Glen Roy, Glen Spean and Glen Gloy, Highland

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Highlights

Glen Roy, with adjacent parts of Glen Spean and Glen Gloy, is an outstanding area of international importance for geomorphology. It is best known for the 'Parallel Roads', a series of ice-dammed lake shorelines that developed during the Loch Lomond Stadial of the Late Devensian. These shorelines form part of a much wider assemblage of outstanding fluvial/glaciofluvial and glacio-lacustrine features that provide unique evidence for the dramatic impact of geomorphological processes on the landscape at the end of the last ice age.

Introduction

Glen Roy and adjacent parts of Glen Gloy and Glen Spean, near Fort William in Lochaber, are long-recognized sites of international importance for the 'Parallel Roads', which are the most extensive and best developed examples of former ice-dammed lake shorelines in Britain. The Parallel Roads have been extensively described in the literature (cf. Gordon, 1993b), and are widely regarded as being a classic example in standard texts on geomorphology and physical geology. Much of the original research on the Parallel Roads was carried out during the 19th century when the landforms of this area were found to provide significant evidence for the former existence of glaciers in Scotland (Agassiz, 1842). The Parallel Roads were first recognized as the shorelines of ice-dammed lakes by Agassiz (1841, 1842), an interpretation later confirmed in the definitive work of Jamieson (1863, 1892). In a more recent series of papers, Sissons (1977b, 1978, 1979a-c, 1981a,b) elucidated the formation of the Parallel Roads through detailed field observations and mapping, and placed them into the wider geomorphological context of contemporaneous events in Glen Spean and the Great Glen.

In addition to the lake shorelines and glacial land-forms, the area is of outstanding interest for a remarkable assemblage of fluvial/glaciofluvial and glacio-lacustrine deposits, including deltas, fans and terraces. These interests have been described by Sissons and Cornish (1983), Peacock (1986, 1989) and Peacock and Cornish (1989) mainly from a geo-morphological perspective, but they also have significant potential for sedimentological studies. The whole landform system and many of its individual elements are of considerable interest both intrinsically and in their relationships to the Parallel Roads and the sequence of lake drainage events in Glen Roy. In this report, the fluvial/glaciofluvial and glacio-lacustrine components are reviewed: the site descriptions draw heavily on Gordon (1993b).

Description and interpretation

Lake shorelines

The Parallel Roads have been described extensively in the literature (cf. Gordon, 1993b). They are almost entirely former lake shorelines, although locally they occur as glaciofluvial terraces. Three main roads occur in Glen Roy at average altitudes of 350 m, 325 m and 260 m; one in Glen Gloy at 355 m; and one in Glen Spean at 260 m (Figure 2.53). Typically they are cut in bedrock and comprise an erosional floor and backslope and a depositional foreslope. Horizontal widths range from 1.6 to 63.6 m, and the backing cliff reaches a maximum height of 6 m (Sissons, 1978). To explain the formation of the features, Sissons (1978) invoked a combination of wave action and powerful frost disruption of the bedrock along each shoreline (see Matthews *et al.* (1986); Dawson *et al.* (1987) and Shakesby and Matthews (1987) for discussion of possible modern analogues). Detailed levelling by Sissons and Cornish (1982a,b) has shown that the shorelines are not uniformly tilted or warped, and that differential movements have occurred between blocks of the Earth's crust.

In Glen Roy, several sites demonstrate key aspects of the lake shorelines. The viewpoint [NN 297 853] affords the classic view of the Parallel Roads, which are strikingly displayed on both the west and east hillsides of the glen. The

section of Parallel Road on the south side of Glen Roy north of the Burn of Agie [NN 369 920] is one of the clearest examples of a shoreline cut in bedrock. It is associated with a prominent delta formed by the penecontemporaneous Burn of Agie. For a distance of about 300 m north of the bum, the middle road is a rock-cut platform up to 12 m wide with a backing cliff up to 5 m high. Shorelines cut in bedrock are also well demonstrated at Braigh Bac [NN 306 882] and Creagan na Gaoithe [NN 370 925]. In a gully on the east side of Glen Roy at [NN 307 877], there is a good exposure showing the middle road cut in bedrock, and in a similar situation at [NN 304 868] the top road is clearly cut across the structural grain of highly fractured bedrock. The susceptibility of the bedrock to weathering, demonstrated at the latter locality and elsewhere, is an important consideration in explaining the processes of formation of the Parallel Roads (Peacock and Cornish, 1989). Well-developed aggradational shorelines are represented in grid squares [NN 35 92] and [NN 36 92]. Locally, additional Parallel Roads are present, for example at 334 m and possibly 344 m at Braigh Bac.

In Glen Gloy, Glen Fintaig [NN 265 885] is important for a sequence of up to eight shorelines (the clearest at 295 m, 355 m, 416 m and 426 m) and lake sediments and river terraces (Peacock and Cornish, 1989). In addition, the main Parallel Road in Glen Gloy at 355 m is also well-developed at Allt Grianach (also 295 m road and delta) [NN 270 905], Auchivarie [NN 287 928] (partly cut in bedrock) and Allt Fearna (partly cut in bedrock) [NN 305 935].

In Glean Spean, the 260 m Parallel Road is extensively developed. Particular examples of note are: (i) at Creag Bhuidhe [NN 304 803], where there is a well-preserved stretch 10–13 m wide; and (ii) in grid square [NN 29 79], where it is cut in drift and demonstrates the original lakeward slope of the shore.

Deltas

At Roughburn (Figure 2.54) a delta [NN 377 813], comprising up to 10 m of coarse gravel in steeply dipping foreset beds on top of silty sands, records the torrential overspill from the 325 m lake in Glen Roy through the col at the head of Glen Glas Dhoire and down the valley of the Feith Shiol into the 260 m lake in Glen Spean (Jamieson, 1863; Peacock and Cornish, 1989). Eastwards along the north shore of Loch Laggan, fine-grained sediments of the distal part of the delta (bottomset or low-angle foreset beds) are well exposed (Peacock and Cornish, 1989).

