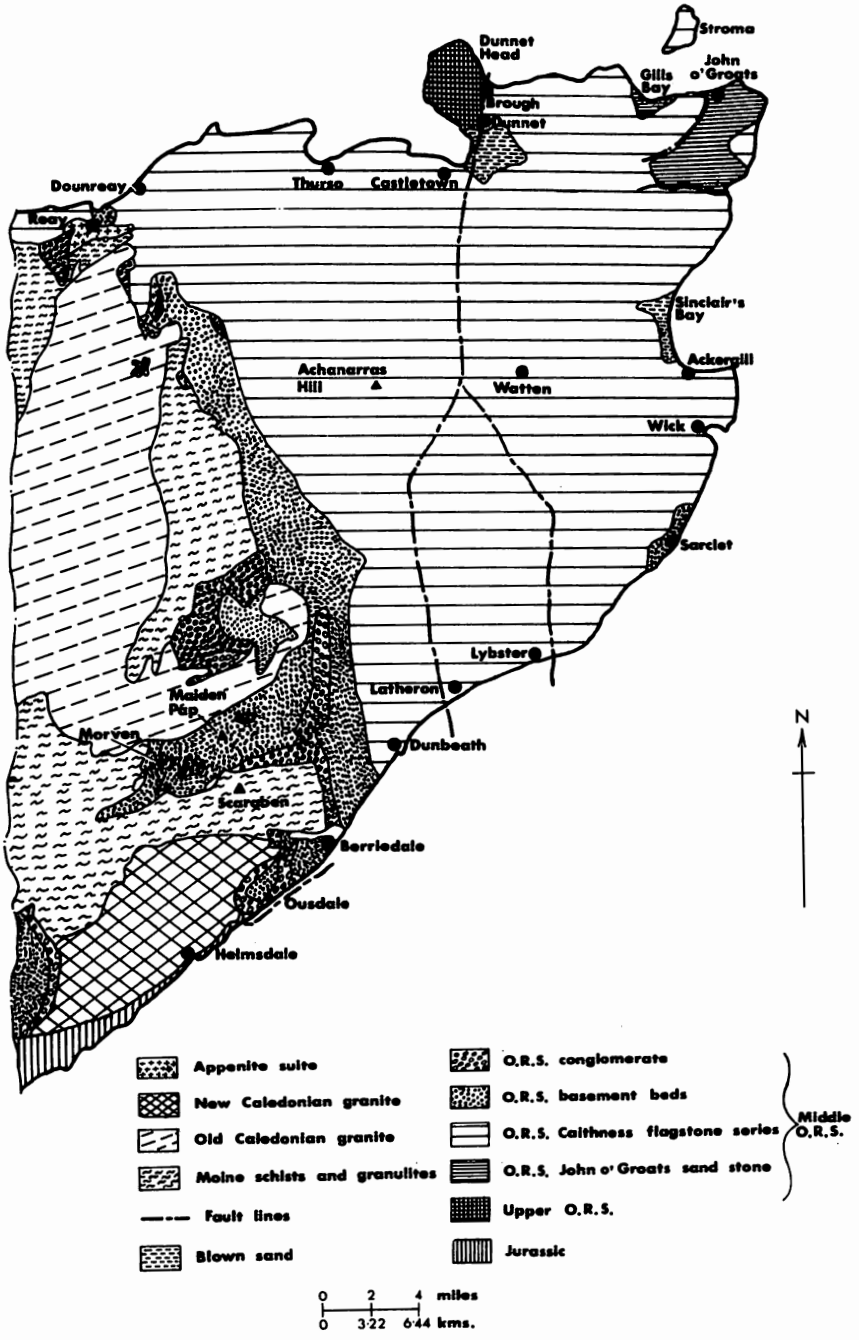

Fig. 1.1. The simplified geology of Caithness (based on Crown copyright ¼" to 1 mile geological survey map).

THE MAKING OF THE CAITHNESS LANDSCAPE

Donald Omand

'Till mak' 'e world in six short days
'E good Loard did contrive;
He spent wan day on Kaitness
An' did 'e rest in five.
An' fan He'd feeneeshed id aal off
An' blissed id wi' Hees bounty.
He looked owld Kaitness ower an' sayed,
" 'At's fit A'd call a county!" '
('Castlegreen' 1975)

SOLID GEOLOGY

The Oldest Rocks

Geologically, Caithness contrasts markedly with the contiguous District of Sutherland. The general structure of Caithness is simple in that it forms part of a basin which extends northwards beyond the Orkneys. The geology map [Fig.1.1] shows that most of the rocks out-cropping on the Caithness surface are of Middle Old Red Sandstone age. However, underlying these is the basement rock, Lewisian gneiss, which may well underlie all the rocks found in Northern Scotland. It is succeeded by the high metamorphic grade schists and granulites of the Moine series. Quartzite outcrops as the spine of the Scarabens (627m) as well as on the Caithness-Sutherland border in the hills of Cnoc Coire na Fearna (481m), Cnoc an Eirannich (518m) and Creag Scalabsdale (554m).

