GeoEssex

Promoting the geology and landscape of Essex

Chelmsford City Council
Report on Local Geological Sites

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Contents

Cover photographs:
***Above**: Cliff of glacial till at the old quarry edge in the southern part of the Phase 6 development area at Channels, Little Waltham. **Below**: Boulder of Hertfordshire puddingstone at the entrance to Channels.*

1. Introduction

The rocks beneath the Essex landscape are a record of the county's prehistory. They provide evidence for ancient volcanoes, deserts, glaciers and deep seas. Some rocks also contain remarkable fossils, from subtropical sharks and crocodiles to Ice Age hippos and mammoths. The geology of Essex is a story that stretches back over 100 million years.

GeoEssex

GeoEssex is the primary source of information about the geology and physical landscape of Essex. The GeoEssex team, or 'Steering Group', consists of professional and amateur geologists, representatives from local authorities, geological and natural history societies, and from Natural England, the Government's nature conservation body.

GeoEssex promotes geology in all its aspects, from quarries, cliffs and boulders to spas, springs and building stones. The fascinating and often magical world of geology is all around us, if only we know where to look.

A primary task of GeoEssex is to identify the best places in Essex to find out about the Earth's distant past and the landscape processes going on today. These sites are called Local Geological Sites, or LoGS (formerly called Regionally Important Geological Sites or RIGS).

GeoEssex aims to advocate and represent geodiversity in planning processes and other initiatives.

Spectacular chalk cliff at Chafford Gorges Nature Park, Thurrock. The cliff represents a section through an ancient sea floor that existed across England about 80 million years ago. The Chalk is present beneath the whole of Essex, appearing at the surface only in the north and south of the county

Geodiversity

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 particularly true in Essex, 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.

Local and national Geodiversity Action Plans

The UK Geodiversity Action Plan (UKGAP) sets out a shared framework for geodiversity action across the UK. It establishes a common aim, themes and targets which link national, regional and local activities. It encompasses how geodiversity can inspire people and what needs to happen to conserve Britain's geodiversity. The Plan for Essex has been drawn up within this framework.

A Local Geodiversity Action Plan (LGAP) has been produced for Essex. It sets out a framework for geodiversity action in Essex. It is an essential document to conserve the County's geodiversity.

The Essex Local Geodiversity Action Plan aims to:

- *Identify, conserve and enhance the best sites that represent the geological history of an area in a scientific, educational, recreational and cultural setting.*
- *Promote geological sites and make geoconservation relevant to people.*
- *Provide a local geodiversity audit (an audit of sites and skills).*
- *Influence local planning policy.*

2. 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.

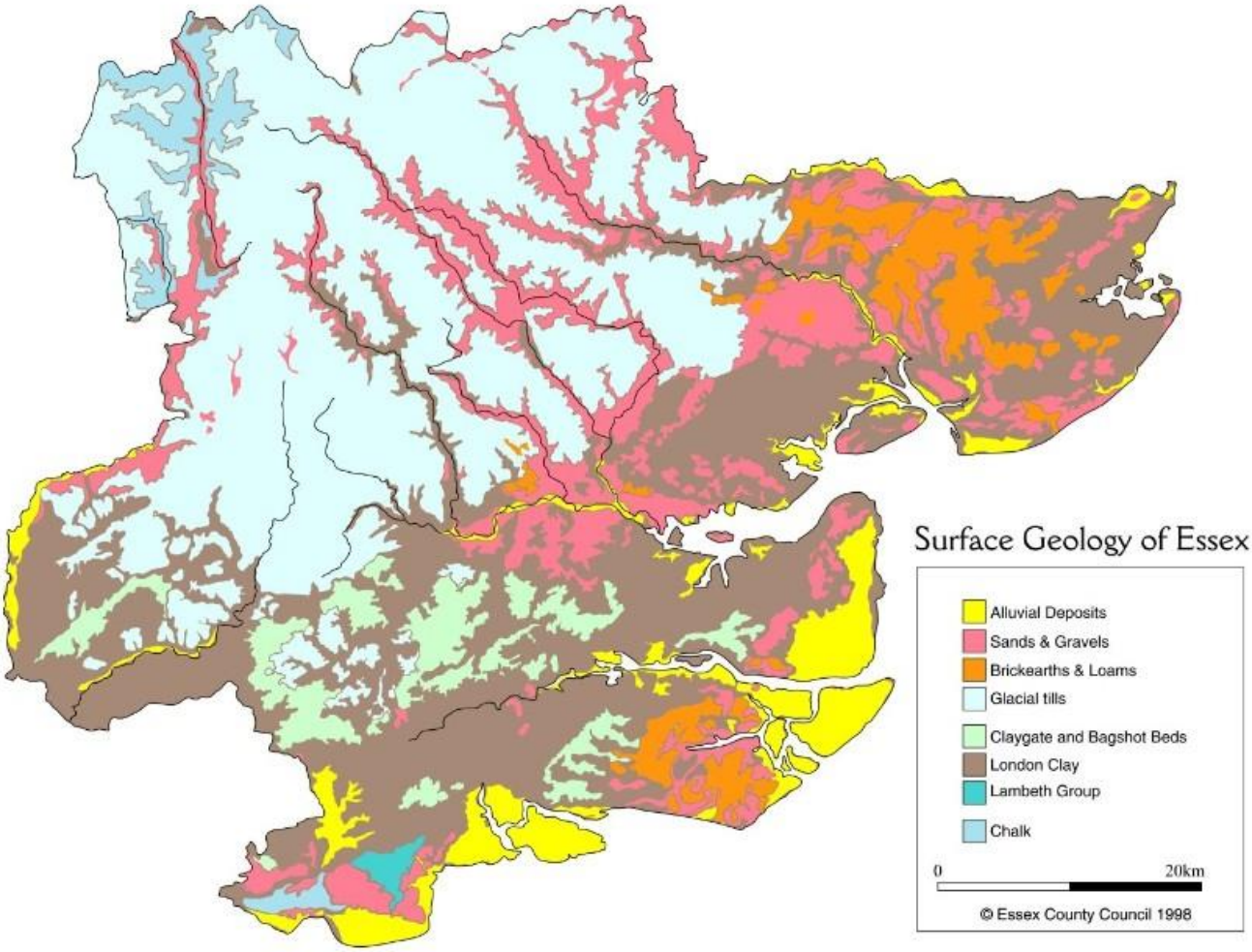
The surface rocks of Essex that were formed before the Ice Age (from the Chalk to the Red Crag) are described as the 'bedrock' or 'solid' geology. Much of this bedrock geology is concealed beneath the deposits left behind by glaciers and rivers during the Ice Age. The material laid down during the Ice Age is known as 'Superficial' or 'drift' deposits.

Era	Period or Epoch		Approx. age in millions of years	Geological formations in Essex
Caenozoic	Quaternary Ice Age	Holocene	0.01	Recent peat and alluvium
		Pleistocene	0.45	River terrace deposits and brickearth (loess)
				Boulder clay (till) and glacial gravel
			1	Kesgrave (Thames) sands and gravels
				Norwich Crag (Chillesford Sand)
			2.4	Red Crag
	Pliocene		10	*No evidence of rocks of this age in Essex but derived Miocene and Pliocene fossils are found in the Red Crag*
	Miocene			
	Oligocene		20	
	Eocene		50	Bagshot Sand
				Claygate Beds
				London Clay (includes the Harwich Formation)
	Palaeocene		55	Lambeth Group (Woolwich and Reading Beds)
				Thanet Sand
Mesozoic	Cretaceous		80	Chalk
			100	Gault and Upper Greensand (Beneath Essex)
	Jurassic		150	*No evidence of rocks of these ages beneath Essex with the exception of Jurassic Oxford Clay in a graben (a sunken part of the crust bordered by faults) beneath East Tilbury.*
	Triassic		220	
Palaeozoic	Permian		250	
	Carboniferous		300	
	Devonian		400	Shales and mudstones dating from these periods occur at depth (about 300 meters) beneath Essex
	Silurian		420	
	Ordovician		450	*No evidence beneath Essex, however, boreholes have not been drilled deep enough to confirm.*
	Cambrian		500	
Pre-Cambrian	Precambrian		Age of Earth 4,600	

Geological Map of Essex

Geological map of Essex showing all the rocks exposed at the surface - bedrock and superficial deposits. An example of a superficial deposit is boulder clay or glacial till left behind by the Anglian Ice Sheet during the Ice Age (shown in pale blue).

Map based on published maps with the permission of the British Geological Survey



Essex through geological time

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.

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 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 present Ice Age, with many warm periods such as the one we are in right now. 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.

