20 Jurassic, Cretaceous and Quaternary rocks of Filey Bay and Speeton

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Purpose

To examine the Devensian glacial deposits, interglacial shell bed, Upper Jurassic Kimmeridge Clay, Lower Cretaceous Speeton Clay and Upper Cretaceous Red* and White Chalks exposed in the coastal cliffs of the southeast part of Filey Bay.

Logistics

Parking for a coach or up to to cars is available near the cliff-top at Reighton Sands [TA 140 763]

The coast section is suitable for a large group, and involves an easy walk of about 4 km (plus 4 km return), taking at least 3 hours.

Note: The section is *accessible only for 3–4 hours on either side of low tide. Hard hats should be worn*. Do not stand close to vertical clay sections during and after rain when they are unstable, and do not attempt to walk across soft active mudflows. On the sloping cliffs it is safest to walk only on vegetated areas. The high chalk cliffs beyond are dangerous because of block falls and *should not be approached closely at any time*. The nature of the Red and White Chalk may be studied in foreshore exposures and fallen blocks away from the cliff base.

Maps

O.S. 1:50 000 Sheet tot Scarborough & Bridlington and 1:25 000 Sheet 301, Scarborough, Bridlington and Flamborough Head; B.G.S. 000 Sheet 55/65 Flamborough & Bridlington.

Geological background

*The 'Red Chalk' is now known as the Hunstanton Formation.

In this section the solid rocks have a low, general southerly, dip so that progressively younger rocks occur southward. Marine Jurassic and Lower Cretaceous clays and shales are overlain by the Red and White Chalk. A non-sequence occurs at the top of the Jurassic rocks (Kimmeridgian Stage, c. 146–151 Ma) and the Portland and Purbeck rocks of the south of England are not developed. The succeeding io cm Coprolite Bed is overlain by the Cretaceous Speeton Clay (about 100 m), forming the finest marine Lower Cretaceous section in Britain and equivalent to five of six Lower Cretaceous Stages (c. 136–106 Ma). The Ewaldi Marl, Gault Clay and lower Red Chalk above represent the sixth Lower Cretaceous Stage and the remainder of the Red Chalk and overlying White Chalk form a very full sequence of Upper Cretaceous rocks. The latter is best examined further south in the Flamborough area (Excursion 21).

During the Late Devensian Stage of the Quaternary, ice advanced southwards in the western part of the North Sea area and deposited tills blocking the seaward end of the Vale of Pickering. From radiocarbon dating of organic remains found above and below the equivalent glacial deposits in Holderness, the ice invaded eastern Yorkshire about 18 000 years ago and finally melted by about 13 000 years ago. Two main tills were deposited — a lower greyish-brown and an upper reddish-brown till. In Holderness these are known as the Skipsea and Withernsea Tills respectively; there they contain more chalk than the equivalent tills in Filey Bay, because the ice crossed the main Chalk outcrop between the two areas. The two tills were probably deposited by a single two-tiered ice-sheet. The Skipsea Till originated from ice which moved across southeast Scotland, Northumberland and Durham, whereas the Withernsea Till was deposited by ice which came from the Lake District and crossed the Pennines via the Vale of Eden, the Stainmore Gap and Lower Teesdale. The Lake District/Teesdale glacier was superimposed on the Scottish/Northumberland ice off Teesmouth, and both then moved

southwards as a two-tiered glacier.

In interglacial periods before the Late Devensian glaciation the eastern end of the Vale of Pickering was an estuary. Sediment which accumulated in the estuary during an interglacial dated by the amino acid method to approximately 200 000 years ago forms the Speeton Shell Bed, which occurs between the Speeton Clay and glacial deposits on New Closes Cliff.

Excursion details

The lane from the A165 at Reighton village to Reighton Sands traverses several drumlins with long axes orientated north-northwest—south-southeast, a local direction of ice movement parallel to the Chalk escarpment. From Reighton Sands car park follow the sloping track to the shore and turn right (southeastwards). The cliffs cut in Pleistocene and Mesozoic clays for the next 2 km are continually changing because of landslipping and coast erosion, so it is impossible to give exact locations of good exposures. Usually about go% of the cliffs are occupied by landslips, many of which are rotational slips. *In situ* exposures have vertical faces and approximately horizontal planes between till and gravel units.

