THE SOILS ROUND JEDBURGH AND MOREBATTLE

THE SOIL SURVEY OF SCOTLAND

The Macaulay Institute for Soil Research, Aberdeen

DEPARTMENT OF AGRICULTURE FOR SCOTLAND

MEMOIRS OF THE
SOIL SURVEY OF GREAT BRITAIN

SCOTLAND

THE SOILS OF THE COUNTRY ROUND JEDBURGH & MOREBATTLE

[SHEETS 17 & 18]

BY

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PREFACE

The soils of the country round Jedburgh and Morebattle (Sheets 17 and 18) were surveyed during the years 1949-53. The principal surveyors were Mr. J. W. Muir (1949-52), Mr. M. J. Mulcahy (1952) and Mr. J. M. Ragg (1953). The memoir has been written and edited by Mr. Muir.

Various members of staff of the Macaulay Institute for Soil Research have contributed to this memoir; Dr. R. L. Mitchell wrote the section on Trace Elements, Dr. R. Hart the section on Minerals in Fine Sand Fractions, Dr. R. C. Mackenzie and Mr. W. A. Mitchell the section on Minerals in Clay Fractions and Mr. S. E. Durno the sub-section on Peat.

Dr. H. G. M. Hardie and staff of the Soil Analysis section of the Pedology Department did the analytical work with the exception of Exchangeable Calcium, Sodium and Potassium which were determined by Dr. R. L. Mitchell and staff of the Spectrochemistry Department. Miss A. M. B. Geddes and Dr. V. C. Farmer read the manuscript and offered many helpful suggestions and criticisms. Plates 1, 2 and 27 are printed by kind permission of the *Hawick News*, the others being the work of Mr. Ragg. Dr. H. H. Corner and Dr. A. M. Smith of the Edinburgh and East of Scotland College of Agriculture, have been of great assistance during the period of survey. The soils could not have been surveyed without the co-operation of land-owners and farmers and this was always willingly given.

Copies of all the field maps (about 2·5 inches to 1 mile) are kept at the Macaulay Institute for Soil Research where they can be inspected.

Robert Glentworth
Head of the Soil Survey of Scotland.

ACKNOWLEDGEMENTS

Acknowledgement is made to Dr. H. H. Corner, the Edinburgh and East of Scotland College of Agriculture who wrote the chapter on Agriculture, to Dr. E. Wylie Fenton, the Edinburgh and East of Scotland College of Agriculture who wrote the chapter on Vegetation and to Mr. W. N. Gibson, Forestry Commission (Scotland) who wrote the chapter on Forestry.

Permission was granted by the Geological Survey, Scotland to base Fig. 7 on a sketch map in a Geological Memoir.

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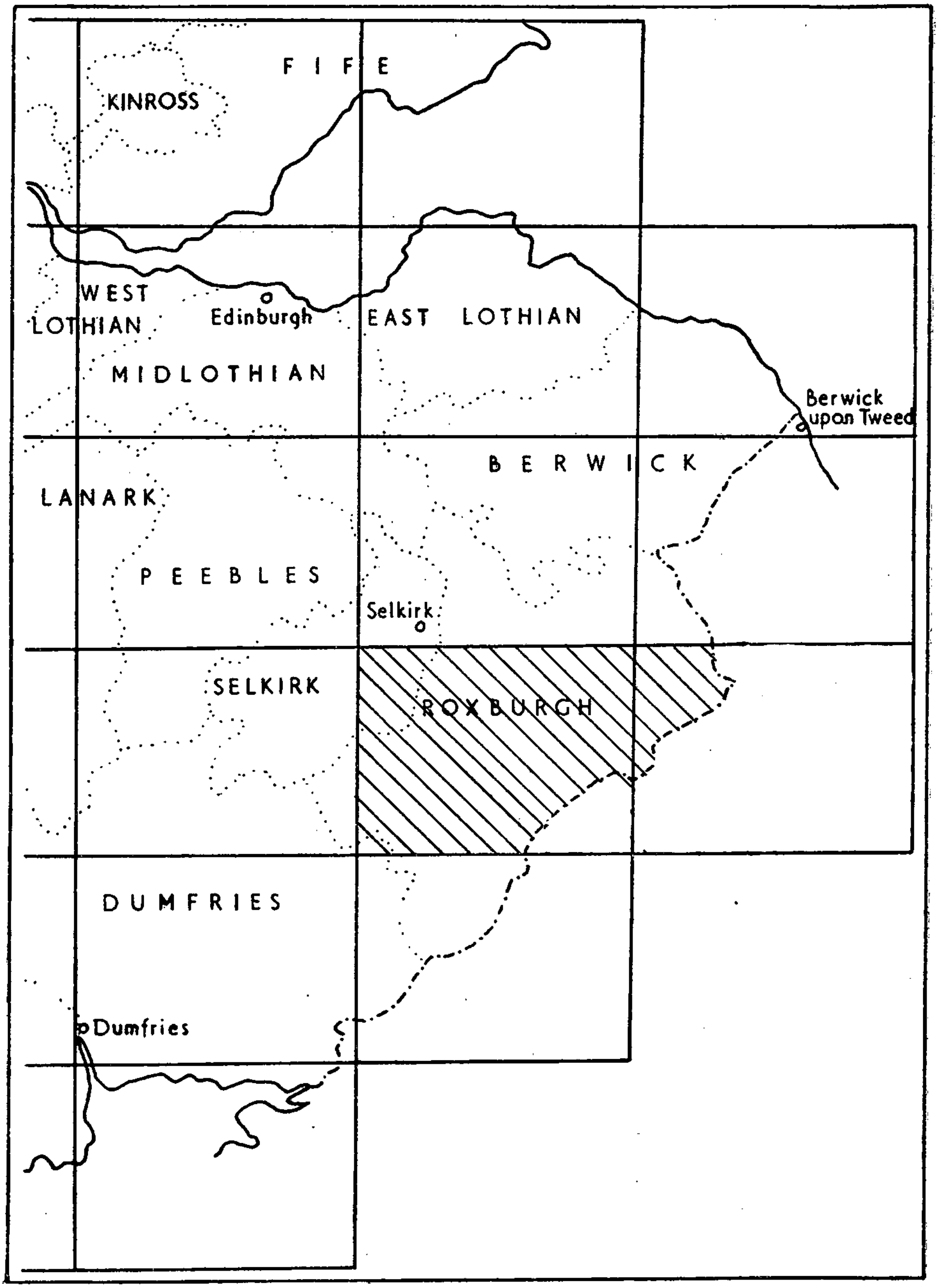


FIG. 1. Location of Area.

CHAPTER 1

General Description of the Area

LOCATION AND EXTENT

THE area described in this memoir lies in the South of Scotland (Fig. 1). It consists of the greater part of Roxburghshire, the south-eastern part of Selkirkshire and north-eastern tip of Dumfriesshire, an area of 450 square miles. Included in it either as a whole or in part are the following parishes:—

Ancrum	Cavers	Hawick	Kirkhope	Oxnam	Teviothead
Ashkirk	Crailing	Hobkirk	Lilliesleaf	Roberton	Yarrow
Bedrule	Eckford	Hounam	Minto	Selkirk	Yetholm
Castleton	Ewes	Jedburgh	Morebattle	Southdean	

Fig. 2 shows the parishes in relation to the area. Four towns serve the area—Hawick, Jedburgh and, although not actually lying within the area, Selkirk and Kelso. Hawick is the principal market centre.

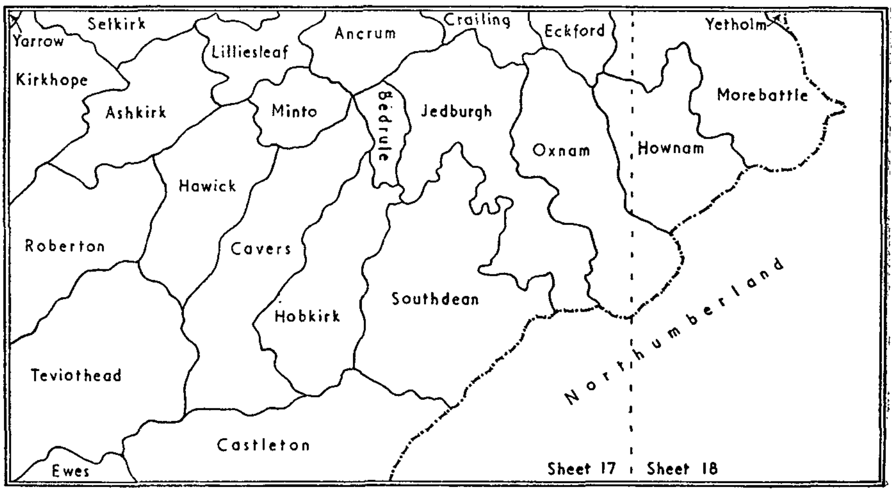


FIG. 2. Parishes within the Area.

PHYSICAL FEATURES

The natural landscape of the area can be divided into three distinct regions (Fig. 3). Along the south and south-eastern boundaries the country is mountainous with high level plateaux. Prominent peaks are Wisp Hill, Tudhope Hill, Cauldcleugh Head, Greatmoor Hill, Peel Fell, Carter Fell, Catcleugh Shin, Beefstand Hill, Mozie Law, Auchope Cairn and the Schil, all of these forming part of the watershed from which the principal rivers spring. With the exception of the Liddel Water, the rivers flow towards the north.

In the west are upland moors, most of them about 1000 feet above sea-level. Here, there are no commanding heights but an interesting feature is the areas of pronounced corrugations caused by the highly-folded nature of the underlying Silurian strata.

In the centre of the area the land is broadly rolling to hilly, dominated here and there by peaks such as Ruberslaw, the Minto Hills and the Dunion. The streams and rivers often run in deep-cut channels.

The chief river is the Teviot which rises on White Hope Edge (just off the south western corner of Sheet 17) and flows north-east. Above Hawick the valley of the Teviot is relatively narrow with no extensive haughlands but below the town it gradually widens and from the neighbourhood of Teviot Bank northwards there are extensive alluvial flats still, on occasion, subject to flooding. Overlooking the valley are many attractive manor houses with well-wooded policies which do much to enhance the pleasant aspect of the countryside.

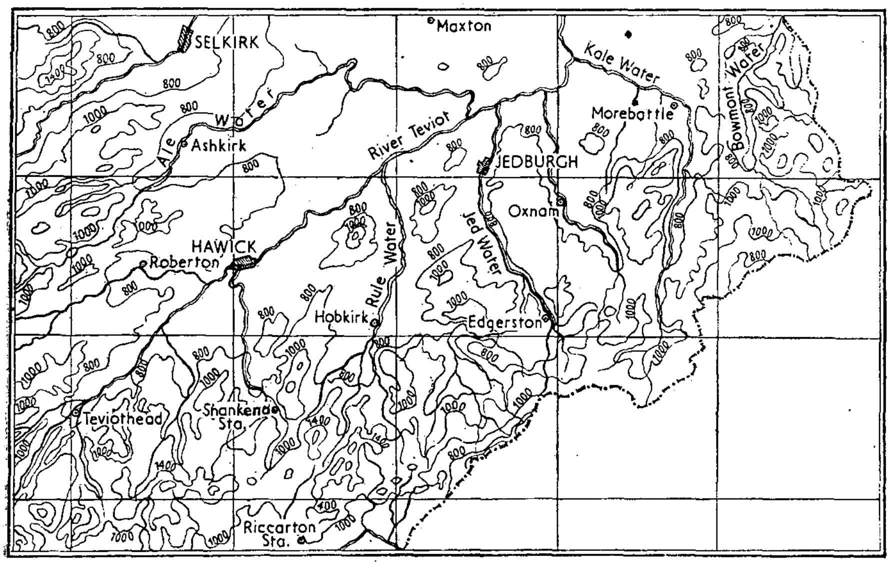


FIG. 3. Physical Map.

The Teviot has numerous tributaries, most of them joining it on the right bank. Only the Borthwick and the Ale Waters join from the left; they flow parallel to the Teviot for most of their length, the Borthwick joining just south of Hawick and the Ale twelve miles further to the north-east, at Ancrum. The principal right-bank tributaries are the Allan, Slitrig, Rule, Jed, Oxnam and Kale Waters. All these flow northwards and approximately parallel to one another, separated by more or less high ground. All have their source on the high-level plateaux of the watershed. Only three other rivers are of any importance—the Bowmont Water, the Ettrick Water and the Liddel Water. The Bowmont Water rises between Auchope Cairn and Mozie Law and flows north to Yetholm where it turns east to join the River Till in Northumberland. A small stretch of the Ettrick Water, which later joins the Yarrow and then the Tweed, is included in the north-western corner of Sheet 17 and in the south, near Riccarton, there is a section of the Liddel Water which flows south into Liddisdale.

CLIMATE

Britain has a temperate climate, cool in summer, cold in winter and with a moderate to high rainfall more or less evenly distributed throughout the year. The east coast of Scotland is drier and colder than the west. The surveyed area is best considered intermediate in type but with the eastern part drier than the western. The prevailing wind is from the south-west and most of the rain comes from that direction. Easterly and southerly winds are much less frequent and are drier while winds from the north are cold and in winter mean hard weather and perhaps snow.

RAINFALL

The annual average rainfall of the area for the period is shown in Fig. 4. Near Jedfoot the rainfall at 25-27·5 inches is one of the lowest in Scotland, but it rapidly increases to the south and west where the country is nearer the source of the rain-bearing winds and is more mountainous. At Tudhope Hill the rainfall is between 70 and 80 inches, three times that at Jedfoot.

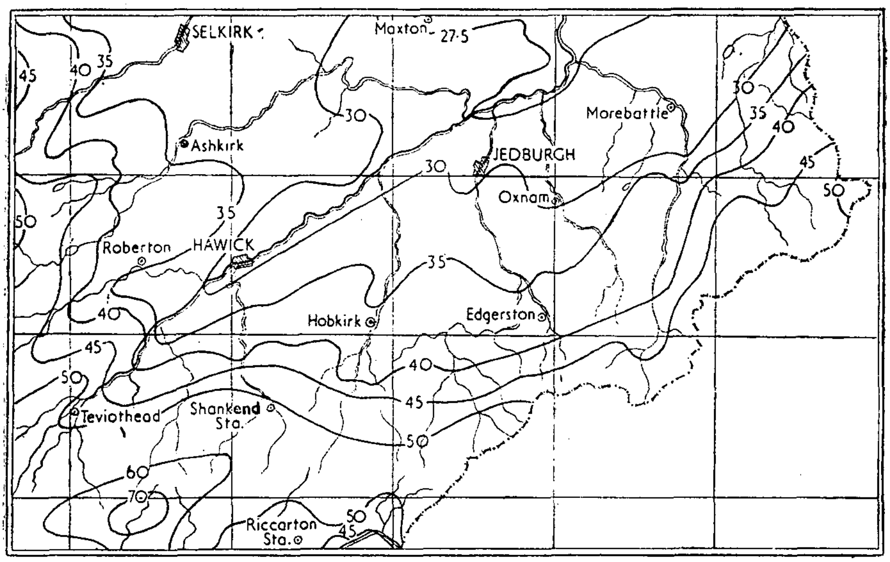


FIG. 4. Distribution of Annual Average Rainfall (1881-1915).

Table A shows average values of rainfall in inches for selected stations in or near the area over the period 1885-1915. These values illustrate admirably the general trends that rainfall increases to the west and south and with increase in altitude. Selkirk in the west has over 8 inches per annum more than Kelso in the east, while at Hawick a difference of 80 feet in altitude brings about a difference of 4 inches per annum in rainfall. Canonbie, on the southern side of the watershed, has a high rainfall at 42·05 inches per annum.

Precipitation at all stations except Kelso is greater in winter than in summer; at Kelso it is the same. It is interesting to note the monthly distribution which, broadly speaking, is similar for all stations. The rainfall for the months October, November and December is very high whereas that for January, February and March is not so high. Of the summer

TABLE A. AVERAGE RAINFALL IN INCHES : PERIOD 1881-1915.

Station	J	F	M	A	My	Jn	Jy	Au	S	O	N	D	Summer	Winter	Year
Kelso (193 ft.)	1·75	1·70	1·95	1·57	1·93	2·11	2·63	2·95	1·90	2·91	2·31	2·32	13·09	12·94	26·03
Selkirk (670 ft.)	2·76	2·78	3·16	2·21	2·47	2·31	3·00	3·39	2·26	3·59	3·31	3·55	15·64	19·15	34·79
Hawick (475 ft.)	2·74	2·63	2·90	1·89	2·25	2·25	3·02	3·22	2·24	3·25	3·31	3·66	14·87	18·49	33·36
Hawick (537 ft.)	3·20	3·26	3·35	2·26	2·34	2·34	3·08	3·34	2·57	3·84	3·87	4·18	15·93	21·70	37·63
Canonbie (160 ft.)	3·75	3·39	3·51	2·31	2·61	2·45	3·37	4·45	3·18	4·11	4·17	4·75	18·37	23·68	42·05

TABLE B. AVERAGE MEANS OF RELATIVE HUMIDITY AT 13H : PERIOD 1921-1935.

Station	J	F	M	A	My	Jn	Jy	Au	S	O	N	D
Kelso (193 ft.)	*80	75	70	65	70	65	70	65	65	70	80	80
Hawick (537 ft.)	85	80	75	70	70	65	70	70	70	75	85	85
The Schil (1,985 ft.)	90	85	75	75	80	75	75	75	75	80	90	90
Tudhope (1,961 ft.)	90	85	70	65	65	70	75	75	75	80	90	90

*Each figure is the lower of a 5% range.

TABLE C. AVERAGE TEMPERATURE °F DAILY MEAN : PERIOD 1906-1935.

Station	J	F	M	A	My	Jn	Jy	Au	S	O	N	D	Year
Kelso (193 ft.)	37·8	38·3	40·5	44·2	50·1	54·9	58·3	57·5	53·2	47·4	40·8	38·4	46·7
Hawick (537 ft.)	36·8	36·9	38·9	42·7	48·9	53·7	56·9	55·8	51·6	46·0	39·5	37·3	45·4
Dumfries (140 ft.)	39·1	39·1	40·9	44·7	50·7	55·5	58·7	57·7	53·7	48·3	41·7	39·5	47·5

TABLE D. AVERAGE DAILY RANGE OF TEMPERATURE °F : PERIOD 1906-1935.

Station	J	F	M	A	My	Jn	Jy	Au	S	O	N	D	Year
Kelso (193 ft.)	10·6	11·9	14·2	16·2	17·1	18·1	16·7	16·4	16·4	14·0	12·2	10·4	14·5
Hawick (537 ft.)	10·2	11·3	14·1	16·5	18·1	19·3	17·3	16·4	16·4	14·2	11·6	9·9	14·6
Dumfries (140 ft.)	9·3	10·3	12·7	14·9	15·7	16·1	14·8	14·1	14·5	12·5	10·8	8·9	12·9

months, July and particularly August are very wet and in fact approach the worst of the winter months.

RELATIVE HUMIDITY

Table B has been compiled from the Climatological Atlas of the British Isles[10] and the data is approximate. Although July and August have a high rainfall their high temperatures keep the relative humidity low. On the other hand, December and January with low temperatures and high rainfalls have a high relative humidity.

TEMPERATURE

It will be seen from Table C that the monthly average of the Daily Mean Temperature is fairly constant throughout the year. For the three towns it is above 50°F for the months May to September and below 40°F from December to February.

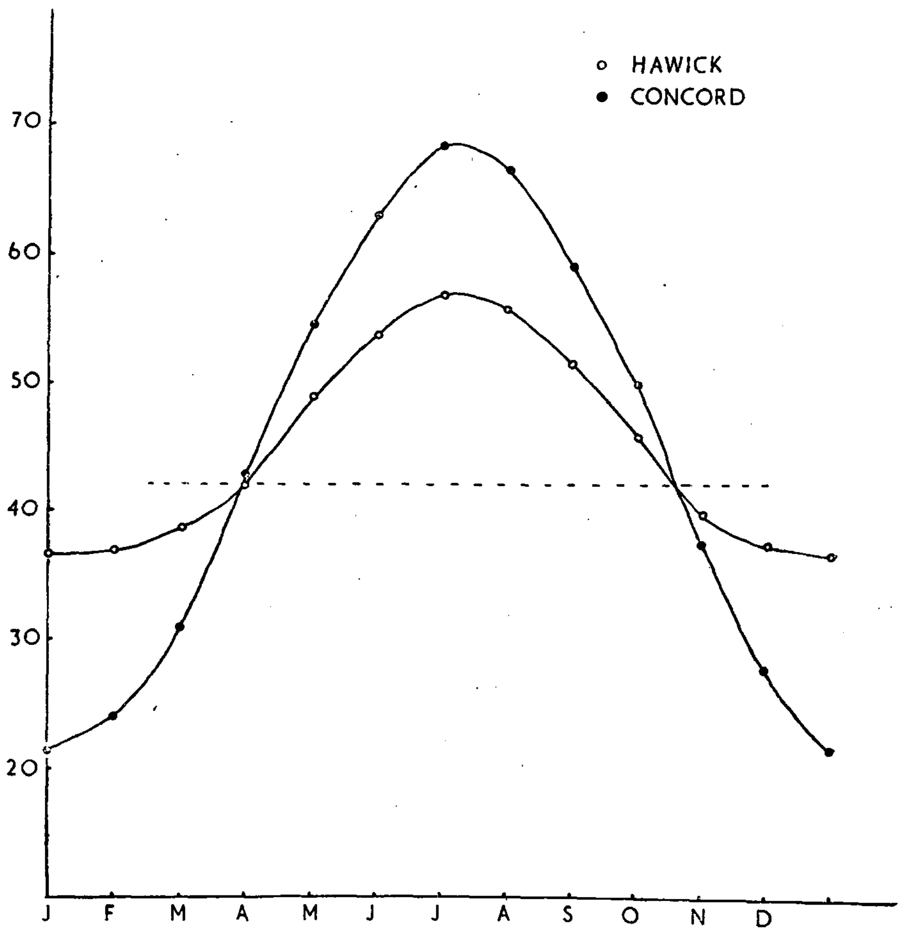


FIG. 5. Smoothed curves of annual march of monthly mean temperature.

The Average Daily Range of Temperature for certain stations is given in Table D. It increases during summer especially for Hawick and Kelso. From April till August it is above 16°F for Kelso and Hawick while for December and January it is about 10°F. Dumfries, which has a climate typical of the west coast, has a smaller range of temperature throughout the year than the other two stations. Hawick, surrounded by hills and less affected by the sea, has a greater range of temperature in summer and smaller range in winter than Kelso.

GROWING SEASON

The growing season for the crops and vegetation most characteristic of a cool temperate climate is approximately determined by the period of the year during which the daily mean temperature is more than 42°F. This can be readily obtained by plotting the daily mean temperature for each month against the month; Fig. 5 illustrates this for Hawick. The average growing season calculated in this fashion for Hawick is 203 days, for Kelso is 222 days and for Dumfries is 227 days.

Manley[9] has studied the effect of altitude on length of growing season and has computed that for the South of Scotland (Dumfries-Wanlockhead) an increase of approximately 250 feet reduces the growing season by 10 days. He has also calculated that for the New England States a reduction of 10 days in length of growing season is brought about by an increase in altitude of 500 feet. The reason for this difference in effectiveness of altitude is readily apparent if Fig. 5, which shows curves for Hawick and Concord, is studied. The curve for Concord is much steeper in spring and autumn than that for Hawick; in other words the transformation from winter temperatures to growing temperatures is more sudden at Concord than at Hawick. An increase in altitude corresponds to a displacement of the temperature curve downwards and the steeper the curve is in spring and autumn, the less effect such displacements have on the length of the growing season. Accordingly the length of growing season at Hawick, which has a flat curve, is more affected by altitude than that of Concord. These facts provide a key to the land-use pattern in the South of Scotland. Altitude has such a profound effect on length of growing season that it is unusual to find arable crops growing over 1000 feet.

CHAPTER 2

Geology

SOLID GEOLOGY

THE various geological formations represented in the area are listed below in chronological order from the youngest downwards.

Pleistocene	Glacial deposits
Carboniferous	Calciferous Sandstone Series
Old Red Sandstone	Upper Old Red Sandstone sediments
	Lower Old Red Sandstone lavas
Silurian	Wenlockian sediments
	Llandoverian sediments.

STRUCTURE

The Silurian sediments were laid down under water (oceanic conditions) and the varying character of the deposits indicates how often and how much the conditions of sedimentation must have changed. Greywacke and similar coarse deposits indicate conditions responsible for rapid sedimentation and consequently rapid erosion of the land areas above the level of the sea: shales indicate the reverse process of slow sedimentation and erosion of land surfaces. At the end of Silurian time, as the result of a great upheaval the strata became highly folded, much of them being raised above the level of the sea. Subsidence then took place and a depression with Jedburgh as its centre was formed. The depression was probably connected with the Midland Valley to the north and extended south into the Cheviots past Carter Fell. The first sediments laid down on the edges of the highly folded Silurian strata are called Lower Old Red Sandstone but they are poorly represented in Sheets 17 and 18. During this period, however, lava poured down from volcanoes in the neighbouring high ground and some of it flowed into the depression, and was later covered with sediments. After further upheaval and denudation, subsidence again occured, and the sediments subsequently laid down are known as Upper Old Red Sandstone: they extend far beyond the edge of the earlier basin. The Lower Carboniferous sediments were laid down over the Upper Old Red Sandstone sediments with no marked disconformity; indeed if lithological differences alone had to be relied on, a boundary between them would be very difficult to map. Yet there must have been a number of vertical oscillations of the region, the interruptions of sedimentation being clearly indicated by numerous intro-formational disconformities.

The Upper Old Red Sandstone sediments are thought to have been laid down under semi-arid conditions in shallow water or at times under desert conditions, the water having been completely dried up. Lower Carboniferous sediments were formed under either esturine or lagoon conditions and except at the time of the transition from Upper Old Red Sandstone to Lower Carboniferous desert conditions were not operative. Most of the quartz grains in the Upper Old Red Sandstone sediments have been wind eroded but this is not so in the Carboniferous. During Carboniferous times a series of intrusions and extrusions occurred throughout the area.

PLATE I
Hawick from the south-east, showing corrugations of the Ettrick Association in the background.

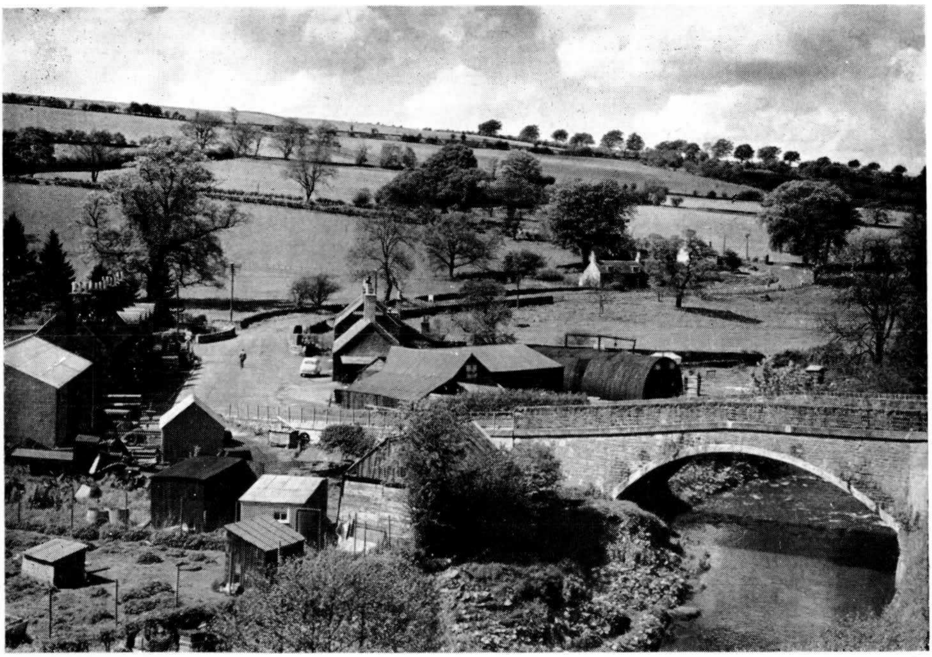


PLATE II
Bonchester Bridge from the south-east, surrounded by soils of the Hobkirk Association.

PLATE III
Soils of the Eckford Association with Peniel Heugh in the distance.

PLATE IV
Teviotdale and the Cheviot Hills from Peniel Heugh.

Silurian Sediments

Two groups of sediments of Silurian Age are present, namely Llandoverian and Wenlockian.

The Llandoverian is represented by the Gala group which consists of the Hawick rocks, the Queensberry grits and the Abbotsford flags. In addition, there are fossiliferous beds known as the Birkhill shales which are very important geologically but are of little consequence to the soil survey since they are thin and rarely outcrop. The Hawick rocks consist of grey, green and red shales with thin bands of greywacke; the Queensberry grits of brown flags and micaceous greywacke; and the Abbotsford flags of purple and grey flags and shales. The Hawick rocks are the most important in the area.

The Wenlockian sediments, overlying the Llandoverian, fall into two groups, namely Riccarton and Raeberry Castle. The Riccarton group which is the lower, consists of conglomerates, greywackes, grits and shales. The Raeberry Castle group consists of green and olive shales with nodules of limestone, thin bedded greywackes with occasional bands of fossiliferous grit, and conglomerates.

To the north-west the Wenlockian rocks have a common boundary with the Llandoverian (Fig. 6). To the east lie either Upper Old Red Sandstone or Carboniferous sediments, the boundary running from Kirkton approximately southwards by Harwood to just north of Hermitage Castle. Outwith this area, the Wenlockian sediments appear as inliers on the northern slopes of the Cheviots at Note of the Gate, Edgerston, Hindhope and Oxnam.

Lower Old Red Sandstone Lavas

The Lower Old Red Sandstone age is mainly represented by a great thickness of lavas which form part of the Cheviot Volcanic Series. The lava-flows fall into three groups—glassy pitchstone-like andesites, oligoclase trachytes and augite-hypersthene-andesites. They vary in colour, being red, brown, purple, grey or black and are often vesicular with agates frequently present in the vesicles. Intercalations of sediment are few though occasionally the flows are separated by beds of tuff. Isolated patches of breccia occur, for instance at Cocklawfoot, and probably indicate the sites of volcanic vents.

The eastern part of the area consists almost entirely of lavas (Fig. 6). To the west lie either Upper Old Red Sandstone or Silurian sediments, the common boundary running roughly North and South and is from Morebattle by Cessford to just east of Crailing, where it turns due south almost to Oxnam. From here the boundary is very irregular, continuing in a general southerly direction by Swineside Hall, Riccalton and north of Hindhope to the National Boundary. Large westward tongues are to be found at Swineside Hall and Riccalton, the Riccalton tongue extending almost to Letham.

Upper Old Red Sandstone Sediments

The lower part of the Upper Old Red Sandstone formation consists of reddish sandstones and conglomerates (pebbles of greywacke, lavas, etc.). The sandstones are composed more or less of wind-eroded sand-grains for which a desert origin has been put forward, the false-bedded character of

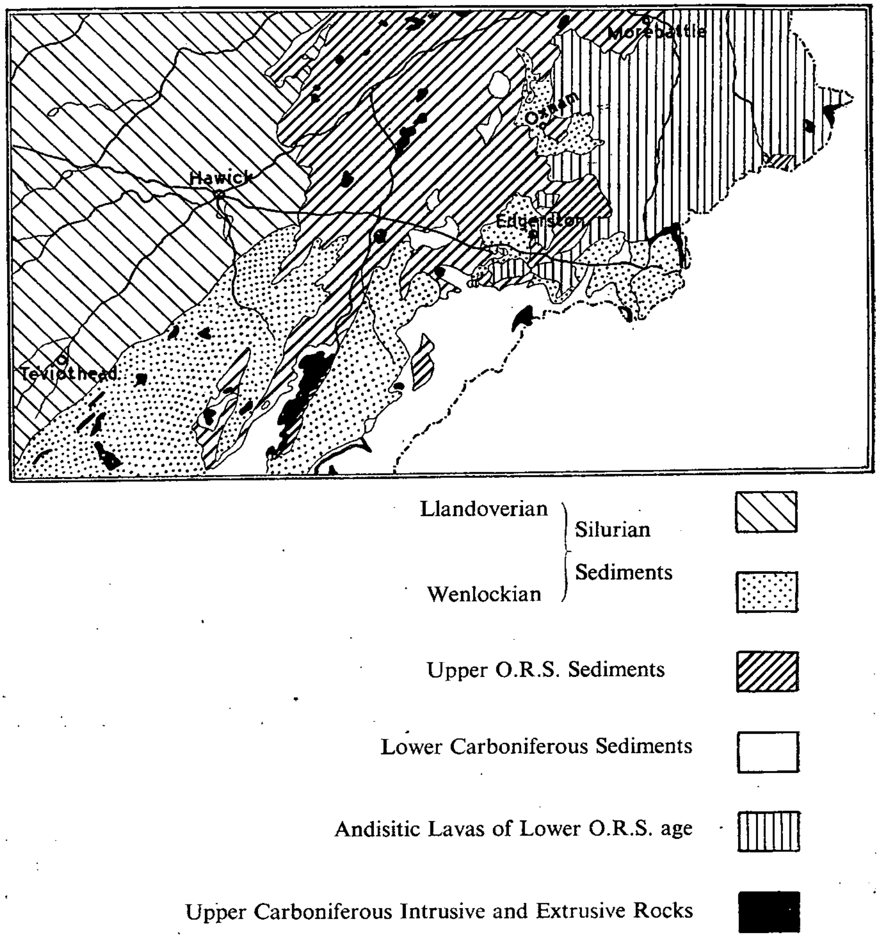


FIG. 6. Distribution of Solid Geological Formations.

some of the sandstones suggesting a sand-dune mode of accumulation. The upper part of the formation is less red and it is difficult to distinguish these sediments from Carboniferous sediments on a purely lithological basis. In the 1st edition of the geological map of this area, the sediments at Kilnsike Tower and above Jedburgh are mapped as Carboniferous but later investigators place these sediments in the Upper Old Red Sandstone formation.

The Upper Old Red Sandstone sediments are to be found in the central part of the area (Fig. 6). To the west there are Llandoverian sediments, to the south, Wenlockian and a little Lower Carboniferous, and to the east, Lower Old Red Sandstone lavas. From Hobkirk there is a narrow faulted strip about 3 miles wide extending almost as far south as Riccalton. Within this area there are inliers of Wenlockian at Camptown and Oxnam.

Lower Carboniferous Sediments

The Lower Carboniferous sediments are represented by 3 groups of the Calciferous Sandstone Series—the Whita Sandstone group, the Cementstone group and the Fell Sandstone group.

The Whita Sandstones are usually red but tend to become yellowish towards the top of the formation. Bands of red sandy marl in the higher reaches of the Jed Water indicate that Old Red Sandstone conditions had prevailed during their formation. In Meadow Cleuch burn the Whita sandstone is about 250 feet thick but beyond the National Boundary in England it is known to be much thicker.

The Cementstone group contains variously coloured shales and sandstones of the Ballagan type with bands of algal Limestone, Cementstone and Marine Limestones. These last possibly accumulated under esturine conditions, marine fossils being deposited when the sea had access. Between Wheelrig Head and Carter Fell there are several outcrops of algal limestone, with a good section at the top of Meadow Cleuch.

Fell Sandstone consists of sandstones with thin intercalations of red and green marly clays and occasional cementstones. The sandstones are siliceous and mostly fine-grained. Near Carter Fell marine shells are also found on several levels and grey clays crowded with ostracods, brachiopods and cephalopods occur near the base of the sandstones at the Old Limekiln in Meadow Cleuch.

The lower Carboniferous sediments occur in a relatively broad strip adjoining the National Boundary from Hungry Law to south of Peel Fell, and in a much narrower strip from Hyndlee to Riccarton Junction (Fig. 6). Various outliers are shown on the Geological Map but later opinion puts most of them in the Upper Old Red Sandstone formation. One, however, is to be found at Greatmoor Hill and another near Browndean Laws.

Intrusive and Extrusive Rocks

Most of the intrusive and extrusive rocks are found in contact with the Upper Old Red Sandstone and Wenlockian sediments (Fig. 6). They tend to be basaltic in type and of Carboniferous Age.

GLACIAL GEOLOGY

The oncoming of glaciation was probably marked by the formation of valley glaciers although all evidence of their action has been obliterated by later ice movements. At the period of maximum glaciation the Southern Uplands were covered by a great depth of ice which from evidence of erratics and striae, moved outwards from certain collection centres. There were three such centres in the South of Scotland—the Kells Range in Wigtownshire, the area near Hart Fell at the headwaters of the Clyde and Tweed, and the Cheviot Massif. Ice streams from sources outside the area also played an important part; ice from Scandinavia impinged on the East Coast and dominated ice movements there whilst an ice stream whose source lay in the Western Highlands dominated ice movements in the Central Valley.

REGIONAL ICE MOVEMENTS

Advance

The direction of movement and the extent of an ice stream is generally deduced from striae and erratics. The directions of flow of the ice streams are shown in Fig. 7. North-moving ice from the Kells range soon encountered ice from the West Highlands and part was diverted westwards into the Firth of Clyde and part eastwards to join the Forth Ice Streams. The south-flowing stream from the Kells range moved into the Solway Firth while the east-flowing ice was deflected towards the south-east over Eskdale into Northumberland.

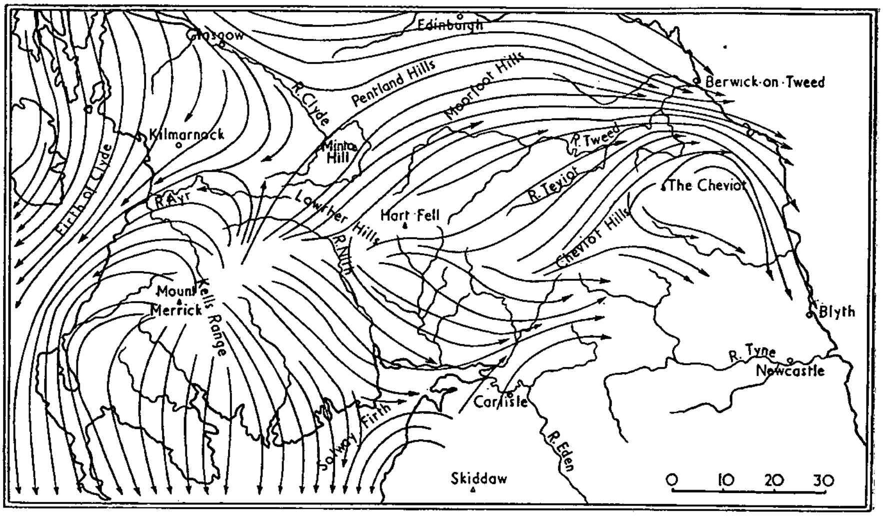


FIG. 7. Map showing direction of Ice Movement in the South of Scotland.

Part of the ice from the Hart Fell area moved north-eastwards and joined the Forth ice, part moved eastwards to join the Tweed Ice and part south-eastward over Liddisdale into Northumberland.

The north-moving Cheviot ice was immediately deflected eastwards by the ice streams from the Forth and Tweed and the south-moving Cheviot ice joined the stream from the Kells Range and Hart Fell.

As they approached the North Sea the Forth and Tweed ice streams were deflected first south-eastwards, and then southwards, by the dominant Scandinavian *mer de glace*. They skirted the northern and eastern flanks of the Cheviot Massif and moved southwards into Northumberland taking with them the north-moving Cheviot ice.

All these ice streams coalesced at the maximum stage of glaciation to form a more or less continuous ice sheet.

Retreat

The sequence of events during the retreat of an ice sheet is more or less constant. As the climate becomes warmer, the amount of ice begins to decrease. The heights and high-level plateaux are gradually denuded of ice and separate glaciers or ice streams are established in the valleys. The movements of the valley glaciers are determined by the seasonal fall of snow. When the snowfall is heavy the glacier advances down the valley. To-day little evidence remains of the advance stages but a succession of moraines resting on solid rock or on till often mark stages of retreat. A spread of fluvio-glacial sands and gravels usually marks the final retreat. The Kells Range and Hart Fell ice first broke from the Cheviot ice between Wansbeck and the Tyne in Northumberland and retreated towards their respective sources. By this time most of the high ground of the watershed was free from ice. Then came retreat of the Tweed and Forth ice, marked by a great spread of fluvio-glacial material first at Glanton in Northumberland and later near Duns in Berwickshire. Several overflow channels near Galashiels and one near Yetholm mark the damming back of waters by the principal Tweed ice stream. Further stages in the final retreat of the ice

PLATE V
A sand and gravel pit at Eckford.

PLATE VI
Part of the face of the sand pit at Eckford, showing bedding of coarse sand.

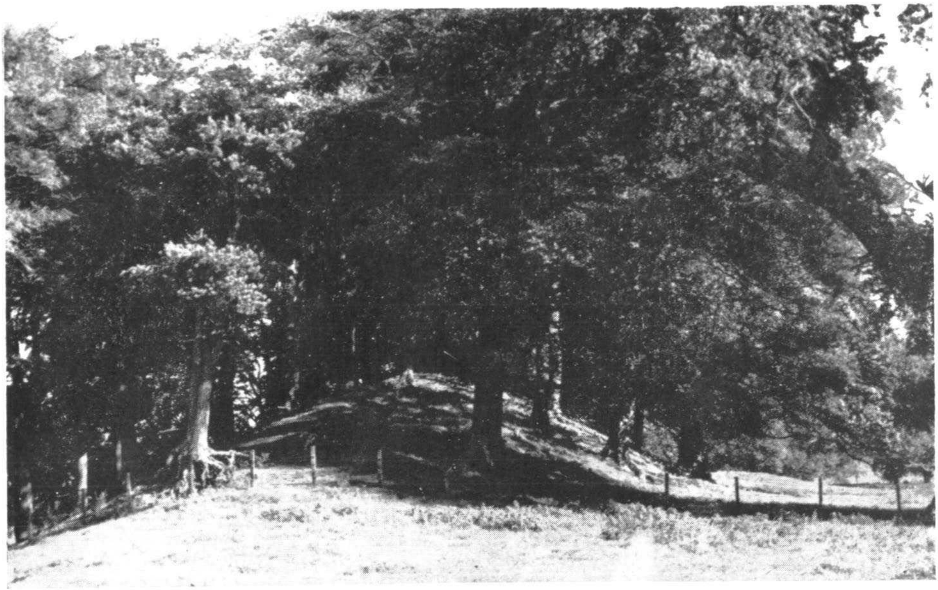


PLATE VII
One of the gravel mounds on the Eckford Association. They are usually planted to mixed deciduous trees.

PLATE VIII
Old Red Sandstone sediments cut by the Jed Water near Mossburnford.

are marked by the occurrence of fluvio-glacial sands and gravels throughout the Midland Valley and at certain localities in the South of Scotland. Finally, many of the principal rivers have terraces of fluvio-glacial material, which were probably formed when the present river systems were swollen by melt waters.

Glacial Deposits and Phenomena of the Area

During the period of glaciation ice radiated from the Cheviot Massif and consequently the ice in the eastern part of the area was not far travelled; the tills, therefore, are local in origin and reflect the character of the underlying solid formations. The western part of the area was glaciated by ice moving from the watershed as far west as Hart Fell towards the north-east along the line of the Ettrick and Teviot Waters. The solid formations over which this ice moved were entirely Silurian, a fact which accounts for the geological purity of the tills. Only at the junction of the Silurian and Old Red Sandstone sediments has it been necessary to separate a mixed till. Elsewhere, the tills are sufficiently free from foreign material to be considered as derived from one solid formation. The generalised distribution of the tills is shown in Fig. 8.

A noteworthy characteristic of the area as a whole is that two tills have been formed from each parent rock. One is more stony and lighter textured than the other and is generally to be found on steep slopes and high-level plateaux. The other, less stony and more clayey, is found in valleys and on smooth slopes.

Some interesting features are to be seen in the district Oxnam-Morebattle-Eckford-Jedfoot. Numerous strips of till, in relatively low positions appear to have been modified by flowing water, a phenomenon probably not unconnected with the evidence of a former course of the Kale Water between Morebattle and Town Yetholm, a diversion of the Jed Water at Mossburnford and overflow channels at Tod Craigs and Primsidemill.

The former course of the Kale Water is unique in that it is considered to have been formed before the Ice Age whereas the others were formed as the result of factors operating during end-glacial times. It seems likely that prior to the Ice Age the Kale Water once flowed over lavas from Morebattle eastwards through Yetholm Loch to join the Bowmont Water at Town Yetholm. At this time a shallow loch probably existed at Morebattle extending westwards as far as Marlfield. The Teviot Water along its lower course flows through relatively soft sedimentary rocks and a tributary running from the vicinity of Marlfield to Eckford could have cut gradually through the sediments and released the loch thus bringing about the capture of the Kale Water by the Teviot.

The Jed water diversion and the overflow channels at Tod Craigs and Primsidemill were the result of conditions in end-glacial times. The Teviot and Tweed ice streams lasted for some time after the local ice had melted on the foot-slopes of the Cheviot Massif and at a certain stage or stages the north flowing tributaries of the Teviot Water were blocked by the main ice eastwards towards Morebattle and finally Town Yetholm. The Jed Water was diverted into the Oxnam Water at Mossburnford and the Oxnam Water in turn overflowed through relatively low ground towards Cessford and as far as Morebattle. There it joined the Kale Water which was then diverted into its former channel to join the Bowmont Water at Town Yetholm. About this time it is probable that the Teviot itself was diverted eastwards from Eckford to join the Kale and later the Bowmont Waters. At yet another stage ice blocked the former course of the Kale Water near Yetholm Loch and overflow channels were formed at Tod Craigs and Primsidemill.

GLACIAL AND SUPERFICIAL DEPOSITS

The most widespread glacial deposit is till which is found over practically the whole area. Fluvio-glacial terraces are also prominent occuring along the courses of the Teviot, Kale, Ettrick and Bowmont Waters. Post-glacial alluvial deposits flank the present-day courses of the rivers.

Till derived from Silurian Sediments

Tills derived from Silurian sediments are to be found in the western part of the area, and in a few inliers further east (Fig. 8). The principal inlier extends from Riccarton Station to Southdean with smaller ones at Camptown, Hindhope and Bloodylaws. In general, the tills are remarkably free from contamination.

On smooth slopes and in valleys the till is clayey with 20-30% silt and less then 50% sand. The stone content is moderate. It is usually more than 4 feet thick as can be seen at an excellent exposure on the banks of the Woo Burn. On steep slopes and high-level plateaux the till has a loamy texture. This till is seldom as much as 4 feet thick and has a high stone content.

The Silurian rocks comprise both Llandoverian and Wenlockian sediments. The tills derived from these are practically indistinguishable but other distinctive features make differentiation possible. The area of Llandoverian sediments has characteristic corrugations on which the till is of a loamy texture, very thin and very stony. Throughout the area of Wenlockian sediments, however, there are few corrugations and the loamy till even on steep slopes is thicker and not quite so stony as that derived from Llandoverian sediments.

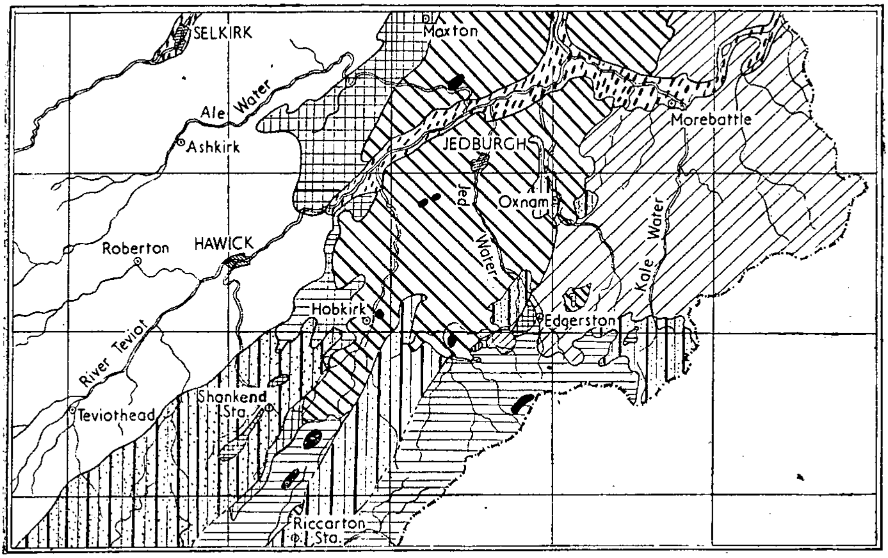
Till derived from Lower Old Red Sandstone Lavas

Till derived from the Lower Old Red Sandstone lavas is to be found over the eastern part of the area (Fig. 8). It is remarkably free from contamination by other geological material. Only along the western and south-western edges and where there are inliers of other rocks has there been any carry-over of other geological material by ice. Over Edgerston Moor part of the till has been derived from the basal conglomerate of Upper Old Red Sandstone sediments, which, however, consists mainly of lava material. Consequently this till is very similar to that derived from the lavas proper and has been mapped as such. Most of the till has been derived from andesitic lava but there is an area near the watershed between Cocklaw and Rushy Fell where it is probably from mica-felsite.

In valleys and on low ridges the till generally has a clayey texture with more than 30% clay. It is more than 4 feet thick as can be seen at Belford where the Bowmont Water has cut through as much as twenty-five feet of till and bared excellent exposures. Examination of these indicates that the till in this area has been derived exclusively from Lower Old Red Sandstone lavas. At Oxnam School there is another excellent exposure but as would be expected from the situation the till here is by no means derived solely from lavas. It contains quite a proportion of material derived from Upper Old Red Sandstone sediments though not sufficient to exclude it from the lava category.

On steep slopes and high-level plateaux the till has a loamy texture with less than 20% clay. It is stony and seldom as much as 4 feet thick. A common feature is a layer of stones, sub-angular and of moderate size, occurring about 6 inches from the surface. At first sight the till seems shallow but once the stone layer has been penetrated it is usually found to be of normal depth. This is the commonest soil parent material derived from lavas.

Near the watershed there are many steep slopes; some are screes, others have a covering of very thin, very stony till. These slopes have been mapped as producing skeletal soils. Solid lava outcrops frequently throughout the area.



Fluvio-Glacial Sand and Gravel—

TILLS DERIVED FROM
Llandoverian
Silurian Sediments—
Wenlockian

Lower Old Red Sandstone Lavas—

Upper Old Red Sandstone Sediments—

Lower Carboniferous Sediments—

Upper Carboniferous Intrusive Igneous Rocks—

Silurian and Upper Old Red Sandstone Sediments—

FIG. 8. Generalized Distribution of Glacial Tills.

Till derived from Upper Old Red Sandstone Sediments

Till derived from Upper Old Red Sandstone sediments is to be found in the central part of the area (Fig. 8). Along its western and south-western edge there is a certain amount of contamination by Silurian material but elsewhere the till is remarkably pure. In the Cessford-Crailing area most of the till on low ground has been modified by water action.

On slopes and hilltops the till is generally loamy, with more than 50% sand and 10%-20% clay and less than 3 feet thick. The nature of the material at any given depth, however, is difficult to establish because of the close resemblance between soft sandstone and sandy till. On occasion, however, there is a distinctive band which can be traced round the inspection pit, and although the material above and below is soft and rarely distinguishable from sandy till, the band itself retains unmistakable properties of solid sandstone.

In some valleys and especially in the valley of the Rule Water, the till is more than 4 feet thick as can be seen from large exposures at the riverside. Its texture is still loamy but the percentage clay is frequently over 25%. At Oxnambrow Hill one small area of rock has given rise to skeletal soils.

Till derived from Lower Carboniferous sediments

Till derived from Lower Carboniferous sediments is to be found in the southern part of the area (Fig. 8). On the western edge the till is generally contaminated by material from other geological formations but elsewhere it seems entirely Carboniferous in origin.

In valleys and on smooth slopes the till is usually more than 4 feet thick, and has a clayey texture with more than 30% clay and less than 20% silt. The percentage silt distinguishes it from Silurian till which it resembles in appearance.

On ridges and high-level plateaux the till has a loamy or sandy texture and is usually shallow with rotten sandstone strata at about 2 feet.

Mixed Till derived from Silurian and Upper Old Red Sandstone Sediments

Mixed till derived from Silurian and Upper Old Red Sandstone sediments is to be found to the south-west and west of the area of Old Red Sandstone till (Fig. 8). The proportions of the constituent materials vary considerably from locality to locality. It is usual to find Silurian material overlying Upper Old Red Sandstone material and the thickness of Silurian material greater in the hollows than on the summits of slopes. The till is generally of clayey texture with a pronounced silty feel. In this respect it is very similar to the tills derived from Silurian sediments only, the percentage silt varying between 20% and 30%.

