Basildon through geological time.

What is geodiversity and why is it important?

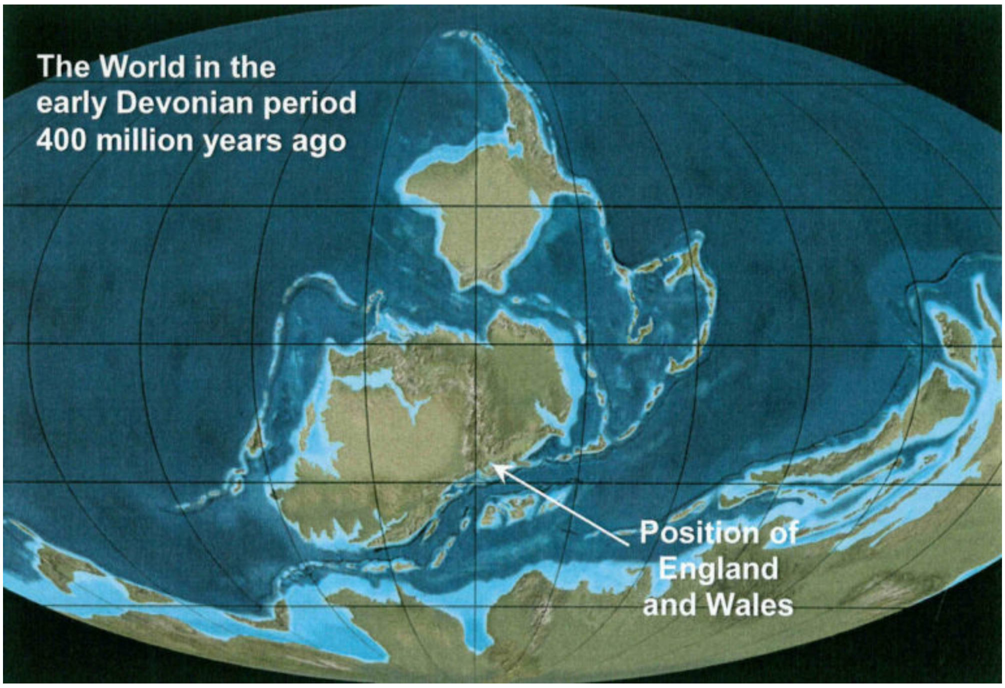
Geodiversity is an integral part of the natural environment. It is the variety of rocks, fossils, minerals, landforms and soil, and all the natural processes that shape the landscape.

The only record of the history of our planet lies in the rocks beneath our feet. Here, and only here, can we trace the cycles of change that have shaped the Earth in the past, and that will continue to do so in the future. This is true for Essex in general and south Essex including the Basildon area, where the record of climate change during the Ice Age is preserved in our quarries and coastal cliffs. The record is unique and much of it is surprisingly fragile.

Apart from the obvious benefits of providing mineral resources such as sand, gravel, chalk and clay, the diversity of the geology is what shapes the landscape, influencing soils, and in turn influencing all of our habitats and species. Geodiversity also has a cultural role to play, influencing the character of our built environment through building stones, providing inspiration to art, and helping to define where we live and our 'sense of place'. It is the link between geology, landscape, nature and people.

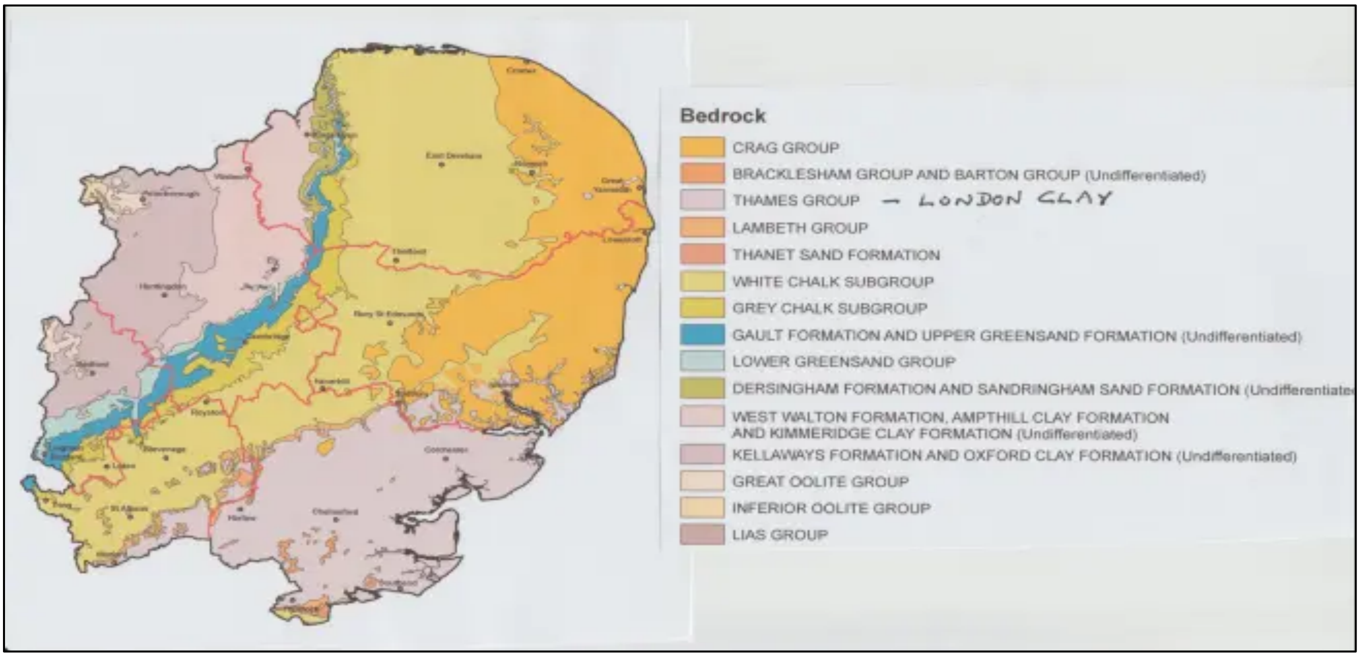
A report previously prepared by GeoEssex for Basildon Council and revised in November 2019 says that It is difficult to know where to begin with our geological story but the earliest evidence we have is the hard rocks deep beneath Essex that were formed some 400 million years ago in the Silurian and Devonian periods (part of the Palaeozoic era) and form what is known as the 'Palaeozoic basement' of Essex.

During the Palaeozoic era the Earth was a very different place. In the early Devonian period, for example (see map below), Britain was situated south of the equator and was part of a large landmass known as Laurussia (also known as Euramerica or the "Old Red Sandstone" continent). Laurussia was made up of present-day North America, Western Europe through the Urals, and Balto-Scandinavia. To the south can be seen the giant continent of Gondwana which is straddling the South Pole.



The Geology of Essex

Compared to most other parts of Britain the rocks of Essex and adjoining counties are young in geological terms. Even the oldest surface rock in Essex (the Chalk) is only about 80 million years old. Much older rocks are, however, present at depth. We have some idea about these ancient rocks because of the records of boreholes that have been sunk in search of coal and oil. The surface rocks of Essex that were formed before the Ice Age (from the Chalk to the Red Crag) are described as the 'bedrock' or 'solid' geology. Much of this bedrock geology is concealed beneath the deposits left behind by glaciers and rivers during the Ice Age. The material laid down during the Ice Age is known as 'Superficial' or 'drift' deposits.



Deserts to Dinosaurs

For a very long time (and before the age of the dinosaurs) these hard Silurian and Devonian rocks formed the surface of the land that was eventually to become Essex. During the Permian and Triassic periods Essex was a desert upland in the middle of a vast continent known as Pangea. By 200 million years ago, at the start of the Jurassic period, tropical seas had spread around this land forming a dinosaur-infested, forested island.

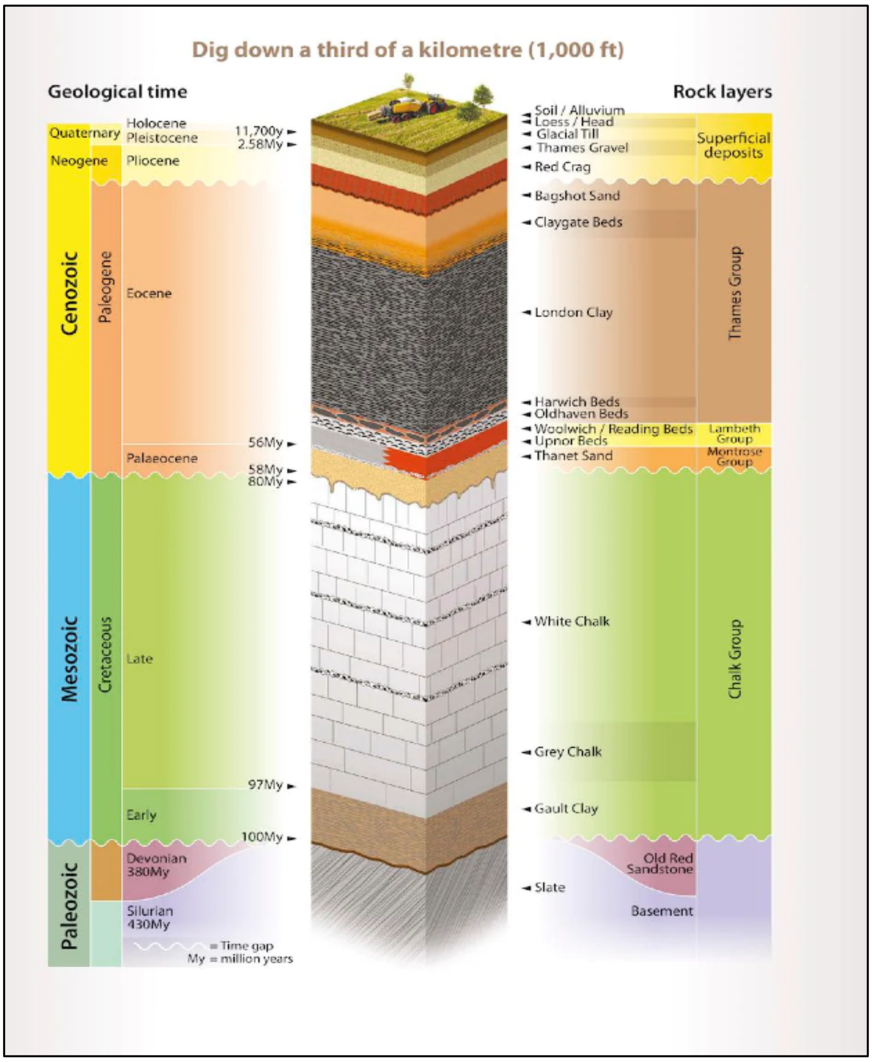
Buried Island

If you could dig down 1000 feet (300 metres) under Essex you would reach the hard rocks of that dinosaur island. All trace of forests and animals from this time have been swept away from the eroded surface of the island, so there are no large dinosaur fossils in Essex.

