10 The geology of the North Tyne and Saughtree

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Purpose

To study the Old Red Sandstone and Lower Carboniferous rocks of the North Tyne valley and the Saughtree area, the sedimentology of the Scremerston Coal Group and the intrusive phenomena of the Whin Sill. Observations are made on the geomorphology and on some geological aspects of the construction of the Kielder Dam.

Logistics

The excursion is not suitable for large parties. Permission must be obtained in advance from Tarmac Roadstone (Eastern) Ltd (Tel: (01434) 681443) for access to Barrasford Quarry (Localities 1–6). Protective helmets must be worn and an indemnity form signed. Park either on the left at the quarry entrance [NY 909 740] or, for Locality 6 only, in Gunnerton [NY 905 750].

Lewis Burn (Locality 9) is on Forestry Commission land and prior permission for visits should be sought from the local Forestry Commission Offices in Bellingham (Tel: (01434) 220242). Wellington boots are essential.

Localities 11–14 are in unfenced sheep country (avoid lambing and keep dogs under control) with mainly single-track roads. Park clear of passing places.

Maps

O.S. 1:50 000 Sheets 80 Cheviot Hills & Kielder Forest, 87 Hexham & Haltwhistle; B.G.S. 1:63 360 Sheets 7 Kielder Castle, 8 Elsdon, (Scotland) Langholm; B.G.S. 1:50 000 Sheets 13 Bellingham, 17E (Scotland) Jedburgh.

Geological background

The sedimentary rocks seen on this excursion occur on the northwestern margin of the Northumberland Trough, on a basement of Silurian greywackes. These are generally poorly exposed, have few distinctive mappable lithologies and contain only very rare diagnostic fossils. The Silurian is overlain with strong unconformity by predominantly fluviatile sediments of the Upper Old Red Sandstone. The actual surface of unconformity is rarely exposed in this area but is the equivalent of Hutton's Unconformity seen in Excursion 1. The O.R.S. is succeeded, apparently conformably, by basic Birrenswark Lavas. Traditionally these have been taken to be the basal member of the Carboniferous and they form a convenient and mappable horizon. In detail, however, they interdigitate with and are succeeded by sandstones of O.R.S. lithology. Local Lower Carboniferous stratigraphy is confused by the lack of a recent overview. The Dinantian sub-divisions adopted in most recent B.G.S. accounts of the Border area are from the base up: Lower, Middle and Upper Border Groups, Lower and Upper Liddesdale Groups. In very broad terms, the Lower and Middle Border Groups correspond to the Cementstone and Fell Sandstone Groups, and the Upper Border Group corresponds to the Scremerston Coal Group.

The Whin Sill intrusion was emplaced at the end of the Carboniferous. It is the type sill having been named by the old lead miners in Co. Durham before its recognition as an igneous rock. The Whin Sill around Barrasford is notable for its unusual intrusive relations. The sill transgresses northeast-southwest from above to below the Oxford Limestone over some 2 km of outcrop. In the region of transgression the full thickness of the limestone can be found both above and below the sill and large rafts of shale and limestone occur within it. In addition the dip slope, which here is overlain by the limestone, is diversified by minor west facing scarps formed by offshoots from the upper surface of the sill. The maximum thickness of sill in the quarry is 40 m but there are rapid regional thickness variations. The main rock of the sill is dolerite of renowned uniformity, but with many local textural and compositional variations.

Much of the route of the excursion runs parallel to the line of the Border Counties Railway (BCR) opened fully to traffic by the North British Railway in 1862, and closed to passengers in 1956. A major reason for promoting the line was the exploitation of the Plashetts Coal seam (Locality g), but other collieries, works and quarries opened along the route, of which Barrasford is the only working survivor.

Excursion details

Barrasford Quarry

The quarry (Figure 10.1) is rapidly expanding and consequently the features seen vary from time to time.