The Inverlair–Fersit area north of Loch Treig (Figure 2.54) demonstrates an excellent example of a partly kettled delta formed in the 260 m lake as the Treig glacier receded back into the valley now occupied by Loch Treig (Peacock and Cornish, 1989). The delta extends from around Inverlair to south of the Treig dam and comprises an extensive area of sand and gravel, with remnants of the original delta surface preserved, particularly around Fersit. A series of kame terraces lead from the delta southwards between Fersit and Loch Treig, notably on the east side of the valley. Foreset beds in the delta are exposed in the former gravel quarry at Fersit and in sections on the west side of Loch Treig. Following drainage of the lake, a series of outwash and river terraces formed in front of the receding glacier. These are represented on the east bank of the Treig (Peacock and Cornish, 1989), and younger terraces are particularly well seen to the south of Tulloch Station, where they continue down Glen Spean (Sissons, 1979a). Areas of waterworn bedrock and p-forms occur on the west shores of Loch Treig. The Fersit area also demonstrates relationships between the lowest Parallel Road and glaciofluvial landforms: south of about [NN 345 789], the 260 m shoreline merges with, and becomes, a kame terrace. Spectacular kettle holes, up to 25 m deep, are present in deltaic deposits at Inverlair.

Fans

At the junction of Glen Roy and Glen Turret there is an important and controversial set of deposits comprising a fan with, at its northern end, an irregular, hummocky surface aligned with a series of subparallel mounds and terraces climbing obliquely up-valley on the east side of Glen Turret (Figure 2.55). Details of several important sections are described by Peacock (1986) and Peacock and Cornish (1989). Sections exposed in the south-east bluff of the fan (e.g. at [NN 346 924]) show it to comprise coarse, poorly bedded gravels, and fine-grained lake sediments can be seen in scrapings on its surface. In a section in the fan (at [NN 338 919]) Peacock and Cornish (1989) reported the following sequence (see also Peacock, 1986):

(3) Well-bedded gravel, clast-supported, bouldery and cobbly (particularly towards the top), with a poorly sorted, sandy matrix; bedding subhori-zontal, parallel to the fan surface, with beds less than 0.3 m thick; local sand beds a few

centimetres thick; local imbrication 21 m

(2) Interbedded, hard, pebbly, laminated silt, and gravel 5.0 m

(1) Gravelly till 1.5 m

Sections in the mounds at the back of the terrace (e.g. at [NN 339 928]) reveal a variety of materials ranging from silts and clays to coarse, angular debris. The sedimentology of these fan deposits and their interpretation is critical in understanding the sequence of events (Sissons and Cornish, 1983; Peacock, 1986; Peacock and Cornish, 1989). Sissons (1977b) interpreted the fan as a delta, and later as a subaerial fan (quoted in Gray, 1978). However, the association of the deposits, the terrace, the mounds on its surface and the lateral ridges up-valley is typical of a former ice margin, and the north-west flank of the terrace closely resembles an ice-contact slope. Thus Rose (quoted in Gray, 1978) interpreted the terrace feature as an outwash fan formed at an ice limit at some time during ice-sheet decay. Peacock (1986) concurred with this interpretation. Sissons and Cornish (1983), however, favoured outwash deposition into the 260 m lake of the rising sequence, at a time when the Gloy glacier extended across the col between Glen Gloy and Glen Roy. They suggested that the rise in lake level in Glen Roy resulted in ablation of the Gloy glacier and its retreat into Glen Gloy, which thus allowed the higher shorelines to form in Glen Turret. The absence of Lateglacial pollen from a sequence of organic deposits in a section and borehole at Turret Bank [NN 337 925] suggested to Lowe and Cairns (1989, 1991) that Glen Turret was occupied by a Loch Lomond Readvance glacier. Although the pollen evidence on its own is inconclusive, Lowe and Cairns (1991) considered that this interpretation best fitted the wider pattern of landforms. However, Peacock (in Peacock and Cornish, 1989) considered that the commencement of organic sedimentation simply related to the drainage of the 260 m lake and not to the end of any glacial event. Further work on the Turret fan to resolve these outstanding issues is awaited (cf. Lowe and Cairns, 1991).

Several superb examples of alluvial fans occur in Glen Roy (Sissons and Cornish, 1983; Peacock, 1986; Evans and Hansom, 1991). On the east side (at [NN 330 907] and [NN 318 896]) two large dissected fans extend across the valley floor from Coire na Reinich and Coire Dubh (the Reinich and Brunachan fans, respectively) (Figure 2.56). Others are associated with the Burn of Agie, the Canal Burn, the East Allt Dearg and the West Allt Dearg (Figure 2.55). Peacock (1986) described several sections in the fans, which principally comprise coarse gravels and sands, in places both overlain and underlain by laminated sediments. According to Sissons and Cornish (1983), these fans were deposited into the lowest lake of the rising sequence, but Peacock (1986) interpreted them as being older, subaerial features.

River terraces

A particularly fine suite of river terraces, formed by the River Roy after drainage of the lowest lake, occurs on the south side of the upper Glen Roy between about [NN 368 920] and [NN 345 920] (Figure 2.54). Terraces also continue along the floor of the glen south-west from Braeroy Lodge.

An important suite of river terraces recording the stages of valley infill and dissection after the drainage of the 260 m lake occurs between Roy Bridge and Spean Bridge (Sissons, 1979a). The upper terraces largely comprise sands (seen in section at [NN 217 819] and [NN 274 811]), which overlie lacustrine silts and clays (Peacock, 1970). The lower terraces are believed to be cut in lake sedi ments (Sissons, 1979a). East of Roy Bridge a higher-level terrace remnant is prominent (Peacock and Cornish, 1989). At Spean Bridge a sandpit [NN 217 819] shows that the terrace in which it is excavated comprises laminated sands with ripple bedding and a small channel near the surface (Peacock and Cornish, 1989). On the south side of the Glen Spean, Peacock and Cornish (1989) recorded a series of exposures in the terrace sequence between Insch and Spean Bridge.

Other landforms and deposits

In the lower part of the valley of the Allt a' Chomlain near its junction with Glen Turret [NN 330 929] a series of gravel mounds and deposits, with kettle holes, have been terraced and dissected by the river. These deposits were formed during the deglaciation of the area, although the precise details are unclear (Peacock and Cornish, 1989).

Also in this area is a terrace which appears to be a delta of the 325 m lake (Peacock and Cornish, 1989).

Thick drift deposits are present at the head of Glen Turret. In a gully section [NN 329 944] there are up to 27 m of laminated silts, sands and gravels containing many angular clasts, which are overlain by up to 3 m of till. Sissons (1978) believed the source of the angular material to have been frost-riven debris transported from the lake shores by ice floes. Peacock (1986), however, considered the material to be waterlain till. East of the section a prominent fan appears to be graded to the level of the 325 m Parallel Road and may therefore be, in part, a delta (Peacock and Cornish, 1989).

