

---

## 13 The Permian and Carboniferous rocks of Knaresborough

Anthony Cooper British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham, NG12 5GG

### Purpose

This day-long excursion visits Knaresborough Gorge, a glacial diversion channel. It examines the Permian strata and their unconformable relationship to the underlying Carboniferous rocks.

### Logistics

If the complete excursion is to be undertaken an entrance fee (which includes car parking) is payable to do the 'Long Walk' and visit Mother Shipton's Cave (tel: 01423 864600 or visit [www.mothershipton.com](http://www.mothershipton.com) for details of opening times and charges). Permission to visit Bunker's Hill Quarry (Locality 3) must be sought in advance from Mrs B. Raistrick (tel: 01423 866264)

The starting point is Old Mother Shipton's [SE 345 571], off the A59, just south of the River Nidd. Alternatively this section west of the river may be omitted and one of the Council-run public car parks [SE 345 572] and [SE 348 567] used as a starting point. In this case Localities 1 and 2 are missed out and the section between High Bridge and Low Bridge on the east bank of the river is walked twice. Alternatively, a deviation can be made to the town and castle. The circular walk is fairly level, about 8 km long and passes numerous pubs, cafes, picnic places and public conveniences.

Hammers must not be taken on this excursion as it is not permitted to hammer any of the rock exposures.

### Maps

O.S. 1:50 000 Sheet 104 Leeds, Bradford & Harrogate; 1:25 000 SE 35 Harrogate; B.G.S. 1:50 000 Sheet 62, Harrogate, Solid and Drift editions.

Geological Survey Memoir, Harrogate (Cooper & Burgess, 1993).

### Geological background

At the start of the last glacial advance (Devensian) the topography of the Knaresborough district was different to that seen today. The proto River Nidd ran to the north and east of the present town. It deviated from its present course at Nidd [SE 302 608] and ran through Brearton and past Farnham [SE 345 605] to the northern outskirts of Knaresborough [SE 363 580], before heading eastwards. During the advance of the Devensian ice-sheet a thick fan of sand and gravel was deposited in this valley, emanating from the front of the ice-sheet via glacial channels around Farnham [SE 352 606] and Occaney [SE 352 619]; this deposit was worked in the gravel pits north of Knaresborough [SE 356 587]

If Knaresborough is approached from the north via the B6166 from Boroughbridge the extent of this buried valley, and its associated sand and gravel deposits, can be appreciated from the road. As the ice advanced further to the south and west it over-rode the sand and gravel, completely blocking the proto-Nidd drainage and diverting the river westwards. Here the river exploited the lowest, softest rocks and incised the present Nidd Gorge. West of the Nidd Gorge the glacial deposits are generally thin and probably pre-Devensian in age; east of the gorge the Devensian deposits comprise thick hummocky glacial till with moraines, eskers and late glacial lake deposits.

The solid rocks exposed in Knaresborough Gorge are of Carboniferous (Namurian) and Upper Permian age. Here the Permian strata overlap onto and submerge a surface of irregular relief eroded in the underlying Carboniferous sandstones and shales. The exposed Carboniferous sequence extends upwards from the Lower Follifoot Grit to the Upper Plompton Grit. At the northern end of Knaresborough the Carboniferous rocks are folded around the nose of the

Harrogate Anticline and dip at up to 27° to the east and southeast. This anticline was formed during the Variscan Orogeny, prior to the late Permian deposition.

