

Geomorphology of the Lincolnshire Wolds: an Excursion Guide

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Abstract: The chalk-capped Lincolnshire Wolds exhibit a range of geomorphological features created largely by river action, and a wealth of smaller features generated under glacial and periglacial conditions. An excursion from the southern sandstone country to the Humber shore visits escarpments, dry valleys, erosion surfaces and meltwater spillways.

The Pleistocene lasted some two million years, of which at least half was cold, with sub-Arctic to Arctic conditions in Lincolnshire. Due to uncertainties about correlation and nomenclature of events before the Devensian, and the central position of Lincolnshire in relation to the glaciations of eastern England, only the terms pre-Devensian and Devensian are used in this text. Pre-Devensian events include the deposition of chalky boulder clay, notably the Calcethorpe Till. Immediately before the Devensian, the warm interglacial (usually

referred to as the Ipswichian) saw the main incision of the Wolds valleys under full forest cover, while its high sea level probably trimmed the marine cliff along the eastern edge of the Wolds. Most of the features described in this excursion evolved during the Devensian, which lasted for 90,000 years, with only about 20,000 years of actual glaciation, notably in the substage 25,000 to 15,000 years BP. The Devensian saw a series of glacial advances between short less cold interstadials; there were long periods of periglacial landscape evolution.

