9 The Lower Carboniferous at Bowden Doors, Roddam Dene and the Coquet Gorge

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Purpose

To examine three contrasting styles of Lower Carboniferous sedimentation within the northern part of the Northumberland Basin: braided river sheet sandstones, alluvial fan conglomerates and coastal alluvial plain sediments. The area also contains a great variety of glacial landforms including drumlins and glacial overflow channels, which are particularly well developed south of Wooler.

Logistics

All three localities can be visited in one full day (Figure 9.1). Roadside parking is available at Bowden Doors and Coquet Gorge. Bowden Doors involves rough walking across hummocky ground and along footpaths. The site is an S.S.S.I. and a popular location for rock climbing. At Coquet Gorge it is necessary to cross the river and care must be taken on the steep, shaley slopes above the river on the south side of the gorge. The area lies within a military firing range and prior permission for a visit should be sought from the Military Authorities at Otterburn Camp (tel: (0191) 261 1046). Access to Roddam Dene is more difficult. The most convenient parking is on farmland for which permission (not necessary in advance) should be sought from the farmer at Roddam Hall. The banks of the dene are very steep, muddy, and slippery when wet. Easier, but less convenient access is provided by a track, large enough for a car, crossing Roddam Burn about 0.75 km above the dene where the conglomerates are replaced by sandstones. The best exposures occur below this locality in the bed and banks of the burn, and it is necessary to keep crossing the stream at intervals. Wellington boots are essential for this section, even at low water. Roddam Dene is not recommended for large parties.

Maps

O.S. 1:50 000 Sheets 75 Berwick-upon-Tweed, 80 Cheviot Hills & Kielder Forest area, and 81 Alnwick & Morpeth; B.G.S. I:50 000 Sheets 4 Holy Island (solid), 5 The Cheviot, and 6 Alnwick; B.G.S. 1:63 360 Sheets 4 Holy Island (drift), and 8 Elsdon.

Geological background

The geology of northern England consists of a sedimentary cover of Carboniferous and Permo-Triassic rocks resting unconformably on Lower Palaeozoic basement. The basement is made up of folded and faulted sedimentary and volcanic rocks, originally deposited in the proto-Atlantic Iapetus Ocean (Figure 3)a. Subduction of the ocean to the northwest led to its closure by the end of the Silurian along the Iapetus suture zone, a major Lower Palaeozoic tectonic line which trends in a northeasterly direction beneath the Northumberland Carboniferous cover. Extensional reactivation of a northerly dipping crustal scale shear zone, associated with the Iapetus suture, led to fault controlled subsidence and the initiation of the Northumberland Basin. The basin is a rifted half-graben oriented northeast–southwest across northern England with its deepest part adjacent to the Stublick-Ninety Fathom Fault system defining its southern margin. During Carboniferous times the basin was filled with over 4 km of sediment, with predominantly marine conditions in the southwest and continental conditions in the northeast. The oldest sediments in the basin are locally developed alluvial fan conglomerates, such as the Roddam Dene Conglomerate, deposited along the flanks of the Cheviot massif, a highly dissected Lower Devonian volcano intruded by granite. Cheviot granite and volcanics, as well as the underlying Silurian greywackes occur as clasts in the conglomerates. The conglomerates are overlain and interbedded with coastal alluvial plain channel sandstones and fluvio-lacustrine interchannel silt-stones, shales and impure limestone (cementstones) of the Cement-stone Group. The overlying succession comprises: (1) fault-controlled braided river sediments of the Fell

Sandstone Group; (2) coastal and lower delta plain sediments of the Scremerston Coal Group; (3) cyclically-deposited marine transgressive-regressive sediments of the Limestone Groups, which were deposited during the change from syn-rift to post-rift phases of basin development; (4) a thin sequence of fluvio-deltaic sediments of Millstone Grit type; and (5) coal-bearing coastal alluvial plain Coal Measure sediments marking the end of Carboniferous sedimentation in the Northumberland Basin.

