Soil Survey of Scotland

THE OUTER HEBRIDES

1:250 000 SHEET 2

The Macaulay Institute for Soil Research
Aberdeen 1982

SOIL SURVEY OF SCOTLAND

Soil and Land Capability for Agriculture

THE OUTER HEBRIDES

By G. Hudson, BSc, W. Towers, BSc, J. S. Bibby, BSc
and D. J. Henderson, BSc

with a contribution by J. S. Robertson, BSc

The Macaulay Institute for Soil Research
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The cover illustration shows the Standing Stones of Callanish, Lewis.

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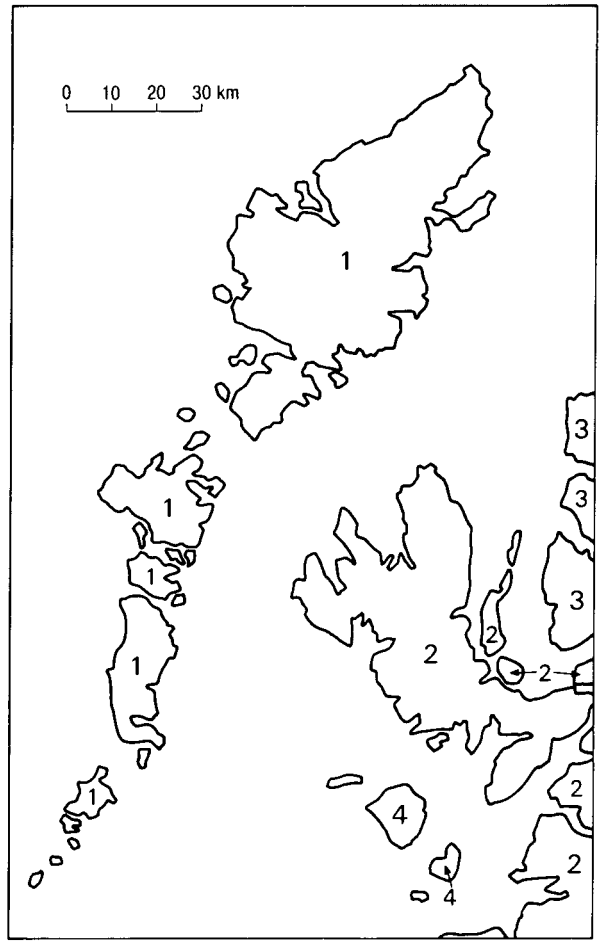
Preface

The soils of this region were largely unsurveyed prior to 1978 with soil surveys confined to Rhum and Ardnamurchan. After approval of the proposal for soil survey of the remaining parts of Scotland at a scale of 1:250 000, mapping was started in 1978 on the Island of Skye by J. S. Bibby, G. Hudson and D. J. Henderson. The mainland peninsulas south of Applecross were surveyed by this survey team with the addition of J. A. Hipkin in 1979, while the peninsulas from Applecross inclusive to the north were mapped by D. W. Futty, W. Towers and A. J. Nolan. The Outer Hebrides were visited in 1981 and surveyed by G. Hudson, W. Towers, J. S. Bell and T. W. M. Brown. The areas of responsibility for mapping are shown in the accompanying figure. Compilation of the soil maps was carried out during 1981 based on a National Soil Map Legend compiled by B. M. Shipley. The Land Capability for Agriculture maps were constructed shortly afterwards and the Handbook was written in late 1981 and early 1982. The vegetation was allocated to plant communities by soil survey field staff using a system designed by E. L. Birse and J. S. Robertson. The latter was responsible for correlation and, with a contribution from D. J. Henderson, wrote the vegetation section. Analytical data quoted in the text were produced at the Macaulay Institute for Soil Research, Aberdeen, mostly in the Department of Mineral Soils. The authors of this handbook are G. Hudson, W. Towers, J. S. Bibby and D. J. Henderson. The handbook has been edited by D. W. Futty.

Assessment of land capability for agriculture was carried out by the field staff, using guidelines devised by Bibby, Douglas, Thomasson and Robertson (1982). Advisory groups were established for the mainland areas to assist the surveyors in this task. They consisted of representatives of the Department of Agriculture and Fisheries for Scotland, the Scottish Agricultural Colleges and the National Farmers' Union of Scotland. Consultation with the local officers of the Department of Agriculture and the Agricultural College was maintained for the areas of the Inner and Outer Hebrides but no formal discussion groups were set up, due to the remoteness of these areas and the expense that would be involved. Valuable contributions were made by the individuals concerned but final responsibility for the maps rests entirely with the Soil Survey of Scotland.

The base map was compiled and drawn by the Soil Survey cartographic section using modified components from Ordnance Survey 1:250 000 scale topographic and administrative maps. The maps were drafted by W. S.



1 G. Hudson, W. Towers, J. S. Bell, T. W. M. Brown

2 J. S. Bibby, G. Hudson, D. J. Henderson

3 D. W. Futty, W. Towers, A. J. Nolan

4 G. Hudson, J. A. Hipkin

Survey teams' map areas

Shirreffs and Miss P. R. Carnegie. The diagrams in this book were drawn by A. D. Moir and Mrs R. M. J. Fulton.

The aerial photographs and copies of the field maps used in the survey may be inspected by prior arrangement with the Department of Soil Survey, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen AB9 2QJ. Photographs in the text are by members of the Soil Survey Department and by Aerofilms Ltd, Borehamwood.

ROBERT GRANT
Head of the Soil Survey of Scotland

Acknowledgements

The Soil Survey Department wishes to thank the many landowners, farmers and crofters who co-operated willingly in the survey by allowing access to their land. Thanks are also due to the local staff of the Department of Agriculture and Fisheries for Scotland and of the North of Scotland College of Agriculture who participated in helpful discussions: in particular A. W. Henry, E. Mills and K. Wilson (DAFS) and J. Nicol and E. E. Dunn (NOSCA).

1 Description of the area

LOCATION AND EXTENT

The region covered by the maps and described in this publication contains 5631 square kilometres of some of the remotest land in Scotland. The complete Outer Hebridean island chain forms 53 per cent of the area, the northern Inner Hebrides group covers a further 33 per cent, while the mainland occupies only 14 per cent. The landscape is replete with breathtaking contrasts from the rugged scenery of the mountains and rock-dominated lands of Harris, Skye, Rhum and the mainland, to the undulating dreary peat-covered plain of north Lewis. Much of the bleak hills and uplands constitute poor hill grazings for sheep and red deer, with forestry more widely practised on the sheltered mainland and Inner Hebrides than on the exposed Outer Hebrides. Mellower, more agricultural, landscapes unfold on the machairs and tills of the Outer Hebrides and on the basalts and Lewisian rocks of Skye, as well as on raised beach or outwash terraces at the heads of many sea lochs.

The remote mainland peninsulas of Wester Ross, Lochalsh and Lochaber form the eastern fringe, with part of Ardnamurchan on the southern edge. Most of these areas are accessible by single-track roads following the coastal fringes, but the area of Knoydart can only be reached by sea or on foot. Mallaig is the main centre of population on the mainland and, along with Kyle of Lochalsh, provides ferry links to Skye, with a further ferry link between Skye and Raasay. The main population centre of Skye is Portree (1400). The two railway lines in the district providing transport to and from Glasgow and Inverness terminate at Mallaig and Kyle of Lochalsh respectively. The Outer Hebrides can be reached via Uig on Skye and from Oban or Ullapool on the mainland. The main population centre of the Outer Isles is Stornoway (5400), but some crofting townships, especially in north Lewis, are also heavily populated.

GEOLOGY, LANDFORMS AND PARENT MATERIALS

GEOLOGY

The underlying rocks range from the ancient Lewisian gneisses to some of the youngest sedimentary strata found in Scotland. The variety of rocks is described in a number of publications of the Institute of Geological Sciences and the

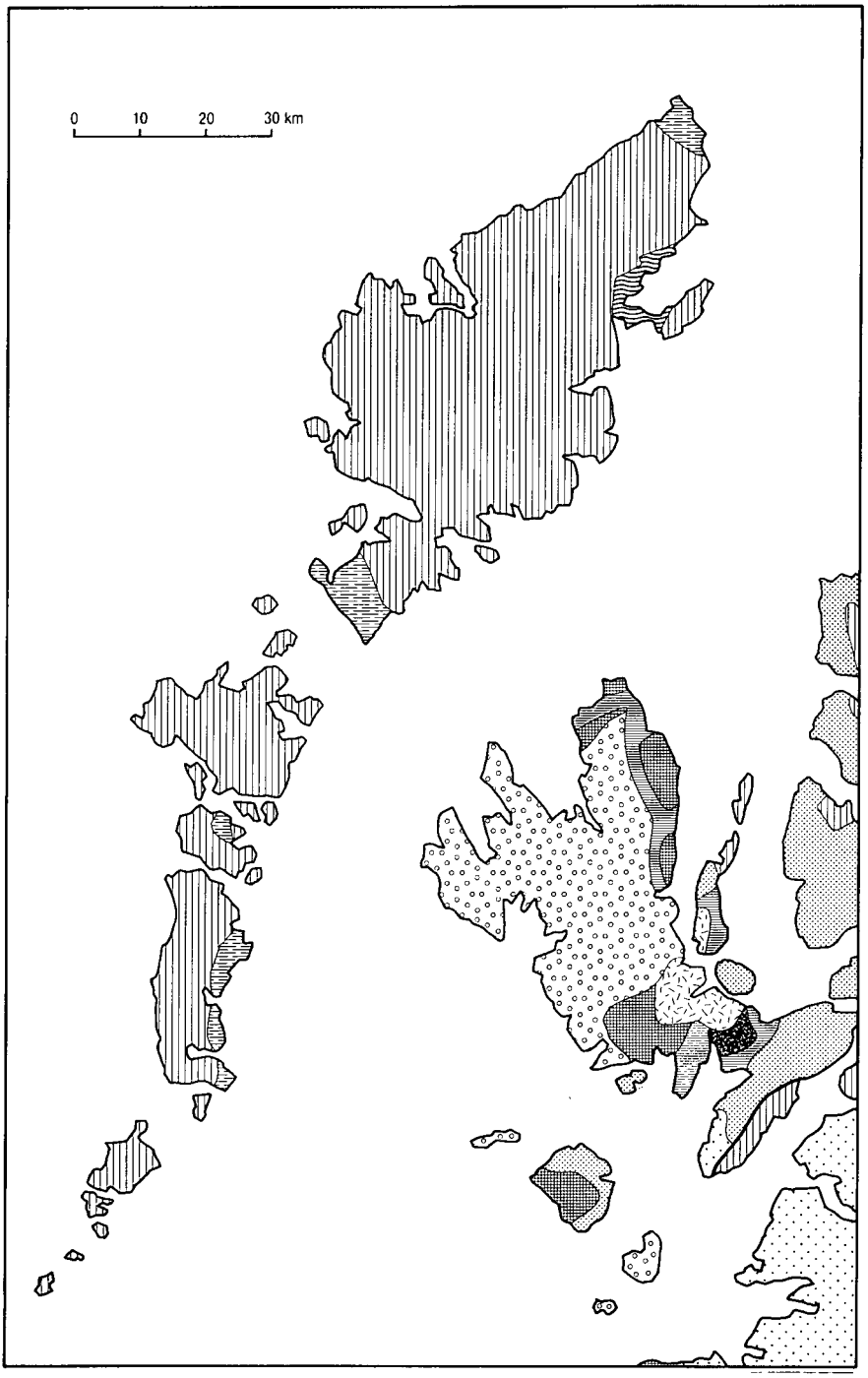


Figure 1. *Geology*

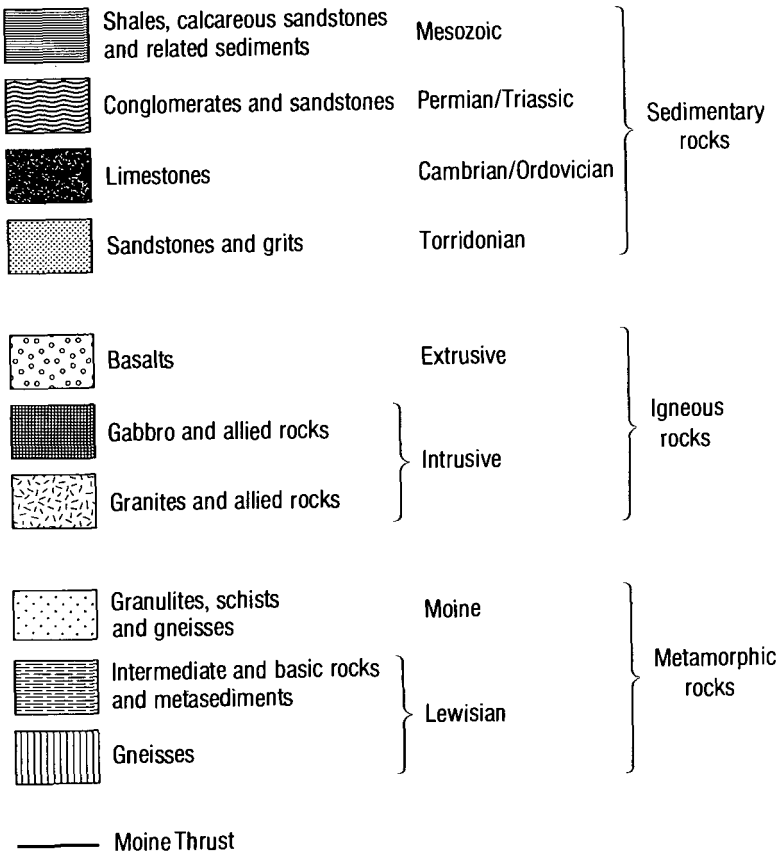


Figure 1. *Geology*

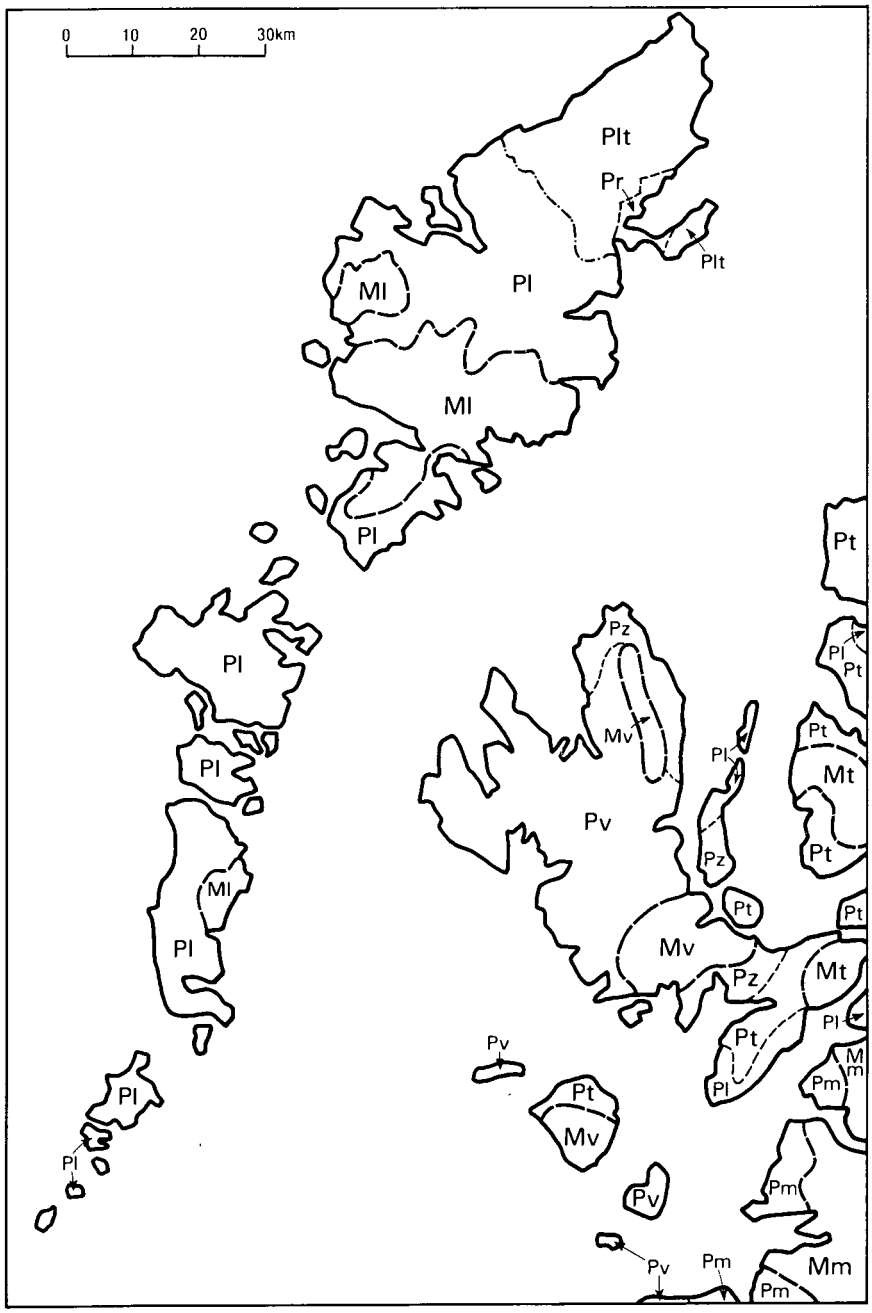
reader is referred to the British Regional Geology Handbooks (Phemister, 1960; Richey, 1961). The key to Fig. 1 shows there is a relatively wide range of rock types which are weathered to form the parent materials of the soil associations described later. The generalized geology map (Fig. 1) indicates the approximate extent of each group of rocks.

Lewisian gneisses underlie practically all of the Outer Hebrides, with the exception of a small area of Triassic rocks around Stornoway. On the mainland around Loch Gairloch, Loch Torridon and the Sound of Sleat there are smaller areas of Lewisian gneisses which also outcrop on Raasay and Rona. More base-rich chlorite-schists and hornblende-schists of Lewisian age form small areas around Glenelg on the mainland and larger tracts on the Sleat peninsula of Skye, the richer vegetation here providing a striking contrast to the bleak landscapes of the Lewisian gneisses and adjacent Torridonian strata, dominated by moorland plant communities. The suite of rocks of Torridonian age comprises sandstones, arkoses and grits, and occupies most of the mainland north of Loch Alsh. These rocks are also found on the islands of Rhum, Skye, Raasay, Scalpay and Soay. The mainland to the south of Loch Hourn is composed almost entirely of rocks of Moinian age, principally granulites. These rocks also crop out at Tarskavaig on the Sleat peninsula. Igneous rocks form a large proportion of Skye and the Small Isles; in general, the intrusive rocks form the mountainous areas and the extrusive basalts occupy the lower ground. Isolated hills in west Skye and the chain of hills along the Trotternish peninsula are exceptions where extrusive rocks reach higher altitudes. Cambrian and Ordovician limestones and quartzites are of local extent while sedimentary Mesozoic rocks are more widespread. These rocks occupy many areas of land in Skye and show marked contrasts to the adjacent ground in soils and land use.

LANDFORMS

The lithology and chemistry of the rocks affect their responses to weathering agencies and geomorphological processes, and a wide variety of landforms are present in this region. The landscapes have been moulded by several glaciations, but most of the drift has been deposited by the most recent, which thus plays the biggest role in soil formation by furnishing the parent materials. Sissons (1976) has identified four principal morphological divisions in the Highlands and Islands of Scotland, two of which occur in this region; they are, firstly, the Western Plateaux, Foothills and Lowlands, and secondly, the Dissected Mountains. Sissons describes the lower ground thus: 'In the west is an area that, despite very varied geology and relief, has a unity in having been severely affected by glacial erosion to produce an extremely irregular rocky landscape and a highly indented coastline. Yet despite this intense glacial activity, the area retains distinct remains of plateaux on many interfluves.' He goes on to say, of the Dissected Mountains: 'The mountain belt, with many summits exceeding 900 m, has been greatly dissected, especially by glacial action: deep valleys separate mountain ridges, each of which is divided by cols, often glacially emphasised, into a series of summits.' This division of the land is represented in Fig. 2, where the principal rock types are also shown because of their influence on parent materials and soil formation. The south-western boundary of the Lewisian till plain is also indicated.

The differences between these two major physiographic regions are illustrated by Figs. 3 and 4. These are, however, idealized diagrams and the



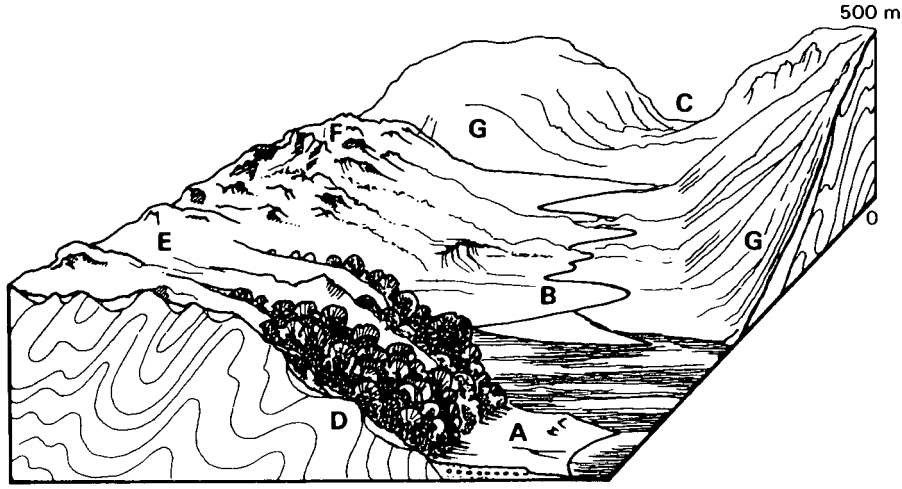
WESTERN PLATEAUX, FOOTHILLS and LOWLANDS

Plt	Lewisian till plain
Pl	Lewisian
Pt	Torridonian
Pm	Moine
Pv	volcanic
Pz	Mesozoic
Pr	Triassic

DISSECTED MOUNTAINS

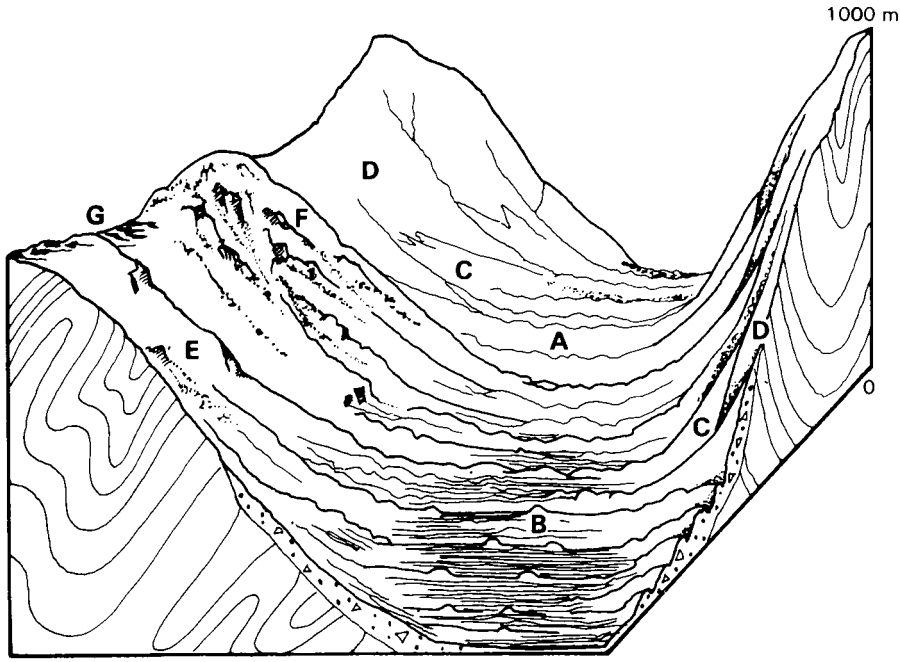
Ml	Lewisian
Mt	Torridonian
Mm	Moine
Mv	volcanic

Figure 2. *Physiographic regions (after Sissons, 1976)*



A Raised beach, variable in form from gravel terraces to sand dune
B Outwash and alluvium, usually terraces and mounds
C Hummocky moraine in U-shaped valleys
D Hill and valley sides with steep slopes; moderately rocky
E Undulating hills with gentle and strong slopes; moderately rocky
F Undulating hills with gentle and strong slopes; very rocky
G Hill and valley sides with strong and steep slopes; non-rocky

Figure 3. *Landforms of the Western Plateaux, Foothills and Lowlands*



A Hummocky valley moraine
B Hummocky valley moraine with peat flats; occasional alluvium and outwash
C Steep gullied moraine with colluvial debris
D Hill sides with steep and very steep slopes; non-rocky
E Hill sides with steep and very steep slopes; moderately rocky
F Hill sides with steep and very steep slopes; very rocky
G Upper slopes, ridge crests and summits with alpine soils

Figure 4. *Landforms of the Dissected Mountains*

different landscapes and landforms do not always occur in the patterns and proportions displayed. In some parts of the region, not all of the landforms are present; for example steep slopes are very rare in the Western Plateaux, Foothills and Lowlands.

The Western Plateaux, Foothills and Lowlands is the more extensive physiographic region and is composed of rocks of Lewisian, Moinian, Torridonian, Cambrian, Ordovician and Mesozoic ages and Tertiary basalts. Although this land rises to about 400 metres, considerable tracts of country are much lower than this. The land (Pl. on Fig. 2) is epitomized by the Lewisian gneisses on the islands of North Uist, Benbecula and South Uist where it is extremely low-lying with 57 per cent of Benbecula, for example, below 10 metres altitude and 27 per cent between 10 and 20 metres. These lowlands are principally non- to moderately rocky and continue north into Harris where they are very rocky and of higher average altitude. The ground designated Plt in north Lewis is very gently undulating, non-rocky and almost entirely peat-covered.

Lewisian, Moinian and Torridonian rocks (Pl, Pm and Pt on Fig. 2) form the major rock types of this landform region on south-east Skye and the mainland. These hillier areas are more aptly described as foothills as they are found closer to the Western Highlands, which are more extensive in Northern Scotland (Sheet 3) and Western Scotland (Sheet 4). The gneisses, schists, granulites, sandstones and arkoses of these geological formations generally give rise to moderately rocky to rugged, very rocky topography; there are, however, some less rocky areas on the Lewisian chlorite-schists around Armadale and on Torridonian rocks north of Loch Torridon where drift cover is slightly thicker.

The land designated Pv in Fig. 2 is restricted to the basalts and is mainly found in northern Skye and on the Small Isles. The landscape is less rocky than the Lewisian country already described, but is more hilly, with occasional summits over 250 metres. The topography is distinctly terraced, a result of differential erosion of the weaker scoriaceous surfaces and the resistant basal parts of the lava flows. A contrast is provided by smoother areas where till overlies the bed-rock, especially on the Trotternish and Waternish peninsulas.

The islands of Skye, Raasay and Eigg and the area around Applecross village are the principal locations of Mesozoic rocks (Pz on Fig. 2). These clay shales, sandstones and limestones occur in moderately to very rocky ground on Raasay and between Elgol and Broadford, but are overlain by till in north Skye where the land is non- to slightly rocky and gently undulating.

The largest area of the Dissected Mountains physiographic region occurs on the islands of Harris and Skye and in the remote mainland districts of Applecross, Knoydart, Morar and Moidart; these mainland areas form the western extremities of a mountain chain more fully described in the handbook on Western Scotland (Sheet 4). Smaller areas are found on Rhum and South Uist. Steep slopes and narrow ridge crests with deeply incised, structurally controlled valleys characterize the land which is composed of a variety of rock types. These include the gabbros and granites of the Cuillin Hills on Skye with their rock-dominated landscape, ultrabasic rocks and some granite on Rhum, and basalts in Trotternish with local non-rocky areas, for example near the summit of The Storr (719 metres). This land is designated Mv on Fig. 2. The Lewisian, Torridonian and Moinian rocks (Ml, Mt and Mm on Fig. 2) on the Outer Hebrides, south-east Skye and the mainland have similar landforms of steep moderately to very rocky slopes which show slight terracing on the Torridonian strata. The moraine landforms are hummocky on the valley floors

and often extremely bouldery; on steep valley sides the hummocks are absent and gully erosion of the deposits is a characteristic feature.

PARENT MATERIALS

The variety of drift types, their extent as soil parent materials and their distribution within the two physiographic regions are listed in Table A. The complete range of drift types, with the exception of cryic deposits, are found in the Western Plateaux, Foothills and Lowlands, while the Dissected Mountains contain a more restricted range. Most types of parent material can be directly correlated with the landforms on Figs. 3 and 4.

Table A Areas of soil parent material derived from areas of soil map units

Parent material	Area (km^2)	Physiographic region*
Windblown sand	124	P
Peat	859	P
Alluvium	7	P/M
Fluvioglacial/Raised beach	22	P/M
Glacio-lacustrine	3	P
Colluvium (includes 'shallow drift')	3624	P/M
Cryic deposits	211	M
Morainic drift	474	P/M
Till	188	P
Bare rock, scree and cliffs	108	P/M
Built-up areas	1	P
Total	5631	

* P Western Plateaux, Foothills and Lowlands.
M Dissected Mountains.

Colluvial deposits, including shallow drift, are by far the most extensive type of parent material and cover approximately 65 per cent of the region. They are found in a wide variety of landform and topographic situations ranging from steep rocky slopes to gently and moderately undulating non-rocky land. On steep slopes, physical weathering and gravity participate in their formation, and this colluvium is associated with landform types D and G in Fig. 3 and D, E and F in Fig. 4. Examples of map units developed on this parent material include *map unit 393* of the Lochinver Association on lower ground, and *map unit 31* of the Arkaig Association in the mountainous regions. On gentler slopes, the deposits include the shallow stony drifts of a wide range of non-, moderately and very rocky map units, for example *map units 556*, *394* and *32* of the Torridon, Lochinver and Arkaig Associations respectively. Physical and chemical weathering are more prominent in colluvial drift formation on this gently sloping ground, and the map units associated with these areas occur on landform types E and F on Fig. 3.

The variety of colluvial landforms is largely dependent on geomorphological processes, but geological differences give rise to a range of textural classes, stoniness and chemical variation in the drifts. The response to soil-forming

factors also depends on geology, with higher proportions of brown forest soils and humus-iron podzols found on colluvial drifts derived from the more basic or base-rich rocks. The Lewisian, Moinian and Torridonian rocks produce stony colluvial drifts with sandy or coarse sandy textures and acidic reaction. The intrusive igneous rocks also tend to give rise to coarse-textured, stony colluvium. However, the Lewisian chlorite-schists and hornblende-schists on the Sleat peninsula and around Glenelg produce a less stony, siltier, colluvium. The basalts form brown, loamy deposits, often slightly deeper than those from other rock types, and less stony on the lower ground.

Peat is an accumulation of organic material which has formed under waterlogged conditions, low temperature and high acidity, factors which inhibit the decomposition of dead plant remains by causing a reduction in the rate of microbiological activity. Commonly, peat is found on level or gently sloping land, overlying till or other drift, but it also occurs on more irregular terrain, occupying hollows and channels between rock outcrops or drift-covered hills. Its distribution is much more extensive than indicated in Table A, where the area given is only for the amount which occurs in areas large enough to delineate as map units at the 1:250 000 scale. The most common landform for peat is a non-rocky analogue of landforms E and F (Fig. 3), although basin peats are found on A and B. Peat is generally absent from the steep slope facets of both Figs. 3 and 4 and from the higher mountain ridge crests. It is often extensive overlying till, especially in north Skye (Plate 8), and in north Lewis where it forms an important fuel source.

Morainic drift is extensive in the deeply incised valleys of the mountains (landforms A, B and C in Fig. 4) and in the smaller valleys in the foothills (landform C in Fig. 3). It also occurs on the more open, low-lying terrain of North Uist, Benbecula and South Uist, but the generalized landform diagram (Fig. 3) does not cater for this situation. *Map units 388* and *391* of the Lochinver Association are found in this more open lowland landscape. Despite the wide range of rock types, the deposits are invariably coarse textured and stony, with loamy sand the most frequent textural class.

Cryic deposits are generally found above 300–400 metres in this area and are formed by freeze-thaw processes. Gravity transports the material downslope. The drifts are often shallow and very stony with humose coarse sandy textures, except on the basalt where the drifts are less stony, with loamy textures.

Till deposits are restricted to the Western Plateaux, Foothills and Lowlands where they generally occur at low altitude, with gently undulating landforms and some areas with isolated drumlins or rock outcrops. A moderately coarse-textured till covers most of north Lewis (Plt on Fig. 2) and is itself largely overlain by peat. The till is mainly derived from Lewisian gneisses and has a sandy loam texture with olive grey or greenish grey colours. It is finer textured and less stony around Ness. Around Stornoway and on part of the Eye Peninsula, the till has sandy clay loam to sandy loam texture, a redder colour (5YR 4/3) and is derived from the local Triassic rocks. A clayey till occurs locally at the Butt of Lewis and is thought to have been derived from sea floor Jurassic rocks by glacial activity: this type of till is more widespread on Skye where Jurassic sediments form the country rocks. Till derived from basalt, with a varying proportion of material from neighbouring Mesozoic rocks, forms the parent material of *map units 149* and *155*, and has a loam texture.

Windblown sands form the parent materials of the Fraserburgh and Links Associations: the former is calcareous due to a high content of shells or shell fragments, whereas the sand of the Links Association is highly siliceous. These

deposits are restricted to landform A of Fig. 3, but can be blown over low-lying areas of E or F. The western fringe of the Outer Hebrides, from North Uist to Barra, has large areas of windblown shelly sand. Since the deposits are sandy and loose, windblow is a risk, especially where grazing pressure is severe.

Fluvioglacial and raised beach sands and gravels are restricted to valleys (landform B in Figs. 3 and 4) and raised beach platforms (landform A in Fig. 3). These sands and gravels constitute the parent materials of the Corby and Gruline Associations and are usually very stony with a coarse sand or loamy coarse sand textures; a large proportion of the stones are subrounded or rounded. The deposits are often crudely stratified but reworking by wave action can restructure the bedding. The fluvioglacial deposits can occur in a terraced or a moundy form, the latter often geographically associated with morainic drifts.

Alluvial deposits are restricted to areas along water courses and next to the sea-shore, commonly at river estuaries. The parent materials are water-laid sediments deposited by freshwater rivers and lakes in the case of *map unit 1* and by sea water in *map unit 2*. Bands of organic material are commonly found. The deposits are most often in landform B of Figs. 3 and 4. Apart from the saline alluvial deposits which are generally silty or fine sandy loams, textures vary considerably due to the mode of deposition and the lithology of the local rocks.

Glacio-lacustrine deposits form the parent material of the Roy Association. In this area they are very restricted in extent and consist chiefly of laminated silts deposited in a former glacial lake impounded by the remnants of the Loch Hourn glacier.

CLIMATE

The main elements of the climate which affect soil formation are temperature and rainfall, which govern the energy available for weathering and biotic activity and the water for leaching and gleying respectively. The area experiences a maritime climate with much of the weather originating from the west. Altitude is the most important factor in modifying the general climate, as an increase in altitude is directly correlated with both a rapid decrease in temperature and similarly rapid increase in rainfall.

The main features of a maritime climate (Francis, 1978) are a small annual variation in mean air temperature with extremes of both low or high temperatures very rare, high wind speeds at sea level and high rainfall fairly evenly spread throughout the year. The weather in maritime climates is much more difficult to predict than in the more settled conditions of continental climates.

