Chapter 9 Shaping the landscape

Pleistocene: advance and retreat of the glaciers

The scale of Glen Coe, with its towering mountains, make it a place of wonder, but, despite the great age of the caldera volcano, it was only during the last 2 million years, in the Quaternary Period, that the glen took on its spectacular appearance (Plate 27).

Western Scotland was heavily glaciated during the Pleistocene Epoch and, although the exact number of glaciations and their relative severity is not precisely known, it is likely that they started around 2.4 million years ago (Gordon and Sutherland, 1993). Little evidence exists on land for those episodes that predated the last major glaciation, which occurred between about 40 000 and 11 500 years ago.

Over the last 100 000 years, the Scottish climate has been dominated by harsh, arctic or subarctic conditions. This largely cold period was punctuated by brief temperate spells (interstadials) of 10 000 to 15 000 years' duration; we are currently in such an interstadial, known as the Holocene Epoch (Figure 27). Between about 25 000 and 15 000 years ago, during the last glacial stage of the Pleistocene (late Devensian Age), intense cold prevailed and glaciers grew to form ice caps in the western Highlands, the Cairngorms and the Southern Uplands. These ice caps coalesced to form a large ice-sheet centred over western Scotland. Evidence from glacial erratics and striae suggest that during this glaciation the general direction of ice movement in the Glencoe area was from east to west from a source in the Rannoch Moor area, close to the present-day watershed. The deep valley of Glen Coe was a major route for ice; glacial striae occur at an altitude of 900 m above sea level on Am Bodach [NN 169 579] and Stob Coire Leith [NN 152 588], and glacial erratics occur at this altitude on Stob Dearg [NN 216 542] and Meall Dearg [NN 162 583] (Bailey, 1960), suggesting that even the highest peaks were covered by the ice-sheet. However, much of the evidence for this, and previous glaciations, has since been removed.

Soon after 18 000 years ago the ice-sheet in Britain was in retreat. Deglaciation did not occur smoothly or synchronously across Scotland, but was punctuated by several re-advances of varying magnitude (Robinson and Ballantyne, 1979; Dawson, 1982; Merritt et al., 1995). The climatic implications of these re-advances and the configuration of the ice-sheet in Britain between about 17 000 and 15 000 years ago are currently the subjects of much debate (McCabe et al., 1998; Adams et al., 1999; Bowen et al., 2002).

Evidence for a short-lived interstadial between 14 5000 and 13 000 years ago is widespread in Scotland, but it is not known whether the Late Devensian glaciers disappeared completely at this time. About 13 000 years ago, ice began to accumulate once again in the south-west Highlands. At the height of this glacial re-advance, which is known as the Loch Lomond Stadial, a considerable ice cap was centred just a few kilometres east of the head of Glen Coe and outlet glaciers extended to sea level in many of the major west Highland fjords. Ice in the Glencoe area was topographically constrained; on mountain spurs such as the Three Sisters an upper zone of advanced weathering can be distinguished from a lower zone of ice-scoured rock. This pattern of weathering and erosion in combination with other geomorphological evidence such as the presence or absence of blockfields, solifluction sheets and fossil screes has been used to delimit the maximum altitude of glaciation during the Loch Lomond Stadial (Thorp, 1981, 1986). The Glencoe glacier probably reached a height of 500 to 600 m on Beinn Fhada, 400 to 450 m on Meall Mòr and 300 m at Ballachulish (Figure 28). Much of the Aonach Eagach and the Bidean nam Bian massif would have remained as ice-free nunataks. This brief glacial period lasted less than 1500 years and ended abruptly 11 500 years ago.

The legacy of glaciation is everywhere in Glen Coe. Large erratic boulders lie scattered on the valley floor and perched on the valley sides. Boulders of granitic rock from the Rannoch Moor Pluton occur on Buachaille Etive Mòr and on the Aonach Eagach at over 800 m above sea level, about 300 m higher than the remaining outcrop (Bailey, 1960). Extensive glacial deposits flank the valley sides of Glen Coe, Glen Etive and their tributary valleys. Where gullies cut into these, poorly sorted, matrix-supported, sandy clay-rich diamicton is exposed. This deposit, generally referred to as till, commonly varies greatly in sedimentology and surface expression, recording deposition in various glacial settings. Where

