red Sandstone rocks (Eckford Association - profile No. 68), or Carboniferous rocks (Darvel Association - profile No. 65), or raised beach deposits derived from Carboniferous sediments (Dreghorn Association-profile No. 66) all have a clay mineralogy dominated by kaolinite with subordinate amounts of illite and quartz. Chlorite is present at the base of the Dreghorn brown forest soil and interstratified chlorite-vermiculite is abundant in the upper two horizons, whereas in the peaty podzol of the Eckford Association, a small amount of chlorite is present in the top and bottom horizons, with chlorite-vermiculite in the horizon between. The integradient mineral at the base of the Darvel Association soil becomes interlayered with aluminium towards the surface of the profile.

Trace Elements

The trace element contents of samples from fifty representative profiles of thirteen different associations and other soil units have been determined spectrochemically using the methods described by Mitchell (1964). For the purposes of this report, the total trace element level in a profile has been assessed from the results of analysis of the mineral B and C horizons. Trace element levels in the B and C horizons, unlike those of overlying A horizons, are largely unaffected by additions of lime, fertilisers, manures, pesticides, herbicides, waste materials or trace element treatments. The overlying Ap horizons are modified by cultivation, while in uncultivated profiles, the A or E horizons are modified by the accumulation of organic matter and/or leaching. The B and C horizons of both cultivated and uncultivated profiles within any one association are, moreover, comparable and can be assessed together. The mean trace element content of the B and C horizons of a profile or group of profiles of the same association is therefore referred to as the total content unless otherwise stated.

The contents of trace elements extractable by 0.43 M acetic acid (cobalt, nickel, lead and vanadium), 0.05 M EDTA (copper, manganese and zinc) or neutral M ammonium acetate (molybdenum), especially from the upper horizons (0-25 cm), provide an indication of the plant-available portion and can be used for assessing the likelihood of problems arising from deficiencies or excesses.

Differences in the geological nature of the soil parent materials are reflected in the soil trace element contents as illustrated for example, by the differences in the contents of the Darleith, Sourhope, Eckford and Fraserburgh Association soils. The influence of weathering and water-sorting on the glacial deposits to produce parent materials of a largely sandy, silty or clayey texture has also had an influence on trace element distribution. Soils of a predominantly sandy nature such as those of the Eckford, Darvel, Fraserburgh Associations and Links soil unit are inherently low in total cobalt and likely to give rise to cobalt deficiency problems in ruminant animals. Although only a small number of profiles have been examined in some cases, it can be concluded that freely drained soils of some other associations including the Giffnock, Hindsward, Kippen, Mountboy and Sourhope and alluvial soils, in addition to those mentioned above, may also be cobalt deficient. Problems of copper deficiency affecting cereal growth might be anticipated on some soils of the Eckford, Fraserburgh, Kippen, and Panbride Associations. The possibility of molybdenum-induced copper deficiency in animals cannot be excluded on the soils of some other associations such as those of Dreghorn, Eckford and Sourhope.

Darleith Association

Six profiles of the association were examined. These represent the freely drained Darleith (Nos. 2 and 64) and Drumain (No. 3) Series; the imperfectly drained Dunlop (No. 64) Series, the freely drained peaty podzol Baidland (No. 5) Series and the poorly drained Amlaird (No. 6) Series.

Total cobalt contents in the twenty nine B and C horizon samples range from 8 to 60, (mean 31 mg/kg), which indicate that the soils should contain adequate levels for grazing stock. Changes in total cobalt contents with increase in depth in

each profile were generally small. In profile No. 5 (Baidland Series, however, levels in the upper horizons are lower either because of the diluting effect of the accumulation of organic matter or because of some removal of cobalt by leaching attributable to the very low soil pH values of around 4.0. Extractable cobalt in the upper horizons of the six profiles is moderately high and ranges from 0.54 to 3.3, (mean 2.2 mg/kg). The vegetation cover on all the profiles was pasture herbage, and both total and extractable cobalt levels in the soils suggest that cobalt deficiency affecting grazing stock is unlikely.

Total nickel contents range from 20 to 150, (mean 84 mg/kg). The subsoils of Nos. 2, 63 and 64 derived from basaltic lavas and basic intrusive rocks contain rather higher nickel contents (100-150 mg/kg) than those of Nos. 3, 5 and 6 derived from quartz-dolerite and agglomerates (20-80 mg/kg) reflecting the differences in the geological nature of their parent materials. Extractable nickel contents range widely from 0.05 to 4.1 mg/kg and show a tendency to decrease with increase in depth. These levels are not high enough to suggest that nickel toxicity might affect vegetation.

Total copper contents range from 20 to 100, (mean 34 mg/kg), and show little variation with increase in depth except in profile No. 5. In this peaty podzol with iron pan, the levels of total copper in the peaty upper parts of the solum are lower, at 2 to 20 mg/kg, than in the underlying mineral solum at 20 to 100 mg/kg, due possibly to dilution by organic matter and losses by leaching. Extractable copper levels in the upper horizons of all six profiles range from 1.9 to 4.1, (mean 2.6 mg/kg), at which level deficiency of copper affecting the growth of cereal crops would not be expected.

Total manganese contents range from 600 to greater than 10,000, (mean 2340 mg/kg), which is well above the typical total manganese level in soils of around 800 mg/kg. The subsoils of profiles 2, 63 and 64, derived from basic igneous rocks, have total manganese levels of 2000 to 10,000 mg/kg, higher than those of profiles No. 3, 5 and 6 derived from quartz-dolerite which contains 600 to 1500 mg/kg. Extractable manganese levels are generally greatest in the upper horizons of the profiles and range from 8 to 260, (mean 102 mg/kg). Some mobilisation of manganese due to gleying is evident in the gleyed B and C horizons of profiles No. 64 and 6 of the Dunlop and Amlaird Series where levels are increased and range from 110 to 180 mg/kg. The relatively high total and extractable manganese levels in the soils of this association suggest that problems of manganese deficiency in crops are unlikely.

Total molybdenum contents in the soils range from less than 1 to 8, (mean 2.2 mg/kg), with occasional values at 3 mg/kg and above. Extractable molybdenum levels in the A horizons of the six profiles range from 0.01 to 0.02 mg/kg and at these levels, problems of molybdenum excess affecting animals appear unlikely. Soil pH values in the upper horizons are generally low, however, ranging from 3.9 to 5.8, and liming could considerably increase the uptake of molybdenum by pasture herbage.

Total vanadium, chromium and titanium levels fall within the ranges 100 to 400, 30 to 400 and 10,000 to 15,000 mg/kg with means of 238, 137 and 12,400 mg/kg respectively. These mean values are well above the corresponding mean values for

soils of the other twelve associations examined and reflect the basic igneous nature of the soil parent material.

Total lead contents are generally very low; ranging from less than 3 to 20 mg/kg, although most values are around 3 mg/kg. Contents in the surface horizons of the six profiles are rather greater at 15 to 60, (mean 29 mg/kg), the highest level of 60 mg/kg being in the peaty H horizon of the uncultivated profile No. 5 of the Baidland Series. Extractable lead levels are also greatest in the uppermost horizons of each profile and range from 0.12 to 0.7, mean 0.31 mg/kg.

Extractable zinc levels are of the order of 0.5 mg/kg or less in the B and C horizons of the profiles and around 2 mg/kg in the surface horizons except for the peaty H horizon of profile No. 5 which contains 52 mg/kg.

Darvel Association

The single profile of the association examined belonged to the freely drained Darvel (No. 65) Series. This was sandy rather than gravelly but containing 10 to 18 per cent clay in the upper 36 centimetres.

Total cobalt contents in the eight B and C horizons examined range from 3 to 15 (mean 7.1 mg/kg). Although the total content of the A horizon is only 10 mg/kg, the extractable level of 1.2 mg/kg suggests that cobalt deficiency affecting animals is unlikely to arise in this particular soil but could not be ruled out on freely drained soils of coarser texture in this association.

Total nickel contents range from 20 to 40 (mean 30 mg/kg), while extractable levels tend to decrease with increase in depth from 1.2 to 0.07 mg/kg.

Total copper contents range from 15 to 40 (mean 23 mg/kg) and extractable levels decrease from 5.0 in the A horizon to 0.24 mg/kg in the lowest C horizon. Copper deficiency affecting crops would not be anticipated.

Total manganese contents range from 1000 to 6000, mean 2000 mg/kg. The B horizon at 10 to l8.centimetres has a very high total manganese content of 6000 mg/kg, greatly in excess of a typical soil level of about 800 mg/kg. This, horizon also has the greatest clay content within the profile. The upper 35 centimetres of the profile contains considerably greater amounts of clay and manganese than the underlying horizons suggesting that manganese may have been introduced by a flush of finer-textured material to form the upper horizons of the profile. Extractable manganese levels of 170 mg/kg in the surface horizon decrease steadily to around 2 mg/kg in the C horizons.

Total molybdenum contents are 3 or less (mean 1.9 mg/kg). An extractable molybdenum level of 0.02 mg/kg in the A horizon suggests that problems of molybdenum excess are unlikely.

Total vanadium, chromium and titanium contents are within the ranges 25 to 80, 15 to 100 and 4000 to 8000 with mean contents of 46, 40 and 5630 mg/kg.

Total lead contents are 10 to 60 (mean 26 mg/kg) greatest contents being in the upper horizons of the profile.

Extractable zinc levels in the three upper horizons of the profile range from 3.4 to 7.2 (mean 5.6 mg/kg) and, in the lower horizons, these are 0.3 mg/kg.

Dreghorn Association

Two profiles of the association were examined, representing the freely drained Dreghorn (No. 67) and the imperfectly drained Quivox (No. 80) Series.

Total cobalt contents in the eight B and C horizons range from 8 to 10 (mean 9.5 mg/kg) and values show little change with increase in depth throughout the profiles. Extractable cobalt levels of 0.72 and 0.76 mg/kg in the Ap horizons of the two profiles, with soil pH of 5.7 and 6.0 respectively, suggest that problems of cobalt deficiency are unlikely.

Total nickel contents range from 25 to 30 (mean 29 mg/kg) and extractable nickel contents in the Ap horizons are close to 0.75 mg/kg.

Total copper contents range from 10 to 30 (mean 19 mg/kg). Extractable copper levels in the Ap horizons are more than adequate at 3.7 and 4.4 mg/kg and problems of copper deficiency affecting the growth of cereals would not be anticipated.

Total manganese contents range from 600 to 1500 (mean 1140 mg/kg). Extractable levels of around 60 mg/kg in the Ap horizons of the Dreghorn Series soil and of 130 mg/kg in the same horizon of the Quivox Series soil suggest that problems of manganese deficiency affecting crops are unlikely.

Total molybdenum contents are 3 or less (mean 2.1 mg/kg) and the extractable levels in the Ap horizons of both profiles are 0.02 mg/kg, at which levels problems of molybdenum excess appear unlikely unless the soils are limed.

Total vanadium, chromium and titanium contents are within the ranges 40 to 60, 40 to 60 and 4000 to 6000 with mean values of 43, 45 and 4880 mg/kg respectively.

Total lead contents range from 10 to 20, mean 15 mg/kg, and both Ap horizons contain 40 mg/kg. Extractable lead levels in the upper horizons of the Dreghorn and Quivox Series soils are 0.35 and 0.46 mg/kg respectively.

Extractable zinc levels in the upper horizons are 2.1 and 3.5 mg/kg respectively.

Eckford Association

Four profiles of the association were examined representing the freely drained Eckford (No. 67) and Giffordtown (No. 14) Series, and the imperfectly drained Kilwhiss (No. 13 and 68) Series. Profiles .No. 67, 14 and 68 were cultivated and supported pasture swards whereas profile No. 13) was uncultivated and sampled in a 30-year-old pine plantation.

Total cobalt contents in the eighteen B and C horizons range from less than 3 to 15, (mean 5.9 mg/kg), while values in the surface horizons of the four profiles tend to be slightly higher at 4 to 20 mg/kg. These differences may be related to the higher clay content in the upper horizons. Extractable cobalt contents in the four surface horizons are surprisingly high, however, at 3.0, 0.57, 0.55 and 2.0 mg/kg respectively. The relatively high total and extractable cobalt levels in the surface horizons of profiles 67 and 68, together with the fact that the underlying B horizons are very low in total and extractable cobalt, suggest that cobalt has been added to these soils. Total cobalt levels in all horizons of the uncultivated profile No. 13 are very low throughout, at 4 mg/kg or less. The results overall suggest that soils of the Eckford Association are likely to support pastures which are deficient in cobalt for the healthy growth of ruminant stock.

The variation of total nickel contents with depth follows that of cobalt, and B and C horizons contain from 10 to 30, (mean 16 mg/kg). The four surface horizons contain 20 to 60 mg/kg. Extractable nickel contents, like those of cobalt, tend to be relatively high in the surface horizons at 2.3, 0.45, 1.4 and 1.7 mg/kg and decrease sharply in underlying horizons. There is little evidence of an increase in nickel extractability in two imperfectly drained profiles compared with the two freely drained soils.

Total copper contents range from less than 3 to 15, (mean 8.4 mg/kg), with slightly greater contents of 10 to 30 mg/kg in the surface horizons. The relatively high total (30 mg/kg) and extractable (10 and 8 mg/kg) copper levels in the upper horizons of profiles No. 67 and 68 of the Eckford and Kilwhiss Series respectively, strongly suggest that copper has been applied to both these soils. The generally low total and extractable copper levels in the subsoil horizons of profiles 67, 14 and 13 suggest that copper deficiency affecting the growth of cereals or the health of grazing stock could be a problem on the soils of this association.

Total manganese contents vary widely from 100 to 1500 (mean 390 mg/kg). Extractable manganese levels range from 8 to 88 (mean 54 mg/kg), the lowest value being in the surface horizon of the uncultivated iron podzol (No. 13) of the Kilwhiss Series. In all four profiles extractable manganese levels in the subsurface horizons are much lower at less than 1to 9 (mean 3.6 mg/kg). The generally low pH values of 3.9 to 6.6 in topsoils suggest, however, that problems of manganese deficiency affecting the growth of crops are unlikely.

Total molybdenum contents vary from less than 3 to 4 (mean 1.8 mg/kg). Extractable molybdenum levels in the surface horizons are 0.03, 0.03, 0.01 and 0.05 mg/kg, the latter value being high enough to suggest that problems of molybdenum excess affecting animals cannot be ruled out, especially following liming.

Total vanadium, chromium and titanium levels are within the ranges 0 to 80, 8 to 60 and 1500 to 6000, with mean values of 36, 30 and 3970 mg/kg respectively. Extractable vanadium levels tend to decrease down the profile in the two freely drained soil Nos. 67 and 14 of the Eckford and Giffordtown Series, but show little change with increase in depth in the two imperfectly drained profiles of the Kilwhiss Series. In these latter profiles, mobilisation of vanadium due to gleying raises extractable vanadium levels throughout the B and C horizons to 1 to 2 mg/kg.

Total lead contents vary between 3 and 15, (mean 10 mg/kg), while in the upper A horizons, values range from 10 to 200, (mean 54 mg/kg). Extractable lead contents range from 0.12 to 7.1, greatest values within any one profile being found in the surface horizon.

Extractable zinc levels, like those of lead, are greatest in surface horizons and decrease with increase in depth. Values in the surface soils range from 1.3 to 15 (mean 8 mg/kg) and there is some evidence of slight mobilisation of zinc due to gleying in the subsoils of profile No. 68 of the Kilwhiss Series where levels are 0.6 mg/kg compared with values of 0.25 mg/kg in comparable horizons of the other three profiles.

Fraserburgh Association

Because the parent materials of both the Fraserburgh Association and the Links soil Unit are wind-blown sand with water pH values in the twenty-seven profile horizons examined ranging from 6.8 to 8.9, (mean 7.7), the two are considered together. The mean values of the total trace element contents of the ten B and C horizons of the Fraserburgh Association are very similar to those of the nine comparable horizons of the Links soil unit, except in the case of manganese with a content of 420 mg/kg in the Fraserburgh Association soils as compared with 930 mg/kg for the Links soils. Four profiles were examined, representing the freely drained Fraserburgh (No. 16 and 69) Series and the freely drained Links (No. 62 and 79) Series. All four soils support a pasture herbage sward.

Total cobalt contents in the nineteen B and C horizons were all less than 3 mg/kg. Greater levels of 4 to 8 mg/kg were only found in the A horizons of the two Links profiles. Extractable cobalt contents in the A horizons of the Fraserburgh Series profiles are 0.50 and 0.70 mg/kg which, considered in relation to the soil pH values of 7 or above, would indicate a strong likelihood of cobalt deficiency affecting ruminants. The greater extractable cobalt levels in the A horizons of the two Links profiles of about 10 and 1.6 mg/kg respectively suggest that cobalt may have been added to these soils and this is supported by the greater total contents mentioned above. The extractable level of 1.0 mg/kg in profile No. 63 would, nevertheless, be considered borderline for a calcareous soil.

Total nickel contents range from less than 10 to 15 (mean 12 mg/kg), which is well below the mean contents for the soils of the other associations. Extractable nickel levels are all less than 1 mg/kg and in most cases less than 0.5 mg/kg throughout all four profiles.

Total copper contents of the B and C horizons are also low ranging from less than 3 to 6, (mean 2.6 mg/kg). The A horizons of the two profiles No. 62, and 79 of the Links contain the unexpectedly high levels of 15 and 10 mg/kg respectively. This, together with the greater extractable copper levels in the A horizon soils of 2.5 and 3.1 mg/kg, suggest that copper also has been added to these soils. Extractable copper in the A horizons of the Fraserburgh Series soils are about 1 mg/kg, at which level copper deficiency might be anticipated if cereals were to be grown.

