

# Tor Formation



## Dartmoor Factsheet

A Level - Geology & Geography

### The Formation of Tors on the Dartmoor Granite - an outline

The processes resulting in the formation of the Dartmoor tors started about 280 million years ago as the granite forming Dartmoor cooled and solidified from molten rock at a temperature of 900 - 1000°C. The minerals which make up granite crystallised as closely interlocking grains forming the hard rock.

Granite is formed of three main minerals: Quartz - appearing in the granite as translucent slightly greyish looking grains; Feldspar - white grains, sometimes stained yellowish or pink (in parts of the granite feldspar forms large white crystals); and Biotite - dark brown glistening flakes.

#### 1 The setting of the initial pattern

The still hot but solid granite continued to cool. Contraction caused the formation of joints (open fractures) usually near vertical, in the granite. Hot water moving through these joints commonly led to their becoming lined or filled by minerals such as quartz or a black mineral called tourmaline or both. The orientation of the joint pattern was controlled by pressure in the earth's crust. The joint pattern was accentuated and modified by actual movements along fractures called faults.

#### 2 The unroofing of the granite

The cover of rocks above the granite, mainly slate and sandstone, which was 2-3 km thick, was worn away quickly, and the fragments of granite and related rocks can be found among the New Red Sandstone rocks of Devon today.

The removal of the pressure of the overlying rock allowed the granite to expand upwards



starting the formation of horizontal joints. These joints tend to follow the shape of the surrounding land. They are usually horizontal on hill top tors and may be inclined on valley-side tors.

#### 3 Kaolinisation

Kaolinisation is one of the important processes leading to the breakdown of the solid granite. It is caused by the circulation of water that has been heated within the granite. The feldspar minerals comprising some 30-40% of the granite are decomposed forming the white clay, kaolin. The major area of kaolinisation is around Lee Moor on the southern edge of the granite, but many smaller areas of kaolinisation occur. Whiteworks for example, 3km SSE of Princetown, as the name suggests, is an area where the granite is more or less kaolinised. This process also affected joints and faults on smaller areas of granite, across the moor. This started the process of shaping the tors as the surrounding granite was softened and weakened in places. The kaolinisation process probably continued for a considerable length of time as heat continued to be generated in the granite by its natural radioactivity.

## 4 Deep weathering of the granite

A considerable length of time elapsed before the next major tor forming process occurred. Some 60 - 30 million years ago the granite stood above sea level but the climate was subtropical (hot and at times wet), as the area that is now Britain was nearer the equator. In such conditions water containing acids from rotting plants is very reactive and the minerals, again mainly the feldspars of granite, were attacked and weakened. The more stable mineral quartz was much less affected. The weathering mainly took place along the lines of the joints through which water moved. Where joints were closely spaced the individual mineral grains of the granite became more or less completely separated to a considerable depth.

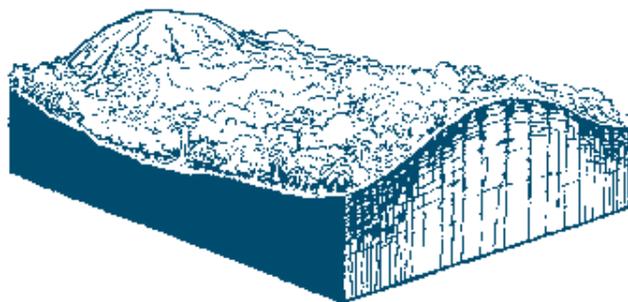
## 5 The Ice Age, the final phase

In cold conditions rocks are not affected by chemical weathering processes but major mechanical forces can take effect. Of these the most important is the expansion of freezing water. The deeply weathered granite was forced apart and broken up into blocks by being subjected to frequent freezing and thawing during the cold periods of the Ice Age, between 2 million to 10,000 years ago. The force of gravity was also important, moving the loose material downhill. This movement, called solifluxion (soil flow), was aided by the ground below the surface being permanently frozen. In the summer the surface layers thawed to produce a wet mush of debris which could slide and flow downhill over the frozen subsoil. Even large blocks and boulders were moved in this process, as much as a kilometre in some parts of the Moor. The result is the boulder fields or clitter surrounding the tors and the cover of gravelly, broken-up granite, called growan locally and Head by geologists. The final result was the removal of the weathered and loose material from around cores of relatively unaltered granite.

