

【論文】

Growan in weathering crust of granitic rock distributed in the Southwest of England

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イングランド南西部に分布する花こう岩類の 風化殻中に見られるグローワン

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Abstract: Weathered granite which has a disintegrated structure of rock is distributed in some granitic rock areas in Cornwall Peninsula, the Southwest of England, where many tors develop. Such disintegrated granite is locally called "growan". The growan is similar to saprolite of granite, although the degree of chemical alteration in weathering process is not so high. It has low content of fine size particles and high content of feldspars.

Keywords: growan, weathered granite, weathering profile

1. Introduction

In Lands End, Bodmin Moor, Dartmoor and other areas in Cornwall and Devon, the Southwest of England, where granitic rocks are distributed widely, granite is called 'maengrowan' in Cornish ---- it means the rock "maen" which makes gravel "growan". The Glossary of Geology, third edition (1987), introduces that the term "growan" has two meanings, (1) An old English term for a coarse-grained granite, grit, or sandstone, (2) A *grus* developed by the disintegration of granite. And the term "grus" is introduced as the fragmental products of in-situ granular disintegration of granite and granitic rocks. The term growan and the related terms which are used in studies on weathering of rock, especially acidic intrusive igneous rocks in Cornwall Peninsula, are discussed in this report.

2. Weathering profile on granitic rocks

Fig.1 shows a typical weathering profile on intrusive igneous rocks. The upper zone is divided into three sub-zones, I A, I B and I C. Zone I A is a part which has a characteristic of zone of eluviation in texture. It is a sedimentary zone rather than a weathered zone of bed rock. Zone I B is rich in clay and silt-size particles

and has a characteristic of zone of illuviation. Zone I C is more soil like than rock like with rock texture. The zones, II A, II B and III, belong to bedrock basically, although transition zone, Zone II A, has a part of saprolite on the surface of weakly weathered rock or along joints.

Most of growan is correspond to the zones from Zone I B to Zone I C, and some growan which is called "bedded growan" is correspond to Zone I A. Bedded growan is sometimes observed at the surface of a gentle slope in shallow valleys or along a river in Dartmoor.

4. Relation between growan and granite saprolite

Most of saprolite is chemically rotted rock with rock structure *in situ*. The term is often applied to the lower portion of a weathering profile. The saprolite on granitic rocks is locally called "grus" or "growan", although the term "growan" may include material broken down by mechanical weathering. In some cases, growan is correspond to a lower part of Zone I C in Fig.1 in the Southwest of England. The term "bedded growan" is used for a mobile zone at near the surface of weathered granite on a slope of valleys in the Dartmoor area. Such a sedimentary zone which is called bedded growan is composed of fragments of weathered granite. In many cases the distribution of bedded growan (Zone I A) is not wide in this area. But it is not always easy to distinguish the mobile zone from the proper saprolite

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derived from the bedrock. Therefore sometimes the term "regolith" is used for the entire mantle of weathered material.

5. Grown in Pre-tors and Tors

Photographs 1 and 2 show grown and pre-tors state at Two Bridges Quarry in Dartmoor, and Photograph 3 shows one of typical tor in the center of the Dartmoor area.

A typical site of thick grown which is shown in Photograph 1 is very rare in granitic rock areas in England, although such a scenery which has a thick zone of granite saprolite with rock texture corresponding to Zone I B and I C on the weathering profile is very common in other weathered granitic rock areas such as Hong Kong and Japan, especially Southwest Japan.

Feldspars, especially plagioclase crystals of granite, and biotite are easily attacked and weakened rather than other minerals. Quartz which is the most stable mineral is much less affected. The weathering mainly took place along the lines of the many joints through which water moved widely in bedrock. Where joints were closely spaced, the individual mineral grains of the granite become more or less completely separated to a considerable depth.

The top of transition zone or partly and weakly weathered rock face has a soil like profile on regolith composed of disaggregated and sediments of fragmental granite. Exposures of granite on the remaining part of the rock face show varying stages of disaggregation resulting from weathering and vertical stress relief parallel to the floor joints which are quite widely spaced. These joints are filled with grown or the related weathering products from granite. Some vertical and steeply dipping joints are coated with dark color.

The granite filling some of the wider flat lying joints is softened and broken down into individual mineral grains. Over most of the rock face the smaller feldspar grains have been collapsed and a little softened. On the main face of the rock area can be seen in which the granite has been broken up into many thin flakes with closely spaced near-horizontal layering. This is the result of wedging action of freezing water probably controlled by stress release in the granite. The separated mineral grains or the aggregation of minerals often found on flat granite surfaces have been loosened from the rock in this way.

Bedded grown has been formed at the lower site on the surface through solifraction process, and a little thick

layer of brownish or dark brownish granite debris which is correspond to the bedded grown can be seen. The layer extends above the surface of rock but is covered by grass and other plants. This layer is the result of the downhill movement of weathered and broken-up granite in Quaternary Age.

