3 Understanding the rocks

3.1 Evolution of the rocks and landscape

Some 280 million years ago, at the beginning of the Permian Period, Britain as we know it today did not exist. Instead the area destined to become Britain lay within a large continent known as Pangea, situated in tropical latitudes very close to the equator.

During the early Permian, northern Europe was one of the world's great deserts. Major earth movements towards the end of Carboniferous times had created mountains across what became northern England. These widespread barren uplands were gradually worn down by Permian desert erosion and up to 500 metres of Carboniferous rocks were removed. The product of this prolonged phase of erosion was a mature, gently rolling plain, probably with, in present-day north-east England, a gentle eastward slope into the subsiding North Sea Basin. This plain became the Carboniferous-Permian unconformity, a surface of generally low relief on which the Permian Yellow Sands Formation was deposited. When the desert environments formed this part of England lay near the western margin of a major inland drainage basin, the floor of which was perhaps 250m below world sea level.

In the late Permian continental extension opened a seaway which flooded low-lying ground and formed inland drainage basins, the so-called Bakevillia and Zechstein seas, approximately in the areas now occupied by the Irish and North seas (Figure 3). The flooding could have taken as little as six years. With a sill or barrier remaining close to normal world sea level, the basin was particularly sensitive to relative sea-level changes and apparently became isolated from time to time when sea level fell. Similar to large enclosed seas of today, such as the Mediterranean, a tidal range of 1m or less was probable.

Straddling latitude 30° north during Late Permian times, the sea was subjected to high evaporation rates. As it was connected to open ocean to the north by a narrow shallow seaway, changes in global sea-levels affected the rates at which incoming sea-water could replace that lost by evaporation. The climate was hot and dry, possibly equivalent to that around the present Persian Gulf. During episodes of high global sea-level, recharge rates through the narrow seaway were high, and so the salinity levels of the Zechstein Sea were normal and limestones were deposited in and around its margins. When global sea-levels fell, the amount of water flowing through the sea-way was significantly reduced, leading to elevated salinity levels and the formation of extensive evaporite deposits (particularly anhydrite ($CaSO_4$) and halite (NaCl)). Repeated rise and fall of global sea-level resulted repetitive depositional cycles. For a long time, and in comparison with the German sequence, five cycles of carbonate to evaporite deposition were recognised, these are known as the Zechstein cycles. A more recent and plausible interpretation recognises seven sequence stratigraphical cycles with evaporite deposition related to low sea levels (lowstands) and carbonate deposition related to high sea levels (highstands).

No early Permian terrestrial sediments in north east England have provided evidence of contemporary life but it is hard to believe that the area was totally lifeless when other apparently equally inhospitable parts of Britain bear clear traces of a range of organisms including carnivores; an equally diverse range of specialized organisms probably inhabited the northeastern desert.

3.2 Yellow Sands Formation

The Yellow Sands Formation consists mainly of weakly cemented, yellow fine- to medium-grained, well-sorted sands or sandstone of wind blown origin. Beautifully rounded and frosted "millet seed" grains are abundant in most samples of the Yellow Sands. At outcrop the sands are typically bright yellow, due to a thin coating of limonite on many of the grains, although patches of white or light grey sand can also be seen in large sections. At depth, below the zone of oxidation, the sands are blue-grey and pyritic. The sands are normally incoherent and lack any cementing material other than limonite, but some beds, the so-called 'sand rock', contain a high proportion of carbonate. The uppermost part of the Yellow Sands, lying immediately below the Marl Slate Formation, is also characteristically cemented in this way. The name

Yellow Sands was first given by Hutton in 1831 following pioneering work by Sedgwick. The western and southern edges of the Permian desert in which the sands were being deposited were fringed by rocky uplands. Breccias derived, from these uplands, and deposited at the same time as the Yellow Sands are present in the south of the area.