compact, clay-rich diamicton forms smooth sheets, a subglacial origin is inferred, in accord with studies of modern, warm-based glaciers (Boulton, 1970, 1986). Good exposures of this type of deposit occur near Loch Achtriochtan [NN 142 570] and on the flanks of An t-Sròn [NN 123 559]. Other, less well-consolidated, sand-rich deposits record an ice-marginal or supraglacial origin. Commonly, these have a hummocky, apparently chaotic morphology, and were probably laid down during glacier retreat. Good examples abound on Rannoch Moor, particularly around Lochan Mathair Eite [NN 285 541]. Well-defined, individual moraines are not common in the Glen Coe–Glen Etive area, where hummocky glacial deposits are more typical. The best-defined end moraines are found at the mouth of the Lairig Gartain, on the north-west flank of Buachaille Etive Mòr [NN 2212 7554], near Alltchaorunn in Glen Etive [NN 194 512], and in Fionn Ghleann [NN 127 539].

The moraine ridge in Fionn Ghleann is associated with a conspicuous series of sand and gravel terraces, which were probably deposited as ice-contact fans (or deltas) by running water issuing from a melting glacier. How much of the material mapped as alluvium on the floor of Glen Coe and the nearby valleys is of glaciofluvial origin, rather than recent fluvial origin, is uncertain. The coarse, bouldery, modern river deposits in Glen Coe are difficult to distinguish from other material that may have been left behind by glacial meltwater torrents. It is probable that much of the sediment immediately down-valley from Loch Achtriochtan [NN 135 566] was deposited at the end of the Loch Lomond Stadial by meltwater flowing from wasting glaciers.

Holocene: after the glaciers

Radiocarbon dates from organic sediments deposited in enclosed basins have been used to determine the timing of deglaciation. On Rannoch Moor, which was one of the centres of ice accumulation, radiocarbon dates of between 9800 and 10 600 years before present demonstrate that the area was ice-free shortly before then (Lowe and Walker, 1992).

