The Yorkshire Coast GA Field Trip notes

Led by Peter F. Rawson & John K. Wright

17-19th May 2019

Ray Pratt

Betton Farm Quarry SSSI (postcode YO13 9HT)

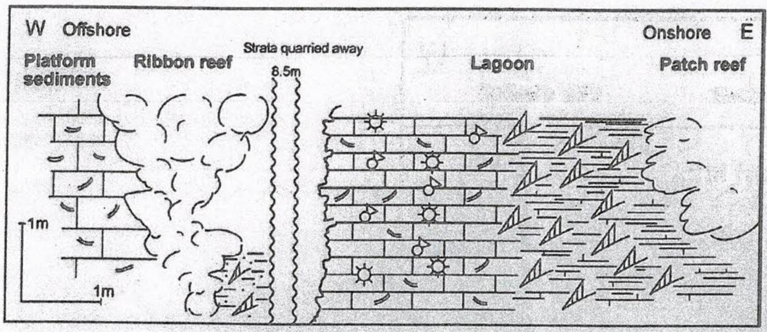


Fig. 13. Reconstructed cross-section of the South Quarry, showing the relationships of the various facies. From left to right: coral-shell sand; ribbon reef; coral-shell sand rich in bivalves and echinoids; fine carbonate mud with gastropods; patch reef.

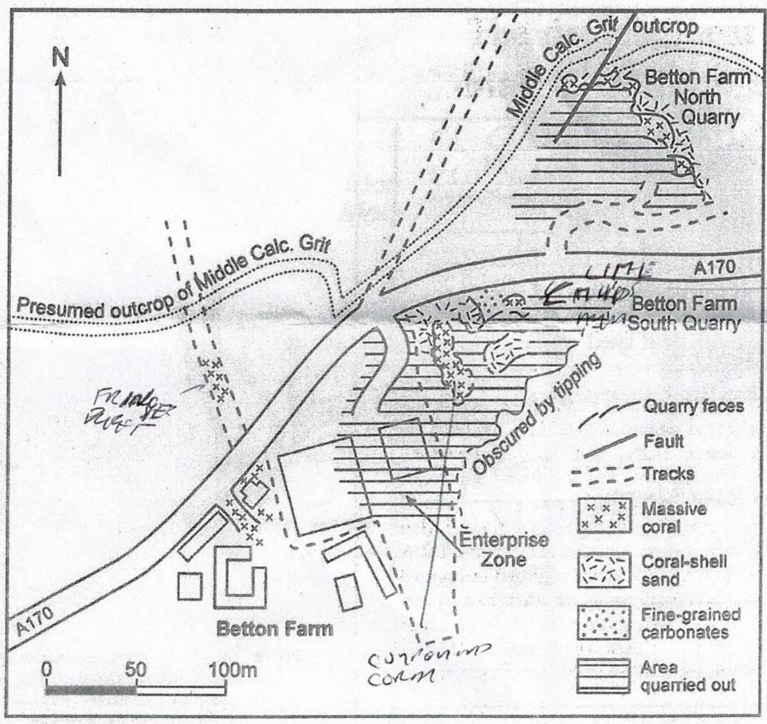


Fig. 6. Detailed map of the Betton Farm area showing the extent of the two disused quarries, remaining quarry faces and relevant geological outcrops. The outcrop of the Middle Calcareous Grit north of Betton Farm is hidden by glacial gravel.

Cleaned up 7 years ago. SSSI. Natural England look after SSIs.. Grants given out by SSIs. Money used to hire a mini digger to make it accessible.

Corals need a hardground surface on which to attach themselves. During the Jurassic this area was temporarily uplifted eroding off some of the middle Corallian beds (Coralline oolite Fm) leaving a good surface on which corals could grow..

Food supply came from the SW (current Vale of Pickering) where an open marine deep water environment existed We know this because the deposits there were ooidoidal, but in a lime mud matrix, not in a shoal. Also large ammonites can be found in these ooid muds.which also indicates that it was a moderately deep water environment. (20-30m deep). Currents from this deep area brought up food particles into the shallow area for the corals to feed and develop. The colonial corals grew on the edge of the shelf forming a fringing reef.

In the back reef area less nutrients were brought in. Sufficient nutrients got through to allow the establishment of dome shaped coral colonies and small fringing reef development, as seen in this quarry.