About 500 m east-southeast of Reighton Gill solid rocks appear in the cliffs from beneath the tills. However sand may be stripped from the beach to provide foreshore exposures of the solid rocks from the Gill onwards. They are divided into Beds A–F, F being the lowest; Beds B–E constitute the Speeton Clay. Minor folding in the argillaceous rocks results from the weight of the Chalk above or the pressure of Quaternary ice.

Locality 1. The cliff section from below the car park to the seaward end of the ravine called Reighton Gill [TA 142 763] to [TA 144 762] exposes the Late Devensian tills.

Approximately half the cliff is formed of the greyish-brown Skipsea Till, often obscured by downslipped masses of the overlying reddish-brown Withernsea Till. Thin gravels are often seen between the two tills or in the lower part of the Withernsea Till. At Reighton Gill the junction between the two tills rapidly descends to about a quarter of the cliff height, and within the Withernsea Till on the southeast side of the Gill there is a 2–3 m thick gravel, which rises rapidly in the cliff section for about 100 m southeastwards. Near its southeastern extremity, there is a large contorted raft of grey Jurassic (Kimmeridge, Oxford or Liassic) clay high in the cliff in the Withernsea Till.

Southeast of Reighton Gill, the glacially disturbed surface of Mesozoic clays rises at approximately 88 m/km from below sea level to approximately 30 m O.D. on New Closes Cliff [TA 147758]

In places the surface is overlain by a thin chalky gravel sometimes containing estuarine shells, the lateral equivalent of part of the Speeton Shell Bed (Locality 2). The overlying tills are usually less well exposed on the sloping, densely vegetated cliffs than they are on either side of Reighton Gill, but a few metres of weathered Withernsea Till is usually visible at the top of the cliff.

Stone orientation measurements show that Skipsea Till ice flowed northeast–southwest in the Reighton area, whereas the parent ice of the Withernsea Till moved north-northwest–south-southeast, parallel to the long axes of the drumlins, which must be composed mainly of Withernsea Till. The lower part of the tiered ice-sheet preserved the regional ice movement direction, but the upper part was controlled by the local topography, notably the direction of the Chalk escarpment.

Locality 2, New Closes Cliff [TA 147 758], some 500 m southeast of Reighton Gill.

Approximately halfway up the cliff [TA 1475 7585] the Speeton Shell Bed is usually exposed between an eroded and contorted surface of Speeton Clay and the Late Devensian Skipsea Till (Figure 20.1). It consists of 2–5 m of sandy loam, grey below but weathered brown in upper layers, lying between two beds of chalk-flint gravels. Shells within the sandy loam include the bivalves *Macoma balthica, Scrobicularia piperata, Cardium edule* and *Mytilus edulis,* and gastropods *Littorina littorea, L. rudis, Hydrobia ulnae* and *Utriculus obtusus,* an assemblage indicating temperate estuarine conditions; many of the same species are in fact common in the modern Humber estuary. A microfauna also indicates

deposition in shallow brackish water. The chalky gravels above and below the Shell Bed probably accumulated by gelifluction in cold periods, so the whole sequence represents a cold–warm–cold oscillation.

The shelly loam often contains narrow shrinkage cracks, probably formed during brief periods of exposure at low water during deposition of the Shell Bed. The loam and chalky gravel above and below are also contorted and faulted. Edwards (in Ellis, 1987) identified two episodes of disturbance: a strong earlier episode of north–south compression which affected the sandy loam, lower chalk gravel and underlying Speeton Clay, and a later weaker northeast–southwest compression which contorted the upper chalk gravel and refolded some of the earlier folds. The later force corresponds with the direction of movement of the lower part of the Late Devensian glacier, which deposited the Skipsea Till. The earlier force raised the eroded top of the Speeton Clay to approximately 28 m higher than its predicted regional level at Reighton, the folds in this clay indicating an outcrop compression of approximately 2:1. The earlier force also pushed the Shell Bed to its present position on New Closes Cliff from a much lower original level of deposition.

The earlier (north–south) force probably resulted from the only other known glaciation of East Yorkshire, which deposited the Basement Till of Holderness, during the Wolstonian Stage (130 000–186 000 years ago) or earlier. A thin layer of Basement Till also occurs locally above the Speeton Shell Bed on New Closes Cliff, but this is probably a large erratic raft picked up by the late Devensian glacier and deposited in the lowest part of the Skipsea Till. Provisional amino acid dating of *Macoma balthica* shells from the Speeton Shell Bed suggests deposition in the Ilfordian Interglacial (186 000–245 000 years ago), which implies that the glaciation resulting in initial disturbance of the Speeton Shell Bed and in deposition of the Basement Till was late Wolstonian.