By 100 million years ago, in the Cretaceous period, the sea flooded across the island to spread Gault Clay and Greensand. The sea then deepened to deposit hundreds of metres of soft white limestone known as Chalk all over the island as well as much of what is now Britain.

Pebbles and Clay

The North Atlantic Ocean, which did not previously exist, began to open out to the west, the land of Essex lifted, chalk hills were worn down and flints were eroded out. Billions of these flints were tumbled on beaches to form layers of sand and beautifully-rounded pebbles across our area.



Around 50 million years ago, in the

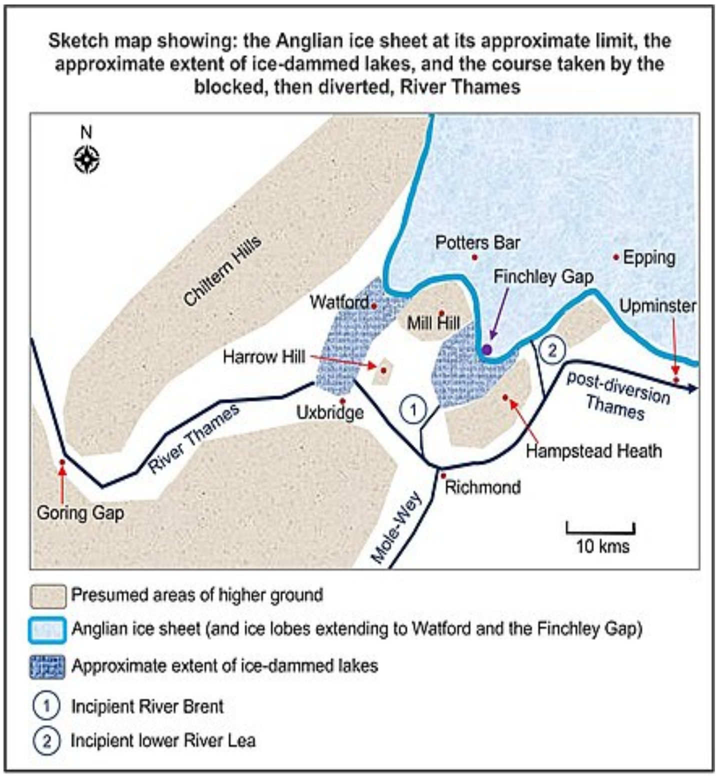
Eocene period, a deep sea fed by muddy rivers spread across what is now Essex and London depositing a great thickness of clay known as London Clay on the sea floor, together with the remains of many plants such as palms and cinnamon, and animals including birds, sharks, turtles, and tiny horses. Atlantic volcanoes poured their ash into this sea.

The Alps and the Thames

Colliding continents pushed up the Alpine mountain chain, bending the crust to form the vale of the Thames river system through mid-Essex. About 2.4 million years ago offshore sandbanks formed red shelly sandstone layers across north Essex known as the Red Crag.

Global cooling led to the Ice Age (the Pleistocene epoch), with many warm periods such as the one we are in right now, which is known as the Holocene. As the sea retreated, the ancestral River Thames spread a succession of flint-rich river gravels across the middle of Essex, through Harlow, Chelmsford and Colchester, and out across the area where the North Sea is now.

Ice and people cover Essex



During an exceptionally cold stage 450,000 years ago a gigantic ice sheet covered most of Britain and Essex as far south as Hornchurch. The moving ice diverted the Thames towards its present day course and dumped its load of boulder clay, or till, on top of these old Thames gravels.

During the past million years of the Ice Age, there have been numerous cold and warm stages and humans have migrated to and from Essex, together with the animals they have hunted. They have left thousands of flint tools and tool-making debris on the banks of the ever-changing Thames and its tributaries.

During the latter part of the Cretaceous period, around 80 million years ago, sea level is thought to have been over 150 metres higher than today. Much of the land which was later to form Britain was covered by sea. In this marine environment, thick deposits of Chalk were laid down.

From the early Palaeocene (from around 65 million years ago), much of what is now Britain emerged above sea level. The maximum uplift occurred in the north-west, with a regional tilt towards the east and south-east. The North Sea basin and the western English Channel basin also developed.

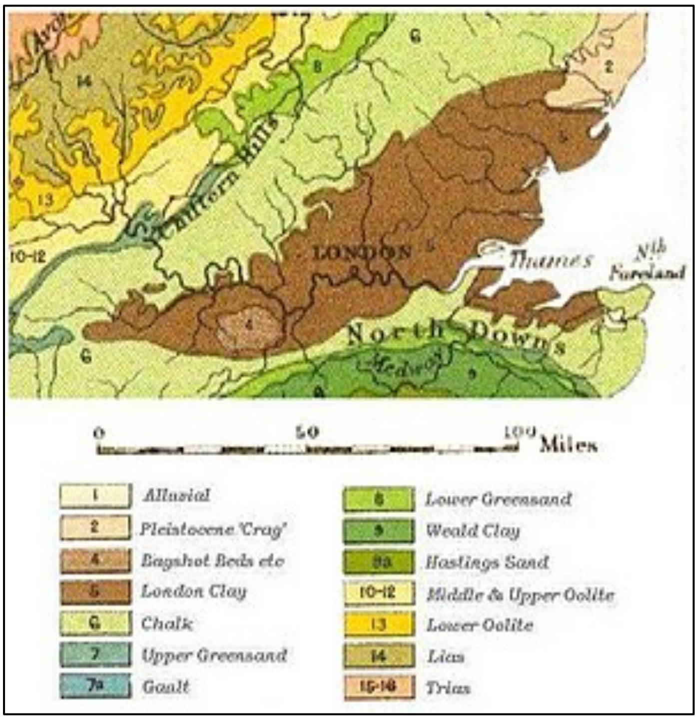
The drainage of much of England was thus aligned to the south-east. As the land emerged from beneath the Cretaceous sea, precursors of some of today's major drainage systems of central, eastern and southern England developed. Thus, from the early Tertiary period a number of major consequent rivers flowed approximately NW-SE down the tilted emergent Chalk surface towards what later became southern England. One of those watercourses was a precursor of the River Thames.

South-eastern England was low-lying and, from the late Palaeocene onwards (from about 55 million years ago), it was inundated periodically by marine transgressions from the east. Substantial deposits of marine, lacustrine and deltaic origin were laid down across the region. In particular, over 150 metres of London Clay were laid down. And, as the Palaeocene period progressed, subsidence in this region led to the formation of the London Basin, with its approximately west-east axis. The Ancestral Thames thus flowed from the north-west, into this basin.

By the Oligocene period, around 30 million years ago, the coastline had retreated to the east of the London Basin. It is believed that, at that time, the Ancestral Thames was still flowing from the north-west, into the London Basin. From there, the river flowed broadly eastwards towards the North Sea basin of that period. And, also by the Oligocene period, the Wealden (or Weald-Artois) Anticline, to the south of the London Basin, was uplifted as a result of the Alpine orogeny.

Rivers which were draining from the northern flank of that anticline - precursors of watercourses like today's Mole (rising in Sussex), the Wey (in Hampshire) and Darent rivers (the Darent a Kentish tributary) - would have begun feeding into the Thames from the south. Further east, a proto-Medway river also flowed northwards from the Weald. But that watercourse flowed parallel to the proto-Thames towards the North Sea basin, and it did not form a confluence with the Thames until later on, in the Pleistocene period.

There were periodic marine transgressions towards the London Basin during the Miocene period (around 10-20 million years ago), but it is thought that these did not significantly alter pre-existing drainage systems. At times during the Pliocene period (around 5-3 million years ago), the North Sea coastline extended westwards, depositing various early Crag formations in an area now occupied by parts of East Anglia. But, again, this appears not to have had any significant effect on the Thames drainage system.



However, in the Late Pliocene and early Pleistocene periods (c.3-2 million years ago), the London Basin became submerged. Fossiliferous sands were deposited. Subsequent Pleistocene uplift caused a relative displacement of c.180 metres between the western London Basin and the Suffolk coast, and remnants of those fossiliferous sands are now found at up to that altitude in the North Downs and Chiltern Hills. As the sea retreated eastwards, the River Thames system occupied the basin vacated by the sea.

There is evidence that, for a time during the Early and possibly Middle Pleistocene period (c.2-0.5 million years ago), the headwaters of the River Thames extended north-westwards as far as north Wales. Pebbles from formations of that area have been found in deposits laid down by the Thames in East Anglia. It has also been established that, during that time, the Thames, after entering the London Basin somewhere around Goring, then followed a course north-eastwards and northwards into North Norfolk, on a course towards the North Sea Basin. At times, "the southern North Sea was occupied by the huge delta complex of the North German Rivers, the Rhine, Thames, Meuse and Scheldt".

The Early and Middle Pleistocene gravel which was deposited by the Thames in East Anglia also contains chert from Lower Greensand beds to the south of London, and this "can only have been transported northwards by south-bank tributaries of the Thames and then the Thames itself". Thus, ancestral versions of today's Mole, Wey and Darent rivers were feeding into the Thames from the Weald at that time. (The Mole and Wey joined to form one river in south London, and that Mole-Wey watercourse flowed north-eastwards across London and south Hertfordshire before joining the Thames.

What is special about Essex Geodiversity?

Essex is an area of predominantly subdued relief with gentle slopes, the result of its underlying geology of soft, relatively young rocks. These generally yield fertile soils. The result is an attractive 'lived in' landscape dominated by arable agriculture, but still retaining forested and heathland areas, particularly where gravels and sands, many of glacial and fluvial origin, have yielded poorer soils. Although lacking the more dramatic geology and landforms of many 'hard rock' areas, Essex geology and geomorphology is still of great interest, possessing abundant evidence of the huge environmental and biodiversity changes that our area has witnessed over the last 100 million years. Among the key themes are dramatic and sometimes long-lasting changes in the distribution of land and sea, major shifts in climate, and mass species extinctions. Many of these phenomena are of great relevance today, and so an understanding of our past is essential in interpreting the challenges to come.