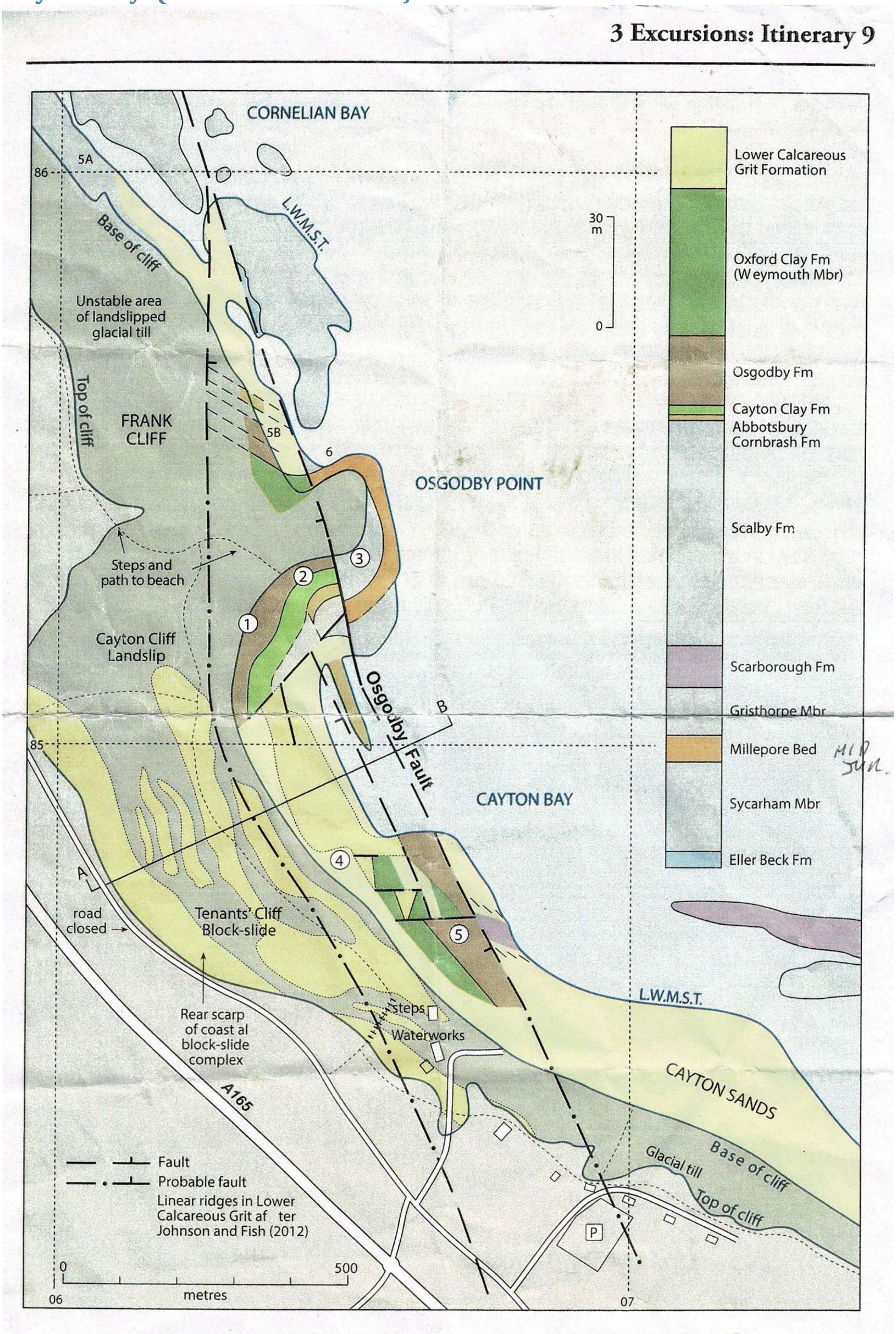
The corals are surrounded by broken coral shell sand. The corals at the fringe of the reef took the brunt of the wave action and broken corals were washed into the inside of the reef into a lagoonal area. Here we find coral shell sand and bivalves, gastropods, echinoderm spicules, Sheltered accumulation of sediment.

Further away from the fringe reef we have lime mud accumulations with gastropods. Quiet protected lagoonal area.

Growth banding is visible 1-2mm per year. (Today grow up to 10mm / yr). Had difficulty establishing themselves in the Jurassic. Consequently not a lot of old coral deposits in Britain.

Used to remove crystalline limestone for road metal.

Cayton Bay (Postcode YO11 3NP)



Cayton Bay.

Looking N towards Osgodby point from Water works)

Millipore bed - marine strata. (orange on map)

Fault cuts through the headland, 100m throw. part of the Peak Trough Fault system

Movement on faults in the Jurassic. Early phase in Jurassic circa 10m throw.

This is not the boundary fault of the Peak Trough, simply a fault inside.

Osgodby Point

Stand on the fault - not obvious

Middle Jurassic. W Smith mapped Great & inferior oolites in the Cotswolds and followed them up through Lincolnshire and was expecting to find them here. Instead he came across these fluvial sandstones (Scalby Formation)

Scandinavia and UK started to part in the Jurassic leading tpo the N sea trough. Time of the N Sea structural traps. Effects of pull apart was that there was less pressure on the mantle which began to partially melt. Lavas erupted NE of Aberdeen in a sting of Jurassic eruptions (out in the North Sea). The uplift had a marked effect here as part of the Mid North Sea High which extended from out in the N Sea to the

Southern Uplands today. Rivers cutting into these highs supplied the sediments deposited here in fluvial conditions. In the Lias this area had been a moderately deep shelf area was by mid Jurassic an alluvial plain. Streams, lakes, swamps. In the guide these sands are described as having a herringbone structure. Crossbedding created by the migration of the migrating layers. Initially going seawards, then westwards then eastwards and so on.

Only way W Smith able to correlate these deposits with these in Southern England was because the uplift was periodic followed by transgression events. Alternations of marine bands (here represented by the Millipore beds (Bryazoa) . Deltaic implies marine influence, so most of this was fluvial with land around as evidenced by dinosaur footprints..

Middle Jurassic always described as fluvio deltaic, which varies laterally

Millipore beds Correlates with the top of the Lincolnshire lst. Only the last of the marine transgressions made its way up here. The only marine incursion to yield ammonites see in Scarborough.

Cross bedding in the Millipore beds caused by tidal currents- forming the wavecut plaform, different to the fluvial cross bedding seen in the cliffs.. Only way it can be proved is due to the inclusion of marine fossils. Fluvial sands always pass up into silts and clays as the land surface becomes further eroded and flatter. A marine incursion that comes next can be impermeable.

These rocks are iron rich (carbonates) origin from land.

Red Cliff Rock member (part of the Osgodby Fm) Yields ammonites of Lower Callovian age. The Callovian Transgression brought an end to fluvial sedimentation in the Clevland Basin.