The Upper Jurassic Kimmeridge Clay (F Bed) is exposed in New Closes Cliff, where it appears from beneath the till, and is also seen from time to time in beach exposures (Figure 20.2). The maximum thickness is 225 m but only the uppermost part is seen in this section. It consists of black pyritic shales and paper shales with large dolomite concretions. White flattened ammonites (*Pectinitites pectinatus*) are abundant, as are small molluscs similarly preserved.

The basal Cretaceous E Bed, the Coprolite Bed (0.1 m), seen in the area of New Closes Cliff, looks hard and cindery and represents the slowly accumulating sweepings of the old sea floor. It consists of rolled and fragmentary phosphatic and pyritic bivalves, ammonites and bones. In the 19th century some 500 tons of coprolites (phosphate content 57–61%) were mined annually until 1869 when a landslip closed the workings. The old wooden adit props may still be seen occasionally emerging from the eroded base of the cliff.

The D Beds (14.21 m, Berriasian, Valanginian and Hauterivian (part) Stages) are well seen in New Closes Cliff, and consist of black, blue and brown clays which may be glauconitic, pyritic or selenitic. In this, and subsequent beds up to the Red Chalk, brown phosphatic nodules of various shapes and sizes are common and provide evidence of the very slow accumulation of these deposits on the old sea floor. The D Beds are characterized by ammonites and the robust square-sectioned belemnite *Acroteuthis*. Bivalves, brachiopods and crustacea also occur and large plesiosaur bones have been found in the higher D Beds. Four thin yellow beds indicate ancient volcanic ashes. The top bed is the Compound Nodular Bed (0.30 m), a series of isolated fossiliferous nodules showing two generations of nodule development indicative of very slow formation.

Locality 3, Middle Cliff [TA 148 757]

The C Beds (39.02 m, Hauterivian Stage) consist of light and dark grey clays characterized by the torpedo-shaped belemnite *Hibolites jaculoides*. Ammonites occur throughout with *Endemoceras* and uncoiled forms such as *Aegocrioceras* and *Crioceratites* commonest in the lower part and *Simbirskites* in the upper part. These indicate the Hauterivian Stage, although there is still some uncertainty about the exact position of the boundary with the overlying Barremian Stage. A wide variety of other fossils occurs. Some of the phosphatic nodules contain the 'Speeton Shrimp' *Meyeria ornata*.

At the eastern end of Middle Cliff an old landslip brings in the higher beds and forms a belt of disturbed ground stretching for about 350 m between there and Black Cliff [TA 153 755]

The clays are largely B Beds but examples of the Red Chalk and White Chalk may also be examined. This is convenient if one does not wish to proceed beyond Speeton Beck [TA 155 754] to see them *in situ*.

Locality 4, Black Cliff [TA 152 755]

The B Beds are characterized by the pointed cylindrical belemnites *Praeoxyteuthis, Anlacoteuthis* and *thyteuthis,* and three divisions are recognized.

The Lower B Beds (20.94 m, Barremian Stage) crop out in Black Cliff and are dark, blue-grey clays with some intercalations of paler clays. Various forms of pyrite are common and glauconite occurs at some horizons. Besides belemnites, shelly fossils include bivalves, gastropods, large fragmentary ammonites and a rare echinoid.

Locality 5, Speeton Beck [TA 155 754]

The beck forms the southern boundary of Black Cliff and provides a stable and easily recognized marker point in this section. It provides access to Speeton Village or the cliff-top path and is an alternative route to a shore-level return to Reighton Gap at the end of the excursion.

The Middle B Beds or Cementstone Beds (9.75 m, Barremian Stage) occur in the upper part of Black Cliff north of Speeton Beck but at beach level south of it. South of the beck the sections are poor, the clays being much obscured by slippage and fallen debris from the high White Chalk cliffs. The black pyritic clays contain seven bands of large impure limestone nodules of which the lowest three are the most persistent. These nodules have approximately the right proportions of clay and limestone for calcining and grinding to make cement and have hence been called 'Cementstones'. In the 19th century they were worked in open workings above Black Cliff and also by adits driven into the cliff. They made a light-coloured Roman cement which set rapidly and did not crack on drying. Over 1000 tons a year were sent annually to Hull by coaster and later by railway.

