Bellever Quarry

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Highlights

A reference site demonstrating the relationship between slope deposits and granite weathering products on Dartmoor, Believer Quarry provides particularly detailed evidence for the origin of 'bedded growan' deposits.

Introduction

Believer Quarry is of considerable geomorphological interest for its related assemblage of periglacial slope deposits and granite weathering features, which are considered typical of many Dartmoor slopes. The generic relationship between the intact, relatively unaltered, granite here and the overlying weathered granite (growan), 'bedded growan' and periglacial head deposits is graphically illustrated, and has long attracted scientific interest (Waters, 1961; Brunsden, 1964, 1968). A detailed description and interpretation of the sequence at Believer Quarry by Green and Eden (1973) has major implications for theories of slope development throughout the region (Te Punga, 1957; Waters, 1964; Mottershead, 1971; Green and Gerrard, 1977; Cullingford, 1982; Cresswell, 1983; Gerrard, 1983, 1989a).

Description

Bellever Quarry [SX 658 763], sometimes known as Lakemoor or Laughter Quarry, lies on the lower slopes of the East Dart Valley in the Believer Plantation, approximately midway between Riddon Ridge and Laughter Tor. It exposes granite, weathered granite and overlying slope deposits in one main face and several other less extensive and more overgrown faces. The stratigraphic sequence is as follows:

4. 'Head' consisting of granite clasts set in a coarse matrix of growan (up to 1.5 m)

3. Disturbed weathered granite ('bedded growan') (up to 1.0 m)

2. *In situ,* undisturbed, weathered granite or growan (> 2.0 m)

1. Intact, relatively unaltered granite

The head (bed 4) shows a concentration of clasts in its lower layers, but there is no indication that the bed should be divided on this basis (Green and Eden, 1973). The disturbed weathered granite (bed 3) shows colour bands which are conspicuously overturned in a downslope direction (Figure 4.12). The apparent layering is related to colour as well as textural variations, and can be traced into both beds 1 and 2. It is believed to be related to a zone or vein of tourmalinization (Green and Eden, 1973; Green and Gerrard, 1977). The amount of lateral displacement of individual layers relative to one another is only a few millimetres at *c.* 2 m depth below the top of the bedded growan (bed 3), but increases upwards in the profile (Green and Eden, 1973) The *in situ,* undisturbed, weathered granite or growan (bed 2) both overlies intact granite (bed 1) and is juxtaposed between bosses or stacks of the relatively sound rock (cf. Two Bridges Quarry).

Interpretation

The first detailed work at this site is attributable to Brunsden (1968), who used evidence from various sites, including Believer Quarry, to devise a classification of weathering zones found in the Dartmoor granite (see Kaolinization or Tertiary chemical weathering?; Two Bridges Quarry). The Bellever Quarry section showed most of the different weathering types proposed: from relatively intact granite with corestones, showing only partial decomposition along joints; through well-rotted, incoherent granite still showing details of the original rock structure; to undisturbed, stained,

weathered granite containing much quartz, but displaying no detail of any previous structure. In addition, the sections showed evidence for soil creep (bed 3; the 'bedded growan' of later workers) as well as a capping layer of head, Brunsden's 'migratory layer'. Sites like Believer Quarry were used by Brunsden to demonstrate that pneumatolytic alteration, deep chemical weathering and physical, frost-assisted processes had all affected the Dartmoor granite, and that evidence for all three could be found in individual profiles.

Although disturbed weathered granite (bedded growan) is not always present between the *in situ* weathered granite and the overlying head on Dartmoor, it is common on many slopes and some interfiuves (Green and Eden, 1973). Waters (1964) attributed its bedded appearance to downslope wash or creep, hence the term 'bedded growan': he appears to have favoured surface wash as the most likely agent in its formation (Waters, 1971; Green and Eden, 1973).

Green and Eden (1973) re-examined the bedded growan from a number of sections on Dartmoor, including those at Bellever Quarry. They showed that, in composition, the material is similar to the underlying undisturbed and *in situ* growan, despite the frequent colour banding and appearance of downslope bedding. They concluded that its general characteristics are not consistent with an origin as a surface-wash deposit. In studying the relationships of local head sequences and clitter patterns to the bedded and *in situ* growan deposits, Green and Eden surmised that the movement of the bedded growan had been contemporaneous with that of the overlying periglacial head: namely that the bedded growan was not a pre-existing surface deposit derived from upper slope source areas. In support of their claim they cited evidence for superficial layers having passed over and displaced underlying *in situ* material elsewhere (e.g. Penck, 1953; Fitzpatrick, 1963; Jahn, 1969).