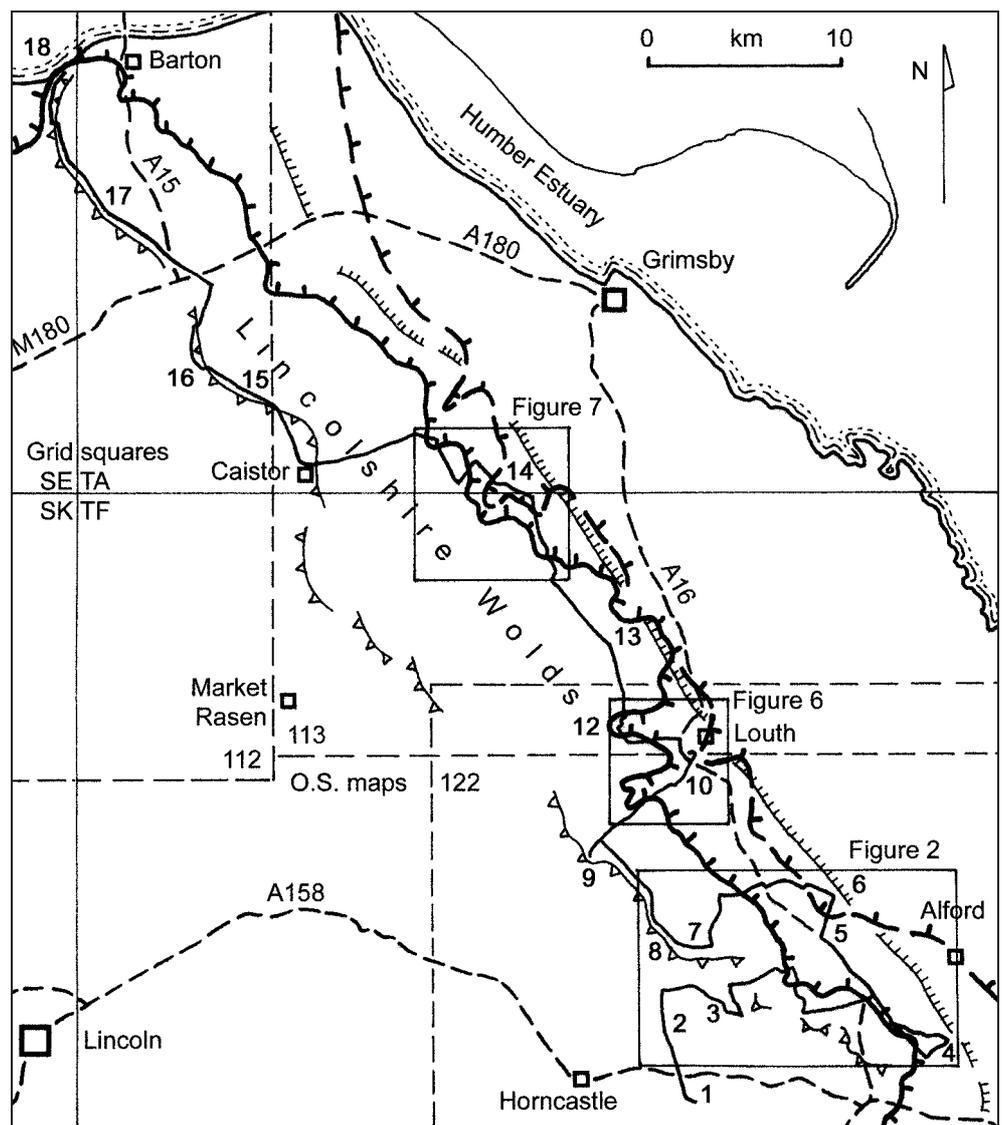


Figure 1. Major features of the Lincolnshire Wolds, and the excursion route. [Key as in Figure 7, except that roads are shown as single lines]

During the Devensian, eastern Lincolnshire was invaded from the northeast by ice that originated in Scotland, northern England and Scandinavia. Its maximum advance is marked by moraines at Stickney in the Fens and Horkstow in the Ancholme valley, and by the location of marginal meltwater spillways in the eastern Wolds. The ice over-rode the frozen chalk of an old marine cliff, and penetrated valleys that had been draining to the east, so that proglacial lakes were impounded by ice until they overflowed into alternative outlets. During the melt-back of the ice, there were periods of stillstand when blocks of dead ice were isolated, and a further series of spillways and associated outwash sands and gravels developed around these. Further melt-back away from the Wolds allowed a short period of fluvial erosion. This was followed by a final re-advance of ice and the cutting of yet more spillways, that remain the youngest and freshest in the landscape, before the final phased recession of ice from the Wolds area (Straw 1958, 1969)

This excursion extends to about 130 km by road across the southern and northern Lincolnshire Wolds. It could be covered in a single long day, as few locations require walking far from the car. Alternatively it can be broken to cover a weekend for those who wish to walk a bit further. The excursion demonstrates features associated with the glaciation, notably some of the seventy meltwater channels, two-thirds of them cut into the Chalk, together with the escarpments and erosion surfaces. All the features can be viewed from public roads or footpaths, so no permissions are required. It would be difficult to follow this excursion without good maps, and the text does not contain precise route details. The relevant OS 1:50,000 maps are sheets 112, 113 and 122. The 6-digit numbers in brackets after locations are the grid references, which are in squares TF (high northings), TA (low northings), SE (high eastings).

The following abbreviations are used throughout this paper:
 LWTNR: Lincolnshire Wildlife Trust Nature Reserve;
 RIGS: Regionally Important Geological/Geomorphological Site;
 SSSI: Site of Special Scientific Interest.

Upper Cretaceous	Upper Chalk	Northern Wolds
	Middle Chalk	Central and
	Lower Chalk	Southeast Wolds
	Red Chalk	
Lower Cretaceous	Carstone	Southwest Wolds and scarp faces
	Roch Formation	
	Tealby Formation Tealby limestone	
	Spilsby Sandstone	
Jurassic	Kimmeridge Clay	Vales to west

Table 1. The sequence of beds seen during the Wolds excursion, and geomorphological features on them.

