Wyns Tor

[SK 241 603]

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Introduction

Wyns Tor, Derbyshire, is an important site for studies of rock weathering, periglacial processes and landscape evolution in the Pennines. The origin of the tor has been explained by Linton (1955) in terms of a two-stage model involving chemical weathering followed by a period of stripping under a glacial or periglacial climate. The tor is unusual for the Pennines in that it is developed not on Millstone Grit but on dolomitized limestone. Wyns Tor was selected for the Geological Conservation Review in order to represent the nature of these dolomite tors and their associated weathering cover. Ford (1963, 1969) has considered in detail the nature of the dolomite tors of this area.

Description

Wyns Tor is a large dolomite tor located immediately south of the village of Winster in Derbyshire. Although the southern Pennines are dominated by Carboniferous Limestone, towards the south-east of the limestone outcrop are patches of dolomite reflecting Permian and Triassic dolomitization of the limestone by subsurface waters (Parsons, 1922; Kent, 1957; Shirley, 1958; Ford, 1963, 1969). Tors are entirely absent on the unaltered limestone of the area, but are common on the dolomite areas (Figure 7.13). On the dolomitized limestone, the landscape is dominated by isolated tors, scattered sink-holes filled with silica sand, patches of chert gravels and soils developed on glacial till and loess (Piggott, 1962; Ford, 1969). The dolomite tors in this part of the Peak District vary from 15 m high, isolated pinnacles, such as those at Grey Tor and Wyns Tor, to much larger landscape elements such as the castellated escarpments up to 50 m high and 1 km in length at Rainster Rocks. Large, open blocks with well-developed joint systems crown all the dolomite tors and many of the lower slopes are strewn with detached boulders and blocks, sourced from the tors (Ford, 1963). Weathering of the tors in the present-day climate is evident, and temporary excavations described by Ford (1963) have highlighted the importance of vegetation in disaggrggation of the dolomite. Decalcification of the dolomite is promoted by soil moisture, by the penetration of tree roots and by humic acids. The net result of this decalcification is to gradually break down the dolomite into an incoherent aggregate of dolomite crystals. In places, temporary excavations have exposed partly exhumed tors from beneath these weathering products.

Wyns Tor is one of the largest and most prominent of the isolated dolomite tors, rising some 15 m above the surrounding land surface. The upper surface of the tor is formed of large blocks separated by wide and open joints. Detached blocks are common on the slopes around the base of the tor. Present-day modification of the tor is evident in frost shattering, the action of humic acids from the soil cover and the wedging apart of blocks by tree-root penetration (Ford, 1963). The dolomite blocks of the tor are angular and edge-rounding of blocks generally is rare or absent. Both bedding and joint surfaces are characteristically pock-marked with small cavities created by the removal of relict calcareous fossils that escaped dolomitization. Wyns Tor is especially rich in such surface features, including many small chert nodules and silicified fossils.

Interpretation

The Pennine tors have long stood at the heart of controversy concerning the nature of deep weathering and landscape evolution in the British Isles. There currently are two main theories that can account for tor formation. The first involves a two-stage model of deep weathering and stripping (Linton, 1955, 1964) and the second requires only a single cycle of denudation under periglacial conditions (Palmer and Radley, 1961; Palmer and Nielson, 1962). Other models of tor formation exist, including the Bunting (1961) model involving the action of contemporary seepage moisture and the Palmer (1956) model involving 'the disintegration of resistant stratum following the rejuvenation of a mature hill-slope'.

More recently, Battiau-Queney (1980, 1984) has suggested that the tors of south-west Wales formed in response to deep chemical weathering (possibly in Tertiary times) followed by stripping in response to local uplift along older structural axes. The last three of these theories are difficult to apply, however, and the first two are regarded generally as the most universally applicable.

