C1 Haytor Rocks area

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Highlights

This classic site contains the best exposure of variants of the coarse, megacrystic granite of Dartmoor, together with a later, intrusive, fine-grained granite sheet. Its coarse-grained granites enclose a variety of genetically significant xenoliths. It also provides excellent evidence of tourmalinization.

Introduction

This site, which is centred on the fine summit tor of Haytor Rocks (Figure 5.9), is unique in containing the two major variants of the Dartmoor Granite whose relationships led to a view of the origins of Cornubian granites which held sway for 30 years or more. Not mentioned by the Geological Survey officers (Reid *et al.,* 1912), the two variants were crucially different in the eyes of Brammall (1926) and Brammall and Harwood (1923, 1932) who interpreted them as an upper, earlier, coarser variety intruded by a lower, finer, later variety, the supposed chilled contact between them being visible in the lower part of Haytor Rocks themselves. Subsequent research in all the Cornubian granites has shown that substantial variations in coarseness are usual among the main biotite-bearing type, although the rocks closer to the walls and roof of each pluton are generally coarser and more megacrystic than those further away. There is a gradational, not intrusive, relationship between coarser and finer, and the contact at Haytor Rocks is now recognized as being due to a separate fine-grained intrusive sheet.

Also to be seen in Haytor Rocks (and more rarely in the neighbouring quarries) is a variety of xenoliths in different stages of assimilation; not as interesting as those at Birch Tor but nevertheless instructive. The composition of xenoliths was used by Brammall and Harwood (1932) in calculations of the modification of the earliest Dartmoor magma into the first of the main magmas; and a cordierite hornfels from Haytor Rocks was described by them in 1923 and a highly granitized 'basic inclusion' from the Haytor Quarry in 1932. Later work suggests that xenoliths are less important than was supposed (Stone and Exley, 1986; Bromley and Holl, 1986). The authors of the Survey Memoir (Reid *et aL,* 1912) described the Dartmoor Granite as being less boron rich than average in south-west England, but the presence in the Haytor Quarries, and in the boulders in the area, of tourmaline-bearing veins and nodular masses of tourmaline called 'suns' indicates that the boron content of the magma was relatively high nevertheless. Brammall and Harwood (1923, 1925, 1932) discussed the significance of this and, especially in their 1925 paper, separated what are now regarded as magmatic, autometasomatic and post-magmatic tourmaline generations. Although later research has modified their views in some details, it has been based on work done elsewhere than Haytor and is described within this volume.

Haytor Rocks were classified as an excellent and 'type' example of 'summit tor' by both Linton (1955) and Gerrard (1974) and figured in photographs in both Linton's (1955) and Palmer and Neilson's (1962) papers.

Description

The greater part of Haytor Rocks is composed of coarse, megacrystic biotite granite with alkali feldspar megacrysts averaging 40 to 50 mm in length. This variety, commonly seen all over Dartmoor, especially in tor outcrops, is like the main granites of other masses in the southwestern peninsula and has been referred to their Type B by Exley and Stone (1982) and Exley *et al,* (1983).

The lower parts of the western and northwestern faces of Haytor Rocks, however, are made up of fine-grained granite, devoid of megacrysts and with pronounced vertical columnar jointing. The contact between the two granites is sharp, although irregular, and dips gently but unevenly towards the south-west; the marginal zone of the lower granite being especially fine grained. Taking into account the exposures in a nearby abandoned cutting, the lower granite must be at least 10 m thick.

Two hundred and fifty metres to the NNW is a small unnamed quarry, while 450 m to the NNE are the much larger eastern Haytor Quarries. In these exposures the rock is not as coarse or as abundantly megacrystic, and this led Brammall and Harwood to the conclusion that there were two granite types, a view that they supported by chemical analyses. They believed that the type forming the upper part of Haytor Rocks and other tors in the vicinity was earlier, sheet like and less potassic. It was known as 'tor' or 'giant' granite. The type found in the quarries was thought to constitute an underlying intrusion into the giant granite, with its chilled contact phenomena visible in the lower part of Haytor Rocks. This later variety was supposed to be derived from the earlier at depth, it was more potassic and was called 'blue' or 'quarry' granite. Other examples of apophyses and sheets of blue granite in contact with giant granite are cited by Brammall (1926) and by Brammall and Harwood (1923), but none is so large and significant as that at Haytor, and it was recognized that the provenance of these minor intrusions was not always clear.