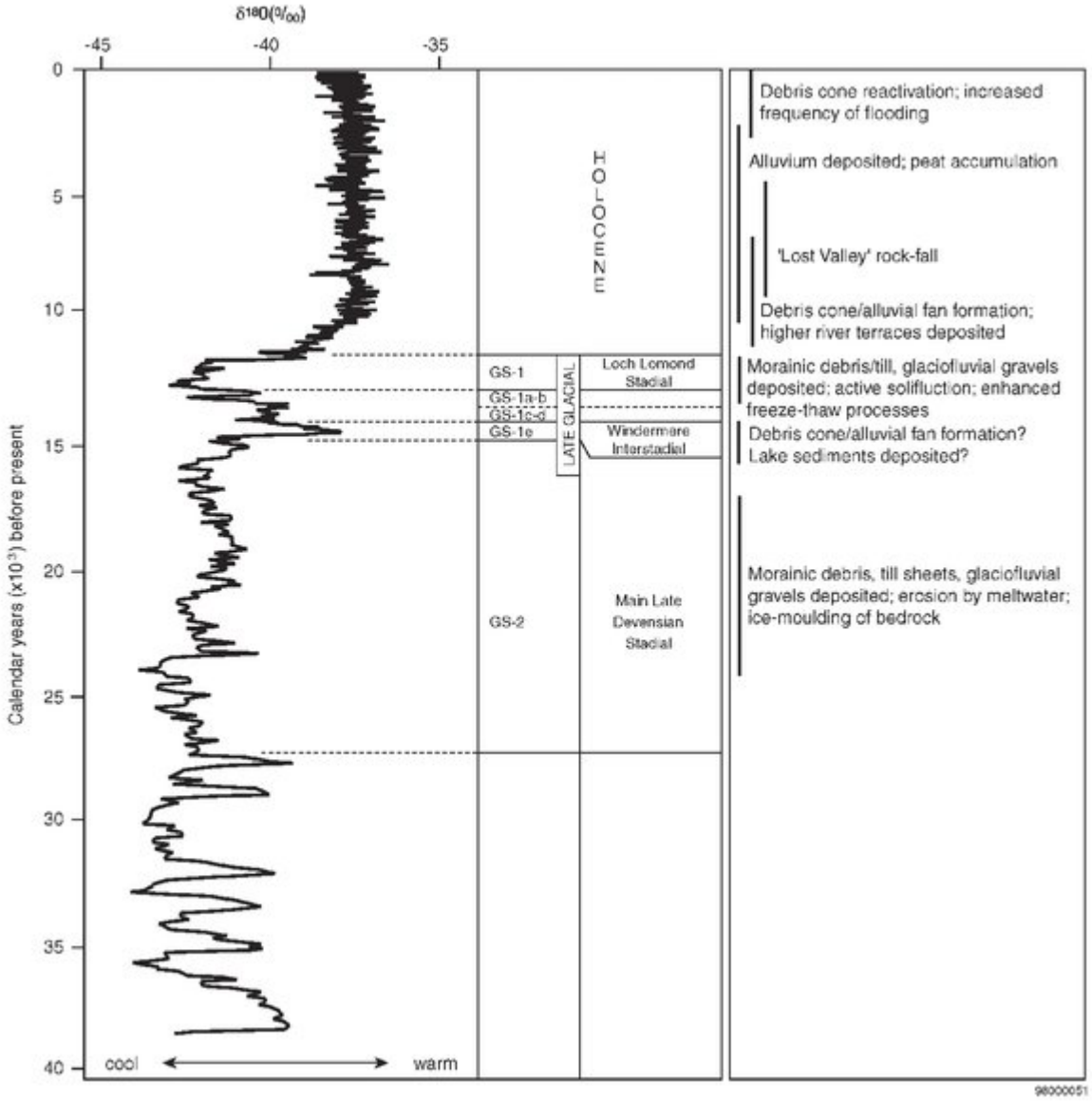
Landscape modification has continued since the retreat of the glaciers. Large amounts of debris and surface sediment were left in potentially unstable settings in Glen Coe when the ice melted. Over the last 11 000 years, various slope processes have created some of the finest examples in Britain of debris cones and mountain alluvial fans (Brazier, 1992; McEwen, 1997). Many of these are currently active and are thought to have undergone renewed activity in the last 500 years (Innes, 1983). The unusually large number of active fans in Glen Coe is largely due to the geology of the surrounding mountains. The abundant microdioritic to microgranitic dykes (Etive Dyke Swarm, see p.100) have weathered preferentially to form spectacular, steep gullies that channel runoff and accentuate erosion. The debris cone at the base of the towering cliffs of Am Bodach is the largest and most striking talus deposit in Glen Coe. It is fed from the north-west flank of Am Bodach and the extensive debris fields beneath The Chancellor (see (Plate 14b)). When swollen, the River Coe erodes the toe of this landform and causes the channels on its surface to incise to a new base level. The last large flow of debris on this cone occurred in AD 1875, but lesser events occur on a timescale of ten years or less. All of the steep debris cones in the valley are commonly reactivated during heavy rain (Innes, 1983; Brazier, 1992); new lobes of debris form as the main channels migrate across the cones.

The River Coe has changed its course several times during the past 130 years (McEwen, 1997), and has probably done so for the past 10 000 years, owing to fluctuations in sediment load and natural instability. Progradation of a delta into Loch Achtriochtan is gradually reducing the size of this lake; as Bailey (1960) commented, the loch is ‘in process of extinction’.

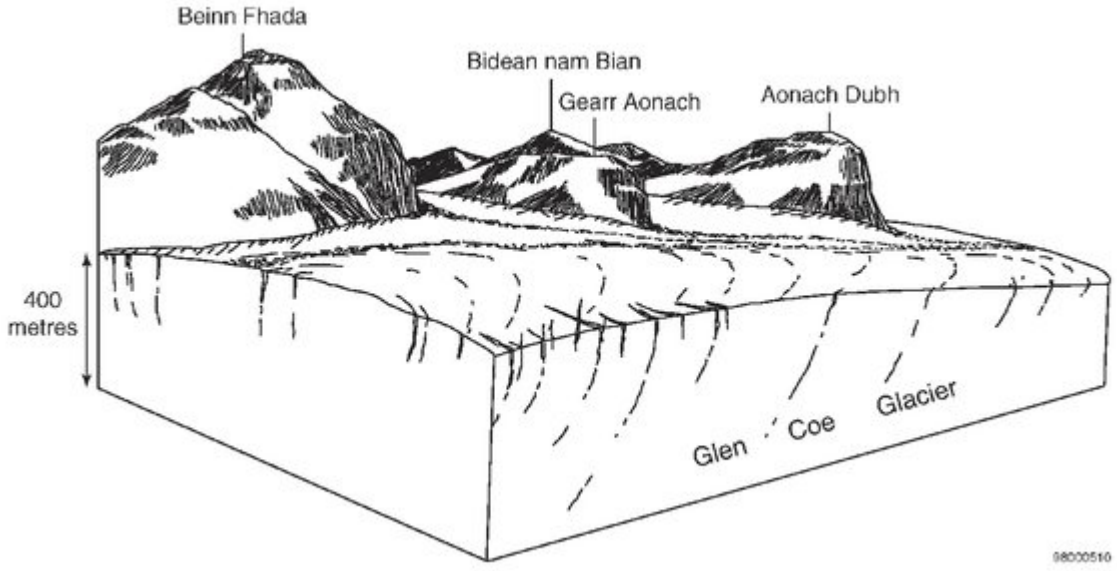
Occasional catastrophic slope processes have resulted in significant landscape change. A large rockfall deposit, which formed during postglacial times in Coire Gabhail (Lost Valley [NN 166 556]), is a spectacular example (Plate 18) and is believed to be the largest catastrophic rockfall feature in Britain (Ballantyne, 1991). Debris from the flank of Gearr Aonach fell into the valley, probably owing to two massive rock-slope failures. The boulders form a talus ‘dam’ over 20 m high; hundreds of thousands of tonnes of debris choke the narrow valley, making it difficult to pass through. Alluvial sediment accumulated behind the dam to form a small alluvial plain that affords good grazing; in historic times cattle were hidden here during times of conflict. The cause and timing of the rock fall are not precisely known.