Total manganese contents range from 300 to 1500, (mean 660 mg/kg). Contents

in the Links Series soils are generally greater than in those of the Fraserburgh Series. Extractable manganese in the surface horizons of profiles No. 16, 69, 62 and 79 are 54, 16, 97 and 56 mg/kg respectively. The levels in three of the soils are moderately high, but manganese may have been added in some cases and the generally high pH values suggest that manganese deficiency could affect the growth of cereal crops if these were to be grown.

Total molybdenum contents are 3 or less (mean 1.6 mg/kg) in all horizons of the four profiles. Extractable molybdenum levels in the surface horizons are 0.02, 0.01, 0.04 and 0.02 mg/kg respectively.

Total vanadium, chromium and titanium contents are within the ranges 25 to 40, 4 to 30 and 380 to 6000, with mean values of 33, 16 and 2450 mg/kg respectively. These values are considerably lower than corresponding figures for the other associations and reflect the sandy nature of the soils. The clay content exceeds 3 per cent in only two horizons of the four profiles.

Total lead contents range from less than 3 to 8 (mean 3.8 mg/kg). Levels in the surface horizons are rather greater at 25, 15, 40 and 25 mg/kg respectively. Extractable lead contents in the same horizons are 0.55, 0.61, 1.5 and 0.58 mg/kg respectively.

Extractable zinc levels in the surface horizons of profiles No, 16, 69, 62 and 79 are 4.3, 1.5, 17 and 3.9 mg/kg respectively, and these decrease sharply with increase in depth to 0.3 mg/kg or less.

Giffnock Association

The six profiles of the association examined represent the freely drained Forestmill (No. 20) Series; the imperfectly drained Aberdona (No. 17), Devilla (No. 70 and 22) and unnamed (No. 23) Series and the poorly drained Scaurs (No. 19) Series. The first three profiles are cultivated and support pasture herbage while the others are uncultivated and support moorland or semi-natural acid grassland vegetation.

Total cobalt contents in the twenty-eight B and C horizon samples range from less than 3 to 20, (mean 10 mg/kg). Total contents in the surface horizons of the cultivated profiles No. 20, 17 and 70 are greater at 10 to 20 mg/kg than in the more highly organic surface horizons of the podzols and gleys No. 22, 23 and 19 at 2 to 8 mg/kg. This pattern is reflected in the extractable cobalt levels which were generally adequate (0.55 to 1.5 mg/kg) in the Ap horizons of the cultivated profiles, but borderline or deficient in the upper horizons of the uncultivated profiles (0.22 to 0.44 ma/kg).

Total nickel contents range from less than 10 to 150, (mean 36 mg/kg). Extractable nickel levels in the surface horizons of all six profiles are generally around 1 mg/kg, averaging 0.9 mg/kg. Levels in the C horizons of profiles 17 and 19 are as high as 6 and 5 mg/kg respectively, probably due to the gleyed conditions evident in the lower horizons of these two profiles which also have much greater clay contents of 30 and 40 per cent compared with 20 per cent or less in the other four profiles. A similar effect is evident in the figures for extractable cobalt.

Total copper contents are less than 3 to 30, (mean 16 mg/kg). Extractable copper values are generally moderately high in the upper horizons of all six profiles, ranging from 1.8 to 6.9 (mean 3.6 mg/kg) and problems of copper deficiency affecting the growth of cereal crops would not be anticipated on these soils.

Total manganese contents range widely from 100 to 2000, (mean 560 mg/kg). Values throughout profiles No. 22 and 19 of the Devilla and Scaurs Series respectively are generally lower, at 400 mg/kg or less, than in the other four profiles. This could be due in part to losses of manganese by leaching because the soil pH values are generally low and in profile No. 19 as low as 3.4 to 3.7 throughout the profile. Extractable manganese contents are also highly variable, decreasing with increase in depth in profiles 20, 70 and 22 but showing the opposite effect in profiles 17 and 19. This could be due to the higher clay contents of the latter two profiles; manganese mobilized by gleying being adsorbed on the surface of the clay particles. In the C horizons of these two profiles, the extractable manganese levels are around 150 mg/kg and represent some 30 per cent of the total contents. Extractable manganese levels in the surface horizons of the three cultivated profiles 20, 17 and 70 and also the surface uncultivated profile No. 22 are moderately high averaging about 100 mg/kg while in profiles 23 and 19 they are low, at 7.4 and 1.9 mg/kg respectively. This difference may be related, as suggested earlier, to losses of mobile manganese due to leaching, the pH values in the surface horizons being 3.8 and 3.7 respectively, compared with 5.0 to 6.1 in the other four profiles.

Total molybdenum contents are 3 or less (mean 1.8 mg/kg). Extractable molybdenum contents in the Ap or E horizons of the six profiles were within the range 0.01 to 0.03 mg/kg and problems of molybdenum excess affecting animals would not normally be expected, except possibly following liming.

Total vanadium ranges from 20 to 100, (mean 54 mg/kg), and generally shows little variation with increase in depths whereas extractable vanadium contents tend to decrease with increase in depth. Levels in the surface horizons range from less than 0.03 to 1.3 mg/kg. Total chromium and titanium range from 10 to 200 and 3000 to 8000 mg/kg with mean contents of 58 and 6390 mg/kg respectively.

Total lead contents range from 10 to 30, (mean 19 mg/kg). Levels are slightly greater in the surface horizons of the three cultivated profiles, at 30 to 40 mg/kg, and considerably greater, at 60 to 300 mg/kg, in the organic L, F or H horizons of the uncultivated profiles. Extractable lead values in the surface horizons range from 0.39 to 5.8 mg/kg and tend to decrease with increase in depth in each profile.

Extractable zinc levels in the upper horizons of the three cultivated profiles No. 20, 17 and 70 are 3.4, 3.2 and 5.8 mg/kg compared with 35, 9.1 and 21 mg/kg in corresponding horizons of the three uncultivated profiles No. 22, 23 and 19.

Gleneagles Association

Two profiles of the association were examined, both representing the freely drained Gleneagles (No. 71 and 24) Series. Both profiles have clay contents of 5 or 6 per cent in the surface horizon, decreasing to 2 per cent or less with increase in depth, and both profiles support a pasture herbage sward.

Total cobalt contents in the eleven B and C horizons examined range from 4 to 15, (mean 10 mg/kg). Throughout profile No. 71, which has greater silt and clay contents, each horizon contains about twice the total cobalt content of corresponding horizons of profile No. 24. Extractable cobalt levels in the surface horizons are 0.68 and 0.51 mg/kg respectively, which is barely adequate in the as latter case. Extractable levels decrease with depth as in freely drained soils.

Total nickel contents range from 6 to 30 (mean 18 mg/kg). Extractable nickel levels in the surface horizons are 0.55 and 0.35 mg/kg respectively.

Total copper contents range from 15 to 30 (mean 22 mg/kg). Extractable copper levels in the surface horizons are 1.9 and 2.1 mg/kg, decreasing with depth to 0.25 mg/kg in the C horizons. At these levels of about 2 mg/kg in the surface horizons, copper deficiency in cereal crops would not be anticipated.

Total manganese contents range from 150 to 1000, (mean 680 mg/kg). Extractable manganese levels of 31 and 19 mg/kg were found in the surface horizons, but levels decrease sharply with increase in depth to 2 mg/kg or less in the C horizons of both profiles. Manganese deficiency in cereals would not be anticipated unless the soils were limed.

Total molybdenum contents are less than 3 mg/kg throughout all the B and C horizons. Extractable molybdenum levels in the surface horizons of 0.03 and 0.01 mg/kg are within the normal range, and problems due to molybdenum excess affecting animals would not normally be anticipated.

Total vanadium, chromium and titanium contents fall within the ranges of 60 to 100, 40 to 150 and 3000 to 6000, with mean values of 76, 65 and 4820 mg/kg respectively.

Total lead contents range from 10 to 30, (mean 15 mg/kg), with rather greater values of 40 and 30 mg/kg in the A horizons. Extractable lead levels in the surface horizons of profiles No. 71 and 24 are moderately high at 2.9 and 1.3 mg/kg respectively.

Extractable zinc levels in the surface horizons are 2.1 and 1.2 mg/kg, decreasing sharply with increase in depth to 0.25 mg/kg.

Hindsward Association

The two profiles of the association examined represented the imperfectly drained Reidston (No. 26) Series and the poorly drained Hindsward (No. 27) Series.

Total cobalt contents in the eleven B and C horizons range from 10 to 20, (mean 14 mg/kg). Extractable cobalt levels in the gleyed subsoils of both profiles are around 1 mg/kg, but in profile No. 27 of the Hindsward Series the two upper horizons contain 0.3 mg/kg, a value low enough to suggest that the possibility of cobalt deficiency on soils of this association cannot be excluded.

Total nickel contents range from 30 to 60 (mean 44 mg/kg) and show little change with increase in depth in both profiles. Extractable nickel contents are around 2 mg/kg throughout the gleyed C horizons of both profiles.

Total copper contents range from 15 to 30, mean 23 mg/kg. Extractable copper levels of 5.1 and 2.0 respectively in the A horizons of the two profiles suggest that copper deficiency of cereal crops is unlikely to arise. Mobilisation of copper throughout the B and C horizons is evident, with extractable values as high as 5.0 and 5.3 mg/kg respectively in the uppermost C horizons of the two profiles.

Total manganese contents range widely from 300 to 2500 (mean 918 mg/kg). The rather greater total levels in profile No. 26 are reflected in higher extractable amounts than in profile No. 27. Extractable manganese levels increase from 150 to 320 mg/kg with increase in depth through the B and C horizons of profile No. 26 and from 6.9 to 70 mg/kg through corresponding horizons of profile No, 27. Levels of 170 and 88 mg/kg respectively in the A horizons indicate that problems of manganese deficiency are unlikely.

Total molybdenum contents are 3 or less (mean 1.8 mg/kg). Extractable levels of 0.01 and 0.02 mg/kg in the A horizons respectively are within the normal range for soils and suggest that problems of molybdenum excess are unlikely.

Total vanadium, chromium and titanium are within the range 60 to 150, 60 to 100 and 5000 to 10,000 with mean values of 87, 71 and 7630 mg/kg respectively.

Total lead contents range from 15 to 30, (mean 21 mg/kg). Total contents of the A horizons of profiles No. 26 and 27 are 30 and 40 mg/kg and extractable lead levels in the same horizons 0.36 and 0.63 mg/kg respectively. Extractable zinc levels in the A horizons are 3.9 and 1.1 mg/kg respectively and some slight mobilisation of zinc due to gleying is evident in the C horizons of both profiles where levels are around 1 mg/kg.

Kippen Association

Two profiles of the association were examined, representing the freely drained Urquhart Series (No. 30) and the imperfectly drained Kippen Series (No. 72).

Total cobalt contents range from less than 3 to 20, (mean 7 mg/kg). The freely drained Urquhart Series profile developed on weathered sandstone has a much lower total cobalt content (3mg/kg or less) throughout than the imperfectly drained Kippen Series profile developed on till, where total cobalt contents are 3 to 8 mg/kg in the upper three horizons increasing to 15 to 20 mg/kg in lower horizons. This marked difference in total cobalt content is probably related to the higher clay content of the latter profile. Extractable cobalt contents in the surface horizons of the

profiles are 0.30 and 0.11 mg/kg respectively which suggest that the soils of both series could produce herbage deficient in cobalt for grazing stock. Some mobilisation of cobalt due to gleying is evident in the B and C horizons of the imperfectly drained Kippen Series profile where extractable cobalt levels are increased to 1.1 mg/kg.

Total nickel contents range from 15 to 30, mean 22 mg/kg, and there is little change in content with increase in depth throughout both profiles. Extractable nickel contents range from 0.06 to 0.5 mg/kg.

Total copper contents range from 4 to 25, (mean 11 mg/kg). Contents throughout profile No. 30 are 4 to 8 mg/kg whereas in profile No. 72 the upper three horizons contain between 4 and 6, but the lower horizons 20 to 25 mg/kg. These differences are probably related, as in the case of cobalt, to differences in soil texture. Extractable copper contents in the surface horizons are 1.5 and 0.51 mg/kg respectively, the latter figure being low enough to suggest that copper deficiency could arise if cereals were to be grown on this soil.

Total manganese contents range from 300 to 1000, (mean 433 mg/kg). Extractable manganese contents decrease with depth from 33 to 1.6 mg/kg in the freely drained soil No. 30, but in the gleyed profile No. 72 some mobilisation of manganese raised the levels to 89 mg/kg in the C horizon. The moderately high levels in the surface horizons of 33 and 58 mg/kg respectively, coupled with the soil pH values of 5.2 and 6.1, suggest that manganese deficiency affecting crops is unlikely on these soils.

Total molybdenum contents are 3 mg/kg or less throughout the profiles and the extractable molybdenum values in the surface horizons of both profiles are 0.0l mg/kg. At these levels, with the soil pH values quoted above, problems of molybdenum excess appear unlikely.

Total vanadium, chromium and titanium values range rather widely from 25 to 100, 20 to 100 and 2500 to 10,000 respectively, with mean contents of 64, 56 and 6500 mg/kg. The higher contents were found in the B and C horizons of profile No. 72 of the Kippen Series which has the highest percentage of clay.

Total lead levels range from 3 to 40, (mean 16 mg/kg). Levels tend to decrease with increase in depth in profile No. 30, but in profile No. 72 the highest content is in the Ap horizons at 23 to 3l centimetres. This horizon has a higher loss-on-ignition value than the horizons overlying it, which suggests that this may be an old buried surface horizon which shows some accumulation of lead. The horizon is also the boundary between horizons having a sandy loam texture above and a loam texture below. Extractable lead levels are normally greatest in the surface horizon within any one profile, as in the case in profile No. 30, but in profile No. 72 the greatest extractable lead is in the B horizon where the highest total lead content was found.

The extractable zinc level is fairly low at 1.2 mg/kg in the surface of profile No. 30 and much greater at 10 mg/kg in the corresponding horizon of profile No. 72. In the latter profile, the B horizon at 23 to 3o centimetres depth has a high extractable zinc level of 29 mg/kg. This may well be due, as suggested above, to this horizon being an old surface layer which has been buried by material of coarser texture.

Mountboy Association

Two profiles of the association were examined, representing the freely drained Garvock (No. 37) Series and the imperfectly drained Mountboy (No. 36) Series.

Total cobalt contents in the ten samples of B and C horizons range from 8 to 15, (mean 13 mg/kg). There is little change in total content with increase in depth. Extractable cobalt levels decrease steadily with increase in depth in the freely drained profile No. 37, but this effect is small in the imperfectly drained profile No. 36 where some mobilisation of cobalt due to gleying has increased levels to around 0.4 mg/kg throughout the C horizons. Extractable cobalt levels in the surface horizons are 0.70 and 0.58 mg/kg, which should normally produce herbage with cobalt levels adequate for grazing stock. The high loss-on-ignition of the surface horizon of profile No. 37, however, means that a level of 0.70 mg/kg would be categorised as deficient so the possibility of cobalt deficiency should be considered.

Total nickel levels range from 25 to 40, (mean 36 mg/kg), and, like cobalt, show little change in content with increase in depth. Extractable nickel contents decrease with increase in depth from 0.5 to 0.1 mg/kg in the freely drained profile No. 37 of the Garvock Series, whereas they increase with depth from 0.2 to 10. mg/kg in the imperfectly drained profile No. 36, probably as a result of gleying.

Total copper contents range from 10 to 25, (mean 18 mg/kg), and show little variation with increase in depth. Extractable copper contents in the A horizons of both profiles, which were cultivated or under grass, are close to 1.5 mg/kg so problems of copper deficiency affecting cereal growth appear unlikely.

Total manganese contents range rather widely from 300 to 2000, (mean 760 mg/kg). Extractable manganese values decrease with increase in depth in the freely drained profile No. 37, but increase strikingly with increase in depth to 150 mg/kg in the imperfectly drained profile No. 36, presumably due to gleying. In the A horizons of both profiles, extractable manganese contents are about 40 mg/kg, so problems of manganese deficiency affecting crops are unlikely.

Total molybdenum contents are 3 mg/kg or less, several horizons of profile No. 36 containing 3 mg/kg. Extractable molybdenum values in the A horizons are 0.02 and 0.03 mg/kg in profiles No. 37 and 36 respectively, which are typical values for surface soils.

Total vanadium, chromium and titanium contents range from 30 to 100, 25 to 80 and 3000 to 8000, with means of 69, 61 and 6100 mg/kg respectively. Rather higher contents of these elements were found in profile No. 37 due probably to the higher clay content.

Total lead contents range from 3 to 15, (mean 11 mg/kg), with rather higher values of 30 mg/kg in the A horizons. Extractable lead values are also greatest in the A horizons at around 0.4 mg/kg and tend to decrease with depth.

Extractable zinc levels are 1 to 2 mg/kg in the A horizons of both profiles and decrease to 0.25 mg/kg in the B horizons.

Panbride Association

One profile of the freely drained Panbride Series (No. 38) was examined. This is the only series of the association represented in the area.

Total cobalt, nickel and copper contents in the five B and C horizons are within the ranges less than3 to 15, 20 to 40 and 8 to 25, with mean contents of 7.5, 30 and 14 mg/kg respectively. Extractable cobalt and nickel levels are around 1 mg/kg in the Ap horizon and problems of cobalt deficiency in animals would not be expected. Extractable copper levels, however, are 0.91 and 0.70 in the A and B horizons which are low enough to suggest that problems of copper deficiency in the growth of cereal crops could arise.