1km Permo Trias

1/2 km Lias

1/4 km Ravenscar gp

subsidence stopped within the Clevland basin followed by inversion giving a 10mm year unconformity. The pull apart changed from an EW pull apart to a NS pull apart with the Vale of Pickering fault opening

Cayton Clay (before the big landslip event)

Sits on top of the Cornbrash beds. The Cayton Clay is widespread, laid down all across England at a point where the influence of the North Sea high was no longer**.**

Landslip Event. Unstable Glacial Till (Boulder Clay).. Keeps moving.. In toe of landslip are lots of blocks of Redcliff Rock.Slides down over the Clayton Clay.

A number of ammonites can be seen. Shelly sandy blocks. Lots of iron, deep orange in colour. packed with bivalves. Boreal ammonites found here.

Lower Calcareous Grit Fm. seen on the beach

Yellow, lots of calcite with grey calcareous nodules, red iron stains, f-m gr, no vis por.

(Sits above the Oxford Clay - 30-40m thick).

Level bedded so must be downfaulted so we are standing in the middle of the Peak trough - 60-70m throw.

The Lower Calcareous Grit and Oxford Clay also slide down as a unit over the Cayton Clay.see diagram below.

The Oxford clay is quite silty and does not have easy slippage whereas the Cayton Clay is very soft and plastic. (The BGS wrongly shows this area as Oxford Clay)

Ammonite in Calcareous Grit

Thalassinoides burrow in Calcareous Grit

Calcite Nodules

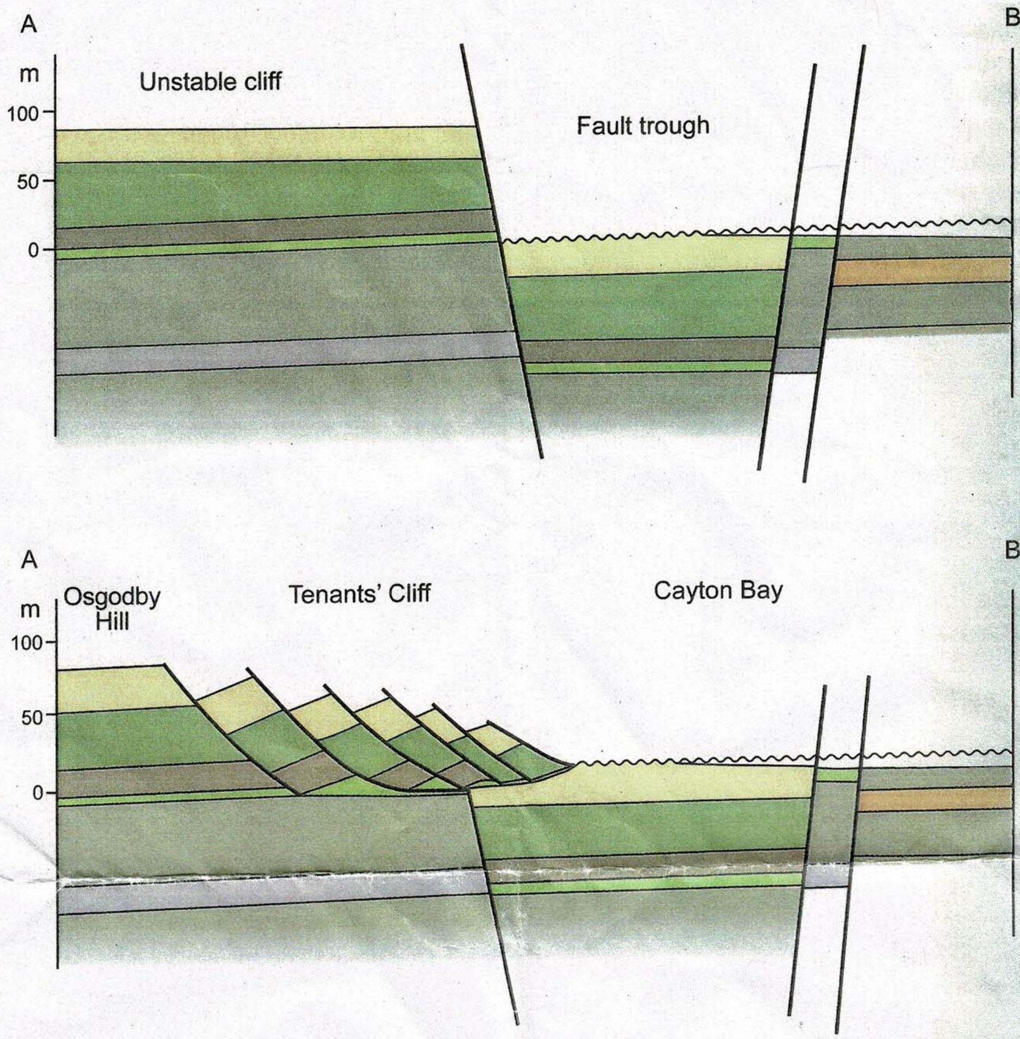


Figure 57. Schematic cross sections along the line A-B in Fig. 54, to demonstrate the development of the Tenant's Cliff block slide. Upper section, prior to block sliding, with coastal erosion reaching the proposed western fault in Fig. 54. Lower section, block sliding of Lower Calcareous Grit, silty Oxford Clay and Osgodby Formation along the slip plane provided by the Cayton Clay.