3. Background to Geological Site designation in Chelmsford

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.

A mammoth tooth from Essex

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, e.g. in the Danbury area. These are of great significance both for biodiversity and recreation.

London Clay outcrops south of Chelmsford, providing fertile soils for arable agriculture, especially wheat. The chalky till found in north and west of Chelmsford eg. the Pleshey Plateau, is also highly suitable for cereal cultivation.

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.

Geodiversity and National Planning Policy

The importance of geodiversity as an integral part of nature conservation and the planning system is reflected in The National Planning Policy Framework (NPPF), and in legislation – Wildlife & Countryside Act 1981 and Countryside and Rights of Way Act 2000.

The NPPF states that:

(1) "the planning system should contribute to and enhance the natural and local environment by protecting and enhancing valued landscapes, geological conservation interests and soils" (Paragraph 109);

(2) "local planning authorities should set criteria based policies against which proposals for any development on or affecting protected wildlife or geodiversity sites or landscape areas will be judged" (Paragraph 113); and

(3) "to minimise impacts on biodiversity and geodiversity, planning policies should aim to prevent harm to geological conservation interests" (Paragraph 117).

Site designations

The most important geodiversity sites have been declared as **Sites of Special Scientific Interest** (SSSIs) which are statutorily protected for their scientific importance (see below for a list of Chelmsford geological SSSIs).

The next tier of geodiversity sites are known as **Local Geological Sites** (LoGS) These have replaced the earlier 'Regionally Important Geological Sites' (RIGS) terminology in line with government guidance.

Local Geological Sites (LoGS) are broadly equivalent to Local Wildlife (species and habitats) Sites ('LoWS') but have a broader remit as they can be designated for their scientific, educational, historical and recreational benefits. Typical Essex LoGS include quarries, pits, walls, boulders, cliffs, springs, and river meanders. Local Wildlife Sites and Local Geological Sites are both designed to provide a system of locally-valued, non-statutory sites.

Most importantly, the NPPF gives Local Geological Sites a weighting equal to Local Wildlife Sites, and both are collectively referred to as 'Local Sites'. However, in actuality the attention and priority afforded to the designation and management of LoGS has historically lagged, and continues to lag well behind that of LoWS.

4. Objectives of current report

Supporting Local Planning Authorities

"*Local and neighbourhood plans and planning decisions have the potential to affect biodiversity or geodiversity outside as well as inside designated areas of importance for biodiversity or geodiversity"* (extract from: www.gov.uk/guidance/natural-environment)

Biodiversity protection is familiar to planning authorities but geodiversity less so. This report will assist planning authorities in meeting their obligations under the National Policy Planning Framework and helping them identify potential development impacts on LoGS.

GeoEssex is therefore seeking to help Local Planning Authorities fulfil their responsibilities with respect to geodiversity.

Further guidance on statutory obligations is given in Circular 06/2005 (*Biodiversity and Geological Conservation*). Geodiversity should be therefore included alongside biodiversity in local authorities' Local Plans. Identifying these non-statutory sites therefore helps local authorities to meet their obligations.

LoGS can also contribute to *sustainability* programmes by providing information about a key element of the environment that contributes to our natural heritage. In addition, the *awareness raising* and *education* function fits well with the principle of community involvement and enabling people to regain their sense of place.

A typical Local Geological Site – an inland cliff in a former quarry consisting of sand and gravel laid down by meltwater from a glacier about 450,000 years ago. The variety of pebble types in the gravel can tell us the route the ice has taken to get to Essex, sometimes from as far away as Norway. Sites like these are valuable for research and education but can easily be obscured or destroyed.

5. Site selection

Site selection and notification to planning authorities

LoGS in Essex are identified by **GeoEssex**, a largely voluntary group composed of representatives from the major Essex geological and conservation bodies and supported by Essex Wildlife Trust, Natural England and Essex County Council (Place Services). The site selection process is based on clearly defined criteria (see below) and includes scientific, educational, historical and aesthetic values. When selecting sites GeoEssex aims to gain the support of landowners whenever possible. The majority of LoGS are on private land and site selection does not infer any right of access.

Like LoWS, proposed LoGS are presented to the Local Sites Partnership (chaired by Essex Wildlife Trust) for endorsement and then passed to local authorities for inclusion in their Local Plans. Local authorities receive a citation and boundary map.

The sites selected as LoGS in the Chelmsford district are summarised below, together with a list of other sites which are potential LoGS. Other sites may be identified in the future, occasioned by housing or other development and restoration following mineral extraction.

Site protection

Like their biodiversity counterparts, LoGS have no statutory protection and the conservation and management of individual sites relies heavily on the support of landowners. Inclusion within local plans also forms a vital role in the protection of LoGS. An example of a comprehensive natural environment policy incorporating geodiversity can be provided on request.

It is recommended that the Local Sites Partnership (c/o Essex Wildlife Trust) should be consulted if any development is proposed that would affect a LoGS.

A spring line runs around Danbury Hill where water seeps out of the permeable Danbury Gravel on meeting the impermeable London Clay below. The largest spring here is Buell Spring, which was an important source of water for the area and originally fed a pumping station. The crystal-clear water of the spring now emerges from a cast iron pipe.

While not appearing to be significant, sites like these are of historical and educational importance but can easily be obscured or destroyed.

Site Assessment Criteria

The assessment criteria used for identifying LoGS are based on DEFRA document *Local Sites: Guidance on their identification, selection and site management* (2006). The guidance states that assessment is a matter of judgement but must be based on an understanding of geological principles and processes, and the distribution and abundance of the resource (national, regional and local). Those sites selected must be 'of substantive importance to the geodiversity of the local area'.

There are four value categories: scientific, educational, historical and aesthetic. A site qualifies for notification as a Local Geological Site if it fulfils the criteria under one or more of these categories. Each site is also given a site assessment score. This score is not a measure of the site's value or importance but a relative assessment of the usefulness of the site in promoting geodiversity.

Land Ownership Notification

Where the landowner is identified as a public body eg. a local authority, Forestry Commission etc., notification is by letter to that authority. For sites under private ownership, where the landowner can be identified, they will be informed by letter.

Nineteenth century engraving of Rolston's Pit, Writtle – an example of a geological site that has been lost. This little disused quarry showed a spectacular section of glacial boulder clay overlying Thames gravels and was visited by several parties of geologists and academics at the time. The site is now an arable field. Illustration taken from *The Geology of England and Wales* by H.B. Woodward (1875).

6. Additional Sources of Information

Scientific literature
If a LoGS has been referred to in the scientific literature these references are of given in the LoGS citation. The fact that a site has been referred to in the scientific literature means that the site is of historical interest and some of these sites will have potential for future research.

Interpretation
If a site is accessible or simply visible to the general public, it is the aim of GeoEssex to provide interpretive information where possible and practical. This could be in the form of interpretive boards or leaflets. Such interpretation will be with the cooperation of landowners and other interested parties.

GeoEssex www.geoessex.org.uk
Background geological information for Essex, together with a selection of sites in each district (SSSIs and public accessible sites) can be found on the GeoEssex website

Essex Field Club www.essexfieldclub.org.uk
The Essex Field Club, founded in 1880, exists to promote the study of the county's natural history, and includes geology amongst its many activities. The club has a centre for Biodiversity and Geodiversity in Wat Tyler Country Park at Pitsea, near Basildon. It is open to the public most weekends. Their website provides comprehensive data on a large number of wildlife and geological sites which can be searched in a number of ways. Details of several hundred geological sites across Essex can be found here which includes LoGS and potential LoGS.

British Geological Survey www.bgs.ac.uk
Other geological resources, maps and borehole information are available on the website of the British Geological Survey.

Essex Rock & Mineral Society www.erms.org.
The Essex Rock and Mineral Society, founded in 1967, is the club for Essex amateur geological enthusiasts.

GeoEast
GeoEast is the East of England Geodiversity Partnership. It is a partnership of organisations active in conserving and promoting Earth heritage in the six counties of the region (including Essex).

Earth Heritage Magazine www.earthheritage.org.uk
Earth Heritage magazine is produced twice a year for the geological and landscape community by Natural England, Scottish Natural Heritage, the Countryside Council for Wales and The Wildlife Trusts.

Geologists' Association www.geologistsassociation.org.uk
The Geologists' Association, founded in 1858, is Britain's largest society for amateur geologists.

Books

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HOSE, T.A. (ed). 2016. *Geoheritage and Geotourism: A European perspective*. The Boydell Press.

LUCY, G. 1999. *Essex Rock: A look beneath the Essex landscape*. Essex Rock and Mineral Society.