Total manganese contents range widely from 100 to 3000 mg/kg, the greatest content being in the B horizon where manganese coatings on sandstone fragments were observed. The extractable manganese level of 100mg/kg in the Ap horizon suggests that problems of manganese deficiency in the growth of crops should not arise.

Total molybdenum contents are 3 or less, (mean 2.1 mg/kg), and the extractable content in the Ap horizon 0.01 mg/kg, suggesting that the likelihood of problems of molybdenum excess is small.

Total vanadium, chromium and titanium contents are within the ranges 25 to 60, 20 to 40 and 3000 to 5000, with mean values of 43, 28 and 4200 mg/kg, these generally low contents being consistent with the sandy nature of the soil parent material.

Total lead contents are 6 to 20 (mean 14 mg/kg). The Ap horizon contains 20 mg/kg total lead of which 0.35 mg/kg is extractable.

The extractable zinc content of the Ap horizon is 1.1 mg/kg.

Rowanhill Association

Seven profiles of the association were examined. These represented the imperfectly drained brown forest soils of the Caprington (No. 39 and 73), Winton (No. 41) and Macmerry (No. 75 and 71) Series, the peaty podzols with iron pan (No. 43) of an unnamed series and the noncalcareous gleys (No. 46) of the Rowanhill Series. Profiles No. 39, 73, 81 and 46 were cultivated and supported pasture herbage, while profiles 42, 74 and 43 were uncultivated and under forest.

Total cobalt contents in the twenty-nine B and C horizon samples vary between less than 3 and 30 mg/kg, but most values are close to the mean content of 15 mg/kg. The contents of A horizon samples are close to 15 mg/kg, there being little change with increase in depth. Extractable cobalt contents in the surface horizons range from 0.55 to 4.0 (mean 1.4 mg/kg) and increase to several mg/kg in the B and C horizons of profiles No. 39, 73 and 46, probably due to gleying. These relatively high levels suggest that cobalt deficiency problems are unlikely on these soils.

Total nickel contents also range widely from 15 to 150, (mean 53 mg/kg), while extractable nickel in all horizons ranges from 0.09 to 7.3 mg/kg. Extractable nickel levels exceed 4 mg/kg in the B and C horizons of profiles 39, 73 and 46, probably as a result of gleying. Although these values are at the upper end of the normal range for extractable nickel in soils, they are not great enough to cause nickel toxicity problems in crops.

Total copper contents are 3 to 30, mean 20 mg/kg, while surface horizon contents range from 12 to 25 with a mean of 19 mg/kg. Extractable copper levels in the surface horizons of the seven profiles range from 2.9 to 18 (mean 7.3 mg/kg). Values in the subsoil horizons of profiles 39, 73, 81 and 46 exceed 3 mg/kg and the general level of extractable values suggests that copper deficiency affecting cereal growth is unlikely on the soils of this association.

Total manganese contents range rather widely from l50 to 2000, with a mean of 690 mg/kg. Extractable manganese contents in the upper horizons of the profiles, range from 58 to 190 (mean 113 mg/kg), which is well above the normal range for EDTA-extractable manganese in soils. Levels in the subsoils of profiles No. 39, 73, 42 and 74, exceed 100 mg/kg and in profile 74 are as great as 360 mg/kg. The pH values in the profiles 39, 73, 81 and 46 are generally 6.5 and above but problems of manganese deficiency affecting crops would not be anticipated.

Total molybdenum contents range from less than 3 to 6, (mean 1.8 mg/kg), and surface horizon contents are 3 mg/kg or less. Extractable molybdenum in the A horizons of the seven profiles ranges from 0.01 to 0.03 mg/kg at which levels problems of molybdenum excess would not normally be expected.

Total vanadium, chromium and titanium contents are within the ranges 6 to 150, 15 to 100 and 1500 to 10,000 with mean values of 71, 68 and 6720 mg/kg. Extractable vanadium levels in surface horizons average 0.71 mg/kg and values in the C horizons of the poorly drained profile No. 46 of the Rowanhill Series increase to 1.6 mg/kg, probably due to gleying.

Total lead contents range from 3 to 25, (mean 16 mg/kg). Significant enrichment in the surface horizons is found only in the uncultivated profiles No. 42, 74 and 43 where contents are 80, 80 and 120 mg/kg respectively. Levels of extractable lead are 0.8 mg/kg or less throughout profiles No. 39, 73, 81 and 46 and tend to decrease slightly with increase in depth. In the uncultivated profiles No. 42, 74 and 43, however, the organic horizons contain 2.0 to 8.5, (mean 4.4 mg/kg).

Extractable zinc values decrease with depth in all except the poorly drained profile No. 46 of the Rowanhill Series where gleying has increased levels in the mineral subsoils to greater than 4 mg/kg. Unusually high amounts of 230, 90 and 62 mg/kg were found in the uppermost humus horizons of the uncultivated profiles No. 42, 74 and 43 compared with 1 to 3.7 mg/kg in the surface horizons of the other four profiles.

Sourhope Association

Six profiles of the association were examined, representing the freely drained Sourhope (No. 75), Cowie (No. 52) and Balquhandy (No. 77) Series, the imperfectly drained Bellshill (No. 76) Series and the poorly drained Atton (No. 55) aand Edgerston (No. 56) Series.

Total cobalt contents in twenty-four B and C horizon samples range from 10 to 25, (mean 15 mg/kg), which is in the middle of the range of 1 to 40 mg/kg commonly found in soils. Little variability in cobalt content is found between the profiles. There is also little change in total cobalt content with increase in depth, except in profiles No. 52 and 77 in which the values for the organic surface horizons are as low as 1 mg/kg due to dilution by the accumulation of organic matter. The cultivated upper horizons of the freely drained profiles, Nos. 75 and 76 have extractable cobalt contents of 0.99 and 0.84 mg/kg respectively, while corresponding horizons of both poorly drained profiles (No. 55 and 56) contain around 3 mg/kg, suggesting that cobalt deficiency affecting stock is unlikely. The peaty upper horizons of the two freely drained profiles Nos. 52 and 77, however, contain much lower extractable cobalt levels (mean 0.31 mg/kg) which suggest that the possibility of cobalt deficiency affecting stock cannot be ruled out. The effect of impeded drainage in mobilizing cobalt is evident in the C horizons of both poorly drained profiles (No. 55 and 56) of the Atton and Edgerton Series, where extractable cobalt is increased to about 1.5 mg/kg compared with levels of about 0.2 mg/kg in similar horizons of the freely drained profiles No. 75 and 76.

Total nickel contents range from 20 to 60, (mean 39 mg/kg), and show little change with increase in depth. Lower contents in upper A or H horizons where organic matter has accumulated are apparent, as is the case with cobalt. Extractable nickel levels in all horizons of the six profiles range from less than 0.06 to 1.4 mg/kg, highest levels being in the surface or lower gleyed horizons of the poorly drained profiles (No. 55 and 56) of the Atton and Edgerton Series.

Total copper contents range from 3 to 30, (mean 19 mg/kg), the lowest value of 3 mg/kg in the B horizon of profile No. 56 being anomalous. There is generally little change in content with increase in depth although some of the upper A or H horizons have contents as low as 3 mg/kg. Extractable copper contents are generally high in the upper horizons of the profiles, particularly those rich in organic matter, and tend to decrease sharply with increase in depth in the freely drained soils. In the three profiles with impeded drainage No. 76, 55 and 56, mobilisation of copper due to gleying of the mineral subsoil horizons is evident with levels of up to about 2.5 mg/kg. Both total and extractable copper levels suggest little likelihood of problems of copper deficiency affecting cereal growth.

Total manganese contents range from 300 to 1000, (mean 530 mg/kg), and show little change with increase in depth throughout the mineral solum. In the peaty A or H horizons of profiles Nos. 52 and 77 of the freely drained Cowie and Balquhandy Series, total manganese contents are considerably lower and range from 15 to 400 mg/kg. Extractable manganese contents in the upper horizons of all six profiles are moderately high, averaging 68 mg/kg. Levels tend to decrease with increase in depth in the freely drained soils whereas, as a result of impeded drainage in the

subsoils of profiles No. 77, 55 and 56, high levels are maintained. The values for pH in water are within the range 3.9 and 5.7, except those in the subsoil of profile No. 55, so problems of manganese deficiency affecting crops are unlikely.

Most total molybdenum contents are less than 3 mg/kg but values of 3 mg/kg are found in horizons of profiles No. 75, 76 and 56. Extractable molybdenum values in selected upper horizons of the six profiles vary from 0.01 to 0.02 mg/kg, however. These are at the low end of the normal range and suggest that problems of molybdenum excess affecting animals are unlikely.

Total vanadium, chromium and titanium levels fall within the narrow ranges of 60 to 100, 40 to 100 and 5000 to 8000 with means of 80, 78 and 6200 mg/kg respectively which are typical for soils derived from intermediate lavas. There is little variation in the contents of all three of these elements with increase in depth throughout the mineral solum, but lower values were generally found in the overlying surface horizons due to the accumulation of organic matter. Some mobilisation of vanadium due to gleying in the C horizons of profile No. 55 is evident, levels rising to 2.9 mg/kg.

Total lead contents range from 8 to 40 (mean 15 mg/kg) and show little change with increase in depth within the B and C horizons. Striking accumulations of lead of up to 800 and 150 mg/kg in the upper horizons of profiles No. 52 and 78 respectively of the Cowie and Baiquhandy Series are apparent. These horizons have loss-on-ignition values of around 90 per cent. Total lead contents are also greatest in the uppermost horizons of the other four profiles, but are within the range 30 to 50 mg/kg where loss-on-ignition values are 10 to 50 per cent. The mineral subsoils of profile No. 52, which shows the greatest surface accumulation of lead, also has an elevated total lead content of 40 mg/kg compared with around 15 mg/kg in the other five profiles. Extractable lead figures range from 0.08 to 8.2 mg/kg and, like those for total lead, are greatest in the upper horizons of the profiles, decreasing with increase in depth.

Extractable zinc levels range widely from less than 0.25 to 110 mg/kg and are greatest in the upper horizons of all the profiles. Highest levels of around 50 and 110 mg/kg were found in the two uppermost organic horizons of profiles 52 and 77 which also show the greatest accumulations of lead.

Alluvial Soils

Five profiles developed on alluvium were examined. These are representative of Culnacoyle (No. 59) and Kaime (No. 58) Series, both of which are sandy, the clayey Heavyside (Nos. 57 and 78) Series and the peaty alluvium (No. 60). Drainage is impeded to some extent in all the profiles and very poor in the latter three, but all support a pasture herbage sward.

Total cobalt contents in the twenty-three B and C horizons examined vary from less than 3 to 30, (mean 14 mg/kg). Mean total cobalt contents of the B and C horizons of individual profiles No.59, 58, 78 and 57 are 3, 4, 16 and 23 mg/kg respectively, reflecting the increasing degree of fineness of texture. The mean cobalt content of profile No. 60 on peaty alluvium is 15 mg/kg. Extractable cobalt levels in the surface

horizons of the profiles are 0.63, 0.40, 0.52, 1.4 and 1.1 mg/kg respectively and at these levels, with soil pH values of around 6 or less and loss-on-ignition values of 10 per cent or less, cobalt deficiency affecting animals appears unlikely. The lowest value of 0.4 mg/kg would, however, be considered borderline so the possibility cannot be dismissed entirely.

Total nickel contents range from 10 to 60 (mean 31 mg/kg). Extractable nickel values in the surface horizons are 0.60, 0.59, 1.0 1.9 and 1.9 mg/kg respectively, while in corresponding gleyed C horizons the values average 0.3, 1.1, 1.5, 2.3 and l.8 mg/kg, both sets of figures reflecting the increasing fineness of texture and degree of drainage impedance.

Total copper contents range from 3 to 30, (mean 16 mg/kg), the levels ‘in the two profiles No. 59 and 58 being generally lower than those in the other three profiles. Extractable copper levels in the surface horizons are 3.0, 2.3, 2.2, 5.3 and 4.3 mg/kg respectively, but increase to 5 to 10 mg/kg in the subsoil horizons of the latter four profiles, presumably due to gleying.

Total manganese contents range very widely from 80 to 10,000 (mean 2210 mg/kg). Total manganese levels in all horizons of the profiles, except No. 57 of the Heavyside Series, are generally around 300 mg/kg. The recent alluvial deposits of profile No. 57 contain much more manganese and in four horizons the levels exceed 1 per cent. Extractable manganese levels in the surface horizons are 47, 18, 11, 320 and 52 mg/kg respectively, the levels in profiles No. 58, and 78 of the Kaime and Heavyside Series being rather low for satisfactory growth of cereal crops. Extractable manganese levels in the B and upper C horizons of profile No. 57 of the poorly drained Heavyside Series are 1000 to 1700 mg/kg. These extremely high are in horizons which contain low amounts of organic matter and have prominent strong brown mottles.

Total molybdenum contents are 3 or less, (mean 1.8 mg/kg), levels of 3 mg/kg being found mainly in profile No 58 of the Kaime Series. Extractable molybdenum levels in the surface horizons of the five profiles are 0.02, 0.01, 0.02, 0.01 and 0.02, at which levels, problems with animals arising from excess molybdenum would not be anticipated.

Total vanadium, chromium and titanium contents are within the rather wide ranges of 20 to 250, 10 to 100 and 2500 to 10,000 with mean values of 74, 54 and 5960 mg/kg respectively. Extractable vanadium levels in the surface horizons of the five profiles are 0.61, 1.2, 1.1, 0.66 and 0.20 mg/kg, while in the subsoils gleying has increased the values to 1.4, 3.3, 2.4, 0.17 and 7.3 mg/kg respectively. The surprisingly low extractable values in the subsoils of profile No. 57 of the Heavyside Series may be due to the rather higher pH of this profile, or to stronger absorption of mobilized vanadium by clay-sized particles.

Total lead contents of the subsoil range from 3 to 60, (mean 18 mg/kg). Total contents in the surface horizons are slightly greater at 15, 20, 30, 40 and 80 mg/kg respectively, with corresponding extractable levels of 0.28, 0.86, 0.81, 0.52 and 1.1 mg/kg.

Extractable zinc levels in the surface horizons are 1.3, 0.88, 1.9, 3.9 and 0.90 mg/kg. Mobilisation of zinc due to gleying in the subsoils of profiles 58, 78, 57 and 60 has increased extractable levels to maxima of 5.2, 7.8, 3.6 and 28.0 mg/kg respectively.

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. The trace element determinations were made spectrochemically according to the methods described by Mitchell (1964).

8. The mineralogy of the clay fractions was determined by differential thermal analysis and X-ray diffraction. Differential thermal curves were determined according to methods described, by Mitchell and Mackenzie (1959). Diffraction patterns of the soil clays were obtained using a Philips 1130/0 diffractometer with iron-filtered CoK_{α} radiation.

7. Vegetation

In prehistoric times, a large part of the area was covered with oak forest, hazel and alder scrub and extensive moorland. None of the original woodland survives today, the present broadleaved trees being planted as policies and shelterbelts by the estates in the 18th and 19th centuries (Leach, 1980). The vegetation is dominated now by arable cultivation and improved pastures to such an extent that, in north east Fife at least, heathlands and unimproved grasslands have been calculated to cover less than 0.1 per cent of the land surface (Nature Conservancy Council 1980). Large areas have been planted with conifers which have shaded out the semi-natural vegetation although, in the more mature plantations, a degree of redevelopment and stability has been attained.

Although confined to the basalt hills, the steep-sided valleys and the coastal strip, a wide range of plant communities has developed.

Broadleaved woodland is found along the many dens of Fife and is associated usually with old mill lades. As mentioned above, it occurs also as policies round the old mansions.

Rough grassland is found on the slopes of the Fife (basaltic hills and the Ochil Hills and the base status of the parent materials is reflected in the presence of the herb-rich elements of the grassland communities. Where seepage water passes over these base-rich rocks and flushes the slopes and hollows below, a range of sedge mires and swamp communities have developed. An oustanding site at Fleecefaulds includes cowslip (*Primula veris*), globeflower (*Trollius europaeus*), fragrant orchid (*Gymnadenia conopsia*), twayblade (*Listera ovata*), quaking grass (*Briza media*) and meadow oat (*Helictotrichon pratense*).

Moorland vegetation is now found mainly in the west of the area on the Cleish Hills with scattered fragments only elsewhere on the less-accessible hill slopes. Many of the lowland mosses have been cut-over in the past or planted with trees, and relatively few sites remain where the blanket bog vegetation is not disturbed. Typical blanket bog occurs still on parts of Din Moss and Moss Morran in the west and on Bankhead Moss in the east. Cranberry (*Vaccinium oxycoccus*) is present on some of the western sites. One small remnant of high-level peat on Mellock Hill is the only site of cloudberry (*Rubus chamaemorus*) in Fife.

Communities of dunes and salt marsh are particularly well-represented on Dumbarnie Links which is a station of the rare variegated horsetail (Eguisetum variegatum). The high shell content of the sand gives rise to species-rich dune slack vegetation that includes grass of Parnassus (*Parnassia palustris*), felwort (*Gentianella amarella*), frog orchid (*Coeloglossum viride*), northern fen orchid (*Dactylorchis purpurella*) and bog pimpernel (*Anagallis tenella*). Darnel fescue (*Catapodium marinum*) and sea wormwood (*Artemesia maritima*) occur on rocky promontories exposed to sea-spray.

