Merrivale

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Highlights

Merrivale is one of the classic British localities for tors and associated periglacial landforms. It exhibits many of the most significant features of tor morphology, and demonstrates their relationships to bedrock lithology and structure. It demonstrates some of the most widely accepted evidence in Britain for cryoplanation.

Introduction

Merrivale GCR site encompasses the Cox Tor and Staple Tors area of Dartmoor, and provides one ofthe most spectacular assemblages of granite landforms anywhere in Britain. The site appeared in Linton's (1955) classic paper *The problem of tors,* while altiplanation terraces around Cox Tor were among the first examples to be described in the British landscape (Te Punga, 1956, 1957; Waters, 1962). Merrivale is also notable for one of the most extensive occurrences in southern Britain of fossil periglacial earth hummocks (Te Punga, 1956; Gerrard, 1983; Bennett *et al.,* 1996). The site has also featured in many other important geomorphological studies (e.g. Worth, 1930, 1967; Palmer and Neilson, 1962; Brunsden, 1964, 1968; Waters, 1964; Stephens, 1970a; Green and Eden, 1971; Green and Gerrard, 1977; Cullingford, 1982) . More recent accounts of the landforms were provided by Gerrard (1983, 1988, 1989a), Ballantyne and Harris (1994) and Harrison *et al.* (1996). The granite tors also possess excellent examples of rock (weathering) basins.

Description

The Merrivale area, encompassing Cox Tor [SX 530 761], Staple Tors [SX 542 760] and Roos Tor [SX 544 765], is located on the western fringe of Dartmoor overlooking the Tamar Valley and adjacent lowlands which separate Dartmoor from Bodmin Moor. The principal landforms exhibited by the site are tors, blockfields and stone stripes (clitter), altiplanation terraces and earth hummocks. The site also shows sections through superficial deposits (head and weathered regolith). The structure and composition of the granite, which underlies part of the site, is well shown in Merrivale Quarry [SX 546 753].

A. Geology

The ,local geology is shown in (Figure 4.5) and controls, significantly, the distribution of landforms (Figure 4.6) and (Figure 4.7). The Staple Tors are developed in granite and are separated from Cox Tor by a col cut in metamorphic rocks of the aureole (mainly Devonian slates) ((Figure 4.5); Reid *et al.,* 1912; Dearman and Butcher, 1959; Gerrard, 1983). Cox Tor is itself formed of diabase (metadolerite) and is surrounded by a belt of calcareous hornfels, bordered by non-calcareous Culm Measures of Carboniferous age (Figure 4.5). The diabase of Cox Tor is more densely jointed than the granite of the Staple Tors and Roos Tor. The latter consists predominantly of medium- to coarse-grained granite but with common veins, inclusions of tourmaline and dykes of finer-grained granite. A large resistant vein of microgranite (aplite) runs through Roos Tor (Dearman and Butcher, 1959; Gerrard, 1983).

The coarse-grained grey granite, which comprises most of the tors in the Staple Tors complex, is well exposed in fresh faces in the adjacent Merrivale Quarry (Dearman and Baynes, 1978). Near the surface, however, joint surfaces show pitting caused by the decomposition of plagioclase feldspar. Widely spread (3–7 m), orthogonal planar joints occur with granulated selvages 50–100 mm wide, composed of fresh, mechanically disintegrated interlocking granite gravel. Some joints are stained red. The origin of the red staining is believed to be hydrothermal, although near the ground surface the joints have also been affected by chemical weathering. Some joints were formed by stress release (Dearman and Baynes, 1978).

B Landforms

Tors

The principal tors of this site are Roos Tor, Great Staple Tor, Middle Staple Tor and Cox Tor (Figure 4.6). These tors occupy summits at elevations above 430 m OD: the smaller and lower-lying feature of Little Staple Tor (*c.* 380 m OD) occurs on an interfluve. Great Staple Tor is of the 'avenue' type with a missing central portion (Green and Gerrard, 1977). It consists mostly of massive stacks of joint-bounded blocks. Sheet joints (pseudo-bedding planes) in the granite of this tor dip downslope at an angle slightly less than that of the local ground surface (Green and Gerrard, 1977).

Blockfields, boulder runs and boulder stripes (clitter)

Clitter is present on most of the hillslopes surrounding the principal tors at Merrivale (re Punga, 1956; Gregory, 1969; Green and Gerrard, 1977; Gerrard, 1988; Bennett *et al.,* 1996), particularly on the western slopes of the granite which forms the Staple Tors complex (Figure 4.6). Many of the north to south-trending valleys exhibit marked cross-valley asymmetry, with west-facing slopes possessing gentler angles. Clitter is often more prominent on these western slopes. Although formerly thought to be randomly distributed, the blocks and boulders (clitter) mantling the local slopes show distinct organization (Fe Punga, 1957; Gerrard, 1988; (Figure 4.6)). First, blockfields are common, particularly towards the base of the main slopes leading from the tors. This detritus is composed of boulders which exhibit considerable variation in long-axis orientation and which are often inclined at steep angles (Gerrard, 1988).

Second, the clitter is arranged, particularly on the western slopes, into stripes, runs and other patterns (Te Punga, 1957; Green and Gerrard, 1977; Gerrard, 1983, 1988; (Figure 4.6)). A vast variety of these forms exists around the Staple Tors, including narrow stone stripes, boulder runs and garlands. Narrow stripes (up to 3 m wide) start and finish in mid-slope positions. In places, they coalesce to form wider runs; elsewhere they diverge or coalesce apparently at random (Gerrard, 1983). However, according to Gerrard (1983), there is an order to the arrangement of the individual blocks. Boulders in the centre of runs often stand on-end or with their long-axes pointing downslope. In some stripes, smaller boulders rest against or override larger ones. Some small stripes show a central hollow (Gerrard, 1983). The stripes are present on slopes as gentle as 6° (Green and Gerrard, 1977).