The results of all these events are Dartmoor Tors

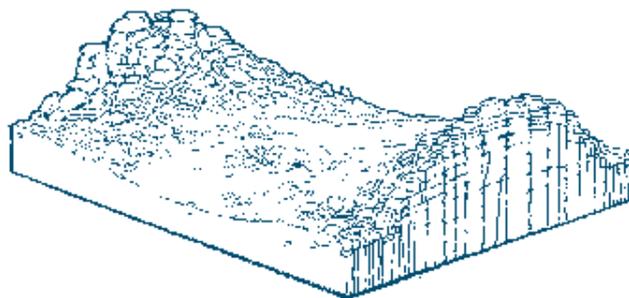
## Dartmoor then and now

*Approximately 30 million years ago*



*How Dartmoor might have looked between 30-60 million years ago. Densely covered with trees and vegetation, the underlying granite is becoming deeply weathered by acidic water penetrating between the joints. The shape of a tor is being formed in the less altered granite.*

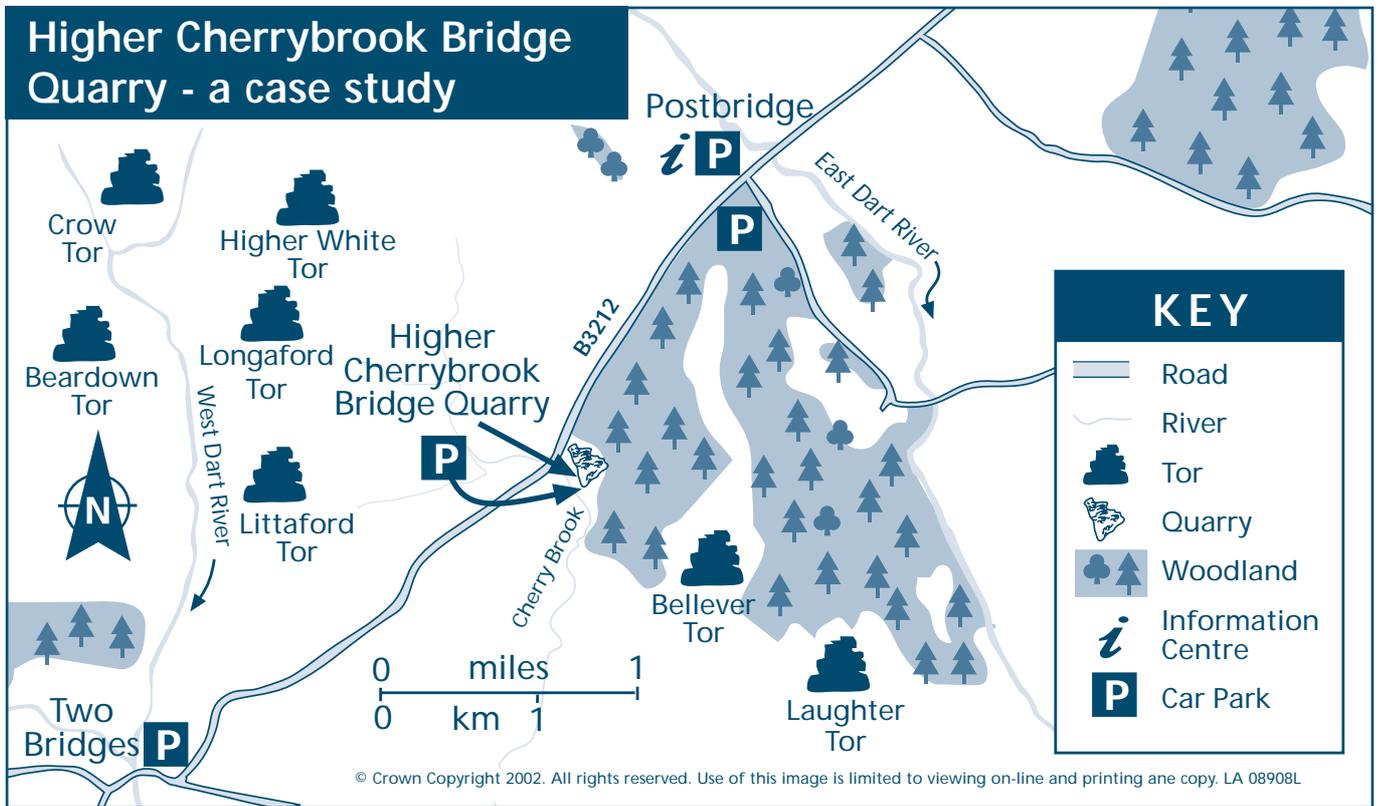
*Present*



*The same scene at the present day. The effects of the Ice Age have stripped away the weathered debris leaving clitter surrounding the bare granite of the tor.*