The overlying Permian strata dip gently eastwards and rest unconformably on the Carboniferous rocks (cross-section in (Figure 13.1)). The lowest Permian rocks seen here are the Cadeby Formation (formerly Lower Magnesian Limestone). This formation is over 40 m thick and subdivided into two members: the Wetherby Member (formerly Lower Subdivision) and the Sprotbrough Member (formerly Upper Subdivision). The Cadeby Formation (Sprotbrough Member) forms the ridge on which Knaresborough is built. The ridge consists largely of cross-bedded oolites and is capped by a small outlier of Edlington Formation (formerly Middle Marl). The Knaresborough ridge appears to be a primary depositional feature, for the limestone thins away from it in all directions and depositional dips mimic the form of the ridge. The thinning of the formation is best illustrated northwest of the town centre, near Conyngham Hall, where it thins to 1–3 m of even-bedded, sandy dolomite; the westward thinning is illustrated by the cross-section in (Figure 13.1). The overlying Edlington Formation comprises red-brown calcareous mudstone with some gypsum and is generally poorly exposed. It overlaps the Cadeby Formation both northwards and westwards to rest directly on the Carboniferous rocks. The Edlington Formation is in turn overlapped by the Brotherton Formation (formerly Upper Magnesian Limestone), a sequence of dolomitic limestone 5–15 m thick, which rests directly on Carboniferous rocks at Scriven [SE 345 585] and Rudfarlington [SE 342 543].

## **Excursion details**

### **Locality 1 [SE 3475 5685]**

Starting at Old Mother Shipton's car park, take the Long Walk to the Weir [SE 3475 5685]; here Carboniferous sandstone (Addlethorpe Grit) is present in the river, and the sub-Permian unconformity is visible in the cliffs below the Walk. About 12 m of dolomite are exposed, overlain by red siltstones of the Edlington Formation. On the opposite bank of the river the Addlethorpe Grit and overlying Cadeby Formation form a sheer cliff; the unconformity at the base of the Permian sequence is clearly visible.

### **Locality 2 [SE 348 565]**

Proceed southwards to the Dropping Well. Here there are several magnificent tufa screens produced by the carbonate- and sulphate-rich waters of the spring. The Dropping Well spring emanates from the dolomite of the Cadeby Formation, but includes dissolved sulphates derived from the gypsum of the overlying Edlington Formation. The carbonate is readily deposited from the water forming the Dropping Well screens and petrifying objects placed in its path. Mother Shipton's Cave, just north of the Dropping Well, is situated below an ancient tufa screen. Tradition says that the notorious sibyl of the North, Mother Shipton, was born near this well in the year 1488. Leave Old Mother Shipton's by the exit at Low Bridge, cross to the east side of the river and walk south about 50 m.

### **Locality 3 [SE 351 565]**

At the entrance to Bunker's Hill Quarry (Low Bridge Caravan Park) massive, cross-bedded oolites of the Cadeby Formation are exposed in the cliff along to the House in the Rock and the Chapel of Our Lady of the Crag which may be visited upon payment of an entrance fee. The chapel was formerly known as St Robert's Chapel after the monk who built it (see Locality 7 for further details). To visit the rock faces in Bunker's Hill Quarry [SE 3515 5655] permission must be sought in advance from the caravan site owner (see Logistics). Near the Chapel of Our Lady of the Crag the cliffs show rows of post holes from the roofs of houses occupied by weavers up to about 1840. Hereabouts the rock faces show sections of oolitic dolomite which occurs in massive cross-bedded units with sets up to 18 m high; these belong to the Sprotbrough Member of the Cadeby Formation. These units represent massive subaqueous oolite sand waves. There is general westward thinning of the sequence from here to Calcutt (see cross-section in (Figure 13.1)).

### **Locality 4 [SE 355 559]**

Proceed southwards along the road to the south end of the garden of the last house (Amtree House) on the east of the road. Please keep out of the private garden. At the far entrance to the grounds, looking up at the rock face to the east, the unconformity between the massive sand-wave facies of the Cadeby Formation and the underlying Upper Plumpton Grit is exposed, now sadly overgrown and best seen in winter. The sandstone is reddened and takes the form of a rounded buried hill with an exposed relief of 8 m and a width of 32 m (Figure 13.2). The overlying Cadeby Formation covers the buried hill with subconcentric drapes of beds 0.1–0.15 m thick. On its flanks they pass laterally into large-scale (t–m) cross-bedding. The Cadeby Formation here comprises fine-grained crystalline to granular dolomite with sporadic poorly preserved oolites.