The Permian Yellow Sands crop out intermittently along the base of the Magnesian Limestone escarpment and dip to the east beneath the limestone. At outcrop the formation is clearly discontinuous and forms ridges of various heights. When they were deposited, the sands formed hills on the land surface and the crests of such hills have been visible in a number of exposures. The ridges, which probably represent accumulations of sand dunes, are typically between one to two kilometres wide with sand thicknesses of up to almost 70 metres and are separated by belts where the sands are thin or absent. The absence of suitable sub-surface information for much of the area makes it impossible to predict accurately where they occur, although it is generally accepted that they occur in west-south-west to east-north-east trending ridges which continue beneath the limestone for some distance. The exact nature of the dunes has been the subject of much discussion and is still a topic of research (Plate 1)

There is no independent evidence for the age of the Yellow Sands Formation, but it is generally considered to be late Early Permian (approximately 270 million years old)

3.3 Marl Slate Formation

The Marl Slate Formation is a laminated, commonly bituminous, silty, argillaceous dolomite with an unusually high concentration of metallic minerals and a distinctive fish, and more rarely reptilian, fossil fauna. It represents a rapid marine transgression that occurred when the Zechstein Sea flooded the enclosed desert basin. At outcrop it is a dark yellowish orange or yellowish brown commonly fissile rock (splits easily along bedding), but where unweathered it is hard and compact, with alternating grey and black laminae. When freshly fractured, it smells of oil. It is locally interbedded with thin beds of dolomite and dolomitic limestone.

The well-established name Marl Slate was applied to the formation in the 19th century, although in strict geological terms the rock is neither a marl, nor a slate. The Marl Slate in places includes rounded sand grains and minerals such as sphalerite, galena and chalcopyrite. It has been suggested that some of the fish and other organic remains in the sequence may have been a source of the mineralisation that was taking place at the same time.

The Marl Slate is well known for its fauna of fossil fish. It has also yielded important fossil reptiles and plants. Permian fossil fish faunas are very limited in number and distribution world wide. Relatively well-preserved and locally numerous examples of fossil fish from the Kupferschiefer of Germany attracted attention early in the 19th century. Those in the Marl Slate of north-east England were discovered at about the same time and were described a little later. In the past well-preserved specimens were collected from localities such as the Ferryhill Gap and from quarries along the escarpment and there are internationally important collections of the fossils in numerous museums. The quarries south of Middridge have been the source of the best-preserved Permian plants found in England (Plate 2) and (Plate 3)

3.4 Raisby Formation (formerly Lower Magnesian Limestone)

This lowest division of the Magnesian Limestone includes rocks which range in composition from yellow or cream dolomites to almost pure, grey limestones, though the latter are rare. Three main lithological units distinguished by colour, bedding thickness, texture and compositional variations can be recognized in many areas. The middle unit is the one most commonly seen; it is a sparingly fossiliferous hard rock with a characteristic mottling rarely found in other parts of the Magnesian Limestone. Lower units of the Raisby Formation are more regularly bedded and, on the whole, slightly coarser grained. Laminated argillaceous layers, commonly of brown clay, are present especially near the base of the sequence. Fossils are rare in the upper unit, but are locally common in the lowest unit. Calcite-lined cavities (or 'vugs') are characteristic of many sections and may represent the replacement of original evaporite minerals. The formation has only a narrow surface outcrop, which is mainly free of, or only thinly covered with, superficial deposits. It commonly forms an escarpment 30 to 60 metres high, but it extends beneath younger strata to the eastern edge of the county. The Raisby Formation is a major source of aggregate (Plate 4).

The Raisby Formation was deposited on a shelf sloping gently eastwards into the Zechstein Basin. During deposition of the limestone this slope was the cause of instability, possibly related to earthquakes, and at times there were minor submarine "avalanches" or 'slumping' of partly lithified sediment which moved downslope. The chaotic and often contorted rock structures produced by such slumping can be seen in the rocks of the Raisby Formation.

The type Section is in Raisby Quarries (now known as Coxhoe Quarry) Nr. Cornforth, County Durham.

At Thickley Quarry the lowest beds of the formation, which comprise thick-bedded dolomitic limestones, are overlain by fossiliferous limestone texturally similar to those at Raisby Hill Quarry. At Raisby this unit is 30 metres thick; at Thickley it is only 1 metre thick.

3.5 Ford Formation (formerly Middle Magnesian Limestone)

The Ford Formations displays a varied sequence of dolomites deposited in three distinct environments: shelf-edge reef that separates a broad belt of back-reef and lagoonal beds to the west from a belt of fore-reef talus aprons and off-reef beds to the east.