Fluvio-glacial Terraces

There are fluvio-glacial terraces along the lower courses of the Teviot, Kale, Bowmont and Ettrick Waters, their geological composition reflecting the formations through which the fluvio-glacial waters passed (Fig. 8). The major constituent in any given place is normally derived from the local rock. The texture is either sandy or loamy.

Alluvium

Two types of alluvium are found in the area—river and lacustrine. All the rivers and streams are flanked by alluvium but only along the Teviot between Denholm and Eckford is it extensive. The alluvium usually consists of from 1 to 3 feet of sandy material overlying gravel. Lacustrine alluvium is associated with existing or former lochs and occurs mainly as small deposits. According to the first and second Statistical Accounts of Scotland many of the deposits of lacustrine alluvium were underlain by marl which was often used for agricultural improvements. Many of the deposits seem to have been worked out but marl can still be seen at Synton Loch.

CHAPTER 3

Methods and Definitions

FIELD METHODS

ONE of the principal functions of a soil survey is to identify and describe soil types and record their distribution on a map. Soils are identified in the field principally by their morphology, that is, by a comparative study of their appearance. Certain other characteristics such as handling properties, are also used but, generally speaking, they are subsidiary. A study of soils at different points on the landscape by this method soon reveals that whilst each has an individual identity some are so much alike that they can be placed into the same primary category. The primary category, for both mapping and classification, is the soil series.

To establish a soil series it is necessary for the pedologist to have a clear appreciation of the permissable range of general morphology. It is unwise to base a separation of soil series on a single characteristic: significantly different soils are distinguishable usually on the whole morphology of the profile.

When it comes to mapping established soil series one problem invariably faces the pedologist, that of drawing suitable boundaries between series. Typical profiles of two soil series may differ markedly from each other but when they have a common boundary it is usual for one to merge into the other over an appreciable distance, say 20 yards. A line is placed on the map to effect a separation but it must be remembered that the two series in fact merge and no sharp change in morphology occurs.

CARTOGRAPHIC METHODS

The series is the primary soil unit both for mapping in the field and for classification. Its place in classification is discussed in Chapter IV. For the purposes of describing series in relation to their environment and especially to geology they are placed into a larger cartographic unit, the soil association. Each soil association consists of series developed on similar parent material. The significance of the word similar is determined by the effect the parent material has on the soil profile and it is the job of the pedologist to assess this. Thus the association is a flexible cartographic unit and can be made to suit the needs of any particular area. Different series, which are developed on similar parent material in the same locality, have usually common boundaries. The usefulness of the association as a cartographic unit is emphasised when it is remembered that these series will merge, one into the other.

The Soil Survey of Scotland uses field maps with a scale of 1 : 25,000 (about 2½ inches to 1 mile). They are reduced to a scale of 1 : 63,360 (1 inch to 1 mile) for publication. Scale introduces certain difficulties. On a scale of 1 : 63,360 it should be possible to delineate an area of about 5 acres but areas smaller than this cannot be shown. Thus it is possible for any uniformly-coloured area on the published map to contain within it an area, less than 5 acres in extent, of some other series. In practice this seldom happens. Any locality where this happened repeatedly would be mapped as a soil complex, with the constituent soil types enumerated and defined in the text.

DESCRIPTION OF SOIL PROFILES

During the survey of an area, sites, typical of each soil series are selected and profile pits dug. The depth of each pit varies somewhat, but, in general, it is about 4 feet. Each profile is then described in standard terms which are defined and explained later in this chapter.

A soil profile is described by noting first certain features of the site followed by a few characteristics of the profile as a whole. The profile is then subdivided into its constituent horizons and these are described separately. It is usual to designate each horizon by a symbol, the same symbol being used for the same horizon in any profile of the same series or, for that matter, of the same major soil group. It should be noted, however, that when a symbol is used for a horizon in two profiles, the first belonging to one major soil group and the second to another major soil group, it may not have quite the same significance. The horizons will probably correspond only in a rough way.

LABORATORY INVESTIGATIONS

Each horizon, occasionally each sub-division of an horizon, is sampled. The samples are taken to the Macaulay Institute for Soil Research where each is given a routine physico-chemical examination. The analyses carried out are shown in Appendix I.

Some profiles are selected and are further analysed by mineralogical, differential thermal, spectrochemical and x-ray methods. Occasionally some are subjected to a total analysis by chemical methods.

STANDARD TERMS AND DEFINITIONS

When describing a soil profile it is usual to describe certain characteristics in standard terms. Some of the characteristics apply to the site, other to the soil profiles proper. Those which refer to the site, namely Relief and Slope Classes, Aspect, Altitude and Vegetation are treated first. The terms used to describe the last three properties are self-explanatory and have not been defined.

Drainage Class and Horizon Nomenclature are properties which apply to the profile as a whole and their standard terms are next to be defined. Finally, certain properties, namely, Colour, Texture, Structure, Consistence, Induration, Amount of Organic Matter, Stoniness, Number of Roots and Mottling are properties which apply to each soil horizon. Standard terms are listed and defined for each.

RELIEF AND SLOPE CLASSES

The soil map shows contours at 100-foot intervals which give a comprehensive picture of the relief so far as the 100-foot intervals allow. In addition, it is usual to give a description of the area in terms of landform or similar units. This has been done in Chapter I.

It may be useful, however, to relate soil series to slope. To facilitate this, single slope classes are given below. They are the single slope classes used by the U.S. Soil Survey[22].

Class	Limits	Name
Class A	Lower 0 per cent. Upper 1-3 per cent.	Name:—level
Class B	Lower 1-3 per cent. Upper 5-8 per cent.	Name:—gentle
Class C	Lower 5-8 per cent. Upper 10-16 per cent.	Name:—moderate
Class D	Lower 10-16 per cent. Upper 20-30 per cent.	Name:—moderately steep
Class E	Lower 20-30 per cent. Upper 45-65 per cent.	Name:—steep
Class F	Lower 45-65 per cent. Upper none	Name:—very steep

HORIZON NOMENCLATURE OF SOIL PROFILES

Typical soil horizons can be readily compared and contrasted if a symbol is assigned to each one. The symbols normally used are L, F, H, A, B, C and D. General definitions of the layers, or horizons to which these symbols are assigned are given first, followed by more precise definitions suitable for each major soil group formed in the area.

L, F and H layers are sub-divisions of the organic matter lying on the surface of the solum.

L — a superficial layer of relatively undecomposed plant litter generally of the past year.
F — a superficial layer of partially decomposed litter with recognisable plant remains.
H — a superficial layer of decomposed organic matter with few or no recognisable plant remains.

The A horizon is the upper mineral part of the solum. It is the horizon of maximum biological activity and the horizon most subject to the direct influence of climate, plants and animals.

The S horizon is the surface horizon of a cultivated soil.

The B horizon is the lower part of the solum lying between A and C horizons. It is characterised by *either* a relatively high content of sesquioxides or clay *or* by having a more or less blocky or prismatic structure. Quite often there are accessory characteristics such as a bright colour.

The C horizon—the weathering rock or parent material from which the soil developed.

The D horizon—a stratum unlike the material from which the solum has developed but may influence profile development indirectly.

Horizon Nomenclature of Certain Major Soil Groups

Peaty Podzols (with thin iron pan)

L — Undecomposed plant litter.
F — Partially decomposed litter.
H — Decomposed organic matter—dark brown or black.
A_1 — the uppermost mineral layer, dark coloured organic matter mixed with mineral matter relatively rich in silica.
A_2 — a layer immediately below the A_1 which is low in organic matter, pale grey in colour and rich in silica. May show signs of gleying when it is designated either A_2 (g) when the gleying is slight or A_2g when the gleying is strong. A concentration of roots may be present at the botton of this layer and they may be partially decomposed.
B_1 — a thin iron pan about $\frac{1}{16}''$ thick. Maximum enrichment of sesquioxides. May be continuous and impermeable to water and impermeable to roots, then strong tendency for gleying and for roots to concentrate immediately above in the A_2.

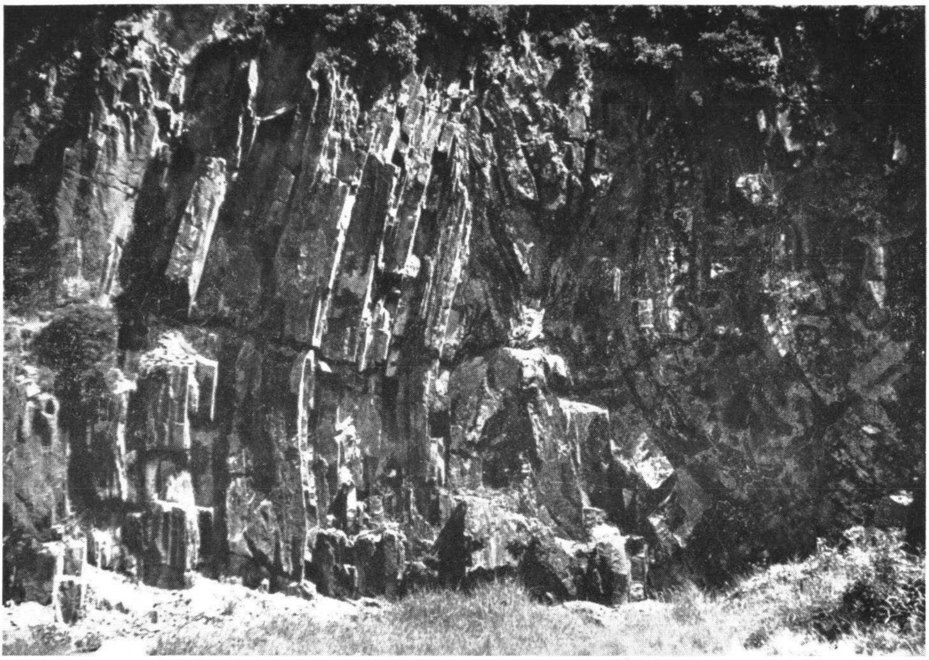


PLATE IX
Silurian sediments near Midlem showing isoclinal folding.

PLATE X
"Corrugations" of the Ettrick Association near Drinkstone.

Plate XI
Upper Teviotdale showing soils of the Ettrick Associations. Note the thick clayey till with ditches to drain off the surface water and thin loamy till on the steeper slopes.

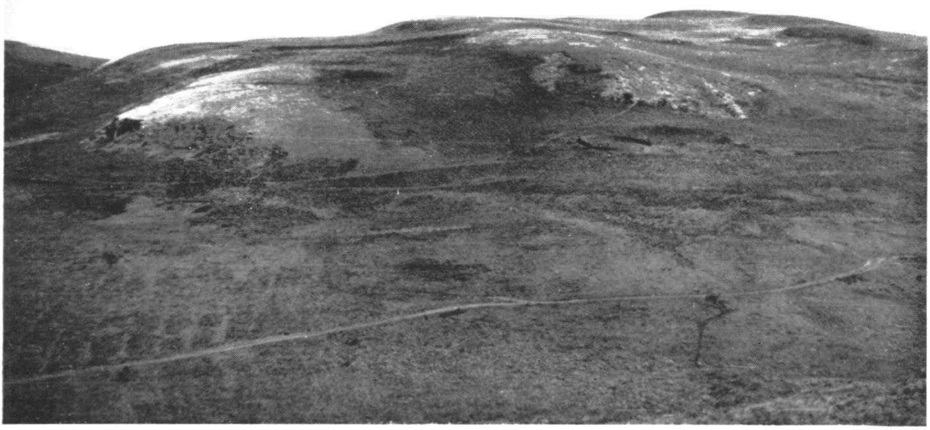


Plate XII
Fasset Hill showing three lava flows. The light coloured vegetation is mainly Moor Mat Grass (*Nardus stricta*) and the dark is Bracken (*Pteridium aquilinum*).

B_2 — brighter than the A or C horizons. Relative enrichment of sesquioxides.
B_3 — not so bright as B_2. Shows some relative enrichment of sesquioxides and a degree of induration.
C — the relatively unweathered parent material.

When a horizon has a moderate amount of gleying its symbol is modified by adding (g), for example, B_2(g).

Brown Forest Soil (low base status)

These soils are roughly equivalent to the Brown Podzolic soils of the U.S.A.

L undecomposed plant litter
F partially decomposed plant litter
H trace of decomposed organic matter—may be absent
A brown colour with medium organic matter, moder type; crumb structure. No differentiation into A_1 or A_2.
B_2 brighter brown colour than the A horizon. A relative enrichment of sesquioxides.
B_3 less bright than the B_2 horizon and nearer to the colour of the parent material. Some degree of induration.
C relatively unweathered parent material.

When a horizon has a moderate amount of gleying, its symbol is modified by adding (g), for example, B_2(g).

Peaty Gleys

L undecomposed plant remains.
F partially decomposed litter.
H decomposed organic matter usually more than 2 ins. thick and dark brown or black in colour.
A_1g mixed organic and mineral layer. A little ochreous mottling associated with roots. Weak structure.
A_2g pale-coloured layer. There may be some ochreous mottling. Weak structure. Low content of organic matter.
B_2g blocky or prismatic structure very apparent. Peds coated with grey but inside show ochreous and grey mottling.
B_3g blocky or prismatic structure less apparent. Still grey coating to peds and inside, ochreous and grey mottling.
Cg original colour of parent material more apparent. Structure more massive but peds still coated with grey and inside there is still ochreous mottling.

Non-calcareous Gleys

L undecomposed plant litter.
F partially decomposed litter.
H trace of decomposed organic matter—often absent.
A_1g mixed mineral-organic layer. Some ochreous mottling associated with roots. Weak structure.
A_2g pale-coloured mineral layer, low in organic matter. Structure weak. May be some ochreous mottling.
B_2g well-defined blocky or prismatic structure. Peds coated with grey and mottled inside with ochreous and grey.
B_3g less well-defined blocky or prismatic structure. Peds coated with grey and mottled inside with ochreous and grey.
Cg original colour of parent material more apparent. Structure more massive although peds may still have grey coatings and ochreous and grey mottling inside.

DRAINAGE CLASSES

The word drainage has several meanings but in this instance it refers strictly to the morphology of profiles. In general freely drained soils have bright, uniformly coloured B horizons while poorly drained soils have dull, mottled B horizons. Mottling, especially grey mottling, is considered evidence of gleying. Thus drainage classes are distinguished purely on morphology.

The sequence of terms used to describe drainage class is given below along with general definitions. Precise descriptions of characters are possible only with individual series.

Drainage:— excessive

The soil horizons are much shallower than usual. The B horizons are bright and uniform in colour. This type of profile is not common in the area.

Drainage:— free

The B horizons are bright and uniformly coloured, although those with a small degree of dullness and some mottles are permitted within the class.

Drainage:— imperfect

The B horizons are not quite so bright as those of the well drained soil and have appreciable mottling. They are designated B_2 (g), B_3 (g), etc. to indicate a moderate amount of gleying.

Drainage:— poor

The Bg horizons are dull and mottling is very evident,

Drainage:— very poor

The Bg horizons are dull and mottling is very evident.

The imperfectly drained soil is intermediate between the freely and poorly drained soil though it is generally rather closer in character to the freely drained soil. It seldom requires to be tile drained before it can be cultivated successfully.

The poorly drained and the very poorly drained soils require tile drainage before successful cultivation can be undertaken. Both may have an A_2g horizon which is often a dull grey colour but it is usually more evident in the very poorly drained. It seems that this horizon is one of maximum gleying.

COLOUR

Colour is an obvious characteristic of the soil. It is one which gives rise to many local soil names, e.g., "whitelands" for the poorly drained series of the Ettrick Association and "red soils" for the Hobkirk Association.

Pedologists attach great importance to the colour of soil horizons; it is one of the characteristics which indicate whether the drainage class of a soil is good or poor. Individuals vary greatly in their ability to describe soil colour accurately and concisely and therefore use is made of colour charts. Munsell Soil Colour Charts[11] are used by the Soil Survey of Scotland.

According to the Munsell system each colour can be considered as the resultant of three variables—Hue, Value and Chroma. There are a number of charts, each with coloured chips. On any one chart all the coloured chips have the same Hue but differ from each other in Value and Chroma. Different charts have chips with different Hues. By comparing a small piece of soil with the coloured chips on the charts, it is possible to find a chip which matches or nearly matches most soil colours. Each coloured chip is designated by Hue, Value and Chroma in that order, e.g., 10YR:6/3. The Hue is 10YR, the Value is 6 and the Chroma is 3. Again each chip is given a standard name, e.g., 10YR:6/3 pale brown.

Hue refers to the dominant Spectral colour, e.g., whether red or yellow;

Value refers to apparent lightness as compared to absolute white and is a function of the intensity of light; Chroma refers to the purity of hue or, alternatively, the apparent departure from neutral greys or whites.

TEXTURE

Several related subjects are discussed under this heading. Soil texture is the relative proportions of the various groups of primary particles in a mass of soil; it refers specifically to the proportion of sand, silt and clay in that part of a soil sample which passes through a 2 mm. sieve. The presence of particles larger than 2 mm. does not affect the texture of the soil directly, but it can be indicated by additional descriptive terms such as stony, pebbly, etc. The texture of a soil horizon is one of its most important properties.

Soil separates are the arbitratily selected size-groups of mineral particles which together make up the soil Specifically they are the sand, silt and clay fractions into which the soil material is separated when subjected to mechanical analysis. The coarse sand separate consists of all those particles in a soil with effective diameters between 2000 μ (or 2 mm.) and 200 μ: the fine sand fraction of particles with effective diameters between 200 μ and 20 μ silt fraction of particles with effective diameters between 20 μ and 2 μ; and the clay fraction of particles with effective diameters less than 2 μ. Separates with these limits are defined by the International Scheme of Mechanical Analysis which, however, is by no means in universal use. The U.S. Department of Agriculture also has a scheme which is widely used. The main difference between the schemes is in the size limits of the silt fraction. Both schemes are given below.

U.S. Dept. Agric. Scheme[22]		*International Scheme*	
Name of Separate	Affective Diameter (range) u	Name of Separate	Effective Diameter (range) μ
sand: very coarse sand	2000—1000	sand: coarse sand I	2000—200
sand: coarse sand	1000—500	sand: fine sand II	200—20
sand: medium sand	500—250		
sand: fine sand	250—100	silt III	20—2
sand: very fine sand	100—50		
silt	50—2	clay IV	<2
clay	<2		

The Soil Survey of Scotland till recently has used the International Scheme exclusively and most of the mechanical analyses quoted in Appendix I are of this type. It has recently been decided, however, to use both schemes and to quote both sets of figures when publishing. At the same time it was decided to use the U.S.D.A. triangular diagram for Textural Classes.

Textural Class Names

In assigning textural class names to soils the Soil Survey of Scotland has combined all the sand separates into one with the general name sand. The percentage of each separate is plotted on a triangular diagram and the area on the diagram into which the soil fits is ascertained. Each area has a Textural Class name and the soil is now given the appropriate name. Fig. 9 is a triangular diagram showing the areas of the various textural class names. These areas have been defined after years of experience, especially in the United States. Strictly speaking, this diagram should be used only when the U.S. Dept. of Agriculture Scheme of Mechanical Analysis is used.

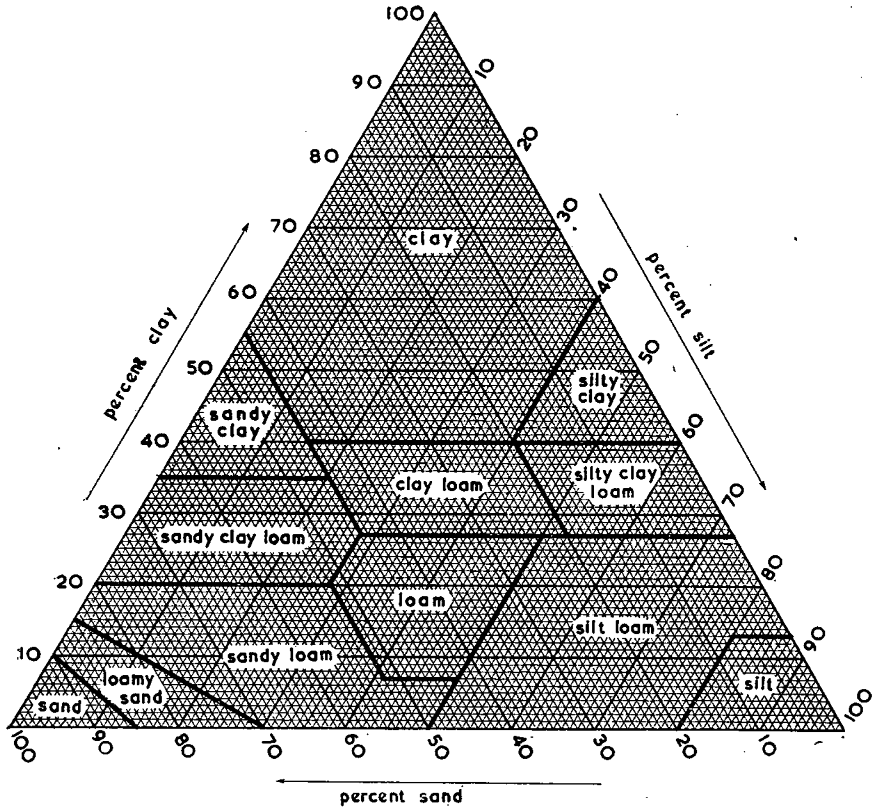


FIG. 9. The percentages of clay ($<2\mu$), Silt (2-$\cdot 50\ \mu$) and Sand (50-$2000\ \mu$) in the basic soil textural classes.

General Grouping of Soil Textural Classes

It is often convenient to distinguish broad groups of textural classes and although the terms "heavy" and "light" have been used for this purpose for many years they may lead to confusion as they do not necessarily bear any relation to the actual weight of the soil; they refer in fact to the power required in ploughing.

Acceptable general terms, in three classes and in five, are shown below with their relationship to the basic soil textural classes.

General terms		*Basic terms*
sandy soils	coarse textured soils	sand loamy sand
loamy soils	moderately coarse textured soils	sandy loam
	medium textured soils	loam silt loam silt
	moderately fine-textured soils	clay loam sandy clay loam silty clay loam
clayey soils	fine textured soils	sandy clay silty clay clay

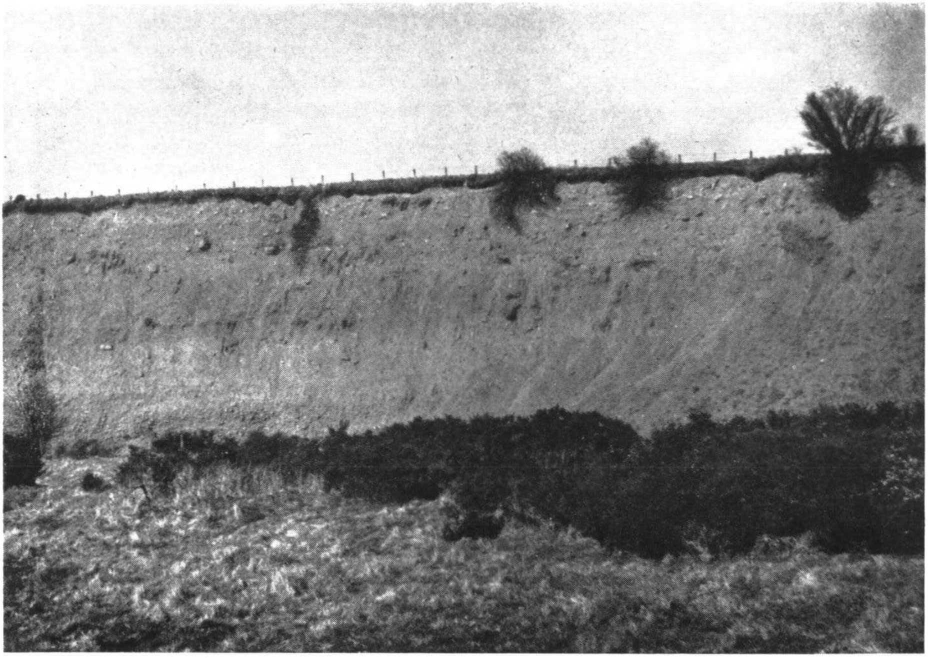


PLATE XIII
Thick till derived from lavas of Old Red Sandstone age (Sourhope Association) where the Bowmont water has cut through near Belford.

PLATE XIV
Soils of the Sourhope Association with arable land on the lower slopes. Note the misfit stream in a gully cut through clayey till.

PLATE XV
The Cheviot Hills (Sourhope Association) from Dere Street. Cheviot itself is in the distance.

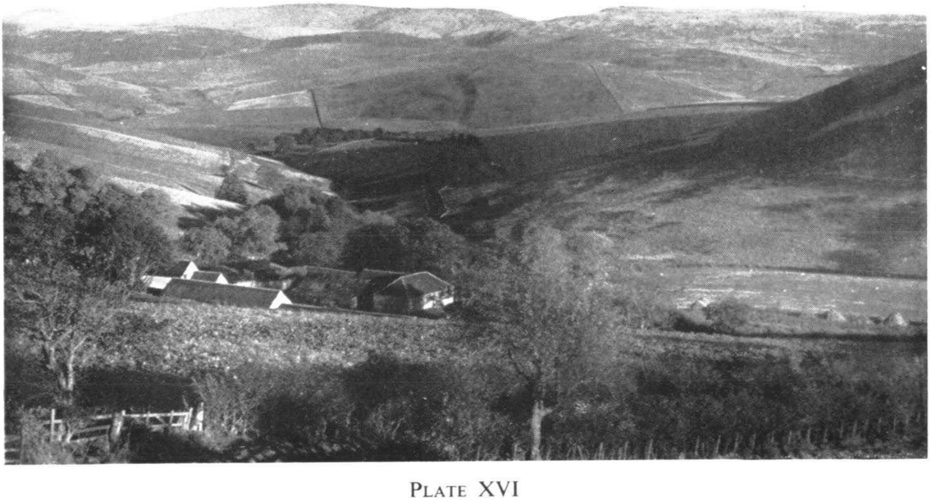


PLATE XVI
Cheviot and the Cheviot Hills (Sourhope Association) from Over Whitton.

STRUCTURE

The structure of a soil is the aggregation of its primary soil particles into compound units. The compound units are largely independent of the surrounding compound units.

Structure is a very important characteristic of soils. A good structure can be as important as an adequate store of nutrients. Generally speaking, soils with aggregates of spheroidal shape have much more pore space between aggregates, have more rapid permeability and are more productive than soils of comparable fertility with massive or blocky structure.

Field description of soil structure note (i) the shape and arrangement; (ii) the size; and (iii) the distinctness and durability of the structural units or, as they are called, peds. Each of these qualities is described by a separate set of terms which, when combined, form a terminology. The shape and arrangement is designated as type of soil structure; size as class; and degree of distinctness as grade. The terms used are defined below.

Type. There are four primary types of structure.

(I) Platy with one dimension, the vertical greatly less than the other two.

(II) Prism-like with two dimensions (horizontal) greatly less than the vertical

(III) Block-like with three dimensions of the same order of magnitude but having plane or curved surfaces that are casts of the moulds formed by faces of the surrounding peds.

(IV) Spheroidal with three dimensions of the same order of magnitude having plane or curved surfaces which have slight or no accommodation to the faces of surrounding peds.

Each of the last three types have two subtypes, namely, prismatic (without rounded ends) and columnar (with rounded ends): angular blocky (with relatively sharp angles) and sub-angular blocky (with rounded faces); and granular (relatively non-porous) and crumb (porous).

Class designates the size of the aggregates; five are recognised for each type. The terms used are very fine, fine, medium, coarse, very coarse. Table E shows the relationships of the various classes and types.

Grade of structure is the degree of aggregation and expresses the differential between cohesion within the aggregates and adhesion between the aggregates. In practice, grade of structure is determined mainly by noting the durability of the aggregates and the ratio of aggregated material to unaggregated when the aggregates are gently displaced or crushed.

Terms used for grade of structure are:—

1. Weak aggregates barely observable in situ. When disturbed the soil material breaks into a mixture of a few unbroken units and many broken with much unaggregated material.
2. Moderate well-formed units but not distinct in undisturbed soil. When disturbed there are many distinct units, some broken units and a little unaggregated material.
3. Strong well-formed units, distinct in undisturbed soil; adhere only weakly to one another. When disturbed consist of entire units with few broken and very little unaggregated material.

When the soil horizon shows no structure it is termed structureless and can be either single-grain (if non-coherent) or massive (if coherent).

Terms describing each of these three qualities are combined to give the structural description, grade first, then class and finally type, e.g., strong, coarse, blocky.

CONSISTENCE

Soil consistence is a quality of soil material which is expressed by the degree of cohesion and adhesion. It is measured by the resistance of soil material to deformation or rupture. Structure and consistence are inter-

TABLE E. TYPES AND CLASSES OF SOIL STRUCTURE

Type (Shape and arrangement of peds).

Class (size)	Platelike with one dimension (the vertical) limited and greatly less than the other two; arranged around a horizontal plane; faces mostly horizontal.	Prismlike with two dimensions (the horizontal) considerably less than the vertical; arranged around a vertical line; vertical faces well defined; vertices angular.		Blocklike: polyhedronlike, or spheroidal, with 3 dimensions of the same order of magnitude; arranged round a point.			
				Blocklike: blocks or polyhedrons having plane or curved surfaces that are casts of the moulds formed by the faces of the surrounding peds.		Spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of surrounding peds.	
		Without rounded caps	With rounded caps	Faces flattened; most vertices sharply angular	Mixed rounded and flattened faces with many rounded vertices	Relatively non-porous peds	Porous peds
	Platy	Prismatic	Columnar	(Angular) Blocky	Subangular Blocky	Granular	Crumb
very fine	very fine platy <1 m.m.	very fine prismatic <10 m.m.	very fine columnar <10 m.m.	very fine angular blocky <5 m.m.	very fine sub-angular blocky <5 m.m.	very fine granular <1 m.m.	very fine crumb <1 m.m.
fine	fine platy 1-2 m.m.	fine prismatic 10-20 m.m.	fine columnar 10-20 m.m.	fine angular blocky 5-10 m.m.	fine subangular blocky 5-10 m.m.	fine granular 1-2 m.m.	fine crumb 1-2 m.m.
medium	medium platy 2-5 m.m.	medium prismatic 20-50 m.m.	medium columnar 20-50 m.m.	medium angular blocky 10-20 m.m.	medium subangular blocky 10-20 m.m.	medium granular 2-5 m.m.	medium crumb 2-5 m.m.
coarse	coarse platy 5-10 m.m.	coarse prismatic 50-100 m.m.	coarse columnar 50-100 m.m.	coarse angular blocky 20-50 m.m.	coarse subangular blocky 20-50 m.m.	coarse granular 5-10 m.m.	
very coarse	very coarse platy >10 m.m.	very coarse prismatic >100 m.m.	very coarse columnar >100 m.m.	very coarse angular blocky >50 m.m.	very coarse subangular blocky >50 m.m.	very coarse granular >10 m.m.	

related, the former being the resultant of forces within the natural soil while the latter is concerned with the forces themselves.

As consistence is strongly influenced by the moisture condition of the soil it is necessary to have a series of terms for each significant moisture state.

Consistence when wet

To evaluate, roll the soil material between thumb and forefinger.

0. Non-plastic — no wire formable
1. Slightly plastic — wire formable and soil mass easily deformed
2. Plastic — wire formable and moderate pressure required to deform soil mass
3. Very plastic — wire formable and much pressure required to deform soil mass

Consistence when moist

To evaluate, attempt to crush in the hand a mass that appears moist.

0. Loose — non-coherent
1. Friable — soil material crushes under very gentle pressure but coheres when pressed together
2. Firm — soil material crushes under moderate pressure between thumb and forefinger but resistance distinctly noticeable
3. Very firm — soil material crushes under strong pressure: sometimes not crushable between thumb and forefinger.

Consistence when dry

To evaluate, break an air-dry mass in the hand.

0. Loose — non-coherent
1. Soft — breaks to powder or individual grains under very slight pressure
2. Hard — can be broken easily in the hands but is barely breakable between thumb and forefinger
3. Very hard — can normally be broken in the hands but only with difficulty.

In Scotland soil horizons are usually either wet or moist.

INDURATION

Induration of soil material refers to a handling property of the soil which appears not to be markedly affected by moisture content. Consistence, on the other hand, varies greatly with moisture. Three terms are used to describe this property and they are defined below.

1. Weakly indurated — not usually detected when digging but presence shown by stabbing a knife into the profile face. Breaks easily in the hand.
2. Moderately indurated — detected when digging. Breaks in the hand by using moderate pressure.
3. Strongly indurated — detected when digging and in fact causes difficulty. Not readily broken in the hand.

ORGANIC MATTER

Organic matter in a soil may be described qualitatively and quantitatively. In profile descriptions it is usual to estimate the amount present in each horizon. If a horizon contains more than 20% organic matter it is considered an organic horizon; if less than 20% organic matter it is considered a mineral horizon. The amount of organic matter in mineral horizons may vary and it is usually indicated by standard terms which are listed and defined below.

high	13%-20%
moderate	8%-13%
low ..	<8%

Organic horizons may often be sub-divided into 3 layers—L, F and H. The L layer is relatively fresh litter; the F layer is fermented litter with the source of the remains still recognisable; and the H layer is the well-decomposed humus with very few recognisable constituents. When the H layer is more than 12 ins. thick the soil is considered a peat.

There are three principal types of humus in this area, namely, mull, moder (silicate) and mor. Mull is an intimate mixture of mineral and organic matter in the A horizon with the constituent parts not identifiable by means of a lens. Silicate moder has an appearance similar to mull but its constituent organic and mineral parts can be identified by a good lens. The third type, mor, is usually found where there are well developed L, F and H layers. There is no intimate mixing of organic and mineral parts, the two remaining obviously distinct. The H layer itself has a very low mineral content.

The various major soil groups are associated with a certain humus type. The brown forest soils of low base status have typically silicate moder but occasionally may have mull. The peaty podzols and peaty gleys have a mor type of humus while the non-calcareous gleys have a form of silicate moder.

It should be noted that the terms mull, moder and mor are used in the way Kubiena[8] uses them.

STONINESS

Stoniness is an important property of a soil or a soil horizon. Stones dilute the finer material and make the soil more freely drained; in addition it may have marked effects on the ease with which cultivations are carried out. When a soil is stony or very stony the cost of wear and tear on implements is likely to be high.

The method for describing the stoniness of soil horizons is not very precise. The terms in use are listed below but it must be emphasised that the percentage stones is estimated and is by no means accurate.

few stones	—	<15% by volume
stony	—	15-50% by volume
very stony	—	>50% by volume

When the stone content reaches 80% or 90% by volume it is probable that the soil will be considered skeletal and placed in the appropriate category.

MOTTLING

To describe mottling accurately it is necessary to note colour and pattern. Colour may be noted by Munsell colour charts but in many of the profile descriptions which follow this has not been done; instead a general descriptive term, "ochreous," has been used to denote different shades of brown. The pattern has been described in terms of—

(1) Abundance

few	—	mottles <2% of surface
frequent	—	mottles 2-20% of surface
many	—	mottles >20% of surface

(2) Size

fine	—	<5 m.m.
medium	—	5-15 m.m.
coarse	—	>15 m.m.

(3) Contrast

faint	—	hue and chroma of matrix closely related
distinct	—	matrix and mottles vary 1-2 hues and several units in chroma and value
prominent	—	matrix and mottles vary several units in hue, value and chroma.

These terms are combined in the order in which they are given above, e.g., few fine distinct ochreous mottles.

CHAPTER IV

Soil Classification and Formation

SOIL CLASSIFICATION

THE system of classification used in this memoir has been provisionally adopted by the Soil Survey of England and Wales and the Soil Survey of Scotland. Experience has shown that certain morphological features can be selected to form the criteria of higher categories. Soil series with very similar profiles are placed in the same major soil groups and sub-groups and major soil groups are then selected on the basis of general characteristics and placed into divisions, the highest taxonomic categories used. Table F gives a summary of the series, major soil groups and divisions found in this area, and descriptions for each category are given below.

TABLE F. CLASSIFICATION OF SOIL SERIES

Division	Major Soil Group	Sub-group	Series
Gleys	Surface-Water Gleys	Non-calcareous Gleys	Ettrick, Atton, Cessford, Letham Minto, Woodend, Peden, Huntford.
		Peaty Gleys	Alemoor, Edgerston, Wauchope, Carter, Stenishope, Hardlee, Lawsuit, Redeswire.
Leached Soils	Podzols	Peaty Podzols (with thin iron pan)	Dod, Cowie, Faw, Arks, Stonedge.
	Normal Brown Earths	Brown Forest Soils (low base status)	Linhope, Sourhope, Hobkirk, Coblaw, Belses, Eckford, Darleith.
Organic Soils	Blanket Peat	Hill Peat	
	Basin Peat	Low Moor	

DIVISION OF GLEYS

Gleys are mineral or peaty (H layer less than 12 in.) soils which have developed under conditions of permanent or intermittent waterlogging. The mineral horizons of gleys are grey or greenish in colour with ochreous mottling. These are secondary colours which often mask colours inherited from parent material.

MAJOR SOIL GROUP: SURFACE WATER GLEYS

Surface-water gleys are soils where effects of gleying are shown which decrease with depth. In these the soil colour inherited from parent material is more apparent in the B_3g and Cg horizons than in any other.

(*a*) *Sub-group*: *non-calcerous gleys..*

Non-calcareous gleys have no free calcium in the upper mineral horizons. The H layer is usually not more than 1 in. thick and although the A_2g may be well-defined it is not invariably so.

(*b*) *Sub-group*: *peaty gleys*

Peaty gleys have no free calcium in the upper mineral layers but the H layer is usually well-formed and over 2 in. thick. The A_2g horizon is always prominent.

Division of Leached Soils

Leached soils are characterised by a uniformly coloured B horizon, absence of free lime in the upper horizons and an acid reaction.

MAJOR SOIL GROUP: PODZOLS

Podzols have a grey bleached A_2 horizon with a very weak structure, an H layer of mor and a strongly acid reaction. There is usually evidence, morphological or chemical, of translocation of sesquioxides.

(*a*) *Sub-group*: *peaty podzols* (*with thin iron pan*)

Peaty podzols with thin iron pan have an H layer of mor humus up to 12 in. thick. The A_2 horizon is usually not well defined and it may show evidence of gleying. The B_1 horizon is a thin iron pan, often continuous, which may be impermeable to water and roots. The B_2 and B_3 horizons have little evidence of gleying.

MAJOR SOIL GROUP: NORMAL BROWN EARTHS

Normal brown earths are characterised by a uniformly coloured B horizon. They have a weakly to moderately acid reaction and a mull or moder humus formation. Each soil horizon merges into the one below.

(*a*) *Sub-group*: *brown forest soils* (*low base status*)

Brown forest soils (low base status) have a moderately acid reaction and a moder humus type. Each soil horizon merges into the one below.

Division of Organic Soils

Organic soils have more than 12 in. organic matter and are usually formed under waterlogged conditions.

MAJOR SOIL GROUP: BLANKET PEAT

Blanket peat is an organic soil formation which is formed over convex as well as concave slopes. The profile is usually much more uniform than that of basin peat.

(*a*) *Sub-group*: *hill peat*

Hill peat is found at high elevations on level ground or gently convex slopes i.e., on high-level plateaux.

MAJOR SOIL GROUP: BASIN PEAT

Basin peat is formed under the influence of ground water in localities where relief is definitely concave. The profile is usually more complex than that of blanket peat.

(*a*) *Sub-group*: *low moor*

Low moor is characterised by having the top of the peat at or below the level of the ground water.

DISTRIBUTION OF MAJOR SOIL GROUPS

Fig. 10 shows the generalised distribution of the major soil groups. In general, hill peat, peaty podzols with thin iron pan and peaty gleys occur near the watershed and on the western uplands. Brown forest soils and non-calcareous gleys are found in the central part of the area.

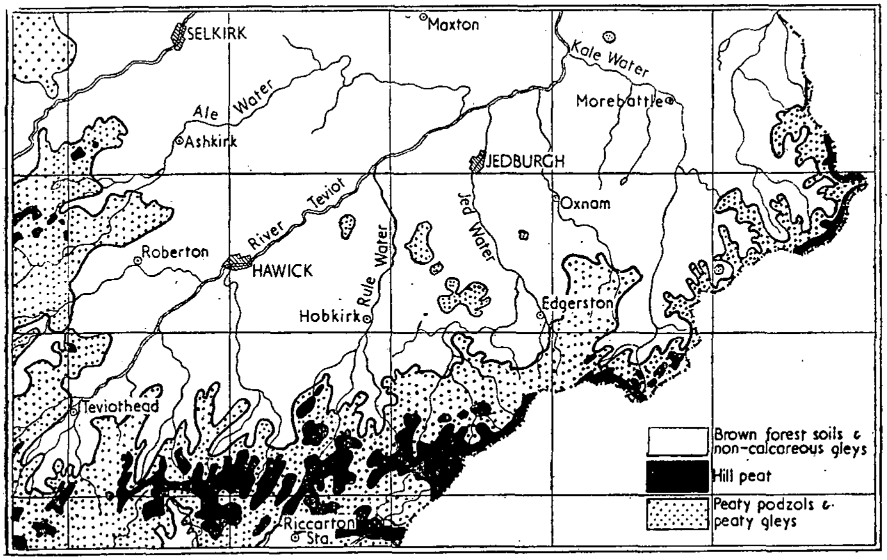


FIG. 10. Generalized Distribution of Major Soil Groups.

Two minor effects, which it has been impossible to show due to considerations of scale, deserve mention. Brown forest soils do occur in areas shown in Fig. 10 as peaty podzols with thin iron pan and peaty gleys but this is an effect of relief and will be discussed under that heading. Likewise non-calcareous gleys occur within the same areas, but only to a very limited extent. No explanation of this can be given except to say that some but not all of them are "flush" types.

FACTORS AFFECTING THE DISTRIBUTION OF MAJOR SOIL GROUPS

The factors (Jenny[7]) affecting the distribution of major soil groups are (1) climate (2) parent material (3) relief (4) vegetation and (5) time.

Climate plays a decisive part in the occurrence and distribution of the major soil groups. Rainfall is the most important climatic element in this area (Fig. 4) and it should be noted at the outset that the rainfall gradient towards the watershed is very steep. Fig. 10 shows the areas where peat, peaty podzols with peaty gleys and brown forest soils with non-calcareous gleys are predominant. A comparison of Fig. 4 and 10 indicates that peat, peaty podzols and peaty gleys generally occur under high rainfall. Brown forest soils do occur under high rainfall but only on steep slopes: this will be discussed under relief. As can be seen from Fig. 10 peaty podzols and peaty gleys are also found to occur under low rainfall in the area of till derived from Upper Old Red Sandstone sediments: this however is a parent material effect and will be discussed later. Disregarding these minor effects, it can be said of the area that with increase in rainfall there is a tendency (1) for mor to accumulate and (2) for iron pan to be formed.

Parent material plays an important part in the distribution of the major soil groups by virtue both of its texture and of its base-richness. The effect of texture will be discussed first.

The texture of the parent material in this area has determined to a large extent the natural drainage of the soils. Some rainfall is obviously necessary before a soil can become leached or gleyed but once there is a certain amount of rainfall, texture plays a part. In this area if a soil is developed on a clayey till it is a gley, either a peaty gley or a non-calcareous gley, whereas if it is developed on a sandy or loamy parent material it is either a peaty podzol or a brown forest soil. This effect is most clearly seen near the boundary between tills derived from Llandoverian and from Upper Old Red Sandstone sediments. On the Llandoverian till which in this locality is predominantly clayey, 90 per cent of the soils are non-calcareous gleys, while on the till derived from Upper Old Red Sandstone sediments which is predominantly sandy or loamy, the soils are 90 per cent. brown forest soils. The texture of a till depends on the nature of the parent rock and the effects of glaciation. Two tills, one lighter textured and more stony than the other, have been formed from each parent rock. The sandy or loamy till occurs on the higher slopes and high-level plateaux and the clayey on the lower slopes and in valleys. This separation into two tills can be attributed to glaciation because it occurs with all the parent rocks but it should be noted that the proportion of sandy or loamy till differs in each case and therefore this can be considered an effect of parent rock. The Llandoverian rocks have yielded for the most part a clayey till, the sandy or loamy till occurring only where there is an area of corrugations. The Wenlockian and Lower Carboniferous Sediments have yielded about equal amounts of clayey and sandy or loamy till. The Lower Old Red Sandstone lavas and the Upper Old Red Sandstone sediments have yielded a very high proportion of sandy or loamy till and little clayey till. To sum up, glaciation has produced in this area two tills, differing in stoniness and texture, from each parent rock, but in each case the ratio of sandy or loamy till to clayey till has been determined by the parent rock. The soils on clayey tills are gleys, while those on sandy or loamy tills are either brown forest soils or peaty podzols. The influence of texture is one of the most important effects of parent material.

The base-richness of the parent rock is also important but its effect is less clear-cut in this area than elsewhere in Scotland. It plays a part in determining the distribution of peaty podzols and peaty gleys on the one hand and brown forest soils and non-calcareous gleys on the other. The distribution of the tills are shown in Fig. 8. The tills derived from all the parent rocks except parts of the Upper Old Red Sandstone and Lower Carboniferous Sediments are unsuitable for study and comparison because of their similar intermediate composition. The Lower Carboniferous sediments are more siliceous but occur only under high rainfall and this masks the parent material effect. The Upper Old Red Sandstone sediments, however, vary in base-richness within themselves, the strata tending to become more siliceous towards the top of the formation. Where this happens in the area of low rainfall it generally leads to the formation of peaty podzols and peaty gleys. Nearby under otherwise similar conditions, but with the till less siliceous, brown forest soils and non-calcareous gleys are found. Fig. 9 shows this clearly, small isolated areas of peaty podzols and peaty gleys occurring under low rainfall wherever the till derived from Upper Old Red Sandstone sediments is more siliceous.

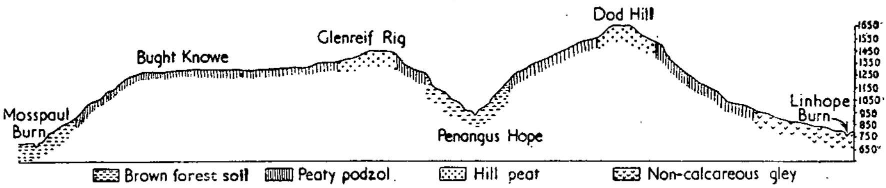


FIG. 11. Vertical Section through Part of the Area showing Major Soil Groups.

Relief plays an important part in the distribution of hill peat, peaty podzols and brown forest soils in areas of high rainfall. Peaty podzols and brown forest soils invariably occur on sandy or loamy till while hill peat sometimes occurs on sandy or loamy till with an iron pan in the mineral soil and sometimes on solid rock. In such areas of high rainfall hill peat occupies the flatter tops, peaty podzols the moderate slopes and brown forest soils the steep slopes, the steepness of the slope occupied by each type varying with the rainfall. A related effect is the way in which the drainage water from the hill peat affects the soils further down the slope tending to make them more peaty e.g. to turn brown forest soils into peaty podzols: steepness of slope hinders this transformation. These points are clearly shown in Fig. 11,a section through part of the area covered by till derived from Wenlockian rocks. Here hill peat on the flatter tops gives way to peaty podzols on moderate slopes and finally to brown forest soils on steep slopes. It should be noted, however, that on Bught Knowe the peaty podzols continue part way down the steep slopes: this is considered to be due to seepage of peaty water from soils above. Finally, on a moderate slope where peaty podzols are predominant brown forest soils nevertheless occur wherever there is a microslope of sufficient steepness.

Robinson[15] and Jenny[7] do not consider vegetation to be an independent variable. Jenny considers that initially all the types of vegetation within a large area have an equal chance of becoming established in a particular spot. The eventual dominance of one type is determined by such factors as soil, climate, slope, exposure, etc. Once a vegetational type becomes established, however, it can markedly affect the development of a soil.

Experience in this area bears out these statements. A certain type of vegetation is usually found associated with each major soil group (Stremme[19]; Muir and Fraser[12]). Brown forest soils often carry some form of acid grassland with *Agrostis spp.*, *Festuca spp.* and *Pteridium aquilinum* prominent. Peaty podzols frequently have some form of Molinietum either *Molinia caerulea—Calluna vulgaris* or *Molinia caerulea—Nardus stricta.* On non-calcareous gleys the vegetation varies; sometimes *Deschampsia caespitosa* is prominent and sometimes the vegetation is *Calluna vulgaris* with *Nardus stricta.* Peaty gleys always have some form of Molinietum. On hill peat the dominant species is either *Eriophorum* or, where it is drier, *Calluna vulgaris.*

Time as measured by years or centuries plays no part in differentiating these soils, for all were freed from glaciation at approximately the same time.

CONCLUSIONS

Climate has had an important influence on the character of the soils in this area. Generally speaking, hill peat, peaty podzols and peaty gleys occur where rainfall is high and brown forest soils and non-calcareous gleys where rainfall is lower. Brown forest soils do occur under high rainfall but only where the slope is favourable to their development. Parent material has two noteworthy influences. Its texture largely determines whether or not a soil is a gley and base-richness affects the distribution of peaty podzols and peaty gleys. A type of vegetation characteristic of each major soil group has been distinguished, but it is doubtful if vegetation has had a primary effect on the type of soil. Time has not had any noticeable effect.

CHAPTER V

The Soils

GENERALLY speaking the soils of this area are representative of the South of Scotland, a large part of which has similar parent materials and a similar range of climatic conditions.

The various soil categories with the area of each given in square miles, are summarised in Table G which is constructed to show certain relationships. All the soil categories which make up a soil association are on the same horizontal line. Individual names are given to series but other categories such as complexes and skeletal soils are distinguished only by a symbol. Each association is given the same name as one of its series usually that of the most characteristic. Vertically, each series is related first to drainage class and secondly to major soil group; skeletal soils and complexes are dealt with separately in the two end columns. Each series may be subdivided into phases on the basis of some property which affects agricultural practice or fertility and this division is usually made by the Soil Survey of Scotland on the basis of thickness of surface horizon. A surface horizon more than 12 in. is termed deep, one between 8 in. and 12 in. is called intermediate and one less than 8 in. is termed shallow. In this area, however, with the exception of the Eckford series which has a surface horizon more than 12 in. thick all the series have a surface horizon of intermediate thickness (8-12 in.).

The major soil group is essentially a unit of classification and it has been discussed in Chapter IV. Nevertheless several points of interest arise from an examination of Table G. Most of the soils recorded there belong to one of 5 major soil groups, namely brown forest soils of low base status, peaty podzols, non-calcareous gleys, peaty gleys and hill peat. There are no calcareous soils in the area despite the fact that calcareous parent materials are found in certain localities. The area occupied by gleys is almost as large as that occupied by brown forest soils (l.b.s.) and peaty podzols combined, whilst hill peat and soils with a peaty top make up 25 per cent. of the soils of the whole area.

The soil association is a cartographic unit containing soil categories developed on parent material derived from the same parent rock. Soils grouped together in an association generally occur in the same neighbourhood—which, incidentally, makes the soil association a convenient unit for the writing of descriptive memoirs—and have in common those properties imparted by parent rock. One such property is the percentage silt (2-20μ) found in all the soils of the Ettrick Association. The type of parent rock also determines to some extent the fraction each constituent soil category forms of the whole association. The Ettrick association is composed of approximately one quarter brown forest soils, two-fifths gleys and one-fifth complexes; the Sourhope association of three-fifths brown forest soils, one-eighth gleys and one-fifth skeletal soils; the Hobkirk association of three-quarters brown forest soils and one-quarter gleys; the Carter association of one-fourteenth brown forest soils and four-fifths gleys; the Minto association of two-fifths brown forest soils and one-half gleys; the Eckford association

TABLE G. AREA OF SOIL CATEGORIES IN SQUARE MILES.