Most of the rainfall over the area is derived from depressions which are often intense, moving rapidly eastwards from the Atlantic. The rainfall is strongly influenced by the relief of the area and increases rapidly with altitude (Fig. 5). The lowest average annual rainfall occurs on the east and west coasts of north Lewis (1000–1200 millimetres) and is partly a result of the rain-shadow effect from the prevailing rain-bearing south-westerly winds of the North Harris hills, but mainly due to the low altitudes in north Lewis. Along the remainder of the coastline, the rainfall varies from 1200 millimetres in North Uist, South Uist and Benbecula to 1400 millimetres in west Lewis and Harris, and 1600 millimetres on much of Skye and the western mainland. The close relationship between rainfall and relief continues inland with the low-lying Uists, Benbecula

Figure 5. *Rainfall (average annual, mm)*

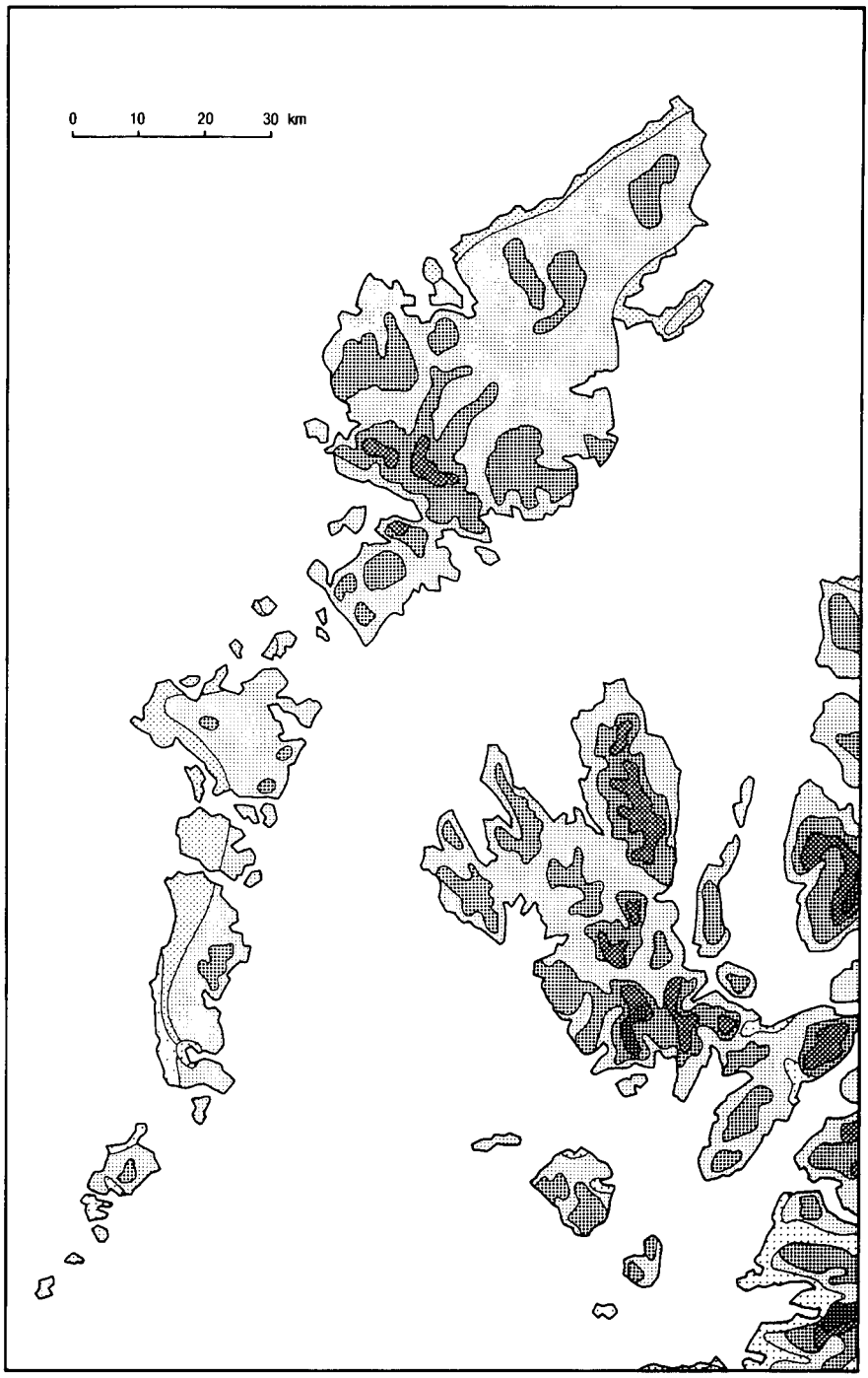
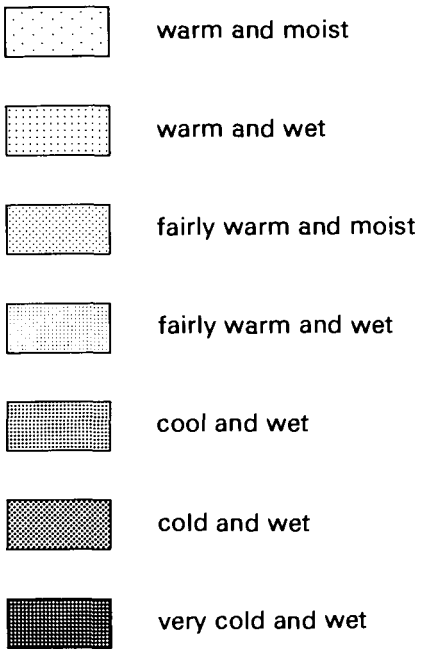


Figure 6. *Accumulated temperature above 5.6°C and potential water deficit*



Accumulated Temperature Divisions		**Potential Water Deficit Divisions**	
RANGE (day °C)	DESCRIPTION	RANGE (mm)	DESCRIPTION
›1375	warm	25-50	moist
1100-1375	fairly warm	‹25	wet
825-1100	cool		
550-825	cold		
0-550	very cold		

Modified from Birse and Dry (1970)

Figure 6. *Accumulated temperature above 5.6°C and potential water deficit*

and Lewis less than 1600 millimetres and the remainder of the area mainly between 1600 and 2400 millimetres. On the highest parts of Skye, Rhum, Applecross and Moidart, the rainfall rises to over 3200 millimetres. In common with much of Scotland the driest spell of the year occurs in the months of April, May and June. This is particularly marked at Stornoway (average annual rainfall 1100 millimetres), where the wettest months (October to January) each have approximately 10–12 per cent of the annual total whereas the drier months of April to June each have about half of this (5–6 per cent). Another feature of the rainfall pattern is the high frequency of rain, which falls on an average of 263 days each year at Stornoway, although daily totals tend to be low. Snowfall on the low ground is infrequent and usually short-lived, a feature typical of islands and coastal areas, but as it is often accompanied by strong winds, it can cause considerable, if somewhat ephemeral havoc. On the mountains, snowfall, and the number of days of snow-lie are considerably less than in the Central Highlands because of the maritime influence.

Potential water deficit (P.W.D.) indicates the effective wetness of the climate. Humidity is generally high and as this reduces evapo-transpiration, the average annual rainfall exceeds potential evapo-transpiration over much of the area, which is classified as wet (Fig. 6). The eastern coasts of the Uists and Benbecula have a lower P.W.D. (0–25 millimetres) but are of limited extent. Particularly in the mountains where rainfall is highest and temperatures are lowest, the summer rainfall (April to September) exceeds the summer evapo-transpiration by more than 500 millimetres. Only on the west coasts of the Uists, Benbecula, Barra and Lewis and around Stornoway are P.W.D.s of 25–50 millimetres found and these areas are assessed as moist.

The most important aspect of temperature relevant to soil formation and plant growth is accumulated temperature and the related growing season length. Temperature reduces with altitude and a standard lapse rate of 6°C per 1000 metres is adopted by the Meteorological Office. Accumulated temperature is a measurement of the total temperature above or below selected thresholds over an extended period of time, expressed in day-degrees centigrade (day °C). In terms of biotic activity, especially plant growth, 0°C and 5.6°C are usually considered important limits. Birse and Robertson (1970) have used accumulated frost (day-degrees below 0°C) as an indication of the severity of winter. The influence of the sea is very evident over much of the area with accumulated frost totals of less than 20 day °C most common, particularly on the low-lying ground of Lewis, the Uists and Benbecula. The main exceptions to this are Harris and inland Skye where the increased altitude pushes up the accumulated frost totals to between 20 and 50 day °C. There is a lack of extreme cold even on the mountains, the summits accumulating 110–230 day °C of frost, considerably less than on the mountains of the Central Highlands.

Values of accumulated temperature above 5.6°C have been calculated by Birse and Dry (1970) and their results are shown in a simplified form in Fig. 6. This threshold is generally accepted as the point above which plant growth becomes significant, but it is worth noting that many wild plants, especially those of the mountains can have a lower growth threshold. The warm category (>1375 day °C) occurs in South Uist, Barra, the southern parts of the Inner Hebrides and south of Loch Nevis on the mainland. Further north, the ground below approximately 200 metres is generally rated as fairly warm (1100–1375 day °C). This trend of cooling northwards is clearly related to latitude. The higher ground is mainly cool with the cold and occasionally very cold categories occurring on the mountain summits.

These figures illustrate the small annual range in temperature with the absence of hard winters offset somewhat by the low accumulated temperatures of the short growing season. The growing season is defined as the length of time for which the daily average temperature is above 5.6°C. At Stornoway, this is approximately 225 days, at Dunvegan on Skye around 240 days, rising to around 250 days in the south of the region. These seasons become appreciably shorter with increasing altitude.

Possibly the most conspicuous feature of the climate, particularly in the Outer Hebrides is the frequency of strong winds. Most of the winds result from air circulating around the deep depressions coming in from the North Atlantic where there are mean speeds of 10 metres per second in winter and 5 metres per second in summer. These velocities are amongst the highest in the world. Birse and Robertson (1970) constructed a map with an assessment of exposure, and the gently undulating landscapes of the Outer Hebrides are mainly shown as very exposed (wind speed range 6.2–8.0 metres per second). Large areas of Skye are rated as exposed (4.4–6.2 metres per second) because of the increased shelter from hilly terrain and headlands. Skye itself shelters the mainland coastline from Loch Gairloch to Loch Nevis, but the remainder is very exposed. Small areas around sheltered bays in Skye are the least exposed sites, whereas the mountain tops are extremely exposed.

The dominance of peaty soils and peat throughout the area partly reflects the interaction of low temperatures and high rainfall. These soils occur mainly in the fairly warm or cool and wet climate divisions. Mineral soils are restricted to the warm and fairly warm accumulated temperature divisions, whilst subalpine and alpine soils occur in the cold, very cold and, occasionally, the cool divisions. The severe exposure has the effect of lowering the altitudinal limits of subalpine and alpine soils compared to much of the Scottish mainland. The wind has both beneficial and adverse effects on agriculture, the latter being much more significant. Particularly on North Uist, South Uist and Benbecula, which enjoy the best climate in the whole area, the exposure factor is limiting and is the main reason for grassland being the most important farming enterprise. The easily erodable sandy soils of this coastline exaggerate this limitation. Windblown shelly sand dunes however have the beneficial effect of enriching a narrow zone of the rather acid soils inland with calcium, magnesium, sodium and potassium.

Thermal subzones (Birse, 1971), especially the boreal, orohemiarctic and oroarctic, are other facets of climate used to aid the description of the soils of this region.

CLASSIFICATION OF THE SOILS

The classification used by the Soil Survey of Scotland is outlined in Handbook 8 of this series. It is based on the recognition of central concepts and is typological rather than definitional (Butler, 1980). This form of classification is very useful in small-scale surveys, where detailed information is restricted. The following section lists the divisions, major soil groups and subgroups found in this region and describes the morphological variation that was encountered. Where a soil is restricted to a particular association or parent material this is stated in the description, otherwise the association is quoted as an example of the occurrence of the soil.

DIVISION 1 IMMATURE SOILS

The main feature of the soils in this division is that they have only incipient B horizon development, or lack this horizon altogether. The soils either have very shallow profiles, due to the proximity of bed-rock in the case of lithosols or rankers, or weakly developed profiles, because of the relatively recent age of the drift in the case of regosols and alluvial soils.

Major soil group 1.1 Lithosols are characterized by rock occurring within 10 centimetres of the surface, and are extensive in the rockier areas of the region. However, because they are otherwise similar to rankers (major soil group 1.4) they have usually been omitted from the map unit descriptions.

No major soil subgroups have been identified.

Major soil group 1.2 Regosols are developed on unconsolidated material, consisting of windblown sand in this area. These deposits can be many metres in depth. Soil horizon development is restricted to a thin humose A horizon lying directly on top of unaltered parent material. Buried A horizons often occur in profiles due to depositional and erosional processes. The drainage is usually excessive.

Major soil subgroup 1.2.1 Calcareous regosols are developed on windblown shelly sands which have high levels of free calcium carbonate. They are restricted to the Fraserburgh Association and can be expected to have high levels of exchangeable calcium and sodium throughout their profiles.

Major soil subgroup 1.2.2 Noncalcareous regosols are developed on windblown siliceous sands derived from acid rocks and they are principally found in the Links Association. They have very low levels of exchangeable cations in their profiles.

Major soil group 1.3 Alluvial soils are developed on recent alluvium. Horizon differentiation is weak in all the subgroups, which usually have an A–C horizon sequence.

Major soil subgroup 1.3.1 Saline alluvial soils are developed on estuarine alluvium, usually with a silty or fine sandy loam texture, and are restricted to areas of saltings (*map unit 2*). The topsoils can be mineral or organic. The soils are subject to tidal inundation and, as a result, can be expected to have a high concentration of water-soluble chlorides, mainly sodium.

Major soil subgroup 1.3.2 Mineral alluvial soils include a wide range of drainage and textural classes, but fine textures are rare in this region. Mottling and other features of gleying are, however, common in imperfectly, poorly or very poorly drained soils where medium textures impede the drainage or a high or fluctuating water-table produces waterlogging for long periods.

Major soil subgroup 1.3.3 Peaty alluvial soils are similar in development to mineral alluvial soils, but have organic surface horizons and often organic subsoils. The organic deposits are distributed through the profile in various ways: interbedded with the mineral layers, accumulated *in situ* over mineral deposits or distributed fairly evenly throughout the entire depth of the profile.

Major soil group 1.4 Rankers are shallow soils found on hard, mainly silicate-rich rocks, or debris derived from such rocks. They also occur on more resistant areas of basic rocks (e.g. in *map unit 158*, the Darleith Association).

Hard continuous rock occurs at depths in excess of 10 centimetres. Their horizon sequence consists of a surface horizon, usually an H, O or A horizon, overlying the parent rock, though there are sometimes incipient E, B or C horizons.

Major soil subgroup 1.4.1 Brown rankers consist of a brown humose A horizon overlying rock or rock rubble. A B horizon is sometimes apparent in the profile. These soils are particularly extensive in *map unit 158* of the Darleith Association.

Major soil subgroup 1.4.4 Peaty rankers have a surface O horizon of up to 50 centimetres, often lying directly on rock but with a thin A, E or C horizon in some profiles. They are widespread where glacial erosion has scoured the land surface free of drift, for example in *map units 32* and *395*.

DIVISION 2 NON-LEACHED SOILS

These soils are characterized by the presence of calcium carbonate and by a neutral to alkaline reaction. They are restricted to calcareous parent materials.

Major soil group 2.1 Rendzinas are shallow soils developed on highly calcareous parent materials, usually formed directly on weathered rock. They have an A–R horizon sequence with only an incipient, if any, B horizon.

Major soil subgroup 2.1.1 Brown rendzinas have a thin brown humose A horizon, usually directly over a C or an R horizon. They are freely drained and have a strong crumb structure. In this area the soils are restricted to the Cambrian and Ordovician limestones of the Inchnadamph Association. High levels of exchangeable calcium and magnesium are common.

Major soil group 2.2 Calcareous soils are freely drained with free calcium carbonate throughout the profile. The free carbonate content usually exceeds 5 per cent, and is often much higher in the Outer Hebridean machair soils.

Major soil subgroup 2.2.1 Brown calcareous soils have an A horizon which is thinner than in other cultivated soils and has high organic-matter content, though not as high as occur in these soils on Tiree (Western Scotland, Sheet 4). This thin A horizon is usually dark brown and overlies a weakly developed pale brown B horizon the colour of which is only just discernible from the underlying light grey C horizon. There is no morphological or chemical evidence of translocated sesquioxides. There is a high pH of around 8.0 in these soils and high exchangeable calcium; alkali-induced trace element deficiencies in crops and livestock are thus a problem. The soils are restricted to the windblown shelly sands of the Fraserburgh Association. Soils on the limestone drifts of the Inchnadamph Association have low levels of exchangeable calcium and are allocated to major soil subgroup 3.2.1, brown forest soils.

DIVISION 3 LEACHED SOILS

These soils have low levels of free calcium carbonate and are acid in their A and B horizons. They are usually freely drained but the B and C horizons may show some gleying expressed as mottling.

Major soil group 3.2 Brown earths have a uniformly coloured B horizon and each horizon usually merges into the one below. They have mull or moder humus and a moderately acid reaction.

Major soil subgroup 3.2.1 Brown forest soils in this area are at the extreme north and west of their range in Scotland. They show gradual changes in colour, which becomes brighter, and structure, which becomes weaker, from the A horizon down the profile. The soils are largely restricted to drifts derived from basic or ultrabasic rocks (e.g. the Darleith or the Corriebreck Associations) and in this region are found at low altitudes in fairly warm, rather wet or wet climates. The brown forest soils of the Corriebreck Association on Rhum are richer in exchangeable magnesium but comparison of levels of magnesium suggests that these soils do not correlate with those of the Leslie Association (Handbook 5). With increasing altitudes, on parent materials derived from basic rocks, B horizon colours become brighter and the soils begin to show podzolic features on chemical analysis, yet they still lack well-developed E horizons. On parent materials derived from the more acid rocks (e.g. the Arkaig, Countesswells, Lochinver and Torridon Associations) this podzolic trend is particularly marked, and bleached sand grains in the A horizons and brighter coloured B horizons are apparent, even at sea level. This parent material effect is even more marked on raised beach deposits; raised beaches derived from basic igneous material (the Gruline Association) have brown forest soils while those derived from acid rocks (the Corby Association) tend to have cultivated podzols.

Major soil group 3.3 Podzols normally have an H layer of raw humus or an O horizon overlying an eluviated, grey E horizon. Below is an illuvial, strong brown Bs horizon with morphological and chemical evidence of sesquioxide translocation and horizons of humus translocation. These soils all have a strongly acid reaction.

Major soil subgroup 3.3.2 Humus-iron podzols in their natural state have very strong horizon differentiation into L, F, H, E, Bh and Bs horizons. This horizon sequence is now restricted to uncultivated areas on steep slopes or very rocky terrain. Many of the soils referred to on the soil map key as humus-iron podzols are cultivated phases both of these soils and of peaty podzols. In the profile, mixing of the L, F, H and E horizons and sometimes the upper part of the B horizons has produced a cultivated A horizon similar to that seen in brown forest soils. However these cultivated podzols have a distinct, brightly coloured podzol B horizon and in this area often have dark horizons of translocated humus. Examples are found throughout the Corby Association and in *map units 388* and *553* in the Lochinver and Torridon Associations.

Major soil subgroup 3.3.4 Peaty podzols have an O horizon up to 50 centimetres thick usually overlying a strongly gleyed Eg horizon. This gleying is caused by the strong thin iron pan at the base of the eluvial horizon and the pan overlies a brightly coloured, freely drained, podzol B horizon. The soils are found in map units on hummocky moraines (e.g. *map units 391* and *554*, the Lochinver and Torridon Associations) where indurated C horizons occur below the iron pan. They also occur in *map unit 101* on sands and gravels.

Major soil subgroup 3.3.5 Subalpine podzols are transitional between the peaty podzols of the boreal zone and the alpine podzols of the oroarctic zone and are found in the orohemiarctic thermal subzone ranging from approximately 350–650 metres in this region. They have thin peaty surface horizons and thin E horizons overlying a distinctive zone of humus enrichment. There is not usually a thin iron pan but the podzol B horizon is well developed. The soils are characteristically loose and stony because physical agencies,

particularly freeze-thaw processes, are dominant in their formation. On parent materials derived from basic igneous rocks the soils lack podzolic features and have a more uniformly brown coloured profile; they are referred to in this handbook as subalpine brown soils (Birse, 1980, p. 233), although this term does not feature in the classification.

Major soil subgroup 3.3.6 Alpine podzols are developed where freeze-thaw processes override the chemical and biological processes active in soil profile formation at lower elevations. The upper part of the profile is strongly affected by the freeze-thaw cycle which prevents any pedological horizon formation but allows stone pavements and layers to form. B horizons are less brightly coloured than in the other podzol subgroups, and are sometimes rich in humus.

DIVISION 4 GLEYS

Gleys develop under conditions of intermittent or permanent waterlogging. The surface horizons often exhibit mottling and subsurface horizons have grey colours, often with a bluish or greenish tinge, which mask the colour inherited from the parent material. Ochreous mottling is very evident in soils where it is not masked by humus staining.

Major soil group 4.1 Surface-water gleys show the effects of gleying more prominently in their upper horizons and these effects decrease with depth. The colour of the parent material is more apparent in the lower part of the profile. These soils are often poorly or very poorly drained because a specific soil property, usually fine texture, induration, or an iron pan, impedes their drainage. The soils can also develop in areas with high rainfall and cool temperatures even on fairly porous parent materials.

Major soil subgroup 4.1.4 Noncalcareous gleys have little or no exchangeable calcium in their upper horizons and their surface horizons are humose in this region. They are primarily developed on the till deposits found in several associations in Lewis and northern Skye and on parts of the mainland. In the Inchkenneth and the Staffin Associations the soils locally have higher contents of exchangeable calcium, possibly sufficient for some of the soils to be classified as calcareous surface-water gleys (major soil subgroup 4.1.2, Handbook 8).

Major soil subgroup 4.1.5 Humic gleys are similar to noncalcareous gleys except that they have a darker more humus-rich surface horizon. They are primarily developed on till deposits and tend to occur on wetter or more flushed sites than the noncalcareous gleys and are richer in nutrients due to the flushing. Suitable sites for their formation include heavy-textured, impermeable tills and depressions in areas of sandier tills.

Major soil subgroup 4.1.6 Peaty gleys are the most widespread soils in the region and are found in practically all associations. The soils are similar to those with the typical peaty gley profile of O–Eg–Bg–Cg horizons, but in this cooler and wetter region of Scotland, the organic-matter contents of the mineral horizons is generally higher than in these soils in the east of the country. This trend is especially noticeable in peaty gleys on colluvium or on other sandy-textured drifts. On more clayey drifts, Bg horizon organic-matter contents are lower. Peaty gleys on indurated morainic drift intergrade to peaty podzols as conditions become drier on steeper slopes or shedding sites.

Major soil group 4.2 Ground-water gleys develop under the influence of a high water-table. The effects of gleying increase with depth and parent material colours are not apparent in the lower part of the profile. These soils are restricted to the low-lying areas of shelly sand in the Fraserburgh Association and to the hollows of mountain ridge crests.

Major soil subgroup 4.2.1 Calcareous gleys have humose A horizons on top of weakly gleyed Bg horizons which are rarely mottled. The Cg horizons often have a faint bluish or greenish tinge as a result of gleying. Frequent horizontal thin layers with higher organic-matter content in the Bg and Cg horizons mark former upper levels of the fluctuating water-table. The soils have high amounts of free calcium carbonate and have high exchangeable calcium and a high pH. The soils have alkali-induced trace element deficiencies. These soils are extensive in *map unit 262*, the Fraserburgh Association, but also of local occurrence in the dune slacks of *map unit 261*.

Major soil subgroups 4.2.5 and 4.2.6 Subalpine and alpine gleys are characteristically loose and stony and display typical gley features with respect to colours and mottling. They occur in the same thermal subzones as subalpine and alpine podzols but are located in hollows and channels where they receive some protection by snow-beds from freeze-thaw processes. The soils can have mineral, humic or peaty topsoils and are often flushed.

DIVISION 5 ORGANIC SOILS

Organic soils are formed under waterlogged conditions, contain very high amounts of organic matter and exceed an arbitrary specified depth.

Major soil group 5.1 Peats are organic soils which contain more than 60 per cent organic matter and exceed 50 centimetres in thickness.

Major soil subgroup 5.1.1 Eutrophic flushed peats are strongly influenced by the fact that they occur in basin sites and receive water rich in basic nutrients from nearby calcareous material. Thus they have high levels of exchangeable cations and pH. They are extensive in *map unit 263*, the Fraserburgh Association.

Major soil subgroups 5.1.3 and 5.1.4 Dystrophic flushed peat and dystrophic peat are very similar except for slightly higher pH and nutrient status in the flushed subgroup. It normally occurs in basin sites and the vegetation reflects the less acid conditions. Humification, stickiness and plasticity normally increase with depth. The unflushed dystrophic peat is widespread in *map unit 4*, blanket peat, and is a component of many map units.

SOIL-FORMING FACTORS AND THEIR RELATION TO SOIL DISTRIBUTION

The distribution and trends of the major soil subgroups are inextricably linked to the geology and parent materials, climate and relief of the area, and to time. Vegetation is a less important parameter, partly because it is dependent on other factors such as climate and soil. Nevertheless, the type of vegetation does have an effect on soil formation. The influence of man is also significant in some areas. Parent material, climate and relief are considered most important and

their influence on the distribution of soil types within the area is now described. Although the individual influences which these factors have on soil formation and distribution are considered here, it must be stressed that soil development is a result of their combined action. Where it is thought particularly relevant, the combined effect of two or more factors is occasionally briefly discussed. Brief comments on the influence of time and of man follow, concluding with a general summary statement on the dominant soil types of the area.

PARENT MATERIAL

The properties of parent material most significantly affecting soil formation are mineralogical composition and texture. Depth of material is also important in this area, and is strongly related to the landscape and relief.

Mineralogical composition is closely related to base-richness; base-rich materials generally remain less leached than siliceous materials because their larger store of bases takes longer to be depleted. Most of the more extensive rock formations of the area are low in bases, for example the Lewisian gneisses, the Torridonian sandstones, the Moinian granulites and Tertiary granites. Leaching of the acid parent materials derived from these rocks gives rise to base-deficient soils which have a surface accumulation of acid organic matter. Climate also plays a significant role in this process.

Parent materials derived from more base-rich rocks carry a higher proportion of brown forest soils and brown rankers than those derived from more acid rocks; the distribution of these soil types is largely a reflection of the base status of the parent material. The Tertiary basalts are the only extensive rock formations in this area which are relatively base-rich, although the smaller outcrops of Mesozoic sediments, the Cambro-Ordovician limestones and the restricted hornblende- and chlorite-schists of the Lewisian gneiss formation also have significant proportions of brown forest soils. Calcareous soils are developed on the windblown shelly sand and brown calcareous soils, calcareous ground-water gleys and calcareous regosols are restricted to these deposits.

Soil texture is generally inherited from the texture of the parent material; in this area, many of the rocks are coarse grained and hard and do not weather very readily. Thus the soils are mainly coarse textured, with loamy sand and sandy loam textures most common. The most notable exceptions are the soils developed on clayey till derived from Jurassic limestones and shales, and the loamy soils associated with the other Mesozoic sediments and parts of the Tertiary basalt lava flows. Although the coarse-textured soils developed on windblown sand and fluvioglacial sands and gravels are freely and occasionally excessively drained, many coarse-textured soils are poorly drained because of some other soil property, such as induration, an iron pan or rock close to the surface, impeding drainage. Many soils are stony, particularly those developed on drifts derived from metamorphic and plutonic igneous rocks, but also those found on the Torridonian sandstones and grits. Because of coarse textures and stoniness, soil structures tend to be weak, and generally only in mineral topsoils and indurated horizons is a moderate or strong soil structure apparent.

CLIMATE

Temperature and rainfall are the two elements of climate which have the greatest influence on soil formation. The amount of water entering the soil is

more important than the actual rainfall. In this area, as a result of moderate to high rainfall and low summer temperatures, evapo-transpiration is low and much of the rainfall enters the soil. Water available for leaching and gleying is therefore plentiful. Leaching of the mainly acid parent materials is intense, the soils become more acid and under the waterlogged conditions a peaty surface horizon is readily formed. The combination of this wet climate acting on base-deficient parent materials results in soils with peaty surface horizons covering much of the area. A large proportion of the more base-rich parent materials also have peaty soils; this indicates that leaching and gleying are dominant processes in this area.

Organic-matter contents in some mineral horizons of soils in this area are higher than in similar soils in the east of Scotland. It is thought this is a reflection of the cool wet climate causing organic matter to accumulate more quickly and also to break down much more slowly. Mineral gleys tend to have humose topsoils (except in the low rainfall area of north Lewis), the A horizons in brown forest soils have moderate amounts of organic matter and peaty gleys have dark humus-stained Eg and Bg horizons.

Subalpine and alpine soils occur at lower altitudes in this area than in most other parts of Scotland. Although the cause is probably partly an effect of latitude, it is considered that the severe exposure is the main reason.

The frequency of strong winds is the principal factor affecting the accumulation, erosion and redeposition of shelly sand into dunes supporting calcareous regosols, and machairs supporting brown calcareous soils and calcareous ground-water gleys.

RELIEF

The relief of the area has a significant influence on climate and this relationship has already been discussed. Relief and parent material are also closely interrelated, and specific parent materials often occur on a characteristic topography.

Large areas of the Western Plateaux, Foothills and Lowlands are intensely ice-scoured and the ground is very rocky, rugged and strongly undulating. Rankers, lithosols and shallow phases of other major soil subgroups are dominant, whilst peat occurs in the basins. Peaty rankers and shallow peaty gleys are very common, although brown forest soils and brown rankers are locally extensive on some of the low-lying areas of base-rich material. Some areas are extremely rocky, with little soil and vegetation cover. A notable feature of the soil pattern in these rocky landscapes is the rapid variation in soil type over very short distances, due to the wide range of slopes and depths of parent material which are present.

Relief also has an influence on soil genesis through its effect on water run-off, for example on the gently sloping till plain of north Lewis. The gentle slopes cause slow run-off and this further enhances the build-up of peat in addition to the parent material and climatic factors. The edges of this plain are dominated by gleys; the gently sloping terrain and indurated subsoils induce gleying processes.

TIME

The soils in general date from the end of the last ice-age, but younger soils, developed on more recent deposits such as alluvium and windblown sand, are usually less mature and show only weak horizon differentiation.

MAN

Man's influence in this area largely consists of the removal of peat and the subsequent cultivation of the ground (Fig. 12). Much of the fringe of the Lewis till plain has developed its soil pattern by this process. Evidence of former peaty surface horizons is found in some parts of these areas, but the original profiles are largely destroyed in the most intensively cultivated ground. The soils present around many of the other crofting townships throughout the area are cultivated phases of various major soil subgroups, a notable example being the cultivated peaty podzols and humus-iron podzols on the moraines of the Uists and Benbecula.

The result of the interaction of these factors is that large parts of the area are covered by coarse-textured acid soils with peaty surface horizons, and peat; the former are frequently shallow. Just over 80 per cent of the area has soils with peaty surface horizons; about half of this percentage is moderately or very rocky.

The remainder of the area consists of a wide range of soils from brown calcareous soils to alpine soils. None is extensive, but some major soil subgroups are locally important. The distribution of these soils is described more extensively in Chapter 2.

VEGETATION

In the following account, the distribution of the plant communities and their relationship with the soils of the region are briefly discussed. The common names quoted for these communities in the text, both here and under each soil association description (Chapter 2) are based on the vegetation field units used in the 1:250 000 survey. These units are listed and described in Handbook 8. Individual species names follow those of Clapham, Tutin and Warburg (1962) for vascular plants, as do the bulk of the common names, those of Smith (1978) for mosses and those of James (1965) for lichens.

The classification of the plant communities in phytosociological terms is quoted in brackets after each community name and follows that of Birse and Robertson (1976) and Birse (1980, 1982). When a community is firmly established as an association, it is put in the Latin form (-etum), but when there is some doubt as to the validity of the association, it is named by one or two plant species followed by the term 'Association'. When there are insufficient records to establish an association, the vegetation is again named by one or two plant species, but with the term 'Community' following.

The diversity of plant communities within the area is an expression of the range in geology, climate, landform, soils and land use, but the overriding influence here is that of oceanicity as reflected in the mild frost-free winters, the high humidity and the constant exposure to strong winds. An effect of this is that a high proportion of the moorland communities are present in either their flushed or their northern forms. The vegetation of the region may be conveniently described under three main headings: (1) The Outer Hebrides, (2) Skye and the Small Isles and (3) The mainland. The percentage cover of communities for area (2) are estimates based on soil map unit areas and additional field information.

THE OUTER HEBRIDES

The vegetation of the Outer Hebrides is not as varied as that of the other parts of the region as the soils are largely formed on three main parent materials—peat, windblown shelly sand (The Fraserburgh Association) and drifts derived from Lewisian gneisses (The Lochinver Association). The dominant plant communities are those of moorland.

Some cultivation of the till soils is practised on the coast around Stornoway and between Barvas and the Butt of Lewis, and large areas of arable crofting lie on the low raised beach shelly sands of the Uists and Benbecula where black oat (*Avena strigosa*) is the main cereal crop grown, often with an admixture of an indigenous strain of rye (*Secale cereale*). Ploughing of the drier machair soils can result in extensive windblow, but a technique is used whereby a very narrow shallow furrow is made which does little more than invert the turf and this turf layer is sufficient to retain some moisture and provide some rooting medium on the most excessively drained sandy soils, although droughting can still occur. An indication of the moisture-retaining capacity of the turf is the presence of marsh ragwort (*Senecio aquaticus*) in the permanent pastures on the freely drained soils. Small plots of potatoes and other crops for local consumption are also worked on the shelly sands, seaweed and peat being added as a compost to increase the organic content of the soil. In direct contrast to this practice is the cultivation of peat by the lazy-bed system whereby peat cut from parallel furrows is spread over the intervening rigs and mixed with shelly sand and seaweed to form a better rooting medium. Other areas of machair that are not too wet are sown out in permanent pasture (Lolio-Cynosuretum) and some of the moraine fields and till deposits where topography is not a limiting factor have also been improved by surface treatment to give better grazings (Lolio-Cynosuretum and the *Galium saxatile–Poa pratensis* Community).

Semi-natural grassland communities with the exception of dune pastures are uncommon in the Outer Hebrides and are confined to the soils of the steep moraines and bouldery hill slopes and to areas adjoining crofting land where grazing pressure has been sufficient to suppress the moorland vegetation. Acid bent–fescue grassland (part of Achilleo-Festucetum arenariae) is found locally on freely drained brown forest soils and humus-iron podzols and common white bent grassland (part of Junco squarrosi-Festucetum tenufoliae) occurs on imperfectly drained podzols and peaty podzols. Sedge mires, rush pastures and swamp communities are found in conjunction with the flushed peaty channels on hill slopes, between morainic mounds and in wet depressions, the most commonly encountered being flea-sedge mire (Caricetum hostiano-pulicaris), star sedge mire (Caricetum echinato-paniceae) and bog-rush mire (the *Schoenus nigricans* Community).

As previously mentioned, the landscape is dominated by moorland communities, the majority of which reflect the influences of exposure and rainfall by the presence of their northern or flushed forms. Blanket peat which is found extensively in North Uist and Lewis carries both the typical and northern forms of blanket bog; the wide flushed slopes and depressions support flying bent bog which may also contain bog myrtle (*Myrica gale*); locally, some upland blanket bog with crowberry (*Empetrum nigrum*) occurs on peat of more exposed lowland sites or at higher altitudes (all parts of Erico-Sphagnetum papillosi). Where management practice has imposed a regime of heavy burning and grazing on the bog vegetation to encourage new palatable growth, cotton-grass tussocks (*Eriophorum vaginatum*), bog asphodel (*Narthecium ossifragum*) and bog

mosses (*Sphagnum* spp.) have been suppressed and the vegetation has become altered to deer-grass and northern deer-grass moor (the *Trichophorum germanicum–Calluna vulgaris* Association). Bog heather and northern bog heather moors (Narthecio-Ericetum tetralicis) are widespread on the shallow peats and peaty gleys. Moist Atlantic heather moor or its northern form (parts of Carici binervis-Ericetum cinereae) occurs on the peaty podzols, peaty rankers and some peaty gleys.