Plant Communities

Woodland

About 6.6 percent (1982) of the area of Kinross and south Fife is under woodland, of which the greatest proportion is made up of coniferous plantations of Scots pine (*Pinus sylvestris*) and Sitka spruce (*Picea sitchensis*) with larches (*Larix* species) as a lesser element, notable examples being those of Glendevon Forest, Blairadam Forest and Edensmuir. Planting has been carried out both by the Forestry Commission and by private landowners. Beneath the more mature plantations, the changes in the vegetation cover have become relatively stablised and the communities can be considered as being semi-natural. The typical community on acid podzols is that of bell heather - Scots pine (*Erica cinerea* - *Pinus sylvestris* plantations), but conifers have been planted also on the sites of former oakwoods or on arable land, especially to the east, and the field layers have become dominated either by broadleaved grasses or by ferns, bramble (*Rubus fruticosus*)and raspberry (*R. idaeus*). The soils are usually brown forest soils.

Much of the broadleaved woodland was planted also as policies, shelter belts or hedgerows and included oak (*Quercus* species), ash (*Fraxinus excelsior*), wych elm (*Ulmus glabra*) and beech (*Fagus sylvatica*)

Gorse scrub (the *Pteridium aguilinum* - *Ulex europaeus* Association) is a common feature on the shallow brown forest soils of the igneous ridges and slopes where ploughing is impracticable and blackthorn scrub (the *Primula vulgaris* - *Prunus spinosa* Association) occurs in places on the same landform unit.

Class:	Querco - Fagetea	Br.-Bl. et Vl. 1937
Order:	Fagetalia sylvaticae	Pawlowskie 1928
Alliance:	Carpinion betuli	Oberd. 1953
Association:	Querco - Ulmetum glabrae	Birse et Robertson 1976

Elmwood (mixed deciduous woodland)

The best examples of this woodland association to be found, lie in the steep-sided dens so characteristic of the Fife countryside and on the precipitous slopes of the lava hills. Stands were recorded from Glen Farg, Dalachy Wood, Craighall Den and along the Kelty Burn. They are representative of the typical subassociation which lacks the presence of ramsons (*Allium ursinum*). The canopies are made up of a mixture of ash (*Fraxinus excelsior*), elm (*Ulmus glabra*) and sycamore (*Acer pseudoplatanus*) save for the stand at Kelty Burn where common or pedunculate oak (*Quercus robur*) is the only tree species.

Some fine specimens of common maple (*Acer campestre*) stand at the head of Craighall Den. The field layers are dominated by dog's mercury (*Mercurialis perennis*), enchanter's nightshade (*Circaea lutetiana*) or bluebell (*Endymion non-scriptus*). Slender false-brome (*Brachypodium sylvaticum*) is present in all but the Kelty Burn stand and hairy brome (*Zerna ramosa*) occurs in the Glen Farg woodland.

The soils are freely or imperfectly drained brown forest soils of moderate or high base status and belong to the Sourhope, Darleith and Rowanhill Associations.

Class:	Quercetea robori-petraeae Br.-Bl. et Tx. 1943
Order:	Quercetalia robori-petraeae Tx (1931) 1937 em. 1955
Alliance:	Quercion robori-petraeae (Malcuit 1929) Br.-Bl. 1932
Association:	Lonicero - Quercetum (Birse et Robertson 1976) Birse 1984

Southern oakwood

Woodland stands which are related to southern oakwood are scattered and fragmentary. One such in Glen Farg has bluebell (*Endymion non-scriptus*) in the field layer and can be classed as belonging to the subassociation with that species, although honeysuckle (*Lonicera periclymenum*), usually a constant species, is absent here. The canopy is a mixture of oak (*Quercus robur*) and common birch (*Betula pubescens*), and wild cherry (*Prunus avium*), sycamore (*Acer pseudoplatanus*) and ash (Fraxinus excelsior) are present also. There is a rich assemblage of herbs in the ground layer which includes wild strawberry (*Fragaria vesca*), barren strawberry (*Potentilla sterilis*) and yellow pimpernel (*Lysimachia nemorum*).

The soil is included in the Sourhope Association and is a freely drained brown forest soil of moderate base status.

A second stand was recorded in Humbie Wood where the conditions are much more acid and where there are far fewer species. The canopy is dominated by silver birch (*Betula pendula*) and the field layer by wavy hair-grass (*Deschampsia flexuosa*), creeping soft-grass (*Holcus mollis*), broad buckler-fern (*Dryopteris dilatata*) and wood-sorrel (*Oxalis acetosella*). Honeysuckle is present both as lianes and as dwarf shrubs.

The soil is imperfectly drained and podzolic and is a member of the Giffnock Association.

Class:	Molinio - Betuletea Pass. et Hofmann 1968
Order:	
Alliance:	
	the *Sphaghum palustre* - *Betula pubescens* Community Birse 1982

Common birch scrub

This community is commonly found in small, peat-filled basins in the north-west and is uncommon within the area. Two stands were recorded on Star Moss which, although not good examples of the typical community, have sufficient species similarity for them to be included here. The canopy is dominated by a mixture of common (*Betula pubescens*) and silver birch (*B. pendula*), and common sallow (*Salix cinerea atrocinerea*) is present as a shrub layer. The composition and cover of the field layer varies greatly across the moss; broad buckler-fern (*Dryopteris dilatata*) forms dominant clumps in places whereas the layer is almost absent elsewhere. Ground cover is similarly very variable with patches totally dominated by

hair moss (*Polytrichum commune*) and bog mosses (*Sphagnum* species). White sedge (*Carex curta*) and chickweed wintergreen (*Trientalis europaea*) are present.

Both stands occur on basin peat which has been cut-over at one time and is now much dried-out.

Grassland

Grassland communities can be divided into two broad categories: pastures dominated by broadleaved grasses associated with cultivation and semi-natural rough grazings associated with the unimproved upland areas. Pastures occur extensively throughout the area, whereas rough grassland is found mainly in the north-west and, elsewhere, on the isolated basalt hills.

Class:	Molinio-Arrhenatheretea Tx. 1937
Order:	Arrhenatheretalia *Pawl*. 1928
Alliance:	Cynosurion cristati Tx. 1947
Association:	Lolio-Cynosuretum (Br.-Bl. et De L. 1936) Tx. 1937
	Ryegrass - crested dog's-tail pasture

As might be expected in a largely arable area, rotational and long ley pastures figure prominantly among the grassland communities. The older, permanent pastures are characterized by the presence of field woodrush (*Luzula campestris*) and bird's-foot trefoil (*Lotus corniculatus*), with the moss *Rhytidiadelphus sguarrosus* in the ground layer. Stands were recorded from Bishop Hill, Vane, Scotlandwell, Moreland, Abbots Deuglie, Mid Dron Hill and Shire End on freely and imperfectly drained brown forest soils with a wide range in base status. A variant of this subassociation with yellow oat (*Trisetum flavescens*) occurs on more calcareous soils and this was found near Elie, on East Links and Chapel Ness, and at Mount Pleasant on windblown shelly sand.

The second subassociation is that of young, rotational pastures which contain annual (*Poa annua*) and rough meadow-grass (*P. trivialis*), timothy (*Phleum pratense*) and creeping buttercup (*Ranunculus repens*). This community was recorded at Fleecefaulds, Broomfield, Larennie, Greenhill, Kelty Burn, Camilla Loch, Loch Gelly and Moss Morran on brown forest soils of moderate or high base status, the level being due in part to the degree of cultivation. A variant on the more poorly drained soils comprises a wet pasture community with marsh foxtail (*Alopecurus geniculatus*) and this was noted at Kilnockiebank, West Feal, Balnethill, Grahamstone and Pilkham Hills.

Class:	Molinio-Arrhenatheretea Tx. 1937
Order:	Arrhenatheretalia Pawl. 1928
Alliance:	Cynosurion cristati Tx. 1947
	the *Galium saxatile* - *Poa pratensis* Community

Meadow grass - bent pasture

A community intermediate between rye grass - crested dog's tail pasture and bent-fescue grassland, meadow-grass - bent pasture, is dominated by broadleaved grasses and forms as a result of a decrease in the fertility of soils beneath the former community or an increase in grazing pressure and dunging on the latter. Because of its origins, the community is found either in association with arable land or on favoured, sheltered areas of the hills where animals tend to congregate. Stands typical of the community were recorded on Largo Law and West Lomond and at Cleish and Stronachie. Further records which were not included in the floristic tables

but which show close similarity in their species content were noted on Bishop Hill and Roscobie Hills and at Vane, Dunmore, Steelend, Easter Cairn, Warroch, Tarhill and Lochelbank.

The soils are freely drained brown forest soils of the Darleith and Sourhope Associations, but stands were found also on Eckford, Rowanhill and Giffnock soils and on alluvium.

Class:	Nardo-Callunetea Prsg. 1949
Order:	Nardetalia Prsg. 1949
Alliance:	Nardo-Galion saxatilis Prsg. 1949
Association:	Achilleo-Festucetum tenuifoliae Birse et Robertson 1976 em Birse 1980

Bent - fescue grassland

This dry, rough grassland represents some of the best natural grazings of the uplands, occurring mainly on the steep slopes of valley sides, summits and corrie walls. It is a community dominated by fine-leaved grasses and, although widely distributed within the area, it is extensive only in the north-west. Two subassociations have been recognised which are related to the nature of the underlying soils. The first, the subassociation with wild thyme (*Thymus drucei*) is a herb-rich community found on soils of a higher base status than those of the second. Stands were recorded from Lendrick Hill, Stronachie, Shire End and Balnethill. The species list from Balnethill site includes rockrose (*Helianthemum chamaecistus*). The soils are freely drained brown forest soils of the Kippen and Sourhope Associations.

The second, typical subassociation is more widespread and extensive than the first. Records of this acid grassland community were taken from West Feal, Bishop Hill, White Craigs, Dron Hill, Dunmore and Moreland.

A variant dominated by bracken (*Pteridium aquilinum*) was recorded on Vane Hill. The soils are usually freely drained brown forest soils of the Darleith, Sourhope, Giffnock and Kippen Associations, but the stand on Bishop Hill was found on a cultivated peaty podzol.

Class:	Nardo-Callunetea Prsg. 1949
Order:	Nardetalia Prsg. 1949
Alliance:	*Nardo*-Galion saxatilis Prsg. 1949
Association:	Junco squarrosi - Festucetum tenuifoliae Birse et Robertson 1976 em. Birse 1980

Heath rush - fescue grassland

A second commonly-encountered association of upland areas is found on the peaty soils of gentle slopes and rounded summits. It comprises two principal communities of white bent (*Nardus*) and flying bent (*Molinia*) grassland. The subassociation with dominant white bent is much the more common of the two within the area and occurs extensively on the Ochil Hills. Stands were recorded on Innerdouny Hill, Lendrick

Hill, Cock Law, Easter Cairn, Craigmead, Benarty, Vane Hill and West Lomond and at Kinneston, Balnethill, Warroch, Cleish, Stronachie, Loch Glow and Dowhill Muir. The soils are either freely drained brown forest soils, often with a humose surface horizon, or imperfectly drained peaty podzols of the Darleith, Sourhope and Kippen Associations.

A second subassociation with dominant flying bent occurs much more locally and is found also mainly in the north-east. These sites represent the easternmost distribution of an extensive and widespread community of northern and western Scotland. The community was found on Lendrick Hill, Dowhill Muir and Craigencat and at Cleish and Stronachie. Soils are less well drained than those of the white bent community, being either, imperfectly drained peaty podzols, poorly drained peaty gleys or peat. The sites were located on soils of the Darleith, Sourhope and Giffnock Associations.

Class:	Festuco-Brometea Br.-B1. et Tx. 1943
Order:	Brometalia erecti Br.-Bl. 1936
Alliance:	Mesobromion Br.-Bl. et Moor 1938 em. Oberd. 1949
	the *Galium verum – Koeleria cristata* Community Birse 1980

Crested hair-grass grassland

A species rich, dry grassland associated with basic lava outcrops is found locally on the Fife basaltic hills. It is characterised by the presence of crested hair-grass (*Koeleria cristata*) and lady's bedstraw (*Galium verum*) and shows close affinities with both the herb-rich form of bent-fescue grassland and red fescue dune pasture.

The community was recorded on the Roscobie and Pilkham Hills and at Kinneston, Pinnels and Abbots Deuglie on freely drained brown forest soils of the Darleith and Sourhope Associations. The base status of these soils is moderate or high in places.

Rush Pastures

Pastures dominated by rushes are a feature of fine-textured, poorly drained soils. They are confined to flush channels and alluvial flats within the arable areas, but are more extensive on the lower hill slopes outwith the influences of cultivation. Two principal associations have been separated, the first dominated by sharp-flowered rush (*Juncus acutiflorus*) and the second by soft rush (*J. effusus*).

Class:	Molinio - Arrhenatheretea Tx. 1937
Order:	Molinietalia W. Koch 1926
Alliance:	Juncion acutiflori Br.-Br. 1947
Association:	Potentillo - Juncetum acutiflori Birse et Robertson 1976 em. Birse 1980

Sharp-flowered rush pasture

This is a widespread and extensive community of the south-west and west, but is more local elsewhere. The releve's recorded in Fife and Kinross are included in the more base-rich subassociation with marsh willow-herb (*Epilobium palustre*). Also present in this vegetation are rough meadow-grass (*Poa trivialis*), Yorkshire fog (*Holcus lanatus*), common sedge (*Carex nigra*), marsh bedstraw (*Galium palustre*) and both creeping (*Ranunculus repens*) and meadow buttercup (*R. acris*). The dominant tufts of sharp-flowered rush do not form such dense tussocks as those of soft rush and die back during the winter.

The subassociation was recorded predominantly in the west at Warroch, Whitehill, Shire End, Craigencat, Vane, Moreland, Pilkham Hills, Miller's Loch and Fleecefaulds on poorly drained noncalcareous gleys, peaty gleys of a range of soil associations and peat.

Alliance:	Calthion Tx. 1937 the *Ranunculus repens - Juncus effusus* Community Birse et Robertson 1976

Soft rush Pasture

Vegetation dominated by soft rush forms a much less extensive community than that of sharp-flowered rush and it is confined to alluvial flats and flushed channels. Soft rush also invades pastures in which the drainage systems have become blocked and the tussocks follow the lines of the drainage ditches. Although a not uncommon community within the area, only one stand was recorded - at Red House on an alluvial peaty gley.

Sedge Mires

Sedge mires are very limited in their areal extent and are confined usually to narrow channels associated with peat mosses or hill flushes. A number were recorded from the district, mostly from the hills to the west.

Class:	Caricetea nigrae (Nordh. 1936) .Den Held et Westh. 1969
Order:	Caricetalia nigrae (W. Koch 1926) Tx. 1955
Alliance:	Caricion curto-nigrae W. Koch 1926 em. Nordh. 1936
Association:	Caricetum echinato-paniceae (Birse et Robertson, 1976) Birse 1980

Star Sedge Mire

A community of acid peat and peaty gleys in channels and on flushed slopes characterized by the dominance of sedges (*Carex*. species) in the vegetation, especially star sedge (*Carex echinata*), carnation-grass (*C. panicea*) and common sedge (*C. nigra*), and with an underlying carpet of bog mosses (*Sphagnum* species).

Stands were recorded from the Cleish Hills and Benarty on peat and these differ slightly from the general description in that the moss cover is very low.

Association: Sphagno - Caricetum curtae Pass. 1964

White Sedge mire

This vegetation is found on flushed acid basin peat, often associated with loch margins, and consists of open stands of white sedge (*Carex curta*) in dense carpets of bog moss (*Sphagnum recurvum*). Bottle sedge (*C. rostrata*) and common cotton-grass (*Eriophorum augustifolium*) are two of the few other plants present in this species-poor community which was recorded round the edges of the Dow and Lurg lochs and in a wet depression on West Lomond.

Association: Caricetum diandrae Jonas 1932 em. Oberd. 1957

Lesser fox sedge swamp

A community of small peat-filled basins in which the peat forms a floating mat in places. The vegetation comprises fairly dense stands of lesser fox sedge. (*Carex diandra*), together with bogbean (*Menyanthes trifoliata*) and marsh cinquefoil (*Potelitiila palustris*). One stand was recorded from the infilled loch at Pitkeathly.

Order:	Tofieldietalia Prsg. apud Oberd. 1949
Alliance:	Eriophorion latifolii Br.-Bl. et Tx. 1943
Association:	Caricetum hostiano-pulicaris (Birse et Robertson 1976) Birse 1980

Flea-sedge mire

Flea-sedge mire is a more base-rich community of flushed hill slopes on noncalcareous gleys, peaty gleys and peat. The vegetation is dominated by sedges (*Carex* species) which include tawny sedge (*C. hostiana*), flea-sedge (*C. pulicaris*) and carnation-grass (*C. panicea*), and grasses such as white bent (*Nardus stricta*), sheep's fescue (*Festuca ovina*) and flying bent (*Molinia caerulea*) are locally abundant.

Two stands were recorded on humic gleys, one on an alluvial soil near Innerdouny Hill and the other on a soil of the Kippen Association at Balnethill. In both stands, the other sedge known as carnation-grass or glaucous sedge (C. flacca) is present also.