Geodiversity's influence on Essex's development.

Essex's geodiversity has exerted a major influence on land use, agriculture and landscape:

The distribution of less fertile ancient river and glacial gravels has been a major influence on historical land use, resulting in the preservation through to the present day of extensive tracts of woodland and to a lesser extent heathland, in a predominantly arable county. These are of great significance both for biodiversity and recreation. The chalky boulder clay, or till, found north and west of Chelmsford is highly suitable for cereal cultivation, especially wheat. London Clay outcrops south of Chelmsford, providing soils less suitable for arable agriculture and more suited to pasture. The brickearth of the Tendring district is the basis of the rich agricultural land of this peninsula.

In earlier times rivers penetrating deep inland, together with proximity to the Continent, provided a succession of invaders and colonisers – from Palaeolithic peoples, through to Roman, Viking and Saxon - with easy access. The deposits of the ancestral Thames and its tributaries have provided Essex with a source of gravel and sand for construction since Roman times. A special kind of gravel naturally cemented by iron called ferricrete was used extensively as a building stone and is found in many medieval churches.

The geology of Basildon district.

The bedrock geology of the district is London Clay, laid down on the floor of a subtropical sea in the Eocene period some 50 million years ago. The Claygate Beds occur above the London Clay and represent a period of geological time when the London Clay Sea was becoming shallower and the clay was becoming increasingly sandy as the shoreline came closer. This culminated in deposition of the Bagshot Sand as the sea became very shallow. Bagshot Sand is therefore considered to be delta and near-coastal sands. Following extensive erosion during the Ice Age, the Claygate Beds and overlying Bagshot Sand are now only exposed on the high ground such as the Langdon Hills and Billericay. These hills are capped by gravels laid down at various times by rivers during the Ice Age. These rivers are thought to have been south bank (northward-flowing) tributaries of the ancient Thames which then flowed far north of its present course. As mentioned earlier, during an exceptionally period of the Ice Age, 450,000 years ago, a gigantic ice sheet covered most of Britain and Essex as far south as Hornchurch. The moving ice diverted the Thames towards its present-day course and dumped its load of boulder clay, or till, across the landscape (shown pale blue on the geological map above). Much of this sheet of boulder clay has been removed by erosion but patches of it remain in the Basildon district, such as to the north and west of Billericay.

The Building stones of Essex

England's rich architectural heritage owes much to the great variety of stones used in buildings and other structures. The building stones commonly reflect the local geology, imparting local distinctiveness to historic towns, villages and rural landscapes. As said, the geological story of Essex starts with rocks that are between 440 and 360 million years old. Dating from the Silurian and Devonian periods (part of the Palaeozoic era), these rocks consist of hard, slaty shales, mudstones and sandstones and are over 300 metres (1,000 feet) below the surface. They have been encountered in boreholes at several places in Essex and they represent a time in the distant past when the first animals were leaving the sea to colonise the land.

Lying on top of these ancient rocks is the Gault, a marly clay from a muddy sea that dates from the middle of the Cretaceous period, about 100 million years ago. This means that, beneath Essex, there is a gap in the geological record of about 250 million years and includes the Triassic, Jurassic and early Cretaceous periods. After deposition of the Gault, sand spread into this sea to form a deposit called the Upper Greensand. At this time sea levels were rising leading to flooding of the continents, the conditions under which the next rock was formed – the Chalk.

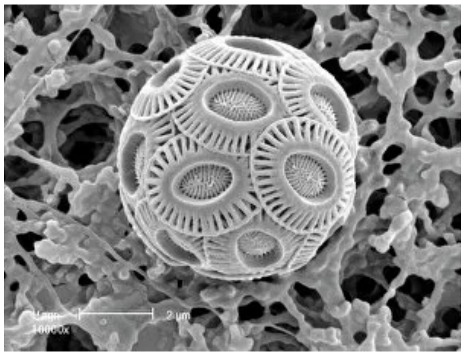
The Chalk Sea

The geology of Essex comprises sedimentary strata laid down during the Cretaceous, Palaeogene-Neogene (Tertiary) and Quaternary periods of geological time. The geological structure is relatively simple, with the Cretaceous-Neogene sediments being gently folded into the open trough London Basin. This structure explains the presence of older rocks in northernmost and southernmost parts of the county and younger rocks in a broad, north-east to south-west trending belt extending roughly from Harwich to Waltham Abbey. The oldest rocks exposed in Essex comprise marine chalks of Late Cretaceous age, assigned to the White Chalk Subgroup. These occur in the broader Saffron Walden area, in the north of the county, where they were formerly quarried on a relatively small scale. The chalks of southern Essex, which crop out around Tilbury and Purfleet, were once extensively quarried and used as a feedstock for the Portland cement industry.

Chalk is effectively the starting point of our geological story as it is the oldest rock exposed at the surface in our county. Chalk also forms the foundations of the London Basin, a large basin-shaped structure beneath London and Essex. A great thickness of chalk forms the Chiltern Hills and their continuation as the hills of south

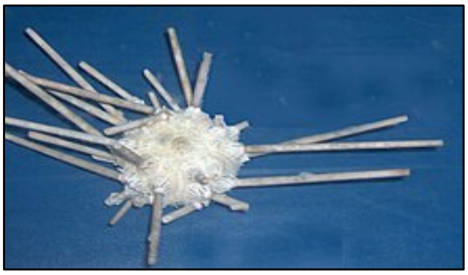
Cambridgeshire; it then passes beneath central London and Essex and comes to the surface again as the North Downs of Surrey and Kent. This layer was originally horizontal, having been laid down as a limy mud on the floor of a tropical sea during the age of the dinosaurs; the folding occurring millions of years later as Britain was squeezed as a result of the African continent pushing into Europe and creating the Alps.

The Chalk Sea was in existence between 80 and 100 million years ago (during the Cretaceous period) and the purity of the chalk means that the water must have been crystal clear and the nearest land a considerable distance away; in fact it is thought that this sea may have covered most of northern Europe. The chalk sea was teeming with marine life such as molluscs, sponges, corals, sea urchins and fish, and at the top of the food chain were the mosasaurs, giant marine reptiles up to 10 metres long with a long body and tail, paddle-like limbs and heavy jaws armed with sharp, conical teeth.



The smallest creatures were microscopic marine algae with protective shells called coccoliths, that accumulated on the sea floor in their billions. In fact it is now realised that chalk is almost entirely made up of these tiny fragmented shells which are only visible under an electron microscope.

Chalk contains numerous nodules of flint, a variety of quartz formed as nodules in the mud on the chalk sea floor. The nodules were mostly formed by the infilling of burrows made by sea creatures in the white mud. As a result, they can be remarkable shapes, often with horns or spiky protrusions.



A fossil echinoid, or sea urchin, of the genus Cidaris from the Chalk of Purfleet complete with many of the spines that protected the animal during its life.

Left: a flint nodule from the Chalk. The bizarre shapes of flint nodules is due to flint infilling the burrows made by crustaceans in the soft white mud on the sea floor.

Chalk can be seen in the south of the county in Thurrock where there are many giant quarries, the remnants of the Portland cement industry. Typical of these quarries is Grays Chalk Quarry, which is a nature reserve, managed by the Essex Wildlife Trust. On the northern limb of the London Basin is Saffron Walden which also has disused chalk quarries but on a much smaller scale, and most of these are rapidly disappearing as a result of development and landfill.

Thanet Sand to the Harwich Formation - The Extinction of the Dinosaurs

A vertical cliff of sand and well-rounded, almost spherical, black pebbles that formerly existed at Orsett Depot Quarry in Thurrock. The pebbles are thought to have been deposited close to a shore line about 55 million years ago and show evidence of being pounded together under storm conditions.

The end of the Cretaceous period saw the extinction of the dinosaurs and the gradual disappearance of the Chalk Sea as sea level fell throughout the world. The next chapter in our story involved further inundations in later geological periods which deposited a great thickness of other rocks over the whole area.

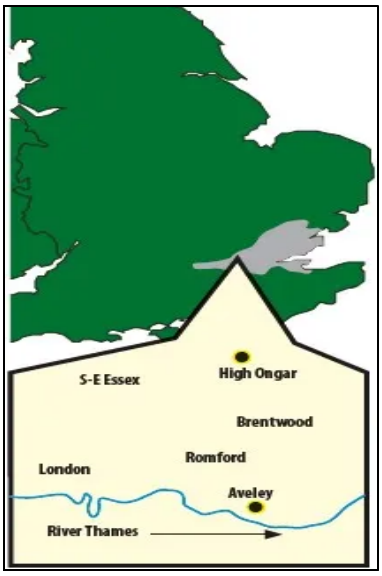
Much of Essex is built on younger rocks but the Chalk is, of course, still present beneath the surface, in some cases as deep as 200 metres below ground level. In many cases the younger rocks consist of pebbles, sand or gravel, the remains of countless billions of flint nodules that have been removed from the chalk and ground down by erosion.

The first rocks to be laid down on the eroded chalk surface are a variety of sands clays and shell beds deposited in shallow marine or estuarine conditions. The first of these was the Thanet Sand, which sits on top of the Chalk and can be clearly seen in south Essex in many of the Thurrock chalk quarries and in the north in the disused pits near Sudbury. Following the Thanet Sand are a group of deposits now known as the Lambeth Group but formerly commonly known as the Woolwich and Reading Beds. These beds are currently exposed in pits in Thurrock.

After a rise in sea level shallow marine conditions were established again leading to deposition of a pebble bed overlain by yellow, shelly sand known as the Oldhaven Beds. In south London the equivalent strata consists of thick pebble beds known as the Blackheath Beds. East and northwards from Thurrock these beds are replaced by sandy clays indicating deeper water conditions. Formerly known as the London Clay Basement Bed they are now classified as the Harwich Formation. This formation is well exposed at Walton-on-the-Naze and at Wrabness on the River Stour, where the cliffs reveal numerous seams of volcanic ash, evidence of volcanic activity in the Eocene period.

Bands of volcanic ash in the cliffs at Wrabness on the north coast of Essex. At least 32 ash bands are present, evidence of volcanoes in western Scotland during the Eocene period following the opening of the Atlantic Ocean.

The ash bands are continuous beneath Essex and have also been found during excavations for the M11 motorway near Stansted.



Sea level continued to rise leading eventually to deposition of dark blue clay across the whole region. This was the London Clay Sea – the next chapter in our story.