The relationship between the periglacial slope deposits and the weathered granite established by Green and Eden (1973) at Believer Quarry and other sites is significant. Formerly, slope deposits on Dartmoor were considered to have developed under periglacial climatic conditions, when successive layers of the pre-existing weathered profile were removed from the upper parts of slopes and deposited in the reverse order on lower slopes the 'inversion' theory of Waters (1964) (Figure 4.3). Such a mechanism also found favour with other workers (e.g. Te Punga, 1957; Brunsden, 1964, 1968), and was the basis for a simple model of slope development. It was noted that

'The rapid wasting away of the land surface during periglaciation, due to the transportation of enormous quantities of material to lower levels, has produced a landscape of subdued aspect characterized by slopes that are convex near the top and concave near the bottom. The convex upper slope has been a zone of wastage and the concave lower slope has been a zone of deposition.' (Tricart, 1951; p. 196; Te Punga, 1957; p. 410).

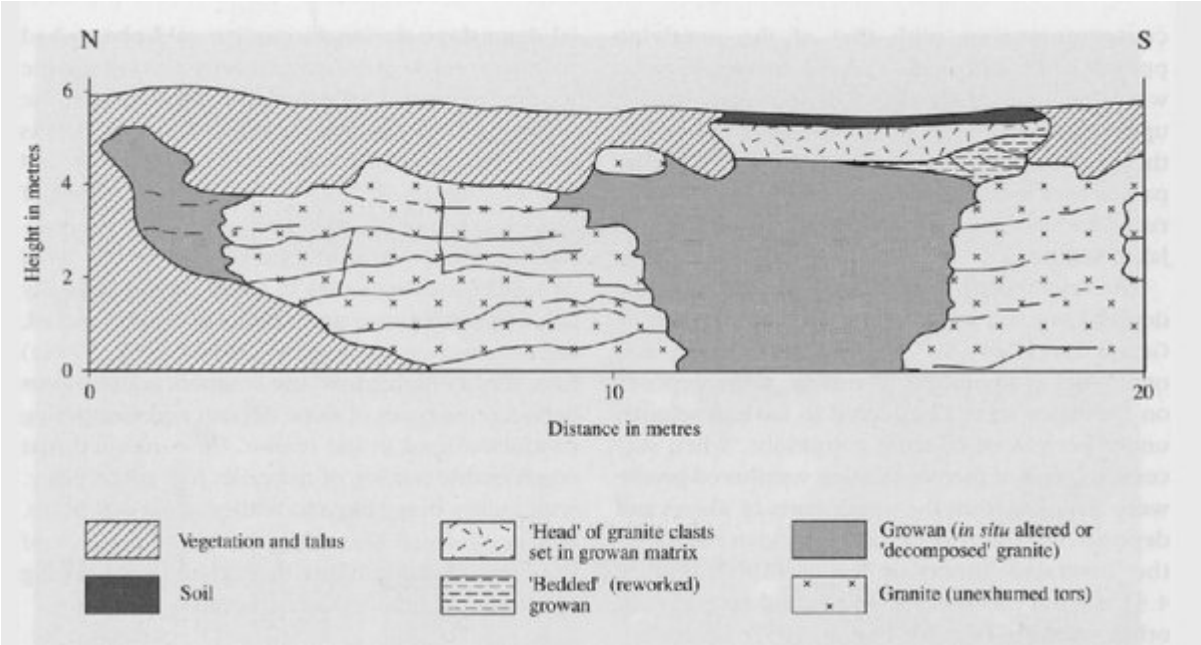
The evidence presented by Green and Eden, derived substantially from Believer Quarry, is vital for demonstrating that this slope transfer and inversion model is not generally applicable. These workers have argued that such inversions are rarely the norm, and that the processes responsible for the formation of slope deposits have included the erosion of substantial amounts of underlying material (ranging from large granite blocks to fine-grained growan) and its incorporation into the transported layer on all parts of the slope. Even on lower slopes, as at Believer Quarry, the movement of slope deposits (head) appears to have been accompanied by the erosion of the underlying weathered granite.

On the basis of this evidence, it was possible to dispel two long-held notions: first, that slopes could be divided into simple 'source' and 'accumulation' areas; second, that there had been a widespread inversion of the pre-existing weathering profile (Green and Eden, 1973; Green and Gerrard, 1977). Waters' (1964) suggestion that transfers of mater ial downslope during successive cold phases had led to a typical three-fold succession overlying the weathered granite, namely the bedded growan, .the 'main head' and the 'upper head' (Figure 4.3), was therefore shown to be untenable on Dartmoor, and any widespread evidence for two separate layers of head was refuted (Green and Eden, 1973). A comparable study by Mottershead (1971), on head deposits overlying schist in south Devon, similarly failed to confirm the applicability of Waters' model. Recent studies by Gerrard (1982, 1983, 1989a) have further highlighted the complex relationships between the types of slope deposit and weathering products found in the region. He confirmed that considerable mixing of materials had taken place, with gullies being cut and infilled at various times, and he showed that complicated sequences of slope modification rather than a simple reworking of weathered granite had occurred.