The barrier reef of the Ford Formation is perhaps the best known feature of the Durham Upper Permian. Most of the reef consists of massive unstratified rock which in places is at least 100m thick. It is composed predominantly of the skeletons of marine animals known as bryozoans along with many shells, some sea urchins and rare corals. Dolomites and dolomitic limestones of reef-facies crop out in a sinuous belt extending south-south-eastwards from Down Hill near Sunderland towards West Hartlepool. This has locally been much more resistant to erosion than adjacent bedded rocks and in places forms distinct topographic features such as Beacon Hill near Easington owing to the framework structure of the reef rocks being more resistant to erosion than the surrounding limestones and dolomites (Plate 5)

It is not always easy to distinguish where the Raisby Formation ends and the Ford Formation starts.

Rocks of the lagoonal type occupy most of the Ford Formation outcrop. They consist of a thick series of granular, oolitic and pisolitic carbonate rocks which are almost universally dolomitized. In most of these rocks the dolomite has recrystallised into platy crystals up to 5 mm across which give rise to a texture referred to as 'felted' and which is virtually confined to these lagoonal beds within the Ford Formation.

One of the largest exposures of late Permian reef-rocks in North-East England is at Hawthorn Quarry. An unusual algal-laminated dolomite, known as the Hesleden Dene Stromatolite Biostrome, overlies the top of the reef at Hawthorn Quarry. It has a boulder conglomerate at its base. The biostrome is named from its occurrence further south in Hesleden Dene and it is also very well exposed at Blackhall rocks.

3.6 Roker Dolomite Formation

The Roker Dolomite Formation includes the Concretionary Limestone, often considered as a separate unit in its own right. The two are best regarded as complementary and joint representatives of Zechstein Cycle 2 carbonates. They were formerly included as part of the Upper Magnesian Limestone along with what is now recognised as the Seaham Formation.

The Concretionary Limestone is about 100 m thick in the Sunderland area but thins southwards and dies out to the south of Seaham. It is by far the most varied carbonate formation of the English Zechstein sequence. Its best known feature is a range of calcite concretions which are spectacularly developed in the Sunderland area, most notably in the 'Cannon-ball Rock' and have been described as 'the most remarkable patterns in sedimentary rocks anywhere in the world'. Concretions are present at all levels but are abundant around Sunderland only at two levels, about 27 m and 55m above the base.

The lower beds are often so laterally variable that exact correlation of adjacent sections is difficult. The formation is composed mainly of thinly bedded granular dolomites of silt- to fine- sand grade, but the rock is locally recrystallised and in some places contains many concretions. When freshly broken these rocks usually smell strongly of oil. In all onshore areas the Concretionary Limestone has foundered and lower beds have suffered varying degrees of collapse brecciation due to the solution of the underlying Hartlepool Anhydrite.

Detailed correlation between exposures is difficult, the only exception being the widespread; 'Flexible Limestone' which is a thin relatively distinctive marker bed slightly below the middle of the formation. It is a thin laminated unit which locally can split into flexible paper-thin sheets. Plant debris is common within the Flexible Limestone and it has yielded fish remains at Fulwell and Hendon. The Concretionary Limestone is exposed in the cliffs from Trow Point to north of Seaham, and in quarries inland, most spectacularly at Fulwell. In coastal exposures the Concretionary Limestone falls into a lower group of beds containing abundant concretionary structures and an upper group in which such structures are generally absent (Plate 6)

Where the Concretionary Limestone is not developed, the Roker Formation consists of thin-bedded and flaggy cream finely granular dolomite and oolitic dolomite. It may in part be a shallow water equivalent of the Concretionary Limestone. It crops out mainly at the type locality, at Hartlepool and north of Seaham. Rocks of the Roker Formation also form a series of isolated outcrops between slipped masses of glacial deposits for about 410 metres on the north side of Dene Mouth [NZ457 408]. Inland it is exposed on the south side of Castle Eden Burn with limited exposures in Nesbitt Dene and Hardwick Dene.