An exposure of London Clay nearby at the aggregate works and landfill site at High Ongar in Essex. The site revealed a significant exposure of London Clay that prompted the look for fossils. As a result, we can compare this site to others in the Eastern London Basin and to place it in an approximate stratigraphic position.

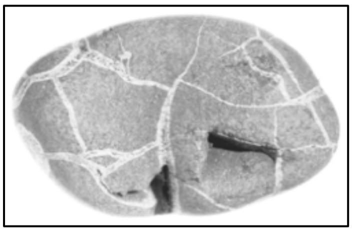
Some 18 miles north of the River Thames and 15 miles due east of London is the village of High Ongar in Essex. Located in the southeast corner of the village were the industrial premises of the LECA works and the Greenways landfill site. Part of these premises consisted of an excavation pit where clay was dug for use in the manufacture of aggregate. As the clay was excavated, it was sorted and any bulky materials removed. It was this excavation and sorting that revealed fossils suitable for collection.

This Locality map showing site locations and the positions of the Tertiary sediment basins that exist in the London and Hampshire regions of the UK. The clay was exposed in a pit lying to the east of the main buildings. It was dug and extracted by means of a large, caterpillar-tracked, single bucket excavator. It was then placed on a single-track conveyor belt and transported to the nearby buildings.

In the pit, the clay was not exposed in neat terraces with horizontal and vertical faces, as it was at Aveley. Instead, the pit had sloping worksurfaces down which freshly excavated clay boulders could tumble. At times, this made it very difficult to identify which level a particular boulder had come from. Specimens were usually collected from the active excavation pit. In addition, site workers occasionally put specimens aside but, as a result of that kindness, there was little idea where these specimens had come from. When in use, it may have been the second largest, man-made inland exposure of London Clay found in the UK. The biggest was probably at Aveley, where there was another landfill site.

Stratigraphy and palaeontology

London Clay is a marine deposit that is well known for its fossils. It is the most important member of the Lower Eocene (Ypresian) strata in Southern England and is deposited over a wide area of the London and Hampshire Basins. Broadly, the London Clay is thought to have been laid down in a marine environment influenced by a tropical or sub-tropical climate. Water depth is thought to have averaged about 200m, but, obviously, would have varied locally. Visually, the clay was an homogenously textured, stiff, blue-grey deposit, weathering to a brown colour.



Very little could be seen in the way of bedding. However, it was evident that there were layers of concretions in the deposit. These consisted of large, calcareous septarian concretions.

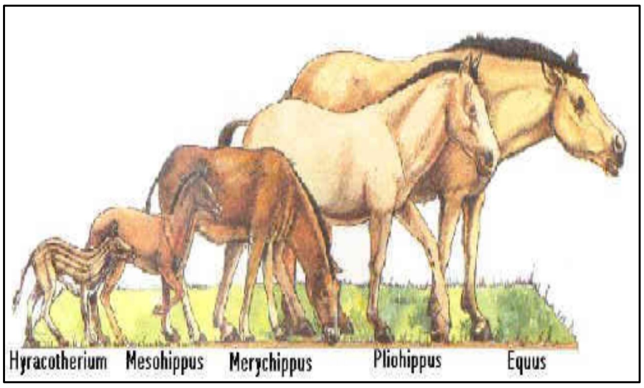
Also present were smaller, softer, phosphatic nodules that yielded the bulk of the fossils.

London Clay & Bagshot Sand.

The London Clay

The environment of the region was now changing dramatically, leading to the deposition of the London Clay, a mud laid down on the floor of a subtropical sea some 50 million years ago. The London Clay has yielded fine fossils of the sea's inhabitants such as molluscs, lobsters, crabs and sharks. There are also fossilised fruits, seeds and twigs which provide us with valuable information about the rain forest vegetation which existed on the land at this time.

Most remarkable of all are probably the fossil turtles and mammals from the workings of the Harwich cement industry in the 18th and 19th centuries.



The cement was made from hard limestone nodules that occur in the clay and in one of these, in 1856, a workman found the skeleton of Hyracotherium (also known as Eohippus). Hyracotherium was the earliest ancestor of the horse and was no larger than a fox, with toes instead of hooves. This animal lived on the river banks and its bones must have been washed down a river into the sea. This was a time of rapid evolution of mammals following extinction of the dinosaurs.

London Clay fossils, particularly sharks' teeth, turn up all around the Essex coast but the most famous site is at Walton-on-the-Naze where the beach is very popular with collectors. The London Clay here is one of the reasons Walton is a site of international importance, mostly because in it are the best preserved bird fossils of Tertiary age to be found anywhere in the world. The London Clay also contains layers of volcanic ash which may have originated in Scotland where there were active volcanoes around this time.

During the Palaeocene Epoch, the Mega-toothed sharks emerged as apex predators, dominating the seas for nearly 60,000,000 years. Otodus obliquus was the first of these giant ocean predators, with vertebrae over 5 inches in diameter, and an estimated body length between 30 to 40 feet, the creature was nearly as long as a bus.

Otodus' long, smooth teeth were ideal for puncturing fish. In addition, the main tooth was flanked by two smaller structures called cusplets. These miniature teeth helped the shark latch onto its prey and hold its meal in place.

The Megalodon tooth contrasted with the Medium Otodus, an ancestor of the Great White Shark from the London Clay. Found on the beach at Althorne, near Burnham-on-Crouch.

As you can see above, Otodus' descendants, the Megalodons, lost these cusplets and developed serrated teeth, a later evolutionary adaptation suited for tearing flesh from cetacean prey.

A fossil Hoploparia lobster from the London Clay, similar to that collected from a former clay pit at Aveley in Thurrock.

Lying on top of the London Clay is a sandy clay called the Claygate Beds. Above this is a delightful, fine-grained yellow sand called Bagshot Sand which indicates a shallowing of this sea. It formerly covered the whole region but erosion has now reduced it to isolated patches on hill tops in central Essex.

The former sand pit on One Tree Hill (part of the Langdon Hills), showing what was then a fine section through the Bagshot Sand with its resident sand martins.

The Bagshot Sand was formed on the floor of a sub-tropical sea some 50 million years ago. The photograph was taken in 1907.

Tunnels in London Clay.

London Clay is an ideal medium for boring tunnels, which is one reason why the London Underground railway network expanded very quickly north of the River Thames. However, south of the Thames, the stratum at tube level is composed of water-bearing sand and gravel (not good for tunnelling) with London Clay below, which partly explains why there are very few tube tunnels south of the Thames. London Clay has a stand-up time long enough to enable support to be installed without urgency. It is also almost waterproof, resulting in virtually no seepage of groundwater into the tunnel. It is over-consolidated, which means that it was once subject to an overburden pressure higher than it is subjected to today, and expands upon excavation, thus gradually loading the support, i.e. it is not necessary to stress the support against the ground.

The Red Crag Sea

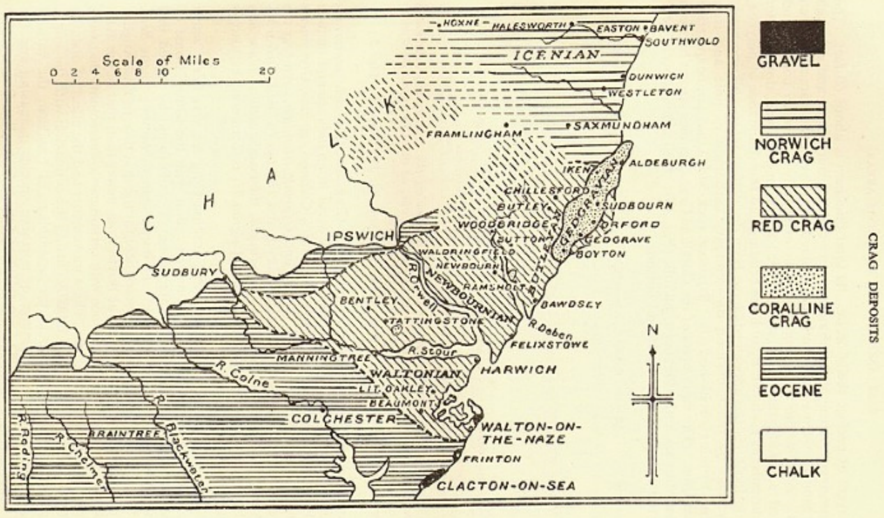


Fig. 14. *Map showing the relative areas occupied by the different Zones of the East Anglian Crag deposits.*
(After F. W. Harmer, 'The Pliocene Mollusca', (*Palaeont. Soc.*), vol. 2, part 1, 1920, p. 497, Fig. 4, and modified after Woodland, the probable extension of the Red Crag and the Norwich Crag (covered by Drift) being indicated by broken lines.)

A gap in the geological record after the deposition of the Bagshot Sand indicates a great time interval and this was no doubt due to subsequent rocks being removed by erosion. This is followed by the two million year old Red Crag which occurs across much of north Essex, although it is only at Walton-on-the-Naze that it is well exposed. Laid down just before the present Ice Age, the red, iron-stained sand is teeming with fossil shells and forms spectacular layers on top of the London Clay.

The Red Crag also contains the teeth of sharks, the most famous of which is Carcharodon megalodon, the largest species of shark that ever lived, weighing in at some 65 tonnes. These teeth, which were derived from rocks of Miocene age and incorporated into the Red Crag, are extremely rare but examples have turned up on the beach over the years.

The sediment in the outcrops mainly consists of coarse-grained and shelly sands that were deposited in sand waves (megaripples) that migrated parallel to the shore in a south-westward direction. The most common fossils are bivalves and gastropods that were often worn by the abrasive environment. The most extensive exposure is found at Bawdsey Cliff, which is designated a Site of Special Scientific Interest (SSSI); here a width of around 2 kilometres (1.2 mi) of Crag is exposed. At the coastline by Walton-on-the-Naze, remains of megalodon were found.

