Y Carneddau

Highlights

Classic ground in early studies of glacial and periglacial phenomena, this site shows some of the finest patterned ground in Wales. Many periglacial landforms had their origins in the Late Devensian but others are still active. Late-glacial depositional features include perhaps the most complex suite of Younger Dryas, final cirque glaciation, moraines in Wales.

Introduction

The Carneddau are important for their range of glacial and periglacial landforms including well developed cirques and Devensian late-glacial moraines, for example at Ffynnon Llugwy and Melynllyn. The Carneddau are noted for periglacial landforms formed by frost-action both during the Late Pleistocene and at the present day (Pearsall 1950; Tallis and Kershaw 1959; Ball 1966; Ball and Goodier 1970; Scoates 1973). Like Snowdon and the Glyderau, the area was one of the first to be studied with respect to the Glacial Theory (for example, Buckland 1842; Mackintosh 1845; Ramsay 1860, 1881; Kidson 1898; Marr and Adie 1898; Jehu 1902). It has featured in geomorphological studies by Seddon (1957), Embleton (1962, 1964a), Unwin (1970, 1973, 1975) and Gray (1982a), and evidence from selected sites within the area provides the basis for reconstructing environmental and vegetational history (Woodhead and Hodgson 1935; Thomas 1972; Walker 1978).

Description and interpretation

The Carneddau lie east of the Glyderau and Snowdon massifs and form the largest area of upland Wales over 900m OD. To the west the range is bounded by the Nant Ffrancon trough, to the east by the Conway Valley and to the north by the coastal plain. The character of the landscape is markedly different to the Glyderau and Snowdon groups of the northern Snowdonian massif, being less highly dissected by large-scale features of glacial erosion. Nonetheless, Unwin (1975) recognised nineteen cirques within the Carneddau, including several examples such as Cwm Lloer and Cwm Ffynnon Llugwy with a convincing staircase of forms. Morphologically the cirques of this range vary considerably from large, semi-circular and over-deepened forms such as those at Dulyn and Melynllyn, to rounded and shallow hollows such as those at Moch and Bychans (Unwin 1975). In contrast to the Glyderau where the dominant cirque orientation is along the strike with the cirque floors excavated in less resistant strata, the Carneddau cirques show considerable variation in relationship to structure. The over-deepened form at Dulyn (Figure 38) is particularly exaggerated, with Jehu's (1902) soundings showing the cirque lake to be 57m deep.

The massif was probably occupied by ice and acted as a dispersal centre on a number of occasions during the Pleistocene, and it also displays significant evidence for a late phase of cirque glacier development. The cirque moraines of the area have been mapped and discussed by Seddon (1957), Unwin (1970, 1973, 1975) and Gray (1982a), and most are believed to have formed during the Younger Dryas (between c 11,00010,000 BP).

Of the cirque forms included within the GCR site, those at Melynllyn, Dulyn and Cwm Ffynnon Llugwy (Figure 38) are particularly notable, both as erosional forms, and for their unusually diverse range of associated depositional landforms of Younger Dryas age. A particularly fine example of a drift and boulder limit with several recessional moraines behind occurs in Cwm Ffynnon Llugwy (Gray 1982a). Here, Gray traced the limit of a former glacier for about 900m on the west side of the valley, although comparable evidence from the eastern side was absent. At c. 630m OD a lateral moraine complex, covered with boulders, occurs south of Craig-y-Llyn cliffs. Below about 530m OD the extent of the former glacier is marked by drift and boulders that run across the valley floor to reach Afon Llugwy. The river at this point is incised into what Gray interpreted as a small marginal glacial meltwater channel. Inside the glacial limit the ground appears to be a chaos of morainic undulations and boulder spreads. However, Gray was able to trace at least five ridges marking successive stages in ice recession. A sequence of recessional features associated with the retreating ice mass

also occurs north of the reservoir. The depositional landforms in Cwm Ffynnon Llugwy were formed by the largest glacier of Younger Dryas age in the Carneddau range (Gray 1982a).

In contrast, the ice limit in the nearby Melynllyn cirque is marked by an unusual, straight and virtually boulder-free moraine (Gray 1982a). At Cwm Dulyn, however, the drift limit is again complex; there is a striking contrast between the mass of blocks and boulders inside the northern limit and the smooth, peat-covered slopes outside (Gray 1982a). Southwards, the limit grades into a series of low (<1m), boulder-covered, end-moraine ridges, from which at least three recessional positions can be recognised (Gray 1982a).