Locality 1 [NY 916 745]

From the quarry entrance, take the roadway south of the crushing and grading machinery to the southeast wall on the second quarry road that traverses the quarry wall. Here the upper contact of the sill with the Oxford Limestone is exposed although some of it may soon be obscured by quarry tipping. The sill is chilled visibly for C.2 m. The overlying limestone, although metamorphosed, still contains identifiable brachiopods, corals and crinoids.

Locality 2 [NY 917 747]

Returning to the quarry floor walk about goo m northeast. The south wall now shows one of the southeast dipping offshoots from the sill's upper surface which cuts across the overlying limestone. Here the quarry, at this level, narrows and to the northwest the exposure in the dolerite cliff shows low-angle fractures along which are shale inclusions.

Locality 3 [NY 919 750] is at the northeast end of the Quarry

The overlying limestone has been stripped off the upper surface of the sill. A metre or so below its chilled margin is a thick zone with numerous amygdales, wholly or partially filled with quartz (so crystal terminations can often be seen), calcite and some iron sulphides. In fallen blocks, the amygdales are 50–150 mm in diameter, have a flat base parallel to the sill's upper contact and a domed top. Underlying these amygdales is a 10–15 mm layer of rock which is coarser and more acid in composition than the normal dolerite.

Locality 4 [NY 917 747]

Here numerous large blocks of whinstone show different varieties of the sill. These include thin sheets (10–200 mm) of dolerite-pegmatite, quartz-calcite amygdales underlain by pegmatite, tachylite veins intruded into dolerite, grey or pink aplite veins (up to 10 mm thick), and mineral veins. The latter, typically 20 mm thick, are common along the major near-vertical joints of the sill. There are two types; the first being composed of white calcite with white, purple-cored quartz, which typically has prism faces developed. The second type carries galena, sphalerite, baryte and brassy-yellow sulphides plus quartz and calcite, and is probably related to the Alston Block mineralisation.

Locality 5 [NY 917 750]

Here, looking south, is a good view of the offshoot from the top of the sill cutting through the limestone previously seen at Locality 2. To the northeast the limestone has been stripped off the sill. Just beyond the eastern quarry boundary is a westward facing scarp, due to a low angle offshoot from the top of the sill rising through the superincumbent limestone.

Locality 6 [NY 915 751]

From a new gate in the quarry boundary [NY 918 710], cross a field to another gate into the field containing a disused quarry in the Oxford Limestone, here below the Whin Sill. The full thickness of the limestone is visible; some of the fossils are coated by the alga *Osagia.* At the top of the quarry face weathered and shalylooking limestone contains fossils preserved as external moulds. Near the western end of the quarry is a small doleritic intrusion and a low angle fracture dipping southeast. Above the limestone its dip slope is a grass covered shelf terminated to the southeast by rising ground where spotted shale is revealed by rabbit burrowing. Above this is a scarp of Whin Sill only 2–3 m high.

About 120 m west in the old quarry face (Figure 10.2), the limestone is upturned and then enclosed within the sill as large flat lying rafts. To the west the limestone can be seen below the sill. As the Oxford Limestone was above the sill in the main quarry (localities 1, 2 & 5) it appears that the sill was probably intruded along a low angle fracture.

Return to the quarry car-park by walking southwest along the path to the north of the escarpment (along the line of an old railway that used to carry dolerite to Barrasford from another quarry 1.5 km to the northeast). If parked at Gunnerton take the farm track running to the west.

North Tyne–Saughtree

On leaving Barrasford Quarry turn right to Wark Bridge (5 ton weight limit), cross the River North Tyne, and follow the B6320 towards Bellingham. Cross the river again on Bellingham Bridge and turn left, following signs to Kielder. The dam is not conspicuous when approached on this road and the reservoir comes into view suddenly. Turn right on to the road across the dam, signposted Hawkhope Car Park (toilets).

