Steel Rigg to Sewingshields Crags, Northumberland

[NY 751 676]–[NY 813 704]

S.C. Loughlin

Introduction

In the Roman Wall region, between Newcastle-upon-Tyne and Carlisle, the Great Whin Sill forms a spectacular north-facing scarp that extends for over 25 km to the north of the River South Tyne. The scarp forms a natural barrier that provided an ideal site for the construction of a substantial length of Hadrian's Wall and several important Roman forts (Figure 6.6). The area is one of outstanding natural beauty, is popular with walkers and rock-climbers and has been used as a major film location. It has been a recommended site for geological conservation since 1945 and is also included in the GCR for its Quaternary geology (Huddart and Glasser, 2002).

The Steel Rigg to Sewingshields Crags GCR site extends from the car park at Steel Rigg [NY 751 677], ENE for about 7 km to Sewingshields Crags [NY 810 703] (Figure 6.24). The quartz-dolerite sill is beautifully exposed in a series of crags over 30 m high and exhibits several fault-controlled transgressions between stratigraphical levels within the Visean sequence, well seen at Sewingshields Crags and House-steads. At Sewingshields Crags there are good exposures of the chilled base and of the contact between the top of the sill and metamorphosed sedimentary rocks. There is also a large raft of baked limestone near the base of the sill.

The geology of the area was described briefly by Wallis (1769), Winch (1817) and Tate (1867, 1868) in their accounts of the geology of Northumberland. Baked sedimentary rocks above the sill in the Roman Wall area were important features in the summary of evidence by Topley and Lebour (1877) that finally established the intrusive origin of the sill. The Geological Survey mapped central and south Northumberland in the 1870s and six-inch sheets 106NE and 106SE were published in 1881. Smythe (1930a) described the transgression of the sill at this site in his extensive study of the geochemistry of the Whin Sill-complex. Further descriptions of the site and a detailed account of the Carboniferous rocks into which the sill is intruded were produced by Johnson (1959). A revision survey was completed by the Geological Survey in 1975 and 1:50 000 Sheet 13 (Bellingham) was published in 1980, together with a memoir (Frost and Holliday, 1980). The results of detailed ground magnetic surveys that clarify the structure of the sill at depth were described by Cornwell and Evans (1986). Descriptions are included in field guides of the area, including those by Jones (in Scrutton, 1995) and Johnson (1997).

Description

The north-facing scarp formed by the sill in this area is arguably the most impressive landscape feature of the whole Whin Sill-complex (Figure 6.25). At this site, and in adjacent areas, the scarp exhibits several offsets, which are caused by transgression of the sill between different levels within the Visean (Liddesdale Group) succession. In general, it is intruded at successively higher stratigraphical levels from east to west. Between the River North Tyne and Sharpley the sill is in the Oxford Limestone; between Carrowborough and Winshields (including this GCR site) it is among the Bathhouse Wood and Shotto Wood limestones (it transgresses both up and down between them); and between Winshields and Greenhead the sill lies just below the Five Yard Limestone. The sedimentary rocks comprise repeated sequences of limestone, mudstone, siltstone, sandstone and coal deposited as Yoredale cycles.

Several transgressions occur close together within this GCR site. They appear to take place along small faults, which are visible in places as truncations in the sedimentary rock outcrops above the sill (Johnson, 1959), but are commonly hidden beneath thick drift deposits. In the western part of the site the sill is intruded into the Shotto Wood Limestone (Scar Limestone of Johnson, 1959). The sill and limestone form a composite dip-slope for several kilometres, along which vegetation on the differing rock-types contrasts sharply in colour and variety (Tate, 1868; Frost and Holliday, 1980). The sill escarpment is heavily indented, probably as a result of small faults that have fractured and shattered the dolerite. The most westerly indentation [NY 753 675] is quite deep and well defined. Several small transgressions take place around Housesteads [NY 790 688], where the sill moves to the top of the Shotto Wood Limestone. Farther east, at Busy Gap [NY 800 695], the sill abruptly changes horizon to the Bathhouse Wood Limestone (Cockleshell Limestone of Johnson, 1959) and is offset several hundred metres to the north.

The sill at this site is composed of homogenous quartz-dolerite with thin chilled margins at the top and base (less than 0.5 m). The thickness of the sill varies from 20 m to 50 m. It shows well-developed columnar jointing, particularly at Sewingshields Crags [NY 800 700] where isolated trapezoid pinnacles have been weathered out at the top of the crag. At Crag Lough and Peel Crag, the columns provide some of the most popular rock climbs in Northumberland. The upper and lower contacts of the sill are very well exposed at several locations within the site; for example, the Bath-house Wood Limestone rests directly on the sill at Sewingshields Crags, forming a composite dip-slope for several kilometres to the east. The contact metamorphism of the overlying sedimentary rocks is also particularly clear at Sewingshields Crags and a 2 m-thick raft of baked Bathhouse Wood Limestone is exposed near the base of the sill at Sewingshields Castle [NY 8114 7041].