Association:	Carici dioici - Eleocharitetum quinqueflorae (Birse et Robertson 1976) Birse 1980

Few-flowered spike-rush mire

This mire is found on the bottom of flush channels and is the most base-rich of the sedge communities described here. The vegetation comprises open stands of few-flowered spike-rush and sedges such as dioecious sedge (*Carex dioica*), tawny sedge (*C. hostiana*), carnation-grass (*C. panicea*) and common yellow sedge (*C. demissa*). The moss *Drepanocladus revolvens* is the abundant species of the ground layer.

The stands recorded in the district are included in the subassociation with yellow mountain-saxifrage (*Saxifraga azoides*), the most base-rich of the two subassociations and associated with calcareous seepage. The community was found near Innerdouny Hill and at Pitkeathly Loch and a third stand of closely-allied vegetation was recorded on Benarty. All three stands were recorded on flushed peat.

Class:	Scheuchzerietea palustris Den Held, Barkman et Westh. 1969
Order:	Scheuchzerietalia palustris Nordh. 1936
Alliance:	Rhynchosporion albae W. Koch 1926
Association:	Caricetum limosae Osv. 1923 em. Dierss. 1978

Mud sedge mire

This vegetation occurs in pools and channels in peat mosses and comprises open stands of mud sedge (*Carex limosa*), together with bogbean (*Menyanthes trifoliata*), marsh cinquefoil (*Potentilla palustris*) or bottle sedge (*C. rostrata*). There is usually a dense mat of submerged mosses.

Stands were recorded at Dow Loch and Pitkeathly Loch on basin peat.

Swamp

Swamp communities are found on the low-lying, waterlogged ground around the margins of the many small lochs and reservoirs. Some areas, such as that round the mouth of the Cocklemill Burn near Elie, are particularly extensive. The more common of these communities are described briefly below and further communities are listed in Appendix V.

Class:	Phragmitetea Tx. et Prsg. 1942
Order:	Phragmitetalia W. Koch. 1926
Alliance:	Magnocaricion W. Koch. 1926
Association:	Caricetum rostratae Rubel 1912

Bottle sedge swamp

Vegetation of loch margins and wet depressions on peat and peaty gleys of moderate to high base status. Tall, open stands of bottle sedge (*Carex rostrata*) with bogbean (*Menyanthes trifoliata*), marsh cinquefoil (*Potentilla palustris*) and water horsetail (*Equisetuin fluviatile*).

Stands were recorded on basin peat at Tarhill, Loch Leven and beside Miller's Loch and Dow Loch.

Association: Lysimachio - Caricetum aquatilis Neumann 1957

Water sedge swamp

Vegetation of loch margins and peat-filled depressions on. peat and peaty gleys of high base status. Tall, often dense stands of water sedge (*Carex aquatilis*).

The community was found at Loch Fitty on an alluvial soil with a humic top and at Dow Loch on basin peat.

Association: Phalaridetum aründinaceae Litt 1931

Reed-grass swamp

This is a common community of alluvial flats and basin peat alongside ponds and ditches. The vegetation comprises dominant stands of reed-grass up to 1.5 metres tall, with an understory of meadow-sweet (*Filipendula ulmaria*), marsh marigold (*Caltha palustris*) or yellow flag (*Iris pseudacorus*). There is usually very little ground cover.

Stands were recorded from Cullaloe Reservoir, Warroch, Lochend, Loch Fitty, Cocklemill Burn and Loch Leven on poorly drained alluvial soils and at Loch Fitty on basin peat.

Community: the *Eleocharis palustris* Community

Common spike-rush swamp

Another species-poor community of loch margins and wet depressions on basin peat and subaqueous soils. Open stands of common spike-rush (*Eleocharis palustris*), with scattered plants of water mint (*Mentha aquatica*), water horsetail (*Equisetum fluviatile*), or marsh marigold (*Caltha palustris*).

The community was recorded from Camilla Loch on subaqueous peat.

Alliance:	Phragmition
Association:	Phragmitetum conmunis Schmale 1939

Reed Swamp

This community is found growing in standing water at the edges of lochs, streams and ditches. The vegetation is dominated by stands of reed (Phragmites communis) over 2 metres tall, with an understory of meadow-sweet (*Filipendula ulmaria*) in places.

One stand was recorded at the edge of Loch Fitty on a very poorly drained alluvial soil with humic top.

Class:	Molinio - Arrhenatheretea Tx. 1931
Order:	Molinietalia W. Koch. 1926
Alliance:	Filipendulion (Br.-Bl. 1947) Lohm. 1967
Association:	Valeriano - Filipenduletum Siss. 1946

Meadow-sweet meadow

Meadow-sweet meadow is a commonly-found community of flushed gentle slopes and wet alluvial flats on soils of high base status, often with organic surface horizons. The vegetation is dominated by meadow-sweet (*Filipendula ulmaria*), with valerian (*Valeriana officinalis*), soft rush (*Juncus effusus*) or tussock-grass (*Deschampsia flexuosa*) abundant in places.

The community was recorded at Fleecefaulds on a humic gley of the Rowanhill Association and on a very poorly drained alluvial soil with organic top beside the Cocklemill Bum.

Springs/Aquatic Communities

There are a number of communities of spring and standing water within the district, but these do not bear any relationship to the soils that have been mapped and are therefore not described here. They are listed in Appendix V.

Maritime Cummunities

The best-developed and most extensive area of maritime vegetation is to be found on Dumbarnie Links and the neighbouring dune systems. The full succession from foreshore, through foredunes and yellow dunes to dune pasture is present and there are a number of dune slack and saltings communities.

Fore shore

Class:	Cakiletea maritimae Tx. et Prsg. 1950
Order:	Cakiletalia maritimae Tx. apud Oberd. 1949
Alliance:	Salsolo - Honkenyion peploidis Tx. 1950
Association:	the *Salsola Kali - Atriplex glabriuscula* Association Tx. 1950

Orache strand-line

This vegetation is found on a mixture of organic debris and sand just above the high water mark. It comprises nitrogen-loving plants, usually annuals, and is dominated by orache species (*Atriplex glabriuscula*, *A.hastata*, *A.laciniata*) and sea rocket (*Cakile maritima*).

The stand on the shore-line at east Links, Elie, contains the oraches *A. glabriuscula* and *A. hastata*, sea rocket and sand couch-grass (Agropyron junceiforme).

Dunes

Class:	Ammophiletea arenariae Br.-Bl. et Tx, 1943
Order:	Ammophiletalia arenariae Br.-B1. (1931) 1933
Alliance:	Agropyrion junceiformis Pignatti 1953
Association:	Elymo-Agropyretum boreo-atlanticum Tx. (1937) 1967

Northern sand couch-grass dune

A community of the foredunes on raw aeolian sand where the vegetation is subjected to constant build-up and erosion of the substrate. The dominant plant is sand couch-grass (*Agropyron junceiforme*), whose long, string-like rhizomes help to bind the sand. Lyme-grass (*Elymus arenarius*) is present in places and the only other plant that is at all frequent is sea sandwort (*Honkenya peploides*).

Releve's were recorded from Dumbarnie Links and from east Links, Elie, on shelly sand.

Alliance:	Ammophilion borealis Tx. (1945) 1952.
Association:	Elymo-Ammophiletum Br.-Bl. et De L. 1936

Northern rnarram grass dune

This is the northern community of actively-building dunes and dune ridges, again on raw aeolian sand. The dominant species is usually marram grass (*Ammophila arenaria*), widely used as a sand-binding agent, but lyme-grass (*Elymus arenarius*) is the more abundant species in a few places. The hairy form of red fescue (*Festuca rubra arenaria*) and smooth meadow-grass (*Poa pratensis*) are present on the more mature dunes.

Stands were recorded oneast Links, Elie,and Dumbarnie Links on shelly sand.

Class:	Sedo-Scleranthetea Br.-Bl. 1955
Order:	Festuco-Sedetalia Tx. 1951
Alliance:	Koelerion albescentis Tx. 1937
Association:	Astragalo-Festucetum arenariae (Westhoff et Tx. MS.) Birse l980

Milk-vetch - red fescue dune

Vegetation of grey or fixed dunes on the eastern seaboard on immature sandy soils with some horizon development. The community comprises a relatively closed turf of grasses and herbs. The most abundant of the grasses are sheep's fescue (*Festuca ovina*), red fescue (*F.rubra*, including var. *arenaria*) and smooth meadow-grass (*Poa pratensis*). Birdsfoot-trefoil (*Lotus corniculatus*) and milk vetch (*Astragalus danicus*) are present.

The stands on east Links, Elie, Dumbarnie Links and St. Ford Links are all representative of the subassociation with purging flax (*Linun catharticum*). Wild thyme (*Thymus drucei*), lady's bedstraw (*Galium verum*) and crested hair-grass (*Koeleria cristata*) are present also. Cowslip (*Primula veris*) is abundant on east Links and frog orchid (Coeloglossum viride) occurs on Dumbarnie and St. Ford. The soils are calcareous regosols of the Fraserburgh Association.

Dune slacks

Class:	Caricetea nigrae (Nordh. 1936) Den Held et Westh. 1969
Order:	Tofieldietalia Prsg. apud Oberd. 1949
Alliance:	Eriophorion latifolii Br.-Bl. et Tx. 1943
Association:	the Anagallis tenella - Equisetum variegatum Association Birse 1980.

Variegated horse-tail dune slack

A very local community of wet depressions behind coastal dunes and on low raised beaches which is confined to Fife and west Lothian. The calcicole vegetation is species-rich and includes variegated horse tail (*Equiseturn variegatum*), bog pimpernel (*Anagallis tenella*) and grass of Parnassus (*Parnassia palustris*). Sheep's fescue (*Festuca ovina*), red fescue (*F. rubra*) and carnation-grass (*Carex flacca*) are abundant usually.

Three releves were recorded from Dumbarnie Links on calcareous gleys of the Fraserburgh Association. Northern fen orchid (*Dactylorchis purpurella*) and felwort (Gentianella amarella) are present.

Class:	Molinio-Arrhenatheretea Tx. 1937
Order:	Trifolio fragiferi - Agrostietalia Oberd. 1967 em. Tx. 1970
Alliance:	Agropyro - Rumicion Nordh. 1940
Community:	the *Potentilla anserina* - *Carex nigra* Commiunity Birse 1980

Silverweed dune slack

A common community of wet depressions behind dune systems and on low raised beaches with high water tables. The vegetation comprises a closed sward of sedges, grasses and forbs of which common sedge (*Carex nigra*), carnation-grass (*C. flacca*), fiorin (*Agrostis stolonifera*), red fescue (*Festuca rubra*), pennywort (*Hydrocotyle vulgaris*) and silverweed (*Potentilla anserina*) are the most abundant species.

The stand on Dumbarnie Links was recorded on a poorly drained saline alluvial soil with an organic top. It is not typical of the community as carnation-grass is absent and the dominant species is brown sedge (*Carex disticha*). Adder's tongue (*Ophioglossum vulgatum*) and variegated horsetail (*Equisetum variegatum*) are present.

Saltings

Class:	Asteretea tripolii Westhoff et Beeftink 1962
Order:	Glauco-Puccinellietalia Beeftink et Westhoff 1962
Alliance:	Puccinellietom maritimae Christiiansen 1927 em. Tx. 1937*
Association:	Puccinellietum maritimae (Warming 1890) Christiansen 1927

Sea poa salt-marsh

Where the saline alluvial soils of estuaries have become stablised, the salt-marsh communities that develop are dependent on their position in relation to the high water mark. The sea poa salt-marsh community colonises an area from just below to just above this feature. The vegetation comprises a short turf dominated by sea poa (*Puccinellia maritima*) or by sea plantain (*Plantago maritima*) and sea pink (*Armeria maritima*).

Releves were recorded from the saltings at the mouth of the Cocklemill Burn and on small patches of saline alluvium lying between the rock ridges on east Links, Elie. Sea poa dominates, sea mulkwort (*Glaux maritima*) is abundant and greater sea-spurrey (*spergularia media*) is present.

Alliance:	Armerion maritimae Br.-Bl. et De L. 1936
Association:	Juncetum gerardii Warming 1906

Mud rush salt-marsh

Vegetation of estuarine soils at levels slightly above those of sea poa salt-marsh and also on low cliffs exposed to sea-spray. The community forms a closed sward dominated by mud rush (*Juncus gerardii*), red fescue (*Festuca rubra*), fiorin (*Agrostis stolonifera*) or sea plantain (*Plantago maritima*).

The stands at Cocklemill Burn and on the rocky shore of east Links, Elie, include sea pink (*Aremeria maritima*), sea arrow-grass (*Triglochin maritima*) and abundant sea milkwort (*Glaux maritima*).

Class:	Bulboschoenetea maritimi Vicherek et Tx. 1969
Order:	Bulboschoenetalia maritimi Hejny 1962 MS.
Alliance:	Bulboschoenion maritimi Soo (1945) 1947
Association:	Scirpetum maritimi (Br.-Bl. 1931) Tx. 1937

Sea club-rush salt-marsh

This is a community of saline alluvial soils in channels and depressions to the rear of salt-marshes where there is flushing with brackish water. The vegetation is dominated by tall stands of sea club-rush (*Scirpus maritimus*).

A releve was recorded from the salt-marsh on the Cocklemill Burn on a saline alluvial soil with an organic surface horizon.

Splash zone

Class:	Asteretea tripolii Westhoff et Beeftink 1962
Order:	Glauco-Puccinellietalia Beeftink et Westhoff 1962
Alliance:	Puccinellion maritimae Christiansen 1927 em. Tx. 1937
Community:	the *Plantago coronopus* Community Birse ital. 1980

Plantain cliff-top pasture

Vegetation of very shallow, humic soils on sea cliffs and rock ledges influenced by sea-spray. The community comprises a very short sward of sea plantain (*Plantago maritima*). Buck's-horn plantain (*P.coronopus*), red fescue (*Festuca rubra*) and sea pink (*Armeria maritima*).

A stand was recorded on the rocky shore at east Links. Elsewhere, in the near vicinity, this community includes the grass Darnel poa (*Catapodium marinun*), and sea wormwood (*Artemesia maritima*) was found in a similar habitat on Chapel Ness.

Moorland

Moorland communities are very restricted both in their distribution and areal extent within the area due to the pressures of cultivation, forestry plantings and hill grazing. Fragments of a formerly much more extensive, heather-dominated vegetation remain only in a few localities where uneven topography precludes surface improvement or where there are still relatively undisturbed peat deposits. These tend to be concentrated on the rocky summits of the higher hills such as the Lomonds and the Ochil Hills and peat mosses such as Din Moss and Moss Morran in the west and Bankhead Moss in the east.

Class:	Nardo-Callunetea Prsg. 1949
Order:	Calluno-Ulicetalia (Quantin 1935) Tx. 1937
Alliance:	Ulicion gallii Des Abb. et Corillion 1949
Association:	Carici binervis - Ericetum cinereae Br.-Bl. et Tx. (1950) 1952 em. Birse 1980

Atlantic heather moor

This dry or moist moorland vegetation is associated with lower altitudes than its boreal counterpart and is found usually below 400 metres. The presence of brown bent-grass (*Agrostis canina montana*), white bent (*Nardus stricta*) and heath-grass (*Sieglingia decumbens*) differentiates this community from the latter. The soils are brown forest soils, humus-iron podzols and peaty podzols.

Stands were noted on Benarty, Vane Hill and Purin Hill and at Stronachie and Pitkeathly Loch. The releves recorded are not typical examples of the community as the above-mentioned grass species are absent or present rarely. The species poor vegetation comprises dominant heather (*Calluna vulgaris*) with abundant blaeberry (*Vaccinium myrtillus*) and frequent wavy hair-grass (*Deschampsia flexuosa*). The soils belong to the Darleith, Sourhope and Kippen Associations and are shallow on rock in places.

Class:	Nardo-Callunetea Prsg. 1949
Order:	Calluno - Ulicetalia (Quantin 1935) Tx. 1937
Alliance:	Empetrion boreale Bocher 1943
Association:	Vaccinio - Ericetum cinereae Birse et Robertson 1976 em. Birse 1980

Boreal heather moor

Dry and moist moorland vegetation of the higher hills and more exposed sites is classed as boreal heather moor. It is a community dominated by dwarf shrubs which include (*Calluna vulgaris*), cowberry (*Vaccinium vitis-idaea*), blueberry (*V. myrtillus*), bearberry (*Arcostaphylos uva-ursi*) and crowberry (*Empetrum nigrum*). It occurs on the same range of soils as that of the Atlantic heather moor, with the addition of subalpine soils.

Stands were recorded on West lomond and on the hills behind Warroch on soils of the Darleith and Sourhope Associations. Heather, cowberry, blueberry and

crowberry dominate the field layer and wavy hair-grass (*Deschampsia flexuosa*) is present.

Order:	Nardetalia Prsg. 1949
Alliance:	Nardo-Galion saxatilis Prsg. 1949
Community:	the *Rhytidiadelphus loreus* – *Vacinnium myrtillus* Community Birse 1980

Blaeberry Heath

Blaeberrry Heath is found typically on steep slopes of corrie walls, snow hollows and valley sides on a wide range of soils which often have been influenced by colluviation. The community comprises dense stands of blueberry (*Vaccinium myrtillus*), with scattered plants of wavy hair-grass (*Deschampsia flexuosa*) and heath bedstraw (*Galium saxatile*).

Stands were recorded on the steep slopes of White Craigs, East and West Lomond and Cowden Hill on freely drained brown forest soils and shallow podzolic soils of the Darleith Association. These releves are classed as part of the typical subcommunity of lower altitudes where stiff sedge (*Carex bigelowii*) is absent.