References

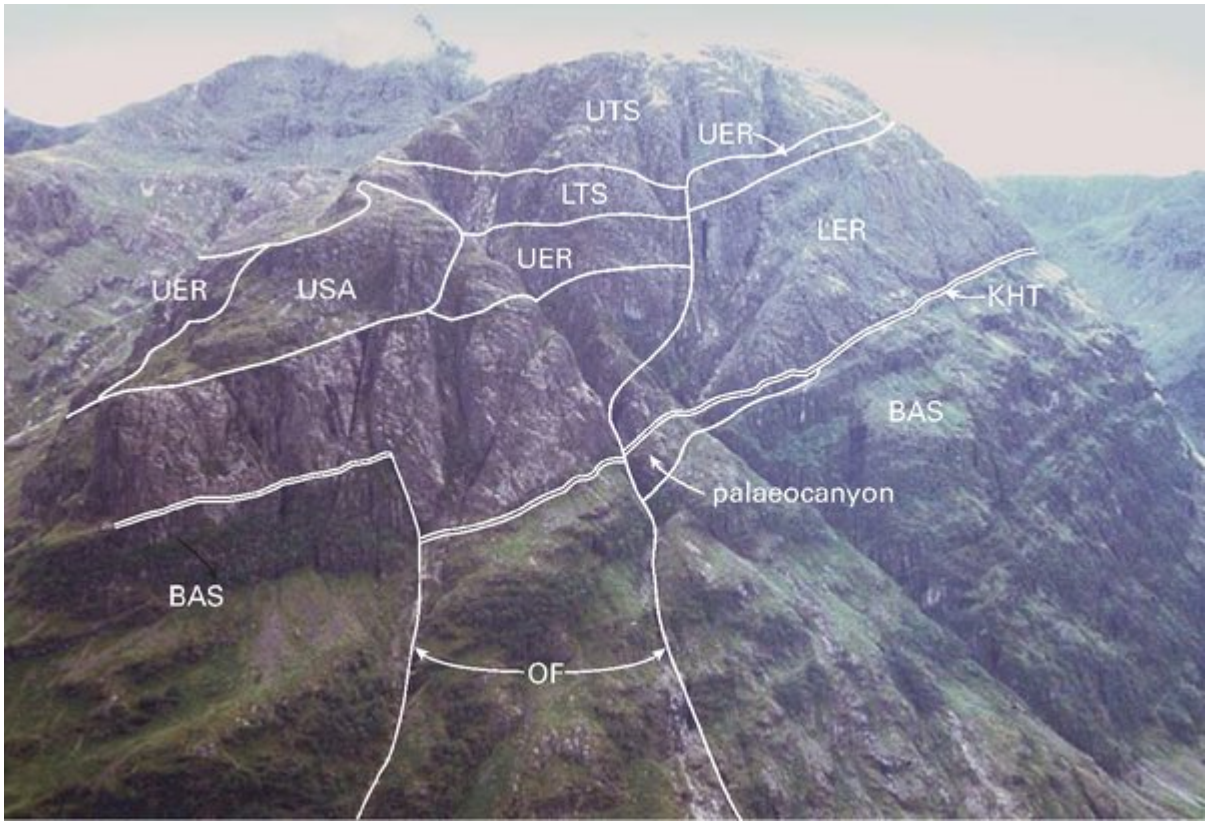
(Plate 27) Glen Coe, looking westwards. Note the U-shaped cross profile of this classic glacial trough (P000731).