The area provides a striking example of the way in which topography is affected by geological factors. The Fell Sandstone, located on the faulted northeast limb of the Holburn Anticline, forms a rugged west-facing scarp overlooking the Wooler valley. The scarp acts as a drainage barrier separating the Cheviot Hills from the sea, and deflecting the drainage of local rivers, such as the Till, to the north. The grass and heather-covered slopes of the Cheviots are dissected by a number of valleys, including Roddam Burn, which forms a steep, wooded gorge (Roddam Dene) cut through Late Devonian-Early Carboniferous sandstones and conglomerates on the eastern side of the Cheviots. On the south side the Coquet River has cut a similar gorge through less resistant Cementstone Group strata west of Alwinton.

Excursion details

Locality 1, Bowden Doors [NU 070 327]

From the centre of Belford village, just off the AI, take the B6349 Wooler road and turn right into the Hazelrigg–Lowick road. Vehicles can be parked on the grass verge by the second gate on the right, next to the sign saying 'Beware of Bull'. Cross the hummocky grass and heather-covered dip slope on the southwest side of the road to the top of Bowden Doors crag (the word *doors* means place of wild animals) and follow the footpath along the base of the crag to the south.

The Fell Sandstone is one of the most prominent lithological units in the Lower Carboniferous succession of the Northumberland Basin. It is also a very important aquifer and the main source of water for Berwick-upon-Tweed. At Bowden Doors the Fell Sandstone forms a 450 m long crag, oriented north-northwest–south-southeast parallel to the local palaeocurrent direction. Stratigraphically the outcrop lies near the top of the Fell Sandstone succession close to the contact with the overlying Scremerston Coal Group, on the faulted northeast limb of the Holburn Anticline, a compressional structure of late Carboniferous age. The crag face, which attains a height of about 8 m at the southern end, consists of two main facies (Figure 9.2). The first comprises moderately sorted, fine to medium-grained sandstone which becomes finer when traced to the south in the downcurrent direction. Where it occurs it always lies beneath the second facies. The sandstone is mainly structureless but contains some undulating diffuse and isolated sets of cross-strata in addition to local water escape and flame structures. This facies has a sharp, planar contact with the second facies above, and the contact between them can be traced along most of the crag face. The general characteristics of this predominantly structureless facies suggests that: (1) it was deposited rapidly from a flow overloaded with sediment, thereby promoting homogenisation and liquefaction of the sediment on pore fluid expulsion; or (2) it was liquefied after deposition, perhaps by contemporaneous fault movement.

The second facies is represented by a fine to medium-grained trough and planar cross-bedded sandstone. Deformed foresets, attributed to shear by sediment-laden water acting on top of the original sandy bedform, are common and vary from simple puckering of the foresets to completely overturned and recumbently folded foresets. Cross-beds are sometimes organized into complex associations of smaller scale cross-beds superimposed on larger ones, deposited mainly as channel bars and in-channel dunes or mega-ripples. Small steep-sided channel-like features, oriented perpendicular to the main channel trend, cut the face of the crag at various levels and are filled with sand identical to that into which they have been emplaced (Figure 9.3). Although the margins of the channels are very steep they show no evidence of scour or slumping, and apart from faint marginal laminations they lack grading or well defined sedimentary structures. These features suggest that the channels originated from bank collapse and the development of sediment-laden mass flows moving across the channel along scoured, pre-channelized pathways, in front of large sandy bedforms. The Fell Sandstone was deposited during a phase of source area uplift and intrabasinal fault activity, by perennial braided river systems prograding across the Northumberland Basin towards the south and southwest. Plots of palaeodrainage patterns suggest that the rivers were largely confined to small intrabasinal graben structures connected by a number of transfer zones located between overlapping fault segments.