PROSSER, C., MURPHY, M. and LARWOOD, J. 2006. *Geological Conservation: A Guide to Good Practice*. English Nature.

A selection of scientific papers relating to the Chelmsford district

COLE, W. 1907. Meeting in the Danbury and Little Baddow Districts in conjunction with the Geologists' Association. *Essex Naturalist*. Vol. 14: Pages 260-264.

GIBBARD, P.L., et al. 1996. Early Middle Pleistocene fossiliferous sediments in the Kesgrave Formation at Broomfield, Essex, England. In C. Turner (ed) The Early Middle Pleistocene in Europe. Rotterdam: Balkema. Pages 83–119.

GREGORY, J.W. 1915. The Danbury Gravels. *Geological Magazine*. Decade VI (Vol. 2). Pages 529-538.

LUCY, G. 2003. Essex erratic boulders: a gazetteer. *Essex Naturalist* (New Series) No. 20. Pages 115-134.

MONCKTON, H.W. 1891. Geological ramble round Chelmsford. *Essex Naturalist*. Vol. 5. Pages 209.

7. List of Sites

The following is a representative list of geological sites in the district. For completeness it includes geological SSSIs but these sites are statutory sites and do not form part of this report.

The list gives an idea of the range of sites that can qualify as Local Geological Sites (LoGS). It includes those LoGS that have already been approved by the Local Sites Partnership.

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.*

Sites of Special Scientific Interest (SSSIs) *(included in this report for completeness)*

GREAT LEIGHS. River Ter SSSI (TL 744 155 to TL 733 157)
The stretch of the River Ter in the vicinity of Lyons Hall has been notified as a geological SSSI because it is representative of a lowland stream with a distinctive flood regime. It illustrates well the relationship between river discharge and channel dimensions and has been used to test theories about why rivers adopt a meandering course. There are public footpaths alongside the river (including the Essex Way).

NEWNEY GREEN. Newney Green Pit SSSI (TL 648 065)
Kesgrave (Thames) Sands and Gravels are present at this site with a palaeosol (fossil soil horizon) of pre-Anglian age. This is overlain by boulder clay (till) which was deposited by the Anglian Ice Sheet. Occasional patches of glacial gravel are also found, and an (Anglian) arctic structure soil is superimposed on the pre-Anglian palaeosol marking a change from warm interglacial to intensely cold glacial conditions. This site is of prime importance for the correlation between Pleistocene sites in the Thames and East Anglian areas. A vital locality in working out the sequence of events in the evolution of the Thames. The pit has now been infilled except for the small area of the SSSI. The site is on private land.

Local Geological Sites (LoGS) *Sites agreed by Local Sites Partnership to date.*

DANBURY. Buell Spring (TL 7839 0451)
Spring issuing clear water from a cast iron pipe. Remains of pumping station. Spring originates from the spring line that runs right around Danbury Hill (from between the Danbury Gravel and the London Clay). Historically important as the water supply for the area. Of particular interest is the accumulation of 'bog-iron' nearby - a cementing of the soil by the iron compounds leached out of the gravel. Land owned by the National Trust.

DANBURY. Danbury Common Gravel Pits (TL 784 047 and TL 781 045)
Deep and extensive disused and overgrown gravel pits on east and west sides of Danbury Common (two separate patches of gravel) which provide visible sections through the Danbury Gravels - gravel that accumulated on the ice margin, where its southward progress was prevented by the London Clay high ground. Owned by the National Trust. Eastern pits heavily used by mountain bikers. The higher parts of the western pits are very sandy and used by badgers.

GREAT BADDOW. Beehive Lane Sarsen Stone (TL 71948 05544)
A sarsen stone 90cm x 70cm x 60cm sits in the car park of the Beehive Public House in Beehive Lane. It was obtained from the old 'Beehive' gravel quarry before 1906.

HIGHWOOD. Parsons Spring Pits (TL 623 028)
Parsons Spring (also known as Parsons Wood) has numerous shallow but steep-sided pits where sand and gravel was once exploited. This sand and gravel is referred to on geological maps as 'Stanmore Gravel' (formerly called 'pebble gravel'). How it was formed has been debated by geologists since the 19th century. Its origin is still unclear today although one theory is that it was laid down by a river, probably over one million years ago, during the early part of the Ice Age. The pits are clearly visible as overgrown hollows either side of the public footpath that runs through the wood.

LITTLE WALTHAM. Channels Golf Club Boulder (TL 72382 11185)
By the entrance to Channels Golf Club is a large boulder of Hertfordshire puddingstone on a mound of grass by the roadside. It is one of the largest puddingstone boulders in Essex, measuring 2.1 metres long by 1.2 metres high by 0.4 metres in thickness. This boulder was found in one of the local gravel pits, all of which have now been restored.

SANDON. Sandon Gravel Pit (TL 747 043)
The disused Sandon gravel pit has good exposures in Kesgrave Sands and Gravels. Much of the pit has not been restored and therefore the quarry slopes and edges are largely as they were when quarrying ceased. This makes the site important for geology as there are several small exposures of gravel, for example on the southern lake edge. The Kesgrave Sands and Gravels were laid down during the early Ice Age by the River Thames when it flowed through mid Essex and Suffolk. The gravel is mostly flint but also contains 'exotic' pebbles of rocks from far upstream. Sandon Pit is also a Local Wildlife Site

SOUTH WOODHAM FERRERS. River Crouch Foreshore (TQ 804 955)
River erosion at several places around the Essex coast has exposed evidence of human occupation dating from the Mesolithic Period. These settlements are now below high tide level and the most important of these is at Hullbridge/South Woodham Ferrers where a prehistoric land surface, possibly as much as 7,000 years old, is exposed on the foreshore of the River Crouch. The sites can only be examined at low tide.

STOCK. Stock Road Gravel Pits (TQ 6965 9962)
In woodland just west of the Stock Road, north of the village of Stock, are disused gravel pits. These pits are an important geological site because it was one of the very few places where the 'Bagshot Pebble Bed' was formerly exposed. The pits are now overgrown but with the permission of the landowner it would be relatively easy to re-expose the gravel for study.

Other sites of geological interest in the district.

(Some of these sites are being considered as potential LoGS).

BROOMFIELD. Broomfield Sarsen Stones (TL 705 104)
Two small but conspicuous sarsen stones by the church gate, the largest 60cm long.

CHELMSFORD. Chelmsford Cathedral (TL 708 069)
Remarkable abundance of 'bunter' quartzite and Hertfordshire puddingstone from the Thames gravels in the extension to the chancel, built in 1923, and the vestry block, built three years later. Plus fine flint craftsmanship on the porch.

CHELMSFORD. Chelmsford Museum Puddingstone (TL 7025 0555)
Boulder of Hertfordshire puddingstone 70cm x 60cm x 30cm by the front entrance to Chelmsford and Essex Museum in Oaklands Park.

CHELMSFORD. Church of Our Lady Immaculate (TL 7050 0625)
Built in 1846 the Church of Our Lady Immaculate in New London Road is a fine example of the use of knapped flint. The flint walls have limestone dressings and the building has a roof of Welsh slate.

CHELMSFORD. Former Moulsham Brickpits (TL 702 060)
Large areas of old Moulsham were formerly brick pits and several of these produced Ice Age fossils in the 19th Century. Particularly notable were the bones of elephant and hippopotamus, some of which are on display in Chelmsford Museum. The conspicuous areas of low-lying ground on the north side of New London Road are former pits. In the latter part of the Ice Age hippos are only recorded as being present in Britain once, during the Ipswichian Interglacial period. These fossils are therefore considered to be Ipswichian in age (about 120,000 years old).

LITTLE WALTHAM. Cliff of Glacial Till (TL 7216 1102)
In the southern part of the Phase 6 housing development area at Channels there is a vertical cliff of glacial till that remarkably has survived since quarrying ceased here several decades ago. Till is the deposit left by the glacier that covered Mid Essex 450.000 years ago, during the coldest part of the Ice Age. It forms the

deposit on which much of the fertile soil of the area is formed. If it can be retained, this cliff would form the only accessible and visible exposure of glacial till in the whole of Essex.

PLESHEY. Pleshey boulders (TL 648 143)
On the traffic island at a road junction west of the village is a fine erratic boulder of Carboniferous Limestone 1.1metre long with fossil corals and a sarsen stone 0.7 metre long.

RETTENDON. All Saints Church (TL 770 960)
Typical church of Kentish Ragstone with a fine view. Splendid tomb of Italian marble.