It is significant that many runs and garlands lead directly from the base of tors. On the other hand, stripes often start mid-slope at a great distance from the nearest outcrop. There is little differentiation in the size of material found in the various boulder structures (Gerrard, 1983).

Altiplanation terraces

The flanks of Cox Tor consist of well-defined rock-cut terraces or 'benched hillslopes'. These are particularly well developed on the north and south slopes where the features are most frequent but small; on the eastern slopes they are more regular and extensive and to the west it is not clear whether the breaks of slope are terrace forms or are the result of clitter accumulations (re Punga, 1956, 1957; Waters, 1962; Green and Gerrard, 1977; Gerrard, 1983, 1988) (Figure 4.7). These terraces were first described by Te Punga (1956, 1957), and were re-mapped in detail by Gerrard (1983). The highest are cut in the diabase of Cox Tor itself, the lower ones in hornfels and Culm Measures. The inclination of the 'treads' varies from 3–9°; the 'risers' from 11–20° (Green and Gerrard, 1977; Gerrard, 1983, 1988). Towards Cox Tor, the risers become small vertical rock cliffs cut in the diabase. Tread widths range from 13–65 m and the features can be as much as 800 m long (Figure 4.7). Local exposures confirm that the terraces are cut in rock: only a very thin veneer of debris, rarely thicker than 1 m, rests upon the treads (Te Punga, 1956; Gerrard, 1983).

Earth hummocks

The Cox Tor area contains one of the most extensive fields of earth hummocks in Britain. Thousands of small sub-hemispherical mounds, up to 2 m in diameter and 0.25 m high, occur on the terraced and adjacent slopes around Cox Tor (Te Punga, 1956; Green and Gerrard, 1977; Gerrard, 1983, 1988; Bennett *et al.,* 1996). They are best developed on the eastern side of the tor and are confined to soils developed on the metamorphic aureole. These mounds form a polygonal network but vary considerably in size and shape: some are elongated downslope, others show degraded profiles on their downslope side (Gerrard, 1983; Bennett *et al.,* 1996). Bennett *et al.* (1996) have classified the hummocks as: 1. 'single hummocks' (of various shapes, but mostly kite-shaped); 2. 'compound hummocks' (multi-peaked with variable morphology); and 3. 'rock-cored hummocks' (prevalent where clitter reaches the ground surface). The vast majority seem to be composed of a well-drained, fibrous brown loam derived from weathering of the diabase, although some are underlain by large boulders (Green and Gerrard, 1977; Bennett *et al.,* 1996). Whether boulder-cored or not, all exhibit considerable sorting of the soil (Gerrard, 1983).

Weathering products

Two roadside exposures through slope materials occur on the lower slopes of Cox and Staple Tors, respectively (Gerrard, 1983). The exposure adjacent to Staple Tors shows up to 0.4 m of head comprising small weathered granite cobbles and more angular schorl underlain by a light-brown sandy gravel (lower head) with some very large boulders. A similar pattern, that is a coarse head overlain by a finer head, is shown by the Cox Tor exposure, although the materials are different. Here, the finer head exhibits a characteristic downslope orientation of particles (Gerrard, 1983; cf. (Figure 4.3)).

Interpretation

It has long been accepted that Dartmoor was never glaciated, but that it lay in the periglacial zone beyond the maximum limit of the ice sheets, and was subjected to cryonival processes (e.g. Waters, 1964; Gerrard, 1983). Most workers have therefore argued that significant landform elements and the superficial deposits at Merrivale, and elsewhere on Dartmoor, are primarily the result of periglacial, frost-assisted processes. Although the nature and origin of the decomposed granite (growan) are key factors in understanding the evolution of these landforms and deposits, and have been much disputed (see 'Kaolinization or Tertiary chemical weathering?'; this chapter), it is generally assumed that the tors were exhumed from beneath a weathered or 'softened' mantle mainly by Pleistocene periglacial activity. The close association between the tors, their clitter (blockfields and stone runs), local rock terraces and earth hummocks has been used as evidence that the features were all formed at a comparatively late stage of the Pleistocene by periglacial weathering (Waters, 1964, 1974; Green and Gerrard, 1977; Gerrard, 1983).

Tors

Both of the main models of tor formation explain the 'exhumation' of tors by periglacial stripping. Linton (1955; p. 476) defined a tor as … a residual mass of bedrock produced below the surface level by a phase of profound rock rotting effected by groundwater and guided by joint systems, followed by a phase of mechanical stripping of the incoherent products of chemical action … '. This two-stage mechanism first involved deep weathering under warm humid conditions (probably during the Palaeogene) when a thick regolith developed with corestones occurring where the joint planes were most widely spaced. Second, the products of weathering (the regolith) were removed by mass wasting, leaving the corestones as upstanding tors. Linton proposed that the tors were exhumed under periglacial conditions in the Pleistocene when solifluction and meltwater would have been efficient agents in removing the regolith (Figure 4.2).

Alternatively, Palmer and Radley (1961) and Palmer and Neilson (1962) suggested that tors, such as those in the Pennines and on Dartmoor, had formed solely as a result of mechanical weathering under periglacial conditions. Indeed, Palmer and Neilson (1962) doubted the former existence of deep weathering at tor sites, and attributed the known occurrences of deep decomposition (e.g. Two Bridges Quarry) to the effects of pneumatoly-sis. Waters (1974) went further and suggested that the chronology of tor formation in the Dartmoor area could be related directly to local head sequences. In identifying two head facies (an upper coarse-grained head and a lower finer-grained head), he argued that the principal phase of tor exhumation had occurred during the Wolstonian (Saalian Stage) when a regolith of fine-grained material was stripped from around the tors and redeposited in valley-side and valley-bottom locations as the 'Main Head' (Figure 4.3). A second phase of periglacial activity, during the Devensian Stage, produced the 'Upper Head', much of the clitter now surrounding the tors and reducing the mass of the tors still further. All of these theories, however, involve stripping of weathering or alteration products from around the tors by periglacial mass wasting processes.