The top of Bowden Doors crag provides spectacular views of the surrounding countryside. To the west across the Wooler valley one can see the prominent rounded slopes of the resistant Cheviot volcanic dome. Large areas of the Wooler valley, underlain by softer, more easily eroded Cementstones, are covered by ice deposited till erosionally moulded into drumlins. Glacial overflow channels are well developed on or near the eastern side of the Cheviots, where the large Powburn (Figure 9.1) channel has cut through a sandstone crag providing easy passage for the A697 Wooler-Newcastle road. Looking east from Bowden Doors the dip slope of the Fell Sandstone falls away gently towards the sea, interrupted in places by the discontinuous resistant crags of the Whin Sill dolerite which is quarried locally at Belford for road metal.

Locality 2, Roddam Dene [NU 025 205]

Take the Roddam Dene turning off the A697 Wooler Road about 8 km south of Wooler. Follow the road up the hill to Roddam Dene Hall, where permission to visit the site should be sought from the farmer (prior permission is not necessary). Immediately after passing the farm house on the left, turn right through a gate into the fields and continue along a track passing through a second farm gate. After parking walk alongside a wooded area on the right keeping close to the fence and after about too m climb the fence and descend carefully down the steep banks into Roddam Burn. Care should be taken in wet weather as the banks are slippy.

The earliest deposits in the Northumberland Basin are the locally developed conglomerates of late-Devonian or early Carboniferous age, which crop out around the flanks of the Cheviot Massif at Roddam Dene (the best exposed), Ramshope Burn and Windy Gyle. The Roddam Dene conglomerate, which has a maximum estimated thickness of 170 m, is cut into three segments by faults. It is a massive conglomerate containing subangular to subrounded pebble to boulder size clasts (4–256 mm in diameter) of Cheviot andesite, with minor amounts of Palaeozoic sediments and rare Cheviot granophyre, set in a poorly-sorted, mottled red and green clay-rich, sandstone. The conglomerate consists of : (1) a lower, matrix supported, weakly stratified and imbricate conglomerate with local sandstone lenses; (2) a middle, coarser, more massive conglomerate and; (3) an upper, better sorted, clast supported, coarsening-upward conglomerate associated with trough cross-bedded sandstone and palaeosols. The conglomerate is sharply, and erosively overlain by trough cross-bedded, rippled and plane bedded, fining-upward red sandstones and siltstones. The conglomerates were deposited predominantly as gravel bars within a braided river system draining the medial parts of a semi-arid alluvial fan, derived from an uplifted, fault-controlled ridge (?Harthope Fault) to the north. The overlying sandstones were deposited by a different fluvial system, on the distal parts of an alluvial floodplain oriented east–west, and sourced in part from the adjacent flanks of the Cheviot.