The Old Caledonian Granites or 'foliated granites', like the quartzite, are formed from the metamorphosis of the original Moine sediments. Of younger age are the New Caledonian Granites which are characteristically pink-red owing to the colouring of the crystals of orthoclase felspar. Associated with the New Caledonian Granites is the dark diorite of Reay. Another member of this suite is the ultra-basic coarse-grained lustrous igneous rock called scyelite which occurs as a small boss of some 30m in diameter 1.6km to the north of Loch Scye, from which it takes its name.

The Barren Basement Sediments

These barren basement sediments consist of beds of conglomerate, breccia, arkose and mudstone which fill hollows in the old land surface floor. The beds, some of which could belong to the Lower Old Red Sandstone, were folded, faulted and eroded prior to the deposition of the Middle Old Red Sandstone sediments. In a trough extending westwards into the Moine

complex is a tongue of coarse conglomerate giving rise to the hills of Smean (510m), Maiden Pap (484m), and Morven (705m), the highest eminence in Caithness.

Lake Orcadie

The rocks of Middle Old Red Sandstone age accumulated as sediments in a large basin named Lake Orcadie which extended from Shetland to south of the Moray Firth. This lake, which existed some 370 million years ago, had a sequence of sedimentation generally believed to be as follows:

John o' Groat's sandstone
Thurso Group
Achanarras Horizon } flagstones
Wick Group

The principal rock type of the Middle Old Red Sandstone series is the Caithness flagstone, a finely laminated carbonate and quartz siltstone. Generally, it is of a grey colour so that the term 'Red' is misleading. Succeeding the flagstones are the John o' Groat's sandstones which are quite distinctive and an abrupt lithological change from the underlying beds. These sandstones are false-bedded, brick red in colour and much coarser than the flagstones.

It is in these sediments laid down in Lake Orcadie that the fossil fishes of Caithness are found.

Upper Old Red Sandstone

At Dunnet Head the non-fossiliferous rocks which rest unconformably on the flagstones are believed to be of Upper Old Red Sandstone age. These sandstones, usually red or yellow in colour, are commonly cross-bedded.

Folding and Faulting

Although the lowest beds occur in the south and west of Caithness, it is not quite true to say that as one travels northward successively younger strata are crossed, because the rocks have been folded into an arch whose axis emerges on the east coast at Sarclet to the south of Wick. This upfold brings the conglomerates of the Barren Basement series to the surface. On either side of this anticline the strata lie in great troughs, forming the Latheron syncline to the south and the Ackergill syncline to the north-west.

It seems likely that the east coast of Caithness is affected by the Brora-Helmsdale fault, which is part of the Great Glen fault system. There are other lines of faulting which are indicated on the geology map [Fig. 1.1].

ROCK TYPE AND LANDSCAPE

Since deposition of the Lake Orcadie sediments, considerable movements

Fig. 1.2. Shattered quartzite on Scaraben (627m), between the Berriedale and Langwell Waters in southern Caithness.

of the crust have taken place, the major dislocations and lines of crush trending in a north-south direction. Their influence on the relief is not dramatic except along the cliff line where they have exerted a strong influence on coastal morphology. But there are quite definite correlations between rock type and landscape, which may be summarised as follows.

The mica-schists and granulitic quartz-biotite-schists are characterised by a subdued relief, part of which forms the low-lying eroded land surface. With prolonged erosion vast thicknesses of sedimentary rocks have been removed revealing the underlying resistant quartzites which now tower boldly above the landscape as the Scarabens (627m). Quartzite seems particularly susceptible to frost action [Fig.1.2], disintegrating to an angular debris which deeply buries the hill summits, clothes the slopes in screes and gives the bold strike ridges a smooth and flowing silhouette.

Granites and associated rock types appear to decay quite deeply to a coarse arkose deposit and impart to the landscape a smooth outline such as is found in the Knockfin Heights and in the exhumed land surface of western Caithness where it borders Sutherland.

The diorite of Reay outcrops in what is clearly a basin of erosion. It is possible that in pre-glacial times the diorite underwent deep and differential decay. At a later date, the ice, selective in its erosion, swept away the rotted products and left upstanding the residual hills which give an irregular knob-like landscape that, within Caithness, is quite peculiar to this area.