RUNWELL. Running Well (TQ 7511 9657)
An ancient spring that gave its name to the village. Situated 300 metres south-east of Poplars Farm between Runwell and Rettendon the well still exists and the water is said today to be of good quality. First recorded in Morant's History and Antiquities of Essex in 1768. The water flows from the junction between the Bagshot Sand and the Claygate Beds.

SOUTH WOODHAM FERRERS. Bushy Hill (TQ 813 986)
Bushy Hill to the north of the town is a prominent and locally important landscape feature. It is composed of London Clay capped by Claygate Beds with notable landslips on the southern and western slopes. There are fine views of the Crouch valley from the summit.

Buell Spring

Site location: Buell Spring, on the eastern side of Danbury Common.

Grid Reference: TL 7839 0451

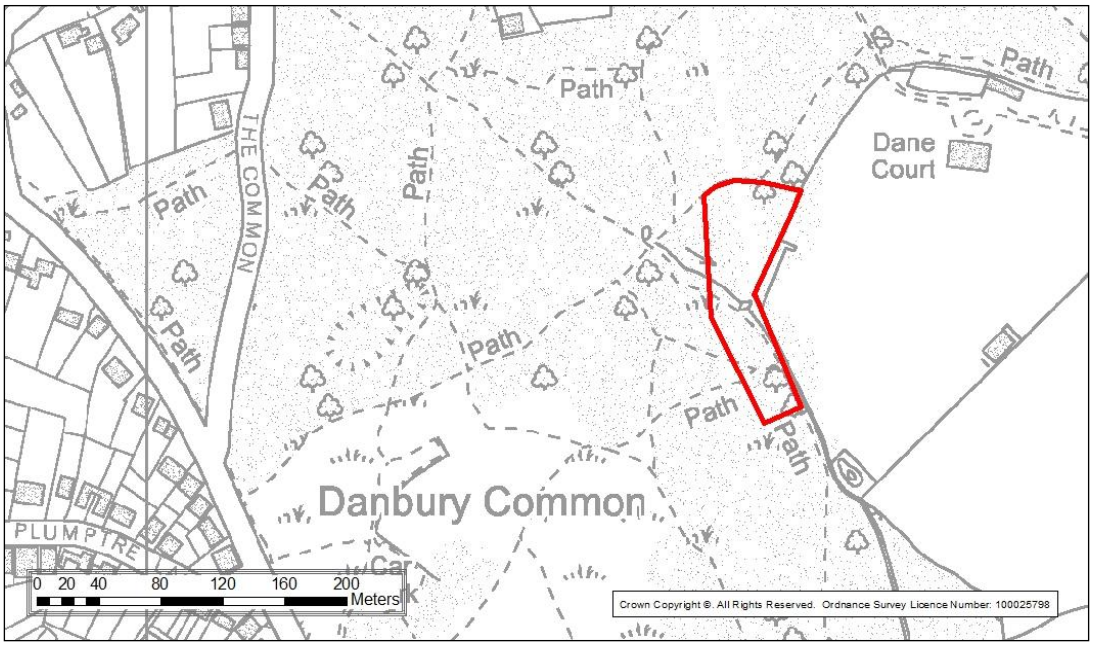
Status: Accessible at all reasonable times

Summary of the geological interest:

A spring line at approximately 70 metres above sea level runs right round Danbury Hill, where water seeps out of the permeable Danbury Gravel on meeting the impermeable London Clay below.

The largest spring here is from Buell Spring, which feeds Buell Brook. The spring itself is some 50 metres to the north, but was piped to this site to enable a pumping station to be built on firmer ground. The pumping station has now been demolished and all that remains of it are the foundations and odd pieces of pipework.

The crystal-clear water of the spring now emerges from a cast iron pipe next to the foundations of the pumping station. Of particular interest is the accumulation of orange/red-coloured 'bog-iron' in the damp ground between here and the site of the spring further up the hill, which is a cementing of the soil by the iron compounds leached out of the gravel.



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Scientific interest and site importance

Buell Spring is not of scientific interest but is of considerable educational interest. It is a good example of a natural spring. It also has a historical connection, formerly being an important source of water for the area. Whitaker (1916) states that the water was supplied to Battlesbridge, Little Baddow, Runwell, Sandon and Wickford station.

Other information

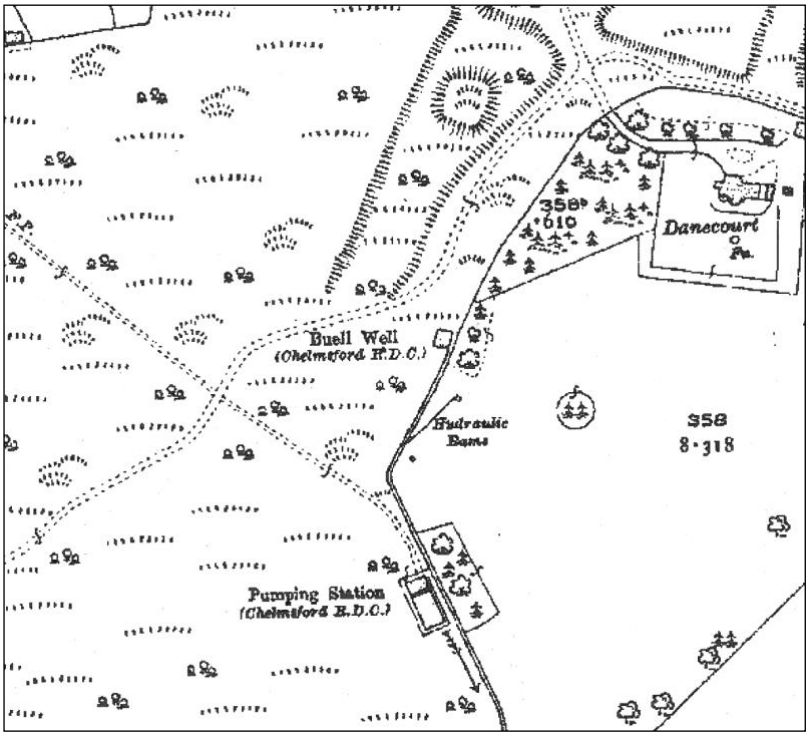
In 1891 water from the spring was raised by self-acting ram to a tank on Danbury Hill, and, by 1900, water from this well was being supplied to communities as far away as Battlesbridge and Wickford. Reservoirs were provided to store water. In 1911 the reservoirs supplied water to a population of about 4,000. The pumps and reservoirs became redundant in 1936 and were finally demolished in 1962. All that now remains of them are the foundations and odd pieces of pipework.

The spring is on land owned by the National Trust and adjacent to the extensive disused gravel pits on Danbury Common. Access is available at all times.

References

WALLIS, R. & MUSSON, J. 1995. *Danbury and Lingwood Commons* ***(booklet). National Trust Enterprises Ltd. Page 10.***

WHITAKER, W. & THRESH, J.C. 1916. *The water supply of Essex from underground sources.* **Memoir of the Geological Survey of Great Britain.** ***HMSO. Pages 76-77***



Extract from 1914-1924 Ordnance Survey Map showing Buell Spring and the pumping station

Danbury Common Gravel Pits

Site location: Northern part of Danbury Common, Danbury.

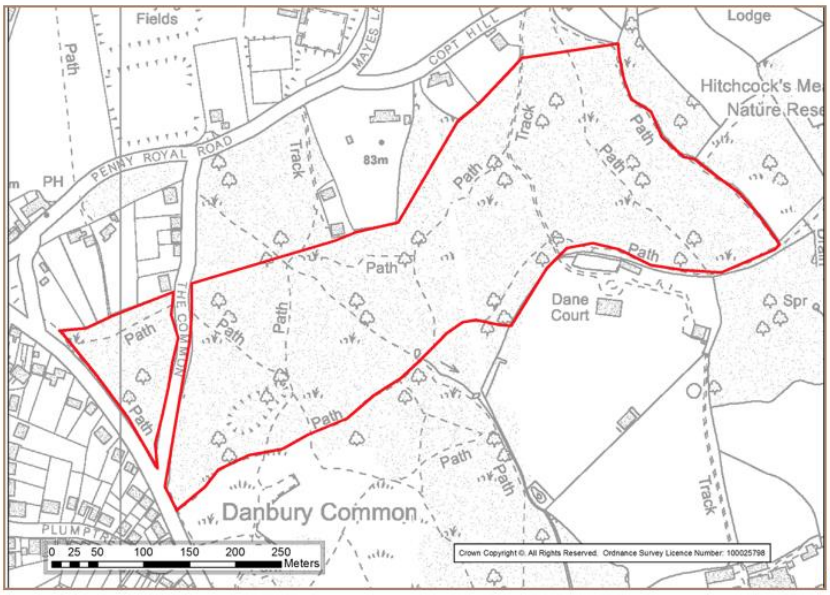
Grid Reference: TL 784 047 (eastern pits) and TL 781 045 (western pits).