Locality 7, Kielder Dam [NY 708 882]

Kielder Reservoir is one of the largest man-made bodies of water in Europe. Water stored in the lake is not taken directly into supply but is used to regulate the flow of the North Tyne, and can be extracted further downstream at Riding Mill and transferred via aqueducts, largely in tunnels, to the Rivers Wear and Tees. Walk to the end of the dam or up to the memorial stone to view the downstream face and the original valley profile. The dam is an embankment constructed largely of glacial till excavated from the valley floor below top water level. It was sited on a long mound of till extending most of the way across the valley in order to minimize the quantity of fill required. Water is discharged from the power station into a stilling basin at the toe of the dam which also receives flow from the spillway, the large concrete channel and weir at the end of the dam. The draw-off tower in the water enables water to be abstracted from different levels in the reservoir and fed through pipes in a tunnel under the dam either to the turbines in the power station or directly to the river via the stilling basin. All of these concrete structures requiring sound foundations are sited at this end of the dam because the river had cut down close to rock on this side of the valley. The base of the pre-glacial valley is lower and more central in the present valley. The upstream slope of the dam, at normal water levels, is faced with concrete blocks to provide wave protection. Riprap, or rock revetment, was used at lower levels and this was mostly quarried from within the reservoir (see Locality 8), although some was also imported from Barrasford.

Return to the main road, turn right, pass the Tower Knowe Visitor Centre and after 7 km, turn right into the Mounces Viewpoint (toilets).

Locality 8, Mounces Viewpoint [NY 657 887]

Walk up to the South Viewpoint for a good view of the lake. Although the valley has been glaciated it does not have the classic U-shaped cross-section; it is not straight and there are major tributary valleys on both sides. The slopes are generally smooth and the drift cover, especially where exposed by erosion on the lake margins, shows that much material is of local origin and probably deposited by solifluction. On the opposite lake shore is a quarry in a dyke, compositionally similar to and probably intruded contemporaneously with the Whin Sill and forming part of the High Green or Highfield complex of roughly east-west en-echelon dykes. The quarry was opened and worked to supply aggregates and revetment stone for construction of the dam, to minimize the traffic of construction materials into the area. Compare the difficulty of quarrying a narrow vertical dyke with the ease of working a long and accessible face in the Whin Sill (localities 1–6).

Return to the road and turn right. After 2 km, take the signposted forest track to Lewis Burn (cars and minibuses only) to the Forks at the confluence of Lewis Burn and Akenshaw Burn. Turn left just before the bridge and park off the track by a steep sandstone cliff. There are no good places to turn round below the Old Stone Bridge over Lewis Burn about 1.5 km above the Forks. Alternative parking is available just across the Old Stone Bridge (Figure 10.4).

Locality 9, Lewis Burn [NY 631 888]

The section here is most completely and continuously exposed when the water level in the burn is low. Good exposures are also present at intervals in the hillside alongside the forestry track.

Structurally the area consists of a series of anticlines and synclines superimposed on a major, extensively faulted synclinal structure. Lewis Burn provides one of the best exposures of Lower Carboniferous Scremerston Coal Group strata (Lewis Burn Beds) in Northeast England, especially above its confluence with the Akenshaw Burn where up to 250 m of the middle part of the succession is continuously exposed on the southeast side of the southeasterly downthrowing Megg's Linn Fault (Figure 10.4). The beds dip c.20° southeast, except along the fault plane where they dip 60° southeast. Lithologically the succession is dominated by shales and sandstones with subordinate limestones, seatearths and coals. The limestones are generally thin, argillaceous, fossiliferous biomicrites. The shales, containing ironstone ribs and nodules, are also fossiliferous with plants, bryozoans, bivalves, gastropods and brachiopods. Bivalves such as pectens, myolinides and *Sanguinolites* are particularly abundant but become subordinate to brachiopods in the more sandy upper part of the succession where limestones are less common and coal seams thicker. A particularly fossiliferous shale occurs below the first marine *in situ* limestone in the succession, exposed in the southeast bank of the burn below the Old Stone Bridge (Figure 10.4). Some of the shale sequences along Lewis Burn attain thicknesses of at least 30 m, some of the thickest shales recorded from the Lower Carboniferous anywhere in Northumberland. Shales and associated coals in the Scremerston Coal Group have attracted considerable interest because of their potential as hydrocarbon source rocks. The coals in the Lewis Burn section have been worked in the past, especially the Lewis Burn Kiln Coal (70 cm thick) and the Lewis Burn House Coal (45 cm thick) (Figure 10.3). The Plashetts seam is the thickest coal, no longer exposed but reported to be at least 1.5 m thick.