As exposure increases, notably in the hilly areas of North Harris, Beinn Mhor in South Uist and Heaval in Barra, there is a tendency for the Atlantic elements in the moorland vegetation to be replaced by boreal species. On the high-level moraines of Mullach an Langa and the neighbouring hills, the appearance of species such as crowberry (*Empetrum nigrum*), fir clubmoss (*Lycopodium selago*) and dwarf juniper (*Juniperus communis nana*) is an indication of a narrow band of boreal heather moor (Vaccinio-Ericetum cinereae) just below the mountain-top communities. Above the zone of peaty soils, the steep upper slopes of the hills and mountains carry alpine and subalpine podzols colonized by mountain white bent grassland (part of the *Carex bigelowii–Festuca vivipara* Association), while the exposed rocky tops have a sparse cover of the fescue–woolly fringe-moss heath (Festuco-Racomitrietum lanuginosi) which may include least willow (*Salix herbacea*), and alpine azalea–lichen heath (Alectorio-Callunetum vulgaris).

The machairs—as already described above—are among the main areas of agricultural activity. The full sequence of dune systems is generally poorly developed due to their constant erosion by wind and water, and sand deposits are often blown up over the till or rocks of low cliffs up to 40 metres high on the west coast. The principal community of the unimproved areas of freely drained soils is the eyebright–red fescue dune pasture (Euphrasio-Festucetum arenariae) which is widespread along the western coastline of North Uist, South Uist and Benbecula. To the landward side of the low raised beaches, wet depressions with calcareous gleys carry a range of swamp and sedge communities of which silverweed pasture (the *Potentilla anserina–Carex nigra* Community) is the most common. Where cliffs and shorelines are exposed to regular inundation with sea-spray, saline gleys, or humic gleys, peaty gleys and peats with high exchangeable sodium have developed and carry a close-cropped turf much favoured by sheep. The vegetation has been classed as vernal squill maritime pasture (the *Scilla verna–Festuca rubra* Community). Saltings are local and of small areal extent, but where they do occur the plant communities of the saline alluvial soils are dominantly those of sea poa salt-marsh (Puccinellietum maritimi) and mud rush salt-marsh (Juncetum gerardii), which also provide good grazing.

Natural woodland communities are very fragmentary and localized and are confined to the islets of lochs, sheltered cliff ledges and small gullies (Currie, 1979). The only extensive area of what might be considered to be semi-natural woodland in the Outer Hebrides lies on the steep rocky slopes to the west of Stornoway where the freely drained brown forest soils and humus-iron podzols carry a dry birch scrub (part of Blechno-Quercetum) which has been much altered by grazing, felling and amenity planting.

SKYE AND THE SMALL ISLES

In contrast to the Outer Hebrides, the Island of Skye and the Small Isles are made up of a wide range of rock types and there is a corresponding diversity in

the plant communities found on their derived soils. Some 4 per cent of the land surface is utilized as arable fields and rye-grass–crested dog's-tail pastures (Lolio-Cynosuretum). The sown-out permanent pastures can degenerate to meadow-grass–bent pasture (the *Galium saxatile–Poa pratensis* Community) if the fertility of the soil is not maintained, though this community may also develop from bent–fescue grassland (Achilleo-Festucetum tenuifoliae) that has been subjected to heavy grazing and dunging. The principal soil types of these fields and pastures are noncalcareous gleys on tills derived from basalt and fine-grained Mesozoic sediments. Areas of former cultivation with more waterlogged soils, peaty and humic gleys, for example, have regressed to species-rich swamp communities such as meadow-sweet meadow (Valeriano-Filipenduletum), yellow flag swamp (the *Iris pseudacorus* Community) and marsh marigold swamp (the *Caltha palustris* Community), or to rush pastures (the *Ranunculus repens–Juncus effusus* Community and Potentillo-Juncetum acutiflorae), which together cover 7 per cent of the islands.

The commonest rough grassland community on brown forest soils and humus-iron podzols is that of bent–fescue grassland (Achilleo-Festucetum tenuifoliae). Both the herb-rich and upland forms of this community are found, the former on drifts derived from the more calcareous basalts and on steep slopes where the percolating drainage waters are nutrient-rich and the latter on scree slopes and basalt hill summits, chiefly in Trotternish. Bent–fescue grassland is also found on peaty podzols on some steep hill slopes where management has imposed a heavy grazing/burning regime on the heather moor more typical of these sites. Heath rush–fescue grassland (Junco squarrosi–Festucetum tenuifoliae) may also occur here. These two grassland associations together comprise some 12 per cent of the total vegetation cover of the islands.

Dry heather moor is the predominant community of peaty podzols and occupies about 7 per cent of the area. It is present mainly in the form of dry and herb-rich Atlantic heather moor (parts of Carici binervis–Ericetum cinereae), but these communities are replaced by boreal heather moor (Vaccinio-Ericetum cinereae) on steep slopes above 250 metres altitude, particularly where the drifts are excessively drained screes derived from acid rocks. The prevalent communities on peaty gleys are moist Atlantic heather moor and bog heather moor (Narthecio-Ericetum tetralicis) and together they account for some 38 per cent of the vegetation cover. Their northern forms colonize exposed sites, particularly above an altitude of 200 metres. Bog-rush mire (the *Schoenus nigricans* Community) commonly occurs on flushed peaty gleys, primarily where dissolved nutrients have been derived from base-rich sources—a trend well illustrated on the vegetation map of Rhum (Ferreira, 1970) where this community is restricted to areas underlain by basic and ultrabasic rocks. The vegetation of some areas of peat shows affinities with that of the peaty gleys in that bog-rush mire occurs where there is a source of base-enriched drainage water. Bog moss water track (the *Juncus effusus–Sphagnum recurvum* Community) is found in drainage channels in blanket peat where the water has a low pH. For the most part however, the vegetation of the peatland is that of blanket and flying bent bogs (parts of Erico-Sphagnetum papillosi), which cover 20 per cent of the area. The upland form of this association is an important community of the gently sloping land at altitudes between 200 and 500 metres.

The harsh conditions of the montane environment permit the survival of only a few specialized plant communities such as stiff sedge–fescue grassland (the *Carex bigelowii–Festuca vivipara* Association) and fescue–woolly fringe-moss

heath (Festuco-Racomitrietum lanuginosi). They account for about 2 per cent of the vegetation cover and are found on exposed ridges and summits on stable sites comparatively unaffected by wind erosion and frost action. The soils of this zone include subalpine podzols, alpine podzols and alpine brown soils (Birse, 1980, p. 233).

Woodland—other than plantations—covers less than one per cent of the area and occurs mainly on steep rocky slopes usually with brown forest soils. The soils of the more basic rocks carry stands of both ashwood and hazel scrub (parts of Primulo-Quercetum) which are well represented at Tokavaig near Ord, and Torrin, both localities being underlain by limestones. The comparatively acid soils of the Torridonian rocks south of Kyleakin support heathy birchwoods (part of Blechno-Quercetum). Trees are absent in the north and west of Skye and in the Small Isles generally, apart from a few remnant stands on sheltered sites of landslips, cliffs and gorges. A former tree line at around 200 metres altitude is marked by scrub vegetation in south-east Skye.

Rendzinas, though of small extent, deserve special mention as the only stations of mountain avens (*Dryas octopetala*) in this area. The *Dryas octopetala–Carex flacca* Association (Birks, 1973) occurs on the limestones which outcrop between Broadford and Torrin, and also on the Triassic rocks of north-west Rhum. Although 6 per cent of the islands are delineated as cliff and scree, it is on the lithosols and rankers of this map unit that some of the most attractive and rarest species have become established. The luxuriant growth of species such as rose-root (*Sedum rosea*), globe flower (*Trollius europaeus*), yellow mountain saxifrage (*Saxifraga aizoides*) and royal fern (*Osmunda regalis*) is sustained by the constant supply of nutrients from drainage water and the addition of freshly comminuted rock fragments from above. One of the rarest plants in the British flora—the tiny Iceland purslane (*Koenigia islandica*)—is found in the hills of northern Skye growing on flushed basaltic screes.

THE MAINLAND

The third subdivision of the area comprises a long narrow strip of mainland headlands and promontories running from Rubha Reidh in the north to Moidart and Ardnamurchan in the south. Moorland communities dominate this subdivision, especially on the infertile peaty soils derived from the Torridonian sandstones and grits of the north. Here, on the headlands around Loch Gairloch and Applecross, the natural vegetation is primarily made up of blanket and northern blanket bogs (parts of Erico-Sphagnetum papillosi) on peat, and bog heather moor and its northern form (Narthecio-Ericetum tetralicis) on peaty gleys. Moist Atlantic heather moor (part of Carici binervis-Ericetum cinereae) is less frequent and occurs on peaty podzols, peaty gleys and peaty rankers on steeper slopes and mounds. On the more exposed lowland sites and at higher altitudes, a zone between the true mountain communities and those of the lowlands may be present with local areas of upland blanket bog (part of Erico-Sphagnetum papillosi) on peat and lichen-rich boreal heather moor (part of Vaccinio-Ericetum cinereae) on subalpine soils. On the headlands of Knoydart, Morar and Moidart to the south, moorland communities are again the dominant feature but the slight increase in the base status of the soils derived from Moinian rocks coupled with the high rainfall has permitted the development of flying bent bog (part of Erico-Sphagnetum papillosi) on flushed sites within areas of blanket peat.

Above the zone of peaty soils, the upper hill and mountain slopes carry stiff sedge–fescue grassland (the *Carex bigelowii–Festuca vivipara* Association) usually dominated by white bent (*Nardus stricta*) on flushed alpine and subalpine soils. The hills of the Rois-Bheinn range, composed of Moinian rocks, are extensively flushed on their steep upper slopes and support a rich flora which includes species such as yellow mountain saxifrage (*Saxifraga aizoides*), starry saxifrage (*S. stellaris*), melancholy thistle (*Cirsium heterophyllum*) and mountain sorrel (*Oxyria digyna*). The dominant community of these slopes is upland bent–fescue grassland (part of Achilleo-Festucetum tenuifoliae). Mountain blanket bog (Rhytidiadelpho-Sphagnetum fusci) is found locally on the eroding peat of level or gently sloping sites on the high tops and ridges and mountain heath communities—principally fescue–woolly fringe-moss heath (Festuco-Racomitrietum lanuginosi) and, to a lesser extent alpine azalea–lichen heath (Alectorio-Callunetum vulgaris)—occur on the alpine podzols and rankers of the exposed summits.

Semi-natural grassland is uncommon and is confined to steeper slopes and mounds where the grazing pressure and muirburn is sufficient to suppress the growth of dwarf shrubs or where the soils have little or no organic top. Examples of both common white bent and flying bent grasslands (parts of Junco squarrosi-Festucetum tenuifoliae) may be found on peaty podzols, peaty gleys or shallow flushed peat, and some bent–fescue grassland (Achilleo-Festucetum tenuifoliae) occurs on the humus-iron podzols and brown forest soils of steep valley slopes, moraines and raised beach terraces. The terraces are also the sites of some limited cultivation and pasture improvement (Lolio-Cynosuretum). Flush channels, slopes and depressions throughout the landscape carry a wide range of swamp, rush and sedge communities on peaty gleys, humic gleys, noncalcareous gleys and peat.

Woodland communities are very local and restricted to steep sheltered valley slopes and moraines with humus-iron podzols and brown forest soils. Oak and birch woodland (Blechno-Quercetum) is most often found and some hazel scrub (part of Primulo-Quercetum) occurs on soils derived from the slightly higher base status soils of the Lewisian rocks to the east of the Moine Thrust.

2 The Soil Map Units

The previous sections have described the factors responsible for soil formation in this region. The different soils have been grouped into 97 soil map units, each of which may contain several major soil subgroups. The map units are grouped by parent materials into 21 soil associations mostly named after geographical locations. The associations are described in alphabetical order commencing after alluvial soils and organic soils and the map units are numbered according to a national system covering Scotland. With the exception of alluvial soils and organic soils (*map units 1–4*), the map units in each association are broadly grouped by their position in the landscape, i.e. whether they occur in lowlands, uplands or on mountains; within these categories units dominated by mineral soils take precedence over those which are mainly peaty, free drainage before poor, and non-rocky units are considered before the rockier ones.

DESCRIPTION OF THE MAP UNITS

THE ALLUVIAL SOILS

(Map units 1 and 2)

These soils are developed on post-glacial alluvial deposits consisting of recent, unconsolidated water-laid sediments. The texture of the material is variable being principally related to water-flow rates and partly to the lithology of the parent rock. Textural variation takes the form of bedding in soil profiles, or of lateral variation in topsoils and subsoils. Gravelly horizons often occur at depth below sandy or loamy topsoils, while gravelly alluvial soils are restricted to debris cones or alluvial fans in the hills and mountains. The parent materials are derived either directly by the attrition of the local rocks or by reworking of pre-existing drifts. The chemical properties of the soils depend to a large extent on the nature of the source rocks. Marine alluvium (saltings) consists of silty loam or fine sandy loam deposits which are often tidally inundated and waterlogged.

Alluvial parent materials are relatively unaltered by pedogenesis and little or no evidence of podzolization is detected by morphological examination. Profile development is restricted to humus accumulations in the surface horizons and, in waterlogged soils, mottling and greyer colours provide evidence of gleying.

These soils are widespread throughout the region and may be seen along any water course. However the map scale allows only the larger areas to be shown and the map units are restricted to 7 square kilometres (0.1 per cent of the land area). Alluvial soils are also significant in other map units (e.g. *map unit 99*). The principal areas are at Kinlochmoidart and Applecross on the mainland, in Glen Sligachan on the Island of Skye, on Rhum, and near Arnol in west Lewis. Saline alluvial soils occur at the head of many sea lochs but only form mappable areas at three localities north of Stornoway.

These soils occur in the fairly warm accumulated temperature division in most of the region, with the warm division restricted to less exposed glens on Skye and the Small Isles and to mainland glens and coastal fringes at low altitude, particularly south of Knoydart. The rainfall is lowest at Arnol on Lewis where it is 1200 millimetres, rising to 1500 millimetres at Applecross and 2000 millimetres at Kinlochmoidart. The rainfall on these soils on Rhum is around 2000 millimetres and reaches its highest (3000 millimetres) at Glen Sligachan. Much of the land is in the wet and rather wet potential water deficit divisions and is mainly exposed and very exposed, with some moderately exposed land in more sheltered east-facing glens.

The plant communities of these soils are also variable but, broadly speaking, the mineral soils are colonized by grassland or pasture communities or used as arable land, the peaty soils support Atlantic heather moor, bog heather moor and blanket bog communities, and the saline alluvial soils support salt-marsh communities.

Map unit 1 is restricted to 5 square kilometres (70 per cent of the association) and occurs at Kinlochmoidart and Applecross on the mainland, Glen Sligachan on Skye, on Rhum, and near Arnol in west Lewis. The land has gentle slopes with no topographic irregularity and, except in Glen Sligachan, lies below 10 metres altitude. The alluvial terraces are crossed by elongated hollows representing former river meanders now filled with alluvium. There are small areas of raised beach platforms and outwash terraces at some localities. Rocky land is also insignificant in this unit and the terrain is in marked contrast to the steep, rocky valley sides of the surrounding country (Plate 7).

On larger scale maps, alluvial soils are generally differentiated into several textural classes and drainage groups, but for this survey, all are included in this map unit. The soils are described under the headings mineral and peaty:

(1) Mineral alluvial soils are found at Kinlochmoidart and at Applecross and form a portion of the unit at Talisker. The silty- and loamy-textured soils at Kinlochmoidart have poor or imperfect drainage classes. At Applecross there are sandier textures with freely or poorly drained soils and small areas of peaty alluvial soils. Small areas of freely drained mineral alluvium are found close to rivers and streams, even where peaty alluvial soils are dominant. Leaching of applied nutrients is less of a problem in freely drained alluvial soils than in the humus-iron podzols of the Corby/Boyndie/Dinnet Associations with their high sand content. However, exchangeable cations tend to be low in alluvial soils and maintenance of an adequate nutrient supply requires frequent application of lime and fertilizer. The total chemistry, exchangeable cation chemistry, and trace element contents can be expected to reflect the levels in the source rocks, although leaching will mask the differences.

(2) The remaining areas of the unit are dominated by peaty alluvial soils and peat. The former soils have two principal forms; almost entirely organic

material fluvially deposited; and interbedded organic and mineral layers developed *in situ*. The soil drainage classes are poor or very poor.

Pasture communities are the main vegetation types on the mineral soils with occasional arable breaks for root crops. The freely or imperfectly drained soils support grassland communities with the poorly drained soils supporting rush pastures. Peaty alluvial soils are colonized by bog heather moor with some blanket bog communities. The grasslands generally provide good grazings while the moorland and bog communities are of low relative grazing value.

Map unit 2 occurs at three localities north of Stornoway and covers 2 square kilometres (30 per cent of the association). However areas of the soils which are too small to show at this scale are seen at many coastal localities. They usually abut soils of *map unit 1*, or of the Corby Association and provide local areas of good grazings for many farms and crofts. The ground surface is dissected by many channels of varying depths formed by tidal action, and numerous very small pools dot the surface.

The soils are developed on medium-textured, mainly fine sandy or silty, marine alluvium. Saline alluvial soils, sometimes with organic surface horizons, are the main soil types. Peats with high exchangeable sodium content are also found, especially in the Outer Isles. The vegetation is dominated by halophytes with salt-marsh communities covering large areas, but the quality of the grazings is good.

THE ORGANIC SOILS

(Map units 3 and 4)

Organic soils comprise basin and valley peats and blanket peats. Peat is defined as a soil having a surface horizon greater than 50 centimetres thick, with an organic-matter content of more than 60 per cent. It is an accumulation of partly decomposed plant remains formed on waterlogged sites where the aerobic process of decomposition has been inhibited. Peat formation is influenced by climate, topography and geology. Climate plays a major role in affecting the amount of peat in the region, mainly by the interaction of high rainfall with low temperatures. The slope is the main aspect of topography influencing peat formation, mainly by its effect on site moisture regimes. Nutrient-deficient parent materials are widespread in the region and provide the acid, low base-status conditions so favourable to peat formation.

Peat is the most extensive soil in the region and forms map units covering 859 square kilometres (15.3 per cent of the land area). This figure is an underestimate of the true extent; the map key reveals that, out of 97 map units, 38 have peat as one of their major soil components with a further 18 having peat as a minor soil component. Some of the units with peat as a major component consist of 30–40 per cent peat. *Map unit 160*, for example, consists of 40 per cent peat and as it covers 589 square kilometres there are approximately 236 square kilometres of peat in this unit. The true extent of peat soils is therefore considerably greater.

Map unit 3 covers 13 square kilometres (2 per cent of the association) and has been mapped on the islands of Skye and Rhum, and on the mainland near Arisaig.

An important factor in the formation and development of basin and valley

peats is topography, for example hollows and other confined sites such as river flood plains and terraces. Initially the vegetation is aquatic or semi-aquatic, resulting in eutrophic or mesotrophic peats, but as the deposit builds up, climatic factors become progressively more important and largely determine the nature of the peat and the rate at which it develops. A fully developed basin peat deposit has a convex or dome-shaped configuration and shows in section several distinct horizons which reflect the changing environmental conditions.

The unit is mainly found in lowland areas below 50 metres altitude where it experiences a fairly warm to warm climate in wet and rather wet moisture conditions with average annual rainfall in the range 1400–2600 millimetres. The map unit mainly occurs in basin and valley floor sites as in the broad valley east of Portree, or on raised beaches or outwash terraces, for example near Arisaig.

Blanket bog is the dominant plant community, with local flying bent bog and bog heather moor. In flushed channels and at the margins of the deposit, swamp, sedge mires and rush pastures are prevalent. The grazing value is generally low, and wetness renders the land a poor proposition for reclamation. Forestry is possible given adequate site preparation and fertilizer inputs, the most suitable species being Sitka spruce and lodgepole pine.

Map unit 4 is the most extensive soil map unit in the region, covering 846 square kilometres (98 per cent of the association). Climate is the important factor in the formation of blanket peat, but peat development is often initiated by the interaction of the climate and acidic parent materials. Leached base-deficient soils support bog mosses and other moorland species whose structural adaptations and growth-form help to hold water at the soil surface and intensify the wet conditions. Most blanket peats are dominated by remains of deer-grass and bog mosses although cotton-grasses are also important. More locally, remains of other plants such as flying bent are common. Blanket peats generally lack the stratigraphical changes apparent in the basin peats.

The largest area of the unit occurs in the northern half of Lewis where, apart from the coastal fringes, much of the land north of a line from Garynahine to Stornoway consists of blanket peat. Other significant areas occur on the mainland east of Melvaig, in the northern half of North Uist, and in Trotternish (Plate 8). Small areas are scattered throughout the whole of the region except in mountainous or hilly terrain where much of the ground is too steep or too rocky for peat to occur extensively.

Much of the landscape has many large areas of ground that are level or gently sloping. Strong slopes vary in frequency, and if they are common, the peat depth is generally less than in more gently undulating terrain. The altitude range is mainly from sea level to 350 metres, except in north Lewis where the elevation rarely rises above 150 metres.

Although blanket peat shows little variation in botanical composition with depth, some of its physical properties do vary in the profile. The top 15–20 centimetres are generally fibrous, weakly humified and slightly plastic. The peat gradually becomes pseudofibrous, and is often amorphous below 80–100 centimetres. The degree of humification also increases and because of these changes, the material becomes increasingly plastic and sticky. Boundaries between horizons are often gradual. The peat is typically very wet and very poorly drained with moisture contents of about 90 per cent in its natural state. It is usually structureless but occasionally very weak subangular blocky structures are found in the top 15–20 centimetres in slightly drier localities. The

peat is extremely acid and base-deficient and only in the narrow weakly flushed channels indicated by sedges and rushes does the pH rise significantly. These flushes are normally the only areas where mineral material occurs in the peat, washed through by the flushing. Roots and tree stumps representing the former forest cover occasionally occur near the base of the peat.

The depth of peat is dependent to an extent on the local topography, and in general is about 2 metres, although in parts of central Lewis it reaches 6 metres. Although, by and large, the ground surface has only slight rill erosion, at higher altitudes the peat is strongly eroded and gullied, often down to mineral material. This is best developed in the areas to the east of Applecross village and Melvaig, but also occurs around Beinn Mholach in central Lewis and Loch Grunavat in west Lewis. On the extensive, very gently undulating areas of Lewis and North Uist, areas of dubh lochans occur, generally on broad ridge tops, well away from the natural drainage channels. Peat has been cut over for fuel around most of the crofting communities, particularly on Lewis, and a very uneven surface results.

The average annual rainfall reflects these altitudinal differences fairly well. On the low-lying areas of the Outer Hebrides the rainfall is 1100–1400 millimetres whereas on the higher areas it is generally over 1600 millimetres, up to a maximum of 2400 millimetres in Applecross. The unit occurs almost entirely in the fairly warm and cool wet climate divisions. Apart from a few slightly more sheltered localities it is mainly very exposed.

Blanket bog and northern blanket bog are the main plant communities found on the peat. Flying bent bog is also common, as well as some upland blanket bog; mountain blanket bog is confined to the higher hills. Blanket bog–terminal phase also occurs. Sedge mires and bog moss water track communities are often associated with the streams flowing through the bogs and although they are very conspicuous, they form a very small proportion of the total area. Where the depth of peat is between 50 and 100 centimetres, usually on strong slopes, bog heather moor and northern bog heather moor occur. These communities are also common on the fringes of the peat areas where they are found on the cut-over peat as 'replacement' communities. The northern forms of plant communities are in general more common on the Outer Isles than on Skye and the mainland.

The highly impermeable nature of the peat and its lack of response to drainage due to slow hydraulic conductivity have greatly retarded its reclamation. Although it is feasible to reseed peat, the management and maintenance of the sward is very costly and difficult. As a result, the land use is restricted to poor rough grazing. Peat is extensively used as a domestic fuel in the crofting areas.

THE ARKAIG ASSOCIATION

(Map units 25–27, 29, 31–34)

The soils of the Arkaig Association are developed on drifts derived from a variety of siliceous metamorphic rocks, principally quartz-feldspar-granulites and gneisses. Although further lithological distinctions have been made by the Institute of Geological Sciences (Phemister, 1960), all the parent materials formed from this assemblage of rocks (including granitic gneiss, pelitic and psammitic schists) appear to give rise to soils with similar properties. The

association is largely confined to the southern portion of the mainland and, on the islands is found only on the southern tip of Skye. It covers 409 square kilometres (7.3 per cent of the land area). The landscape is often dominated by rock outcrops and the main parent material is shallow stony colluvium of loamy sand texture. However some morainic drift is present in the deep glaciated valleys and cryic deposits on the mountains. The climate ranges from warm and rather wet in the coastal lowlands with a rainfall of around 1600 millimetres, to very cold and wet on the mountains with a rainfall of over 2400 millimetres.

The most frequently occurring soils are peaty gleys, peat and peaty rankers on rugged lowlands; the chief contrasts to this are provided by the steep rocky slopes where humus-iron podzols are found at low altitudes, and subalpine podzols on the mountains. Because of the rugged landscape with steep slopes and shallow soils, land use is restricted to forestry, rough grazings, and recreation.

The dominant plant community is moist Atlantic heather moor found especially on peaty gleys. On the peat deposits flying bent bog is the most prevalent vegetation type. Woodland and grassland communities are sparsely represented, usually occurring on mineral soils at low altitudes. With increasing altitude and the advent of subalpine and alpine soils, communities typical of exposed situations, such as fescue–woolly fringe-moss heath and upland bent–fescue grassland, growing on wind-swept plateaux and slightly more sheltered slopes respectively, become prominent.

Map unit 25 is of restricted extent and covers 1 square kilometre (less than 1 per cent of the association) near Inverie on the Knoydart peninsula. The hummocky moraine landform is similar to that described in *map unit 26*, and the major soil subgroup distribution depends on the landform. The steeper terrain with gullied moraine is mainly occupied by humus-iron podzols and brown forest soils, while on the lower ground these soils occur on the moraine mounds with noncalcareous and humic gleys in hollows and channels. Also included at this locality are small patches of silty lacustrine drift. The lower slopes of the unit are forested while the upper slopes provide good grazings.

Map unit 26 occupying 18 square kilometres (4 per cent of the association) consists of moundy moraines with peaty soils. There are peaty gleys and peaty podzols on the mounds and steeper slopes with peat in the hollows and on flats. The corresponding vegetation pattern is moist Atlantic heather moor on the shedding sites and flying bent bog on the intervening waterlogged depressions.

Morainic drift is generally unsorted with abundant angular stones. Iron pans are common in soil profiles, as are indurated layers. C horizon textures are loamy sand to sand and the colour of the parent material ranges from grey to brown.

Although the landform is simply described as hummocky moraines a range of topography is encountered from gently undulating to intensely moundy, and as the gradients of the valley sides increase, the moundiness of the valley floors is replaced by gullied slope moraines. The proportion of soil components too, alters with the landscape; peat is dominant on gently sloping land, and is progressively replaced as the landscape becomes more irregular and steep, first by peaty gleys then by peaty podzols.

Since the unit is largely non-rocky, forestry is a suitable alternative to the traditional use as rough grazing land for sheep and deer, though surface boulders are a problem in some areas.

Map unit 27 covers 43 square kilometres (11 per cent of the association) and is confined to the mainland where it occurs chiefly on steep slopes, though rugged low-lying tracts may be seen around Arisaig. Most of the terrain is very rocky, and rockfalls, boulders and small cliffs are often present. Parent materials are shallow, stony and of patchy distribution. The brown forest soils and humus-iron podzols are poorly developed and often have much humus throughout their profiles due to lateral seepage of drainage water. In such rocky situations rankers abound while flushes have humic and peaty gleys. In coastal areas the unit often includes small patches of sands and gravels, the parent materials of the Corby Association, which are not extensive enough to distinguish on a map of this scale.

Oakwoods and birchwoods constitute the chief vegetation cover, though the field layer often consists of little more than a carpet of mosses, lichens and liverworts. Clearings have bent–fescue grasslands and Atlantic heather moor on well-drained soils while flushed areas have bog myrtle scrub and flying bent grassland. Bracken is often an accompanying species provided that permanent waterlogging is absent from the topsoil.

Except for a few locally less rocky or more gently sloping stretches which can be reseeded or forested, it seems likely that the unit will continue to provide only rough grazings of variable quality, though it does have the advantage of giving shelter to stock. Some of the larger stands of oakwood furnish good examples of a relatively rare part of the natural environment, of particular interest to ecologists and tourists, as at Beasdale, near Arisaig.

Map unit 29 consists of moderately rocky topography dominated by peaty gleys and peat and occupies 31 square kilometres (8 per cent of the association). The main areas are in Knoydart and Moidart and on the Sleat peninsula of Skye. The landscape is illustrated on Plate 1. The distribution of the soils, parent materials and plant communities is closely linked to the topography which can be divided into three facets:

(1) Ridges and knolls with rock outcrops. Soils are peaty rankers and peaty gleys on shallow, stony colluvium of loamy sand texture. Bog heather moor, moist Atlantic heather moor and flying bent grassland are the principal vegetation types.

(2) Short, steep, generally non-rocky slopes, with peaty podzols, on deep colluvium or small pockets of morainic drift, and lodgement till of loamy sand to sandy loam texture. These better drained sites carry dry heather moors and heath rush–fescue grassland.

(3) Hollows, flats and very gentle slopes with peat deposits underlain by rock or drift. The main communities of these sites are flying bent bog (flushed) and blanket bog (unflushed).

Apart from peat, the most commonly occurring soils are peaty gleys which typically have an O horizon overlying a very humose dark brown stony loamy sand Bg horizon with bed-rock within 60 centimetres of the surface.

Map unit 31 occurs on steep slopes and consists of peaty gleys, peaty podzols and peaty rankers in a slightly to very rocky landscape. Thus the soils are similar to those of *map units 29* and *32* except that the steep gradients preclude any significant development of peat. Slopes vary from planar with slabs to stepped with minor crags. The unit covers 75 square kilometres (18 per cent of the association).

Plate 1. *Loch a' Ghille Ghobaich, Morar. Map unit 29, the Arkaig Association: peaty gleys and peat in a moderately rocky, gently and strongly sloping landscape. Land capability class 6.3.* Aerofilms.

Plate 2. *Eilean Shona, Loch Moidart. Map unit 32, the Arkaig Association: peaty gleys, peaty rankers and peat in a very rocky, rugged, gently and strongly sloping landscape. Land capability class 6.3.* Aerofilms.

Plant communities include Atlantic heather moor and bog heather moor with common white bent grassland on localized well-drained slopes. This vegetation provides rough grazing land of poor to moderate quality.

Map unit 32 is a very rocky unit, some areas of which consist of little more than bare rock slabs, for example east of Ockle, Ardnamurchan. Peaty gleys, peaty rankers, peat and peaty podzols occur between the outcrops. It is similar to *map unit 29* but with more rugged topography and local steep slopes on the sides of prominent knolls (Plate 2).

The plant communities are identical to those described for *map unit 29*, and have a similar distribution within the unit.

The unit is the main unit in the parishes of Knoydart and Moidart as well as being the most extensive of the association, covering 200 square kilometres (49 per cent of the association).

Map unit 33 occurs in the mountains of Knoydart and Moidart and extends to 25 square kilometres (6 per cent of the association). Subalpine podzols are the main soils on the slopes above 400 metres, while the more limited summit areas (above 700 metres) have alpine podzols. There are some small plateaux between 400 and 700 metres, too small to separate as *map unit 34*. Slope angles are very variable, as is the rockiness, and there are some active screes and boulder fields.

Vegetation too shows great variety, and both heath and grassland communities are common. Slopes with subalpine soils carry upland bent–fescue and mountain white bent grasslands, and occasionally lichen-rich boreal heather moor. The exposed summits have wind-cut fescue–woolly fringe-moss heath and stiff sedge–fescue grassland. Thus some moderate upland grazings are seasonally available.

Map unit 34 is found on the undulating, rocky plateaux of the mainland, generally above 400 metres, where it accounts for 16 square kilometres (4 per cent of the association). Soils are subalpine podzols and subalpine gleys while receiving sites have eroded peat deposits. Plant communities include stiff sedge–fescue grassland, upland blanket bog and mountain blanket bog. Some grazings, mainly of poor quality, are available during the summer months.

THE ARRAN ASSOCIATION

(Map units 37 and 38)

The Stornoway Beds have, in the past, been variously assigned to Torridonian, Devonian or Triassic ages by different authors (Stevens, 1914; Jehu and Craig, 1934; Kürsten, 1957). The Institute of Geological Sciences (1979a) attributes these rocks to the Triassic. They consist of conglomerates with lenticular layers of dark brown sandstone, and are soft by comparison with the Lewisian gneiss which they overlie unconformably. The boulders in the conglomerate are all of local origin, consisting of sheared gneiss. The drifts derived from these rocks have sandy loam or sandy clay loam textures with dark reddish brown or reddish brown colours and are provisionally correlated with similar drifts on Arran, from where the association is named. The deposits are mostly till, with rare colluvial material where rock is close to the surface. The tills have finer textures than the colluvium. The boundaries of the drift, especially west of Stornoway and on the Eye Peninsula, are not precisely determined and the

reddish colour fades gradually into the more olive colours of tills of the Lochinver Association, with a corresponding gradual change in the soils. Some of the material in the till is possibly of sub-sea origin, and marine shells have been reported (von Weymarn, 1979). Till deposits mapped in the Ness district of north Lewis have features which show affinities with Arran Association, but because they lack the characteristic reddish brown colour, being only slightly pink, they were included with Lochinver Association at the time of mapping.

The association is principally low-lying, and is found on the Eye Peninsula and between Stornoway and Gress covering 35 square kilometres (0.6 per cent of the land area). The landscape is till-covered with few rock outcrops, and drumlin features are conspicuously absent here as elsewhere on the Lewis till plain. Altitude seldom exceeds 50 metres, and slopes are gentle, so the mineral soils of the association provide favourable sites for the few farms in the island. The climate is fairly warm and moist with rainfall less than 1200 millimetres. The principal soils are noncalcareous gleys, humic gleys, and peaty gleys, with some peat. There are local areas of peaty podzols on steeper slopes.

Arable and permanent pastures are dominant on the noncalcareous and humic gleys. The more strongly flushed humic gleys are too wet for arable use, and pasture improvements quickly revert to rush pastures and sedge mires because sown species do not tolerate waterlogged ground. The peaty gleys mainly support bog heather moor although some areas of improved pasture are found around the edges of crofting settlements. The areas of peat have blanket bog and northern blanket bog communities.

Map unit 37 forms some of the best land of the region and occurs around Stornoway. The unit covers 16 square kilometres (45 per cent of the association) and its landforms are gently rolling and predominantly non-rocky with rare strong slopes and rock outcrops. A typical area of the unit is shown on Plate 11. The parent material is principally till though some colluvium is also found. The main soil types are noncalcareous gleys, which provide land for the few farms of the Outer Isles, and also form excellent crofting areas. The compact subsoil impedes drainage and the soils would benefit from subsoiling and installation of a suitable drainage system. Humus-iron podzols occur on shedding sites. Channels and hollows in the rolling topography are occupied by wetter soils, principally humic and peaty gleys, often flushed. The land was probably reclaimed from beneath peat, and many soils still have topsoils with high organic-matter contents (Fig. 12). Much of the land is under permanent pastures, with root crops and cereals providing short arable rotations. The humic gleys and poorly drained or flushed areas revert rapidly to rush pastures and sedge mires unless good management standards are maintained.

Map unit 38 covers 19 square kilometres (55 per cent of the association) forming gently undulating, non-rocky terrain at slightly higher altitude than *map unit 37*. The parent material is mainly till and there are minor areas of sandy loam colluvium on steeper slopes. The principal soils are peaty gleys and peat with some peaty podzols restricted to the better drained colluvial drifts. Peat-cutting is carried out extensively on this unit, and is a form of land management leading to reseeded pastures on peaty soils (Fig. 12). The natural vegetation, however, is bog heather moor and blanket bog with some Atlantic heather moor on the peaty podzols, and has low grazing value. Forestry potential is low, mainly owing to exposure.