# Higher Cherrybrook Bridge Quarry - a case study



Higher Cherrybrook Bridge Quarry is a Regionally Important Geological Site (RIGS). These are sites which show a range of geological and geomorphological features and are considered to be of county-wide importance. Designated by English Nature, they have been selected for their scientific, educational, historical and aesthetic value. There are currently approximately 34 RIGS within Devon.

The details below are taken from the RIGS register.

- RIGS reference no. **SX67NW 2**
- Name: **Higher Cherrybrook Bridge Quarry**
- District: **Dartmoor National Park, West Devon** Parish: **Dartmoor Forest**
- Ordnance Survey (OS) National Grid Ref: **SX 6350 7705**
- OS sheets: **1:50k 191 1:25k OL28**
- Geological Survey **1:50k 338**

### Locality description (address):

South side of the B3212 about 75 metres north of Higher Cherrybrook Bridge

### Nature of the site:

Small quarry used as a car park

### Geological/geomorphological features:

The top of the quarry face exposes a soil profile on about 1.5m of Head composed of disaggregated and soliflucted granite. Exposures of coarse moderately megacrystic tourmaline-bearing granite on the remaining part of the quarry 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 as much as 200 mm wide and filled with disaggregating granite. Some vertical and steeply dipping joints are coated with dark tourmaline.

At the northern end of the face the more solid rock is sharply terminated by a fault zone about 0.5m wide. For about 2 m on either side of the fault the granite is softened and probably partly kaolinised. The alignment

of the fault and alteration zone is about 334°. This is similar to the alignment of wide 'avenue' joints such as those through Bellever Tor to the south and provides a probable explanation for their origin. The site has been described and illustrated by Dearman and Baynes (1978), who refer to this quarry as Powder Mills Quarry.

### Reasons for registration as a County Geological Site:

This site has been registered as it clearly demonstrates tor formation processes, is easily accessible and has parking. It provides an excellent alternative to the previously favoured Two Bridges site, which can become crowded.

Site sensitivity: None

Safety: Safe

### Interested groups:

Schools: Years 12-16; Years 17-18.

University Undergraduate - Research

Professional geologists - Amateur geologists

- General public

Access and Parking: Direct access from the B3212 to the car park.