The Upper B Beds (9.4 m, Barremian and Aptian Stages) are very pyritic clays with some browner beds. Poorly exposed, most are Barremian but the highest part has yielded Aptian ammonites.

The A Beds (c. 12 m, Aptian and Albian Stages) commence with the Ewaldi Marl, which consists of dark brown streaky clays with green glauconite patches, phosphatic nodules and a basal nodul bed. The typical belemnite is the small torpedo-shaped *Neohibolites ewaldi*.

The overlying beds consist of red-brown clays with some green-grey clays and a thin (0.2 m) band of glauconite with phosphate nodules ('The Greensand Streak') at the base. The small (2–3 cm long) belemnite '*Neohibolites minimus'* indicates an Albian age which is confirmed by rare ammonite finds.

Locality 6, Buckton Cliffs [TA 163 751]

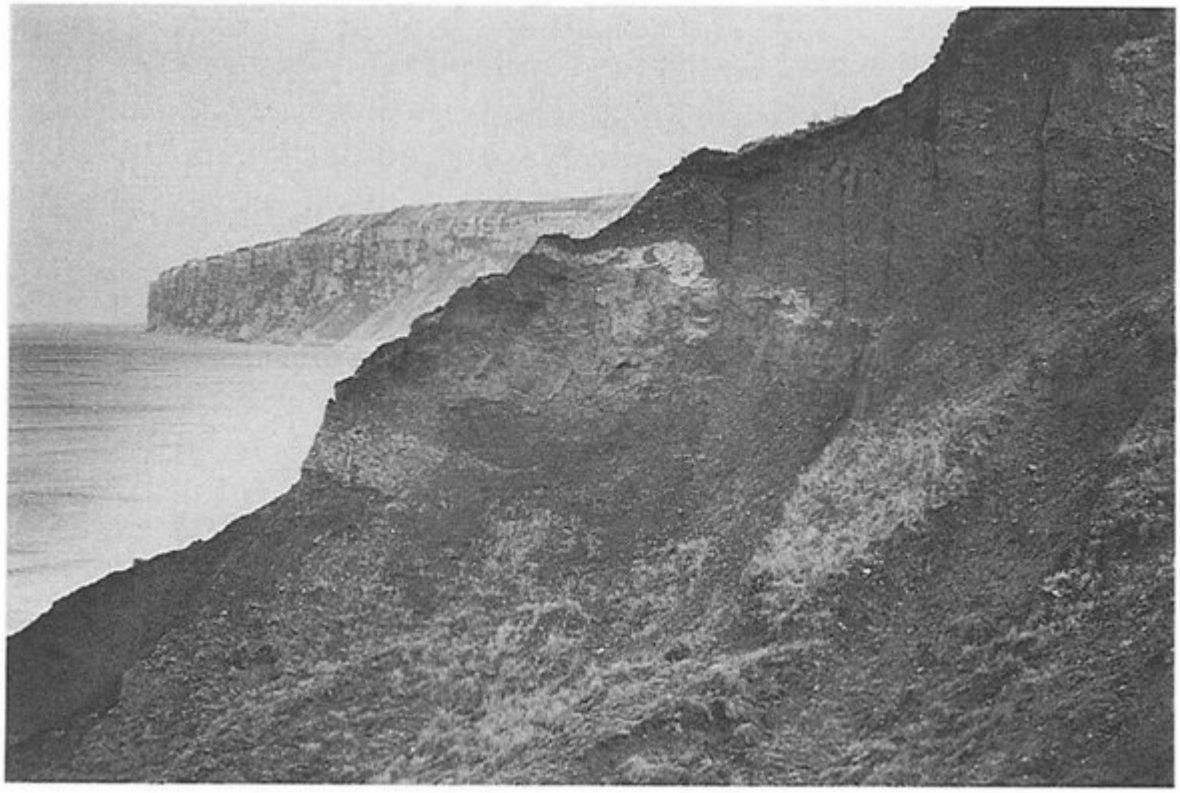
About 600 m east-southeast of Speeton Beck the Red and White Chalk form the impressive Buckton and Bempton cliffs stretching on to Flamborough Head (Excursion 21)

The Red Chalk (up to 30 m, Albian and Cenomanian Stages) is essentially white chalk coloured by ferric oxide, probably derived from Triassic rocks and incorporated in the limy ooze of the sea floor at the time of deposition. As little as 1% of ferric oxide will give a good red colour. The same belemnite occurs as in the previous beds as well as other fossils, notably terebratulid brachiopods. Ammonites show that the bulk of the Red Chalk belong to the Upper Albian. The remainder is placed in the Cenomanian, the lowest stage of the Upper Cretaceous.