Periglacial landforms and features

The Carneddau Mountains contain a range of periglacial landforms and features probably unparalleled elsewhere in Wales, although the inaccessibility of the area has meant that relatively few studies have been carried out (Pearsall 1950; Tanis and Kershaw 1959; Ball 1966; Ball and Goodier 1970; Scoates 1973). The distribution of the main features is shown in (Figure 38).

Pearsall (1950) was the first to record patterned ground in the Carneddau; on the broad saddle (Waun-y-Garnedd) connecting Foel Grach with Carnedd Llewellyn, where he described a series of stone polygons and stripes. These were later studied by Tallis and Kershaw (1959) who concluded that the polygonal patterns were unstable, showing rapid rearrangements because of fluctuating climatic conditions, particularly the erosive influence of wind and rain. Ball and Goodier (1970) recorded a graduated sequence of features ranging from well defined polygons, through elongated polygons to rather sinuous sorted stripes, in each case with a repeat distance of some 0.30–0.45m. They showed that over a number of seasons the patterns were less active than when observed by Tallis and Kershaw (1959). They also noted that such features were absent at lower altitudes in Snowdonia, and concluded that the present climate could only sustain patterned ground at the highest altitudes (that is above 900m). This was supported by a study of periglacial features throughout the Carneddau which confirmed that all polygons were found, without exception, above altitudes of 913m (3,000 ft), on volcanic rocks, and always in groups on flat or nearly flat areas (<2° of slope) (Scoates 1973).

Scoates also described sorted nets (patterned ground transitional between circles and polygons) on a number of other flat summit tops (for instance, Drosgl and Llwydrnor) and low angle slopes (for instance, Foel Fras) at high altitude. Patterned ground in the form of stone stripes was also recorded, with good examples at Foel Fras and on the back wall of Cwm Ffynnon Llugwy. No conclusions were drawn about the distribution of these features with regard to altitude and aspect, although most of the stripes showed a north-west aspect above 770m (2,500 ft).

A wide range of other features associated with frost-action have been recorded in the Carneddau (Ball and Goodier 1970; Scoates 1973). Blocicffelds are widespread and conspicuous, being especially well developed at Foel Fras [SH 696 683] at 942m (3,092 ft), Garnedd Uchaf [SH 687 668] at 904m (2,970 ft), and Bera Bach [SH 673 678] at 780m (2,560 ft) (Scoates 1973). These blocicffelds, felsenmeer or areas of 'mountain-top detritus' were considered to have formed by shattering of bedrock, the size of the accumulated material being highly dependent on lithology, temperature and the duration and rate of weathering. The age of the features is not known, but their large-scale development probably precludes a Holocene age, and it would appear that major gelifractive activity has now ceased (Scoates 1973).

Frequently associated with the blockfields are a number of well developed tors. These have been divided into upland tors, including degraded tors on crests, ridges and summit plains (Scoates 1973), and these are equivalent to the tor-like summits (Ball and Goodier 1970), and valley side or buttress tors (Scoates 1973). Examples of the summit tors include those at Foel Grach, Garnedd Uchaf, Bera Bach and Bera Mawr. The origin of tors occupies a substantial literature and is more fully discussed elsewhere (see Trefgarn and Preseli reports) and a wide variety of mechanisms has been proposed. Linton (1955) suggested a non-periglacial origin; with tors formed at depth under warm humid conditions, followed by a period of exhumation. However, Palmer and Nielson (1962) in discussing the origin of granitic tors on Dartmoor, proposed that formation was due to periglacial conditions. Angular differs and the lack of clay in the disintegrated residue led Scoates to argue a periglacial origin for features in the Carneddau. However, it is likely that weathering products from any chemical weathering phase would have been removed from the exposed watershed locations, although Ball (1964) described the weathering product gibbsite, a clay mineral from the feldspars of the

microporphyritic granite on Y Llymllvvyd [SH 631 609] in the Glyderau. Other workers (for example, Jahn 1962), however, have stressed the importance of rock structure rather than climatic factors in tor formation, and in this context Scoates (1973) noted that jointing had played an important role in the formation of the tors at Bera Mawr and Bera Bach.

One of the most extensive landforms associated with frost-action in the Carneddau is scree. Particularly extensive and well developed examples are found in Cwm Ffynnon Llugwy and around the slopes of Yr Elen. The characteristics of these features have been described in detail by Ball (1966), Ball and Goodier (1970) and Scoates (1973). Ball (1966) suggested that the Carneddau screes, in common with those elsewhere in Mid and North Wales, dated from Pollen Zones I and III of the Devensian late-glacial, and that re-sorting, rather than accretion of freshly shattered rock, was the dominant contemporary process.