Status: Accessible at all reasonable times

Summary of the geological interest:

In woodland in the northern part of Danbury Common are extensive disused gravel pits which formerly worked the Danbury Gravel, a thick layer of orange-brown sandy gravel that caps Danbury Hill. Several of the pits have very steep, almost vertical faces, providing a number of small exposures. The Danbury Gravel clearly dates from the Ice Age but its precise origin is still not clear, despite various investigations over the last 150 years. There are separate areas of gravel pits on the east and west sides of the common, each situated on separate tongues of gravel separated by a shallow valley which is underlain by London Clay bedrock.

During the Anglian Glaciation, 450,000 years ago, the ice was banked up against the north side of Danbury Hill, which formed a barrier to the southern advance of the ice sheet. It is thought that colossal torrents of meltwater were released which deposited a great thickness of glacial sand and gravel – the Danbury Gravel - on the high ground. However, this explanation may be too simplistic as the deposits are not always typical of ice-marginal features, and they occur at a very high elevation (sometimes over 100 metres). Some of the gravel bodies on Danbury Hill are also intensely deformed by ice pressure.



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Scientific interest and site importance

Danbury Hill rises quite sharply above the surrounding plateau to a height of over 100 metres. The hill consists of London Clay almost entirely covered by Danbury Gravel. The origin of the Danbury Gravel is still controversial. What is clear, however, is that the Danbury-Tiptree Ridge, of which Danbury Hill was part, was a barrier to the progress of the Anglian Ice Sheet, although there is evidence that an early oscillation was able to by-pass the ridge to the south.

There have been several theories concerning the origin of the various gravel outcrops on Danbury Hill but from their character and composition there is no doubt that the gravel in the Danbury Common pits is glaciofluvial, in other words it is outwash gravel deposited by torrents of meltwater from the ice sheet.

The Danbury Gravels have been exploited in numerous other pits on the summit and slopes of the ridge but most of these have been infilled and the land developed. The pits on Danbury Common have survived without restoration and are therefore scientifically and historically important. There are two or three exposures where the gravel can be examined and there is the opportunity for creating better exposures with the permission of the landowner, the National Trust.

The thickness of the gravel varies considerably across the hill but a BGS borehole at Gay Bowers Farm, sunk in 1969, penetrated almost 10 metres of gravel before reaching London Clay. The borehole was at Danecourt (TL 7864 0456), only 250 metres south-east of the eastern pits on Danbury Common.

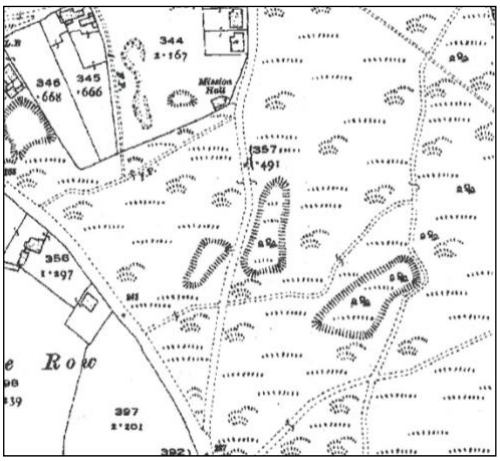
Other information

Danbury Common is an SSSI that has been notified for its biological importance. Most of the pits are deep with steep faces and many are very overgrown and impenetrable. The eastern pits are a popular venue for mountain bike users who have created trails through and over the edge of the pits. In June 1906, when the pits were in operation, they were visited by a party from the Geologists' Association and the Essex Field Club (Cole 1907).

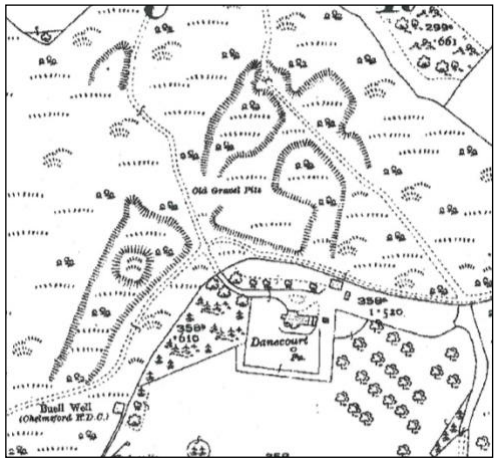
References

ALLEN, P. 1999. **The Anglian cold stage in Essex – a review**. *Essex Naturalist*. Vol. 16 (New series). p. 83-100.

COLE, W. 1907. **Meeting in the Danbury and Little Baddow Districts in conjunction with the Geologists' Association**. *Essex Naturalist*. Volume 14: Pages 260-264.



The western pits



The eastern pits

Extracts from 1914-1924 Ordnance Survey Map showing the Danbury Common gravel pits

Beehive Lane Sarsen Stone

Site location: Sarsen stone in the car park of the Beehive Public House in Beehive Lane, Great Baddow.

Grid Reference: TL 71948 05544

Status: On private land but accessible at all times

Summary of the geological interest:

A sarsen stone 90cm x 70cm x 60cm (3' x 2'4" x 2') in size sits in the car park of the Beehive Public House in Beehive Lane. It was obtained from the old 'Beehive' gravel quarry nearby before 1906.

Sarsens are boulders of extremely hard sandstone that were formed about 55 million years ago during the Palaeocene period in sandy strata called the Reading Beds that occur on top of the Chalk. The stones in the Chelmsford area were carried here from north and west of Essex by the Thames when it flowed through central Essex about 500,000 years ago.

Sarsens are not uncommon in Essex, but this is a reasonable large example in a conspicuous position, and tells a story about the history and geology of the area.

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Scientific interest and site importance

Sarsens are an extremely hard sandstone formed around 55 million years ago when the climate of Britain was hot and a layer of sand beneath the surface of the ground became cemented with quartz. The formation of silcretes (which includes sarsens) has been the subject of recent scientific debate. Research has compared the conditions under which sarsens were formed with the present day climate in the Kalahari Desert and parts of Australia. The stones are tough and very resistant to erosion and have survived the rigours of the Ice Age. They probably originated on the chalk downland to the north-west of Essex and must have been brought here by the early Thames which flowed through this area about 500,000 years ago.

This sarsen stone came from the former Beehive Gravel Pit nearby. This must have been before 1906 as it is recorded by Salter (1906). Bristow (1985) provides a short account of the pit which was working the Kesgrave (Thames) Sands and Gravels. Several sarsen stones were apparently found in the pit, together with Hertfordshire puddingstone and other glacial erratics, including small boulders of far-travelled volcanic rocks.

This stone is water-worn and typical of sarsens elsewhere in Essex.

The distribution of sarsen stones across Essex is of scientific interest. Sarsen stones are also of historic interest. They link geology, archaeology and social history.

References

BRISTOW, C.R. 1985. **Geology of the country around Chelmsford**. Geological Survey Memoir. British Geological Survey. HMSO. Page 42.

SALTER, A.E. 1906 **Meeting in the Danbury and Little Baddow districts in conjunction with the Geologists' Association**. *Essex Naturalist*. Vol. 14. Page 262.

Parsons Spring Pits

Site location: Disused sand and gravel pits in Parsons Spring, near Highwood.