THE CORBY/BOYNDIE/DINNET ASSOCIATIONS

(Map units 97, 99–101, 103 and 105)

These associations are separately delineated on larger scale maps but they have been amalgamated at the 1:250 000 scale. Soils typical of the Dinnet Association, which has a parent material of water-worked till, do not occur in this area, but the Corby and Boyndie Associations have both been previously mapped (Bibby, Hudson and Henderson, 1980). The Corby Association comprises soils developed on sands and gravels derived from acid rocks and the Boyndie Association consists of soils formed on sands derived from acid rocks. The soils are mostly formed on gravels and sands in this area, so they will be referred to as the Corby Association in the account. This association covers 16 square kilometres or 0.3 per cent of the land area.

The rocks which contribute to the sands and gravels are mainly schists and gneisses of Moinian and/or Lewisian age, but also include Torridonian sandstones, shales and grits. Three characteristic landforms occur in the association; fluvioglacial ice-contact mounds, fluvioglacial outwash terraces and raised beach terraces. Ice-contact deposits show a complete range from unsorted non-stratified material with subangular stones, to well-sorted stratified or current-bedded sands and gravels with rounded stones; this latter material is typical of outwash terraces. Raised beach deposits are usually more uniformly bedded and coarse textured with rounded stones, although around sheltered sea lochs where wave action is less, the stones can be subangular. The parent material is coarse textured and moderately coarse textured (sands, loamy sands and sandy loams) and the subsoil is generally coarser and stonier than the topsoil. The parent material is thus readily permeable, but iron pans have formed in many subsoils, restricting water movement, and a surprisingly high proportion (30 per cent) of the association consists of map units dominated by peaty soils. Map units dominated by mineral soils constitute the best land of farms and crofts, especially where the soils of the surrounding associations are peaty, or situated in rocky, mountainous terrain. The permeable nature of the drift allows leaching from the soils and frequent applications of lime and fertilizers are required to maintain satisfactory levels of pH and nutrients under the predominantly high rainfall. The soils have developed under a fairly warm and wet or rather wet climate and rainfall is in the range 1600–2000 millimetres.

Peaty podzols, often cultivated, are the main soil type of the association and occur in most of the map units. Below the Eg horizon they have an iron pan which impedes the drainage of an otherwise freely draining permeable subsoil. Peat and peaty gleys are also fairly widely distributed. Mineral soils are less frequent and mainly consist of cultivated podzols developed after peat removal and cultivation and disruption of the iron pans in peaty podzols, although some humus-iron podzols doubtless existed prior to man's activities. Many of the natural profile characteristics have been lost by mixing of horizons. The upper layer now consists of a dark brown humose A horizon consisting of mixed, former O, H and E horizons, over an unaltered podzol Bs horizon.

Atlantic heather moor is found on the peaty podzols with the northern forms present on Lewis. Permanent pastures with some arable and rush pastures are found on the mineral soils. Blanket bog and flying bent bog communities are found on the peat and bog heather moor on the peaty gleys.

Map unit 97 is found only on the mainland at South Erradale and Gairloch covering 2 square kilometres (15 per cent of the association). The raised beach terraces of the unit have gentle slopes and the soils are mainly humus-iron podzols with some gleys. The soils have cultivated surface horizons and are at least partly reclaimed from peaty podzols and peaty gleys, with remnants of the peaty surface found at South Erradale. The coarse texture is an advantage in the high rainfall, but nutrient losses from the soil are a serious problem. Rainfall and exposure are the main limiting factors for agriculture although stoniness also restricts land use. Most of the land is under permanent pastures, with ley pastures of minimal extent.

Map unit 99 is of minor extent (less than 1 square kilometre). It is found at Kyleakin on Skye (incorrectly included with *map unit 557* on the soil map), and on the northern shore of Loch nan Uamh near Arisaig. The parent materials are raised beach sands and gravels with landforms similar to those of *map unit 97*; stretches of alluvium are also included in the unit. The soils are cultivated humus-iron and peaty podzols, humic gleys and alluvial soils. The land is under permanent pasture with rare arable breaks.

Map unit 100 is confined to Knoydart where it occupies 4 square kilometres (25 per cent of the association) near Inverguseran and Croulin. These areas are complex in terms of landscape and soils. Outwash terraces and ice-contact mounds with both unsorted and bedded sands and gravels were deposited and subsequently reworked by streams, rivers and wave action to produce gullied terraces, alluvial deposits and raised beach flats respectively. The soils include humus-iron podzols, noncalcareous gleys, peaty gleys and alluvial soils with local occurrences of peaty podzols and peaty gleys.

At present the level raised beach areas close to the sea remain under permanent pasture since they are rather stony for arable use. On the upper terrace south of Inverguseran, ruined croft houses and rig and furrow patterns indicate that the land was once more intensively used. The present plant communities are principally bent–fescue grassland, Atlantic heather moor and rush pastures. Apart from on the heather moors, good grazing is available.

Map unit 101, 5 square kilometres in extent (30 per cent of the association), is seen at Broadford and Kyleakin in Skye, Slisneach in Knoydart and Scamadale at the west end of Loch Morar. The drift has moundy and terraced landforms and consists of fluvioglacial outwash, well sorted into sands and gravels, with some reworking to form raised beaches and shingle bars. Soils are peaty gleys and peaty podzols with some peat, though areas with mineral soils are also present on the raised beaches.

Plant communities are moist Atlantic heather moor and bog heather moor with flying bent bog in places with thicker organic horizons. Some patch reclamation is possible in the less waterlogged areas with either a thin peaty or a mineral topsoil, but natural grazings are poor in general.

Apart from its rough grazing and forestry potential the unit is a major source of sand and gravel for construction purposes.

Map unit 103 covers 2 square kilometres (15 per cent of the association) at Duirinish and Plockton. It occurs on raised beach platforms and fluvioglacial terraces, and is slightly rocky. The sands and gravels are mainly derived from local Torridonian rocks. The map unit has soils of strongly contrasting types, humus-iron podzols, peaty podzols, noncalcareous gleys, humic gleys, peaty gleys and peat, occurring as small discrete patches, making this unit very

variable. Although some of the ground has been cultivated, most of it remains under permanent and rush pastures because of intricate soil patterns.

Map unit 105 occupies 3 square kilometres (20 per cent of the association) and has been mapped where there are areas with a wide range of soils: humus-iron podzols, noncalcareous gleys, peaty gleys, alluvial soils, peaty podzols and peat. Relatively large discrete areas of this map unit, each with a distinctive pattern of soils and topography, can be mapped at scales larger than 1:250 000—for example level raised beaches with mineral soils, and outwash mounds with peaty soils.

The chief areas are at Lochailort and Inverie where arable fields occur on level areas of raised beach with mineral soils. Reseeding of the moundy tracts has taken place where gradients are gentler. Rough grazings are available on the remaining peaty land, the quality ranging from good to poor. Plant communities include bent–fescue grassland, rush pastures, Atlantic heather moor, blanket bog and flying bent bog.

THE CORRIEBRECK ASSOCIATION

(Map units 108–112)

The Corriebreck Association is found exclusively on the island of Rhum where it covers 34 square kilometres (0.6 per cent of the land area).

A preliminary account of the soils has been published (Ragg and Ball, 1964). The soils are developed on drifts derived from ultrabasic rocks, mainly olivine- and anorthite-rich allivalite, peridotite and harrisite. Small areas of eucrite and gabbro, which form drifts of the Insch Association, are mapped with the Corriebreck Association. The rocks are among the most basic found in Britain, with silica contents as low as 39 per cent and low aluminium and calcium contents (Harker, 1908). They have a very high magnesium content (30–40 per cent), contained in the olivine. These high total amounts of magnesium do not affect the extractable levels in the soils. These are generally low, with the exception of peaty podzols on colluvium, where increased weathering of the minerals is thought to account for higher levels of exchangeable magnesium. The extractable magnesium is generally too low for the soils to be classed with the magnesian subgroups of brown soils and gleys which occur in the Leslie Association (Eastern Scotland).

Field examination reveals that the drifts are principally colluvial or residual, with cryic deposits and morainic drift less extensive. The drift cover, except in areas of moraine, is shallow and discontinuous. The terrain below about 400 metres is moderately to very rocky, forming gently undulating to rugged areas with steeper slopes flanking the mountains. The areas of hummocky moraines are bouldery. On the Rhum Cuillin rocky land predominates, with steep and precipitous slopes (Plate 16), although windblown sand, consisting mainly of olivine formed by physical weathering of the rock, forms steep smooth slopes around Barkeval and at the head of Glen Harris.

The main soil types are peaty gleys and peaty podzols which are found on colluvium and moraine below approximately 400 metres. In common with most basic parent materials, the peaty podzols lack the morphological podzol E horizon, and have unusually high exchangeable cations and percentage base saturation. Peat is widespread on the more gently sloping ground and in channels and hollows. On the local steep slopes around Papadil and Glen

Harris, where deeper coarse-textured colluvial deposits are found, there are brown forest soils and brown rankers. On the cryic deposits subalpine and alpine soils become dominant, podzols occurring on steep slopes and gleys on more level sites.

The climate is fairly warm on the lower ground, but cool and cold on the mountains, and wet overall, except on the west of Rhum where it is rather wet; the average annual rainfall ranges from below 1600 millimetres around the south-west coast, to over 3200 millimetres on the mountain tops.

The peaty soils are covered by Atlantic heather moor and bog heather moor, with bog-rush mires growing on shallow soils in the west of the island (Ferreira, 1970). Flying bent grassland is found locally. Blanket and flying bent bog communities are widespread on the peat. The brown forest soils support bent–fescue grasslands, locally herb-rich, which provide good grazings. Mountain white bent grasslands provide moderate category grazings on subalpine soils on steep slopes, but they have a restricted grazing season.

Map unit 108 is dominated by brown forest soils, brown rankers and humus-iron podzols on loamy colluvial drifts. The map unit is of restricted extent (1 square kilometre) and is found around Papadil and Harris on steep slopes with a wide range of rockiness. There are small areas of slightly rocky terrain with gentler slopes in the area of the map unit adjacent to the raised beach at Harris, and these form the only reclaimable ground in the association. The plant communities are principally herb-rich bent–fescue grasslands, with some herb-rich Atlantic heather moor and woodland, providing good and moderate grazings.

Map unit 109 consists of gently and strongly sloping, moderately rocky ground covering 3 square kilometres (10 per cent of the association). The parent materials are colluvial drifts with sandy loam textures, often shallow on rock. Peaty gleys and peaty podzols are the principal soils on the slopes and knolls, with small peat flats on more gentle slopes and in rock basins. The peaty gleys support bog heather moor with some bog-rush mire and local flying bent grassland. Peaty podzols with iron pans have the same communities as the peaty gleys, but where drier moisture regimes prevail they support Atlantic heather moor and some common white bent grassland. Flying bent bog and blanket bog cover the peat. Soil wetness precludes pasture improvement and the natural grazings are of low relative value. Some forestry potential exists.

Map unit 110 has similar slopes, parent materials, soils and vegetation to *map unit 109*; it is however extremely rocky with an associated reduction in the amount of peat and an increase in peaty rankers. It is the most extensive map unit of the association covering 13 square kilometres (40 per cent of the association). Rockiness restricts land use to rough grazings and the vegetation is the same as in *map unit 109*, providing poor grazings.

Map unit 111 is developed on moundy valley moraines, covering 7 square kilometres (20 per cent of the association). The terrain is boulder-strewn with a few rock outcrops. The deposits principally occur in Glen Dibidil and upper Glen Harris. Peaty podzols are prevalent on the mounds and steeper ground while peaty gleys and peat occupy the more gently sloping channels and hollows. Soil and slope patterns and boulderiness restrict land use to rough grazings, the heather moors and bog communities having low relative grazing values. The more sheltered eastern glens provide the best areas for forestry on this unit.

Map unit 112 covers steep, rocky slopes and ridge crests in the mountains, occupying 10 square kilometres (30 per cent of the association). The terrain is mainly rock and scree with soil development restricted to the more stable sites. The ultrabasic rocks are particularly susceptible to frost-weathering which produces loose sandy debris. This material is transported to cols and ridge crests by strong winds, and provides deep drifts of local extent where freely drained subalpine and alpine soils have developed, with subalpine gleys and some hagged peat on gentler slopes and in cols. Vegetation cover is patchy, with upland bent–fescue and mountain white bent grasslands on the slopes providing good summer grazings. Mountain blanket bog occurs on the localized hagged peat.

THE COUNTESSWELLS/DALBEATTIE/PRIESTLAW ASSOCIATIONS

(Map units 122, 123, 126, 127, 132 and 134)

For the purpose of the 1:250 000 soil map, three soil associations, all comprising soils developed on drifts derived from granitic rocks, have been combined. Only the Countesswells Association occurs in this area. The soils are confined to Skye, Rhum, Raasay and Scalpay, and cover 70 square kilometres (1.2 per cent of the land area). The major area is west of Glen Sligachan on Skye, and is formed of granites and granophyres of two main plutonic centres. The coarsely crystalline rocks have produced conical, scree-covered mountains, with heather-dominated lower slopes. Moderately to very rocky ground is seen at lower elevations, with hummocky moraines in the valleys. On Rhum and Raasay the rocks consist of granites, granophyres and microgranites forming moderately or very rocky terrain, with some mountainous land on Rhum.

The drifts are derived from a variety of acid intrusive igneous rocks, principally coarse grained, in contrast to the fine-grained acid intrusive rocks of the Knockskae Association south of Torrin. The main rock types in the drifts of the Countesswells Association are granites, granophyres and microgranites. In western Lewis and parts of Harris, there are also drifts derived from granites and granitic gneisses but because they are of local extent they have been mapped within the Lochinver Association. The coarsely crystalline rocks weather to form drift with a high proportion of siliceous coarse sand, and an acid reaction. The granites of Raasay and Rhum are low-lying and gently sloping and consist of moderately and very rocky peaty moorland. The granite hills of Skye are mapped as rock and scree, but colluvium is the most extensive drift type of the association (53 per cent), with moraine a close second (41 per cent). Because of the rockiness of the mountain summits, cryic deposits cover only 6 per cent, and are mapped only on Rhum.

The climate is fairly warm and rather wet on the lower ground, in the valleys and on lower slopes of mountains, but changes rapidly with increasing altitude to cold and wet on the hills and mountains. Vegetation cover is sparse on the upper mountain slopes because of rockiness, but the steep lower slopes of the Red Hills are clothed in dry heather moors. These communities are more typical of eastern Scotland, but a combination of steep slopes and permeable scree parent material enables their development. The plant communities supported by the remainder of the association are typical of acid parent materials in fairly cool, wet climates; flying bent grassland, flying bent bog, bog heather moor and blanket bog.

Map units dominated by peaty gleys, peaty podzols and peat cover 64 square kilometres (91 per cent of the association), and are found on a wide slope range on moraine and colluvium. The remaining map units consist of subalpine and alpine soils with some peat (6 per cent), and humus-iron podzols (3 per cent). Organic-matter contents of the soils are generally high, partly because of the acidity of the drift and also as a result of the high rainfall and low temperatures. The soil colours are black or dark reddish brown owing to this humus accumulation, especially in the peaty gleys.

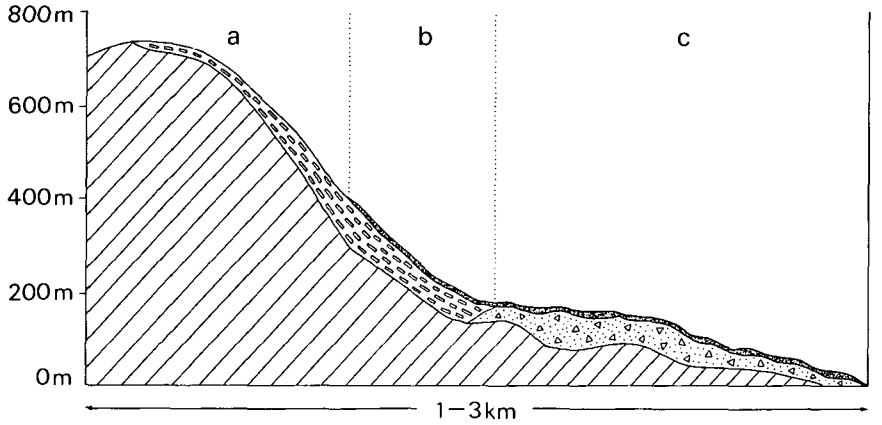
Map unit 122 is located on the island of Scalpay and around the village of Sconser by Loch Sligachan and covers 2 square kilometres (less than 5 per cent of the association). Moundy and gently undulating moraine forms a landscape with more or less intricate soil and slope patterns. In spite of this, the soils have been cultivated, particularly at Sconser, where they form one of the few crofting tracts in the central mountains of Skye. The principal soils are humus-iron and peaty podzols, with some humic and peaty gleys in hollows and channels. The plant communities have been influenced by land use, and consist of permanent pasture and acid bent–fescue grassland on ground with good drainage, and permanent pastures, rush pastures and sedge mires in flushed channels, hollows and other poorly drained sites.

Map unit 123 is the most extensive in this association, covers 27 square kilometres (40 per cent of the association) and is found on hummocky valley moraines, particularly around Loch Ainort, Skye. Some areas of this deposit are seen on steep slopes, where moundiness is less evident and active gullying is prominent. The drift is bouldery, coarse textured, mostly loamy coarse sand, and poorly sorted compared to the drifts of the Corby Association. Much of the drift consists of physically weathered granite, broken down to its constituent feldspars, quartz and micas. Individual minerals show little chemical weathering. There are more basic rocks in the drift adjacent to the moraines of Torosay Association in Glen Sligachan.

These deeper, coarse-textured drifts are more permeable than the shallow drifts of *map units 127* and *132* and the dominant soils are peaty podzols, with some peaty gleys and peat. The peaty podzols are found on mounds and steeper slopes. Peaty gleys and peat occupy the channels, hollows and other poorly drained areas. Land use is restricted to rough grazing by surface wetness and boulderiness. Plant communities consist of Atlantic heather moor and bog heather moor on the podzols and gleys, and blanket bog on the peat.

Map unit 126 occurs on steep, heather-dominated slopes on the Red Hills, between the scree-covered upper slopes and moraine-filled valleys (Fig. 7). It covers 8 square kilometres (10 per cent of the association). As in *map unit 123* the dominant soils are peaty podzols, but this unit has a low proportion of peaty gleys and no peat because of the permeability of the parent material and the steepness of the slopes. The parent material comprises stable scree, and consists of blocks of weathered granite, with gritty interstitial material. Organic-matter content of the mineral horizons is high but the O horizons are thinner than in the peaty podzols of *map unit 123*, because of steeper slopes. Dry Atlantic heather moor is the dominant plant community, giving poor grazings. At higher elevations, boreal heather moor communities are present. Agricultural land use is restricted to rough grazing, whilst boulderiness is a limitation to forestry.

Map unit 127 is a moderately rocky unit, comprising mainly peaty gleys and peat, with some peaty podzols. Slopes are less than 15 degrees, and the unit



a Bare rock, cliff and scree on the summits and upper slopes
b *Map unit 126*: stabilized scree with peaty podzols and peaty rankers supporting dry Atlantic and boreal heather moors
c *Map unit 123*: hummocky and slope moraines with peaty podzols, peaty gleys and peat

Figure 7. *Landscape position of map units 123 and 126, the Countesswells Association*

covers 16 square kilometres (25 per cent of the association). The drift type is colluvium of local origin, consisting of a loamy or humose, coarse sandy deposit on top of rock. The shallowness of the drift and gentle and strong slopes cause wet conditions and peaty gleys are widespread. The hollows between rock outcrops are often peat-filled. The unit provides only poor rough grazings, the main communities being moist Atlantic heather moor and bog heather moor on the peaty gleys, with blanket bog on the peat.

Map unit 132 is similar to *map unit 127* but is very rocky, and has a higher proportion of peaty rankers. It covers 13 square kilometres (20 per cent of the association). The plant communities also have low grazing values.

Map unit 134 covering 4 square kilometres (5 per cent of the association), is shown only in western Rhum since the summits of the granite hills on Skye were too small to delineate separately from rock. The unit, which occurs on the summit plateaux of Orval (571 metres) and the neighbouring peaks, and consists of gently and strongly sloping hill summits in the orohemiarctic and oroarctic thermal subzones. The soils are subalpine and alpine podzols and gleys with some peat. Mountain heath communities and upland blanket bog are grazed in summer but the quality of the sward is poor.

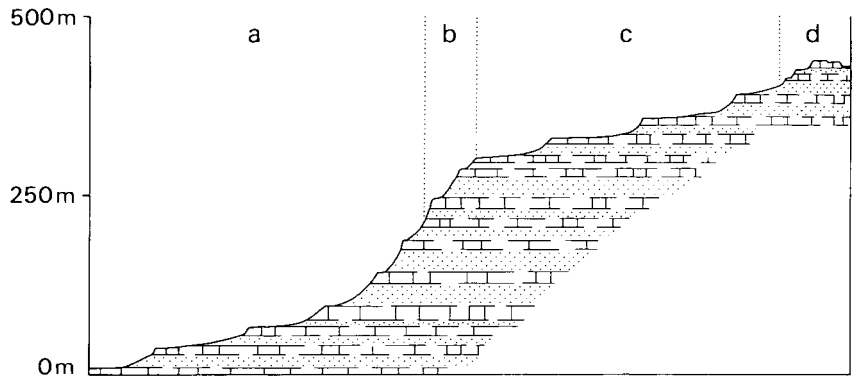
THE DARLEITH/KIRKTONMOOR ASSOCIATIONS

(Map units 149, 155, 157–162)

The basaltic rocks of Tertiary age have been comprehensively described by Harker (1904), Richey (1961), and Anderson and Dunham (1966) amongst others. Drifts derived from these rocks have been mapped into the Darleith Association. It and the Kirktonmoor Association were originally described on Carboniferous basalts in Ayrshire (Mitchell and Jarvis, 1956) but the

Kirktonmoor parent materials were specifically on moraine. At the 1:250 000 map scale this is no longer considered an appropriate criterion for distinction of a separate association, but the name is included to provide a link with previous mapping. An abbreviated version of the title, the Darleith Assocation, will be used in the remainder of this account. The association is the second most extensive in the region and covers 942 square kilometres (16.7 per cent of the land area).

Olivine-rich basalts are extensive in northern Skye and the islands of Canna, Muck and Eigg and extend southwards into Western Scotland (Sheet 4). Their distinctive landscape of strongly terraced hills, with the form of the intervening valleys largely determined by lines of structural weakness, has an important bearing on the distribution of soil types and map units. Differentiation of individual lava flows during formation into upper scoriaceous and lower massive layers and the subsequent response of each layer to erosion is



a *Map unit 158*: dominantly freely drained brown forest soils, but with restricted areas of poorly drained peaty ground
b *Map unit 159*: dominantly freely drained below a peaty surface horizon. Peaty and humus-iron podzols with occasional gleys
c *Map unit 160*: dominantly poorly drained. Peat and peaty gleys with occasional podzols on the steeper slopes. Climate causes peat formation at all sites
d *Map unit 162*: soils developed in the oroarctic climate zone. Subalpine podzols and gleys and strongly hagged peat

Figure 8. *Landscape position of map units 158, 159, 160 and 162 in the Darleith Association*

responsible for the terracing. The high porosity of the slaggy layers allows water penetration, provides a large surface area for chemical weathering and, especially when the region had a periglacial environment, provided a weakness that was exploited by accelerated mechanical weathering (Fig. 9). The lower parts of the flows, by contrast, are massive and weather only slowly. The distribution of soil types follows the differences in rock fabric closely, and this is most marked at low altitudes. Where massive rock is near the surface the soils are shallow and often wet and peaty, in contrast to the deeper, more freely draining soils over the scoriaceous parts of the flows and on their associated drifts. At higher altitudes where the effect of climate induces the widespread development of peaty surfaces, the differences are marked by changes from peaty gleys or deep peat to peaty podzols (Fig. 8).

The drift types within the association are varied. Colluvium is extensive and,

together with a thin, indurated coarser drift with infrequent erratic pebbles that has been interpreted as a lodgement till from the main glaciation, accounts for over 90 per cent of the area. On the Trotternish and Waternish peninsulas of northern Skye areas of topography which are less strongly stepped are associated with a thin till which, although dominated by basalt, undoubtedly contains a contribution from neighbouring softer Mesozoic strata. On larger scales of maps these areas could be distinguished as a separate association. They account for 9 per cent of the area. The final 1 per cent is occupied by a deeper moundy morainic drift (formerly the Kirktonmoor Association) which is probably the only part of the association to have carried outlying corrie glaciers during the Loch Lomond Readvance.

As the topography indicates, the thickness of the soil parent material is not great (predominantly less than 80 centimetres). Its texture is sandy loam or loam although a higher silt content is found in drifts with a contribution from the Mesozoic rocks. The colour is most commonly dark brown (7.5 YR 3/2). Some of the drifts are indurated and exhibit a weak very coarse platy structure and the deposits are moderately stony.

The basic composition of the basalt, and the ease with which some bands within it weather, is reflected in the distribution of the major soil subgroups. The Darleith Association has a higher percentage of map units dominated by brown forest soils (approximately 20 per cent) than associations derived from more siliceous parent materials in similar environments (approximately 4 per cent in the Torridon Association and 11 per cent in the Arkaig Association). Map units containing peaty gleys and peat are dominant however (70 per cent of the association) and those with podzols account for a further 7 per cent. The remaining 3 per cent consist of soils of the oroarctic thermal subzone.

The climate throughout the association is wet (more than 1600 millimetres of rainfall except for Muck and a small area of Eigg). Accumulated temperatures are fairly high but this is insufficient to compensate for the wetness, and lower proportions of mineral soils are found than on similar parent materials in warmer zones to the south (40 per cent in Mull and Morvern). Climate is obviously of the greatest relevance to current land use; the coolness and wetness of the areas of the association make most arable agriculture a marginal and risky operation and the landscapes are dominated by pastoral farming and by forestry. The areas have long been settled however and in the late eighteenth century carried a substantial population at subsistence level. Severe financial burdens are imposed on the agricultural economy by the remoteness of the region.

The vegetation on the soils of the association is dominated by western elements although there are strong tendencies towards northern elements, particularly in the hill land communities. Bent–fescue grassland, often with bracken, occupies unimproved lowland sites and herb-rich forms of Atlantic heather moor communities are found on the steeper slopes. Moist Atlantic heather moor, often dominated by flying bent, and flying bent bog occupy large areas of the hills. There are considerable tracts dominated by communities which lack any indication of a basic component. An account of the past and present vegetation of Skye has been published by Birks (1973).

Map unit 149 is restricted to the north of Skye on the western flanks of the Trotternish and Waternish peninsulas. It occupies 30 square kilometres (3 per cent of the association) and although of restricted extent is an agriculturally important unit. It is similar in appearance to the more extensive *map unit 158* but

has less rock outcrop and a weaker terrace structure. This is apparently due to a deeper cover of drift. Field evidence provided little trace of Mesozoic rocks, such as produce the heavier textured soils at Staffin and Kilvaxter on the northern extremity of Trotternish, but the map unit is often closely associated with outcrops of Mesozoic rocks or areas where these rocks are known to occur offshore.

The soils of the unit have a high proportion of noncalcareous and humic gleys but some brown forest soils are also found. The gleying is due to a higher silt content than is usual in the Darleith Association in north-west Scotland (over 50 per cent compared with 20 to 25 per cent in the freely drained soils) and a slightly higher clay content. Organic-matter levels in the topsoil are about 10 per cent but decrease sharply with depth, in contrast to the freely drained soils whose organic-matter content may still be 10 per cent at depths of 40 centimetres. Base saturation, and exchangeable calcium and magnesium for the till near Waternish House are all higher than is usual in the Darleith Association, another possible indicator of the incorporation of Mesozoic rocks.

Cultivations on poorly drained gleys in high rainfall areas are difficult. Most of the unit is under improved grassland which can be very productive if the problems of poaching can be overcome in autumn and early winter. Some of the areas with more brown forest soils, and thus better natural drainage, are more amenable to cultivation. There are no areas of semi-natural vegetation, and little afforestation except for amenity close to the larger estate houses.

Map unit 155 has similar parent material to *map unit 149* and a greater extent (55 square kilometres, 6 per cent of the association). It occurs on the west-facing slopes of the Trotternish peninsula and carries peaty gleys and peat as its dominant soils. The till cover either prevented the development of the strong terraced topography so characteristic of the bulk of this association or effectively masks it. The landscape is one of long even slopes rising to altitudes over 300 metres. The till does not appear to be very thick (generally less than 1 metre). Some similar units occur in the Lochinver and Torridon Associations in the vicinity of Loch Torridon and Loch Gairloch on the extreme eastern edge of the region and may be part of a trend of slightly increased drift cover in north-west Scotland. The till is of a dark brown colour, stony, with a sandy loam texture and is usually compact. Despite the organic surface horizons, organic-matter contents in the subsoils decrease rapidly with depth. Thin iron pans are often found, but the B horizons are not podzolic.

The vegetation is heath grass–white bent grassland and moist Atlantic heather moor, often dominated by flying bent. Some areas of flying bent bog occur. There is much flushing and rush communities are common; the land is largely used as rough grazing and forest land and has severe surface wetness problems.

Map unit 157 is the least extensive in the association (7 square kilometres, less than 1 per cent of the association). It comprises non-rocky, strongly hummocky valley moraine probably produced by outlying corrie glaciers during the Loch Lomond Readvance. It fits the description of Kirktonmoor Association given by Mitchell and Jarvis (1956, p. 96). The principal soils are peaty podzols, often with no clear E horizon development and with gleying above the iron pan. Peat and peaty gleys occur in intervening hollows. It has analogues in many other soil associations. Although principally found in the valleys near The Storr on the Trotternish peninsula it also occurs in western Skye in the north-east facing valley between Loch Bharcasaig and Healabhal Bheag.

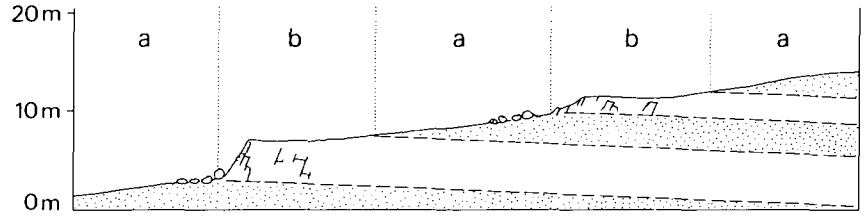
Plate 3. *Glendale, Skye. Map unit 158 in the foreground, consisting of brown forest soils and brown rankers of the Darleith Association, illustrates the terraced topography characteristic of the landform of most of this association. Map unit 160 occurs on the hill in the background. These are more terraced forms of the soil landscapes illustrated in Plate 14. There is a small area of alluvial soils on the lower ground. The mineral soils are rated as class 5.1 in this area, but where rock outcrops and shallow soils become frequent, classes 5.2 and 5.3 are mapped. The peaty land is class 6.3.*

The vegetation is heath grass–white bent grassland associated with the peaty podzols on mounds, and flying bent bog in hollows. Some areas have been forested.

Map unit 158, although only the second most extensive (148 square kilometres, 16 per cent of the association), is economically the most important unit. Dominated by mineral soils derived from the weathering of scoriaceous olivine-basalts at low elevations, the soils of the unit are freely drained and consequently important agriculturally. Deeper soils are frequently cultivated, shallow soils are surface seeded and provide good grazing while sites not suitable for improvement (due to steepness or small areas dominated by rock) carry herb-rich bent–fescue grassland and meadow-grass–bent pasture of high grazing value, often invaded by bracken. The pattern of soils in any area is dictated by the underlying rock structure (Fig. 9). Where rock approaches the surface and intercepts subsurface drainage, small wet patches occur, often characterized by an organic surface horizon.

The map unit is essentially lowland extending into hill areas along steep valley flanks. It is almost all confined to altitudes less than 100 metres. There is a wide range of slopes, but large areas are below 11 degrees and thus offer little impedance to agricultural machinery. Rock exposures although frequent are small and low; nevertheless they can seriously interfere with agricultural operations and it is the pattern and depth of soil which is the most seriously limiting factor. The typical appearance of the unit is illustrated on Plate 3.

The principal soil is the freely drained brown forest soil which is quite shallow (detailed investigations in Mull and Morvern have shown over 70 per cent shallower than 75 centimetres and the unit in Skye is believed to be similar). The textures are sandy loam with, occasionally, loamy sand C horizons. Organic-matter content is characteristically very high in the A horizon (unusual in similar soils elsewhere in Scotland except at high altitudes) and often remains high in B horizons. It is likely that these soils are western variants and that the high humus contents are reflections of the climate zone in which they have formed.



a Deeper drifts underlain by the permeable rocks of the top of the lava flow; vesicular basalts which weather easily. Freely drained brown forest soils

b Shallow drifts underlain by the less permeable rocks of the base of the lava flow; hard coarsely jointed basalt which weathers slowly. Brown rankers or, occasionally, peaty soils

Figure 9. *Soil and drift pattern in map unit 158*

The second most extensive soil is the brown ranker, with loam texture, occupying between 10 and 20 per cent of the map unit. Such soils are usually too shallow for cultivation but may be surface seeded. The remainder of the map unit comprises small areas of wet soils, both humic and peaty gleys, alluvial soils and occasional rock outcrops.

Map unit 159 is a variable unit intergrading between *map units 158* and *160*, both in character and topographic position. It contains a wide variety of soil types and drainage classes but with a preponderance of peaty podzols. Mitchell and Jarvis (1956) noted that podzols on basaltic drifts commonly lack E horizons. The development of thin iron pans is also sporadic, although they can be exceptionally strong in some localities. Heavy staining by organic matter is common. The degree of wetness of the surface horizons is directly related to slope; at lower slope angles, wetness and peat thickness increase and strongly gleyed variants (intergrading to peaty gleys) develop. Steep slopes at elevations above 100 metres frequently have many peaty podzols but because of their restricted area they are rarely sufficiently extensive to show on maps at this scale. Thus during compilation from 1:50 000 field maps many amalgamations of land of this type with *map unit 160* were made.

This map unit occurs sporadically throughout northern Skye and is also found on Eigg and Canna. It occupies steep slopes between 100 and 400 metres and the degree of rockiness is very variable. Plant communities also cover a broad range; dry and moist Atlantic heather moors develop over podzols and are sometimes herb-rich when these soils are weakly flushed. The wetter sites with deeper, peaty surface horizons support bog heather moor, while a pattern of heather moors and bent–fescue grassland with bracken characterizes the lower part of the landscape, intergrading to *map unit 158*.

Although this land is normally used for rough grazing (moderate grazing category) some scope for reclamation exists. Some areas are forested. The unit extends to 69 square kilometres (7 per cent of the association).

Map unit 160 extending over 589 square kilometres (63 per cent of the association) is characterized by the development of peat and peaty gleys, with minor peaty podzols on steeper slopes. The map unit is extensive between 100 and 400 metres but occurs at lower altitudes if impeded drainage encourages the formation of a wet organic surface horizon. Three variants of the unit are commonly found: a strongly terraced and craggy form associated with hill crests and exposed positions, frequently with eroded areas, a variant with considerably less crag and more deep peat, sometimes hagged, and, finally similar but less extensive and often isolated occurrences, some of which have been assimilated into *map unit 158*, are found in lowland areas. Gentle slopes usually dominate in this unit.

The major soil is peat (about 40 per cent) with peaty gleys (20 per cent), peaty rankers (20 per cent) and peaty podzols (10 per cent). The range of soil types represented is usually narrow. High organic-matter contents, and pH levels below 5 characterize the organic surface horizons. In the peaty gleys, mottling is subdued by organic-matter staining and is only prominent around weathering basaltic stones. Eg horizons beneath the peat are rare, but darker bands of organic accumulation above rock or, occasionally, induration are frequent. Organic-matter content is high (12–15 per cent) throughout the subsoil. Base status is low and the soils are usually shallow.

