Giggleswick Scar

[SD 803 655]

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Introduction

Giggleswick Scar is a classic example of a fault-line scarp. It follows the line of the South Craven Fault and has been caused by differential erosion between the Dinantian Malham Limestone to the north-east and the Namurian sediments to the south-west, and has been enhanced by glacial erosion during several glaciations. The whole Craven Fault Zone, of which this area forms a part, is complex and shows evidence of long-continued tectonic movement. There is additional geomorphological interest in the drift-covered terraces, screes, dry valley systems and intermittent spring and small caves associated with the scarp.

Description

Fault-line scarp

The major structural units of the northern Pennines, the Alston and Askrigg Blocks, are divided by the Stainmore Syncline (Hudson, 1933, 1938), and are defined by complex, fault-line scarps forming prominent features in the landscape (Figure 5.74). Along the southern edge of the stable, Askrigg Block, the 'Craven Faults System' (Phillips, 1836) collectively demarcates the upland limestone to the north from the lower, younger, non-carbonate, Carboniferous rocks to the south. The Craven faults run mainly WNW–ESE and the throws are all to the south-west and south. In the Ingleborough area the fault-line scarp is a broad-stepped slope across the whole fault zone, but farther to the south-east this fault-line scarp is best seen at the spectacularly clean-cut Giggleswick Scar. Here, the scar marks the erosion of the actual fault line by successive phases of ice erosion during the Pleistocene Epoch, to give one of the most impressive fault-line scarps in Britain (Figure 5.75). It extends in its best developed form for over 2 km, with a height differential between the north-east and south-west sides of approximately 100 m. The scar itself is formed of the Malham Formation, whereas the lower ground is glacial drift covered. The freshness of the topography suggests that the fault was active as late as the Late Tertiary (Brumhead, 1979; Nicholson, 1990) and it is possible that it is still active today.

Glacial landforms

The scars are formed by ice plucking the limestone so that differential erosion has produced a series of terraces, most of which are covered by thin, glacial drift. The drumlin zone south and south-east of Ingleborough indicates ice moving south-eastwards towards Airedale from Kingsdale, Chapel-le-Dale, Crummackdale and down Ribblesdale (Tiddeman, 1872, Arthurton *et al.,* 1988). At the western end of the scar, near Scar Top, a shallow, dry, valley system runs across the scar to two feeder entry points which coalesce into a large depression. A series of similar shallow valleys cut the surface of the scar to the south-east. One such narrow valley, about 25 m in width, can be seen running from Kinsey cave for about 75 m to the front face of the scar, where it abruptly terminates ((Figure 5.76)a). Blocky scree is found on both sides of this valley and the most likely explanation for the dry valleys is a subglacial channel, probably a subglacial chute, which ran down the scar under the ice and flowed back into the ice where it suddenly terminates. Extensive aprons of blocky scree below the individual scars form along the length of Giggleswick Scar.

Caves

Brook *et al.* (1982) describe a series of small caves situated on Giggleswick Scar (Figure 5.77), which are important in terms of archaeology but also indicate an earlier, phreatic drainage system that has been totally disrupted by glacial erosion. For example, Spider Cave is a 21 m phreatic tube that is now connected to the surface along a grike ((Figure 5.76)b). Kinsey Cave, just to the north, has an 8 m wide overhanging entrance 2.4 m high, is 23 in long and has a phreatic roof showing large scallops and anastomoses. It has important sediment fills, flow-stone on the walls and terminates in a calcited blockfall.