The xenoliths in the area vary in size, but are mostly less than about 0.5 m across and are generally rounded. They range in composition from basic, through diorite and grandiorite, to metasedimentary; and give an indication of the variety of rocks penetrated by the granite magma. Tourmalinization, in evidence everywhere, especially in the quarries, is occasionally in the form of narrow quartz–tourmaline veins but more spectacularly as the nodular masses –sometimes granular, sometimes acicular – of quartz and tourmaline known as 'suns'.

Interpretation

The Haytor Rocks site demonstrates, better than any other single site, evidence which has been used to support hypotheses regarding the origins of the Cornubian granites. The most significant is the presence of the two major granite variants thought by Brammall and Harwood to be distinct and separate intrusions. However, it is now realized that most of the chemical and textural variations in the coarser Cornubian granites is gradational and does not allow the separation of types which can be shown to be different statistically (for example, Chayes, 1955; Al-Turki and Stone, 1978); thus both Haytor variants can be accommodated in Exley and Stone's Type B granite or the 'coarse megacrystic' and 'coarse poorly megacrystic' varieties of Dangerfield and Hawkes (1981). Moreover, it is generally accepted that the fine-grained intrusion at Haytor Rocks is a large sheet later than, and independent of, the coarse granites in both the tors and the quarries. It has a significantly different composition, and is thus considered to belong to the Type C of Exley and Stone (1982) or 'fine poorly megacrystic' type of Dangerfield and Hawkes (1981). Although both field relations and trace element ratios suggest that some Type-C granites were derived from the Type-B magma (Exley *et al.,* 1983), variations in their chemistry indicate that others were not and that the process was not straightforward (Exley *et al.,* 1983; Stone and Exley, 1986). For example, describing fine-grained granite from a few miles to the north, Hawkes (*in* Edmonds *et al.,* 1968) included both chilling and contamination among possible origins. The fine-grained sheets noted by Brammall and Harwood do not all have the same origin, therefore.

It was postulated by Brammall and Harwood (1932) that the earliest magma was 'sodipotassic' and that it was modified and made increasingly potassic by the assimilation of xenolith material, particularly metasedimentary fragments, from the rocks through which it ascended, and, while concentrating attention on material from the contact at Burrator, on the west of Dartmoor, they quote an analysis from a Haytor xenolith in their paper. According to Reynolds (1946), the chemical changes resulting from assimilation and granitization make suspect Brammall and Harwood's identification of some xenoliths as originally basic. Furthermore, the derivation of much of the biotite in the granite as a 'restite' mineral from the source rocks (Stone, 1979; Stone and Exley, 1986) and the physicochemical difficulties of assimilation by a magmatic system close to the 'granite' system ternary minimum of Tuttle and Bowen (1958), (Bromley and Holl, 1986) have reduced the significance of xenoliths in modern views about the petrogenesis. Nevertheless, the presence of a wide variety of xenoliths, many of which are metasedimentary, gives these granites the aspect of Chappell and White's (1974) S-type, although relatively high concentrations of some metallic and halogen elements suggest the addition of some mantle components (Exley *et al.,* 1983; Stone and Exley, 1986). The Dartmoor petrogenetic model is put into historical context in the earlier part of this chapter.