3.7 Seaham Residue

The Seaham Residue is interpreted as the insoluble remains of the Fordon Evaporites a mixture of salt (halite) and anhydrite with dolomite. At the type locality just north of Seaham Harbour it is a heterogeneous mass, up to 9 m thick, of angular blocks and fragments of limestone and dolomite in a clayey dolomite matrix. The residue is also exposed south of Blackhall Rocks.

3.8 Seaham Formation

Although itself highly variable, the Seaham Formation is the most uniform of the Late Permian carbonate units. It consists predominantly of thin-bedded limestone with some dolomite, but in places may resemble the Concretionary Limestone. Along with the Roker Dolomite Formation and Concretionary Limestone, the Seaham Formation was once considered to be part of the Upper Magnesian Limestone sequence.

The formation carries a unique and distinctive diagnostic assemblage of alga and bivalves. Small tubular, stick-like remains of the probable alga *Calcinema permiana* are present in great abundance. The Seaham Formation is exposed mainly in coastal cliffs at Seaham, but is also patchily exposed inland in Seaham Dene. Its type exposure is in the sides of the dock at Seaham Harbour (Plate 7)

3.9 Rotten Marl

The Rotten Marl is a dull dark red-brown silty mudstone, which in borehole cores contains scattered halite crystals and a network of veins of fibrous halite and gypsum. It occurs in situ only south of the area and offshore. It was exposed with the filling of a breccia pipe, or fissure filling, at the top of the north wall in Seaham Dock, but has now been largely obscured.

3.10 Quaternary deposits

Quaternary deposits are sediments that were deposited during the Quaternary episode of earth history, between 2.5 million years ago and the present day. The Quaternary is divided into two periods: the Pleistocene Period dates from 2.5 million years ago until 10 000 years ago and the Holocene continues to the present day. For a long time these deposits were collectively referred to as 'drift', but are now more commonly referred to as 'superficial deposits' to separate them from the 'bedrock' which used to be termed 'solid'.

Global cooling caused the Quaternary Period to be a time dominated by a series of 'ice ages' when the climate oscillated between colder (glacial) and warmer (interglacial) stages. Successive glaciations advanced across the landscape, sourced from the upland areas of Scotland, Wales, northern England and Scandinavia and formed extensive ice sheets that were over 1 km thick in places. Unfortunately, the nature of glaciations is that their imprint on the landscape is largely destroyed by any subsequent glacial advance, so most evidence for glacial advance in northern Britain dates from the most recent cold period, the Late Devensian, from about 25 000 to 10 000 years ago. The effects of persistent freeze-thaw action in ground which was often very deeply frozen, and the deposition of a variety of glacial sediments further modified any pre-existing landscape. The deposits of the Holocene Period reflect erosion and deposition in a varied succession of environments during much milder climatic conditions.

Quaternary deposits and their interpretation provide a wealth of information on the environments of the recent geological past. Information from glacial landforms and the nature and morphology of glacial deposits is essential to understanding these climatic conditions and may provide valuable insights into likely future environmental changes related to global warming.

Details of the Quaternary deposits are given in the geological survey memoirs for the area (Smith, 1994; Smith and Francis, 1967) and, more recently for the south of the area by Young (2008). The Quaternary Research Association Field Guide to the 'Quaternary of North-east England' (Bridgland et al., 1999) contains a wealth of useful and up-to-date information, including illustrations of key sections.

Glacial deposits

There is very little evidence of the earlier part of the Quaternary in north-eastern England. The most probable reason for this is that the later glaciations reworked the material deposited during earlier glaciations and interglacial intervals. However, two sites on the Durham Coast provide evidence of the presence of Quaternary sediments that predate the last glaciation. (Figure 4) illustrates the relationship of the glacial deposits found on the Durham coast.

Fissure fills in the Magnesian Limestone coastal cliffs represent the oldest known Quaternary deposits in the area, likely to have formed in the Lower and Middle Quaternary. The fissures contain a variety of boulders, fragments of rock and clay that have been forced in from above by later glaciations. A pre-Devensian till containing mollusc remains and Scandinavian erratics lies unconformably over the Magnesian Limestone bedrock at Warren House Gill about 2.5 km south of Shippersea Bay. Fossil material in some of the fissure fill from Warren House Gill and nearby Blackhall Colliery includes shells, peat, tree trunks, insects, rodent teeth and the vertebra of an elephant resembling *Mammuthus meridionalis*. Some of the fissures contain exotic rocks similar to those within the later Scandinavian Drift.