Apart from the resistant quartzites, conglomerates form the only high prominent hills. They are the outliers of a much more extensive sheet of conglomerate of Middle Old Red Sandstone age and form the conspicuous isolated hills of Morven, Smean and Maiden Pap whose steep and regular slopes are deeply buried in screes of large angular blocks. With the exception of conglomerate, Old Red sediments form lower ground than the surrounding granites and schists, a subdued and gently undulating relief

Fig. 1.3. The low-lying Caithness plain showing Wick Airport and Sinclair Bay.

[Fig.1.3] characterising the flagstone and sandstone facies which underlie most of lowland Caithness. The Upper Old Red Sandstone of Dunnet Head, a block faulted against the flags of Middle Old Red age, gives rise to a series of bold escarpments whose faces can have slopes exceeding 30°.

Deep chemical weathering of rocks has been widely reported in Scotland. Caithness is no exception. Here, sites showing such weathering have been observed in a great diversity of rock types: mica-schist, pegmatite, granite, flagstone and sandstone.

THE DRAINAGE SYSTEM

The major watershed of the District runs through Ben Alisky, the hills of Caplaich, Stemster, Spittal and Olrig, through Duncansby Head and may at one time have been continued into the Orkneys.

Two drainage systems have developed on either side of the watershed, to the east of which a striking parallelism is exemplified by the Wick and Dunbeath rivers and by the major segments of the Langwell and Berriedale Waters. Clearly the Langwell and Berriedale Waters are superimposed and traverse the rocks outcropping at the suface with a total disregard for structure. It is possible that these south-easterly flowing rivers represent the consequent drainage of the area having been superimposed on to the

present geological outcrops from a sedimentary cover long since removed. These rivers, particularly those of Langwell and Berriedale, became deeply incised into the landscape, perhaps during the uplift of land that took place in later Tertiary times.

To the west of the watershed the drainage was primarily subsequent. The lower Forss Water is clearly fault-controlled running along the fault line which forms the eastern shore of Loch Calder. It is possible that the north-westerly flow of the Thurso River in the section from its confluence with the Little River northwards to Olgrinmore follows the same fault line. The suggestion has been made that the Forss and Thurso rivers have beheaded the upper reaches of the south-easterly flowing rivers (Crampton *et al* 1914; Godard 1965). Many of the lesser water courses to the east of the watershed are undoubtedly adapted to structure and run in conformity with the strike of the rocks e.g. the burns of Sarclet, Latheronwheel, Houstry and the upper segment of the Clyth.

It may be that some of the Caithness lochs (many of which are rock basin ones) were formed in pre-glacial times by sub-aerial erosion in favourable circumstances, e.g. in fault-shattered rocks and in dipping beds of sandstone where differential erosion could excavate the required hollow. In the former category could be lochs such as Rangag; in the latter, those of Sarclet and Watenan.

PEAT

Essentially, peat — which covers some 60% of Caithness — is the result of the continuous accumulation of partly decomposed plant remains whose normal decay has been prevented by excess of moisture or submersion in water at the soil surface. Where the development of peat has led to its spread over the contours of the land 'blanket bog' is formed. In Caithness there are three large blanket bogs whose principal characteristics are listed in the table below:

Caithness Blanket Peat Bogs

	Area		Peat Solids		Average Depth	
	Hectares	*Acres*	*Million Kilos*	*Million Tons*	*Metres*	*Feet*
1. Altnabreac	8,537	20,996	13,440	13.2	2.1	7.2
2. Achairn Bog	3,309	8,177	6,618	6.5	2.2	7.5
3. Shielton Bog	1,630	4,028	2,564	3.5	2.4	8.0

'Caithness peat is a good fuel because it is rich in chemicals and it is this richness which tends to make it less valuable for horticultural usage. The reason is that during the drying process these chemicals render the peat irreversibly hard and water-repellant and so useless as a soil conditioner. The need for advanced technology lies in solving the question as to what properties peat would have if most of the chemicals were removed from it.' (Penny 1972)

THE COAST

Cliffs

Undoubtedly the most spectacular scenery in Caithness is to be found along its 167km of fretted cliff coastline, interrupted only where sand has accumulated in open shallow bays. The highest cliffs, towering up to 120m, are cut in Ord granite between Berriedale Ness and the boundary with Sutherland. Near Berriedale, cliffs cut in sandstone rise to 90m while the highest flagstone cliffs, exceeding 60m, occur immediately to the west of Thurso and between Wick and Thrumster. Where the flagstones dip gently towards the sea a low cliff line may form, as between Isauld Point and Brims Ness on the north coast.