The sandstones in the succession are locally thick (15–45 m) and predominantly lenticular in character. They are fine to medium-grained and contain trough cross-bedding, flat bedding, ripple cross-lamination and siltstone and mudstone partings. Most sandstones contain carbonaceous plant material and are burrowed and bioturbated; a few are fossiliferous. The succession is characterized by three types of facies sequence. The first type is a fluvially-dominated fining-upward sequence composed of an erosively-based, coarse to fine sandstone passing up into mainly non-marine siltstone and shale with rare cementstone type limestone capped by seatearth and coal. The second facies sequence coarsens upwards from fossiliferous shelf and prodelta shales or limestones into fine to medium-grained, trough cross-bedded, delta front sheet sands capped by seatearth and coal. Coarsening-upward progradational facies sequences are less common in this part of the succession but increase in abundance upwards. The third facies sequence is more marine in character and consists of limestone, shale and sandstone, lacking any fining or coarsening-upward trends, which grade upwards into seatearth and coal. Within these marine packages shell-rich beds, containing crinoids indicative of fully marine conditions, are interbedded with poorly fossiliferous beds and the sandstones are profusely cross-bedded, burrowed and bioturbated. All these sequences owe their origin to interaction between fluvial and marine processes along a low relief, humid lower delta plain characterized by repeated phases of fluvially-induced delta progradation, abandonment and marine transgression. Rapid delta shifting and transgression effectively prevented the development of thick coals. A feature of these sequences is the lateral persistence and argillaceous nature of the marine sediments, and their thickness, which suggests that the sea may have been deeper at this time than during deposition of the lower part of the succession.

Return to the road and turn left towards Kidder Village. 1 km beyond the village, the North Tyne, here reduced to a shallow stream due to headwater capture by the Liddel Water across the Border, is crossed on a stone bridge. After a further 2.4 km stop on the nearside verge opposite a pair of houses.

Locality 10, Deadwater [NY 604 969]

Below to the west is a large area of peat moss that forms the watershed of the Tyne and the Liddel Water. Quarries on the hillside beyond worked Middle Border Group freestone (sandstone) and limestone.

Continue on the road, crossing the border and passing a large double-arch lime kiln on the left. Limestone was worked in shallow quarries on the hillside beyond, but the beds are thin and the overburden increases rapidly into the hillside. After 2.5 km the road emerges from the forest, crosses a stone bridge and a cattle grid. Turn right immediately into a level grassy area by the stream.

Locality 11, Caddroun Burn [NY 584 985]

The burn flows southeast before it turns sharply to join Liddel Water, and was probably once a tributary of the North Tyne. A small exposure of sandstone dipping downstream, largely under water, at the downstream end of the large circular culvert represents the oldest exposed Carboniferous sediments in the Lower Border Group. Climb over the railway embankment. On its upstream side are exposures of the earliest Carboniferous Birrenswark Lavas below the sandstone. These are olivine basalts, often vesicular especially towards the tops of flows, and usually highly weathered. Continue 250 m upstream of the culvert to a small cliff on the west bank showing 5–6 m of Upper Old Red Sandstone. This exposure is loose and overhanging. Traces of drilling suggest it was quarried, probably for railway construction. The O.R.S. here consists mainly of red and mottled sandstones with subordinate mudstones and sandy shales. There are two horizons of calcrete, one at the base approximately 10 cm thick and another near the top of the succession about r.1 m thick. The base of the lavas is visible at the top of the exposure and can be inspected safely in a smaller exposure 20 m upstream where it is vesicular and exhibits spheroidal weathering. The lavas appear to be conformable with the O.R.S. and dip downstream at about 5. If time permits, further good exposures of the O.R.S. can be seen 400 m upstream in the Caddroun Pots, a series of scour holes in the stream bed.