At Shippersea Bay the bevelled upper surface of the Magnesian Limestone represents the wave-cut platform on which rest the deposits of the Easington Raised Beach (Figure 5) and (Plate 8). The partly cemented sands and gravels are over 30m above the modern sea level and the deposit contains marine shells as well as pebbles bored by marine molluscs and worms. The remains of molluscan shells, which occur in the sands, indicate a temperate climate with sea surface temperatures 3–4 degrees above present temperatures. These raised beach deposits have been assigned to the Ipswichian Interglacial, indicating that the overlying boulder clays are Devensian in age. Erosion surfaces, perhaps related to post-glacial sea levels higher than the present day, and elevated by some uplift of the land, include a prominent platform up to about 0.8 kilometres wide, at about 30 metres above the present coastline between Marsden and Whitburn. This surface may be equivalent to that on which the Easington raised Beach lies further south.

The most widespread glacial deposit is Till (or boulder clay) which usually consists of a heterogeneous mixture of grey silty clay with rock fragments ranging in size from gravel and pebbles to boulders several till sequences are recognised:

Scandinavian Drift-The Warren House Till has been identified as a deposit that may have formed before the last glaciation. The deposit consists mainly of locally derived limestone but is distinctive because the erratics it contains have been matched with rocks that occur beneath the North Sea and in Scandinavia rather than with rocks present on the British mainland. The ice mass from which this till was deposited originated in Norway, crossed the North Sea and covered the coastal parts of the county, but it is unlikely that the ice travelled further inland. This glacial deposit, the oldest in the area, is found in the base of buried valleys and topographic lows, the clearest exposures of which are found on the coast at such localities as Warren House Gill.

The Lower till (The Durham Lower Boulder Clay) containing North British rocks including Lake District and Scottish rocks was deposited by the British ice sheet after the Scandinavian ice sheet retreated. It is possible that there is a complete climatic cycle between the deposition of the Scandinavian and British Drift deposits. It is generally a tough, grey or brown, sandy boulder clay, or 'till', in which occur scattered pebbles cobbles and boulders of a variety of rock types that originated outside the district. These exotic rock types, known as 'glacial erratics' mainly comprise fragments of grey limestone and dolerite ('whinstone') derived from the Pennines or south Northumberland, accompanied by scarcer and smaller fragments of a variety of rock types originating from south-west Scotland, the Cheviots and the Lake District. Many of the included boulders exhibit conspicuous scratches, or striations, resulting from the grinding of boulders against one another as they were transported by the ice

The Upper till (The Durham Upper Boulder Clay) is a red-brown stony clay that overlies both the Lower Till and the Scandinavian drift. The deposit is widespread and was deposited during the last glaciation.

In parts of the county a tripartite division in the Devensian sediments has been recognised. This consists of the Lower and Upper tills, separated by an intervening body of sand and gravel referred to as the Middle or Ryhope Sands. These deposits may have been deposited by meltwaters from the retreat of the western ice back to the Lake District and Southern Uplands. Other bodies of sand and gravel include more recent deposits overlying the upper till and locally a group of basal sands and gravels.

Various ice-contact slopes are found in the area of the Upper Till, especially between Sheraton and Hart, south of Heselden Dene (Smith and Francis, 1967, fig. 28). There is also a series of elongated or rounded ridges forming a moraine from Easington through Sheraton to Elwick.

The Pelaw Clay, which was referred to in older literature as the 'Upper Wear Clay' takes its name from the disused Pelaw Brick Pits [NZ 310 625]. It typically consists of brown to purple silty clay with scattered stones. Generally between 1 and 2 metres thick, though locally over 4 metres thick, it mantles much of the north of the area, concealing other 'drift' and 'solid' formations. It has been interpreted as a product of re-working of previously deposited glacial sediments, possibly during periglacial conditions.