Archaeologically, King (1974) described these caves and others, such as Kelco and Sewell's Cave, as south-facing, human rock shelters but that they had incomplete early excavation reports. Excavations from 1925 provided evidence of Romano-British and Late Pleistocene occupation (Jackson and Mattinson, 1932; Thornber, 1959). The remains of domestic animals used for food and Romano-British material were found in the upper layers and in the lower layers the remains of reindeer, bison, bear and lynx were located. A fragment of worked rod of reindeer antler was excavated from the lower layer, which had a tapering squared section, the corners being rounded and longitudinally it had been scored with paired lines. Some Creswellian points were also excavated. In Sewell's Cave one complete and one incomplete Roman sword were excavated, together with a piece of possible plate mail, six human skulls and the skull of a young pig, but because of disturbance it was not possible to say if the material was Romano-British or earlier. Sir Arthur Keith in his report suggested that the cave had been used as a burial place, with new burials disturbing the older ones (Raistrick, 1936). At Greater and Lesser Kelco caves excavations from as early as 1850 and later from 1928 to 1933 yielded numerous Romano-British finds, along with the remains of domestic food animals. Both caves also produced Neolithic pottery and human skulls, possibly from the Bronze age.

Intermittent spring

Sweeting (1972) suggests that the best known intermittent spring in Britain is the Ebbing and Flowing Well at the base of the Giggleswick Scar (Figure 5.78). This well is more a reciprocating spring, which is one that does not dry up between the flows but runs continuously, with irregular discharge. All observers of the Ebbing Flowing Well have commented on its irregular flow and Stevens (1964) has collected information about the well, such as the rises and falls noted by Swainson in 1796 (quoted in Housman, 1800) and Sweeting in 1947. It now ebbs and flows only during periods of moderate rainfall. In dry weather it flows without interruption and after heavy rain it floods like others in the same area. It appears to be less active than in the past and it has been suggested that in time all ebbing and flowing springs become normal karst springs (Sweeting, 1972).

Interpretation

Fault-line scarp

Although Giggleswick Scar is situated on the line of the South Craven Fault it is part of a complex tectonic area, the evolution of which is controversial (see details in Tiddeman, 1889, 1891; Hudson, 1930, 1933, 1944; Wager, 1931; Hudson and Mitchell, 1937; O'Connor *et al.,* 1974; Johnson, 1967; Tegerdine *et al.,* 1981; Leeder, 1982; Arthurton, 1984). The controversy lies in when the faulting was initiated and its influence on subsequent sedimentation (Arthurton *et al.,* 1988).

Recent movement has occurred on the South Craven Fault system, as Versey (1948) recorded a seismic event known as the 'Skipton (or Settle) earthquake', which occurred in 1944. He regarded the epicentre as in all probability lying along the Gargrave fault. Damage was caused to a bridge and subsurface drains along the unspecified 'mapped line of the fault'. There has been repeated occurrence of small earthquakes along the edge of the Askrigg Block that bear witness to differential movement still taking place along these fault systems.

The results of this complex fault movement are important for the landscape because Wager (1931) demonstrated that the direction and density of the joints in the Dinantian limestones were related to the major faulting along the Craven Fault system, although the mechanism for their formation is still in dispute (Moseley and Ahmed, 1967; Doughty, 1968). Wager (1931) demonstrated the direction of jointing in the Malham area and interpreted the changes near the faults as an indication that the North Craven Fault was sinistral and the Mid-Craven Fault dextral. Away from the faults the joint trends are NW–SE and NE–SW. As the North Craven Fault is approached from the north the joints tend to swing anticlockwise so that those in the north-west sector swing to a more east–west trend. Less marked but nevertheless the same is the anticlockwise deflection found close to the south of the fault. In contrast, the joints close to the Mid-Craven Fault show a clockwise deflection and joints in the north-west sector tend to swing to a more northerly direction. Between the two faults there are a number of cross-faults, with most trending north-west to south-east. Their throw is small, sometimes negligible and they are probably wrench faults formed by the stresses and strains set up in the lateral movement of the North Craven and Mid-Craven faults. These small faults can be picked out by glacial drainage as weaknesses and it is possible that many of the dry valley systems could be initiated along these lines. They certainly have been demonstrated to be important in the development of vertical pitches in caves (Waltham *et al.,* 1997) and some of the collapse dolines, such as Great Douk Pot, are on such faults. The density of jointing close to faults also gives a very different type of limestone pavement morphology (Sweeting, 1966; Trudgill, 1985; Waltham *et al.,* 1997).