Rejoin the road. Continue southwest to the second of two prominent rock scars on the left, parking at a lay-by just before a stone wall meets the road at right-angles.

Locality 12, Hudshouse [NY 576 978]

The scar is steep and unstable and it should be examined from the near bank of the stream. It exhibits two different aspects. On the left are thinly bedded dark shales, mudstones, siltstones and limestones probably of the Middle Border Group. On the right the rock is mostly unstratified and blocky, with rounded corners where weathering has penetrated. This is a dolerite dyke trending approximately northwest–southeast, almost parallel to the face and probably of Tertiary age. The field relations here may appear confusing, but the dyke is not truly vertical and steps back as it rises, while part of it has been undercut by the river and has fallen away to reveal the sediments behind.

Return to the road and note on the northwest side a succession of roughly semicircular landslip scars, probably formed at a time when the river was higher and was actively cutting into the lower slope. Apart from soil creep shown by terracettes these old slips are now reasonably stable. However, within the next 400 m along the road, notice that cuts have been made to widen the road and numerous small scarps show that movements have been reactivated. The slopes above are relatively gentle and are underlain by drift which has probably been soliflucted.

Continue to Saughtree and turn right at the T-junction [NY 561 967] on to the B6357. Cross a small stone bridge and notice further examples of landslipping on the drift slopes to the left. Cross a cattle grid and park in a lay-by, immediately after a stone bridge which crosses the stream to the left.

Locality 13, Dawston Burn [NY 568 981]

This is the site of a BCR viaduct, demolished when the line was closed. Looking downstream from the bridge, outcrops dipping downstream at low angles are of Lower Border Group sandstones, possibly the equivalent of the Whita Sandstone of the Langholm area. These beds underlie the drift in the slopes to the right, but above the line of the old railway, scattered stream exposures are mainly in the O.R.S. The hills that form the northwest skyline (Saughtree Fell) are underlain by Silurian greywackes. The oldest rocks thus occupy the highest ground. The field relations in this area are obscure due to the lack of exposure but some outcrops of the O.R.S. have vertical bedding, suggesting faulting or monoclinal folding, or both.

The same succession is discontinuously exposed in the Dawston Burn for i km upstream of the bridge, but is difficult to see if the water is high. Unless the transport can follow, it may be best to examine the lower part of the section, return to the lay-by and then drive to Locality 14.

As in the Caddroun Burn, the beds dip downstream and older strata are encountered upstream. The Lower Border Group is represented mainly by sandstone, although there are a few exposures of shales. A dyke which may be the extension of the Hudshouse Dyke cuts the section. The Birrenswark Lavas crop out approximately 400 m upstream of the bridge and may be traced up the slope southeast of the road. Sandstones of the Upper O.R.S. underlie the lavas but differ little in lithology from some of the Carboniferous sandstones.