Flying bent bog is associated with both peat and peaty gleys together with blanket bog in less flushed areas. Moist Atlantic heather moor is found on peaty podzols on steeper sites. Some common cotton-grass bog also occurs and provides valuable early grazing for sheep in spring. Grazing values are low however and the severe surface wetness restricts the agricultural use of the land. Reclamation is usually not feasible and, where it has been attempted, a rapid and dense rush infestation often occurs. For forestry the principal problems are

wetness, windthrow and surface horizon acidity which restrict the choice of species, management and yield. Sitka spruce will grow satisfactorily on areas occupied by the denser flying bent swards and lodgepole pines are usually planted where the deer-grass is more common. Extensive areas of this unit are being afforested.

Map unit 161 is a small unit extending to 14 square kilometres (1 per cent of the association) and closely related to the larger *map unit 158*. It contains similar soils but occupies steep slopes, most often of stabilized and vegetated loamy scree surmounted by crags. Like *map unit 159* there are problems of representation at this scale. On the scarp which runs the length of the Trotternish peninsula from Portree to Staffin, many areas occur which at larger scales would qualify for inclusion in this unit. Because of the considerable cliffs, however, the scarp was mostly mapped into the rock category. The unit is obviously unsuited to cultivation because of slopes over 30 degrees and a risk of erosion, but its vegetation (bent–fescue and common white bent grasslands with occasional herb-rich Atlantic heather moor) provides a valuable grazing resource for sheep and occasionally cattle.

Map unit 162 occurs above 400 metres and is of fairly restricted extent in the association (30 square kilometres, 3 per cent of the association). Peat, often hagged, and subalpine podzols are dominant, the latter particularly on steep ground. On aeolian drifts in cols or on stabilized screes below cliffs subalpine brown soils (see major soil subgroup 3.3.5—subalpine podzols) are found, though these are of limited extent. Tor-like landforms, the remnants of the more resistant bands in the lavas, are common in the west but more restricted on The Storr ridge in the north-east. Intermittent stone pavements with polygons and stone stripes, and areas of wind-scoops are commonplace on slight swells, the hollows being occupied by a fine black amorphous peat, often strongly hagged. The land is unplantable for forestry, but mosaics of moderate grazings for sheep are available on upland bent–fescue or mountain white bent grasslands particularly on the steeper slopes, and are utilized during the summer months.

THE DURNHILL ASSOCIATION
(Map units 188 and 190)

This association is of limited extent (4 square kilometres, less than 0.1 per cent of the land area), and is restricted to one area on the Sleat peninsula, near Loch Eishort. Two rocky quartzite hills rising to about 250 metres occur on either side of the road from Isleornsay to Ord, and the white colour of the rocks is a sudden change from the Torridonian landscape with its pinkish grey outcrops. The rock outcrops take the form of large rounded slabs and bosses, separated by narrow colluvium- and peat-filled channels.

False-bedded grits and quartzites ('basal quartzite'), and flaggy and fine grained quartzites ('pipe-rock') of Lower Cambrian age form the parent rocks of this association. The rock breaks up to give a colluvial drift which is shallow, very stony and has a coarse texture. The acidic, siliceous character of the drift is not favourable to biotic activity and there is consequently a high proportion of organic matter in the mineral horizons.

The principal soils are peaty gleys and peaty rankers, with some peat in basin sites, and the vegetation is predominantly heather moor with some blanket bog communities. The land use is restricted by rockiness to rough grazing, which is of low value.

Map unit 188 is of very local extent (less than 1 square kilometre) and is moderately rocky with gentle and strong slopes. The major soils are peaty gleys and peat, with some peaty rankers. Plant communities are heather moors and blanket bogs providing rough grazings of low value, but the moderate rockiness allows some forestry potential.

Map unit 190 covers 4 square kilometres and has a very rocky rugged landscape. Peaty gleys and peaty rankers are its principal soils, with some peat and peaty podzols. The mineral horizons are thin and stony with high organic-matter content, and the soils have a low pH. Bog heather moor is dominant, with Atlantic heather moors on drier knolls and rock ridges. Blanket bog and flying bent bog cover the peat. Land use is restricted to rough grazings of low relative value.

THE FRASERBURGH ASSOCIATION

(Map units 259–263)

The western coastline of the Outer Hebrides from North Uist to Barra consists of long stretches of windblown shelly sand which extends for approximately 90 kilometres and accounts for 80 per cent of the association. Many bays around the coast of Lewis and, especially, Harris also have shell sand deposits. There is also a small area of this material on the mainland at Big Sand, near Gairloch. The association covers 123 square kilometres (2.2 per cent of the land area).

A very high proportion of the association is low lying; Mather and Ritchie (1977) state that 87 per cent of the machairs on the Outer Hebrides occurs below 50 metres and approximately 18 per cent lies below 10 metres. In some localities however, the sand has been blown to considerable altitudes; at Eoligarry on Barra, it reaches an altitude of 100 metres and on Pabbay in the Sound of Harris 150 metres.

Blown sand landforms in this area have been described by Mather and Ritchie (1977) and Ritchie (1979). The different types they describe may be summarized as hilly, hillocky, undulating and plain, but such detailed landform distinctions are not appropriate to a survey of this scale. Undulating and plain machair surfaces are grouped together, as are hilly and hillocky machair. A separate landform type, with varying amounts of rock outcrop and shallow blown sand over bed-rock, has also been recognized and forms 15 per cent of the Fraserburgh Association; this unit has been distinguished because of the implications of rockiness for land use.

The sand has a variable proportion of silica grains mixed with the shell fragments and the Links Association is mapped when the silica proportion is known to be high. According to Mather and Ritchie (1977) this is very infrequent in the Outer Hebrides, where only 2 per cent of their samples have lime content lower than 10 per cent, and 82 per cent have a lime content of more than 40 per cent. The observations made during the current survey confirmed this, and the soils are therefore assigned to the Fraserburgh Association. The texture of the material is sand, with 100 per cent of the particles greater than 50μm. Consisting of comminuted shell fragments which are lime-rich, the sand has high values of some biologically significant chemical properties, especially pH, exchangeable calcium and percentage base saturation. The high levels of pH affect the availability of other elements to plants and animals. Machairs are known to cause problems with cobalt deficiencies in animals.

The parent material was probably formed during and after the last major glaciation. Strong winds constantly erode and redeposit the material, interrupting the soil-forming processes so that fully developed brown calcareous soils are rare. Soils are seen at all stages of development from regosols to brown calcareous soils, but strongly coloured B horizons are very scarce, even in the latter soils. Ground-water gleys are also common, and there are some eutrophic flushed peats in depressions.

The land is divided into common grazings and inbye land at most crofting townships, and is used for summer grazings and to provide winter keep. Reseeding is usually successful, but on the unfenced common land, cattle and sheep rapidly graze out improved areas unless the improvements are carried out on a large enough scale to withstand this pressure. Manganese deficiency affects the cereals, and small oats (*Avena strigosa*) and indigenous rye (*Secale cereale*) are the only cereals known to tolerate the high pH levels. Spraying with manganese sulphate would be beneficial if other cereals are to be grown, but the small areas involved would rarely justify the expense.

This association has the most favourable climate, despite exposure to wind, of any in this region. Nearly all of the land is at low elevation and is in the fairly warm and moist accumulated temperature and potential water deficit divisions respectively. South of Stoneybridge, South Uist and in Barra the warm category of accumulated temperature occurs. In north Lewis, potential water deficit is lower, and some of the land lies in the rather wet division.

There is a high proportion of permanent pasture and dune pasture in the uncultivated areas of the mineral soils. Swards with good grazing values are frequently overgrazed to produce a short turf. Where this is breached there is a high erosion risk. Poorly drained mineral soils support silverweed pasture and sedge mires in addition to permanent and dune pastures. On the peaty land silverweed pasture, swamp and sedge mires are present and have a lower grazing value.

Map unit 259 consists of level or gently undulating land, often with a seaward fringe of dunes too small to show as *map unit 261*. The unit is found below 20 metres altitude almost everywhere, but is often at a slightly higher elevation than *map unit 262*, with poorly drained soils. These broad expanses of level to gently sloping ground (Plate 4) are unique in this area, where small-scale topographic irregularity is the rule. The landform and general landscape position of these map units are represented in Fig. 10. Covering 29 square kilometres (25 per cent of the association) the unit is extensive on North and South Uist and Benbecula, and there are small areas of this soil landscape on Lewis and Harris, and on the mainland at Big Sand near Gairloch.

Addition or removal of material by wind action at the surface of the deposit is evident at most localities. Under such conditions long-term profile development rarely takes place as the surface layers are either being buried or removed. The soils have free or excessive drainage and textures of sand or coarse sand, but do not suffer the same impoverishment by leaching as the acid sandy soils in the Corby or the Links Associations. Leaching does take place in the Fraserburgh Association soils, but the pool of available nutrients, especially calcium, is rapidly replenished by newly weathered material.

The principal soils in this unit are brown calcareous soils with some calcareous regosols where recent windblow has occurred. The typical profile in the brown calcareous soils has a dark greyish brown humose sand topsoil, which can have a reddish tinge from the organic matter. This horizon can be up to 30

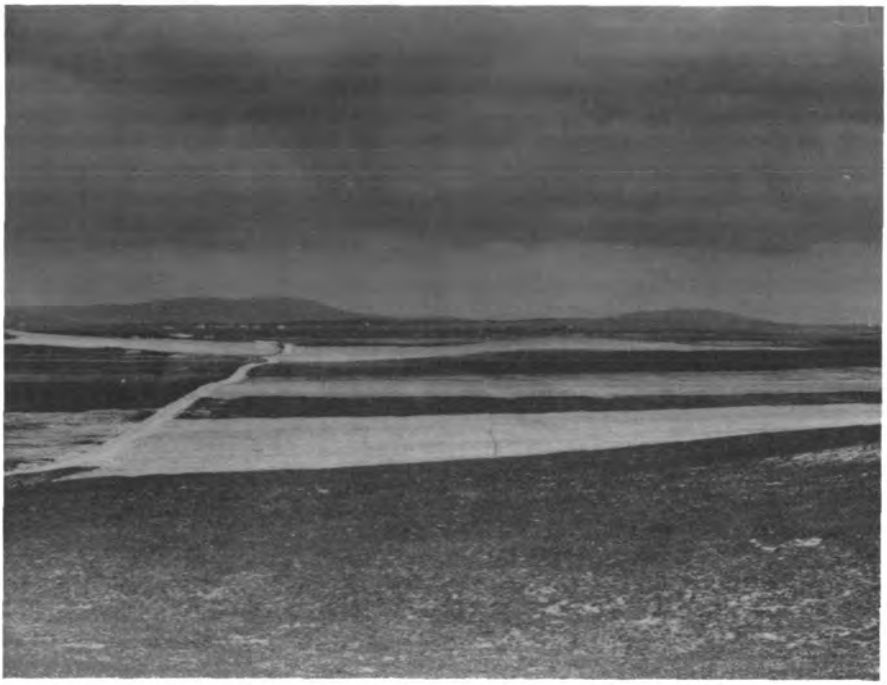
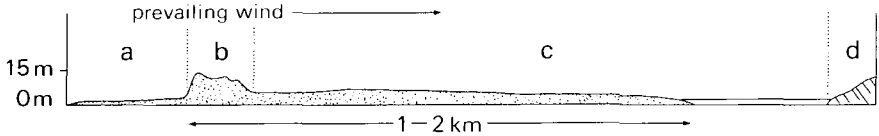


Plate 4. *Nature reserve near Hougharry, North Uist. Brown calcareous soils and calcareous regosols of map unit 259 in the Fraserburgh Association. Gently undulating non-rocky land surface. The strips are often cultivated by shallow ploughing followed by hand-broadcasting of seed. This land is rated as class 5.1 because of the severe erosion risk.*

centimetres thick but is often thinner and is partly formed by cultivation, and partly by the natural breakdown products of plant remains and animal dung. Below this humose horizon is a light brownish grey or pale brown B horizon, the colours indicating there is some humus redeposition, but future chemical analyses may indicate that cation translocation is a contributory factor to the colour. The underlying C horizon is light grey to white and there is sometimes evidence of periodic ground-water inundation provided by thin discrete layers of humus accumulation. Regosols, which lack even a weakly developed morphological B horizon, occur throughout this map unit but are described in *map unit 261* where they are more extensive.

Humus in the topsoil can reduce permeability, and, especially after periods of heavy rain, standing water is seen on the surface. Such flooding is of short duration. Cultivation of these soils attempts to leave this horizon fairly intact and stops short of exposing the looser subsoil. This technique of shallow ploughing minimizes the risk of windblow because the bare soil surface is held together by the existing root mat. The high pH of these soils restricts trace element mobility in the soils. Pine in cattle and sheep caused by a lack of cobalt, and swayback in sheep caused by copper deficiency are mentioned as the main deficiency diseases (Dunn, 1980). Alleviation of many of these ailments is achieved by dosage of the animal, as this is more cost-effective than spraying the soil or vegetation.

The plant communities which occur in this unit have been affected by cultivation and reseeding; permanent pasture is most frequent. Deep-rooted weeds soon invade the improved ground, however, and the sward rapidly reverts to eyebright–red fescue dune pasture. This community has a relative grazing value much lower than the permanent pasture but it is still considered good. Vernal squill maritime pasture is fairly frequent and this also has high grazing value. The map unit is managed as improved pasture almost everywhere and the crofters make conscious efforts to reduce windblow risks by shallow ploughing and controlling stocking rates.



a Beach: not part of map unit
b Fringe of active dunes with calcareous regosols and some brown calcareous soils: *map unit 261* where extensive
c Undulating machair plain up to 2 kilometres broad. Brown calcareous soils and calcareous regosols form *map unit 259* which is slightly more strongly undulating than *map unit 262* with calcareous ground-water gleys
d Lochinver Association map units

Figure 10. *Landscape position of map units 259 and 262, the Fraserburgh Association*

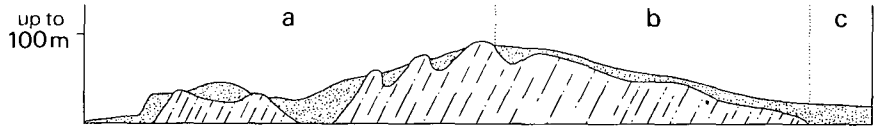
Map unit 260 covers 21 square kilometres (15 per cent of the association) and is found where the shell sand has been blown over Lewisian gneisses. The full range of rockiness classes occurs although non-rocky land is rare, for example Eoligarry Hill on Barra. Very rocky areas are also uncommon and most of the land lies between these two extremes. Differences in the landforms of the rocky and non-rocky variants are shown in Fig. 11. The soils are shallow over bed-

rock which is often encountered within profile depth. Brown calcareous soils and calcareous regosols are the principal soil types, described in *map units 259* and *261* respectively. The best examples of this type of land occur on Pabbay, Boreray and Berneray in the Sound of Harris and on Pabbay south of Barra.

Plant communities are similar to those described in *map unit 259* but with less emphasis on permanent pasture since there is less cultivation and pasture improvement in this rockier land; eyebright–red fescue dune pasture is more widespread, and the land provides good grazings.

Map unit 261 is the most extensive in the association, covering 52 square kilometres (40 per cent of the association). This proportion of dunes is much higher than reported by Ritchie (1979). All dunes are included in this map unit, whether stabilized or active, and this may account for the difference. The dune landform is irregular and moundy with dune ridges and hillocks 30 metres high in exceptional circumstances. More usually the dunes are about 5 metres high and 10–20 metres broad with anastomosing hollows and channels 5–10 metres broad.

The principal soil type is the calcareous regosol, which has a weakly differentiated A horizon, brown to grey in colour, with a high Munsell value (Munsell Color Co. Inc., 1971), overlying the light grey C horizon. These soils are found on the dunes, which are thus susceptible to drought in warm dry weather. Brown calcareous soils occupy small areas more usually mapped as



a Rocky phase of *map unit 260*. Windblown shelly sand with rock outcrops. Shallow brown calcareous soils and calcareous regosols
b Non-rocky phase of *map unit 260*. Windblown shelly sand over rock (e.g. Ben Eoligarry, Barra) with very few outcrops. Brown calcareous soils and calcareous regosols
c *Map units 259* or *262*

Figure 11. *Rocky and non-rocky areas of map unit 260*

map unit 259 where extensive. Calcareous ground-water gleys and, occasionally, peaty gleys are found in the low-lying dune slacks. Active erosion of the sand parent material is frequently observed; it is exacerbated by over-use of the land.

Northern marram grass dune pasture colonizes the most immature soils with no A horizons, and is replaced by eyebright–red fescue dune pasture as the soil begins to develop an A horizon. Silverweed pasture, swamp and sedge mires are supported by the poorly drained soils, both mineral and peaty. Because of topographic irregularity and the high erosion risk, land use is largely restricted to rough grazing; the relative grazing value is moderate to high. A few gently sloping areas have been reseeded, at some risk of erosion.

Map unit 262 consists of level or very gently undulating land with slopes less than 1 degree and occurs as broad flat areas up to about 2 kilometres wide. More low-lying than *map unit 259* it is found between 2 and 10 metres altitude. The unit covers 15 square kilometres (10 per cent of the association) and is

especially extensive near Loch Bee in South Uist, around Benbecula aerodrome, and along the south-west coast of North Uist.

Calcareous ground-water gleys are the principal soils of the unit, with some brown calcareous soils on slight rises where the water-table is lower. The gleys have imperfect or poor drainage, depending on the depth to ground-water and the associated periodicity of waterlogging higher in the profile. The topsoil has a dark greyish brown colour, sometimes with a reddish tinge and overlies a pale brown, light brown or white Bg horizon. The Cg horizon is light grey, but is yellower (Munsell hue 2.5Y or 5Y) than in the free-draining brown calcareous soils of *map unit 259*.

Problems of trace element availability and uptake are common in soils with high pH, and the gleys are no exception. However, droughtiness limitations, common in *map unit 259* are reduced by the high water-table and the moist soils are less susceptible to wind erosion. The water-table, combined with erosion and/or deposition, is thought to be the cause of the exceptionally level surface. Some flooding may occur during heavy autumn and winter rainfalls, but with good management arable crops can be grown. Crop establishment should be more successful than on the brown calcareous soils because of the lower risks of droughtiness and wind erosion.

Apart from arable and pasture land the plant communities are mainly silverweed pasture and vernal squill maritime pasture, vegetation with moderate to high grazing values.

Map unit 263* covers 6 square kilometres (less than 5 per cent of the association), mainly in South Uist. The unit is generally found on the landward side of areas of windblown sand. Many small narrow areas similar to this unit have had to be included with other map units for reasons of scale. It often occurs as very narrow strips adjacent to lochs, or occupies former loch sites. The land is level, low-lying and waterlogged. The principal soils are eutrophic flushed peat and peaty gleys with high exchangeable calcium. The plant communities are dominated by silverweed pasture, swamp and sedge mires. Land use is restricted by wetness to rough grazings with moderate to low relative value.

THE GRULINE ASSOCIATION

(Map units 278–280)

The soils of the Gruline Association are developed upon raised beach or fluvioglacial outwash sands and gravels derived from a range of igneous rocks but with a strong basic igneous component. They are closely related in their distribution to the outcrop of basalt and gabbro in the Tertiary igneous province (on Skye, Rhum, Eigg and the Ardnamurchan peninsula). By virtue of the mode of formation of the parent material the association occupies valley sites, usually at low altitude (below 40 metres) and close to the sea. Very gentle slopes predominate. Major drainage channels passing through the deposits have resulted in erosion and often a pattern of alluvium and peat occurs along their courses. Terracing, from both beach elevation and alluvial downcutting, is common. The soils of the Gruline Association have long been used for crofting, farming and as centres of settlement, and although restricted in extent

* The area shown as map unit 236 near Northton, South Harris, is incorrectly symbolled; it should be symbolled as map unit 263.

Plate 5. *Glen Brittle, Skye. Map unit 279 of the Gruline Association on the valley floor consists of soils developed on windblown sand, raised beach sands and gravels and alluvial parent materials. The soils in this locality have mineral topsoils to the left of the buildings, and peaty topsoils to the right. The mineral soils are land capability for agriculture class 4.2.*

The afforested slopes, the smoother terrain to their left and in the foreground consist of peaty gleys and peat in the Torosay Association (map unit 548) here developed on pneumatolysed basalts: contrast this gently undulating terrain with the terraced topography on the upper slopes which has peaty gleys and peat in the Darleith Association (map unit 160) on unaltered basalts. These units have low value grazings and are rated as class 6.3.

(6 square kilometres, 0.1 per cent of the land area) they are important in these respects.

The parent material, having a significant proportion of basic igneous rock, is usually dark brown in colour. The texture is dominantly gravelly loam with, sometimes, very coarse gravel on old storm beaches, but lenses and belts of sand and very fine gravel are not uncommon. The material is sometimes indurated and this characteristic is prevalent on the upper beach terraces. The material of the lower terraces is very rarely indurated. Compared with other associations developed on raised beach or outwash materials the textures of the soils of the Gruline Association are usually more loamy and the tendency for podzols to develop is not as marked, a reflection of the more basic nature of the parent material.

The very limited areas of the association are valued as pasture, for the conservation of grass and for producing fodder crops such as cereals or turnips. Potatoes for local consumption are also grown. Peaty areas, either in hollows in the gravels or on associated alluvial flats, contrast strongly with cultivated ground and are not often improved. Moist Atlantic heather moor, rush pastures, sedge mires and yellow flag swamp are common communities on such land. The climate is warm or fairly warm, and wet.

Map units 278 and 279 were differentiated on the absence or presence of peaty hollows. There is however a very wide area of overlap and in view of their limited extent they are described together. *Map unit 278* (1 square kilometre, 15 per cent of the association) is composed of humus-iron podzols developed on sand derived from basic rocks, and is found backing the Bay of Laig on the Isle of Eigg. A small alluvial hollow with some peaty alluvial soils lies between the sand and the crofts of Cleadale. *Map unit 279* (4 square kilometres, 65 per cent of the association) is found in Glen Brittle, Skye (Plate 5), where an area of stabilized dune sand is succeeded inland by raised beach and fluvioglacial gravels and alluvium near the farm. Further upstream is an area of peat and peaty alluvial soils. The unit also occurs on either side of the Narrows of Raasay: on Skye similar areas of freely drained humus-iron podzols and brown forest soils are interspersed with peat and peaty alluvial hollows, whereas on Raasay the peaty elements are restricted in occurrence.

The expression of podzolic characters in the gravels, a feature of the Corby Association soils, is not so strongly developed in the Gruline Association. The soils are however leached, and many of the profiles are cultivated humus-iron podzols. The long history of use, varied management treatments over the years and the variable nature of the parent material itself renders these soils very difficult to categorize. Both map units have been intensively crofted and farmed and little natural vegetation remains except in the peaty hollows.

Map unit 280 is formed almost exclusively of wet soils, with peaty gleys and peaty podzols fairly extensive. It consists for the most part of a narrow coastal rock platform, probably preglacial in origin, which is extensive in Western Scotland (Sheet 4) but only occurs on the extreme southern edge of Sheet 2 on the coast of the Ardnamurchan peninsula. It covers 1 square kilometre (15 per cent of the association). The platform has little beach sediment except in hollows and the combination of rockiness and continual flushing from the surrounding higher land has resulted in wet soils dominated by organic surface horizons. Rush pasture, sedge mires, yellow flag swamp and some blanket bog are found and provide low quality grazing. Reclamation is not possible in this area.

THE INCHKENNETH ASSOCIATION

(Map units 307, 311–313*)

The Inchkenneth Association is not extensive (76 square kilometres, 1.4 per cent of the land area) but is an important soil resource in several of the crofting townships. It consists of deposits derived from the sandstones, limestones and shales of the Mesozoic succession, but excludes the Kimmeridge and Oxford clays which form the fine-textured parent material of the Staffin Association. The association occurs on Raasay, through southern central Skye and on Eigg. Of these the most extensive area is from the islands of Pabay and Scalpay through the Broadford area to Loch Slapin, Strathaird and Elgol in Skye.

Three types of drift are found, colluvium, moraine and till, different map units being established upon each. The colluvium, which is most extensive, is often shallow and discontinuous. The sandy loam or loamy sand textures result in permeable soils with dark brown and dark reddish brown colours; little or no unaltered parent material is found, weathering often penetrating into the rock. The moraines, found only in one small area at Applecross, have a sandy loam or loam texture. The till occurs only on southern Raasay and has not been examined in detail. The three types have quite different landscapes; those on colluvium are often terraced and show the influence of underlying rock structures, the moraines are hummocky and the till is a valley infill.

Of the major soil subgroups, areas dominated by brown forest soils, brown rankers and humus-iron podzols total 37 per cent. There are few humic or noncalcareous gleys due to the prevalence of colluvial parent materials, the remaining 63 per cent being predominantly peaty gleys, peat and some peaty podzols.

Practically all the areas of mineral soils have, at some stage in the past, been cultivated but most have now reverted to permanent grassland. The difficulties of coping with very small areas of deeper soils in a pattern of strong slopes and broken rocky topography are too severe for farm machinery within the economic framework of modern farming. Acid bent–fescue grassland and meadow-grass–bent pasture are the dominant plant communities, with rush pastures on gley soils in flushes. The peaty soils carry Atlantic heather moor, flying bent bog and blanket bog. Hollows are frequently flushed and where limestone contributes to seepage water the communities may be species-rich.

Map unit 307 occupies 28 square kilometres (35 per cent of the association) and has a dip-and-scarp landform dictated by the bedding of the underlying strata. It may be steeply inclined and is often broken into a series of small hillocks. The soils are predominantly colluvial and shallow, and rocky ridges break the slopes. Brown forest soils are found where limestones or calcareous sandstones and shales occur but humus-iron podzols are more common where siliceous sandstones are prevalent. Flushed humic gleys in channels are common. The map unit occurs on the south of Raasay round the settlement of Inverarish, and on the islands of Scalpay and Pabay to the south. The main extent of the unit is in southern Skye where it occurs around the villages of Broadford and Elgol. It also forms agricultural ground at Strathaird and Suisnish and was obviously used intensively in the days of subsistence agriculture on the island. Very few areas are now regularly cultivated, the soil

* The area shown as *map unit 309* on Raasay is incorrectly symbolled and coloured; the correct *map unit* is *307*.

pattern providing problems for modern machinery, but surface cultivations for improved grasslands are very satisfactory.

Map unit 311 is very restricted in extent (approximately 2 square kilometres, less than 5 per cent of the association) and found only on the island of Raasay beside Holoman Bay. A deep sandy loam till with finer textured patches occupies the valley. Traces of similar till also occur on the slopes above Eyre on southern Raasay. The till contains Torridonian and igneous stones but is primarily derived from Mesozoic rocks. The soils are peaty gleys and peat although at the eastern end of the map unit some noncalcareous gleys are found. Some rock outcrops are present. The vegetation is moist Atlantic heather moor with some flying bent bog and there is strong flushing.

Map unit 312 is the most extensive in the association (44 square kilometres, 60 per cent of the association). Most of the Jurassic rocks (primarily sandstones) between Broadford and Loch Slapin and again on the Elgol peninsula are found in this map unit. In the latter area even the Kimmeridge and Oxford beds are sandstones rather than clays, and although one or two areas of clayey soils are found they are not sufficiently extensive to map as the Staffin Association. The pattern throughout *map unit 312* is strongly affected by underlying rock structure and outcrops are common. The soils are peaty gleys, with peat in hollows. Occasional peaty podzols occur on deeper drifts at the foot of scarps or on steeper slopes. The wet climate of the area makes the soils difficult to manage. Some attempts at reclamation have been made, primarily where the unit is slightly drier and a higher proportion of peaty podzols occurs, but deterioration of sown swards is usually rapid and rush infestation common. The vegetation of Atlantic heather moor and bog heather moor with blanket bog gives grazing of a low value. The use of the land for forestry is restricted by soil shallowness, wetness and exposure but Sitka spruce and lodgepole pine could be planted.

Map unit 313 comprises brown forest soils with peaty gleys and dystrophic peat. It is developed on hummocky moraine derived mainly from Mesozoic sandstones, shales and limestones, but includes an admixture of Torridonian rocks which gives the drift a reddish tinge.

The map unit covers 3 square kilometres (less than 5 per cent of the association) and it occurs only in one place near Applecross.

The brown forest soils, largely freely drained with an indurated B horizon, are developed on the mounds and support acid bent–fescue grassland or herb-rich Atlantic heather moor, with some arable and permanent pastures on the less moundy lower ground. The peaty gleys and the peat occur in the channels and hollows and on the flats between the mounds, carrying soft rush pasture, sedge mires and some blanket bog and flying bent bog.

On the higher ground, climate and pattern restrict the agricultural capability to use as improved grassland, but on the lower ground, limitations are less severe and cultivation is possible.

THE INCHNADAMPH ASSOCIATION

(Map units 314 and 315)

The Inchnadamph Association is one of the smallest in extent (14 square kilometres, 0.3 per cent of the land area). It is found only on the Island of Skye between Torrin and Broadford although it is more extensive in Northern

Scotland (Sheet 3). Its importance stems from the fact that it supports several farming and crofting settlements in areas where the surrounding soil resources are extremely poor. The parent material of the association is largely colluvial in origin (although there are many areas of shallow till) and derived from limestones of Cambro-Ordovician age. These 'Durness limestones' vary from dolomite to almost completely magnesium-free limestone but the former is prevalent and soil analyses from the association support this observation.

The landscapes strongly reflect the form of the underlying rock, with short, irregular slopes and frequent rock outcrops. The soils are obviously shallow, and even when a peaty surface develops it is frequently drier and more strongly structured than in surrounding areas. Small pot-holes and other signs of karst-type landscapes are found. The association is confined to ground below 250 metres.

The principal soils are brown rendzinas on rock, and brown forest soils (the latter developed on a shallow mixed drift of quartzite, schist and limestone), with peaty gleys and peat at higher altitudes. Map units with mineral soils account for about 70 per cent of the association.

The climatic conditions are cool and wet and this is reflected in the pastoral land use. The association provides richer grazing and is heavily stocked, often with the larger Cheviot in distinction to the more usual Blackface sheep of the western mountains. There is a little semi-natural woodland. The road from Broadford to Torrin follows the limestone outcrop for much of its course and from it a good impression of both landscape and land use can be obtained.

Map unit 314 is the more extensive (10 square kilometres, 70 per cent of the association). It occurs below 200 metres and consists of brown rendzinas and brown forest soils developed on gently and strongly sloping limestone ridges and knolls. The landscape is often rocky, sometimes extremely so, and the soils dominantly shallow. The soils are dark yellowish brown to brownish yellow in colour in contrast to the sombre greys in the Deecastle Association, an analogous association developed on limestone and calc-silicate rocks in Western Scotland (Sheet 4). Textures are usually silty loam, the amount of silt (2–50 μm) being of the order of 50–70 per cent and the soils are moderately stony. Base saturation figures are higher than in comparable soils on the calc-silicate rocks, magnesium figures higher and the organic-matter content about 8–10 per cent.

Plant communities are dominated by herb-rich bent–fescue grassland and permanent pasture. There is little arable land, except small pockets between the rocks utilized for forage crops or potatoes by the crofting community. The land is predominantly grazing land of high quality and often heavily stocked. The shallowness of the soils, the exposed situation of the Western Highlands in general (although the Broadford–Torrin valley is relatively sheltered) and higher pH of the subsoil horizons will cause difficulties for forestry on this land.

Map unit 315 occupies the ridge-crest site overlooking the Broadford–Torrin valley, where it covers 4 square kilometres (30 per cent of the association). It is one of the few units which include both mineral and organic soils, brown mineral soils on steeper local slopes contrasting with broader peaty hollows. At higher elevations peaty podzols with strongly gleyed E horizons occupy the slopes (particularly on local drifts) and peaty gleys the hollows. The rock is often close to the surface and peaty horizons resting directly on rock are not uncommon. In such situations the organic horizon is drier, coarsely structured into a series of prisms and the soil supports dry Atlantic heather moor. In flushed hollows the effects of the limestone can be seen in the enrichment of the

plant communities, but acid bent–fescue grassland occupies the brown forest soils. Grazings in this map unit are usually of moderate quality in contrast to similar units on acid rocks, which are generally poorer.

THE INSCH ASSOCIATION

(Map units 322, 323, 325 and 327)

The drifts of the Insch Association (21 square kilometres, 0.4 per cent of the land area) are derived from gabbro and eucrite and occur in the Cuillin Hills of Skye and on the Ardnamurchan peninsula. The soils on the smaller plutonic masses of basic rock associated with the ultrabasic complex of Rhum have been included in the Corriebreck Association.

On Skye the gabbroic rocks are so resistant to the soil-forming processes that they have mainly been included with the bare rock, scree and cliffs unit which covers most of the Cuillin Hills, although rankers and lithosols are locally present. Significant areas of soil are limited to the moraine-filled valleys and a few less rocky areas where the textures are stony sandy loams. In Ardnamurchan the terrain is marginally more subdued but rock outcrops are still a prominent feature of the map units.

There is a marked contrast in the climate of the two localities; Skye is cold and wet with average annual rainfall exceeding 3000 millimetres while Ardnamurchan is warm and rather wet with an average of only 1600 millimetres of rain per annum.

Map unit 322 is found in the corries and valleys of the Cuillin Hills where it occupies 7 square kilometres (35 per cent of the association). The morainic drift is an extremely bouldery, sometimes strongly moundy deposit, which occasionally forms arcuate terminal boulder moraines as at Coire a' Ghrunnda. The soils are peaty podzols, peaty gleys and peat, developed on very stony deposits. Bedrock frequently breaks the surface as glacially scoured rock slabs. Where the moraines have been eroded by streams there are some patches of alluvium and peaty alluvium, notably north-west of Loch Coruisk. In such inhospitable terrain it seems likely that the land will continue to be used as rough grazings, the chief plant communities being heather moors and flying bent bog.

Map unit 323 is restricted in extent (less than 1 square kilometre, less than 5 per cent of the association) and occurs on the Ardnamurchan peninsula. The dominant soils are brown forest soils and brown rankers which are both freely drained; there is also a small area of windblown shelly sand included in this map unit with soils of the Fraserburgh Association developed on it. The land provides good grazings but the soils are often too shallow for all but very minor arable cropping.

Map unit 325, present only in Ardnamurchan, occupies 2 square kilometres and accounts for 10 per cent of the association. The landscape has irregular rocky knolls with peaty gleys and peaty rankers while the flats and hollows between the knolls have an infilling of peat.

Land use is chiefly rough grazings, but the unit has some potential for afforestation. Plant communities include moist Atlantic heather moor, bog heather moor, and flying bent bog; grazing values are low and moderate.

Map unit 327 is very similar to *map unit 325* but is generally much rockier with less peat and more peaty rankers and peaty gleys. It is probable that the land

will remain as rough pasture as it is too rugged and waterlogged for most other uses. It covers 12 square kilometres (55 per cent of the association) around the north-west coast of Ardnamurchan, and peripheral to the Cuillin Hills where it occupies some steeper slopes.

THE KNOCKSKAE ASSOCIATION

(Map unit 358)

The Knockskae Association is of very minor extent (5 square kilometres, less than 0.1 per cent of the land area) and is found extending north-eastwards from Rubha Suisnish (at the confluence of Lochs Slapin and Eishort) towards Broadford. The parent rocks of the association are spherulitic granophyres and quartz-felsites, both very acid, hard rocks which provide very little fine material for soil formation. The parent material is almost always an angular stony rubble set in a matrix rich in organic matter. The soils are peaty gleys and peaty rankers, often eroded and with areas of bare rock. Peat is also a component of the single map unit in the association, which lies in a cool wet lowland area with a rainfall of over 2000 millimetres per annum.