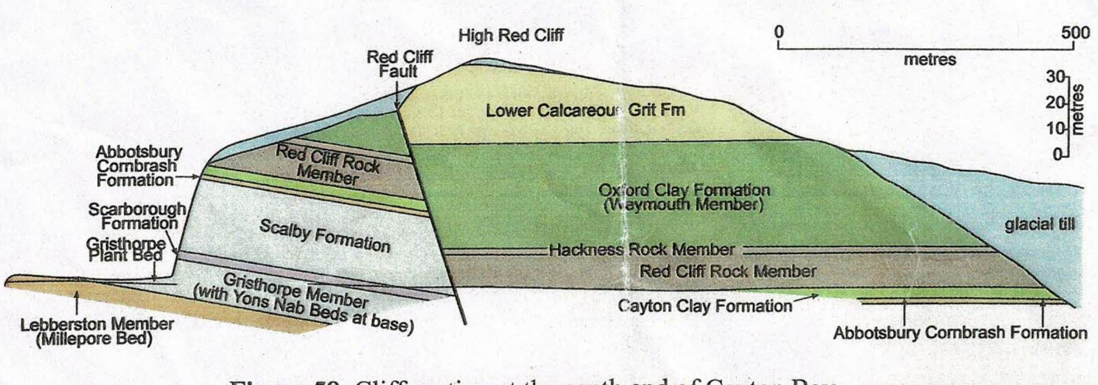
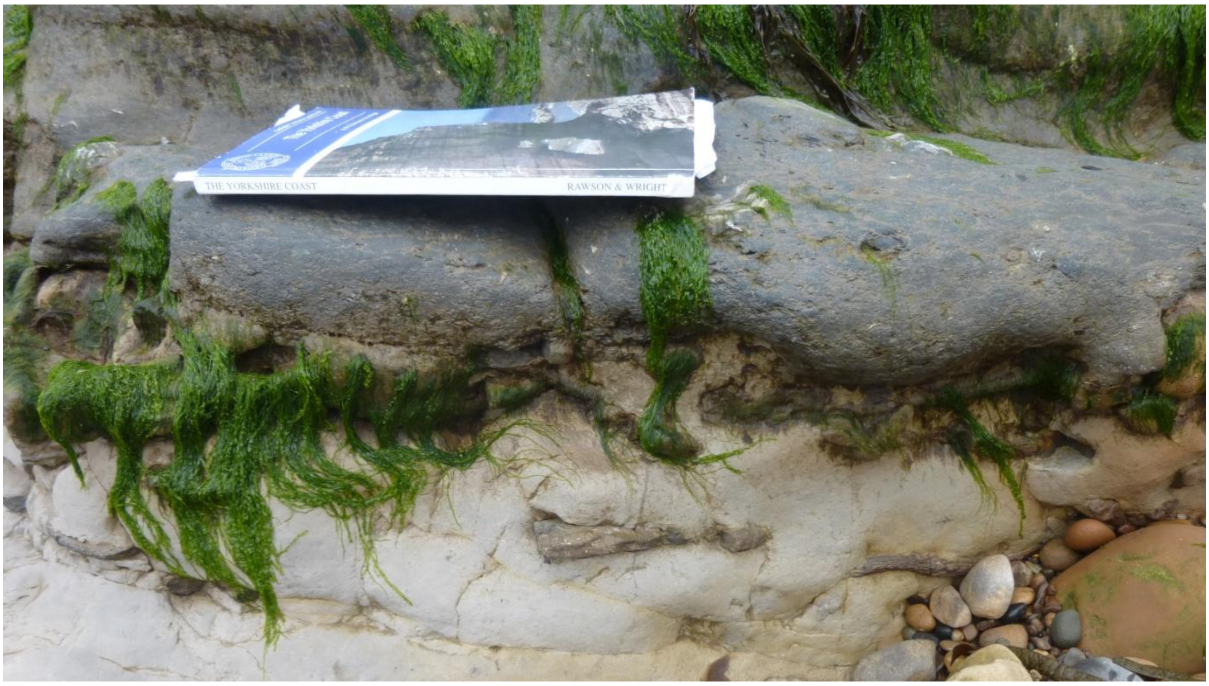


Figure 58. Cliff section at the south end of Cayton Bay.

Oxford Clay ay Tenants Cliff

Redcliff

Cornbrash. Full of oysters. Tolerant of variable environments. Burrowing animals went down into the underlying Scalby beds. Cornbrash forms a reef on the foreshore (dark grey). Underlain by non marine beds of the Scalby Fm (buff). Refuge burrows in the scalby formation can be seen to be lined with the clays from the Cornbrash



Above the Cornbrash is the Cayton clay and in the cliffs we see the Redcliff Rock member. These round erosional features are seen to line 1 horizon along the cliff.

The vertical planes are caused by stress in the rock, sandwiched between 2 faults.

The Lower part of the Redcliff Rock is a soft sandstone, fine grained, near 2/3 way up becomes tough ironstone - chamosite, ooids and oysters with occasional ammonites.

The Oxford clay here is 30m thick and marks the maximum marine incursion during the Oxfordian. Above is the Lower calcareous Grit at very top.. The Calcareous grits here do not yield ammonites despite that we are only 1/2km away from those along the beach to the north.

Speeton Cliffs (Postcode YO14 9SH)