Landforms and deposits in the Allt Bhreac Achaidh area [NN 298 875] (Peacock and Cornish, 1989) include ridges of laminated silt and gravel with liquefaction and other deformation structures (Ringrose, 1987b, 1989), river terraces underlain by laminated silt, and glacial and paraglacial land-forms and deposits.

On the hillside north of the viewpoint in Glen Roy, the limit of the Loch Lomond Readvance ice occurs at, or a little beyond, the northern end of a massive, dissected drift plug up to 80 m thick (approximately [NN 298 864]–[NN 300 850]) (Sissons, 1979b). Here, the probable ice margin is marked by a clear drift limit, while on the east side of the glen there is a landslide and drift ridge at the ice limit. Roadside sections near the top of the drift infill reveal glaciofluvial sands and gravels, and lacustrine silts and sands with drop stones and slump structures [NN 296 858]. Various gully exposures (see Peacock and Cornish, 1989) reveal further sands and gravels, and till near the base. These deposits form a glacio-lacustrine delta with foreset and bottomset beds. A sequence of river terraces extends from the southern end of the drift plug to Roy Bridge and merges with the Glen Spean terraces. The former relate to the dissection of the drift plug by the waters of a remnant lake impounded by the plug following the drainage of the 260 m lake (Sissons, 1979a).

At the Caol Lairig [NN 288 864] four shorelines, in part lacustrine deltas, are present on the valley sides; a shoreline at 297 m is related to the altitude of the Caol Lairig–Glen Roy col. Deltas and fans occur on the valley floor. Several sections in glacio-lacustrine sediments (Peacock and Cornish, 1989) display sedimentary structures that may relate to earthquake deformation (Ringrose, 1987b, 1989).

Good sections in lake sediments are frequently exposed in cuttings along the public road in Glen Roy, and they provide a valuable source of sedimentary information. For example, Miller (1987) has identified two types of rhythmic deposit on the basis of their sediment characteristics and strati-graphic position. 'Group I laminates' (fine sands and silts) tend to cap major sediment bodies. They are typical of proximal glacio-lacustrine deposits and they were probably deposited in the 350 m lake during the Loch Lomond Stadial. 'Group II laminates' (silts and clays) typically underlie major sediment bodies. They have characteristics of distal glacio-lacustrine sediments, probably deposited during an early stage of the rising lake sequence.

Several mounds (at [NN 280 910]) near Alltnaray are believed to mark the limit of the Loch Lomond Readvance ice in Glen Gloy (Peacock, 1970; Sissons, 1979b), although this was not accepted by Sissons and Cornish (1983) (see also discussion of the Turret fan above). Inside this limit, thick drift deposits are exposed along the forest road on the west side of the glen. They are attributed to debris flows and delta formation (Peacock and Cornish, 1989).

In Glen Gloy at the Allt Neurlain [NN 303 926] several features are of interest, including fault-controlled streams, a delta at the 355 m road and sandy hummocks that possibly comprise a subglacial fan.

The valley of the Allt Leachdach, a south bank-tributary of the River Spean, provides important evidence for lake levels above 113 m (Peacock and Cornish, 1989). Near Loch a' Bhuic [NN 264 788], which is dammed by an esker, a kame terrace grades into the 260 m shoreline and a 'collapsed' fan/delta is also associated with it. Lower down the valley, deltas and fans are associated with successively lower lake levels at about 143 m, 130 m, 122 m and 114 m. The last level corresponds to the 113 m lake discussed by Sissons (1979a). These levels provide significant evidence for interpreting the sequence of lakes that followed drainage of the 260 m lake. However, it is unclear whether they relate to the period of variable lake level following drainage of the 260 m lake (see Sissons, 1979a) or indicate an intermittent drop in lake level (Peacock and Cornish, 1989). Later terraces and Hjulström-type deltas in Glen Spean are also well demonstrated in this area, for example near Coirechoille [NN 250 807].

Deltas, fans and high-level terraces elsewhere in Glen Spean provide important evidence for interpreting the sequence of events at the time of, and following, the 260 m lake:

- Kame terrace/delta at Achnacochine [NN 310 807] associated with the 260 m Parallel Road and with retreat of the Spean glacier.
- The 175 m delta of the River Spean at Tulloch [NN 330 807].
- Glacio-lacustrine delta, with a good section showing internal composition, at Innis nan Seangan [NN 317 794] above the level of the 260 m Parallel Road.
- Large outwash trains in the valley of the Allt nam Bruach [NN 314 807], associated with the 260 m lake. Following the drainage of the lake, the outwash was dissected by the Allt nam Bruach and the material redeposited at the mouth of the valley as steeply sloping terraces which merge with those of Glen Spean (Sissons, 1979a). Near [NN 309 802] the lowest Parallel Road merges with a glaciofluvial terrace.
- High Spean terrace at Insch [NN 264 802], with good sections in deltaic bottomset beds.

Many of these deposits in Glen Spean consist of delta topset beds overlying bottomset beds, without foreset beds, in contrast to the Roughburn and Treig deltas. They are thus probably of HjulstrOm type rather than Gilbert type G.D. Peacock, unpublished data).

The Inverlair [NN 341 806] and Monessie [NN 298 811] gorges on the River Spean are of interest as features of fluvial erosion and, although utilized during Lateglacial times, are possibly older in origin. At the eastern end of the Monessie gorge several large, and numerous small, potholes are of note.

The cross-valley moraines that occur in Glen Spean and the valley of the Allt Achadh na Dalach west of Spean Bridge may have formed in association with a calving ice margin after drainage of the 260 m lake (cf. Gordon, 1993b).

West of Spean Bridge the River Spean turns abruptly northwards to flow through a gorge, 3 km long and up to 30 m deep, into the Great Glen at Gairlochy, while the obvious continuation of the valley to the south-west is occupied by the misfit Allt Achadh na Dalach (Figure 2.57).