Association	Series: Brown Forest Soils Low Base Status — Freely drained: Intermediate	Brown Forest Soils Low Base Status — Freely drained: Deep	Peaty Podzols — Freely drained with peaty top	Non-calcareous Gleys — Poorly drained	Non-calcareous Gleys — Very poorly drained	Peaty Gleys — Poorly drained with peaty top	Peaty Gleys — Very poorly drained with peaty top	Complexes		Skeletal Soils
Ettrick 187·6	Linhope 50·1		Dod 13·7	Ettrick 55·7	Peden 0·8	Alemoor 22·4	Hardlee 0·8	ER. c. 39·4	ER. ch. 3·7	ER. z. 1·0
Sourhope 81·9	Sourhope 49·5		Cowie 7·6	Atton 8·2		Edgerston 1·3	Lawsuit 0·2			SH. z. 15·1
Hobkirk 64·6	Hobkirk 48·4		Faw 0·8	Cessford 11·1		Wauchope 4·3				HK. z. 0·0
Carter 29·0	Coblaw 2·0		Arks 2·1	Letham 6·1	Huntford 0·2	Carter 17·7	Redeswire 0·2			CT. z. 0·7
Minto 22·9	Belses 9·9		Stonedge 0·3	Minto 10·5		Stenishope 2·2				
Eckford 5·7		Eckford 5·4		Woodend 0·3						
Darleith 3·4	Darleith 2·4									DL. z. 1·1
Major Soil Group, etc. Total area	167·7		24·5	92·9		49·1		43·1		17·4

Hill Peat	28·4	Mixed Bottom Lands }	25·5
Basin Peat	0·8	Alluvium }	

of more than nine-tenths brown forest soils; and the Darleith association of seven-tenths brown forest soils and three-tenths skeletal. The exact proportions can be calculated from Table G.

The soil associations are described in detail in this chapter. After a general introduction to each association the distribution, parent material and constituent soils are described. A brief note on the application of each soil is added. Soil categories such as peat, alluvium and mixed bottom lands, which have very individual properties, are also described and discussed.

ASSOCIATIONS

THE ETTRICK ASSOCIATION

The Ettrick Association is by far the most extensive, covering the whole of the western part of the area and occurring as inliers further east. It is developed on till derived from Llandoverian and Wenlockian sediments both of which are subdivisions of the Silurian. While the tills and soils from both Llandoverian and Wenlockian sediments cannot be distinguished by profile inspection there are certain external characteristics which indicate whether a given locality is underlain by one or the other. The principal distinguishing feature is the presence or absence of corrugations. The Llandoverian sediments invariably form corrugations but with Wenlockian this is exceptional. The line of demarcation runs from the south-west corner of the area by way of Stobs Station to Old Birnie Knowe. Everything to the north of this line is considered Llandoverian and to the south Wenlockian. The inliers are all Wenlockian.

DISTRIBUTION

The Ettrick Association falls naturally into three divisions:

Area I lies in the western part of Sheet 17. It is by far the largest area of any association to be discussed in this memoir. To the east it has common boundaries with the Minto association and to a lesser extent with the Hobkirk and Carter associations. The boundary runs approximately north and south from the neighbourhood of Lilliesleaf via Denholm and Harwood to Braidley burn. To the south, west, and north, Area I is bounded by land which has yet to be surveyed.

The northern part of Area I is underlain by Llandoverian sediments and has a very characteristic relief. These sediments are very highly folded and areas of corrugations are common, especially along the banks of the Teviot Water, in the neighbourhood of Ashkirk and along the Ettrick Water. To the west there are upland moors but throughout the remainder of this part of Area I the relief is rolling with long slopes.

The southern part of Area I is underlain by Wenlockian sediments which are also folded but, whatever the cause, there are few corrugations. Here the relief is hilly to mountainous with high-level plateaux near the watershed. The sides of the hills are often very steep.

Area II lies to the east of Area I and extends from Riccarton Station to the neighbourhood of Abbotrule. It is entirely underlain by Wenlockian sediments and there are no corrugations. The relief is hilly to mountainous with high-level plateaux near the watershed.

Area III: There are relatively small outliers of Wenlockian sediments at Hindhope, Mervinslaw and Bloodylaws, which can be conveniently grouped together. As in Area II there are no corrugations. At Hindhope the relief is hilly to mountainous with high-level plateaux at the watershed, at Bloodylaws it is hilly, and at Mervinslaw smoothly rolling.

Parent Material

The Ettrick Association is developed on till derived from both divisions of Silurian sediments, Llandoverian and Wenlockian. Where the rock type is Llandoverian a large number of areas with "corrugated" relief occur and because of the complex pattern of parent material type and soil type, these areas have been mapped as a complex. In general, however, two types of till are formed from each division. In valleys and on gentle slopes the till is normally over four feet thick with a clayey texture and moderate stone content. On steeper slopes and on high level plateaux it is usually less than four feet thick with loamy texture and high stone content.

It is interesting to note the proportion of loamy till, clayey till and complex derived from each type of Silurian sediment.

	Llandoverian	Wenlockian
Clayey till	43%	42%
Loamy till	24%	57%
Complex	33%	0·2%

The percentage of clayey till is the same for both parent sediments. The total area of loamy till and corrugated complex is also the same in both cases but whereas the Llandoverian sediments give rise to 33% corrugated complex the Wenlockian sediments give rise to only 0·2%. It should be emphasised that the tills from both types of Silurian sediments are apparently identical in the field. All that can be said is that the loamy till on the corrugations derived from Llandoverian is generally shallower than that derived from Wenlockian sediments despite the fact that the latter often occur on very steep slopes.

Throughout the association there are localities where the till has a definite red tinge, e.g., round Ettrickbridge End, the Brieryhill-Whitehaugh area, and near Mosspaul. This redness can often be associated with intrusions of igneous rock such as the Hawick Dyke.

Area I is remarkably free from extraneous material. There is a certain amount of igneous erratics near intrusions but otherwise nothing of any consequence. The western edge of Area II is slightly affected by Carboniferous, igneous and Old Red Sandstone material but not to any significant degree. Of the three inliers forming Area III, Hindhope is more or less free from extraneous material, Mervinslaw has a small admixture of lava material, and Bloodylaws is contaminated slightly in places by material from Old Red Sandstone sediments.

Soils

Most of the major soil groups found over the whole area are represented in the Ettrick Association. They include Brown Forest soils (l.b.s.) Peaty Podzols, Non-calcareous gleys and Peaty Gleys.

Within the association there are series with drainage varying from free to very poor, several of which are further distinguished by having peaty tops. Two complexes have also been delineated: in one, ER.c., most of the constituent soils have no peaty top while in the other, ER.ch., most of the constituent soils have a peaty top.

Both series with free drainage, Linhope and Dod, generally occupy the steeper slopes where the till is loamy in texture while those series with poor or very poor drainage, Ettrick, Alemoor, Peden and Hardlee, tend to occupy gentle slopes where the till has a clayey texture.

Under low rainfall (less than 40 inches) the series with no peaty top, Linhope, Ettrick and Peden are predominant and where the rainfall is high those with peaty top, Dod, Alemoor and Hardlee are predominant. The constituent soils of the complexes have a similar distribution, those with peaty top predominating under high rainfall.

The profile descriptions given below are of soils with semi-natural vegetation, that is to say, soils which have not been cultivated.

Series

LINHOPE SERIES

The Linhope series is developed on till with a loamy texture and moderate to high stone content. This till is to be found on steep slopes and hill tops and in the vicinity of corrugations. The vegetation is usually some form of acid grassland. The drainage class of the series is free.

GENERALISED PROFILE DESCRIPTION

SLOPE short, steep
ASPECT south
ALTITUDE 1,000 feet
VEGETATION *Agrostis spp.* *(a), *Festuca spp.* (a) *Pteridium aquilinum* (f) *Hypnaceous mosses* (f)
DRAINAGE CLASS free

Horizon	Depth or Thickness	
L	½″	Litter
F	½″	Partially decomposed litter
H	1″	Dark brown humus; live roots penetrate
A	0-10″	Yellowish brown (10YR: 5/4) loam; weak, medium crumb structure; very friable; low organic matter; stony; roots abundant; no mottling; merging into
B_2	10-14″	Yellowish brown (10YR: 5/6) clay loam; weak medium crumb; very friable; low organic matter; roots frequent; no mottling. Sharp change into
B_3	14-17″	Yellowish brown (10YR: 5/4) clay loam; weak medium blocky; friable; no organic matter; stony; roots frequent; no mottling. Sharp change into
C	17-36″+	Light olive (2·5Y: 5/3) brown clay loam; very stony with fine material in the interstices; no organic matter; roots rare; no mottling

*d=dominant; co-d=co-dominant; a=abundant; f=frequent; c=common; o=occasional; r=rare.

This description has certain features which are typical of the series as a whole. The typical A horizon has a good crumb structure and a low content of organic matter which is silicate moder in type. The B_2 horizon may have either a crumb or fine granular structure. There is often weak induration in the B_3 horizon but it lessens with depth. The C horizon is very stony and there is not much fine material. Very little mottling is evident throughout the profile.

When developed on material derived from Llandoverian sediments, this series is usually shallower than indicated in the above description; shattered rock is often encountered about 2 feet from the surface. When the series is developed on material derived from Wenlockian sediments, however, the above description is typical even for soils on steep slopes. It is always surprising to find such a depth of till on steep slopes.

NOTE ON AGRICULTURE. The vegetation characteristic of this series provides excellent pasture, but bracken readily invades and must be kept under control.

Certain adverse natural conditions must be overcome before cultivation is possible. The series is stony, occasionally very stony, resulting in severe wear and tear on implements. Much of it lies above 1000 feet where normal grain crops do not have sufficient time to ripen. Near the watershed the series usually occurs on very steep slopes and any disturbance of the existing vegetation is liable to cause soil erosion.

DOD SERIES

The Dod series generally occurs on gentle to moderate slopes on high-level plateaux under high rainfall (greater than 40 in.). The till has a loamy texture and is often stony. The series is usually freely drained below the B_1 horizon but above it may be imperfectly or poorly drained. The vegetation is frequently some form of Molinietum or Nardetum.

GENERALISED PROFILE DESCRIPTION

SLOPE moderate
ASPECT north
ALTITUDE 1,100 feet
VEGETATION *Molinia caerulea* (a and d), *Calluna vulgaris* (a and d), *Polytrichum commune* (a), *Hypnaceous mosses* (f)
DRAINAGE CLASS Poor above pan, imperfect below

Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter
H	6″	Very dark brown greasy humus; live roots penetrate. Sharp change into
A_1-A_2	0-3″	Dark grey-brown (10YR: 4/2) clay loam; weak medium blocky; friable; brown patches of organic staining; some stones present; roots frequent, forming a mat just above iron pan which is not often penetrated; no mottling. Sharp change into
B_1	at 3″	¼″ iron pan, hard and well defined; continuous. Sharp change into.
B_2	3-10″	Pale brown (10YR: 6/3) clay loam; weak medium blocky; friable; no organic matter; stony; roots rare; frequent medium distinct ochreous and grey mottles; few fine distinct black mottles: merging into
B_3	10-18″	Gritty reddish brown (5YR: 5/4) clay loam; moderate medium blocky; weakly indurated; very stony; roots very rare; few medium distinct ochreous mottles; frequent fine distinct black mottles.

The thickness of the H layer is variable but is usually more than 2 inches: when it is more than 12 inches the soil is considered a peat. The formation of a root mat above the B_1 is very typical. Roots do not generally penetrate the B_1 horizon but penetration does occasionally occur presumably where the pan is fissured. Quite often the B_1 impedes the free flow of water vertically down the profile and this causes gleying in the A horizon. The B_1 is usually well formed but it can be rudimentary: when it is, there is very little evidence of gleying in the A horizons and not much sign of a root concentration. The B_2 and B_3 horizons are very similar to the corresponding horizons in the Linhope series. The B_2 has a weak blocky structure and is friable while the B_3 has a moderate blocky structure and is weakly indurated. They can show a certain amount of mottling but not of the same intensity as in a poorly drained series. These horizons are usually loamy in texture.

NOTE ON AGRICULTURE. This series generally carries some form of

PLATE XVII
Kelsocleugh, a typical hill farm on the Sourhope Association.

PLATE XVIII
Peel Farm in Liddesdale, a typical hill farm on the Carter Association.

PLATE XIX
Wooplaw and the Arks, two typical hill farms on the Carter Association.

PLATE XX
Arable land on the Hobkirk Association. Large farms (about 850 acres), large fields and few stone dykes are common features.

Molinietum or Nardetum which makes poor grazing. Conditions in the surface horizons are likely to be wet during most of the year.

Cultivation, in general, is impractical. The iron pan is readily ruptured by a deep tyne when ploughing but unfortunately most of this series is to be found on the flattish shoulders of hills. Generally speaking it is too inaccessible and exposed for successful cropping. It should be possible, however, to grow satisfactory timber after the pan has been ruptured.

ETTRICK SERIES

The Ettrick series is to be found on clayey till which occurs usually on gentle to moderate slopes. Its drainage class is poor, often because of its clayey texture. Between Hawick and Ashkirk there is quite a large area of Ettrick soils and here they often occur on moderate slopes where a till of loamy texture would give rise to freely drained soils.

A broad-leaved grassy vegetation is typical of the Ettrick series with *Deschampsia caespitosa* abundant but occasionally it carries some form of Callunetum or Nardetum.

GENERALISED PROFILE DESCRIPTION

SLOPE	gentle
ASPECT	north
ALTITUDE	975 feet
VEGETATION	*Calluna vulgaris* (a), *Nardus stricta* (a), *Molinia caerulea* (o), *Hypnaceous mosses.*
DRAINAGE CLASS	Poor

Horizon	*Depth or Thickness*	
L	Trace	Litter
F	Trace	Partially decomposed litter
H	1″	Very dark brown greasy humus
A_1g	0-3″	Light brown grey (10YR:6/2) clay loam; weak, medium blocky; firm; medium organic matter; some stones present; roots abundant; few, fine, distinct ochreous mottles associated with roots. Sharp change into
A_2g	3-8″	White (5Y:8/2) clay; weak medium blocky; firm; low organic matter; some stones present; roots frequent; few fine distinct ochreous mottles; merging into
B_2g	8-13″	Pale yellow (5Y:7/3) clay; moderate, medium prismatic; firm; low organic matter; some stones present; roots frequent distinct grey coating round stones and peds; also few fine distinct ochreous mottles; merging into
B_2g	13-19″	Pale yellow (2·5Y:8/4) clay; moderate medium prismatic; low organic matter; firm; stony; roots rare; prominent grey coating round stones and peds; few fine distinct ochreous mottles; merging into
B_3g	19-30″	Pale yellow (2·5Y:7/4) clay; moderate coarse prismatic; very firm; low organic matter; stony; roots rare; distinct grey coating round stones and peds but not nearly so much as in B_2g; few fine distinct ochreous mottles; merging into
Cg	30-42″+	Light grey (2·5Y:7/5) clay; weak coarse prismatic; very firm; low organic matter; stony; roots rare; faint grey coating round stones and peds; stones weathered ochreous brown while in other horizons weathered grey.

The H layer is usually less than 2 in. thick in this series. The A_1g horizon has generally a weak subangular blocky structure with a few ochreous mottles associated with plant roots. The A_2g is the horizon which shows the maximum effect of gleying. It has a drab grey colour with few ochreous mottles; its structure is weak sub-angular blocky. The B_2g horizon usually has a prismatic structure; mottles are more distinct and more frequent than in any other horizon, and frequently the peds and stones are coated with material of a lighter shade of grey. It is much more firm and tenacious than the A_2g horizon. In the B_3g horizon the structure is not so well defined and the horizon is becoming more massive. There are still grey faces to the peds and stones but ochreous mottles are fewer and less distinct. The horizon is very firm and tenacious. In the Cg horizon the structure is coarse prismatic to massive. The grey faces to peds and stones are faint and ochreous mottling is not common.

NOTE ON AGRICULTURE. This series generally provides only poor to moderate grazing. The surface horizon will tend to be wet for long periods during the year. It may be necessary to drain with open ditches before this series will provide even satisfactory grazing for stock.

Before cultivation is attempted this series should be tile drained; even then careful management will be required for it will always be subject to poaching. Probably the best method is to follow a relatively long crop rotation and leave in grass once a satisfactory sward has been established.

ALEMOOR SERIES

The Alemoor series generally occurs under higher rainfall (more than 40 in.) than the Ettrick series. It is developed as a rule on till with a clayey texture and is to be found on gentle or moderate slopes. Its vegetation is frequently some form of Molinietum and drainage class is poor.

GENERALISED PROFILE DESCRIPTION

SLOPE	very gentle
ASPECT	north
ALTITUDE	1,000 feet
VEGETATION	*Molinia caerulea* (a and d) *Trichophorum caespitosum* (f) *Calluna vulgaris* (f) *Hypnaceous mosses* (o)
DRAINAGE CLASS	poor

Horizon	*Depth or Thickness*	
L	½″	Litter
F	1″	Partially decomposed litter
H	4½″	Black (5YR:2/1) humus; live roots penetrate.
A_1g	0-4″	Olive grey (5Y:5/2) loam; weak fine blocky; firm; medium organic matter; some stones present; roots abundant; prominent fine brown mottling especially round root channels: merging into
A_2g	4-9″	Light olive grey (5Y:6/2) clay loam; weak medium blocky; firm; low organic matter; some stones present; roots frequent; prominent fine brown mottling round root channels. Sharp change into
B_2g	9-20″	Light brown grey (2·5Y:6/2) clay loam; moderate medium prismatic; firm; low organic matter; some stones present; roots occasional; few prominent fine orange and brown mottles; prominent grey coatings round root channels, faces of peds and stones; merging into
B_3g	20-30″	Light brown grey (2·5Y:6/2) clay; moderate coarse prismatic; very firm; low organic matter; stony; roots rare; few prominent fine orange and brown mottles; prominent grey coatings to roots channels, faces of peds and stones but becoming less prominent with depth; merging into
Cg	30-36″+	Grey brown (2·5Y:5/2) clay; weak coarse prismatic; very firm; low organic matter; stony; roots rare; few distinct fine orange and brown mottles; distinct grey coatings to root channels, peds and stones.

The H layer is usually more than 2 in. but less than 12 in. thick (over 12 in. it is peat). The A_1g horizon has generally a fine blocky structure and some fine ochreous mottles near root channels. The A_2g horizon is the horizon of maximum gleying. Characteristically it has a lightish colour and a weak blocky structure. Ochreous mottles occur but less often than in the B_2g. The B_2g horizon has a moderate prismatic structure with grey faces to peds, stones and root channels. Ochreous mottles are frequent. In the B_3g horizon the structure is coarse prismatic. There are still grey faces to peds and stones but these are less noticeable than in the B_2g horizon. In the Cg horizon the structure is coarse prismatic to massive. The grey faces to peds are less distinct and ochreous mottling is not so noticeable.

NOTE ON AGRICULTURE. The characteristic vegetation of this series makes indifferent grazing. In addition, it is usually advisable to have open ditches to run off surface water before allowing sheep to graze. It is not easy to cultivate this series. Tile draining is a necessary preliminary and the thick humus layer indicates that a liberal manurial programme is required. Afterwards careful management is still advisable because this type of soil is subject to poaching.

PEDEN SERIES

The Peden series is not extensive. It is usually to be found in small level areas surrounded by the more common Ettrick series. One of the reasons why the Peden series is not common is that there is a tendency for lacustrine alluvium to occur wherever the relief is level. Sometimes the alluvium is less than a foot thick lying on till but more often it is over 3 feet thick. The H layer is less than 2 in. thick and the drainage is very poor. The characteristic vegetation contains *Deschampsia caespitosa* and sometimes *Juncus spp.*

GENERALISED PROFILE DESCRIPTION

SLOPE	flat
ASPECT	nil
ALTITUDE	975 feet
VEGETATION	*Deschampsia caespitosa* (co-d) *Juncus effusus* (co-d)
DRAINAGE CLASS	very poor

Horizon	*Depth or Thickness*	
L	½″	Litter, mainly sphagnum
F	1″	Partially decomposed litter
H	1″	Very dark brown humus, well decomposed with abundant live roots. Sharp change into
A_1g	0-7″	Very dark grey (10YR:3/2) brown loam; weak fine blocky; slightly plastic; high organic matter; few stones; roots abundant; uniform drab colour. Sharp change into
A_2g	7-13″	Grey brown (2·5Y:5/2) clay loam; weak medium blocky; plastic; low organic matter; few stones; live roots frequent —some dead roots; uniform drab colour: merging into
B_2g	13-17″	Grey (5Y:5/1) clay; moderate medium prismatic; firm; low organic matter; some stones; live roots occasional dead roots with faint grey coating round them; few fine distinct ochreous mottles; merging into
B_2g	17-29″	Grey (5Y:5/1) clay; moderate medium prismatic; firm; low organic matter; numerous small rotten stones; dead roots with faint grey coating which in turn has a distinct ochreous coating: merging into
B_3g	29-39″+	Grey (5Y:5/1) clay; weak medium prismatic to course prismatic very firm; low organic matter; stony (small stones ¼″-½″); live roots rare but dead roots with distinct ochreous coating; frequent faint olive brown mottles (probably original parent material colour).

The top horizons of this soil tend to be wet and the lower horizons moist. This is apparent from the terms used to describe consistence. From the B_2g horizon down the colours of the horizons have a bluish appearance which cannot be matched in the Munsell colour book; there the horizons are most nearly matched by greys.

The H layer is usually less than 2 in. thick. The A_1g horizon has a uniform drab colour with little or no mottling. The structure is usually weak fine blocky. The A_2g horizon is the zone of maximum gleying and, in this series, is usually quite thick. It has a weak blocky structure but there are few mottles. The B_2g horizon is usually very thick and here the prismatic structure is most clearly defined. The B_3g horizon is often characterised by the presence of ochreous coatings to old root channels (the dead roots may still be there): sometimes there is a faint inner coating of grey surrounded by a prominent ochreous coating. With depth olive brown mottles become apparent; these may be the colour of the original parent material. The whole profile is strongly gleyed.

NOTE ON AGRICULTURE. It is often necessary to drain this series with open ditches before it can be used for grazing; even then the quality of the pasture is low. Before attempting to cultivate, tile drains should be laid. Difficulty may be experienced in finding a suitable outlet for the tile drains as this series often occurs on low-lying ground. Once an efficient tile system of drainage has been laid there is still need for careful management: this series is very readily poached.

HARDLEE SERIES

The Hardlee series is not extensive. It is usually to be found associated with the Peden series or surrounded by the Alemoor series. It is similar to the Peden series but its H layer is usually more than 2 in. thick. The drainage class is very poor and the typical vegetation is some form of Molinietum.

GENERALISED PROFILE DESCRIPTION

SLOPE flat
ASPECT nil
ALTITUDE 975
VEGETATION *Calluna vulgaris* (a) *Nardus stricta* (a) *Molinia caerulea* (f) *Sphagnum spp.* (a)
DRAINAGE CLASS very poor

Horizon	*Depth or Thickness*	
L	Trace	Litter
F	Trace	Partially decomposed litter
H	7″	Very dark grey brown (2·5Y:3/2) fibrous peat
A_2g	0-7″	White (2·5Y:8/0) clay; moderate medium blocky; plastic; low organic matter; some stones; roots abundant; few faint brown mottles associated with roots. Sharp change into
B_2g	7-12″	White (2·5Y:8/0) clay; moderate medium prismatic; plastic; low organic matter; some stones; roots frequent; frequent medium distinct ochreous mottles: merging into
B_2g	12-29″	White (2·5Y-8/0) clay; moderate medium prismatic; firm; low organic matter; stony, with most stones strongly weathered; roots occasional; frequent medium distinct pale brown mottles, patches of prominent ochreous mottles associated with rotten stones; distinct ochreous coating to roots; distinct grey coating to stones; merging into
B_3g	29-35″+	Light grey (2·5Y:7/5) clay; weak coarse prismatic; very firm; low organic matter; stony, with many weathered; roots rare; prominent ochreous coating to dead roots, distinct grey coating to stones.

The H layer of raw humus is usually between 2 and 12 in. thick. The A_2g horizon is characteristically pale in colour with a less pronounced structure. Ochreous mottling is not prevalent. The B_2g horizon has a stronger structure and more ochreous mottles. A characteristic of the B_2g and B_3g horizons is the presence of ochreous coatings to the channels of dead roots and grey coatings to stones. In some profiles this feature is almost entirely confined to the B_3g horizon. In the B_3g horizon the structure is less well defined and the colour is darker.

NOTE ON AGRICULTURE. The typical vegetation of this series makes poor pasture unless *Eriophorum spp.* are a major constituent: it then becomes a valuable source of food especially in the spring. Open ditches are necessary to run off excess surface water and make the grazing suitable for sheep.

In general, cultivation is not satisfactory. To begin with an effective tile drainage scheme is essential and this may not be easily provided because this series generally occurs where there is no easy outfall for tile drains. The thick humus layer must be got rid of, principally by means of a liberal manuring programme. Careful management is still required for this series is susceptible to poaching.

Skeletal Soils

Skeletal soils are to be found throughout most of the Ettrick Association but many of the areas are so small that they have been mapped along with small areas of other series as a complex. Areas of mappable size do occur especially near the Ettrick Water, in the vicinity of Mosspaul and in the inlier at Hindhope.

The character of these soils depends on either parent material or parent rock. In some localities the parent material is scree usually on very steep slopes; in others rubble over shattered rock. Under high rainfall there is a tendency for organic matter to accumulate and these soils may have anything up to 12 in. over the rubble or rock. To be precise these soils are skeletal soils with peaty top but it was considered impractical to delineate them. A generalised profile description of a common type of skeletal soil is given below.

GENERALISED PROFILE DESCRIPTION

SLOPE	crest of short, very steep slope
ASPECT	nil
ALTITUDE	900 feet
VEGETATION	*Agrostis spp., Festuca spp.* (co-d). Vegetation cover tends not to be close and individual plants are small.

Horizon	*Depth or Thickness*	
L	Trace	Litter
F	½″	Partially decomposed litter
H	Trace	Humus
A_1	0-6″	Brown (10YR:5/3) very stony gritty loam; uniform colour. Fine material in interstices between stones.
D	6″+	Shattered rock

NOTE ON AGRICULTURE. These soils can be used only for grazing either because of the steepness of slope or the nearness of rock to the surface. The quality of the grazing varies with the type of vegetation.

Complexes

Areas of corrugations are common where the underlying sediments are Llandoverian. The type of soil on and near corrugations changes quickly, and it has been impractical to delineate each soil type. In consequence each area of corrugations has been separated as one of two types of complex, ER.c. or ER.ch.

The constituent soils of the complex ER.c. are characterised by most of them not having a peaty top whereas most of the constituent soils of the complex ER.ch. have a peaty top. The complex ER.ch. normally occurs where the rainfall is greater than 40 in.

CONSTITUENT SOILS OF COMPLEX ER.c.

(i) Linhope series
(ii) skeletal soils
(iii) soils developed on colluvium.

The Linhope series has been described earlier but when a constituent of a complex it is stonier and shallower than normal.

The description given previously for skeletal soils applies to those in the complex.

Soils developed on colluvium are to found in the hollows between corrugations. The colluvium is usually not more than 4 ft. thick. The drainage class of these soils is not easy to determine. They are best described as "flush" soils, that is, soils which receive flushing water from the neighbouring slopes. The texture of the colluvium is loamy and it is often stony to very stony. Consequently the flushing water passes readily through the colluvium and there is little evidence of the morphological characters associated with gleying. A description of a soil developed on colluvium is given below:

GENERALISED PROFILE DESCRIPTION

SLOPE	very gentle; at bottom of hollow between two corrugations
ASPECT	north-west
ALTITUDE	800 feet
VEGETATION	*Deschampsia flexuosa* (f) *Cynosurus cristatus* (f) *Pteridium aquilinum* (o.) *Anthoxanthum odoratum* (f) *Nardus stricta* (o.) *Hypnaceous mosses* (f)
DRAINAGE CLASS	flush, with good aeration.

Horizon	*Depth or Thickness*	
L & F	Trace	Litter
H	1″	Dark brown organic matter
A_1	0-8″	Brown (10YR:4/3) clay loam, weak medium crumb; moderate organic matter; some stones; roots abundant; few fine distinct dark ochreous mottles: merging into
B_2	8-19″	Yellowish brown (10YR:5/4) clay loam; weak medium subangular blocky; firm; low organic matter; stony; roots frequent; distinct grey coatings to stones. Sharp change into
B_3C	19-29″+	Dark grey brown (2·5Y:4/2) gritty loam; weak medium blocky; very firm; low organic matter; very stony (small angular stones); roots rare; no mottling.

CONSTITUENT SOILS OF COMPLEX ER.ch.

(i) Linhope Series
(ii) Dod series
(iii) skeletal soils with no peaty top
(iv) skeletal soils with peaty top
(v) soils with peaty top on colluvium.

The Linhope series has been described earlier. In the complex ER.ch. it is to be found usually on steep slopes which have a sufficient depth of till. It is not a common constituent.

The Dod series is to be found on the less steep slopes with a sufficient depth of till. It has often an iron pan and is a common constituent of the complex.

Skeletal soils with no peaty top are to be found on steep slopes where there is no till. They are not a common constituent of the complex.

Skeletal soils with peaty top are one of the principal constituents of the Complex ER.ch. These occur on less steep slopes where there is no till.

Soils with peaty top on colluvium are to be found in the hollows between corrugations. Again they belong to a flush type but it is less well aerated than that described previously. Gleying is more intense with prominent grey coatings to the stones.

THE SOURHOPE ASSOCIATION

The Sourhope Association is next to the Ettrick Association in size, extending to some 80 square miles. Except for three small inliers it occurs as one large block in the eastern part of the area.

The Association is developed on parent material derived from intermediate lavas of Lower Old Red Sandstone age. The principal parent material is a stony till, loamy in texture. There is a smaller amount of clayey till which is usually not quite so stony. One characteristic of this association is the prevalence of skeletal soils: these are mainly developed on screes and where there are rock outcrops.

Distribution

Of the principal area about 50 square miles are on Sheet 18 and 30 square miles on Sheet 17. The National Boundary from Hindhope to Steer Rig is the eastern limit. From Steer Rig to Morebattle, the land to the north has still to be surveyed but from Morebattle to the vicinity of Cessford the northern boundary is shared by the Eckford Association. The western boundary for most of its length coincides with the eastern boundary of the Hobkirk Association: it is approximately north to south from Cessford to the neighbourhood of Edgerston. From there the southern boundary runs irregularly to the National Boundary near Hindhope.

Three small areas occur just to the west of the principal area; one near Fala, another near Edgerston and the third to the west of Letham.

Parent Material

The parent material of the Sourhope Association is derived from lavas of Lower Old Red Sandstone age. The lavas are intermediate in composition. On moderate to steep slopes and on high-level plateaux there is a stony loamy till, which is seldom as much as 4 feet thick. This till usually gives rise to the Sourhope series and the Cowie series.

In the valleys and on gentle to moderate slopes the till is often less stony and of a clayey texture and is frequently over 4 feet thick. Excellent exposures have been bared by the Bowmont Water, especially near Belford. This till generally gives rise to the Atton series, the Edgerston series and the Lawsuit series.

On the very steep slopes there are usually screes with no great depth of material to the solid rock. These give rise to skeletal soils which are a feature of the association.

The proportions of the various soil parent materials are as follows:

stony, loamy till ..	70%
clayey till	12%
screes	18%

The stony, loamy till is by far the most extensive. A notable feature of this till on high-level plateaux is the presence of a layer of stones within one foot of the surface; below, the till appears to be quite normal. The clayey till is not widespread but usually occurs in valleys and is easily accessible from the farm buildings. The screes are quite extensive and are to be found near the watershed especially in the neighbourhood of Heatherhope.

All types of the parent material are remarkably free from contamination by material from other geological formations. Along the western edge of the association, however, there has been a certain carry-over of material from Upper Old Red Sandstone sediments but not sufficient to justify mapping a new association. Again, on Edgerston Moor the till has been derived from conglomerate of the Upper Old Red Sandstone formation but since the constituents of the conglomerate were predominantly of lava origin the till is almost indistinguishable from lava till proper. Consequently most of Edgerston Moor has been mapped as Sourhope Association.

Soils

A range of series from freely drained to very poorly drained has been mapped. Skeletal soils are also very extensive.

The Sourhope and Cowie series are developed on stony, loamy till, while the Atton, Edgerston and Lawsuit series are developed on clayey till. The Cowie, Edgerston and Lawsuit series tend to occur under high rainfall and the Sourhope and Atton series under low rainfall. This distribution may be modified by topography and parent material, steep slopes and base-richness favouring those series without peaty top. Under high rainfall skeletal soils tend to have a peaty top but it was considered impractical to map two variants of this category.

The profile descriptions are of soils under semi-natural vegetation, that is to say soils which have not been cultivated.

Series

SOURHOPE SERIES

The Sourhope series is developed on stony, loamy till which occurs usually on moderate to steep slopes and on high-level plateaux. It is the dominant soil series accounting for more than half the area of the association. It is usually to be found under a low rainfall (less than 40 in.) but it does occur under higher rainfall on steep slopes. The drainage class is free and the vegetation is often some form of acid grassland.

1. Upper Old Red Sandstone sediments cut by the Jed Water south of Jedburgh.

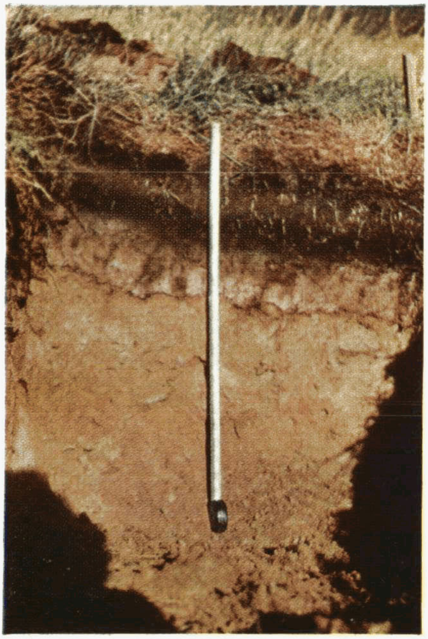
2. Hobkirk Association, Hobkirk series. Vegetation is acid grassland and there is a thin H layer. The B horizons are bright red.

3. Carter Association, Carter series. Vegetation is Molinietum with a well-developed H layer. The A_2g horizon is humus stained and the B_2g and B_3g horizons are strongly gleyed.

4. Darleith Association, Darleith series. Note the freely drained B_2 horizon with numerous stones, resting on shattered rock.

5. Ettrick Association, Linhope series. Vegetation is acid grassland and there is a thin H layer.

6. Ettrick Association, Dod series. Vegetation is Molinietum with a well-developed H layer. Note the thin iron pan (B_1) and freely drained B_2 horizon.



7. Ettrick Association, Dod series. Vegetation is Molinietum with a well-developed H layer. The thin iron pan (B_1) is well developed and the A_2 horizon above it is strongly gleyed. The B_2 horizon is slightly gleyed.

8. Ettrick Association, Ettrick series. Note the strongly gleyed B_2g and B_3g horizons.

GENERALISED PROFILE DESCRIPTION

SLOPE moderate
ASPECT south
ALTITUDE 1,000 feet
VEGETATION *Agrostis spp.* (d) *Festuca spp.* (f) *Nardus stricta* (o) *Deschampsia flexuosa* (o).

DRAINAGE CLASS free

Horizon	*Depth or Thickness*	
L	1″	Litter
F	½″	Partially decomposed litter
H	½″	Dark brown humus; abundant live roots. Sharp change into
A	0-4″	Brown (7·5YR:5/4) loam; weak fine crumb; friable; moderate organic matter; few stones; roots abundant; no mottling; merging into
B_2	4-10″	Light reddish brown (5YR:6/4) gritty loam; moderate medium sub-angular blocky; friable; low organic matter; stony; roots frequent; no mottling: merging into
B_3	10-21″	Reddish brown (5YR:5/3) gritty loam; moderate medium sub-angular blocky; weakly indurated; low organic matter; stony (¼ in. diam.); roots occasional; no mottling: merging into
B_3C	21-46″	Reddish brown (5YR:4/3) gritty clay loam; weak medium prismatic; firm; low organic matter; stony; roots rare; no mottling. Sharp change into
D	at 46″	Light reddish brown (2·5YR:6/4) rotten lava.

There is usually an H layer present in this series but it is seldom more than 1 in. thick. The A horizon is characterised by a crumb structure and friable consistency. The humus is of the silicate moder type. The B_2 horizon has invariably a relatively bright colour. The structure is usually sub-angular blocky and the consistency friable. There is a degree of induration in the B_3 horizon; in some profiles it is quite marked but in others less so. Depending on the depth of till the B_3 horizon merges into rock or into a C horizon. The C horizon is invariably less indurated than the B_3 horizon. Sometimes the texture is heavier and it may show a weak prismatic structure. Throughout the profile there is very little mottling; where it does occur it is usually associated with roots.

NOTE ON AGRICULTURE. This series provides good pastureland though bracken may be present and must be kept under control. In dry weather, there is a tendency for the series to burn yet stock seem to continue to thrive. Conditions underfoot are dry and, in general, healthy.

Cultivation is possible if the slope is not too steep for implements. Solid rock is close to the surface in places but can readily be avoided. The soils are stony and cause severe wear and tear to implements.

COWIE SERIES

The Cowie series is developed on stony loamy till which is usually less than 4 feet thick. It is generally to be found under high rainfall (more than 40 in.) on gentle to moderate slopes of the high-level plateaux. The series is not extensive, accounting for some 10% of the association. Drainage class is free below the iron pan and the vegetation is often some form of Molinietum, occasionally some from of Nardetum.

GENERALISED PROFILE DESCRIPTION

SLOPE moderate
ASPECT north
ALTITUDE 1,250 feet
VEGETATION *Nardus stricta* (a), *Festuca spp.* (f), *Agrostis spp.* (f), *Anthoxanthum odoratum* (f) *Deschampsia flexuosa* (f), *Trichophorum caespitosum* (o), *Polytrichum commune* (f), *other mosses* (f).
DRAINAGE CLASS imperfect above pan; free below

Horizon	*Depth or Thickness*	
L	1″	Litter
F	½″	Partially decomposed litter
H	8½″	Very dark brown greasy humus. Sharp irregular change into
A_1	0-3″	Dark reddish brown (5YR:2/2) gritty sandy loam; weak fine sub-angular blocky; friable; moderate organic matter; few stones; roots abundant, accumulating above pan and not penetrating it often; no mottling. Sharp change into
B_1	at 3″	Thin ($\frac{1}{16}$″) iron pan. Sharp change into
B_2	3-6″	Yellowish red (5YR:4/6) gritty loam; moderate fine sub-angular blocky; friable; low organic matter; few stones; roots occasional; few faint ochreous mottles; merging into
B_3	6-17″	Brown (7·5YR:4/4) gritty sandy loam; moderate fine sub-angular blocky; indurated; low organic matter; few stones; roots occasional; few faint ochreous mottles; faint grey faces to stones: merging into
B_3C	17-28″+	Brown (7·5YR:5/4) gritty sandy loam; weak fine sub-angular blocky; low organic matter; stony; roots rare; faint grey faces to stones.

The presence of an H horizon, which is invariably more than 2 in. thick is an important characteristic. The A horizon can vary somewhat: in certain profiles there may be abundant evidence of gleying but in others there may be little. Its structure is usually fine sub-angular blocky and consistency usually friable. At the base of the horizon there is often a concentration of roots: they are unable to penetrate the thin iron pan which forms the B_1 horizon. The pan is about $\frac{1}{16}$ in. thick and although it is usually continuous there are localities where it is ill-formed and rudimentary. It is often present inside many types of stone as can be seen when they are broken open. The B_2 horizon is very similar to the typical B_2 horizon of the Sourhope series. There may be some evidence of gleying but never sufficient for the soils to be classed as poorly drained. The B_3 horizon shows a certain degree of induration. This lessens with depth and the C horizon is usually friable. Stoniness often increases in the B_3 and C horizons.

NOTE ON AGRICULTURE. The grazing value of the vegetation characteristic of this series is low. Cultivation is not a good proposition for various reasons. Most of this series is not readily accessible and rather exposed. The raw humus in the surface indicates that a liberal manurial policy would be necessary to restore reasonable fertility. An iron pan is present although it can be readily ruptured when ploughing by a suitable tyne attached to the plough. If the pan is effectively broken up the drainage of the surface soil is improved and plant roots are allowed to grow into the B_2 horizon. Fast rocks and numerous stones may cause trouble in certain localities.

ATTON SERIES

The Atton series is developed on clayey till which is normally more than 4 feet thick. It occurs usually on gentle to moderate slopes in or near valleys.

It is not extensive, accounting for only about 10% of the association. The vegetation is often grassy with a certain proportion of *Deschampsia caespitosa* and *Nardus stricta.* The drainage class is poor.

GENERALISED PROFILE DESCRIPTION

SLOPE		moderate
ASPECT		south-west
ALTITUDE		750 feet
VEGETATION		*Nardus stricta* (a), *Deschampsia caespitosa* (f), *Agrostis spp.* (f), *Festuca spp.* (f), *Hypnaceous mosses* (f).
DRAINAGE CLASS		poor
Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter. Sharp change into
A_1g	0-4″	Dark reddish grey (5YR:4/2) gritty clay loam; moderate medium blocky; firm; moderate organic matter; few stones; roots abundant; few faint ochreous mottles; merging into
A_2g	4-12″	Pinkish grey (7·5YR:3/2) clay; weak medium blocky; friable; low organic matter; few stones; roots frequent; no mottling: merging into
B_2g	12-18″	Reddish brown (5YR:5/3) gritty clay; strong medium prismatic; firm; few stones; roots occasional; prominent grey coating round stones and peds; frequent medium distinct ochreous mottles inside peds: merging into
B_3g	18-28″	Reddish brown (5YR:4/3) gritty clay; moderate medium prismatic; firm; few stones; roots occasional; distinct grey coating to stones and peds, frequent medium distinct ochreous mottles inside peds; merging into
Cg	28-47″+	Weak red (10R:4/3) gritty clay; weak medium prismatic; very firm; few stones; roots occasional; faint grey coating round stones and peds; few medium faint ochreous mottles inside peds.

There is seldom an H layer more than 1 in. thick. The A_1g horizon has a moderate organic matter content, a medium blocky structure and a few ochreous mottles which are usually associated with roots. The A_2g horizon is distinctly paler in colour than any other horizon. Its structure may be either medium or fine blocky and there are seldom more than a few ochreous mottles. The B_2g horizon is usually the horizon of maximum ochreous mottling. The structure is generally medium prismatic with grey coatings to the peds. In the B_3g horizon the structure is less well defined and the grey coatings are less intense. Ochreous mottling is about the same, perhaps a little less. The Cg horizon has characteristically a weaker structure and less distinct grey coatings to the peds. Ochreous mottling is also diminished.

NOTE ON AGRICULTURE. The vegetation characteristic of this series makes moderate to poor grazing for stock. In certain places it may be necessary to get rid of surface water by opening ditches. Before arable crops can be grown successfully it is usually necessary to tile-drain. Even then, this series must be managed carefully for like most clayey soils it is readily poached by stock and implements in wet weather. It is invariably accessible from the farm buildings.

EDGERSTON SERIES

The Edgerston series is not extensive, accounting for less than 2% of the association. It is developed on clayey till, which is more than 4 feet thick. It is usually to be found on gentle to moderate slopes in or near valleys where the rainfall is very often high (more than 40 in.). The drainage class is poor and the vegetation is commonly some form of Molinietum.

GENERALISED PROFILE DESCRIPTION

SLOPE gentle
ASPECT west
ALTITUDE 650 feet
VEGETATION *Molinia caerulea* (d), *Erica tetralix* (f), *Calluna vulgaris* (o), *Lycopodium clavatium* (f).
DRAINAGE CLASS poor

Horizon	*Depth or Thickness*	
L	1″	Litter
F	1″	Partially decomposed litter
H	6″	Dark reddish brown organic matter (5YR:3/2)
A_1g	0-2″	Dark reddish grey (5YR:4/2) loam; moderate fine blocky; firm; moderate organic matter; few stones; roots abundant; few faint ochreous mottles: merging into
A_2g	2-6″	Pale brown (10YR:6/3) gritty loam; weak fine blocky; friable; low organic matter; few stones; roots frequent; few distinct ochreous mottles; merging into
B_2g	6-14″	Light reddish brown (5YR:6/4) gritty clay; moderate medium prismatic; firm; low organic matter; stony; roots frequent, some dead; prominent grey coating to peds and stones; many distinct ochreous mottles inside peds: merging into
B_3g	14-20″	Light reddish brown (5YR:6/4) gritty clay; weak medium prismatic; very firm; no organic matter; roots occasional, some dead; stony; distinct grey coating to peds and stones; many distinct ochreous mottles inside peds: merging into
Cg	20-34″+	Light reddish brown (2·5YR:6/4) gritty clay; weak medium prismatic to massive; very firm; no organic matter; roots occasional mostly dead; stony; many faint ochreous mottles inside peds; faint grey coating to stones and peds.

The H layer is always more than 2 in. thick and is usually about 5 in. The A_1g horizon has a moderate organic matter content, a weak to moderate blocky structure and very little ochreous mottling. The A_2g is the palest horizon in the profile. Its structure is weak or moderate blocky and there is little mottling. The B_2g horizon shows a maximum intensity of ochreous mottling and the structure is usually moderate or strong prismatic. The peds and stones are coated with grey. In the B_3g horizon the structure is less intense. The grey coatings to the peds and stones are not so marked. The Cg horizon has a more massive structure and the grey coatings to stones and peds are even less noticeable.

NOTE ON AGRICULTURE. The grazing value of the characteristic vegetation of this series is low. Open ditches are invariably required to take away surface water. Cropping is not a good proposition. Firstly, a tile drainage system is required and secondly, a liberal fertiliser programme must be followed to raise the fertility status to a satisfactory level and get rid of the peaty top. The clayey texture of this series, however, will always make it subject to poaching by machinery and animals. There is no danger of interference from stones or rocks and, in general, it is easily accessible from farm steadings.

LAWSUIT SERIES

The Lawsuit series is not extensive amounting to less than 0·5% of the association. It is developed on clayey till which is more than 4 feet thick and usually occurs on gentle slopes in or near valleys. The type vegetation is variable. Sometimes *Eriophorum spp.* are common, sometimes *Molinia caerulea*. The drainage class is very poor.

GENERALISED PROFILE DESCRIPTION

SLOPE	flat
ASPECT	nil
ALTITUDE	650 feet
VEGETATION	*Eriophorum spp.* (d) *Erica tetralix* (o), *Vaccinum vitis-idaea* (o), *Molinia caerulea* (o), *Carex spp.* (o), *Sphagnum spp.* (o). *Lycopodium clavatum* (o).
DRAINAGE CLASS	very poor

Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter
H	7″	Dark reddish brown (7·5YR:3/2) organic matter. Live roots abundant. Very difficult to cut through surface with spade. Sharp change into
A_1g	0-5″	Dark brown (7·5YR:4/2) loam; weak fine sub-angular blocky; friable; moderate organic matter; few stones; roots abundant; few distinct ochreous mottles at root channels. Sharp change into
A_2g	5-9″	Pinkish grey (7·5YR:6/2) clay; weak medium sub-angular blocky; friable; low organic matter; few stones; roots frequent, some dead; few distinct ochreous mottles at root channels. Sharp change into
A_2g	9-15″	Pink (7·5YR:7/4) gritty clay; weak medium prismatic; firm; low organic matter; few stones; roots frequent, some dead; no mottles; merging into
B_2g	15-28″	Light reddish (5YR:6/3) gritty clay; moderate medium prismatic; very firm; no organic matter; roots occasional, mostly dead; stony; prominent grey coating round peds and stones; many distinct ochreous mottles inside peds: merging into
B_3g	28-36″	Light reddish brown (5YR:6/4) gritty clay; weak medium prismatic to massive; very firm; no organic matter; roots rare; stony; distinct grey coating round peds and stones but less than B_2g; numerous distinct ochreous mottles inside peds.

The H layer is invariably present and is usually between 2 and 12 inches thick. The A_1g horizon has a weak fine to medium blocky structure and perhaps a little ochreous mottling associated with roots. The A_2g horizon is usually quite thick. Its colour is the palest of the profile and its structure is weak fine to medium blocky. There is little or no mottling present. The B_2g horizon has a more clearly defined structure, usually moderate to strong prismatic. Ochreous mottles are either frequent or many, while the peds have distinct grey coatings. In the B_3g horizon there is less intense ochreous mottling and the grey coatings to peds and stones are not quite so striking. Its structure is more massive.

NOTE ON AGRICULTURE. The characteristic vegetation of this series makes poor grazing. Open ditches are required to control surface water even when the series is permanent pasture. This type of soil is not suitable for cropping. A tile drainage system is necessary and it is not always a simple matter to get a suitable outfall from the typically low-lying sites. Even when suitably drained a clayey texture makes this series particularly susceptible to poaching by animals or machinery.

Skeletal Soils

Skeletal soils are to be found near the watershed. They are quite extensive, forming about 18% of the association.

The character of skeletal soils is dominated by parent material or parent rock. In this association they are usually developed on screes on very steep slopes. Occasionally they are found where solid rock outcrops.

As in the Ettrick Association there are two types of skeletal soils, one with a peaty top and one without, but it was considered impractical to map them separately. The skeletal soils without peaty top are usually on the steeper slopes under high rainfall (more than 40 in.) or on gentler slopes under low rainfall. The vegetation is dwarf and scanty. The skeletal soils with peaty top which can be, theoretically, any depth up to 12 in., are usually to be found on gentler slopes under high rainfall (more than 40 in.). If the peaty top is greater then 12 in. the soil is classed as peat.

The profile description below is of a soil at the top of a lava flow.

GENERALISED PROFILE DESCRIPTION

SLOPE	gentle
ASPECT	east
ALTITUDE	900 feet
VEGETATION	*Nardus stricta* (d), *Vaccinium vitis-idaea* (f), *Potentilla erecta* (f), *Gallium saxatile* (f), *Anthoxanthum odorata* (f), *Hypnaceous mosses* (f)

Horizon	*Depth or Thickness*	
L	1″	Litter
F	1″	Partially decomposed litter
H	5″	Very dark brown humus. Boulders very common, often just under the surface.
A_1	0-7″	Dark brown gritty loamy sand; very stony with infilling of finer material; stained strongly with organic matter; roots abundant, concentration at top of loose joint-blocks of lava.
D_1	7″+	Loose joint-blocks of lava; where roots are concentrated between the blocks there is also a concentration of black-brown humus.

NOTE ON AGRICULTURE. This type of soil is used only for grazing. Its value largely depends on the type of vegetation which is often some form of Nardetum. When there has been no rain for some time this soil dries out quickly and the vegetation shows burning.

THE HOBKIRK ASSOCIATION

The Hobkirk Association occurs in the centre of the area. As the name suggests the village and parish of Hobkirk lie almost entirely within the association. It is the third most extensive of the associations covering some 14% of the whole area. The parent materials are derived from Upper Old Red Sandstone sediments which have imparted a red colour to the soils. The relief is rolling in the vicinity of the Teviot Water but it becomes hilly further south. Some of the rivers, especially the Jed Water, have cut deeply into the solid strata exposing large rock faces. Others, such as the Rule Water, have cut through deep till leaving large exposures suitable for examination. As the watershed is approached the association gives way to the Minto, Ettrick and Carter Associations.

DISTRIBUTION

With the exception of one small outlier at Edgerston Moor the association occurs as a single large area. Along the northern boundary, from Cessford in the east to Ashieburn in the west, there is land still to be surveyed. The western boundary is irregular extending approximately north to south from Ashieburn by Denholm, Bonchester Bridge, Harwood to just west of Windburgh Hill. The southern boundary is very irregular and is shared with the Ettrick, Carter and Sourhope Associations. From Windburgh Hill it runs eastward to Hemlaw Knowes, then by Abbotrule and Southdean to Patonhaugh. The eastern boundary is common to Ettrick, Sourhope and Minto Associations, running from Patonhaugh to Cessford by way of Mervinslaw, Oxnam and Crailinghall. The Teviot Water with its fluvio-glacial terraces divides the area of the association in two.

Parent Material

The Hobkirk Association is developed on parent materials derived from Upper Old Red Sandstone sediments. The commonest parent material is loamy till with between 10% and 20% clay, more than 50% sand, and less than 15% silt. This till is usually to be found on moderate to steep slopes and on hilltops. Its depth is often difficult to ascertain, perhaps because the till is very similar to soft, rotten sandstone. Sometimes, however, a distinctive band can be traced round the inspection pit above and below which the material is soft and indistinguishable from a sandy till the band itself retaining unmistakable properties of solid sandstone. From such evidence it is possible to say that this till is seldom as much as 4 feet thick. In the valleys, especially in the valley of the Rule Water below Hobkirk, there is a greater thickness of till; this is readily seen along the banks of the Rule where there are large exposures. This till usually has a greater amount of clay, between 20% and 30%, but not sufficient to classify it as clayey. Near Oxnam School there is one small area of soft rock which has given rise to skeletal soils.