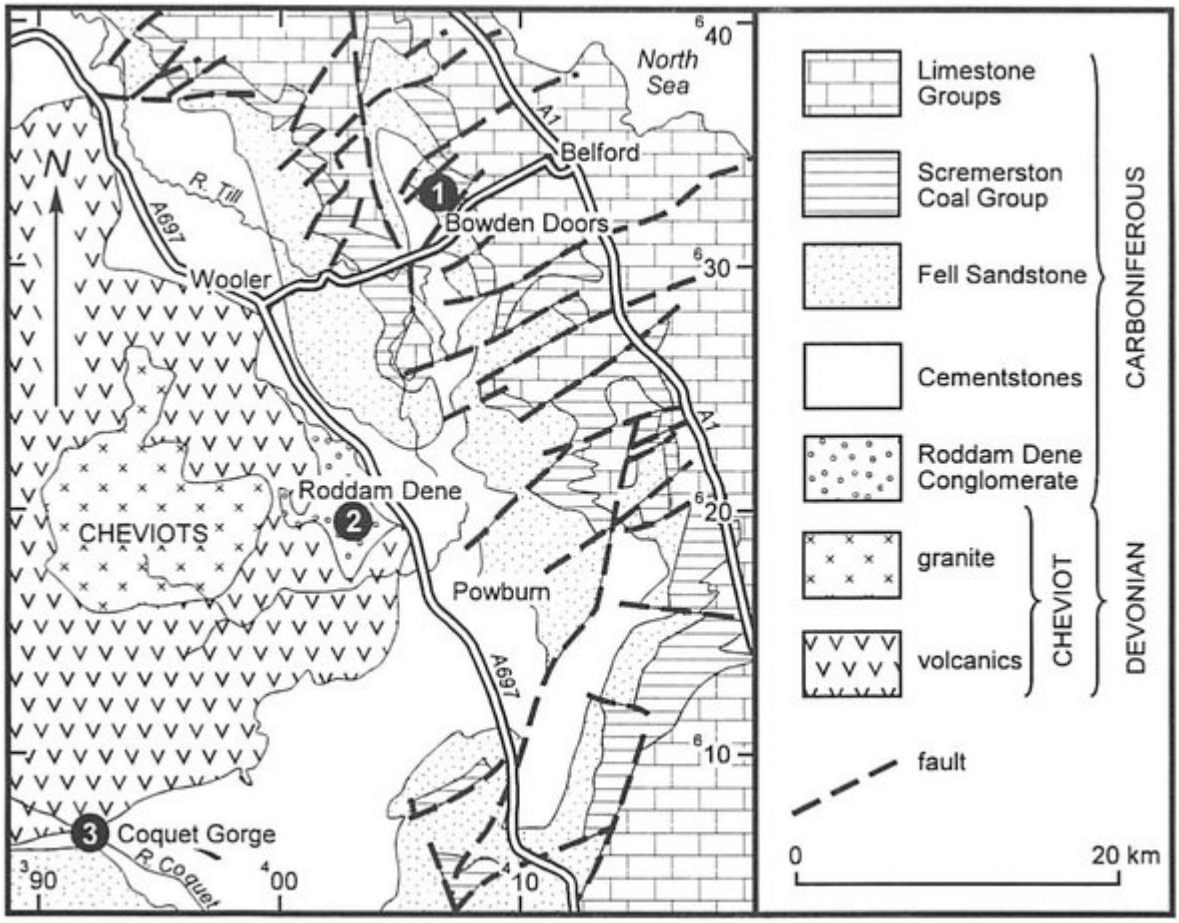
Locality 3, Coquet Gorge [NT 905 061]

From the B6341 Rothbury to Otterburn Road take the turning to Sharperton and Alwinton about 6 km west of Rothbury. Follow the narrow tarred road from Alwinton to Coquet Gorge, about 1.5 km west of Alwinton. Cars can be parked off the road at a number of localities. Easiest access is by way of the footpath at the western end of the gorge which crosses the end of Kay Crag as it descends into the valley, adjacent to a farm fence. The river must be crossed to examine the cliff section on the south side of the River Coquet, and wellington boots are essential, even at low water. The best exposures occur in the upper part of the cliff and are only accessible via small erosional gullies. Care must be taken on the steep, loose shaley slopes, especially in wet weather. A rough track ascends the eastern end of the cliff but exposures along the track are poor. Prior permission is necessary to visit this site (see Logistics).