Admiralty charts show that submarine contours come closest to the land at the principal promontories of Holborn, Dunnet and Duncansby Heads. There is also a marked parallelism of shoreline and adjacent submarine contours. Many of the cliffs in Caithness are partially drowned and plunge beneath the water before meeting the sea floor with no evidence of an abrasion platform at their foot. Some caves are still flooded by sea even at Low Water Mark. All these factors point to a submergent cliff coastline and as peat has been found in a number of localities below High Water Mark, at least some of the submergence is very recent.

Coastal scenery in Caithness is quite characteristic of that developed on rocks of Middle Old Red Sandstone age. The variety of forms apparent in plan and section of this crenulated coastline are quite astonishing and are attributable to a host of influences. Within the Old Red Sandstone series, coastal lithology varies from coarse conglomerates through arkoses to thickly bedded sandstones, thinly bedded flags and impure limestones. Such lithological differences coupled with a great diversity of intersecting joints, dip/strike relationships and faulting, not forgetting the factors of exposure to marine erosion and the direction of greatest fetch (which in Caithness is from the north-east) account for the intricacy and multiplicity of coastal forms.

Geos

The most characteristic feature of the Caithness coastline is the *geo* or *goe* (Old Norse *gja* 'creek') — a long, narrow, steep-walled, structurally-controlled tidal inlet. Geos occur in only the sandstones and flagstones of the Old Red Sandstone. In the Upper Old Red Sandstone they are seen as extremely narrow slots traversing the full height of the cliff and are typically excavated in the deeply weathered 'dykes' of Dunnet Head. Good examples of more open geos are found in the John o' Groat's sandstone, but their most spectacular development occurs in the Wick and Thurso flagstone series which are cut by sets of well-spaced joints. The simplest form of geo follows a narrow fissure in the rock; wider subparallel geos are excavated between two fractures — e.g. the geo at Sinclair/Girnigoe Castle and Ellen's Geo, Ulbster. Where their form is joint-controlled, geos trend

Fig. 1.4. The Stacks of Duncansby, just south of Duncansby Head at the north-east corner of Caithness.

at high angles to the strike of the rocks; where fault-controlled they follow the line of least resistance, irrespective of direction. The biggest of the geos, both in length and width, are excavated along fault lines where the material would probably be less resistant to removal than elsewhere along the coast.

Marine Erosion

Glacial debris still lies in a number of bays (Thurso, Gills and Dunbeath) and it is clear that the sea is in process of excavating a fossil coast-line formed before or during the Ice Age.

As the drift plug in the Caithness bays is still substantial, the impression given is that marine erosion by the late-glacial and post-glacial seas since the last ice retreat has been of a limited extent. Even the marine platforms visible at low tide in Caithness cannot be entirely attributed to the present action of the sea. The best developed of these is in Thurso Bay where the 'fossilised' platform is in process of exhumation as the sea drives inland removing the glacial debris which forms some of the coastline to the east of Scrabster. In fact it is the existence of a concrete face along the unconsolidated cliff and a road surface at the cliff top that have helped to stem the sea's progress in the south-west corner of the bay. At this point on

the coast the sea gained 4.6m on the land between 1956 and 1967. On the much more exposed east shore of Thurso Bay the drift cover has been entirely removed from the platform.

Another well-developed marine platform is cut in John o' Groat's sandstone at the pyramidal stacks of Duncansby [Fig. 1.4]. Here, the friability of the sandstone coupled with its network of intersecting joints may have made it more sensitive to mechanical action than the adjacent flagstone rocks, and accounted for the more rapid coastal retreat of the cliff face. At the foot of the stacks and some of the mainland gullies lie protective lichen-covered boulders which inhibit the landward progress of the sea, and for many people it is difficult to accept that the cliff line has retreated over 200m from the outermost stack to its present position since the Ice Age ended some 10,000 years ago. (A flat-topped *stack* is usually called a *clett,* as at Holborn Head [Fig.1.5]).

As the sea fails to reach the backwalls in so many geos, it is tempting to suggest that they were excavated when the sea stood higher upon the land. It is also an attractive idea to link this old, higher sea level with the rock benches cut in the cliff line at 2m to 3m above the present mean sea level. These benches, which are unlikely to have been cut in the fluctuating sea levels of late-glacial and post-glacial times are best seen on the east coast between Thrumster and Clyth.

Raised Shorelines

Skirting some parts of the Caithness coastline are marine deposits representing beaches now elevated above sea level. Since these beaches were first reported in the literature (Crampton *et al* 1914), contrasting views have been expressed regarding their interpretation as well as their altitudes above sea level.

Having levelled some of the discontinuous and widely separated sites of raised shorelines, it was found that along the east coast their altitude declines northwards from Dunbeath and along the north coast it declines eastwards from Crosskirk Bay to the east of Reay village. Commonly associated with these raised shorelines are notches cut at an equivalent height above Ordnance Datum. Because of the patchy nature of the raised beaches and the difficulty of attributing age to them, insufficient evidence is available to draw a shoreline diagram.