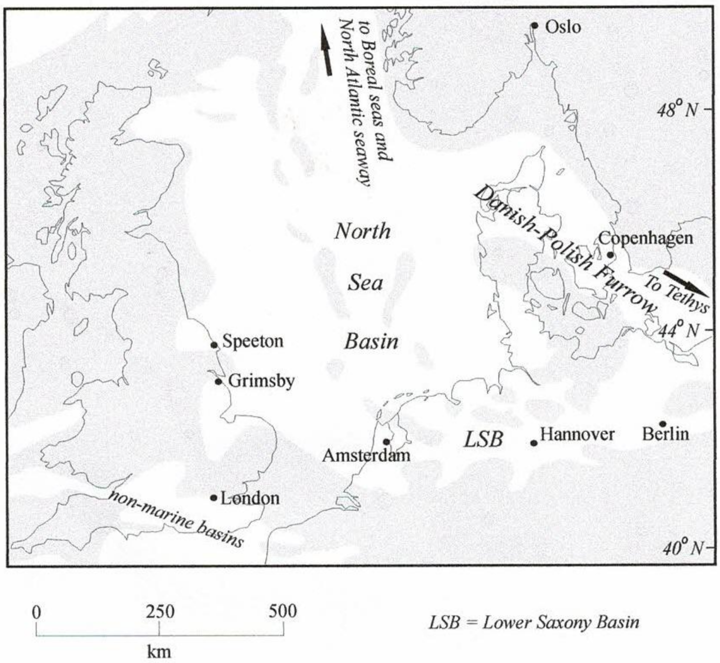
STAGE	BIOZONE	LITHOSTRATIGRAPHY		FORMER DIVISION
66 Ma MAASTRICHTIAN				
72 Ma CAMPANIAN	*Belemnitella mucronata* s.l.	White Chalk Subgroup	Rowe Formation	Upper Chalk
	Gonioteuthis quadrata		— ? —	
84 Ma	*Sphenoceramus lingua*		Flamborough Chalk Formation > 300 m	
SANTONIAN	*Marsupites testudinarius*			
86 Ma	*Uintacrinus socialis*			
CONIACIAN	*Hagenowia rostrata*		Burnham Chalk Formation 150 m	
90 Ma	*Micraster cortestudinarium*			
TURONIAN	*Sternotaxis plana*			
	Terebratulina lata		Welton Chalk Formation 53 m	Middle Chalk
94 Ma	*Mytiloides* spp.			
CENOMANIAN (pars)	*Sciponoceras gracile*			
	Holaster trecensis	Grey Chalk Subgroup	Ferriby Chalk Formation 33m	Lower Chalk
	Holaster subglobosus			

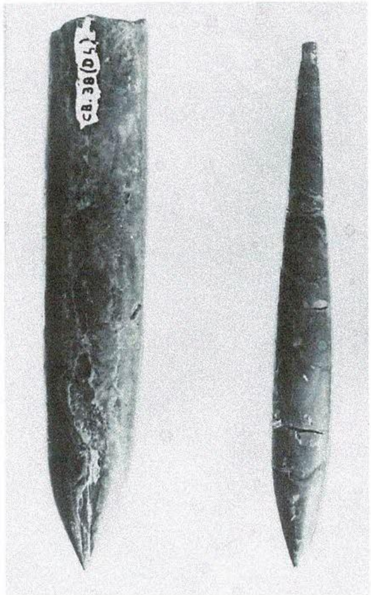
Subdivision of the Upper Cretaceous

	STANDARD STAGE/SUBSTAGE			LITHOSTRATIGRAPHY		
	CENOMANIAN (pars) 101 Ma			Hunstanton Formation ("Red Chalk") 33 m		
LOWER CRETACEOUS	ALBIAN		M-U			
	113 Ma		L	Speeton Clay Formation c.109 m	A beds c. 12 m	UA1-UA4 c. 7 m
	APTIAN		U			LA1-LA6 5 m
	125 Ma		L		B beds c. 46 m	upper B beds c. 9 m
	BARREMIAN		U			cement beds c. 10 m
	129 Ma		L			LB1-LB6 27 m
	HAUTERIVIAN		U		C beds 39 m	C1-C7 mid 29 m
	133 Ma		L			C7 mid-C11 10 m
	VALANGINIAN		U		D beds 12 m	D1-D2D 1 m
	140 Ma		L			D2E-D8 11 m
	BERRIASIAN	REGIONAL STAGE: RYAZANIAN	U			
	145 Ma		L			
U. J.	TITHONIAN	VOLGIAN		(Kimmeridge Clay Formation)		

Subdivision of the Lower Cretaceous

THE SPEETON CLAY





Acroteuthis
D beds

Hibolites
C beds

Marine clays of Early Cretaceous age (145-100 million years ago) extend from North Germany across the North Sea Basin to the Yorkshire coast. In Yorkshire they form the Speeton Clay Formation, which crops out along the lower part of the Wolds scarp and forms low cliffs along the south-eastern part of Filey Bay, in the Parish of Speeton. Here the formation rests on the Kimmeridge Clay Formation, the boundary being marked by a 10 cm thick phosphatic nodule band which was mined from the cliffs in early Victorian times to provide a fertiliser.

Although the formation is very thin at Speeton (only about 109 m), it spans almost the whole of Early Cretaceous time, though with some significant breaks in the succession. Despite this limitation, Speeton is a key section for understanding the Early Cretaceous evolution of NW Europe - especially its climate and its marine life. Fossils are common at many levels, particularly belemnites and ammonites. Scattered ichthyosaur vertebrae are not uncommon, but more complete vertebrate remains are rarely found. Among microfossils, the clays abound with ostracods, foraminifera and nannofossils.