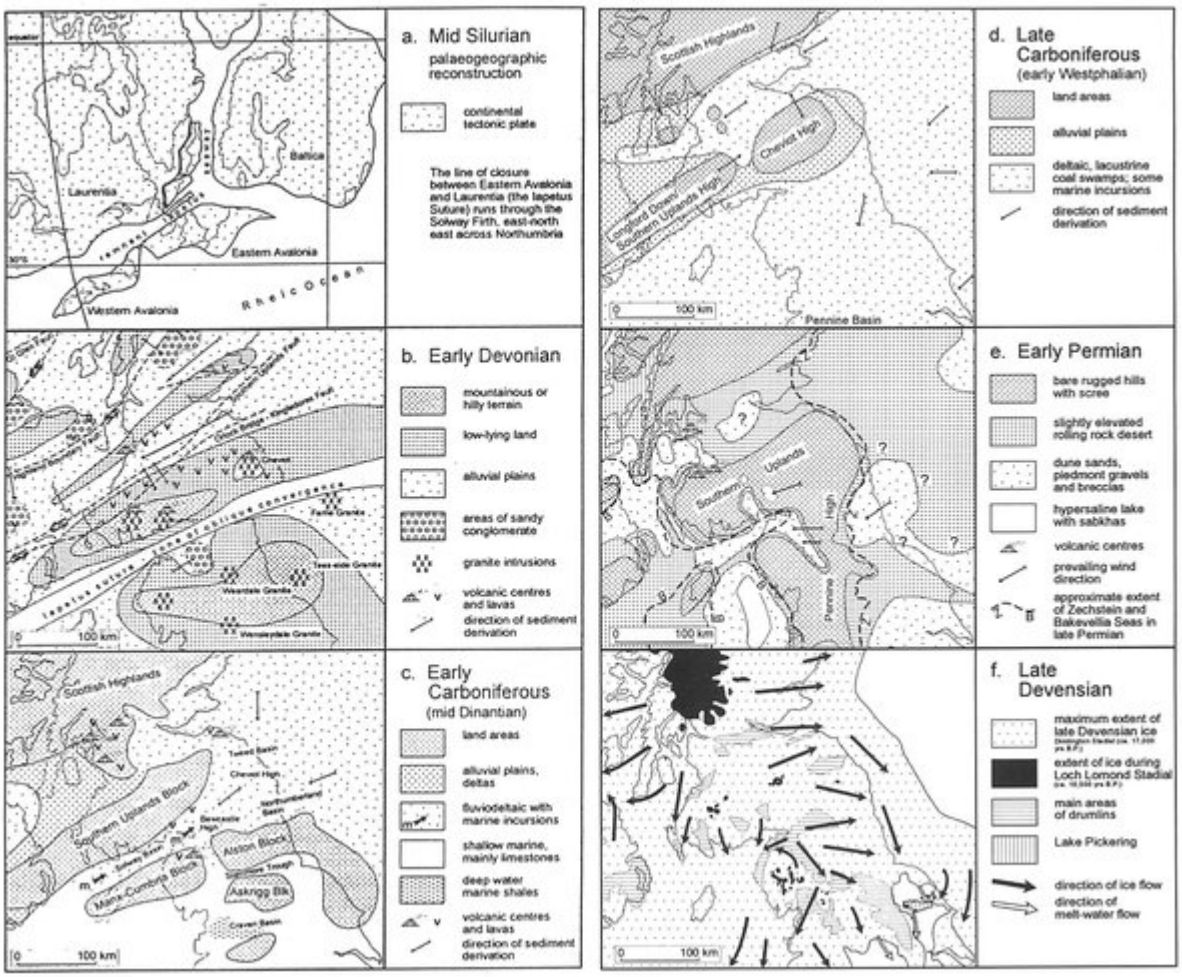
At this locality the River Coquet cuts a spectacular gorge through part of the Cementstone Group. The cliffs rise some 50 m above the river at Barrow Scar and provide the best exposures of Cementstones in Northumberland. A fault north of the road brings up Lower Old Red Sandstone lavas (see Excursion 4) against Cementstones, while to the south of the gorge another fault downthrows the Fell Sandstone and Scremerston Coal Group. The Cementstone section along the gorge consists of thin sandstones (<1 m) interbedded with thicker (1–2 m), softer shales and subordinate impure limestones or cementstones (<30 cm). A striking feature of the cliff section is the absence of thick, prominent channel sandbodies similar to those seen in the Cementstone Group in the Tweed Basin. Exposures also occur in the bed, and at intervals along the northern bank of the river. Although the sandstones in the succession may contain cross-bedding in the lower part, they are predominantly ripple cross-laminated with bedding surfaces showing a variety of ripple marks, dominated by straight to slightly sinuous types with crest-line bifurcation. The sandstones are highly micaceous,