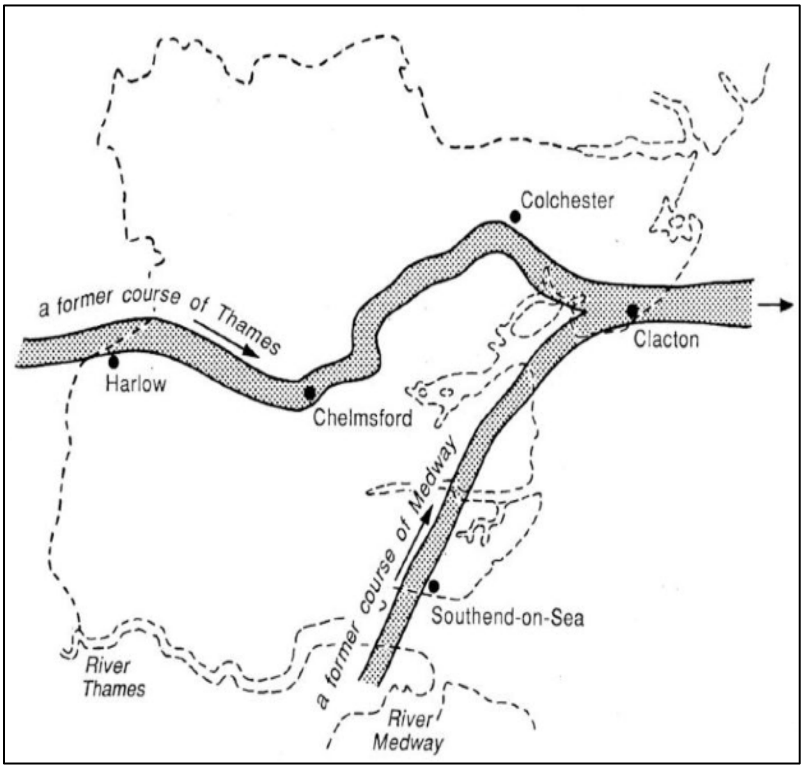
A Buried Landscape.

As mentioned earlier, the Gault Clay was laid down when the sea flooded south-east England in the mid Cretaceous period about 100 million years ago. The land that was inundated consisted of rocks dating from the Palaeozoic era (rocks from the Devonian period in what is now south Essex and from the Silurian period in north-east Essex). This ancient, buried land surface still exists beneath our feet and has been encountered in the boreholes at Harwich, Weeley, Fobbing, Beckton and Canvey Island.

The Ice Age – Cooling of the Planet.

The 'icing' on the county's geological 'cake' is the remarkable variety of deposits laid down during the Ice Age.
The story of the Ice Age starts around two million years ago. At this time the climate was probably not too dissimilar to the present day but the temperature had been slowly dropping for tens of millions of years, ever since the balmy, tropical days of the dinosaurs. The oldest Ice Age deposit in our region was laid down in a shallow sea and is known as the Chillesford Sand (part of the Norwich Crag Formation).

This sand occurs at the base of gravel pits in north-west Essex but it is extremely difficult to date due to the absence of fossils for much of its thickness. Following deposition of the Chillesford Sand there is a very fragmentary record of our climate and landscape over the next million years or so. This period, which makes up most of the early part of the Ice Age, is poorly understood but some evidence has been preserved, thanks largely to an early route of the River Thames.



The route of the Thames and the Medway through Essex, about 400,000 years ago, just before the arrival of the Anglian Ice Sheet. Illustration taken from Essex Rock (1999).

The Early Thames

During the early Ice Age the Thames flowed to the north of London, through north Essex, Suffolk and Norfolk and out across what is now the southern North Sea to become a tributary of the Rhine; the evidence for this being a substantial thickness of what is called Kesgrave Sands and Gravels which, remarkably, represents the actual bed of the river. These old Thames gravels contain a variety of unusual pebbles from as far away as North Wales, proving that, at that time, the Thames, and its tributaries, must have been a huge river system draining the Welsh mountains and bringing their characteristic volcanic rocks into the Thames basin.

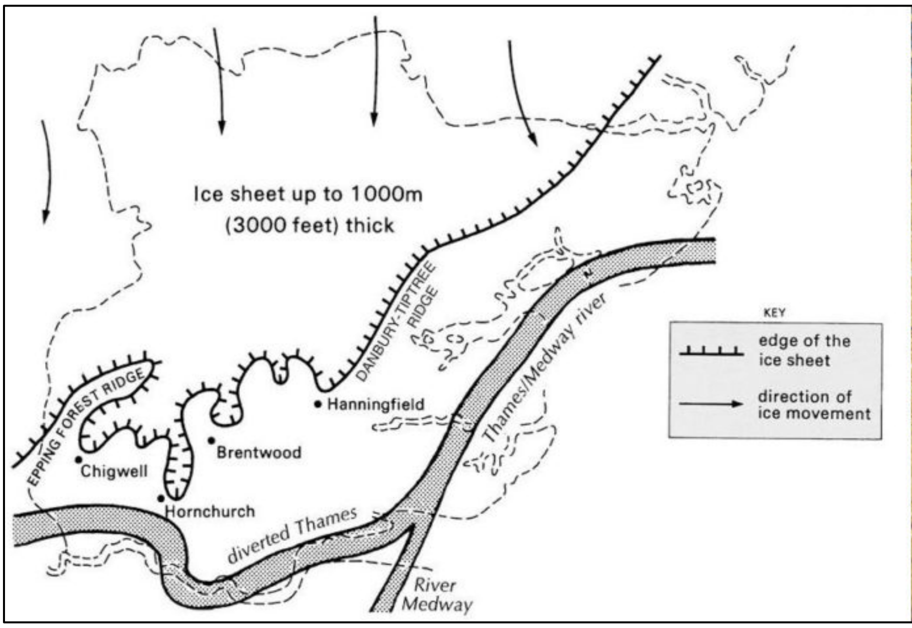
Kesgrave Sands and Gravels at Broomfield Gravel Quarry in 1971. Photo © British Geological Survey (P21103)

The gravels also contain large boulders of puddingstone and sarsens, which are very hard conglomerates and sandstones respectively. They are believed to be derived from pebble and sand seams in the Reading Beds, and which have subsequently become cemented by quartz. They have been put to use by man as ancient way markers at road junctions. The gravels have great commercial value and are worked in numerous gravel pits between Harlow, Chelmsford and Colchester, which was the route of the Thames over 450,000 years ago.

During this time the River Medway flowed north across east Essex to join the Thames near Clacton, leaving behind a ribbon of distinctive gravel which can be found between Burnham-on-Crouch and Bradwell-on-Sea. There were also other northward-flowing tributaries of the early Thames. Evidence of these are the patches of gravel that are found on the tops of the hills in south Essex, such as the Langdon Hills, Warley and High Beach in Epping Forest.

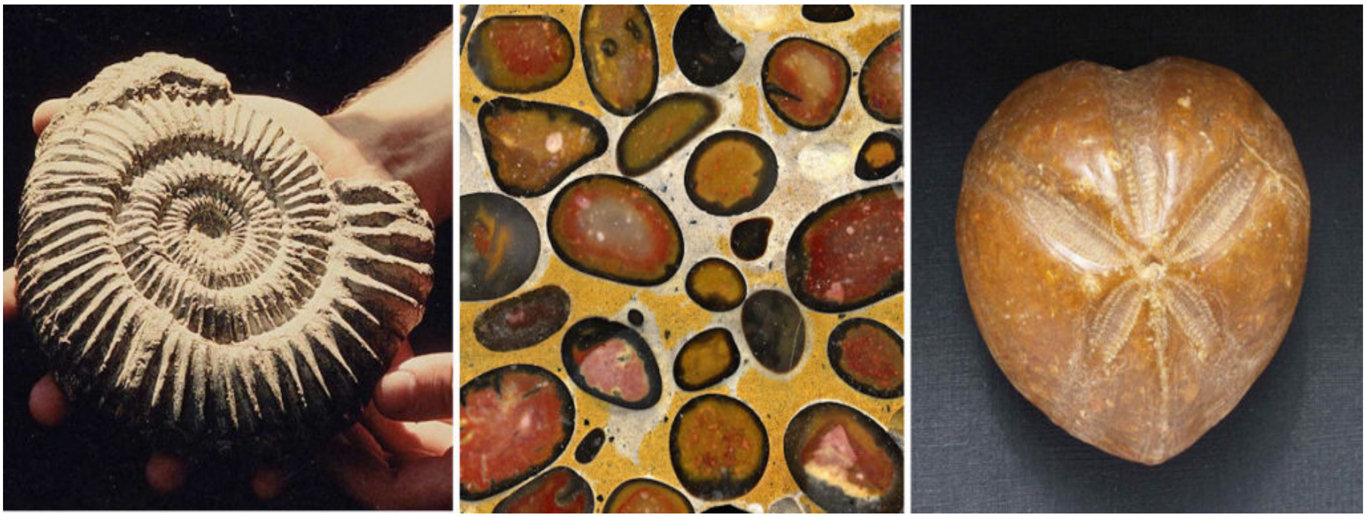
The Anglian Ice Sheet

The regular pulses of climate change culminated in the Anglian glaciation, a severe cold stage about 450,000 years ago that allowed a great ice sheet to spread south into the region across the valley of the early Thames. A lobe of ice from this ice sheet blocked the Thames in the Vale of St. Albans causing a catastrophic change to the route of the river, diverting it south to its present position.



Left: the maximum extent of the Anglian Ice Sheet in Essex. Probable routes of the diverted Thames and Thames-Medway Rivers are shown. Illustration taken from Essex Rock (1999). Right: boulder clay, or till, exposed in a road cutting in Chelmsford. This material was deposited by an ice sheet 450,000 years ago. Photo courtesy of G. Lucy.

Evidence for the existence of this ice sheet is a substantial thickness of boulder clay, or till, left behind by the ice as it ground southwards across the frozen landscape. The boulder clay, lying on top of the old Thames gravels, forms a distinct plateau over the north of Essex, now dissected by modern river valleys. Boulder clay can be found as far south as Hornchurch, which is known as the most southerly point in England that the ice penetrated during the whole of the Ice Age. The boulder clay contains rocks, called glacial erratics, which have been carried south by the ice, some of them from as far away as northern England and Scotland. The boulder clay also contains some fossils such as Jurassic ammonites and belemnites, brought here from the Midlands.



Left: a fossil ammonite (from the Jurassic period) found in the boulder clay at Saffron Walden. Middle: a polished slice of Hertfordshire Puddingstone from the Thames gravels at Stanway, near Colchester. Right: a flint Micraster echinoid (derived from the Chalk) from a gravel pit in Chelmsford. Photos courtesy of g. Lucy.

The landscape at this time is almost impossible for us to visualise. As the region was situated at the southern-most limit of the Anglian ice sheet, colossal volumes of melt water would have been continually released and the evidence for this is also preserved beneath our feet. In parts of East Anglia, boreholes have revealed deep, steep-sided valleys cut into the chalk bedrock and now completely filled with sand and gravel and hidden by a covering of boulder clay. Known as buried tunnel valleys or buried channels these remarkable natural features were formed beneath the ice sheet and were the main drainage routes for melt water.