6. Development process of grown

Palmer and Neilson (1962) reported some geologic columns and geological sections based on drilling data at two cross-sections of valleys in the Dartmoor area. These columnar sections show that the granite changes into rotted granite which has from a few meters to about twenty meters in thickness below the surface. Palmer and Neilson thought that the rotted granite is correspond to grown which occurs near surface and also the altered granite is influenced of pneumatolysis at the end stage of the intrusion of granite because of including pneumatlitic minerals such as tourmaline. They concluded that the grown was derived from pneumatolysis when granite was intrusive.

But not only grown but also the granite which doesn't change into grown includes pneumatlitic minerals. So the existence of tourmaline in grown doesn't show that all zones of grown are derived from pneumatolysis.

Doornkamp (1974) reported that the degree of chemical alteration of quartz in the granite is not so high, based on his scanning electron microscopic observation studies on some quartz grains which are included in the granite with pneumatlitic minerals from a quarry in the Dartmoor area. And he reported that there is a high feldspar content, lack of alteration of the feldspars and low clay content by using x-ray diffraction.

Eden and Green (1971) reported that the velocity of elastic waves at valleys in Dartmoor is classified into two groups, one is the zone of 310~370m/sec, the other is the zone of 1400~2900m/sec. The low velocity zone, the upper zone which is grown and the related zone, is about one or two meters in thickness. And the high velocity zone, the lower zone which is composed of weak weathered rock and unweathered bedrock, is situated under the low velocity zone. Such a structural characteristic in vertical sections of the weathering crust at a valley is contrasted with the structure of weathering crust at hills or heaps of boulders which is called tors in granitic rock area in Cornwall Peninsula, especially Bodmin Moor and Dartmoor.

6. Summary

Growth in weathered granitic rock areas where many tors are formed, especially Bodmin Moor and Dartmoor, in Cornwall and Devon, the Southwest of England, is a kind of granite saprolite. But the degree of chemical weathering is relatively low in general. So it is disintegrated granite rather than decomposed granite. The distribution of growth is very restricted in the Southwest of England, because most of growth has been eroded for long time.

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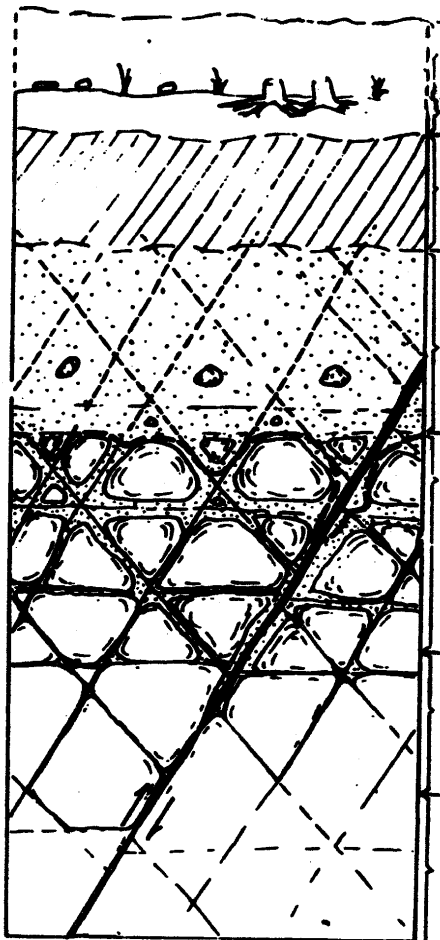


Fig1. Typical weathering profile on granitic rocks.
from Deere and Patton(1971)

Colluvium etc.

I A: zone of eluviation, with sandy textures and a high organic content

I B: zone of illuviation, rich in clay-sized particles

I C: more soil like than rock like, with rock structure.

II A: transition zone, a transition between saprolite and weathered rock

II B: partly weathered rock

III: unweathered bedrock



Photograph 1. Typical growan at Two Bridges Quarry in Dartmoor, the Southwest of England.

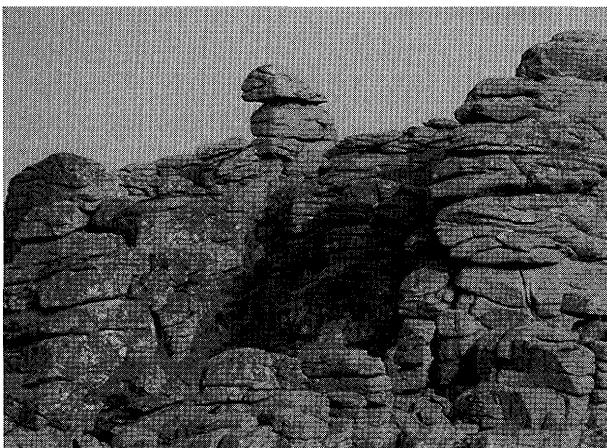
Such an exposure point of growan is very rare in England, although a resemble scenery is very common in many weathered granitic rock areas in Japan and others. The following description on the information board in front of the quarry shows that the scenery is extremely few.

 Site of Special Scientific Interest,
 “ Please keep off the quarry face to prevent further
 damage to geologically-important rock formations ”



Photograph 2. A pre-tors state next to thick growan at Two Bridges Quarry.

The big rectangular blocks will become a tor in far future..



Photograph 3. A typical tor without growan in Dartmoor.

Most of growan between brocks has been eroded for long time. In a few cases, growan remains along open joints at the lowest part of a tor..