The proportion of the various parent materials is given below:

Loamy till (10%-20% clay)	76%
Loamy till (20%-30% clay)	24%
Soft rock	0·5%

The loamy till (10%-20% clay) is three times as common as the loamy till (20%-30% clay). This can be attributed to the character of the parent rock. Furthermore, it is largely due to the character of the parent rock that the percentage of skeletal soils is so small.

Contamination of the parent material by material of other geological origin is not serious. There has been a certain amount along the western and southern edges of the association and in the outlier at Edgerston but not to any significant extent. All the seriously contaminated soils have been mapped as Minto Association.

Soils

The Hobkirk Association has representatives of all the drainage classes except the very poorly drained, and as already mentioned there is one small area of skeletal soils.

The Hobkirk series is the most extensive, partly owing to the prevalence of loamy till. The Cessford series is fairly common, occurring especially where the texture of the till is more clayey. The Faw series and the Wauchope series are not widespread, probably because the association gives way to others as the watershed, with its higher rainfall, is approached. These series do occur under low rainfall (less than 40 in.), but probably only as a result of the occurrence in certain places of parent material with a higher proportion of siliceous material than is normal for the association.

Throughout the association, but more especially in the Jedburgh area, certain narrow, shallow channels occur. The soils in these channels are freely to imperfectly drained and have been included in the Hobkirk series although the surface horizon is usually deeper (about 12 inches) and darker in colour than is normal for the series. In the Morebattle-Eckford-Jedfoot-Oxnam area it is probable that most of the till in low-lying situations has been partially sorted by water. The soils here are usually poorly drained with a surface horizon about 14 in. thick developed from water-modified material and they have been classed as Cessford series.

The profile descriptions given below are of soils with a semi-natural vegetation, that is to say soils which have not been cultivated.

Series

HOBKIRK SERIES

The Hobkirk series is developed on till with a sandy to loamy texture. The till is not more than 4 feet thick. The series occurs on gentle to moderate slopes of the flattish hilltops and on the steeper sides of the hills. The vegetation is often some form of acid grassland and the drainage class is free. This is the most extensive series accounting for some 75% of the association.

GENERALISED PROFILE DESCRIPTION

SLOPE	moderate
ASPECT	west
ALTITUDE	650 feet
VEGETATION	*Agrostis spp.* (d) *Holcus lanatus* (f) *Cynosurus cristatus* (f) *Trifolium repens* (f) *Hypnaceous mosses* (f)
DRAINAGE CLASS	free

Horizon	*Depth or Thickness*	
A	0-7″	Dark reddish grey (5YR:4/2) sandy loam; weak fine crumb; very friable; moderate organic matter; stones few; roots abundant; no mottling: merging into
B_2	7-11″	Light brown (7·5 YR:6/4) sandy loam; weak fine granular; very friable; low organic matter; stony at top of layer, otherwise few stones; roots frequent; no mottling: merging into
B_3	11-19″	Light reddish brown (2·5YR:6/4) loam; weak fine granular; weakly indurated; low organic matter; stony; roots frequent; no mottling: merging into
D	19-31″	Reddish brown (2·5YR:5/4) rotten rock; variable texture but mostly loamy sand.

The A horizon is characterised by a crumb structure and friable consistency. The humus is of a silicate moder type and mottling is rare or absent and the consistency is usually friable. The B_2 horizon has a yellow colour and the structure tends to be granular. There is little or no mottling. The B_3 horizon is usually indurated to some degree and its colour is frequently less yellow. With this series it is unusual to find a C horizon for the till is generally very shallow. The properties of the D horizon can vary greatly.

NOTE ON AGRICULTURE. The characteristic vegetation of this series makes a good pasture although in a dry spell it may show burning. Drinking water for stock is often scarce in such times. Where the slope is satisfactory this series is readily cultivated. The till is not generally thick but the sandstone strata are usually quite soft and yield to implements.

PLATE XXI
Arable land on the Hobkirk Association at Southdean.

PLATE XXII
Cessford, one of the largest arable farms (Hobkirk Association) in the Borders (1800 acres).

PLATE XXIII
Hobkirk Association, Cessford series. The till is thick and the drainage class is poor.

PLATE XXIV
Ettrick Association, with corrugations prominent. Note the old rig and furrows on the extreme right.

FAW SERIES

The Faw series occurs usually on till with a loamy texture. It is to be found on gentle to moderate slopes, generally on hilltops, under a high rainfall (more than 40 in.). Where it occurs under a low rainfall (less than 40 in.) the till is almost certainly derived from strata which are more siliceous than normal. Like the Hobkirk series it is developed on till less than 4 feet thick. The solid strata, however, are readily weathered and sometimes it is impossible to differentiate between till and rotten sandstone. The vegetation is commonly some form of Molinietum or occasionally Callunetum and the drainage class below the thin iron pan is free.

Generalised Profile Description

SLOPE	moderate
ASPECT	west
ALTITUDE	1,000 feet
VEGETATION	*Calluna vulgaris* (d) *Hypnaceous mosses* (f) burnt over some 5 years' earlier.
DRAINAGE CLASS	imperfect above pan, free below.

Horizon	*Depth or Thickness*	
L	$\frac{1}{2}''$	Litter
F	$\frac{1}{2}''$	Partially decomposed litter
H	$2''$	Dark brown organic matter; greasy; sharp change into
A_2	0-6″	Pinkish grey (7·5YR:6/2) loamy sand; weak fine blocky; very friable; few stones; roots abundant forming a mat just above iron pan which is seldom penetrated; no mottling. Sharp change into
B_1	at 6″	Thin ($\frac{1}{16}''$) iron pan; continuous but not strong. Sharp change into
B_2	6-13″	Reddish brown (5YR:5/4) loam; weak medium blocky; friable; low organic matter; few stones; roots rare; few fine distinct mottles tending to occur near root channels. Sharp change into
D	13-36″+	Weak red (10R:5/4) rotten sandstone.

The H layer is invariably more than 1 in. thick and consists of raw humus. The A_2 horizon has a weak structure and a mat of roots is formed just above the iron pan. Mottling and other evidence of gleying is sometimes quite prominent, depending on the impermeability of the iron pan and the site of the soil. The B_1 (iron pan) horizon is usually, although not necessarily, continuous and impermeable to water. The B_2 horizon is similar to that of the Hobkirk series with a yellower colour than any other horizon and weak blocky structure. Sometimes there may be some evidence of gleying but never sufficient to place it in the poorly drained category. The till is usually very thin and often the B_2 horizon rests on rotten sandstone strata. If there is a B_3 horizon, however, it usually shows a certain degree of induration.

NOTE ON AGRICULTURE. The grazing value of this series is not usually high but depends on the vegetational type. The soils can be readily cultivated but would require to be given liberal dressings of fertiliser to bring it to a satisfactory level of fertility. The iron pan must first be ruptured to make the A horizon more freely drained and allow plant roots to penetrate into the B_2 horizon.

CESSFORD SERIES

The Cessford series is usually developed on loamy till, occasionally on clayey till which is frequently more than 4 feet thick. It is to be found on gentle to moderate slopes in or near valleys. It is fairly extensive accounting for about 17% of the association. The vegetation is often grassy, with *Deschampsia caespitosa* a common constituent and the drainage class is poor.

GENERALISED PROFILE DESCRIPTION

SLOPE — gentle
ASPECT — west
ALTITUDE — 600 feet
VEGETATION — *Juncus effusus* (co-d) *Deschampsia caespitosa* (co-d) *Molinia caerulea* (o) *Hypnaceous mosses* (f)
DRAINAGE CLASS — poor

Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter
H	½″	Dark brown organic matter
A_1g	0-4″	Dark brown (7·5YR:4/2) loam; moderate, very fine sub-angular blocky; friable; moderate organic matter; stones few; roots abundant; few fine distinct mottles associated with roots: merging into
A_2g	4-6″	Pinkish grey (7·5YR:5/4) loam; weak fine sub-angular blocky; friable; low organic matter; stones few; roots frequent; few prominent ochreous mottles; prominent ochreous coating round root channels: merging into
B_2g	6-11″	Light reddish brown (5YR:6/3) loam; moderate fine prismatic; friable; low organic matter; stony; roots frequent; distinct grey coating to peds: merging into
B_2g	11-20″	Reddish brown (5YR:5/4) loam; moderate, fine prismatic; firm; low organic matter; stony; roots occasional; distinct grey coating to peds and round stones and roots: merging into
B_3g	20-32″	Reddish brown (2·5YR:4/4) clay loam; weak medium prismatic to massive; very firm; low organic matter; stony; roots occasional; distinct grey coating to peds and round stones and roots: merging into
Cg	32-42″+	Reddish brown (2·5YR:4/4) clay loam; weak medium prismatic to massive; very firm; low organic matter; stony; roots rare; faint grey coating to peds and stones.

The H layer is invariably less than 1 in. thick. The A_1g horizon has a moderate organic matter content and a weak to moderate sub-angular blocky structure. There are usually a few mottles associated with plant roots. The A_2g horizon is weak sub-angular blocky and there may be ochreous mottles. The B_2g has normally a well-defined prismatic structure with grey coatings to the peds and stones and sometimes with some ochreous mottling. In the B_3g horizon the structure is less well defined although as a rule it is still prismatic. The grey coatings to the peds and stones are less striking. There is usually a weak prismatic to massive structure in the Cg horizon where the grey coatings to the peds and stones are much less easily distinguished.

NOTE ON AGRICULTURE. The grazing value of the typical vegetation of this series is poor to moderate. Open ditches may be required to keep surface water under control before it can be used even for grazing. A tile drainage system is necessary if cultivation is to be reasonably successful. It is true to say, however, that the series is much less intractable than the corresponding series Ettrick, Letham and Minto in the Ettrick, Carter and Minto Associations respectively; nor does it poach quite so readily.

WAUCHOPE SERIES

The Wauchope series is not extensive, amounting to only some 7% of the association. It is developed on till, generally loamy in texture but occasionally clayey, which tends to be more than 4 feet thick. High rainfall (more than 40 in.) favours this series, but it does occur under a small rainfall (less than 40 in.) where the parent material is more siliceous than normal. It is to be found on gentle to moderate slopes in or near valleys. The vegetation is frequently some form of Molinietum, occasionally Callunetum or Nardetum. The drainage class is poor.

Generalised Profile Description

SLOPE gentle
ASPECT west
ALTITUDE 850 feet
VEGETATION Burned over about 6 years ago. *Calluna vulgaris* (d) *Nardus stricta* (f) *Juncus squarrosus* (o) *Erica tetralix* (o) *Mosses* (f)
DRAINAGE CLASS poor

Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter
H	3″	Dark brown organic matter. Wet and greasy. Sharp change into
A_1g	0-2″	Dark brown (7·5YR:4/2) loam; weak fine subangular blocky; friable; moderate organic matter; stones few; roots abundant; merging into
A_2g	2-6″	Light grey (10YR:7/2) loam; weak fine sub-angular blocky; friable; low organic matter but organic staining; stones few; roots abundant; merging into
B_2g	6-11″	Light brown (7·5YR:6/4) clay loam; moderate fine prismatic; firm; low organic matter; stones few; roots frequent; frequent medium, distinct ochreous mottles inside peds; prominent grey faces to peds, round stones and roots: merging into
B_2g	11-18″	Light brown (7·5YR:5/4) clay loam; moderate medium prismatic; firm; low organic matter; few stones; roots occasional; frequent medium distinct ochreous mottles inside peds; prominent grey faces to peds, round stones and roots; merging into
B_3g	18-28″	Reddish brown (5YR:6/4) clay loam; weak medium prismatic; firm; low organic matter; stony; roots occasional; few medium distinct ochreous mottles; distinct grey faces to peds, round stones and roots; merging into
Cg	28-38″+	Reddish brown (5YR:5/4) clay; weak medium prismatic to massive; very firm; low organic matter; stony; roots few; few, medium, faint ochreous mottles; distinct grey faces to peds and round stones and roots, lessening with depth.

The H layer is usually over 2 in. thick. The A_1g horizon has characteristically a weak sub-angular blocky structure and friable consistency. There may be a little ochreous mottling associated with roots. In the A_2g horizon the structure is weak sub-angular blocky. The colour is paler than in any other horizon. The B_2g horizon has a moderate to strong prismatic structure. The peds have a distinct to prominent coating of grey material but there is usually much ochreous mottling. In the B_3g horizon the peds are less strongly formed: they have still grey faces but these are rather less distinct than in the B_2g. Ochreous mottling is less noticeable. The Cg horizon has less evidence of gleying. The structure tends to be more massive but the peds though not so well formed still have a grey facing. Ochreous mottling is present but to a lesser extent than in the B_3g horizon.

Note on Agriculture. The characteristic vegetation provides poor to moderate pasture for stock. The depth of mor humus indicates that the level of fertility is low and open ditches may be required to control surface water. Cultivation is not a very good proposition. A tile-drainage system is essential before satisfactory results can be obtained and liberal dressings of fertiliser are required, especially in the early stages. This series has a tendency to poach in wet weather but not so readily as the corresponding series in the Ettrick, Minto and Carter Associations.

Skeletal Soils

There is only one small area of skeletal soils in the Hobkirk Association, on the north bank of the Oxnam Water opposite Oxnam School. Here it is very steep and vegetation is scanty. Hawthorn bushes help to prevent erosion. There is little or no profile development.

Note on Agriculture. This soil type is only suitable for grazing as the steepness rules out any possibility of cropping.

THE CARTER ASSOCIATION

The Carter Association is moderately extensive, amounting to some 29 square miles or 6·4% of the whole area. It is found near the watershed in the general neighbourhood of Carter Bar from which it takes its name. Developed on till derived from sediments of Lower Carboniferous Age, it is characterised by the dominance of poor drainage and peaty tops; about 83% of the association is poorly drained while some 69% has a peaty top, i.e., the H layer is up to 12 inches thick. The principal parent material is a clayey till which tends to occur in valleys and on lower ridges. At higher altitudes and on steep slopes there is usually a shallow sandy or loamy textured till. A prominent feature of the landscape near Carter Bar is a long ridge some 1800 ft. high which is part of the principal watershed of the region. Several lower ridges branch out from it to divide this part of the area into relatively wide basins: the basin of the upper Jed Water is a typical example. Most of the rivers rise near the principal watershed and are still quite small as they flow through the Carter Association.

Distribution

There are three areas of this association, two relatively large and one small, all occurring near the watershed under high rainfall (more than 40 in.). The first is a strip some 3 to 6 miles wide from Hungry Law in the east to Saughtree Station in the west, the second strip about 3 to 4 miles wide from the vicinity of Windburgh Hill in the north to Ninestone Rig in the south and the last a small area near Fawhope.

Parent Material

The Carter Association is developed on till derived from sediments of Lower Carboniferous Age. For the most part these sediments are whitish in colour but near Fawhope and to a lesser extent near the Arks they are reddish. The till in the valleys is thick, usually more than 4 feet, and has a clayey texture, but on the steep slopes the till is thin and has a sandy or loamy texture. On the flatter ridge tops there is either a sandy till or peat. The approximate proportions of the various parent materials are:

Clayey till	= 83%
Sandy or loamy till	= 14%
Soft rock	= 2·4%

The clayey till is by far the most widespread of the parent materials, the sandy or loamy till being of secondary importance. The lime rich strata in the parent rock do not seem to have had a marked effect on the character of the soils. The heavy till is similar in appearance to that of the Ettrick Association but can be distinguished from it mainly by the percentage silt; the Ettrick till has invariably over 20% silt and 25% to 60% sand whereas the Carter till has less than 20% silt and 40% to 70% sand.

The parent materials are relatively free from contamination. Slight contamination occurs on the western edge of the area near Windburgh Hill but it is comparatively unimportant.

SOILS

The soils of the Carter Association are dominantly peaty-topped. This is partly accounted for by their occurrence under high rainfall (more than 40 in.) but the siliceous character of the parent material is also a contributory factor. Lime-rich till may be found where a limestone stratum approaches the surface but the effect of the base-richness is certainly not obvious. Largely as a result of high rainfall and the dominance of till with a clayey texture, most of the soils are poorly drained, 84% falling into this category: only 14% are freely drained and half of these have a peaty top. The freely drained soils are developed on sandy or loamy till found on steep slopes or on the tops of high ridges, the steep slopes being associated with the Coblaw series and the flatter ridge tops with the Arks series.

Very little of this association is cultivated, as most of the soils on slopes which might otherwise be suitable for cultivation are poorly drained.

The profile descriptions given below are of soils with a semi-natural vegetation, that is to say soils which have not been cultivated.

Series

COBLAW SERIES

The Coblaw series is not extensive, amounting to some 2 square miles or 7% of the association. It is developed on sandy or loamy till less than 4 feet thick, with a moderate to high stone content and is found on moderate to steep slopes.

The vegetation is usually some form of acid grassland and the drainage class is free.

GENERALISED PROFILE DESCRIPTION

SLOPE	moderate
ASPECT	north
ALTITUDE	1,125 feet
VEGETATION	*Pteridium aquilinum* (a & d) *Agrostis spp.* (a) *Festuca spp.* (a) *Trifolium repens* (o)
DRAINAGE CLASS	free

Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter
H	trace	Dark brown humus
A	0-3″	Dark reddish brown (5YR:3/2) loamy sand; weak very fine crumb; very friable; moderate organic matter; stony; roots abundant; no mottling; merging into
A	3-10″	Dark brown (7·5YR:3/2) loamy sand; weak fine crumb; loose; low organic matter; stony; roots frequent; no mottling. Sharp change into
B_2	10-20″	Strong brown (7·5YR:5/8) loamy sand; weak fine crumb; friable; low organic matter; stony; roots occasional; no mottling; merging into

Horizon	Thickness Depth or	
B_3	20-28″	Yellowish brown (10YR:5/5) sandy loam; moderate fine blocky; moderately indurated; low organic matter; very stony; roots rare; no mottling: merging into
B_3-C	28-36″+	Brown (10YR:5/3) loam; weak medium blocky; friable; low organic matter; very stony; roots rare; few fine distinct ochreous mottles; faint grey faces to peds.

The H layer is generally less than 1 in. thick. The A horizon is characterised by a crumb or fine sub-angular blocky structure and friable or very friable consistency; the humus is of the silicate moder type. In the B_2 horizon the structure is usually weak to moderate sub-angular blocky. The colour is characteristically lighter than that of the other horizons and there is little grey or ochreous mottling. The B_3 horizon shows some degree of induration and its structure is usually weak to moderate blocky. The C horizon is also weak to moderate blocky but this horizon is less indurated than the B_3 horizon.

NOTE ON AGRICULTURE. The grazing value of the typical vegetation of this series is moderate to good, but bracken readily invades and requires to be controlled. Steepness of slope generally prevents cultivation of this series, although it is otherwise quite suitable.

ARKS SERIES

The Arks series is developed on a sandy to loamy till with moderate to high stone content which is usually less than 4 feet thick. It is not extensive, amounting to some 2·1 square miles or 7% of the association and is generally to be found on gentle to moderate slopes under high rainfall (more than 40 in.). The vegetation is usually some form of Molinietum and under the iron pan the drainage class is generally free.

GENERALISED PROFILE DESCRIPTION

SLOPE	moderate
ASPECT	south
ALTITUDE	900 feet
VEGETATION	*Calluna vulgaris* (d) *Molinia caerulea* (a) *Trichophorum caespitosum* (f) *Nardus stricta* (f)
DRAINAGE CLASS	imperfect above pan and free below pan.

Horizon	Depth or Thickness	
L	½″	Litter
F	½″	Partially decomposed litter
H	5″	Black (7·5R:2/0) humus, well decomposed. Occasional stone at bottom. Sharp change into
A_1	0-3″	Very dusky red (2·5YR:2/2) loamy sand; weak fine sub-angular blocky; very friable; high organic matter; few stones; roots abundant; no mottling. Sharp change into
B_1	at 3″	Thin iron pan. Sharp change into
B_2	3-9″	Strong brown (7·5YR:5/8) sandy loam; weak medium sub-angular blocky; friable; low organic matter but occasional organic streak; few stones; occasional roots; few fine faint grey mottles: merging into
B_3	9-16″	Strong brown (7·5YR:5/6) sandy loam; moderate medium blocky; weakly indurated; no organic matter; few stones, mostly rotten; roots rare; no mottling. Sharp change into
D	16-24″+	Light yellowish brown (10YR:6/4) rotten sandstones in situ? weak medium angular blocky; hard; less weathered rock with depth.

The H layer is usually more than 2 in. thick. The A horizon has a moderate organic matter content, weak to moderate sub-angular blocky structure, and a very friable to friable consistency. It is usual to find a concentration of plant roots just above the thin iron pan. There may be a certain amount of gleying but this depends largely on the permeability of the iron pan. The thin iron pan or B_1 horizon is usually from $\frac{1}{16}''$ to $\frac{3}{16}''$ thick, and normally continuous and impermeable to water. The B_2 horizon is similar to that of the Coblaw series with an orange-brown colour and weak to moderate sub-angular blocky structure. There may be some grey or ochreous mottling but never sufficient to class the soil as poorly drained. The B_3 horizon has a certain degree of induration and its colour is less bright than that of the B_2 horizon. When present the C horizon is less indurated and usually more stony. In the profile given there is no C horizon but instead rotten sandstone in situ.

NOTE ON AGRICULTURE. The grazing value of the typical vegetation is low. The series usually occurs on gentle to moderate slopes where cultivation is theoretically quite possible but the sites are generally exposed and unsuited to cropping. Trees would probably grow well if the thin iron pan were first adequately broken.

LETHAM SERIES

This poorly drained series is developed on clayey till which is usually more than 4 feet thick, on gentle to moderate slopes. As this association occurs under a high rainfall it is not surprising to find that only 21% of it (6 square miles) is of the Letham series whereas 61% is of the Carter series, i.e., poorly drained with peaty top. The Letham series usually carries a grassy vegetation with *Deschampsia caespitosa* present. The drainage class is poor.

GENERALISED PROFILE DESCRIPTION

SLOPE	moderate
ASPECT	north
ALTITUDE	1,150 feet
VEGETATION	*Deschampsia caespitosa* (a & d) *Juncus articulatus* (f) *Anthoxanthum oderatum* (f)
DRAINAGE CLASS	poor

Horizon	*Depth or Thickness*	
A_1g	0-6″	Very dark grey brown (2·5Y:3/2) sandy loam; moderate fine sub-angular blocky; friable; moderate organic matter; few stones; abundant roots; few fine faint ochreous mottles. Sharp change into
A_2g	6-15″	Light brown grey (2·5Y:6/2) sandy loam; weak fine sub-angular blocky; friable; low organic matter; few stones; roots frequent; frequent fine distinct strong brown and dark brown mottles. Sharp change into
B_2g	15-24″	Grey (10YR:5/1) clay loam; moderate medium prismatic; firm; low organic matter; few stones; roots occasional but dead roots frequent; frequent medium prominent reddish yellow and dark brown mottles especially near dead roots; distinct grey faces to peds and stones: merging into
B_3g	24-33″	Grey (2/5Y:5/1) clay; weak medium prismatic; very firm; low organic matter; few stones; roots occasional but dead roots frequent; frequent fine distinct reddish yellow and also dark brown mottles especially near dead roots; distinct grey faces to peds and stones: merging into
Cg	33-39″+	Grey (2·5Y:5/1) clay; weak medium prismatic to massive; very firm; low organic matter; few stones; roots rare but dead roots frequent; few fine distinct reddish yellow and also dark brown mottles especially near dead roots; faint grey faces to peds.

The A_1g horizon has a fine sub-angular blocky structure and characteristically a little ochreous mottling associated with roots. The A_2g horizon is probably the palest of the grey coloured horizons in the profile. The structure is weak medium prismatic and there may be some ochreous mottling, especially towards the base of the horizon. In the B_2g horizon the structure is moderate prismatic with a maximum of ochreous mottling, usually inside the peds, which are coated with grey. The B_3g horizon has a weak prismatic structure; ochreous mottling is present but to a lesser degree than in the B_2g horizon, and the peds are coated with grey. The Cg horizon is more massive in structure and ochreous mottling has decreased but the peds are still coated with grey.

NOTE ON AGRICULTURE. The typical vegetation is grassland with *Deschampsia caespitosa* prominent and its grazing quality is low, although open ditching can do much to improve this. A tile drainage system is a necessary preliminary to cultivation and consequently very little of the series has been cropped. Moreover a clayey texture renders a soil subject to poaching.

CARTER SERIES

A high rainfall is primarily responsible for the Carter series (17·7 square miles) being the most extensive in the association, accounting for 61 % of the whole. The series is generally found on gentle to moderate slopes in or near valleys, developed on till with a clayey texture and more than 4 feet thick.

The typical vegetation is some form of Molinietum and the drainage class is poor.

GENERALISED PROFILE DESCRIPTION

SLOPE moderate
ASPECT south
ALTITUDE 900 feet
VEGETATION *Molinia caerulea* (d) *Calluna vulgaris* (o) *Festuca spp.* (o)
DRAINAGE CLASS poor

Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter
H	7″	Dark reddish brown (5YR:2/2) organic matter; not fibrous but rather amorphous: merging into
A_1g	0-3″	Very dark grey brown (10YR:3/2) clay loam; moderate fine sub-angular blocky; firm; high organic matter; stones few; roots abundant; few fine distinct ochreous mottles usually associated with roots; merging into
A_2g	3-9″	Pale yellow (2·5Y:7/4) clay; moderate medium sub-angular blocky; firm; low organic matter but some organic staining; stones few; roots frequent; few fine distinct ochreous mottles; merging into
B_2g	9-16″	Pale yellow (5Y:7/4) clay; strong medium prismatic; very firm; low organic matter; stones few; roots occasional; many medium and fine distinct ochreous mottles; distinct grey faces to peds and stones. Sharp change into
B_3g	16-24″	Pale olive (5Y:6/3) clay; moderate medium prismatic; very firm; low organic matter; stones few; roots occasional frequent medium and fine distinct ochreous mottles; distinct grey faces to peds and stones: merging into
Cg	24-36″+	Brown (10YR:5/3) clay; weak medium prismatic to massive; very firm; low organic matter; stones few; roots rare; frequent medium brown mottles; distinct grey faces to peds and stones.

The H layer is invariably more than 2 in. thick. The A_1g horizon has a moderate to high organic matter content and usually a weak to moderate sub-angular blocky structure. There may be a little ochreous mottling associated with roots. The A_2g is usually the palest horizon in the profile, and is characterised by a weak to moderate sub-angular blocky structure. Ochreous mottling may be common especially towards the bottom of the horizon. The B_2g horizon has a moderate to strong prismatic structure the peds being coated with grey. Ochreous mottling is marked. These features are less distinct in the B_3g horizon where the structure is still prismatic but noticeably weaker; the grey coating to the peds is less striking than above and ochreous mottling less prominent although still common. The structure in the Cg horizon tends to be more massive. The grey coating to the peds is much less distinct and the ochreous mottling greatly diminished. The colour of the original parent material is discernible in the Cg horizon although gleying effects still tend to obscure it.

NOTE ON AGRICULTURE. The typical vegetation of this series is Molinietum which makes poor pasture for stock. At present very little of the series is drained with open ditches but the value of the grazing would probably increase if this were done. Cultivation is not a good prospect, involving tile-drainage and a liberal manurial programme to raise the level of fertility. The soils will always be liable to poaching by machinery and stock because of their clayey texture. The high rainfall and exposed situation are additional drawbacks.

HUNTFORD SERIES

The Huntford series is developed on clayey till which is invariably over 4 feet thick. It is found on gentle slopes usually surrounded by the more extensive Carter or Letham series. The area of this series is not large, amounting to about 0·7% of the association (0·2 square miles). The vegetation is grassy with *Deschampsia caespitosa* and perhaps some *Juncus spp*. The drainage class is very poor.

GENERALISED PROFILE DESCRIPTION

SLOPE	gentle
ASPECT	north
ALTITUDE	1,000 feet
VEGETATION	*Deschampsia caespitosa* (co-d) *Juncus articulatus* (co-d) *Spirea ulmaria* (f)
DRAINAGE CLASS	very poor

Horizon	*Depth or Thickness*	
L	trace	Litter
F	trace	Partially decomposed litter
H	trace	Humus
A_1g	0-8″	Very dark grey brown (2·5Y:3/2) loam; moderate fine sub-angular blocky; friable; moderate organic matter; few stones; abundant roots; few fine faint ochreous mottles. Sharp change into
A_2g	8-12″	Light brown grey (2·5Y:6/2) sandy loam; weak fine sub-angular blocky; friable; low organic matter; few stones; roots frequent; frequent fine distinct ochreous mottles. Sharp change into
B_2g	12-19″	Grey (2·5Y:5/2) clay loam; strong medium prismatic; firm; low organic matter; few stones; roots occasional but dead roots frequent; many medium and fine distinct ochreous mottles; distinct grey faces to peds and stones; merging into

Horizon	Depth or Thickness	
B_2g	19-26″	Grey (2·5Y:5/2) clay; moderate medium prismatic; firm; low organic matter; few stones; roots occasional but dead roots frequent; many medium and fine distinct ochreous mottles especially round dead roots; distinct grey faces to peds and stones; merging into
B_3g	26-32″	Dark grey brown (2·5Y:4/2) clay; moderate medium prismatic; very firm; low organic matter; few stones; roots occasional but dead roots frequent; frequent medium and fine distinct ochreous mottles especially round dead roots; distinct grey faces to peds and stones; merging into
Cg	32-42″+	Dark brown grey (2·5Y:4/3) clay; weak medium prismatic to massive; very firm; low organic matter; few stones; roots rare but dead roots occasional; frequent medium and fine distinct ochreous mottles especially round dead roots; distinct grey faces to peds and stones.

Where an H layer is present it is generally less than 1 in. The A_1g horizon has a moderate organic matter content and a moderate fine sub-angular blocky structure. The A_2g horizon is usually the palest in the profile. Its structure is weak or moderate sub-angular blocky and there is usually some ochreous mottling. The B_2g horizon has a strong or moderate prismatic structure, the peds having a distinct facing of grey and frequent ochreous mottles inside. The B_3g horizon has a less well defined prismatic structure and rather less ochreous mottling associated with root channels. The peds are still coated with grey though rather less distinctly. In the Cg horizon the structure tends to be more massive and the colour of the original parent material is more apparent. The peds have a distinct to faint coating of grey and there is still ochreous mottling associated with root channels.

NOTE ON AGRICULTURE. The vegetation typical of this series makes poor grazing for stock. The site is frequently low lying and requires open ditches to control surface water. Cultivation is not an attractive proposition. A tile-drainage system is necessary and some difficulty may be encountered in finding a suitable outlet. Moreover, the texture is often clayey and this means that the soil is readily poached by stock and machinery.

REDESWIRE SERIES

The Redeswire series is developed on clayey till with a low to moderate stone content; the till is usually more than 4 feet thick. Generally the series is to be found on very gentle to gentle slopes. There are often a few inches of alluvial material on the surface of the profile but never sufficient to put the series into the category of Alluvium. In all, the Redeswire series accounts for 0·7% of the association or 0·2 square miles. The vegetation is variable but *Molinea caerulea* and *Eriophorum spp.* are frequently present. The drainage class is very poor.

GENERALISED PROFILE DESCRIPTION

SLOPE	level
ASPECT	nil
ALTITUDE	850 feet
VEGETATION	*Eriophorum spp.* (d) *Calluna vulgaris* (a) *Carex spp.* (o) *Molinia caerulea* (o) *Hypnaceous mosses* (a)
DRAINAGE CLASS	very poor

Horizon	Depth or Thickness	
L	2″	Litter, mostly from mosses
F	4″	Partially decomposed litter
H	5″	Very dark grey brown (10YR:3/2) organic matter; merging into

Horizon	Depth or Thickness	
A_1g	0-3″	Dark grey brown (10YR:4/2) clay loam; moderate medium sub-angular blocky; firm; high organic matter; stones few; roots abundant; no mottling. Sharp change into
A_2g	3-10″	Dark grey brown (10YR:4/2) clay; moderate medium sub-angular blocky; firm; low organic matter but plentiful organic staining; strong smell of H_2S; stones few; live roots frequent, dead roots occasional; no mottling. Sharp change into
B_2g	10-19″	Light olive brown (2·5Y:5/2) clay loam; moderate medium prismatic; firm; low organic matter; stones few; live roots rare, dead roots frequent; frequent medium distinct ochreous mottles: merging into
B_3g	19-33″+	Grey brown (2·5Y:5/2) clay; moderate medium prismatic; firm; low organic matter; stones few; live roots rare, dead roots frequent; distinct ochreous coating to dead roots; few medium faint brown mottles which are probably original P.M. colour.

The H layer is invariably more than 2 in. thick and merges into an A_1g horizon with a moderate to high organic matter content and a weak to moderate sub-angular blocky structure in which there may be some ochreous mottling associated with roots. The A_2g horizon is usually the palest in the profile but the paleness can be obscured by organic staining. The structure is often weak to moderate sub-angular blocky and there may be ochreous mottling especially near root channels. The B_2g horizon generally has a moderate to strong prismatic structure with grey coated peds showing frequent ochreous mottles inside. In the B_3g horizon the peds are not so well formed although they are still coated with grey; the ochreous mottles inside are less frequent than in the B_2g horizon. Brown mottles are occasionally seen, this colour being apparently inherited from the parent material. In the profile description above there is no Cg horizon but where this horizon is present the effects of gleying are less noticeable, e.g., grey faces to peds and ochreous mottles are less distinct and the structure is more massive. The brown colour of the original parent material is quite apparent.

NOTE ON AGRICULTURE. This series usually occurs on level sites which are not easily drained either by open ditches or tile drains. The characteristic vegetation may provide useful feed for stock in the early spring but it is often necessary to control surface water by ditches. Cultivation is practically out of the question: even if successfully tile-drained, this series will always be susceptible to poaching by machinery and animals.

Skeletal Soils

Skeletal soils are not widespread, accounting for only 2·4% of the association (0·7 square miles). They are to be found near the watershed on steep or very steep slopes.

The character of these soils is largely determined by parent material. Shallowness is their principal characteristic for the sediments of Lower Carboniferous Age are invariably near to the surface of these soils. Above the surface mineral horizon there may be present any thickness of peaty top up to 12 in. Shallowness and steepness of slope make cultivation impossible and grazing value depends largely on the vegetational type.

A phenomenon associated with Lower Carboniferous sediments is the occurrence of landslips which scar the hillside by leaving the ground denuded of vegetation and topsoil. One explanation is that in particularly wet weather the fossiliferous beds in the solid strata become saturated with water and if they are near the surface and steeply inclined they give way and cause a landslip. Skeletal soils are likely to form on the scars left by these landslips.

THE MINTO ASSOCIATION

The Minto Association is normally found between the Ettrick and Hobkirk Associations. It is developed on a mixed till derived from Silurian greywacke and shales and from Upper Old Red Sandstone marls and sandstones. One of the smaller associations, it accounts from some 5% of the total area (23 square miles). As the name suggests, the village and policies of Minto are largely of this association.

It is usual in the Minto Association to find a greater concentration of Silurian material in the surface horizon than in the subsoil, due to the fact that the ice movements were mainly from the Silurian strata on to the Old Red Sandstone sediments. Again, the depth of Silurian material is greater in hollows than on the tops of ridges. Stones are dominantly of the resistant Silurian greywacke but as a rule the subsoil has a distinct red colour inherited from the Old Red Sandstone strata. The relief is rolling near the Teviot Water, becoming more hilly as the watershed is approached. There are no other rivers within the bounds of this association.

DISTRIBUTION

The main area of the Minto Association is a narrow strip of country between 1 to 6 miles wide, from Belses in the north to Harwood in the south. There are five other small areas: between Maiden Paps and Shankend Station; at Berryfell Hill; near Sandy Edge; near Camptown and in the vicinity of Oxnam.

PARENT MATERIAL

The parent material is a mixed till derived from Silurian shales and greywackes and Old Red Sandstone marls and sandstones. As already stated, the top soil has frequently a greater proportion of Silurian material than the subsoil, the colour of the top soil being brown and that of the subsoil a distinct red. The thickness of Silurian material is greater in the hollows than on slopes and ridges.

The parent material contains between 20% and 35% silt, between 30% and 50% clay and less than 45% sand, which as the subsoil has a large proportion of Old Red Sandstone material, is quite surprising. The Hobkirk Association developed on Old Red Sandstone material is much less rich in silt and clay. The explanation is probably that the basal layers of the Old Red Sandstone formation in this area are derived originally from Silurian strata and that the Minto Association obtains most of its Old Red Sandstone material from these basal layers. Certainly the mechanical analysis of the parent materials of Ettrick and Minto Associations show some striking similarities, e.g., in the percentage of silt. The relief of most of this association is rolling and there is little difference in texture between the till in the hollows and the till on the crests of the ridges.

SOILS

Most of the drainage classes are represented in the Minto Association. The Belses and Minto series are by far the most extensive. There are only small areas of the Stonedge and Stenishope series which have a peaty top, and these are to be found near the watershed under high rainfall. Very little of this association, however, does occur under high rainfall and this more than anything explains the small proportion of its soils with a peaty top.

Some of the profiles given below are of soils with a semi-natural vegetation, that is to say soils which have not been cultivated. Others are of arable soils.

Series

BELSES SERIES

The Belses series is developed on till with a clayey texture and moderate to low stone content and is found on moderate to steep slopes, generally under low rainfall (less then 40 in.). It is relatively extensive, accounting for some 43% of the association (9·9 square miles).

The semi-natural vegetation is generally some form of acid grassland and the drainage class is imperfect.

GENERALISED PROFILE DESCRIPTION

SLOPE moderate
ASPECT north
ALTITUDE 575 feet
VEGETATION 2nd year grass—good
DRAINAGE CLASS imperfect

Horizon	*Depth or Thickness*	
S	0-11″	Light brown grey (10YR:6/2) clay; moderate coarse granular firm; moderate organic matter; few stones; roots abundant; no mottling: merging into
$B_2(g)$	11-17″	Very pale brown (10YR:7/4) clay; moderate coarse sub-angular blocky; firm; low organic matter; stony, mostly Silurian greywacke; roots frequent; few faint ochreous mottles: merging into
B_3C	17-25″	Light brown (7·5YR:6/4) clay; moderate medium prismatic; firm; low organic matter; stony, mostly Silurian greywackes; roots occasional; few fine, faint ochreous mottles; frequent, medium distinct black staining (MnO_2?): merging into
C	25-42″+	Light reddish brown (2·5YR:6/4) clay; weak, coarse prismatic to massive; very firm; low organic matter; stony mostly Silurian greywacke; roots rare; no mottles.

The surface horizon has usually a granular or a fine sub-angular blocky structure, and organic matter content is moderate to low. The B_2 (g) horizon does not have the bright yellow colour characteristic of many freely drained soils, but a pale brown colour indicative of a certain amount of gleying. The structure is either sub-angular blocky or prismatic and the peds have usually a dull surface. There are sometimes ochreous mottles. The B_3C horizon often has a prismatic structure but the surface of the peds is less dull than in the B_2g horizon. There is sometimes ochreous mottling and there is frequently some manganiferous staining. In general, evidence of gleying is less than in the $B_2(g)$. In the C horizon the structure tends to be more massive and it is unusual to find any ochreous mottling.

NOTE ON AGRICULTURE. Much of this series is cultivated. Any of it in permanent pasture carries moderately good grazing. Most of the cultivated soils are of good quality but the texture is often clayey and on that score alone they require to be carefully handled. There is invariably a good depth of soil with little risk of touching solid rock.

STONEDGE SERIES

The Stonedge series generally occurs under high rainfall (more than 40 in.). It is not extensive, accounting for only 1·3% of the association or 0·3 square miles. It is developed on a mixed till with a clay-loam to clay texture and low to medium stone content. The vegetation is often some form of Molinietum and the drainage class is imperfect.

GENERALISED PROFILE DESCRIPTION

SLOPE gentle
ASPECT north east
ALTITUDE 1,200 feet
VEGETATION *Nardus stricta* (a) *Deschampsia flexuosa* (a) *Molinia caerulea* (a) *Hypnaceous spp.* (f)
DRAINAGE CLASS imperfect

Horizon	Depth or Thickness	
L	½″	Litter
F	½″	Partially decomposed litter
H	3″	Black (5YR:2/1) humus. Sharp change into
A_1	0-3″	Dark reddish brown (5YR:3/2) loam; moderate fine sub-angular blocky; friable; high organic matter; few stones; roots abundant; no mottling; merging into
A_2	3-7″	Dark grey brown (10YR:4/2) loam; moderate fine sub-angular blocky; friable; low organic matter; few stones; roots frequent; some stones at base of horizon have dark ochreous coating, suggestive of a thin iron pan. Sharp change into
B_2	7-15″	Reddish brown (5YR:5/4) clay loam; moderate medium granular; weakly indurated; low organic matter; stony, mostly greywacke; roots occasional; few fine distinct ochreous mottles usually associated with root channels; frequent, medium, distinct black stains (MnO_2?): merging into
B_3	15-23″	Reddish brown (2·5YR:4/4) gritty clay loam; moderate, medium, granular; indurated; low organic matter; stony, mostly Silurian greywacke: roots rare; few fine, ochreous mottles. Sharp change into
D	23″+	Solid greywacke striking S.W.-N.E. Coating of grey clay and old root casts on joint faces.

This profile is not typical of the association as a whole in that Old Red Sandstone material overlies Silurian material: it is usual to find Silurian material overlying Old Red Sandstone material.

The H layer is frequently more than 1 in. thick. In the A_1 horizon the organic matter content is generally moderate to high. The structure is sub-angular blocky and there may be some ochreous mottling associated with roots. The A_2 horizon is pale-coloured, and its structure is fine sub-angular blocky. Towards the base there may be indications of a thin iron pan. The B_2 horizon has a bright brown colour with either a fine sub-angular blocky or a granular structure. There may be a little ochreous mottling and some manganiferous stains. The B_3 horizon is invariably indurated to some degree. Ochreous mottling may be present but is never so pronounced as to make the horizon other than freely drained. The C horizon is absent in the above profile, solid greywacke occurring immediately below the B_3.

NOTE ON AGRICULTURE. The grazing value of the typical vegetation of this series is not high. Cultivation should be relatively simple but its success depends firstly on the rupture, when ploughing, of the thin iron pan (if present) and secondly on liberal manuring to get rid of the mor humus and raise the fertility of the soil to a satisfactory level.

MINTO SERIES

The Minto series is developed on till of clayey texture and low to moderate stone content and usually occurs under low rainfall (less than 40 in.) on gentle to moderate slopes. It is comparatively extensive, amounting to some 45% of the association or 10·5 square miles; the greatest area occurs between Minto and Belses. Most of this series is arable. The drainage class is poor.

GENERALISED PROFILE DESCRIPTION

SLOPE	gentle
ASPECT	north
ALTITUDE	550 feet
VEGETATION	2nd year grass—good
DRAINAGE CLASS	poor

Horizon	*Depth or Thickness*	
S	0-11″	Brown (10YR:5/3) clay loam; moderate, medium sub-angular blocky; firm; moderate organic matter; few stones; roots abundant; few fine distinct ochreous mottles associated with roots. Sharp change into
B_2g	11-16″	Light yellowish brown (10YR:6/4) clay; moderate medium prismatic; very firm; low organic matter; stony, mostly Silurian greywacke; roots frequent; frequent, fine distinct ochreous mottles; frequent medium prominent black mottles (MnO_2?); distinct grey faces to peds and stones: merging into
B_3g	16-20″	Light brown (7·5YR:6/4) clay; weak medium prismatic; very firm; low organic matter; stony, mostly Silurian greywacke; roots occasional; few fine faint ochreous mottles; few fine distinct black mottles (MnO_2?); distinct grey faces to peds and coatings to stones and root channels but less than in B_2g: merging into
Cg	20-44″+	Reddish brown (2·5YR:4/4) clay; weak, coarse, prismatic to massive; very firm; low organic matter; stony, mostly Silurian greywacke; roots rare; few fine faint ochreous mottles; faint grey faces to peds and coatings to root channels and stones, much less well defined than in B_3g.

The S horizon has a medium sub-angular blocky structure, and there is normally some ochreous mottling associated with roots. The B_2g horizon has a well defined prismatic structure with grey facings to the peds; ochreous mottling is common and sometimes manganiferous stains are found. In the B_3g horizon the prisms are less well defined. They are still coated with grey and it is usual to find some manganiferous staining but ochreous mottling is not common. The Cg horizon tends to be massive with still some ochreous mottles and grey faces to the ill-defined peds but these tend to disappear with depth.

NOTE ON AGRICULTURE. Permanent pasture on this series is poor to moderate in value, and ditching is necessary to control surface water. The series is largely cultivated, however, and yields good crops. The clayey texture makes the soil very susceptible to poaching by machinery and animals and it must be carefully handled. A tile-drainage system is essential.

STENISHOPE SERIES

The Stenishope series is usually developed on till of a clayey texture and low to moderate stone content. It tends to occur under high rainfall (over 40 in.) on gentle to moderate slopes. Relatively it is not extensive, accounting for only some 10% of the association (2·2 square miles).

The vegetation is normally some form of Molinietum or Callunetum and the drainage class is poor.

GENERALISED PROFILE DESCRIPTION

SLOPE	flat
ASPECT	north east
ALTITUDE	1,150 feet
VEGETATION	*Calluna* (d) *Eriophorum angustifolium* (f) *Trichophorum caespitosum* (f) *Sphagnum spp.* (a) *Polytrichum spp.* (f)
DRAINAGE CLASS	poor

Horizon	*Depth or Thickness*	
L	Trace	
F	Trace	
H	9″	Black (5YR:2/1) wet organic matter
A_1g	0-2″	Dark reddish brown (5YR:3/2) loam; weak fine sub-angular blocky; friable; medium organic matter; few stones; roots abundant; few fine faint ochreous mottles; merging into
A_2g	2-5″	Light grey brown (10YR:6/2) clay loam; weak medium sub-angular blocky; firm; low organic matter; stony, mostly greywackes; roots frequent; few fine distinct ochreous mottles especially towards the base of the horizon; merging into
B_2g	5-11″	Light reddish brown (5YR:6/3) clay loam; moderate medium prismatic; firm; low organic matter; stony, mostly greywacke; roots frequent; frequent, fine distinct ochreous mottles inside peds, distinct grey coating to peds and stones; merging into
B_3g	11-17″	Reddish brown (5YR:4/3) clay loam; weak medium prismatic firm; low organic matter; stony, mostly greywacke; roots occasional; frequent fine faint ochreous mottles inside peds; distinct grey coatings to peds and stones; merging into
Cg	17-30″+	Reddish brown (2·5YR:4/4) clay loam; weak medium prismatic to massive; very firm; low organic matter; very stony, mostly greywacke; roots occasional; few fine faint ochreous mottles inside peds; faint grey faces to peds and stones; few medium distinct black mottles (MnO_2?).

The H layer is invariably more than 2 in. thick. The A_2g has a moderate to high organic matter content, with a fine sub-angular blocky structure and few fine ochreous mottles near root channels. The A_2g horizon has the palest colour of all the horizons in the profile. Its structure is generally weak to moderate fine sub-angular blocky and ochreous mottling may occur especially near the bottom of the horizon. The B_2g horizon has a well defined prismatic structure with grey facings on the peds, inside which there is ochreous mottling. In the B_3g horizon the structure is prismatic but less well defined than in the B_2g horizon. The peds are still grey-coated with ochreous mottling inside. In general, however, the effects of gleying are less apparent in the B_3g horizon than in the B_2g and still less apparent in the Cg horizon. Here, the structure tends to be more massive. The ill-formed peds are still coated with grey coloured material but to a much lesser degree and the ochreous mottling inside the peds is likewise reduced.

NOTE ON AGRICULTURE. The typical vegetation of this series makes poor grazing although *Eriophorum angustifolium* often provides a useful bite in the late spring. Open ditches are advisable to control surface water. Tile-draining and liberal manuring are necessary preliminaries to successful cultivation but in many cases the position in which the series is found is too exposed for arable land.

PLATE XXV
Ettrick Association, Linhope series. A freely drained soil developed on thin till over shattered Silurian sediments.

PLATE XXVI
Half-bred ewes, a Border Leicester-Cheviot cross.

PLATE XXVII
A winter scene near Hawick. The sheep have to search under the snow for food.

PLATE XXVIII
Vegetation on the Ettrick Association near Billhope. On the skyline can be seen small areas of hill peat. The ridges carry Molinietum and the steep slopes acid grassland with Bracken (*Pteridium aquilinum*).

THE ECKFORD ASSOCIATION

The Eckford Association is one of the smaller associations, extending for some 5·7 square miles (1·3% of the total area). It is developed on fluvio-glacial sands and gravels associated with the lower courses of the rivers. The soils are dominantly freely drained and sandy or loamy in texture. The top soils are usually about 12 in. thick.

DISTRIBUTION

The Eckford Association is to be found associated with the Teviot, Ettrick, and Kale Waters. The Teviot Water from about Teviotbank north-eastwards is flanked by a relatively broad terrace which widens out appreciably at the village of Eckford and joins the terrace associated with the Kale Water, which extends eastwards to Morebattle. Although only a small part of the Ettrick Water is within the area it has a fairly large terrace. Traces of fluvio-glacial terraces are found here and there along the upper courses of the Kale and Teviot Waters but none of these are sufficiently important to be mapped.

PARENT MATERIAL

The parent material of the Eckford Association is fluvio-glacial sand and gravel. Its character at any given spot reflects the tills and parent rocks through which the river has flowed but local rocks and tills generally make a decisive contribution. From Teviotbank to just west of Denholm the terrace of the Teviot Water is dominantly Silurian in origin, but from Denholm north-eastwards it is dominated by material from Old Red Sandstone sediments. At Morebattle the terrace of the Kale Water is dominantly derived from Lower Old Red Sandstone lavas but westwards from Morebattle the influence of Upper Old Red Sandstone sediments becomes increasingly apparent. At the village of Eckford where the Teviot and Kale Waters meet there is a wide terrace, which is shown by a sandpit with a face over 20 feet high to be of mixed origin although Old Red Sandstone sediments probably make the largest contribution. The terrace of the Ettrick Water is largely derived from Silurian sediments.

The texture of these terraces is mainly loamy, sometimes sandy. They are generally several feet thick though naturally they become thinner the further they are from the river.

SOILS

The only series found in the area are a freely drained (Eckford series) and a poorly drained (Woodend series), the former being very much more extensive than the latter. Neither series has a peaty top. The Woodend series is found only in depressions and even so there is likely to be an impermeable horizon at some depth under the solum for, under normal conditions, the texture of the solum itself is unlikely to cause poor drainage. The profile descriptions given below are of arable soils.

Series

ECKFORD SERIES

The Eckford series is by far the more extensive, amounting to 5·4 square miles or 94·7% of the association. It is developed on fluvio-glacial sands and gravels and has a sandy or loamy texture. The gravels are not widespread and the drainage class is free.

GENERALISED PROFILE DESCRIPTION

SLOPE	short, steep
ASPECT	south-east
ALTITUDE	200 feet
VEGETATION	pasture with *Dactylis glomerata* and *Trifolium repens* dominant
DRAINAGE CLASS	free

Horizon	*Depth or Thickness*	
S	0-3″	Dark brown (7·5YR:3/2) sandy loam; weak medium crumb; very friable; moderate organic matter; few stones; roots abundant; no mottling; merging into
S	3-11″	Dark brown (7·5YR:3/2) loamy sand; weak medium crumb; very friable; low organic matter; few stones; roots abundant; no mottling: merging into
B-C	11-44″+	Brown (7·5YR:4/4) sand; structureless, single grain; no organic matter; roots frequent but decreasing with depth; no mottling.

The A horizon is usually about 12 in. thick, with sandy or loamy texture and a weak crumb structure. The B and C horizons are not readily distinguishable, the colour being much the same for both, although there may be a very gradual change with depth. The structure in both is usually weak crumb or weak fine sub-angular blocky: on occasion it is single-grain.

NOTE ON AGRICULTURE. Some of the best arable land in the area is in this series with a topsoil about 12 in. thick and very easily tilled. Here and there it is subject to drought but overall this is not a serious problem. Gravel ridges are found in places but these are generally not cultivated.

WOODEND SERIES

The Woodend series is not extensive, amounting to some 0·3 square miles or 5% of the association. The parent material is so sandy in texture that poorly drained soils occur only when there presumably is, at some depth below the solum, some barrier to free vertical movement of water.