The southeastern Wolds

Start east of Horncastle (Fig. 1) at the Snipe Dales Nature Reserve (LWTNR), where there is a car park at Winceby (320682). This is sandstone country lying below the chalk-capped Wolds to the north. Walk a short distance into the reserve to a viewpoint (**Locality 1**, 322684) over the valley, where there is an interpretation board. Since its deposition in an earlier pre-Devensian glaciation, much of the covering of chalky boulder clay (Calcethorpe Till) has been removed. Valleys have been eroded through the Spilsby Sandstone into Kimmeridge Clay, and spring sapping has cut recesses back into the sandstone. On the south side a tougher band of sandstone forms a small bluff by the viewpoint, but on the warmer, south-facing, north side the slope is gentler, and the bluff is masked by solifluction deposits most probably formed during periglacial conditions of the Devensian stage.

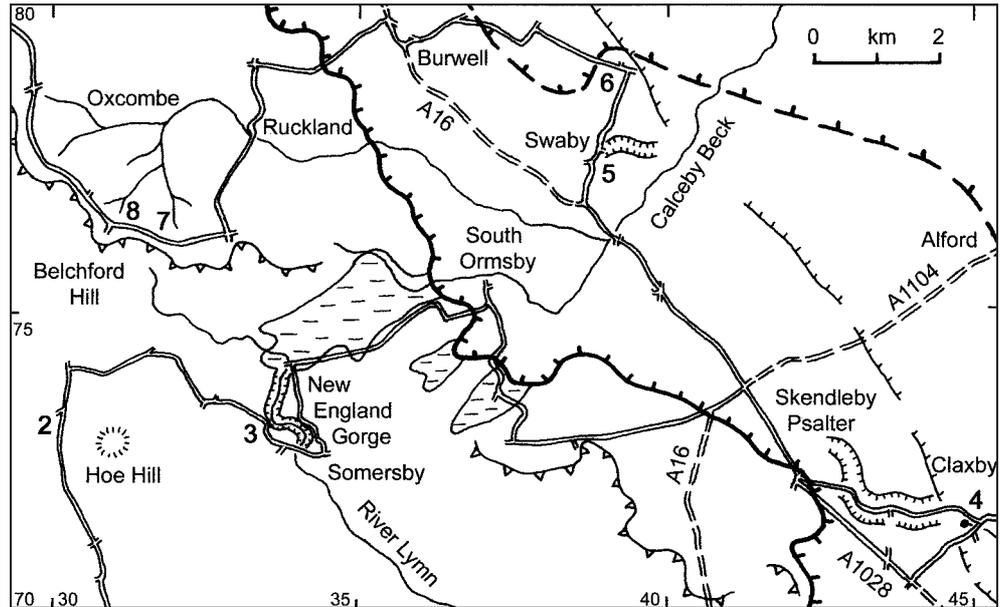
Head north through Greetham, and follow the ridge of Lower Cretaceous Tealby Formation capped by Calcethorpe Till, north to **Locality 2**, at 302733. A view east is of the steep-sided Hoe Hill outlier (RIGS). The flat top marks the outcrop of the Roach Formation (Roachstone), a hard calcareous sandstone; this has been separated by the headward extension of tributaries of the River Lymn, through a combination of fluvial and mass movement processes largely under a cold periglacial climate.

Continue north, and then turn east to descend the slope of the Lower Cretaceous ridge at Nab Hill, onto the wide bench of Spilsby Sandstone, and continue through Salmonby, onto a narrow road towards Somersby. At a sharp right bend (335732), the deep, steep-sided New England Gorge (SSSI) lies below to the left, but vegetation usually prevents a clear view.

The impressive New England Gorge (**Locality 3**) is a glacial spillway, or overflow channel (Straw, 1957). During the Devensian glaciation the eastward-flowing course of the Tetford-Calceby Beck was blocked by advancing ice and a pro-glacial lake formed in the broad depression east of Tetford. The water escaped over a low watershed into the River Lymn system, and cut the gorge down through the Spilsby Sandstone into the Kimmeridge Clay, effecting a permanent diversion of the Tetford Beck (Fig. 2). A short distance further on the road crosses the mis-fit stream as it leaves the gorge.