### Date of assessment (V = visited):

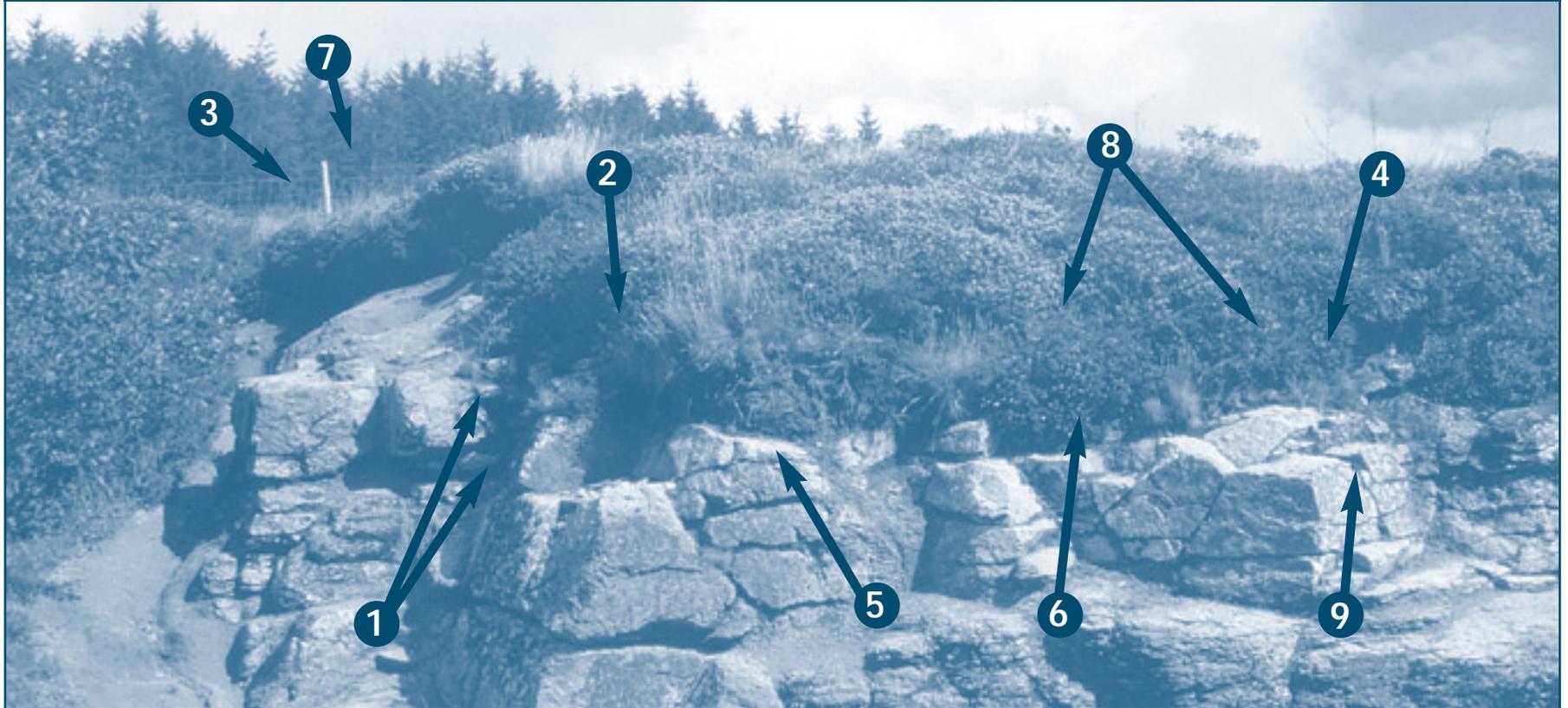
V 12th March 1998 R T Taylor

Site owner: Forestry Commission (Forest Enterprise)

Other Comments: The exposed face has been cleared and extended (October 1999) considerably improving the visibility of the features.

References: DEARMAN, W.R. and BAYNES, F.J., 1978. A field study of weathering patterns in the Dartmoor Granite. *Proceedings of the Usher Society*. Vol. 4(2), pp.192-203.

## Sketch of the face of Higher Cherrybrook Bridge Quarry viewed from the south east



- 1 Steeply inclined joint surfaces (Stage 1) - some with surfaces coated with a layer of black tourmaline. A wider vein with quartz-tourmaline and fine-grained granite cuts across the southern end of the face near its foot.
- 2 Horizontal jointing (Stage 2)
- 3 Faulting and kaolinisation (Stage 2-3) - At the northern end of the quarry (farthest from the entrance and behind the small trees) where the more solid rock stops, the granite is very soft and white; here a zone of kaolinisation several metres wide occurs on either side of a small fault aligned NNW-SSE.

- 4 Deep weathering (Stage 4) - The granite filling some of the wider flat lying joints is softened and broken down into individual mineral grains. Over most of the quarry face the smaller feldspar grains have been softened.
- 5 Frost action (Stage 5) - On the main face of the quarry a large area can be seen in which the granite has been broken up into 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.
- 6 Freezing and thawing of water in winter is still slowly breaking up the granite of the tors. The

separated mineral grains often found on flat granite surfaces have been loosened from the rock in this way.

- 7 Solifluxion (Stage 5) - At the northern end of the quarry, above the kaolinised fault zone, a thick layer of yellowish granite debris can be seen. The layer extends above the main quarry face but is covered by heather and grass. This layer is the result of the downhill movement of weathered and broken-up granite in the Ice Age.
- 8 Steep joint surfaces coated with black tourmaline.
- 9 Quartz-tourmaline aplite vein (aplite is a fine grained form of granite.) (Stage 1)

Produced with the support of the Devon RIGS Group, the Action for Wildlife the Dartmoor Biodiversity Project and Forest Enterprise.

For further information, and a list of other Fact Sheets available, contact the

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<<http://www.dartmoor-npa.gov.uk>>

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