Alteration of the sill typically includes chloritization along joint planes and there are also some good examples of pectolitization. Pectolite (a zeolite) occurs at several places in the Whin Sill-complex but is particularly abundant in the vicinity of the Roman Wall. It generally takes the form of thin veins associated with calcite and also occurs in amygdales (Smythe, 1930a). These are surrounded by an aureole up to 1.5 cm wide of light-green altered dolerite in which further clusters of pectolite crystals can be observed. In other places amygdales comprise quartz and calcite.

Interpretation

The origin of the Whin Sill-complex was debated at length early in the 19th century. Early workers considered that it represented lava flows (e.g. Phillips, 1836; Hutton, 1838) but Tate (1867, 1868) recognized the evidence for intrusion in the vicinity of the Roman Wall, based on the metamorphism of the overlying strata. In their definitive discussion on the intrusive nature of the Whin Sill-complex, Topley and Lebour (1877) cited Sewingshields Crags as one of the better places to see evidence of contact metamorphism at the upper contact.

Since drift deposits at this site commonly cover areas crucial to the understanding of the sill transgression and its relationship to faulting, magnetic surveys have been used to work out the structure of the sill at depth. Strong magnetic anomalies occur along outcrops of the sill and also down-dip, where the intrusions can be detected at depths of up to several hundred metres below the surface. The Roman Wall area reveals numerous complicated anomalies which have been investigated by several groups (e.g. Summers *et al.,* 1982; Cornwell and Evans, 1986). These studies reveal dearly the segmented nature of the sill and, in a study of the Hexham area, Cornwell and Evans identified many magnetic lineaments, interpreted as faults or joints that are not necessarily visible at the surface. Based on magnetic evidence within this GCR site, the main offset at Busy Gap is seen to coincide with a NW-trending lineament that swings to the ESE about 4 km south of the outcrop. A major offset in the sill at Limestone Corner, 10 km to the east of the site, is controlled by a similar structure (Cornwell and Evans, 1986).

The relationship of the sill to faulting in the region has been of interest to many authors. In the adjacent area east of the River North Tyne, Randall (1959) observed transgressions and faulting but was unable to ascertain the exact age relationship, although he considered that the faults could not be younger than the intrusion. Johnson (1959) considered the transgressive steps at this GCR site to be fault-controlled. The predominant fault trend in the region is ENE, with a secondary ESE trend. These have been interpreted as conjugate shears formed during a period of E–W-trending compression, after the main north–south Variscan compression, but before intrusion of the Whin Sill-complex (Frost and Holliday, 1980). However, Frost and Holliday also suggested that the faulting and intrusion could be contemporaneous. Cornwell and Evans (1986) interpreted the segmented nature of the sill in this region as evidence of fault and/or joint control on the form of the intrusion. They were unable to determine the age of faulting from magnetic evidence but considered it probable that a major component was in existence at the time of intrusion. The minor indentations in the scarp suggest some faulting after emplacement of the sill and the largest indentation acted as a water channel which drained a lake to the north of the sill at the end of the last glaciation. Crag Lough is a remnant of this glacial lake, which formed in an ice-scoured basin (Johnson, 1997).