The gorge functioned as a subglacial routeway for the catastrophic drainage of ice-dammed lakes in Glen Spean, but may have originated earlier (Sissons, 1979a). The relationships of river terraces to the gorge are discussed by Sissons (1979a,c). In this area, around Brackletter and across the Spean gorge to the east, there is a varied and important assemblage of glaciofluvial and glacio-lacustrine landforms (Figure 2.57):

- A sequence of cross-valley moraines associated with the Spean Glacier ((Figure 2.57), A-H).
- A Gilbert-type glacio-lacustrine delta related to the 113 m lake ((Figure 2.57), I). Good sections in topset, foreset and bottomset beds have been exposed in Brackletter sandpit.
- Giant potholes in the gorge of the Allt a' Mhill Dhuibh [NN 197 827], possibly formed sub-glacially *by jokulblaup* (glacier burst) discharge (Peacock and Cornish, 1989) ((Figure 2.57), P).
- Glaciofluvial landforms including eskers, kames and kettles north of Brackletter.

At the northern exit of the Spean Gorge and in the area around Gairlochy two suites of terraces relate to former higher levels of Loch Lochy (Peacock, 1970; Sissons, 1979a,c).

The Lundy Gorge is a large meltwater channel which functioned as an outlet for ice-dammed lakes in Glen Spean for a period after the drainage of the 260 m lake. It is an important element in the history of events in the area, and its role and relationships have been discussed in detail by Sissons (1979c). Recent sand and gravel extraction has exposed the rock-cut north wall of the gorge from beneath the kamiform sand and gravel deposits that extend to the north and north-east. There is a good section in these deposits at Tom na h-Iolaire [NN 185 778].

An unusual, 'cirque-like' feature which leads into a meltwater channel on a hilltop south of Glenfintaig House [NN 201 857] ((Figure 2.57), K), has been interpreted by Sissons (1979c) as an abandoned waterfall site recording the final *jökulhlaup* (glacier burst) of the ice-dammed lake in Glen Spean, that had been periodically discharging through the

Lundy Gorge.

Evolution of the glacial lake system

The history of the interpretation of the Parallel Roads is reviewed elsewhere (Gordon, 1993b). In summary, Agassiz (1841, 1842), first propounded the existence of former ice-dammed lakes in Glen Roy, following a visit there in 1840. This idea was subsequently elaborated by Jamieson (1863, 1892). More recently, Sissons (1977b, 1978, 1979a-c, 1981a,b) established in some detail the sequence of events involved. Lakes in Glen Roy, Glen Gloy and Glen Spean were impounded by ice of the Loch Lomond Readvance from west of the Great Glen, coalescing with glaciers from the Ben Nevis range and from the ground to the south via the Laire and Treig breached valleys (Figure 2.58). At its maximum extent the ice reached the western end of the present Loch Laggan and penetrated up-valley into Glen Roy and Glen Gloy (Figure 2.58). As it advanced, the ice ponded back a series of ice-dammed lakes, successively at 260 m, 325 m and 350 m (the rising sequence). The levels of these lakes were controlled by the altitudes of the lowest ice-free cols on their perimeters (Jamieson, 1863; Sissons, 1977b). At the maximum extent of the ice, the Glen Gloy lake, overflowed through the col at 355 m on the Gloy–Turret watershed into the Glen Roy lake which attained maximum dimensions of 16 km in length and 200 m in depth. The level of the Glen Roy lake was controlled by the 350 m col leading into Strathspey at the head of the glen. The waters of a contemporary lake in Glen Glas Dhoire escaped to the east through a col at 325 m into an extensive lake at 260 m controlled by the Feagour col at the eastern end of the present Loch Laggan. As the ice retreated, lakes were formed at successively lower levels (the falling sequence). First in Glen Roy, the 325 m col became available as an outlet for the Roy lake, and the latter fell to its middle level. Subsequent decay and westward retreat of the ice margin to the vicinity of Spean Bridge allowed the Roy lake to fall to the level of the 260 m lake in Glen Spean, which at its maximum extent was 35 km long. In Glen Gloy the level of the lake remained constant, as the col at the head of the glen is the lowest in the watershed.

Drainage of the 260 m lake may be inferred by analogy with modern ice-dammed lakes in many parts of the world, which drain periodically by catastrophic subglacial flow of the ponded water (for example, Liestol, 1956; Stone, 1963; Mathews, 1973; Dawson, 1983; Clement, 1984; Shakesby, 1985; Russell, 1989); the resulting floods are commonly described by the Icelandic term '*jökulhlaup*' (glacier burst). From his detailed investigation of the field evidence, Sissons (1979c) proposed that the 260 m lake was drained by catastrophic subglacial flow through the Spean Gorge and northwards along the Great Glen to the Moray Firth. At Fort Augustus (see Firth, 1993) an extensive spread of sand and gravel is thought to have been deposited by the *jökulhlaup,* as is a large gravel deposit in the Beauly Firth at Inverness (Sissons, 1981a). Subsequently, there was a period of oscillating lake levels and smaller *jökulhlaup*events through the Spean Gorge and later through the Lundy Gorge. Upon the abandonment of the latter route, drainage shifted back to the north-east, first in the form of *a jökulhlaup* along a now-abandoned waterfall and channel near Glenfintaig House then via an overspill channel from a later lake in Glen Spean at 113 m. Considerable fluvial infill took place in Glen Roy and Glen Spean after the drainage of the 260 m lake, and a complex series of over 20 terraces has been identified (Sissons, 1979a), some of which relate to a variety of lower lake levels in Glen Spean and other, later, ones to higher levels of Loch Lochy. Failure of the ice dam in Glen Spean led to final drainage through the Spean Gorge, further dissection of the valley infill and terrace deposition in the Gairlochy area.

Assessment

Glen Roy, Glen Spean and Glen Gloy together form an area of outstanding importance for geomorphology. This area provides the clearest and most complete assemblage of morphological and sedimentological evidence in Britain for the formation and drainage of ice-dammed lakes. It is unique in Britain not only for the extent, clarity and degree of development of glacial lake shorelines, but also for the remarkable assemblage of related landforms and deposits. These record geomorphological processes both during and following successive stages of glacial lake development and catastrophic drainage, and include moraines, stagnant-ice deposits, kame terraces, meltwater gorges, lake-floor sediments, fans, Gilbert-type and Hjulström-type deltas, river terraces and landslides. Moreover, variations in the altitudes of the shorelines have provided new and significant evidence concerning deformation and dislocation of the Earth's crust in glaciated areas. The pre-eminence of the area is also recognized historically when, particularly during the 19th century, it played a significant role in the development of geomorphological ideas and models of landscape

formation.