Blanket and raised bog

Vegetation of unflushed basin and blanket peat is characterised by the presence of cotton-grass (*Eriophorum vaginatum*) and bog mosses (*Sphagnum* species). The canopy is dominated usually by heather (*Calluna vulgaris*) and bog heather (*Erica tetralix*), and deer-grass (*Trichophorum cespitosum*) is present in places.
There are few areas of peat that have not been affected by cutting-over or by forestry plantings, but a few sites do remain, preserved by a history of land management or as nature reserves, where the vegetation remains relatively ‘natural’. Two releves of the typical or lowland subassociation were recorded on Din Moss where the vegetation is remarkable for the presence of cranberry *(Vaccinium ocycoccus*). The ground layer of one stand is dominated by the bog moss *Sphagnum recurvum*. Stands related to but not typical of the lowland subassociation were noted also on the blanket peat around Lurg Loch and on Bankhead Moss and Moss Morran. *Sphagnum recurvum* is an abundant element of the ground ayer at the first two sites and cranberry is also present at Lurg Loch.
The subassociation with hook moss (*Rhytidiadelphus loreus*) is characteristic of more upland sites. The presence of hook moss and crowberry (Empetrum nigrum) differentiate it from the lowland subassociation. Releves were recorded from the higher hill slopes above Stronachie and Lurg Loch, where blaeberry (*Vaccinium myrtillus*), wavy hair-grass (*Deschampsia flexuosa*) and common sedge (*Carex nigra*) are present also.

Oroarctic (Mountain)

On the highest hills and mountains, where the degree of exposure, the severity of the climate and the nature of the soils attain a certain, critical level, the vegetation becomes markedly wind-cut and is covered in places by snow for several months of the year. Both grassland and moorland mountain communities develop in such an environment, although these are very localised and inextensive within the area.

Class:	Nardo - Callunetea Prsg. 1949
Order:	Nardetalia Prsg. 1949
Alliance:	Nardion Br.-Bl. 1926
Association:	the *Carex bigelowii* - *Festuca vivipara* Association (Birse et Robertson 1976) Birse 1980

Stiff sedge - fescue grassland

This grassland community is found on the gentle slopes and summits of the high hills where there is some snow cover during, the winter. The vegetation is dominated by white bent (*Nardus stricta*), heath rush (*Juncus sguarrosus*), stiff sedge (*Carex bigelowii*), viviparous fescue (*Festuea vivipara*) or tussock-grass (*Deschampsia cespitosa*). The soils are subalpine or alpine.

A stand on Lendrick Hill dominated by heath rush is closely related to the association but not typical. Other species present include common sedge (*Carex nigra*) wavy hair-grass (*Deschanipsia flexuosa*) and blaeberry (*Vaccinium myrtillus*). The soil is shallow peat on rock.

Class:	Oxycocco - Sphagnetea Br.-Bl. et Tx. 1943
Order:	Sphagnetalia fusci Tx. (1970) 1972
Alliance:	Sphagnion fusci Br.-Bl. 1920
Association:	Rhytidiadelpho - Sphagnetum fusci (Birse et Robertson 1976) Birse 1980

Mountain Blanket bog

Vegetation on peat of the saddles and gentle summit slopes of high hills and mountains is characterised by the presence of cloudberry (*Rubus chamaemorus*). Both hook moss (*Rhytidiadelphus loreus*) and crowberry (*Empetrum nigrum*) are present, as in upland blanket bog.

The community was recorded on a much-eroded peat remnant on the upper slopes of Mellock Hill.

The Relationship between Soils and Vegetation

There is a clear relationship between soils and the plant communities that develop on them. Soil is, however, only one element of many that constitute the environment and some vegetation types are found on a wide range of soils where some other factor such as climate exerts the dominating influence on the distribution of plant communities. Conversely, in some instances, several different communities can be found on one soil type. This is due, in part, to the influences of management on the vegetation whereby a particular site can carry woodland, moorland or grassland depending on management policy.

The major soil subgroups and variants distinguished in the area are considered in terms of plant communities associated with them, both in the context of data collected from the whole of Scotland and of stands recorded locally from within the survey area. Some indication of the properties of these soils is given. The subdivisions of subgroups are based principally on levels of base saturation which appear to exert a critical influence on the form of vegetation that is present (Birse and Robertson 1976). Soils of very small areal extent and variants of subgroups have not been mapped and therefore do not appear in the legend of the 1:63 360 soil map. They are, however, included in this account because of the distinctive plant communities that are found on them and are discussed under the subgroup to which they belong. The soil association on which the stands of vegetation were recorded are given in brackets.

Brown Earths

Brown earths are extensive within the area but are cultivated widely and are only undisturbed on sites such as steep valley slopes and rocky terrain where improvement has not been possible.

Brown Forest Soils – of moderate or high base status (BFS)

These soils are defined as having a base saturation of over 50 per cent in the surface of the A horizon, but generally the values recorded are well above this figure and, in some instances, the horizon is fully saturated. The soils are freely drained. The plant communities most often found on these soils are broadleaved woodland – usually Elmwood (Querco - Ulmetum glabrae), pastures and herb-rich bent-fescue grassland (part of Achilleo - Festucetum tenuifoliae).

Stands of elmwood were recorded in Craighall Den, Dalachy Wood and Glen Farg on soils of the Darleith, Rowanhill and Sourhope Associations. One record of southern oakwood with bluebell (part of Lonicero - Quercetum) was noted in Glen Farg. Permanent pasture (part of Lolio - Cynosuretum) occurs at Scotlandwell (Kippen Association) and at Moreland (Hindsward Association) and crested hair-grass grassland (the *Galium verum – Koeleria cristata* Community), vegetation of more base-rich sites, was recorded at Pinnels (Darleith Association).

A shallow phase pf this soil type on rock (BFL) was noted also under permanent pasture on east Links (Darleith Association).

Brown forest soils – of low base status (BP)

Brown forest soils with a base saturation of less than 50 per cent in the surface of the A horizon are considered to be low base status soils. Base saturations of less than 10 per cent have been recorded from several sites throughout the country and, in most cases, the values are below 30 per cent. A thin, but well-developed, black humus horizon is present in places overlying the surface mineral horizon. The soils are freely drained.

Plant communities occurring on these soils are typically the associations of broadleaved woodland – mainly oak and birch, some pastures, common bent-fescue grassland (part of Achilleo - Festucetum tenuifoliae) and herb-rich heather moors. This soil type is widespread on the hill slopes of the area and carries permanent pasture (part of Lolio - Cynosuretum), meadow-grass – bent pasture (the *Galium saxatile – Poa pratensis* Community), crested hair-grass grassland (the *Galium verum – Koeleria cristata* Community), the herb-rich, common and bracken-dominated forms of bent-fescue grassland and white bent grassland (part of Junco squarrosi – Festucetum tenuifoliae). The soils are predominantly those of the Darleith and Sourhope Associations.

A shallow variant of this soil type on rock (BPL) was recorded under dry Atlantic heather moor (part of Carici binervis – Ericetum cinereae) on Benarty (Darleith Association) and under white bent grassland on Lendrick Hill (Sourhope Association).

Brown forest soils with gleying – of moderate or high base status (GBS)

This group of soils is characterised by having base saturation levels of 40 per cent or more in the surface of the A horizon and by the gley features in the B and C horizons. The soils are imperfectly drained.

The related plant communities are those that occur also on the freely drained brown soils. However, the only stands of vegetation recorded in the area were those of ley pasture (part of Lolio – Cynosuretum) at Broomfield (Darvel Association) and near the Kelty Burn (Sourhope Association).

Brown forest soils with gleying – of low base status (GBP)

Low base status brown forest soils with gley features in the B and C horizons have base saturation levels of less than 40 per cent in the surface of the A horizon. The soils are imperfectly drained.

As with the higher base status group, the communities found on these soils are mainly those of the corresponding freely drained soils. Pastures, both ley and permanent (Lolio – Cynosuretum), are the predominant communities within the area, mostly on soils of the Sourhope Asspciation. Stands of Elmwood (Qureco – Ulmetum glabrae) were recorded beside Kelty Burn and in Glen Farg (both Sourhope Association) and an example of common bent-fescue grassland (part of the Achilleo – Festucetum tenuifoliae) was noted at Steelend (Rowanhill Association).

Podzols

These acid soils are confined mostly to the hills of the district.

Humus-iron Podzols (HIP)

Humus-iron podzols have base saturation levels of 30 per cent or less in their H horizons or surface mineral layers. The soils are freely drained.

Associated plant communities are acid woodland, rough grassland and moorland. No stands of woodland were noted within the area on these soils, but common white bent grassland (part of Junco squarrosi – Festucetum tenuifoliae) was recorded on Bishop Hill (Kippen Association), dry Atlantic heather moor (part of Carici binervis – Ericetum cinereae) on Purin Hill (Darleith Association) and dry boreal heather moor (part of Vaccinio-Ericetum cinereae) on West Lomond (Darleith Association). Dry Atlantic heather moor was noted also from Vane Hill on a shallow phase of this soil type (HIL)

Podzols with gleying (GP)

Imperfectly drained podzols have base saturation levels of less than 20 per cent in the H horizon or surface of the mineral layer.

The plant communities are those that are found also on the freely drained podzols but there is a tendency for the wetter elements of the associations to be present. One stand of grassy southern birchwood (part of Lonicero – Quercetum) was recorded in Humbie Wood and common white bent grassland (part of Junco squarrosi – Festucetum tenuifoliae) was noted on Dowhill Muir (both Giffnock Association).

Peaty Podzols (PP)

Peaty podzols have base saturation levels of less than 20 per cent in their organic surface horizons. The soils are usually imperfectly drained above the iron pan, although in some cases the degree of gleying is extreme and the upper horizons are poorly drained.

Communities associated commonly with these soils are common white bent grassland (part of Junco squarrosi – Festucetum tenuifoliae), the moist facies of heather moors, bog heather moor (Narthecio – Ericetum tetralicis) and native pinewood (Pinetum scoticae). In the Fife/Kinross area, the representative community is that of common white bent grassland, which was recorded in the hills at Stronachie, Warroch and Glen Devon (Sourhope Association) and on West Lomond, White Craigs and the Cleish Hills (Darleith Association). One stand of common bent-fescue grassland (part of Achilleo – Festucetum tenuifoliae) was noted on Bishop Hill where the surface horizons of the soil have been disturbed by cultivation in the past (Darleith Association).

A group of soils with characters intermediate between those of brown earths and peaty podzols was distinguished and mapped in the hills of the west. These soils

have now been grouped with the peaty podzols (see Appendix 1 Methods and Definitions). The associated vegetation is very similar to that on peaty podzols, the dominant community being white bent grassland which was recorded at Loch Glow, Easter Cairn and east Lomond (all Darleith Association), and at Craigmead (Sourhope Association).

Gley Soils

This group of soils is confined commonly to fine-textured boulder clay of the valleys and hill basins, often associated with peat.

Noncalcareous Gleys – of moderate or high base status (BG)

These are poorly drained soils with base saturation levels of 30 per cent or more in their surface horizons. Their associated communities arre rush pastures, sedge mires and Elmwood (Querco – Ulmetum glabrae).

Three stands of sharp-flowered rush pasture (Potentilla – Juncetum acutiflori) were recorded at Fleecefaulds (Rowanhill Association), at Warroch (Sourhope Association) and near Arnot Reservoir (Kippen Association).

Calcareous Gleys

Gley soils formed on the shelly sand of the dune slacks contain high levels of calcium carbonate within profile depth and the soil horizons are usually fully saturated with bases.

The plant communities are those of the specialised dune slack habitat, namely silverweed pasture (the *Potentilla anserina* – *Carex nigra* Community) and, more rarely, the variegated horse-tail community (the *Anagallis tenella* – *Equisetum variegatum* association) of which one station is on Dumbarnie Links (Fraserburgh Association).

Peaty Gleys – of low base status (PG)

Poorly or very poorly drained soils with well-developed organic surface horizons are classed as peaty gleys. The base saturation levels in the organic horizon are 30 per cent or less in the low base status subdivision. The communities common to these soils are those of rush pastures, sedge mires, flying bent grassland (part of Junco squarrosi – Festucetum tenuifoliae) and bog heather moor (Narthecio – Ericetum tetralicis).

Sharp-flowered rush pasture (Potentilla – Juncetum acutiflori) was recorded in the wet channels of the Pilkham Hills (Darleith Association), flying bent grassland on Dowhill Muir (Giffnock Association) and few-flowered spike-rush mire (Carici dioici – Eleocharitetum quinqueflorae) on the shores of Loch Leven at Vane (Eckford Association).

Peaty Gleys – of moderate or base status (HG)

This group of soils have base saturation levels of over 30 per cent in their organic surface horizons. Associated plant communities are rush pastures, sedge mires and swamp vegetation.

One stand of meadow-sweet meadow (Valeriano – Filipenduletum) was noted on a flushed slope at Fleecefaulds (Rowanhill Association), and stands of sharp-flowered rush pasture (Potentilla – Juncetum acutiflori) are recorded at Whitehill (Sourhope Association), Vane (Eckford Association) and Moreland (Hindsward Association).

Regosols (RBA, RCA, BCA)

Regosols are immature soils with little profile development other than a very thin humose A horizon in places, usually developed on windblown sand. They are well-represented along the coastline of the district, especially round Largo Bay. All the examples noted here have developed either on shelly sand or on sand of moderate or high base status.

The associated plant communities are those of the typical dune sequence, namely foredune (Elymo – Agropyretum boreo-atlanticum), yellow dune (Elymo – Ammophiletum0 and, on the east coast, milk-vetch – red fescue dune pasture (Astragalo – Festucetum arenariai).

Foredunes and yellow dunes were recorded on east Links, Elie and Dumbarnie Links, and dune pasture on both these sites and St Ford Links (Fraserburgh Association).

Alluvial Soils

This group comprises soils developed on recent, alluvial deposits with weak horizon differentiation, found throughout the district in association with the watercourses, wet depressions and loch basins.

There are three main categories:

Saline (RSF, SG, SHG)

Soils associated with saltings and storm beaches. Drainage is poor or very poor and the profile is high in exchangeable sodium. The related plant communities are those of salt-marsh and dune slacks, the most commonly encountered being sea poa salt-marsh (Puccinellietum maritimae) and mud rush salt marsh (Juncetum gerardii). Stands of both communities were found on east Links and at the mouth of the Cocklemill Burn, near Elie. Silverweed pasture (the Potentilla anserina – Carex nigra Community) was recorded on a saline alluvial soil with a highly organic surface horizon on Dumbarnie Links.

Mineral (RCF, RBF, WRF, CF, BF, WAF)
Mineral alluvial soils are found along the stream courses and round the margins of the many small lochs and reservoirs. There is a full range in base status and

drainage, but the majority of the soils are moderate to high base status and poorly to very poorly drained, some being under standing water. The vegetation found on these soils is usually that of swamp and aquatic habitats.

Most commonly found community is that of reed-grass swamp (Phalaridetum arundinaceae), which was recorded on the shores of Cullaloe Reservoir, Loch Fittty and Loch Leven.

Peaty (PF, HF)

Alluvial soils with organic surface horizons, often redistributed, are found in loch basins. They have been divided into a low base status group (PF), where the levels of base saturation are below 30 per cent, and a moderate or high base status group (HF). Communities found in association with these soils are those of swamp, sedge mire and aquatic habitats and include both flush and swamp alderwood.

Wet pasture (part of Lolio – Cynosuretum) was recorded at Larennie and soft rush pasture (the *Ranunculus repens* – Juncus effusus Community) at Red House on low base status soils. The community most recorded on the higher base status group was reed-grass swamp (Phalaridetum arundinaceae) which was found on an alluvial terrace at Warroch, in wet depressions at Tarhill and Grahamstone on Loch Leven, and alongside the Cocklemill Burn, near Elie.

Rankers (BR, SBR, HR, PR, PPR)

Rankers are shallow soils with little profile development other than a humus rich A horizon overlying rock debris. Their associated vegetation is that of freely or excessively drained, rocky sites such as bent-fescue grassland (Achilleo – Festucetum tenifoliae), dry heather moor and various stonecrop (*Sedum*) communities.

Herb-rich bent-fescue grassland was recorded on a brown ranker at Balnethill (Kippen Association) and a stand of plantain cliff-top pasture (the *Plantago coronopus* Community) on east Links where the soil is influenced by sea-spray (Darleith Association). Vegetation recorded on podzolic rankers was dry Atlantic heather moor (part of Carici binervis – Ericetum cinereae) at Warroch (Sourhope Association) and blaeberry heath (the *Rhytidiadelphus loreus* – *Vaccinium myrtillus* Community) on White Craigs and West Lomond (Darleith Association).

Peats (FPT, BPT, WPT, WEH)

Flushed peat is found extensively in the west in association with the many small lochs and with channels in the hills. The communities present reflect the base status of the flush water and are those of rush pastures, sedge mires and swamp. Within the district, the flushed peats are base-rich predominantly and the communities commonly found are species-rich sharp-flowered rush pasture (part of Potentilla – Juncetum acutiflori), few-flowered spike-rush mire (Carici dioici – Eleocharitelum quinqueflorae) and bottle sedge swamp (Caricetum rostratae). Where the peat is completely submerged, aquatic vegetation has developed.

Unflushed Dystrophic Peat (RM, PT, HPT, MPT)

There are few lowland mosses remaining, the best examples being Din Moss and Moss Morran in the west and Bankhead Moss in the east. The dominant vegetation is that of lowland blanket bog (part of Erico – Sphagnetum papillosi) which was recorded at each of the above-mentioned sites and at Lurg Loch.