Gerrard (1983, 1988) argued that tors, such as those at Merrivale, formed where weathered material (whatever its origin) was removed faster than it was produced. Thus, the tors are found in 'high energy' locations such as steep valley-side slopes, at breaks of slope and on summits where the processes of removal are most efficient (Gerrard, 1983, 1988). He argued that a simple explanation, based on weathering followed by removal, is not adequate to explain the major elements of a granite landscape with tors, and that several possible relationships exist between the rates of accumulation and removal of material. For example, where the ground surface is stable, deepening of the regolith may occur. Where the ground surface is unstable, a gradual removal of regolith is likely. Alternatively, local conditions may promote the renewal and removal of material at similar rates. Thus, these conditions may exist concurrently at different sites and vary in significance through time.

Such thinking is mirrored by Battiau-Queney's (1984, 1987) work in Wales, particularly on tor landscapes in the Preseli and Trefgarn areas (Campbell and Bowen, 1989). Like Linton, she argued that the tors had formed in response to two main factors. First, evidence, particularly from Trefgarn, showed that deep chemical weathering of the land surface had occurred in a hot humid environment (probably during the Palaeogene). Secondly, this weathered mantle had been stripped, but not solely by periglacial processes in the Pleistocene. Rather, the exhumation of the more resistant tors had occurred as the result of protracted uplift along old structural axes throughout the Cenozoic, and not simply because of changing climatic and environmental conditions. Battiau-Queney therefore suggested that the tors were formed in response to slow uplift where sub-aerial denudation had exceeded (perhaps only locally) the rate of chemical weathering. Consequently, a sharp deterioration of climate was not required to trigger stripping of the weathered regolith. Instead, a closely balanced relationship between persisting local uplift and erosion offered the most conducive conditions for tor formation (Battiau-Queney, 1984, 1987).

Green and Gerrard (1977) suggested that the pattern of vertical and horizontal jointing in the granite of Staple Tors (particularly Great Staple Tor) suggests that some form of 'unloading' mechanism has operated in the past, along a broadly whale-backed ridge of the granite. They argued that the centre of the ridge was probably its weakest part, accounting for the missing portion of the tor.

Clitter

It has been suggested that the Dartmoor clitter (blockfields, stone runs and stripes etc.) was derived from the periglacial demolition of the tors (e.g. Waters, 1964, 1974), and it has long been recognized that frost heaving and thrusting, as well as differential movement downslope, have been involved in its formation. However, the exact origin of the clitter is poorly understood (Gerrard, 1983).

The traditional view that tors and clitter are closely associated is partly borne out by the stone runs and garlands at Merrivale which lead directly from the base of some tors (Gerrard, 1983). However, other boulder accumulations appear to have originated in *situ.* For example, some of the stone stripes start mid-slope at a great distance from the nearest tor or outcrop. Similarly, many of the blockfields occur towards the base of slopes, suggesting that much of the clitter has not travelled very far, and has therefore originated *in situ* (Green and Eden, 1973; Green and Gerrard, 1977; Gerrard, 1983). The possibility that some of this clitter might resemble protalus ramparts or even rock glaciers must not be discounted (Harrison *et al.,* 1996).

Gerrard (1983) suggested that the size distribution of the boulders was clearly a function of the intensity of jointing in the granite, and therefore that the difference in pattern and arrangement of the boulders was likely to be the result of the relative abundance of blocks: where blocks occur in profusion, blockfields, boulder garlands, lobes and runs might be expected, whereas where fewer blocks are available, stone stripes may be the dominant feature.

Further support for the limited transport of blockfield material comes from the patterns of the constituent boulder long-axes. In the blockfields these show considerable variation, with many boulders being inclined at steep angles often into the slope. In contrast, boulders in the stripes show a dominant long-axis orientation parallel with the steepest local slopes, suggesting greater downslope movement and sorting (Gerrard, 1983). Gerrard tentatively suggested that slope angle was probably not a controlling factor in the distribution of the various boulder (clitter) patterns, since all types occur on slopes of similar angles. Recently, Bennett *et al.* (1996) have re-examined the boulder runs on the west-facing slopes beneath Great Staple and Middle Staple tors (Figure 4.10). Controversially, they have concluded that the runs originated from the erosion of soil in lines, perhaps by ancient springs, to reveal the clitter beneath. In'this model, the boulder runs are regarded simply as a function of discontinuous soil cover.

Altiplanation terraces

The benched hillslopes or rock terraces described around Cox Tor (Te Punga, 1956, 1957; Waters, 1962; Brunsden, 1968; Green and Gerrard, 1977; Gerrard, 1983, 1988; Ballantyne and Harris, 1994) closely resemble altiplanation terraces described elsewhere in the world which have been attributed to periglacial conditions (e.g. Demek, 1968; Czudek and Demek, 1970). Altiplanation terraces in the British landscape were first recognized by Guilcher (1950) who described several examples around the coasts of north Devon. The examples flanking Cox Tor were described in detail by Te Punga (1956) who argued that they closely resembled features currently forming in perennially frozen ground in Alaska (Eakin, 1916; Lewis, 1939). Te Punga suggested that the terraces had formed where snow patches, with their major axes lying transverse to the local pattern of drainage, had eroded backwards and downwards into the hillside by frost-action, leaving a series of pronounced 'treads' and 'risers' (Fe Punga, 1956). There could be no doubt, he argued, that the formation of these terraces around Cox Tor (and elsewhere in southern England) was closely associated with perennially frozen ground (permafrost), developed under Pleistocene periglacial conditions. Comparable features were later recognized elsewhere on Dartmoor (Waters, 1962).