At the mouths of the re-entrants at Dunbeath (ND 178293), Latheronwheel (ND 191322) and Achastle (ND 230341) occur exposures of well-rounded to sub-angular pebbles of sandstone, gneiss and granite, some 50cm in depth, overlying the shelly till. Godard (1965) who had noted the sites at Dunbeath and Latheronwheel called them 'slightly doubtful evidences of raised shorelines'. The maximum altitudes of these deposits above Ordnance Datum in a south to north sequence were found to be as follows:- Dunbeath 26.2m, Latheronwheel 26.0m and Achastle 29.6m. These three fragmentary deposits, occurring on the south-east coast of Caithness, are difficult to interpret, their origin and age being uncertain.

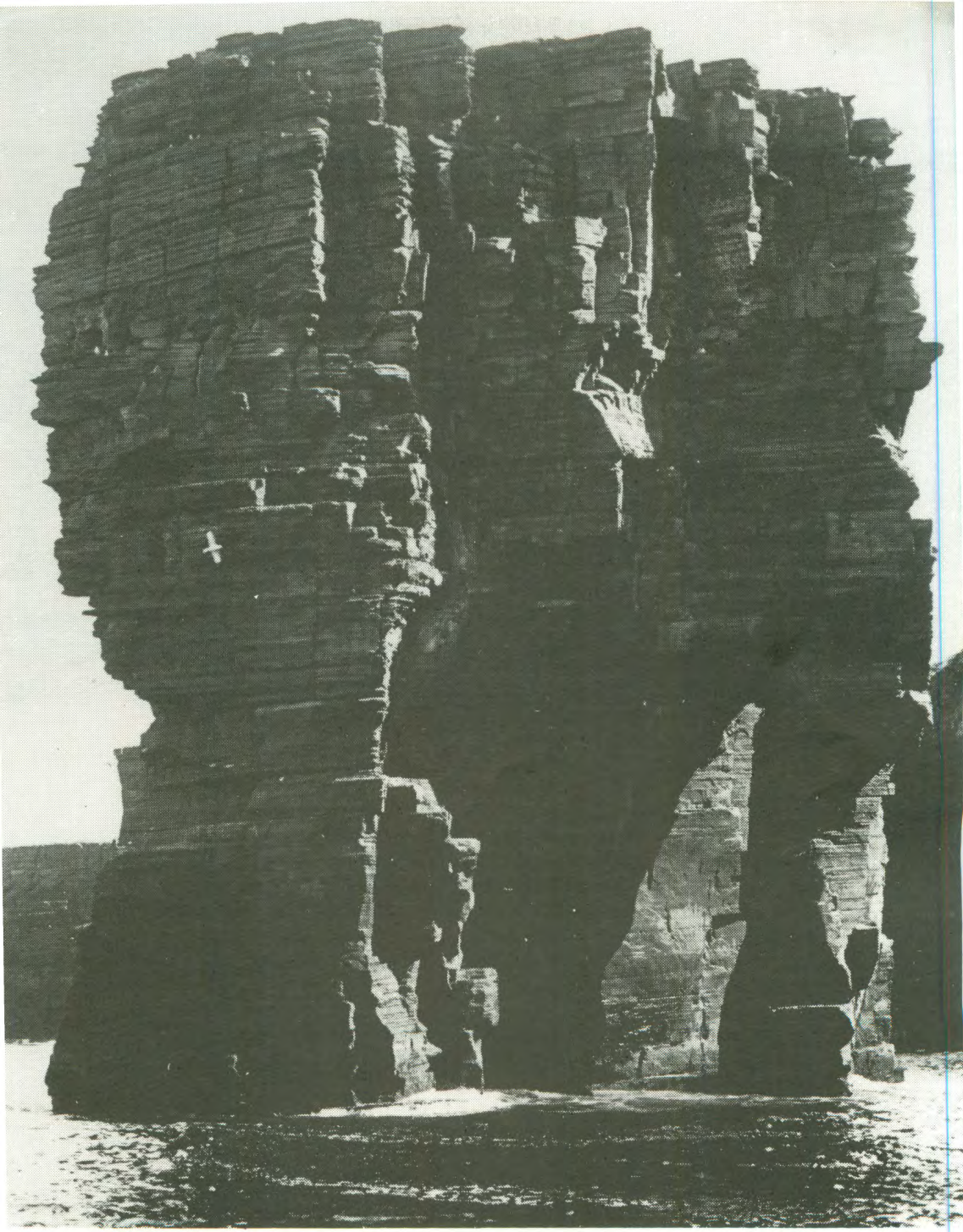

Fig. 1.5. The Clett Rock, a sea stack at Holborn Head, near Thurso.