Further up the hill slopes, the effects of exposure result in the development of upland blanket bog, part of the same association. Stands were recorded at Lurg Loch and Stronacjie. Flying bent grassland (part of Junco squarrosi – Festucetum tenifoliae was found also at Stronachie and on Craigencat.

Where the effects of exposure are severe, mountain communities develop on blanket peat, the most commonly found being mountain blanket bog (Rhytidiadelphus – Sphagnetum fuscii). This was recorded on Mellock Hill. A stand of mountain heath rush grassland (part of *Carex bigelowii – Festuca vivipara* Association) waw noted on the upper slopes of Lendrick Hill.

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Appendix 1: Methods and Definitions

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 3. 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.

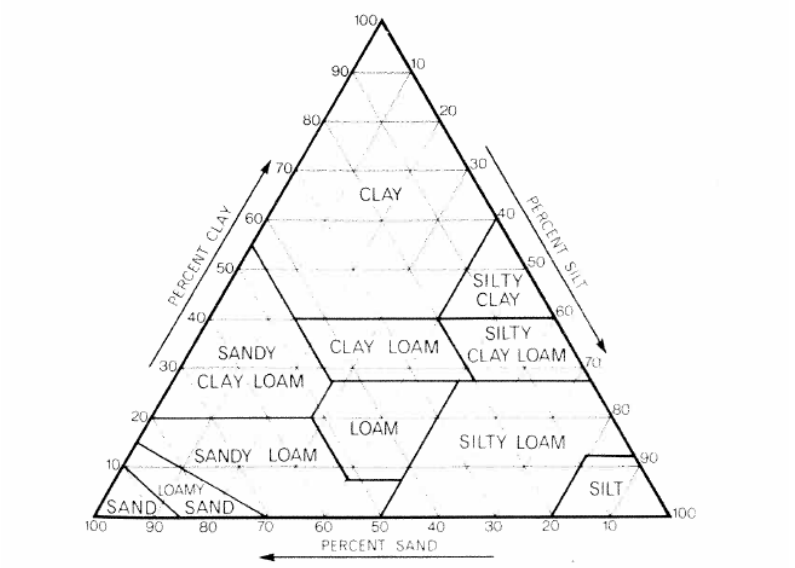
Two textural classifications based on different particle-size grades were in use at the time of the survey: United States of America Department of Agriculture (USDA) and the International Scheme. Early samples (approximately pre 1954) were analysed using solely the International size fractions, but post 1954 both schemes were adopted. The size fractions of each scheme are given in Table 11 below.

Table 11. U.S.D.A. and International 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 9) used in conjunction with the range of grain sizes established by the United States Department of Agriculture (USDA). Soil textures are assigned by noting the area in which the size grade composition occurs when plotted on the diagram.

Figure 9. 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.

Vegetation

Recording of the vegetation in the field was based on the methods laid down by Poore (1955) and modified by Birse and Robertson (1976). The survey did not attempt a quatitative estimation of the plant communities in the area, but was restricted to an anlysis of the main vegetation types on selected sites. The releves so collected were compared with the phytosociological tables used in the classification of Scottish Vegetation by Birse and Robertson (1976) and by Birse (1980, 1984).

In Chapter 4, each community or association is placed within its appropriate class, order and alliance and a short description of its general characters, together with those of the local releves, is given. A further section deals with the relationship between the major soil subgroups and the plant communities.

A more comprehensive account of the associations and their morphology, status, distribution and environment is given in the publications on the Scottish classification listed above.

Definitions

A stand of vegetation is the physical entity that occurs on a site; a releve is a written record of that stand. Phytosociological tables are made up of groups of similar releves. Ground cover is the areal cover of the lowest layer of vegetation made up of mosses, liverworts and lichens. Field cover is that of the higher plants, excluding trees and shrubs.

Appendix 2: Standard Analytical Data for Profiles (Nos. 64-82) (not described in text)

No.63 Largo Law A 233541-46 Darleith Association Darleith Series

Horizon	A	A	A/Bw	Bw	C	C
Depth (cm)	2.5-10	18-25	36-43	58-66	76-84	91-99
Sand 50-2000 μm %	33.0	43.5	38.5	59.0	62.7	63.3
Silt 2-50 μm %	39.5	34.5	36.9	26.5	25.8	25.4
Clay <2 μm %	22.4	22.0	24.6	14.5	11.5	11.3
Exchangeable Cations						
Calcium (me/100g)	32.61	33.39	34.19	38.96	38.73	39.03
Magnesium (me/100g)	23.02	22.46	25.82	22.54	21.35	20.99
Sodium (me/100g)	0.50	0.53	0.59	0.74	0.89	1.07
Potassium (me/100g)	0.23	0.13	0.08	0.04	0.03	0.04
Hydrogen (me/100g)	17.41	9.12	8.24	6.19	5.05	6.35
Base Saturation %	76.4	86.1	88.0	91.0	92.4	90.6
pH (in water)	5.5	5.9	6.2	6.4	6.5	6.5
pH (in $CaCl_2$)	5.21	5.60	5.90	6.20	6.16	6.30
Loss on Ignition %	16.70	10.95	10.87	10.04	8.01	8.84
Carbon %	5.97	2.40	4.16			
Nitrogen %	0.55	0.24	0.39			
Organic Matter %	10.27	4.01	7.15			
Total Phosphorus (mg P_2O_5/100g)	325	322	368	415	402	340

No.64 Largo Law B 233547-51 Darleith Association Dunlop Series

Horizon	A1	A2	B(g)1	B(g)2	C
Depth (cm)	7.5-10	20-28	38-46	56-64	81-89
Sand 50-2000 μm %	36.1	37.0	57.8	69.2	66.4
Silt 2-50 μm %	36.1	33.8	24.5	19.6	23.6
Clay <2 μm %	27.8	29.2	17.7	11.2	10.0
Exchangeable Cations					
Calcium (me/100g)	30.83	35.52	38.27	34.47	21.82
Magnesium (me/100g)	11.86	11.64	19.53	19.65	9.93
Sodium (me/100g)	0.31	0.33	0.41	0.38	0.29
Potassium (me/100g)	1.01	0.20	0.09	0.03	0.03
Hydrogen (me/100g)	10.75	10.55	4.60	3.82	3.36
Base Saturation %	80.4	82.8	92.7	93.5	90.5
pH (in water)	5.8	6.0	6.4	6.4	6.6
pH (in $CaCl_2$)	5.5	5.9	6.1	6.3	6.4
Loss on Ignition %	13.21	11.00	9.67	5.82	5.55
Carbon %	2.23	2.07			
Nitrogen %	0.21	0.20			
Organic Matter %	3.85	3.55			
Total Phosphorus (mg P_2O_5/100g)	381	310	352	434	321

No.65 Keavil B 248026-34 Darvel Association Darvel Series

Horizon	Ap	Ap	AB	Bw	BC	C1	C2	C3	C3
Depth (cm)	0-7.5	10-18	25-35	43-53	53-61	61-69	71-81	86-96	112-122
Sand 50-2000 μm %	47.2	49.8	60.7	77.1	91.9	94.0	88.1	94.0	98.0
Silt 2-50 μm %	28.0	25.8	20.7	13.2	5.1	4.0	9.9	4.0	-
Clay <2 μm %	11.4	18.5	15.1	6.9	3.0	2.0	2.0	2.0	2.0
Exchangeable Cations									
Calcium (me/100g)	13.44	10.83	11.50	8.55	4.24	3.02	3.79	1.81	1.05
Magnesium (me/100g)	4.15	1.23	0.64	0.42	0.21	0.16	0.21	0.08	0.08
Sodium (me/100g)	0.11	0.11	0.07	0.07	0.04	0.04	0.04	0.07	-
Potassium (me/100g)	0.38	0.36	0.10	0.07	0.04	0.04	0.05	0.04	0.04
Hydrogen (me/100g)	6.06	6.09	4.08	2.22	1.67	1.14	0.31	0.82	0.22
Base Saturation %	75.0	67.3	75.2	80.2	73.0	74.0	92.9	70.9	84.3
pH (in water)	6.29	5.91	6.40	6.51	6.49	6.52	6.61	6.59	6.29
pH (in $CaCl_2$)	6.01	5.35	5.92	6.02	6.08	6.09	6.10	6.00	5.79
Loss on Ignition %	17.85	11.81	7.09	5.55	3.57	2.14	3.47	1.17	1.14
Carbon %	6.13	4.25	2.44						
Nitrogen %	0.56	0.28	0.17						
Organic Matter %	10.52	7.31	4.18						
Total Phosphorus (mg P_2O_5/100g)	344	304	246	182	67	57	78	56	56

No.66 Kilconquhar Mains 233552-57 Dreghorn Association Dreghorn Series

Horizon	Ap	Ap	Bw	C	C	C
Depth (cm)	2.5-10	18-25	38-46	63-71	81-89	101-109
Sand 50-2000 μm %	69.1	71.3	84.3	92.4	93.4	93.4
Silt 2-50 μm %	15.9	13.6	7.9	4.8	4.6	3.8
Clay <2 μm %	12.0	12.2	8.1	2.8	2.0	2.8
Exchangeable Cations						
Calcium (me/100g)	7.93	7.49	5.32	3.02	3.32	3.93
Magnesium (me/100g)	0.96	0.63	0.42	0.37	0.32	0.43
Sodium (me/100g)	0.11	0.14	0.08	0.05	0.04	0.05
Potassium (me/100g)	0.10	-	-	-	-	-
Hydrogen (me/100g)	2.21	3.48	0.95	2.73	6.39	7.89
Base Saturation %	80.5	70.4	86.0	55.8	36.5	35.9
pH (in water)	5.7	5.6	6.0	6.1	6.0	5.9
pH (in $CaCl_2$)	5.5	5.4	5.8	5.9	5.9	5.7
Loss on Ignition %	5.96	5.84	3.80	1.66	1.69	1.73
Carbon %	2.19	2.28	1.26			
Nitrogen %	0.19	0.19	0.09			
Organic Matter %	3.76	3.92	2.16			
Total Phosphorus (mg P_2O_5/100g)	288	285	160	83	73	56

- = less than lower limit of determination

No.67 Levenmouth 225479-84 Eckford Association Eckford Series

Horizon	Ap	Bs1	Bs1	Bs1	Bs2	C
Depth (cm)	5-15	23-31	38-46	56-64	74-84	86-96
Sand 50-2000 μm %	64.6	98.6	98.6	98.6	96.0	99.0
Silt 2-50 μm %	14.9	0.8	0.8	0.8	3.4	0.4
Clay <2 μm %	15.0	0.6	0.6	0.6	0.6	0.6
Exchangeable Cations						
Calcium (me/100g)	14.76	0.98	0.75	0.75	9.66	1.81
Magnesium (me/100g)	1.94	0.12	0.12	0.12	0.49	0.16
Sodium (me/100g)	0.08	-	-	-	0.03	-
Potassium (me/100g)	-	-	-	-	-	-
Hydrogen (me/100g)	3.59	2.64	2.62	2.00	-	-
Base Saturation %	82.4	29.4	24.9	30.3	100.0	100.0
pH (in water)	6.6	6.7	6.4	6.5	7.2	7.3
pH (in $CaCl_2$)	6.3	6.3	6.2	6.2	6.9	7.0
Loss on Ignition %	7.02	0.33	0.38	0.30	1.34	0.40
Carbon %	nd	nd	nd	nd	nd	nd
Nitrogen %	nd	nd	nd	nd	nd	nd
Organic Matter %	nd	nd	nd	nd	nd	nd
Total Phosphorus (mg P_2O_5/100g)	1.72	25	19	20	33	33
nd = no data						

- = less than lower limit of determination

No.68 Scotlandwell 225491-96 Eckford Association Kilwhiss Series

Horizon	Ap	E	Bf	Bs	C	C
Depth (cm)	5-16	25-30	33-36	43-51	61-69	76-84
Sand 50-2000 μm %	nd	92.6	92.5	86.4	93.5	94.3
Silt 2-50 μm %	nd	2.4	4.3	9.5	3.3	2.7
Clay <2 μm %	nd	5.0	3.2	4.3	3.2	3.0
Exchangeable Cations						
Calcium (me/100g)	24.58	2.41	2.43	1.68	1.22	1.21
Magnesium (me/100g)	1.81	0.21	0.25	0.25	0.12	0.12
Sodium (me/100g)	0.16	-	0.04	0.03	0.05	0.04
Potassium (me/100g)	18.00	-	-	-	-	-
Hydrogen (me/100g)	25.44	1.14	8.92	9.48	5.96	4.31
Base Saturation %	51.2	69.7	23.4	17.1	18.9	24.1
pH (in water)	5.2	5.1	4.7	4.6	4.6	4.6
pH (in $CaCl_2$)	4.6	4.4	4.0	4.0	4.1	4.1
Loss on Ignition %	27.50	1.42	3.76	3.06	2.03	2.03
Carbon %	nd	nd	nd	nd	nd	nd
Nitrogen %	nd	nd	nd	nd	nd	nd
Organic Matter %	nd	nd	nd	nd	nd	nd
Total Phosphorus (mg P_2O_5/100g)	251	27	59	103	106	101
nd = no data						

- = less than lower limit of determination

No.69 Carrick Villa 233522-27 Fraserburgh Association Fraserburgh Series

Horizon	A1	A2	Bw	C	C	C
Depth (cm)	5-13	18-25	33-41	51-58	74-81	91-99
Sand 50-2000 μm %	98.4	98.4	98.6	98.6	98.8	98.8
Silt 2-50 μm %	-	-	-	-	-	-
Clay <2 μm %	1.6	1.6	1.4	1.4	1.2	1.2
Exchangeable Cations						
Calcium (me/100g)	54.49	60.12	66.15	59.45	66.23	66.19
Magnesium (me/100g)	0.79	1.08	1.05	0.81	0.96	0.94
Sodium (me/100g)	0.41	0.47	0.47	0.47	0.45	0.49
Potassium (me/100g)	0.12	0.23	0.06	0.09	0.12	0.14
Hydrogen (me/100g)	-	-	-	-	-	-
Base Saturation %	100.0	100.0	100.0	100.0	100.0	100.0
pH (in water)	6.9	7.2	6.7	6.9	7.2	7.0
pH (in $CaCl_2$)	6.8	7.0	6.5	6.9	7.2	6.9
Loss on Ignition %	7.60	7.43	4.70	3.73	2.96	4.81
Carbon %	2.81	2.22	1.50			
Nitrogen %	0.15	0.09	0.02			
Organic Matter %	4.82	3.81	2.58			
Total Phosphorus (mg P_2O_5/100g)	69	55	37	48	41	42

- = less than lower limit of determination

No.70 Craigluscar 270657-62 Giffnock Association Devilla Series

Horizon	Ap	Ap	Bs1	Bs2	Bx	C
Depth (cm)	5-13	23-30	36-43	46-53	53-61	69-76
Sand 50-2000 μm %	38.0	41.0	41.0	52.0	51.0	65.0
Silt 2-50 μm %	37.0	34.0	40.0	36.0	34.0	24.0
Clay <2 μm %	25.0	25.0	12.0	9.0	12.0	11.0
Exchangeable Cations						
Calcium (me/100g)	10.90	8.15	18.20	12.20	10.70	5.47
Magnesium (me/100g)	1.58	1.51	1.93	1.29	1.03	0.56
Sodium (me/100g)	0.12	0.19	0.11	0.15	0.07	0.06
Potassium (me/100g)	0.17	0.13	0.06	0.06	0.08	0.05
Hydrogen (me/100g)	10.60	8.00	8.90	6.70	6.70	3.20
Base Saturation %	54.7	55.6	69.5	67.2	64.0	65.5
pH (in water)	5.0	5.5	5.7	5.6	5.7	5.8
pH (in $CaCl_2$)	4.6	4.9	5.1	5.1	5.1	5.2
Loss on Ignition %	10.00	8.60	14.30	6.40	6.40	4.60
Carbon %	4.24	3.00	1.96			
Nitrogen %	0.73	0.50	0.39			
Organic Matter %	7.30	5.20	3.40			
Total Phosphorus (mg P_2O_5/100g)	518	497	359	264	275	127

No.71 Tullibole 259110-16 Gleneagles Association Gleneagles Series

Horizon	Ap	Ap	Bs	Bx	C1	C2	C3
Depth (cm)	5-13	20-28	33-41	48-56	63-71	86-96	117-124
Sand 50-2000 μm %	58.0	57.0	79.0	88.0	88.0	89.0	93.0
Silt 2-50 μm %	27.0	30.0	13.0	8.0	8.0	10.0	5.0
Clay <2 μm %	6.0	5.0	4.0	2.0	2.0	2.0	2.0
Exchangeable Cations							
Calcium (me/100g)	11.53	11.85	3.89	1.08	0.93	1.08	2.15
Magnesium (me/100g)	0.56	0.31	0.13	0.07	0.07	0.07	0.15
Sodium (me/100g)	0.09	0.16	0.09	0.04	0.04	0.13	0.04
Potassium (me/100g)	0.24	0.22	0.07	0.08	0.08	0.08	0.07
Hydrogen (me/100g)	14.30	13.80	13.00	10.40	9.80	8.00	6.90
Base Saturation %	46.5	47.6	24.3	10.9	10.3	14.5	25.9
pH (in water)	5.7	5.9	5.9	5.8	5.8	5.9	6.1
pH (in $CaCl_2$)	5.3	5.4	5.2	5.1	5.1	5.2	5.3
Loss on Ignition %	17.4	16.0	9.2	5.3	5.1	4.8	3.9
Carbon %	7.53	8.55	4.31				
Nitrogen %	0.70	0.81	0.40				
Organic Matter %	13.00	14.70	7.42				
Total Phosphorus (mg P_2O_5/100g)	449	411	299	197	279	190	247