Evidence for tor formation has been gathered primarily from two geographical areas, from the tors of the northern Pennines, which are developed in Millstone Grit, and from the tors of Dartmoor, which are developed on granitic lithologies. However, the geographically separate group of tors in the Peak District of the southern Pennines, developed in the dolomitized limestone, also contributes to an understanding of the problem of tors. The evolution of the dolomite tors of the Peak District is complex. The tors cannot be understood in isolation and must be considered in conjunction with the evidence contained in the surrounding silica sand deposits and glacial deposits. Between the tors are large numbers of sink-holes filled with silica sand and clay (Ford, 1969). These sinkholes developed in Tertiary times during periods of solution and collapse and are commonly filled with an inwash of silica sand derived from early Tertiary weathering of the surrounding Millstone Grit and Coal Measures (Figure 7.14). Ford (1963) has reviewed this evidence and suggests that there is no genetic relationship between the dolomite tors and the silica sand deposits. As the pockets of silica sand were deposited against walls of tors, the dolomite tors must pre-date the deposition of the silica sands in the Tertiary Sub-era. Ford uses this to argue for a Tertiary origin for features such as Wyns Tor. There is further evidence for the age of these features in the glaciogenic deposits of the region, because glacial tills commonly contain dolomite blocks of similar dimensions to those that form the modern tors. On the assumption that these blocks are derived from glacial erosion of the tors, the tors of this area must pre-date the glaciation.

Ford (1963) suggested a two-phase evolution for the dolomitized limestone tors of the southern Pennines. Firstly, the porosity of the dolomite allowed the removal of calcite by percolating waters flowing along joints in the bedrock. This had the effect of weathering the dolomite along lines of weakness and allowing frost-wedging, tree roots and soil moisture to further open the joints. Secondly, the weathered products were removed by erosion to leave the tors upstanding. The precise nature of this removal is debatable. Ford (1963) envisages that this could be achieved during periods of glaciation, although there are problems in explaining the selectivity of this glacial erosion. Periglacial solifluction and block wedging by frost action may have assisted in the development of the tors, although there is no clear evidence for the weathering process that exposed tors such as Wyns Tor. Ford (1963) clearly prefers an age for exhumation of the tors prior to the last interglacial, whereas in the two-stage model of tor formation proposed by Linton (1955) for the Millstone Grit tors, exhumation would have been achieved during the last glaciation.

To summarize, it is helpful to list the significant features of the dolomite tors of the Peak District noted by Ford (1963). These are as follows:

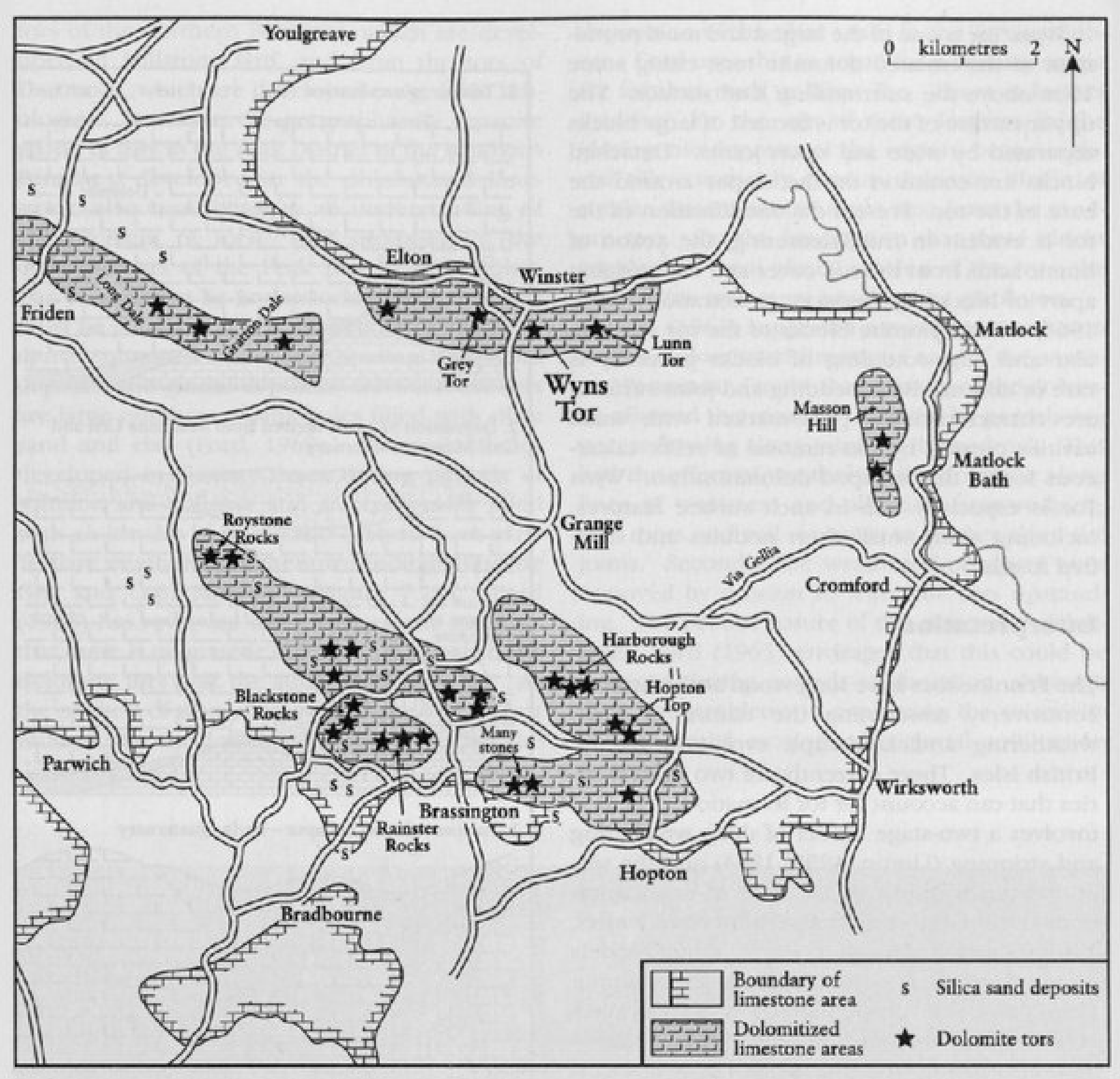
1. The tors are confined entirely to the dolomite outcrop and do not occur on the Carboniferous Limestone.
2. The dolomite is highly porous and susceptible to chemical decay by the removal of calcite along bedrock joints.
3. Some of the dolomite tors may pre-date the silica sand deposits of the region, and according to Ford (1963) this suggests a Tertiary age for these features.
4. Glacial deposits overlying the silica sand contain blocks derived from the dolomite tors, implying that the tors were exposed at the surface during the last glaciation.
5. The existence of detached boulders around the base of tors such as Wyns Tor (Figure 7.15) implies that modification in the present-day climate is an ongoing process, although the rate of this modification cannot be quantified.

Conclusions

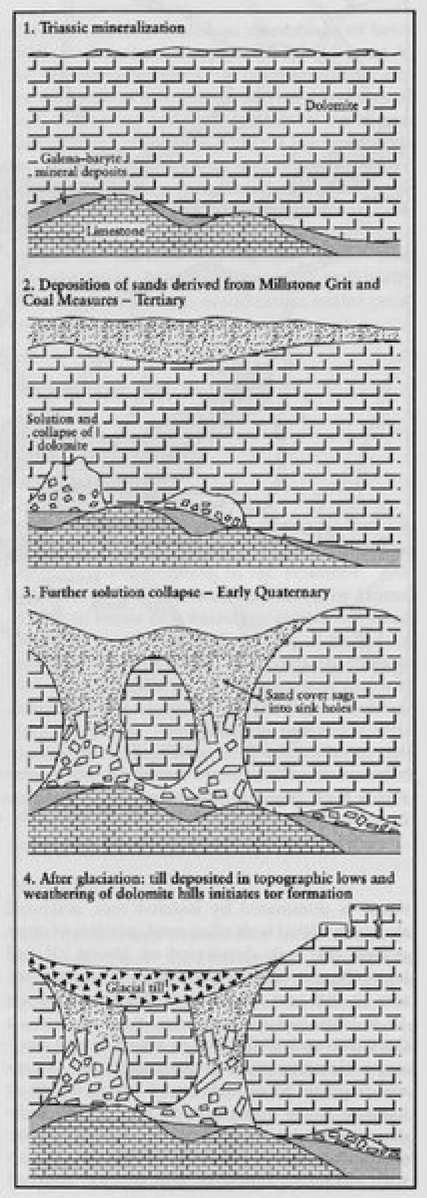
Wyns Tor is the best example of a tor developed on dolomitized limestone in Britain and the site contains important information on the nature of rock weathering, periglacial processes and landscape evolution in this part of the Pennines. The dolomite tors of the southern Pennines have a complex geological history but probably owe their gross morphology to periods of weathering in Tertiary times. Stripping of this weathering cover has proceeded intermittently under a variety of climatic regimes and continues into the present day. As such, Wyns Tor is a good exemplar of the two-stage model of tor formation proposed by Linton (1955). It is therefore a key site in unravelling the complex Pleistocene history of the