#### **Locality 5 [SE 357 557]**

Continue southwards to the car turning point. Northeast of here the unconformity at the base of the Cadeby Formation dips down into a concealed valley, but reappears in the quarry east of the road. Here 3.6 m of Carboniferous sandstone (Upper Plumpton Grit) is present beneath 13.5 m of Cadeby Formation. The reddened and weathered sandstone is very coarse to granule-grained, feldspathic, with quartz pebbles, and occurs in very thick cross-bedded units. At the base of the overlying limestone there is a thin impersistent bed (0–0.1 m) of yellow, very coarse-grained sandstone with a dolomitic cement. It is not apparent whether this is part of the Carboniferous sequence, re-cemented with dolomite, or a very sandy bed at the base of the Permian. The overlying thin, medium and thick beds comprise dolomite with quartz grains in the lowest 0.5 m or so.

#### **Locality 6 [SE 357 557]**

About 100 m southeast of Locality 5 the same unconformity rises to the top of the old quarry in the private grounds east of the road, from where it can be well seen. The quarry should not be entered. The section now exposes 10.5 m of Carboniferous sandstone overlain by 4 m of dolomite. This shows that locally the relief on the unconformity is at least 8 m.

#### **Locality 7 [SE 361 570]**

Continue along the riverside road to the north-northeast for about 500 m where St Robert's Cave is situated in the river bank below the road; entry is through a gap in the wall and down a flight of steps. This cave was the former abode of the pious monk Robert Flower of York from Fountains Abbey, AD 1160–1218. He took refuge in the cave and turned another cave into St Robert's Chapel (Locality 3). The cave also gained notoriety as the scene in 1745 of the murder of Daniel Clark, for which crime Eugene Aram, a scholar of considerable ability, was hanged at York in 1759. At St Robert's Cave thin sub-horizontal beds of cross-bedded, oolitic dolomite are exposed with a channel structure to the south of the cave entrance. These beds are sparsely fossiliferous and probably represent the Wetherby Member (lower subdivision) of the Cadeby Formation. The member must, however, wedge out rapidly southwards because it is not present at Grimbald Crag (Locality 8) only 300 m to the south. From St Robert's Cave proceed northwards along the road, cross the River Nidd by the Wetherby Road, and head southwards on the riverside footpath to Grimbald Crag.

#### **Locality 8 [SE 361 558]**

Grimbald Crag exposes a sequence similar to that found at Abbey Crags and reveals another hill in the pre-Permian topography. About 16 m of massive, cross-bedded dolomite rest unconformably on reddened Lower Plumpton Grit with one footpath running along the unconformity. The unconformity was formerly exposed overlain by about 2 m of evenly bedded dolomitic limestone; then by massive cross-bedded units typical of the area (Dr D. B. Smith, pers. comm.). The unconformity is now obscured, but the lowest Permian beds seen contain abundant derived quartz grains. South of Grimbald Crag a fault, downthrowing to the south, brings the Brotherton Formation limestone outcrop against that of the Lower Plumpton Grit.

#### **Locality 9 [SE 3567 5552]**

The Brotherton Formation limestone is poorly exposed at the top of the bank west of Birkham Wood. This poor exposure comprises 1.5 m of white and pale grey, thin-bedded, porcellanous, dolomitic limestone which contains fossils. These include small tube-like algal threads of *Calcinema permiana* which commonly occur in drifts and other concentrations, as well as the bivalves *Schizodus obscurus* and *Liebea*.

#### **Locality 10 [SE 356 556]**

About 100 m north of Locality 9, the Grimbald Crag Fault crosses the River Nidd opposite the Priory and is marked by a prolific spring. At this locality the Brotherton Formation limestone and Roxby Formation (formerly called the Upper Marl) are thrown against the Cadeby Formation, the fault scarp forming a prominent feature which can be traced to the west.