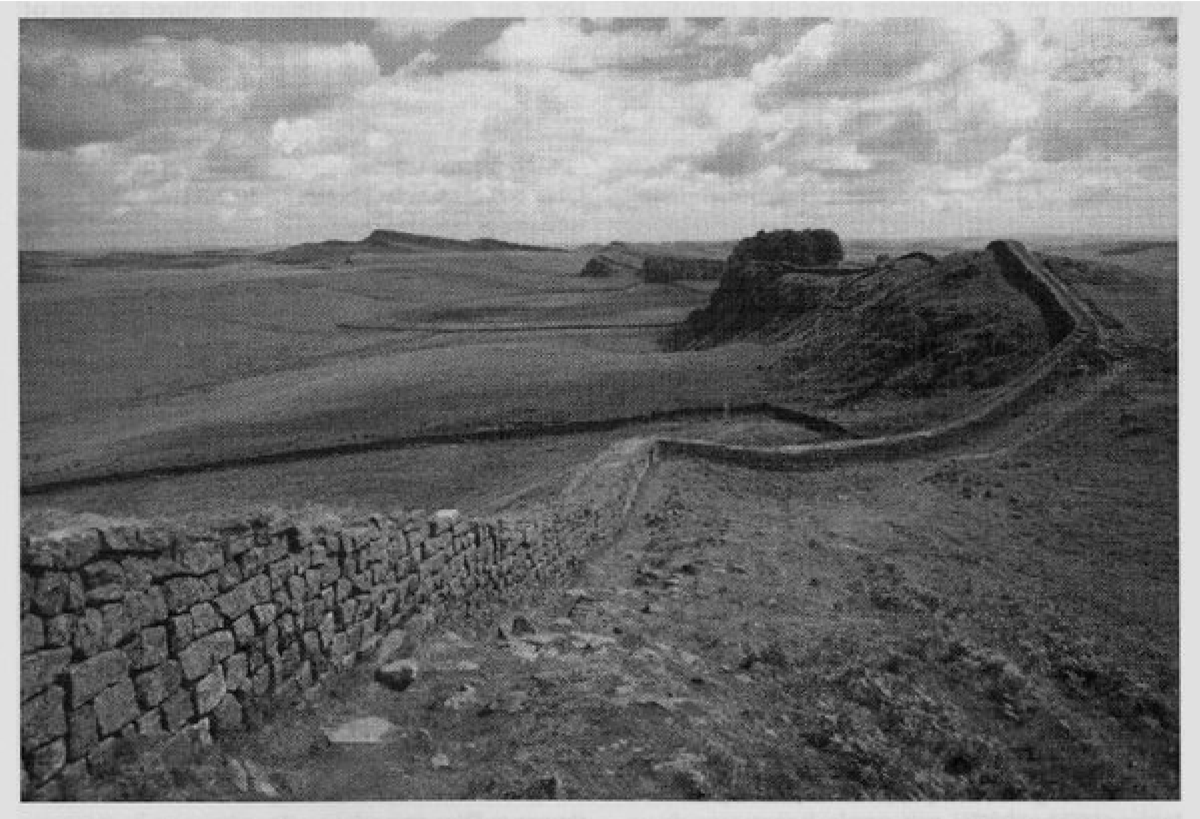
The St Oswald's Chapel Dyke, a member of the dyke-swarm associated with the sill-complex (Figure 6.2), crops out over a distance of several tens of kilometres, sub-parallel to the outcrop of the sill and about 5–7 km to the south. It has a continuous magnetic anomaly showing no fault displacement or *en échelon* structures and appears to be emplaced partly along a preexisting WNW-trending structure (Cornwell and Evans, 1986).

Conclusions

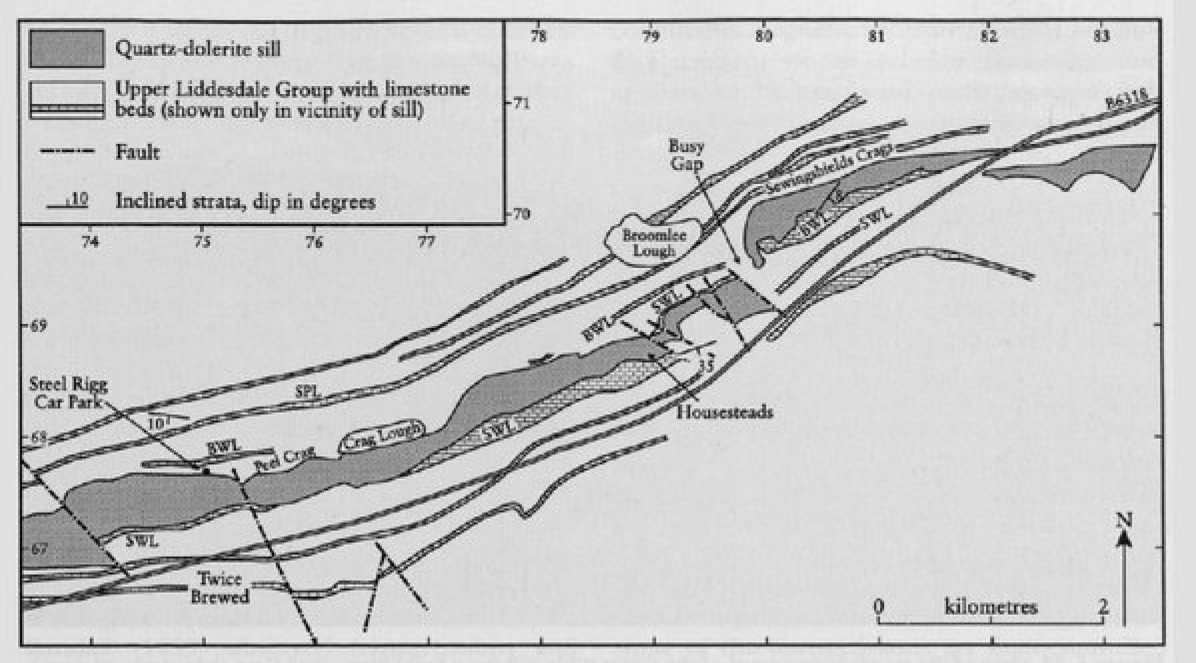
The Steel Rigg to Sewingshields Crags GCR site demonstrates very well the dramatic effect that the Great Whin Sill has on the landscape, here forming a substantial north-facing scarp upon which Hadrian's Wall and several Roman forts were built. The scarp is offset at several places as a result of transgression of the sill between different levels within the sedimentary succession of the Visean Liddesdale Group. These transgressions have been the subject of much discussion, as the role of faulting is not always clear. Geophysical methods tend to suggest that some of the transgressions are fault-controlled and that magma moved along pre-existing fault zones. Small later faults cut the sill forming minor indentations in the outcrop; one of these acted as a channel when water drained from a glacial lake on the north side of the scarp at the end of the last glaciation.