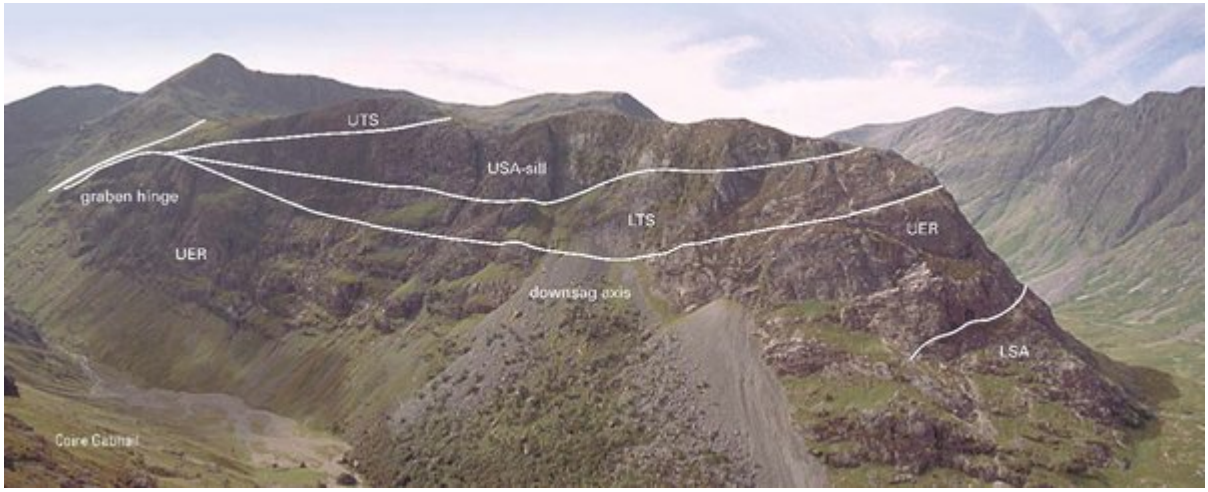
(Figure 27) Relative timing of events affecting the Glencoe area over the last 40 000 years (or since the last Glacial Maximum). The graph on the left shows the oxygen isotope record from the Greenland (GISP) ice-core, a proxy for Northern Hemisphere temperature.



(Figure 28) A reconstruction of the Glencoe glacier approximately 12 000 years ago, during the Loch Lomond Stadial. View towards south-west.



(Plate 14b) North face of Aonach Dubh [NN 15 56] and northern side of Glen Coe [NN 16 57]. b. Traces of the Northeastern Graben Fault (NEGF) and its footwall scarp along the north side of the Pass of Glencoe [NN 16 57]. The scarp, composed of Basal Andesite Sill-complex (BAS), formed a volcanotectonic topographical barrier during emplacement of the Upper Etive Rhyolite (UER), which is ponded against it, as well as forming a subterranean barrier during intrusion of the Lower Streaky Andesites sill (LSA-sill) within the Glencoe Graben. Lower Streaky Andesites lavas, which form much of the ridge crest from Am Bodach to the Aonach Eagach, were extruded onto the footwall block outside of the graben. The talus cone in the lower left of the view is the largest and most active in the vicinity (P611787). CRT Crowberry Ridge Tuffs; OF Ossian Fault.



(Plate 18) Gearr Aonach viewed from the east across Coire Gabhail [NN 16 55] showing ponding of the Lower Three Sisters Ignimbrite (LTS) within a downsag north-west of the Queen's Cairn Fault. The ignimbrite is up to 50 m thick along the downsag axis (which trends north-west along the Glencoe Graben) and it thins progressively towards the south-western graben hinge, as does the overlying sill of the Upper Streaky Andesites (USA). The Upper Three Sisters Ignimbrite (UTS) shows similar thinning relationships, but overlaps the hinge line. The large composite debris cone in the foreground was formed by catastrophic rockfall following deglaciation (see p.109) (P611793). LSA Lower Streaky

Andesites; UER Upper Etive Rhyolite.