The lithological characteristics of the local bedrock were seen as important in the development of the features, particularly for maintaining a sharp shoulder at the margin of the terraces (Te Punga, 1956). Indeed, rock control appears to be crucial, since terraces such as those at Cox Tor and elsewhere on Dartmoor are always found on metamorphic rocks and not on the granite (Green and Gerrard, 1977; Gerrard, 1983): closely spaced joints, and the cleavage and bedding planes found in the former rocks, may have facilitated more effective frost-action. Similarly, Te Punga (1956) noted that variations in hardness of subhorizontally stratified rocks also favoured the development of altiplanation terraces: the features, however, are not restricted to such conditions for they commonly bevel steeply inclined strata and may also be cut in massive homogenous bedrock (Te Punga, 1956).

Te Punga also recorded that the surfaces of the altiplanation terraces in north Devon were closely associated with the occurrence of stone polygons. Indeed, stone polygons were so common on such terraces and adjacent summits elsewhere, that ' it may be desirable to regard all areas covered by stone polygons, formed in material derived by periglacial robbing of the underlying bedrock, as altiplanation features' (Te Punga, 1956; p. 337). It was not made clear, however, whether the low earth mounds found on the terraces and flanks of Cox Tor were generically similar (see below).

Earth hummocks

Sharp (1942) first used the term 'earth hummocks' to describe patterned ground characterized by dome-shaped, apparently non-sorted nets or circles. Such features have a circumpolar distribution, and are found in northern Europe, Siberia, Greenland, Iceland and North America (Gerrard, 1983). Comparable features have been described on Ben Wyvis in northern Scotland (Ballantyne, 1986), in the Pennines (Tufnell, 1975) and Cumbria (Pemberton, 1980), and are broadly analogous to the thufue of tundra areas (Ballantyne and Harris, 1994).

Te Punga (1956) likened the small, roughly circular mounds around Cox Tor (Figure 4.11) to the thigh-centred polygons' of high latitudes, and suggested that they had also been formed under periglacial conditions. Gerrard (1983, 1988) argued that there is no evidence to suggest that the features at Cox Tor are forming at the present time, and some are indeed being destroyed. Many of the mounds occur on top of clitter and only formed once the cutter had become stabilized, presumably after the Younger Dryas. Some have been removed by Bronze Age humans during the construction of circular huts in the area. It seems likely, therefore, that the mounds formed at some time between *c.* 9000 and 2000 BP (Gerrard, 1983), although Brunsden (1968) considered that they might be even younger, having formed as the result of spring action dissecting the thick soil cover.

There is considerable doubt, however, as to the mode of formation of the earth hummocks. Although two principal types occur around Cox Tor (boulder-cored and non-boulder-cored, with the latter being dominant), all demonstrate considerable sorting of the soil: the soil of the mounds is consistently finer than that at the same depth in the depressions alongside, and it is thought that frost-heaving is the primary process in their formation (Gerrard, 1983, 1988). Beskow (1935) has shown that frost-heaving is unlikely to occur in soils with less than 30% silt and clay (cf. Williams, 1957; Corte, 1963). Gerrard (1983, 1988) has argued that such requirements may have controlled the distribution of the earth hummocks at Merrivale, restricting the features to the fine silty loam soils derived from the weathering of the Cox Tor diabase, and excluding their development on adjacent granitic soils which are generally deficient in the silt and clay grades. Recent work by Bennett *et al.* (1996) has confirmed this fundamental relationship between soil type and hummock distribution. It is interesting that such hummocks occur all along the western edge of Dartmoor where similar rock types exist.

Most authors seem to agree that earth hummocks are formed by frost-heaving, caused by uneven ground freezing and thawing, although the specific mechanisms involved are disputed (Ballantyne and Harris, 1994). The main problem in understanding the genesis of these small-scale landforms, however, is establishing how the initial micro-relief forms. Once the mounds are created, their vegetation cover may afford better insulation than the intervening water-soaked areas where freezing is likely to occur first: this differential freezing may set up pressures forcing material inward and upward into the hummocks, causing them to 'grow' (Beskow, 1935; Gerrard, 1983, 1988; Bennett *et al.,* 1996). Although a variety of mechanisms has been suggested which would produce the initial micro-relief, for example, hillwash, soil movement, wind deposition and differential vegetation growth in clumps (Gerrard, 1983; Bennett *et al.,* 1996), the exact mode of formation of the mounds is largely conjectural (Green and Gerrard, 1977; Ballantyne and Harris, 1994; Bennett *et al.,* 1996): all that can be said with any certainty is that the mounds are fossil features which appear unrelated to present conditions (Gerrard, 1983, 1988). Bennett *et al.* (1996) provide a comprehensive review of the earth hummocks at Merrivale, and discuss possible modes of formation.

Weathering products and slopes

The relationships between weathering products, solifluction deposits and resultant slope forms in the Merrivale area are complex. It has been suggested that two different head deposits occur in the Dartmoor area, namely a lower fine-grained deposit and an overlying coarse-grained sediment — both periglacial solifluction deposits (e.g. Waters, 1964, 1974; Mottershead, 1976). Such a sequence of head deposits has been taken to reflect an inversion of a normal granite weathering profile, that is, with finer-grained weathering products removed from upper slopes during an initial periglacial phase, and subsequently redeposited on lower slopes and in valley bottoms; and with a subsequent phase of periglacial activity removing large, sound blocks from tors and other surface exposures, and depositing them on top of the finer-grained head materials (Figure 4.3). Green and Eden (1973) challenged this view and demonstrated that much of the coarse debris actually occurs in the lower parts of the head sequences, and has been derived from proximal basal sources and not from more elevated and distant rock outcrops. It is likely, therefore, that the head deposits are derived from many parts of the slope and that *an* inversion of weathering profiles will only have occurred in localized situations (Green and Gerrard, 1977; Gerrard, 1983).