The site was important during the early debate on the origins of the Whin Sill as it provides abundant evidence of the contact metamorphism of overlying sedimentary rocks, thus proving that it is an intrusion and not a lava flow. Other features of this site, typical of sills in general, include a large raft of baked limestone near the base of the sill and well-developed columnar jointing.

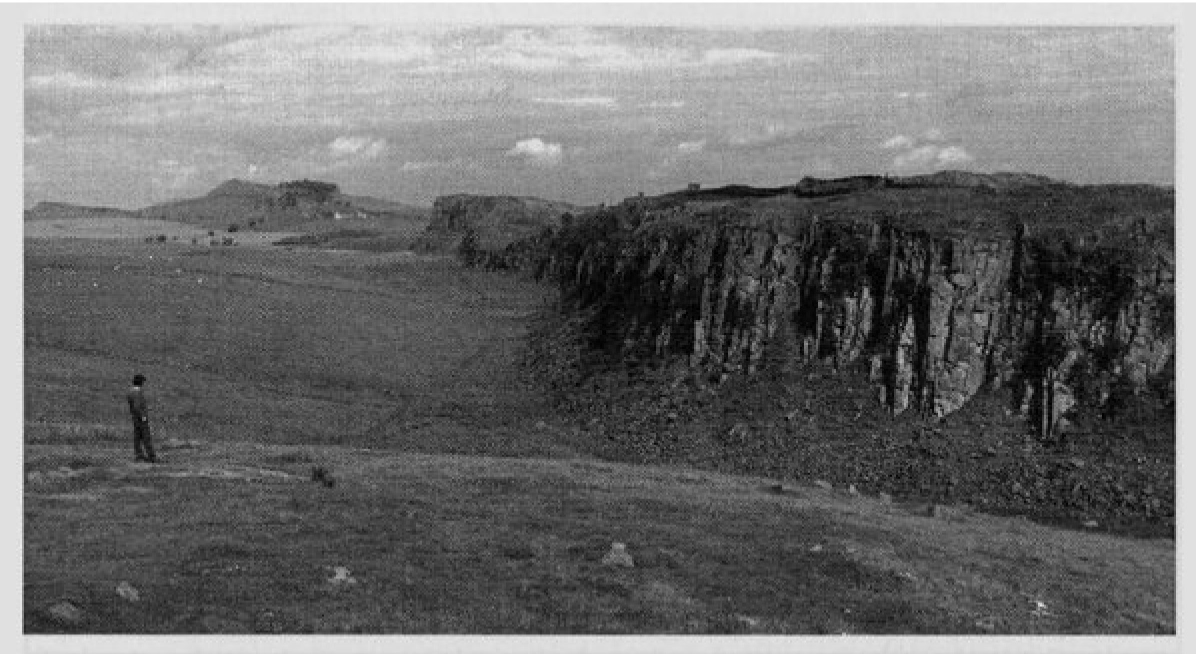
References



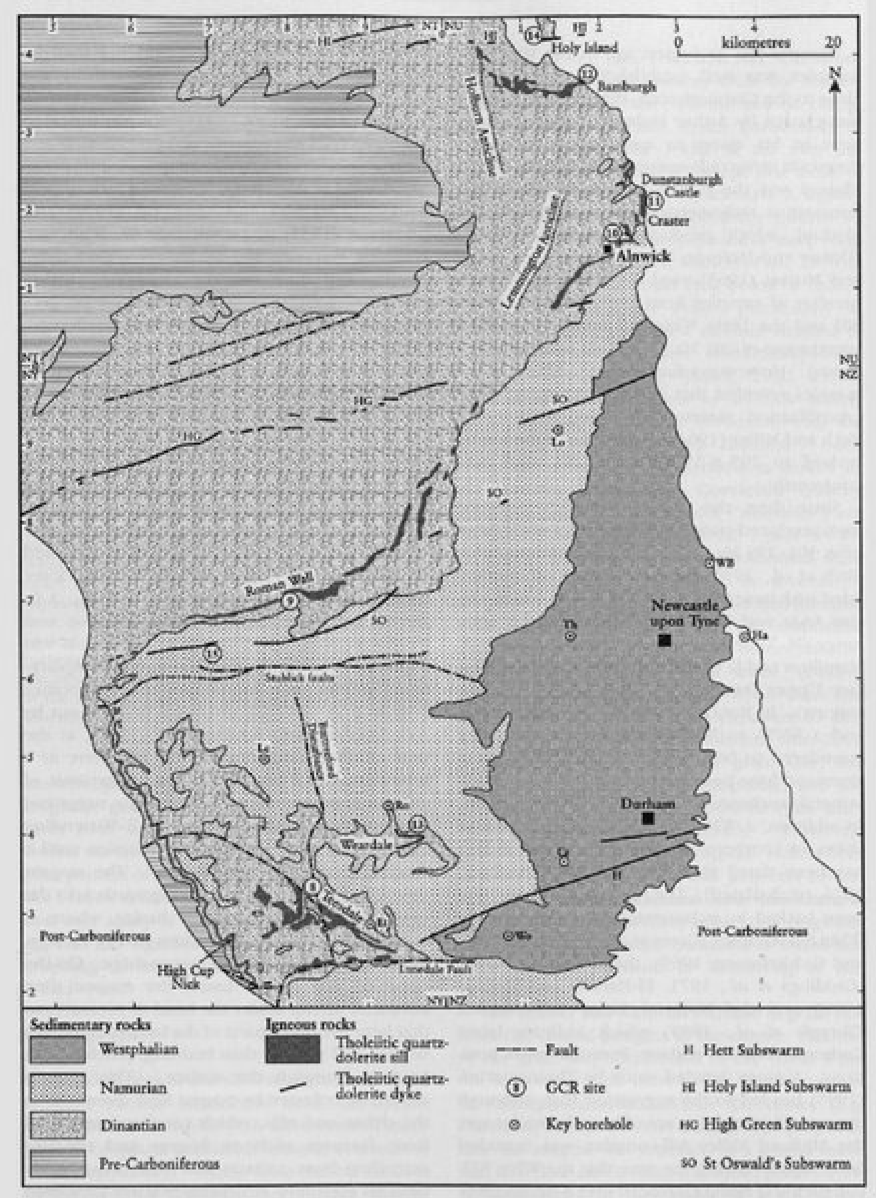
(Figure 6.6) Hadrian's Wall capping north-facing crags of the Great Whin Sill at Housesteads, Northumberland. (Photo: British Geological Survey, No. L1512, reproduced with the permission of the Director, British Geological Survey, © NERC.)



(Figure 6.24) Map of the area around the Steel Rigg to Sewingshields Crags GCR site. (BWL = Bath-house Wood Limestone, SPL = Single Post Limestone, SWL = Shotto Wood Limestone.) After Johnson (1959).



(Figure 6.25) View of the north-facing crags of the Great Whin Sill from Steel Rigg. Peel Crag (nearest to camera), Crag Lough and Sewingshields Crags in the distance, are all topped by Hadrian's Wall. (Photo: British Geological Survey, No. L1555, reproduced with the permission of the Director, British Geological Survey, NERC.)



(Figure 6.2) Map of north-east England, showing the area intruded by the Late Carboniferous tholeiitic Whin Sill-complex and associated dyke subswarms. GCR sites: 8 = Upper Teesdale; 9 = Steel Rigg to Sewingshields Crags; 10 = Longhoughton Quarry; 11 = Cullernose Point to Castle Point; 12 = Budle Point to Harkess Rocks; 13 = Greenfoot Quarry; 14 = Holy Island; 15 = Wydon. (Key boreholes: Cr = Crook; Et = Ettersgill; Ha = Harton; Lh = Longhorseley; Lo = Longcleugh; Ro = Rookhope; Th = Throckley; WB = Whitley Bay; Wo = Woodland.) After Francis (1982); and Johnson and K.C. Dunham (2001).