The Carneddau also contain a wide range of other features attributable to frost-action. These include widespread solifluction deposits and terraces, stone or turf-banked lobes, terracettes, earth-hummocks and gliding blocks; the morphology and distribution of these features are discussed by Ball and Goodier (1970) and Scoates (1973), but they have not been investigated in detail.

Many factors have contributed to the development and range of periglacial landforms seen in the Carneddau massif. In a detailed study of similar features in the Cairngorms, King (1968) pinpointed five controls of overriding importance, namely lithology, slope angle, altitude, vegetation and aspect. Scoates assessed the range and distribution of periglacial features within the Carneddau with respect to these parameters and she concluded that lithology was of overriding importance in tor and blockfield formation and, to a lesser degree, in scree development. Patterned ground, however, occurred irrespective of underlying lithology.

As regards angles of slope, Scoates considered an almost flat, plateau-like surface to be a prerequisite for blockfields and to a lesser extent tors. Similarly, patterned ground in the area was clearly related to changes in slope angle, with nets, polygons and circles occurring on slopes of <3°, and stone stripes occurring in areas where slopes exceeded 5°.

Altitude was seen by Scoates as being the most significant factor in limiting the distribution of features, particularly patterned ground which occurs over a small range and always around 900m in the Carneddau. She concluded that the available evidence did not emphasise any particular correlation of periglacial features with aspect, save for the lack of westerly-facing phenomena. The effect of vegetation was also similarly difficult to assess.

Holocene environmental and vegetation history

With the exception of Woodhead and Hodgson's (1935) preliminary study of selected peats and Thomas' (1972) inventory of diatomaceous deposits, the Carneddau have received surprisingly scant attention in studies of vegetational change. Walker's (1978) study of diatoms and pollen from a sediment profile at Melynllyn provides the only detailed record of such changes in the Carneddau. She obtained pollen and diatoms from two cores from the bottom deposits of Cwm Melynllyn, situated behind the moraine. Also obtained from the profile were materials yielding six radiocarbon dates. The stratigraphy of the sediments at Melynllyn compares closely with a profile described by Evans and Walker (1977) from Llyn Glas, in the Snowdon massif: at both sites the lowest deposit sampled is a clay with a typical post-Allerød (post Devensian late-glacial interstadial) pollen assemblage. The apparent absence of any earlier deposits within these basins was used by Walker (1978) as evidence to support Seddon's (1957) claim that the moraines at Cwm Melynllyn and Cwm Glas were formed during the post-Allerød climatic recession, during the Younger Dryas. This is consistent with dated, pollen and geomorphological evidence from elsewhere in Snowdonia (Ince 1981, 1983; Gray 1982a).

The diatom succession at Melynllyn indicates that in early Holocene times a change from alkaline to approximately neutral conditions took place. Diatoms characteristic of acidic, oligotrophic waters have been well established in the lake from mid Holocene times to the present day (Walker 1978). The pollen data from the site show a fairly typical Holocene vegetation succession for upland North Wales, and permit correlation of deposits with other sites in Snowdonia (Walker 1978).

The Carneddau demonstrate a wide range of glacial and periglacial landforms. The cirques at Cwm Ffynnon Llugwy, Melynllyn and Dulyn are noteworthy both as large-scale erosional forms and for the contrasting depositional features contained within them: Cwm Ffynnon Llugwy displays one of the most extensive and complex suites of Younger Dryas moraines in Wales, and the features at Dulyn and Melynllyn further serve to show the diversity of landforms associated with glacial limits of the Younger Dryas. The features at Cwm Ffynnon Llugwy, in particular, provide a graphic demonstration of recessional phases and limits associated with the wasting of Younger Dryas ice. Organic deposits behind the moraine at Melynllyn have provided confirmatory radiocarbon and pollen evidence for the dating of this last glacial phase in the area. The deposits at Melynllyn also provide an important record of vegetational changes in this part of upland Wales during the Holocene.