Fig. 1.6. Dunnet Sands at the head of Dunnet Bay, north coast of Caithness.

Dunes and Links

The coastal sand dunes and links may be grouped into three categories:
1. At Keiss and Dunnet [Fig.1.6] a long dune range parallel to the coast is backed by a sandy machair-type flat containing a number of subsidiary dunes. 'Blow outs' in the dunes quickly cause erosion and permit the landward movement of sand.
2. At Freswick and Reay the dunes are more irregularly distributed. Here, flat stretches of sand are absent.
3. The links of John O' Groats consist of low, fixed dunes of shell sand. Similar accumulations are found at the Bay of Sannick. In both localities the deposit may consolidate into a coarse, compact material called calcrete.

GLACIATION

Erosion

It seems that the passage of ice has left little imprint on the higher plateaux of Caithness, and an examination of the sandstone and flagstone outcrops of lowland Caithness demonstrates unequivocally that 'moulded'

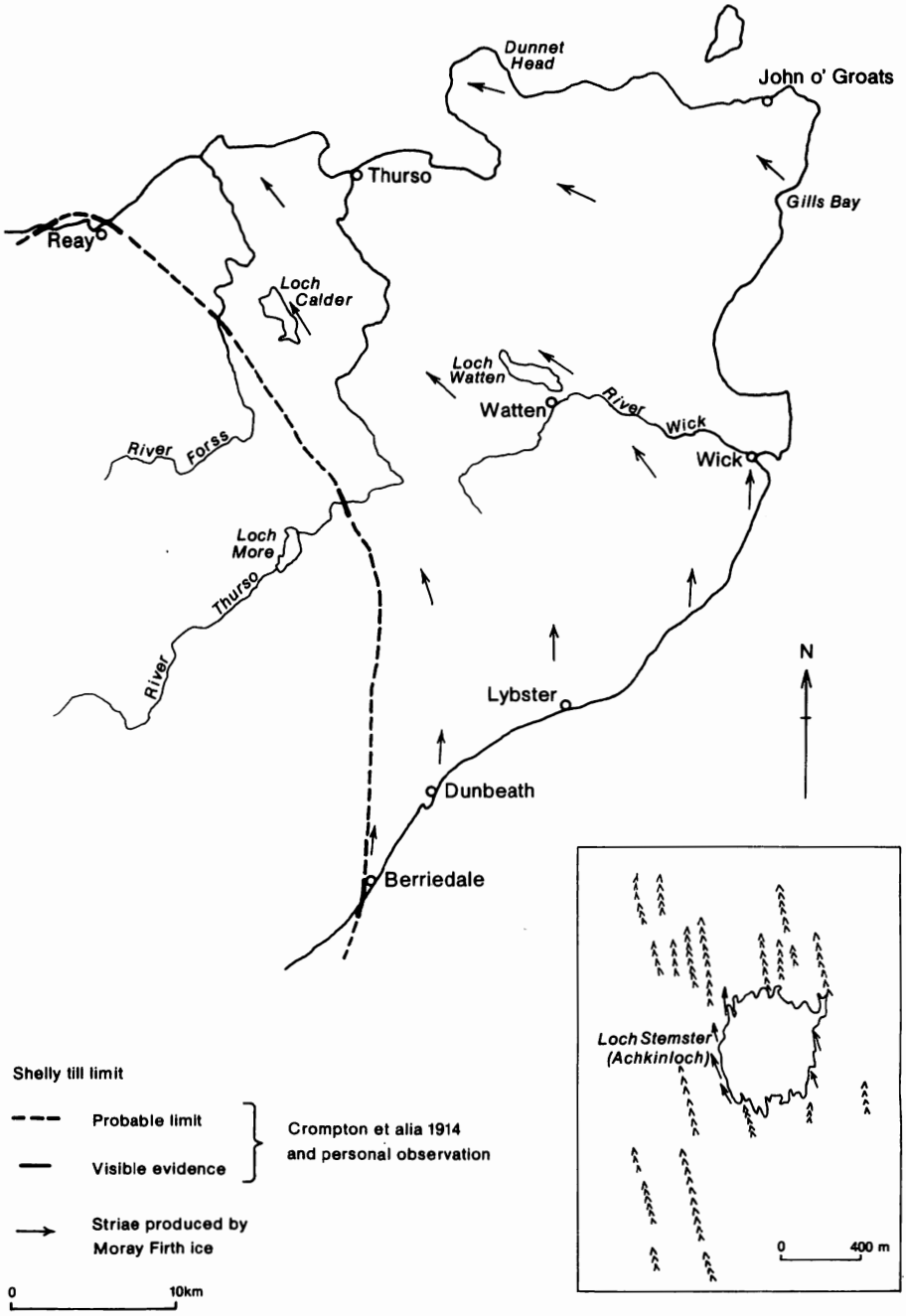

Fig. 1.7. Features of the glaciation of Caithness. *Inset:* Glacially-moulded ridges and striae to the north of Lybster.

landscapes occur primarily where geological strike and ice flow directions of the glacial maximum are parallel. This relationship can be readily established in the south-east of the District where large numbers of parallel strike ridges are aligned in harmony with the Moray Firth ice movement [Fig.1.7; inset]. Where this coincidence does not occur moulding is difficult to establish.