No.72 Springfield 208386-91 Kippen Association Kippen Series

Horizon	Ap1	Ap2	Ap2	B(g)1	B(g)2	C(g)
Depth (cm)	2.5-8	10-18	23-31	36-43	53-63	79-89
Sand 50-2000 μm %	63.2	66.0	62.8	54.1	55.4	54.1
Silt 2-50 μm %	19.1	18.6	22.7	20.0	17.4	16.5
Clay <2 μm %	13.4	12.1	8.1	25.9	27.2	29.4
Exchangeable Cations						
Calcium (me/100g)	6.88	0.92	0.93	0.77	5.05	1.99
Magnesium (me/100g)	3.28	0.68	0.57	0.58	2.70	0.79
Sodium (me/100g)	0.10	0.05	0.04	0.07	0.13	0.15
Potassium (me/100g)	0.84	0.21	0.22	0.21	0.21	0.39
Hydrogen (me/100g)	5.13	9.08	19.57	7.25	7.47	2.19
Base Saturation %	68.4	17.0	8.3	18.4	52.0	60.3
pH (in water)	6.1	5.1	4.7	4.6	4.8	5.5
pH (in $CaCl_2$)						
Loss on Ignition %	8.51	6.52	12.80	3.42	3.26	3.18
Carbon %	3.94	3.37	6.34			
Nitrogen %	0.20	0.20	0.35			
Organic Matter %	6.77	5.96	10.87			
Total Phosphorus (mg P_2O_5/100g)	114	97	104	51	68	77

No.73 Cambo A 1888884-88 Rowanhill Association Caprington Series

Horizon	Ap	B(g)1	B(g)2	C(g)	C(g)
Depth (cm)	5-13	20-30	41-51	64-74	79-89
Sand 50-2000 μm %	52.3	50.4	52.0	48.0	49.2
Silt 2-50 μm %	19.4	19.9	20.1	23.2	22.1
Clay <2 μm %	25.4	29.7	27.9	28.8	28.7
Exchangeable Cations					
Calcium (me/100g)	22.74	17.39	14.87	13.65	12.61
Magnesium (me/100g)	0.88	1.02	3.06	4.37	5.00
Sodium (me/100g)	0.13	0.08	0.11	0.16	0.17
Potassium (me/100g)	0.25	0.22	0.10	0.14	0.12
Hydrogen (me/100g)	-	-	-	-	-
Base Saturation %	100.0	100.0	100.0	100.0	100.0
pH (in water)	7.0	7.0	7.5	7.4	7.5
pH (in $CaCl_2$)	nd	nd	nd	nd	nd
Loss on Ignition %	5.74	4.58	4.68	4.56	4.63
Carbon %	2.46	0.66			
Nitrogen %	0.18	0.06			
Organic Matter %	4.22	1.13			
Total Phosphorus (mg P_2O_5/100g)	178	69	74	118	95

- = less than lower limit of determination

No.74 Dykehead Wood 209188-93 Rowanhill Association Macmerry Series

Horizon	LFH	A	Bs	B(g)	C(g)	C(g)
Depth (cm)	0-4	11-22	29-37	42-52	62-72	83-93
Sand 50-2000 μm %	nd	64.0	69.9	66.6	59.2	61.7
Silt 2-50 μm %	nd	18.6	14.9	15.1	16.0	15.0
Clay <2 μm %	nd	12.2	11.7	16.1	24.8	23.3
Exchangeable Cations						
Calcium (me/100g)	7.44	0.93	-	-	3.49	6.43
Magnesium (me/100g)	4.03	0.24	0.09	0.06	1.37	3.02
Sodium (me/100g)	0.43	0.07	0.05	0.03	0.22	0.27
Potassium (me/100g)	0.99	-	-	-	0.12	0.12
Hydrogen (me/100g)	47.39	12.30	12.26	4.98	3.36	1.18
Base Saturation %	21.4	9.2	1.1	1.8	60.7	89.3
pH (in water)	4.3	5.3	5.1	5.5	5.5	5.9
pH (in $CaCl_2$)	nd	nd	nd	nd	nd	nd
Loss on Ignition %	57.00	10.40	7.00	4.32	1.75	2.68
Carbon %	28.86	3.31	2.46			
Nitrogen %	1.49	0.27	0.23			
Organic Matter %	49.65	5.68	4.13			
Total Phosphorus (mg P_2O_5/100g)	205	104	120	70	62	75

- = less than lower limit of determination

No.75 Pitcairns 209183-87 Sourhope Association Sourhope Series

Horizon	Ap1	Ap2	Bw1	Bw2	C
Depth (cm)	5-15	25-33	46-56	61-69	74-84
Sand 50-2000 μm %	48.4	53.5	67.1	64.8	60.4
Silt 2-50 μm %	25.3	21.1	15.7	16.2	18.5
Clay <2 μm %	19.7	22.4	17.2	19.0	21.1
Exchangeable Cations					
Calcium (me/100g)	4.50	-	0.76	1.67	2.13
Magnesium (me/100g)	0.93	0.13	0.21	0.53	0.82
Sodium (me/100g)	0.07	0.01	0.01	0.01	0.03
Potassium (me/100g)	0.37	0.12	-	0.06	0.10
Hydrogen (me/100g)	9.27	6.32	1.53	2.81	1.59
Base Saturation %	38.8	4.0	39.0	44.7	66.0
pH (in water)	5.2	5.0	5.4	5.5	5.5
pH (in $CaCl_2$)	nd	nd	nd	nd	nd
Loss on Ignition %	13.10	6.05	2.17	2.12	2.20
Carbon %	4.23	2.07			
Nitrogen %	0.34	0.17			
Organic Matter %	7.29	3.55			
Total Phosphorus (mg P_2O_5/100g)	228	178	64	57	58

- = less than lower limit of determination

No.76 Montrave Hill 235236-43 Sourhope Association Bellshill Series

Horizon	Ap	B(g)1	B(g)1	B(g)2	B(g)2	C(g)	C(g)	C(g)
Depth (cm)	8-15	25-33	48-56	69-76	89-97	117-124	132-140	147-155
Sand 50-2000 μm %	54.6	67.0	71.9	68.5	64.6	68.3	53.8	55.0
Silt 2-50 μm %	23.4	24.1	22.8	18.1	19.3	17.7	27.1	24.8
Clay <2 μm %	17.3	8.9	5.3	13.4	16.1	14.0	19.1	20.2
Exchangeable Cations								
Calcium (me/100g)	14.67	1.97	3.49	6.25	6.71	7.64	9.69	10.12
Magnesium (me/100g)	0.09	0.44	0.71	1.79	1.79	3.08	6.25	3.99
Sodium (me/100g)	0.43	0.88	0.06	0.07	0.04	0.04	0.12	0.15
Potassium (me/100g)	0.18	0.10	0.02	0.06	0.01	0.02	0.10	0.08
Hydrogen (me/100g)	5.04	1.45	1.35	4.23	4.63	4.54	4.63	4.65
Base Saturation %	75.3	70.0	76.0	65.9	64.9	70.4	77.7	75.5
pH (in water)	5.5	4.8	4.7	4.7	4.7	4.8	5.1	4.2
pH (in $CaCl_2$)	4.9	4.0	4.1	4.1	4.0	4.2	4.4	4.6
Loss on Ignition %	9.40	2.51	2.04	2.63	2.78	2.52	3.08	3.3
Carbon %	4.11	0.57	0.34					
Nitrogen %	0.33	0.03	0.02					
Organic Matter %	7.06	0.97	0.58					
Total Phosphorus (mg P_2O_5/100g)	254	68	36	42	60	117	137	137

No.77 Stronachy B 270641-46 Sourhope Association Balquhandy Series

Horizon	LF	H	Bh	Bw	BC	C
Depth (cm)	0-5	10-12.5	20-28	30-40	50-55	56-63
Sand 50-2000 μm %	nd	nd	nd	nd	nd	nd
Silt 2-50 μm %	nd	nd	nd	nd	nd	nd
Clay <2 μm %	nd	nd	nd	nd	nd	nd
Exchangeable Cations						
Calcium (me/100g)	3.31	2.91	0.62	0.30	0.21	0.13
Magnesium (me/100g)	2.34	2.34	0.63	0.10	0.85	
Sodium (me/100g)	0.89	0.36	0.19	0.03	0.02	0.12
Potassium (me/100g)	2.29	0.64	0.15	-	-	0.05
Hydrogen (me/100g)	53.20	102.70	86.30	33.40	19.30	15.40
Base Saturation %	15.6	5.7	1.8	1.2	5.4	1.9
pH (in water)	4.9	4.1	4.1	4.7	4.7	4.7
pH (in $CaCl_2$)	3.8	3.4	3.7	4.4	4.4	4.4
Loss on Ignition %	88.20	78.10	44.80	26.80	12.80	10.50
Carbon %	49.80	44.20	24.00			
Nitrogen %	2.46	2.24	1.30			
Organic Matter %	85.60	76.10	41.30			
Total Phosphorus (mg P_2O_5/100g)	331	405	342	404	260	201

- = less than lower limit of determination

No.78 Mutehill 259175-82 Alluvium Heavyside Series

Horizon	A	A/B(g)1	B(g)1	B(g)1	B(g)2	B(g)2	Cg	Cg
Depth (cm)	8-15	25-30	38-46	56-64	74-81	94-102	109-114	129-137
Sand 50-2000 μm %	44.0	42.0	18.0	41.0	24.0	16.0	22.0	12.0
Silt 2-50 μm %	40.0	36.0	53.0	38.0	49.0	55.0	47.0	58.0
Clay <2 μm %	12.0	20.0	27.0	19.0	24.0	26.0	28.0	27.0
Exchangeable Cations								
Calcium (me/100g)	11.05	10.10	11.06	7.15	6.85	6.38	7.15	9.58
Magnesium (me/100g)	0.59	1.71	1.90	1.93	2.60	3.31	3.01	5.73
Sodium (me/100g)	0.11	0.04	0.07	0.07	0.09	0.11	0.18	0.15
Potassium (me/100g)	0.13	0.08	0.14	0.08	0.10	0.14	0.18	0.21
Hydrogen (me/100g)	10.40	8.30	6.80	5.80	6.80	5.60	4.10	2.00
Base Saturation %	53.3	59.0	65.9	61.4	58.6	64.0	72.0	88.7
pH (in water)	5.6	6.1	6.2	6.1	6.0	5.9	6.7	7.6
pH (in $CaCl_2$)	5.4	5.1	5.1	5.0	5.0	4.9	5.7	6.8
Loss on Ignition %	10.90	6.50	5.30	5.30	5.80	5.80	6.00	6.4
Carbon %	5.96	2.48	1.09					
Nitrogen %	0.54	0.19	0.26					
Organic Matter %	10.30	4.26	1.87					
Total Phosphorus (mg P_2O_5/100g)	137	57	57	81	112	136	143	143

No.79 The Lecks 274652-56 Links Freely Drained

Horizon	A	A	B	C	C
Depth (cm)	5-13	20-28	35-43	56-64	79-87
Sand 50-2000 μm %	85.0	80.0	97.0	97.0	97.0
Silt 2-50 μm %	8.0	11.0	<1	<1	<1
Clay <2 μm %	7.0	9.0	3.0	3.0	3.0
Exchangeable Cations					
Calcium (me/100g)	48.00	41.60	41.80	37.30	41.10
Magnesium (me/100g)	2.06	1.92	2.88	3.08	3.30
Sodium (me/100g)	0.79	0.63	0.74	0.70	0.81
Potassium (me/100g)	0.96	0.40	0.20	0.17	0.18
Hydrogen (me/100g)	-	-	-	-	-
Base Saturation %	100.0	100.0	100.0	100.0	100.0
pH (in water)	7.4	7.9	8.8	8.8	8.9
pH (in $CaCl_2$)	7.0	7.4	7.9	8.1	8.1
Loss on Ignition %	12.80	10.00	16.20	17.00	15.30
Carbon %	6.12	3.02	6.89		
Nitrogen %	0.50	0.78	0.09		
Organic Matter %	10.50	5.20	11.90		
Total Phosphorus (mg P_2O_5/100g)	167	141	57	41	42

- = less than lower limit of determination

No.80 Bullions A 284261-65 Dreghorn Association Quivox Series

Horizon	Ap	Bw(g)	Bw	C	C
Depth (cm)	5-15	40-50	63-71	76-86	102-112
Sand 50-2000 μm %	64.0	67.0	86.0	91.0	92.0
Silt 2-50 μm %	17.0	18.0	9.0	5.0	5.0
Clay <2 μm %	16.0	13.0	5.0	4.0	3.0
Exchangeable Cations					
Calcium (me/100g)	7.94	6.26	5.29	4.88	4.07
Magnesium (me/100g)	1.46	0.58	0.53	0.57	0.49
Sodium (me/100g)	0.09	0.07	0.09	0.07	0.06
Potassium (me/100g)	0.27	0.27	0.18	0.16	0.09
Hydrogen (me/100g)	5.00	2.20	1.50	1.00	1.00
Base Saturation %	66.2	76.6	80.3	84.9	82.5
pH (in water)	6.0	6.3	6.5	6.5	6.6
pH (in $CaCl_2$)	5.4	5.6	5.7	5.8	5.8
Loss on Ignition %	7.00	4.70	3.60	3.00	2.90
Carbon %	2.92	1.25			
Nitrogen %	0.18	0.07			
Organic Matter %	5.00	2.20			
Total Phosphorus (mg P_2O_5/100g)	259	110	80	88	99

No.81 Bullions B 284266-70 Rowanhill Association Macmerry Series

Horizon	Ap	Bw1(g)	Bw2(g)	Cg1	Cg2
Depth (cm)	5-15	25-35	45-55	65-75	79-89
Sand 50-2000 μm %	65.0	65.0	68.0	65.0	61.0
Silt 2-50 μm %	16.0	15.0	14.0	17.0	18.0
Clay <2 μm %	15.0	18.0	16.0	16.0	19.0
Exchangeable Cations					
Calcium (me/100g)	9.58	9.12	7.90	6.68	7.00
Magnesium (me/100g)	0.57	0.95	1.32	1.32	2.75
Sodium (me/100g)	0.09	0.10	0.10	0.10	0.21
Potassium (me/100g)	0.18	0.12	0.09	0.13	0.10
Hydrogen (me/100g)	3.00	1.50	2.10	2.70	3.00
Base Saturation %	77.6	87.3	81.7	75.3	77.1
pH (in water)	6.3	6.8	6.6	6.3	5.9
pH (in $CaCl_2$)	5.8	5.9	5.7	5.4	5.0
Loss on Ignition %	6.60	4.80	4.50	4.00	4.30
Carbon %	2.50	1.36			
Nitrogen %	0.16	0.06			
Organic Matter %	4.30	2.30			
Total Phosphorus (mg P_2O_5/100g)	182	51	52	57	65

Appendix 3: Percentages of Minerals in the Clay Fraction (<2μ)

Association	Series	Profile No.	Horizon	Kaolinite	Illite	Chlorite	Smectite	Vermiculite	Chlorite-vermiculite	Illite-smectite	Illite-vermiculite	Intergrade	Amorphous	Quartz	Feldspar
Darleith	Baidland	5	H	+	+				+++				+++	+	
			Eh	++	+				+++					++	+
			C	+	+				+++					tr	tr
	Darleith	2	Ap	++	tr				++					+	+
				++	tr				++					+	
				+					+++					+	
	Darleith	63	A	+			+++							tr	tr
			Bw1	+			+++								tr
			Bw1	+			+++								tr
														tr	
Darvel	Darvel	65		+++	+				+						+
			BC	+++	+				+						
				+++	+							+			+
Dreghorn	Dreghorn	66	B	++	+				++					+	
				+++	+				++					+	
				+++	+	+	+			+				+	+
Eckford	Kilwhiss	68		++	+	+								+	+
				++	+				+					+	+
				++	+	+								+	+
Giffnock	Aberdona	17	Ap	+++	+				+					+	
			Cg	+++			+			+				+	
			Cg	+++	+		+			+				+	
	Scaurs	19	H	+++	+									+	
				+++	+					+				+	
				+++	+					+				+	
Kippen	Kippen	72	Ap	++	+				++					+	+
			Bg	++	++	+		++		+				+	+
			Cg	++	++	+				++				+	+
Rowanhill	Caprington	73		+++	+					+				+	+
				+++	+					++	++			+	tr
				+++	+					++	++			+	tr
	Winton	42	LF	+	+			+			+		+++	+	+
			Bg	+++	+	++								+	+
			Cg	++	++	+		++						+	+

Appendix 3: Percentages of Minerals in the Clay Fraction (<2μ) (cont'd).

Association	Series	Profile No.	Horizon	Kaolinite	Illite	Chlorite	Smectite	Vermiculite	Chlorite-vermiculite	Illite-smectite	Illite-vermiculite	Intergrade	Amorphous	Quartz	Feldspar
Sourhope	Bellshill	76	Ap	++	tr				+		+			+	+
			B(g)2	++			++			++				+	+
			Cg	++			++			++				+	+
	Edgerston	56	H	++					++					+	+
			Bg	++	+						++	++		+	+
			Cg	++	++++	+								+	