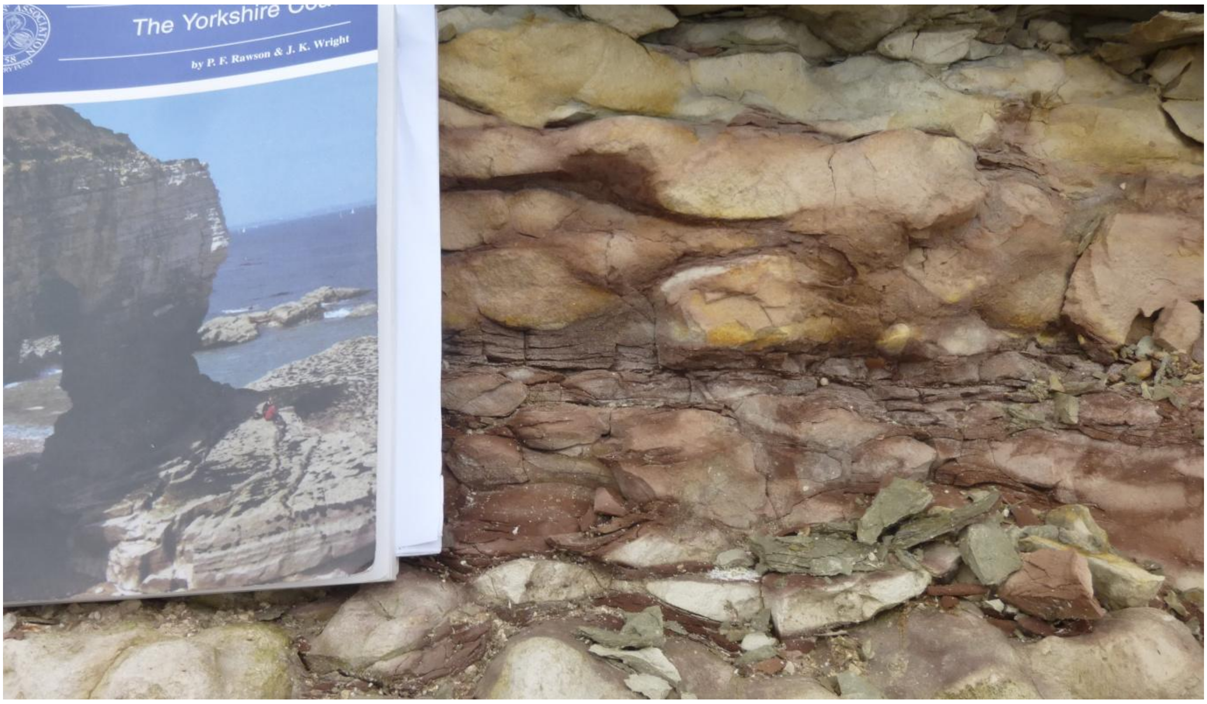
How many fossils are found depends very much on the state of exposure. The low clay cliffs are constantly changing due to a combination of landslip, cliff falls and erosion by sea and rain. And the higher beds are almost completely hidden beneath major landslips. In addition the clays are folded – a distant reflection of the Alpine orogeny. So it is hardly surprising that in 1891 J. F. Blake wrote that the section appeared "a wild and tumbled slope of clay, in which at first sight it is hopeless to make out any order". But a few years earlier, during the 1880s, a young Bridlington businessman, George William Lamplugh, had cracked the long-standing problem. He realised that he could use the belemnites to divide the sequence into four main units, which he called the A (top), B, C and D beds. He also recognised finer, lithological, divisions, especially in the D (D1-D8) and C (C1-C11) beds. After his pioneering work was published in 1889 Lamplugh left his business to become a lowly fossil collector for the Geological Survey – but ended up as Assistant Director!

On entering the beach from the car park at Reighton Gap we see that the cliffs are dominated by boulder clay (till). We walked right (South) to the chalk cliffs then made our way back along the beach. (This was a safety precaution against an incoming tide).

The boulder clays were called a "wild and tumbled sloe" as there was no observable order. Underlying the beach deposits (and the boulder clay) is the Kimmmeridge clay

Hunstanton Fm (Red Chalk). Top of early Cretaceous. Seem in beach as walking south.

Speeton Cliffs. Chalk The Hustantion formation straddles the Albian Cenomanian periods. On foreshore believed to be Albian but in the cliffs it is Cenomanian.


The Yorkshire Coa
by P. F. Rawson & J. K. Wright

The depositional environments fluctuated as evidenced by the intermittent deposits of red chalk as seen at different levels in the cliffs. The boudinage effect probably a result of the calcareous clays in these chalks.. Further up the cliffs the chalks become cleaner and more massive.

As we move back along the beach the red chalks rise in the cliffs and the underlying Speeton Clays start to appear. Close to beck.
L Cretaceous marine throughout.
Speeton on the western margin of the N sea basin. Landmass between Yorkshire & Lincolnshire on one. SE basins on the other. Links to north (boreal, and also to a seaway to the west of Britain (via the north-see map above), and a link to the E - Danish Polish Furrow. Evidence for the north Atlantic seaway comes from a borehole (Jason Jeremia) containing a Tethian Belemnite in the Barremian , also a level with a lot of Tethian nanofossils. This was found to be more abundant the further north investigation went.
The Danish Polish Furrow was closed in the Barremian so these Tethian fossils could not come from that direction. The Speeton clay fauna and flora are a mix of predominantly Boreal (northern) and periodic Tethian influence. as seen in the belemnites. Speeton Clay sequence very thin 109m (whole of early Cretaceous time - some breaks in the sequence.. George William Lampoon? of Bridlington worked out that there were a sequence of belemnites. Came up with the A, B, C & D beds.. Subdivided the beds eg D1-D8, C beds from C1 to C11. His A beds were at the top (youngest) the reverse of todays practice.. Similarly his C1 is at the top not at the bottom.. His work was so good that it could be followed.

The Speeton B beds are black with ammonites and belenites, plastic, soft, unstructured, Aptian/Albian in age. Marine anoxic environment

Cementstones - part of Speeton Clay B beds seen at Speeton Beck. Concrete blocks and pill box on the foreshore
Located on the foreshore. Round in cross section, forming bands within the Speeton Clay.

There are a total of 7 bands of Doggers in the cementstones unit. These were used as a local source of cement. Initial division of the B beds were Lower B, Cement beds and Upper B.. Lower B subdivided into zones 1 - 6. Further along the beach we cross a fault and the formations are repeated but not always available to view.