The Durham Denes are features of the landscape in the eastern part of the county. These west–east orientated steep-sided coastal valleys are incised through the cover of Quaternary Deposits into the Magnesian Limestone. The 'denes' are in part glacial meltwater channels, cut rapidly by streams flowing to the North Sea at the end of the Devensian glaciation. The distinct morphology of these channels in this coastal area is due to the rapidity of the erosion.

Holocene deposits

Marine Beach Deposits are modern day accumulations of sand and shingle exposed between the high and low water marks. In addition to boulders and pebbles of Magnesian Limestone, a high proportion of the naturally occurring beach material appears to have been derived from the Quaternary deposits eroded from the cliffs. A variety of glacially transported rock types can be seen in most accumulations of beach shingle. Most prominent are boulders of Carboniferous limestones and sandstones, with smaller quantities of whin Sill dolerite, some Cheviot volcanic rocks and rocks derived from southern Scotland and the Lake District, including granites, volcanic rocks, slates and greywacke sandstones.

Storm beach deposits are accumulations of beach material built up by storms and high tides well above normal high tide level. Substantial deposits of colliery spoil at Dawdon Blast Beach and at Hawthorn Hive are, in effect, storm beach deposits, albeit composed of tipped material.

Submerged forest

Periods of reduced sea levels are recorded in the 'submerged forests' found locally around the British coastline. These typically comprise beds of peaty sediment with tree stumps in former growth position. One small example of such a submerged forest deposit is present at Whitburn. This is intermittently exposed, normally after storms have removed the overlying sand. Remains of a variety of tree species, including alder, birch, hazel and oak have been recorded, together with bones of deer and Bos primagenius (Smith, 1994). A significant exposure of peat beds with abundant wood remains is exposed in several places in the intertidal zone in Hartlepool Bay at the southern edge of the area.

Blown sand occurs as coastal dunes in the south of the area around Crimdon. The largest patches of Blown Sand are up to 2 metres thick. A small area of sand dunes, composed of wind-blown sand, lies adjacent to the coast at the mouth of the Tyne at South Shields. The dune system and golf course roughs at Hart Warren supports many species characteristic of both northern and southern British dune floras.

By their very nature, as generally weak and unconsolidated materials, there are few permanent natural exposures of Quaternary deposits within the inland parts of the district. However, continuing marine erosion ensures that the coastal cliffs provide almost continuous, though inevitably changing, sections through parts of some of these deposits. These materials are typically found in the upper portions of the cliff sections, though their instability commonly results in parts of the Quaternary succession being partially obscured due to slipping of loose material or, in places, the development of significant vegetation cover.

In addition to numerous important exposures of Permian rocks and Quaternary deposits, the Durham coast includes a number of characteristic coastal landforms:

Sea cliffs extend almost continuously along the coastline. Typically the cliff profile reflects the geological deposits exposed. The 'solid' limestones of the Magnesian Limestone generally stand as vertical or near vertical cliffs. Overlying this, a more gently inclined profile marks the exposure of a variety of Quaternary deposits, mainly till and sands and gravels. The variable erosion of sections of the cliff has produced a series of bays and headlands