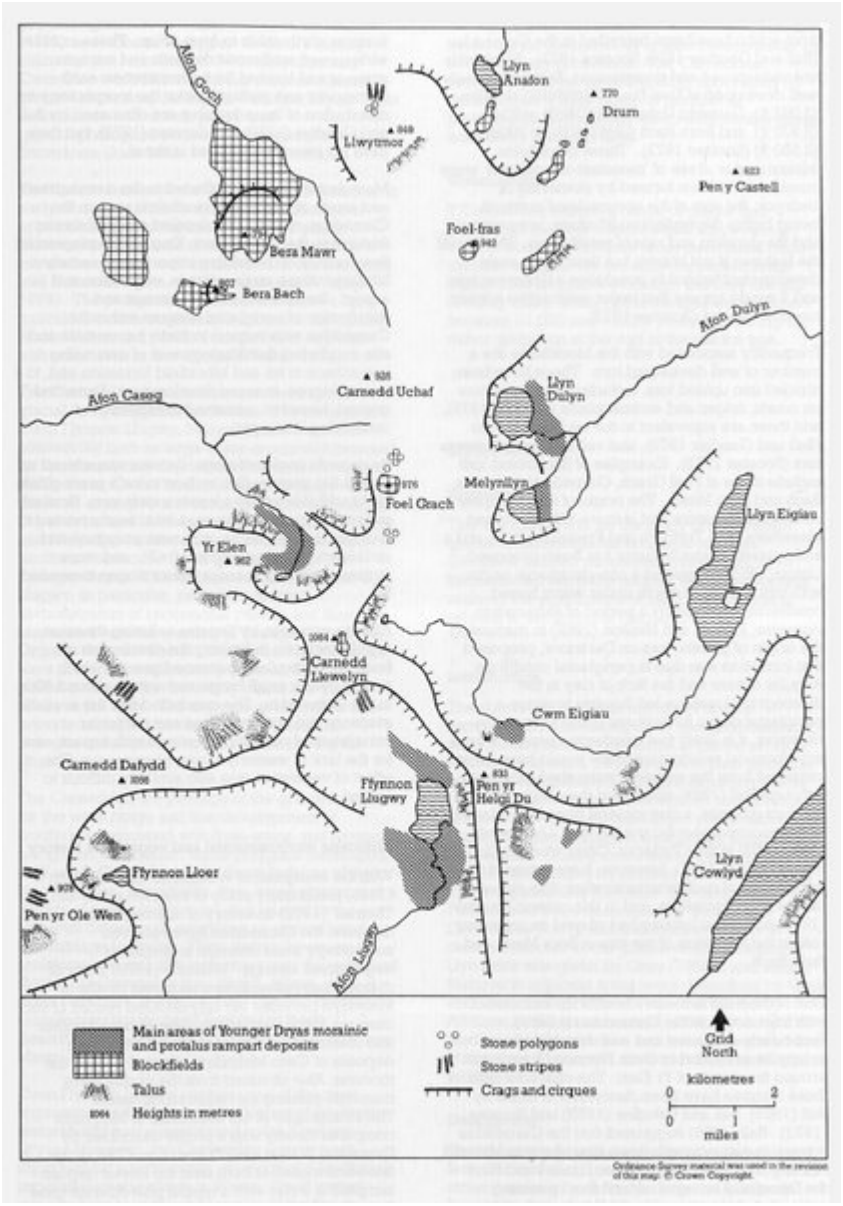
The Carneddau are perhaps of the greatest interest for the wide range and fine development of landforms associated with frost-action and former periglacial conditions. Stone polygons developed at Waen-y-Garnedd are the finest features of their kind in Wales. Blockfields, tors, scree slopes, and a variety of patterned ground and related forms are also well developed, providing an unparalleled assemblage in Wales. Their dating, however, is problematical and although many may have formed during the Devensian late-glacial, others, such as stone polygons, are still active. The site provides a complementary range of features to those described in the Rhinog Mountains and at Moelwyn Mawr.

Cwm Ffynnon Llugwy contains one of the most impressive and diverse assemblages of landform features and moraines formed in the Younger Dryas. However, the Carneddau area is most important for a wide range of periglacial landforms unparalleled elsewhere in Wales. Small sorted stone polygons at the site are one of the finest examples in Great Britain. Although many of the periglacial landforms were probably formed during the Devensian late-glacial, others provide evidence for formation, or at least maintenance, by contemporary processes. The Carneddau therefore provide an outstanding opportunity to demonstrate a wide range of periglacial phenomena, and to study their relationships within a relatively compact area.

Conclusions

Y Carneddau contain a range of glacial and periglacial features without equal elsewhere in Wales. Some of the small-scale periglacial (cold-climate) features are the finest examples in the British Isles and show evidence that they are still forming today. Many of the features were formed between 11,000 and 10,000 years ago during the minor glaciation at the end of the last ice age.

References



(Figure 38) Y Carneddau: principal landforms