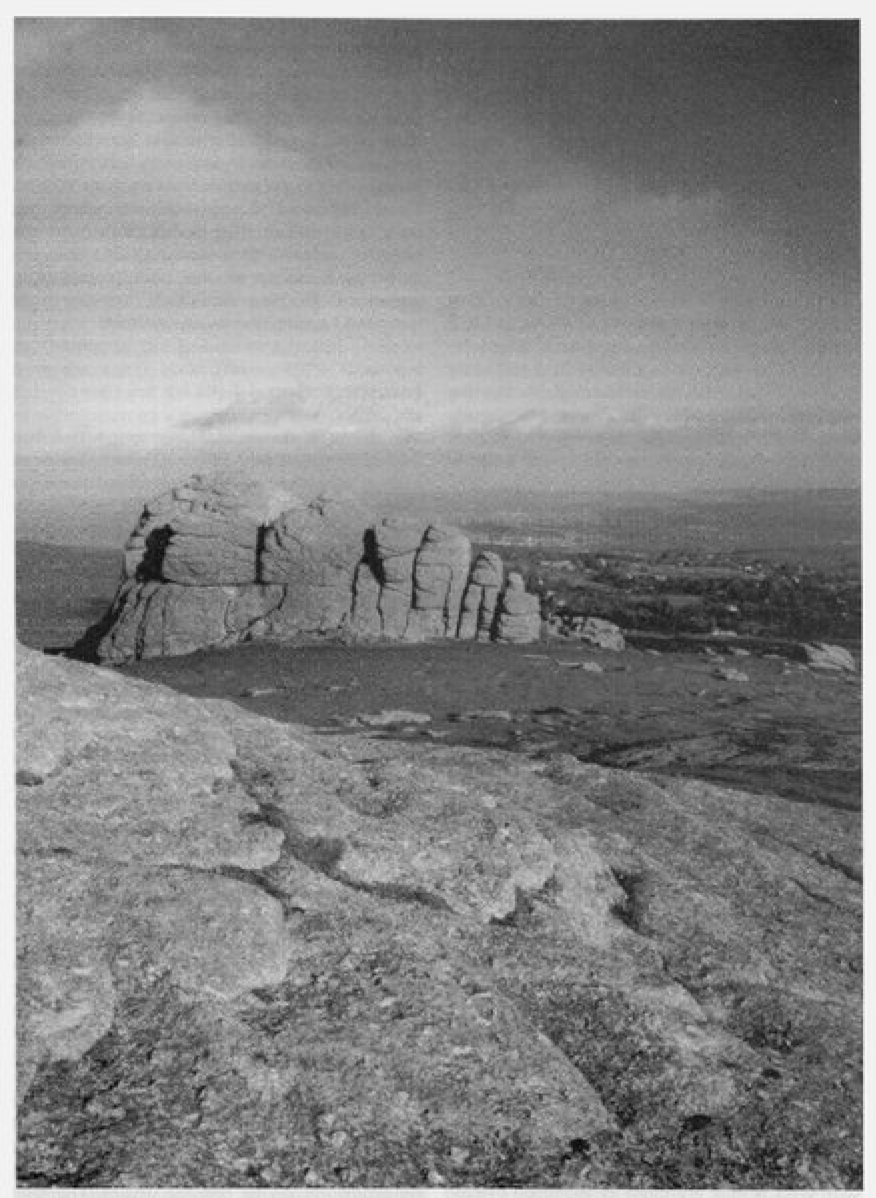
A relatively high boron concentration in the Cornubian magmas played a very important role in late- and post-magmatic activity of various kinds including mineralization. By comparison with granites further west, such activity was restricted in the Dartmoor area: quartz–tourmaline veins and nodules such as are well displayed in the rocks around Haytor, provide excellent examples of the early stages of these phenomena. Brammall and Harwood (1925) suggested that there was a reciprocal relationship between the proportions of biotite and tourmaline, a suggestion supported by a deficiency of biotite in the rock surrounding some of the tourmaline 'suns' found in the Haytor Quarries. They argued that Fe, Mg and Ti were distributed in biotite, tourmaline, rutile, anatase and brookite or zircon according to the temperature of the magma, concentrations of B and extent of post-magmatic alteration (Brammall and Harwood, 1923, 1925, 1927).

This site contains the exposures which led Brammall and Harwood (1923, 1932) to believe that the finer-grained Dartmoor Granite was intrusive into earlier, coarser-grained variety, a belief which is not now accepted. It also contains examples of the xenoliths whose assimilation these authors considered to have played a crucial role in modifying the composition of the initial magma. Lastly, it contains a variety of veins and nodules which illustrate the effects of tourmalinization resulting from the high boron concentration in the magma.

Conclusions

The Haytor Rocks site constitutes an ideal area in which to examine textural and compositional variations in the earlier, main suite of Dartmoor granites in particular and in the Cornubian granites in general. Additionally, there is evidence for the way in which the magma was modified both by the incorporation of xenolithic constituents and by reaction with boron. Geomorpho-logically, the site is dominated by a classic example of a summit tor.

References



(Figure 5.9) Haytor Rocks, exposing the coarse megacrystic granite of Dartmoor. The megacrystic character of the granite is visible in the foreground exposure. (Photo: S. Campbell.)