#### **Locality 11 [SE 352 560]**

North of the Grimbald Crag Fault, Calcutt Cricket Ground occupies a quarry excavated in the Sprotbrough Member of the Cadeby Formation. East of the quarry the Lower Plumpton Grit is exposed in the river bed, while to the south and north the Edlington Formation overlies the dolomite of the Cadeby Formation. East of the Nidd, beneath Knaresborough, the Cadeby Formation is thick and its top rises to 75 m O.D., but at Calcutt it is thin and the top only rises to 53 m. As the regional dip of the Permian rocks is to the east, the westward thinning of the Cadeby Formation at this point is clearly illustrated (see cross-section in (Figure 13.1)). Proceed along the riverside path to Low Bridge, a convenient place to break for lunch with pubs nearby.

#### **Locality 12 [SE 348 569]**

Cross the river at Low Bridge and head northwards on the east side of the Nidd. Below the castle the cliff section near the Weir, seen earlier from the opposite bank of the river, exposes the unconformity at the base of the Cadeby Formation. The 27 m high vertical face is not accessible. At road level 2–3 m of weathered Addlethorpe Grit is exposed with a fossilized tree-trunk present below an overhang about 1 m above ground level. The remaining 27 m of the cliff comprises a basal zone 6–7 m thick of reddish-buff sandy dolomite overlain by about 17 m of dolomite in large-scale cross-bedded units.

#### **Locality 13 [SE 349 569]**

For the energetic, a walk up the cliff path, just north of Locality 12, to Knaresborough Castle affords an opportunity to examine the Cadeby Formation at close hand and to visit the castle. The castle was originally Norman, though all traces of that period have now disappeared; then, from 1371, it was a stronghold of the Duchy of Lancaster and used as a barracks. From the castle viewpoint the form of the Knaresborough Gorge glacial diversion channel can be appreciated; return to the riverside walk (via the town to High Bridge if you have already walked this section).

#### **Locality 14 [SE 3425 5742]**

Continue upstream past the High Bridge to Conyngnam Hall Farm, where the track crosses the river again. About 50 m to the east, in the wooded area below Conyngnam Hall, the attenuated Cadeby Formation (only 1.2 m thick) is seen resting on weathered purple-brown Carboniferous siltstones, and overlain by the Edlington Formation. The exposed Edlington Formation comprises 2.6 m of red-brown mudstone and sandstone. It includes sandy and micaceous detritus derived from Carboniferous sandstones similar to those exposed 100 m to the east, where the Edlington Formation rests directly on Carboniferous strata. The north–south cross-section through here is similar to the east–west cross-section shown in (Figure 13.1).

#### **Locality 15 [SE 342 575]**

Near Conyngnam Hall Farm the Upper Follifoot Grit crosses the river, forming the foundations of the bridge. The sandstone dips to the east at 27° and comprises some 7 m of fine to medium-grained sandstone with subordinate siltstone partings and a thick bed of siliceous ganister with rootlets near the middle of the unit. The Carboniferous rocks