Map unit 358 is recognized in three separate areas near Rubha Suisnish. They are all part of the same intrusion (a sill) and have a steep south-easterly facing scarp and a more gentle north-westerly dip slope. The scarp presents a rough, rocky appearance and the dip slope is covered by a thin layer of eroding peat. The plant communities of moist Atlantic heather moor, bog heather moor and blanket bog are all of low grazing value. Some of the areas are being forested but there are severe limitations due to windthrow caused by exposure and shallow soils.

THE LINKS ASSOCIATION

(Map units 381 and 384)

The soils of the Links Association cover 1 square kilometre (less than 0.1 per cent of the land area) and are developed on silica sand which is chiefly a stabilized aeolian deposit with few active dunes. A few pockets of shell sand occur but they are never large enough to distinguish separately. On the most recently formed deposits close to the sea there are noncalcareous regosols, while the undulating stabilized dunes slightly further inland have humus-iron podzols.

Map unit 381 accounts for most of the area of the association and covers 1 square kilometre in the parish of Morar where it provides much of the farmland. The soils are chiefly noncalcareous regosols and humus-iron podzols though a few noncalcareous ground-water gleys and peaty soils are present in small receiving hollows. Topography is mainly undulating or moundy but a more level area similar to the machairs of the islands occurs at Traigh, near Morar. This area may be a raised beach.

Most of the farmland the unit provides is suitable only as permanent pasture because of the wind erosion risk, but there are occasional arable fields. In an area of such outstanding scenic beauty increasing use of farmland as camp and caravan sites is being made.

Map unit 384 occupying less than 1 square kilometre is found at Peanmeanach, Ardnish. It consists of two contrasting zones; firstly, a coastal strip of stabilized dunes with both peaty and mineral soils, mainly noncalcareous regosols with some immature peaty gleys and humus-iron podzols, secondly, a level area further inland which has peaty gleys and peat.

This small area of subdued topography in the midst of some very rocky terrain, now used only as grazing land, was once the scene of a thriving crofting community. Even within such a small compass, plant communities include dune and rush pastures, heather moors and blanket bog.

THE LOCHINVER ASSOCIATION

(Map units 385–398)

The Lochinver Association is the most extensive in the region, covering 2152 square kilometres (38.2 per cent of the land area) the bulk of which occurs on the Outer Hebrides. There are also small areas scattered along the western seaboard of the mainland from Rubha Reidh to Loch Hourn and on the islands of Skye, Raasay and Rona. The association is also extensive along the western coast of Northern Scotland (Sheet 3). The land is particularly low-lying on North Uist, Benbecula and South Uist where much of the terrain lies below 100 metres altitude. Hilly and mountainous terrain is restricted to eastern South Uist and North Uist in the southern islands, becoming more extensive in west Lewis and Harris where mountains and rocky hills dominate the scene, which culminates in Clisham (799 metres).

The soils of the Lochinver Association are developed on drifts from crystalline rocks of Lewisian age. There is a wide variety of metamorphic rocks in the formation but they can be broadly classified as gneisses and schists. The gneisses are dominant and consist largely of granitic gneiss with small plutons of granite in west Lewis and parts of Harris, and less extensive basic gneisses. The granitic gneiss is dominant over large areas and is typically foliated in white and grey or pink bands. Garnetiferous hornblende-gneiss with darker green or black bands is restricted to small areas in South Harris, the Ness district of Lewis and eastern South Uist. The gneisses, both acid and basic, are slow to weather; their drifts have sandy loam to sand textures, are very stony and are similar to those of the Countesswells/Dalbeattie/Priestlaw Associations. The range of soils in the more basic areas shows little difference from that in the acid areas. The schists are much more limited in extent than the gneisses and their outcrops are found in the same districts as the basic gneisses on the Outer Hebrides. They also occur on the Sleat peninsula of the Island of Skye. The latter area is adjacent to the Moine Thrust and is composed of chlorite-schists which are more easily weathered than the other Lewisian rocks of the region and form drifts, which, although shallow, obscure the bedrock over large areas. This drift is less stony, has a higher proportion of silt (around 30 per cent in the B horizon) and is slightly deeper than that derived from gneisses.

Considering the complete association, the greatest depths of drift are found on the till plain of north Lewis (Plt on Fig. 2), which is largely peat-covered, and in areas of hummocky moraines. The morainic drifts occur in the valleys of North Harris, west Lewis and the Park district but are also extensive on the more open lowlands of North Uist, Benbecula and South Uist. Colluvium is the most widespread drift type and cryic deposits are restricted to the mountains. Weathered rock (Glentworth, 1979) forms the parent material at a number of

localities, but its extent is unknown. These parent material types plus the modifying factors of climate and topography influence soil distribution within the association. Peaty soils are dominant on till, moraine and colluvium, and peat is widespread, being found in many map units. The proportion of peat is much lower in hilly regions where slopes are steep. Peaty podzols and humus-iron podzols occur on the moraines; humus-iron podzols and brown forest soils on colluvium principally on the chlorite-schists. Noncalcareous and humic gleys are found with peaty gleys on till, and alpine and subalpine podzols occur on cryic deposits.

Map units dominated by peaty soils cover 1929 square kilometres (89.6 per cent of the association). Peaty gleys are the most frequently occurring soils. The profiles generally have high organic-matter contents, especially in the Eg horizon where they have dark greyish brown colours. Greyish brown colours are more common where organic-matter contents are lower, in the Bg horizon, and the Cg horizon is olive brown. Peaty podzols are of more restricted extent, being found on shedding sites, particularly the crests or side-slopes of moraine hummocks, and on steeper slopes (on till, colluvium and morainic drift) especially where rainfall is lower. These soils have a strong thin iron pan which is virtually impervious, and the Eg horizon is similar to that found in peaty gleys. The underlying Bs and C horizons have free drainage. Peaty rankers are widespread in the rockier terrain, but are also found occasionally in non-rocky terrain with shallow drift or colluvium parent materials. They are rare in map units dominantly of till or morainic parent materials. The O horizon/rock interface is prone to separate if the organic material undergoes many seasonal wetting and drying cycles and this weakness can lead to erosion of the organic layer.

Map units dominated by humus-iron podzols and brown forest soils cover 107 square kilometres (5.0 per cent of the association) and are mainly found on the morainic and colluvial drifts of North Uist, Benbecula and South Uist with smaller but significant areas on the Sleat peninsula of Skye on colluvium derived from chlorite-schists. Humus-iron podzols are often cultivated and have a well-developed Ap horizon about 30 centimetres in thickness, sometimes overlying an E horizon. The Bs horizons are stony, gritty and indurated in the moraine and silty on the chlorite-schists. Included with the humus-iron podzols are some soils that were probably peaty podzols before cultivation. They have occasional thin iron pans and more humose surface horizons. The brown forest soils generally have B horizons with higher chroma than usual, are restricted to steeper ground and are developed on colluvium.

The noncalcareous and humic gleys are found in north Lewis developed on till and form a map unit covering 22 square kilometres. The mottling in the A and Bg horizons is a result of waterlogging in the profile, caused by a compact or indurated C horizon combined with gently sloping topography. Because of the low rainfall in this area some humus-iron podzols occur restricted to slightly steeper ground or shedding sites.

Subalpine podzols and subalpine gleys are the most common soils on the upper slopes of the mountains, with alpine soils restricted to the exposed highest summits and ridge-crests.

The average annual rainfall is 1200–1600 millimetres over much of North Uist, Benbecula and South Uist, but elsewhere varies from about 1000 millimetres along the coast of north Lewis to over 2400 millimetres on the Harris mountains. The low ground is mainly fairly warm and wet with some moderately dry areas in South Uist, whereas cool or cold and wet climates are

prevalent on the higher ground of west Lewis and Harris. The whole area of the association suffers from exposure to westerly winds which are particularly severe on the coasts and mountain summits.

As would be expected from the distribution of soils, moorland and bog plant communities are common, whereas grassland, mountain heath and, particularly, woodland communities are restricted in extent. Bog heather moor and northern bog heather moor are most widespread, dominating the peaty gleys and forming part of the vegetation cover on peaty rankers, peaty podzols and shallow peat. Northern blanket bog and blanket bog are most common on the peat however, with flying bent bog occurring where there is weak flushing, which can be quite extensive particularly in rocky terrain. Upland blanket bog and, rarely, mountain blanket bog are present at higher altitudes. Moist, northern, and occasionally dry Atlantic heather moors occur on the drier peaty podzols, peaty rankers and shallower peat. The cultivated podzols and gleys carry permanent and long ley pastures, with occasional arable breaks for root crops and cereals. Rush pastures and sedge mires indicate that flushing is present in the humic gleys and wetter noncalcareous gleys. The brown forest soils and brown rankers support the best grazings of the association which consist mainly of acid bent–fescue grassland. Dry birchwoods occur on some of the steeper slopes. Mountain white bent grassland covers steep slopes on the mountains with mountain heath communities on the more gently sloping high ground.

Map unit 385 is confined to Lewis, being found on the Eye Peninsula and at Tolsta and along the north-west coast where it is associated with most of the crofting townships between Shawbost and Ness. The unit covers 22 square kilometres (1 per cent of the association). The landform is typical of the Lewis till plain; gently undulating with gentle and strong slopes, non-rocky, and mostly below 50 metres altitude.

The soils are noncalcareous and humic gleys with some humus-iron podzols and are developed on a deep, stony till of sandy loam texture. The soils are distributed around the periphery of the large peat-covered till plain of north Lewis and parts of the map unit have been reclaimed from the peaty gleys, peat and peaty podzols of *map unit 390*. There are still some small areas of peaty gleys in wetter hollows, and the mineral gleys often have humose topsoils. The poor drainage is largely due to a combination of gentle slopes and compact or indurated subsoil. Freely drained humus-iron podzols (cultivated) are found where sites are less waterlogged, for example on strong slopes or shedding sites, and are locally common.

The pattern of land use is influenced by the crofting system, and strip cultivation is widely practised (Plate 6). Most of the land is under permanent and long ley pastures with occasional arable breaks for root crops and cereals. There are occasional rush pastures on wetter or flushed sites.

Map unit 386 covers 45 square kilometres (2 per cent of the association). The most extensive areas occur at Leurbost, Balallan, and Carloway on Lewis and between Garrynamonie and Daliburgh on South Uist. The unit is situated at low altitudes on valley sides and undulating lowlands with gentle and strong slopes and is slightly to moderately rocky. The landform is similar to that in *map unit 387*, but soil types and textures differ.

The soils are humus-iron podzols, with peaty gleys and peaty rankers. The freely drained soils are found on the shedding sites and steeper slopes associated

Plate 6. *Five Penny Borve, Lewis. Noncalcareous gleys and humic gleys with some cultivated humus-iron podzols developed on till of the Lochinver Association (map unit 385) form the inbye land of the crofts. The peaty gleys and cut-over peat in the foreground, also developed on till of the Lochinver Association, form map unit 390. Strip cultivation associated with crofting is well-illustrated in this area. Note the coastal fringe where exposure and salt-spray restrict the land use to rough grazings of high quality on maritime grassland. The cultivated crofted land is rated class 4.2, while the peaty land is class 5.3.* Aerofilms.

with the rocky knolls, with flushed noncalcareous and peaty gleys between. In many areas the unit has been reclaimed from peaty gleys and peat (*map unit 394*) and remnants of the former peaty surface are evident. Reclamation on North and South Uist, and Benbecula was assisted by proximity to the machair—which provided a source of lime. While some of the ground can be cultivated, much is under permanent pasture, with rush pastures on the wetter sites.

Map unit 387 is restricted to Skye from around Isleornsay to south of Armadale on the Sleat peninsula where it covers 18 square kilometres (less than 1 per cent of the association). The Lewisian rocks in this district are chlorite-schists which have produced siltier drifts and less rocky landscapes than are found on the gneisses. The parent material is colluvium with silty loam or loam textures and abundant micaceous material. Despite the relative ease with which the rock weathers, the drifts are shallow with rock usually within 100 centimetres of the surface. The landscape, despite the paucity of drift cover, is only slightly rocky but the form of the underlying rock structure clearly affects the landform, which is hillocky with gentle and strong slopes. A small area of drift (possibly glacial till) derived from chlorite-schist occurs overlying rocks of Torridonian age to the west near Armadale.

The soils are dominantly brown forest soils and brown rankers, with minor humus-iron podzols and peaty gleys. The brown forest soils often have strong brown B horizons. The plant communities are acid bent–fescue grassland with arable and permanent pastures in less hillocky terrain. There are localized rush pastures and sedge mires on poorly drained soils in hollows. Land use is dominated by crofting, with cultivation of the gently sloping, slightly rocky ground and grazing of the steeper or more rocky terrain. The grazings are of high to moderate value.

Map unit 388 is mainly found on the west sides of North Uist, Benbecula and South Uist, with smaller areas along the south shores of Loch Eport in North Uist and in Lewis at Kershader on Loch Erisort and Arivruaich on Loch Seaforth. The unit is low lying and almost always occurs below 30 metres. The soils are developed on gently hummocky or undulating moraine fields, a landform which is more strongly expressed and more bouldery, in the deeply cut glaciated valleys of North Harris. Nevertheless, there are some strongly and steeply sloping areas on the sides of the mounds. The textures of the drifts are loamy sand or sand; some soils have similar sand contents to those of the Corby Association. The unit covers 43 square kilometres (2 per cent of the association).

The principal soils are humus-iron podzols, noncalcareous gleys and humic gleys with some peaty gleys and peaty podzols. The podzols are located on the mounds while the gleys are found in receiving sites in the associated hollows and channels. The humus-iron podzols are cultivated throughout this unit and include soils which were formerly peaty podzols. Many retain a high level of organic matter in the Ap horizon and iron pans can still be seen in some profiles. The cultivated profiles have a dark greyish brown Ap horizon overlying a bright podzolic Bs horizon, underlain by the olive-coloured indurated parent material. Much of the land is adjacent to the Fraserburgh Association soils, the shelly sands of which have probably been added to the soils of *map unit 388* in the past.

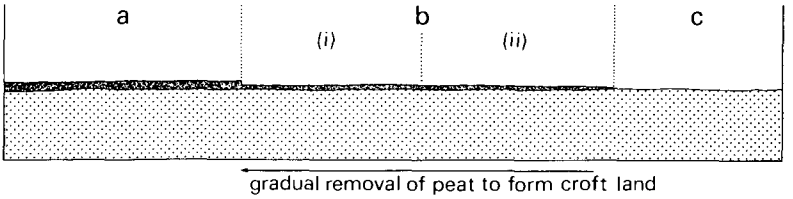
Boulderiness and slope or soil pattern limit land use to grazing and much of the ground is under permanent or long ley pastures with rush pastures, yellow flag swamp and mire communities in the flushed channels.

Map unit 389 is of restricted extent, covering 1 square kilometre (less than 1 per cent of the association) on the west shore of Loch Shieldaig and near North Erradale on the mainland, and near Stornoway. The land has moderately to very rocky steep slopes, with brown forest soils, humus-iron podzols and some peaty rankers and peaty gleys developed on colluvium. The plant communities are woodland, bent–fescue grassland and some Atlantic heather moor, which provide grazings ranging in quality from good to moderate.

Map unit 390 occurs inland from *map unit 385* at the fringes of the peat in north Lewis, and is most extensive between Shawbost and Ness along the west coast. The total area of the map unit is 48 square kilometres (2 per cent of the association). The landform is non-rocky undulating lowland with gentle and strong slopes and some bouldery patches. The soils are developed on a sandy loam to sandy clay loam till with considerable amounts of coarse and very coarse sand.

The principal soils are peaty gleys and peat with some peaty podzols on steeper slopes, but much of the ground has been reclaimed from peat by man's activities. In the past, the peat cover was almost certainly much thicker, but centuries of cutting for fuel has resulted in an increase in the proportion of peaty gleys as the blanket of peat was gradually removed (Fig. 12). *Map unit 385* is considered, in some areas, to be a stage further in this process. The land is commonly termed 'skinned land' and the effect of the long-term and intensive peat-cutting is to produce an uneven surface which eventually settles down. The peaty gleys often have an iron pan in the profile resting on the indurated or compact C horizon and, although the drainage has been improved in many areas, subsoiling would be beneficial, though its cost-effectiveness is questionable on peaty land. The unit is adjacent to crofting townships and because of increased grazing pressures, particularly in the fenced areas, species such as white bent and heath grass are more abundant.

The soils occur in the lowest rainfall area of the region and soil wetness, which gives trafficability problems on peaty terrain, is less than in other areas. Land use is principally rough grazing of low value on the dominant heather moor and bog communities, with some moderate value grazings where grasses are more frequent.



a Uncut peat of *map unit 4*
b *Map unit 38* (Arran Association) or *map unit 390* (Lochinver Association).
  (i) Peat cuttings with some uncut peat
  (ii) Reclaimed peaty gleys
c *Map unit 37* (Arran Association) or *map unit 385* (Lochinver Association). Noncalcareous and humic gleys with some cultivated humus-iron podzols

Figure 12. *Diagrammatic representation of a sequence from blanket peat to croft land*

Map unit 391 consists of peaty podzols and peat with some peaty gleys and is developed on hummocky moraines. Slopes are mainly gentle and strong, but individual mounds frequently have short steep slopes and there are steep slopes on valley sides. This unit occurs in valleys in Lewis and Harris, but on more open lowland sites in the Uists and has an extent of 267 square kilometres (12 per cent of the association). The largest single area is around Loch Seaforth, but it is also extensive in the valleys of the hilly regions of North Harris, west Lewis and the Park district. Significant areas also occur around Loch Eport in North Uist and Lochs Bee, Druidibeg, and Ollay in South Uist.

The soil pattern is basically one of peaty podzols occurring on the mounds with peat and peaty gleys in the channels and flats between them. The proportions of the soil types vary according to the topographic situation in which the unit occurs. In narrow valleys such as those in Harris, the mounds are often contiguous, peat is uncommon and weakly flushed peaty gleys occur in the narrow channels between the mounds. This variant tends to be moderately or very bouldery. In more open sites, the mounds are much more widely spaced, and quite large expanses of peat occur on the gently sloping areas between them, as, for example, on the west side of Loch Seaforth near Arivruaich. These areas are generally non- or only slightly bouldery. Peaty gleys occur on some of the more subdued mounds where the slopes are gentle. There are some subalpine soils on the mound crests in exposed cols above about 200 metres.

Land use is restricted to poor rough grazing or deer-forest either by the boulderiness of the mounds or wetness limitations due to the amount of peat. The main plant communities are bog heather moor and bog communities, and their northern forms.

Map unit 392 consists mainly of peat and peaty gleys, and some peaty podzols and occurs on non-rocky hill sides and undulating land with gentle and strong slopes. Although it is an extensive unit covering 223 square kilometres (10 per cent of the association), individual areas tend to be small and scattered amongst other rock-controlled units. The largest areas are on Benbecula and North Uist and between Loch Erisort and Loch Shell in east Lewis.

This unit is like *map unit 390* in that both have a similar range of soils and occur on non-rocky landscapes. However, whereas *map unit 390* has developed over a deep till, this unit is rock controlled and the drift is correspondingly much shallower. The underlying rock structure is quite evident in some areas, for example the Gravir–Lemreway areas and on Benbecula, and rock crops out occasionally.

Peat and peaty gleys are usually co-dominant but in areas where slopes are mainly gentle, peat is very widespread. The peaty gleys and less frequent peaty podzols are confined to the more strongly sloping rock-controlled ridges which rise above the expanse of peat. In these situations, recognition of individual soils from their surface expression is easy. On hill slopes with few undulations however, the peat and peaty gleys occur in a very complex pattern and the thickness of the organic horizon displays rapid short-range variation with slight changes in topography. Peaty gleys are usually the most widespread soils in these situations.

Land use is mainly restricted to poor rough grazing due to wetness and climatic limitations. However, in the drier north and east of Lewis, some of the unit is marginally suitable for improvement although the wet peaty surface horizons have low trafficability. Bog and heather moor communities are dominant.

Map unit 393 is restricted to one locality* on the mainland south of Glenelg Bay and covers less than 1 square kilometre on steeply sloping moderately rocky terrain. The soils are principally brown forest soils and humus-iron podzols. The unit provides good grazing land further east, but is afforested in this district.

Map unit 394 is the second most extensive map unit of the region, covering 762 square kilometres (35 per cent of the association) and is widespread in the loch-studded ground of southern Lewis. It is found in smaller areas throughout the Outer Hebrides, on the Sleat peninsula of Skye and on the mainland. The terrain is moderately rocky with gentle and strong slopes, and the unit is principally found below 150 metres, being replaced by *map unit 396* on the steep slopes which are prevalent at higher altitudes.

The soils are mainly peaty gleys and peat with some peaty rankers and peaty podzols. They are developed on a stony, sandy loam colluvium with some shallow till. The proportion of peat is largely determined by topography; it is most extensive in southern Lewis where slopes are gentle and a large proportion of the unit is covered by peat flats. Peaty gleys are widespread throughout, mainly on strong slopes and on ridge crests and knolls. Peaty rankers are associated with the rock outcrops while the limited proportion of peaty podzols is found in slightly drier areas or where the parent material is thicker or more permeable allowing better drainage.

The plant communities are mainly bog heather moor and northern bog heather moor on the peaty gleys, peaty rankers and peaty podzols, with some Atlantic heather moor on shedding sites. The peat supports blanket bog, northern blanket bog and flying bent bog. The grazing value of such vegetation is low. Some areas of improved ground, however, have higher grazing values.

Map unit 395 is a rugged, very rocky unit with dissected terrain and has gentle and strong slopes with some steeper areas. This is the second most extensive unit in the association, covering 553 square kilometres (26 per cent of the association) and is dominant in South Harris and between Loch Roag and West Loch Tarbert. Numerous small areas occur down the west side of North Uist and South Uist.

The landscape is more rugged and tends to occur on higher ground than *map unit 394*. The land is mainly below 250 metres except in the area between Loch Tamanavay and Camas Uig, where it rises to 500 metres on Griomaval. There are subalpine soils at the higher altitudes. The drift cover in this rocky terrain is patchy and very shallow and the soils are peaty gleys, peaty rankers, and peat. The peat occurs in basin and channel sites which often follow fault lines or slightly softer rock bands. Peaty rankers are found with the peaty gleys and peaty podzols on the rocky knolls. Extensive rock pavements are seen in some localities, particularly South Harris where some rock has been mapped.

The plant communities are bog heather moor and northern bog heather moor with bog communities on the peat. This vegetation gives only poor grazing, except in small areas where improvements to the sward have been carried out by liming with shelly sand and reseeding, mostly by hand.

Map unit 396 is found on slightly to very rocky, steep or very steeply sloping hill and valley sides and the soils are developed on colluvial parent materials.

* The area of *393* shown on Pabbay (by Mingulay) is an incorrectly symbolled area of *map unit 395*.

The unit covers 76 square kilometres (4 per cent of the association) mainly in the hilly parts of the region, although shorter slopes too small to show at this scale are included with *map units 394* and *395*. There is little peat and higher proportions of peaty gleys and peaty podzols, with peaty rankers in the rockier land. Many of the soils are weakly flushed. Bog heather moor and northern bog heather moor communities are dominant on the peaty gleys, peaty rankers and wetter peaty podzols. Moist Atlantic heather moor and common white bent grassland are restricted to the unflushed, drier peaty podzols.

Map unit 397 is a unit of subalpine podzols and peat and occurs on slightly and moderately rocky upland plateaux with gentle and strong slopes. The podzols are developed on cryic deposits. The unit covers 40 square kilometres (2 per cent of the association) and occurs as small scattered areas in the North Harris hills and in the Park district to the east of Loch Seaforth.

The plateaux have an altitude range of 250–550 metres, but occur mainly above 350 metres, and both peat and subalpine podzols are developed. There is a distinctive pattern of subalpine podzols on the rocky and bouldery knolls with hagged peat between. Although there is often a transition zone of peaty gleys and peaty podzols it forms a very small part of the unit.

Climate, soil and wetness limitations all restrict land use to poor rough grazing.

Map unit 398 consists of subalpine and alpine soils, lithosols, noncalcareous regosols and rankers and occurs on slightly to very rocky mountain plateaux and slopes. The soils are developed on cryic and colluvial material. It is the more extensive mountain unit, covering 54 square kilometres (3 per cent of the association). It is most common in the North Harris hills but is also quite extensive on the hills of South Uist. Smaller areas occur on Beinn Mhor, east of Loch Seaforth, and on Heaval in Barra.

Although the unit is found as low as 250 metres, its altitudinal range is mainly 400–800 metres. The land consists of either strongly sloping plateaux or steep slopes, although both gentle and very steep slopes also occur. Subalpine podzols are most common, merging into alpine podzols on the very exposed tops, usually at around 600 metres. Podzolic characteristics are weakly developed on the colluvial soils. The very steep slopes are mainly unvegetated crag and scree with lithosols, noncalcareous regosols and rankers the dominant soils. Peaty rankers may occur on the lower slopes.

Because of the overriding climatic limitation, land use is restricted to rough grazing and deer-forest. Grazing values vary, but the stiff sedge–fescue grassland provides moderate grazings whereas the more restricted mountain heaths are poor.

THE ROY ASSOCIATION

(Map units 452 and 453)

The parent materials of the Roy Association were deposited in a glacial lake impounded by the remnants of the Loch Hourn glacier at the end of the last ice-age and are analogous to the sediments of Glen Roy and Glen Gloy described in the handbook for Western Scotland (Sheet 4). The deposits are chiefly laminated silts, though bands of sands and gravels are present, which, where

they reach the surface, form small areas of the soils of the Corby Association. Layers of silty clay are also found at depth in the deposits. The Roy Association, because of textural variation over short distances, has soils of different drainage classes in close proximity. In this region the association is found only around Inverie in Knoydart and covers 3 square kilometres (less than 0.1 per cent of the land area).

The two map units of the association have a similar undulating to moundy landform, and a broad range of soils, one unit being dominated by mineral soils (humus-iron podzols on the gravels, and noncalcareous or humic gleys on the silts), the other by peaty gleys and peat. Close to sea level, narrow raised beach terraces (the Corby Association) have been incorporated within the map units since they cannot be delineated at this scale. This area of Knoydart experiences high rainfall but, as the map units are found below 150 metres, accumulated temperatures are in the fairly warm division. Plant communities include woodland, rush pastures and grasslands. The land use varies from permanent pastures and rough grazings to forestry.

Map unit 452 occupying 1 square kilometre (35 per cent of the association) in the valley of the Scottas Burn has cultivated humus-iron podzols, noncalcareous gleys and humic gleys as the major soils. Broadleaved woodland, rush pastures and rye-grass–crested dog's-tail pasture are the main plant communities. Most of the land however, is under permanent pasture, though there are some small cultivable fields on the raised beach fringes.

Map unit 453 is the larger of the two units, accounting for 2 square kilometres (65 per cent of the association) in the valley of the Allt a' Mhuilinn. Though some mineral soils similar to those of the previous unit are present, the soils are most often peaty gleys, peaty podzols and peat. The vegetation consists of moist Atlantic heather moor and bog heather moor, rush pastures and bog communities. Apart from a tiny fringe of cultivated ground the land is used for forestry and rough grazings, which vary from moderate to poor in quality.

THE STAFFIN ASSOCIATION

(Map units 483–486)

The association, which occupies 48 square kilometres (0.9 per cent of the land area) is restricted to northern Skye, Raasay and the northern tip of Lewis. The soils are developed upon a silty or clayey till derived from calcareous shales, clays (Kimmeridge and Oxford clays) and some limestone of Jurassic age on Skye. On Raasay the till has been carried over rocks of Torridonian age, but on Lewis it overlies Lewisian rocks with no terrestrial outcrops of Mesozoic rocks near. In both instances it is likely that the drift has been derived from sub-sea basins of younger rocks which are known to occur nearby (Institute of Geological Sciences, 1979b). The stones in the till have several sources and often include local rocks but there is little doubt of the origins of the main mass of the drift. The texture of the parent material varies from loam to silty clay (the former probably reflecting local contamination by weathered sandstone on Skye), and its colour is dark greenish grey. In the Scottish context clayey parent materials derived from Mesozoic rocks are unusual, the only other recorded occurrences being to the south of the current map on Tiree, and at Shempston Farm near Duffus in north-east Scotland (Grant, 1960).

The landscape consists of gently undulating, subdued drumlins separated by

wet hollows and flats and is usually below 100 metres. The areas are dominantly non-rocky. The Staffin Association is one of the few soil associations of the region with high base status and significant amounts of exchangeable calcium and magnesium (the others being the Fraserburgh, Inchnadamph and some soils within the Darleith and Inchkenneth Associations). Exchangeable sodium is also unusually high, probably as a result of the island situation with salt contamination from sea-spray. The vegetation on unimproved sites (of which there are relatively few) is not halophytic however. In common with associations on basic rocks, high proportions of mineral soils are recorded (about 60 per cent of the association has map units dominated by mineral soils). The principal major soil subgroups are calcareous, noncalcareous and humic gleys, with peaty alluvial soils, peaty gleys and peat occurring in hollows.

The association occurs under fairly warm and moist or rather wet climate conditions and average annual rainfall ranges from 1100–1800 millimetres. The land is mainly used as grazings, both rough and improved, although a restricted range of arable crops is sometimes grown. Very careful management of the soils is necessary to avoid extensive poaching by stock and compaction by tractor operations. In the forestry context, the soils usually occur in very exposed areas which, combined with restrictions on rooting imposed by the calcareous nature of some of the subsoils and their slow permeability would give problems of windthrow.

Map unit 483 covers 26 square kilometres (55 per cent of the association), and most occurs in northern Skye, between Totscore and Kilvaxter, near Kilmaluag and patchily through croft lands southwards from Staffin. A small area occurs on Raasay. The principal components are gleys; mainly calcareous, noncalcareous and humic gleys but some peaty gleys and peaty alluvial soils are present in hollows. The gleys have a shallow plough layer (less than 20 centimetres), often mottled and underlain by a more strongly mottled brown B horizon. This has coarse prismatic structure and silty clay or clay loam texture and may be up to 40 centimetres thick. Succeeding this is a slightly mottled C horizon with massive structure. Fields with soils of slightly lighter texture are used for arable cropping but permanent pasture, often invaded by rushes, is more usual. Rush pastures and yellow flag swamp are found on the wetter sites.

Map unit 484 is very similar to *map unit 483* but is slightly rocky. It is confined to the Butt of Lewis where it covers 3 square kilometres (5 per cent of the association). The soils are humic gleys on till with some rankers associated with rock knolls. Grazing is the main land use on the improved and rush pastures.

Map unit 485 is composed of peaty gleys and peat and covers 18 square kilometres (40 per cent of the association). It occurs in both northern Skye and Raasay in close association with *map unit 483*, to which it has similar landforms. The management of soils with peaty surface horizons under rainfalls of 1400–1600 millimetres is extremely difficult, and the clayey subsoils do not help in establishing drainage. As a result little modern reclamation has so far been attempted on these sites although old rig and furrow and ditch lines are to be seen, indicating that attempts have been made in the past to bring them under cultivation. The plant communities include moist Atlantic heather moor, bog heather moor, blanket bog and yellow flag swamp and the quality of the grazings varies from poor to moderate.

Map unit 486 is of very restricted extent, occupying only 1 square kilometre (less than 5 per cent of the association) and is found near Culnaknock on the

Trotternish peninsula in Skye. The map unit is essentially composed of similar soils to *map unit 485* with the addition of small rocky outcrops. The area north of Culnaknock is broken by outcrops of basaltic sills intruded into Jurassic rocks and presents a complex landscape; brown forest soils occupy the basaltic scarps, shallow peaty rankers and gleys the flatter dip slopes and peaty gleys and peat over Jurassic tills are found in the hollows. The land is primarily used for rough grazing, but parts of it could also be used for forestry.

THE TOROSAY ASSOCIATION

(Map units 546–551)

The Torosay Association was first mapped on the Island of Mull to accommodate soils developed on a mixed drift derived from igneous rocks of widely varied composition which occurred in juxtaposition. It has since been recognized in a number of the centres of volcanic activity in the Tertiary igneous province in the Inner Hebrides, including central Skye, Rhum, Eigg and Ardnamurchan to which, in this region, it is entirely confined. Geologists have documented the rock types and history of the vents in some detail. When a rock occurs in a uniform and well-defined mass, its weathering products characterize the drifts and they are allocated to the appropriate associations (for example gabbros to the Insch Association and granites to the Countesswells Association). Many of the intrusive and extrusive rocks associated with the vents have, however been invaded by later intrusive rocks that not only differ widely from them in chemical composition but have also altered their host rock, both chemically and structurally, by the process of thermal metamorphism. Drifts derived by subsequent weathering of these complex suites of igneous rocks have a recognizable soil-landform relationship which has been grouped into the Torosay Association. The parent material of the association is heterogeneous and has many local variants. The association covers 112 square kilometres (2.0 per cent of the land area).

As would be expected from its occurrence on the rocks of central Skye, the landscapes of the association are mountainous. Three major types of parent material are found, shallow cryic deposits which cover the mountain summits and upper slopes, colluvial deposits on the lower slopes and a deeper hummocky moraine occupying the valley floors and sides. The colluvial parent materials are shallow, very stony and heavily humus-stained from water percolating laterally down steep slopes. Dark brown colours of low value and chroma are common. The morainic materials often have colours with a higher value but a similarly low chroma. They are very stony and in addition indurated. By analogy with a vast area of the Highlands to the east of this region, it is probable that the moraines were produced during the Loch Lomond Readvance.

The climate of the area of the association is wet and average annual rainfall exceeds 2000 millimetres in most places. The foothill areas are warm and the upper slopes and summits of the mountains are cold. The major soil subgroups reflect these conditions. Only 4 per cent of the area covered by the soil map units consists of free-draining brown forest soils. A further 4 per cent has subalpine soils. The remaining 92 per cent is dominated by soils with peaty surface horizons; 74 per cent are peaty gleys and peat and 18 per cent peaty podzols.

The peaty gleys and peat are dominated by moist Atlantic heather moor, often flushed, and by bog heather moor and blanket bog plant communities. The peaty podzols are confined to steep slopes and are associated with common

white bent grassland and boreal heather moor. The subalpine and alpine mountain summits and slopes support upland bent–fescue grassland, upland blanket bog and fescue–woolly fringe-moss heath. The brown forest soils carry both acid and herb-rich bent–fescue grassland.

Map unit 546 contains brown forest soils which often show podzolic features, and brown rankers. Humic and peaty gleys occupy the hollows and can extend from them where rock is very close to the surface. The unit occupies a coastal strip of steep rocky land north of Elgol in Skye and also two small areas on the north coast of Ardnamurchan (on the extreme southern edge of the map). Although nationally some parts of this map unit give scope for farming, most of the land in this area has too severe topographic limitations, and is only suited to use as unimproved grazings.

The soils are shallow and stony and developed on colluvium with a textural range from loamy sand to sandy loam but organic-matter content of the surface horizons is always high (up to 19 per cent) which gives a finer feel to the soils. Even at depth organic-matter contents can remain fairly high (7 per cent) and in this respect they are similar to the freely drained soils of the Darleith Association. The base status of the soils is always low, attesting to a high degree of leaching, and pH is usually about 5.

This map unit is always found at low elevations, and occasionally carries oak and birch woodland. More usually the plant communities are bent–fescue grassland with rush pastures in hollows. The grazing value of the land is high. The exposed nature of much of the unit probably restricts its value for forestry. The map unit occupies 5 square kilometres (less than 5 per cent of the association).

Map unit 547 accounts for 53 square kilometres (45 per cent of the association) and is mapped on hummocky moraines. They occur in the valleys of central Skye and are derived from an extremely wide range of rocks. Local variations in texture depending on the predominance of one contributory rock type or another are frequent. Their bouldery hummocks and wet hollows, rich in bog myrtle and flying bent, form a foreground to many of the picturesque views of the Cuillin Hills.