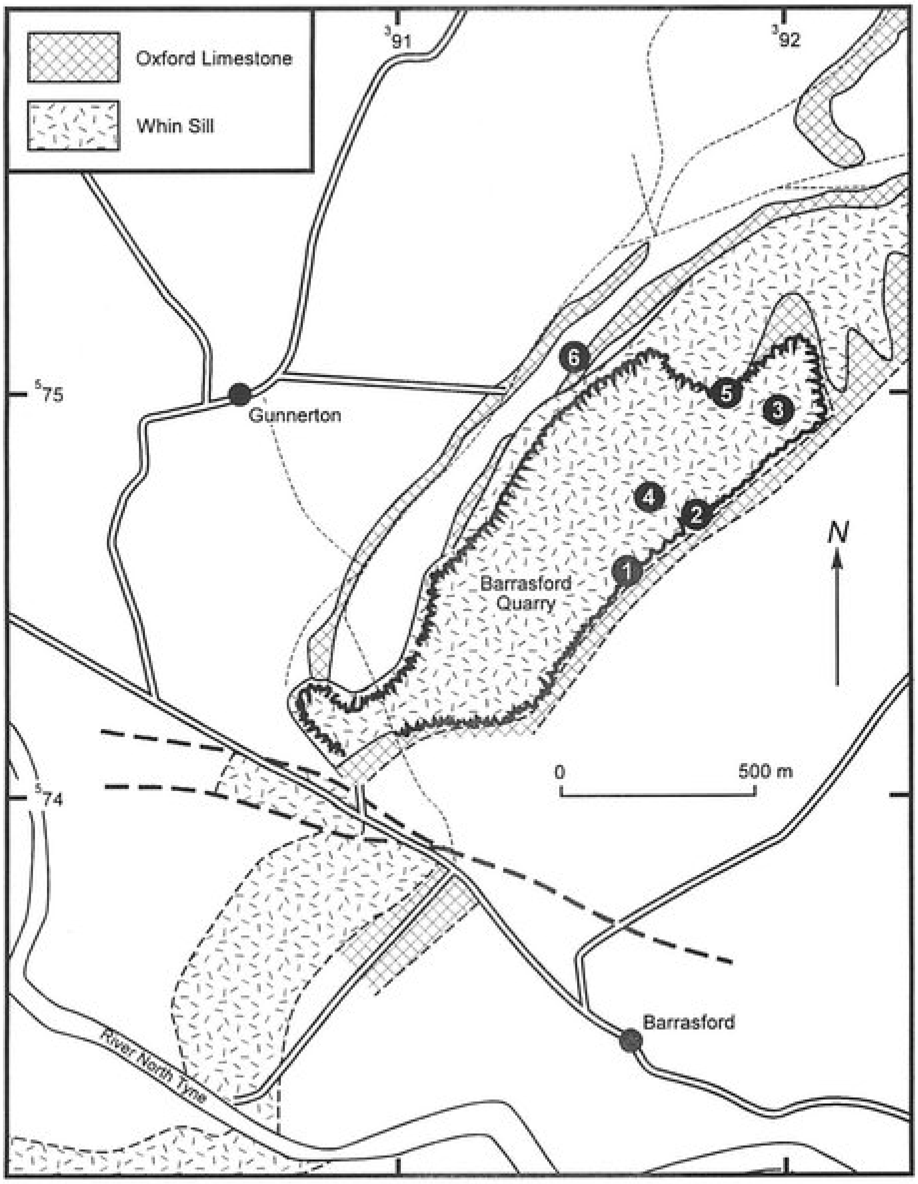
From the lay-by continue i km up the road to the end of the safety fence. Here the stream swings away from the road and it is possible to park on a grassy track to the left.

Locality 14 [NY 574 989]

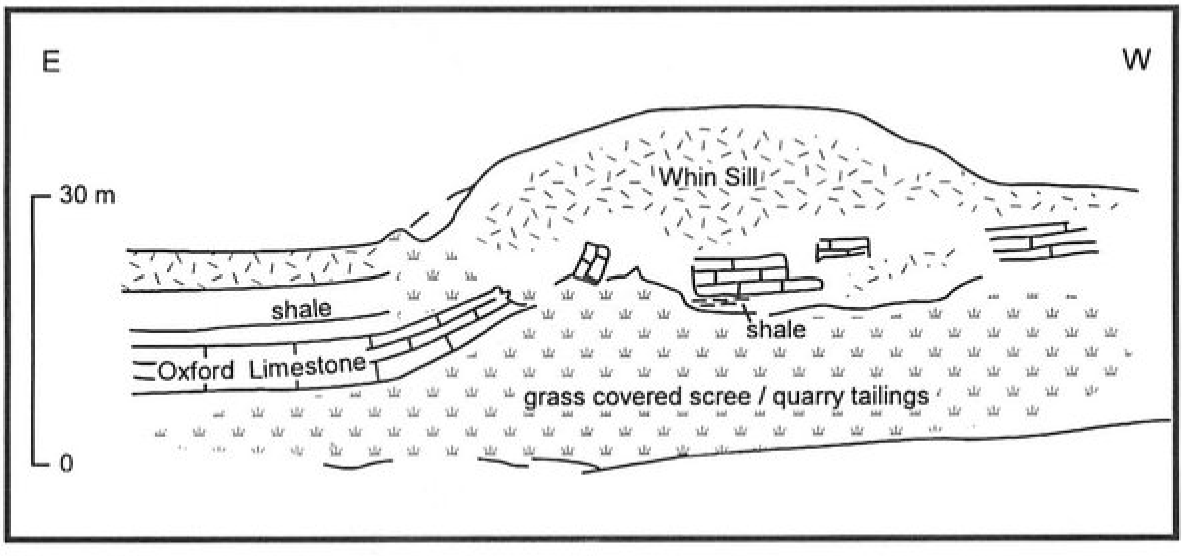
On the slope across the stream there is a rather vegetated exposure of the O.R.S. which dips downstream at about 20° and consists of planar and cross-bedded red sandstones with some pebbly horizons, particularly towards the base. To the right of this, and in the stream bed, Silurian greywackes crop out, dipping downstream at 55–60°. These are greywacke-siltstones and mud-stones of Wenlock age with poorly developed cleavage. The unconformity between the O.R.S. and the Silurian is not exposed.