Cave development

On a more major scale, rejuvenation of the Askrigg Block along the line of the Craven Fault System has influenced the relief and the caves markedly. This is because the Askrigg Block has been uplifted relatively to the Craven and Lonsdale lowlands since at least Tertiary times. This has allowed waters to descend more rapidly into the limestone and to form deeper underground channels, vertical potholes and shafts and to produce the waterfalls and gorge systems in an area. The caves associated with Giggleswick Scar do not show this verticality and are relict phreatic tubes, which formed when the water table was much higher and therefore must be of considerable antiquity. The cave systems have now been exposed by glacial erosion on the scars and form rock shelters that have been used by humans from the late Palaeolithic period onwards.

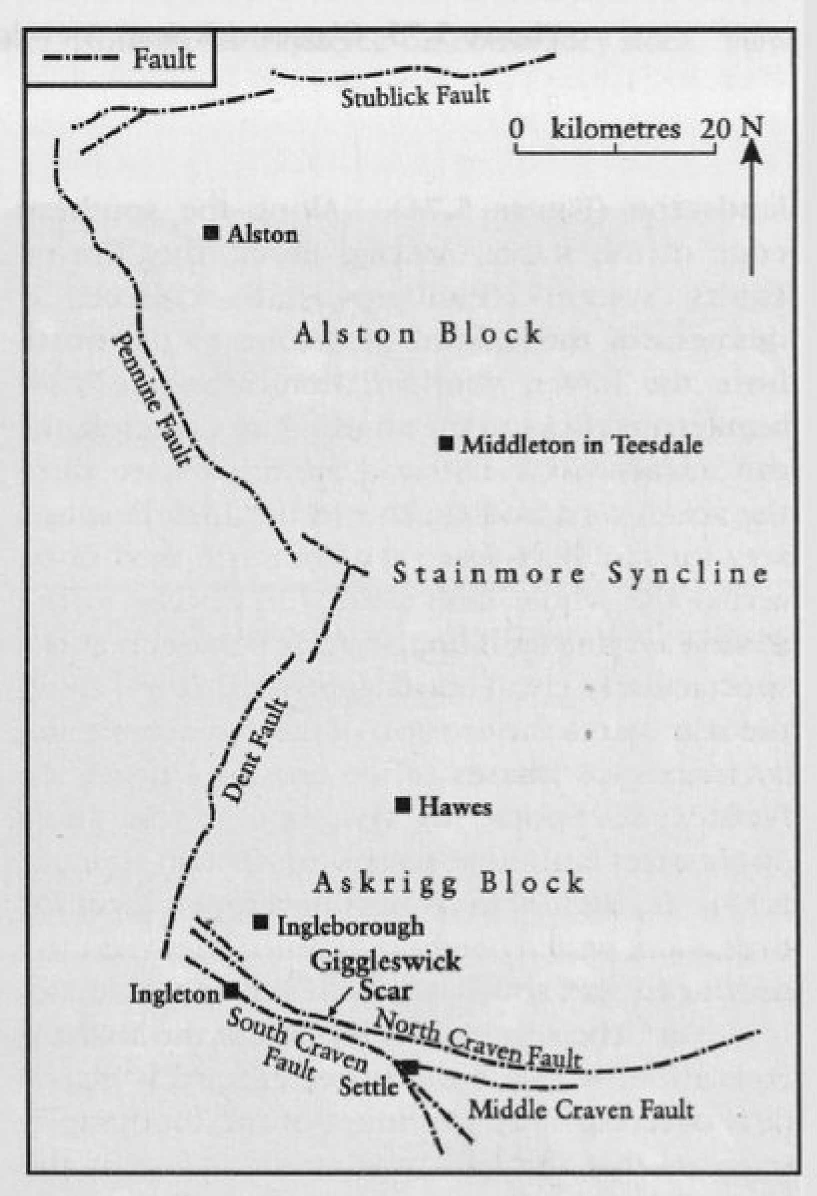
Reciprocating spring

Different explanations have been given for the intermittent spring that tried to account for the reciprocation, its irregularity and the influence of wet and dry seasons. A solution on the principle of the double syphon was given by Thomas Hargraves of Settle (Howson, 1850) and is illustrated in (Figure 5.78). Chamber A is connected to a further chamber C by a duct (B). This chamber is connected to the resurgence at E by a further duct (D). Above and below duct B are a series of further ducts (F and G). Ducts B and D each form a syphon, where B draws off the water from the basin A and fills the smaller basin C until it runs over at D. As D is wider than B it soon empties the basin C and then the stream ceases until C is filled again, thus causing the reciprocation. The irregularity of the reciprocation is caused by the fact that B draws off water from A faster than it is supplied by the spring and therefore A becomes empty and no reciprocation takes place until