This map unit has a very characteristic topography of mounds and hollows. There are analogous map units in many of the soil associations of west Scotland. Soils on the mounds are predominantly peaty gleys with induration, or occasionally peaty podzols, with strongly gleyed E horizons, where the accumulation of a deeper mantle of slipped material from the mounds allows better subsoil drainage. The peaty gleys have, below the surface organic horizon, a shallow eluviated horizon often heavily stained with organic material. B horizons, too, have heavy staining which obscures gley morphology except around weathering stones. A root mat and sometimes a thin iron pan directly overlie the greyish brown to olive-grey indurated morainic drift. The presence of an indurated horizon is characteristic of all the soils in this map unit, though it may vary in its depth from the surface. Soil textures are generally gravelly sandy loams, but significant variation from sand to silt occurs within the deposit. Stoniness also varies considerably. Parts of the moraine, especially close to the surface, have obviously been affected considerably by resorting, possibly during the ice-melt.

The moraine frequently extends on to the steeper hill slopes. Above angles of approximately 15 degrees, peat is absent and the unit loses its moundy character and assumes a fluted form with erosion gullies and ridges. The soils

remain dominantly peaty gleys, often with an iron pan on the surface of the indurated horizon. Above the upper limit of the moraine a more permeable soil texture of loamy scree allows better drainage and the development of the podzols associated with *map unit 549*.

These soils provide little scope for reclamation for agricultural use and their flying bent bog and bog heather moors are of moderate to low grazing value. They have some capability for afforestation and some areas are being planted, principally with Sitka spruce and lodgepole pine.

Map unit 548 is found extensively on areas of pneumatolysed basalt affected by cone-sheets and other intrusions associated with the adjoining volcanic centres. Basalts would normally be mapped into the Darleith Association but the scoriaceous layers have been hardened by pneumatolytic action and no longer produce the finer material which forms the parent material of that association. They are, moreover, clearly part of the main vent landscape. The contrast between *map unit 548* on pneumatolysed basalt and *map unit 160* on unaltered basalt is illustrated on Plate 5.

The included soils are peaty gleys, often very shallow and stony, and even shallower peaty rankers. Detailed work on this map unit in Western Scotland (Mull and Ardnamurchan) showed that these soils accounted for 56 per cent of the unit, a further 20 per cent being peat in broad hollows and channels. Peaty podzols occupied 9 per cent and on steeper faces at low altitudes some brown forest soils and brown rankers were found (5 per cent).

The vegetation of the unit is almost entirely moist Atlantic heather moor and bog heather moor with blanket bog on the peat. Some of the shallow areas could be improved in patches but only for use by sheep. Rush infestation would be a problem. The shallowness of the soils is a disadvantage for forestry, particularly since the major areas are in exposed situations (overlooking Loch Brittle, Soay Sound and Loch Scavaig, exposed to the prevailing south-westerly winds). The map unit occupies 20 per cent of the association (25 square kilometres).

Map unit 549 is developed on the steeper mid and upper slopes of the hills, usually between the moraines of *map unit 547* and the subalpine soils of *map unit 551*. It contains a wide range of soil types in which podzols are dominant. Many of the soil profiles are disturbed by soil creep, wash-outs or mass slips and bisequel profiles are common. There is therefore, strong short range variation in the depth and type of solum and the soil types.

Amounting to 20 square kilometres (20 per cent of the association), the unit is the third most extensive of the association. It supports bent–fescue, common white bent and flying bent grasslands and rush pastures, all of which are important and useful grazing communities. There is however, hardly any scope for mechanized improvements and the altitude is such that it lies on the upper edge of the planting zone for forestry.

Map unit 550 is similar in most respects to *map unit 548* except that it is very rocky. It occurs on the islands of Rhum and Eigg; on the latter it occurs on An Sgurr in the south of the island. It is relatively unimportant, amounting to only 5 square kilometres (less than 5 per cent of the association).

Map unit 551 occupies only 4 square kilometres (less than 5 per cent of the association) between 400 and 800 metres on the summits of Slat Bheinn and Glamaig on Skye, and Sgurr nan Gillean and Ainshval on Rhum. The landforms are generally steep and rocky, but on Slat Bheinn the unit occurs as a

plateau. Developed in the orohemiarctic climate zone, the soils include hagged amorphous peat, subalpine podzols and subalpine gleys developed on stony frost-shattered debris. Some accumulations of aeolian sand in cols have also been noted. The keynote of this map unit is its extreme variation, often within distances of only a few metres. The surface horizons of the soils are mixed by winter frost action and bleached sand grains occur among the very fine strongly humified, black, organic matter. On acid rocks some leached horizons may develop but on the more basic parent materials there is little horizon differentiation. Stone pavements are seen and, sometimes, polygons and stone stripes. Some grazing is available, particularly on steeper slopes. The soils are unplantable.

THE TORRIDON ASSOCIATION

(Map units 553–561)

The Torridon Association occurs on the mainland mainly in Wester Ross between Rubha Reidh and Loch Alsh, but is also extensive in south-east Skye. Smaller areas occur on the islands of Rhum, Scalpay and Raasay. The total extent is 585 square kilometres or 10.4 per cent of the land area. It is more extensive in Northern Scotland (Sheet 3).

The soils of the association are developed on drifts derived from sedimentary rocks of the Torridonian formation. Within this formation are two major groups of varying lithology: the Applecross Group which predominates in Wester Ross, Rhum and Raasay and consists of red arkoses and grits, conglomerates and brown shales; and the Diabaig Group which occurs in south-east Skye and consists of grey shales and phyllites. The dominantly arenaceous and rudaceous rocks of the former produce reddish stony drifts, generally of loamy sand texture, whereas the drifts of the latter tend to be finer textured and greyer in colour.

The most widespread parent material is a shallow colluvium on a rocky landscape, the average depth of material decreasing as the amount of rock outcrop increases. A thin stony till occurs on non-rocky ground. Other types of drift include moraines found mainly in valleys, colluvium and scree on steep hill and valley slopes, and cryic deposits on the mountain plateaux.

Much of the land is below 450 metres and strongly rock-controlled; the crudely terraced topography reflects the bedding in the sandstone. Only a few areas of more gently undulating non-rocky land and of boulder-strewn hummocky valley moraine break up the rugged, rocky landscape. The mountains of Applecross rise to over 800 metres with very steep crags on their eastern sides. Their western slopes are an extension of the rocky landscape found at lower altitudes and form gently and strongly sloping plateau-type landforms.

The dominance of peaty soils is clearly demonstrated by the fact that map units with peaty gleys, peaty podzols, peaty rankers and peat as their main components account for 92 per cent of the association, map units with mainly mineral soils cover only 4 per cent and the remaining 4 per cent is taken up by map units of the mountain summits and slopes.

Peaty gleys are the most common soils, usually on thin stony colluvium with rock often within 60 centimetres of the surface. This feature is largely responsible for the waterlogging of the profile and the consequent dull colours which mask the reddish colours of the parent material. Peat is also common and

locally dominant in some areas. The peat occurs on level and gently sloping sites and is very wet, very poorly drained and structureless. The surface layers are generally fibrous with little decomposition, but become more humified, plastic and sticky with depth. Above about 400 metres, the surface of the peat is strongly hagged. Peaty rankers are very common in the rockier units where much of the land is drift-free and the organic horizon frequently sits directly on top of rock. These soils also occur on steep and very steep slopes developed on scree. Peaty podzols are generally restricted to strong, steep and very steep slopes or to moraine mounds and are also more common in coastal areas where the rainfall is lower. A strongly gleyed E horizon above a well-defined iron pan is usual, except on the steepest slopes where the gleying is less well-developed. Induration frequently occurs directly below the iron pan and these features prevent drainage through the subsoil.

Rainfall is generally high, ranging from 1400–1600 millimetres on the coast, rising to 3200 millimetres in the mountainous east. The lower ground, below about 200 metres, is fairly warm and wet, but the climate becomes increasingly cold with increasing altitude, mountain tops being very cold and wet. Exposure also generally increases with altitude, from exposed at the coast, to extremely exposed on the mountains. This element of the climate is strongly influenced by local aspect and topography.

The pre-eminence of peaty soils is reflected in the dominance of moorland communities. Bog heather moor and northern bog heather moor are most common and occur on the peaty gleys and the wetter peaty rankers and peaty podzols, while blanket bog, including its northern and upland forms, and mountain blanket bog are found on the peat. The altitude at which the peat occurs largely determines which community is present. Moist and northern Atlantic heather moor are found on the drier peaty podzols and peaty rankers.

Map unit 553 consists of humus-iron podzols and humic gleys and occurs on non- and slightly rocky lowlands with gentle and strong slopes. Although it is not extensive, covering only 4 square kilometres (less than 1 per cent of the association), it is an important unit associated with most of the crofting communities on the coast between Rubha Reidh and Loch Torridon. Some of the areas of these soils are too small to show on the 1:250 000 soil map.

The soils are developed on a shallow stony till, with freely and imperfectly drained podzols occurring on rocky knolls and flushed humic gleys in channels and basins. Many of these soils result from the cultivation of peaty podzols and peaty gleys and they have very dark humose Ap horizons.

The wet climate, stoniness and the adverse pattern of soils have restricted the land use mainly to permanent grassland although occasional root crops are grown. Soft rush pasture is common on the gleys.

Map unit 554 consists of peaty podzols, peat and peaty gleys, and the soils are mainly developed on hummocky valley moraines typical of the Loch Lomond Readvance. Slopes are mainly gentle and strong, but some steeper areas of gullied moraine are also present. It covers 39 square kilometres (7 per cent of the association) and is most extensive in the valleys of the Applecross peninsula and south-east Skye.

Like most of the larger areas further east in Northern Scotland (Sheet 3), this unit is often bouldery with peaty podzols generally the most common soils. They occur on the mounds, with weakly flushed peaty gleys in narrow channels, and peat in the hollows and flats. In addition to the common plant

communities found on these soils, weakly flushed communities such as flying bent grassland are occasionally present. Peaty gleys also occur on the mounds, particularly where the slopes are gentle and moundiness is more subdued. There is a wide variation in the proportions of the component soils; the amount of peat especially is subject to local fluctuations of gradient and moundiness. It is often absent from steep slopes and areas with closely packed hummocks. There are also local occurrences of other components, for example subalpine podzols on exposed mounds at over 350 metres, humus-iron podzols on very steep slopes and small tracts of peaty alluvial soils and mineral alluvial soils in some of the valley bottoms.

The bouldery, undulating nature of the ground and the waterlogged soils rule out any agricultural use other than poor quality rough grazing. Only small areas of grassland associated with the alluvial soils and steep gullied slopes with humus-iron podzols provide moderate grazing. Much of the unit could be afforested in spite of boulderiness, waterlogging and steep slopes.

Map unit 555 consists mainly of brown forest soils, brown rankers, and humus-iron podzols, with some humic gleys and peaty gleys in wetter flushed sites. It occurs on strong to very steep, moderately to very rocky slopes. It covers 17 square kilometres (3 per cent of the association) and is most extensive in south-east Skye.

The soils are developed on stony colluvium; the dominant brown forest soils are frequently weakly podzolized and support acid bent–fescue grassland and hazel, oak and birch woodland. The humus-iron podzols are generally under Atlantic heather moor. The flushed nature of the gleys and the peaty soils is indicated by rush pastures and bog myrtle scrub.

Although these slopes are too steep to cultivate or improve, their semi-natural vegetation provides moderate to good quality grazings.

Map unit 556 consists of peaty gleys and peat with some peaty podzols and it occurs on non-rocky undulating lowlands and hill sides with gentle and strong slopes. It is the second most extensive unit of the association covering 91 square kilometres (16 per cent of the association) and is found mainly north of Loch Torridon, although some smaller areas are present on the Applecross peninsula.

The landscape is covered by a shallow stony till, but the stepped nature of the underlying rock is often still evident. Peaty gleys and peat dominate, with peaty podzols restricted to some strong and a few short steep slopes. Numerous slightly to moderately bouldery patches are scattered throughout the unit, as are small areas similar to the rockier *map unit 557*, but these are all insignificant compared to the total area.

Land use is primarily rough grazing. Below 200 metres much of the land is marginally suitable for improvement although the wet peaty surface horizons have a low trafficability. Above this altitude, climate restricts the land use to rough grazing, the moorland communities giving poor quality grazing. The small localized grassy areas provide moderate grazing. Severe grazing pressure has led to the local dominance of flying bent and white bent and may also have initiated erosion of peaty horizons even in comparatively sheltered low-lying areas.

Map unit 557 consists of peaty gleys and peat with some peaty podzols and peaty rankers on moderately rocky, strongly undulating and hilly land. The slopes are mainly gentle and strong, but also include some short steep slopes.

The soils are developed on till and colluvium which are frequently shallow. It is by far the most extensive unit of the association, extending to 305 square kilometres (52 per cent of the association), and occurs mainly in Applecross, south-east Skye and Rhum.

The unit is found in the same general position in the landscape as *map unit 556*, but the additional rockiness gives it a more rugged appearance. Differential erosion within rock strata of differing composition and along the many joints and faults has produced a complex topography of rock ridges, knolls, channels and flats. The landscape is usually crudely terraced or stepped, with small crags and gently sloping slabs. Peat is the dominant soil in areas of gentle slopes, but peaty gleys usually form the largest component on more knolly terrain. Peaty rankers are found close to the rock outcrops, and peaty podzols occupy the lower sections of the short steep slopes where the drift is generally deepest.

Land use is restricted to low-quality rough grazing and deer-forest, the limiting factors being topography and wetness. Small areas of flying bent grassland and bog provide marginally better rough grazing.

Map unit 558 has peaty gleys, peaty rankers and some peaty podzols. It occurs on very rocky and/or extremely bouldery rugged hills with gentle and strong slopes. Steep and very steep slopes occur locally. It covers 52 square kilometres (9 per cent of the association) and forms limited areas in Raasay, Scalpay, Skye and Applecross.

The main differences between this unit and *map unit 557* are that the associated landform is more rocky, the drift cover is generally shallower and more patchy and there is less peat and more peaty rankers. The peaty gleys and peaty rankers are developed on the shallow drift, the peaty podzols generally restricted to the short steep colluvial slopes and the peat, which is often hagged, occurs mainly in channels.

Land use is restricted by the irregular very rocky topography and the moorland plant communities to poor rough grazing and deer-forest.

Map unit 559 consists of peaty gleys and peaty podzols with some peaty rankers and occurs on moderately and very rocky hill sides and steep and very steep slopes. The parent materials are colluvium and scree. The unit covers 49 square kilometres (8 per cent of the association) and is present on the slopes of the mountains and deeply incised valleys of the Applecross peninsula, Skye and Rhum.

In some respects this unit is similar to *map units, 557* and *558*, but the slopes are much steeper, peaty podzols are more common, and there is little or no peat. The peaty gleys occur on concave slopes, the peaty podzols on straight or convex slopes and the peaty rankers are associated with the rock outcrops or on scree.

The steep rocky slopes combined with the wet peaty soils restrict the land use to rough grazing. The prevalent moorland communities provide mainly poor quality grazing although short local slopes with common white bent grassland do help to provide a mosaic with better grazing, particularly in Applecross.

Map unit 560 has subalpine podzols on the cryic material around bouldery rock knolls and hagged peat in the hollows. These soils have developed between 400 and 500 metres on non- to very rocky plateaux with gentle and strong slopes. Only poor rough grazings are available on mountain heath and mountain blanket bog communities. It covers 1 square kilometre, accounting for less than 1 per cent of the association, and is thus the least extensive unit.

Table B Areas of soil map units

ASSOCIATION (sq. km., % Total Area)	MAP UNIT	AREA (sq. km)	% Land Area	% Association
ALLUVIAL SOILS (7 sq. km., 0.1%)	1	5	<0.1	70
	2	2	<0.1	30
ORGANIC SOILS (859 sq. km., 15.3%)	3	13	0.2	2
	4	846	15.0	98
ARKAIG (409 sq. km., 7.3%)	25	1	<0.1	<1
	26	18	0.3	4
	27	43	0.8	11
	29	31	0.6	8
	31	75	1.3	18
	32	200	3.6	49
	33	25	0.4	6
	34	16	0.3	4
ARRAN (35 sq. km., 0.6%)	37	16	0.3	45
	38	19	0.3	55
CORBY (16 sq. km., 0.3%)	97	2	<0.1	15
	99	<1	<0.1	<5
	100	4	<0.1	25
	101	5	<0.1	30
	103	2	<0.1	15
	105	3	<0.1	20
CORRIEBRECK (34 sq. km., 0.6%)	108	1	<0.1	<5
	109	3	<0.1	10
	110	13	0.2	40
	111	7	0.1	20
	112	10	0.2	30
COUNTESSWELLS (70 sq. km., 1.2%)	122	2	<0.1	<5
	123	27	0.5	40
	126	8	0.1	10
	127	16	0.3	25
	132	13	0.2	20
	134	4	<0.1	5
DARLEITH (942 sq. km., 16.7%)	149	30	0.5	3
	155	55	1.0	6
	157	7	0.1	<1
	158	148	2.6	16
	159	69	1.2	7
	160	589	10.5	63
	161	14	0.3	1
	162	30	0.5	3
DURNHILL (4 sq. km., <0.1%)	188	<1	<0.1	<5
	190	4	<0.1	100
FRASERBURGH (123 sq. km., 2.2%)	259	29	0.5	25
	260	21	0.4	15
	261	52	0.9	40
	262	15	0.3	10
	263	6	0.1	<5
GRULINE (6 sq. km., 0.1%)	278	1	<0.1	15
	279	4	<0.1	65
	280	1	<0.1	15
INCHKENNETH (76 sq. km., 1.4%)	307	28	0.5	35
	311	1	<0.1	<5
	312	44	0.8	60
	313	3	<0.1	<5
INCHNADAMPH (14 sq. km., 0.3%)	314	10	0.2	70
	315	4	<0.1	30
INSCH (21 sq. km., 0.4%)	322	7	0.1	35
	323	<1	<0.1	<5
	325	2	<0.1	10
	327	12	0.2	55
KNOCKSKAE	358	5	<0.1	100
LINKS (1 sq. km., <0.1%)	381	1	<0.1	100
	384	<1	<0.1	<5
LOCHINVER (2152 sq. km., 38.2%)	385	22	0.4	1
	386	45	0.8	2
	387	18	0.3	<1
	388	43	0.8	2
	389	1	<0.1	<1
	390	48	0.9	2
	391	267	4.7	12
	392	223	4.0	10
	393	<1	<0.1	<1
	394	762	13.5	35
	395	553	9.8	26
	396	76	1.4	4
	397	40	0.7	2
	398	54	1.0	3
ROY (3 sq. km., <0.1%)	452	1	<0.1	35
	453	2	<0.1	65
STAFFIN (48 sq. km., 0.9%)	483	26	0.5	55
	484	3	<0.1	5
	485	18	0.3	40
	486	1	<0.1	<5

Table B Areas of soil map units

ASSOCIATION (sq. km., % Total Area)	MAP UNIT	AREA (sq. km)	% Land Area	% Association
	546	5	‹0.1	‹5
	547	53	0.9	45
TOROSAY	548	25	0.4	20
(112 sq. km., 2.0%)	549	20	0.4	20
	550	5	‹0.1	‹5
	551	4	‹0.1	‹5
	553	4	‹0.1	‹1
	554	39	0.7	7
	555	17	0.3	3
	556	91	1.6	16
TORRIDON	557	305	5.4	52
(585 sq. km., 10.4%)	558	52	0.9	9
	559	49	0.9	8
	560	1	‹0.1	‹1
	561	27	0.5	5
ROCK		108	1.9	
BUILT-UP AREAS		1	‹0.1	

Map unit 561 consists of subalpine and alpine soils, noncalcareous regosols and lithosols. It occurs in mountain areas and has a wide range of slope and rockiness class. The soils are developed on cryic and colluvial material and occasionally with a little windblown sand. The unit extends to 27 square kilometres (5 per cent of the association) in the Applecross area and on south-east Skye. In Northern Scotland it is an extensive unit on the high mountains of Torridonian sandstone.

The unit has two landscape facets—steep and very steep slopes with crags and screes, and gently to strongly sloping summit plateaux with freeze-thaw features such as boulder lobes and solifluction terraces. In the former facet the dominant soils are lithosols and subalpine podzols, while the latter has alpine and subalpine podzols with some gleys and peat in flushes and hollows, and noncalcareous regosols on the aeolian drift. Some lower slopes have contrasting soils—peaty gleys, peaty podzols and peaty rankers—but they have been included in the map unit as they form a topographic continuity with the subalpine slopes and are too narrow to represent separately. Climatic influences arising from altitudinal variation produce gradual transitions in the soil types; peaty podzols on the boreal lower slopes grade to subalpine podzols on the orohemiarctic upper slopes, which in turn grade to alpine podzols on the oroarctic summits. All soils are very stony, loose and have loamy sand or sand textures.

Though much of the mountain tops are bare and stony, mountain heath communities, stiff sedge–fescue grassland and lichen-rich boreal heather moor are common, providing poor grazings chiefly in the summer months. In addition local white bent grasslands, particularly in Skye, give moderate grazings.

BARE ROCK, SCREE AND CLIFFS

Areas of extremely rocky land—rock pavements, slabs, cliffs and scree—are included in this map unit, which occupies 108 square kilometres (1.9 per cent of the land area). It is most extensive on the gabbros of the Black Cuillin Hills and the granites of the Red Cuillin, with smaller areas on the Lewisian gneisses, the basalts and Moine schists and granulites. Although rock dominates the land, minor amounts of lithosols, rankers and other major soil subgroups also occur.

Rock outcrops are extensive in many other parts of the area and form a component of many map units, for example *map units 32* and *395* are very rocky, and *map units 29* and *394* are moderately rocky.

BUILT-UP AREA

Built-up area is very restricted in this region, and covers 1 square kilometre (less than 0.1 per cent of the land area); the smallest area on any map sheet in this series.

AN ILLUSTRATED GUIDE TO THE SOIL LANDSCAPES OF THE REGION

The way in which the land has been classified into groups suitable for soil map units is discussed in Handbook 8. Parent materials, landforms and soil types have been used to separate map units. When these differentiating criteria are precisely applied, many distinct soil landscapes can be formulated, far more than there is scope to describe in this guide. Hence, many amalgamations of soil landscape 'types' have been made and the following section should be treated as a broad generalization, rather than as a definitive reference work. The guide is intended as an aid to the recognition of map units in the field and as an adjunct to the soil map.

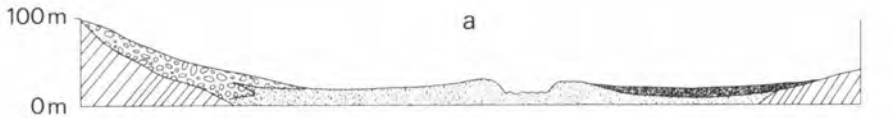
For each soil landscape there is a photograph of a specific locality with a description of soil map units and land capability for agriculture classes. This is followed by a landform description and a cross-section diagram illustrating the soil landscape, and finally there is a table of soil map units. Many of the cross-sections are idealized so it is not appropriate to append vertical or horizontal scales, but where it is meaningful this information appears.

SOIL LANDSCAPES ON DRIFT-CONTROLLED LANDFORMS

ALLUVIAL SOIL LANDSCAPES

Plate 7. *Alluvial soils at the head of Loch Moidart with mineral alluvial soils (map unit 1) to the right and terrace peat to the left. The rest of the ground is mapped in the Arkaig Association: the wooded slopes flanking the alluvium and the loch-side forming map unit 27, and the higher rocky ground, map unit 32. The mineral alluvial soils are class 5.1, the wooded slopes 6.2 and the rocky land is 6.3.*

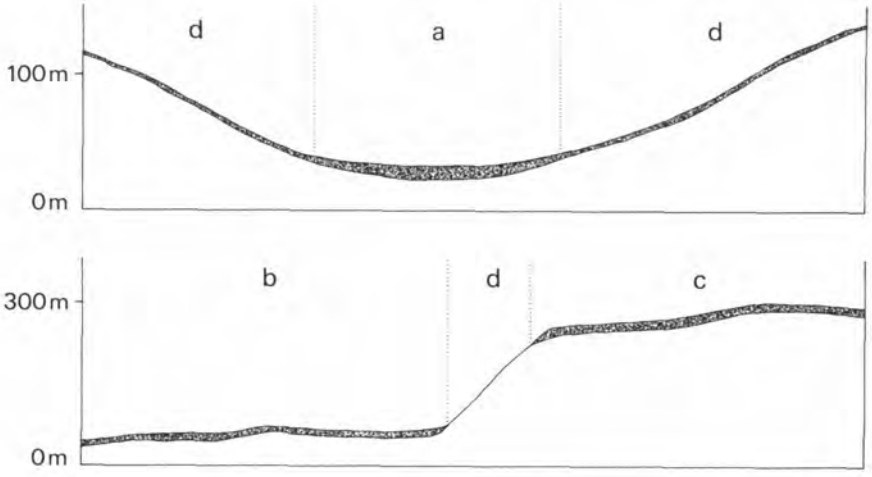
Landform description: level or gently undulating terraces, sometimes with old meander channels. The terrain is non-rocky. Silty alluvial deposits in estuaries or at the edge of river deltas form saltings, but these are rarely large enough to show on this scale of map. In mountains alluvial debris cones form a significant component of soil map units on hummocky moraines.



Soils	Map units
a. Mineral and peaty alluvial soils (all drainage classes)	1
b. Saline alluvial soils and saline peats (not shown on section)	2

Plate 8. *Organic soils at Lealt River, Trotternish. Peat overlying a gently undulating till plain. The peat is class 6.3. Near the coast the soils are developed on the till of the Staffin Association.*

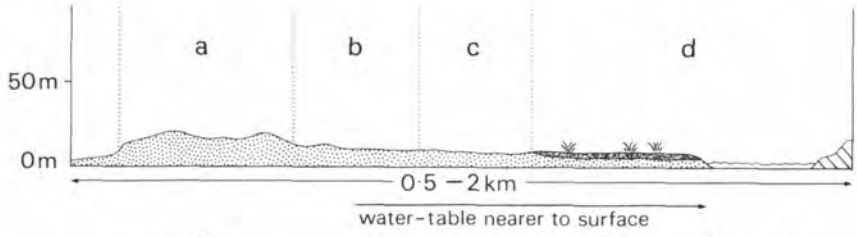
Landform description: organic deposits occur on gentle and strong slopes. They are found on outwash or raised beach terraces, in valleys, on gentle hill sides and on ridge crests. The deposits are hagged in exposed localities above about 350 metres on Skye, and above about 150 metres on Lewis and Harris.



Soils	Map units
a. Peat, flushed peat, some peaty alluvial soils (Basin peat)	3
b. Peat, some dubh lochan peat (Blanket peat)	4
c. Peat, some hagged peat (Blanket peat)	4
d. Map units other than 3 and 4	

Plate 9. *Windblown shelly sand at Balmartin, North Uist. Two map units of the Fraserburgh Association are illustrated: map unit 259 on gently undulating machair with brown calcareous soils and calcareous regosols, and map unit 261 on strongly undulating dunes with calcareous regosols and some brown calcareous soils with eroded patches. The level machair is class 5.1 while the dunes are class 6.1.* Aerofilms.

Landform description: level and gently undulating machairs or strongly undulating stabilized dunes, sometimes with rock outcrops.



Soils	Map units
a. Calcareous regosols and brown calcareous soils	261
b. Brown calcareous soils and calcareous regosols	259
c. Calcareous ground-water gleys	262
d. Peaty gleys and eutrophic flushed peat	263
Types a, b or c with rock outcrops (see Fig. 11)	260

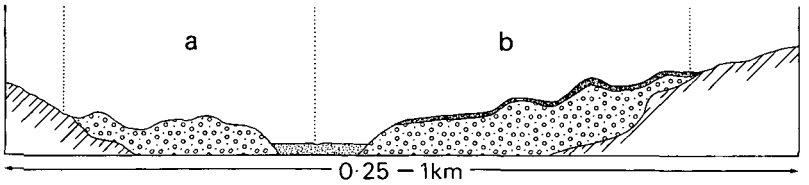
Map units 381 and 384 of the Links Association have analogous landforms to map units 259 and 263 of the Fraserburgh Association. The parent material is windblown silica sand and the soils are noncalcareous

FLUVIOGLACIAL AND RAISED BEACH SOIL LANDSCAPES

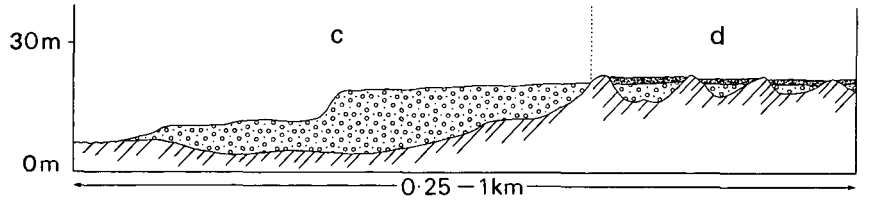
Plate 10. *Raised beach at Gruinard Bay, Wester Ross. Map unit 97 of the Corby Association, comprising humus-iron podzols developed on raised beach sands and gravels. Although this locality is outwith this region, it exemplifies the landforms of the numerous small raised beach areas which occur on the western mainland. Map unit 395 of the Lochinver Association, an extensive unit on the Outer Hebrides, occurs in the background.*

Landform description: raised beaches are found below 30 metres, are level or gently sloping and non- to moderately rocky. Steep slopes are found on the edges of terraces but are of local extent. Fluvioglacial deposits form level or gently undulating outwash terraces, or moundy terrain with eskers. Alluvial soils are frequently found within areas of both landforms. Raised beach and outwash terraces are frequently juxtaposed in this area, and are often included in a single map unit.

Fluvioglacial soil landscapes



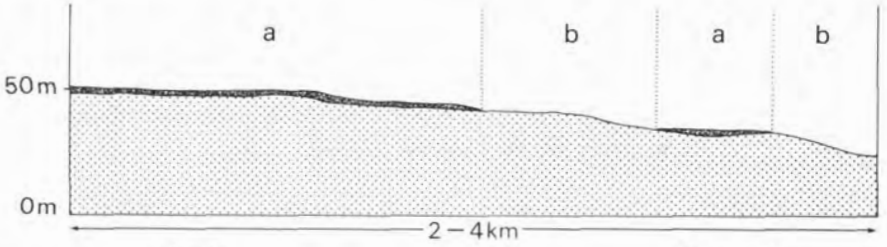
Raised beach soil landscapes



Soils	Map units
a. Brown forest soils and cultivated podzols	100, 452
b. Peaty podzols, peaty gleys and peat	101, 453
c. Brown forest soils and cultivated podzols with minor peaty soils	97, 278
d. Peaty gleys, peaty podzols and peat with rock outcrops	280
Soil landscape c plus alluvial soils	99
Soil landscape d plus humus-iron podzols	103
Soil landscapes a or c with peaty soils co-dominant with mineral soils	105, 279

Plate 11. *Till at Back, Lewis. Till derived from the Stornoway beds forms soils of the Arran Association. Map unit 37, in the foreground, comprising noncalcareous and humic gleys with some cultivated peaty podzols and peaty gleys, constitutes some of the best arable land of the Outer Hebrides. Peaty gleys and peat of map unit 38 occupy the depression in the middle distance on the left. The mineral soils are class 4.1, and the peaty soils are class 5.3.* Aerofilms.

Landform description: till deposits are gently undulating with gentle and strong slopes. The material conceals underlying rock structure and rock outcrops are rarely seen, but some areas of soils developed on till with occasional rock outcrops are mapped separately in the Inchkenneth, Staffin and Torridon Associations.

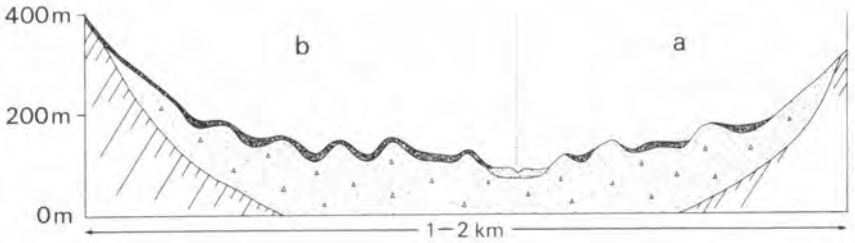


Soils	Map units
a. Peaty gleys and peat with frequent peat-cuttings	38, 390, 485
b. Noncalcareous and humic gleys	37, 385, 483
Soil landscape a with rock outcrops	311, 486
Soil landscape b with rock outcrops	484, 553

MORAINE SOIL LANDSCAPES

Plate 12. *Morainic drift south of Camas Uig, West Lewis. Hummocky bouldery moraine of the Lochinver Association with peaty podzols, peaty gleys and peat (map unit 391). The very rocky hills in the background have peaty gleys and peaty rankers of map unit 395. Both map units are class 6.3.*

Landform description: moundy moraines form deep deposits on valley floors and on the pre-Quaternary plateaux of North and South Uist and Benbecula. On steep valley sides the moundiness becomes less pronounced and active gullying of the moraines forms small alluvial fans by redistribution of the material.



Soils	Map units
a. Humus-iron podzols, noncalcareous gleys and peaty gleys	25, 122, 313, 388
b. Peaty podzols, peaty gleys and peat	26, 111, 123, 157, 322, 391, 547, 554

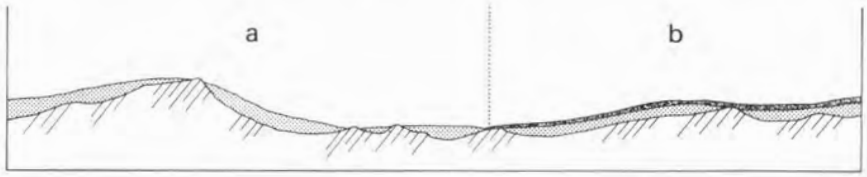
On the Uists and Benbecula gentle and moderate slopes predominate in map units 388 and 391

SOIL LANDSCAPES ON ROCK-CONTROLLED LANDFORMS

NON-ROCKY SOIL LANDSCAPES

Plate 13. *Non-rocky, rock-controlled landscape at Ben Langass, North Uist. Peat and peaty gleys in the non-rocky terrain of map unit 392, the Lochinver Association. Peat-cutting is widely practised on the peat flats in this and other map units on the Outer Hebrides. Although class 6.3, generally, some areas of map unit 392 are class 5.3 where potential water deficit is higher or the proportion of peat lower.*

Landform description: gently or strongly sloping and undulating non-rocky land. Landform is controlled by a combination of the under-lying rock structure and the cover of shallow drift.



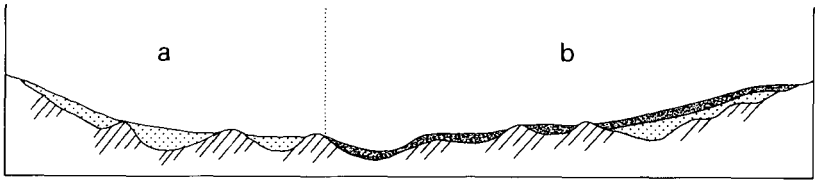
Soils	Map units
a. Noncalcareous gleys and humic gleys	149
b. Peaty gleys and peat	155, 392, 556

MODERATELY AND VERY ROCKY SOIL LANDSCAPES

Plate 14. *Moderately rocky terrain with colluvial drifts at Elgol, Skye. The parent material of the Inchkenneth Association at this locality is colluvium derived from Mesozoic sandstones, shales and limestones. The crofting land in the centre and to the left occurs on the brown forest soils and humus-iron podzols of map unit 307 and is class 5.2. The uncultivated land to the right and in the foreground consists of peaty gleys, peaty podzols and peat of map unit 312, class 6.3.* Aerofilms.