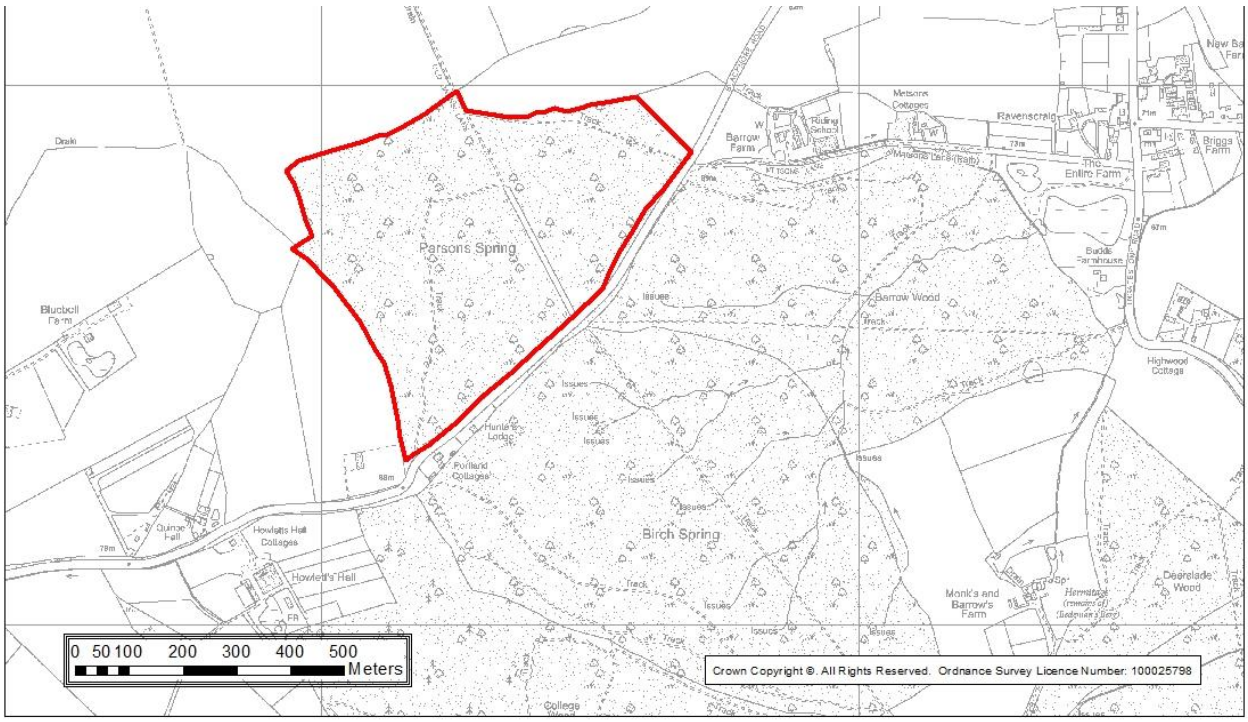
Grid Reference: TL 623 028

Status: Privately owned

Summary of the geological interest:

Parsons Spring (also known as Parsons Wood) has numerous shallow but steep-sided pits where sand and gravel was once exploited, probably for hoggin for use on the paths of Writtle Park estate. This sand and gravel is referred to on geological maps as 'Stanmore Gravel' (formerly called 'pebble gravel') and it occurs elsewhere on the high ground of the adjoining Brentwood district. How it was formed has been debated by geologists since the 19th century. Its origin is still unclear today although one theory is that it was laid down by a river, probably over one million years ago, during the early part of the Ice Age. Other geologists have suggested that it could be a marine deposit.

The pits are clearly visible as overgrown hollows either side of the public footpath that runs through the wood. Some sand and gravel can be seen in the sides of the pits and especially in the roots of fallen trees where the well-rounded pebbles are conspicuous.



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Scientific interest and site importance

The outcrop of sand and gravel at Parsons Spring is about 300 metres in diameter and lies on top of bedrock of Claygate Beds. A 3.3 metre section through these deposits was revealed in a trial pit dug by the British Geological Survey and described in the 1987 geological survey memoir (Millward et al. 1987). The deposits are described in the memoir as 'older Head' and their origin is discussed. More recent geological mapping by the BGS has reclassified these deposits as Stanmore Gravel. The origin of Stanmore Gravel is discussed by Ellison (2004) who resurrects an old established theory that it may be an early Ice Age marine deposit.

Similar deposits (formerly called 'pebble gravel') occur on high ground elsewhere in this part of Essex (generally above 90 metres OD) but the outcrop at Parsons Spring is one of the best described. It is also one of the thickest, up to 7.2 metres having been recorded here.

The deposits are very variable both vertically and horizontally, and in places very colourful. It is mostly silty sand and sandy clay - sometimes mottled grey and bright orange - with layers of flint pebbles. There are also minor amounts of other rock types. The flint pebbles are mostly well-rounded - originally formed on an ancient beach - and probably derived from marine deposits in south Essex and Kent.

The great variation of the deposits is clear from the BGS trial pit which was dug at TL 6229 0280. It generally revealed silt, sand and clay, often mottled and with great colour variation. There are pockets and layers of gravel, both of angular and well-rounded, mainly white, patinated flints. Lateral variation may be due to cryoturbation (freezing and thawing), which has also resulted in flints with their long axes vertical. No study has yet been made of the different rock types in the deposit in Parsons Spring but in College Wood to the south, the gravel was found to contain vein quartz, quartzite and rare Lower Greensand pebbles. The gravel outcrops in Parsons Spring and College Wood are similar and are characterized by rather different pebble assemblages compared to occurrences elsewhere in the area (Millward et al 1987). Future research here may therefore be important in helping to establish an origin for this enigmatic deposit.

Other information

There are a large number of overgrown pits of varying sizes in Parsons Spring. The wood is private property but the pits are clearly visible as hollows either side of Old Barns Lane, a public footpath running through the wood north from Blackmore Road. The geology of this area is interesting with Anglian boulder clay, or till, outcropping to the north and west of the wood and Claygate Beds and Bagshot Sand outcropping in the woods to the south.

References

ELLISON, R.A. 2004. **Geology of London**. Special Memoir for 1:50,000 Geological sheets 256 (North London), 257 (Romford), 270 (South London) & 271 (Dartford). British Geological Survey. Page 52.

MILLWARD, D, ELLISON, R.A., LAKE R.D. AND MOORLOCK, B.S.P. 1987. **Geology of the country around Epping**. Memoir of the British Geological Survey, sheet 240 (England and Wales). British Geological Survey. HMSO. Pages 25, 26 and 28.

Channels Puddingstone

Site location: Boulder of Hertfordshire puddingstone by the entrance to Channels Golf Club in Belsteads Farm Lane, Little Waltham.

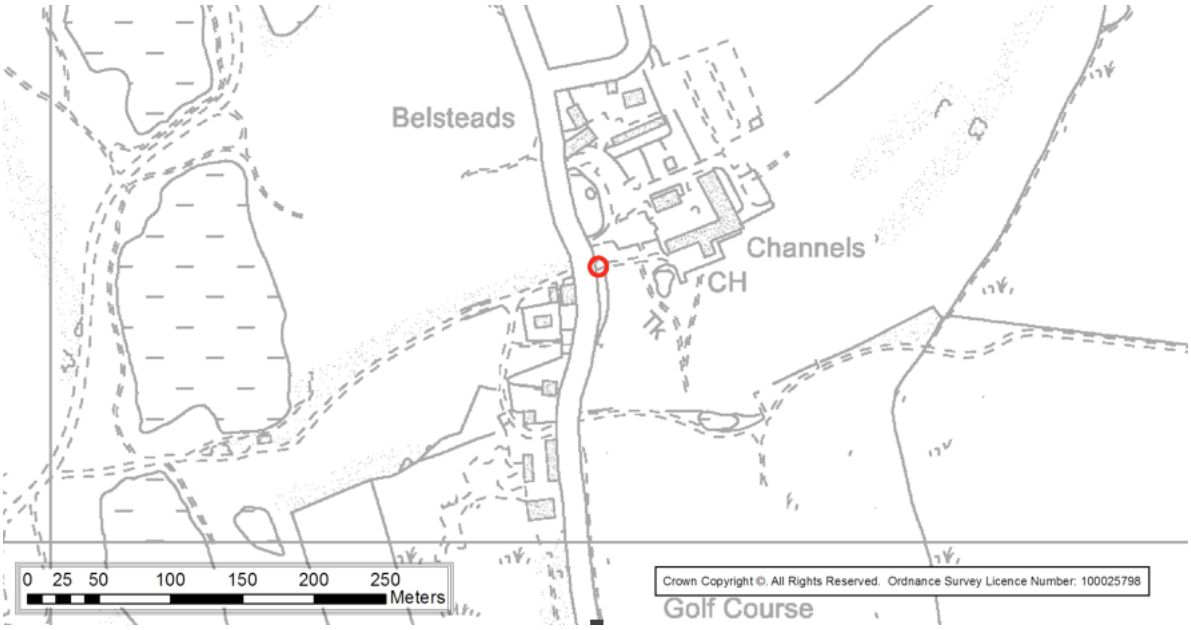
Grid Reference: TL 72382 11185

Status: On private land but accessible at all times

Summary of the geological interest:

By the entrance to Channels Golf Club is a large boulder of Hertfordshire puddingstone on a mound of grass by the roadside. It is one of the largest puddingstone boulders in Essex, measuring 2.1 metres long by 1.2 metres high by 0.4 metres in thickness. It is cared for by the landowner and surrounded by attractive bedding plants in the Summer. This boulder was found in one of the local gravel pits, all of which have now been restored.