GENERALISED PROFILE DESCRIPTION

SLOPE	level
ASPECT	nil
ALTITUDE	200 feet
VEGETATION	old pasture with *Juncus effusus* (a) and *Rumex obtusifolius* (f)
DRAINAGE CLASS	poor

Horizon	*Depth or Thickness*	
S	0-12″	Very dark grey (5YR:3/1) sandy loam; weak fine blocky; very friable; moderate organic matter; few stones; roots abundant; no mottling: merging into
B_2g	12-21″	Dark brown (7·5YR:4/2) loamy sand; moderate medium sub-angular blocky; friable; no organic matter; few stones; live roots frequent, dead roots occasional; few, fine, faint ochreous mottles; merging into
B_2g	21-28″	Brown (10YR:5/3) sand; weak sub-angular blocky; weakly indurated; no organic matter; few stones; live roots occasional dead roots occasional: no mottling but general greyish cast; merging into
Cg	28-42″+	Light brown grey (2·5Y:6/2) sand; structureless, single grain; very friable; no organic matter; few stones; live roots rare, dead roots occasional; no mottling but general greyish cast.

The S horizon has a weak sub-angular blocky structure and there may be a little ochreous mottling near root channels. In the B_2g horizons the structure is often moderate sub-angular blocky and the consistency friable; there may be some fine ochreous mottles. The B_3g horizon has a general greyish appearance which is associated with gleying. Ochreous mottling is present only to a limited extent and the structure is weak sub-angular blocky. The Cg horizon has a similar greyish appearance. The structure is always very weak and may even be single-grain. There is little or no ochreous mottling. The whole appearance of this profile suggests that there is an impervious layer below the solum with free water perched above it for a significant length of time each year.

NOTE ON AGRICULTURE. The area of this series is very small. Before cultivation this series will probably have to be tile drained but the distance between the drains is likely to be great. Most of the series can be cultivated with very satisfactory results.

THE DARLEITH ASSOCIATION

The Darleith Association, so named because it was first mapped near Darleith in Ayrshire, is the least extensive in the area, covering only 3·4 square miles or 0·8% of the whole. It is found throughout the area but principally where the surrounding rocks are Upper Old Red Sandstone sediments or Silurian (Wenlockian) sediments. The soils on most of the prominent hill tops (Ruberslaw, Peniel Heugh, Dunion Hill, Windburgh Hill, Catcleugh Shin, etc.) belong to this association.

PARENT MATERIAL

The Darleith Association is developed on parent material derived from intrusive and extrusive basaltic rocks. A stony loamy till which is normally less than 3 feet thick, is the predominant parent material, the remainder being screes or rock outcrops. The association is confined to prominent hill-tops because lower down in the valleys where intrusions or extrusions have occurred there is so much material derived from surrounding sedimentary rocks that the till is better considered as giving rise to other associations, the intrusive or extrusive material amounting to no more than contamination.

SOILS

In this area the Darleith association is represented only by a freely drained series (the Darleith series) and by skeletal soils. Because of stoniness, shallowness and exposure the soils are of little practical value.

Series

DARLEITH SERIES

The Darleith series (2·4 square miles) forms approximately 69% of the association. The soils are usually less than 3 feet deep and very stony.

GENERALISED PROFILE DESCRIPTION

SLOPE moderate
ASPECT north
ALTITUDE 1,400 feet
VEGETATION *Agrostis spp.* (co-d) *Festuca spp.* (co-d) *Deschampsia flexuosa* (f)
DRAINAGE CLASS free

Horizon	*Depth or Thickness*	
L	1″	Litter
F	1″	Partially decomposed litter

Horizon	Depth of Thickness	
H	½″	Very dark brown humus; merging into
A	0-1″	Very dark brown (10YR:2/2) loam; moderate medium crumb; friable; moderate organic matter; few stones; roots abundant; no mottling; merging into
A	1-2″	Very dark reddish brown (2·5YR:3/3) loam; moderate medium crumb; friable; low organic matter; few stones; roots abundant; no mottling; merging into
B_2	2-5″	Reddish brown (5YR:5/4) loam; moderate fine sub-angular blocky; friable; low organic matter; few stones; roots frequent; no mottling; merging into
B_3	5-11″	Reddish brown (5YR:5/4) loam; moderate fine sub-angular blocky; weakly indurated; low organic matter; stony; roots frequent; slight greying round stones. Sharp change into
D	11″+	Basalt rock

The H layer is generally less than 2 in. thick and merges into an A horizon characterised by a crumb structure and friable consistency. The organic matter content is usually moderate in the top inch of the A horizon and low to moderate below this. Ochreous mottling is not common but is sometimes associated with plant roots. The B_2 horizon is normally bright brown, with a fine sub-angular structure and little ochreous mottling. The B_3 horizon is usually indurated to some degree; the structure is still sub-angular blocky and there may be some grey and ochreous mottling. As a rule solid rock lies immediately below the B_3 horizon.

NOTE ON AGRICULTURE. The typical vegetation of this series provides excellent grazing. Cropping is seldom practised due to the shallowness and stoniness of the soils.

Skeletal Soils

The skeletal soils are not widespread amounting to only 1·1 square miles but, nevertheless, this is 32% of the association. Most are formed on screes and in the vicinity of rock outcrops. They are characterised by excessive stoniness and the proximity of solid rock to the surface.

ALLUVIUM

There are two principal types of alluvium, freshwater and marine; only the former is to be found in the area. Freshwater alluvium can be subdivided into river and lacrustine both of which are present in this area although no attempt has been made to differentiate them on the map. They are easily distinguished by noting that river alluvium is associated with stream and river courses whilst lacrustine is associated with the sites of lakes or ponds.

Alluvium is quite extensive amounting to 20 square miles or 4·4% of the total area. The soils developed on river alluvium are dominantly sandy and imperfectly drained whilst those on lacustrine alluvium are loamy or clayey and poorly or very poorly drained.

DISTRIBUTION

River alluvium is to be found flanking streams and rivers throughout the area. The Teviot Water is the principal river and naturally it is associated with the greatest extent of alluvium; near Jedfoot the alluvium is 1 mile wide. The Kale Water near Morebattle also has very wide alluvial terraces but those of the Ettrick, Rule, Jed and Bowmont Waters are rather less than ½ mile wide.

Lacustrine alluvium is very widespread. It generally occurs in relatively small areas and although found throughout the region it is more concentrated north and west of Hawick. The surrounding associations are usually either Ettrick or Minto.

Parent Material

River alluvium usually reflects the geological formations through which the river or its tributaries have passed. If the river is a large one and if the geological character of the region through which it flows is complex the alluvial deposits may be very heterogeneous. In this area the alluvial deposits tend to be fairly homogenous. The Teviot Water from its source to Teviotbank is flanked by alluvium which is almost entirely derived from rocks of Silurian age or related glacial deposits. From Teviotbank north-eastwards the alluvium consists more and more of material derived ultimately from Upper Old Red Sandstone sediments. The Kale Water near its source has alluvium which is probably derived ultimately from Silurian and Carboniferous sediments but as it flows northward the alluvium changes character being ultimately from Lower Old Red Sandstone lavas. This type of alluvium persists till the Kale nears the Teviot Water at Eckford where the alluvium becomes influenced by Upper Old Red Sandstone material. The pattern is similar with the alluvium of other rivers. The alluvium of the Ettrick Water is derived mainly from Silurian sediments that of the Jed and Rule Waters mainly from Upper Old Red Sandstone sediments and that of the Bowmont Water mainly from Lower Old Red Sandstone Lavas.

River alluvium consists usually of 2 to 3 feet of sandy material overlying gravel. The thickness of the finer material is variable generally becoming thinner as the source of the river is approached; near its source a river is often faster flowing and less likely to deposit finer material.

Lacustrine alluvium is generally speaking more homogenous than river alluvium, with the surrounding rocks and glacial deposits the principal sources of material. It usually consists of loamy or clayey material. Gravel is seldom present at any depth up to four feet.

Soils

It is usual to treat alluvial soils in one of two ways, namely (1) to leave them undifferentiated or (2) where there is a large area, to differentiate them on the basis of texture and drainage. Frequently it is impractical to distinguish series visually because many alluvial soils have very little profile development.

The alluvial soils of this area have not been differentiated mainly because no large concentration of them are to be found. Nevertheless certain general statements can be made. Near the river alluvial soils are liable to be flooded when the river is in spate. Levee's may give satisfactory protection. Away from the river there is often a sharp rise where the alluvium gives way to a thick deposit of till or a higher fluvio-glacial terrace. The alluvial soils near this junction are usually very poorly drained. Water frequently stands here during the winter months probably because the tile drains and ditches are unable to cope with the flow of water from the higher ground.

The profile descriptions given below are of soils developed on alluvium. The first two are on alluvium associated with the Teviot Water while the third is at Jedfoot where the Jed and Teviot Waters join. Many similarities are apparent but there is a gradual change in colour from the first to the third. The fourth profile description is of a soil developed on lacustrine alluvium.

Generalised Profile Description

LOCALITY	Ashybank
SLOPE	level
ASPECT	nil
ALTITUDE	275 feet
VEGETATION	3rd year grass—good
DRAINAGE CLASS	imperfect

Horizon	*Depth or Thickness*	
S	0-10″	Brown (10YR:5/3) loam; moderate medium sub-angular blocky; firm; moderate organic matter; few stones; roots abundant; no mottling: merging into
B-C	10-36″	Light yellowish brown (10YR:6/4) sandy loam; weak fine prismatic; firm; low organic matter; few stones; roots frequent becoming occasional at 36″; no mottling. Sharp change into
D	36-42″+	Yellowish brown (10YR:5/4) fine gravel; structureless, single-grain; low organic matter; stony, mostly less than ½″ diameter; roots rare; no mottling.

This soil is almost entirely derived from Silurian material.

Generalised Profile Description

LOCALITY	Lanton Mill
SLOPE	level
ASPECT	nil
ALTITUDE	175 feet
VEGETATION	old grass
DRAINAGE CLASS	imperfect

Horizon	*Depth or Thickness*	
S	0-10″	Light brown (7·5YR:6/4) loam; moderate medium sub-angular blocky; firm; moderate organic matter; few stones; roots abundant; no mottling; merging into
B-C	10-32″	Light brown (7·5YR:6/4) sandy loam; moderate medium prismatic; firm; low organic matter; few stones; roots frequent, decreasing with depth; no mottling. Sharp change into
D	32-40″+	Brown (7·5YR:5/3) sandy gravel; structureless, single grain; low organic matter; very stony, with many 1″ diameter stones in smaller gravel and sand matrix; roots rare; no mottling.

This soil is developed on material derived originally from Silurian and Upper Old Red Sandstone sediments.

Generalised Profile Description

LOCALITY	Mounthooly
SLOPE	level
ASPECT	nil
ALTITUDE	175 feet
VEGETATION	2nd year grass—good
DRAINAGE CLASS	imperfect

Horizon	*Depth or Thickness*	
S	0-9″	Reddish brown (5YR:5/3) sandy loam; moderate medium sub-angular blocky; firm; moderate organic matter; few stones; roots abundant; no mottling; merging into
B-C	9-34″	Reddish brown loam; moderate coarse prismatic; very firm; low organic matter; few stones; roots frequent becoming occasional near 34″; no mottling; dull greyish faces to peds. Sharp change into
D	34-40″+	Sandy gravel; structureless, single grain; low organic matter; very stony; rounded Old Red sandstones with some basalts; roots rare; no mottling.

This soil is developed on material almost wholly derived from Upper Old Red Sandstone sediments.

These three soils have similar features, in particular their texture, structure and the depth at which gravel occurs, but they differ significantly in colour, becoming increasingly reddish as the proportion of Upper Old Red Sandstone material increases. All three are imperfectly drained.

Lacustrine alluvium usually differs from river alluvium in texture and natural drainage class. Lacustrine alluvium is frequently silty or clayey and very poorly drained. A profile description of a soil developed on lacustrine alluvium is given below.

GENERALISED PROFILE DESCRIPTION

SLOPE	gentle
ASPECT	north
ALTITUDE	975 feet
VEGETATION	*Juncus articulatus* (d) *Deschampsia caespitosa* (a) *Molinia caerulea* (a) *Hypnaceous mosses* (a)
DRAINAGE CLASS	very poor

Horizon	*Depth or Thickness*	
L	½″	Litter
F	½″	Partially decomposed litter
H	trace	Black humus
A_1g	0-8″	Grey brown (2·5Y:5/2) loam; weak medium sub-angular blocky; friable; high organic matter; few stones; roots abundant; few fine distinct ochreous mottles associated with roots. Sharp change into
A_2g	8-11″	Pale yellow (2·5Y:7/4) clay; moderate medium prismatic; firm; low organic matter; few stones; roots frequent; frequent, medium, distinct yellow mottles; distinct grey coating to root channels and peds; merging into
B_2g	11-19″	Light grey (2·5Y:7/2) clay; strong medium prismatic; firm; low organic matter; few stones; roots occasional; frequent medium distinct yellow ochreous mottles; faint grey faces to root channels and peds: merging into
B_3g	19-31″	Light grey (5Y:7/2) clay loam; weak medium prismatic; firm; low organic matter; few stones; roots rare; frequent medium distinct ochreous mottles; faint grey faces to root channels and peds: merging into
Cg	31-42″+	Light olive grey (5Y:6/2) clay loam; weak medium prismatic; very firm; low organic matter; few stones; roots rare; dead roots occasional; distinct grey faces to root channels and peds.

NOTE ON AGRICULTURE. River alluvium, in general, is very fertile, but from the farmers' point of view it has certain drawbacks. In the first place it is much more liable to flooding than any other type of land and if the floods occur at harvest-time as they may well do, the crop is likely to be lost or severely damaged. Secondly, near the boundary between river alluvium and either the thick till deposit or an older fluvio-glacial terrace, alluvial soils are inclined to be very poorly drained: if artificial drainage is attempted there is generally no easy outlet. These considerations tend to limit the extent to which river alluvium can be intensively cultivated. Where it is cultivated, the rotation is usually long and it is kept in pasture for a good number of years.

Lacustrine alluvium is to be found in low-lying areas where it is often very poorly drained. If artificial drainage is attempted there is often difficulty in finding a suitable outlet. This, together with the fact that its texture is usually silty or clayey, means that lacustrine alluvium is unsatisfactory for intensive cultivation. Altogether it is a much less easily managed type of land than river alluvium.

BASIN PEAT

There are only a few areas of basin peat in the lower lying parts of Roxburghshire, none as yet at the Raised-Moss stage of development.

Adderstonlee is an example of a basin peat at the Low-Moor stage. Over most of its area it carries a stand of trees—Birch, Alder, Willow and a few scattered Pines, while round the margin is a belt of Phragmites with sedges. The peat is about 2 metres deep and is of the sedge-grass type in a low state of decomposition, being coarse and fibrous.

Wooden Loch, Eckford. Peat formation at this site is at an earlier stage of development than at Adderstonlee. The margin of the loch carries a lush growth of eutrophic vegetation of a fen type and this is giving rise to a layer of peat which as yet is only shallow.

HILL PEAT

Hill peat covers considerable areas on the hills of Roxburghshire. Over many of the hills it has formed to a general depth of 1·5-2·0 metres, and in some cases has been found to exceed this on saddles and in basins. The peat is mostly composed of *Calluna vulgaris, Eriophorum spp.* and *Sphagnum spp.* in an unstratified and nearly homogenous mixture, although there are small areas which do not conform to this type.

The surface vegetation of the hill peat shows many local variations but the dominant species are the same as those which have gone to form the underlying peat i.e. *Eriophorum spp.*, *Calluna vulgaris* and *Sphagnum spp.*

A saddle peat at *Note o' the Gate* was found on examination to be over 3 metres deep. It was typical of the peat on the adjoining hills consisting of an unstratified and nearly homogenous mixture of the remains of *Calluna vulgaris*, *Eriophorum spp.* and *Sphagnum spp.*

On a saddle near *Billhope* however the depth of peat was found to be rather less than 2 metres, with the upper layer a relatively undecomposed fibrous grass peat; the more highly humified lower layer below was composed of the remains of *Eriophorum spp.*, *Sphagnum spp.* and *Betula spp.*

Erosion

The character of the hills in the area Carter Bar-Mosspaul depends on whether they are underlain by Silurian or Carboniferous rocks. The highly folded Silurian strata give rise to steep-sided hills with narrow summit ridges or peaks and the Carboniferous sediments to broad flat-topped hills with moderately sloping sides. Narrow stretches of peat cap the Silurian hills, while broad expanses cover the Carboniferous plateaux. The way in which this topographical difference has influenced the nature of peat erosion is illustrated by a comparison of the Pennygant Hill to Cauldcleugh Head ridge and Peel Fell. Pennygant to Cauldcleugh Head is a typical Silurian ridge where the peat cover extends down the sides and is deeply hagged in a regular pattern by backward erosion. On Peel Fell, which is composed of Carboniferous sediments, the erosion is of a different type. The peat on the flat tops is extensively and severely eroded, but not to a regular pattern. Hags (up to 3·5 metres deep) are arranged in a network with islands of peat, pools of water, and areas of exposed rock, where a redeposition of peat as fine black mud is encouraging colonisation by plants, particularly *Eriophorum angustifolium.*

MIXED BOTTOM LANDS

Mixed Bottom Lands is essentially a unit for mapping. The term is applied to stream channels which are so narrow that the different soil types within the channel cannot be mapped individually on a scale of 1 inch to 1 mile. Mixed Bottom Lands include the soils of the sides of the channels, which are often steep, and of the very heterogeneous alluvial deposits in the vicinity of the stream. The steep sides frequently bear more resemblance to a profile section than to a soil surface.

CHAPTER VI

Agriculture

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JEDBURGH DISTRICT (SHEET 17)

HISTORICAL

THE earliest remains of human habitation are the small forts which were erected on the tops of many of the lower hills. Occasionally forts are also found at strategic points on the banks of rivers. In the hill country there are earthworks which were trenched across the moorland for some unknown purpose. There are a few stone circles of the time of the Druids but nothing on the scale of those found in the North of Scotland.

The Romans have left unmistakeable signs of their activity. The Roman road known as Watling Street, or Dere Street, crosses the Cheviot Hills near the farm of Easter Hindhope and proceeds north in a more or less straight line to the banks of the Tweed. This road may still be traversed for the greater part of its length, and though it is grass-grown and not easily passable by wheeled-vehicles, it was used as a drove-road for sheep and cattle until the coming of the motor lorry in the 1920's. The road will be looked upon with envy by the surveyor of modern times as it shows how an arterial highway should be constructed on a scale and concept that takes everything before it.

The remains of a marching-camp alongside the Roman road are still to be seen at Pennymuir among the hills. The site extends to about forty acres and the earthworks look as though they had been thrown up quite recently. Many subsidiary roads or tracks radiated off the main road, no doubt to connect up with military outposts. One of these Roman forts at Oakwood in Selkirkshire, lying near the River Ettrick, was recently excavated.

Very little is known about agriculture in the Middle Ages in Roxburghshire except for references in records of the abbeys of Jedburgh, Kelso, Dryburgh, and Melrose. From these records it is known that in the olden days sheep were kept on the Cheviot Hills where they have remained in unbroken succession ever since. The Border country was in those times famous for its export of wool.

In the 17th century, agricultural conditions were still somewhat primitive and the enclosure of farm-lands into large-scale farming units had not proceeded to any great extent. In the early 18th century, the pattern of agriculture as we know it today began to emerge, and the process was largely completed by the close of the century. Researches in recent times, notably by Hanley[4], have revealed a great deal of valuable information on this period.

The first full account of the agriculture of the area was prepared by Douglas[1] in 1798. The parish surveys which were written for The Statistical Account of Scotland and which were edited by Sir John Sinclair[17] also appeared at this time. What strikes one in reading the survey written by Douglas in 1798 is the remarkable developments which had been made in agriculture by that date. It seems clear that the face of the country in this particular part of Scotland was very much as we know it today. The farms were similar in size to those of the present day and were equipped with substantial farm-steadings and farm-houses built of stone and lime; grassland and arable crops were grown in rotation; the common lands had been enclosed and parcelled off into farms; woodlands and policy parks had been planted up; ditching, hedging and draining were in full swing. The state of the farm cottages, however, was very poor indeed. Douglas, in his survey, says, "Hitherto they are mostly built with clay, and few, if any of them, are slated. Those erected for shepherds are miserable temporary hovels. Their walls are alternate rows of stone and sods, and their roofs are of coarse and slender timber, covered with turf and rushes". He goes on to say, however, "though cottages may be found of every intermediate degree, between the worst and the best of those described, yet every year lessens the number of those that are pitiful, and adds to the number of those that are decent and respectable."

The beautiful mansion houses erected by the proprietors were an outstanding feature of the countryside. These together with their magnificent policy parks and the areas of well managed woodland gave a grace and charm to the countryside which has persisted to the present day.

The 18th century was a period of unprecedented advance. In the area with which we are concerned, it abounded in men of great ability and enterprise, proprietors and farmers alike. The large amount of capital which was sunk in the land was no doubt the result of industrial expansion and the consequent high price ruling for agricultural produce. It was also the result of colonial development overseas which added to the industrial prosperity of the nation and which incidentally supplied an outlet for the scions of the noble houses. Suffice it to say that the Border agriculturist was not slow to take advantage of all the resources which were offered by the times in which he lived.

CLIMATE

According to records of the Meteorological Office, as one ascends the Teviot Valley and its tributaries, there is a steady increase in the annual rainfall. In the vicinity of Crailing and Ancrum, it is less than thirty inches in the year, while some twenty miles further up the Teviot Valley, namely at Teviothead it is approximately forty-five inches. The average rainfall along the ridge of the Cheviot Hills west of Carter Bar is about fifty inches.

The lower parts of the Teviot Valley are therefore much better suited to arable cultivation and the harvesting of crops than the upper parts. In the hill farms to the west of the surveyed area, it is sometimes a difficult matter to secure the hay crop owing to wet weather. In 1953, large areas of hay on hill farms were cut but never gathered. It is the practice on hill farms to maintain at least one years' reserve of hay in stack on the ground where it is to be used.

Severe snowstorms are occasionally met with, perhaps once in ten years. In February, 1947, a snow-storm swept the Borders and persisted until the beginning of April. Approximately 25% of the ewe hoggs and 15% of the ewes perished on hill farms. A severe storm also occurred in 1937.

As the district is about thirty miles from the sea at its nearest point, and most of the farming land consists of upland country at an elevation of

400 ft. to 900 ft., frosts in winter are often severe, particularly in January and February. Late-spring frosts are liable to occur over the whole area in April and occasionally in May which tend to injure vegetation and to destroy fruit blossom. This is a handicap against the production of market-garden crops and very little land is devoted to such crops or to fruit.

While spring rainfall is liable to variation, one can usually depend on dry weather in March for the sowing of grain crops. During the months of May, June, and July, there is usually sufficient moisture for crops and grass, and perhaps too much moisture during August for the harvesting of crops. September is the main harvest month and is reckoned to give settled weather with fairly long dry periods.

SIZE OF FARMS

A distinctive feature of the farms in the area is their relatively large size. There is no population of crofters and there are very few small farmers. The vast majority of the farms were squared-off in the eighteenth century into units of around 400 acres. Every parish has at least one farm of over 1,000 acres. The large size of these arable farms gives scope for the running of stocks of breeding sheep under the charge of a skilled shepherd. The shepherd's craft has been handed down from father to son for generations and the area is fortunate in having a reservoir of skilled men to carry on the sheep industry.

The large size of the holdings gives scope for mechanisation and so from 1939 onwards there was a rapid introduction of machinery to meet the need for extra tillage. The horse has largely disappeared from the scene and it is seldom that young men can be found willing to work them.

As regards the hill farms, these are not large in area, the average size being around 1,600 acres. On the other hand the hills are everywhere overlain with soil capable of supporting a grassy type of vegetation with varying amounts of heather, and so the carrying capacity for sheep is much greater than in most hill districts of Scotland. A farm of this size carries 1,000 breeding sheep and employs two shepherds. Included in the above acreage are about 60 acres of arable land and 40 acres of permanent pasture which provide hay for the sheep and winter forage for cattle.

LAND TENURE

The greater part of the area is owned by large estates who let out the farms to tenants. The chief proprietors are the Buccleuch Estates Ltd., The Lothian Estates, and the Duke of Roxburghe. These owners have held their lands for many centuries and have carried on a great tradition of improvement since early times. Leases nowadays are generally for ten or for fourteen years with a break at five or seven years, and with a stipulated annual rent. In addition, the tenant in some cases requires to pay half the cost of the upkeep of march fences, half of the cost of the cutting of hedges, and a proportion of the cost of the upkeep of roofs and paintwork. These additions to rent have become common in recent years as the money-rent is usually well below present-day values.

The situation as regards farm-rents in 1954 is rather confused owing to the working of the Agricultural Holdings Act of 1949. There is no longer a free market in the letting of farms. Where new leases for sitting tenants are negotiated, the annual rent in 1954 in the lower valley of the Teviot and its tributaries is £2 to £2. 10/- per acre. Where the proprietor has been in a position to advertise such farms, however, the rent has been as high as £4 per acre. It is interesting to note that in 1798 the rent of such farms was from £1 to £1 5/- per acre.

In the upper reaches of the Teviot Valley the annual rent in 1954 for arable farms is still about £1 per acre.

High-lying arable stock rearing farms over 600 feet in elevation are still in 1954 rented at around 15/- per acre. It may be remarked, however, that as a rule these farms are large, generally running to about 500 acres, As leases expire, the rent of these farms to sitting tenants is often increased by the addition of 15% to the figures already quoted.

In the case of hill farms, the rent works out in 1954 at about 5/- per acre for the hill ground and 10/- per acre for the arable land. A farm with 1,000 acres of hill land and 100 acres of arable land is rented at about £300.

SOIL FERTILITY

During the period of close-cropping made necessary by the war of 1939-45, the loamy soils of the Hobkirk and Sourhope Associations tended to get depleted of organic matter. Fears were expressed that this would have a serious effect on soil fertility but this did not actually happen. These soils had lain in grass for five or six years at a time, in the rotation practised before the war, and so they were in a position to stand repeated cropping. Deep ploughing kept down weeds and gave a greater body of soil for the roots of crops to work on. Lime and artificial fertilisers were freely used and produced a marked response.

On clayey soils such as are generally found in the Ettrick Association, fertility increased during the war period. Ploughing by tractor enabled a much greater acreage to be ploughed before the winter to obtain the benefit of winter-frosts. Deep ploughing was carried out on a scale never before known and helped to break up the stiff subsoil which is generally present. Lime added new life, but perhaps the greatest effect on these high-lying cold soils was the influence of compound fertilisers containing nitrogen. Before the war no fertilisers were applied to grain crops on these farms but after the Agricultural Executive Committee started to issue directions each year for the manuring of some 10,000 acres of cereal crop and green crop on marginal farms in the area, a transformation was brought about. Farmers everywhere found that a marked increase in yield was obtained.

Before the introduction by the government of the lime-subsidy-scheme in 1938, there was not a very marked deficiency of lime in low-ground farms on any soil type in the area. The pH figures generally ran from pH 5·6 to pH 6·2. With an increase in elevation, however, there was a corresponding increase in lime-requirement. On upland farms which constitute the great bulk of the area the pH figures ranged from about pH 5·3 to pH 5·6.

Since that time lime has been applied on a substantial scale, aided by contractors with lime-spreading machinery. The pH value on low ground farms now generally runs from pH 6·5 to pH 6·8 while on upland farms the figures now usually range from pH 5·8 to pH 6·6. In many cases the application of lime has led to a deficiency of boron. Brown heart in Swedes is common on farms at all elevations after a dry season. Manganese deficiency in oats is found on some farms on the lighter soils.

As regards available potash, the lighter soils under arable cultivation are generally lacking in potash. The application of compound fertiliser with a substantial content of potash is nowadays the rule. On the heavier soils, and generally throughout the Ettrick association, the supply of available potash is usually good.

The manurial constituent in which there is the greatest lack is available phosphorus. This is naturally lacking in all soils of the area particularly those which have been grazed for many years by live-stock. Most farmers recognise the need to apply a basal dressing of a phosphatic fertiliser such as Basic Slag or Ground Mineral Phosphate at least once in the rotation in addition to the usual dressings of a quick-acting compound fertiliser.

Hill soils show a substantial lime-requirement with a pH around 5·3. Available phosphate is very low, while available potash is usually high. It is seldom that lime or artificial manures are applied to hill land, however, as the possible increase in output from such land is too low to justify it. Local farming opinion takes the view that it must either be done over a large part of the grazing or not at all. The interference with the normal grazing habits of sheep when small patches are treated, is everywhere condemned.

SYSTEMS OF FARMING

Throughout the surveyed area, the chief farming activity is the breeding of sheep, and this applies to every type of farm whether low-ground farms, upland farms, or hill farms. There are a few dairy farms, but these are generally big enough to carry small flocks of breeding ewes. Combined with sheep breeding, there is cattle rearing on all types of farms. On arable farms, there is a substantial amount of grain and roots, partly for sale in the case of grain, but mainly for the upkeep of the livestock enterprises.

Low Ground Farms

On the low-ground farms, flocks of Half-bred ewes are kept and are crossed with Oxford Down or Suffolk Down rams to produce lambs for the store market. The chief markets are St. Boswell's and Hawick to which buyers come from the feeding districts in the Lothians, Fife, Angus, and the Midlands of England. The average price for lambs received in the autumn of 1954 was £6 10/-.

The sheep-breeding enterprise of the Borders requires a very large supply of rams of superior quality to meet the needs of low-ground and upland farms. The Kelso ram sales are held every year in September and are the principal sales in Scotland for rams of the Border Leicester, Oxford Down, and Suffolk Down breeds. Kelso is situated at the junction of the River Teviot with the River Tweed just a few miles beyond the northern boundary of the surveyed area.

The Half-bred ewe is well suited to her job. The fertility rate is high, the lamb crop usually reaching 170%. There is a very good flow of milk rather like a miniature dairy cow. In fact, she is the dairy cow of the Borders. She possesses great hardiness and is able to stand exposure. The progeny are capable of rapid growth, and twin-lambs will reach a live-weight of 100 lbs. per head in 5 months on grass alone. It is thought that part at least of the valuable commercial qualities of the Half-bred ewe do not come from either parent in particular, but are the result of the hybrid-vigour obtained by the mating of the Border Leicester ram with the Cheviot ewe.

The ewes are drafted after producing three crops of lambs, but there is now a tendency to take four crops of lambs owing to the high cost of replacements; ewe-lambs in the autumn of 1954 cost about £10 each. Draft ewes make high prices from English and Scottish buyers when exposed at St. Boswells and

Hawick. They are graded by the sellers into two classes, (1) warranted correct in mouths and udders; (2) warranted correct in udders only. The type of sheep generally exposed at St. Boswells is of greater weight and substance than at Hawick, as they come off the better classes of land. The smaller class of sheep from Hawick, however, often shift better as they are usually off higher land and have been bred under harder conditions.

The problem with sheep on arable land is that it is not possible to run them thick enough to keep the grass under control in summer. The rate of stocking on low-ground farms is 2 Half-bred ewes, with twin lambs, per acre on first year's grass, and 1½ Half-bred ewes with twin lambs, per acre on older grass. In other words, the stocking varies from four to six sheep per acre of pasture. This rate of stocking is trifling compared with the production of herbage. Nevertheless, if these numbers are exceeded to any extent, the lambs do not thrive, they develop diarrhoea, the death rate rises, and the lambs are in much poorer condition at sale-time. The trouble is partly due to an increase in parasitic thread-worms of the stomach and intestine, and to the fouling of the pasture with dung and with urine. The consequence is that pastures cannot be kept in condition by sheep alone but must be kept down by cattle or by the use of the mowing machine.

Before lambing, the ewes are folded on roots during the daytime for a period of six weeks, but are run off on to a grass field every afternoon where they receive hay and are given exercise so as to keep the urinary system in working order. It is usual to reckon that a score of Half-bred ewes will require one acre of turnips and 1½ tons of hay to see them through the winter till the grass comes. An allowance of concentrated food is given during the last three or four weeks before lambing in order to build up the udders of the ewes for lactation and to give strong lambs.

The lambing season is a period of great activity and very careful preparations are made for the comfort of the ewes and the protection of the young lambs. A large lambing enclosure is surrounded with straw to a height of about four feet so as to be completely windproof, while at one end of the enclosure small pens 4 feet long by 4 feet wide are roofed over with straw. The ewe after lambing is put into the pen with her lambs overnight for one or two nights. In the field outside the lambing enclosure, wind-barriers of straw are erected at different points so that on a rough day the lambs can get shelter from every direction. The ewes come in to the lambing field in regular sequence according to the order in which they have been tupped, while the ewes which have lambed are drafted out into the surrounding pasture fields, certain fields being set apart for ewes of different ages with single or double lambs. The whole process of lambing is spread over a period of four to five weeks beginning in the first days of March.

Sheep are subject to a great variety of ailments, and low-ground sheep have their full measure. Fortunately there is preventive treatment which can be given for many of them. Parasitic worms of the stomach and intestine are everywhere to be found, and, unfortunately, a new form of worm has recently come to light which is difficult to treat. Contagious abortion in ewes caused severe losses in the past and reduced the lamb crop in some cases by thirty per cent. Fortunately it is now possible to vaccinate against the trouble. Pregnancy toxaemia is got in some seasons but losses are not usually high. Pneumonia in hoggs, udder-clap, foot-rot, and orf all tend to appear at one time or another, but can often be guarded against by good management. An insidious disease which descends upon the successful farmer when his lambs are doing particularly well is pulpy kidney disease, or enterotoxaemia. Some of the biggest and best lambs in good health in the evening are found dead in the morning. Apparently the germs which cause the trouble live normally in the intestine and only increase their activities when the lamb is in a rapidly thriving state. Fortunately the sword of Damocles can be prevented from falling by giving preventive innoculation in good time. As regards disease in general, some authorities are of the opinion that a policy of breeding and selection from sheep which are apparently resistant to disease should be adopted. This field has still to be explored.

Stocks of cattle have greatly increased on low-ground farms owing to the better prices prevailing since pre-war days. Breeding cows are maintained on many farms, usually bought in as Irish cross-Shorthorn heifers which are mated with an Aberdeen-Angus bull. The cows are commonly wintered out of doors, but young animals are always kept indoors during their first winter.

Many farms buy in extra store cattle by purchasing suckled calves or yearling cattle from upland and hill farms. There is also a regular trade in the purchase of Irish and North of England store cattle of around two and a half years old for fattening purposes. Regular consignments of these cattle are sent over to St. Boswells and Hawick. It is generally agreed that more cattle could be kept and that the extra wintering can be readily provided by making more silage. This process is going forward rapidly.

Upland Farms

On upland farms, the main enterprise is the production of Half-bred ewe lambs so as to provide the low-ground farmer with a regular replenishment of breeding stock. The chief market for this class of sheep is St. Boswells and to a lesser extent Hawick. The carefully graded pens of ewe-lambs at these centres brought out in the best of condition is one of the sights of the agricultural year.

Of recent years, the North Country Cheviot ewe has largely superceded the South Country Cheviot as they are of greater size, they are more prolific, and they are better milkers. Accordingly they produce a bigger and more robust type of Half-bred ewe lamb. The wether lambs are all sold off for feeding purposes.

Careful arrangements are made for the care of the flock before and after lambing as in the case of the low-ground farms.

The upland farms all produce a heavy growth of grass in summer and here the problem is the same as on the low-ground. The stocks of sheep cannot keep pace with the growth of grass and so it is essential to have large numbers of cattle to run on the pastures in the interests of the sheep. Before the war, cattle did not pay, and so the numbers were comparatively few. Pastures got extremely rough, and on these upland farms they reverted to useless grass such as *Agrostis spp.* and *Holcus spp.* by the third year. A general lack of lime and phosphate hastened the process. Pastures, therefore, at that time were in a poor state and the resources of these upland farms were by force of economic circumstances being tapped in a most rudimentary manner. Now things have greatly altered. Lime and phosphate has been liberally applied, there has been a considerable increase in cattle to supply the feeding farms lower down, and the coming of the tractor-mower has enabled rough pastures to be topped.

The chief class of breeding cow is the Blue-grey which is crossed with the Aberdeen-Angus bull. The Blue-grey is the progeny of the Galloway cow

PLATE XXIX
Hill peat on the watershed at Windy Gyle, showing erosion where the slope becomes steep.

PLATE XXX
A closer view of the hill peat at Windy Gyle.

PLATE XXXI

Molinia grass (*Molinia caerulea*) with a little Moor Mat Grass (*Nardus stricta*) and Sweet Vernal (*Anthoxanthum oderatum*) in characteristic tufts.

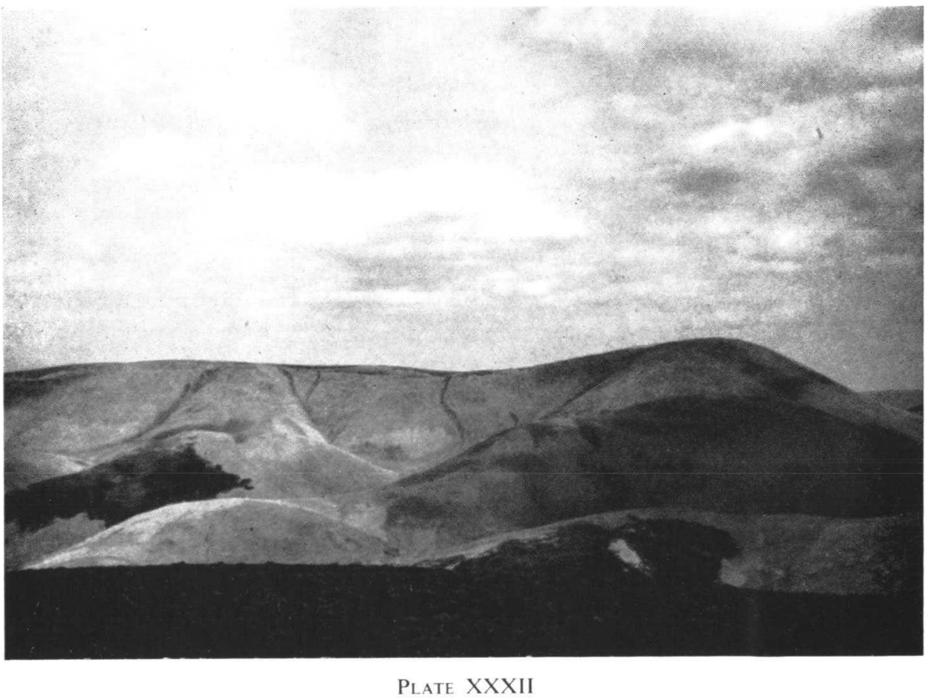

PLATE XXXII

A view of the watershed near Mosspaul showing areas of hill peat in the saddles. The less steep slopes carry Molinietum, occasionally Callunetum, and the steep and very steep slopes carry an acid grassland.

and the White Shorthorn bull. Galloways are run in large numbers in the hill country while a special breed of White Shorthorns has been bred for this purpose in Cumberland for generations. The Blue-grey cow therefore has a legacy of hardiness, good milking properties, and rapid growth in the progeny. The cows are generally outwintered in a sheltered situation. Here also, as in the case of the Half-bred ewe, much of the value of the Blue-grey cow is due to the hybrid-vigour which she carries with her.

The cattle stocks on upland farms have increased but the cattle potential is still far from being realised. The chief hindrances to further expansion are (1) the capital needed to lay-on extra stock; (2) the greater amount of winter food which must be laid in, and (3) the shortage of labour to do the additional work involved. These difficulties are however being overcome on many farms, and cattle are being maintained on many upland farms at the rate of one beast over six months old to 1⅓ acres of grass, in addition to the normal sheep stock.

Hill Farms

Hill farms represent about one-third of the surveyed area. In the East Borders, which is that part of the Cheviot Hills which lies to the east of the Carter Bar road, the land and the climate are comparatively dry and the hills are grassy almost to their summits. On the actual summits there are deposits of climatic peat. Heather, unfortunately, is almost entirely absent from these grazings so that on all farms it is necessary to hay the sheep during snow-storms in winter. The ewe-stocks are bound to the ground and the ewe hoggs are all wintered at home.

The sheep-stock is mainly Cheviot since Cheviot sheep are well adapted to a grassy type of herbage. In recent years, however, there has been an increase in the Blackface breed due to the ability of the Blackface to yield a high proportion of fat lambs straight off the hill. The stock carried in the East Borders is one ewe or ewe-hogg to 1¼ acres of hill land which is a comparatively high concentration. The area is free from some of the more serious troubles affecting hill sheep. There is little or no sheep-tick so that louping-ill and tick-borne fever are largely absent. Braxy in hoggs is almost unknown. Liver Fluke is seldom heard of. As, however, fuller details regarding the East Borders are given under Sheet 18 no further comment need be made.

In the West Borders, which lie to the west of the Carter Bar road, the land is deeper and wetter and there are great areas of *Molinia caerulea* or Flying Bent which is of no value for grazing. Heather is not very plentiful. The rate of stocking is 2 acres per ewe or ewe-hogg. The haying of sheep in winter is not so necessary in this area as the deep land gives plenty of rough vegetation in which the sheep can work during snow. The Blackface is rather more plentiful than the Cheviot.

There is rather more disease present in the West Borders. The sheep tick is common on many grazings while the wetter climate and the retentive subsoil often give rise to conditions favourable to the Liver Fluke.

In both the East Borders and the West Borders the hill sheep are run on the intensively managed system common in the South of Scotland. Each shepherd has approximately 28 score of breeding sheep, including ewe-hoggs, and these are generally divided up into three groups. Each group grazes on its own separate territory, or heft, which has an outer portion of high ground and an inner portion of lower and more sheltered ground. Here the grass is saved as far as possible for the winter, and stone-shelters or stells, are provided to hold all the sheep in a snow-storm. All types of plant association are included in each heft, as far as possible, and the fullest possible use is thereby made of the grazing both in summer and in winter. The hefts are not fenced but as the sheep have been born on the ground they know their own territory perfectly well. Hawick is the principal market for hill sheep.

Breeding cows are maintained on all hill-grazings. They are generally Galloway cows which are outwintered in sheltered situations and produce Blue-grey calves. If there is room in the steading for in-wintering, Blue-grey cows or cross Highland cows may be kept. It is reckoned that one ton of hay is needed for the wintering of each cow so that when hay has to be provided for sheep as well as for cattle it limits the number of cows which can be kept. There is usually one breeding cow to 1½-2 score of breeding sheep. If there is plenty of heather, then more cattle can be kept as the sheep will not need so much hay. Some hill farmers have an arable farm as well as a hill farm, in which case the wintering problem is largely solved.

TABLE H. Returns from a Number of Hill Farms, 1939-52

Year	No. of Farms studied	Average No. of Breeding Ewes carried per Farm	Hill Sheep Subsidy		Average Profit or Loss	
			Rate	Per Farm	(*a*) Per Farm	(*b*) Per 100 Ewes
			s. d.	£	£	£
1939-40	24	1,213	..	..	Loss 48	Loss 4
1940-41	25	1,193	2 6	132	,, 45	,, 4
1941-42	19	1,109	7 6	408	Profit 337	Profit 30
1942-43	21	975	8 0	304	,, 488	,, 50
1943-44	23	1,004	6 0	326	,, 681	,, 68
1944-45	24	1,018	7 6	364	,, 714	,, 70
1945-46	26	1,059	7 6	406	,, 747	,, 71
1946-47	28	1,019	8 9	425	,, 412	,, 40
1947-48	28	981	16 0	648	,, 346	,, 35
1948-49	30	990	10 0	616	,, 1,148	,, 116
1949-50	29	1,022	5 0	302	,, 1,151	,, 113
1950-51	31	980	6 0	290	,, 483	,, 49
1951-52	33	965	2 6	147	,, 742	,, 77

Reproduced from W. B. Duthie, 'The Economics of Hill and Upland Farms', Bulletin No. 41, Edinburgh and East of Scotland College of Agriculture.

The financial returns from hill farms have never been large and it has been difficult to meet the rising costs of materials and labour, Table H. shows the returns recorded on hill farms over a period of years.

The figures given in the above table cover the average returns from thirty-three hill farms in the South-East of Scotland. Of these, twenty-three are in the Border counties and the general picture is appropriate to the area of this survey. They show that without the hill-sheep subsidy, few farms would be able to leave much profit.

In regard to systems of farming in general, the main feature is that the hill farms and the upland farms form a reservoir of sheep and cattle to meet the needs of the low ground farms within the area and also beyond it. All classes of farms are closely integrated and the live-stock reaches the market in large quantities carefully graded according to type and of high quality and reliability. The numbers of sheep which annually pass through St. Boswells Auction Mart is 195,000 and through Hawick Market it is 175,000. Consequently buyers are attracted from near and far and the good level of trade thereby obtained is seen in the prosperity and well-being of the countryside.

CROPPING

The rotation followed on the low-ground farms is generally the six-course rotation with three years in grass, followed by oats, roots, barley or oats. Farmers normally wish to leave their pastures down for three years in order to give scope for summer grazing for breeding stock. The Government still requires a fairly high level of tillage and some of the better farms may have to plough up their grass after two years. On upland farms, the land lies down in grass for at least three years and often for four or five years.

Grass is regarded as the backbone of the rotation and care is taken to get a good establishment by sowing out on a dry and fairly fine seed bed well supplied with lime and phosphate. The modern type of grass seed mixture is everywhere in use. As sheep are the main livestock there is a demand for leafy strains of perennial ryegrass and cocks-foot which give a finer type of herbage.

Oats account for the greatest acreage of cereal crops. High-yielding varieties of oats are everywhere grown, both on low-ground and on high-ground. The high price for grain has brought about the disappearance of the old straw-producing varieties such as Potato oats. Barley is grown on all low-ground farms and is harvested with the combine harvester. These came into the district in 1944 and are now an essential part of the equipment of the larger farms. The use of short-strawed Scandinavian varieties of barley has brought about an increase amounting on the average to about six hundredweights of grain per acre. In the upland districts barley is not grown to any extent as the grain is coarser and the colour is too dark for the needs of the maltster or distiller. Wheat is not grown to any great extent unless there is a regular acreage of potatoes, in which case the wheat straw is necessary for the potato pits and wheat does better after potatoes than after any other crop.

The yields of grain have markedly increased since 1939. This has been due to the use of improved varieties, the application of lime, more thorough cultivation by tractor, and the use of compound fertilisers containing nitrogen. The great discovery during the war was the influence of artificial fertilisers in stepping-up the yield of the grain crop. An estimate of the difference in yields of grain in the area before 1939 compared with the present time is set out below.

	Average Yields per acre	
	Period before 1939 cwts.	*Period around* 1954 cwts.
Oats	16	20
Barley	19	26
Wheat	18	24

In considering these average figures, it should be borne in mind that oats are grown on all soils at all elevations while barley and wheat are generally grown on the best soils on low ground. The over-all picture is an increase of grain above pre-war days amounting to thirty per cent. At the same time the yield of straw has fallen by about ten per cent, particularly in the case of barley, but straw is super-abundant in any case.

Turnips are grown to a less extent than formerly owing to the shortage of labour. Part of the turnip acreage is often replaced by kale or rape while on many farms the production of grass silage has greatly increased and this is used instead of roots. In a few cases no roots at all are grown, their place being taken by grass silage both for breeding ewes and for cattle. Potatoes are not grown to any great extent.

The system of manuring as carried on by progressive farmers is to apply a liberal dressing of a phosphatic fertiliser such as Basic Slag or Ground Mineral Phosphate to the root crop in Spring. The usual rate of application is 200 lbs. per acre of phosphoric acid. This is a basal dressing for the needs of the rotation and is in addition to a dressing of around 7 cwts. per acre of Turnip Manure which is given at the time of sowing. If the slag or mineral phosphate is not given to roots it is applied to "Seeds" in Autumn. This liberal manuring with phosphate has lasting benefits upon succeeding crops. It is usual to manure most cereal crops and the higher the elevation the greater the quantity of manure.

RURAL CRAFTS

The old type of rural crafts and trades which formed such an essential part of the life of the countryside has declined. For example, in the whole of the area there are in 1954 no more than five drystane dykers. As stone dykes are the usual form of fence in upland country it is now a difficult matter to keep them in repair. With the passing of the agricultural horse the blacksmith's shop has ceased to function in many districts. The parish meal-mill is largely a thing of the past, there being only one mill still at work. The sound of the stone-breaker is no longer heard on rural roads. Instead, the whole of the road-metal required for the area is produced at one quarry on the Dunion Hill, Jedburgh. Any farmer may obtain tar-macadam ready-mixed, direct from the quarry, to lay on farm roads and around steadings.

LABOUR

There is a shortage of regular labour and so the increased tillage that must be maintained to meet the national need is carried on with difficulty. Fortunately, there have been developments in agricultural engineering on a great scale and farms in the area are very fully mechanised. Tractors have replaced horses almost completely and whereas in former days one horseman with a pair of horses produced 60 acres of tillage on level ground and 40 acres of tillage on steep land, the same man with a tractor can nowadays deal with 100 acres on level ground or 80 acres on steep land. The output per man has, therefore, practically doubled. The hay crop is largely baled out of the rick or picked up by a one-man baler, while almost the whole of the barley crop is handled with the combine harvester. The need for hand-labour at certain periods, however, such as singling of roots, hay-making, sheep clipping, grain-harvesting and the lifting of turnips is still very great and is beyond the capacity of the regular farm-staff.

There are very few small farms from which part-time labour can be got and workers from villages are scarce. Irish workers used to come across in large numbers but they are now much fewer. Some farmers get over the difficulty of turnip singling by arranging with the regular staff to go on piece-work. The staff cease to draw a weekly wage, and as wives and families turn out to assist, and long hours are worked, the income to the worker is very greatly increased while the work is put through rapidly. The root crop is gradually declining and is being replaced by silage which can be fully mechanised at all stages.

Hill farmers sometimes find difficulty in getting shepherds to replace older men. There is no easy solution as it is not easy to get young married women with children to face the isolation on remote hill farms.

The County Education Committees in the Borders are considering setting up a farm-school for boys in the last year of their school course. Boys who wish to take up agricultural work whether they come from the country or from the town will be selected for training. On leaving the farm school they will go on to a farm in the district under the Scottish Farm Apprenticeship Scheme and thereby will be well on the way to making a career on the land. This should be a great help to agricultural production in the long run. It would seem to be desirable also to have a farm school for girls so that some training can be given in the domestic side of rural life.

MOREBATTLE DISTRICT (SHEET 18)

HISTORICAL

The area of land shown on Sheet 18 consists almost entirely of hill country and forms part of the East Borders of Scotland. It was settled in prehistoric times by hill people who erected forts consisting of embankments of earth and stone surmounted with pallisades of wood. Within these fortifications huts were built to accommodate the people. These hill forts are numerous throughout Bowmont Water and Kale Water, and are often accompanied by cultivation terraces on lower ground, now grown over with grass but otherwise very much as their owners left them. Living under primitive conditions on these exposed sites at an elevation of 1,000-1,500 feet must have called for great powers of endurance and one is inclined to think that these forts were mainly used as summer encampments.

Coming to more recent times, the area became notable in the eighteenth century as the home of the Cheviot breed of sheep. Douglas[1] records that in 1760 James Robson of Belford, which is a hill farm in Bowmont Water, went to Lincolnshire to obtain rams to help to improve the commercial qualities of his sheep which were lacking in substance. From the progeny of these sheep there arose in the course of time the Cheviot breed of the present day. Sir John Sinclair bought some of these Border Cheviots in 1792 for sending into the Northern Highlands, and it is well known that the North Country Cheviot sheep of today in Caithness and Sutherland originated from these introductions. This is of interest because at the present time there is a steady trade in bringing Cheviot sheep back to the Borders from the North of Scotland as they are rather bigger and are generally more productive.

SIZE OF FARMS

The survey area includes some nineteen hill farms, the average size being 1,538 acres of hill land with 88 acres of enclosed grassland and arable land.

On seven of these hill farms no cultivation is carried on but in other cases some of the enclosed land is worked in rotation with small acreages of turnips and oats. On all farms hay is obtained from the enclosed grassland. The elevation of the hill land extends from 600 feet to 2,000 feet.

The average annual rent amounts to about three shillings per acre for the hill land and ten shillings per acre for the arable land.

SYSTEM OF HILL FARMING

A full account of the system of hill farming in the area is given by Duthie[2,3] who carried out a detailed survey of three parishes in the East Borders, namely, Morebattle, Hounam, and Oxnam. Accordingly, only a brief reference need be made here.

Almost the whole of the area rests on andesitic lavas of Lower Old Red Sandstone age which gives rise to a light open soil often only a few inches deep and rather liable to drought. The hills are grassy with large stretches of the *Agrostis-Festuca* type of herbage merging into peat on the high tops. There is very little heather on most grazings so that hay has to be supplied to the sheep when there is deep snow or when the surface of the snow is frozen hard.