Turn left in Somersby, and pass the heads of two spring-sapped subsequent tributary valleys of the gorge, before gaining a view of the head of the gorge back to the left at the T-junction. Head east towards South Ormsby, passing between the broad floor of the Tetford pro-glacial lake to the north and hills capped by small outliers of chalk to the south. Turn south through Brinkhill, and rise onto a broad ridge capped by Red and Lower Chalk, that extends to Ulceby.

Figure 2. Some morphological features of the southeastern Wolds (after Straw, 1957). [Key as in Figure 7]



Continue southeast on the A1028 along the ridge, and from the crossroads at 439706, descend towards Claxby. At the foot of the hill, Claxby Spring (**Locality 4**, 450714, RIGS) is the source of Burlands Beck. It has a headwall of chalk, cut back into the general slope that marks the eastern boundary of the Wolds, and is probably a degraded marine cliff that pre-dates the Devensian glaciation. Turn west up the Skendleby Psalter valley, which is dry and drift-free. Strongly fault-guided, this has been fluviably deepened after recession of the Devensian ice from the Wolds, so that the Carstone is now exposed along the valley floor below the chalk (Straw, 1958).

Head north on the A16 across the 100 m plateau on chalk, and descend to cross the outwash gravel terraces of the Calceby Beck valley. Leave the main road to go into Swaby village. Turn right into Pado

Lane, and the walk right along Valley Lane and the footpath beyond into Swaby Valley (**Locality 5**, 391776, LWTNR, SSSI). This is a fine example of a meltwater channel (Fig. 3) that was associated with a decaying block of ice to the south, in the valley between Swaby and Calceby. A sinuous steep-sided feature was cut into the Chalk, and is unusual because gravel terraces survive within it. Swaby Beck is permanently diverted through the gorge; its old valley southwards from Swaby is now partly blocked by glacial drift (Straw, 1961a).

Continue north to Meagram Top (**Locality 6**, 392789), near the eastern edge of the Wolds, where there is a good view across the old cliff line to the Middle Marsh - an undulating and locally hummocky area of Devensian till on a wave-cut platform of chalk. Continue west towards Burwell, and follow the upper course of Swaby Beck. Just east



Figure 3. The open entrance to the Swaby Valley spillway. [Photos by author]



Figure 4. The scarp face of the chalk northwest from Belchford Hill.

of Burwell, the road passes through a small meltwater channel that is still occupied by a stream; the old valley (360792) curves round the south side of a small chalk knoll. At Burwell turn right onto the A16 and in a few hundred metres just through the village turn left towards Maidenwell.

From the A16 at Burwell, a minor road rises westwards through a good example of a dry valley system in chalk; its valley sides are marked by darker streaks in the soil or as crop marks that lie over shallow, filled, linear gullies. Turn south through Ruckland where a major tributary of the Calceby Beck has cut down into the Tealby Formation. Climb up onto the crest of the Wolds, and turn right along the ancient trackway of the Bluestone Heath Road. **Locality 7** is a layby viewpoint with interpretive board at 317762. To the southeast, the scarp of the Chalk caps the eastern part of the southern Wolds, and a tiny outlier of Carstone caps the knoll at Glebe Farm in the foreground. Southward the country is based by the Tealby Formation and Spilsby Sandstone. To the southwest and west, the ridge of Lower Cretaceous rocks, partly capped by Calcethorpe Till, extends through Fulletby to Greetham; it overlooks to the west the valley of the River Waring which crosses through the ridge at Belchford.

Stop at the top of Belchford Hill (**Locality 8**, 309763) for a good view northwest of the scalloped face of the chalk escarpment (Fig. 4). This is formed by Lower Chalk, whose outcrop is reduced to a ridge less than 200 m wide where a dendritic system of deep valleys is cut into the dip slope. The rounded amphitheatres at these valley heads (well seen here to the north at Oxcombe), and the thick deposits of chalk gravel on the valley floors, indicate that final stage of erosion took place under Devensian periglacial conditions.