One of the best examples of a buried channel is the Cam-Stort Buried Channel that is present from Great Chesterford south as far as Bishops Stortford. You can't see it but in Newport it passes beneath your feet and is some 100 metres (300 feet) deep, almost half of this depth being below present sea level. Glacial gravel is present in many other places in Essex. It is recognisable as an unsorted residue of many rock types, mostly flint, laid down under these exceptional conditions.

There is a noted cliff of glacial gravel at Fingringhoe Wick Nature Reserve near Colchester. The gravel was laid down by torrents of melt water issuing from beneath an ice sheet.

The Arrival of Humans.

Early Human Occupation in Essex

The first species of humans arrived in Britain over 700,000 years ago and evidence for this has been found in Norfolk. Although some worked flint tools from pre-Anglian deposits have been found in Essex, the earliest substantial evidence for human occupation in the county is from about 400,000 years ago, in deposits laid down immediately after the Anglian glaciation, during a warm interglacial stage known as the Hoxnian. Humans made their way north from Europe during this period taking advantage of the retreat of the ice.

The Thames had now been diverted south and flowed approximately along its present course but in the Southend area it turned north to Clacton along the old valley of the River Medway as the Thames-Medway River. This combined river laid down gravel which can be seen in the cliffs at Cudmore Grove Country Park in East Mersea. At Clacton similar gravels have yielded worked flints and it is these early flint tools that are the earliest evidence of humans in Essex.

Cliff of 250,000 year old Thames-Medway gravel at Cudmore Grove, East Mersea. Photo courtesy of G. Lucy

Perhaps the most important Hoxnian site is Marks Tey Brick Pit, near Colchester, where lake sediments have revealed distinctive layers containing fossil pollen, revealing to geologists a remarkably detailed record of the vegetation living during this interglacial stage. Subsequent glacial and interglacial stages saw humans retreat from Britain and return when the climate improved.

Numerous geological sites in Essex from these interglacial periods have revealed flint implements, most commonly beautifully crafted hand-axes.

The photograph was taken in 1981, a few minutes after it was found, revealed by its edge protruding through the sandy clay in the side of the cutting. In mint condition, it was crafted by a Neanderthal hunting the local wildlife on the banks of the Thames about 300,000 years ago during a warm interglacial stage. It is one of the largest hand-axes ever found in the UK. Photo courtesy of G.R. Ward.

The Modern Thames

The modern (post-diversion) Thames has numerous bench-like terraces on either side of the valley, the oldest being at the highest elevation. They were formed during subsequent cold (glacial) and warm (interglacial) stages. Terraces are formed as the river slowly cuts down through successive flood plains creating new flood plains at lower levels; each terrace containing fossils that reveal the flora and fauna of each of these periods. Geological sites in these terraces in south Essex are now being re-examined and are revealing a wealth of information making them some of the most important sites in Europe for the study of this middle period of the Ice Age.

The working of brick clay at Ilford in the mid-19th century yielded the bones of numerous of mammoths and woolly rhinoceroses in the former pits. The largest complete mammoth skull ever found in Britain (the 'Ilford mammoth') was discovered here. Downstream, there are many other sites such as at Aveley, where a clay pit yielded the famous Aveley elephants, and Grays, which produced a huge quantity of fossil bones from the brick pits in the early 19th century.

Left: the skull of the Ilford Mammoth on display in the mammal gallery of the Natural History Museum, London. Discovered in 1863 it is still the largest complete mammoth skull to have been found in Britain. The tusks are nearly 3 metres (10 feet) long. Photo courtesy of G. Lucy. Right: the excavation of two elephant skeletons, one a mammoth and the other a straight-tusked elephant at a clay pit in Aveley in 1964. The find attracted much media attention and the quarry workers gave up their spare time to control the crowds. The find was originally made by a young amateur geologist looking for fossils in the pit. All the bones, still encased in a block of peat, are now in the Natural History Museum, London. Photo courtesy of G.R. Ward.

Timescale of the Ice Age

In Essex there is evidence for great swings of climate since the Anglian glaciation, 450,000 years ago, with four temperate stages at least as warm as today, separated by cold stages with arctic conditions. About 20 years ago only two of these warm stages were known, but evidence from Essex, particularly Thurrock, has been extremely important in unravelling a more complex climate history.

Epoch	Old Stages	New Stages	Climate	Marine Isotope Stages	Age in years
Holocene	Flandrian	Flandrian	Temperate	1	10,000
Pleistocene	Devensian Glacial	Devensian Glacial	Glacial	2-5d	50,000
	Ipswichian Interglacial	Ipswichian Interglacial	Temperate	5e	125,000
	Wolstonian Glacial	Unnamed cold	Cold	6	150,000
		'Aveley' Interglacial	Temperate	7	200,000
		Unnamed cold	Cold	8	250,000
		'Purfleet' Interglacial	Temperate	9	300,000
		Unnamed glacial	Glacial	10	350,000
	Hoxnian Interglacial	Hoxnian Interglacial	Temperate	11	400,000
	Anglian Glacial	Anglian Glacial	Glacial	12	450,000

Timescale of the last 450,000 years of the Ice Age (since the Anglian glaciation). We are now living in the Holocene or Flandrian stage.

Formation of the Modern Landscape.

The Ipswichian Interglacial

The greatest and the warmest interglacial stage during the whole of the Ice Age was the Ipswichian, about 120,000 years ago. This period must have been warmer than the present day with monkeys, elephants and lions in southern England, the bones of which were found beneath Trafalgar Square in the 1950s as a result of building excavations. Downstream, the foreshore at East Mersea is currently one of the best sites of Ipswichian age in Britain. Here there are highly fossiliferous sediments called 'hippo gravels,' so called because the hippopotamus was remarkably abundant in our region at this time, but curiously absent during almost all of the other interglacial stages. Fossils indicate that humans and animals such as the horse were absent from Britain during the Ipswichian. Each interglacial stage has a distinctive fauna, presumably because, in each case, some animals were not quick enough to migrate north as the climate improved and were halted by the reappearance of the English Channel as sea level rose.

Part of a submerged forest, between 5,000 and 6,000 years old exposed at low tide on the Thames foreshore at Purfleet. The forest was in existence in the Neolithic Period, at a time when sea level was much lower.

Photo courtesy of G. Lucy

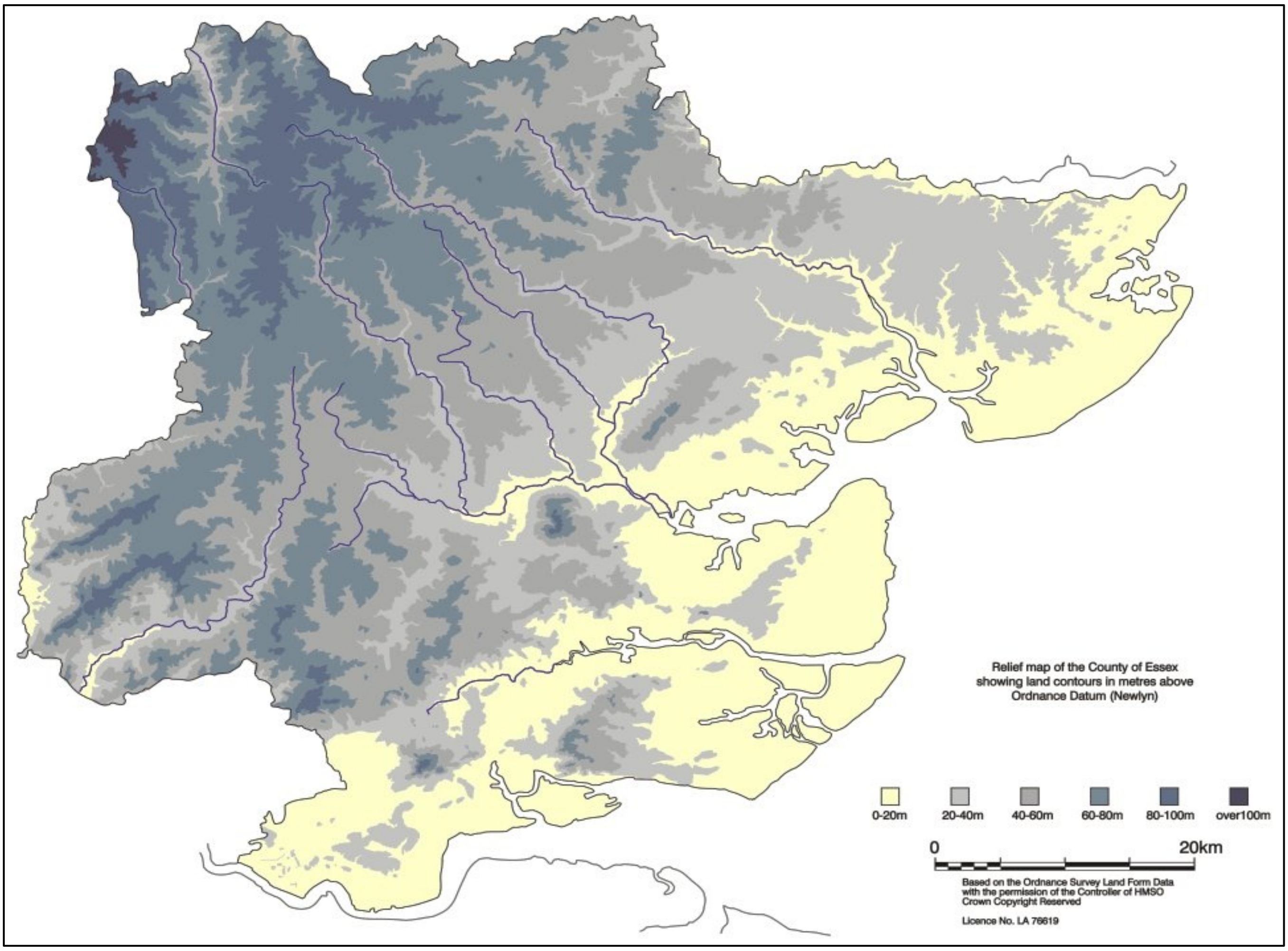
The Most Recent Glaciation

Following the warmth of the Ipswichian came the intense cold of the Devensian stage when an ice sheet again spread south but this time reaching no further than north Norfolk. Permafrost conditions gripped this region, providing home for reindeer, arctic wolf and similar species. Fossils of these animals have been found in a gravel pit at Great Totham and further west in the Lea valley.