The lower slopes of the hills carry a good deal of bracken and a large-scale investigation into the control of bracken by mechanical means has been in operation in Bowmont Water and Kale Water during the last four years. This investigation has been carried out on seven hill farms by the Scottish Machinery Testing Station in conjunction with the Edinburgh and East of Scotland College of Agriculture. The results have not yet been published but it is understood that a considerable measure of control has been obtained at an economic cost on this type of land by tractor-drawn implements. Hill farmers are realising that to deal effectively with bracken a policy of regular cutting or crushing will have to be adopted as a routine measure and that complete eradication is not to be looked for.

The hirsels of hill sheep in the area are generally divided into three portions or hefts, each carrying about eight to ten score of sheep. These include the ewe-hoggs which are generally wintered at home.

Each heft carries its own ewes of all ages together with the ewe hoggs needed to carry on the stock. On this system the sheep get to know the grazing extremely well and can select the herbage to the best advantage. On some farms, however, a different system is followed in which the ewes run on their own separate ground and the ewe-hoggs run on a different part of the hill grazing. The hoggs do better on this system as they are given the best ground and they do not have the competition of the ewes. The rate of stocking of hill land is generally one ewe or ewe-hogg to $1\frac{1}{4}$ acres of hill land.

The Cheviot breed of sheep is the most numerous though the Blackface has tended to increase in recent years. It is usual to take at least four crops of lambs off the ewes but on the poorest and highest grazings it is sometimes the custom not to breed from the gimmers and so the ewes in such cases will be drafted after three crops of lambs.

The area is relatively healthy for sheep and the output is correspondingly good. The average lamb crop works out at ninety per cent of the ewe-stock.

Stocks of breeding cattle are run on most hill-farms, the breeding cows including the pure Galloway, the Blue Grey, and the Shorthorn-Highland. Cattle help to eat down the rougher herbage and so improve the grazing for sheep but care has to be taken that this process is not carried too far otherwise the sheep may suffer from a lack of winter-meat. Fuller details relating to cattle-raising will be found in the survey by Duthie[2,3].

CONSTITUTION OF A SHEEPS' GRAZING

In order to illustrate the botanical constitution of a typical hill grazing in the area, a regular grazing, or heft, on one of the lower hill farms was selected and the area occupied by the different plant-associations was measured by means of a measuring chain. The grazing comprises 292·5 acres and carries a stock of 260 Border Cheviot ewes. It extends from an elevation of 575 feet at its lowest point to 1,090 feet at the highest and the distance from one end to the other is 1½ miles. The grazing is raked by the sheep every day from end to end. The area is well watered by several streams and there are no rock exposures or bare surfaces anywhere, the whole of the ground being entirely covered with grass. The area occupied by each vegetational type is shown in Table J.

TABLE J. VEGETATIONAL TYPES ON A HEFT IN THE CHEVIOT HILLS

Vegetational Types	Acres	Per Cent.
1. *Agrostic spp.* with *Festuca spp.*		
(*a*) on shallow land (1″-5″)	136·340	46·60
(*b*) on semi-deep land (6″-10″)	26·315	8·94
(*c*) on deep land (11″-40″)	15·145	5·18
2. *Deschampsia caespitosa*		
(*a*) on semi-deep land (8″-12″)	1·074	0·37
(*b*) on deep land (13″-40″)	4·393	1·50
3. Mixed Herbage		
Deschampsia caespitosa, Molinia caerulea		
Juncus articulatis, Agrostis spp.		
Holcus spp., Nardus stricta, Poa spp., etc.		
(*a*) on semi-deep land (8″-12″)	7·762	2·65
(*b*) on deep land (13″-40″)	31·834	10·88
4. *Molinia caerulea*		
on semi-deep land and on deep land (8″-30″)	67·436	23·04
5. *Juncus spp.*	1·845	0·69
6. *Trichophorum spp.-Sphagnum spp.*	0·445	0·15
7. *Calluna vulgaris*	Nil	Nil
8. *Eriophorum spp.*	Nil	Nil
Total	292·5	100·0

The sheep receive no supplementary feeding in an open winter until the first days of March when hay is given, continuing well into April. A supply of hay has to be fed at any period of the winter when snow is deep or frozen hard which generally amounts to about three weeks in each winter. Lambing begins on April 16th each year by which time there is generally a certain amount of new growth of grass on the sweet or fine ground, otherwise known as the land which carries *Acrostis spp.* with *Festuca spp.*

Wire Bent grass, or *Nardus stricta* is scattered throughout the grazing and tends in some places to crowd out the useful grasses.

The area of land covered with bracken was found to be 11·4 acres, or 3·8% of this particular heft, which is a good deal less than the average for the district. It is thin bracken which does little harm as it helps to shade the grass in a dry summer.

Taking the whole area of the grazing or heft, described above, there emerges the fact that 136·3 acres or 46·6% of the whole consists of the *Agrostis-Festuca* association of grasses growing on 1″ to 5″ of soil resting directly on solid rock. This relatively shallow land is liable to drought in a dry season so that the grazing as a whole is reckoned to be able to carry only a moderate number of cattle in addition to the regular sheep stock. A stock of 12 breeding cows is maintained throughout the summer and winter, or one breeding cow to 25 acres. Hay is supplied in winter.

As regards winter-grazing, the absence of heather on this ground is a serious draw-back. Nevertheless, on grazings of this type, consisting almost entirely of grass, the amount of green herbage in winter is usually much greater than appearances would lead one to expect when the surface looks withered and dead. Green shoots can always be found growing among the tufts. In this respect the areas of land under (*a*) *Agrostis spp.* with *Festuca spp.* on deep land; (*b*) mixed herbage with *Juncus articulatis* etc., and (*c*) *Deschampsia caespitosa*, which amount to 20·1 per cent of the whole grazing, are invaluable for winter purposes.

An estimation made at the end of December on the land carrying *Agrostis spp.* with *Festuca spp.* showed that 27·4 per cent of the total herbage in terms of dry matter was green material at that date and there were from 7-10 hundredweights per acre of dry matter on the ground in the form of green material. At the end of March the amount of green material was still appreciable. It accounted for 16·2 per cent of the herbage on the ground at that date and provided 3-5 hundredweights of dry matter per acre.

It will be seen therefore that hill sheep on grazings of this kind, even without heather, are never at any time deprived of a supply of green herbage so long as the ground remains open, though admittedly it takes much searching for by the sheep in the early spring months. Provided the land has not been overgrazed with cattle during the previous summer there is sufficient food in an open winter to carry the sheep-stock through to the beginning of March when the feeding of hay is advisable.

HEALTH OF SHEEP STOCK

The soundness or otherwise of hill grazings is of much importance in the sheep industry and certain districts have their own special features which are well-known to those engaged in the business. The East Borders, which include the area covered by this survey, are in a distinct category, because they are largely free from some of the major ailments of sheep owing to the local conditions of soil and climate. In this respect it is useful to consult past records of a time when measures of disease-control were not so highly developed as now.

In the years 1934 and 1935 an enquiry into the health of sheep stocks in the area was carried out by the writer and details were collected from the records of twelve farms carrying a total of 11,634 ewes, gimmers, and ewe-hoggs. The figures set out below are the average of the two years. They are of interest as they show the situation as it existed twenty years ago.

Death Rate	*per annum per cent.*
Ewes and gimmers	3·12
Ewe hoggs	4·01

Incidence of Disease	*per annum per cent.*
Abortion in ewes	2·78
Tup-eild ewes	4·01
Braxy in hoggs	2·2
Pine Disease (excluding lambs)	2·2
Lamb Dysentery	0·8
Liver Fluke	0·1
Pulpy Kidney Disease in lambs (Entero-toxaemia) per 100 ewes ..	1·1
Louping Ill	NIL
Tick-borne Fever	NIL

The annual death rate of three per cent. among ewes and four per cent. in the case of ewe-hoggs is low for hill sheep and testifies to the general healthiness of the region.

On none of the hill farms was vaccination undertaken for braxy, nevertheless the death rate among ewe-hoggs from this cause was only 2·2 per cent. The district has been distinguished from time immemorial by its relative freedom from braxy which may perhaps be correlated with the fact that on some farms there are symptoms of a lack of cobalt in the grazings (pine disease) which tends to reduce the vitality of hoggs in the autumn. Cobalt is now regularly administered on affected farms as a routine measure with beneficial results in the control of pine disease.

Owing to the dryness of the region, liver-fluke disease is almost unknown.

The absence of louping-ill and tick-borne fever is accounted for by the fact that in 1934 and 1935 the carrier of these diseases, namely, the sheep tick, was not found in the region to any extent. Out of twenty-eight hill farms visited in the East Borders only two reported the presence of this disease and that only in a very slight degree, causing an occasional death. Since then the sheep tick has spread to one or two additional farms but the population of ticks is reported not to be very numerous.

In 1946, the Scottish Hill Farm Research Committee, in conjunction with the Edinburgh and East of Scotland College of Agriculture, set up a research station on the hill farm of Sourhope in Bowmont Water. This is one of several stations in Scotland formed for the purpose of enquiring into the hill-farming industry. Among other work, a survey is being carried on into the incidence of sheep diseases, and preliminary results have been published by Stamp and Watt[18] and by Thomlinson[20, 21]. It is reported that the chief diseases among hill sheep at Sourhope are abortion, barreness, and parasitic worms of the stomach and intestine. It is thought that the disease problems at Sourhope are representative of those of other farms in the Border area except that losses due to sheep-tick are of more importance in some other hill districts.

CHAPTER VII

Vegetation

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A FEATURE of the hills in South-east Scotland is that they carry a characteristic grassy type of vegetation in contrast to areas of similar relief in the North and North-east where upland heath, dominated by Heather (*Calluna vulgaris*), occurs over a wide area.

In the following paragraphs the six main communities which comprise the hill vegetation of the area will be briefly mentioned. Thereafter a few specific localities will be described and the factors concerned in the distribution and modification of the plant communities discussed.

Common names of plants are used throughout but the scientific name is bracketed where the species is first mentioned. A species list giving the common and scientific names of the plants referred to in the text can be consulted at the end of the chapter.

1. Hill peat is fairly extensive over the higher ground and here plants such as Cotton Grass (*Eriophorum vaginatum*) and Heather are prominent. The species comprising the vegetation, however, are relatively few and show a high degree of constancy, but marked variations in their frequency occur from place to place. For example in the wetter areas Cotton Grass and Cross-leaved heath (*Erica tetralix*) are the chief species and Sphagnum moss (*Sphagnum spp.*) is abundant. Drier conditions are usually accompanied by an increase in the amount and vigour of Heather, Hypnaceous Mosses (*Hypnum spp.*) become prominent while Sphagnum is greatly reduced. Other species characteristic of the hill peat vegetation will be mentioned later.
2. Peat is generally absent from the lower slopes and here on a moderately fertile mineral soil (brown forest soil) two main vegetation types occur. Acid grassland dominated either by Bent (*Agrostis spp.*) or Fescue (*Festuca spp.*) is characteristic of the valley slopes and stream sides. Associated species are relatively abundant and this community provides the best natural pasturage in the area.
3. Bracken (*Pteridium aquilinium*) is a common invader of these acid grasslands and has become dominant over many of the sheltered lower slopes. The shade produced by its dense fronds may eventually alter or suppress the grassy sward on which it establishes itself, and its rapid vegetative spread is causing a marked deterioration in the grazing value of these pastures.
4. A fourth type, dominated by Heather, occurs locally on some of the hill slopes. Here continuous leaching of the soil has promoted podzolisation and a thin accumulation of raw humus has occurred. An iron pan may or may not be present in the profile. Species characteristic of deep peat are, on the whole absent, their place being taken by Bell Heather (*Erica cinerea*), Blaeberry (*Vaccinium myrtillus*) and Wavy Hair Grass (*Deschampsia flexuosa*) etc.

Finally two communities are mentioned which can be grouped under the heading of Grass Moors.

5. On gentle wet slopes where soils such as peaty gleys or peaty podzols with an iron pan occur, extensive areas are dominated by Molinia Grass (*Molinia caerulea*). The peat here is brown and amorphous in character and some lateral movement of soil water is indicated. In many places the Molinia forms an almost pure stand and few subsidiary species are present.

6. The last type is dominated by Moor Mat Grass or White Bent (*Nardus stricta*) which, like Molinia, is a peat forming plant. It is a rapid coloniser of redistributed peat derived from the eroding peat cap of the upland plateaux. Hence, it is often found forming a zone between the acid grassland and the hill peat vegetation. Here the soils are mainly peaty podzols with an iron pan. Moor Mat Grass is also dominant in the valleys where it is associated with poorly drained soils developed on clayey till.

Plant remains in the peat indicate that Birch (*Betula pubescens*) was once common at quite high elevations. Indeed many of the grassy slopes are potential woodland but are kept in a pre-climax stage by intensive grazing of sheep. Relicts indicate that in the valleys Oak, (*Quercus petraea*) Pine (*Pinus sylvestris*) and Alder (*Alnus glutinosa*) were by no means uncommon.

VEGETATION OF SELECTED AREAS

COCKLAWFOOT

In this locality the summits carry a peat cap of variable depth but it is generally absent from the sharper ridges. Cotton Grass is generally dominant on these peat covered tops while drainage channels, natural or artificial, are usually colonised by *Sphagnum spp.*

On the hillsides patches of Heather often occur especially where there is a downward flow of peat debris or acid water. Elsewhere the slopes carry a Bent-Fescue type of vegetation with or without Bracken. Moor Mat Grass is a common constituent of these pastures and the spread of this relatively unpalatable species may be attributed to the selective grazing of the sward by sheep. At lower elevations grazing is more intense and this, for example, may suppress such plants as Heather and favour the establishment of a grassy vegetation.

CARTER BAR AND ARKS EDGE

The vegetation of this area closely resembles that of Cocklawfoot, but Molinia is more widespread over gently sloping ground.

A relatively rich grassy vegetation of which Wild White Clover (*Trifolium repens*) is a constituent, can be found locally and appears to be associated with spring flushes.

Various stages of change in the vegetation from Cotton Grass to a grassy type containing Fescue and Bent Grasses can be observed here. Accompanying changes occur in the soil from a pure peat to a dark humus soil with an occasional earthworm. Deer Grass (*Trichophorum caespitosum*) and Cross-leaved Heath tend to replace Cotton Grass as conditions become less wet. On drier slopes Molinia, Wavy Hair Grass and Heather may be present. Intensive grazing and dunging of this type may induce a grassy vegetation in which Bent and/or Fescue are dominant. Lack of adequate drainage can, however, reverse this change and a return to Cotton Grass is by no means rare.

THE SCHIL

An interesting feature of this locality is that south facing slopes are drier, more grassy and have more bracken than north facing slopes. The latter are characterised by the presence of peat and peat debris. The southern slopes tend to be very dry in summer where intensive grazing has produced a closely cropped vegetation.

There is evidence that peat debris, washed down from higher elevations affects the soil at lower levels. Where this humus material is present Molinia and Moor Mat Grass are frequent and locally dominant. Bent Fescue, Wavy Hair Grass and a little Sweet Vernal (*Anthoxanthum odoratum*) are the most frequent subsidiary species. In places Molinia is tufted but clearly disintegrating while a little Blaeberry is usually present. As found elsewhere Molinia is more readily grazed in this condition, the soil often having that peculiar sweet acid smell which indicates a biological change. Where the soils are slightly better drained there seems to be a tendency for Moor Mat Grass to succeed Molinia as the latter dies out.

On parts of the higher ground Blaeberry may increase at the expense of Heather. In wet habitats Sphagnum may be abundant but as conditions become drier it is gradually replaced by the Hair Moss (*Polytrichum commune*).

Changes due to break down of peat and falling water table are again well represented. Where peat is breaking down and conditions are very wet Deer Grass is frequent or locally dominant but under drier conditions it is replaced by Moor Mat Grass. Under improved drainage conditions Cotton Grass often fails to flower and eventually may be replaced by Molinia with Heather and Blaeberry appearing later.

The dry lower grassy slopes have a fairly rich flora including such herbs as Mountain Vetchling (*Lathyrus montanus*), Heath Bedstraw (*Galium saxatile*), Tormentil (*Potentilla erecta*), and Wild Thyme (*Thymus serpyllum*). Unfortunately this community is often invaded by Bracken.

HOUNAM

This part is interesting as it shows various stages of change from Cotton Grass to a Bent-Fescue type. Much of the vegetation is of a grassy nature with limited areas of Heather and local patches of Cotton Grass and Molinia. For the most part the area is rather level and apart from some small peaks is suggestive of an undulating plateau.

Cattle are present on these hills and play an important part in modifying the vegetation. Their heavy tread and liking for Molinia cuts up the surface of this tufted vegetation and allows a break down of the peaty surface to take place. Due, however, to the subsequent invasion of these areas by Moor Mat Grass cattle in this instance, are causing a deterioration of the pastures, although they will graze Moor Mat Grass more readily than will sheep.

On the other hand cattle have a useful effect on ground where Bracken is dominant. Trampling results in serious mechanical damage to the fronds thus reducing the stand of the fern.

On most of the higher ground Heather is decreasing due in many cases to bad management and has been replaced by Blaeberry, Moor Mat Grass with Wavy Hair Grass or a Bent-Fescue sward. Where drainage is impeded Cotton Grass and Molinia are dominant while Sphagnum, Heath Rush (*Juncus squarrosus*) and the Hair Moss are also indicators of poor drainage conditions.

ETTRICK: YARROW TO ETTRICKBRIDGE END

This locality lies on the northern side of the Ettrick Valley and has a southern exposure. The outstanding feature is that Heather now covers a small part of the area it formerly occupied while Bracken has greatly extended its area of dominance.

Dead stems of Heather can be found in almost every place where Bracken is now dominant. The age of these stems clearly indicates that burning and general management were neglected in the past. The retreat of Heather in this area is well shown near a line of shooting butts where the vegetation is now completely dominated by grasses or Bracken.

Deterioration in drainage due to choked ditches and the consequent raising of the water table has also affected the vegetation. For example, parts formerly dominated by Heather are now very wet so that Cross-leaved Heath and Molinia are locally co-dominant. Deer Grass is a frequent subsidiary species. This transition is emphasised by the fact that these plants are not truly established and Sphagnum is, in many places, only now appearing.

Locally on little knolls where sheep have concentrated, grazing and dunging have produced a grassy sward dominated by Bent and Fescue with other species such as Wavy Hair Grass, Moor Mat Grass, Sweet Vernal, Yorkshire Fog (*Holcus lanatus*) and Creeping Soft Grass (*Holcus mollis*).

The most valuable grassy pastures occur on mineral soils which have little or no development of mor humus.

ETTRICK: SOUTH OF ETTRICK VILLAGE

This area can be roughly divided into two sections: the higher ground with a peat cap, or the remains of a peat cap, and the lower slopes where grasses predominate.

On the higher parts, Heather, Cotton Grass, Molinia, Blaeberry and Moor Mat Grass are the main species while Fescue, Bent and Wavy Hair Grass occur at lower elevations. The effect of downward acid wash from the peat is reflected in the local occurrence of Heather, Molinia, Deer Grass, Bog Rush, Cross-leaved Heath, Sphagnum and the Hair Moss.

Part of the lower slopes and valleys has formerly been cultivated but the retreat of agriculture has taken place many years ago. In most of these areas drainage has been carefully planned and successfully completed. Occasionally hay had been cut and stored for winter keep. The vivid green of these grassy areas was a marked feature of the vegetation and stocking rates were high.

Patches of Scurvy Grass (*Cochlearia officinalis*) are to be found on some of these hills.

ALEMOOR LOCH

Topographically this area consists of an upland plateau with a slight depression in which lie a series of small lochs. With few exceptions the peat has long since disintegrated or has been washed down to lower levels. Even so, sufficient traces of peat remain to affect the vegetation so that a few plants of Heather, Cotton Grass, Blaeberry and rarely Molinia still survive. The vegetation is, however, predominantly grassy. Bent, Fescue and Wavy Hair Grass are the chief species, the quantity of each varying from place to place according to soil conditions, elevation, aspect and slope. There is no doubt that in former times cultivation in this area was more extensive than at present. Aerial photographs illustrate this quite clearly but, even today, careful drainage is essential before utilisation is possible.

MOSSPAUL

In this area the hills are high and the slopes steep. A peat cap of variable depth—2 feet and over in most places—normally covers the summits. On and near the peat caps plants such as Cotton Grass and Heather are dominant, their proportion and that of subsidiary species varying according to local conditions. Where the peat is breaking down Mountain Cloudberry (*Rubus chamaemorus*) is frequent and this plant may be taken as a good indicator of peat erosion.

Below the peat cap an area of mixed vegetation occurs in which Cotton Grass, Deer Grass, Molinia, Sphagnum, Heather, Blaeberry, Bog Bush, Wavy Hair Grass, Moor Mat Grass, Bent Fescue are all present. In places where sheep tend to congregate a deflected succession in the vegetation may result, leading to a biotic climax where grasses such as Bent and Fescue are dominant.

Lower down the slope a grassy vegetation is generally dominant and Wood Cow Wheat (*Melampyrum sylvaticum*)—a relict of former woodland—is found locally. Heather is frequently present on the middle slopes but at lower levels it is suppressed by the heavier grazing, and acid grassland with varying amounts of Bracken is the dominant vegetation type.

Across the valley a similar zonation can be seen. The peat cap here is in a transitional stage towards disintegration. Extensive parts of the slopes support Molinia and as conditions become drier, Moor Mat Grass, Fescue, Wavy Hair Grass and Bent predominate in varying proportions.

In spite of the general dominance of grassland at lower elevations, Cotton Grass, Cross-leaved Heath, Sphagnum, Heather, Deer Grass, etc. can occur locally where drainage is impeded or where the soil is flushed with acid water.

Species Mentioned in the Text

Alder	*Alnus glutinosa*
Bell Heather	*Erica cinerea*
Bent Grass	*Agrostis spp.* (*A tenuis* and *A canina*)
Birch	*Betula pubescens*
Blaeberry	*Vaccinium myrtillus*
Bracken	*Pteridium aquilinum*
Cotton Grass	*Eriophorum vaginatum*
Creeping Soft Grass	*Holcus mollis*
Cross-leaved Heath	*Erica tetralix*
Deer Grass	*Trichophorum caespitosum*
Fescue (Sheep's Fescue and Red Fescue)	*Festuca spp.* (*F. ovina* and *F. rubra*)
Hair Moss	*Polytrichum commune*
Heath Bedstraw	*Galium saxatile*
Heath Rush	*Juncus squarrosus*
Heather	*Calluna vulgaris*
Hypnaceous Mosses	*Hypnum spp.*
Moor Mat Grass (or White Bent)	*Nardus stricta*
Molinia Grass (or Blow Grass)	*Molinia caerulea*
Mountain Cloudberry	*Rubus chamaemorus*
Mountain Vetchling	*Lathyrus montanus*
Oak	*Quercus petraea*
Pine	*Pinus sylvestris*
Scurvy Grass	*Cochlearia officinalis*
Sphagnum Moss	*Sphagnum spp.*
Sweet Vernal Grass	*Anthoxanthum odoratum*
Tormentil	*Potentilla erecta*
Wavy Hair Grass	*Deschampsia flexuosa*
Wild Thyme	*Thymus serpyllum*
Wild White Clover	*Trifolium repens*
Yorkshire Fog	*Holcus lanatus*
Wood Cow Wheat	*Melampyrum sylvaticum*

CHAPTER VIII

Forestry

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IN this area the land has a high agricultural value and consequently the woodlands are mainly small blocks laid down with the object of providing shelter to farm land. Approximately 5% of the area is woodland and of this 80% is under private control, the remainder being Commission forests. Between 1939 and 1945 about 25% of the total woodland was felled but considerable progress has been made with replanting.

PRIVATE WOODLANDS

The larger private estates in the area have, in all, about 7,000 acres of woodland, 6,000 of which are dedicated and under efficient management. The largest of the estates is Monteviot with 2,862 acres of woodland but many smaller estates have maintained a high standard of forestry although on a much smaller scale, woodlands in the past playing an important part in their general economy. Over half the stocked area is classified as Broad Leaved High Forest and although much of this is policy and amenity woodlands, there are many high quality hardwood stands, particularly of Oak and Beech, at lower elevations. Excellent crops of Scots Pine and to a lesser extent European Larch are also found but at rather higher elevations.

COMMISSION FORESTS

There are two commission forests in the area, Wauchope and Leithope, and a part of a third, Craik. Both Wauchope and Leithope lie on the northern slopes of the watershed on land which was formerly hill grazing and almost devoid of woodland. The total area planted is now about 4,600 acres almost all stocked within the last ten years. Sitka and Norway spruce are the main species used, Norway on moist sites on the lower slopes and in frost hollows and Sitka on land at higher elevations where exposure is marked and peaty soils are predominant. Japanese larch is generally confined to the drier and steeper slopes where there is a mineral soil. On the poorest and most exposed sites a mixture of Sitka spruce and Lodgepole pine is planted, the pine helping to establish the spruce. Scots pine is planted only on rocky outcrops or screes which are not too exposed. European and Hybrid larch, Douglas fir and Grand fir are also planted but to a limited extent.

PLANTING

In the preparation of land for planting, ploughing is now normal practice on both peaty and mineral soils. In addition to providing artificial drainage, ploughing checks the growth of the natural vegetation, an important factor in the establishment of a young crop and a considerable saving in subsequent weeding costs. Three types of plough are in general use. Both a single and a double mouldboard plough provide a furrow slice on which the young trees are planted. A deep single mouldboard plough is used for ditching the intervals between the drainage ditches varying with the site. Planting is by notching into the furrow slice so that the roots of the young trees are placed between the furrow and the ground below. In the case of the thick furrow slice of the drainage plough part of it has to be dug away before notching. Mineral phosphate at the rate of 1½ ozs. per plant is applied only on deep fibrous peat where weathering and improvement is slower than on other soils, including amorphous types of peat.

Only in comparatively recent times has it been possible to establish plantations above 1,000 feet but as a result of modern methods such as ploughing and the use of newer species and strains, plantations are now growing successfully up to 1,300 feet.

SOIL TYPE AND SPECIES

Most of the private woodlands occur at low elevations, with the hardwoods on either the Eckford or Hobkirk series. On the Eckford series they are not confined to any type of locality but on the Hobkirk series they have usually been established on steep river banks unsuited for cultivation. Conifers are grown in small blocks, principally on the Hobkirk series, at rather higher elevations than the hardwoods.

The two Commission forests of Wauchope and Leithope are on adjacent parts of the watershed. The nursery at Wauchope is on the Hobkirk series but most of the forest has been planted on series within the Ettrick association, principally the Alemoor and the Dod. The Alemoor has a clayey texture and requires to be drained by ploughing before planting while the Dod has a thin iron pan which has to be ruptured before planting either by deep ploughing or by attaching a tyne to the plough when turning a shallow furrow slice. Breaking the thin iron pan improves the natural drainage of the horizons above. The Leithope forest is principally on the Carter association, the predominant series being the Carter and the Arks. The Carter series is clayey and has to be drained by ploughing before planting and the Arks series with its thin iron pan has to be treated similarly to the Dod series. Sitka spruce is generally planted on the Carter and Alemoor series and larch on the Dod series provided the H layer is not more than three or four inches thick. If the H layer is thicker Sitka spruce is used. Peat is common in both forests and here Sitka spruce and Lodgepole pine are planted together.

Species Mentioned in the Text

Beech	*Fagus sylvatica*	Norway Spruce	*Picea abies*
Douglas Fir	*Pseudotsuga taxifolia*	Oak	*Quercus spp.*
European Larch	*Larix europaea*	Scots Pine	*Pinus sylvestris*
Hybrid Larch	*Larix eurolepis*	Lodgepole Pine	*Pinus contorta*
Japanese Larch	*Larix leptolepis*	Sitka Spruce	*Picea sitchaensis*

CHAPTER IX

Discussion of Analytical Data

SOIL profiles considered typical of the soil series present in an area are sampled during the period of survey and each sample is subjected to routine analyses which include those for loss on ignition, soil separates, exchangeable cations, percentage saturation, pH, carbon and nitrogen, readily soluble phosphorus and total phosphorus. Sometimes certain samples are considered worthy of more detailed investigation when it is customary to determine the ultimate constituents by means of silicate analysis, the minerals in the clay fraction by x-ray and differential thermal methods, the minerals in the fine sand fraction by specific gravity and optical methods and trace elements by spectrochemical methods. The discussion that follows deals with data from each of these methods.

The data obtained from routine analyses of soils in the surveyed area are given in Appendix I, each profile receiving a number which provides a ready means of identification whenever a profile is referred to in other sections of the chapter. When the values for each constituent are correlated and compared it is apparent that certain trends are common to members of a major soil group while others are common to members of an association. Each constituent is dealt with separately and any trend in the values is pointed out.

LOSS ON IGNITION

When the amount of organic matter is large the loss on ignition is high. In general the loss on ignition decreases down the profile of all major soil groups to about 4 per cent. If there is a root concentration such as may be found above the B_1 horizon in peaty podzols with thin iron pan, the value for loss of ignition will be markedly increased.

SOIL SEPARATES

The soil separates, namely sand, silt and clay, are determined by means of mechanical analysis. Until 1953 the Soil Survey of Scotland used only the size limits laid down in the International Scheme of Mechanical Analysis but since then each sample has been analysed to yield separates with the size limits of both the International and the U.S. Department of Agriculture Schemes. The principal differences are the ranges of the sand and silt separates. The U.S.D.A. sand is 50μ-$2{,}000\mu$ and silt 2μ-50μ whereas the International sand is 20μ-$2{,}000\mu$ and silt in 2μ-20μ. In the following section the percentage separates of both schemes are given and discussed.

In the soils from the surveyed area the percentage of the three soil separates is more closely related to association than to major soil group and accordingly it is the associations which are considered here. Figures are quoted for both American and International fractions, the former silt and sand being indicated by (A) and the latter by (I).

In the soils of the Hobkirk Association the percentage silt (I) is normally less than 20% but the percentage silt (A) is very variable. The clay content is more than 25% in one till and less than 20% in the other. The percentage sand (I) is often over 50%.

The soils of the Ettrick association have between 20% and 35% silt (I) and between 30% and 50% silt (A). This indicates that all have a significant amount of material with effective diameters between 20μ and 50μ. The percentage clay varies between 20% and 30% for the loamy till and 30% and 55% for the clayey till. A noteworthy feature is that approximately equal values are obtained for the percentages of silt and clay when the American size limits are used.

In the soils of the Sourhope association the percentage silt (I) is normally less than 25% but the percentage silt (A) is very variable, indicating that some soils have a large amount of material with an effective diameter between 20μ and 50μ and others very little. The clay content is more than 25% in one of the two tills and less than 20% in the other. The percentage sand (I) is often greater than 50.

The soils of the Carter association have normally less than 20% silt (I) and less than 30% silt (A). The percentage clay is generally greater than 30% in one till and less than 25% in the other.

The soils of the Minto association have between 20% and 30% silt (I) and between 40% and 60% silt (A), indicating that in all samples there is a large amount of material with effective diameter between 20μ and 50μ. The clay content is high, varying from 27% to 50%.

EXCHANGEABLE CATIONS

EXCHANGEABLE CALCIUM (Ca)

In brown forest soils when the values of exchangeable calcium are high there is often an increase down the profile, when moderate there is a minimum in the B_2 horizon, and when low there is a decrease to the B_2 horizon and then a constant level in the B_3 and C. In peaty podzols with thin iron pan the values of exchangeable calcium are low throughout the profile. There is usually a minimum of exchangeable calcium in the A_2g or B_2g horizon of non-calcareous and peaty gleys but if values are high there may be an increase with depth.

EXCHANGEABLE MAGNESIUM (Mg)

In brown forest soils when values of exchangeable magnesium are high there is usually an increase down the profile but when they are moderate there is normally a minimum in the B_2 or B_3 horizon. Peaty podzols with thin iron pan have low values and there is likely to be a minimum in the B_2. In non-calcareous gleys there is frequently a minimal value in the A_2g or sometimes in the B_2g. The values in the A_2g horixon (sometimes in the A_1g horizon) of peaty gleys is normally a minimum.

EXCHANGEABLE POTASSIUM (K)

Except in the Linhope series, where there is a straight decrease from A tc C, there is a minimal value of exchangeable potassium in the B_2 horizon of brown forest soils. In peaty podzols with thin iron pan the values are very low but the value in the B_2 horizon tends to be minimal. The value in the A_2g horizon (or occasionally in the B_2g horizon) of non-calcareous gleys is minimal. Similarly for some of the peaty gleys but quite a few profiles have no observable trend.

EXCHANGEABLE SODIUM (Na)

There does not seem to be any significant trend in exchangeable sodium values in any of the major soil groups.

EXCHANGEABLE HYDROGEN (H)

There is a straight decrease in the value of exchangeable hydrogen down the profiles of all major soil groups.

PERCENTAGE BASE SATURATION AND pH

In brown forest soils if the percentage base saturation is high, there is a straight increase down the profile, but if it is low or medium, the value in the B_2 horizon is minimal. Values are low throughout in peaty podzols with thin iron pan with the value in the B_2 horizon normally a minimum. The values in non-calcareous gleys are high increasing down the profile, while in peaty gleys the values are lower, with the A_2g minimal.

The pH values increase with depth in all major soil groups.

CARBON AND NITROGEN

The percentage carbon and percentage nitrogen decrease with depth in all major soil groups except the peaty podzol with thin iron pan in which they may increase *if there is a root concentration just above the* B_1 *horizon.* The values in all major soil groups from the B_2 or B_2g horizon downwards are very low.

PHOSPHORUS

TOTAL PHOSPHORUS (P_2O_5)

The percentage total P_2O_5 decreases to the B_3 horizon in brown forest soils after which it remains constant or increases. There does not seem to be any consistent trend in percentage total P_2O_5 throughout members of the peaty podzols with thin iron pan group. In the Dod series (Ettrick association) and Faw series (Hobkirk association) there is an increase down the profile, in the Cowie series (Sourhope association) there is a decrease down the profile whilst the Arks series (Carter association) shows no discernible trend. There is a minimal percentage of total P_2O_5 in either the A_2g or B_2g horizon of non-calcareous and peaty gleys.

READILY SOLUBLE PHOSPHORUS (P_2O_5)

In brown forest soils if the values of readily soluble P_2O_5 are high there is an increase with depth; otherwise the value in the B_2 horizon is minimal. Values are low with a minimum normally in the B_2 horizon of peaty podzols with thin iron pan. In non-calcareous gleys, if values are low or moderate there is likely to be a minimum in the A_2g or B_2g horizon. If values are high, there may be a maximum in the B_3g with a sudden drop to the Cg horizon. In such cases the values for certain other determinations such as pH and exchangeable calcium are particularly high in the Cg horizon. These phenomena are being investigated in an effort to obtain a satisfactory explanation. The value for readily soluble P_2O_5 is usually a minimum in the A_2g or B_2g horizon of peaty gleys.

ULTIMATE CONSTITUENTS

Ultimate analyses have been carried out on a number of typical profiles by the usual fusion methods. The results are given in Tables 1 to 4 (Appendix 2). The analyses were carried out on ignited samples, the loss on ignition being particularly high in the H layers and A_1g horizons. The actual values can be obtained from the appropriate tables in Appendix I.

In brown forest soils the percentage SiO_2 decreases gradually with depth, the values for percentage TiO_2 following a similar trend. The percentage Fe_2O_3, Al_2O_3 and MgO increase with depth and may have a maximum in the B_2 or B_3 horizon. The percentage CaO is high in profile 7 and it increases steadily down the profile but in profile 4 where there is only half the amount, there is a minimal value in the B_2 horizon: this is probably due to accumulation of CaO in the plant residues. The values for percentage P_2O_5 decreases with depth and the relatively high values in the A and B_2 horizon are probably due to accumulation in the plant residues.

In peaty podzols with thin iron pan, the percentage SiO_2 is high in the A_1 or A_2 horizon, very low in the B_1 horizon, and in general decreases from the B_2 to the C horizon. The percentage Fe_2O_3 is low in the A_1 or A_2 horizon, and very high in the B_1 horizon, thereafter remaining comparatively constant. The percentage Al_2O_3 is high in the A_1 or A_2 horizon probably because of accumulation in the plant residues. In the B_1 horizon it is low, rising sharply to the B_2 horizon and thereafter decreasing slightly. The percentage TiO_2 is relativedly constant except in the B_1 horizon where it is low. The percentage MgO decreases from the A_1 or A_2 horizon to the B_1 horizon and then increases with depth. There is a minimal value for percentage CaO in the B_2 horizon of profile 25 but in profile 20 there is a regular decrease with depth. Accumulation of CaO in the plant residues probably takes place in both. Except in the B_1 horizon, where it is low the percentage K_2O seems to be relatively constant.

In non-calcareous gleys the percentage SiO_2 decreases with depth; there is especially a sharp drop from the A_2g to the B_2g horizons. The percentage Fe_2O_3 increases with depth in profiles 47 and 51 but in profiles 40 and 45 there is a maximum in the B_2g or B_3g horizons. The percentage Al_2O_3 behaves similarly, increasing with depth or showing a maximum in the B_2g or B_3g horizon. The values for percentage CaO normally increase with depth although there may be a minimal value in the A_2g or B_2g. In general the percentage MgO increases with depth and the percentage K_2O behaves similarly in all the profiles except 45 where it decreases.

In profile 60, a peaty gley, the percentage SiO_2 shows a maximum in the B_2g horizon. This is probably explained by the high amount of organic matter in the H layer and the effect the ash would have on the composition of the mineral matter. The percentage Fe_2O_3 shows a steady increase down the profile while the percentages Al_2O_3 has a minimal value in the B_2g horizon indicating accumulation of Al_2O_3 in the plant residues. The percentage CaO is minimal in the A_2g horizon but the percentage MgO increases regularly with depth. The percentage K_2O is at a minumim in the B_2g horizon.

ELLUVIAL-ACCUMULATIVE COEFFICIENTS

According to Rode, there are two basic phenomena in each soil-forming process, transformation of matter *in situ* and transportation of matter from one horizon to another or out of the soil altogether. In this section only transportation of the mineral part of the soil will be considered.

The method employed is similar to that of Rode[16] and Nikiforoff and Drosdoff[13,14] Certain assumptions are made in this treatment: (*i*) the material from which the soil developed was originally uniform in composition (*ii*) the C horizon of the present profile is nearest in composition to the original parent material (*iii*) silica (SiO_2) is relatively immobile and can be used as a standard of comparison.

The data obtained by means of ultimate analyses present the composition of each soil horizon as percentages of its ultimate constituents. Differences in composition between horizons of the same soil form the bases of a conclusion about the soil process. It is necessary, however, to make suitable adjustments to the data from each horizon before a fair comparison can be made. For example, 100 grams of an A horizon is seldom strictly comparable with 100 grams of the corresponding C horizon. The A horizon is likely to have suffered considerably more leaching than the C horizon and 100 grams of it is probably the weathering product of $100+x$ grams of original parent material.

To make all the horizons of a soil comparable it is necessary to select an oxide which is relatively immobile or unaffected by weathering processes. In this instance, the one selected is silica (SiO_2). Thus the equivalent of 1 gram of parent material in a given horizon is given by:

$$Q = \frac{{}_{h}SiO_2}{{}_{o}SiO_2}$$

where Q is known as the parent material quotient
${}_{h}SiO_2$ is the percentage SiO_2 in the given horizon
${}_{o}SiO_2$ is the percentage SiO_2 in the parent material.

The losses or gains of any ultimate constituent for each 100 grams of the parent material is then obtained from the formula:

$$x = S_o - S_h Q$$

where x = the losses or gains of an ultimate constituent per 100 grams of parent material.
S_o = percentage of the ultimate constituent in the parent material.
S_h = percentage of the ultimate constituent in the given horizon.
Q = the parent material quotient.

An elluvial-accumulative coefficient can also be calculated. It is the ratio of the losses or gains of an ultimate constituent relative to the percentage of the ultimate constituent in the parent material i.e. $x/S_o = S_o/S_o - S_h Q/S_o$. A negative coefficient indicates a loss of constituent relative to the parent material and a positive coefficient indicates a gain.

The elluvial-accumulative coefficients for Fe_2O_3, Al_2O_3, CaO and MgO are given in tables 1 to 4 (Appendix 2) alongside the appropriate values of these constituents in the ultimate analyses. Other profiles were analysed but the data showed few consistent trends. This confirmed field observations which indicated that these profiles were not developed on a uniform parent material, the upper horizons being developed on till and the lower on rotten sediments.

In brown forest soils the elluvial-accumulative coefficients for Fe_2O_3 becomes less negative with depth except for the B_3C horizon in profile 7. The coefficients become less negative for Al_2O_3 with depth and in the B_2 horizon of profile 4 and the B_3C horizon of profile 7 they are actually positive. For CaO, the coefficients become less negative with depth, although the A horizon of profile 4 is slightly less negative than the B_2 horizon indicating a slight relative accumulation, probably due to the effect of plant residues. The co-efficients for MgO become less negative with depth, no loss being indicated in the B_3 horizon of profile 4.

In peaty podzols with thin iron pan the elluvial-accumulative coefficients for Fe_2O_3 indicate leaching becoming less with depth, except the one for the B_1 horizon which indicates marked accumulation. The coefficients for Al_2O_3 are negative except for the B_2 horizon which is positive in both profiles. For CaO, the coefficients do not show very much regularity, but those for MgO become less negative with depth.

In non-calcareous gleys the elluvial-accumulative coefficients for Fe_2O_3 indicate less leaching in the B_2g and B_3g horizons, in fact they are positive in profiles 40 and 45. The coefficients for Al_2O_3 become less negative with depth, being actually positive in the B_2g horizon of profiles 40, 45 and 51. The coefficients for CaO in profiles 40 and 51 indicate a very high degree of leaching throughout the profile but a better explanation is that the Cg horizons were originally relatively rich in secondary calcite making it seem that leaching in the other horizons has been marked. The coefficients in the A_2g horizon of profiles 47 and 51 indicate that leaching has probably been offset by accumulation due to plants. The coefficients for MgO become less negative with depth in profiles, 40, 47 and 51 but they are not very consistent in profile 45.

In the peaty gley the elluvial-accumulative coefficients for Fe_2O_3 become less negative with depth. The coefficients for Al_2O_3 indicate accumulation in the H layer (plant residues) and to a small degree in the B_3g horizons. Similarly the coefficients for CaO indicate little relative loss in the H layer. The coefficient in the A_2g is very negative, becoming less negative down the profile. The coefficients for MgO become less negative from the H layer to the B_3g horizon where no leaching or accumulation is indicated.

The dominant soil process in all these soils is leaching. Only in the B_1 horizon of peaty podzols is their overwhelming evidence of accumulation of Fe_2O_3. There are some horizons, namely the B_3 horizon of brown forest soils and peaty podzols with thin iron pan, the B_2g and B_3g horizons of non-calcareous gleys and the H and B_3g horizons of a peaty gley where there is a slight accumulation of Al_2O_3 but all the other horizons show leaching of the selected ultimate constituents.

TRACE ELEMENTS

Sixteen profiles from the Sourhope, Darleith, Carter, Hobkirk and Ettrick Associations have been examined for total and acetic acid soluble trace element contents. The elements of most practical significance in what is essentially a stock-rearing area are cobalt, copper and molybdenum. Cobalt and copper are recognised to be essential for the healthy growth of ruminant animals, while molybdenum and possibly other metallic constituents are toxic when present in the diet in more than trace amounts. Elements which are suspect from this point of view include lead, tin and zinc, but the relationship between copper and other heavy metals in disorders such as swayback of sheep has not yet been clarified and other factors are involved. For the healthy growth of plants the essential trace elements include, copper, zinc, manganese, iron, molybdenum and boron while high soil availability of nickel or indeed most heavy metals restricts or prevents growth.

As a result of glaciation to which the whole area has been subjected, it is difficult to distinguish accurately in the field the precise parent material, particularly when thin and variable sedimentary deposits are concerned. The present knowledge of trace elements in soils derived from sedimentary rocks is less extensive than that with soils of igneous origin.

The Darleith and Sourhope Associations are formed on tills of mainly igneous origin. The only Darleith profile examined was a peaty podzol with thin iron pan from Kiln Knowe, developed on a parent material derived mainly from basaltic lavas. These are distinguished, as would be anticipated, by relatively high total contents of cobalt (60 p.p.m.), nickel (100-150 p.p.m.), chromium (200 p.p.m.), zinc (200 p.p.m.), manganese (1,500 p.p.m.) and copper (25 p.p.m.) and low contents of barium (600 p.p.m.), strontium (150 p.p.m.), zirconium (200 p.p.m.).

The acetic acid soluble cobalt is quite high (1·5 p.p.m.) in the freely drained B horizon of the soil; the nickel content is around 1 p.p.m. and the vanadium 0·4 p.p.m., both of which are relatively high but not dangerously so form an agricultural point of view. The extractable aluminium is very high at over 1%—a finding which is not unexpected on soils derived from basaltic lavas.

The soils of the Sourhope Association are developed on lavas of Lower Old Red Sandstone age, described as felsitic or andesitic in character. The profile from Rushy Fell (26), a peaty podzol with thin iron pan, is fully sampled and is interesting from several points of view. The cobalt (10 p.p.m.) and nickel (20 p.p.m.) contents suggest that the felsitic rocks from which it was derived are more acid than the soils of the same association at Fasset. There is, on a dry matter basis, a considerable increase in lead in the F and H layers with contents of 100-200 p.p.m. compared with 10-20 p.p.m. in the under lying mineral soil. The contents of Cr (80-100 p.p.m.), Mn (100-500 p.p.m.), Ba (1,000-1,500 p.p.m.), Sr (500 p.p.m.) V (150 p.p.m.), Zr (500-1,000 p.p.m.) and Zn (300 p.p.m.) in the mineral horizons are all in line with a rather acid igneous parent material. The F and H layers show some accumulation of germanium, silver, zinc and tin in addition to lead, while, on the same dry matter basis, cobalt, nickel, chromium, titanium and vanadium are less abundant than in the mineral horizon, although Co and Ni are more so on an ash basis.

Determinations of acetic acid soluble trace constituents are interesting in that they show the accumulation of soluble iron (940 p.p.m.) in the thin iron pan compared with 100 p.p.m. in other horizons. None of the other elements determined show an effect of this order, in fact vanadium and titanium are much more soluble in the A horizon and aluminium in the B_2 or B_3 (C). There is a slight accumulation of total copper in the thin iron pan; acetic soluble copper figures are not available.

The contents of acetic acid soluble trace elements from the profile from the Gair (25), a peaty podzol with thin iron pan, resemble those from Rushy Fell very closely where comparative horizons are available. Totals have not been determined but the parent material would appear from the trace element analyses to be acid in character.

The contents of the brown forest soil (7) and the non-calcerous gley (45) from Fasset suggest that their parent tills are rather more basic. Total contents of cobalt (20 p.p.m.) and nickel (60 p.p.m.) suggest that the tills are derived from rocks of at least andesitic composition. The total lead content (50 p.p.m.) is on the other hand quite high, while chromium (100 p.p.m.) and vanadium (150 p.p.m.) are at intermediate levels. The acetic acid soluble cobalt (0·3-0·5 p.p.m.) and nickel (0·3-0·8 p.p.m.) are 2-3 times those in the peaty podzols with thin iron pan from Rushy Fell and Gair and the soluble lead (1 p.p.m.) is relatively high. The soluble aluminium is low (200 p.p.m.) compared with the lower layers of the Gair and Rushy Fell soils (4,000 p.p.m.), and it is doubtful if this can be ascribed entirely to drainage conditions. Poorly drained soils in general are lower in soluble aluminium than their freely drained counterparts, but the cobalt, nickel and vanadium in the non-calcareous gley show little sign of the increased mobilization which normally occurs with poor drainage. This latter finding may however be related to the properties of the constituent minerals in which these trace elements are incorporated.

The soils of the Ettrick Association, formed on Llandoverian and Wenlockian (Silurian) sediments which are mainly greywackes, mudstones and shales, would in consequence be expected to be quite rich in trace elements, and the analyses confirm this. Typical total contents throughout the mineral layers of the profiles are cobalt (20-30 p.p.m.), nickel (80-100 p.p.m.), chromium (200 p.p.m.), vanadium (200 p.p.m.), copper (40-50 p.p.m.), lead (10-20 p.p.m.), barium (700 p.p.m.), strontium (50-100 p.p.m.), lithium (50-100 p.p.m.), rubidium (200-300 p.p.m.), scandium (10-20 p.p.m.), zirconium (700 p.p.m.), yttrium (60 p.p.m.), lanthanum (50 p.p.m.), manganese (500-1000 p.p.m.), and gallium (25 p.p.m.). All are within the normal ranges for argillaceous sediments. The effect of poor drainage in increasing the availibility of nickel and vanadium in particular is obvious in the results obtained for acetic acid soluble contents of the series of profiles from Woo Law (4, 40, 60) where the peaty gley (60) has in the H layer nickel 4·3 p.p.m. and vanadium 1·2 p.p.m. compared with nickel 0·38 p.p.m. and vanadium 0·05 p.p.m. in the brown forest soil (4). Cobalt is relatively high being above 1·5 p.p.m. in both instances and cobalt deficiency would not be anticipated on such soils. The soluble contents from the B_2 and B_3 horizons of the Dod Hill profile (20), a peaty podzol with thin iron pan, are not dissimilar from those of the brown forest soil (4).

The total trace element contents of the soils developed on the Hobkirk Association (Upper Old Red Sandstone sediments) tend in general to be lower in such elements as cobalt, nickel, chromium, vanadium, copper, lead, manganese, lithium and rubidium and higher in barium, strontium, yttrium, lanthanum and zirconium, by a factor of about 2, suggesting derivation from more arenaceous sediments. Again the poorly drained soil, as exemplified by a non-calcareous gley from Dolphinston Moor has the highest soluble content of cobalt, nickel and vanadium, but the contents are lower than in the Ettrick Association.

The profiles of the Carter Association (16, 30, 51) vary from brown forest soils to peaty podzols with iron pan, developed on till derived from Lower Carboniferous sediments. The total contents of trace elements in the various horizons of the peaty podzol from Carterbar (30) suggest that the till has been derived mainly from sandstone with low cobalt (<10 p.p.m.), nickel (<20-25 p.p.m.) copper (<10 p.p.m.) and chromium (25-60 p.p.m.) and relatively high zirconium (1,000 p.p.m.) and barium (1,500 p.p.m.) contents. The acetic acid soluble contents of cobalt tend to be low (<0·2 p.p.m.) except in an non-calcareous gley from Wooplaw Rig (51) in which soluble cobalt contents of over 0·6 p.p.m. occur in the B_2g and Cg horizons. There is no evidence of increased vanadium solubility in this instance, presumably because of the form in which the vanadium is initially present. There is however a suggestion of soluble lead in the A_2g and B_2g at the 1 p.p.m. level, and in the A_1g the soluble lead is 3·5 p.p.m.

Generally the trace element status of the soils from this area which have been examined is quite normal for the parent materials involved. The contents of cobalt in the Darleith and Ettrick Associations are such as to make the occurrence of pining in sheep in these areas unlikely. On the other hand certain of the Sourhope, Hobkirk and Carter soils are quite low in total cobalt and one might suspect the possibility of cobalt deficiency occurring on herbage in these areas, particularly if the drainage is free. No very low total copper contents have been found, but only the profile from the Darleith association is above the 10-20 p.p.m. level. The soil analyses do not indicate any likelihood of heavy metal toxicity arising from excess of such elements as nickel, lead or molybdenum.

MINERALS IN FINE SAND FRACTIONS (20-200μ)

Fine sand fractions of samples from selected soil profiles have been separated into three groups according to specific gravity, the groups being characterised by orthoclase felspar, quartz, and ferromagnesian silicate minerals respectively. The method of separation has been described previously by Hart[5].

The results of this separation are shown in Table 5. (Appendix 2). There is a distinct variation in the percentage of ferromagnesian silicate materials in soils which belong to the same association. This may be partly due to the variation in concentrations of minerals in the glacial till deposits or in the parent rocks. The different textures of the tills also affect the rate of percolation of water which, in turn, affects the rate of solution of the minerals.

Generally those soils developed on till derived from igneous rocks have a higher percentage of ferromagnesian silicate minerals. There does not seem to be any marked distinction between the figures for the soils developed on till derived from Old Red Sandstone sediments and derived from Carboniferous sediments. A feature of the soils from the Silurian areas is the high proportion of material in the orthoclase group. This due to the presence of rock fragments in the fine sand.

Fine sand fractions of the same samples have also been examined under the microscope as described previously by Hart[6], and the constituent minerals identified and their frequency of occurrence estimated. The results are shown in Tables 6 to 9 (Appendix 2). These Tables and Table 5 (Appendix 2) are complementary.