Ammonite in the Speeton B

The Funeral / exhumation of the ammonite

Speeton Clay pushed out over the top of Glacial boulder clay.

Past the fault. Speeton Clays C beds
Rarely seen today since they have ceased removing gravel from the beach
Brown weathering bands in the cliff (C7a at top, C7f at bottom) below is C8 marked by nodules, but a huge change in the ammonite faunas. Below the ammonites derived from the south, at change get an unfurling ammonite endemic to this basin is next and above have boreal ammonites. Big changes). Such in depth work shows haw much the faunas change.

At the outcrop we see yellow sulpher derived from iron pyrites. Thin banded B pyritic horizon suspected to be volcanic in origin

The boundary of the Kimmeridge clay and the Speeton clay is marked by Coprolite beds (Bed D of the Speeton Clay)..

Brown is wafer thin hard shales overlying a nodular phosphatic (coprolite) layer. This is the base Createceous. Below this is a 10mm year gap and the black kimmeridge clays. In the north Sea there was continuous sedimentation	Coprolite / nodular phosphatic layer. Speeton D beds
	

Kimmeridge Clay. Organic rich. Folding
Ice coming from n to south. Suspected the ice did some folding - maybe
Most probably all Alpine folds squeezed between harder rocks above and below.

10cm dark brown horizon at the top - phosphate rich horizon

Glacial Deposits
Late Devensian, . Missed n N Yorkshire moors, Missed the chalks of the Yorkshire Wolds
River Derwent course shifted southwards into the Humber
Ice came in from the north.
Plenty of rhomb porphyry which has come from Scandinavia (from Oslo Graben). Further south , whole of Holderness covered by glacial till.. All the bays have solid rocks at the margins but glacial till down to beach level

Flamborough Head Postcode YO15 1AN
Selwicks Bay

Footpath to north of lighthouse at Flamborough Head leading to Selwicks Bay

On the southside of the bay the chalk bedding, highlighted by cherts and flints , is gentle.

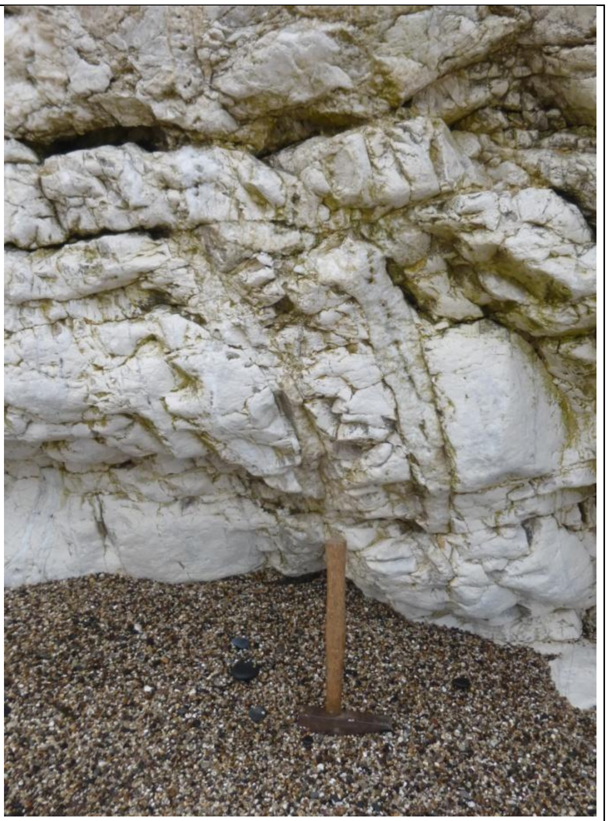
In the inside of the bay we see the lower beds are still horizontal whereas the upper beds show deformation.

At this promontory within the bay we see severe folding effects, fault breccias and calcite crystals infilling fractures

Fault Breccia to left

Fractures in filled by calcite crystals

Above and below; calcite filled stress fractures

Sinusoidal thick calcite lines lining the fold fractures

Panoramic shot of the fault zone part of the Howardian Flamborough Fault Belt

Thrust zone ?

Fold axis over thrust plane, just to north of stairs with a roll over

Moving to the north we see the beds retuning to gentle dips with some normal faulting

High Stacks

This itinerary given in the GA guide is no longer accessible due to erosion

Glacial till and gravels cover the top of high stacks

Little Thornwick Bay

This lies to the north of the cafe and is no longer accessible due to coast erosion.