Scientific interest in Glen Roy, Glen Spean and Glen Gloy is therefore focused not only on individual or unique landforms, but also on the total assemblage of features, how they interrelate and together provide the evidence for interpreting the complex sequence of events recorded in the land-forms and sediments of the area. The prime features of this interest from a fluvial and lacustrine perspective are as follows:

1. The Parallel Roads which are the best examples in Britain of shorelines formed by ice-dammed lakes; their extent, altitudes, clarity of preservation, variations in form and nature (both erosional and depositional) and relationships to former ice-fronts are all of major importance.
2. The alluvial fans in Glen Roy, which are among the most extensive and clearly developed in Britain, both as landform examples and for their potential for sedimentological studies. By contrast with other alluvial fans included in this volume (e.g. Quoich fan, Feshie/Spey confluence fan), the origin of the fans in Glen Roy is now relatively well documented.
3. The lake deltas, particularly at Inverlair-Fersit, Roughburn and Brackletter, which are of key interest both for landforms and sedimentology, and are among the best examples of their kind in Britain; compared with Achnasheen (see Gordon and Sutherland, 1993) they generally demonstrate much more extensive sediment collapse related to burial and melting of masses of glacier ice. The contrasting Gilbert-type and Hjulström-type deltas are essential elements in understanding the sedimentary processes during and following the time of the Parallel Roads lakes.
4. The river terraces in lower Glen Roy and middle and lower Glen Spean, which in their landforms and sediments preserve a detailed record of geomorphological change and adjustments to changed sediment supply and discharge conditions at the Lateglacial–Holocene transition and subsequently during the Holocene. The staircase of over 20 terraces in lower Glen Spean provides one of the most complete records of valley floor incision thus far recorded in Scotland. This aspect has significant potential for further research in the light of studies elsewhere (e.g. Maizels and Aitken (1991), and the terraces on the River Findhorn (see report in this volume)).
5. The meltwater gorges, possibly related to catastrophic lake drainage, which afford some of the most noteworthy examples of bedrock channels in Scotland of known origin.
6. The lake sediments, with their potential for process studies and interpreting patterns of palaeoseismicity.
7. The total assemblage of features, which provides uniquely detailed evidence in Britain for catastrophic glacial lake drainage.
8. The archive of landforms and deposits clearly related to a particular geological datum, which provides unsurpassed potential for comparative studies of a whole range of geomorphological process magnitudes and rates during a period of extremely rapid environmental change.

In summary, many of the individual fluvial/glaciofluvial and glacio-lacustrine landforms are not only exceptional in terms of their quality, but also in terms of their location within a relatively small area. Furthermore, they provide the evidence for the sequence of events associated with the formation and catastrophic drainage of the most famous ice-dammed lake system in Britain. Although ice-dammed lakes have been identified elsewhere in Scotland (Ballantyne, 1979; Sissons, 1977a, 1982) and in England (Shotton, 1953; Straw, 1979; Gaunt, 1981), extensive shorelines and related landform assemblages are rarely as well developed or preserved. Above all, what distinguishes Glen Roy and the Parallel Roads as a locality of international importance for geomorphology is the total range of landforms, their clearly demonstrated relationships and the relatively compact extent of the whole assemblage.

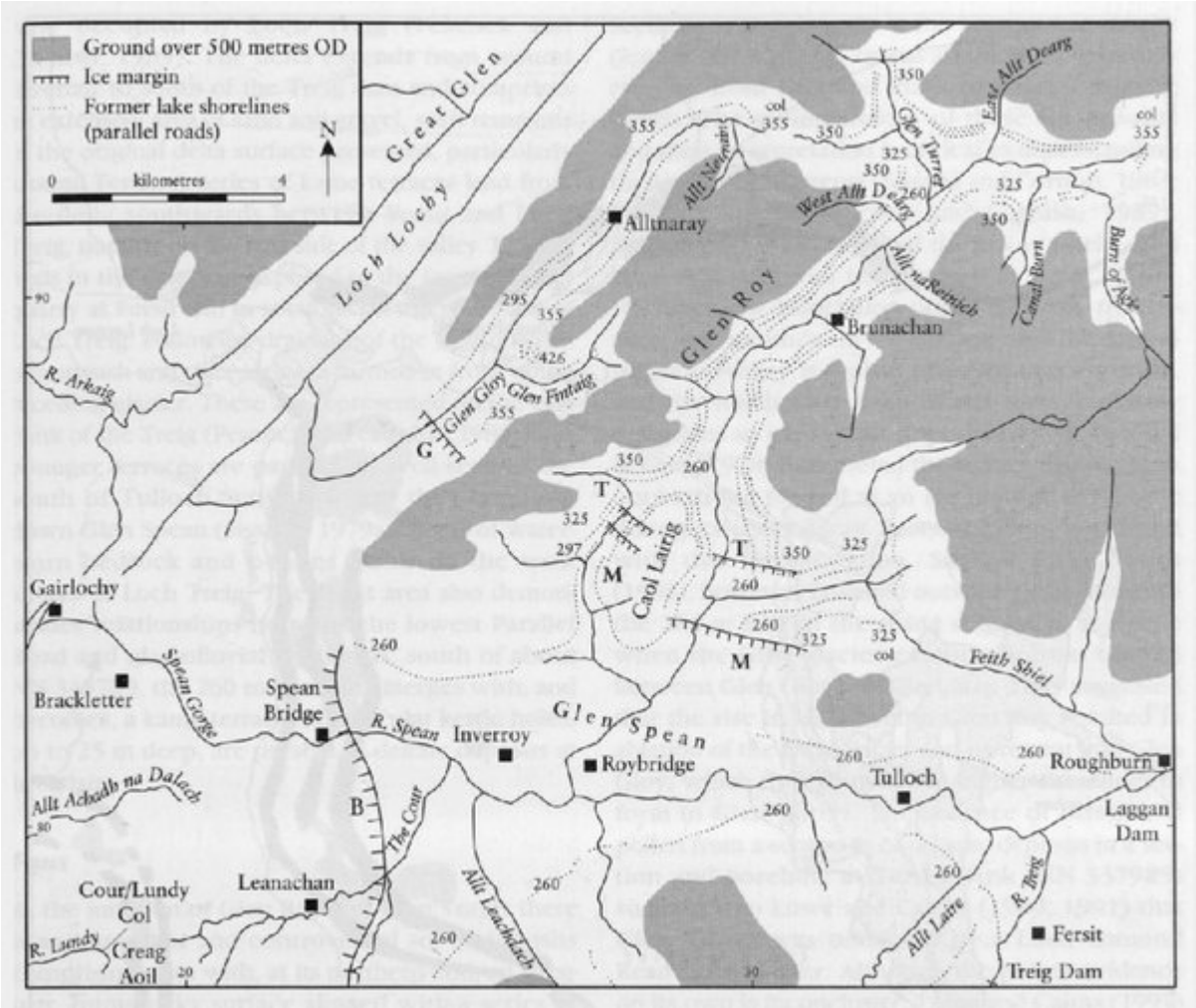
Although the area has been studied for over 200 years, it still has significant potential for further research, particularly on the sedimentology of the various deposits, the relationships between sediments, landforms and geomorphological processes, the changes in process rates through time and problems of landform genesis and chronology.