Although the principal Caithness lochs such as Calder, Watten and Heilen occur in linear depressions which are elongated more or less parallel with the direction of ice movement, it must not be assumed that ice was wholly or even mainly responsible for such depressions. It would appear that major elements in the landscape of north-east Caithness are strike orientated e.g. the long depression between Sinclair's Bay and Dunnet Bay. Ice would have played its part in emphasising the existing relief features of Caithness, but there is no evidence to suggest that ice cut indiscriminately across the grain of the District to superimpose an orientation of forms quite alien to the preglacial landscape.

Deposition

The low-lying nature of the District might give the casual observer the impression that Caithness is thickly plastered with glacial drift. This is not so. Outwith the larger coastal re-entrants and principal water courses the drift is typically in the region of one metre in thickness.

The Dunbeath Till. References to the tills of Caithness appear quite early in the subject literature, which has produced a multiplicity of interpretations of the glacial phenomena of Caithness including reference to a drift underlying the shelly till of the glacial maximum. In the course of personal fieldwork in Caithness, drift sections were examined at Drumhollistan (ND 921653), Latheronwheel (ND 191322) [Fig. 1.8], and Dunbeath (ND 158300) which showed a sharp division of colour between a dark brown to blue-grey shelly till and an underlying till of a light brown colour. Only at Drumhollistan was a water-laid deposit 1.5m thick found separating the two tills. Unlike the upper till, the lower one contained no shell fragments. Moreover, stone counts revealed a marked lithological difference between the lower non-shelly till and the overlying shelly one. The Drumhollistan site was particularly instructive. Here, the lower drift with its contained migmatites and hornblende is derived from the area to the south and south-west, whereas the upper drift has 76% of its sample of 50 stones derived from the Middle Old Red Sandstone series which lies to the south-west. Some faint markings of striae aligned south-west to north-east coupled with erratic content evidence may indicate that ice invaded at least part of lowland Caithness from the interior prior to deposition of the shelly till.

The Lybster Till (The Shelly Till). Since it was first described, the shelly till of Caithness has been credited as being of various shades of blue or grey or any combination of both. Such descriptions are misleading as the colour of the deposit varies greatly from one locality to another, the variation of

Fig. 1.8. Superimposed tills at Latheronwheel, south-east coast of Caithness.

blue-grey to chocolate-brown being directly attributable to the hue of the underlying or adjacent bedrock.

Of considerable interest to field workers has been the diversity of Mesozoic rocks contained in the shelly till, which are quite unknown *in situ* in Caithness. The most noteworthy is the Leavad Cretaceous erratic (ND 173460) whose dimensions by bore hole evidence were found to be 220m x 137m x 8m (Carruthers 1911). The Mesozoic rocks are likely to have derived from rocks outcropping on or off the east coast of Sutherland.

Blocks of a distinctive angular conglomerate found outcropping at Sarclet 6.4km to the south of Wick have been found in a broad scatter to the north and north-west as far away as Holborn Head on Thurso Bay. This evidence allied to the occurrence of marine fauna in the drift along with abundant striae indicates that the ice movement which deposited the shelly drift was onshore from the Moray Firth [Fig.1.7].

Since Croll (1870) advocated the presence of a Scandinavian 'mer de glace' in the Moray Firth which compelled Scottish ice to veer north-westwards over lowland Caithness, successive authors have developed the theme of an ice barrier to the east of Caithness. From the increasing westward orientation of striae as one goes northward in the District, it appears that if such a barrier existed it is likely to have been to the north,

rather than to the east, of Caithness. Alternatively, it is possible that the shelly drift 'merely indicates the spreading out of the ice stream after having passed the constriction of the major feeding valleys, particularly the Great Glen and the Inner Moray Firth' (Smith 1968).

As the shelly till which was deposited by ice from the Moray Firth represents the glacial maximum in Caithness, it was decided to collect a sample of shells (*Turritella ungulina*) from a drift exposure at Gills Bay (ND 323733) in order to obtain a radiocarbon dating. This was carried out by Professor Shotton, Birmingham University, who obtained dates of > 34,700BP for the outer fraction and > 40,800BP for the inner one (Shotton 1971). The infinite carbon dates obtained for shells from the shelly drift of Caithness do not permit easy conclusions to be made regarding the age of the deposit.