it is filled again to the height of syphon B. At which time the fullness of A causes a powerful flow and before the well goes down to its average flow, a series of flows takes place and the interval between each flux and reflux increases, until A is emptied again. In dry weather there is no reciprocation because the water is insufficient to fill B and it escapes through the duct F below. After much rain the basin C is supplied by too much water from B and the duct G operates. Sweeting (1972) suggested that the irregularity could be the result of the presence of air bubbles associated with the ebb and flow. Over time the passages will be enlarged by solution and an increasingly large flow will be needed to start up the ebb and flow action, or alternatively the passage will be adjusted to take the flow at all times (Myers, 1962), and eventually it will become just a normal spring.

Conclusions

Giggleswick Scar was been formed as a result of a complex tectonic history over a long period of time along the South Craven Fault, but this line of faulting has been eroded by glacial plucking and abrasion to give an impressive fault-line scarp. A series of small caves, originally forming beneath the water table in the phreatic zone, which was disrupted on a major scale by these glacials, now form rock shelters in which there are important archaeological and palaeontological remains. Minor glacial landforms, such as scars, drift-covered terraces and dry valley systems are located on Giggleswick Scar and there is an important reciprocating spring.

References



(Figure 5.74) Structural units in the northern Pennines and the position of the Craven faults.

(Figure 5.75) Giggleswick Scar. View looking south-east. (Photo: D. Huddart.)

Figure 5.76a Dry valley system leading from Kinsey cave. Note the blocky scree on both valley sides. View looking north-east. (Photo: D. Huddart.)