burrowed and contain plant material and trace fossils. Root-penetrated fine sandstones and siltstones occur beneath dark, carbonaceous-rich shale. The thicker shale sequences contain ironstone concretions, plant material and silty interbeds with trace fossils such as *Crossopodia* (formed by arthropods) on bedding under-surfaces. Small calcite-lined cavities, representing pseudomorphs of calcite after original evaporite minerals are present in the cementstones. They also contain fine shaley partings, plant material and brachiopods, some of which are locally pyritized. Shelly fossils are more common than in the Cementstones at Burnmouth in the Tweed Basin (see Excursion 2), possibly because of the greater marine influence on sedimentation at Coquet Gorge. Occasional thick lenticular sandstones occur within the more regularly interbedded Cementstone succession, a good example of which is the cliff forming Kay Crag sandstone at the western end of Coquet Gorge on the north side of the river. A local spring line occurs below the base of the crag near the top of the underlying shale-dominated part of the sequence. Kay Crag sand-stone is an 8 m thick, coarse to medium grained, highly micaceous (white and black mica), profusely cross-bedded sandstone. The scoured base of the sandstone is overlain by intraclasts of shale, siltstone and plant material locally concentrated into a basal channel lag conglomerate. The sandstone was deposited by a low sinuosity distributary channel flowing to the southwest, across a dry, low relief coastal alluvial plain subjected to periodic marine incursions from the south. The origins of the cementstones are discussed in more detail in Excursion 2.