Continue north, past two more steep valley heads to the east, and cross the A153 onto the summit plateau of the Wolds, the High Street Bluestone Surface. At 150 m, this is the highest and oldest of the erosion surfaces of the Wolds, dating from the end of the Tertiary (Straw, 1961b).

Turn left at 272818 to go over the crest of the Wolds escarpment, and down to Red Hill (LWTNR; SSSI) where there are two small roadside parking areas (**Locality 9**, 265806). Below the disused chalk quarry there is a fine exposure of Red Chalk and Carstone. The lower part (which is becoming increasingly masked by weathering and scree accumulation) shows the beds curving downslope as they pass into a capping of angular rubble; this is a fine example of a gelifluction deposit (the material generally known as head) that has been produced by frost shattering, solifluction and mass movement (Robinson, 1971).

From the top of the quarry there are good views of the Spilsby Sandstone bench at the foot of the hill which is notched by a small stream flowing against the dip of the rock. This joins the Scamblesby Beck which has cut down to the Kimmeridge Clay, producing strong bluffs of sandstone through Goulceby village. The gap between the two exposures of Red Chalk was created as a wash-out during the torrential rain on 29 May 1920 that caused the destructive flooding in both Horncastle and Louth (see below). In the field immediately south across the road from the gap in the quarry rim, the run-off water of this one storm cut a gully and deposited a debris fan towards Goulceby. Despite ploughing, it can still be identified by its soil colouration or crop marking. To the southwest Imber Hill is capped by Tealby Limestone, and on a clear day it is possible to see beyond to Lincoln Cathedral on its ridge.

The Wolds above Louth

Approaching Louth on the A153 from the south, the brow of Stanmore Hill (**Locality 10**, 315854) offers a fine view north to the tree-lined gorge of Hubbard's Hills, with the bypass curving round it (Fig. 5) and a shallow nick across the spur to the northwest (just off the photograph). In the Devensian glaciation a lobe of ice penetrated the Hallington valley, initially to just beyond Hallington village (Fig. 6). During its melt-back, the ice impeded the flow of spring meltwaters down the Hallington and Tathwell valleys, ponding them back into a deep lake. The first escape route north for the water was probably the shallow nick across the spur. Subsequently the water escaped over the spur a little further east, into the Welton valley, and a waterfall cut back rapidly into the chalk to create a gorge whose sides were then trimmed by frost action. It is likely that the gorge was created rapidly by powerful meltwater flows early in each summer; it may have been formed entirely within just 200-300 years.

Across the A16 bypass, turn left at the tollhouse along Halfpenny Lane into the Hallington valley. The lane cuts through the thick moraine that was deposited at the ice margin and ensured the permanent diversion of the Hallington Beck through its new gorge. There is a parking area at 315860, where a footpath leads through the classic open-ended gorge of Hubbard's Hills (**Locality 11**, RIGS). From the top of the steps from the car park, the broad pre-Devensian valley of Hallington Beck can be seen heading east past the tollhouse towards the Marsh.

The last time the stream, which becomes the River Lud, was a raging torrent was on 29 May 1920, the occasion of the tragic Louth flash flood. On that Saturday, 114 mm of rain fell in less than three hours on the headwaters of the River Lud catchment. Gullies up to two metres deep were carved into fields, trees uprooted and bridges swept