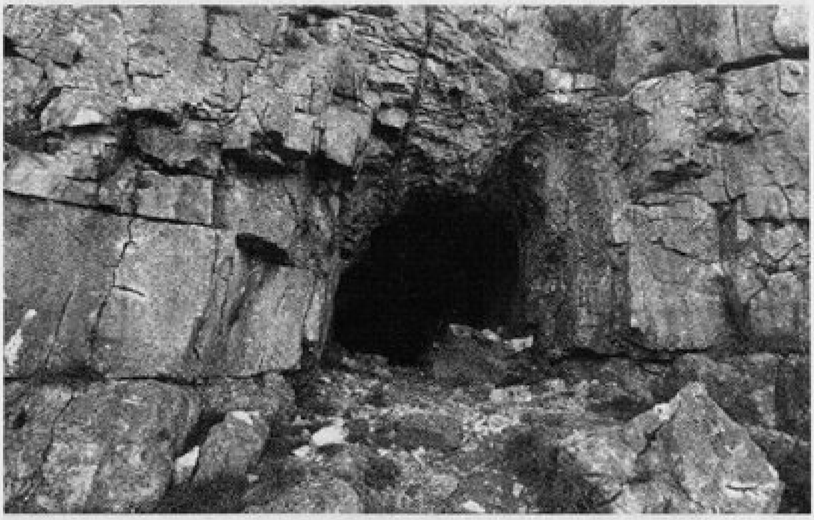
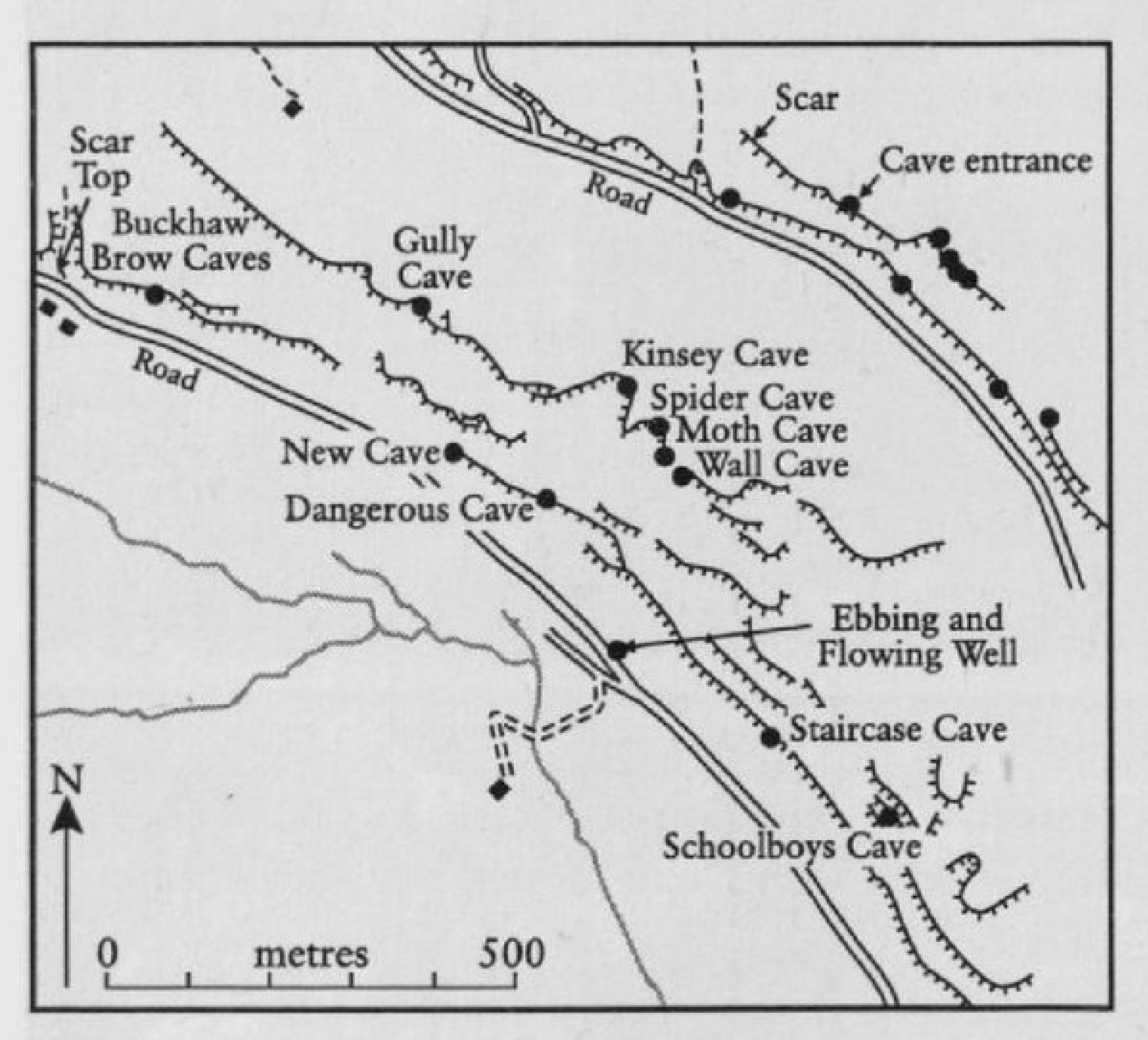
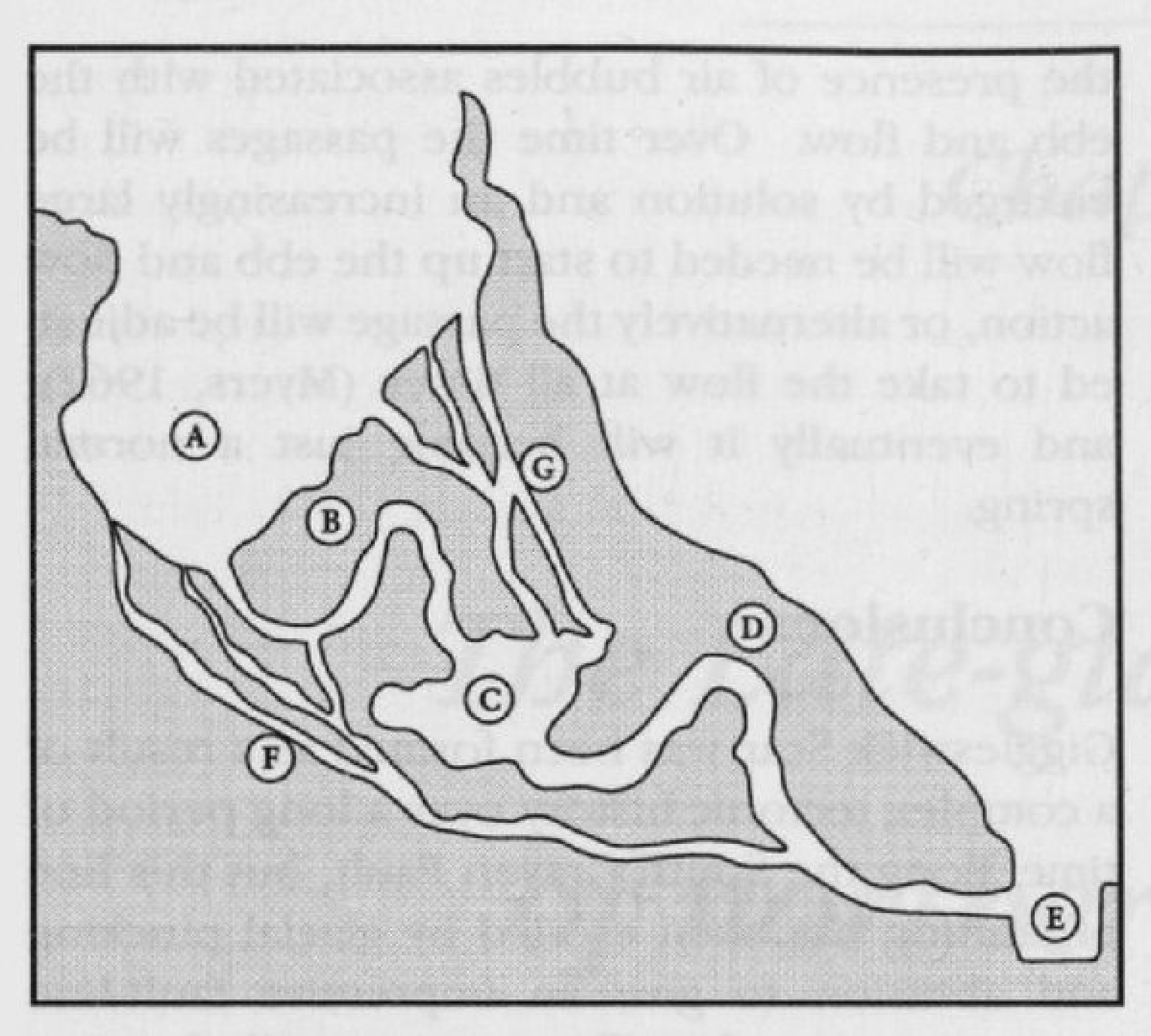


Figure 5.76b Spider Cave entrance, a phreatic tube. (Photo: D. Huddart.)

(Figure 5.76) a. Dry valley system leading from Kinsey cave. Note the blocky scree on both valley sides. View looking north-east. (Photo: D. Huddart.) b. Spider Cave entrance, a phreatic tube. (Photo: D. Huddart.)



(Figure 5.77) Caves in the Giggleswick Scar area (after Brook et al., 1982).



(Figure 5.78) Intermittent spring at Giggleswick Scar (after Howson, 1850). A–G: see text.