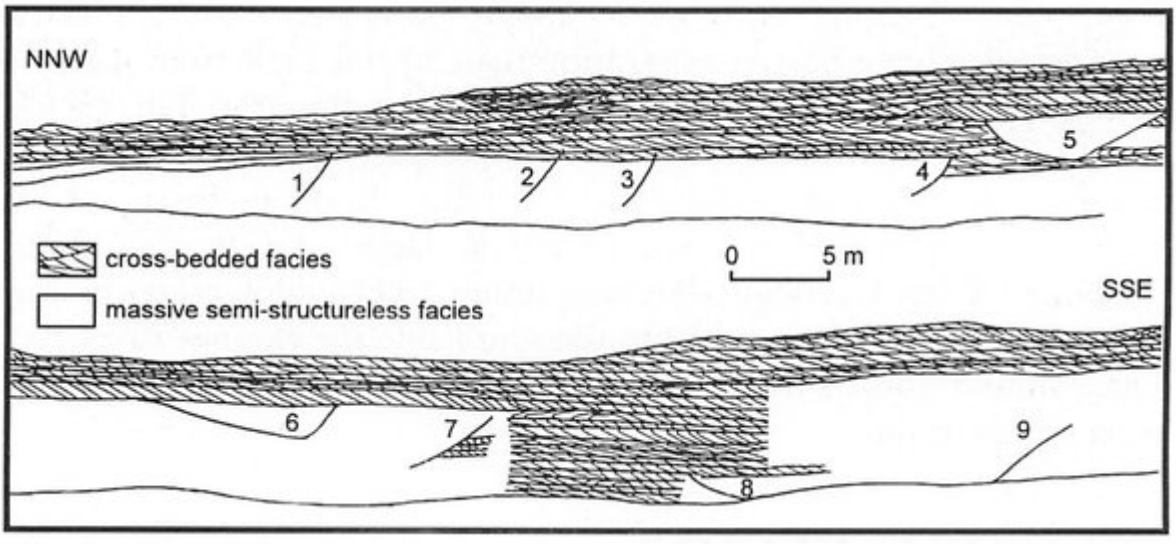
Bibliography



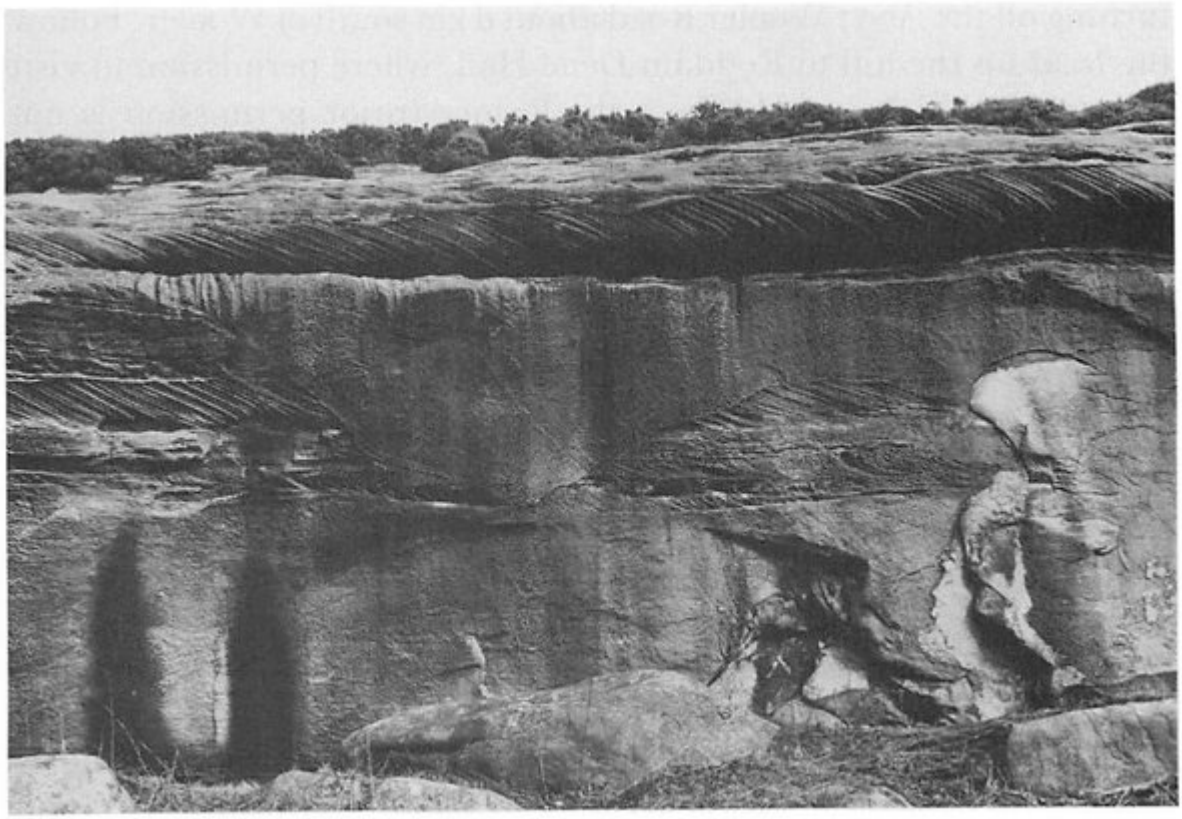
(Figure 9.1) Generalized geological map of northeast Northumberland showing excursion localities.



(Figure 3) Palaeogeographic maps indicating: (a) the distribution of continental plates in the mid Silurian (based on Scotese & McKerrow 1990 and other sources) and (b–f) the distribution of land and major sedimentary environments at various times in Northumbria and surrounding areas (based on Cope, et al. 1992 and other sources).



(Figure 9.2) Tracing from photograph of Bowden Doors Crag showing lithofacies and location of some of the mass-flow emplaced channels numbered 1-9.



(Figure 9.3) Mass-flow emplaced, steep-sided, sand-filled channel in the Fell Sandstone at Bowden Doors. Photo: B. R. Turner.