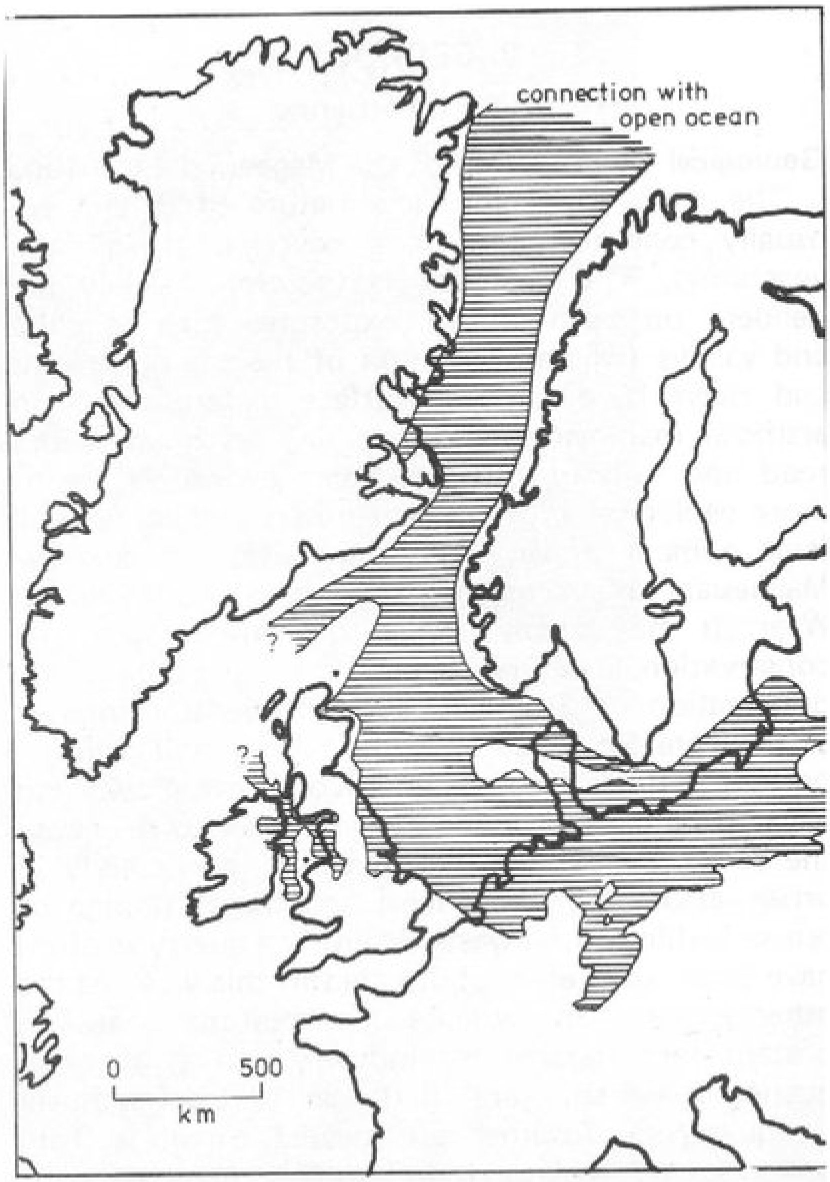
Sea stacks are residual masses of rather more resistant limestone created by the retreat of the cliff line. Good examples may be seen at Marsden Bay and Blackhall rocks.

Caves of varying sizes are present within the Magnesian Limestone at many places along the coast. They are readily developed by wave action where the limestone is highly fractured by collapse brecciation, or adjacent to joints.

Wave cut platforms are more or less flat areas of bare rock cut by marine erosion at beach level. Examples include the expanses of Magnesian Limestone exposed on the beach between Hawthorn Hive and Horden Dene.

(Plate 8) The Easington Raised Beach at Shippersea Bay.

References



(Figure 3) Map showing the position of Zechstein Sea in relation to present day geography (adapted from Pettigrew,1980). Greenland is shown in its inferred position before continental drift.