Great Thornwick Bay

Access is via steps at the southern end of the bay near the sign

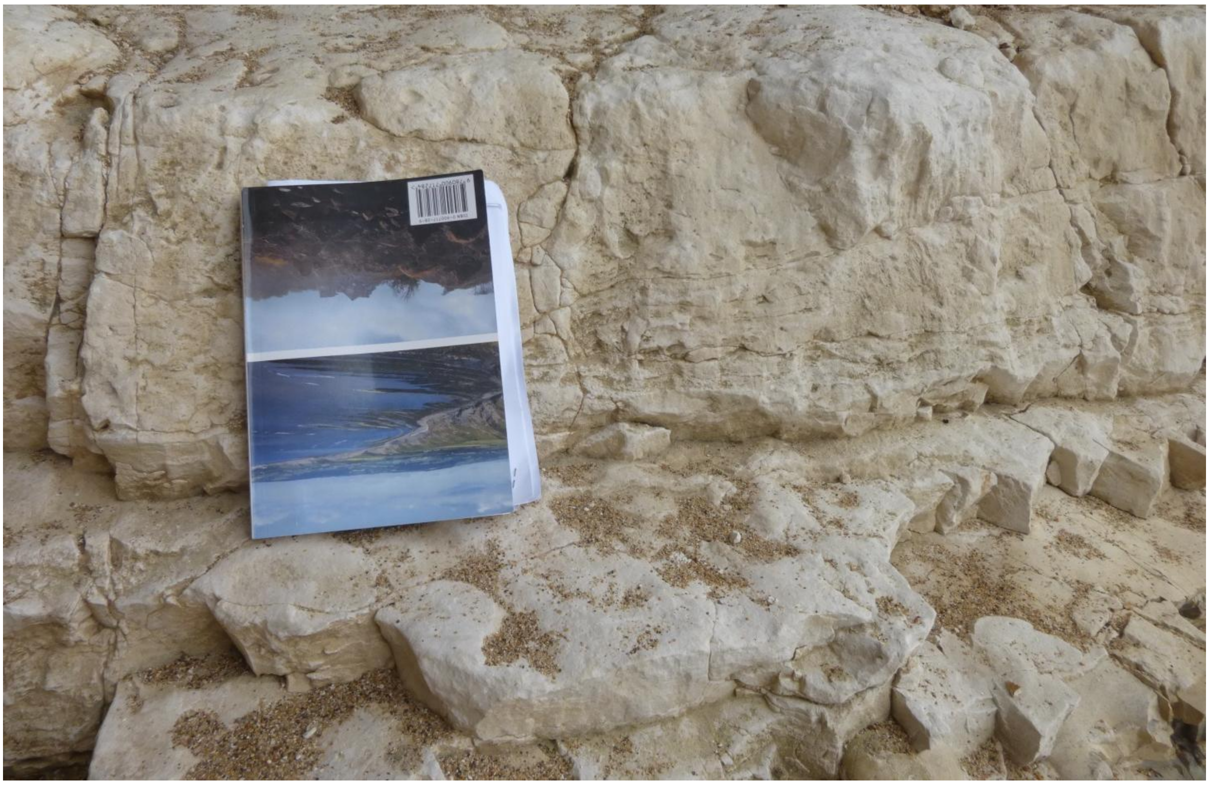
Thornwick Nab promontory at the north end of the bay. Channel features within the chalk can be seen (below)

Thornwick nab from the south end of Thornwick bay

North Landing

	At the north end of the bay is a cave. The lower chalk beds are thinly bedded with lots of chert bands. Those above are more massive and display current bedding features

Fine current bedding can be seen in these chalks (above and below)



Appendix
carnelian
a semi-precious stone consisting of a dull red or reddish-white variety of chalcedony (quartz

Septarian Nodules are concretions that have a series of radiating cracks, crossed by a series of concentric cracks to form a “turtle-back” appearance. They are also known the "Dragon Stone Healing Stone."

https://en.wikipedia.org/wiki/Flamborough_Head

Flamborough Head is a promontory, 8 miles long on the Yorkshire coast of England, between the Filey and Bridlington bays of the North Sea. It is a chalk headland, with sheer white cliffs. The cliff top has two standing lighthouse towers, the oldest dating from 1669 and Flamborough Head Lighthouse built in 1806. Wikipedia

Geology[edit]

Flamborough Head

Flamborough Head in the East Riding of Yorkshire

The headland is the only chalk sea cliff in the north. The coastline within the SSSI has strata from the upper Jurassic through to top of the Cretaceousperiod, and the headland exhibits a complete sequence of Chalk Group North Sea Basin strata, dated from 100 to 70 million years ago. The various chalk deposits are known as the Ferriby, Welton, Burnham and Flamborough Chalk.[7] The dramatic white cliffs contrast with the low coast of Holderness to the south, where the chalk is deeply buried and the glacial boulder clay above erodes very readily.[8] The chalk cliffs have a larger number and a wider range of cave habitats at Flamborough than at any other chalk site in Britain, the largest of which are known to extend for more than 50 metres from their entrance on the coast. There are also stacks, natural arches and blowholes. The site is identified as being of international importance in the Geological Conservation Review.[7]

Battle of Flamborough Head 1779[edit]

A Franco-American squadron fought the Battle of Flamborough Head with a pair of Royal Navy frigates in the American Revolutionary War on 23 September 1779. In the engagement, USS *Bonhomme Richard* and *Pallas*, with USS *Alliance*, captured HMS *Serapis* and HM hired ship *Countess of Scarborough*, the best-known incident of Captain John Paul Jones's naval career. The toposcope at the lighthouse commemorates the 180th (1959) anniversary of the battle.

North Landing, Flamborough Head, c. 1880. Photo National Maritime Museum, ID: G2381

Danes Dyke[edit]

Danes Dyke is a 2-mile (3.2 km) long ditch that runs north to south isolating the seaward 5 square miles (13 km^2) of the headland. The dyke and the steep cliffs make the enclosed territory and its two boat launching beaches, North and South Landings, easily defended. Despite its name, the dyke is prehistoric in origin, and Bronze Age arrowheads were found when it was excavated by Pitt-Rivers in 1879. It is a Local Nature Reserve.[11][12]

Late Cretaceous

Maastrichtian – (66-72.1 Mya)

Campanian – (72.1-83.6 Mya)

Santonian – (83.6-86.3 Mya)

Coniacian – (86.3-89.8 Mya)

Turonian – (89.8-93.9 Mya)

Cenomanian – (93.9-100.5 Mya)

Early Cretaceous

Albian – (100.5-113.0 Mya)

Aptian – (113.0-125.0 Mya)

Barremian – (125.0-129.4 Mya)

Hauterivian – (129.4-132.9 Mya)

Valanginian – (132.9-139.8 Mya)

Berriasian – (139.8-145.0 Mya)