The soils of the Ettrick Association are characterised by the large proportion of rock fragments in the fine sand fraction. The fragments are principally of fine-grained shale and indicate that the weathering has not gone so far as in soils from other associations. Similar results have been obtained by Hart for soils developed on Silurian sediments in other areas. Another feature of the soils is the high proportions of chlorite and the two micas, biotite and muscovite.

Garnet occurs frequently in the fine sand fractions of the soils of the Hobkirk Association. Some of them are also rich in augite but this indicates contamination locally by lava rocks, or that the sediments were derived from eroded lava.

The soils of the Carter Association are generally rich in augite likewise indicating contamination from igneous rocks or that the sediments were derived from eroded lava.

A feature of the soils of the Sourhope Association is the large proportions of plagioclase and pyroxene minerals, such as augite, hypersthene and enstatite, in the fine sand fractions.

MINERALS IN CLAY FRACTIONS ($<1{\cdot}4\mu$)

The fraction of soil commonly used for the study of clay minerals is that with particles of effective diameter less than $1{\cdot}4\mu$. Although it is called a clay fraction, it differs from the one used in mechanical analysis ($<2\mu$).

The clay fractions of soils typical of the principal Associations were examined by x-ray diffraction and by differential thermal analysis and approximate quantitative mineralogical analyses were made. As with most other Scottish soils examined, illite was generally found to be the predominating clay mineral, with kaolin minerals always present.

The soils of the most extensive association, Ettrick, are derived from Silurian greywackes and shales and their clay fractions contain considerable amounts of chlorite inherited directly from these parent sediments. The presence of small amounts of chlorite in some of the soils of other associations is probably because other parent rocks such as Upper Old Red Sandstone sediments were largely derived from eroded Silurian material. The results for the non-calcareous gley and peaty gley of the Ettrick Association (40, 60) in Table 10 (Appendix 2) suggest that poor natural drainage favours the formation of a mixed layer mineral containing illitic and chloritic components. This inference is based on the reduction in the amount of chlorite and the increase in the amount of mixed-layer mineral in going from poor to very poor drainage.

The Hobkirk Association derived from Upper Old Red Sandstone sediments shows very little variation in clay minerals either down the profile or under different drainage conditions. The average composition of the clay is about 70% illite, 20% kaolin, and 5% each of quartz and haematite.

Lavas of Lower Old Red Sandstone age are the parent rocks of the Sourhope Association and in addition to illite and kaolin, the clay fractions contain vermiculite and/or montmorillonite, depending on the drainage. The brown forest soil (7) contains vermiculite in the surface layers and montmorillonite in the lower layers while the non-calcareous gley (45) has montmorillonite throughout the profile, the amount increasing with depth (Table 10, Appendix 2.) A mixed-layer mineral probably chlorite-vermiculite, sometimes occurs amd it is certainly not due to contamination by Silurian material.

The soils of the Carter Association are derived from Lower Carboniferous sediments. The usual composition of the clay fraction is 70-80 per cent. illite (often partly replaced by mixed-layer minerals), 10-20 per cent. kaolin, up to 10 per cent. vermiculite at the bottom of the profile and frequently some goethite in the surface layers.

Cold precipitated hydrated ferric oxide, which is readily identified by differential thermal analyses, frequently occurs in soil clays from North-east Scotland but was found in only one soil from this area, the surface layer of a brown forest soil (11.) belonging to the Hobkirk series developed on parent material derived from Upper Old Red Sandstone sediments.

SUMMARY OF ANALYTICAL METHODS

1. Soil separates (sand, silt and clay) were determined by a modification of the hydrometer method. (Buoyoucos, G. J. (1937). Soil Sc. **23**, 319 and 343).

2. The exchangeable cations were determined in a neutral normal ammonium acetate leachate, calcium, sodium and potassium being determined by flame photometry (Ure, A. M., 1954, "The Application of Electronics to Spectrochemistry", Thesis, Aberdeen University) and magnesium colorometrically (Hunter, J. G., (1950), Analyst, **75**, 91).

3. Exchangeable hydrogen was determined by electrometric titration of a neutral normal barium acetate leachate (Parker, F. W. (1929), Jour. Amer.

Soc. Agron., **21,** 1030). 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, A., and Black, I. A., (1934). Soil Sci., **37,** 29).

5. Total Nitrogen was determined by a semi-micro Kjeldahl method (Markham, R., (1942). Biochem., Journ., **36,** 790).

6. Total phosphate was determined by a colorometric method using hydrazine sulphate, after fusing the soil with sodium carbonate (Muir, J. W., (1952). Analyst, **77,** 313).

7. Readily soluble phosphate was determined colorometrically in a 2·5% acetic acid extract (Williams, E. G., and Stewart, A. B., (1941). Journ. Soc., Chem., Ind., **60,** 291).

8. Ultimate constituents:—One portion of ignited soil was fused with sodium carbonate (Robinson, W. O., (1939). U.S.D.A. Circ. No. 139), and silica determined after a double evaporation with hydrochloric acid. Aluminium (Robertson, G., (1950). Jour. Sci., Food & Agric., **1,** 59) and iron (Scott, R. O., (1941). Analyst, **66,** 142) were determined colorometrically in aliquots of the filtrate from the silica. From another aliquot the sesquioxides were precipitated by means of ammonium hydroxide and ammonium persulphate (Hillebrand, W. F., and Lundell, G. E. F., (1948). Applied Inorganic Analysis, 10th Printing, 731), dissolved in sulphuric acid, and manganese and titanium determined colorometrically in this solution (Hillebrand and Lundell, 350 and 456). Calcium was determined chemically (by precipitation as oxalate and titration with potassium permanganate) in the filtrate from the sesquioxides, and magnesium colorometrically in the filtrate from calcium (Hunter, J. G., (1950). Analyst, **75,** 91) after removal of ammonium salts by evaporation with nitric acid. A separate portion of soil was fused with calcium carbonate and ammonium chloride for the determination of sodium and potassium, according to the well-known J. Lawrence Smith method (Robinson, W. O., (1939). U.S.D.A. Circ. No. 139). After fusion the sintered cake was slaked with water and filtered several times, then the calcium removed by a double precipitation with ammonium carbonate and ammonium hydroxide. The combined filtrates were evaporated to dryness, ignited gently to destroy ammonium salts and the residue dissolved in a small amount of hydrochloric acid and distilled water. Sodium and potassium were determined in this solution by means of a flame photometer (Ure, A. M., (1954). "The Application of Electronics to Spectro chemistry", Thesis, Aberdeen University).

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APPENDIX I.

BROWN FOREST SOILS. (LOW BASE STATUS)

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100. Read. Sol. P_2O_5	Remarks
1.	ETTRICK ASSOCIATION; Linhope Series. Carewoodrig, 103557-103560.																		
A_1	0-2	22·50	38·6	31·7	56·4	12·4	14·3	0·64	0·56	0·20	0·82	30·75	6·7	4·53	10·40	0·760	0·309	1·0	Low exchangeable bases. Low readily soluble P_2O_5 in A_1 and A_2.
A_2	3-6	16·28	24·0	36·9	39·0	22·7	26·1	0·32	0·36	0·17	0·57	20·30	6·5	4·63	6·07	0·457	0·246	0·6	
B_2	10-13	6·43	43·8	37·4	60·6	21·6	14·6	Nil	0·10	0·09	0·08	5·60	4·6	5·06			0·141	4·9	
B_3	28-32	5·93	64·5	18·3	67·9	12·9	16·2	0·15	0·10	0·08	0·07	3·95	9·2	5·17			0·141	3·8	
2.	ETTRICK ASSOCIATION; Linhope Series. Stobie Slack, 91726-91729.																		
A	0-4	13·85	N.D.	N.D.	55·1	19·8	18·2	0·31	0·32	0·07	0·33	16·40	5·9	4·59	5·68	0·435	0·270	1·4	Low exchangeable bases.
B_2	8-12	7·27	N.D.	N.D.	38·9	27·2	30·3	0·16	0·10	0·06	0·10	9·75	4·1	4·78	2·38	0·212	0·239	0·6	
B_2	12-16	6·04	N.D.	N.D.	39·7	32·4	24·9	Nil	0·10	0·05	0·04	8·18	2·3	4·90			0·169	0·7	Low readily soluble P_2O_5.
B_3	19-23	5·73	N.D.	N.D.	54·4	25·1	17·6	Nil	0·04	0·04	Nil	4·54	1·7	5·08			0·129	1·0	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
3.	ETTRICK ASSOCIATION; Linhope Series. Wigg Burn, 90475-90461.																		
A	1-2	11·70	N.D.	N.D.	50·6	19·2	24·4	0·32	0·32	0·14	0·88	20·15	7·6	4·43	6·50	0·482	0·106	1·1	Low exchangeable bases.
A	3-6	10·40	N.D.	N.D.	33·1	27·1	34·6	0·16	0·18	0·09	0·48	13·71	6·2	4·72	3·58	0·317	0·036	0·5	
B_2	9-14	7·45	N.D.	N.D.	34·9	29·6	31·8	Nil	0·08	0·05	0·16	6·45	4·3	4·80			0·062	0·5	Low total P_2O_5
B_3	19-24	3·84	N.D.	N.D.	50·4	24·3	21·5	Nil	0·08	0·05	0·04	2·42	6·6	4·80			0·069	1·5	Low readily soluble P_2O_5.
C	30-33	4·13	N.D.	N.D.	39·8	28·8	29·3	0·31	0·26	0·04	0·04	2·42	21·2	5·17			0·124	2·4	
4.	ETTRICK ASSOCIATION; Linhope Series. Woo Law, 90470-90474.																		
A	2-8	14·90	30·8	32·0	37·8	21·6	33·2	3·38	0·52	0·09	0·64	17·75	20·7	5·04	5·55	0·434	0·190	0·4	Low exchangeable bases, except in A.
B_2	11-14	9·45	15·7	41·6	28·6	26·5	40·3	0·76	0·22	0·15	0·10	10·98	10·1	5·21	2·19	0·204	0·133	0·2	Low total P_2O_5 in B_2 B_3 and C.
B_2	15-18	6·52	19·8	43·6	32·5	26·4	38·8	0·15	0·16	0·08	0·05	6·18	6·7	5·22			0·075	0·4	
B_3	21-26	4·33	28·5	43·8	42·9	25·7	29·2	0·15	0·12	0·08	0·04	4·89	7·4	5·30			0·091	8·6	Low readily soluble P_2O_5 in A and B_2.
C	33-36	4·04	27·4	40·8	41·0	25·4	31·6	0·76	0·24	0·04	0·02	4·58	18·8	5·32			0·083	10·8	High per cent. clay in B_2.

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
5.			**ETTRICK ASSOCIATION; Linhope Series. Woodburn, 91746-91749.**																
A	5-8	9·71	N.D.	N.D.	27·8	29·2	38·2	0·31	0·18	0·20	0·19	15·28	5·4	4·65	3·94	0·323	0·207	0·8	Low exchangeable bases.
B_2	9-13	6·15	N.D.	N.D.	24·9	33·4	38·6	Nil	0·12	0·18	0·11	12·20	3·2	4·71	1·82	0·178	0·181	0·7	
B_3	14-17	6·29	N.D.	N.D.	28·3	32·2	36·4	0·15	0·08	0·14	0·07	10·04	4·2	4·93			0·153	0·6	Low readily soluble P_2O_5.
C	28-31	4·20	N.D.	N.D.	37·5	25·8	34·6	0·46	0·32	0·11	0·07	4·98	16·2	5·31			0·105	1·6	
6.			**SOURHOPE ASSOCIATION; Sourhope Series. Fasset, 77218-77222.**																
A	2-9	8·67	N.D.	N.D.	44·2	19·5	32·0	2·78	1·32	0·13	0·33	11·35	28·7	5·50	3·33	0·323	0·269	3·5	High exchangeable bases in C and D.
B_2	14-20	6·94	N.D.	N.D.	57·1	13·9	25·5	1·29	0·57	0·03	0·23	9·40	18·4	5·68	1·71	0·155	0·275	7·5	
B_3	24-30	7·80	N.D.	N.D.	57·4	11·9	26·8	5·70	3·30	0·10	0·36	6·60	58·8	5·84			0·252	13·7	High readily soluble P_2O_5 in B_3, C and D.
C	31-36	4·22	N.D.	N.D.	63·8	15·8	18·3	9·68	5·13	0·12	0·45	2·79	84·5	6·00			0·136	17·6	
D	50-55	3·64	N.D.	N.D.	80·4	7·5	8·5	17·15	8·24	0·29	0·80	3·83	87·5	6·11			0·296	89·8	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% •Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
7.								SOURHOPE ASSOCIATION; Sourhope Series. Fasset, 77223-77227.											
A	3-9	9·46	14·5	43·9	43·1	19·0	33·2	2·36	1·69	0·18	0·60	16·38	22·8	5·20	3·68	0·359	0·321	3·7	High exchangeable bases in B_3, B_3C and C.
B_2	14-19	5·87	29·9	39·7	49·7	18·0	29·4	3·05	2·04	0·15	0·46	10·00	35·2	5·40	1·93	0·210	0·280	5·1	
B_3	23-28	5·69	24·3	23·6	33·4	17·3	46·5	15·90	9·06	0·28	0·74	8·40	75·5	5·76			0·105	2·7	High readily soluble P_2O_5 in C.
B_3C	31-36	4·52	23·5	30·0	37·1	20·4	40·3	19·70	10·15	0·37	0·82	2·94	91·3	5·79			0·076	3·0	
C	41-48	3·75	20·9	39·4	32·7	26·2	37·4	19·30	9·70	0·33	0·72	Nil	100·0	5·83			0·153	28·2	High per cent. clay.
8.								SOURHOPE ASSOCIATION; Sourhope Series. Fasset, 77238-77243.											
A	0-4	16·[illegible]0	N.D.	N.D.	58·2	12·1	17·5	0·96	0·53	0·02	1·15	19·70	11·9	4·63	6·57	0·593	0·357	4·3	Low exchangeable bases, becoming higher in C and D.
B_2	6-9	11·90	N.D.	N.D.	64·6	12·2	17·3	0·22	0·22	Nil	0·63	19·25	5·3	4·99	4·52	0·419	0·306	2·2	
B_3	11-16	6·45	N.D.	N.D.	67·3	8·7	20·8	Nil	0·08	Nil	0·24	9·45	3·3	4·99			0·434	17·4	High readily soluble P_2O_5 in B_3, C and D.
C	20-25	5·81	N.D.	N.D.	53·1	16·5	27·5	6·27	1·78	0·04	0·42	26·40	27·3	5·43			0·324	20·4	
D	31-36	3·79	N.D.	N.D.	47·0	13·6	35·6	1·32	2·29	0·02	0·42	10·50	27·9	5·44			0·248	51·6	High total P_2O_5 in A, B_2, B_3 and C.
D	39-45	4·18	N.D.	N.D.	43·3	14·3	40·4	4·58	5·72	0·09	0·58	11·70	48·4	5·49			0·254	56·3	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
9.			SOURHOPE ASSOCIATION; Sourhope Series. Fasset, 77244-77249.																
A	0-3	11·50	N.D.	N.D.	46·6	24·0	23·7	0·92	0·65	Nil	1·05	14·20	15·6	4·36	4·70	0·482	0·226	7·2	Low exchangeable bases except Mg. in C and D.
B_2	5-9	4·44	N.D.	N.D.	63·8	9·6	24·4	Nil	0·18	Nil	0·23	14·30	2·8	4·97	0·64	0·074	0·290	19·5	
B_3	13-18	4·14	N.D.	N.D.	65·9	8·9	23·1	0·05	0·16	0·01	0·39	21·40	2·8	5·20			0·331	51·2	High total P_2O_5 in B_3, C and D.
C	25-31	4·19	N.D.	N.D.	47·9	16·0	34·0	0·21	1·05	0·02	0·49	20·90	7·8	5·17			0·325	66·2	
C	35-41	4·37	N.D.	N.D.	44·1	13·3	40·4	0·87	4·12	0·05	0·60	16·40	25·6	5·29			0·309	85·5	High readily soluble P_2O_5 in B_2, very high in B_3, C and D.
D	46-52	4·65	N.D.	N.D.	N.D.	N.D.	N.D.	1·85	5·00	0·11	0·80	22·30	25·8	5·39			0·334	120·3	
10.			HOBKIRK ASSOCIATION; Hobkirk Series. Bowmont Forest, 85877-85881.																
A	2-7	3·68	N.D.	N.D.	74·4	15·3	6·6	3·24	0·48	Nil	0·10	4·10	48·3	5·27	1·79	0·132	0·084	1·3	Low exchangeable bases except Ca in A, B_2 and B_3.
B_2	8-10	1·96	N.D.	N.D.	77·0	4·8	16·3	2·62	0·26	Nil	0·06	1·07	73·4	6·05	0·52	0·071	0·052	0·7	
B_3	11-16	1·81	N.D.	N.D.	72·0	5·1	21·1	4·45	0·20	Nil	0·14	Nil	100·0	6·31			0·039	0·7	Low total P_2O_5
D	24-33	6·76	N.D.	N.D.	68·2	6·1	22·4	4·79	0·18	0·05	0·17	Nil	100·0	6·53			0·035	1·2	Low readily soluble P_2O_5 except in D.
D	36-43	1·38	N.D.	N.D.	72·2	7·1	19·3	0·81	0·14	Nil	0·21	3·09	27·3	5·05			0·060	14·6	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100g. Read. Sol. P_2O_5	Remarks
11.								HOBKIRK ASSOCIATION; Hobkirk Series. Cessford Moor, 79502-79506.											
A	0-1	10·70	32·3	34·8	61·7	5·3	27·5	0·14	0·63	0·02	0·71	23·79	5·9	4·90	5·36	0·355	0·161	1·0	Very low exchangeable bases.
B_2	3-6	4·77	39·2	37·5	60·3	16·4	20·9	Nil	0·13	Nil	0·17	12·23	2·4	4·91	1·34	0·112	0·092	Nil	
B_3	9-12	3·80	26·3	41·0	50·9	16·4	28·9	Nil	0·16	Nil	0·14	8·63	3·4	4·99			0·081	Nil	Very low readily soluble P_2O_5.
C	16-20	3·34	38·8	30·8	53·8	15·8	27·1	Nil	0·22	Nil	0·16	8·96	4·1	5·01			0·107	Nil	
C	35-41	3·08	35·2	33·3	53·8	14·7	28·4	Nil	0·53	Nil	0·19	11·25	6·0	4·90			0·110	Nil	
12.								HOBKIRK ASSOCIATION; Hobkirk Series. Dolphinston Moor, 83045-83049.											
A	1-6	9·85	46·2	35·2	68·5	12·9	13·7	2·04	0·64	Nil	0·27	24·10	10·9	4·95	3·60	0·348	0·134	0·9	Low exchangeable bases.
B_2	8-10	3·91	45·6	35·6	65·1	15·1	17·0	0·96	0·06	Nil	0·07	16·55	6·2	5·56	0·99	0·091	0·103	0·9	
B_3	12-17	2·63	40·8	35·4	54·6	18·2	24·6	0·51	0·08	Nil	0·09	13·58	4·8	5·34	0·23	0·061	0·108	2·1	Low readily soluble P_2O_5.
D	20-24	2·02	67·4	14·1	74·2	9·2	14·6	0·20	0·06	Nil	0·08	12·68	2·6	5·24			0·093	4·2	
D	26-31	3·71	39·5	34·7	61·9	10·8	24·9	0·50	0·08	Nil	0·13	12·14	5·5	5·22			0·102	1·5	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
13.																			
HOBKIRK ASSOCIATION; Hobkirk Series. Graden Moor, 79443-79447.																			
A	0-2	9·60	N.D.	N.D.	82·9	6·0	6·3	0·21	0·18	Nil	0·24	25·68	2·4	3·92	5·52	0·174	0·061	0·7	Low exchangeable bases in A, B_2 and B_3.
B_2	4-8	5·48	N.D.	N.D.	59·9	27·8	9·6	0·15	0·09	0·02	0·08	23·15	1·4	4·42	2·59	0·102	0·040	0·5	
B_3	12-15	1·38	N.D.	N.D.	80·5	6·7	11·4	0·25	0·13	0·07	0·08	4·75	10·0	4·80			0·097	5·9	Low total P_2O_5 in A and B_2.
C	26-28	1·91	N.D.	N.D.	74·3	12·6	11·2	2·04	1·22	0·04	0·20	6·40	35·4	5·29			0·139	6·4	Low readily soluble P_2O_5 in A and B_2.
C	36-42	2·28	N.D.	N.D.	59·4	14·2	24·1	4·40	2·18	0·11	0·35	9·43	42·7	5·40			0·180	11·4	
14.																			
HOBKIRK ASSOCIATION; Hobkirk Series. Kerchester, 79460-79464.																			
A	1-5	5·57	N.D.	N.D.	75·3	8·9	12·7	8·81	1·62	0·05	0·11	6·35	62·5	6·13	2·31	0·202	0·105	7·6	
B_2	8-13	3·80	N.D.	N.D.	75·0	8·6	12·6	6·89	0·68	0·07	0·05	2·83	73·0	6·45	1·19	0·101	0·066	0·7	Low total P_2O_5.
B_3	17-21	1·32	N.D.	N.D.	80·7	7·9	10·1	3·77	0·20	0·07	0·05	0·91	81·8	6·59			0·059	0·3	
B_3	26-32	1·88	N.D.	N.D.	75·3	9·0	13·8	4·60	0·19	0·09	0·06	0·30	94·2	6·95			0·048	Nil	Low readily soluble P_2O_5 except in A.
C	37-43	1·85	N.D.	N.D.	82·6	6·5	9·1	4·28	0·34	0·07	0·10	Nil	100·0	7·01			0·042	0·6	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
15.								HOBKIRK ASSOCIATION; Hobkirk Series. Kerchester, 79479-79483.											
A	2-6	6·39	N.D.	N.D.	72·3	8·9	15·6	6·95	0·59	Nil	0·14	6·75	53·2	6·08	2·29	0·163	0·129	8·5	Low exchangeable bases in D.
B_2	10-14	2·35	N.D.	N.D.	71·1	8·8	17·8	3·72	0·46	Nil	0·14	3·84	52·9	6·31	0·64	0·050	0·097	8·9	
B_3	20-24	1·74	N.D.	N.D.	67·9	11·9	19·3	3·04	0·28	Nil	0·17	6·40	35·4	5·71			0·082	8·7	Low total P_2O_5 except in A.
D	32-36	3·51	N.D.	N.D.	85·8	2·8	7·9	1·26	0·10	Nil	0·08	2·52	36·4	5·70			0·066	25·7	High readily soluble P_2O_5 in D.
D	42-47	1·26	N.D.	N.D.	88·0	3·5	7·2	1·01	0·13	Nil	0·08	3·12	28·2	5·50			0·069	26·5	
16.								CARTER ASSOCIATION; Coblaw Series. Carter Bar, 98525-98528.											
A	1-5	11·55	52·5	27·4	69·0	10·9	14·3	1·41	0·50	0·09	0·31	17·60	11·6	5·00	4·60	0·312	0·164	0·5	
A	6-9	10·00	52·7	26·9	67·0	12·6	15·4	2·65	0·88	0·12	0·22	13·20	22·6	5·54	3·45	0·250	0·163	0·4	Low readily
B_2	11-15	7·34	52·4	28·3	65·6	15·1	15·6	2·49	1·06	0·08	0·13	10·30	26·8	5·68			0·141	0·4	soluble P_2O_5.
B_3	16-20	4·12	55·0	22·8	66·9	10·9	20·1	2·32	0·92	0·06	0·23	5·34	40·5	5·89			0·122	2·5	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
17.								CARTER ASSOCIATION; Coblaw Series. Martinlee, 98520-98524.											
A	0-3	6·05	N.D.	N.D.	77·5	8·7	10·8	0·92	0·18	0·08	0·22	11·00	11·3	4·42	2·92	0·204	0·089	0·8	
A	5-9	2·93	N.D.	N.D.	76·8	9·8	10·5	Nil	0·02	0·04	0·05	5·98	1·8	4·98	1·02	0·102	0·075	0·8	Very low exchangeable bases.
B_2	12-16	2·33	N.D.	N.D.	78·0	8·1	11·6	Nil	0·02	0·04	0·01	4·47	1·5	4·78			0·080	0·6	Low total P_2O_5.
B_3	21-25	2·58	N.D.	N.D.	66·9	9·8	20·7	Nil	0·02	0·06	0·05	4·47	2·8	4·94			0·057	0·5	Low readily soluble P_2O_5.
C(g)	28-34	2·72	N.D.	N.D.	45·2	29·0	23·1	Nil	0·04	0·04	0·07	4·51	3·2	4·95			0·046	0·4	
18.								ECKFORD ASSOCIATION; Eckford Series. Eckford, 103574-103578.											
A	0-3	6·61	52·5	30·5	72·2	9·1	13·4	7·02	0·46	0·26	0·38	2·07	79·6	6·26	2·30	0·154	0·131	4·0	
A	5-9	3·46	54·1	30·4	75·8	8·4	12·3	7·28	0·22	0·16	0·08	1·50	83·7	6·55	1·47	0·100	0·124	6·6	
B_2	12-16	2·64	53·3	32·7	78·8	7·7	10·9	5·75	0·20	0·13	0·05	Nil	100·0	7·25			0·105	3·6	
B_3	20-24	2·48	52·9	34·6	79·0	7·2	11·3	5·30	0·08	0·07	0·12	Nil	100·0	7·27			0·120	4·8	
C	40-44	2·39	60·3	27·2	79·1	7·5	11·1	4·24	0·12	0·07	0·12	Nil	100·0	7·22			0·122	3·3	

PEATY PODZOLS (WITH IRON PAN)

19. ETTRICK ASSOCIATION; Dod Series. Carewoodrig, 103553-103556.

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
A_2	1-4	17·30	27·0	40·5	48·0	19·5	19·5	0·31	0·30	0·25	0·24	31·58	3·4	4·24	8·50	0·515	0·287	1·3	Very low exchangeable bases.
B_2	5-9	10·04	26·2	40·5	44·3	22·0	28·7	0·16	0·06	0·21	0·07	19·65	2·5	4·82	2·94	0·203	0·675	6·9	
B_3	12-16	13·89	55·1	28·0	68·6	13·9	10·6	Nil	0·08	0·16	0·08	20·78	1·5	4·72			0·822	5·1	High total P_2O_5 in B_2 and B_3.
C	24-30	7·10	31·1	44·0	46·6	28·5	21·3	0·15	0·06	0·10	0·04	7·22	4·6	5·00			0·246	2·2	

20. ETTRICK ASSOCIATION; Dod Series. Dod Hill, 92885-92887.

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
A_1	0-2	11·90	40·3	30·4	52·8	17·9	23·4	Nil	0·04	0·10	0·09	28·20	0·8	4·58	5·74	0·284	0·120	0·6	Very low exchangeable bases.
B_2	3-6	6·96	31·4	30·7	41·7	20·4	34·4	Nil	0·04	0·06	0·04	15·05	0·9	4·98	1·47	0·137	0·238	0·6	Low readily soluble P_2O_5 in A_1 and B_2.
B_3	18-21	6·08	57·5	22·9	67·9	12·5	16·6	0·16	0·12	0·06	0·02	8·65	4·0	5·16			0·292	4·8	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							

21. ETTRICK ASSOCIATION; Dod Series. Wigg Burn, 90462-90464.

A_1	0-4	12·70	N.D.	N.D.	46·3	25·8	21·7	0·16	0·12	0·09	0·10	22·40	2·1	4·15	6·80	0·355	0·106	1·0	Very low exchangeable bases.
B_2	5-10	6·95	N.D.	N.D.	32·1	28·8	35·6	Nil	0·04	0·06	0·04	10·90	1·3	4·92	1·40	0·110	0·380	4·4	High total P_2O_5 in B_2.
B_3	12-15	4·68	N.D.	N.D.	30·2	25·5	42·0	0·15	0·14	0·07	0·08	7·06	5·9	4·97			0·168	6·7	High per cent. clay in B_2 and B_3.

22. SOURHOPE ASSOCIATION; Cowie Series. The Curr, 77257-77261.

H	6-1	53·50	N.D.	N.D.	N.D.	N.D.	N.D.	1·06	1·69	0·36	1·10	88·20	3·5	3·78	21·60	1·200	0·282	8·6	Very low exchangeable bases except in H.
A_2	4-10	8·24	N.D.	N.D.	61·8	24·0	10·1	Nil	0·08	0·01	0·08	15·25	1·1	4·80	1·49	0·167	0·341	11·5	
B_2	12-16	4·47	N.D.	N.D.	68·4	22·6	6·8	Nil	Nil	0·01	0·06	8·40	0·8	4·71			0·278	24·6	High total P_2O_5 in A_2.
B_3	20-24	3·99	N.D.	N.D.	67·0	22·8	6·2	Nil	0·08	0·01	0·06	7·77	1·5	4·70			0·172	37·5	High readily soluble P_2O_5.
C	29-34	4·48	N.D.	N.D.	65·2	24·8	7·8	Nil	0·10	0·01	0·11	10·75	2·0	4·54			0·234	39·6	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
23.							SOURHOPE ASSOCIATION; Cowie Series. The Gair, 77199-77203												
H	5-1	79·40	N.D.	N.D.	N.D.	N.D.	N.D.	4·56	4·48	1·04	2·10	50·30	19·5	3·93	35·50	2·470	0·477	25·4	Very low exchangeable bases
B_2	4-9	6·61	N.D.	N.D.	63·9	14·1	18·7	Nil	0·06	0·24	0·06	12·25	2·9	5·22	2·24	0·166	0·372	2·7	except in H.
B_2	11-15	7·37	N.D.	N.D.	75·6	10·3	10·4	Nil	0·10	0·22	Nil	12·55	2·5	4·97	1·68	0·191	0·439	2·7	High total P_2O_5 in H and B_2.
B_3	17-22	4·45	N.D.	N.D.	63·7	24·0	10·1	Nil	0·04	0·07	0·04	6·60	2·2	4·94			0·262	17·9	High readily soluble.
C	34-39	5·71	N.D.	N.D.	56·0	28·0	13·2	0·10	0·32	0·16	0·12	15·83	4·2	5·14			0·282	39·8	P_2O_5 in H, B_3 and C.
24.							SOURHOPE ASSOCIATION; Cowie Series. The Gair, 77204-77208.												
H	4-0	84·60	N.D.	N.D.	N.D.	N.D.	N.D.	2·73	3·54	1·22	1·93	49·70	15·9	3·84	33·21	2·820	0·400	10·0	Very low exchangeable
B_2	11-15	9·48	N.D.	N.D.	64·8	12·4	18·1	Nil	0·05	0·03	0·04	16·20	0·7	4·79	2·69	0·148	0·322	2·9	bases except in H.
B_2	17-20	6·41	N.D.	N.D.	70·5	14·6	11·7	Nil	0·04	0·04	0·03	8·50	1·3	4·90			0·233	2·8	
B_3	26-33	3·88	N.D.	N.D.	68·6	17·6	9·9	Nil	0·03	0·04	0·03	4·20	2·3	4·83			0·146	5·8	High total P_2O_5 in H and B_2.
C	38-42	4·35	N.D.	N.D.	76·7	12·3	8·8	0·05	0·05	0·06	0·04	3·70	5·1	4·86			0·102	3·0	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
25. SOURHOPE ASSOCIATION; Cowie Series. The Gair, 103579-103582.																			
A_2	4-8	14·20	46·9	34·0	67·6	12·1	13·2	0·16	0·08	0·10	0·13	25·50	1·8	4·80	6·20	0·302	0·223	3·7	Very low exchangeable bases.
B_2	11-14	8·81	43·3	37·9	64·2	16·0	15·4	0·16	0·02	0·08	0·11	12·90	2·8	4·86	2·40	0·109	0·259	2·2	
B_3	17-21	7·05	46·8	35·8	68·1	16·8	11·6	0·15	0·06	0·08	0·09	9·17	4·0	4·90			0·238	4·9	
C	32-36	8·01	56·3	29·4	75·6	9·9	10·5	0·15	0·04	0·11	0·09	10·02	3·8	4·83			0·236	4·2	
26. SOURHOPE ASSOCIATION; Cowie Series. Rushy Fell, 97197-97201																			
H	6-2	89·60	N.D.	N.D.	N.D.	N.D.	N.D.	3·52	2·22	0·56	0·73	97·00	6·7	3·90	44·40	1·980	0·305	4·9	Very low exchangeable bases except in H.
A_2	0-2½	15·45	65·7	15·2	73·2	7·7	11·4	0·16	0·16	0·20	0·24	30·30	2·5	4·45	7·22	0·370	0·146	1·1	
B_2	3-6½	4·86	62·0	24·0	72·8	13·2	11·6	Nil	0·02	0·05	0·04	6·30	1·7	4·96			0·100	1·0	
B_3	14-18	7·09	65·2	20·6	71·1	14·9	10·5	Nil	0·02	0·06	0·06	11·88	1·2	4·94			0·261	4·4	
27. HOBKIRK ASSOCIATION; Faw Series. Bellinghill, 83062-83066.																			
A_2	0-3	8·70	N.D.	N.D.	75·3	12·3	8·2	0·51	0·62	Nil	0·27	10·39	11·9	4·08	4·52	0·255	0·056	2·4	Very low exchangeable bases.
B_2	4-7	4·20	N.D.	N.D.	66·8	23·1	8·0	Nil	0·02	Nil	0·09	6·22	1·7	4·40	1·00	0·082	0·220	12·7	
B_3	9-14	1·85	N.D.	N.D.	61·9	8·0	28·3	Nil	0·04	Nil	0·13	4·60	3·6	4·87	0·24	0·072	0·075	6·6	Low total P_2O_5 except in B_2.
C	20-26	1·65	N.D.	N.D.	61·7	11·2	25·5	Nil	0·18	Nil	0·16	4·88	6·5	5·03			0·080	10·3	
D	34-38	1·74	N.D.	N.D.	68·9	8·4	21·0	Nil	0·20	Nil	0·16	5·40	6·3	5·11			0·078	2·2	

28. HOBKIRK ASSOCIATION; Faw Series. Bellinghill, 83067-83071.

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
A_2	1-6	2·40	77·5	14·3	87·2	4·6	5·8	0·05	0·04	Nil	0·04	4·53	2·8	4·16	1·38	0·151	0·030	0·6	Very low exchangeable bases.
B_2	7-12	1·76	65·4	15·1	68·2	9·1	20·9	Nil	0·06	Nil	0·07	6·52	2·0	4·95	0·38	0·071	0·121	7·9	
D	14-17	2·43	36·0	31·4	47·8	16·8	33·0	Nil	0·26	Nil	0·25	7·70	6·2	5·11			0·114	10·6	Low total P_2O_5 in A_2.
D	23-27	1·30	63·7	22·8	75·8	10·0	12·9	Nil	0·16	Nil	0·13	3·56	7·5	5·12			0·091	17·8	Low readily soluble P_2O_5 in A_2.
D	33-39	1·75	17·7	51·7	36·3	31·1	30·9	Nil	0·28	Nil	0·25	8·23	5·0	5·05			0·104	14·1	

29. HOBKIRK ASSOCIATION; Faw Series. Kilnsike Tower, 83077-83081.

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
A_1	0-3	23·50	60·8	16·8	74·2	3·4	4·8	Nil	0·26	Nil	0·48	30·10	2·4	4·01	11·08	0·472	0·043	1·2	Very low exchangeable bases.
B_2	5-9	3·64	53·4	22·3	68·6	7·1	20·7	Nil	0·04	Nil	0·04	6·50	1·2	4·75	0·84	0·091	0·071	0·4	
B_3	14-18	2·73	47·9	17·3	55·5	9·7	32·1	Nil	0·08	Nil	0·13	6·21	3·3	4·78	0·23	0·051	0·068	0·5	Low total P_2O_5.
B_3	23-29	2·49	43·9	22·9	56·9	9·9	30·7	Nil	0·30	Nil	0·15	7·64	5·6	4·92			0·091	1·0	Low readily soluble P_2O_5 especially in B_2 and B_3.
D	37-41	2·36	45·3	22·3	57·1	10·5	30·0	Nil	0·62	Nil	0·15	7·24	9·6	5·01			0·100	2·6	

Horizon	Depth in.	% Loss on Ignition	Soil Separates % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g. Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
30.																			
CARTER ASSOCIATION; Arks Series. Carter Bar, 98529-98532.																			
A_2	0-3	10·20	69·8	17·0	79·8	7·0	8·1	0·16	0·12	0·07	0·16	27·40	1·8	3·95	4·84	0·187	0·070	0·6	Very low exchangeable bases.
B_2	7-11	4·75	63·7	19·5	75·4	7·8	14·4	Nil	0·06	0·04	0·07	13·09	1·3	4·69	1·09	0·082	0·078	0·4	
B_3	13-17	3·61	68·9	14·4	76·5	6·8	13·1	Nil	0·04	0·04	0·03	8·19	1·3	4·70			0·067	0·5	Low total P_2O_5.
C	17-23	1·78	82·3	3·5	83·5	2·3	12·4	Nil	0·04	0·02	0·03	3·32	2·6	5·03			0·051	3·5	Low readily soluble P_2O_5 except in C.
31.																			
CARTER ASSOCIATION; Arks Series. Martinlee, 83118-83123.																			
A_1	2-8	17·80	63·4	17·8	74·1	7·1	5·4	Nil	0·44	Nil	0·27	33·00	2·1	4·09	9·34	0·333	0·070	2·1	Very low exchangeable bases.
B_1	@ 13	7·80	60·6	20·1	71·9	8·8	15·4	Nil	0·18	Nil	0·13	23·38	1·3	4·27	3·14	0·205	0·065	0·5	
$B_2(g)$	13-18	1·29	50·2	22·2	61·7	10·7	26·3	Nil	0·12	Nil	0·07	11·52	1·6	4·77	0·39	0·102	0·045	0·4	Low total P_2O_5.
$B_3(g)$	20-26	4·17	34·7	21·6	44·2	12·1	41·6	Nil	0·20	Nil	0·14	11·05	3·0	4·89			0·046	0·5	Low readily soluble P_2O_5 except in A_1.
$B_3(g)$	29-34	3·29	43·5	18·4	52·0	9·9	34·8	Nil	0·46	Nil	0·13	10·78	5·2	5·02			0·052	0·6	
$C(g)$	36-42	3·37	39·1	20·4	46·4	13·1	37·1	Nil	0·48	Nil	0·13	10·91	5·3	5·17			0·065	0·6	

NON-CALCAREOUS GLEYS

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100g. Read. Sol. P_2O_5	Remarks
32.								ETTRICK ASSOCIATION; Ettrick Series. Carewoodrig, 103565-103569.											
A_2g	2-5	11·30	8·3	62·2	27·6	42·1	24·6	5·58	2·38	0·27	0·25	8·67	49·5	5·65	4·47	0·342	0·167	5·8	High pH in B_3g and Cg.
B_2g	8-11	7·68	Nil	66·6	17·2	45·7	33·3	6·18	2·28	0·19	0·13	5·05	60·6	5·92	2·48	0·182	0·129	11·1	
B_2g	12-15	9·42	5·4	56·0	24·8	38·4	32·1	7·72	2·40	0·22	0·14	5·25	66·6	5·94			0·116	16·1	High readily soluble P_2O_5 except in A_2g.
B_3g	19-23	4·10	24·1	40·9	36·0	29·6	32·3	5·80	2·40	0·12	0·14	Nil	100·0	7·02			0·177	106·2	
Cg	35-39	4·07	30·9	33·5	41·8	20·5	35·7	6·08	1·90	0·12	0·17	Nil	100·0	7·44			0·188	88·1	
33.								ETTRICK ASSOCIATION; Ettrick Series. Curling, 88247-88252.											
A_1g	0-5	12·60	N.D.	N.D.	31·0	27·0	35·7	3·92	0·74	0·39	0·29	13·50	28·4	5·51	5·01	0·421	0·123	1·3	High exchangeable Ca in B_3g and Cg.
A_2g	7-12	7·62	N.D.	N.D.	7·6	19·8	68·8	4·73	1·34	0·27	0·20	8·37	43·8	5·86	0·99	0·153	0·080	1·5	High pH in B_3g and Cg.
B_2g	13-16	5·73	N.D.	N.D.	24·4	29·9	42·8	3·24	0·68	0·17	0·17	6·90	38·2	5·75	1·74	0·204	0·085	3·0	Low total P_2O_5 in A_2g and B_2g.
B_2g	17-20	4·68	N.D.	N.D.	27·3	28·4	42·0	4·14	1·06	0·10	0·10	2·54	68·1	6·21			0·050	2·1	High readily soluble P_2O_5 in B_2g and Cg.
B_3g	22-26	4·31	N.D.	N.D.	31·9	23·1	42·9	9·07	1·64	0·13	0·10	Nil	100·0	7·11			0·140	40·8	
Cg	35-41	2·69	N.D.	N.D.	40·3	22·4	34·6	8·85	2·12	0·15	0·10	Nil	100·0	7·45			0·123	32·1	High clay content, particularly in A_2g.

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
34.							ETTRICK ASSOCIATION; Ettrick Series. Gee, 90481-90485.												
A_1g	1-4	11·25	N.D.	N.D.	39·7	22·0	32·7	1·25	0·46	0·15	0·34	13·15	14·3	4·51	4·55	0·289	0·124	1·5	Low exchangeable bases in A_2g, high in B_3g and Cg. High pH in B_3g and Cg. Low total P_2O_5 in A_2g. Low readily soluble P_2O_5 except in B_3g. High clay content.
A_2g	5-8	5·72	N.D.	N.D.	23·0	27·7	46·4	0·77	0·34	0·13	0·17	5·37	20·8	4·92	0·95	0·108	0·071	1·1	
B_2g	10-15	4·83	N.D.	N.D.	20·6	27·3	49·8	3·69	0·62	0·11	0·13	3·66	55·5	5·65			0·128	0·9	
B_3g	22-28	4·21	N.D.	N.D.	25·9	23·2	48·8	12·80	2·12	0·12	0·17	Nil	100·0	7·80			0·204	48·5	
Cg	33-36	7·95	N.D.	N.D.	25·1	25·3	45·6	57·80	2·16	0·16	0·31	Nil	100·0	8·62			0·168	0·6	
35.							ETTRICK ASSOCIATION; Ettrick Series. Girnwoodhill, 92866-92869.												
A_1g	1-5	13·90	24·1	32·3	33·3	23·1	36·7	5·56	1·76	0·20	0·36	17·50	31·1	5·60	4·93	0·428	0·188	1·6	High exchangeable bases in B_3g and Cg. High pH in B_3g and Cg. Low total P_2O_5 in B_2g. Low readily soluble P_2O_5 in A_1g, high otherwise. High clay content.
B_2g	11-16	4·68	15·2	46·6	34·7	27·1	35·9	4·01	1·28	0·10	0·08	1·83	75·0	6·14	0·79	0·072	0·075	11·3	
B_3g	21-25	4·05	22·3	37·9	37·0	23·2	37·8	8·78	2·10	0·09	0·13	Nil	100·0	7·68			0·148	66·3	
Cg	28-33	4·03	21·1	31·7	29·1	23·3	45·2	9·26	2·62	0·12	0·17	Nil	100·0	7·84			0·157	63·4	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							

36. ETTRICK ASSOCIATION; Ettrick Series. Groundistone, 87390-87393.

A_1g	2-8	11·14	N.D.	N.D.	23·6	40·2	30·6	10·52	0·42	0·19	0·16	5·17	68·7	5·94	5·32	0·386	0·125	1·9	High exchangeable Ca except in B_2g. High pH in B_3g and Cg. Low total P_2O_5 in B_2g. Low readily soluble P_2O_5 in A_1g and Cg, high in B_3g.
B_2g	11-15	3·63	N.D.	N.D.	37·6	25·7	33·1	5·22	0·24	0·12	0·02	1·88	75·0	6·43	0·60	0·076	0·056	7·8	
B_3g	22-28	4·00	N.D.	N.D.	24·5	26·0	45·5	13·60	1·30	0·12	0·08	Nil	100·0	7·37			0·155	50·4	
Cg	34-40	7·67	N.D.	N.D.	23·5	29·1	43·6	54·50	1·68	0·13	0·20	Nil	100·0	8·61			0·134	1·0	

37. ETTRICK ASSOCIATION; Ettrick Series. Langsidebrae, 92874-92877.

A_1g	1-4	10·91	N.D.	N.D.	33·4	25·0	36·2	1·26	0·62	0·21	0·22	12·85	15·2	5·01	4·02	0·359	0·156	1·3	Low total P_2O_5 in B_2g. Low readily soluble P_2O_5 in A_1g, A_2g and B_2g.
A_2g	6-9	8·83	N.D.	N.D.	27·8	27·8	40·0	1·87	0·74	0·12	0·16	9·66	23·0	5·40	2·75	0·255	0·141	1·0	
B_2g	12-17	4·25	N.D.	N.D.	31·9	23·9	42·2	2·45	1·44	0·19	0·08	2·97	58·4	5·75			0·055	0·6	
Cg	34-36	3 49	N.D.	N.D.	35·3	20·7	40·6	2·02	2·72	0·20	0·13	2·02	71·6	6·70			0·132	4·7	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
38.								ETTRICK ASSOCIATION; Ettrick Series Stobie Slack, 91720-91724.											
A_1g	1-3	13·00	N.D.	N.D.	47·8	19·5	26·2	2·65	0·60	0·24	0·28	15·40	19·7	5·08	5·43	0·426	0·167	0·5	Low total P_2O_5 in B_2g B_3g and Cg.
A_2g	5-8	9·80	N.D.	N.D.	39·7	26·4	29·0	2·34	0·82	0·19	0·17	11·81	22·9	5·32	4·03	0·384	0·159	0·3	
B_2g	12-15	4·60	N.D.	N.D.	42·7	22·4	32·6	1·39	0·54	0·09	0·05	7·65	21·3	5·47			0·076	0·3	Low readily soluble P_2O_5 throughout.
B_3g	17-21	3·16	N.D.	N.D.	44·1	23·8	28·9	1·53	0·82	0·10	0·05	4·95	33·6	5·96			0·056	0·3	
Cg	27-30	3·25	N.D.	N.D.	39·3	22·5	35·0	4·75	3·00	0·14	0·13	Nil	100·0	6·27			0·089	0·3	
39.								ETTRICK ASSOCIATION; Ettrick Series. Woodburn, 91730-91735.											
A_1g	1-4	22·90	43·6	30·6	61·3	12·9	8·7	0·48	0·56	0·19	0·38	27·18	5·6	4·61	8·50	0·834	0·312	2·2	Low exchangeable Ca except in Cg.
A_2g	5-7	9·20	18·1	42·4	31·4	25·8	38·2	0·16	0·12	0·19	0·07	13·25	3·9	4·73	3·02	0·236	0·191	0·5	
A_2g	8-10	7·75	3·8	44·9	10·3	38·4	47·4	0·16	0·12	0·18	0·05	10·10	4·8	4·80	1·87	0·169	0·258	1·7	High pH in Cg.
B_2g	12-14	5·81	6·1	49·5	22·5	33·1	41·5	0·15	0·26	0·13	0·05	7·07	7·7	4·87			0·161	2·0	Low readily soluble P_2O_5 except in Cg.
B_3g	17-20	4·90	14·7	37·2	24·2	28·3	45·2	1·38	0·62	0·11	0·07	5·00	38·8	5·37			0·129	1·4	
Cg	29-32	4·36	17·2	39·4	30·6	24·6	42·6	18·50	1·02	0·16	0·14	Nil	100·0	8·15			0·190	38·5	Low clay content in A_1g.