If continuing up the valley, as the road climbs, further exposures of weathered greywackes will be seen along the roadside. zoo m beyond the cattle grid stop on the left at the entrance to a disused quarry. In clear weather, the Tyne-Liddel watershed can be seen beyond the deep valley of the Caddroun Burn.

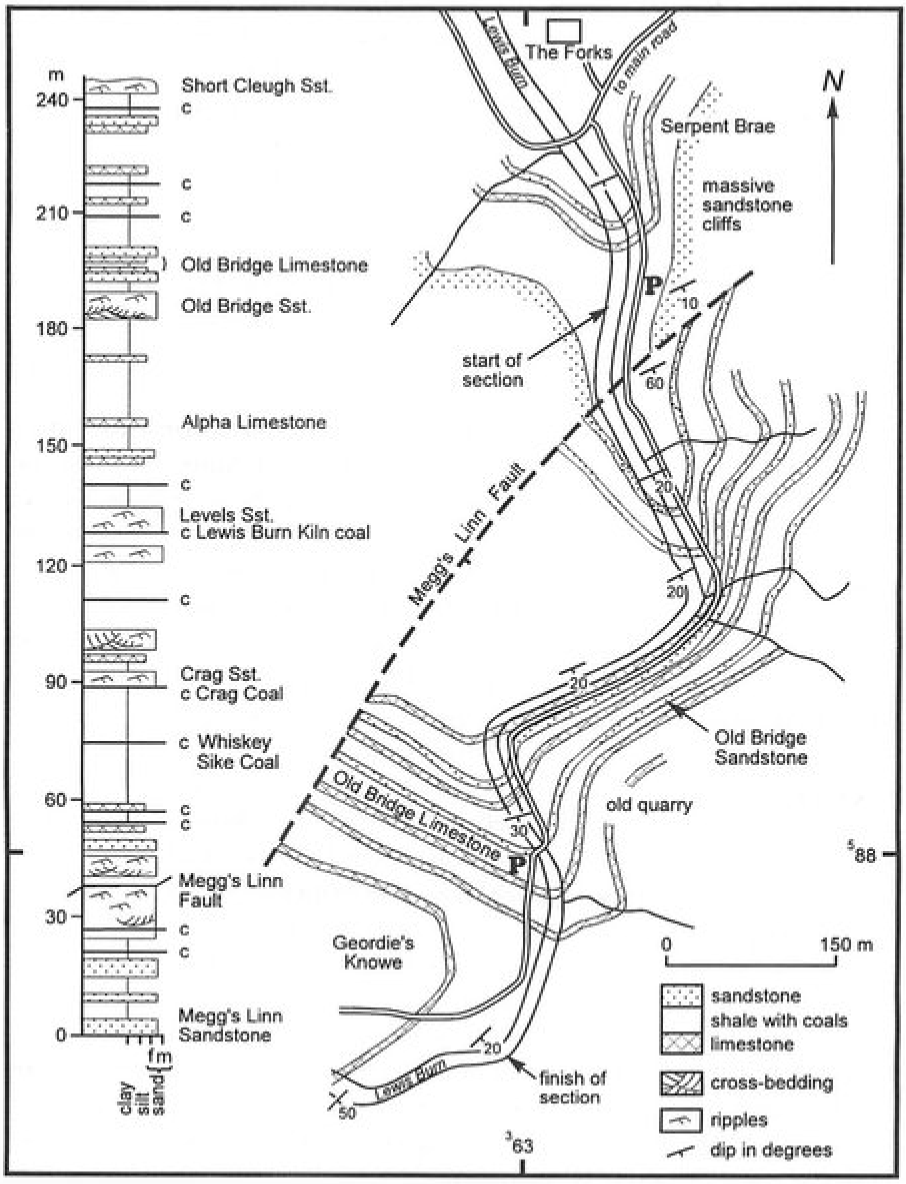