Gerrard (1982, 1983, 1989a) has presented detailed evidence from head sequences throughout Dartmoor to show that initial weathering profiles were probably more complex than hitherto thought, and that periglacial processes led to a substantial mixing of materials, rather than to simple re-sorting. Indeed, in 47 exposures across Dartmoor, Gerrard (1982, 1989a) has shown that the relationship between the coarse- and fine-grained facies is complex, with both layers often being intermixed and with large blocks of granite occurring throughout the beds. He argued that significant mixing of materials has therefore occurred, with gullies having been cut and infilled at different times, showing complicated sequences of slope modification rather than simple reworking of weathered granite. The Merrivale exposures may therefore be somewhat atypical in showing 'coarse' head overlain by 'fine' head, and exposures elsewhere show that the distribution and characteristics of solifluction deposits are far more complex.

In conservation terms, Merrivale provides an outstanding assemblage of the landforms character istically developed on the granite intrusions and adjacent aureole rocks of upland South-West England. While the broad configuration of the area, with its large dome-shaped ridge of granite bordered by valleys, had probably been established by the mid-Tertiary, smaller details of the local slopes, altiplanation terraces, tors, clitter and slope deposits reflect the operation of periglacial processes throughout the Pleistocene. The Pleistocene periglacial legacy to the Dartmoor landscape has been substantial and Merrivale illustrates many of the key features of its periglacial geomorphology. The tors and clitter are some of the very finest examples anywhere in Britain: the Staple Tors and Roos Tor demonstrate, particularly clearly, the relationship between bedrock lithology and structure and tor morphology and development. The critter shows a remarkable variety of forms (blockfields, stone stripes, stone runs and garlands), and its distribution and characteristics have a considerable bearing on processes of slope development, and on the origin of the tors themselves.

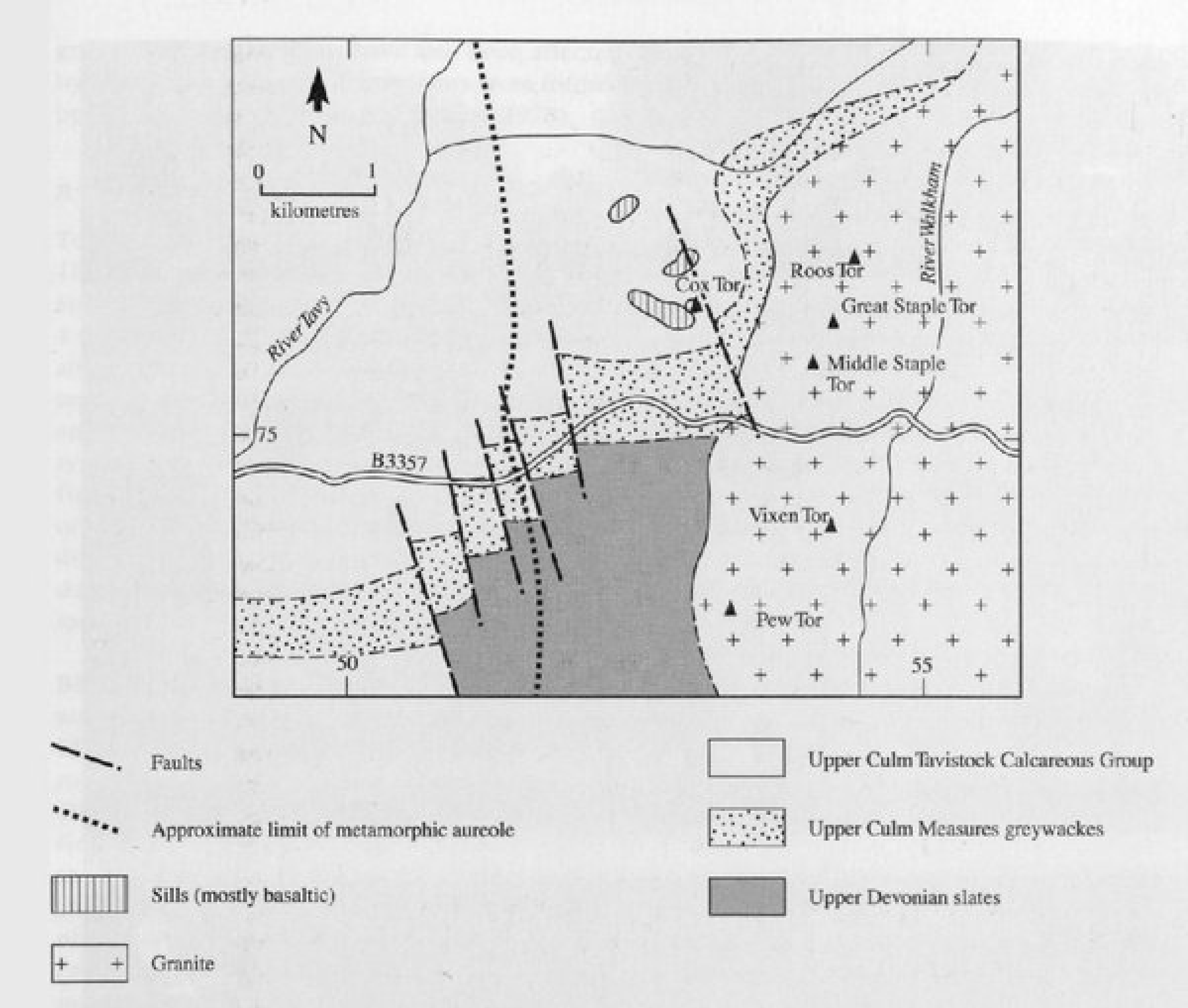
The Cox Tor area of Merrivale shows some of the finest altiplanation terraces in southern Britain and some of the most convincing evidence for cryoplanation: the Cox Tor examples are also of historical significance since they were the subject of the first detailed exposition of altiplanation terraces in the British landscape (Te Punga, 1956). The superb and profusely developed earth hummocks in this area also add significantly to its scientific interest, although their precise age and origin are still far from clear.