Peak District and the surrounding area.

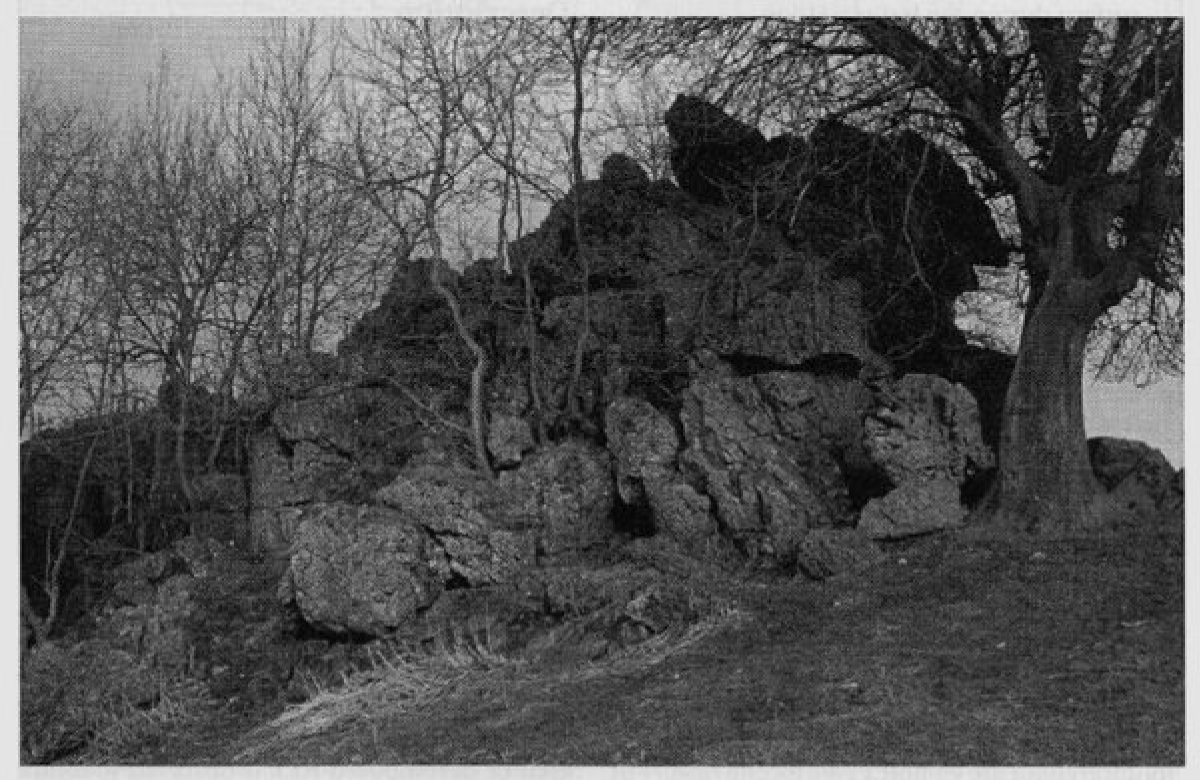
References



(Figure 7.13) Map of the distribution of dolomite tors in the south-east of the Peak District (after Ford, 1963). Note the relationship between the distribution of the dolomitized limestone and the location of the tors.



(Figure 7.14) Simplified model showing the evolution of the sand-filled sink-holes and the dolomite tors in the Peak District (modified from Ford, 1969).



(Figure 7.15) Wyns Tor. (Photo: N.F. Glasser.)