Bibliography



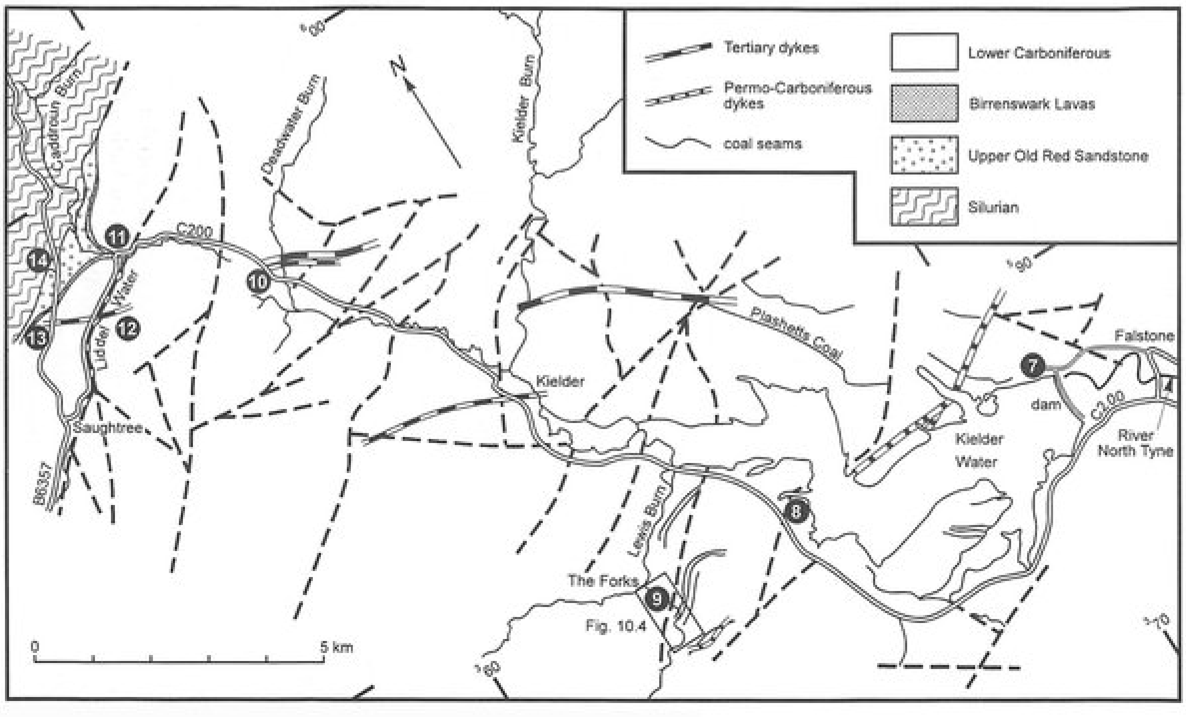
(Figure 10.1) Map of the region around Barrasford Quarry.



(Figure 10.2) Diagrammatic sketch of Gunnerton Crag (Locality 6).



(Figure 10.4) The geology of the Lewis Burn Section (Locality 9).



(Figure 10.3) Location map of the North Tyne–Saughtree area.