While the individual landforms are exceptional and worthy of special note, the landform assemblage as a whole is probably unparalleled elsewhere in Britain. In particular, Merrivale provides an outstanding assemblage of interrelated landforms which illustrate many of the most significant theories of long-term and, especially, periglacial landscape evolution in southern Britain.

Conclusion

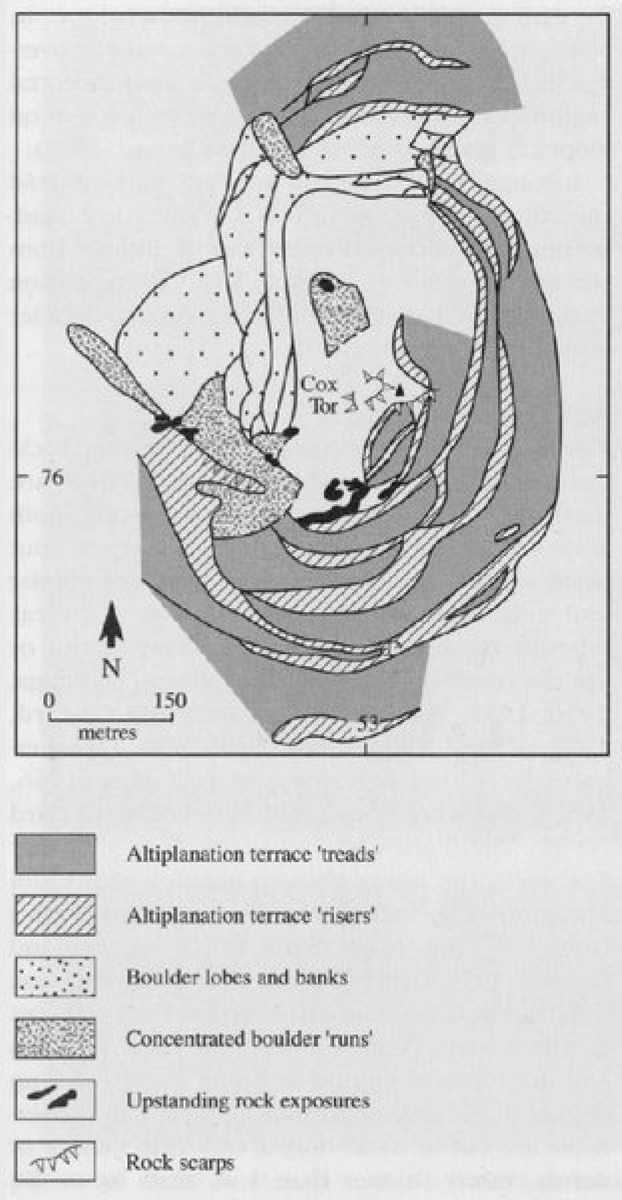
Merrivale is one of Britain's most important sites for understanding the development of granite landscapes. When the Dartmoor granite was intruded into the surrounding 'country' rocks about 290 million years ago, it altered them profoundly, and the wide range of landforms now seen at Merrivale in part reflects differences in rock type and local geological structure: the Staple and Roos tors are granite landforms of textbook quality, showing clearly how tors have developed in relation to the pattern and density of jointing in the host rock. In contrast, the more angular outlines of Cox Tor reflect the nature of its constituent rocks, in particular the markedly different reaction of the diabase to protracted weathering. Cox Tor is surrounded by arguably the finest 'altiplanation terraces' in Britain, a 'staircase' of horizontal benches cut back into the rock by freeze-thaw processes at a time when perennial snow patches were present on Dartmoor. The siltier soils of the Cox Tor area have given rise to one of the best British examples of 'earth hummocks', controversial landforms of disputed age and origin, although almost certainly formed by frost-assisted processes in the Late Devensian. Many of the landforms at Merrivale the large accumulations of loose rock or 'clime, the altiplanation terraces and earth hummocks owe their origin to a range of cold-climate processes which operated during the Quaternary. Frost-shattering of local rocks, the repeated contraction and heaving of the ground surface as it alternately froze and thawed, and the downslope movement (solifluction) of weathered materials over frozen ground (permafrost) all gave rise to characteristic landforms now seen in fossil form today. Merrivale is also important because some of the landforms, such as tors, may have begun to form well before the Pleistocene ice ages of the last two million years or so — perhaps as far back as the early and mid-Tertiary, when subtropical or even tropical conditions may have prevailed. Merrivale is unique in showing such a wide range of landforms in a small area, and provides important evidence for understanding how landscapes evolve over timescales of many millions of years.