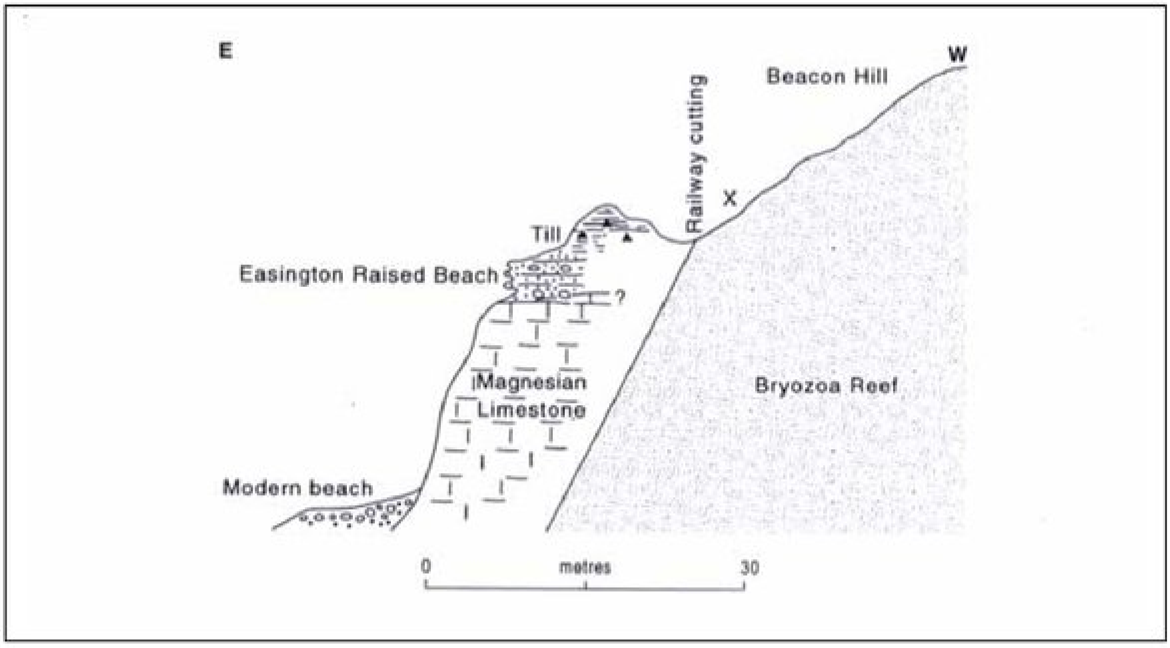
(Plate 2) Searching for fossil fish in the Marl Slate at Hepplewhites (Cold Knuckles) Quarry.

(Plate 3) Palaeoniscid fish from the Marl Slate Formation at Quarrington, found in 2006 (photo © G. Easterbrook, may be used freely, with acknowledgement, in 'not for profit' publications).

(Plate 5) Ford Formation Reff Limestone at Tunstall Hill.

(Plate 6) The Concretionary Limestone overlying slide debris in the Ford Formation at Trow Point.

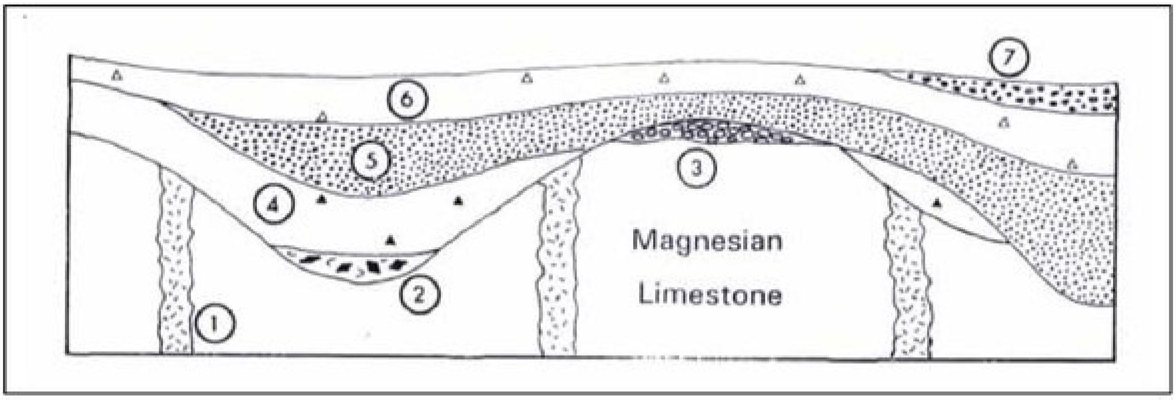
(Plate 7) The Seaham Formation at Seaham Harbour.



(Figure 5) Schematic section of coast showing Easington Raised Beach (after Bridgland et al., 1999).

(Plate 8) The Easington Raised Beach at Shippersea Bay.

(Plate 1) Yellow Sands beneath the Ford Formation Reef at Claxheugh Rock, Sunderland.



(Figure 4) Idealized section through the Quaternary sequence exposed on the Durham coast (after Bridgland et al., 1999) 1 Fissure infills; 2 Scandinavian Drift; 3. Easington Raised Beach; 4. Lower Till; 5. Middle Sands and Gravels; 6. Upper Till; 7. Upper Gravels.

(Plate 4) Dolomitic limestone of the Raisby Formation at Aycliffe Quarry .