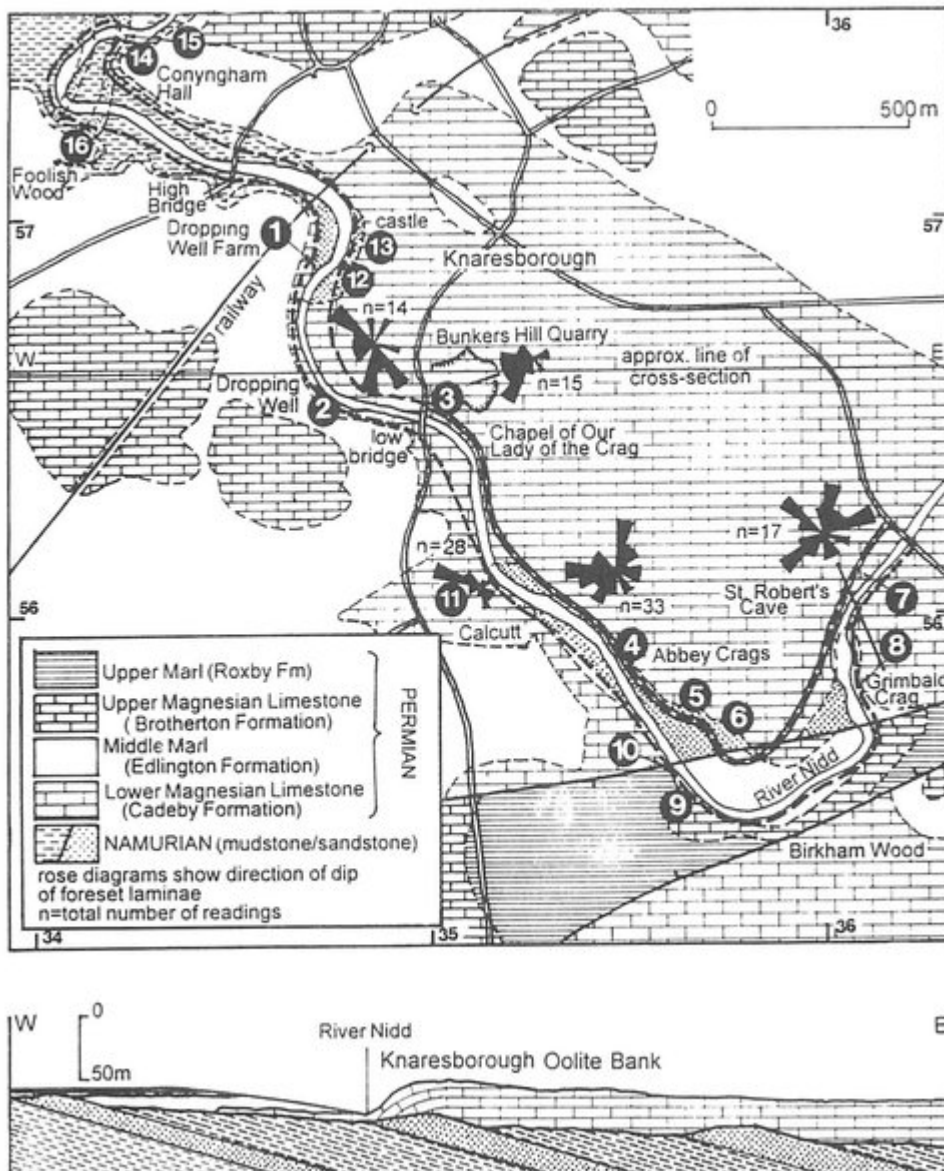
here, and at Locality 16, dip steeply eastwards around the nose of the Harrogate Anticline. The resistant sandstone units form small escarpments projecting above the general level of the sub-Permian unconformity, and the basal Permian sedimentary rocks are banked against them.

### Locality 16 [SE 3413 5722]

Follow the river southwards to Foolish Wood where in an old, difficult to find, quarry the Upper Follifoot Grit dips southwest at 27°. At the back of the quarry, sub-horizontal dolomite, 0.5 m thick, of the Cadeby Formation rests with a basal conglomerate of local material on an irregular sandstone surface, and is overlain by red siltstone. The sandstone apparently formed a ridge on the sea-floor prior to the deposition of the Cadeby Formation. Only a few metres to the north of the quarry, where the dolomite rests on siltstones underlying the Upper Follifoot Grit it thickens to 3 m, forming an escarpment from which large blocks have slipped down to the river bank.

Continue southwards on the west side of the River Nidd to Old Mother Shipton's car park; ensure that you arrive back before the car park closes.

### Bibliography



(Figure 13.1) Geological map and cross-section of the Knaresborough area (with palaeocurrent information from Dr J. G. Kaldi).



*(Figure 13.2) Carboniferous-Permian unconformity at Abbey Crags (Locality 4). Photo: B.G.S.*