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
40.								ETTRICK ASSOCIATION; Ettrick Series. Woo Law, 88286-88291.											
A_1g	0-3	15·50	31·3	30·4	41·9	20·7	25·8	1·09	0·34	0·10	0·52	20·90	8·9	4·76	6·25	0·330	0·109	0·8	Low exchangeable Ca in A_1g, A_2g and B_2g, high in B_3g and Cg.
A_2g	3-7	5·16	13·3	42·8	24·5	29·8	43·1	0·30	0·20	0·06	0·13	6·88	9·1	5·26	0·70	0·081	0·058	3·1	
B_2g	9-12	8·50	10·8	36·8	21·8	27·2	46·8	1·67	0·38	0·08	0·18	6·72	25·6	5·16	0·40	0·071	0·076	0·5	High pH in B_3g and Cg.
B_2g	14-18	5·25	16·2	32·9	25·6	25·5	46·3	7·03	0·60	0·09	0·13	4·02	66·1	5·62			0·120	2·1	
B_3g	22-28	4·70	19·3	28·2	25·1	22·7	49·9	17·40	1·20	0·13	0·17	Nil	100·0	7·26			0·158	43·8	Low total P_2O_5 in A_2g and B_2g.
Cg	34-40	7·10	20·8	29·0	26·2	20·6	49·8	59·40	1·40	0·13	0·30	Nil	100·0	8·31			0·145	0·8	Low readily soluble P_2O_5 except in B_3g.
41.								ETTRICK ASSOCIATION; Peden Series. Curling, 88253-88258.											
A_1g	0-3	23·30	N.D.	N.D.	50·3	14·9	17·3	16·75	2·30	0·28	0·32	11·20	62·5	6·15	10·88	0·728	0·172	3·8	High to very high exchangeable bases.
A_2g	7-13	7·26	N.D.	N.D.	28·2	30·9	37·3	9·42	1·24	0·15	0·13	4·78	69·5	6·71	1·96	0·230	0·119	12·6	
B_2g	16-20	4·26	N.D.	N.D.	24·9	28·7	44·3	11·27	1·76	0·14	0·10	Nil	100·0	7·46	0·48	0·088	0·155	66·8	High pH in B_2g, B_3g and Cg.
B_2g	21-25	3·89	N.D.	N.D.	30·6	25·4	40·2	12·68	1·86	0·14	0·08	Nil	100·0	7·84			0·152	82·0	
B_3g	27-32	3·96	N.D.	N.D.	26·5	26·8	42·8	17·95	1·82	0·14	0·13	Nil	100·0	8·09			0·159	85·6	High readily soluble P_2O_5 except in A_1g and Cg.
Cg	35-41	3·42	N.D.	N.D.	28·0	28·1	40·5	59·20	2·00	0·17	0·22	Nil	100·0	8·61			0·144	2·6	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
42.					ETTRICK ASSOCIATION; Peden Series. Gee, 90475-90480.														
A_1g	1-5	24·80	N.D.	N.D.	42·0	17·9	21·6	1·60	0·76	0·38	0·30	30·50	9·1	4·51	14·45	0·551	0·222	1·7	Low exchangeable bases in A_1g, A_2g, and B_2g, high in Cg. High pH in Cg. Low total P_2O_5 in A_2g and B_2g. Low readily soluble P_2O_5 in A_1g, A_2g and B_2g, high in B_3g.
A_2g	9-12	6·45	N.D.	N.D.	34·3	26·5	36·0	0·92	0·26	0·10	0·08	9·63	12·4	4·92	2·21	0·163	0·084	1·4	
B_2g	14-17	4·36	N.D.	N.D.	20·8	27·0	50·0	1·37	0·50	0·05	0·10	4·85	29·4	5·29	0·56	0·087	0·058	1·5	
B_3g	17-23	3·83	N.D.	N.D.	13·1	26·1	57·0	5·70	1·14	0·13	0·17	2·44	74·5	5·68			0·166	69·5	
B_3g	29-32	5·05	N.D.	N.D.	21·2	25·3	51·0	7·15	0·82	0·09	0·17	Nil	100·0	7·49			0·202	43·0	
Cg	36-39	4·48	N.D.	N.D.	24·5	27·5	45·8	23·80	0·82	0·12	0·24	Nil	100·0	8·13			0·193	4·5	
43.					ETTRICK ASSOCIATION; Peden Series. Wigg, 90495-90499.														
A_1g	1-6	21·70	N.D.	N.D.	50·9	12·3	20·0	20·15	2·34	0·26	0·35	15·85	59·4	5·57	9·95	0·937	0·386	1·5	High exchangeable bases in A_1g and B_2g. Low total P_2O_5 in B_2g and B_3g, high in A_1g. Low readily soluble P_2O_5 in A_1g, high in B_2g, B_3g and Cg.
B_2g	12-17	5·20	N.D.	N.D	31·3	22·0	44·2	8·33	1·18	0·11	0·13	3·16	75·5	6·15	1·11	0·128	0·085	7·4	
B_2g	20-24	5·33	N.D.	N.D.	29·1	22·4	45·8	8·95	2·08	0·10	0·14	2·95	79·5	6·26			0·085	13·5	
B_3g	27-31	3·15	N.D.	N.D.	39·7	30·0	27·2	4·73	1·12	0·14	0·11	1·70	78·3	5·90			0·075	25·2	
Cg	38-42	3·75	N.D.	N.D.	30·1	27·9	38·3	3·96	1·02	0·10	0·17	1·94	73·2	5·61			0·111	15·4	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
44.																			
ETTRICK ASSOCIATION; Peden Series. Woodburn, 91736-91741.																			
A_1g	1-5	13·63	30·0	42·0	46·2	26·5	20·6	12·31	1·62	0·19	0·16	8·74	62·0	5·71	5·20	0·486	0·186	6·3	High exchangeable bases.
A_2g	5-8	11·65	27·8	45·0	44·0	26·0	24·2	12·60	1·94	0·25	0·15	7·17	67·6	6·05	4·34	0·406	0·178	10·2	
B_2g	9-12	15·75	25·0	32·6	32·7	21·7	37·7	21·20	3·18	0·25	0·18	8·35	75·0	6·27	6·41	0·595	0·227	9·8	High pH in B_3g and Cg.
B_2g	13-17	8·00	Nil	46·1	13·7	32·4	49·9	20·55	3·40	0·18	0·16	4·13	85·5	6·81			0·156	24·7	High readily soluble P_2O_5 except in A_1g.
B_3g	18-24	4·23	13·4	48·7	30·4	31·9	35·6	6·84	0·88	0·14	0·10	Nil	100·0	7·08			0·180	78·3	
Cg	36-39	4·39	27·3	35·6	38·2	24·7	34·9	9·31	0·78	0·08	0·13	Nil	100·0	8·02			0·198	66·8	
45.																			
SOURHOPE ASSOCIATION; Atton Series. Fasset, 77228-77232.																			
A_1g	1-4	10·30	44·2	24·8	57·1	12·9	24·9	5·66	2·91	0·18	0·73	7·55	55·6	4·92	3·97	0·399	0·220	3·5	High exchangeable bases except ih A_1g.
A_2g	6-11	4·76	31·5	26·7	45·3	13·8	38·6	13·40	7·10	0·27	0·43	2·88	88·0	5·76	0·93	0·096	0·068	1·2	
B_2g	17-23	3·84	25·1	26·2	35·0	16·4	44·8	19·60	10·50	0·23	0·53	2·05	93·9	5·90			0·068	1·5	Low total P_2O_5in A_2g and B_2g.
B_3g	25-31	3·11	29·7	30·4	43·6	17·9	35·4	17·20	8·85	0·22	0·42	2·17	92·5	5·97			0·152	9·8	Low readily soluble P_2O_5 in A_2g and B_2g, high in Cg.
Cg	41-46	3·34	31·9	27·6	43·3	18·0	35·4	20·90	10·70	0·26	0·44	Nil	100·0	6·05			0·175	19·6	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
46.								HOBKIRK ASSOCIATION; Cessford Series. Cessford Moor, 79496-79501.											
A_1g	1-4	9·07	N.D.	N.D.	59·2	19·0	17·3	Nil	0·33	0·02	0·25	19·72	3·0	4·69	4·24	0·267	0·139	0·5	Low exchangeable bases, except in B_3g and Cg.
A_2g	6-9	3·03	N.D.	N.D.	60·8	14·8	21·4	Nil	0·25	Nil	0·08	9·52	3·4	5·10	0·47	0·051	0·061	Nil	
B_2g	11·15	1·99	N.D.	N.D.	71·6	14·4	12·0	0·77	0·52	Nil	0·04	4·05	24·7	5·46			0·074	Nil	Low total P_2O_5 in A_2g and B_2g
B_2g	18-22	2·41	N.D.	N.D.	66·1	15·0	16·5	1·58	1·22	0·01	0·13	4·08	41·8	5·68			0·085	Nil	
B_3g	26-30	3·03	N.D.	N.D.	45·9	18·9	32·2	3·87	2·96	0·02	0·20	4·79	59·5	6·05			0·111	18·7	Low readily soluble P_2O_5 except in B_3g and Cg.
C	35-39	2·96	N.D.	N.D.	52·4	16·4	28·2	4·32	2·65	0·02	0·16	3·16	69·5	6·05			0·147	50·3	
47.								HOBKIRK ASSOCIATION; Cessford Series. Cessford Moor, 79507-79511.											
A_2g	2-5	5·28	40·7	28·8	65·1	4·4	27·9	1·00	0·53	Nil	0·23	10·53	14·3	5·17	2·20	0·183	0·060	0·5	Low exchangeable bases except in Cg.
B_2g	7-10	2·02	50·9	29·4	67·2	13·1	17·7	1·12	0·64	Nil	0·10	4·47	29·4	5·62	0·24	0·034	0·058	Nil	
B_2g	13-16	2·46	48·6	33·1	68·4	13·3	15·8	2·34	2·07	0·02	0·13	2·84	61·6	6·21			0·085	5·6	Low total P_2O_5 in A_2g and B_2g.
B_3g	24-29	3·08	33·5	38·5	52·7	19·3	24·9	2·80	1·99	Nil	0·04	2·55	65·5	6·62			0·137	32·9	Low readily soluble P_2O_5 in A_2g and B_2g high in B_3g and Cg.
Cg	35-41	3·18	30·4	39·5	53·2	16·7	26·9	7·44	2·96	0·05	0·16	2·55	80·7	6·37			0·148	20·1	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
48.								HOBKIRK ASSOCIATION; Cessford Series. Graden Moor, 79448-79453.											
A_1g	2-5	12·60	N.D.	N.D.	69·8	8·5	9·1	3·86	1·24	0·15	0·20	18·85	22·4	5·08	5·07	0·404	0·164	1·7	High exchangeable bases in Cg; high pH in Cg; low total P_2O_5 in A_2g and B_2g; low readily soluble P_2O_5 in A_1g and A_2g, high in B_2g, B_3g and Cg.
A_2g	8-10	2·60	N.D.	N.D.	74·1	10·6	12·7	3·32	1·63	0·03	0·08	4·17	54·9	5·76	0·21	0·051	0·072	1·3	
B_2g	13-18	2·12	N.D.	N.D.	69·9	16·7	11·3	3·78	2·02	0·05	0·08	1·92	75·5	6·01			0·089	18·0	
B_2g	19-23	1·33	N.D.	N.D.	83·2	3·2	12·3	4·02	1·92	0·02	0·08	Nil	100·0	6·61			0·118	61·8	
B_3g	29-35	1·60	N.D.	N.D.	76·9	3·2	18·3	5·55	2·13	0·03	0·14	Nil	100·0	6·92			0·192	92·5	
Cg	39-45	4·26	N.D.	N.D.	72·8	4·2	20·9	8·70	5·88	0·01	0·20	Nil	100·0	8·35			0·155	41·4	
49.								HOBKIRK ASSOCIATION; Cessford Series. Spittal, 90486-90490.											
A_1g	0-4	14·05	45·4	36·3	65·8	16·3	10·9	11·95	5·12	0·22	0·31	3·99	81·5	6·07	6·45	0·505	0·107	0·9	High exchangeable bases in A_1g and Cg; high pH in B_3g and Cg; low total P_2O_5 in A_2g and B_2g; low readily soluble P_2O_5 in A_1g, B_2g and Cg, high in B_3g.
A_2g	6-8	4·74	28·1	41·2	51·1	19·1	27·4	5·38	1·14	0·17	0·14	0·97	87·5	6·43	1·44	0·145	0·062	1·4	
B_2g	9-12	3·74	20·2	38·2	37·8	19·1	39·4	7·22	3·28	0·11	0·20	Nil	100·0	7·08			0·078	4·9	
B_3g	17-22	3·40	24·9	35·6	44·3	15·8	36·5	7·38	3·30	0·10	0·18	Nil	100·0	7·95			0·159	54·0	
Cg	40-46	6·06	28·0	33·2	43·9	16·3	36·8	31·80	5·06	0·14	0·28	Nil	100·0	8·68			0·158	2·9	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
50.								CARTER ASSOCIATION; Letham Series. Kiln Knowe, 97185-97189.											
A_1g	1-5	10·70	N.D.	N.D.	72·1	8·5	14·1	4·67	1·06	0·25	0·29	11·30	35·6	5·19	4·42	0·405	0·236	1·0	High exchangeable bases in B_3g and Cg.
A_2g	8-12	3·05	N.D.	N.D.	65·5	12·4	19·1	2·45	0·82	0·14	0·08	3·47	50·1	5·58	0·54	0·061	0·059	2·6	
B_2g	17-22	3·70	N.D.	N.D.	48·4	9·1	38·8	7·46	2·52	0·16	0·27	3·54	74·7	5·87			0·054	1·2	Low total P_2O_5 in A_2g, B_2g and B_3g.
B_3g	26-30	4·20	N.D.	N.D.	42·6	9·7	45·6	9·43	3·14	0·21	0·29	2·46	84·0	6·17			0·072	6·2	Low readily soluble P_2O_5 in A_1g, A_2g and B_2g, high in Cg.
Cg	35-39	4·12	N.D.	N.D.	42·0	10·2	43·7	9·80	3·22	0·17	0·28	0·95	93·3	6·99			0·145	50·3	
51.								CARTER ASSOCIATION; Letham Series. Wooplaw Rig, 83025-83030.											
A_1g	1-5	6·65	41·2	38·5	63·7	15·4	17·6	2·63	0·96	Nil	0·23	13·89	21·5	5·12	3·60	0·304	0·111	1·2	High exchangeable bases in B_3g and Cg.
A_2g	7-9	2·94	43·1	31·1	60·2	15·2	21·7	2·18	1·08	Nil	0·11	5·78	36·8	5·62	0·68	0·061	0·097	0·6	
B_2g	11-16	2·70	44·1	23·5	53·5	12·4	31·4	4·03	2·20	Nil	0·18	4·48	58·8	5·96	0·38	0·041	0·042	0·4	Low total P_2O_5 in B_2g and B_3g.
B_2g	18-24	2·32	48·3	17·0	51·5	10·4	35·8	6·95	3·86	Nil	0·26	1·95	85·0	6·54			0·048	0·4	Low readily soluble P_2O_5 in A_1g, A_2g and B_2g, high in Cg.
B_3g	26-32	2·48	50·0	17·5	54·4	9·6	33·5	7·71	3·78	Nil	0·24	Nil	100·0	7·18			0·074	7·4	
Cg	34-39	2·33	48·8	16·1	53·2	12·6	31·9	10·88	7·40	Nil	0·25	Nil	100·0	7·98			0·125	41·6	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100g. Read. Sol. P_2O_5	Remarks
52.						CARTER ASSOCIATION; Letham Series. Wooplaw Rig, 83019-83024.													
A_1g	1-5	15·60	N.D.	N.D.	52·4	14·7	21·3	10·71	7·05	0·14	0·48	8·60	68·2	5·77	7·39	0·646	0·236	2·2	High exchangeable Ca in A_1g and Cg, high exchangeable Mg throughout; high pH in B_2g, B_3g and Cg. Low total P_2O_5 in A_2g and B_2g. Low readily soluble P_2O_5 in A_1g, A_2g, and B_2g. High in B_3g snd Cg.
A_2g	6-8	4·50	N.D.	N.D.	61·4	14·1	22·3	4·66	4·67	Nil	0·10	4·72	66·6	6·64	1·15	0·092	0·082	3·3	
B_2g	10-15	3·24	N.D.	N.D.	48·0	16·2	32·6	7·34	6·31	Nil	0·20	Nil	100·0	7·23	0·46	0·103	0·069	1·1	
B_2g	18-22	2·79	N.D.	N.D.	43·4	22·6	31·2	6·61	4·46	Nil	0·25	Nil	100·0	7·69			0·094	10·1	
B_3g	26-32	2·71	N.D.	N.D.	42·3	19·2	35·8	6·52	5·28	Nil	0·34	Nil	100·0	7·88			0·146	53·7	
Cg	35-41	3·81	N.D.	N.D.	49·8	18·1	28·3	9·91	8·44	Nil	0·32	Nil	100·0	8·18			0·127	31·0	
53.						MINTO ASSOCIATION; Minto Series. Minto Kames, 86755-86758A.													
S	2-8	8·22	12·9	51·9	36·0	28·8	31·1	11·45	0·78	0·12	0·16	4·28	74·7	6·09	2·49	0·277	0·154	6·0	High exchangeable Ca in S.
A_2g	11-15	3·05	21·2	50·4	43·4	28·2	26·9	6·75	0·72	0·06	0·08	1·83	80·7	6·35	0·58	0·071	0·059	4·7	Low total P_2O_5 in A_2g, B_2g and B_3g. High readily soluble P_2O_5 in Cg.
B_2g	16½-19½	2·94	22·1	48·9	44·5	26·5	27·5	6·73	1·14	0·07	0·13	2·08	79·5	6·38			0·050	6·6	
B_3g	25-30	3·16	24·3	43·3	44·2	23·4	30·9	7·53	1·94	0·07	0·14	1·83	84·0	6·81			0·093	10·1	
Cg	39-44	2·31	20·2	46·8	41·9	25·1	30·7	8·00	1·56	0·07	0·18	1·47	87·0	6·84			0·125	19·2	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
54.								MINTO ASSOCIATION; Minto Series. Netheraw, 86739-86743.											
S	2-8	5·03	N.D.	N.D.	40·5	24·9	32·1	10·88	0·56	0·10	0·09	1·83	86·5	6·55	1·29	0·155	0·139	5·3	High exchangeable Ca throughout; high readily soluble P_2O_5 in B_2g, B_3g and Cg.
A_2g	11-14	3·29	N.D.	N.D.	44·4	28·3	24·0	9·92	0·28	0·09	0·05	Nil	100·0	7·02	0·32	0·060	0·091	9·9	
B_2g	16-20	4·04	N.D.	N.D.	44·9	31·1	22·1	10·92	0·44	0·11	0·05	Nil	100·0	7·05			0·136	42·4	
B_3g	25-29	2·73	N.D.	N.D.	50·8	26·7	20·0	8·85	0·66	0·09	0·07	Nil	100·0	7·03			0·163	69·8	
Cg	37-43	2·76	N.D.	N.D.	49·0	26·0	22·3	9·45	0·80	0·09	0·07	Nil	100·0	7·35			0·170	77·5	

PEATY GLEYS

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
55.								ETTRICK ASSOCIATION; Alemoor Series. Bishop Stone, 88270-88275.											
A_1g	0-4	16·10	N.D.	N.D.	50·4	17·2	24·4	0·16	0·36	0·11	0·21	38·40	2·1	4·28	8·22	0·499	0·142	1·9	Low exchangeable bases.
A_2g	4-7	7·70	N.D.	N.D.	22·6	32·9	40·8	0·16	0·12	0·07	0·16	19·05	2·6	4·82	2·66	0·212	0·104	0·5	
B_2g	9-13	4·66	N.D.	N.D.	39·1	24·4	34·2	0·15	0·08	0·03	0·07	10·11	3·2	4·98	0·96	0·111	0·068	0·8	Low total P_2O_5 in B_2g and Cg.
B_2g	16-20	2·61	N.D.	N.D.	62·9	16·3	18·4	0·15	0·16	0·04	0·04	5·08	7·1	5·23			0·061	3·3	Low readily soluble P_2O_5.
B_3g	23-29	3·81	N.D.	N.D.	34·7	20·2	41·3	1·08	0·98	0·10	0·10	8·18	21·6	5·60			0·116	0·6	
Cg	33-39	3·99	N.D.	N.D.	28·7	25·6	41·8	1·38	1·08	0·10	0·10	8·56	23·7	5·64			0·076	0·3	Low clay content in B_2g.
56.								ETTRICK ASSOCIATION; Alemoor Series. Carewoodrig, 103561-103564.											
A_2g	3-7	10·16	Nil	46·9	13·7	29·4	51·8	0·93	0·46	0·16	0·12	16·51	9·2	4·85	3·06	0·207	0·140	0·8	Low exchangeable bases in A_2g and B_2g.
B_2g	12-16	5·27	Nil	53·0	13·0	37·4	47·0	1·84	1·06	0·13	0·08	7·06	29·6	5·22	0·55	0·056	0·060	1·4	Low total P_2O_5 in A_2g and B_2g.
B_3g	20-24	5·14	Nil	50·8	12·8	36·4	48·2	5·44	4·10	0·19	0·18	3·48	74·1	5·82			0·067	9·0	Low readily soluble P_2O_5 in A_2g and B_2g, high in Cg.
Cg	28-32	4·48	11·3	38·5	21·4	28·4	48·0	7·54	3·86	0·15	0·21	1·59	88·9	6·67			0·169	71·2	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	Read. Sol. P_2O_5 mg./100g.	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
57.								ETTRICK ASSOCIATION; Alemoor Series. Girnwood Hill, 92862-92865.											
A_1g	0-4	10·50	33·1	32·0	41·3	23·8	29·6	Nil	0·12	0·09	0·04	30·80	0·8	4·17	4·70	0·283	0·095	0·3	Low exchangeable bases.
A_2g	4-8	5·31	13·7	42·4	25·7	30·4	41·2	Nil	0·04	0·05	0·02	12·37	0·9	4·58	1·20	0·113	0·088	0·2	Low total P_2O_5 except in B_3g.
B_2g	8-12	4·44	19·6	41·9	32·0	29·5	36·3	0·15	0·08	0·07	0·04	3·55	8·7	4·94			0·081	0·2	
B_3g	15-19	4·14	19·7	35·5	31·5	23·7	42·7	0·31	0·18	0·09	0·07	5·40	10·7	5·18			0·120	0·5	Low readily soluble P_2O_5.
58.								ETTRICK ASSOCIATION; Alemoor Series. Langsidebrae, 92878-92881.											
A_1g	1-4	15·25	N.D.	N.D.	50·2	16·8	25·4	Nil	0·12	0·17	0·19	19·70	2·4	4·60	6·65	0·465	0·198	1·1	Low exchangeable bases.
A_2g	5-8	9·35	N.D.	N.D.	30·1	26·6	38·7	Nil	0·08	0·15	0·10	13·90	2·3	4·73	3·22	0·254	0·162	0·9	Low total P_2O_5 in B_2g and B_3g.
B_2g	12-18	4·35	N.D.	N.D.	35·5	28·4	33·9	Nil	0·16	0·12	0·04	6·03	5·1	4·85			0·071	2·9	
B_3g	27-30	4·37	N.D.	N.D.	30·8	25·8	41·2	2·30	1·94	0·16	0·10	5·54	48·3	5·55			0·088	0·9	Low readily soluble P_2O_5.

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100g. Read. Sol. P_2O_5	Remarks
59.						ETTRICK ASSOCIATION; Alemoor Series. Stobie Slack, 91725A-91725D.													
A_1g	0-4	7·88	N.D.	N.D.	37·8	31·7	26·6	Nil	0·06	0·10	0·07	15·20	1·5	4·80	3·07	0·206	0·115	0·3	Low exchangeable bases except in B_3g.
A_2g	5-9	4·62	N.D.	N.D.	46·5	27·9	23·3	Nil	0·06	0·09	0·03	7·05	2·5	4·95	0·89	0·071	0·076	0·2	
B_2g	11-15	3·34	N.D.	N.D.	40·9	26·9	28·8	Nil	0·04	0·06	0·03	4·81	2·6	4·99			0·061	0·4	Low total P_2O_5 except in A_1g.
B_3g	23-26	3·09	N.D.	N.D.	39·4	21·8	35·7	3·97	2·40	0·10	0·13	2·02	76·5	6·11			0·096	0·6	Low readily soluble P_2O_5.
60.						ETTRICK ASSOCIATION; Hardlee Series. Woo Law, 88281-88285.													
H	6-1	45·90	N.D.	N.D.	N.D.	N.D.	N.D.	10·87	2·92	0·53	0·68	52·10	22·4	4·59	21·56	1·100	0·210	2·3	Low exchangeable bases in A_2g and B_2g.
A_2g	1-6	4·60	Nil	49·9	15·9	32·6	48·3	1·83	0·60	0·11	0·04	6·93	27·2	5·45	1·09	0·082	0·043	2·5	
B_2g	8-11	4·22	9·8	49·3	28·4	30·7	38·8	1·82	0·54	0·08	0·20	1·50	63·8	5·56			0·083	21·5	Low total P_2O_5 in A_2g and B_2g.
B_3g	15-21	4·72	6·3	37·0	14·8	29·5	53·3	5·65	0·84	0·12	0·13	Nil	100·0	5·62			0·151	62·5	Low readily soluble P_2O_5 in H and A_2g, high in B_2g, B_3g and Cg.
Cg	29-35	4·58	11·3	36·8	23·2	25·7	48·9	7·43	0·64	0·07	0·15	Nil	100·0	5·96			0·159	56·3	

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
61.	SOURHOPE ASSOCIATION; Edgerston Series. Lawsuit, 83087-83091.																		
H	6-1	33·30	N.D.	N.D.	N.D.	N.D.	N.D.	Nil	0·50	0·10	0·61	41·40	2·8	3·88	17·60	0·921	0·241	3·1	Low exchangeable bases except in Cg.
A_2g	0-5	3·09	48·6	25·8	59·0	15·4	22·5	Nil	0·16	Nil	0·10	10·38	2·4	4·78	1·01	0·071	0·078	1·1	Low total P_2O_5 in A_2g and B_2g.
B_2g	7-13	3·10	50·8	17·1	57·1	10·8	29·0	0·51	0·60	Nil	0·18	7·53	14·6	5·20			0·077	0·7	
B_3g	15-19	2·47	45·7	19·4	52·2	12·9	32·4	0·97	1·10	Nil	0·24	7·28	24·1	5·39			0·108	1·8	Low readily soluble P_2O_5 in A_2g, B_2g and B_3g.
Cg	28-34	2·66	49·7	20·6	55·1	15·2	27·0	2·66	2·06	Nil	0·25	5·12	49·3	5·68			0·152	11·3	
62.	SOURHOPE ASSOCIATION; Lawsuit Series. Lawsuit, 83092-83096.																		
H	7-1	73·30	N.D.	N.D.	N.D.	N.D.	N.D.	2·36	0·74	0·43	0·61	37·50	9·9	3·82	23·40	1·270	0·300	4·1	Low exchangeable bases in A_2g and B_2g.
A_2g	1-8	13·60	42·3	27·4	51·1	18·6	23·5	0·78	0·38	Nil	0·19	24·60	5·2	4·59	5·38	0·292	0·179	1·7	
B_2g	10-14	2·84	34·0	39·5	50·3	23·2	23·7	1·58	1·22	0·04	0·13	5·93	33·4	5·48			0·070	0·9	Low total P_2O_5 in B_2g.
B_3g	17-22	2·93	44·8	20·8	52·1	13·5	31·5	4·68	2·68	0·01	0·19	3·81	66·5	5·59			0·147	2·1	
Cg	30-38	2·79	49·2	17·8	54·0	13·0	30·2	5·73	2·50	0·02	0·24	2·56	76·8	5·85			0·104	22·4	Low readily soluble P_2O_5 in A_2g, B_2g and B_3g, high in Cg.

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
63.	HOBKIRK ASSOCIATION; Wauchope Series. Kilnsike Tower, 83072-83076.																		
H	3-1	34·00	N.D.	N.D.	N.D.	N.D.	N.D.	0·86	0·58	Nil	0·49	39·70	4·6	3·72	18·70	0·772	0·215	7·5	Low exchangeable bases.
A_2g	0-4	3·40	47·4	27·1	61·1	14·1	21·4	Nil	0·10	Nil	0·08	13·18	1·3	4·40	1·45	0·092	0·049	0·5	Low total P_2O_5 except in H.
B_2g	6-10	3·74	17·1	48·1	55·6	12·1	28·6	Nil	0·26	Nil	0·10	9·98	3·5	5·01			0·047	0·4	Low readily soluble P_2O_5 except in H.
B_3g	18-24	2·65	39·9	24·7	49·6	13·6	34·2	0·66	1·52	Nil	0·15	3·67	38·9	5·24			0·042	0·4	
64.	CARTER ASSOCIATION; Carter Series. Kiln Knowe, 97193-97196.																		
A_2g	3-6	4·66	N.D.	N.D.	58·8	14·7	21·9	1·07	0·26	0·36	0·07	12·60	12·2	4·57	1·65	0·102	0·056	0·7	Low exchangeable bases in A_2g, high in B_3g and Cg.
B_2g	7-11	4·81	N.D.	N.D.	35·7	16·7	42·8	4·36	1·18	0·25	0·22	10·70	35·9	5·12	0·78	0·073	0·051	0·6	Low total P_2O_5 except in Cg.
B_3g	15-19	4·43	N.D.	N.D.	41·6	11·7	42·4	10·31	3·44	0·36	0·29	2·04	87·6	6·55			0·076	4·5	Low readily soluble P_2O_5 in A_2g and B_2g, high in Cg.
Cg	33-39	6·99	N.D.	N.D.	41·7	19·9	34·9	30·00	6·80	0·19	0·37	Nil	100·0	8·51			0·155	23·0	

Horizon	Depth in.	% Loss on Ignition	Soil Separates % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g. Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
65.								CARTER ASSOCIATION; Carter Series. Martinlee, 83113-83117.											
H	6-1	52·00	N.D.	N.D.	N.D.	N.D.	N.D.	1·56	1·04	0·06	0·80	66·80	4·9	4·05	27·03	1·668	0·289	1·9	Low exchangeable bases in H, A_2g and B_2g, high in Cg.
A_2g	1-6	4·90	45·6	25·3	57·9	13·0	26·7	0·26	0·20	Nil	0·07	14·40	3·5	4·92	1·22	0·113	0·070	0·5	
B_2g	10-14	4·22	15·2	39·1	36·9	17·0	44·0	2·06	1·26	Nil	0·22	10·03	26·1	5·47			0·043	0·4	Low total P_2O_5 except in H and Cg.
B_3g	18-23	5·07	7·6	54·0	30·0	31·6	35·9	5·85	4·64	0·01	0·31	9·40	53·5	5·84			0·062	0·7	
Cg	30-36	5·07	11·7	41·8	25·7	27·8	44·0	10·00	6·30	0·02	0·36	8·35	66·6	6·31			0·136	1·7	Low readily soluble P_2O_5.
66.								CARTER ASSOCIATION; Redeswire Series. Wooplaw Rig, 83014-83018.											
H	5-1	39·18	N.D.	N.D.	N.D.	N.D.	N.D.	5·63	0·95	0·09	0·50	48·80	12·8	3·80	16·35	0·844	0·212	4·7	Low exchangeable bases except in H and B_3g.
A_1g	0-3	23·40	51·1	23·3	64·1	9·7	8·5	1·06	0·53	Nil	0·49	32·20	6·1	4·05	13·05	0·594	0·153	1·1	
A_2g	4-9	8·80	39·6	20·1	48·3	11·4	35·9	1·97	1·12	Nil	0·30	27·20	11·1	4·65			0·088	0·5	Low total P_2O_5 in A_2g and B_2g.
B_2g	12-17	2·91	41·8	20·8	51·7	10·9	34·5	2·06	0·94	Nil	0·22	8·84	26·7	4·69			0·065	0·5	
B_3g	27-33	2·64	39·9	23·5	48·8	12·2	36·4	5·75	3·84	Nil	0·26	4·31	69·5	5·99			0·134	11·6	Low readily soluble P_2O_5 except in H and Cg.

Horizon	Depth in.	% Loss on Ignition	Soil Separates					Exchangeable Cations m.e./100g.					% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
			% Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Ca	Mg	Na	K	H							
67.			CARTER ASSOCIATION; Redeswire Series. Wooplaw Rig, 83031-83035.																
H	6-1	81·50	N.D.	N.D.	N.D.	N.D.	N.D.	2·90	1·38	0·29	1·55	90·60	6·3	3·75	26·30	2·001	0·274	5·4	Low exchangeable bases except in B_3g and Cg.
A_2g	1-2	2·83	N.D.	N.D.	67·4	11·7	18·1	0·20	0·32	Nil	0·11	7·79	7·5	4·54	1·15	0·091	0·044	0·4	
B_2g	6-12	3·63	N.D.	N.D.	40·2	9·8	46·4	1·66	1·04	Nil	0·25	8·48	25·8	4·94			0·049	0·4	Low total P_2O_5 except in H and Cg.
B_3g	15-19	3·26	N.D.	N.D.	47·7	13·3	35·7	3·60	1·46	Nil	0·31	2·78	66·0	5·87			0·080	1·7	
Cg	25-30	3·22	N.D.	N.D.	44·9	13·6	38·3	9·22	2·56	Nil	0·31	Nil	100·0	6·98			0·131	35·6	Low readily soluble P_2O_5 except in H and Cg.

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Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	Soil Separates: % Silt, U.S.D.A.	Soil Separates: % Sand Inter.	Soil Separates: % Silt Inter.	Soil Separates: % Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	mg./100g. Read. Sol. P_2O_5	Remarks
68.								Ashybank, 87366-87369.											
S	2-8	5·16	N.D.	N.D.	49·5	19·4	28·5	9·33	0·36	0·09	0·13	2·08	82·6	6·31	1·64	0·170	0·154	15·1	Low total P_2O_5 except in S.
B	14-20	3·45	N.D.	N.D.	60·9	17·5	18·3	7·00	0·42	0·11	0·10	1·35	85·0	6·89	0·32	0·088	0·080	1·0	
B	26-32	2·84	N.D.	N.D.	59·0	16·3	22·0	6·70	0·38	0·14	0·06	Nil	100·0	7·15			0·066	0·7	Low readily soluble P_2O_5 in B.
D	36-42	3·07	N.D.	N.D.	75·4	9·0	12·6	5·63	0·38	0·08	0·04	Nil	100·0	7·54			0·088	9·9	
69.								Lanton Mill, 87362-87365.											
S	2-8	4·19	N.D.	N.D.	52·9	22·9	22·1	7·31	0·98	0·09	0·10	1·35	86·3	6·74	1·20	0·144	0·155	48·7	
B	14-20	4·33	N.D.	N.D.	60·3	18·5	19·0	6·08	0·82	0·06	0·07	Nil	100·0	7·00	0·63	0·078	0·121	51·5	High readily soluble P_2O_5.
B	26-32	3·12	N.D.	N.D.	65·6	14·4	17·0	5·47	0·88	0·08	0·07	Nil	100·0	6·99			0·124	47·3	
D	36-40	2·42	N.D.	N.D.	87·2	2·0	8·5	3·48	0·66	0·05	0·07	Nil	100·0	7·04			0·110	28·0	

Horizon	Depth in.	% Loss on Ignition	Soil Separates: % Sand, U.S.D.A.	% Silt, U.S.D.A.	% Sand Inter.	% Silt Inter.	% Clay	Exchangeable Cations m.e./100g.: Ca	Mg	Na	K	H	% Saturation	pH	% Carbon	% Nitrogen	% P_2O_5	m.g./100g. Read. Sol. P_2O_5	Remarks
70.								Mountholy, 87375-87378.											
S	1-7	3·33	N.D.	N.D.	67·5	10·4	18·8	7·28	0·42	0·06	0·19	1·70	82·4	6·73	1·20	0·112	0·110	17·8	Low total P_2O_5 except in S.
B	11-15	2·33	N.D.	N.D.	66·5	7·7	23·5	6·54	0·48	0·08	0·20	1·40	83·9	6·72	0·50	0·088	0·086	9·1	
B	22-30	2·74	N.D.	N.D.	60·4	9·9	27·0	8·85	0·50	0·12	0·17	Nil	100·0	7·19			0·091	10·0	High readily soluble P_2O_5.
D	36-40	1·58	N.D.	N.D.	84·0	3·2	11·2	4·68	0·22	0·10	0·14	Nil	100·0	6·99			0·072	15·9	
71.								Mountholy, 87379-87383.											
S	1-7	3·13	N.D.	N.D.	66·2	9·9	20·8	5·93	0·38	0·09	0·08	2·07	75·8	6·20	1·24	0·121	0·094	12·4	
B	9-14	2·13	N.D.	N.D.	67·2	9·7	21·0	5·93	0·34	0·07	0·09	1·35	82·8	6·51	0·63	0·080	0·062	4·7	Low total P_2O_5
B	19-24	1·44	N.D.	N.D.	79·8	6·5	12·4	14·80	0·22	0·18	0·18	1·29	92·3	6·74			0·051	7·5	High readily soluble P_2O_5 except in B.
B	28-32	1·20	N.D.	N.D.	85·1	5·3	8·5	4·24	0·14	0·08	0·05	Nil	100·0	7·11			0·052	12·7	
D	36-42	1·11	N.D.	N.D.	87·2	3·3	8·5	3·17	0·10	0·05	0·04	Nil	100·0	7·21			0·059	16·3	

APPENDIX II.

TABLE 1.

Percentage Ultimate Constituents in Brown Forest Soils.

Profile No. 4. ETTRICK ASSOCIATION, Linhope Series (Woo Law).

Horizon Soil No.	A 90470	B_2 90471	B_2 90472	B_3 90473	C 90474
SiO_2	71·28	70·42	68·33	69·10	68·53
Fe_2O_3	6·38 (—·09)	6·58 (—·05)	6·80 (—·02)	6·70 (—·01)	6·70
Al_2O_3	15·05 (—·10)	15·60 (—·06)	16·56 (+·04)	15·90 (—·02)	16·00
TiO_2	0·94	0·92	0·88	0·85	0·87
Mn_3O_4	0·15	0·07	0·08	0·09	0·09
CaO	0·32 (—·28)	0·29 (—·35)	0·28 (—·35)	0·35 (—·02)	0·43
MgO	2·12 (—·38)	2·12 (—·37)	2·90 (—·12)	3·32 (—·00)	3·28
K_2O	1·90	2·00	1·80	1·90	2·40
Na_2O	1·60	1·60	1·60	1·30	1·40
P_2O_5	0·22	0·15	0·08	0·09	0·09
	99·96	99·75	99·31	99·60	99·79

Profile No. 7. SOURHOPE ASSOCIATION, Sourhope Series (Fasset).

Horizon Soil No.	A 77223	B_2 77224	B_3 77225	B_3C 77226	C 77227
SiO_2	71·37	71·38	68·42	67·81	67·26
Fe_2O_3	4·18(—·19)	4·62(—·08)	4·79(—·01)	4·44(—·07)	4·74
Al_2O_3	15·33(—·22)	15·33(—·22)	18·35(—·02)	18·78(+·00)	18·45
TiO_2	0·90	0·87	0·75	0·67	0·67
Mn_3O_4	0·20	0·11	0·05	0·02	0·04
CaO	0·72(—·42)	0·74(—·41)	1·05(—·13)	1·09(—·08)	1·18
MgO	1·34(—·42)	1·40(—·39)	2·49(—·12)	2·32(—·06)	2·18
K_2O	3·80	4·00	2·60	3·20	3·20
Na_2O	0·65	0·86	0·57	0·51	1·00
P_2O_5	0·36	0·30	0·11	0·08	0·16
	98·85	99·61	99·18	98·92	98·88

TABLE 2.

PERCENTAGE ULTIMATE CONSTITUENTS IN PEATY PODZOLS WITH THIN IRON PAN.

Profile No. 20. ETTRICK ASSOCIATION, Dod Series (Dod Hill).

Horizon Soil No.	A_1 92885	B_1 107259	B_2 92886	B_3 92887
SiO_2	77·47	41·14	68·47	67·89
Fe_2O_3	1·17 (−·89)	44·40 (+6·89)	7·18 (−·23)	8·78 (−·05)
Al_2O_3	15·33 (−·19)	9·38 (−·06)	17·20 (+·03)	15·75 (−·05)
TiO_2	0·73	0·57	0·86	0·88
Mn_3O_4	0·00	0·03	0·19	0·14
CaO	0·16 (+1·00)	0·17 (+3·00)	0·11 (+·57)	0·08 (+·14)
MgO	1·08 (−·33)	0·58 (−·33)	1·26 (−·12)	1·39 (−·02)
K_2O	2·80	1·70	2·80	2·50
Na_2O	1·20	0·57	2·00	1·20
P_2O_5	0·14	N.D.	0·26	0·31
	100·08	98·54	100·33	98·98

Profile No. 25. SOURHOPE ASSOCIATION, Cowie Series (The Gair).

Horizon Soil No.	A_2 103579	B_1 107261	B_2 103580	B_3 103581	C 103582
SiO_2	72·12	47·81	67·97	68·82	68·08
Fe_2O_3	3·72 (−·44)	36·90 (+7·44)	6·45 (+·04)	5·98 (−·05)	6·23
Al_2O_3	15·85 (−·07)	9·93 (−·12)	16·38 (+·02)	16·15 (−·01)	16·10
TiO_2	0·95	0·83	0·98	0·92	0·92
Mn_3O_4	0·00	0·05	0·00	0·00	0·00
CaO	0·52 (−·25)	0·43 (−·06)	0·34 (−·48)	0·60 (−·09)	0·65
MgO	1·20 (−·47)	0·88 (−·42)	1·78 (−·17)	1·01	2·14
K_2O	3·80	2·40	3·60	3·70	3·80
Na_2O	1·40	0·57	2·30	2·30	2·30
P_2O_5	0·25	N.D.	0·28	0·26	0·26
	99·81	99·80	100·08	99·74	100·48

TABLE 3

PERCENTAGE ULTIMATE CONSTITUENTS IN NON-CALCAREOUS GLEYS

Profile No. 40. ETTRICK ASSOCIATION, Ettrick Series (Woo Law).

Horizon Soil No.	A_1g 88286	A_2g 88287	B_2g 88288	B_2g 88289	B_3g 88290	Cg 88291
SiO_2	70·26	67·43	65·64	63·94	64·50	61·39
Fe_2O_3	5·96 (−·29)	7·38 (−·09)	7·35 (−·14)	8·30 (+·07)	8·00 (+·03)	7·38
Al_2O_3	16·88 (−·15)	17·00 (−·11)	18·30 (−·02)	18·85 (+·04)	17·93 (−·02)	17·35
TiO_2	0·95	0·80	0·84	0·88	0·88	0·90
Mn_3O_4	0·00	0·04	0·05	0·04	0·05	0·07
CaO	0·11(−·98)	0·31(−·95)	0·28(−·95)	0·56(−·90)	1·01(−·82)	5·48
MgO	2·08(−·46)	3·12(−·15)	3·20(−·10)	2·98(−·14)	3·44(−·02)	3·32
K_2O	2·00	2·30	2·60	2·80	2·90	2·80
Na_2O	1·10	1·40	1·20	1·00	1·20	1·40
P_2O_5	0·13	0·06	0·08	0·13	0·17	0·16
	99·47	99·84	99·54	99·48	100·06	100·25

Profile No. 45. SOURHOPE ASSOCIATION, Atton Series (Fasset).

Horizon Soil No.	A_1g 77228	A_2g 77229	B_2g 77230	B_3g 77231	Cg 77232
SiO_2	71·47	70·44	68·79	68·84	69·13
Fe_2O_3	4·32(+·00)	4·24(+·00)	4·39(+·05)	4·87(+·17)	4·18
Al_2O_3	15·48(−·12)	15·90(−·08)	17·55(+·04)	17·00(+·00)	16·95
TiO_2	0·87	0·69	0·61	0·65	0·70
Mn_3O_4	0·18	N.D.	N.D.	0·04	0·06
CaO	0·12(−·92)	1·13(−·25)	1·28(−·13)	1·08(−·27)	1·47
MgO	1·34(−·40)	1·66(−·25)	2·16(+·00)	1·66(−·25)	2·16
K_2O	3·80	3·80	3·40	3·20	2·90
Na_2O	0·65	0·86	0·81	0·86	0·86
P_2O_5	0·36	0·07	0·07	0·16	0·18
	98·59	98·79	99·06	98·36	98·59

TABLE 3—*continued*

Profile No. 47. HOBKIRK ASSOCIATION, Cessford Series (Cessford Moor).

Horizon Soil No.	A_2g 79507	B_2g 79508	B_2g 79509	B_3g 79510	Cg 79511
SiO_2	87·39	85·06	81·80	76·69	75·81
Fe_2O_3	1·42(—·76)	2·62(—·55)	3·51(—·37)	4·77(—·28)	5·15
Al_2O_3	8·13(—·44)	8·08(—·44)	9·40(—·31)	11·88(—·08)	12·73
TiO_2	0·52	0·62	0·66	0·71	0·64
Mn_3O_4	0·01	0·05	0·07	0·08	0·08
CaO	0·27(—·49)	0·06(—·89)	0·35(—·27)	0·36(—·02)	0·45
MgO	0·45(—·66)	0·71(—·45)	1·01(—·18)	1·26(—·09)	1·15
K_2O	1·10	1·40	1·60	2·10	2·40
Na_2O	0·14	0·24	0·59	0·73	0·05
P_2O_5	0·06	0·06	0·09	0·14	0·15
	99·49	98·90	99·08	98·72	98·61

Profile No. 51. CARTER ASSOCIATION, Letham Series (Wooplaw Rig).

Horizon Soil No.	A_1g 83025	A_2g 83026	B_2g 83027	B_2g 83028	B_3g 83029	Cg 83030
SiO_2	85·18	83·36	80·32	78·84	79·17	77·85
Fe_2O_3	1·87(—·57)	3·70(—·13)	4·09(—·01)	3·67(—·08)	3·75(—·06)	3·93
Al_2O_3	8·35(—·27)	7·95(—·29)	9·43(—·12)	10·53(+·01)	10·18(—·04)	10·35
TiO_2	0·68	0·61	0·48	0·42	0·45	0·51
Mn_3O_4	0·02	0·02	0·01	0·10	0·08	0·04
CaO	0·45(—·54)	0·39(—·60)	0·32(—·65)	0·36(—·60)	0·51(—·44)	0·89
MgO	0·65(—·64)	0·69(—·61)	0·97(—·43)	1·45(—·13)	1·40(—·17)	1·65
K_2O	2·30	2·50	3·00	3·60	3·70	3·60
Na_2O	0·30	0·23	0·25	0·19	0·23	0·19
P_2O_5	0·12	0·10	0·04	0·05	0·08	0·13
	99·92	99·55	98·91	99·21	99·55	99·14

TABLE 4.

PERCENTAGE ULTIMATE CONSTITUENTS IN A PEATY GLEY.

Profile No. 60. ETTRICK ASSOCIATION, Hardlee Series (Woo Law).

Horizon	H	A_2g	B_2g	B_3g	Cg
Soil No.	88281	88282	88283	88284	88285
SiO_2	68·22	70·64	71·08	65·63	65·63
Fe_2O_3	3·01(—·59)	3·63(—·52)	4·52(—·41)	6·45(—·09)	7·08
Al_2O_3	21·08(+·19)	17·55(—·05)	15·85(—·14)	18·35(+·07)	17·08
TiO_2	1·00	0·07	0·83	0·94	0·84
Mn_3O_4	0·00	0·01	0·00	0·00	0·05
CaO	0·61(—·03)	0·14(—·79)	0·33(—·49)	0·46(—·25)	0·61
MgO	1·93(—·43)	2·74(—·22)	2·86(—·19)	3·27(+·00)	3·27
K_2O	2·70	2·70	2·20	3·10	3·00
Na_2O	2·10	3·20	1·50	1·90	2·30
P_2O_5	0·39	0·05	0·09	0·16	0·17
	101·04	101·63	99·17	100·26	100·03

TABLE 5. PERCENTAGE MINERAL GROUPS IN FINE SAND FRACTIONS (20-200μ).

Association	Series	Major Soil Group	Profile No. in Appendix I	Horizon	Soil No.	%age Mineral (Specific Gravity) Groups. Orthoclase Sp. Gr. <2·6	Quartz Sp. Gr. 2·6-2·9	Ferro-silicate Sp. Gr>2·9
ETTRICK	LINHOPE	Brown Forest soil	4	A	90470	12·5	83·3	4·2
				C	4	9·8	86·1	4·1
	DOD	Peaty Podzol with iron pan	20	A_1	92885	6·7	90·8	2·5
				B_2	6	7·2	89·7	3·1
				B_3	7	8·8	88·3	2·9
	ETTRICK	Non-calcareous gley	40	A_1g	88286	12·3	83·0	4·7
				Cg	91	13·9	81·3	4·8
	HARDLEE	Peaty gley	60	A_2g	88282	7·2	90·9	2·9
				B_3g	4	10·9	85·5	3·6
				Cg	5	11·8	84·1	4·1
SOURHOPE	SOURHOPE	Brown Forest soil	7	A	77223	6·5	89·7	3·8
				C	7	7·1	89·0	3·9
	COWIE	Peaty Podzol with iron pan	25	A_2	103579	5·2	89·4	5·4
				C	82	5·6	87·9	6·5
	ATTON	Non-calcareous gley	45	A_1g	77228	8·6	87·5	3·9
				Cg	32	7·2	88·7	4·1
HOBKIRK	HOBKIRK	Brown Forest soil	11	A	79502	1·5	96·2	2·3
				C	6	2·7	93·7	3·6
	FAW	Peaty Podzol with iron pan	28	A_2	83067	0·9	98·0	1·1
				D	71	2·4	95·0	2·5

TABLE 5—Continued

Association	Series	Major Soil Group	Profile No in Appendix I	Horizon	Soil No.	%age Mineral (Specific Gravity) Groups: Orthoclase Sp. Gr<2·6	Quartz Sp. Gr. 2·6-2·9	Ferro-silicate Sp. Gr.>2·9
HOBKIRK	CESSFORD	Non-calcareous gley	47	A_2g	79507	1·1	96·2	2·7
				Cg	11	2·4	94·1	3·5
	CESSFORD	Non-calcareous gley		A_1g	83040	2·2	95·3	2·5
				Dg	4	2·7	94·2	3·1
CARTER	COBLAW	Brown Forest Soil	16	A	98526	1·8	95·3	2·9
				B_3	8	2·1	94·7	3·2
	ARKS	Peaty Podzol with iron pan	30	A_2	98529	1·4	96·9	1·7
				B_3	31	2·3	93·6	4·1
	LETHAM	Non-calcareous gley	51	A_1g	83025	1·9	95·5	2·6
				Cg	30	2·5	94·0	3·5
	REDESWIRE	Peaty gley	67	A_2g	83032	1·6	95·3	3·1
				Cg	5	2·1	94·0	3·9

TABLE 6.

FREQUENCY OF MINERAL SUITES OTHER THAN QUARTZ IN THE ETTRICK ASSOCIATION (derived from Silurian Sediments).

Series	LINHOPE		DOD			ETTRICK		HARDLEE		
Horizon	A	C	A_1	B_2	B_3	A_1g	Cg	A_2g	B_3g	Cg
Soil No.	90470	90474	92885	92886	92887	88286	88291	88282	88284	88285
Apatite	—	—	—	—	—	—	—	—	—	—
Augite	*s	s	s	s	s	s	s	s	s	s
Biotite	a	a	a	a	a	a	a	a	a	a
Chlorite	a	a	c	c	c	c	c	c	c	c
Enstatite	—	—	—	—	—	—	—	—	—	—
Garnet	—	—	—	—	—	—	—	—	—	—
Hornblende	s	s	s	s	s	s	s	s	s	s
Hypersthene	—	—	—	—	—	—	—	—	—	—
Iron oxides	s	s	c	c	c	c	c	c	a	a
Muscovite	c	c	c	c	c	c	c	c	c	c
Orthoclase and Microcline	c	c	a	a	a	a	a	a	c	c
Plagioclase	d	d	d	d	d	d	d	d	a	d
Rutile	r	r	—	—	—	r	r	r	r	r
Tourmaline	r	r	r	r	r	r	r	r	r	r
Zircon	r	r	r	r	r	r	r	s	s	s
Rock particles	d	d	d	d	d	d	d	d	d	d

*d=dominant; a=abundant; c=common; s=scarce; r=rare.

TABLE 7.

FREQUENCY OF MINERAL SUITES OTHER THAN QUARTZ IN THE SOURHOPE ASSOCIATION (derived from Old Red Sandstone lavas).

Series	Sourhope		Cowie		Atton	
Horizon	A	C	A_2	C	A_1g	Cg
Soil No.	77223	77227	103579	103582	77228	77232
Apatite	r	s	r	s	r	s
Augite	a	a	a	a	a	a
Biotite	c	c	c	c	c	a
Chlorite	—	—	—	—	—	—
Enstatite	s	s	s	s	c	s
Garnet	r	r	s	s	r	r
Horneblende	c	c	c	c	c	c
Hypersthene	s	s	c	c	c	c
Iron oxides	a	d	d	d	a	a
Muscovite	s	s	s	s	s	s
Orthoclase and Microcline	d	a	a	a	d	d
Plagioclase	d	d	d	d	d	d
Rutile	r	r	r	r	r	r
Tourmaline	r	r	r	r	r	r
Zircon	s	s	r	r	s	r
Rock particles	—	—	—	—	—	—

TABLE 8.

FREQUENCY OF MINERAL SUITES OTHER THAN QUARTZ IN THE HOBKIRK ASSOCIATION (derived from Old Red Sandstone sediments).

Series	Hobkirk		Faw		Cessford		Cessford	
Horizon	A	C	A_2	D	A_2g	Cg	A_1g	Dg
Soil No.	79502	79506	83067	83071	79503	79511	83040	83044
Apatite	—	—	—	—	—	—	r	r
Augite	c	a	c	c	c	a	a	c
Biotite	c	c	c	c	c	c	c	c
Chlorite	—	s	—	—	s	s	—	—
Enstatite	—	—	—	—	—	—	—	—
Garnet	c	c	c	s	c	c	c	c
Horneblende	s	s	s	s	c	s	c	c
Hypersthene	s	s	s	s	r	r	r	r
Iron oxides	d	d	a	d	d	d	d	d
Muscovite	c	c	c	c	s	c	c	c
Orthoclase and Microcline	a	c	d	d	a	c	a	d
Plagioclase	d	d	d	a	d	d	d	d
Rutile	r	r	r	r	r	r	r	r
Tourmaline	r	r	r	r	r	r	r	r
Zircon	s	s	s	s	s	s	s	r
Rock particles	—	—	—	—	—	—	—	—

TABLE 9.

FREQUENCY OF MINERAL SUITES OTHER THAN QUARTZ IN THE CARTER ASSOCIATION (derived from Carboniferous sediments).

Series	Coblaw		Arks		Letham		Redeswire	
Horizon	A	B_3	A_2	B_3	A_1g	Cg	A_2g	Cg
Soil No.	98526	98528	98529	98531	83025	83030	83032	83035
Apatite	—	r	—	r	—	r	—	r
Augite	a	a	a	a	a	a	a	a
Biotite	c	c	c	c	c	c	c	c
Chlorite	r	—	r	r	r	r	r	—
Enstatite	—	—	—	—	—	—	s	—
Garnet	c	c	c	c	c	c	c	c
Horneblende	r	r	s	s	s	s	r	s
Hypersthene	r	r	—	—	r	r	—	—
Iron oxide	d	a	a	a	d	d	d	d
Muscovite	c	c	s	s	c	c	c	c
Orthoclase and Microcline	c	c	c	c	c	c	c	c
Plagioclase	d	d	d	d	d	d	d	d
Rutile	s	s	r	r	r	r	r	r
Zircon	s	s	s	s	s	s	s	s
Rock particles	—	—	—	—	—	—	—	—

TABLE 10.

PERCENTAGE MINERALS IN CLAY FRACTIONS ($<1{\cdot}4\mu$)

Association	Series	Major Soil Group	Profile No. in Appendix I	Horizon	Soil No.	%age Clay Minerals: Illite & Mixed Layer Mineral	Kaolin	Chlorite
ETTRICK	ETTRICK	Non-calcareous gley (poorly drained)	40	A_1g	88286	40	25	35
				A_2g	7	40	20	40
				B_2g	9	50	15	35
				Cg	88291	65	15	20
	HARDLEE	Peaty gley (very poorly drained)	60	A_2g	88282	65	25	10
				B_2g	3	65	20	15
				B_3g	4	70	15	15
				Cg	5	70	15	15

Association	Series	Major Soil Group	Profile No. in Appendix I	Horizon	Soil No.	Illite	Kaolin	Vermiculite	Montmorillonite	Quartz
SOURHOPE	SOURHOPE	Brown forest soil	7	A	77223	45	30	10	0	15
				B_2	4	60	20	5	5	10
				B_3	5	55	20	0	15	10
				B_3C	6	65	15	0	15	5
				C	7	65	10	0	20	5
	ATTON	Non-calcareous gley	45	A_1g	77228	55	30		10	5
				A_2g	9	65	20		10	5
				B_2g	30	70	15		10	5
				B_3g	1	70	15		15	0
				Cg	2	70	10		20	0

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*A normal kilometre national grid reference is given with each place name. Unless otherwise stated the full kilometre reference is obtained by prefixing NT (or 36 in the old system), e.g., Adderstonlee (NT 5311) or (36/5311).

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