The Reay Till. To the west of the generally dark-grey shelly till limit the typical drift section is a brown to red colour reflecting the hue of the igneous/metamorphic and sedimentary rocks of the west and south of the District from which the glacial debris is derived. No shells were found in any of the sections of this locally derived drift. Striae and stone orientation measurements taken in the centre of Caithness suggest that here ice was moving from west to east, but at Reay on the north coast a south-east to north-west movement is implied — i.e. the local ice may have been compelled to turn towards the north-west by Moray Firth ice. This interpretation would make the Lybster and Reay tills coeval — i.e. they are different facies of the same glaciation. It is arguable that all three tills (Dunbeath, Lybster and Reay) can be attributed to the same glaciation, the Dunbeath till being the component of the Reay one on to which shelly till was superimposed by the movement of ice inland from the Moray Firth.

Periglacial Caithness

In Caithness many sections are visible showing fragmented flagstones and sandstones underlying glacial debris. In addition to this early cold phase, the area has been subjected to periglacial activity since the deposition of the drifts. This may be considered under two headings:

Features associated with permafrost. Severe disturbance of the upper metre or so of drift sections is very common and occurs to the east and west of the shelly till limit. (By contrast such disturbance does not appear prevalent in contiguous areas of Sutherland). Typically the local fissile flagstones shatter into wafer thin layers but even hard sandstone cobbles may be ruptured.

Evidence of an indurated soil horizon is widespread in Caithness. Fitzpatrick (1956) has suggested that this indicates the 'fossilised permafrost layer'.

Thin deposits of head can occur in the scarp/vale areas of eastern Caithness, the thickest accumulation found being 2.1m in the Langwell valley (ND 103223). The presence of sheet solifluction has given an additional smoothing to the landscape, which appears to have inherited a

Fig. 1.9. Braemore, on the Berriedale Water, southern Caithness. In the foreground — Maiden Pap (484m); in the background — Morven (705m); left of centre — Smean (510m).

subdued relief from Tertiary erosion. The evidence of stone orientation measurements taken in the major valleys justifies the impression given to the eye that some of the drift plug choking them is the result of solifluction. In these valleys, e.g. Langwell, soliflucted drift can exceed depths of 20 metres.

Features indicative of a colder climate than at present. Striking tors occur on the summits of Morven, Smean and Maiden Pap [Fig.1.9], whose flanks are substantially buried under large angular fallen blocks which stretch downslope from the tor summits. This suggests that although the tors may have had their origins in preglacial times, they have subsequently been fashioned under periglacial conditions.

Blockfields are impressively developed on the quartzite hills of Scaraben and Creag Scalabsdale. Under the influence of solifluction the angular blocks have moved downhill imparting a smooth, rounded contour to the form.

Although the terracettes found on the highest hills of Caithness probably originated in a colder climate than the present it would appear that they are still active. On the south slopes of Scaraben, at altitudes above 520m, good examples of stone-banked terracettes parallel to the contour occur. Few of the terracettes have vegetation on the risers which are seldom more than 0.5m high while the treads may extend for up to 3m. The conglomerate summit of Morven above the 610m contour has weathered down into a thick spread of coarse gravel which slopes to the south. The gravel has formed a suite of terracettes, mainly turf banked, with risers of up to 1m and treads of up to 5m. Many of the terracettes appear quite active as turf rupture along the risers indicates.

POSTSCRIPT

Not surprisingly, the natural environment has had a profound influence on the settlement pattern and land utilisation of Caithness, the high cliffed areas repelling population growth which was primarily attracted to the coastal re-entrants. To this day the extensive peat-mantled interior is a virtual wilderness, its topographic features named in Gaelic in marked contrast to the arable lowlands dominated by Old Norse placenames, reflecting a distribution of population that has persisted for well over a thousand years.

Acknowledgment

I wish to record my thanks to Mr. J. Campbell for the use of Figs. 1.4, 1.5, 1.6; to Mr. R. Sharpe for Fig. 1.3; to Mr. A. Luciani for Fig. 1.2; to Mr. R. Stewart for Fig. 1.8; to Mr. J. Macrae for Fig. 1.9. Fig. 1.1 is based on the Crown copyright ¼" to 1 mile geological survey map.

Note

It is not possible to include all detail and placenames on the accompanying maps. Readers are recommended to refer to the appropriate Ordnance Survey 1" or 1:50 000 Series maps, or to Bartholomew's ½" or 1:100 000 Series maps.

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