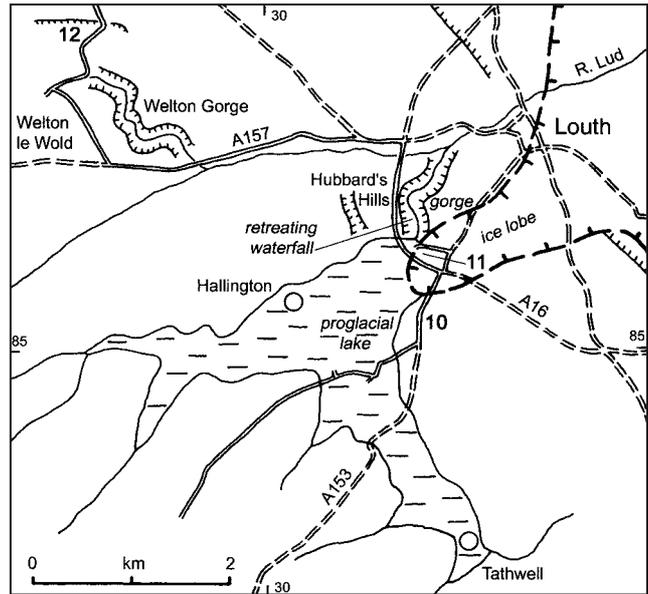


Figure 6. The ice-dammed lake in the Hallington valley; features labelled in italics were active in Devensian times. The main gorge, east of the A16, was cut by waterfall retreat; west of the A16, a higher, older overflow channel had been cut when the ice dam reached further up the valley. [Key as in Figure 7]

away. Rain began around 2pm, and around 5pm a debris dam which had built up at Little Welton gave way, so that a wall of water over four metres high swept towards Louth and its unsuspecting residents (after joining the already swollen Hallington Beck).

The narrow winding course of the Lud through Louth was constricted by terraced houses and industrial buildings. In 20 minutes the debris-laden flood waters cut through the town, destroyed over 50 houses, left another 250 in need of rebuilding, and claimed 23 lives. Brown and yellow mud from the chalk catchment left a clear floodmark on surviving buildings (Robinson, 2000).



Figure 5. The overflow channel at Hubbard's Hills.

Head west away from Louth on the A157 towards Lincoln. At 293869, a straight section of road dips across the south end of the Welton gorge. Further west, turn right through Welton le Wold to **Locality 12**, the disused gravel quarry (282882, SSSI). To the north, an exposure of whitish Calcethorpe Till survives, but the dark brown Welton Till and the flinty gravels and sands beneath it are now hidden by backfill. Derived Hoxnian tusks and teeth of elephant were recovered from the gravels in 1974, along with some Acheulian flint handaxes (Alabaster & Straw, 1976). East of the road there is an exposure of brown Devensian till; this was deposited on top of the eroded and much older gravels and tills at the limit of the Devensian ice penetration of the valley. Meltwaters escaped southeast from this whole area to cut the sinuous Welton gorge. The Welton deposits are evidence of the re-advance of ice from the east over the flinty gravel, and the periglacial emplacement of some of the material known as Calcethorpe Till (Straw, 1969).

The northern Wolds

Head north across the A131, over a broad plateau to **Locality 13**, a road junction above North Ormsby (270925) that offers the best views. This lies on the remarkably flat Kelstern Surface, which, at a level of 115-130 m, is probably a marine planation of early Pleistocene date (Straw, 1961b). It is largely veneered by less than 5 m of Calcethorpe Till, but both the rock platform and the till have been eroded

at the margins by headward incision of valleys that drain both east and west. The steep eastern slope of the Wolds is a continuation of the degraded cliff seen at Locality 4. The valleys to the east are floored by Devensian till that forms the hummocky Middle Marsh beyond and underlies the marine silts towards the coast.

Continue north across the Kelstern Surface and descend into Wold Newton by the large dry valley that is so typical of the upland chalk fluviokarst. At South Farm (245961), a prominent tree-lined meltwater channel called The Valley enters from the east. Beyond Wold Newton, a short-lived nineteenth-century brickworks exploited localised lacustrine deposits at Petterhills (238983). At East Ravendale, turn west along another meltwater channel that continues past West Ravendale (Fig. 7), where the face of a disused quarry on the right (225000, RIGS) exposes faulted Upper Chalk with tabular flints.