Hertfordshire puddingstone is an extremely hard rock that was formed about 55 million years ago during the Palaeocene period in sandy strata called the Reading Beds that occur on top of the Chalk. The stones in the Chelmsford area are thought to have been carried here from Hertfordshire by the Thames when it flowed through central Essex about 500,000 years ago and was then a very large river. However, the condition and distribution of puddingstone in Essex indicate that there may once have been a more local source.



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Scientific interest and site importance

Hertfordshire Puddingstone was formed around 55 million years ago when the climate of Britain was hot and a layer of pebbles beneath the surface of the ground became cemented with quartz. They are thus very resistant to erosion and have survived the rigours of the Ice Age. They originated in Hertfordshire, hence the name, and were probably carried to Essex by the River Thames when it flowed north of its present course. However, the distribution and abundance of Hertfordshire puddingstone in parts of Essex suggests that some occurrences may once have had a local Essex source.

Boulders of Hertfordshire puddingstone are not uncommon in Essex, but this is a large example in a conspicuous position, and tells a story about the history and geology of the area.

Other information

Close by is another puddingstone boulder (90cm x 70cm x 30cm), placed in an upright position and provided with a plaque commemorating the restoration of a nearby gravel pit. By the golf club car park is a large sarsen stone (180cm x 100cm x 60cm). Other sarsen stones can be seen by the side of the road nearby. Sarsen stones have a similar origin to puddingstone.

Note: The large boulder of metamorphic rock nearby is not thought to be of local origin.

Sandon Pit

Site location: On the eastern side of the A12, south-east of Sandon village.

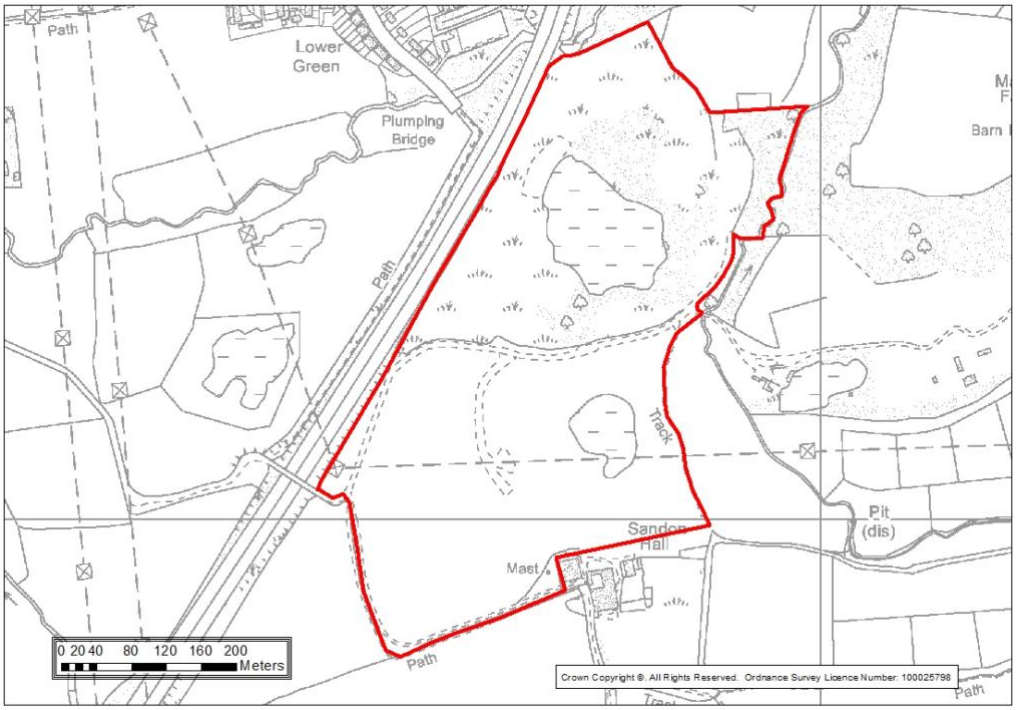
Grid Reference: TL 747 043

Status: On private land.

Summary of the geological interest:

The disused Sandon gravel pit has reasonably good exposures in Kesgrave Sands and Gravels. Much of the pit has not been restored and therefore the quarry slopes and edges are largely as they were when quarrying ceased. This makes the site important for geology as there are several small exposures of gravel, for example on the southern lake edge.

The Kesgrave Sands and Gravels were laid down during the early Ice Age by the River Thames when it flowed through mid Essex and Suffolk and out across what is now the southern North Sea to become a tributary of the Rhine. The gravel is mostly flint but also contains 'exotic' pebbles of rocks from far upstream, some of which are ignimbrite (a volcanic rock) from North Wales.



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Scientific interest and site importance

The exposures of sand and gravel at Sandon Pit are typical of the Kesgrave Sands and Gravels. However, disused gravel pits such as this are rare nowadays; most having been restored with no geological exposures remaining. There may also be the opportunity, with the permission of the landowner, to create a significant permanent exposure of Thames gravel which would be of educational and scientific interest.

Sandon Pit is also a Local Wildlife Site.

Bristow (1985) states that up to 10 metres of cross-bedded sand and gravel was formerly exposed at Sandon Pit.

References

BRISTOW, C.R. 1985. **Geology of the country around Chelmsford**. Geological Survey Memoir. British Geological Survey. HMSO. Page 57.

Sandon Pit. *Photo: G.Lucy*

South Woodham Ferrers Foreshore

Site location: Foreshore at South Woodham Ferrers, on the north bank of the river Crouch.

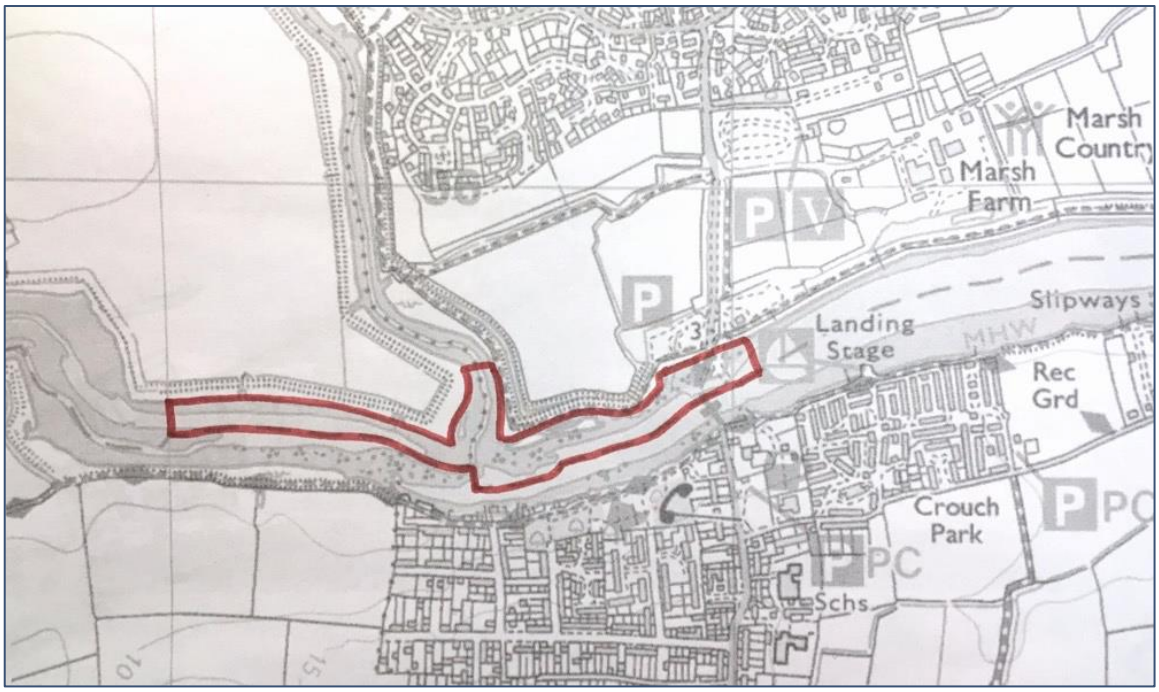
Grid reference: TQ 804 955

Status: Accessible at low tide

Summary of the geological interest:

River erosion at several places around the Essex coast has exposed evidence of human occupation dating from the Mesolithic Period. These settlements are now below high tide level and the most important of these is at Hullbridge/South Woodham Ferrers where a prehistoric land surface, possibly as much as 7,000 years old, is exposed on the foreshore of the River Crouch. The site then lay well inland and the abundance of flint flakes and blades suggests that this was a 'base camp' to exploit the wildlife of the then-existing North Sea lowlands.