Conclusion

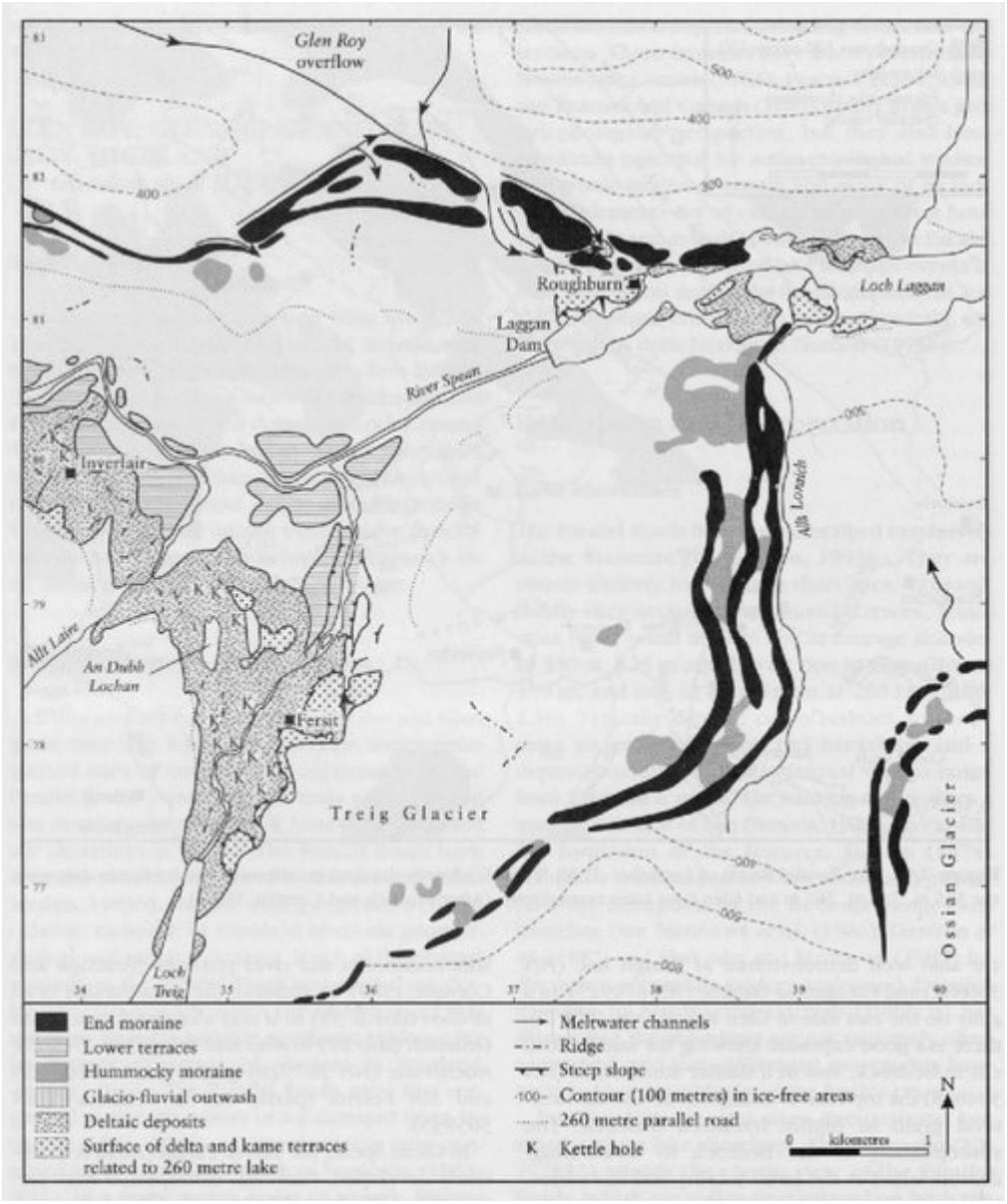
Glen Roy is one of the most famous landform landmarks in Britain and is internationally recognized as a classic locality for the shorelines of an ice-dammed lake, represented by the Parallel Roads, that formed during the Loch Lomond

Stadial (approximately 11 000–10 000 BP). In their extent, continuity and degree of preservation, the Parallel Roads of Glen Roy and adjacent glens are unique in Britain. Associated with the Parallel Roads is a remarkable system of fluvial/glaciofluvial and glacio-lacustrine landforms and deposits recording a complex sequence of landscape changes in Lateglacial and early Holocene times. Many of these features are amongst the most extensive and clearly developed of their kind in Britain.