An old drift-blocked valley lies north from West Ravendale, but the road curves west through the deep dry Round Hill valley (**Locality 14**, 220003, RIGS). This is a fine example of a meltwater channel, with steep flanks, that are steepest on the outer sides of bends, a flattish floor and a constant gradient westward. Several channels in the West Ravendale and Hatcliffe area originated as marginal drainage features around wasting masses of ice (Fig. 7). The ice decay left low mounds of boulder clay and gravel, for example to the west of the exit from the Round Hill valley (213003).

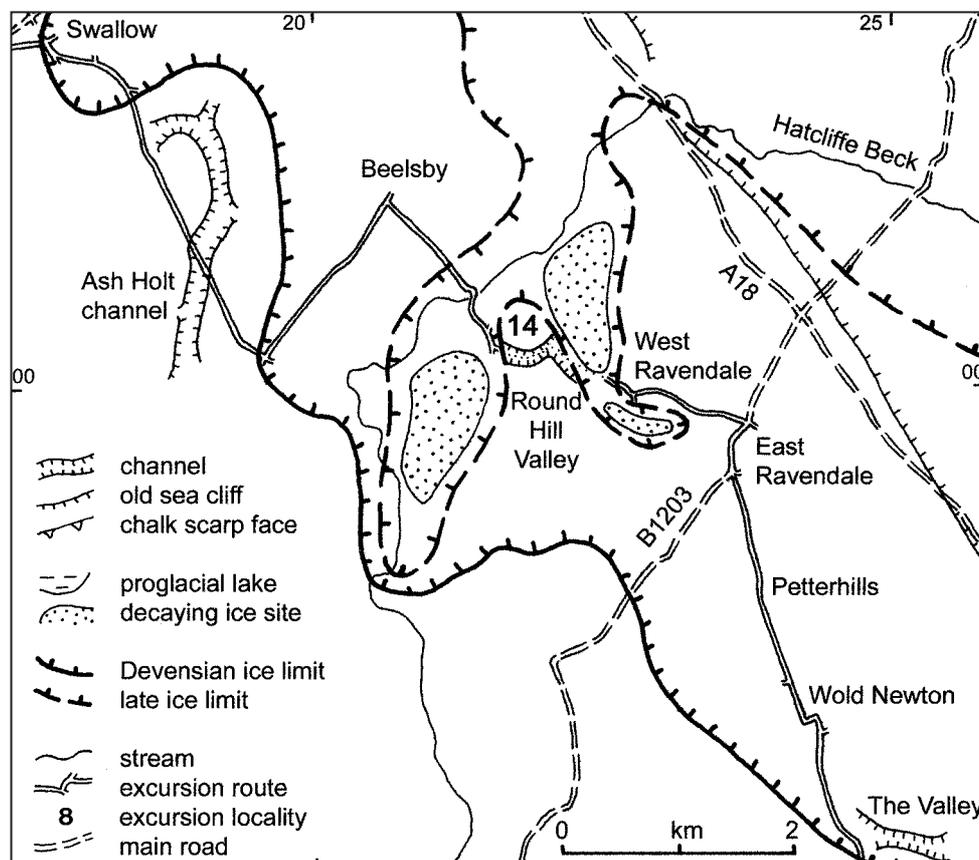


Figure 7. Ice margin features around West Ravendale, showing the sites of three masses of decaying ice left by the late Devensian melt-back of the main ice sheet that had moved in from the east (after Straw, 1961a). [Key applies also to Figures 2 and 6]

Continue north to Beelsby and south towards Croxby, but then turn north towards Swallow, to cross the Ash Holt channel at 191010. This has gently graded sides that are furrowed by shallow gullies, and contains a considerable deposit of blown sand, both indicating that it is somewhat degraded and older than the Round Hill channel (Straw, 1961a).