References

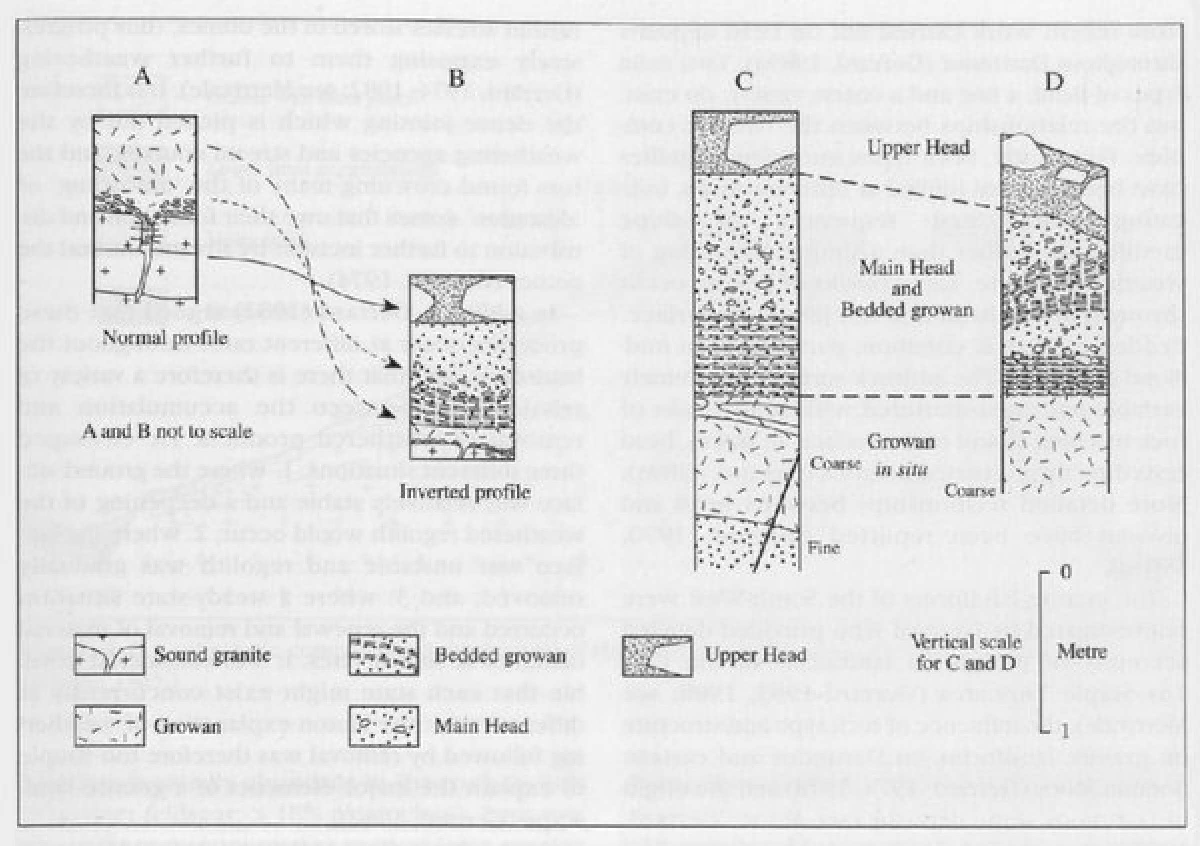


(Figure 4.5) Simplified geology of the Merrivale area. (Adapted from Gerrard, 1983.)

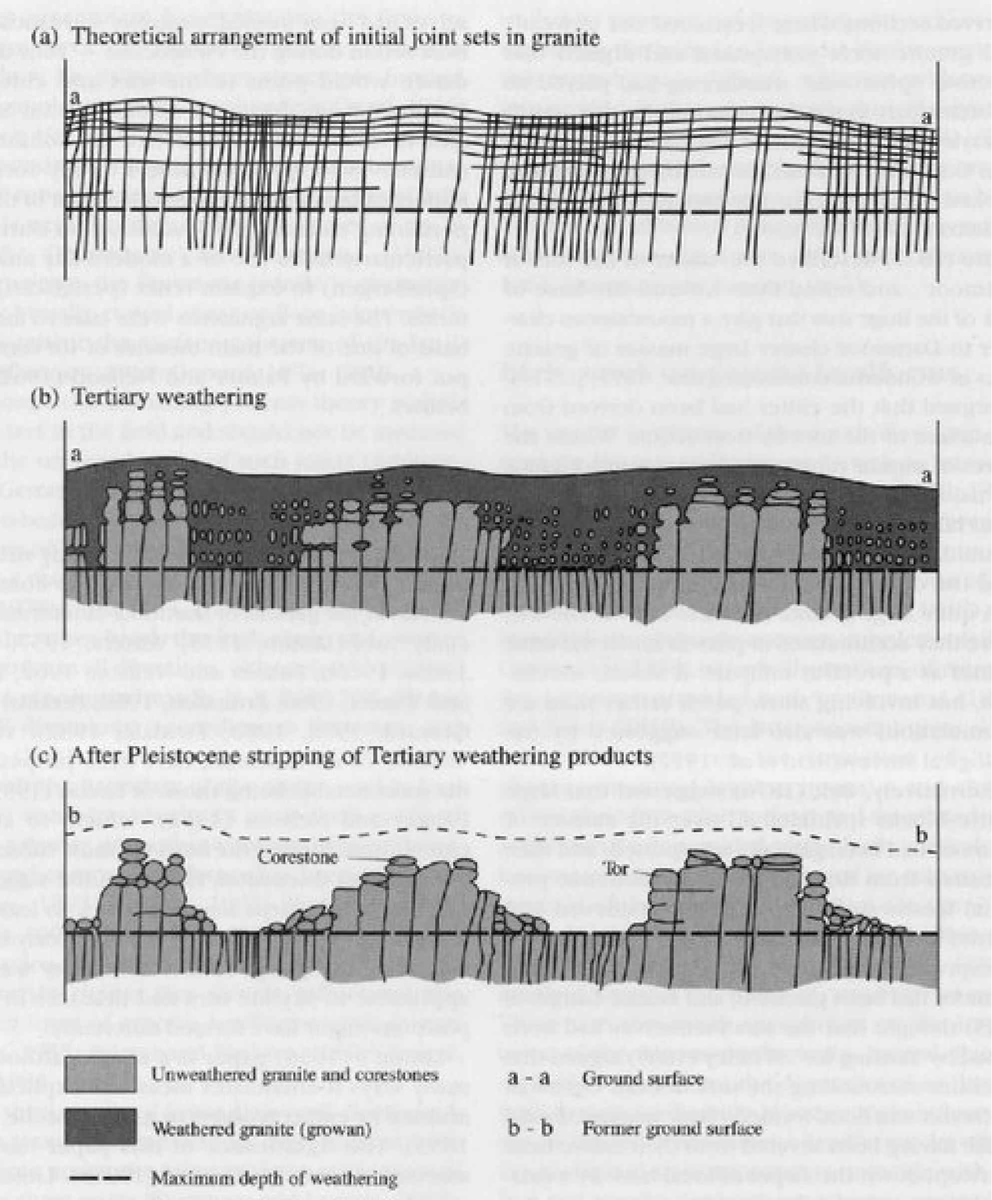
(Figure 4.6) Aerial photograph (scale c. 1:10 000) showing: (a) Cox Tor; (b) Roos Tor; (c) Great Staple Tor; (d) Middle Staple Tor; (e) Little Staple Tor; (f) Merrivale Quarry. Distinct 'boulder runs' of cater are particularly evident around the Staple Tors. (Cambridge University Collection: copyright reserved.)