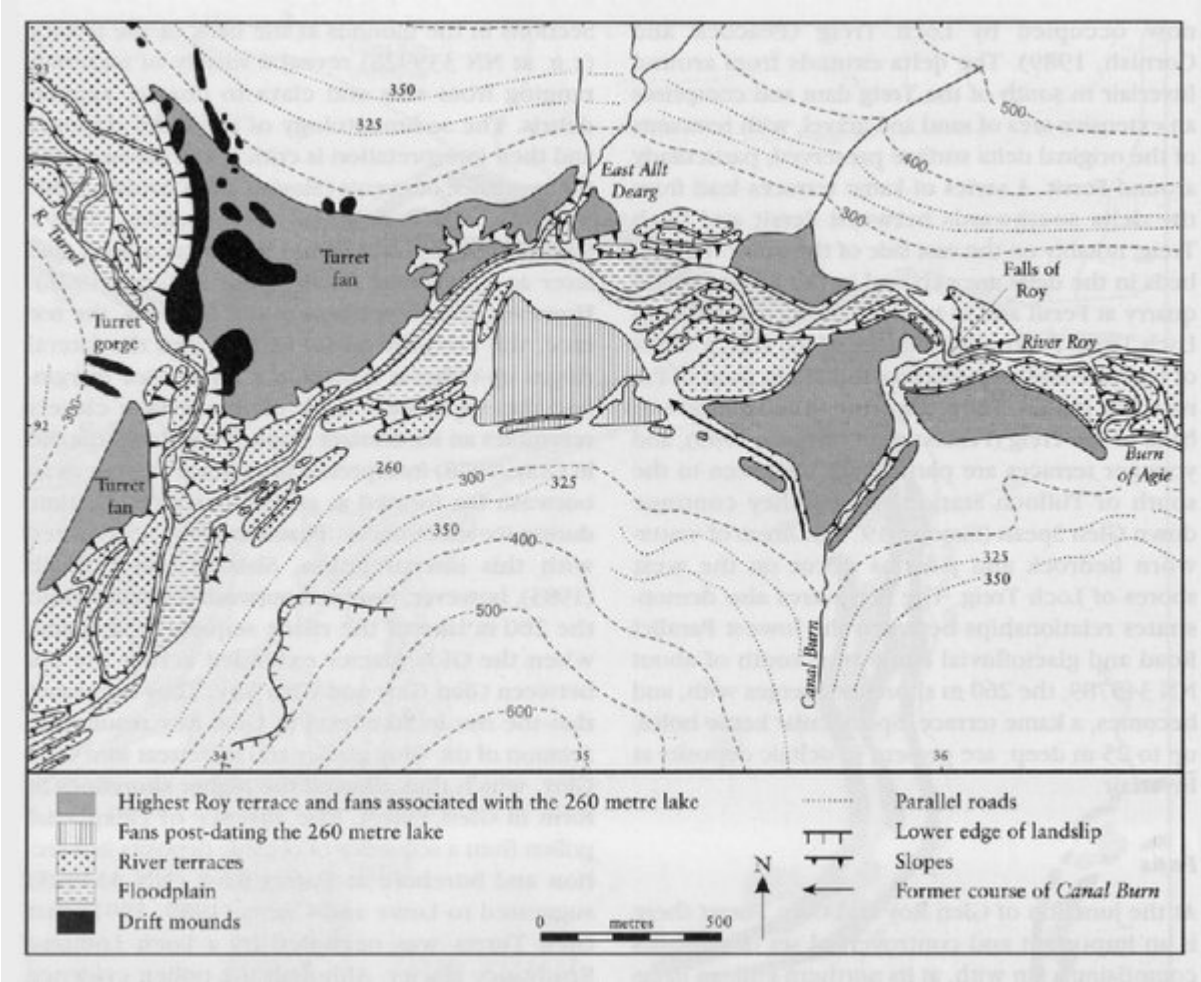
References



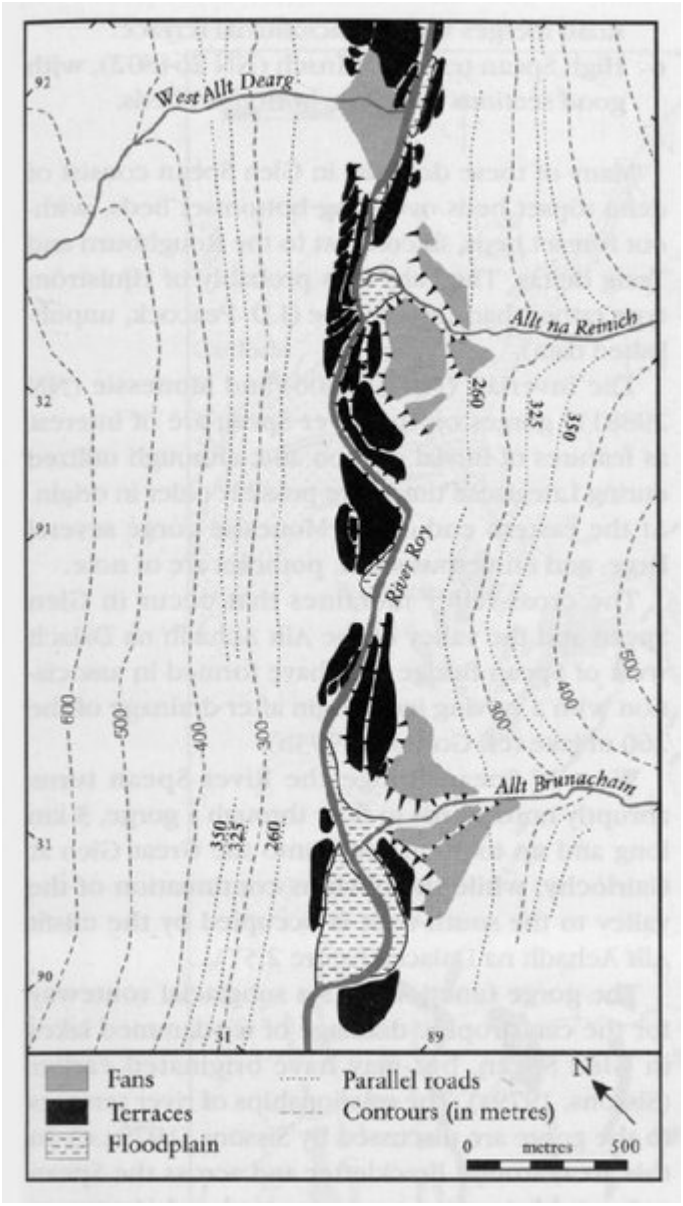
(Figure 2.53) The Parallel Roads of Lochaber. T, M, B and G identify the final positions of the ice-fronts damming the 355 m, 325 m, 260 m and Glen Gloy lakes respectively. (After Peacock and Cornish, 1989.)