From Swallow join the A46 to ascend the chalk dip slope that is incised by dendritic dry valleys; at Caistor Top, regain the High Street Bluestone Surface at 150-170 m. Fork right onto the A1084 and descend the scarp through Caistor, thence across cover sands that are partly wind-blown; these are banked against the scarp face, which is fretted with steep dry valleys (Straw, 1963). At Clixby the road climbs the scarp again, where its alignment swings to northwest under the influence of a monocline in the underlying rocks. At Caistor, and further south, the profile of the Wolds scarp face is complicated by benches and knolls controlled by variations in erosional resistance of the Lower Cretaceous sequence of Carstone, Tealby Formation and Spilsby Sandstone. Around Clixby, these Lower Cretaceous rocks are pinched out between the Upper Cretaceous Chalk and the Jurassic Kimmeridge Clay. Consequently, northwards from Clixby, all the way to the Humber, the scarp has a lower and relatively simple form.

At the highest part of the road, above Owmbly, **Locality 15** (078057) offers good views west across the Ancholme valley, where low mounds of Kimmeridge Clay are capped by pre-Devensian chalky boulder clay, and east down the dip-slope to the industrial sites of the Humber Bank. The narrow road down to Somerby meets the foot of the slope at **Locality 16** (065065) where there is a fine view southeast of the chalk scarp face.

Continue north through Bigby, over a shoulder of the chalk escarpment, and down to Melton Ross. This lies in the Barnetby Gap, which was exploited by meltwaters flowing west from a Devensian ice front that stood at Kirmington, about 4 km east of the road junction (Twidale, 1956). Head northwest on the minor road that passes under the two motorways and between two disused chalk quarries above Elsham. Keep to the scarp crest to Worlaby Top (**Locality 17**, 020145). This spot offers fine views southeast of the Wold escarpment, west across the Ancholme valley and the Jurassic limestone escarpment to the Scunthorpe steelworks, and east down the chalk dip slope towards the Humber Bank. From the high point on Saxby Wolds (around 000165) there are good views of the River Humber and the Yorkshire Wolds.

Continue on the ridge top road to the T-junction at Horkstow Wolds, then descend the scarp and continue north to South Ferriby. Cross the A1077 and park on a track at 989213. Walk along the unmetalled track and follow the footpath down to the Humber shoreline (SSSI).

The Humber Gap is a very old feature that probably originated millions of years ago in concert with other east-flowing rivers of eastern England. The river would have initially flowed at a level well above the present-day crest of the chalk escarpment, and its course may have been influenced by east-west faults that are known to exist under and near the Gap. Prior to the Devensian glaciation, the River Humber flowed due east to reach the North Sea near Withernsea through a valley that is now buried by Devensian deposits (but is known from borehole records). Devensian ice passed westward through the Humber Gap, ponding water in the Ancholme, Trent and Ouse valleys. At a later stage, after the ice had melted from within the Humber Gap, an ice



Figure 8. Dark silts and glacial till overlie frost shattered chalk at the South Ferriby cliff; the white material above the till is chalk waste from a quarry.

front lay east of Hull; this deflected the re-established Humber towards the southeast, into the course that it has since retained.

Where the footpath descends to the shore, **Locality 18** (993218) there is the unusual sight of raised saltmarsh on a beach of discoidal pebbles of chalk. To the northeast, a low cliff exposes till overlain by a terrace deposit of unstratified sandy chalk gravel that was probably a solifluction sheet of frost-shattered chalk from a dry valley to the southeast. The gravels exhibit good frost wedge structures and soil-filled pipe features. Further northeast, the Devensian till is exposed resting on a planed surface of disturbed and cryoturbated chalk (Fig. 8). Lenses of laminated sandy silt and pebbles between the chalk and the till indicate the margin of an ice-dammed lake that probably existed as ice was melting away in the Humber Gap. The purplish-brown till is up to 8 m thick, and local oxidation and decalcification, from Flandrian weathering, has given the top 2-3 m a reddish-brown colouration (Catt, 1977; Robinson, 1988).

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