Perhaps the most spectacular evidence of the Devensian cold stage is the network of ice wedge polygons that are occasionally revealed by crop marks in fields during hot, dry summers. Ice wedges are formed when the frozen ground shrinks and cracks during times of extreme cold. Each summer the cracks filled with water which then froze the following winter widening the cracks; a process that continued for thousands of years. At the end of the glacial stage the crack filled with debris preserving them as ice wedge casts, which are now revealed as crop marks.

A remarkable pattern of ice wedge polygons revealed by cropmarks in a field south of Harlow. The photo was taken during the hot, dry summer of 1976 when the crop marks were well displayed.

The Landscape Today



Topographical map of Essex giving a good impression of surface relief. The highest ground is on the chalk downland to the extreme north-west of the county. The lowest land is the flat coastal areas of river alluvium and salt marsh. Map © Essex County Council

Soils.

Soil is the uppermost layer of the Earth's surface and is immensely important for life on Earth. It is a mixture of weathered rock fragments and minerals, living organisms, and decaying organic matter called humus, and is the product of several complex interacting processes. Soil forms over a long period of time. There are many types, each one reflecting the influence of climate, relief and the underlying geology, as well as the chemical and biological processes involved. Soils are classified according to the national system of the Soil Survey of England and Wales.

The soil types of Essex have helped shape the landscape, wildlife and economy of the County. The boulder clay region of north-west and central Essex has soils which are a rich, crop-producing resource. The London Clay gives rise to less fertile soil and its heavy nature has made arable farming difficult leading to small, dispersed settlements, and an emphasis on pasture. However, the extensive brickearth that overlies the London Clay to the north and east of Colchester form a rich, fertile soil suited particularly to market gardening. Soils developed on the Bagshot Hills, such as the Epping Forest Ridge, are extremely complex with mixed hornbeam/oak woodland on the London Clay and beech on the Claygate Beds.

This brief account of Essex soils is summarised from The Essex Environment: A Report on the State of the County's Environment published by Essex County Council (1992). A good introduction to the soils of Essex can be found in a comprehensive report for Essex produced in 2003 as part of English Heritage's National Mapping Programme (NMP). **LoGS report for Basildon Council Revised 19 November 2019.**

The Basildon Borough through geological time.
The following sites have been selected to represent the different aspects of geology and landscape in the district. Not all sites have something to see; many are solely of historical interest as a record of an important or interesting discovery. Some sites are not strictly geological but have a geological connection. Geological sites are therefore defined in their widest sense and include, for example, buildings, walls, wells, spas, springs, graves, boreholes, plaques, landslips and viewpoints. This is not a complete list of geological sites in the district. Others will be added and descriptions expanded as further research is carried out.
Important note: Not all of the sites here described are accessible. Some sites are on private land and can only be viewed from footpaths that pass through or alongside the site. Inclusion of a site on this list does not, therefore, imply any right of access. Please remember not to trespass on private land.

BILLERICAY. Norsey Wood Nature Reserve (TQ 691 955)
The reserve has a varied geology, which consists of London Clay, Claygate Beds, Bagshot Sand and Bagshot Pebble Bed. There are no exposures but rounded pebbles are visible in the steep paths.

Harris' Brothers Brickworks at Charity Farm.
The Claygate river beds on Bagshot sand deposited on the London Clay beds held a water table enabling local people to drill fresh water wells in the High Street. The Harris Brickworks, running parallel to the railway on the far side of Radford Way was the location of the Brickworks. The local clay also proved suited to the manufacture of handmade bricks.
A railway spur line ran from the former Goods Yard into the brickfields where they made the handmade 'Red Bricks' and the sand was also transported to the Midlands for casting purposes. The yard closed in the late 1930's.
There were other brickworks in Billericay, one site where Chestnut Avenue is now located.

LANGDON HILLS. Langdon Hills Country Park (TQ 683 866)
The Bagshot Sand, Claygate Beds and London Clay were formed on the floor of an sub-tropical sea some 50 million years ago but the gravel at the very top of the hill is clearly much younger and of a different origin. Originally known as 'pebble gravel,' and called Stanmore Gravel on modern geological maps, this gravel was for years thought to have been laid down under a sea but it is now thought that it may have been deposited by a river. But how could river gravel, of geological recent origin, be capping the tops of some of the highest hills in the region?

For many geologists the riddle of the pebble gravel has now been solved by studying the pebbles it contains. Although mostly of flint, a small proportion are distinctive pebbles of chert from the Lower Greensand of The Weald, and other rock types that could only have been deposited by a river flowing from the south. Similar gravels are found capping the high ground of the Rayleigh Hills. These isolated outcrops of gravel date from the early part of the Ice Age, perhaps as much as a million years ago, and were probably laid down by northward-flowing tributaries of the Thames, when the Thames flowed across central Essex and Suffolk before its diversion to its present course by the Anglian ice sheet 450,000 years ago. It is difficult to believe that this gravel may originally have been the floor of an ancient river valley. Curiously this gravel may even be the reason these hills are here, the gravel protecting these parts of Essex while the surrounding land was reduced to the present lowland by hundreds of thousands of years of erosion.

The Langdon Hills are a remarkable natural feature; an isolated high point in an area of low relief. From here there are fine views where they have not been obscured by the rampant growth of trees in recent years. In 1767, the English writer Arthur Young commented on the view from the Langdon Hills: "…near Horndon, on the summit of a vast hill, one of the most astonishing prospects to be beheld, breaks almost at once upon one of the dark lanes.

Such a prodigious valley, everywhere painted with the finest verdure, and intersected with numberless hedges and woods, appears beneath you, that it is past description; the Thames winding thro' it, full of ships and bounded by the hills of Kent. Nothing can exceed it…" In some areas of high ground in the district, such as Norsey Wood near Billericay, the gravel seems to consist almost entirely of well-rounded flint 'beach pebbles' and sometimes referred to as the Bagshot Pebble Bed. Instability of the London Clay Even though it is some 50 million years old, the London Clay is too young to have been changed into a stronger 'mudstone' and it is therefore still able to absorb and lose moisture.

London Clay contains montmorillonite, a mineral that absorbs water when wet and swells, and loses it when dry and shrinks. This is a common phenomenon in clays and makes them unstable. When dry, the shrinkage shows up at the ground surface as cracks, often seen in grassland such as parks, football pitches and the like. In buildings the frequent movement can cause cracks in walls. The cracks also allow surface water to penetrate more deeply into the soil when it rains. When wet, usually from rain, it is usually only the top 2 metres, rarely more than 5 metres, that is affected in our present climate.

On slopes, notably those steeper than 8 degrees, the shrinking and swelling is affected by gravity and there is a slow movement downslope, again affecting buildings. In more severe conditions, the saturation of the clay makes it less cohesive and also heavier, so slow flows and land slipping can occur. These can be seen as hummocky ground, usually covered by brambles, scrub vegetation and small trees. These processes were the cause of the loss, for instance, of St Michael's Church at Pitsea. Spectacular views over the Thames Estuary. Part of the site is in Thurrock District.

LANGDON HILLS. Lincewood, part of Langdon Nature Reserve (TQ 675 873)
An isolated, wooded hill known as Lincewood with an identical geology to the Langdon Hills. The hill is essentially an isolated patch of Bagshot Sand overlying Claygate Beds and London Clay, with the summit capped with Stanmore Gravel ('pebble gravel'). There is a possibility of creating permanent exposures in Bagshot Sand and Pebble Gravel. The reserve is owned by Essex Wildlife Trust.

Langdon Hills Brickfield (Little Burstead).
The Brickworks were situated on the Langdon Hills side of the railway line, west of the High Road and Station in the parish of Little Burstead. The boundary of Langdon Hills and Little Burstead was in the vicinity of Vowler Road. The Brickworks had operated from around 1900 to 1910. The Clay pit remains, in thick undergrowth and undisturbed since then.

The brickfield itself was further up the hill and owned by a Mr A Robinson Parker, who lived in a white house on Crown Hill, opposite Lee Chapel Lane – Butlers Grove House. The clay was carried to the sheds by a small railway line. Usually two trucks were chained together and the slope of the track on the hill gave gravity propulsion with a man standing on the step of the back truck. There was also a small siding that that took the bricks in wagons on to the main Southend to Fenchurch Street line.

It is mentioned of a brick and kiln field with a pond shown on a 1797 map and listed in the tithe award of 1841 of fields named Kiln Field etc. These fields appear to be part of the Goldsmith estate on the South side of Langdon Hills. From the information available, it would appear that the brick making enterprise only last a few years and was certainly gone by 1911. I have however been told that the bricks had the mark 'Laindon' on them.

PITSEA. St. Michael's Hill (TQ 738 878)
Abandoned River Thames cliff line. The hill is an example of land slipped ground, with fine views over the modern Thames Valley.

Vange Hall Brickworks (1886-1921).
Apart from its known depth of brickmaking soil, it also had exclusive access to the wharf on Vange Creek.
There was also a smaller brick-field owned by Messrs Clark, Nicholls and Coombs from around 1908. This was situated to the west of the wharf or Merricks Lane.
CASTLE POINT
The following sites have been selected to represent the different aspects of geology and landscape in the district.
Not all sites have something to see; many are solely of historical interest as a record of an important or interesting

discovery.
Local Geological Sites (LoGS) Castle Point District Council – Report on Local Geological Sites – June 2019.

HADLEIGH. Hadleigh Castle Landslip (TQ 810 860)
The most impressive London Clay landslip in Essex. The severe effects on the castle can be clearly seen.
Aerial view of Hadleigh Castle with its conspicuous landslip. Photo © Essex County Council

HADLEIGH. Shipwrights Wood (TQ 795 871)
Steep slopes of London Clay, Claygate Beds and Bagshot Sand with landslips. Best woodland in Essex for natural landforms.

DAWS HEATH. Pound Wood Nature Reserve (TQ 816 888)
Fine undulating landscape of London Clay, overlain by Claygate Beds and Bagshot Sand. Highest point capped with Daws Heath Gravel, which was laid down by the River Medway probably over a million years ago. No visible exposures of the underlying rocks but pebbles from the gravel are conspicuous in paths and roots of fallen trees.