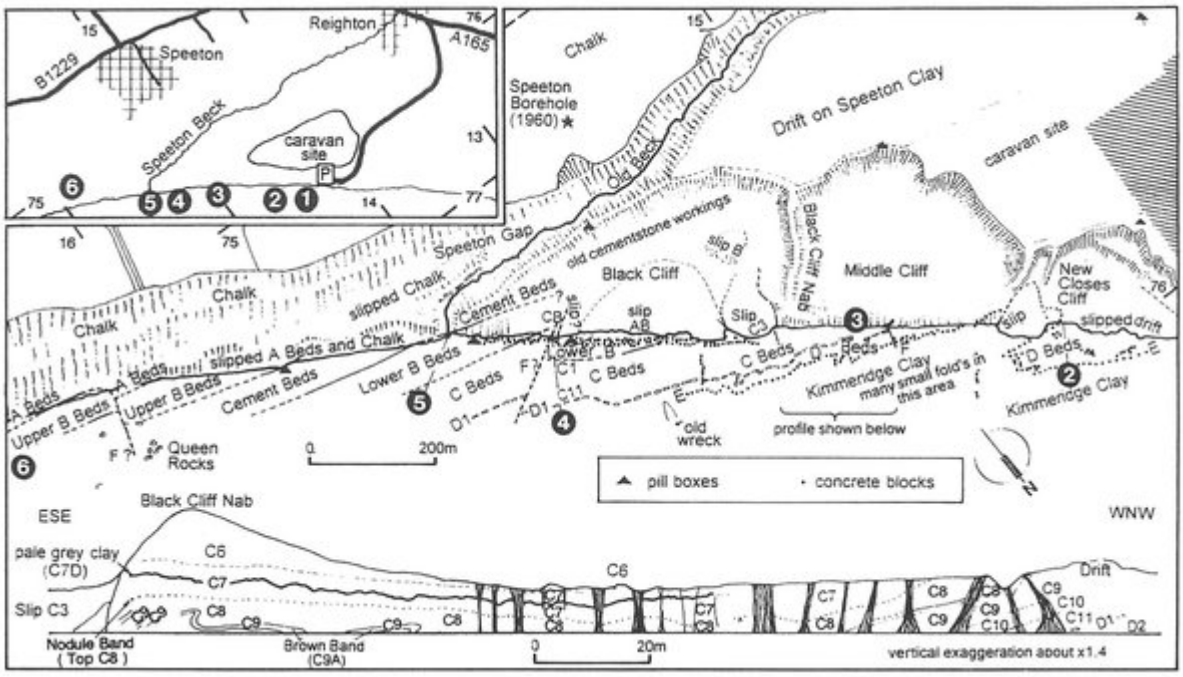
The hard limestone of the Chalk Group (about 400 m in the Flamborough area, Upper Cretaceous) forms the high cliffs of Speeton, Buckton and Bempton. The hardness of the chalk in Yorkshire is a result of its calcite cement. Only the flintless lower part (Ferriby Chalk Formation, 44 m) is accessible here, but beware of falling debris and the possibility of being cut off by the rising ride. The formation contains a wide variety of fossils throughout, but they are scattered, often fragmentary and difficult to extract. Bivalves of the genus *Inoceramus* are the best known.

A black streak visible high in the cliff is the Black Band, which lies just above the base of the predominantly flinty chalks of the overlying Welton Chalk Formation. Boulders from these flinty chalks lie on the beach and some contain good *Thalassinoides* burrow-fill flints.

Bibliography



(Figure 20.1) Speeton Shell Bed, between Speeton Clay and Skipsea Till, New Closes Cliff. The spade rests against the basal chalk-flint gravel of the Shell Bed. Photo : J. Catt.



(Figure 20.2) Map of the Speeton Clay section (after Neale in Rayner & Hemingway, 1974). Inset map shows approach to the coastal section from Reighton.