[*see notes overleaf*

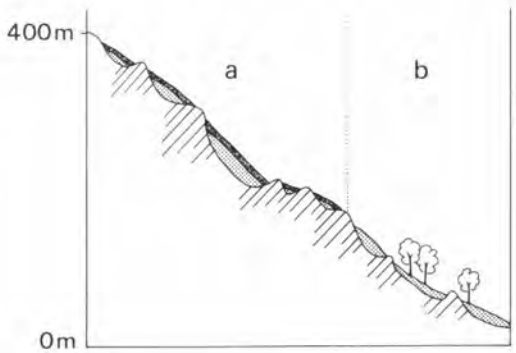
Landform description: the underlying rock structure governs the landform, which is of two main types: terraced on extrusive basic igneous rocks and some sedimentary rocks (Fig. 8 and Plate 3); ridged, hillocky and irregular on metamorphic or intrusive igneous rocks. The land is slightly to moderately rocky with gentle and strong slopes.



Soils	Map units
a. Brown forest soil and humus-iron podzols	158, 307, 314, 323, 386, 387
b. Peaty gleys and peat	29, 109, 127, 160, 188, 312, 315, 325, 394, 548, 557
Soil landscape b with very rocky terrain and a greater proportion of peaty rankers (illustrated in Plate 2)	32, 110, 132, 190, 327, 358, 395, 558

Plate 15. *Steep colluvial slopes on Sgurr a Mhuidhe, east of Loch Eilt. Arkaig Association; the lower, wooded and bracken-dominated slopes consist of mineral soils typical of map unit 27, while the upper peaty slopes are map unit 3.1. Classes are 6.2 (moderate grazing) on the lower slopes and 6.3 (poor grazing) on the peaty soils of map unit 31.*

Landform description: steep slopes greater than 15 degrees, often irregular in cross-section. Slightly to very rocky with shallow drifts of scree or colluvium. In larger scale surveys, the different classes of rockiness are mapped separately.

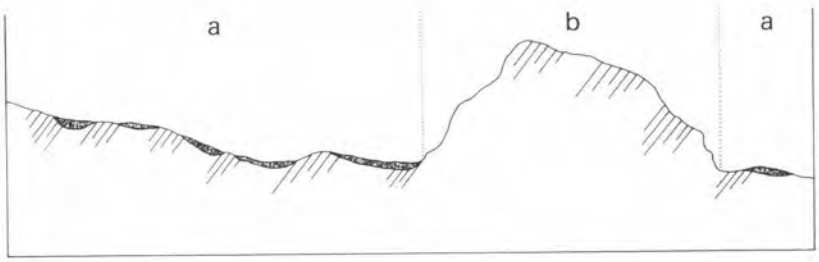


Soils	Map units
a. Peaty gleys, peaty podzols and peaty rankers; peaty podzols dominant in 126, 159 and 549	31, 126*, 159*, 396, 549, 550, 559
b. Brown forest soils and humus-iron podzols	27, 108, 161, 389, 393*, 546, 555

* these map units are slightly rocky, the rest moderately and very rocky

Plate 16. *Mountain slopes with cryic deposits on Hallival, Rhum. Map unit 112 of the Corriebreck Association consists of gentle to steep slopes with subalpine or alpine soils. Grazings of moderate quality are found on the steeper terrain, which is class 6.2.*

Landform description: found above 300 or 400 metres depending on exposure and accumulated temperature. Steep slopes and gently sloping ridge crests occur, and the terrain is slightly to extremely rocky. Active freeze-thaw movement of the cryic debris produces terracettes and stone striping on the gentler slopes.



Soils	Map units
a. Subalpine soils and peat	34, 134, 397, 560
b. Subalpine and alpine podzols	33, 112, 162, 398, 551, 561

3 Land Evaluation

Earlier chapters of this book have described the main natural resource attributes of the region (climate, landform, soil and vegetation) and classified them into a number of units. The characteristics of each of these units influence man's use of the land contained within it. Land evaluation is the assessment of a range of possible uses of the land units, for example for agriculture, forestry, recreation or engineering. It incorporates not only the physical attributes of the land but also man's resources of technology, finance and labour. Since the latter are variable through time in a manner not accurately predictable, systems of assessing the capability of land for any specific purpose usually attempt to standardize them. The potential use of the land may then be assessed under the standard conditions and expressed as capability classes. Land evaluation is not something which is static, but must be reviewed periodically and repeated when significant changes take place in any of the human resources.

It is worth stressing that land capability classifications are not recommendations for the particular use of a piece of land. They seek to identify areas where that use may be carried out most easily. Only by carefully comparing all the alternatives and incorporating economic and political judgements in particular cases can recommendations for actual land use be arrived at. For this reason no one map indicating 'best land use' is likely to be achieved.

In Scotland, a system of land capability classification for general agricultural purposes has been constructed (Bibby *et al.*, 1982). An explanation of its broad principles and the parameters used in its application in this region form the bulk of this chapter. A final section attempts to provide some comments on the effects of natural resources on other uses, for which fuller classification systems have not yet been constructed.

LAND CAPABILITY CLASSIFICATION FOR AGRICULTURE

The land capability classification for agriculture has as its objective the integration of detailed information on soil, climate and relief in a form which will be of value to land-use planners, agricultural advisers, farmers and others involved in optimizing the use of land resources.

Its applications include the following:

1 Contributing to an inventory of the national land resource
2 Providing a means of assessing the value to agriculture of land on a uniform basis as an input to planning decisions
3 Defining major limitations to land use
4 Assisting in environmental and amenity planning
5 Contributing to farm and estate planning and to technical advisory work.

PHYSICAL FACTORS AND THEIR EFFECTS UPON THE AGRICULTURE OF THE REGION

Climate

The main features of the climate which affect land use in this area are rainfall, exposure and temperature. The average annual rainfall is moderate to high, ranging from 1200 millimetres near the coasts of the Outer Hebrides to greater than 3200 millimetres on the mountains of Skye and the mainland (Fig. 5). In terms of accumulated temperature above 5.6°C (Fig. 6), there are only a few areas in the warm category, in the south and south-east of the region and most of the low ground is fairly warm. In land capability classification for agriculture, the initial assessment of class and division is based on potential soil moisture deficit in millimetres and accumulated temperature (January to June period) above 0°C. These guidelines place the low ground of the Outer Isles in Class 3.2, using data from stations at Stornoway and on Benbecula. These districts are exposed and very exposed (wind speeds 4.4–8.0 metres per second) however, and this factor downgrades the land to Class 4. The principal risk from high wind speeds is of physical damage to arable crops, but physiological damage from salt-spray is also significant. Land-use choices are thus restricted to grass production with occasional root crops or cereals in the driest, slightly less exposed areas.

A feature of the climate is low spring temperatures, which often inhibit germination and early season growth. This late start to the growing season, coupled with wet weather in late summer and autumn, render harvesting of arable or grass crops a difficult proposition in a significant number of years.

Gradient

The slopes are predominantly gentle and strong on the agricultural ground and pose few problems. Steeper slopes are found in the hills and mountains where climate and the bouldery or rocky terrain also impose restrictions on land use. Two-wheel drive tractors can be operated with care on steep slopes where there are mineral soils, but peaty soils and grassy surfaces reduce these operational limits, as do heavy trailed implements.

Soils

There are six main features of the soil which affect land use: texture, drainage, droughtiness, shallowness, peatiness and chemistry. Texture is described in three broad groups. Stony or sandy soils are difficult to cultivate and suffer from a lack of structure. They are often freely drained however. Clayey soils have weak structure and are usually poorly drained with associated wetness problems. Loamy soils with good structure and free drainage are exceptional in this area and are found in the Darleith Association. The sandy or stony soils are susceptible to droughting in years when spring and early summer weather is dry. This induces burning of grasses and reduces plant growth rates, so affecting

production in hill land grazings. They suffer from low nutrient-retention capacity and, in the case of the machairs, are also liable to wind erosion. Poor or imperfect drainage in some soils is a result of induration or compaction in the subsoil and can be improved by subsoiling to shatter the dense layers. Shallowness is a feature of the rockier land and of some colluvial parent materials and often restricts the scale of cultivation in this area. Peaty soils suffer from low bearing strength, poor structure and wetness, and are a poor prospect for reclamation in all but the driest parts of the region. The calcareous soils of the machairs are liable to cause alkali-induced deficiencies in important trace elements in crops and livestock.

Wetness

The combination of moderate to high rainfall with soil features such as shallowness, fine texture and high organic-matter contents is the main cause of soil wetness. The cooler temperatures inhibit the rate of organic matter breakdown, even in mineral soils, and the resulting high levels of humus exacerbate the problem by retaining soil moisture. Wetness affects both poorly and freely drained soils in this region. Poorly drained soils remain at field capacity until late spring and return to field capacity in early autumn, and even freely drained soils may be at field capacity in summer during long periods of heavy rain. Flooding affects the freely drained machair soils after heavy rain, but is only of short duration in summer.

Erosion

The most spectacular results of wind erosion can be seen in some units of the Fraserburgh Association developed on the machairs and is well demonstrated by the severe erosion at Bornish on South Uist. Wind erosion of the other soils of the region is less, with the exception of the soils of the Links Association which is of minor extent. The way in which this erosion risk is minimized is described in *map unit 259*. Water erosion affects all cultivated land but on the gentle and moderate slopes and under the grassland-cropping regime of this area there is only a slight risk. On steep land, small landslip scars of very localized extent appear after the spring snow-melt releases large volumes of water.

Pattern

The short range variations in soils, landforms, parent materials and topography found throughout the region are serious limitations to land use by modern farming techniques. However, under the crofting system which predominates, the land is divided into many smallholdings and the labour-intensive cultivation techniques reduce the impact of pattern. Limitations include drainage, stoniness or textural patterns especially in the soils developed on till, and patterns of rock or boulders where colluvial drifts or moraines are found. Slope patterns and the pattern of exposure in irregular ground are also important.

THE CLASSIFICATION

The classification comprises three main categories, the class, the division and the unit, of which only the first two are utilized on the 1:250 000 map presented with this report. Land placed in any *class* or in any *division* has a similar *overall degree* of limitation; within any class or division there are different management requirements. Comments on the principal *types* of limitation and the manage-

ment problems which occur will be found in the descriptions of the classes and divisions.

Land in Classes 1 to 4 is suited to arable use and that in Classes 5–7 unsuited to arable use. There are no divisions within Classes 1, 2 and 7; two divisions in each of Classes 3 and 4; and three divisions in Classes 5 and 6. A full description of the classification system and national guidelines is available as a Soil Survey Monograph (Bibby *et al.* 1982). The following is a condensed description of the classes and divisions.

Land suited to arable cropping

Class 1 *Land capable of producing a very wide range of crops*
Cropping is highly flexible and includes the more exacting crops such as winter-harvested vegetables. The level of yield is consistently high.

Class 2 *Land capable of producing a wide range of crops*
Cropping is very flexible and a wide range of crops can be grown but difficulties with winter vegetables may be encountered in some years. The level of yield is high but less consistently obtained than in Class 1.

Class 3 *Land capable of producing a moderate range of crops*
Division 1 The land is capable of producing consistently high yields of a narrow range of crops (cereals and grass) or moderate yields of a wider range (potatoes, field beans and other vegetables and root crops). Grass leys of short duration are common.
Division 2 The land is capable of average production but high yields of grass, barley and oats are often obtained. Grass leys are common and longer than in division 1.

Class 4 *Land capable of producing a narrow range of crops*
Division 1 Long-ley grassland is commonly encountered but the land is capable of producing forage crops and cereals for stock.
Division 2 The land is primarily grassland with some limited potential for other crops.

Land suited only to improved grassland and rough grazing

Class 5 *Land capable of use as improved grassland*
Division 1 Land well suited to reclamation and use as improved grassland.
Division 2 Land moderately suited to reclamation and use as improved grassland.
Division 3 Land marginally suited to reclamation and use as improved grassland.

Class 6 *Land capable only of use as rough grazing*
Division 1 Land with high grazing value.
Division 2 Land with moderate grazing value.
Division 3 Land with low grazing value.

Class 7 *Land of very limited agricultural value.*

The following assumptions must be taken into account in using the classification:

1 The classification is designed primarily to assess the value of land for agriculture.
2 Land is classified according to the degree to which its physical characteristics affect the flexibility of cropping and its ability to produce certain crops consistently.
3 The classification does not group land according to its most profitable use.
4 The standard of management adopted is the level of input and intensity of soil, crop and grassland management applied successfully by the reasonable and practical farmer within the relevant sector of the farming industry. Such management will maintain or improve the land resource.*
5 Land which has limitations which may be removed or reduced at economic cost by the farmer or his contractors is classed on the severity of the remaining limitations.
6 Land with severe limitations is classified accordingly except where there is clear evidence that a major improvement project (e.g. arterial drainage) will be completed within the next 10 years. In such cases the land is classed as if the improvements had occurred.
7 Location, farm structure, standard of fixed equipment and access to markets do not influence the grading. They may, however, affect land-use decisions.
8 The interpretations are an expression of current knowledge and revision may be necessary with new experience or technological innovations.

THE CLASSES AND DIVISIONS IN THE REGION

Classes 1–3

Classes 1 to 3 do not occur in the region because of climatic constraints. There is adequate warmth and a sufficiently high potential soil moisture deficit for Class 3.2 to be attained at Stornoway and on Benbecula and hence for the bulk of the low ground of the Outer Hebrides, but the exposure is so severe that the land is downgraded to Class 4 which thus forms the best land of the region. On the mainland and Inner Hebrides a lessening of exposure is offset by increased soil wetness and the best class attainable thus remains Class 4.

Class 4

The land is marginal for the economic production of crops, which are usually confined to types suitable for winter feeding to livestock, with some potatoes for human consumption. Farming systems are based primarily on grass with short arable breaks. Year-to-year variability in the yield of crops other than grass is large with a high risk of poor weather interfering with harvests. There are normally no problems in establishing a grass sward on this land, but harvesting of silage or hay can be difficult in wet seasons.

Such marginal arable land is distributed throughout the region with the bulk of it on Lewis, the Uists and Benbecula. On the Inner Hebrides and the mainland it occurs as isolated areas bordered by mountain and moorland. The limited extent of many occurrences of the class has given serious difficulties in its representation at the 1:250 000 scale. In some places the areas have been

* Although the land is assessed under farming systems of management, crofting is the principal agricultural land use in this region. Good crofting management can be very intensive because of the small areas involved and crop yields or crop ranges greater than those expected from farming.

slightly enlarged, while in others several small parcels of arable land, separated by land of lower quality, have been amalgamated if the arable areas were predominant. Despite these attempts to depict the key areas for hill land utilization, some small areas have not been shown. The land in the Darleith, Gruline and Corby Associations proved the most difficult in this respect. Class 4 land occupies 65 square kilometres (1.2 per cent of the land area).

Division 1 Restricted to north Lewis, where it covers 26 square kilometres (40 per cent of the class), this division is distributed sporadically between Callanish and the Butt of Lewis in the west, and between the Eye Peninsula and Tolsta on the east coast. Long ley pastures are commonly encountered but forage or cereal crops can also be produced and cultivated fields are frequently seen (Plate 6). Cereals are usually grown for feeding stock because of the yearly variation in yield and quality which is generally low, but potatoes are grown as a cash crop for local consumption.

Land in this division on the east coast, especially around Stornoway is slightly more sheltered and has a longer workable period (less than 200 days at field capacity) than on the west coast. The effects of exposure to high wind speeds and salt-spray are well displayed on the west where cultivation stops well before the shoreline (Plate 6).

Noncalcareous gleys and some humus-iron podzols of the Arran and the Lochinver Associations are included in the division, and they occur on gently or strongly sloping land with only slight pattern limitations consisting of small channels or hollows with humic gleys and peaty gleys. Poor drainage and soil wetness are the principal limitations, caused by compaction or induration in the B horizon of the coarse-textured soils and by slow hydraulic conductivity in the finer textured soils of the Arran Association. Subsoiling would markedly improve the drainage by disrupting the compact or indurated horizons, but is hardly ever practised in the Outer Hebrides. The installation of drainage systems benefits both textural groups. The humus-iron podzols sometimes have an iron pan over the compact horizons so that, although freely drained below the pan, there is slow water movement in these soils. Poorly drained soils in Class 4 are normally downgraded to division 2 if the guidelines (Bibby *et al.*, 1982) are strictly applied, but these soils have been included with division 1 because of the moderate rainfall, longer workability period, and the probable benefits of drainage and subsoiling. There are also significant areas of freely drained soils.

Division 2 The land is mainly grassland with limited potential for other crops. Grass yields can be high but there are often severe harvesting difficulties caused by wetness. Forage cropping and an occasional cereal crop are both possible but there is a greater risk of crop failure or low yield in this division.

Covering 39 square kilometres (60 per cent of the class), the land occurs in many areas along the western seaboard of the Outer Hebrides between North Uist and South Uist where it is restricted to the calcareous ground-water gleys of the Fraserburgh Association. On Skye, land in this division occurs on the Darleith and Gruline Associations at many local sites near the heads of sea lochs, and on the Waternish peninsula. On the mainland, it is confined to mineral soils of the Corby, Gruline, Inchkenneth and Torridon Associations.

In this region, land is placed in Class 4 principally because of climatic factors, which are sufficiently severe to ensure most of the land remains in division 2, where soil limitations become more significant. The poorly drained calcareous

ground-water gleys of Fraserburgh Association (*map unit 262*) have a more favourable climate than much of Class 4, but are restricted by their high water-table, high pH and coarse texture, to division 2. However, on these very exposed islands, the high water-table also has some advantages; it keeps the topsoil moist, substantially reducing the risk of windblow during cultivation and before seedling establishment. Although these coarse-textured soils also dry out rapidly in springtime, there is a reserve of ground-water for the plants. The high pH (around 8.0) affects the availability of important trace elements but this problem can be overcome by spraying the fields or dosing the stock. Since the land is very low-lying and level it floods easily, but such flooding is non-damaging, being largely restricted to the winter months. Nevertheless, careful timing of agricultural operations is necessary to avoid damage to the soil during wet periods.

The remaining land in this division occurs on the mainland north and south of Loch Alsh and on Skye. The accumulated temperature in all these districts is fairly warm to warm, and exposure is less than on the Outer Hebrides. Rainfall is higher, however, and is a major factor in confining the land to division 2. A variety of soils are found, each with its own land-use problems. Brown forest soils of the Darleith Association have the advantage of free drainage, but shallowness, occasional rock outcrops and high organic-matter contents are limiting. Freely drained humus-iron podzols of the Corby and Gruline Associations are developed on raised beach and outwash gravels but they are stony and have low nutrient retention capacities. During dry weather, droughtiness and the resulting slow growth of crops or grasses is an occasional, if somewhat short-lived problem on the very gravelly soils. Noncalcareous gleys on the slightly finer textured tills of *map unit 149* (the Darleith Association), mainly found on the Waternish peninsula, suffer from wetness which reduces the workability period. The soils of the raised beaches are weakly structured as are, to a lesser extent, the noncalcareous gleys. Soil and topographic pattern limitations in *map unit 313* (the Inchkenneth Association) restricts the only area of it around Applecross to this division.

Class 5

Class 5 land is restricted to grass production and frequently forms an important part of the economy of British hill farms. Land qualifies for this class if mechanized treatments to improve or reclaim it are possible, and if the resulting grass crops can be successfully utilized by grazing animals. The mechanized treatments can range through ploughing or rotavation to surface seeding, although some land is improved by simple techniques of liming, fertilizing and reseeding. Although occasional pioneer forage crops may be grown, the land is generally unsuited to the introduction of an arable rotation of any kind. Grass yields within the class can be variable and difficulties in production and utilization are common. The allocation of land to this class only indicates that it is suited to improvement, not that it should be improved. The decision to improve can only be determined after due regard to farm structure, farm management and capitalization. It may be neither necessary nor desirable to improve all the Class 5 land on a holding.

The important factors to be considered in improvement are (a) the ease of sward establishment, (b) the persistence of the sown species, (c) the ease of maintenance and (d) whether the resultant sward can merely be used for grass conservation or whether it can merely be grazed. In this area grass conservation

is primarily carried out on land in Class 4, while the improved grasslands of Class 5 are almost entirely used as additional grazings. The ease of establishment and maintenance depends on the soil drainage and texture as well as site characteristics, principally slope and rockiness. The persistence and utilization of sown grass species is best on freely drained soils, and both decline with increased soil waterlogging.

Generally, areas with large amounts of freely draining soils have the best potential, the Darleith Association being notable in this respect. Fraserburgh Association (*map unit 259*) is also useful, but the soils are susceptible to wind erosion if the vegetation mat is breached. Poorly drained soils are less suited to reclamation (for example, *map unit 483* is classed as 5.2), while peaty soils are only included in division 3 of Class 5 under the most favourable climatic conditions (in this area, rainfall below about 1200 millimetres can be used as a local guideline). The class occupies 755 square kilometres (13.4 per cent of the land area).

Division 1 Covering 131 square kilometres (17.4 per cent of the class), the division includes a wide range of soil types. On the Outer Hebrides the land is mainly non-rocky and the principal soils are freely drained brown calcareous soils of the Fraserburgh Association and humus-iron podzols on moraine in *map unit 388* of the Lochinver Association. On the Island of Skye and on Eigg, brown forest soils and noncalcareous gleys of the Darleith and Inchkenneth Associations are good reclamation prospects, especially where rock outcrops are restricted.

There is a serious risk of wind erosion in the brown calcareous soils but this can be reduced by surface seeding instead of cultivation, by shallow ploughing, or by sowing in warm moist conditions to facilitate rapid germination. Flooding is short-lived and restricted to the winter and short spells after heavy rain in summer. It is generally non-damaging and is caused by the combination of gentle slopes and humose topsoils. The soils of *map unit 388* occur on moundy terrain with slope pattern limitations and with poorly drained soils in channels. The brown forest soils and noncalcareous gleys of the Darleith and Inchkenneth Associations have a loamy texture and produce a good tilth which promotes excellent germination even in dry weather. High organic-matter contents in the brown forest soils help soil moisture retention but can cause problems in wet weather, when poaching damage to the sward occurs, often resulting in lower subsequent grass yields. On the Sleat peninsula, humus-iron podzols of *map unit 387*, developed on colluvium in the Lochinver Association, though shallow, have a sufficiently low proportion of rock outcrops between Teangue and Armadale to be included in this division. With the exception of some very localized areas, this division is absent from the mountainous terrain of the mainland.

Division 2 Consisting of land moderately suited to reclamation and to use as improved grassland, this division covers 231 square kilometres (30.6 per cent of the class). The soils are essentially the same as in division 1 of this class with the exceptions that brown calcareous soils of the Fraserburgh Association are entirely in the upper division, and there are in addition poorly drained noncalcareous gleys on the clayey drifts of the Staffin Association. In contrast to the land in division 1 however, it has greater problems with rockiness, steeper slopes, more severe pattern limitations or increased wetness associated with finer textures. On the Outer Hebrides this division has been mapped on humus-

iron podzols and gleys of *map unit 388* where the morainic drift is more hummocky with severe soil and slope patterns and surface boulders. On Skye, Eigg and Muck brown forest soils of the Darleith Association (*map unit 158*) and humus-iron podzols of the Lochinver Association (*map unit 387*), both on colluvial drifts, are included where rockiness seriously reduces the amount of ground available for improvement. The soils are freely drained, but there is increased poaching risk under the wetter climate of Skye. The poorly drained soils of the Staffin Association on north Skye have only slight topographic limitations to their use, but soil wetness gives serious management problems due to low trafficability and rapid sward degeneration (brought about by poaching and waterlogging.) Because of high rainfall and slow hydraulic conductivity, drainage schemes require backfill and close drain spacing. On the mainland, the alluvial soils at Kinlochmoidart are incorporated because soil wetness and silty textures give trafficability problems. This alluvial flood plain also has some small areas of imperfectly drained loamy alluvial soils which meet the requirements of Class 4.2 but are too small to show at the 1:250 000 scale.

Division 3 Land dominated by both mineral and peaty soils is included; in the former case the soils may be freely drained but the reclaimable ground is reduced to between 40 and 60 per cent of the unit because of rock outcrops and steep slope patterns; in the latter instance the units may be non-rocky but they still form the most marginal land in Class 5 due to the wetness and low surface bearing strengths of the topsoils. The division covers 393 square kilometres (52.1 per cent of the class) and is most extensive on the Uists and Lewis, particularly around the fringes of the major peat areas of Lewis.

The mineral soils in this division are principally freely drained, and consist of brown forest soils and humus-iron podzols of the Darleith and Lochinver Associations. The soils are developed on shallow colluvial drifts and occur in a rocky landscape on Skye, while hummocky moraines with severe boulderiness and soil pattern limitations occur on the Uists and Benbecula.

The peaty gleys and peat included in the division occur within the Arran, Lochinver and Torridon Associations and form the most marginal land in Class 5 because of their serious wetness problems and low surface bearing strengths. The peaty areas on the Uists and Benbecula have a slight advantage accruing from their proximity to the machairs, where calcareous sand is blown onto the topsoils by strong winds. In the past, this sand was applied by man to raise the general fertility.

Class 6

Land in Class 6 is defined as unsuited to improvement by mechanized means, but having some sustained grazing which varies widely in its value to the grazing animal. At the top end of the class, land with a good natural or semi-natural sward could be a more valuable asset than land marginally improvable in Class 5.3 but carrying a financial penalty in recurrent maintenance costs. Land in division 3 of Class 6, however, only permits extremely low stocking rates. The class, which covers 4698 square kilometres (83.4 per cent of the land area), has three divisions according to the relative grazing value of the plant communities.

Division 1 Land in which the dominant plant communities have a high grazing value covers 143 square kilometres (3.0 per cent of the class). The

communities are principally grasslands and occur on brown forest soils, brown calcareous soils, humus-iron podzols and calcareous regosols. The principal areas are on the dune systems of North Uist, South Uist and Benbecula where slope pattern and the extreme exposure are the main limitations. The relative grazing value of the natural dune pastures is high, though there may be deficiencies of some trace elements in stock. The management requirement is limited to controlling stocking rates to reduce the erosion risk. Grazing land of high quality is also found on steep slopes with brown forest soils in the Corriebreck, Darleith and Lochinver Associations on the Inner Hebrides and on the mainland, though these areas are more localized. Some patch reclamation covering less than 40 per cent of the area may be possible on gentler slopes.

Division 2 Land with moderate grazings characterizes the division, which covers 296 square kilometres (6.3 per cent of the class) and comprises two distinct land types. In the first, brown forest soils and humus-iron podzols with some peaty gleys occur on steep slopes in the Arkaig Association (*map unit 27*). The mineral soils support acid bent–fescue grassland of high grazing value, often with bracken infestation or shaded by woodland, and the peaty soils have moorland communities which reduce the overall grazing value of the land. The second type of land in the division occurs on the steep upper mountain slopes where subalpine podzols colonized by mountain white bent grasslands which have moderate grazings available for over 5 months of the year. The middle and lower slopes of these hills regrettably have little land on which to base farm units so the upper slopes are destined to be under-utilized because of the lack of availability of winter feed.

Division 3 The most extensive land in the region, covering 4249 square kilometres (90.7 per cent of the class, 75.6 per cent of the land area), has vegetation dominated by plants of low grazing value, especially heather moor and bog communities. The soils are dominantly peaty in a wide variety of landscapes, and where steep slopes or rockiness do not preclude improvement, the principal limitation is wetness combined with peaty soils. Management usually consists of allowing stock to range freely over the land, but mosaic improvements are sometimes made to encourage the animals to range more widely. Burning rank or old vegetation is a form of management which encourages young palatable growth, but the effects of this technique are short-lived, especially on bogs with a high proportion of flying bent.

Class 7

Covering 112 square kilometres (2.0 per cent of the land area), the land in Class 7 has extremely severe limitations which cannot be rectified. The land is of several types and includes exposed mountain summits with alpine soils, rock-dominated land such as in the Cuillin Hills of Skye, and dubh lochan bogs in north Lewis. Some grazings are available on the high summits for limited periods in summer.

LAND CAPABILITY FOR NON-AGRICULTURAL USES

The land of the region is put to a wide range of uses other than agriculture, including forestry, recreation, housing, airfields and military training. Forestry

Table C Areas of land capability for agriculture map units

CLASS and DIVISION	SHEET 2		SCOTLAND	
	SQ. KM.	% LAND AREA	SQ. KM.	% LAND AREA
1	0	0	41	0.1
2	0	0	1723	2.2
3	0	0	11724	15.2
3.1	0	0	4586	5.9
3.2	0	0	7138	9.3
4	65	1.2	8219	10.7
4.1	26	0.5	3690	4.8
4.2	39	0.7	4529	5.9
5	755	13.4	14270	18.5
5.1	131	2.3	1810	2.4
5.2	231	4.1	5899	7.6
5.3	393	7.0	6561	8.5
6	4698	83.4	37329	48.4
6.1	143	2.5	1556	2.0
6.2	296	5.3	5463	7.1
6.3	4259	75.6	30310	39.3
7	112	2.0	2548	3.3
BUILT-UP AREAS	1	<0.1	1233	1.6
TOTAL	5631		77087	

1 sq. km. = 100 hectares

Areas in this table have been estimated by point-count methods. Care should be exercised in calculations involving units of less than 10 square kilometres. Discussion of method and estimation of error is contained in Handbook 8.

is one of the more extensive land uses after agriculture on the Inner Hebrides and the mainland, but potential forestry land on the Outer Hebrides is restricted to North Harris by exposure. Deer stalking is another extensive form of land use in this region. Recreation, housing and airfields make intensive demands on land resources throughout the region, farmland in particular being under pressure from such uses. Land capability classifications for these and other uses are not yet established in Scotland, but there are examples in the United States and Canada. Nevertheless, for any stated land use, relevant comments can be made about the advantages and limitations of the soils identified in this survey.

FORESTRY

Although good specimens of trees can be grown in sheltered localities in this region, there is a dearth of land suited to forestry. The major restrictions to tree growth are the unfavourable climate, with certain features of the soil, notably induration, shallowness or poor drainage, also important limiting factors. The principal climatic restraint throughout the Outer Hebrides, excluding the mountain areas, is the exposure, which is most severe on the gently undulating till plain of Lewis and on the low-lying ground of South Harris, the Uists and Benbecula. The strong winds have two main effects on tree growth; (1) physical damage to young shoots, especially the leading shoot, and curtailing yearly growth of branches on the windward side; (2) salt-spray damage causing burning of the foliage. Trees do not grow well in these severely exposed areas. In the more mountainous areas of North Harris, South Uist, the Inner Hebrides and the mainland, very exposed land is restricted to western coasts and upper slopes of hills and mountains. More sheltered land is found on slopes and in glens, especially where they face away from the prevailing south-westerly winds. The best areas are east-facing. Another problem linked with exposure is the frequency of damaging gales, which cause uprooting of trees in shallow soils or even snapping of tree trunks and branches.

The soils in many of these glens are peaty podzols, peaty gleys and peats developed on hummocky moraines: soil *map units 26, 111, 123, 157, 322, 391, 547* and *554*. The terrain associated with these soils is often very bouldery which, together with the moundy topography, hampers ploughing, thinning and harvesting. There are, however, many areas of these map units with fewer surface boulders, and these are more suitable for forestry operations. Good examples of these areas are *map unit 26* in Knoydart, *map unit 547* north of Sligachan in Skye and *map unit 391*, north of Seaforth Island, on Lewis; nonetheless the latter two map units maintain a bouldery aspect in the mountains of Skye and Harris respectively.

Soils of the Corby and Gruline Associations have no surface boulders and usually pose few problems to tree growth if iron pans are disrupted by ploughing. Stands of mature trees can be seen around Kinloch Castle on Rhum on *map unit 279* (the Gruline Association), in a sheltered locality. These associations have soils that are much in demand for farming and crofting, and they rarely become available for forestry.

On Skye where average wind speeds are slightly lower than on the Outer Hebrides there are large areas of *map units 155, 160, 294* and *557* with their principal soils peaty gleys and peat. At lower altitudes these soils will be quite suitable for tree planting after adequate soil preparation, particularly drainage. The usual species choice under such high rainfall is Sitka spruce on peaty gleys

and lodgepole pine on the peat. In the Darleith Association there may be a phosphate uptake problem causing a check in tree growth after several years.

Very rocky terrain is extensive in this area and *map units 32, 110, 132, 190, 327, 358, 395* and *558*, consisting of rugged land with peaty gleys and peaty rankers with some peat, cover 852 square kilometres, 15.1 per cent of the region. Rocky land is also found in many steep soil map units. This terrain is not unplantable, but ploughing must be undertaken with great care and is much more time consuming than on less rocky terrain. Hand-planting is another option but these areas are rarely used for large-scale forestry.

Alpine and subalpine soils occur in severe climate zones where trees grow only slowly or cannot survive, and include soil *map units 33, 34, 112, 134, 162, 397, 398, 551, 560* and *561* covering 211 square kilometres (3.7 per cent of the area). The main limitations to tree growth are exposure and low temperatures.

RECREATION

The principal recreational pursuits in this area are land-based, including such diverse activities as ornithology, rock climbing, touring by car, geology and, perhaps eventually, pedology. Mountaineering, used here to include all walking whether along valleys or over the high tops, is probably the outdoor pursuit with most impact on the environment. This sport attracts large groups of people into mountain areas where the recovery of plants and soil after trampling damage is slow.

Many of the people involved in these pastimes choose camping as their means of accommodation, although chalet developments are beginning to appear in Scotland. The provision of camping facilities requires well-drained soils on level sites with fairly low stone content. Chalets can be constructed on more poorly-drained soils and on irregular ground or slopes but the more severe these factors are, the higher the building costs. Sewage disposal is usually by septic tank and requires an adequate depth of subsoil with good drainage. The soils which approach most closely to the ideal for camping are the humus-iron podzols of the Corby and the Gruline Associations and any associated alluvium or stabilized dunes with free drainage (for example the camp site at Glen Brittle, Skye, see Plate 5). This kind of land is favourable for both agriculture and camping and choices of use are often based on local economics rather than national requirements for land. The camping season is short and the land is available for grazing for the rest of the year. Other suitable soils for camping or construction are the brown forest soils of, for example, *map unit 158*, the Darleith Association, but while these soils are stone-free and freely drained they often lack the depth of solum required for adequate septic tank installation to cope with large volumes. The freely drained soils of the Fraserburgh Association would on superficial examination appear to be ideal for camping, being freely drained, stone free, with deep subsoil and level terrain. However the main drawbacks are related to climate: any slight damage to the turf is exploited by the strong winds of the Outer Hebrides, causing rapid erosion of topsoil and subsoil; these strong winds are of frequent occurrence and in any case make living in a tent uncomfortable or impossible.

Within this area, as in any region, there are pronounced focal points for climbing and walking mainly centred on hills, mountains, lochs and the sea-shore. The principal walking and climbing areas are the Cuillin Hills of Skye with the mountains of Harris and the mainland enjoying less popularity. Soil damage by the climbing activity itself is virtually non-existent but paths to and

from the cliffs can be severely eroded. Peaty soils and subalpine and alpine soils are the most susceptible to damage by walking. The peaty soils have low bearing strengths when at field capacity and this allows rapid destruction of the organic layer and exposure of the subsoil. Gullying or wash-out erosion can then follow during rainstorms. The alpine and subalpine soils are at risk because their stabilizing vegetation cover, once trampled or killed, can take many years to regenerate because only a very slow growth rate is possible at such low temperatures. Lowland mineral soils are least susceptible to damage, and footpaths crossing these soils are less readily eroded. Excessive use of sandy coastal soils gives rise to erosion problems, particularly on sand dunes where irreversible large-scale damage can occur if the vegetation is killed and strong winds remobilize the deposits.

PEAT-CUTTING

Peat-cutting is practised throughout the region, particularly on the Outer Hebrides where transport costs make imported fuel expensive. The principal exploitation of the resource is in the crofting townships of north Lewis—these settlements fringe the large peat mass of this area. In other parts of the Outer Hebrides, and in the rest of the area, much of the cut peat occurs as small flats within other map units, for example *map units 392* and *394*. There are enormous reserves of these deposits, particularly in Lewis and North Uist, but commercial exploitation is not carried out at present.

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