The foreshore here is therefore an important site with many fine sections of recent alluvial deposits, resting on London Clay, beautifully exposed and constantly being eroded. The sites can only be examined at low tide and extreme care should be taken to avoid getting stuck in the intertidal mud.



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Scientific interest and site importance

About 10,000 years ago, at the end of the last glacial stage (the Devensian), large areas of the North Sea basin were dry land and human hunter-gatherers migrated to Britain as the climate improved. The ice sheets were rapidly melting around the world and raising sea level by as much as 2 metres (6 feet) per century, finally breaching the Straits of Dover and isolating Britain from the rest of the continent. The period from the end of the last glacial stage to about 5,000 years ago is called the Mesolithic or Middle Stone Age and during this time hunter-gatherers spread into Essex and occupied sites that are now well below present sea level.

River erosion at several places around the coast has exposed evidence of these settlements below high tide level and the most important of these is on the foreshore of the River Crouch at where a prehistoric land surface, possibly as much as 7,000 years old, is exposed. The site is on the north bank of the river near South Woodham Ferrers (Chelmsford District) and on the south bank near Hullbridge (Rochford District). The site then lay well inland, adjacent to a freshwater river, and the abundance of flint flakes and blades suggests that this was a 'base camp' to exploit the wildlife of the then-existing North Sea lowlands.

The main location for the flint working site on the north bank extends from the mouth of Fenn Creek eastwards for about 400 metres. Banks of gravel can sometimes be seen in the bed of the river either side of Fenn Creek, especially on the west side.

History of research

Mr. William Henry Rand apparently first explored this site in the early 1900s. Later collectors included F.N. Haward, A. Wright, and the famous Essex prehistorian S.H. Warren who, with F.W. Reader, published papers on the site in the Essex Naturalist in 1911.

In the late 1970s Stephen Vincent and Bill George collected from the site and published a short account of it in their pamphlet entitled *Some Mesolithic Sites along the Rivers Blackwater and Crouch, Essex* which appeared in 1980. This aroused considerable interest in the site which culminated in the publication, by the Essex County Council in 1995, of Messrs. Wilkinson and Murphy's *Archaeology of the Essex Coast, Volume 1: The Hullbridge Survey*. This fascinating work, which dated many of the deposits and examined the environmental evidence from the Holocene deposits, greatly influenced the appearance of *England's Coastal Heritage: A survey for English Heritage and the RCHME* in 1997.

References

GEORGE, W.H. and VINCENT, S. 1980. Some Mesolithic Sites along the Rivers Blackwater and Crouch, Essex. Privately published.

WILKINSON, T.J. and MURPHY, P.L 1995. The Archaeology of the Essex Coast, Volume 1: The Hullbridge Survey. *East Anglian Archaeology Report No.71*. Essex County Council. Pages 90-100.

A photograph of the bed of the River Crouch at Hullbridge taken before the First World War (from Warren's 1911 paper in the 'Essex Naturalist').
Photo © Essex Field Club

Stock Road Gravel Pits

Site location: Stock Road Gravel Pits (disused), Stock Road, near Stock, Essex

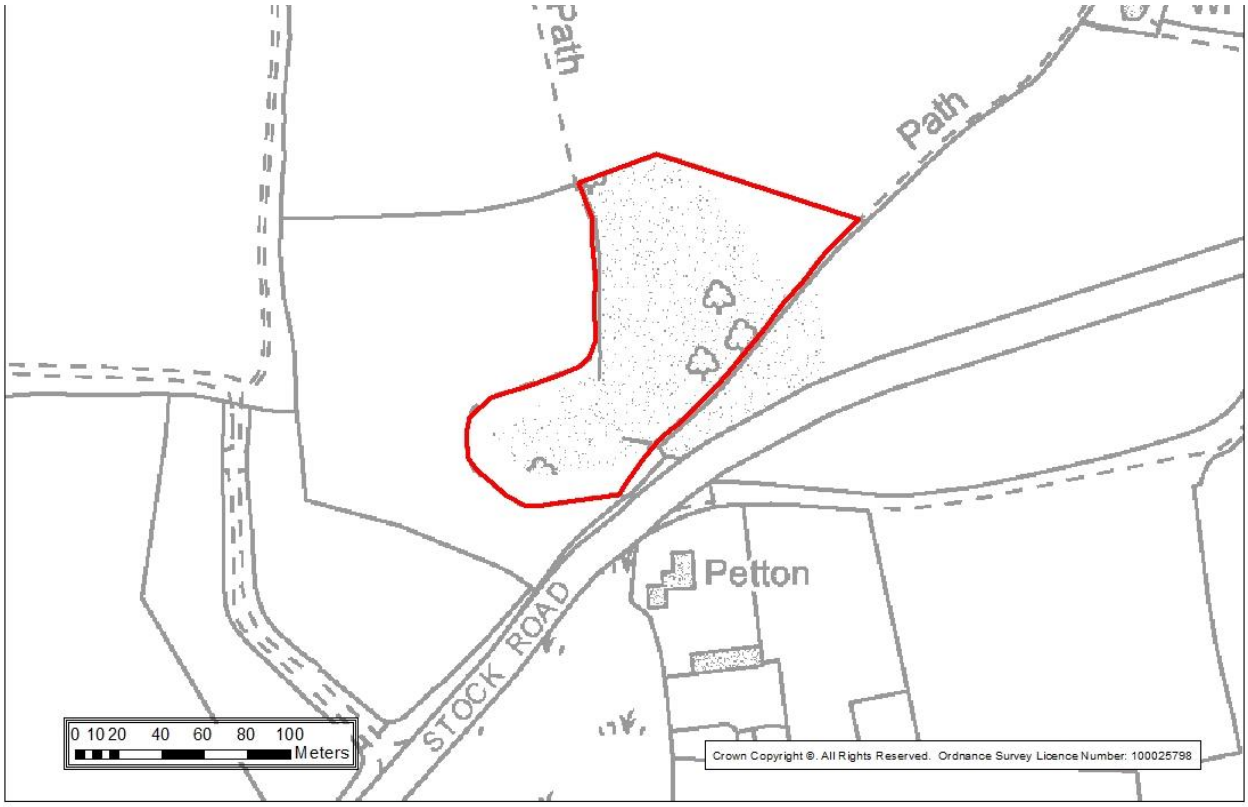
Grid Reference: TQ 6965 9962

Status: Privately owned.

Summary of the geological interest:

Hidden in woodland just west of the Stock Road, north of the village of Stock, are disused gravel pits. These pits are one of the very few places where the 'Bagshot Pebble Bed' was formerly exposed. The pits are now overgrown but with the permission of the landowner it would be relatively easy to re-expose the gravel for study.

The Bagshot Pebble Bed is a layer of well-rounded flint pebbles that occurs on top of the Bagshot Sand. It has been interpreted by some geologists as being formed on the floor of a shallow, subtropical sea some 50 million years ago immediately after deposition of the Bagshot Sand; perhaps representing a beach as the coastline migrated across Essex. Others consider it to be younger, perhaps a marine deposit laid down at the very beginning of the Ice Age.



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Scientific interest and site importance

In the 1980s Bristow (1985) mapped the exposures at Stock as Bagshot Pebble Bed of Eocene age, but Ellison (2004) has reinterpreted them as Stanmore Gravel (formerly called 'pebble gravel') which is seen elsewhere in the district and probably early Pleistocene in age. The origin of Stanmore Gravel is itself controversial and Ellison considers that it may be marine. The pits at stock are therefore important to resolve this issue. The Stock exposures originally showed evidence of stratification (Dines & Edmunds 1925).

The site is of historical interest and has potential for research.

The British Geological Survey holds several archive photographs of these pits taken in 1923.

Other information

The pits are on private land and prior permission is required for access.

References

Bristow, C.R. 1985. **Geology of the country around Chelmsford**. Geological Survey Memoir. British Geological Survey. HMSO. Pages 26-27.

Dines, H.G. and Edmunds, F.H. 1925. **The Geology of the Country around Romford**. *Memoirs of the Geol. Survey*. Explanation of sheet 257. Pages 25.

Greensmith, J.T., Blezard, R.G., Bristow C.R., Markham R., and Tucker E.V. 1973. **Geologists' Association Guide No. 12. The Estuarine Region of Suffolk and Essex**. Geologists' Association. Pages 32-33.

Ellison, R.A. 2004. **Geology of London.** Special Memoir for 1:50,000 Geological sheets 256 (North London), 257 (Romford), 270 (South London) & 271 (Dartford). British Geological Survey. Page 52.

Disturbed Bagshot Pebble Bed revealed in the gravel pit near Stock. The photograph was taken in 1923.
Photo: British Geological Survey (P202467)