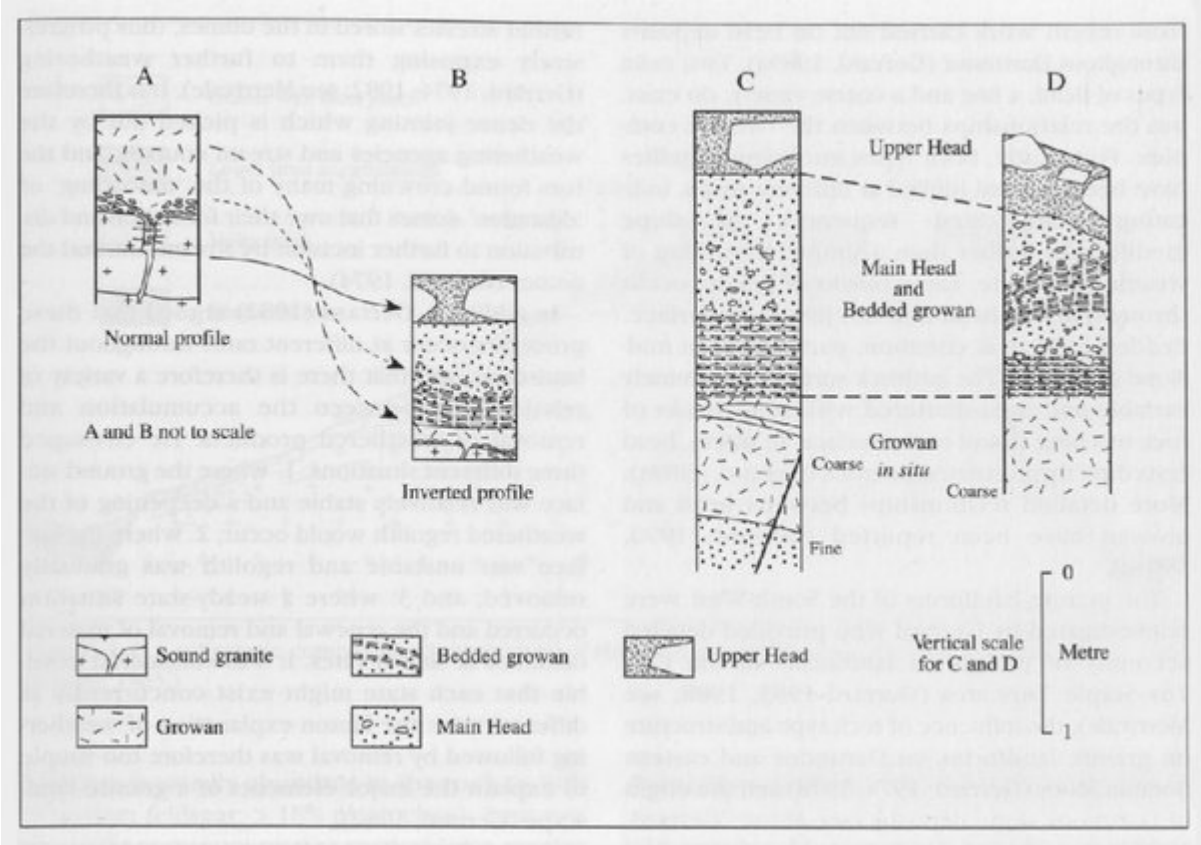
Conclusion

Believer Quarry provides particularly strong evidence to demonstrate that the bedded growan of Dartmoor did not accumulate at the ground surface, but instead formed beneath periglacial head deposits while they accumulated. Such evidence has profound implications for models of slope development in the region. Both Two Bridges and Believer quarries provide significant evidence for the numerous arguments regarding the origin of the decomposed granite on Dartmoor, and its relevance to landscape evolution, and particularly tor formation. Whereas Two Bridges Quarry has become almost pre-eminent in such debates, Believer Quarry provides complementary evidence, and is fundamental to understanding mechanisms of slope development, and especially the relationships of slope deposits (principally periglacial head) to the underlying granite weathering/alter-ation products.

References



(Figure 4.12) Granite alteration products and slope deposits at Believer Quarry being examined during the 1977 INQUA trip to the South-West. (Photo: N. Stephens.)



(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).