DAWS HEATH. West Wood. (TQ 805 880)
West Wood has a varied geology which has influenced the species of trees that exist from valley floor to hill top. The Prittle Brook flows in the valley in the centre of the wood which is underlain by a bedrock of Claygate Beds. To the north and south the rising ground gives way to the overlying Bagshot Sands. On the highest ground, close to the north and south boundaries of the wood, there are overgrown shallow pits where lots of exotic gravel can be found. This is Daws Heath Gravel which is an ancient remnant of a terrace of river gravel deposited by the River Medway when it flowed across eastern Essex in the early part of the Ice Age, perhaps as much as a million years ago.

HADLEIGH. Hadleigh Country Park (TQ 799 868)
Fine undulating landscape of London Clay, overlain by Claygate Beds and Bagshot Sand. The exposure of Bagshot Sand created in 2007 has been obscured by the Olympic cycle track but a new exposure is planned. Site of British Geological Survey's 1973 Hadleigh borehole. Fine views over Thames to Kent.

THUNDERSLEY. Coombe Wood (TQ 782 882)
Steeply sloping woodland situated on the Claygate Beds with Bagshot Sand on the highest ground. The layers of sandy clay that make up the Claygate Beds can be seen in the sides of a stream that cuts through the wood in a very steep valley which is almost a ravine. Some sites are not strictly geological but have a geological connection. Geological sites are therefore defined in their widest sense and include, for example, buildings, walls, wells, spas, springs, graves, boreholes, plaques, landslips and viewpoints.

THE RAYLEIGH HILLS.
Research shows that the River Medway in Kent is a very ancient river and before the diversion of the Thames to its present course the Medway flowed across eastern Essex to join the Thames in what is now north Essex or Suffolk.
The route of this river has left behind evidence of its existence as layers and patches of gravel between Hadleigh and Bradwell-on-Sea. The higher the altitude of this gravel the older it is and the highest of this gravel (known as Daws Heath Gravel and Claydons Gravel) is on the Rayleigh Hills between Hadleigh and Hockley which, in places, is over 80 metres (240 feet) above sea level.

It is difficult to believe that this gravel, which caps some of the highest ground in south Essex, was originally the floor of an ancient river valley. However, this must have been the situation over 700,000 years ago. Like the gravel on the summit of the Langdon Hills (which was deposited by another northward-flowing tributary of the ancient

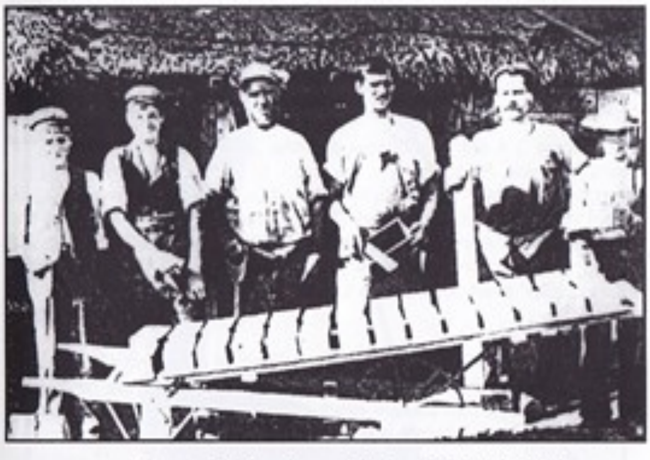
Thames), the Rayleigh Hills gravel contains distinctive pebbles of chert from the Lower Greensand of The Weald, together with other rock types that could only have been deposited by a river flowing from the south. It also contains boulders of sarsen stone which must also have originated in Kent.

An example is the 45 centimetre (18 inch) diameter specimen in the south wall of Hadleigh Church although nineteenth century observers have described much larger boulders that were formerly present on the roadside in several parts of the district.

The existence of this high level river gravel may even have contributed to the creation of the Rayleigh Hills by protecting the Bagshot Sands and Claygate Beds from erosion while the surrounding areas were slowly reduced to the present lowland. It is a vivid reminder of the immense erosion that has taken place during the ice age and how the land surface can be considerably reshaped in relatively short periods of geological time.

Brickfields in the Rochford and Southend Districts.
There were brickfields at Star Lane, Great Wakering; Cherry Orchard Lane, Stroud Green; Purdy's Farm, Rochford and Ballards Gore, Great Stambridge. All took advantage of the plentiful London clay lying just under the surface to provide the much needed bricks required for the rapid expansion of housing between the World Wars and until 30 or 40 years ago.
Roman bricks and tiles have been found in the construction of Great Wakering church so it is possible that the local brick industry may have a very long history indeed. Before the 1860s a few brick yards existed in Wakering as bricks were needed for, at least, the chimneys in wooden and wattle and daub buildings. These early brick yards were small, family owned, affairs. They usually had a horse driven pug mill where the brick earth was mixed with water and lime and a small bench where the bricks were moulded. Digging out the brick earth resulted in a lowering of the soil level, evidence of which can still be seen at the southern end of Exhibition Lane which is called Brick Lane by some of the older inhabitants.

By the beginning of the 20th century, the brick making industry had grown so much that the total workforce was larger than that in all other forms of local employment. From census information it can be seen that the population of Wakering had increased nearly threefold in the previous century when that of the surrounding parishes had either decreased or remained static.



Gang of Brickmakers at the Landwick Brickfields

The early years of the 20th century saw the peak of the brick making industry at Wakering with both the Landwick and Millhead yards together employing more than 600 men, women and boys. In 1918 the Landwick site was worked out and closed. The equipment was transferred to Millhead which was further expanded but which, itself, was closed in the 1960s.

Gradually the hand making process was displaced and brick making machines were installed. There was a decline in the number of men employed but the new ranges at Shoebury offered alternative employment. In 1936 a new brick field was opened in Star Lane by The Milton Hall Brick Co. A hundred years after the high point of Wakering brick making this works was also closed.

Sailing barges had been owned and worked in the rivers and creeks around Barling, Wakering and the islands since the early 1800s. Before the coming of the railway and proper roads they were the only economical way of transporting large, heavy loads. Ideally suited to navigating the shallow waters around the Thames estuary due to their flat bottom and wide beam. Many of the vessels used locally were owned by Rutters, who had an interest in the Wakering brick fields.

There were at least eight barge owners at Barling and a further four or so at Little Wakering. Most of these were engaged in the transportation of corn, hay and straw, and were sometimes called "stackies" because of the great stacks piled on deck. Other barges carried flint and tarmac which were hauled from the hold in baskets and used to reinforce the seawalls around Wakering, Barling and Foulness.

The barges, known as "brickies", would be loaded with 45,000 bricks at a time, about a week's production. In the 1920s the going carriage rate for a load to London was 15 pence per 1000! The other cargo carried by the brickies was sand. This was dug out of the sandbanks off Leigh by hand using a wooden bladed spade with a steel edge. It was very hard work and when they reached Wakering the crew had to unload the sand, again by hand, and barrow it over the seawall to the brick fields where it was spread out and dried. The sand was then used in the sanding of the brick moulds to prevent the wet clay from sticking in the moulds.

Rutters had built their last four barges, the “Anthony,” “Gascoigne,” “Juniper” and “K.C.” in their Crayford, Kent, yards around the time the Landwick brick field was closed. The last barges sailing from Wakering with bricks left around the 2nd World War by which time lorries were carrying these heavy loads. (From: “History of the Wakering and Barling Barges,” by Gordon Wiseman, 1999)

Rawreth and Stambridge (right)

The tide mills at Rawreth and Stambridge were first built hundreds of years ago to take advantage of the fast flowing rivers Crouch and Roach at their tidal and navigable limits. Both were still functioning until relatively recently. Originally built to mill locally grown corn for flour, in later years they produced animal feedstuffs from beans and barley.

Battlesbridge Mill today

The mill on the southside of the Crouch at Battlesbridge has been demolished but that on the north bank still gives a good idea of how it looked. The Stambridge mill was functioning more recently until a fire made it unviable.

The Essex Earthquake.

Although it is generally thought that earthquakes are rare in Britain they do in fact occur quite frequently. Approximately 300 are detected each year by sophisticated monitoring equipment and of these about 30 are strong enough to be felt. Occasionally, however, Britain is shaken by an earthquake which causes structural damage.

The most destructive earthquake ever recorded in Britain occurred in Essex on the morning of 22 April 1884 and strongly shook most of the county. It is known as the Colchester earthquake because the greatest damage was caused to Colchester, Wivenhoe and the towns and villages nearby. The tremor was felt over much of southern England and parts of France and Belgium, and its magnitude has been estimated at 5.2 on the Richter scale.

The number of casualties is difficult to estimate, but it is doubtful whether any deaths or serious injuries can be attributed to the earthquake. The earthquake was probably due to movement along a fault in the ancient Palaeozoic rocks under Essex which would have affected the overlying cover of Cretaceous and Tertiary strata.

An extensive study of the effects of the earthquake was carried out shortly afterwards by the Essex Field Club and their detailed report, published in 1885, is a fascinating and extremely valuable account. Copies of the report are available for reference at Colchester and Chelmsford libraries.

A plaque commemorating the Essex Earthquake on the wall of a building in Peldon (photo © W.H. George) & a fine brick mansion at Great Wigborough, damaged by the 1884 earthquake that caused considerable damage to over 1,200 buildings in Essex (photo © Essex Libraries).

Although distant from the nearest plate boundary, the Mid-Atlantic Ridge, earthquakes in the UK occur as crustal stresses within the tectonic plates are relieved by movement occurring on pre-existing fault planes.

The driving forces for earthquake activity in the UK are unclear. They include regional compression caused by motion of the Earth's tectonic plates and uplift resulting from the melting of the ice sheets that covered many parts of Britain thousands of years ago.

Each year, between 200 and 300 earthquakes are detected and located in the UK by BGS. Between 20 to 30 earthquakes are felt by people each year and a few hundred smaller ones are only recorded by sensitive instruments. Most of these are very small and cause no damage. However, some British earthquakes have caused considerable damage, although nothing like the devastation caused by large earthquakes in other parts of the world.

A magnitude 4 earthquake happens in Britain roughly every two years. We experience a magnitude 5 roughly every 10–20 years. Research suggests that the largest possible earthquake in the UK is around magnitude 6.5.

BGS routinely studies earthquake hazards for engineering projects. This work can influence construction methods and operating procedures for large projects like the Channel Tunnel or for new power stations, for example.

The largest known British earthquake occurred near the Dogger Bank in 1931, with a magnitude of 6.1. Fortunately, it was 60 miles offshore but was still powerful enough to cause minor damage to buildings on the east coast of England.

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