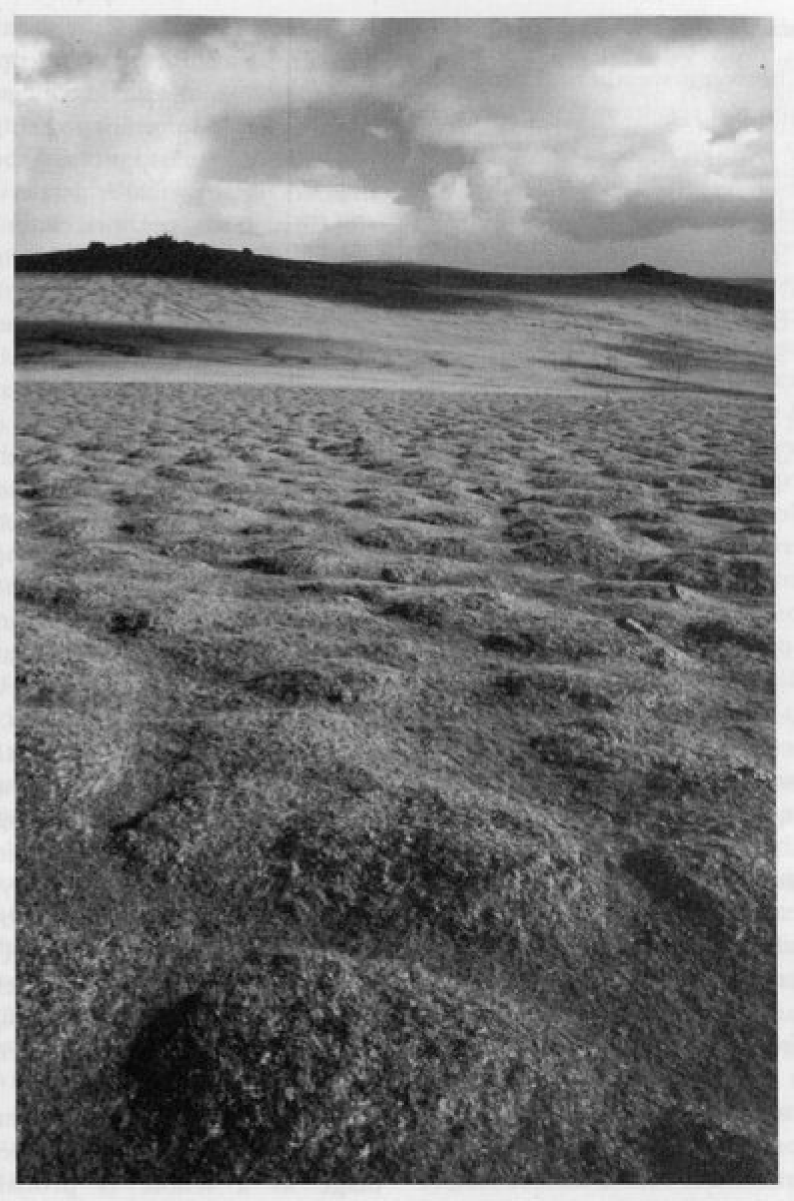
(Figure 4.7) The geomorphology of Cox Tor and adjacent areas. (Adapted from Gerrard, 1983.)



(Figure 4.3) A model of slope development for Dartmoor, after Waters (1964). Profiles: (a) Products of in situ weathering on a granite substrate; (b) Inversion of normal weathering profile following two separate periods of periglacial mass wasting; (c) and (d) Measured sections at Shilstone Pit [SX 659 902], Dartmoor. Many slope configurations, however, do not conform to this model (see text).



(Figure 4.2) Linton's (1955) classic two-stage model of tor formation.



(Figure 4.10) Great Staple Tor seen from Cox Tor, revealing a diverging anastomosing pattern of boulder runs on the west-facing slopes. (Photo: S. Campbell.)

(Figure 4.11) A profusion of earth hummocks on the east-facing slopes of Cox Tor, with Great Staple Tor and Middle Staple Tor on the horizon. (Photo: S. Campbell.)