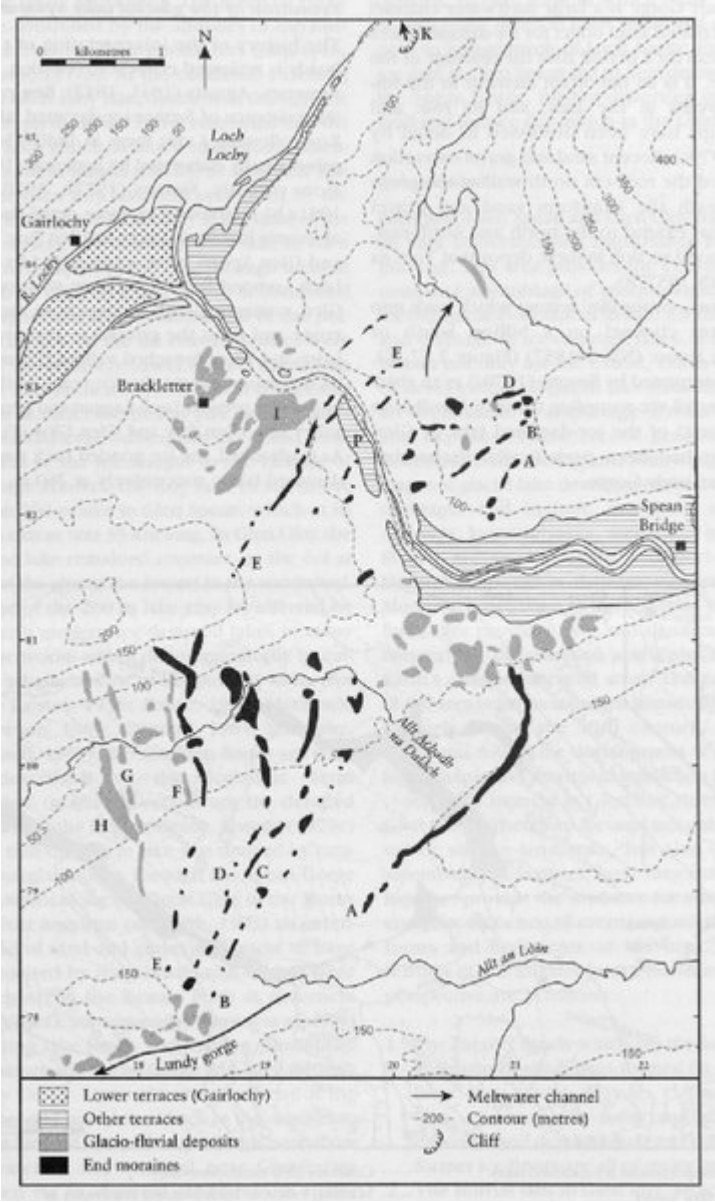
(Figure 2.54) The landforms and deposits of the Treig–Laggan area. (After Sissons 1977b; Peacock and Cornish, 1989.)



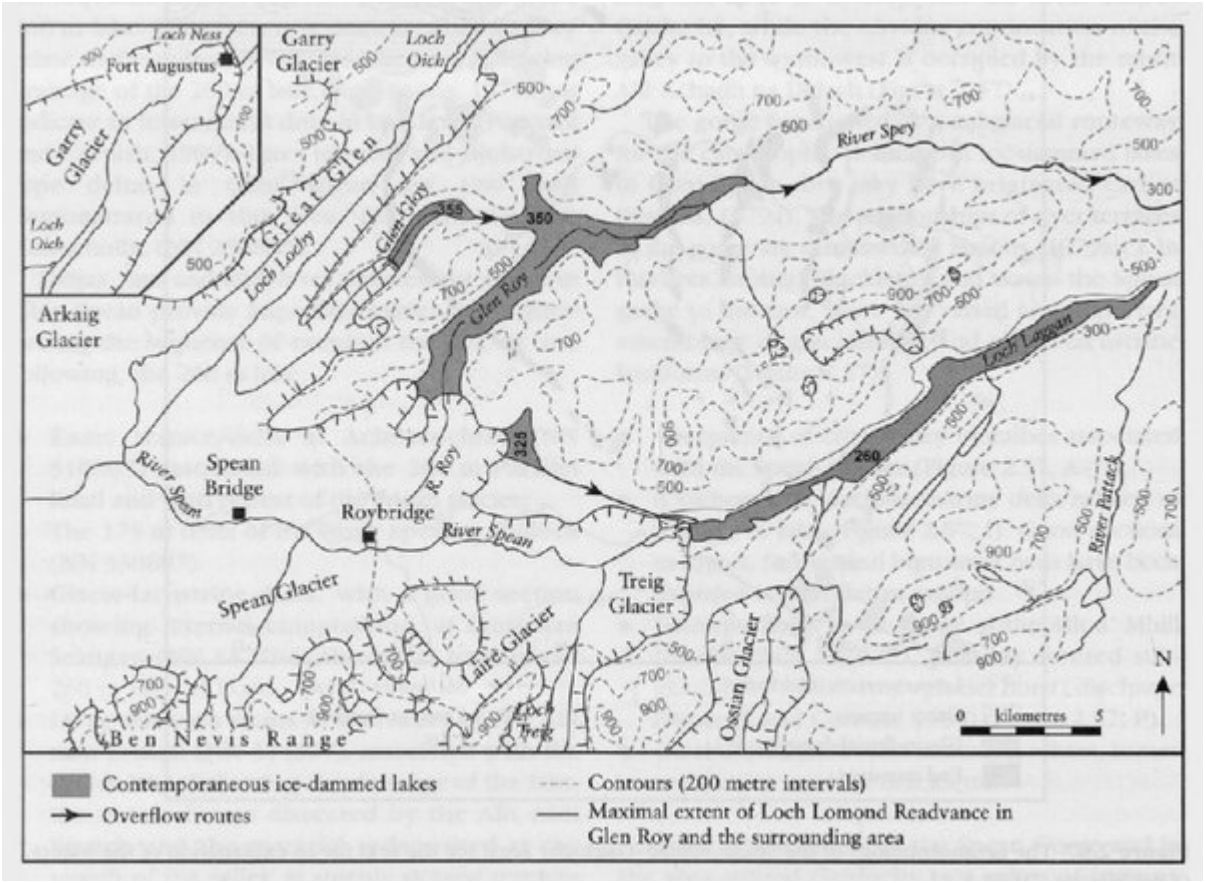
(Figure 2.55) The geomorphology of the northern part of upper Glen Roy. (After Sissons and Cornish, 1983.)



(Figure 2.56) The fans and river terraces of the southern part of upper Glen Roy. (After Sissons and Cornish, 1983.)



(Figure 2.57) The geomorphology of the Spean Bridge–Gairlochy area: see the text for an explanation of the letters. (After Sissons, 1979c.)



(Figure 2.58) The Loch Lomond Readvance ice limits and associated ice-dammed lakes in the Glen Roy–Glen Spean area. (After Sissons, 1981b.)